AMERICAN ASSOCIATION OF
COLLEGES OF
PODIATRIC MEDICINE

Curricular Guide for Podiatric Medical Education

AACPM Council of Faculties
2023 Edition

Approved by the AACPM Board of Directors
February 8, 2023

"The Curricular Guide for Podiatric Medical Education is designed to be a guidance document approved by the Board of Directors of the American Association of Colleges of Podiatric Medicine (AACPM) and represents a collaborative effort by AACPM's member colleges. The contents of this document are a set of recommendations on what a comprehensive curriculum may look like. AACPM is not responsible for how the contents of this guide may be implemented or used.

The Guide is not prescriptive and is not necessarily representative of what is taught at any given institution, nor should it be taken as a set of requirements or standards, the contents of this document represent general guidance and recommendations. A school should consider its own unique facts and circumstances before adopting any of the guidance herein. An educational program not following the guidance contained herein should not be taken as evidence that an educational program is in any way deficient."

AACPM COUNCIL OF FACULTIES
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Background

The 2005 APMA House of Delegates adopted Resolution No. 2-05. This resolution charged APMA to do the following:

> *RESOLVED, That the APMA commit itself to achieving the goal by 2015 of podiatrist being defined as physicians who treat patients in the physician's specialty without restrictions; and*
> *RESOLVED, That the APMA create a master plan to accomplish this goal and report its progress to the House of Delegates starting in 2006 and in subsequent years.*

A Plan to Obtain National Recognition of the Podiatric Physician Working Document reported in May 2009 the following:

Overall Mission

Podiatrists are universally accepted and recognized as physicians consistent with their education, training, and experience

Objectives

1. Evaluate and ensure that podiatric medical education is comparable to that of allopathic and osteopathic physicians.
2. Demonstrate to the entire health care community that the education, training, and experience of a podiatric physician are comparable to that of allopathic and osteopathic physicians.
3. Obtain state and federal government recognition that podiatrists are physicians.
4. Market and promote podiatrists as physicians.
5. Attract high quality applicants to colleges of podiatric medicine and thereby to the profession.

AACPM Council of Faculties Curriculum Review and Educational Objective Development Project

On March 4, 2009, the AACPM Council of Deans (COD) received the report of the March 2 meeting of the AACPM Council of Faculties (COF) which proposed a plan and timeline for completion of a comprehensive review of core competency criteria that might provide guidelines for the scope of concepts essential to present and future preparation of practitioners of Podiatric Medicine. The COF recommended that the currently examined areas of Part I and Part II of the National Board of Podiatric Medical Education serve as the organizing framework for the creation of a comprehensive set of educational objectives. The Deans approved the COF recommendations and the Board of Directors voted unanimously to fully fund the project. This living document contains a comprehensive set of weighted learning objectives in each of the content areas below.

Core Competency Review

Preclinical Science Areas	***Clinical Areas***
General Anatomy	General Medicine
Lower Extremity Anatomy	Radiology
Biochemistry	Orthopedics/Biomechanics/Sports Medicine
Physiology	Surgery/Anesthesia
Microbiology/Immunology	Community Health/Jurisprudence/Research
Pathology	Geriatrics
Pharmacology	Professionalism and Cultural Competencies
Neuro science	Behavioral Medicine
Embryology	
Genetics	
Histology	

All content areas were completely updated 2023

Even as version 1.0 of the Curriculum Guide was being finalized, content areas that were not part of the original list were identified, with plans for starting work on them for inclusion in version 2.0. These additional content areas include Neuroanatomy (now Neuroscience), Histology, Embryology, Genetics and Geriatrics. Consideration was also given to separating the individual components in the area of Community Health, Jurisprudence and Research when that area is updated.

The learning objectives listed in this document were derived by content area experts from each of the schools and colleges of podiatric medicine; with emphasis placed on the importance of the learning objectives as being absolutely essential for each graduating podiatric medical student to master prior to entering their podiatric medical residency.

These objectives were developed using Bloom's *Taxonomy of Objectives for the Cognitive Domain* (1956), to categorize cognitive tasks, usually in increasingly sophisticated order.

Bloom's Taxonomy

Bloom's Taxonomy breaks education into 6 different areas: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. These levels are increasingly complex—that is, Knowledge is the most basic of areas and Evaluation is the most complex.

A comprehensive mix of learning objectives takes specificity and focus into account, as well as education areas and complexity. The mix also depends on the actual content; an introductory text will tend to be more heavily weighted on the Knowledge, Comprehension, and Application learning objectives, whereas a text on advanced thermodynamics will tend to be focused on Analysis, Synthesis, and Evaluation.

To provide more detail on Bloom's areas and the verbs often associated with each level, you can refer to the table in Appendix I.

COMPETENCIES

(July 2016)

DOMAIN I: MEDICAL KNOWLEDGE

Competency Statement: Apply current and emerging knowledge of human structure, function, development, pathology, pathophysiology, and psychosocial development, and of pharmacology and microbiology to the foundation of podiatric clinical training, residency and practice.

1. Describe normal development, structure and function of the body with emphasis on the lower extremities.
2. Explain the genetic, molecular, biochemical and cellular mechanisms important to maintaining the body's homeostasis.
3. Relate the altered development, structure and function of the body and its major organ systems to diseases and pathological conditions.
4. Apply knowledge from pre-clinical and clinical sciences in simulated and clinical settings to patient care.
5. Use current and emerging knowledge of health and disease to identify and solve problems in patient care.

DOMAIN II: PATIENT CARE

Competency Statement: Provide effective, appropriate and compassionate patient-centered care that promotes overall health to diverse populations.

1. Apply medical knowledge to distinguish between wellness and disease.
2. Perform and interpret appropriate, accurate, and problem-focused history and physical examinations.
3. Perform lower extremity exams required for the diagnosis and management of disorders and conditions.
4. Formulate a prioritized differential diagnosis based on examination and clinical assessments.
5. Perform and/or Interpret appropriate diagnostic studies, and tests required for management and treatment.
6. Participate actively in the performance of treatment techniques using medical and surgical means.
7. Recommend appropriate referrals of patients ensuring continuity of care through transitions between providers or settings, and determining patient progress.
8. Recognize evidence of mental or physical impairment of oneself or other in order to protect patients from harm.
9. Develop and implement patient specific management plans and prevention strategies.
10. Demonstrate awareness of issues related to culture, religion, age, gender, sexual orientation, and mental and physical disabilities.
11. Engage patients and their families in shared decision-making through counseling and education.
12. Use information technology to access online medical information, manage information and assimilate evidence from scientific studies to patient care.

DOMAIN III: RESEARCH AND SCHOLARSHIP

Competency Statement: Apply concepts of research to further one's understanding of contemporary podiatric medicine and its application to appropriate care for patients.

1. Identify responsible practices and ethical behaviors used in research.
2. Demonstrate the acquisition and interpretation of medical and scientific literature.
3. Apply knowledge of the principles of research methodology and its relevance for clinical decision making.
4. Investigate opportunities that enhance life-long learning and contribute to the body of knowledge in podiatric research and scholarship.

DOMAIN IV: INTERPERSONAL AND INTERPROFESSIONAL COMMUNICATIONS

Competency Statement: Demonstrate communication and interpersonal skills that result in relevant information exchanges and decision-making with patients, their families, and members of the healthcare team.

1. Effectively communicate by utilizing oral, digital and written communication formats.
2. Communicate effectively (including non-verbal cues) with patients, families, and other healthcare professionals, especially when special barriers to communication exist.
3. Interact appropriately with peers, faculty, staff, and healthcare professionals in academic, research and healthcare settings.
4. Exhibit behavior that demonstrates the capacity to establish a doctor/patient relationship.

DOMAIN V: PROFESSIONALISM

Competency Statement: Exhibit the highest standards of competence, ethics, integrity, and accountability to patients. Place the patient's interest above oneself.

1. Apply theories and principles that govern ethical decision-making to the practice of medicine and research.
2. Recognize potential conflicts of interest inherent in various financial and organizational arrangements for the practice of medicine, in medical education and research.
3. Practice the standards that ensure patient privacy and confidentiality.
4. Demonstrate dependability, commitment and reliability in interactions with patients and their families and other health professionals.
5. Recognize and address in a constructive manner, unprofessional behaviors in oneself and others with whom one interacts.
6. Demonstrate personal behaviors that promote patient safety.
7. Identify personal deficiencies in knowledge and skills, and address them by implementing methods for improvement.
8. Employ strategies for seeking and incorporating feedback from patients, peers, and other health professionals to improve personal and patient outcomes.

DOMAIN VI: INTERPROFESSIONAL COLLABORATIVE PRACTICE

Competency Statement: Demonstrate the ability to work as an effective member of a healthcare team.

1. Demonstrate an understanding of and respect for other health care professionals and to work collaboratively with them in caring for patients.
2. Perform effectively in diverse health care delivery settings and divers health care systems.
3. Describe the structure and function of health care delivery and payer systems used in the United States.
4. Identify resources for patients in situations in which social and economic barriers limit access to health care.

Domain V

II: Social Awareness/Pain and Addiction

Competency Statement: Demonstrate an understanding of common societal problems including issues of addiction or abuse and their impact on patients and their families.

1. Use a socio-psycho-biological model to develop individualized prevention strategies for persons with pain and/or opioid use disorder.
2. Employ an integrated, team-based approach to the patient.
3. Engage family and social support in the care to the patient.

PROFESSIONALISM AND CULTURAL COMPETENCE

LEARNING OBJECTIVES

Cultural Competence

Structural Competence

Ethics Competence

Professionalism

I. Cultural Competence

1. Define race, ethnicity, culture and their implications in healthcare.
2. Define and understand the difference between cultural awareness, cultural competency and cultural humility[1].
3. Recognize and acknowledge patient and family healing traditions and beliefs, including ethno-medical beliefs.
4. Define and describe how social determinants impact health and health care.
5. Describe the inherent power imbalance between physician and patient and how it affects the clinical encounter.
6. Explain and summarize the various dimensions of patient identities (race, ethnicity, sexual orientation, age, gender expression, disabilities, economic factors, etc.) as they relate to healthcare disparities and quality of health care.
7. Describe methods to identify and understand the historical impact of bias on health and health care.
8. Define and describe how institutional, and social determinants of health factors impact health care disparities.
9. Describe methods to identify, understand and discuss the dangers of forming stereotypes and bias, and how they affect communication, judgment, relationships, and patient care.
10. Discuss and demonstrate the ability to elicit patient cultural and religious preferences and respond appropriately to patient feedback.
11. Describe methods to identify key community health advocates in order to address community needs.
12. Demonstrate compassionate care to all patients regardless of the patient's disease, prognosis, age, sex, race, sexual orientation, ethnicity, religion, spiritual beliefs, cultural health-related beliefs, socioeconomic class, and/or citizenship status.

II. Structural Competence

Definition: Structural Competency emphasizes diagnostic recognition of the economic and social conditions that produce and racialize inequalities in health, and healthcare.

1. Define the concept of structural competency in healthcare.
2. Recognize and understand how structures shape clinical interactions.
3. Recognize structured ways race, gender identity/expression, and socio economic status impact health and healthcare.
4. Recognize and describe how structural racism disproportionately affects and harms levels of healthcare, healthcare access, and services for communities of color.
5. Describe and identify how structures, practices, and policies within healthcare can be in direct conflict with our ability to achieve health equity.
6. Recognize and explain models of patient advocacy, practice and manage patient care in variety of communities (local and global).

[1] Willingness to learn and recognize the non-dominant cultures of the healthcare community,

III. Ethics Competence

1. Discuss the historical background and basic principles of ethics including cultural and religious differences between healthcare practitioners and patients, beginning of life issues and end of life issues.
2. Identify and demonstrate knowledge of the principles of bioethics.
3. Discuss the role that ethical decision making plays in society, and appropriate healthcare practitioner-patient relationships.
4. Demonstrate the ability to identify conflicts of interest including customary and accepted ethical standards of professional practice.
5. Describe and understand ethical clinical practice, including but not limited to informed consent, confidentiality, respect for human dignity and autonomy, and how these influence the ethical standards in clinical practice.
6. Demonstrate patient centered care, governed by ethical principles, integrity, honesty, empathy and compassion.
7. Demonstrate respect, honesty and integrity in the collection, synthesis, analysis, and presentation of scientific and clinical data.

IV. Professionalism

1. Define professionalism as it relates to the medical profession.
2. Demonstrate knowledge of and model the ethical, physical, emotional and legal boundaries of the doctor-patietn relationship.
3. Recognize the importance of life-long learning and commit to maintaining competence throughout their medicial career for the advancement of patient care.
4. Demonstrate professional responsibility, including being punctual, present and engaged in the classroom, patient encounters, meetings and other professional activities.
5. Recognize and demonstrate the willingness and ability to acknowledge personal limitation and to seek help with the expertise, knowledge, or level of experience is insufficient to ha ndle a situation in the diadiactic, clinical or research setting.
6. Demonstrate the willingness and ability to seek and accept feedback and constructive criticism from peers, faculty members, residents, clinicians and staff in order to continually improve their educational experience, knowledge and clinical skills.
7. Communicate respectful feedback when evaluating faculty members, residents and clinicians.
8. Demonstrate honesty and integrity in all interactions, including:
    a. Accurately attribute sources in all written and oral-presentations
    b. Accurately represent clinical actions and findings
    c. Admit mistakes and errors
9. Demonstrate the ability to refrain from discussing patient care and/or unprofessional depiction of themselves and others on social media and networking sites.
10. Demonstrate and model professional demanor in their interactions with teachers, fellow students, patients and all members of the health-care team at all times. These qualities should be evident in:
    a. Appearance
    b. Appropriate behavior and attitudes toward others and the profession
11. Exibit respect, honesty and integrity in the collection, synthesis, analysis, and presentation of scientific and clinical data.
12. Demonstrate the ability to work collaborately with other health care providers and to function in a professional manner in interdisciplinary settings.

13. Demonstrate respect for knowledge, skills and expertise of all team members.
14. Develop personal habits that promote holistic well-being.
15. Recognize signs of impairment in yourself and others and take appropriate action.
16. Demonstrate the ability to appropriately place the patient's interest above your own.
17. Communicate professional medical information in a clear and humanistic manner with patients, family members, other professionals, and the public.

BIOCHEMISTRY

LEARNING OBJECTIVES

Biological Acids, Bases and Buffers

Amino Acids and Protein Structure

Enzymes

Molecular Biology

Lipids and Biological Membranes

Hormones, Second Messengers, SignalTransduction

Bioenergetics and Energy Metabolism

Carbohydrate Metabolism

Lipid Metabolism

Protein and Amino Acid Metabolism

Nucleotide Metabolism

Heme Metabolism

Hemostasis and Blood Coagulation

Diabetes Mellitus

Free Radicals and Antioxidants

Metabolism of Ethanol

Nutrition

Integration of Metabolism

I. Biological Acids, Bases and Buffers

1. Define the terms *pH*, acidosis and alkalosis.
2. Differentiate between strong acid, weak acid, strong base, weak base, and buffer.
3. Describe how the Henderson-Hassellbach equation relates pH and pKa.
4. List the buffer systems that predominate in intracellular and extracellular fluid, distinguishing between blood and interstitial fluid.
5. Define *acidosis* and *alkalosis*.
6. Explain the physiological significance of carbonic anhydrase.

II. Amino Acids and Protein Structure

A. Amino Acids and General Concepts of Protein Structure

1. Identify the basic structure of alpha amino acids and the peptide bond.
2. Describe the biochemical functions of polar, nonpolar, acidic, basic, aromatic, or sulfur-containing amino acids.
3. Define isoelectric point as it pertains to amino acids and proteins.
4. Define primary, secondary, tertiary and quaternary structures of protein.
5. Explain protein domains.
6. Describe stabilizing factors of protein structures.
7. Describe protein denaturation and conditions that can contribute to this process.

B. Relationship of Protein Structure and Function

1. Describe the relationship between protein conformational dynamics and function.
2. Describe structural and functional differences between hemoglobin and myoglobin.
3. Explain the role of heme in both hemoglobin and myoglobin.
4. Explain the oxygen dissociation curve of hemoglobin and myoglobin.
5. Summarize the effects of H^+, CO, CO_2 and 2,3-bisphosphoglycerate (2,3-BPG) on the affinity of hemoglobin for oxygen.
6. Relate the unique amino acid composition of collagen to its molecular structure and function.
7. Explain the role of ascorbic acid and copper in collagen synthesis.
8. Correlate altered protein structures to sickle cell anemia, thalassemias, osteogenesis imperfecta, Ehlers-Danlos syndrome, and scurvy.

III. Enzymes

1. Explain the reactions catalyzed by oxidoreductases, transferases, hydrolases, lyases, isomerases, and ligases.
2. Explain the physiological significance of carbonic anhydrase.
3. Define *co-factor*, *coenzyme*, *prosthetic group*, *holoenzyme*, and *apoenzyme*.
4. Explain the active site and its significance to enzymatic function.
5. Describe the effect of enzymes on the energy of activation for the forward and reverse reaction, and the equilibrium constant of a reaction.
6. Explain how temperature alters enzyme-catalyzed reactions.
7. Relate the importance of pH to enzyme function.
8. Define V_{max} and $K_{m.}$
9. Describe Michaelis-Menten enzyme kinetics in terms of V_{max} and $K_{m.}$

10. Recognize competitive inhibition and noncompetitive inhibition from the Michaelis-Menten and Lineweaver-Burk double-reciprocal plots.
11. Explain irreversible inhibition.
12. Explain allosteric enzymes.
13. Contrast allosteric kinetics and Michaelis-Menten kinetics.
14. Define *isoenzyme*.
15. Define *zymogen*.
16. Describe and provide specific examples for mechanisms of enzyme regulation, including:
    a. product inhibition, feedback inhibition and forward activation;
    b. phosphorylation/dephosphorylation;
    c. calcium-binding proteins;
    d. proteolytic activation/deactivation;
    e. allosteric regulation;
    f. induction/repression;
    g. substrate availability; and
    h. compartmentalization.

IV. Molecular Biology

A. Structure and Organization of Nucleic Acids

1. Describe the basic structural unit of DNA and RNA molecules.
2. Distinguish between the primary and secondary structure of DNA and RNA.
3. Differentiate between euchromatin and heterochromatin.
4. Explain base pair complementarity.
5. Explain the denaturation and renaturation of the DNA molecule.
6. Explain the nucleosome complex.
7. Contrast the organization of genes in prokaryotic and eukaryotic genomes and chromatin.
8. Define *introns* and *exons*.
9. Describe the structure and function of each type of RNA (mRNA, rRNA, tRNA, and microRNA).

B. DNA Replication

1. Describe semi-conservative DNA replication.
2. Define *origin of replication*, *replication fork*, *primer*, and *template*.
3. Discuss the functions of helicase and topoisomerases I and II.
4. Distinguish between the leading and lagging strands of DNA.
5. Describe Okazaki fragments.
6. Explain telomeres in relationship to DNA replication.

C. Mutations

1. Describe mutations caused by UV light and X-rays.
2. Define *mutagen*.
3. Describe the following DNA damage repair mechanisms and the consequences of DNA repair defects:
    a. base excision repair
    b. mismatch repair
    c. repair of double stranded breaks (DSBs)

D. Transcription and RNA processing

1. Define *transcription*.
2. Differentiate between coding and non-coding (template) strand of a gene.
3. Describe post-transcriptional processing of mRNA, rRNA, and tRNA in eukaryotes.
4. Explain the general role of basal transcription factors in the function of eukaryotic RNA polymerases.

E. Translation and Protein Processing

1. Explain the translation process (initiation, elongation, and termination).
2. Outline structurely how the ribosome, mRNA and tRNA assemble for protein synthesis and explain their roles.
3. Identify properties of genetic codes.
4. Explain the "Wobble Hypothesis."
5. List post-translational modifications of proteins.
6. Describe the role of the signal peptide in protein translocation and secretion.
7. Discuss protein turnover with reference to the role of ubiquitin and the proteasome.

F. Regulation of Gene Expression

1. Define:
    a. chromatin remodeling
    b. acetylation/deacetylation of histone
    c. methylation/demethylation of DNA
    d. epigenetics
    e. gene expression
    f. operon
    g. promoter
    h. operator
    i. inducers
    j. response elements

2. Compare and contrast general vs. gene-specific transcription factors.
3. Explain the regulation of eukaryotic gene expression at multiple levels; transcription, mRNA transcription, mRNA stability, translation initiation, RNA interference.
4. Describe the gene regulatory functions of the steroid**/**thyroid hormone receptor superfamily**.**
5. Explain microRNA (miRNA) and small interfering RNA (siRNA).

G. Biotechnology

1. Explain gel electrophoresis.
2. Describe how restriction enzymes are used in recombinant DNA technology.
3. Explain the method of DNA sequencing by synthesis, including the Sanger method.
4. Describe the following techniques:
    a. Western blotting analysis
    b. Enzyme-linked immunosorbent assay (ELISA)
5. Explain the polymerase chain reaction (PCR).
6. Explain reverse transcription (RT)-PCR.
7. Explain GeneArrays (or Microarrays).
8. Explain the use of RNA sequencing for analysis of gene expression.

H. Cancer

1. Define *proto-oncogenes* and *oncogenes*.
2. List classes of proteins coded for by proto-oncogenes.
3. Summarize the mechanisms through which proto-oncogenes become oncogenes.
4. Define tumor suppressor genes.
5. Outline the process of carcinogenesis (using colorectal cancer as an example).

V. Lipids and Biological Membranes

1. Define:
    a. amphipathic
    b. emulsification
    c. liposome
    d. micelle
    e. membrane fluidity
    f. fatty acid nomenclature
2. Describe the structural features of fatty acids, phospholipids, sphingolipids, triglycerides, and cholesterol.
3. Describe the role of cholesterol, glycoproteins and glycolipids in biological membranes.
4. Describe the organization and function of biological membranes.
5. Distinguish between integral and peripheral membrane proteins and describe the structural properties of each.
6. Compare active transport, secondary active transport, symport, and antiport.
7. Distinguish between facilitated diffusion and simple passive diffusion.

VI. Hormones, Second Messengers, Signal Transduction

1. Define *hormone* and distinguish between endocrine, paracrine, and autocrine signaling.
2. Differentiate between the properties and mode of action of the hydrophilic and hydrophobic hormones.
3. Define *second messenger*.
4. Describe the structure and function of monomeric and trimeric G-proteins.
5. Compare and contrast the cAMP and IP_3/DAG/Ca_{2+} signal transduction systems.
6. Outline the mode of action of growth factors and the role of receptors with endogenous enzyme activity.
7. Distinguish between the modes of action of insulin and glucagon.
8. Describe the role of calcium in signal transduction.
9. Explain the effect of cholera and pertussis toxin on G protein coupled receptors.

VII. Bioenergetics and Energy Metabolism

A. Introduction to Metabolism and Free Energy

1. Contrast the roles of anabolic and catabolic pathways.
2. Explain the functions of NAD^+, $NADP^+$, FAD, and FMN in enzymatic reactions.

3. Explain the central roles of glucose 6-phosphate, acetyl-CoA, and pyruvate in the integration of metabolic pathways.
4. Differentiate between substrate-level phosphorylation and oxidative phosphorylation.
5. Describe the regulation of anabolic and catabolic pathways by insulin, glucagon, epinephrine and cortisol.
6. Describe the concept of free energy change of the reaction.
7. Explain the relationship between the free energy change (ΔG) of the reaction and standard free energy change (ΔG^0) of the reaction.
8. Explain reaction coupling.
9. Describe "high-energy" bonds in terms of thermodynamic principles.
10. Differentiate exergonic and endergonic reactions.
11. Explain oxidation and reduction.

B. Pyruvate Dehydrogenase Complex (PDH)

1. Describe the pyruvate dehydrogenase complex as an alpha-ketoacid dehydrogenase which is a highly organized assembly of 5 cofactors and 3 enzymes.
2. Describe the reaction catalyzed by the pyruvate dehydrogenase enzyme in terms of the origin of the substrate, the products, and its cellular location.
3. Describe the central role of acetyl-SCoA (Acetyl-CoA) as a crossroads in metabolism.
4. Describe the reaction catalyzed by the pyruvate dehydrogenase enzyme in terms of the origin of the substrate, the products, and its cellular location.

C. Citric Acid Cycle (CAC) / Tricarboxylic Acid (TCA) Cycle / Krebs Cycle

1. Distinguish between substrate level phosphorylation and oxidative phosphorylation.
2. List the regulatory enzymes in the citric acid cycle and describe how each is controlled.
3. Define anapleurotic reactions.
4. Describe the coordinated regulation between the CAC and Oxidative Phosphorylation by oxygen and ADP levels.

D. The Electron Transport Chain (ETC)

1. Describe the structure and function of mitochondrion and its various compartments.
2. Determine the localization and function of the components of the mitochondrial electron transport chain (ETC).
3. Identify common inhibitors of ETC.
4. Explain the concept of transporting reducing equivalents across mitochondrial membranes.
5. Explain chemiosmotic potential (or proton motive force) and its relation to mitochondrial ATP production.
6. Describe mitochondrial ATP synthase.
7. Explain oxidative phosphorylation.
8. Explain uncoupling proteins and other uncoupling agents.

VIII. Carbohydrate Metabolism

1. Describe mono-, di-, oligo-, and polysaccharides.
2. Describe the chemical properties of *aldose* and *ketose*.
3. Explain the digestion and absorption of carbohydrates.
4. Describe the biochemical causes and consequences of disaccharidase defects.

5. Describe phosphorylation-coupled trapping of monosaccharides.
6. Describe the glycolytic degradation of glucose, galactose, and fructose.
7. Outline regulated steps in glycolysis and identify the regulatory factors.
8. Identify the glycolytic reactions that consume or generate ATP.
9. Explain the significance of oxidation of NADH in anaerobic glycolysis.
10. Explain NADH oxidation in anaerobic conditions.
11. Explain the consequences of the following :
    a. Pyruvate kinase deficiency
    b. Fructose intolerance
    c. Classic galactosemia
    d. Arsenic poisoning
12. Describe gluconeogenesis.
13. Explain how impaired gluconeogenesis causes lactic acidosis and fasting hypoglycemia.
14. Explain the importance of insulin- and glucagon-dependent regulation of glycolysis and gluconeogenesis.
15. Describe the pentose phosphate pathway (Hexo Monophosphate Shunt).
16. Describe the consequences of glucose-6-phosphate dehydrogenase deficiency.
17. Explain how insulin, glucagon, epinephrine and cortisol influence carbohydrate metabolism to maintain blood glucose level.
18. Describe the key reactions and enzymes of glycogen metabolism.
19. Compare regulation and biochemical significance of glycogen in the liver and muscle.
20. Identify and describe common featues of glycogen storage diseases such as von Gierke, Pompe and McArdle diseases.
21. Describe the structures and functions of glycosaminoglycans and proteoglycans.

IX. Lipid Metabolism

A. Fatty Acid Oxidation (Beta-oxidation) and Ketogenesis

1. Identify the major tissues that carry out lipolysis, beta oxidation and ketogenesis, the conditions under which these pathways operate and how they are regulated.
2. Describe the function and regulation of hormone-sensitive lipase in lipolysis.
3. Explain fatty acid activation.
4. Explain the function and regulation of carnitine shuttle.
5. Describe Beta-oxidation of various types of fatty acids (saturated, unsaturated, and branched-chain).
6. Describe the metabolic fate of the products of fatty acid oxidation.
7. Describe the role of peroxisomes in fatty acid oxidation.
8. Identify the ketone bodies produced in the liver and explain their metabolic fates.
9. Explain the relationship between gluconeogenesis, fatty acid oxidation and ketogenesis.
10. Characterize fatty acids as unusable precursors for the net synthesis of glucose.
11. Explain the metabolic consequences of fatty acid catabolism disorders.
12. Explain dietary interventions to mitigate the metabolic effects of fatty acid oxidation disorders.

B. Fatty Acid Biosynthesis

1. Identify the major tissues that carry out fatty acid synthesis, the conditions under which this process occurs and how it is regulated.
2. Describe the mechanism of substrate acquisition, the committed step, and the final product of fatty acid biosynthesis.
3. Explain the significance of NADPH in lipid synthesis.

4. Describe the reaction carried out by fatty acide synthase and explain the structural properties of this enzyme.
5. Explain how fatty acids are elongated and desaturated.
6. Explain why essential fatty acids are required in the human diet.

C. <u>TAG, Membrane Lipid and Eicosanoid Biosynthesis</u>

1. Describe triacylglycerol synthesis.
2. Describe membrane lipid structure and synthesis.
3. Describe the biosynthesis of eicosanoids.
4. Describe the principal regulatory enzymes, such as phospholipase A_2 and the cyclooxygenases (COX-1 and COX-2).
5. Describe the effects of glucocorticoids and NSAIDs on eicosanoid production.
6. Explain the biochemical defects associated with the sphingolipidoses Tay-Sachs, Gaucher and Niemann-Pick diseases.

D. <u>Cholesterol Metabolism</u>

1. Describe the general structure of cholesterol.
2. Compare and contrast cholesterol and cholesterol ester in terms of chemical characteristics and cellular significance.
3. Identify the major tissues that carry out cholesterol synthesis, the conditions under which this process occurs and how it is regulated.
4. Summarize the pathway of cholesterol biosynthesis, highlighting the importance of cytosolic HMG-CoA and mevalonic acid.
5. Explain the regulation of the cytosolic HMG-CoA reductase.
6. Explain the biochemical basis of how the statin drugs lower serum cholesterol.

E. <u>Cholesterol Derivatives</u>

1. Describe the reactions of bile acid/bile salt synthesis and their significance for cholesterol excretion and fat absorption.
2. Explain how bile salt is recycled.
3. Explain the regulation of bile acid synthesis via cholesterol 7-α-hydroxylase.
4. Describe the mechanism of action of cholestyramine.

F. <u>Plasma Lipoproteins and Lipid Transport</u>

1. Compare and contrast chylomicron (CM), chylomicron remnant, VLDL, LDL, and HDL in terms of composition, function, location of synthesis, and delivery of lipid contents.
2. Describe the reactions catalyzed by the following enzymes:
    a. lipoprotein lipase (LPL)
    b. phosphatidylcholine
    c. cholesterol acyltransferase (PCAT, also known as LCAT, in which "L" stands for lecithin)
    d. acyl-CoA: cholesterol acyltransferase (ACAT)
    e. Cholesterylmester transfer protein (CETP)
    f. hepatic lipase
3. Explain the etiology of familial hypercholesterolemia.
4. Describe the process of atherosclerosis and the roles played by LDL and HDL.

X. Protein and Amino Acid Metabolism

A. Protein Digestion

1. Describe the process of dietary protein digestion and amino acid absorption.

B. Transamination and the Urea Cycle

1. Describe the basic function of transaminases and the role of pyridoxal phosphate in transamination reactions.
2. Describe the metabolic processes that produce ammonia.
3. Explain the urea cycle and its role in ammonia detoxification.
4. Identify the enzymes and their respective locations of the urea cycle.
5. Describe the regulation of the urea cycle.
6. Describe the biochemical defect and clinical result of disorders of the urea cycle (OTC deficiency, arginase deficiency).

C. Metabolism of Individual Amino Acids

1. Describe the metabolic significance of branched-chain amino acids in skeletal muscle.
2. Describe the enzymatic defect involved in maple syrup urine disease.
3. Describe the significance of creatine and its metabolites.
4. Explain the relationship between hyperhomocysteinemia, vitamin B_{12} deficiency and cardiovascular disease.
5. Explain the role of SAM, tetrahydrofolate (FH_4) and vitamin B_{12} in one carbon metabolism.
6. Describe how vitamin B_{12} deficiency results in "folate (methyl) trap."
7. Explain the cause and symptoms of phenylketonuria (PKU).
8. Identify the amino acids that are precursors for the synthesis of dopamine, norepinephrine, acetylcholine, histamine, GABA, glutathione, and creatine.

D. Amino Acid Metabolism in Tissues

1. Describe the metabolic fates of amino acids released from muscle in the fasting state.
2. Describe the pathways of amino acid oxidation in muscle in the fasting state.
3. Describe the glucose-alanine cycle and explain its function.

XI. Nucleotide Metabolism

A. General Concepts

1. Differentiate between nucleoside, nucleotide, deoxynucleosides and deoxynucleotides.
2. Contrast the functions of ribonucleotides and deoxyribonucleotides.
3. Describe the importance of the pentose phosphate pathway (also called hexose monophosphate shunt) for biosynthesis of nucleotides.
4. Describe the importance of PRPP synthetase and its regulation in relationship to purine and pyrimidine nucleotide synthesis

B. Metabolism of Purine Nucleotides

1. Outline the regulatory steps of de novo and salvage pathways of purine nucleotide synthesis.
2. Describe the importance of folate in purine nucleotide biosynthesis.
3. Describe salvage pathways of purine nucleotides.

4. Explain the conversion of ribonucleotides into deoxyribonucleotides.
5. Describe the degradation of purine nucleotides.
6. Relate hyperuricemia and gout disease.
7. Compare the chemotherapies available for the management of gout.
8. Descibe the biochemical basis of Lesch-Nyhan syndrome.

C. Metabolism of Pyrimidine Nucleotides

1. Describe the *de novo* synthesis pathway of pyrimidine.
2. Identify and describe the key regulatory step of *de novo* synthesis pathway of pyrimidine.
3. Explain the importance of carbamoyl phosphate synthetase II.
4. Differentiate between carbamoyl phosphate synthetase II and carbamoyl phosphate synthetase I.
5. Describe thymidylate synthase and the reaction it catalyzes.
6. Explain the effect of folate deficiency on the activity of thymidylate synthase.
7. Explain the use of 5-fluorouracil (5-Fu) as an anti-cancer drug.
8. Explain the use of methotrexate as an anti-cancer drug.

XII. Heme Metabolism

1. Identify the committed step in heme synthesis and explain its regulation.
2. Describe the metabolism of bilirubin in the liver and in the gut.
3. Explain the relationship between enzyme deficiencies in heme synthesis and patient presentation in cutaneous and hepatic porphyrias.
4. Distinguish between hemolytic, cholestatic and hepatocellular jaundice.
5. Explain the effect of lead poisoning on heme synthesis.

XIII. Hemostasis and Blood Coagulation

1. Define:
    a. hemostasis
    b. coagulation
2. Describe the role of platelets in wound healing.
3. Describe the roles of the following factors in platelet activation and aggregation:
    a. ADP
    b. Platelet activating factor (PAF)
    c. Prostacyclin (PGI_2)
    d. Thrombin
    e. Thromboxane A_2 (TXA_2)
4. Explain the anti-platelet effect aspirin in low dosages.
5. Describe the role of von Willebrand factor in coagulation.
6. Describe the following pathways of coagulation:
    a. Tissue factor pathway (extrinsic)
    b. Contact activation pathway (intrinsic)
    c. Final common pathway
7. Explain the importance of vitamin K-dependent gamma-carboxylation of certain glutamate residues of factors VII, IX, X, II and proteins C and S.
8. Explain the importance of vitamin K epoxide reductase (VKOR or VKORC).
9. Describe the action mechanisms of the following anticoagulants:
    a. Antithrombin

    b. Heparin
    c. Tissue factor pathway inhibitor (TFPI)
    d. Proteins C and S
10. Explain the anti-coagulation action of warfarin and related coumarins.
11. Define *fibrinolysis*.
12. Explain the action of plasmin.
13. Explain the roles of the following factors in fibrinolysis:
    a. Tissue plasminogen activator (tPA)
    b. Urokinase
    c. Plasminogen
    d. Plasminogen activator inhibitor (PAI)

XIV. Diabetes Mellitus

1. Define diabetes mellitus.
2. Differentiate between type 1 and type 2 diabetes.
3. Explain what is meant by the term glucose tolerance test, and how it is performed.
4. Compare and contrast metabolic changes that occur in type 1 and type2 diabetes.
5. Explain the relevance of non-enzymatic glycation of proteins and advanced glycation end products.
6. Explain how HbA1c can become glycosylated, and the clinical significance of HbA1c levels.
7. Describe the polyol pathway and its relationship to complications of diabetes.
8. Describe how altered biochemical pathways lead to ketoacidosis, hyperosmolarity, and hypoglycemic in diabetes.
9. Identify the steps in insulin synthesis.
10. Identify factors that regulate insulin secretion.
11. Identify what factors other than insulin contribute to blood glucose regulation.
12. Identify the risk factors associated with type 2 diabetes.

XV. Free Radicals and Antioxidants

1. Define *free radicals* and reactive oxygen species (ROS).
2. Define *antioxidant*.
3. Explain how mitochondrial metabolism leads to the generation of ROS.
4. Describe the synthesis of nitric oxide by nitric oxide synthase (NOS).
5. Describe ROS-induced damages to nucleic acids, proteins and membranes.
6. Describe the functions of superoxide dismutase, catalase, and glutathione peroxidase.
7. Describe the synthesis and biological function of glutathione.
8. Relate hemolytic anemia to G6PD deficiency.
9. Explain the oxygen-dependent pathway of microbial killing in neutrophils.

XVI. Metabolism of Ethanol

1. Describe the enzymatic reaction for the following enzymes:
    a. Alcohol dehydrogenase
    b. Acetaldehyde dehydrogenase
    c. CYP2E1 and MEOS
2. Describe the different products and troxicities associated with ethanol metabolism.
3. Describe how ethanol metabolism impacts the NADH/NAD^+ ratio.
4. Describe the role of ethanol on the development of a fatty liver.

XVII. Nutrition

A. Metabolic Fuels and Dietary Components

1. Explain resting metabolic rate (RMR), body mass index (BMI), dietary reference intakes (DRI), and daily energy expenditure (DEE).
2. List the energy content (calories per gram) of carbohydrates, alcohol, fat, and protein.
3. Explain the glycemic index of foods.
4. Compare and ontrast proteins from wheat, corn, rice, and beans against animal proteins in terms of quality.
5. Differentiate between kwashiorkor and marasmus.
6. List the water and fat-soluble vitamins and the function of each.
7. Describe the symptoms of the following vitamin deficiencies:
    a. Vitamin B_3 (niacin) deficiency and pellagra
    b. Vitamin B_1 (thiamine) deficiency and Beri-Beri and Wernicke-Korsakoff syndromes
    c. Vitamin C (ascorbic acid) deficiency and scurvy
    d. Vitamin D deficiency and rickets and osteomalacia
    e. Vitamin A deficiency and night blindness and retardation of growth
    f. Vitamin K deficiency and hemorrhage
    g. Folic acid (vitamin B_9) deficiency and megaloblastic anemia and birth defects
    h. Vitamin B_{12} (cobalamin) deficiency and megaloblastic anemia and neuropathy
    i. Vitamin B_2 (riboflavin) deficiency and dermatitis
8. Describe the functions of the following minerals and the symptoms of associated deficiencies/toxicities:
    a. Iron
9. List the tissues and describe the reactions required for vitamin D activation.

B. The Fed or Absorptive State

1. Define fed (absorptive) state.
2. Describe the digestion and absorption of dietary carbohydrates, proteins, and fats.
3. Describe the changes in hormone levels after a meal.
4. Compare glucose metabolism during the fed and fasting states in the following tissues:
    a. brain and other neural tissues
    b. red blood cells
    c. muscle
    d. adipose tissue
5. Describe the functions of lipoproteins in the fed state.
6. Describe metabolic fate of dietary amino acids in the fed state.

C. Fasting and Starvation

1. Define *fasting state*.
2. Explain the metabolism of the liver during fasting.
3. Explain the metabolism of the liver, adipose tissue, brain and muscle tissue during fasting.
4. Explain the effects of prolonged fasting on the body.
5. Define *prolonged fasting/starvation*.
6. Describe the metabolic changes in various tissues during prolonged fasting.
7. Describe the changes in hormone levels in the post absorptive state through starvation.

XVIII. Integration of Metabolism

1. Identify the major metabolic pathways operating in the liver, brain, red blood cell, heart and skeletal muscle, adipose tissue, and the metabolic fuels used by them.
2. Describe how the organs and tissues work together to ensure that fuel homoostasis meets energy demands.
3. Describe how insulin, glucagon, and epinephrine regulate metabolic pathways by controlling the activity of key enzymes in various tissues.
4. Describe the alterations in metabolism that occur in the obese state and the biochemical signals regulating obesity.
5. Explain the metabolic changes that occur during acute and chronic ethanol consumption.

COMPOSITE HISTOLOGY

LEARNING OBJECTIVES

Microscopy and the Cell

Tissue and Basic Tissue Types

Epithelium and Glands

Connective Tissue Proper

Specialized Connective Tissues

Muscle Tissue

Nervous Tissue

Circulatory System

Lymphatic System

Integumentary System

Endocrine System

Respiratory System

Urinary System

Digestive System

Male Reproductive System

Female Reproductive System

I. MICROSCOPY AND THE CELL

1. Describe the primary functions of the major cellular organelles visible under light microscopy (LM) & electron microscopy (EM).
2. Determine the functions of a cell based on the complement and arrangement of its organelles.
3. Determine the activity of the nucleus based on the structure and arrangement of its euchromatin and heterochromatin, as visible under LM and EM.
4. Describe the plasma membrane and its functions based on its structure and any specializations.
5. Compare and contrast the major cytoskeletal components based on their structure, location in the cell, and functions.
6. Describe the stages of the cell cycle, mitosis, and meiosis.
7. Compare and contrast the processes of necrosis and apoptosis.

II. TISSUE AND BASIC TISSUE TYPES

1. Define *tissue*.
2. Relate the characteristics of each of the 4 primary histological tissue types (epithelial, connective, muscle, nervous) to their functions.

III. EPITHELIUM AND GLANDS

1. Describe the major features that must be present to identify epithelial tissue (free surface, basement membrane, polarity, avascularity).
2. Describe the classification of different types of epithelium based on the number of cell layers and surface cell type.
3. Describe the structures and functions of the surface specializations of the epithelium (cilia, microvilli, stereocilia, keratinization, infoldings, brush border).
4. Describe the structure and functions of the basement membrane.
5. Relate the structure and functions of each type of epithelium to its location in the body.
6. Describe the structural & physiological significance of junctional complexes (tight, adhering, and gap).
7. Compare and contrast exocrine and endocrine glands based on their development, structure, secretion products, and modes of secretion.

IV. CONNECTIVE TISSUE PROPER

1. Describe the major features that must be present to identify connective tissue proper (cells, fibers, ground substance, vascularity, ratio of cells to extracellular matrix).
2. Describe the classification of the different types of adult connective tissue proper based on fiber type, density, and arrangement.
3. Describe the functions of the major components of the ground substance (glycoslaminoglycans, proteoglycans, fibronectin, laminin and multi-adhesive proteins).
4. Compare and contrast collagen, elastic and reticular fibers in terms of their structure, functions, and locations in the body.
5. Compare and contrast the major isoforms of collagen (types I – IV), based on their structure, functions, and locations in the body.
6. Describe the functions of the resident (fixed) and transient (wandering) cells in connective tissue proper (fibroblasts, telocytes, mast cells, plasma cells, macrophages, adipocytes).

V. SPECIALIZED CONNECTIVE TISSUES

A. ADIPOSE TISSUE

1. Describe white adipose tissue, including its structure, main functions (energy storage, endocrine, insulation, mechanical padding), and normal (nonpathological) locations in the body.
2. Describe brown adipose tissue, including its structure, main functions (thermogenesis, energy storage, endocrine), and normal (nonpathological) locations in the body of neonates and adults.

B. CARTILAGE

1. Compare and contrast the structure of the different types of cartilage (hyaline, elastic, fibrocartilage) based on their cellular organization, matrix composition, and biomechanical properties, and locations in the body.
2. Compare and contrast the chondroblast and the chondrocyte based on their structure and functions.
3. Describe the roles of chondroblasts and chondrocytes in bone development, growth, and regeneration.
4. Describe the structure and function of the perichondrium.
5. Compare and contrast interstitial and appositional growth of cartilage.

C. BONE

1. Compare and contrast bone cells (osteoblasts, osteocytes, osteoclasts) based on their lineage, morphology, functions, and locations in bone tissue.
2. Relate the composition of bone matrix to its role in calcium homeostasis.
3. Compare and contrast mature (lamellar) and immature (woven) bone tissue, based on their structure and functions.
4. Compare and contrast compact and spongy bone, based on their structure and locations within the body.
6. Compare and contrast the processes of intramembranous ossification and endochondral bone formation, including the locations in the body where each occurs.
7. Describe the process of fracture repair.
8. Describe the process of bone remodeling.

D. BLOOD

1. List the main formed elements of blood (red blood cells, reticulocytes, neutrophils, band neutrophils, eosinophils, basophils, lymphocytes, monocytes, platelets) that would be visible on a routine blood smear.
2. Relate the morphology of the mature red blood cell to its role in gas exchange.
3. Describe the clinical significance of increased numbers of reticulocytes on a complete blood count (CBC).
3. Compare and contrast the granulocytes (neutrophils, eosinophils, basophils) in terms of their morphology and functions.
4. Describe the structure and functions of monocytes (and their derivatives) and lymphocytes (B cells, T cells, natural killer cells) and the role they play in immunity.

5. Describe the morphology of platelets and their function in clotting.
6. Describe the clinical significance of alterations in white blood cell counts on a CBC.
7. Define hematocrit and describe its clinical significance.
8. Distinguish between serum and plasma.

E. HEMATOPOIESIS

1. Define a stem cell (asymmetric division and self renewal).
2. Define hematopoiesis, erythropoiesis, granulopoiesis, lymphopoiesis, and thrombopoiesis.
3. Describe the renewal of red blood cells, focusing on the transition from nucleated cells to reticulocytes to mature red blood cells.
4. Describe how platelets form from megakaryocytes.
5. Compare and contrast red and yellow bone marrow in terms of the cells present and location in the adult body.

VI. MUSCLE TISSUE

1. Compare and contrast the histological structure of the three muscle tissue types (skeletal, cardiac, smooth).
2. Describe the fascicular organization of skeletal muscle fibers, including the location of epimysium, perimysium and endomysium.
3. Describe how the ultrastructural components of striated muscle (myofibers, myofibrils, sarcomeres, myofilaments, T-tubules, sarcoplasmic reticulum, and neuromuscular junction) contribute to muscle contraction.
4. Describe the role of dystrophin molecules in anchoring myofibrils to the sarcolemma.
5. Describe the structure and function of gap junctions in cardiac and smooth muscle, and of intercalated discs in cardiac muscle.
6. Describe the basic structure, locations, and functions of muscle spindles and Golgi tendon organs.
7. Compare and contrast the regenerative potentials of cardiac, smooth and skeletal muscle.

VII. NERVOUS TISSUE

1. Describe how the structure of neurons (soma, dendrites, axon, myelin, nodes of Ranvier, and the synaptic terminal) contributes to neuronal function.
2. Compare and contrast multipolar, pseudo-unipolar and bipolar neurons in terms of their structure, functions, and locations in the body.
3. Describe the structure and function of glial cells (Schwann cells, satellite cells, oligodendrocytes, astrocytes, microglial cells and ependymal cells).
4. Compare and contrast how axons are myelinated in the peripheral and central nervous systems.
5. Describe the fascicular organization of peripheral nerves, including epineurium, perineurium, and endoneurium.
6. List the components of the blood-brain and blood-nerve barriers.

VIII. CIRCULATORY SYSTEM

1. Describe the origins, structure, and functions of endothelial cells.
2. Compare and contrast the structure of the three layers (tunics) of blood vessels.
3. Relate the structure of the different arterial vessels (elastic arteries, muscular arteries, small arteries, and arterioles) to their functions.
4. Relate the structure of the different venous vessels (large veins, medium veins, small veins, and venules) to their functions.
5. Relate differences in structure between arterial and venous vessels to differences in function, blood volume, blood velocity and blood pressure.
6. Compare and contrast the different types of capillaries (continuous, fenestrated, sinusoidal) in terms of their structure, functions, and locations in the body.
7. Compare and contrast the structure of the three layers of the heart (endocardium, myocardium and epicardium).
8. Describe how Purkinje fibers and gap junctions contribute to the function of the conduction system of the heart.

IX. LYMPHATIC SYSTEM

1. Distinguish between the functions of the innate and adaptive immune systems.
2. Compare and contrast the roles of different cell types that are involved in innate and adaptive immune responses.
3. Compare and contrast the structure of primary and secondary lymphatic nodules.
4. Describe mucosa-associated lymphoid tissue (MALT) in terms of its structure, immune cells present, functions, and common locations in the body.
4. Compare and contrast the three types of tonsils in terms of their structure (including crypts and nodules), epithelial and immune cells present, functions, and location in the body.
5. Describe lymph nodes in terms of their structure (including capsule, subcapsular space, cortex, paracortex, medulla, medullary sinus, medullary cords, nodules, afferent lymphatic vessels, efferent lymphatic vessels, high endothelial venules), immune cells present, and functions.
6. Describe the thymus in terms of its structure (including capsule, cortex, medulla, Hassal corpuscles), cells present (immune cells, epithelial reticular cells, thymocytes), and functions.
7. Describe the spleen in terms of its structure (including capsule, red pulp, white pulp, nodules, arteries, periarteriolar lymphatic sheaths, veins, sinusoids), red and white blood cells present, and functions.

X. INTEGUMENTARY SYSTEM

1. Describe the layers of the epidermis and their functions.
2. Describe the structure, location and general function of the cells within each layer of the epidermis (keratinocytes, Langerhans cells, Merkel cells, melanocytes, basal cells).
3 Distinguish among the functions of keratin, keratinohyaline granules, lamellar bodies and melanin granules in the epidermis.
4. Describe the maturation of keratinocytes as they migrate through each epidermal layer.
5. Compare and contrast the layers of the dermis (papillary & reticular) in terms of their contents and functions.
6. Compare and contrast the Pacinian, Meissner, & Ruffini corpuscles in terms of their structure, function, and location.
7. Describe the contents and functions of the hypodermis.
8. Describe the structure and function of skin-associated structures (hair follicles, hair shaft, arrector pili muscles, sebaceous glands, eccrine sweat glands).

9. Describe the structure and function of nail-associated structures (nail matrix, nail plate, nail bed, hyponechium, eponechium, cuticle).
10. Compare and contrast thick and thin skin in terms of the epidermal layers and skin-associated structures present, and their location in the body.

XI. ENDOCRINE SYSTEM

1. Describe the embryologic origin and structure of the anterior and posterior pituitary.
2. Describe the anterior pituitary, in terms of the endocrine secretory cells present (the different types of acidophils and basophils) and the hormones each secretes, and the other cells present (chromophobes).
3. Describe the posterior pituitary, in terms of cells (pituicytes) and other structures (Herring bodies) present, and the functions of each.
4. Describe the thyroid gland, including follicular and parafollicular cells and the hormones they secrete, and the appearance and function of colloid.
5. Describe the parathyroid gland, including the chief cells, the hormone chief cells secrete, the oxyphil cells, and the function of oxyphil cells.
6. Describe the structure of the adrenal (suprarenal) glands, including the cortex, zona glomerulosa, zona fasciculata, zona reticularis, sinusoids, and medulla.
7. Compare and contrast the zona glomerulosa, zona fasciculata and zona reticularis of the adrenal cortex based on their structure (cellular and vascular organization) and major endocrine secretions.
8. Describe the functions and endocrine secretions of the chromaffin cells of the adrenal medulla.
9. Describe how the pancreas is divided into exocrine and endocrine (islets) portions.
10. List the the most common endocrine secretory cells of the pancreatic islets of Langerhans (alpha, beta & delta) and their endocrine secretions.

XII. RESPIRATORY SYSTEM

1. Compare and contrast the structure and locations of olfactory and respiratory epithelia, and describe their function in conditioning inhaled air and olfaction.
2. Compare and contrast the structure of the trachea and bronchi, including type of epithelium, epithelial cells present, submucosa, glands, BALT, arrangement of cartilage, and smooth muscle.
3. Compare and contrast the structure of the bronchi and bronchioles, including type of epithelium, epithelial cells present, submucosa, glands, cartilage, and smooth muscle), and relate histological differences to function.
4. Describe the structural organization of the alveolar duct, alveolar sac, and alveoli (including type of epithelium, types of alveolar cells present, and smooth muscle).
5. Describe the components of the air-blood barrier.
6. Relate the structure and function of respiratory cells to their location in the airways: ciliated cells, goblet cells, basal cells, Kulchitsky cells, club cells (Clara cells), Type 1 and Type 2 alveolar cells (pneumocytes), endothelial cells, and dust cells.
7. Contrast the structure and functions of the pulmonary and bronchial circulations.

XIII. URINARY SYSTEM

1. Describe the structure of the kidney, including the capsule, cortex, medulla, renal columns, sinuses, major and minor calyces, renal pyramids and renal pelvis.

2. Describe the circulation of the kidney, including the interlobular and arcuate vessels, afferent and efferent arterioles, the glomerulus, peritubular and vasa recta capillary networks, and portal system.
3. List the components of the nephron.
4. Describe the structures of the renal corpuscle (including Bowman's capsule/parietal layer, Bowman's space, glomerular capillaries, podocytes/visceral layer, urinary and vascular poles, and the associated macula densa).
5. Relate the structure of the components of the glomerular filtration barrier (podocytes, basement membrane, and endothelial cells) to their functions.
6. Compare and contrast the specific regions of the renal tubules in corticomedullary and juxtamedullary nephrons (proximal and distal convoluted tubules, thick and thin segments of the Loop of Henle and collecting ducts) in terms of their structure, locations, and functions.
7. Describe the structures and functions of the components of the juxtaglomerular (JG) apparatus (JG cells and macula densa).
8. Describe the structure of the ureter and urinary bladder, including the epithelium, submucosa, and number of smooth muscle layers.
9. Compare and contrast the structure of the female and male urethrae.

XIV. DIGESTIVE SYSTEM

A. ALIMENTARY CANAL

1. Describe the histological structure of the four basic layers of the alimentary canal: mucosa, submucosa, muscularis externa, and serosa or adventitia, emphasizing the unique local features of each section and the enteric nervous system.
2. Relate the structure of the esophagus (epithelium, skeletal and smooth muscle, and esophageal glands) to its functions.
3. Describe the structure and functions of the stomach mucosa, including the types of cells present (mucus, chief, parietal and enteroendocrine cells), and their secretory products.
4. Relate the structure of the small intestine mucosa, including intestinal crypts of Lieberkuhn, lacteals, Brunner's glands, and types of cells present (enterocytes, goblet cells, Paneth cells, and enteroendocrine cells), to the functions of the small intestine.
5. Describe how mucosal folds, villi, and microvilli increase the absorptive surface area of the small intestine.
6. Relate the structure of the large intestine mucosa (goblet cells, water channels) to the functions of the large intestine.

B. DIGESTIVE GLANDS

1. Describe the structure of the pancreas, including the pancreatic acini, ducts, centroacinar cells, and pancreatic islets of Langerhans.
2. Describe the structure of the liver, emphasizing the function of the classic lobule, portal triads, hepatic plates, sinusoids, perisinusoidal space of Disse, bile canaliculi, and central veins.
3. Describe the functions of liver cells, including endothelial cells, hepatocytes, Kupffer cells and Ito (stellate) cells.

4. Trace the paths of bile and blood through a classic liver lobule.

XIV. MALE REPRODUCTIVE SYSTEM

1. Describe the functions and structure (including capsule, seminiferous tubules) of the testis.
2. Compare and contrast Sertoli and Leydig cells in terms of their functions, structure, and locations in the testis.
3. Relate the structure of a mature sperm cell to its functions.
4. Compare and contrast the epididymis, prostate gland, and seminal vesicles, based on their structure and functions.
5. Describe how erections form and are maintained.

XV. FEMALE REPRODUCTIVE SYSTEM

1. Describe the functions and structure (including capsule, ova (egg cells), and primary, secondary, and Graafian follicles) of the ovary.
2. Describe the structure and functions of the uterine tube, uterus, and vagina.
3. Describe the histological appearance and physiological changes of the endometrium over the course of one menstrual cycle.
4. Compare and contrast estrogen, progesterone, luteal hormone, and follicle stimulating hormone, in terms of their functions and where they are synthesized.

EMBRYOLOGY

LEARNING OBJECTIVES

Fertilization, Implantation, and Early Development

Development of the Gastrointestinal System

Development of the Respiratory System

Development of the Cardiovascular System

Development of the Urogenital System

Development of the Pharyngeal Apparatus and the Head and Neck

Development of the Nervous System

Development of the Musculoskeletal System

Development of the Limbs

Development of the Integumentary System

I. Fertilization, Implantation, and Early Development

1. Describe the process of fertilization.
2. Describe the formation of the blastocyst, including components and the products of their formation.
3. Describe the process of implantation, including the formation of the bilaminar disc.
4. Describe the process of gastrulation, the formation of the germ layers and their derivatives.
5. Describe the reorganization of the intraembryonic mesoderm.
6. Describe the process and significance of notochordal development.
7. Describe the process of embryonic folding and the formation of the intraembryonic coelom.
8. Describe the subdivision of the intraembryonic coelom into the body cavities.
9. Describe the critical nature of the third through eighth weeks of human development and the effects of major teratogens.

II. Development of the Gastrointestinal System

1. Describe the development and major derivatives of the foregut, the midgut, and the hindgut, including common anomalies.
2. Describe the rotations, herniation, and repositioning of the embryonic gut and gut-derivative organs, including common anomalies.

III. Development of the Respiratory System

1. Describe the development of the respiratory system, stages of lung development and formation of the diaphragm.
2. Describe the embryogenesis of tracheoesophageal atresias, stenoses, and fistulas.

IV. Development of the Cardiovascular System

1. Describe the development of the primitive cardiovascular system.
2. Describe the development of the fetal heart from the embryonic heart tube.
3. Describe septation of the atria and ventricles, and discuss commonly associated defects.
4. Describe changes of the cardiovascular system following birth.

V. Development of the Urogenital System

1. Describe the formation and derivatives of the pronephros, mesonephros, and metanephros.
2. Describe the development of the kidneys and ureters, including repositioning and anomalies.
3. Describe the development of the urinary bladder and urethra.
4. Describe the development of the male and female gonads, ducts, and external genitalia, including common anomalies.

VI. Development of the Pharyngeal Apparatus and the Head and Neck

1. Describe the development and derivatives of the pharyngeal (brachial) apparatus and common anomalies.

2. Describe the development of the face, palate, and nasal cavities, including common anomalies.

VII. Development of the Nervous System

1. Describe the process of neurulation and neural crest formation, including neural tube defects.
2. List the major derivatives of the neural crest and describe common neurocristopathies.
3. Describe cell differentiation within the neural tube.
4. Describe the development of the brain vesicles and their derivatives, including common anomalies.
5. Describe the development of the spinal cord, including common anomalies.
6. Describe the formation of the peripheral nervous system and cranial nerves.

VIII. Development of the Musculoskeletal System

1. Describe the three groups of cells derived from somites, their migration and the structures derived from each group.
2. Describe the role of somatic mesoderm in muscular system development.
3. Describe the development and derivatives of hypaxial and epaxial musculature.
4. Describe the process of intramembranous and endochondral ossification and their role in development of the axial and appendicular skeletal systems, including common anomalies.

IX. Development of the Limbs

1. Describe the role of the apical ectodermal ridge (AER) in lower limb development.
2. Describe and compare hand and foot plates, and digital rays in upper and lower limb development.
3. Describe the importance of limb axes and limb rotation.
4. Describe the importance of myotome and dermatome formation in limb development.
5. Describe the development of the nerve distribution of the limbs.
6. Describe the anomalies in limb development (e.g., amelia and meromelia, cleft foot/hand, talipes equinovarus, polydactyly, and syndactyly).

X. Development of the Integumentary System

1. Describe the development of epidermis and dermis.
2. Describe the development of skin appendages (eg, hair, nails, sebaceous glands and sweat glands).

GENERAL ANATOMY

LEARNING OBJECTIVES

Basic Anatomy of the Back

Clinical Anatomy of the Back

Basic Anatomy of the Upper Limb

Clinical Anatomy of the Upper Limb

Basic Anatomy of Pelvis and Perineum

Clinical Anatomy of Pelvis and Perineum

Basic Anatomy of Thorax

Clinical Anatomy of Thorax

Basic Anatomy of Abdomen

Clinical Anatomy of Abdomen

Basic Anatomy of Head and Neck

Clinical Anatomy of Head and Neck

I. Basic Anatomy of the Back

1. Identify the major surface features and anatomical landmarks of the back.
2. Differentiate between the primary and secondary curvatures of the spine.
3. Describe the osteological features of typical and atypical vertebrae.
4. Explain the structure and function of an intervertebral disc.
5. Describe the attachments, locations and functions of the ligaments of the vertebral column.
6. Describe the intervertebral joints and their functions.
7. Explain the structure and function of the facet (zygapophyseal) joints and compare them in the cervical, thoracic, and lumbar regions.
8. Describe the boundaries and contents of the intervertebral foramen.
9. Describe the atlanto-occipital and atlanto-axial joints with emphasis on their movements.
10. Describe the innervation and major actions of the intrinsic muscles of the back.
11. Describe the major features of the spinal cord, meninges, and meningeal spaces and their relationships within the vertebral canal.
12. Describe the structure of a typical spinal nerve and its functional components.
13. Define dermatome and myotome.
14. Describe the vascular supply and venous and lymphatic drainage of the back, vertebral column, and spinal cord.

II. Clinical Anatomy of the Back

1. Identify the osteological features of the back as demonstrated on diagnostic imaging.
2. Identify soft-tissue structures of the back on sagittal and transverse CTs and MRIs.
3. Describe the abnormal curvatures of the spine; scoliosis, kyphosis and lordosis.
4. Describe the anatomical basis for spondylosis, spondylolysis and spondylolisthesis and recognize relevant features on an oblique lumbar radiograph.
5. Explain the relationship between a herniated disc and spinal nerve compression in the cervical and lumbar regions.
6. Describe the anatomical basis for spinal stenosis vs foraminal stenosis and the structures impacted by each.
7. Defend the choice of sites for lumbar puncture and epidural anesthesia.
8. List, in order, the structures and spaces pierced in a lumbar puncture and epidural anesthesia.

III. Basic Anatomy of the Upper Limb

1. Identify the surface anatomy and palpable bony landmarks of the upper extremity.
2. Distinguish the innervation of the upper extremity with respect to dermatomes and peripheral nerve distribution.
3. Describe the superficial and deep venous and lymphatic drainage of the upper extremity.
4. Describe the structure and function of the joints of the upper extremity including associated bursae.
5. Describe the superficial and deep fascia of the upper extremity in terms of myofascial compartments and their contents, including the blood vessel associated with each.
6. Describe the osteological features of the of the bones of the upper extremity.
7. Describe the extrinsic (superficial) muscles of the back in terms of their attachments, innervations, and major actions.
8. Describe the muscles of the pectoral region in terms of attachments, innervations, and major actions.
9. Describe the muscles in each compartment of the upper extremity in terms of their attachments, innervations, and major actions.

10. Describe the structure and function of the rotator cuff.
11. Describe the course and branches of each of the major arteries of the upper extremity.
12. Describe the formation of the brachial plexus and the course of the branches through each of the compartments of the upper extremity.
13. Describe the structure and function of the extensor retinaculum and palmar carpal ligament.
14. Describe the structure and function of synovial tendon sheaths.
15. Describe the orientation of the structures within the cubital fossa.
16. Describe the boundaries and contents the anatomical snuffbox.
17. Describe the structure of the carpal tunnel and its contents.
18. Explain the structure and function of the extensor expansions (aponeuroses).

IV. Clinical Anatomy of the Upper Limb

1. Identify the osteological features of the upper extremity as demonstrated on diagnostic imaging.
2. Identify soft tissue structures of the shoulder, arm, elbow, forearm, wrist, and hand on CT and MRI images.
3. Explain the anatomical basis for winging of the scapula and its clinical implications.
4. Distinguish shoulder separation and shoulder dislocation with respect to joint involved, symptoms and complications.
5. Describe the clinical significance of rotator cuff injuries.
6. Explain the anatomical basis of subluxation and dislocation of the proximal radioulnar joint.
7. Explain the clinical significance of scaphoid and Colles fractures and lunate dislocation, including radiographic diagnosis.
8. Explain Dupuytren's contracture and its clinical significance.
9. Describe DeQuervain's tenosynovitis.
10. Describe the functional deficits resulting from superior and inferior brachial plexus injuries.
11. Diagnose probable injury sites of the brachial plexus based on clinical presentation.
12. Diagnose carpal tunnel syndrome clinical presentation.
13. Identify sites where pulses are taken in the upper extremity.
14. Describe the arterial anastomoses of the shoulder, elbow, and hand and recognize the clinical significance of each.
21. Identify common sites used for venipuncture.
22. Describe the clinical significance of lymphadenopathy.
23. Describe common routes for the spread of infection from the hand to the forearm.
24. Recognize neurovascular structures at risk with surgical neck and mid-shaft fractures of the humerus.
25. Identify sites where deep tendon reflexes are evaluated and the clinical significance of each.

V. Basic Anatomy of Pelvis and Perineum

1. Describe the structure of the male and female bony pelvis including joints and associated ligaments.
2. Describe the structures that pass through the greater and lesser sciatic foramen and the obturator canal.
3. Describe the musculature associated with the antero- and posterolateral walls of the pelvic cavity.
4. Describe the arterial supply (internal iliac) and venous drainage to and from the pelvis musculature and organs.
5. Describe the lymphatic drainage from the pelvis and perineum.
6. Describe the sacral plexus and its branches.
7. Describe the somatic and autonomic innervations of the pelvis and perineum.
8. Identify the boundaries and contents of the perineal, urogenital, and anal triangles.

9. Describe the pudendal nerve and internal pudendal artery and their branches.
10. Compare and contrast the anal canal above the pectinate line and below the pectinate line in terms of arterial supply, venous drainage, and innervation.
11. Compare and contrast the internal and external anal sphincters in terms of location, structure, and innervation.
12. Describe the course, constrictions, and relationships of the ureters in the pelvis.
13. Explain the structure and function of the urinary bladder.
14. Distinguish the urethra and urethral sphincters between the male and female.
15. Describe the relationships of the seminal vesicles, ductus deferens (including the ampulla) and the prostate gland in relationship with the urinary bladder and urethra.
16. Compare and contrast the anatomy of the penis and clitoris (homologues) which would include a working knowledge of blood supply and innervation.
17. Describe the peritoneal reflections, pouches, and ligaments that form important support for the female pelvic organs.
18. Describe the structure, blood supply, lymphatic drainage of the female pelvic organs: uterus, uterine tubes, vagina, ovaries.
19. Compare and contrast the male and female superficial anatomy of the perineal structures associated with the urogenital and anal triangles.

VI. Clinical Anatomy of Pelvis and Perineum

1. Identify the osteological and soft tissue features of the pelvis and perineum in diagnostic imaging.
2. Describe the palpable osseous anatomical landmarks of the pelvis and explain their clinical significance.
3. Explain the clinical significance of an open female peritoneal cavity (uterine tubes) versus a closed male peritoneal cavity.
4. Explain the clinical significance of the vascular anastomosis between vessels in the pelvis and perineum.
5. Describe the pudendal nerve in terms of clinically relevant sites for nerve block.
6. Compare and contrast internal hemorrhoids from external hemorrhoids in terms of location, venous drainage, and possible causes.
7. Compare and contrast the internal and external anal sphincters in terms of fecal continence.
8. Explain the functional and clinical significance of the perineal body.
9. Relate urinary stress incontinence or uterine prolapse to weakness of the pelvic diaphragm.
10. Describe the organization and relationships of the pelvic viscera in sagittal, frontal, and transverse sections of the male and the female pelvis with respect to diagnostic imaging.

VII. Basic Anatomy of Thorax

1. Describe commonly-used vertical reference lines on the anterior and lateral thoracic wall.
2. Describe the surface landmarks related to the heart and great vessels, the trachea, the margins of the pleura, and the lobes and fissures of the lungs.
3. Demonstrate the osteological features of the thoracic vertebrae, sternum, ribs, and clavicle.
4. Describe the costovertebral, sternocostal, and sternoclavicular joints.
5. Describe the boundaries of the thoracic inlet and outlet, and identify the structures passing through them.
6. Describe the sternal angle and its use as a reference point.
7. List the vertebral levels of suprasternal notch, sternal angle, and xiphisternal joint.
8. Describe the origins and courses of the intercostal nerves and vessels.
9. Describe the segmental innervation (dermatomes) of the skin of the thoracic wall.

10. Describe the layers of the thoracic wall from the superficial to the deep.
11. Describe the fiber orientation, innervations, and actions of the intrinsic muscles of the thoracic wall.
12. Describe the structure, function, and sensory and motor innervation of the diaphragm, and related surface landmarks.
13. Identify the vertebral levels of the diaphragmatic openings.
14. Describe the origin, course, and functions of the phrenic nerves.
15. Describe the musculoskeletal mechanisms by which the thoracic cavity diameters are altered during inspiration and expiration.
16. Describe the pleural and pericardial cavities and their associated membranes and recesses.
17. Describe the location of the organs within the thoracic cavity and their relationships to one another.
18 Describe the endothoracic fascia and suprapleural membrane.
19. Explain the structure and function of the lungs.
20. Compare and contrast the right and left lung, including root structures.
21. Describe the innervation of, and the blood flow to and from, the lungs.
22. Describe the trachea and bronchial tree.
23. Describe a bronchopulmonary segment.
24. Describe the boundaries and contents of the mediastinal divisions.
25. Identify the branches of the subclavian arteries that supply structures in the thorax.
26. Describe the courses and branches of the vagus nerves in the thorax.
27. Compare and contrast the left and right recurrent laryngeal nerves.
28. Describe the location and relationships of the thymus, and typical age-related changes.
29. Describe the layers of the pericardium and their attachments and reflections.
30. Identify and describe the oblique and transverse pericardial sinuses.
31. Describe the pathway of blood flow through the heart.
32. Describe fetal circulation and the changes that occur at birth.
33. Describe the external and internal anatomy of the heart with emphasis on the chambers and valves.
34. Describe the cardiac skeleton.
35. Explain the structure and function of the cardiac valves.
36. Describe the arterial and venous coronary circulation.
37. Describe the conducting system of the heart.
38. Describe the autonomic innervation of the heart.
39 Describe the posterior mediastinum and its contents.
40. Describe the gross structure and course of the esophagus.
41. Describe the course and relationships of the thoracic aorta and its branches.
42. Describe the azygos system of veins.
43. Describe the lymphatic drainage of the thoracic wall, including the breast.
44. Describe the lymphatic drainage of the visceral organs of the cardiothoracic cavity.
45. Distinguish drainage patterns of the right lymphatic duct and the thoracic duct.
46. Describe the thoracic portion of the sympathetic chain.
47. Describe the origins and courses of the thoracic splanchnic nerves.
48. Describe the autonomic nervous plexuses within the thorax (cardiac, pulmonary, and esophageal).
49. Describe the structure of the female breast.

VIII. Clinical Anatomy of Thorax

1. Describe the surface landmarks related to auscultation of the lungs and pleurae.
2. Describe the lymphatic drainage of the breast in relation to the spread of breast cancer.
3. Identify bony features and soft tissue structures of the thorax on radiographs, MRI, CT, and angiograms.
4. Describe cervical rib and thoracic outlet syndromes.
5. Describe the significance of the differences in afferent innervation of the parietal and visceral pleura in clinical presentations.
6. Define pneumothorax, hemothorax, chylothorax, paradoxical respiration (flail chest) and pleurisy.
7. Describe the clinical significance of the costomediastinal and costodiaphragmatic recesses in relation to thoracocentesis.
8. Explain the functional significance of the bronchial tree and bronchopulmonary segments in relation to inhalation injury and surgical resection.
9. Describe the surface landmarks related to sites of auscultation of the cardiac valves and describe the placement of ECG electrodes.
10. Explain the cardiac tamponade and routes of pericardiocentesis.
11. Describe the congenital and acquired anomalies of the heart and great vessels.
12. Describe the functional consequences of coronary artery obstruction.
13. Describe the mechanism and patterns of of referred pain from thoracic organs.
14. Describe the clinical significance of the azygos venous system as it relates to esophageal varices.
15. Identify mediastinal structures on diagnostic imaging.

IX. Basic Anatomy of Abdomen

1. Describe the regional and quadrant reference systems of the abdomen and the position of abdominal viscera relative to these systems.
2. Describe the organization and function of the abdominal wall, including fascial and muscle layers in terms of attachments, actions, innervation, and blood supply.
3. Describe the nerve supply (dermatomes), arterial supply, venous and lymphatic drainage of the abdominal wall.
4. Describe the organization and contents of the inguinal canal in females and males.
5. Describe the anatomy of the scrotum, testes and epididymis including the arterial supply, venous and lymphatic drainage.
6. Describe the course and contents of the spermatic cord.
7. Distinguish the parietal and visceral peritoneum and explain where the peritoneal cavity is located.
8. Explain the difference between the peritoneal ligaments, mesenteries and omenta.
9. Distinguish intraperitoneal, primarily retroperitoneal, and secondarily retroperitoneal organs.
10. Describe the boundaries of the lesser and greater peritoneal sacs and the relationship of the lesser sac to the epiploic foramen.
11. Describe the portal triad and the duct system for the passage of bile from the liver to the duodenum, and for storage in the gallbladder.
12. Describe the course of the major branches of the abdominal aorta, venous drainage to the inferior vena cava and portal vein, and lymphatic drainage from the viscera.
13. Discuss the autonomic and visceral sensory innervation of the visceral organs in the abdominal cavity.
14. Describe the structure and function of the gastrointestinal abdominal viscera and spleen.
15. Identify the structures passing through the three diaphragmatic openings.

16. Describe the attachments, innervation, blood supply and action of the posterior abdominal wall muscles.
17. Describe the lumbar plexus and its branches.
18. Discuss the structure of the kidney, including its arterial supply and venous drainage, and its relationship to surface landmarks of the abdominal wall.
19. Discuss the location, arterial supply, and venous drainage of the suprarenal (adrenal) gland.

X. Clinical Anatomy of the Abdomen

1. Describe the structural relationships, bony features, and soft tissue structures of the abdomen within the context of diagnostic imaging.
2. Identify palpable landmarks of the abdomen utilized for physical exam or clinical procedures.
3. Define the boundaries of the inguinal (Hesselbach's) triangle through which direct hernias pass.
4. Describe the descent of the testes and formation of the spermatic cord in relation to the inguinal canal to understand indirect hernias and cryptorchidism.
5. Discuss the difference between indirect and direct inguinal hernias and their relationship to the inferior epigastric vessels and deep inguinal ring.
6. Distinguish inguinal and femoral hernias.
7. Describe pain referral patterns of the abdominal viscera.
8. Define hydrocele, hematocele, and varicocele.
9. Discuss the removal of ascites from the peritoneal cavity (paracentesis).
10. Discuss the location of the hepatorenal recess (Morrison's pouch) and the conditions that can affect it.
11. Discuss the portal-caval anastomosis and its importance in portal hypertension.
12. Discuss where renal calculi (stones) typically become lodged in the ureter.
13. Describe the location of the appendix with respect to surface landmarks of the abdomen.

XI. Basic Anatomy of Head & Neck

Head

1. Describe the osteological features of the skull.
2. Identify the major sutures of the skull.
3. Describe fontanel, define the location and the times of closure for the major fontanels.
4. Describe the boundaries of the cranial fossae, their contents, bony landmarks, foramina and fissures, and the structures that each transmits.
5. Describe the relationships of three meningeal coverings of the brain.
6. Describe the dural reflections and dural venous sinuses.
7. Describe each cranial nerve in terms of:
    a. name and Roman numeral
    b. where emerges from CNS
    c. associated foramina
    d. functional components
    e. ganglia
    f. course and distribution

A. Scalp and Face

1. Describe the layers of the scalp.
2. Describe the cutaneous innervation, major blood supply, and venous and lymphatic drainage of the face and scalp.

3. Discuss the muscles of facial expression, their innervation and function.
4. Describe the parotid gland and its relationship to the facial nerve and external carotid artery.
5. Describe the parasympathetic innervation of the parotid gland.
6. Describe the sympathetic innervations of the face.

B. Orbit and its Contents

1. Describe the extraocular muscles, in terms of their attachments, innervations, and actions.
2. Describe the muscles responsible for opening and closing the palpebral fissure.
3. Describe the intrinsic muscles of the eye, as well as their actions and innervation.
4. Describe the innervation, arterial supply and venous drainage of the orbit.

C. Infratemporal Fossa

1. Describe the boundaries and contents of the infratemporal fossa in terms of:
   a. muscles of mastication (actions and innervations)
   b. mandibular nerve and its major branches
   c. chorda tympani (origin and functions)
   d. major branches of maxillary artery
   e. pterygoid plexus of veins
2. Describe the temporomandibular joint (TMJ).
3. Describe the major venous anastomoses of the head (e.gs., cavernous sinus, pterygoid plexus, facial veins and veins of the scalp).

D. Nasal Cavity, Paranasal Sinuses & Pterygopalatine Fossa

1. Describe the nasal cavity, its blood supply and innervation.
2. Describe the paranasal sinuses, their blood supply and innervation.
3. Describe the pterygopalatine fossa and its contents.

E. Oral Cavity

1. Describe the functional anatomy of the tongue, including its motor and sensory (general and special) innervations.
2. Describe the neurovasculature of the oral cavity.
3. Describe the major salivary glands, their blood supply and innervation.

F. Pharynx and Palate

1. Describe the structure and function of the pharynx, including the auditory tube and the piriform recess.
2. Describe the blood supply, innervation, lymphatic and venous drainage of the pharynx.
3. Describe the roles the soft palate, pharyngeal constrictors, and tongue play in swallowing.
4. Describe the anatomic arrangement and functional significance of the lymphoid tissue in the tonsils, pharyngeal, and posterior nasal walls.
5. Describe the blood supply, innervation, lymphatic and venous drainage of the palatine tonsil.

G. Larynx

1. Explain the structure and function of the hyoid bone and larynx.
2. Describe the muscles of the larynx, in terms of attachments, actions, and innervations.

3. Describe the internal structure, blood supply, innervation, lymphatic and venous drainage of the larynx.

H. Ear

1. Explain the structure, function, and innervation of the external and middle ear.

Neck

1. Describe the fascial layers and spaces of the neck.
2. Describe the sternocleidomastoid, suprahyoid, and infrahyoid muscles, including their attachments, actions, and innervations.
3. Describe the boundaries and contents of the anterior and posterior triangles of the neck (including subtriangles).
4. Describe relationships between the major structures passing between the neck and the thorax.
5. Describe the location, anatomic relations, function and blood supply of the thyroid and parathyroid glands.
6. Describe the cervical plexus, its distribution and the cutaneous innervation of the neck.
7. Describe the cervical sympathetic ganglia in the neck.
8. Describe the course and relationships of the vagus, accessory, hypoglossal and phrenic nerves in the neck.
9. Describe the courses, branches and important relationships of the subclavian vessels.
10. Describe the carotid sheath and its contents.
11. Describe branches of the common and external carotid arteries.
12. Describe the carotid sinus and carotid body.
13. Describe the course of the brachiocephalic, external jugular and internal jugular veins.
14. Describe the arrangement of the cervical lymph nodes and lymphatic drainage of the head and neck.

XII. Clinical Anatomy of Head and Neck

1. Identify bony features and soft tissue structures of the head and neck in diagnostic imaging.
2. Distinguish the appearance of extradural and subdural hematomas on transverse CT scans.
3. Describe how fractures of the cribriform plate can result in meningitis and anosmia.
4. Explain the clinical significance of emissary veins.
5. Describe the “danger areas” of the face and scalp, nature of scalp injuries and the spread of infection through the pterygoid plexus and/or into the dural venous sinuses.
6. Describe the major arteries that supply the lateral wall and nasal septum in relation to epistaxis.
7. Explain dislocation of the temporomandibular joint.
8. Describe the clinical presentation of cranial nerve dysfunction.
9. Explain the anatomical basis of Horner syndrome.
10. Distinguish clinical presentations of the laryngeal nerve injuries.
11. Explain the anatomical basis for the spread of infections from the oral cavity into the thorax.
12. Identify the surface landmarks for the carotid pulse.
13. Describe the clinical importance of the cervical pleura in relation to trauma at the base of the neck.
14. Identify surface landmarks that are commonly used when inserting a central venous line.
15. Describe the thoracic outlet syndrome.
16. Identify surface landmarks for the hyoid bone, thyroid cartilage, cricoid cartilage, and tracheal rings.
17. Describe the clinical anatomy of procedures that open or maintain the airway.

LOWER EXTREMITY ANATOMY

LEARNING OBJECTIVES

Anatomical Terminology and Gait Cycle

Osteology of the Thigh and Gluteal Region

Joints of the Thigh and Gluteal Region

Muscles and Fasciae of the Thigh and Gluteal Region

Vascularization of the Thigh and Gluteal Region

Lymphatics of the Thigh and Gluteal Region

Innervation of the Thigh and Gluteal Region

Osteology of the Leg

Joints of the Leg

Muscles and Fasciae of the Leg

Vascularization of the Leg

Lymphatics of the Leg

Innervation of the Leg

Osteology of the Foot

Joints of the Foot

Muscles and Fasciae of the Foot

Vascularization of the Foot

Lymphatics of the Foot

Innervation of the Foot

Sectional Anatomy of the Lower Extremity

Lumbosacral Plexus

Surface Anatomy of the Lower Extremity

Development of the Lower Extremity

I. Anatomical Terminology and Gait Cycle

1. Describe the anatomical position of the lower extremity.
2. Apply anatomical terms to movements of the lower extremity.
3. Define the stance and swing phases of the gait cycle.

II. Osteology of the Thigh and Gluteal Region

1. Describe the bony features of the pelvis and femur that serve as muscular and/or ligamentous attachment sites in the gluteal region and thigh.
2. Describe the major features of the femur.
3. Define the angle of femoral inclination, declination (femoral torsion), and anteversion.
4. Define coxa valga and coxa vara.
5. Identify the osteological features of the thigh and gluteal region in diagnostic images.
6. List the palpable landmarks of the gluteal region and thigh utilized for physical exam or clinical procedures.

III. Joints of the Thigh and Gluteal Region

1. Describe the formation, axes of motion, and ligamentous structure of the sacroiliac joint.
2. Describe the formation, axes of motion, and ligamentous structure of the hip joint.
3. Identify the osteological features of the hip joint in diagnostic images.

IV. Muscles and Fasciae of the Thigh and Gluteal Region

1. Describe the superficial fascia and its contents in the gluteal region and thigh.
2. Describe how the deep fascia forms the anterior, medial, and posterior compartments of the thigh.
3. Describe the boundaries and contents of the muscular and vascular compartments deep to the inguinal ligament (subinguinal space).
4. Describe the origin, course, insertion, and action of the Iliacus and psoas major muscles.
5. Identify the muscles in the gluteal region and describe the origin, course, insertion, and action for each muscle.
6. Identify the muscles in the anterior, medial, and posterior compartments of the thigh and describe the origin, course, insertion, and action for each muscle.
7. Describe the boundaries and contents of the femoral triangle.
8. Describe the boundaries and contents of the adductor canal.
9. Describe the bursae of the hip and gluteal region.
10. Discuss the anatomical basis of the Trendelenburg Gait.
11. Identify the gluteal muscles and muscles of the thigh on diagnostic images.

V. Vascularization of the Thigh and Gluteal Region

1. Describe the superficial and deep veins of the thigh, including their formation, course, and terminations.
2. Describe the course of the superior and inferior gluteal arteries and their respective branches.
3. Describe the course of the obturator artery and its branches.
4. Describe the course of the femoral artery and its branches.
5. Describe the course of the profunda femoris artery and its branches.
6. Describe the collateral circulation around the hip and proximal thigh.
7. Describe the anatomical basis for avascular necrosis of the femoral head.

VI. Lymphatics of the Thigh and Gluteal Region

1. Describe the superficial and deep lymphatic drainage patterns of the thigh and gluteal regions.
2. Distinguish the groups of lymph nodes in the inguinal region.

VII. Innervation of the Thigh and Gluteal Region

1. Describe the superior and inferior gluteal nerves and their branches.
2. Describe the femoral nerve and its branches.
3. Describe the obturator nerve and its branches.
4. Describe the lateral femoral cutaneous nerve and its branches.
5. Describe the posterior femoral cutaneous nerve and its branches.
6. Describe the sciatic nerve and its divisions.

VIII. Osteology of the Leg

1. Describe the features of the tibia, fibula, and patella.
2. Define tibial torsion and Q angle.
3. Identify the features of the leg in diagnostic images.

IX. Joints of the Leg

1. Describe the formation and ligamentous support of the superior and inferior tibiofibular joints.
2. Describe the interosseous membrane.
3. Describe the formation, axes of motion, ligamentous support, and structure (extracapsular, capsular, and intracapsular) of the knee joint.
4. Describe the bursae around the knee joint.
5. Identify the osteological features of the tibiofibular and knee joints in diagnostic images.
6. Describe common ligamentous, meniscal, and articular damage to the knee joint.

X. Muscles and Fasciae of the Leg

1. Describe the superficial fascia and its contents.
2. Describe how the deep fascia contributes to the formation of the anterior, lateral, and superficial and deep posterior compartments.
3. Describe the formation of the five retinacula around the ankle and proximal foot and the arrangement of structures passing deep to them.
4. Identify the muscles of the anterior, lateral, and superficial and deep posterior compartments and describe the origin, course, insertion, and action for each muscle.
5. Describe the location of the retrocalcaneal and subcutaneous calcaneal bursae.
6. Describe the boundaries and contents of the popliteal fossa.
7. Describe compartment syndromes.

XI. Vascularization of the Leg

1. Describe the superficial and deep veins of the leg, including their formation, course, and terminations.
2. Describe the course and branches of the popliteal artery.
3. Describe the collateral circulation around the knee joint.
4. Describe the course and branches of the anterior and posterior tibial, and fibular (peroneal) arteries.

5. Describe the collateral circulation around the ankle joint.
6. Describe the formation of varicosities and thromboses.
7. Describe the function of the calf muscle pump.

XII. Lymphatics of the Leg

1. Describe the superficial and deep lymphatic drainage patterns.
2. Describe the lymph nodes of the popliteal fossa and leg.

XIII. Innervation of the Leg

1. Describe the course and branches of the common fibular (peroneal) nerve.
2. Describe the course and branches of the deep and superficial fibular (peroneal) nerves.
3. Describe the course and branches of the tibial nerve.
4. Discus the origins and course of the sural nerve.
5. Describe the saphenous nerve and its branches.
6. Discuss the anatomical causes of foot drop.

XIV. Osteology of the Foot

1. Describe the anatomical, biomechanical, and surgical divisions of the foot.
2. Describe the features of the individual tarsal and metatarsal bones.
3. Compare and contrast the features of the proximal, middle, and distal phalanges.
4. Distinguish the features of the foot in diagnostic images, including ossification patterns.
5. Describe the location and functions of the first metatarsal sesamoids.
6. Describe the locations of variable sesamoids and identify them in diagnostic images.
7. Describe the locations of accessory ossicles and identify them in diagnostic images.
8. Describe the following clinical aspects of the osteology of the foot: heel spur, neutral triangle of the calcaneus, calcaneal apophysitis, Haglund deformity, talar torsion, Stieda process, metatarsal stress fractures, fusion of the middle and distal phalanges of the fifth toe.

XV. Joints of the Foot

1. Describe the formation, axis of motion, and ligamentous support of the ankle joint.
2. Compare and contrast anatomical versus functional definitions of the tarsal joints.
3. Describe the formation, axis, and motion of the functional subtalar joint.
4. Describe the formation, axes, and motions of the functional midtarsal (Chopart) joint.
5. Describe the formation and ligamentous support of the tarsometatarsal (Lisfranc) joints.
6. Describe the formation and ligamentous support of the anatomical subtalar joint.
7. Describe the formation and ligamentous support of the talocalcaneonavicular joint.
8. Describe the formation and ligamentous support of the calcaneocuboid joint.
9. Describe the formation and ligamentous support of the great tarsal joint (cuboideonavicular, cuneonavicular, intercuneiform, cuneocuboid, middle tarsometatarsal articulations).
10. Describe the formation and ligamentous support of the medial and lateral tarsometatarsal joints.
11. Describe the formation and ligamentous support of the intermetatarsal joints.
12. Describe the formation and ligamentous support of the lesser metatarsophalangeal joints.
13. Describe the formation and ligamentous support of the first metatarsophalangeal joint.
14. Describe the formation and ligamentous support of the interphalangeal joints.

15. Distinguish the components of the joints of the foot in diagnostic images.
16. Identify the synovial cavities of the foot and list the articulations found within each synovial cavity.
17. Describe the formation and the osseous, ligamentous, and muscular support of the longitudinal and transverse arches of the foot.
18. Describe the anatomical bases of ankle sprains.

XVI. Muscles and Fasciae of the Foot

1. Describe the superficial fascia on the dorsal and plantar aspects of the foot, including its contents.
2. Describe the complexity of the dorsalis pedis fascia.
3. Describe the origin, course, insertion, and actions of the intrinsic muscles on the dorsum of the foot.
4. Describe the formation and the functions of the extensor hood (expansion) of the hallux and lesser digits
5. Describe the divisions of the plantar aponeurosis, its proximal and distal attachment sites, and its continuity with the intermuscular septa.
6. Describe the boundaries and contents of the three major compartments in the plantar foot.
7. Identify the intrinsic and extrinsic muscles in each of the four layers of the plantar foot and for each intrinsic muscle, list the origin, course, insertion, and action(s).
8. Describe the relationship between the tendons of the extrinsic muscles and the intrinsic muscles on the dorsal and plantar surfaces of the foot.
9. Describe the synovial sheaths of the extrinsic muscles of the foot.
11. Describe the common muscular variations found in the foot.
12. Explain the spread of infections within and between compartments of the foot and leg.

XVII. Vascularization of the Foot

1. Describe the superficial and deep venous return.
2. Describe the formation, course, and branches of the dorsalis pedis artery.
3. Describe the formation, course, and branches of the medial and lateral plantar arteries.
4. Describe the formation of the dorsal and plantar digital arteries.
5. Describe the major anastomoses in the rearfoot and the forefoot.
6. Identify common variations in the vascular supply of the foot.
7. Describe the anatomical basis for avascular necrosis of the talar head.

XVIII. Lymphatics of the Foot

1. Explain the superficial and deep lymphatic drainage.

XIX. Innervation of the Foot

1. Describe the formation, course, and the branches of the deep fibular (peroneal) nerve.
2. Describe the formation and courses of the medial and intermediate dorsal cutaneous nerves and their respective branches.
3. Describe the formation and course of the lateral dorsal cutaneous nerve and its branches.
4. Describe the formation and course of the saphenous nerve.
5. Describe the formation and courses of the medial and lateral plantar nerves and their respective branches.
6. Describe the formation and courses of the medial and lateral calcaneal nerves.
7. Describe the anatomical bases for tarsal tunnel syndrome, Morton neuroma, and digital nerve blocks.

XX. Sectional Anatomy of the Lower Extremity

1. Identify the osteology, integument, superficial fascia, deep fascia, compartments, muscles/tendons, vessels, and nerves on a transverse section through the mid-thigh.
2. Identify the osteology, integument, superficial fascia, deep fascia, compartments, muscles/tendons, vessels, and nerves on a transverse section through the tibial tuberosity of the leg.
3. Identify the osteology, integument, superficial fascia, deep fascia, interosseous membrane, compartment muscles/tendons, vessels, and nerves on a transverse section through the middle one third of the leg.
4. Identify the osteology, integument, superficial fascia, deep fascia, muscles/tendons, vessels, and nerves on a transverse section through the malleoli of the leg.
5. Label the osteology, integument, superficial fascia, deep fascia, ligaments, muscles/tendons, vessels, and nerves on a frontal or coronal section through the mid metatarsal shaft regions of the right and leg foot.
6. Identify the osteology, integument, superficial fascia, deep fascia, ligaments, muscles/tendons, vessels, and nerves on a coronal section through each of the metatarsophalangeal joints of the foot.
7. Identify the osteology, integument, superficial fascia, deep fascia, ligaments, muscles/tendons, vessels, and nerves on a coronal section through the proximal and distal interphalangeal joints of the foot.
8. Identify the osteology, integument, superficial fascia, deep fascia, ligaments, muscles/tendons, vessels, and nerves on sagittal sections through the first and fifth rays of the foot.

XXI. Lumbosacral Plexus

1. Describe the lumbar portion of the lumbosacral plexus and its branches.
2. Describe the sacral portion of the lumbosacral plexus and its branches.
3. Describe the dermatomes of the lower extremity.
4. Review the cutaneous innervation of the lower extremity.
5. Review the origin, course, and functions of the sympathetic system in the lower extremity.
6. Describe the myotomes and deep tendon reflexes of the lower extremity.
7. Compare and contrast anatomical bases of radiculopathies and peripheral neuropathies of the lower extremity.

XXII. Surface Anatomy of the Lower Extremity

1. Describe the surface anatomy of the thigh region.
2. Describe the surface anatomy of the gluteal region.
3. Describe the surface anatomy of the popliteal fossa and knee region.
4. Describe the surface anatomy of the leg region.
5. Describe the surface anatomy of the foot and ankle.
6. Compare and contrast Langer lines and relaxed skin tension lines.

XXIII. Development of the Lower Extremity

1. Describe the early development of a limb bud and its differentiation into thigh, leg, and foot regions.
2. Describe the sequence of rotations during development.
3. Describe the development of the arterial system.
4. Describe the development of the innervation.
5. Describe the chondrification and ossification.
6. Describe the development of the muscles.
7. Describe the development of the joints.
8. Compare and contrast pre- and post-axial structures.

MEDICAL GENETICS

LEARNING OBJECTIVES

I. Medical Knowledge

Genome Organization/Gene Regulation

Gene Variation

Population Genetics

Inheritance

Cytogenetics and Molecular Genetics

Biochemical Genetics

II. Patient Care

Medical Genetics/Inheritance

Genetic Testing

Cancer Genetics

Reproductive and Prenatal Genetics

Treatment/Management

Interpersonal and Communication Skills

Practice-Based Learning and Improvement

Professionalism

Systems-Based Practice

I. Medical Knowledge

A. Genome Organization/Gene Regulation

1. Describe the organization of the human genome including the approximate number of genes, the number of chromosomes, and how DNA is packaged into chromatin, and the function of heterochromatin and euchromatin. Describe the organization of the mitochondrial genome.
2. Describe the structure and function of genes.
3. Describe the processes of transcription and translation of eukaryotic genes including the different steps. Describe how transcription is regulated by regulatory factors.
4. Explain how temporal and spatial patterns of gene expression vary throughout the lifespan, how gene expression patterns can influence disease, and how errors in gene expression influence disease.
5. Explain epigenetic regulation of gene expression during development, and in response to environmental influences and disease.

B. Genetic Variation

1. Explain the concept of genetic individuality as it applies to human physiological variation.
2. Describe the types and extent of variation in the human genome and how they contribute to normal phenotypic variation and to disease.
3. Describe missense, nonsense, frame shift, microdeletions, and splice site mutations that lead to human disease and their functional consequences.
4. Explain the basis of genotype-phenotype correlations and how different types of mutations influence clinical outcomes and disease severity.
5. Define dominant negative, loss of function, gain of function, haploinsufficiency mutations.
6. Describe the spectrum of genetic contribution to disease, from disease-causing mutations in Mendelian disorders to genetic and environmental susceptibility factors in multifactorial disease.
7. Compare and contrast rare versus common genetic variants with respect to their contribution to human health and disease susceptibility.
8. Explain how genetic variants can affect drug response in individuals, including efficacy and adverse drug reactions.
9. Describe the principles of genetic linkage analysis and genome-wide association studies, including the concept of linkage disequilbrium, and how they are used to identify genes contributing to disease.
10. Describe how understanding the pathophysiology of a specific genetic mutation could lead to more effective treatment.
11. Describe how understanding the effect of a specific mutation could lead to more effective treatment.
12. Describe how mutations can arise during the process of DNA replication and DNA repair.

C. Population Genetics

6. Explain genetic variation with respect to geographic ancestry and evolution, and its effect on variation between populations.
2. Explain basic concepts of population genetics, including heterozygote advantage and consanguinity.
3. Apply the concepts of the Hardy-Weinberg law to determine genetic risk carrier frequency, gene frequency, and disease frequency for autosomal and X-linked disorders.
4. Explain how carrier frequency within populations influences local health care policy and practice.

5. Compare and contrast genetic and biogeographical ancestry with the social construct of race with respect to their influence on health disparities.

D. Inheritance

1. Compare and contrast monogenic and multifactorial inheritance.
2. Describe the characteristic features of Mendelian inheritance patterns (autosomal, X-linked, recessive and dominant).
3. Use information in a pedigree to deduce probabilities of transmission for Mendelian traits and diseases.
4. Explain how factors such as incomplete penetrance, delayed age of onset, variable expressivity, genetic heterogeneity (allelic and locus), anticipation, pleiotropy uniparental disomy and environmental factors affect the phenotypic expression of a disease and the observed pattern of inheritance.
5. Describe how non-Mendelian inheritance, including somatic and germline mosaicism, uniparental disomy, epigenetics and genomic imprinting, unstable repeat expansion and contraction, and chromosomal rearrangements affect the phenotype and recurrence risk of genetic disorders.
6. Describe the characteristic features of mitochondrial inheritance and explain the role of maternal inheritance and heteroplasmy in mitochondrial diseases.
7. Explain the principles of multifactorial inheritance as it applies to complex disorders.
8. Describe the threshold model and the factors that can be used as predictors of multifactorial inheritance.

E. Cytogenetics and Molecular Genetics

1. Describe the structure and function of chromosomes. Compare and contrast their segregation in mitosis and meiosis.
2. Demonstrate a basic understanding of cytogenetic nomenclature.
3. Explain the indications for and limitations of karyotype analysis.
4. Describe the types of numerical and structural abnormalities seen in human chromosomes.
5. Explain the concept of somatic and germline mosaicism and how it affects the phenotypic expression of a disorder.
6. Compare molecular diagnostic techniques used in genetic testing.

F. Biochemical Genetics

1. Explain what is meant by an inborn error of metabolism.
2. Describe the underlying genetic defect and mode of inheritance for inborn errors of metabolism, particularly those related to bone health and gout.
3. Describe how allelic heterogeneity and environmental factors contribute to variable presentation of metabolic diseases, particularly with regard to type 2 diabetes.

II. Patient Care

A. Medical Genetics/Inheritance

1. Recognize the indications to refer for a genetics evaluation, including family history of disease, congenital anomalies, developmental disability, and multiple miscarriages or reproductive failure.

2. Obtain and interpret medical, social, and family histories and physical exam findings in order to determine if a patient is at risk for a genetic disorder.
3. Utilize a three-generation family history to construct a pedigree and interpret the mode of inheritance.
4. Assess recurrence risks for Mendelian, multifactorial, mitochondrial disorders and chromosomal abnormalities.
5. Explain the relevance of a genetics evaluation and basic concepts of inheritance to the patient.
6. Obtain appropriate information regarding management and surveillance of the disorder after genetic diagnosis is made.
7. Provide information about appropriate patient support and resources including genetics support groups, community groups, or other resources that may benefit the patient and their family.

B. Genetic Testing

1. Explain screening, diagnostic, and predictive genetic testing strategies as components in the evaluation of a patient.
2. Identify the benefits, indications for and limitations and risks of genetic tests, including the ethical concerns associated with genetic testing and the importance of the informed consent process and of genetic counseling.
3. Explain how genetic and genomic testing (including direct to consumer genetic testing) may be used as a component of personalized health care with a focus on prevention, assessment of disease risk, identification of pharmacogenetic variants and treatment options.

C. Cancer Genetics

1. Differentiate among sporadic, familial, and hereditary cancer based on medical and family history, and identify individuals at increased personal risk for developing cancer.
2. Describe the role of genetic and genomic testing, including the benefits, limitations, and ethical implications for cancer patients and their unaffected family members.
3. Explain how cytogenetic and molecular technologies can be used to establish and guide the diagnosis, prognosis, treatment and long-term follow up of cancer.
4. Explain how germline mutations in oncogenes, tumor suppressor genes and DNA repair genes are associated with an increased risk of cancer and with inherited cancer syndromes.
5. Compare the genetic and epigenetic mechanisms underlying a multistep mechanism for cancer development including somatic and germline mutations and epigenetic changes.

D. Reproductive and Prenatal Genetics

1. Recognize the indications for preconception and prenatal carrier testing for genetic disorders depending on family history and specific ethnic background and parental age.
2. Discuss commonly used prenatal screening tests, including first and/or second trimester serum screening, cell free fetal DNA testing, and ultrasound evaluation.
3. Define association, sequence, malformation, deformation, disruption and syndrome.

E. Treatment/Management

1. Discuss the following treatment strategies for genetic disease, including when they are best utilized clinically:
    a. Organ transplantation, stem cell therapy and regenerative medicine
    b. Correction, enhancement, or replacement of a defective structural protein or enzyme

c. Dietary modulation/intervention
d. Diversion/shunting

2. Describe how modification of non-genetic factors, such as diet, exercise and other lifestyle factors can prevent or mitigate disease in some genetically predisposed individuals.
3. Describe the ways in which pharmacogenetics/pharmacogenomics can inform dosing of medication, including prediction of physiological response and/or adverse drug reactions.

F. Interpersonal and Communication Skills

1. Communicate with patients and families regarding genetic information in a culturally sensitive and non-judgmental manner in a way that can be understood by the patient accounting for differences in educational, socio-economic, and ethnic backgrounds.
2. Explain the medical and legal processes for diagnostic and predictive testing of adults and minors, including the risks, benefits, limitations, and implications for other family members, and of obtaining informed consent and pre-and post-test counseling.
3. Communicate family history and medical history pertinent to genetics with an interdisciplinary team of health care professionals.
4. Recognize the need to reduce public fear and misinformation about genetics.

G. Practice-Based Learning and Improvement

1. Identify and utilize peer-reviewed resources to obtain current information about genetics and its application to clinical practice.
2. Describe the role of clinical genetics professionals (e.g., medical geneticists, genetic counselors, clinical laboratory directors) in patient care, and the process of making appropriate referrals for genetic evaluations.

H. Professionalism

1. Describe how genetic information is different from other medical information and how that difference may affect decisions of health care providers, patients, and their families.
2. Identify examples of misuse of genetic/genomic information and testing results.
3. Describe the potential impact of genetic information on insurance coverage and employment status.

I. Systems-Based Practice

1. Explain the implications of local, state and federal laws, including the Genetic Information Non-Discrimination Act (GINA), that affect the privacy, confidentiality and potential discrimination related to genetic information.
2. Identify the challenges of including genetic information in electronic medical records, including confidentiality, insurance coverage, and other unforeseen issues, (including reclassification of Variants of Unknown Significance).
3. Recognize the scope of practice of genetics health professionals and the collaborative nature of genetic patient care.

MICROBIOLOGY/IMMUNOLOGY

LEARNING OBJECTIVES

Antimicrobial Agents and Control of Microbes

Basic Bacteriology

Basic Concepts in Immunology

Clinical Immunology

Basic Mycology

Basic Parasitology

Basic Virology

Microbial Pathogenesis

Cardiac Infections

Genitourinary Infections and STDs

Gastrointestinal Infections

Skin, Soft Tissue, and Bone Infections

Nervous System Infections

Respiratory Tract Infections

Zoonotic and Opportunistic Infections

Blood and Systemic Infections

I. Antimicrobial Agents and Control of Microbes

1. Define:
    a. antiseptic
    b. aseptic
    c. bactericidal
    d. bacteriostatic
    e. disinfectant
    f. germicide
    g. sanitization
    h. sterilization
2. Describe the general effects chemical and physical agents have on membranes, proteins, and nucleic acids that are lethal to cells.
3. Describe the differential effect that dry and moist heat have on cells.
4. Compare and contrast using boiling versus autoclaving to control microbial growth.
5. Identify appropriate methods of sterilization and conditions when each method is used:
    a. Filtration
    b. Autoclaving
    c. Boiling
    d. Radiation (ionizing and nonionizing)
6. Identify the mechanism of action and uses of the following in controlling microbial growth:
    a. alcohols
    b. alkylating agents
    c. ethylene oxide
    d. formaldehyde
    e. glutaraldehyde
    f. halogens
    g. heavy metals
    h. hydrogen peroxide
    i. iodine, iodophor, chlorine and its various forms
    j. phenol and derivatives of phenol
    k. quaternary ammonium compounds
7. Identify the microbiological basis on which antimicrobials (antibacterial, antiviral, antifungal, and antiparasitic agents) are selected to treat infections.
8. Describe the significance of antibiotic susceptibility testing and be able to interpret results, including defining Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC).
9. Define broad-spectrum, narrow-spectrum, and extended-spectrum antimicrobials.
10. Compare and contrast bactericidal and bacteriostatic antimicrobials.
11. Identify the target, primary mode of action, mechanisms of bacterial resistance, spectrum of activity, and any unique characteristics of the following classes of antimicrobial agents, and list examples:
    a. Anti-mycobacterial inhibitors
    b. Cell wall synthesis inhibitors
    c. Membrane disruptors
    d. Metabolic inhibitors
    e. Nucleic acid inhibitors
    f. Protein synthesis inhibitors
12. Discuss the role of gastric acid lability of antibiotics.

13. Explain why some antimicrobial agents are most effective against rapidly growing cells while other agents are active against both rapidly growing and resting cells.
14. Explain the mechanisms of the following inherent resistances to antimicrobial agents: mycoplasma resistance to cell wall active antibiotics, anaerobe resistance to aminoglycosides, aerobic resistance to metronidazole, and gram-negative resistance to vancomycin.
15. Discuss the pros and cons of antibiotic prophylaxis and of prescribing simultaneous antibiotics in relation to antimicrobial resistance.
16. Identify the target, primary mode of action, mechanisms of resistance, spectrum of activity, and any unique characteristics of the following classes of antifungal agents, and list examples.
    a. Azoles
    b. Flucytosine
    c. Echinocandins
    d. Griseofulvin
    e. Polyenes
    f. Potassium iodide
    g. Terbinafine
    h. Tolnaftate
    i. Ibrexafungerp
27. Identify the target, primary mode of action, mechanisms of resistance, and any unique characteristics of the following classes of antiviral agents, and list examples.
    a. Protease inhibitors
    b. Nucleic acid inhibitors
    c. Neuraminidase inhibitor
    d. Protein synthesis inhibitors
    e. Immunomodulators
    f. Integrase inhibitors
    g. Entry/fusion inhibitors
    h. Reverse transcriptase inhibitors
    i. Polymerase inhibitors
28. Identify the target, spectrum of activity, and any unique characteristics of antiparasitic agents

II. Basic Bacteriology

1. Compare and contrast prokaryotic and eukaryotic cells, particularly with respect to cell wall structure, nuclear membranes, DNA structure, plasmids, and ribosomes.
2. Describe the microscopic morphology and arrangements of bacterial cells.
3. Describe the structure, function, and pathogenic significance of external prokaryotic structures, such as: flagella, pili/fimbriae, capsule, and biofilm production
4. Compare and contrast the structure of gram-positive, gram-negative, and acid-fast cell walls, along with the significance and procedure of Gram and acid-fast staining.
5. Describe the functions of the components of cell walls, including LPS, porins, teichoic acid, and mycolic acid.
6. Describe the synthesis and role of peptidoglycan in bacteria and as a target for antibiotics.
7. Define lysozyme and explain where it is found, as well as its biological activity.
8. Describe the bacterial secretion systems, including where they are found and their importance to pathogenicity.
9. Explain the uniqueness of mycoplasmas among bacteria.
10. Describe the structure and functions of cytoplasmic membranes in bacteria.
11. Identify the clinically-relevant bacteria that produce endospores and describe the similarities and differences between them along with the structure and function of endospores

12. Explain the methods used to classify bacteria taxonomically.
13. Classify bacteria based upon oxygen and temperature requirements and list examples of each classification.
14. Describe the phases of the bacterial growth curve, the generation time, and components (such as osmolarity, temperature, and pH) that can impact bacterial growth.
15. Explain "quorum sensing" and its importance.
16. Explain how to obtain and differentiate a pure culture of bacteria and explain the importance of and list examples of media critical to differential diagnosis (non-selective, selective, and differential).
17. Describe the various microscopic methods used to observe microbial pathogens.
18. Define glycolysis, fermentation, aerobic respiration, and anaerobic respiration and their role in bacterial identification.
19. Compare and contrast bacterial and eukaryotic transcription and translation.
20. Explain transformation, transduction (generalized/specialized) and conjugation as it occurs in bacteria and their significance to human medicine.
21. Describe the selective pressures that favor the development of antibiotic-resistant bacteria.
22. Define insertion sequence and transposon and explain their importance to virulence and disease.
23. Describe the lytic and lysogenic cycles as they occur in bacteriophage-infected bacteria and the significance of prophages in a clinical environment.
24. Explain Koch's Postulates and its limitations.
25. Explain the strategies of how pathogenic microbes can evade host defenses.
26. Differentiate between a toxigenic and an invasive pathogen.
27. Compare and contrast exotoxins, endotoxins, and enterotoxins and give examples of each.
28. Describe the source and function of superantigens, such as toxic shock syndrome toxin.
29. Explain the attributes of a microbe that contribute to invasiveness.
30. Describe the major normal flora microbes classified as opportunistic pathogens found in/on the skin, GI tract, respiratory tract, genitourinary tract, and the ear/nose/oral cavity, and understand their disease associations.
31. Describe the role of the human microbiome in health and disease.
32. Describe the major mechanisms of bacterial transmission.
33. Define the following terms with respect to bacteria:
    a. bacteremia
    b. carrier
    c. communicable disease
    d. endemic
    e. fomite
    f. infectious dose
    g. latent infection
    h. opportunistic pathogen
    i. pandemic pathogenicity
    j. primary pathogen
    k. pyemia
    l. pyogenic
    m. pyrogenic
    n. subclinical infection
    o. superinfection
    p. systemic infection
    q. systemic inflammatory response syndrome (SIRS), sepsis, severe sepsis, septic shock, and septicemia
    r. virulence
    s. zoonosis

III. Basic Concepts in Immunology

1. Compare and contrast innate and adaptive immunity.
2. Define antigenicity, immunogenicity, antigen (self and non-self), antigenic determinant, epitope, hapten, immunogen, tolerogen, and mitogen, and give examples of each.
3. Characterize active and passive immunity.
4. Identify physical and physiological barriers to infection.
5. Describe the process of white blood cell hematopoiesis.
6. Explain the role of antimicrobial peptides such as defensins or cathelicidins in innate immunity.
7. Describe the characteristics and functions of the granulocytic cells, mast cells, monocytes and macrophages, and dendritic cells (conventional, plasmacytoid, and follicular).
8. Explain the concept of innate pattern recognition of microbes.
9. Explain the role of pattern recognition receptors (PRRs) and their interaction with pathogen (microbial) associated molecular patterns (PAMPs/MAMPs) and damage associated molecular patterns (DAMPs) in the activation of innate immune cells.
10. Describe the chemotactic factors involved in the recruitment of various inflammatory cells.
11. Explain the importance of chemokines and chemokine receptors in regulation of immune cell trafficking and localization within immune organs.
12. Describe the general process of phagocytic cell recruitment and migration into sites of inflammation: rolling, activation, adherence, and transendothelial migration.
13. Define an inflammasome and its role in inflammation.
14. Define opsonin and opsonization.
15. Explain the role of Fc receptors and complement receptors in phagocytosis, and activation of phagocytic cells.
16. Describe the importance of the oxidative burst in phagocytic elimination of microbes.
17. Explain the function of natural killer (NK) cells, the role of activating and inhibitory receptors in the control of their function, and how NK cells induce apoptosis of target cells.
18. Describe the local and systemic effects of the inflammatory response.
19. Explain the role of the acute phase response and associated soluble effector proteins in the innate immune response.
20. Identify the key inflammatory cytokines and their local, as well as systemic, roles in innate immunity**.**
21. Describe the role of the complement system in innate immunity and its regulation.
22. Describe the complement receptors, expression pattern and function.
23. Compare and contrast the three complement pathways: classical, lectin, and alternative.
24. Describe how complement mediates the following and which proteins are involved:
    a. B cell activation
    b. cell lysis (membrane attack complex)
    c. chemotaxis
    d. clearance of immune complexes
    e. inflammation due to anaphylatoxins
    f. opsonization
25. Describe the general functions of the following cytokines and their receptors:
    a. IL-1, IL-2, IL-4, IL-6, IL-10, IL-12, IFNs, TNF-alpha
    b. IL-3, IL- 5, IL-7, IL-8, IL-15, IL-17, TGF-beta, CSFs
26. Explain the role of the lymphatic system in the transport of antigen and immune cells in the body.
27. Describe the function of the secondary lymphoid organs in trapping and processing of antigens.
28. Explain the function of different regions of the spleen and lymph nodes in adaptive immune responses.
29. Explain the location and function of specialized lymphoid tissues, such as the mucosal-associated lymphoid tissues (MALT)**.**

30. Describe the role of specialized epithelial cells (Paneth cells, M cells, Goblet cells, intraepithelial lymphocytes) in mucosal immunity.
31. Describe lymphocyte recirculation and the role of adhesion molecules in lymphocyte trafficking.
32. Describe the cells of adaptive immunity (T cells and B cells).
33. Describe the phases of the adaptive immune response.
34. Describe the general characteristics of humoral and cell-mediated immunity.
35. List and describe the features of the adaptive immune response – specificity, diversity, specialization, self-limitation, and memory.
36. Explain the theory of clonal selection.
37. Describe the basic aspects of naïve T and B cell activation and the role of professional antigen presenting cells in this process.
38. Describe the basic effector functions of T and B cells in an immune response.
39. Describe the maturation of B and T cells in primary lymphoid tissues.
40. Describe the functional significance and/or cellular distribution of the following:
    a. CD3
    b. CD4
    c. CD8
    d. CD14
    e. CD19
    f. CD20
    g. CD25
    h. CD40
    i. TCR
    j. BCR

41. Explain the role of the bone marrow in lymphocyte origin.
42. Describe the process of T cell maturation in the thymus:
    a. Role of thymic stromal cells and expression of AIRE
    b. Stages of T cell maturation (developmental pathway)
    c. Development and structure of the TCR complex
    d. Expression of CD4/CD8
    d. Positive and negative selection
    e. Programmed cell death (apoptosis)
43. Describe the process of B cell maturation in the bone marrow:
    a. Order of rearrangement and expression of immunoglobulin heavy and light chain genes
    b. Development and structure of the BCR complex.
    c. Light chain editing
    d. Negative selection
    e. Programmed cell death (apoptosis)
64. Explain the fundamental difference between B cell and T cell epitopes.
44. Describe the function of MHC molecules in antigen presentation and in cell-cell interactions in the immune system.
45. Describe and compare the major structural features of MHC Class I and Class II glycoproteins.
46. Identify the cells expressing class I and class II MHC molecules.
47. Identify examples of MHC/disease correlations and provide a hypothesis to account for this correlation.
48. Explain MHC polymorphism and its selective advantage.
49. Explain MHC restriction.
50. Define MHC haplotypes.
51. Explain how T lymphocytes recognize antigen bound to MHC molecules.
52. List and describe the functions of each type of professional antigen presenting cell (APC).

53. Compare and contrast the pathways of processing and presentation of both exogenous and endogenous protein antigens.
54. Describe the overall structure and function of the TCR complex on mature T cells.
55. Describe the molecular genetic mechanisms used to generate diversity in the TCR.
56. Explain the activation of T cells (e.g., the interactions between APCs and T cells leading to T cell activation), including the functional roles of CD4, CD8 and B7-CD28 costimulation.
57. Identify examples of cell adhesion molecules, and describe their role in T cell activation.
58. Describe the mechanism of superantigen activation of T cells.
59. Describe the effector T cell populations in the periphery.
60. Describe the different T helper subpopulations and their role in controlling the immune response.
61. Identify the populations of effector T cells and explain their activation requirements.
62. Explain the role of cytokines in T helper cell differentiation into Th1, Th2, or Th17 cells and describe the production and function of cytokines by these distinct T helper cell subsets.
63. Explain the process by which effector CTLs recognize target cells.
64. Describe the two processes (degranulation and Fas-FasL) of effector CTL-mediated cell lysis.
65. Explain the role of CTLA-4 and PD-1 in attenuation of T cell activation and function.
66. Describe the overall structure and function of the B cell receptor complex.
67. Describe the mechanism of antigen induced B lymphocyte activation.
68. Compare and contrast the effects of T-independent and T-dependent antigens on B cell activation.
69. Explain the activation of B cells and the role of CD40-CD40L and cytokine costimulation by CD4 T cells.
70. Identify and describe B cell subpopulations (B-1, B-2, and MZ B cells).
71. Explain the role of the germinal center in B cell responses to antigen.
72. Describe antigen-antibody interactions.
73. Define affinity and avidity.
74. Differentiate between soluble and insoluble immune complexes and explain their roles in immune processes.
75. Describe the basic structure of the 5 classes of immunoglobulins (Ig) and their functional domains.
76. Identify the two types of light chains (kappa and lambda).
77. Describe constant, variable and hypervariable regions with respect to antibody structure.
78. Explain the specialized functions of the human Ig isotypes and their role in host defense.
79. Explain the process by which IgA crosses the epithelium and identify the role of the poly-Ig receptor in IgA secretion.
80. Explain molecular genetic mechanisms involved in the generation of antibody diversity (e.g., multiple V region gene elements, variable recombination, junctional diversity, etc.).
81. Describe the mechanisms of central and peripheral tolerance in T and B cells, including anergy, deletion and suppression by Treg cells.
82. Explain the role of Fas and Fas ligand in mediating apoptosis of activated T and B cells.
83. Describe antibody dependent cell-mediated cytotoxicity (ADCC).

IV. Clinical Immunology

1. Compare and contrast the timing and mechanisms of each type of hypersensitivity reaction.
2. Describe the pathophysiologic mechanisms associated with Type I (IgE)-mediated injury.
3. Explain the process of mast cell degranulation.
4. Describe the primary effector mediators released by mast cells.
5. Describe the pathologic changes in tissues during anaphylactic reactions.
6. Compare and contrast the early and late phase responses in anaphylactic reactions.
7. Explain the role of eosinophils in allergic and anaphylactic reactions.
8. Identify treatment options for type I hypersensitivities and their mechanism of action.
9. Describe the diagnosis of Type I hypersensitivity via skin tests and immunoassays.

10. Describe the clinical symptoms and basis of the symptoms of type I hypersensitive reactions.
11. Compare and contrast type II and type III hypersensitivity reactions and give examples of each.
12. Compare complement-mediated cell lysis with antibody dependent cell cytotoxicity.
13. Explain the pathogenesis of drug-induced hypersensitivities.
14. Describe the immunological basis for erythroblastosis fetalis.
15. Describe the mechanism and histopathology of Arthus reaction.
16. Describe type IV hypersensitivity.
17. Identify the basis for and examples of contact hypersensitivity.
18. Identify the mechanisms involved in and manifestations of a positive tuberculin reaction.
19. Describe the granulomatous response.
20. Identify and describe autoimmune diseases associated with specific organs.
21. Identify autoimmune diseases that are systemic in nature.
22. Explain the role that gender, genetics, environment, and infectious disease play in the development of autoimmunity.
23. Describe the mechanisms that help to explain anti--self-responses
24. Explain the role of MHC genes in autoimmunity.
25. Describe immunotherapies used to treat autoimmune disease.
26. Describe the immunologic basis of graft rejection.
27. Define autograft, isograft, allograft, and xenograft.
28. Explain why allogeneic MHC molecules are the major molecular targets in graft rejection.
29. Compare and contrast major and minor histocompatability molecules in transplant rejection.
30. Describe hyperacute, acute, and chronic rejection and graft versus host disease.
31. Describe approaches to prolonging graft survival (e.g., immunosuppressive drugs, mAbs, and immune modulators).
32. Compare and contrast congenital (primary) and acquired (secondary) immunodeficiencies.
33. Describe causes of acquired immunodeficiencies.
34. Describe the clinical presentation and pathophysiology associated with severe combined immunodeficiencies.
35. Describe the basic defect and clinical manifestations seen in the following immunodeficiencies:
    a. Ataxia-telangiectasia
    b. Chediak-Higashi syndrome
    c. Chronic granulomatous disease
    d. Common variable immunodeficiency
    e. DiGeorge syndrome
    f. Hyper-IgM syndrome
    g. Leukocyte adhesion deficiencies
    h. Selective IgA deficiency
    i. Wiskcott-Aldrich syndrome
    j. X-linked agammaglobulinemia
    k. Congenital neutropenia
36. Explain the effects of specific complement deficiencies on patients.
37. Identify basic therapeutic approaches for treatment of immunodeficiencies.
38. Identify the immunological abnormalities associated with HIV infection.
39. Describe the concept of immunosurveillance.
40. Compare and contrast tumor-specific and tumor-associated antigens and their clinical significance.
41. Describe the roles of antibody, T cells, NK cells, and macrophages in tumor immunity.
42. Compare and contrast anti-tumor immune responses by T cells and NK cells.
43. Explain ways that tumors evade immune recognition within the tumor microenvironment.
44. Describe approaches to tumor immunotherapy: antibody-based therapies, checkpoint inhibitors, adoptive T cell therapies, cancer vaccines.

45. Describe the immune response to both intracellular and extracellular bacterial infections.
46. Explain the role of adjuvants in vaccines.
47. Describe delayed type hypersensitivity as it relates to host responses against intracellular bacteria.
48. Describe the host immune response to parasitic infection.
49. Identify mechanisms of pathogen-mediated immune evasion.
50. Explain the basis for inactivated, attenuated, subunit, toxoid, recombinant, and mRNA vaccines.
51. Differentiate between active and passive immunity to microbes.
52. Differentiate between primary and secondary immune responses.
53. Describe the use of monoclonal antibodies to modulate immune cell function.
54. Describe the use of immunosuppressive drugs for the treatment of autoimmune disease or to prevent transplant rejection.
55. Describe the use of IVIG in the treatment of autoimmune disease and congenital immunodeficiencies.
56. Identify the potential therapeutic roles of cytokines or antibodies specific for cytokines and/or their receptors in the treatment of immune-mediated diseases.
57. Describe the principles of the following diagnostic assays: ELISA, Western blot, flow cytometry/FACS, immunoprecipitation, agglutination/hemagglutination, immunofluorescence, and immunohistochemistry.
58. Differentiate between immune tolerance and immune deficiency.
59. Explain how tolerance mechanisms can fail, facilitating development of autoimmunity.
60. Explain the role of Th17 and Treg cells in mucosal immunity.
61. Describe the immune mechanisms involved with Celiac disease, Crohn's disease and ulcerative colitis.
65. Compare and contrast different types of vaccines, including advantages and disadvantages of each.

V. Basic Mycology

1. Define:
    a. arthroconidia
    b. blastospores
    c. conidia
    d. dematiaceous
    e. dimorphism
    f. hyaline
    g. hyphae
    h. macroconidia
    i. microconidia
    j. mycelium
    k. nonseptate/aseptate/coenocytic
    l. pseudohyphae/pseudomycelia
    m. septate
    n. sporangiospores
    o. zygospores
2. Compare the structure of fungal cells to other eukaryotic cells and to bacteria.
3. Compare and contrast yeasts, molds, and dimorphic fungi.
4. Describe the clinical laboratory identification of fungi.
5. Describe the purpose of a KOH preparation in the identification of fungi.
6. Define mycotoxicosis.
7. Identify the primary genera that cause cutaneous mycoses (dermatomycoses).
8. Differentiate among anthropophilic, zoophilic, and geophilic dermatophytes, and describe the clinical significance of associating the mycotic agent with its source.

9. Describe the use of the UV or Wood's lamp in diagnosing mycotic infections.
10. Describe the basis of the "Id reaction."
11. Describe the use of macroconidia and microconidia identification in in the determination of dermatophytes.
12. Differentiate between eumycotic and actinomycotic mycetomas.
13. Identify the causative agent, method of acquisition, geographic distribution, primary symptoms, and treatment for sporotrichosis, chromoblastomycosis, histoplasmosis, blastomycosis, coccidiomycosis, mucormycosis, cryptococcosis and candidiasis.
14. Differentiate among superficial, cutaneous, subcutaneous, systemic and opportunistic mycoses and give examples of each.

VI. Basic Parasitology

1. Define cyst, trophozoite, oocyst, vector, intermediate host, definitive host, and paratenic host.
2. Describe the classification and general structure of each protozoal class.
3. Describe the classification and general structure of each helminth class.
4. Explain the roles of insects and arachnids as either ectoparasites or vectors in human disease.
5. Describe the structural characteristics, mode of transmission, pathogenesis, clinical manifestations, and geographic distribution of the following parasitic organisms:
    a. *Acanthamoeba* sp.
    b. Ascaris lumbricoides
    c. *Babesia* sp.
    d. *Cryptosporidium parvum*
    e. *Entamoeba histolytica*
    f. *Enterobius vermicularis*
    g. *Giardia lamblia* (*intestinalis*)
    h. Hookworms (*Necator, Ancylostoma*)
    i. *Naegleria fowleri*
    j. *Plasmodium* sp.
    k. *Schistosoma* sp.
    l. *Toxocara canis*
    m. *Toxoplasma gondii*
    n. *Trichinella spiralis*
    o. *Trichomonas vaginalis*
    p. *Wuchereria bancrofti*

VII. Basic Virology

1. Define:
    a. cytopathic effect
    b. hemagglutination
    c. plaque
    d. reassortment
    e. reverse transcription
    f. syncytia
2. Describe the size, shape, nucleic acid, capsid, capsomere, nucleocapsid, capsid symmetry, icosahedral, helical, and envelope of viruses.
3. Describe the classification of DNA virus families, including whether they are enveloped or non-enveloped; the DNA structure (dsDNA, ssDNA, linear, circular); and replication site.

4. Describe the classification of RNA virus families, including whether they are enveloped or non-enveloped; the RNA structure (dsRNA, ssRNA, linear, circular); sense (positive, negative, or ambisense); and replication site.
5. Explain defective viruses.
6. Explain prions.
7. Describe virus replication, including adsorption, entry, uncoating, genome replication, viral protein synthesis, assembly, maturation, and release (lysis or budding).
8. Differentiate between antigenic drift and antigenic shift.
9. Discuss malignant transformation, oncogenes and tumor suppressor proteins.

VIII. Microbial Pathogenesis

1. Differentiate between endogenous (i.e., normal flora) and exogenous sources of infection and how normal flora on skin or mucosal membranes can cause disease when introduced into deeper tissues.
2. Explain the significance of microbial adhesion and what components help in establishment of an infection.
3. Describe what structures act as adhesins for enveloped versus nonenveloped viruses.
4. Describe how host cell surface components can act as receptors.
5. Discuss the function of neutralizing antibodies in preventing microbial attachment.
6. Explain how attachment helps microorganisms to remain at a particular location/evade innate defense mechanisms.
7. Describe the role and function of the following structures or secreted enzymes in pathogenesis of bacteria.
    a. coagulase
    b. IgA protease
    c. leukocidin
    d. hemolysins
    e. M protein
    f. pili/fimbriae
    g. lipopolysaccharide/lipooligosaccharide
    h. polysaccharide capsule
    i. protein A
8. Describe the advantage of encapsulation for bacteria and give examples of encapsulated organisms.
9. Explain how hemolysis patterns on blood agar can help with species differentiation and disease diagnosis.
10. Discuss dvantages and modes of intracellular growth from a microbial perspective.
11. List acteria that rearrange actin to enable their entry into host cells.
12. Charactrize the following intracellular survival mechanisms:
    a. alteration of phagolysosomal environment
    b. escape from phagosome
    c. prevention of phagolysosome fusion
13. Describ the adaptations/virulence factors utilized by extracellular bacteria to evade the host's antimicrobial defenses.
14. Assess he significance of intracellular growth when selecting an appropriate antimicrobial agent.
15. Explain he significance of tissue tropism in microbial pathogenesis.
16. Identify he factors, both host and microbial, that influence the colonization of a particular site by a microorganism.
17. Define nd compare/contrast benefits of symbiosis, commensalism, parasitism, colonization, and mutualism between organism and host.

18. Identify factors that predispose to the development of disease when a host encounters a microorganism.
19. Identify mechanisms of host cell and tissue damage by pathogens.
20. Explain pathogenesis of septic shock.
21. Explain he pathogenesis of disseminated intravascular coagulation due to infection.
22. Describe the morphologic growth patterns of fungi and identify which are advantageous for allowing invasion of host tissue.
23. Explain occurrences in a virally-infected cell that result in persistent or latent infection.
24. Describe the changes in a cell that is transformed by viral infection.
25. Identify acterial components that are active in eliciting a host immune response.
26. Explain how antigenic variation facilitates evasion of the host immune response by pathogens, and how this affects host and therapeutic/prophylactic mechanisms to prevent reinfection.
27. Identify and describe viruses that produce syncytia and explain the mechanism of cell-to-cell spread that enhances their ability to evade the host immune response.
28. Describe mechanisms used by viruses to produce persistent infections.
29. Describe the mechanism through which herpes viruses produce a latent infection in their host and the contribution to the ability to evade the host immune response.
30. Explain the lack of host immune response in prion diseases.
31. Explain the contribution of antigenic shift and antigenic drift to the ability of influenza virus to evade the host immune response.
32. Describe and give examples of the following modes of transmission:
    a. aerosols/aerosolization
    b. community-acquired
    c. endogenous infection
    d. fecal-oral
    e. fomites
    f. food/water
    g. horizontal transmission
    h. nosocomial/hospital-acquired
    i. percutaneous
    j. person-to-person
    k. rodent-borne
    l. sexual contact
    m. soil
    n. vector-borne
    o. vertical transmission
    p. zoonotic
33. Describe structural features of viruses that often affect their stability in the environment and mode of transmission.
34. Identify the major sites of entry for infectious agents into the body and the barriers they must overcome at these sites to survive.
35. Define reservoir and vector in the context of zoonoses.
36. Differentiate among self-limited infection, subacute infection, acute infection, latent infection, persistent infection, and chronic infection.
37. Describe the steps that occur in an acute, self-limiting infection with respect to the pathogen, pathogenesis, and host immune response.
38. Describe the role of international travel, exotic pets, and exotic food sources in the spread of emerging infectious diseases.
39. Describe how the creation of new environmental niches and climate change have contributed to the development of several emerging infectious diseases.

40. Explain the term “chronic carrier.”
41. Compare/contrast the replicating viral trajectory of different viruses.

IX. Cardiac Infections

1. Identify the organisms that commonly cause endocarditis.
2. Explain the risk factors underlying etiologies in particular patients.
3. Describe “vegetative” lesions associated with endocarditis and explain the contribution to the diagnosis and effect on therapeutic options.
4. Differentiate between acute and subacute bacterial endocarditis (ABE and SBE) and give examples of each.
5. Explain the laboratory procedures that distinguish among the organisms causing endocarditis.
6. Describe the important virulence factors for pathogens causing endocarditis and discuss how these factors contribute to the virulence of these organisms.
7. Describe the role of lysogenized strains of *Corynebacterium diphtheriae* in causing congestive heart failure.
8. Identify the most common infectious causes of myocarditis.

X. Genitourinary Infections and STDs

1. Define cystitis and pyelonephritis.
2. Distinguish acute from chronic pyelonephritis.
3. Describe the most common causes of community-acquired versus nosocomial urinary tract infections (UTIs).
4. Explain why some UTIs cause urolithiasis.
5. Explain the routes of transmission of agents of UTIs.
6. Identify the host defenses that protect against infection by UTI-causing bacteria.
7. Identify factors that predispose patients to UTIs.
8. Explain the prevalence of bacterial UTIs in females.
9. Describe diagnostic methods for bacterial UTIs.
10. Describe the risk factors and pathogenesis of agents causing UTIs, including:
    a. *Enterococcus* spp.
    b. *Mycoplasma* spp.
    c. *Ureaplasma urealyticum*
    d. *Klebsiella* spp.
    e. *Proteus* spp.
    f. *Pseudomonas aeruginosa*
    g. *Staphylococcus saprophyticus*
    h. Uropathogenic *E. coli* and Extraintestinal Pathogenic *E. coli*
11. Describe structural characteristics of *Treponema pallidum* spp *pallidium*.
12. Describe the transmission, risk factors, epidemiology, pathogenesis, and clinical identification of syphilis, including primary, secondary, and tertiary manifestations of disease.
13. Describe congenital syphilis and describe its manifestations and prevention.
14. Explain the difference between non-specific and specific serological tests for syphilis and the pattern of the immune response.
15. Describe structural characteristics of *Neisseria gonorrhoeae* and growth media requirements.
16. Describe the transmission, risk factors, epidemiology, pathogenesis, treatment and clinical identification of *N. gonorrhoeae infection*.
17. Distinguish between gonococcal and non-gonococcal urethritis and identify causative agents of non-gonococcal urethritis (NGU).

18. Describe disseminated gonococcal infections and distinguish them from gonococcal infections of the eyes and throat.
19. Explain the importance of phase and antigenic variation in pathogenesis of *Neisseria gonorrhoeae*.
20. Describe the correlation between *N. gonorrhoeae* cervicitis and pelvic inflammatory disease (PID) in women.
21. Describe the life cycle and unique properties of *Chlamydia trachomatis*.
22. Describe structural characteristics of *Mycoplasma genitalium* and growth media requirements.
23. Describe the diagnosis and treatment of non-gonococcal urethritis (NGU).
24. Describe how NGU can lead to PID in women.
25. Describe the characteristics and causative agent of lymphogranuloma venereum (LGV).
26. Describe the transmission, risk factors, epidemiology, pathogenesis, clinical identification and treatment of infections by the protozoan *Trichomonas vaginalis.*
27. Describe the signs and symptoms associated with non-specific vaginitis and bacterial vaginosis.
28. Describe the characteristics, diagnosis, and treatment of vulvovaginal candidiasis.
29. Explain how *Candida* can cause disease as a member of normal human flora.
30. Describe the virion and genome structure of herpes simplex types 1 & 2 (HSV-1 and HSV-2).
31. Describe the transmission and pathogenesis of genital HSV-1 and HSV-2 infections.
32. Describe the concept of viral latency/reactivity and its significance of genital herpes infections.
33. Identify and explain current strategies for preventing and treating HSV-1 and HSV-2 infections.
34. Describe the virion and genome structure of human papillomavirus (HPV).
35. Explain the transmission and pathogenesis of HPV.
36. Explain the association of cervical cancer with certain types of HPV infections.
37. Describe methods for detection, treatment, and prevention of HPV infections.

XI. Gastrointestinal Infections

1. Define inflammatory and non-inflammatory diarrhea.
2. Describe clinical findings in acute gastroenteritis.
3. Differentiate between an invasive infection and an enterotoxin-mediated illness based on clinical findings.
4. Describe the modes for transmitting infectious agents that cause gastroenteritis and diarrhea.
5. Describe the pathogenesis of viral, bacterial and parasitic diarrheas.
6. Explain the mechanisms of damage from enterotoxins, cytotoxins, and invasive organisms.
7. Describe the clinical and diagnostic techniques used to identify organisms causing gastroenteritis.
8. Explain the recommended treatment for gastroenteritis.
9. Describ the transmission, risk factors, epidemiology, pathogenesis, clinical dentification, treatment and prevention of the major bacterial, viral, and parasitic organisms causing gastrointestinal infection:
    a. *Bacillus cereus* intoxication
    b. Botulism/infant botulism
    c. *Campylobacter jejuni*
    d. Caliciviruses (Norovirus)
    e. *Clostridium difficile*
    c. *Clostridium perfringens*
    d. *Cryptosporidium parvum*
    e. *Entamoeba histolytica*
    f. *Escherichia coli*
    g. *Giardia lamblia (intestinalis)*
    h. *Listeria monocytogenes*
    i. Rotavirus
    j. *S. aureus* infections/intoxications

k. *Salmonella* spp. (typhoid and non-typhoid)
l. *Shigella* spp.
m. *Vibrio cholerae*
n. *Vibrio parahemolyticus*
o. *Yersinia enterocolitica*

10. Define hepatitis and jaundice.
11. Describe the symptoms and laboratory findings present in acute viral hepatitis.
12. Identify the potential long-term sequelae of chronic viral hepatitis.
13. Identify external factors that greatly accelerate microbe-induced liver damage.
14. Describe the basic viral properties, principal routes of infection, global prevalence, potential to establish chronic infections, clinical symptoms, means of diagnosis (including serologic markers), and treatment options for Hepatitis A-E.
15. Identify the viral hepatitis infections that can be prevented by immunization.
16. Identify additional viruses (other than Hepatitis A-E), parasites and bacteria that target the liver.
17. Describe the characteristics of *Helicobacter pylori* and explain the inflammatory conditions of the GI tract with which it is associated.
18. Differentiate among the conditions caused by the ETEC, EPEC, EIEC, EAggEC and EHEC strain designations of *Escherichia coli*.
19. Identify the bacteria that are associated with causing food intoxications; denote approximate time between ingestion of the toxin and the appearance of symptoms for each.
20. Describe the epidemiology and pathogenesis of antibiotic-associated diarrhea.
21. Describe the oral diseases and pathogenesis caused by *Candida*, HSV, HPV, *Actinomyces israelii*, viridans-group streptococci, *Histoplasma*, and Coxsackieviruses.
22. Describe the infections caused by oral normal flora in other parts of the body.

XII. Skin, Soft Tissue, and Bone Infections

1. Define:
    a. abscess
    b. boil
    c. bulla
    d. carbuncle
    e. cellulitis
    f. erysipelas
    g. erythrasma
    h. eschar
    i. exanthem
    j. furuncle
    k. folliculitis
    l. impetigo
    m. macule
    n. pyoderma
    o. papule
    p. petechiae
    q. plaque
    r. purpura
    s. pustule
    t. vesicle
2. Identify infectious causes of myositis.

3. Describe the virulence factors for *Staphylococcus aureus* and detail the contribution of these factors to the pathogenicity of the organism.
4. Identify the causative agents of myonecrosis.
5. Explain the pathogenesis of myonecrosis and virulence factors that affect this pathogenesis.
6. Identify the infectious causes of osteomyelitis.
7. Describe the important microbial virulence factors associated with osteomyelitis and the contribution of each to the pathogenesis.
8. Describe the routes by which various microbes gain access to bone and explain why these lesions are often polymicrobial.
9. Explain the use of surgical debridement and prolonged bactericidal antibiotic therapy in chronic osteomyelitis.
10. Explain how laboratory procedures distinguish among the causative agents of osteomyelitis.
11. Explain the role of an anaerobic environment in the pathogenesis of gas gangrene.
12. Explain why anaerobic or necrotic wounds are typically necessary for the development of tetanus.
13. Identify the condition in infants that has been associated with the ingestion of raw or unpasteurized honey.
14. Distinguish between septic arthritis, aseptic arthritis and reactive arthritis. Identify etiological agents associated with each.
15. Explain the role of *Mycobacterium marinum* and other *Mycobacterium* species in causing cutaneous infections.
16. Explain the role of *Corynebacterium diphtheriae* and diphtheroid relatives in causing cutaneous infections.

A. <u>Pathogens</u>

[Apply the following learning objectives to each of the pathogens that follow]

1. Describe transmission, risk factors, epidemiology, clinical presentation, pathogenesis (virulence factors), clinical identification, treatment and prevention of infections from the following organisms:
    a. *Bacillus anthracis:* Cutaneous anthrax
    b. *Blastomyces dermatiditis*: Blastomycosis
    c. *Borrelia burgdorferi*: Lyme disease
    d. *Candida* spp.: Thrush
    e. *Clostridium perfringens*: Gas gangrene
    f. *Clostridium tetani*: Tetanus
    g. *Coccidioides immitis*: Coccidiodomycosis
    h. *Corynebacterium minutissum*: Erythrasma
    i. Coxsackievirus: Vesicles, hand foot and mouth disease
    j. Herpes Simplex: Vesicles, herpetic whitlow, gladiatorium
    k. Hookworms (*Ancylostoma* and *Necator*): Cutaneous larval migrans
    l. *Hortaea werneckii, Trichosporon beigelii, Piedraia hortae*: Tinea nigra, white piedra, black piedra
    m. HHV-6: Roseola
    n. KSHV(HHV-8): Kaposi's sarcoma
    o. *Leishmania* sp: Leishmaniasis
    p. *Malassezia furfur*: Tinea versicolor
    q. Measles: Maculopapular rash
    r. *Microsporum*, *Trichophyton*, and *Epidermophyton*: Tinea corporis, tinea pedis, tinea cruris, tinea nigra, tinea capitis, onychomycosis
    s. *Mycobacterium leprae*: Leprosy (Hansen's disease)

t. *Nocardia* sp.: Cutaneous nocardiosis/actinomycetoma
u. Papillomaviruses: Warts
v. Parvovirus B19: Maculopapular rash, arthritis
w. *Petriellidium* and *Madurella*: Eumycetoma
x. *Phialophora* and *Cladosporum*: Chromoblastomycosis
y. Poxviruses – Molluscum contagiosum (fleshy papules) and Smallpox
z. *Propionibacterium (Cutibacterium) acnes*: Acne
aa. *Pseudomonas aeruginosa*: ecthyma gangrenosum, burn/wound infections
bb. *Rickettsia rickettsii:* Rocky Mountain spotted fever
cc. Rubella: Maculopapular rash, German measles
dd. *Sporothrix schenckii:* Sporotrichosis
ee. *Staphylococcus aureus:* Scalded skin syndrome, carbuncle, furuncle, folliculitis, impetigo, wound infection, toxic shock syndrome, osteomyelitis, septic arthritis
ff. *Streptococcus pyogenes*: Impetigo, erysipelas, cellulitis, necrotizing fasciitis, scarlet fever, toxic shock syndrome, pharyngitis, post-infectious sequelae
gg. *Treponema pallidum* spp. *pallidum:* Syphilis
nn. Varicella zoster virus (VZV): Chickenpox and shingles

XIII. Nervous System Infections

1. Identify the common causes of bacterial meningitis in infants less than 1 month of age.
2. Identify the organisms most commonly associated with bacterial meningitis beyond the neonatal period.
3. Describe host factors that may increase the risk for bacterial meningitis.
4. Define aseptic meningitis.
5. Describe the pathogenesis, clinical signs and symptoms, and diagnostic techniques that allow for differentiation among bacterial, viral, parasitic and fungal meningitis and encephalitis.
6. Describe the structural characteristics, transmission, pathogenesis, clinical signs and symptoms, diagnostic techniques, and treatments for the following causes of meningitis/encephalitis:
    a. *Acanthamoeba* spp.
    b. Arboviruses
    c. CMV
    d. *Coccidioides immitis*
    e. *Cryptococcus neoformans*
    f. *Escherichia coli*
    g. *Haemophilus influenzae*
    h. Herpesviruses
    i. *Histoplasma capsulatum*
    j. HIV
    k. Influenza viruses
    l. *Listeria monocytogenes*
    m. Mumps
    n. *Mycobacterium tuberculosis*
    o. *Naegleria fowleri*
    p. *Neisseria meningitidis*
    q. *Plasmodium falciparum*
    r. Polio virus (poliomyelitis)
    s. Rabies virus
    t. Rubella
    u. *Streptococcus agalactiae (*Group B strep)
    v. *Streptococcus pneumoniae*

w. *Taenia solium* (neurocystercercosis)
x. *Toxoplasma gondii*
y. *Trypanosoma* spp.

7. Describe the pathogenesis, transmission pattern, and course of disease for both Creutzfeldt-Jakob disease (CJD) and variant CJD.
8. Describe the risks to the fetus associated with Group B streptococci carriage as part of the normal vaginal flora in a pregnant woman.
9. Describe the role of certain bacteria and viruses in causing Guillian-Barre syndrome.

XIV. Respiratory Tract Infections

1. Identify the types of viruses that cause most cases of rhinitis and how they are spread.
2. Identify host defenses preventing infections by rhinitis-causing viruses.
3. Identify the characteristics and describe the means of spread of viruses causing pharyngitis:
    a. Adenoviruses
    b. Coronaviruses
    c. Epstein-Barr virus
    d. Influenza
    e. Rhinoviruses
4. Identify the virulence factors, normal reservoirs, and mode of transmission of the bacterial causes of pharyngitis:
    a. *Bordetella pertussis*
    b. *Corynebacterium diphtheriae*
    c. *Neisseria gonorrhoeae*
    d. *Streptococcus pyogenes*
5. Describe methods for identifying causative agents of bacterial pharyngitis.
6. Identify complications of infection by *Streptococcus pyogenes* and describe the events that lead to the complications.
7. Identify the bacterial causes of sinusitis and identify characteristics, normal reservoirs, and virulence factors associated with each.
8. Identify the host defenses that protect against sinusitis-causing bacteria.
9. Identify bacterial causes of otitis media and otitis externa and identify characteristics, normal reservoirs, and virulence factors associated with each.
10. Identify the host defenses that protect against bacteria that cause otitis media and otitis externa.
11. Identify the infectious agents involved in bronchitis and bronchiolitis and identify characteristics, normal reservoirs, and virulence factors associated with each.
12. Describe the means by which the etiologic agents of bronchitis and bronchiolitis are spread.
13. Identify the host defenses preventing infection by agents causing bronchitis and bronchiolitis.
14. Name the bacterial agents causing pneumonia, their mode of transmission and describe the clinical presentations associated with each.
15. Describe the mode of transmission, risk factors, epidemiology, pathogenesis/virulence factors, clinical manifestations, diagnosis, treatments, and prevention of the following organisms that can cause pneumonia:
    a. Adenovirus
    b. Anaerobic bacteria
    c. *Aspergillus* spp.
    d. *Blastomyces* spp.
    e. *Chlamydophila pneumoniae*
    f. *Coccidioides immitis*/*posadasii*
    g. *Cryptococcus neoformans*

h. *Haemophilus influenzae*
i. Hantavirus
j. *Histoplasma capsulatum*
k. Influenzaviruses
l. *Klebsiella pneumoniae*
m. *Legionella pneumophila*
n. *Moraxella catarrhalis*
o. *Mucor* spp.
p. *Mycobacterium tuberculosis* and MAC
q. *Mycoplasma pneumoniae*
r. *Nocardia asteroides*
s. *Pneumoncystis jiroveci*
t. *Pseudomonas aeruginosa*
u. RSV
v. Coronaviruses
w. *Staphylococcus aureus*
x. *Streptococcus pneumoniae*

16. Describe the normal reservoir of each bacterial, fungal, and viral agent of pneumonia.
17. Identify the host defenses preventing infection by these agents causing pneumonia.
18. Define miliary tuberculosis and describe its clinical manifestations.
19. Describe the pathogenesis of primary respiratory infection caused by the influenza virus followed by bacterial pneumonia.

XV. Zoonotic Infections

1. Describe the mode of transmission, risk factors, epidemiology/animal reservoir(s), athogenesis/virulence factors, clinical manifestations, diagnosis, treatments, and prevention for the following organisms:
    a. *Bacillus anthracis*
    b. *Bartonella henselae*
    c. *Borrelia* spp.
    d. *Francisella tularensis*
    e. *Pasteurella multocida*
    f. Rabies virus
    g. Viral hemorrhagic fever viruses, including dengue, yellow fever, Ebola, Marburg and Arenavirus
    h. *Yersinia pestis*
2. Describe the opportunistic infections by the following agents: Move to respective system(s) and call out opportunistic pathogen:
    a. *Actinomyces*
    b. *Bacteroides*
    c. *Eikenella corrodens*
    d. *Haemophilus influenzae* (nontypeable)
    e. *Mycobacterium avium-intracellulare*
    f. *Pneumocystis jiroveci*
    g. *Pseudomonas aeruginosa*
    h. *Vibrio vulnificus*

XVI. Blood and Systemic Infections

1. Describe transmission, risk factors, epidemiology, clinical presentation, pathogenesis (virulence factors), clinical identification, treatment and prevention of infections from the following organisms:
    a. Arenaviruses
    b. Dengue virus
    c. Ebola and Marburg viruses
    d. Herpesviruses
    e. HIV
    f. HTLV-1 and HTLV-2
    g. Measles virus
    h. *Plasmodium* spp.
    i. *Schistosoma* spp.
    j. *Trypansoma cruzi*
    k. Yellow fever virus
    l. Zika virus

NEUROSCIENCE

LEARNING OBJECTIVES

I. Structures and Systems

Gross Structure of the Brain
Gross Structure of the Spinal Cord and Spinal Nerves
Meninges and Ventricles
Vasculature of the Central Nervous System
Somatosensory and Proprioceptive Systems of the Body
Somatosensory of the Head
Motor Systems – Somatic Motor System, Cerebellum, and Basal Ganglia
Visual System
Vestibular System and Medial Longitudinal Fasciculus
Auditory System
Olfactory and Gustatory Systems
Hypothalamus
Autonomic Nervous System
Limbic System
Reticular Formation

II. Clinical Correlations of Central Nervous System

III. Clinical correlations of Peripheral Nevous System

I. Structures and Systems

I. Gross Structure of the Brain

1. Describe the central axis of the portions of the brain and the anatomical directions for each portion.
2. Explain the divisions of the CNS.
3. Describe the external (topographical) anatomy of the lobes of the cerebrum.
4. Explain the functional and somatopical organization of the lobes of the cerebrum.
5. Describe the distribution of the gray and white matter of the cerebrum.
6. Describe the projection, association, and commissural fibers of the cerebral cortex.
7. Describe the external (topographical) anatomy of the cerebellum.
8. Describe the distribution of the gray and white matter of the cerebellum.
9. Describe the structure and functions of each division of the diencephalon.
10. Describe the external anatomy of each region of the brainstem.
11. Describe the nuclei and tracts of each region of the brainstem.
12. Describe the sensory components of the cranial nerves.
13. Describe the motor components of the cranial nerves.
14. Describe the uses of computerized tomography (CT) and magnetic resonance image (MRI) for normal and pathological neuroimaging.

II. Gross Structure of the Spinal Cord and Spinal Nerves

1. Describe the external (topographical) anatomy of the spinal cord.
2. Discuss the relationship of spinal nerves to roots and rami upon entrance and exit of the spinal cord.
3. Compare and contrast the effects of lesions to a dorsal root, ventral root, and spinal nerve.
4. Describe the topographic distribution of motoneurons and limb segments in the gray matter regions of the spinal cord.
5. Describe the funiculi (dorsal, lateral, and anterior) in the white matter of the spinal cord.

III. Meninges and Ventricles

1. Describe the dura mater, dural reflections, and the formation of venous sinuses.
2. Describe the arachnoid mater and the formation of the subarachnoid space.
3. Explain the differences between the cranial and spinal meningeal layers.
4. Describe the ventricular system of the brain and the production and flow of cerebrospinal fluid.
5. Discuss the structural and functional basis of the blood-brain barrier.

IV. Vasculature of the Central Nervous System

1. Discuss the vascular supply to the brain.
2. Explain the venous drainage of the brain.
3. Discuss the vascular supply to the spinal cord.
4. Explain the venous drainage of the spinal cord.

V. Somatosensory and Proprioceptive Systems of the Body

1. Describe the peripheral receptors and sensory modalities of the somatosensory systems of the body.
2. Describe the sensory neurons and the nerve fibers of the somatosensory systems of the body.

3. Compare and contrast different types of pain, including nociceptive, neuropathic, and central.
4. Discuss the dorsal column-medial lemniscus pathway.
5. Describe the tracts of the anterolateral system.
6. Describe the anatomy and function of the peripheral receptors associated with proprioception (muscle spindles & Golgi Tendon Organs).
7. Describe the spinocerebellar tracts.

VI. Somatosensory of the Head

1. Describe the peripheral receptors and sensory modalities of the trigeminal system.
2. Describe the mesencephalic, principal (main, chief) sensory, and spinal trigeminal nuclei.
3. Describe the central pathways of the trigeminal system.
4. Identify and describe trigeminal reflexes.

VII. Motor Systems – Somatic Motor System, Cerebellum, and Basal Ganglia

1. Describe the components of the somatic motor system.
2. Describe the cortical descending pathways (corticospinal and corticonuclear tracts).
3. Identify the components of the basal nuclei.
4. Describe the connections between components of the basal nuclei, and their function (direct and indirect pathways).
5. Recognize the neuroanatomical and functional relationships of major brainstem descending pathways.
6. Describe the three layers of the cerebellar cortex, connections and their functions.
7. Describe the divisions (modules) of the cerebellum, connections and their functions.
8. Describe the pathways of the myotatic reflex, reciprocal inhibition, flexor reflex, and the crossed extension reflex.

VIII. Visual System

1. Describe the functional anatomy of the eye, the retina, and photoreceptors in the image formation process.
2. Describe the visual pathways and the visual cortex.
3. Identify and describe pupillary light, accommodation, corneal, and convergence reflexes.

IX. Vestibular System and Medial Longitudinal Fasciculus

1. Describe the functional anatomy of the vestibular apparatus.
2. Discuss vestibular pathways and the associated nuclei.
3. Describe the neuroanatomical basis of the vestibulo-ocular and vestibulospinal reflexes.
4. Describe the anatomy and function of the ascending and descending portions of the medial longitudinal fasciculus.
5. Describe neuroanatomical basis of nystagmus.

X. Auditory System

1. Describe the functional anatomy of the ear (outer, middle, inner).
2. Describe the auditory pathways and auditory cortex.

XI. Olfactory and Gustatory Systems

1. Describe the cranial nerve distribution and function of the taste and olfactory pathways.

XII. Hypothalamus and Autonomic Nervous System

1. Describe the functional anatomy of the hypothalamus.
2. Describe the afferent and efferent pathways of the hypothalamus.
3. Describe the role of the hypothalamus in the control of ANS function.
4. Describe the functional anatomy of the central nervous system and peripheral nervous system portions of the autonomic nervous system.
5. Describe the central regulation of the autonomic nervous system.
6. Identify and describe the autonomic reflexes.

XIII. Limbic System

1. Describe the functional anatomy of the limbic lobe and the limbic system.

XIV. Reticular Formation

1. Describe the location of the reticular formation.
2. Describe the reticular formation's contribution to: modulation of pain transmission, control of movement, autonomic reflexes, and the ascending reticular activating system (ARAS).

II. Clinical Correlations of Central Nervous System

1. Explain spinal shock.
2. Describe developmental disorders of the spinal cord.
3. Discuss the disorders associated with formation, circulation, and reabsorption of cerebrospinal fluid.
4. Describe the neuroanatomical basis of meningitis.
5. Describe the relationship of arachnoid, epidural and subdural hematomas and hemorrhages to the layers of the eninges.
6. Describe alternating hemiplegia.
7. Describe gaze palsies.
8. Describe lesions at different points in the dorsal column-medial lemniscus pathway.
9. Describe tabes dorsalis.
10. Describe sensory ataxia.
11. Describe the neurological deficits related to occlusion of the posterior spinal artery.
12. Describe lesions at different points in the anterolateral system.
13. Describe referred pain.
14. Describe neuroanatomical basis of phantom limb pain.
15. Describe syringomyelia.
16. Compare and contrast lesions in the primary and association somatosensory cortices.
17. Describe the deficits associated with lesions of each of the cranial nerves.
18. Describe the deficits of a unilateral lesion in the primary motor cortex.
19. Describe the deficits of a unilateral lesion in the supplementary motor cortex.
20. Describe the effects of a unilateral lesion in the premotor cortex.
21. Describe the effects of lesions in the corticonuclear tract.

22. Describe the effects of lesions at different points in the corticospinal tract.
23. Compare and contrast upper motor neuron and lower motor neuron lesion signs.
24. Describe the deficits expected with complete or partial spinal cord Injury.
25. Describe clinical signs and symptoms commonly associated with multiple sclerosis.
26. Describe the neuroanatomical basis of amyotrophic lateral sclerosis.
27. Discuss the neuroanatomical basis of poliomyelitis post-polio syndrome.
28. Correlate the symptoms and pathology of movement disorders.
29. Describe the effects of occlusion of the lenticulostriate arteries.
30. Describe Friedrich's ataxia.
31. Describe symptoms of dysfunction in each cerebellar module.
32. Describe the role of cerebral cortex in kinesthesia.
33. Describe deficits of lesions of the visual pathways.
34 Describe impairments associated with the vestibular system.
35. Describe the autonomic dysreflexia.
36. Describe the hippocampal memory disorders.
37. Describe the signs, symptoms associated with dementia/Alzheimer's disease.
38. Describe apraxia, aphasia and agnosias.
39. Describe contralateral (hemispatial) neglect syndrome.
40. Describe the signs and symptoms of seizure disorders.
41. Describe the continuum of traumatic brain injury its clinical presentation from mild to severe.
42. Describe complex regional pain syndrome.
43. Describe symptoms of sleep, and associated sleep disorders.

III. Clinical correlations of the Peripheral nervous System

1. Describe the result of damage to peripheral nervous tissue, and the mechanisms of collateral and regenerative recovery.
2. Describe the autonomic contribution to peripheral neuropathy.
3. Describe peripheral nerve neuropathies.

PATHOLOGY

LEARNING OBJECTIVES

I. General Pathology

Cell Adaptation, Injury, and Death
Inflammation
Control of Cell Growth and Repair
Fluid and Hemodynamics
Coagulation
Genetics
Immunopathology
Neoplasia
Infectious Disease
Environmental Pathology
Nutritional Disease
Principles of Laboratory Testing

II. Systemic Pathology

Vascular Disease
Cardiac Disease
Hematopoietic System Disorders
Myeloid Neoplasms
Lymphoid Neoplasms
Pulmonary Disease
Gastrointestinal Disease
Liver and Extra-hepatic Biliary System Diseases
Pancreatic Disease
Genitourinary Disease
Kidney Disease
Breast Disease
Endocrine Disorders
Diabetes
Dermatopathology
Joint Disease
Bone Disease
Soft Tissue Disease
Head, Neck, and Special Sensory Organ Pathology
Neuromuscular Disease
Central Nervous System Disease

I. General Pathology

A. Cell Adaptation, Injury, and Death

Learning Goals: Apply knowledge of histology, physiology, and biochemistry to discuss cellular response to both reversible and irreversible injury at the cellular, tissue and organ level, with emphasis on mechanisms, morphology, and possible diagnostic and laboratory findings.

1. **Adaptation:** Discuss the pathogenesis of hypertrophy, hyperplasia, atrophy, and metaplasia at both the cellular and organ level and compare and contrast physiologic and pathologic causes.
2. **Necrosis:** Compare and contrast the morphologic differences in the different forms of necrosis with emphasis on causative mechanisms.
3. **Ischemia:** Compare and contrast ischemia and hypoxia and discuss the molecular events that occur at a cellular level in response to a lack of oxygen, emphasizing the events that distinguish reversible from irreversible injury. Discuss reperfusion injury.
4. **Oxidative Stress:** Define the term "free radical". Discuss their formation, mechanisms for causing injury, and how they are removed.
5. **Cell Death:** Compare and contrast the etiology, mechanisms, and morphology of apoptosis with those of necrosis. Discuss the circumstances that determine whether a cell will undergo apoptosis or necrosis.
6. **Intracellular Accumulations:** Describe the mechanisms of intracellular accumulations and their morphologic and clinical consequences.
7. **Calcification:** Compare and contrast dystrophic and metastatic calcification in terms of athogenesis, morphologic appearance, and clinical significance

B. Inflammation

Learning Goals: Apply knowledge of biochemistry, histology, and physiology to describe the pathogenic mechanisms of acute and chronic inflammation and the morphologic changes at a cellular, tissue, and organ level.

1. **Acute Inflammatory Response:** Describe the time course of the vascular and cellular events of the acute inflammatory response with emphasis on the causative triggers, receptors, and ligands responsible for these events.
2. **Phagocytosis:** Describe phagocytosis and the molecular mechanisms of intracellular killing.
3. **Mediators of Inflammation:** Discuss the chemical mediators of inflammation in terms of their origins, targets, interrelationships, and their chief functions.
4. **Systemic Changes in Inflammation:** Describe the systemic effects of inflammation including pathogenesis, laboratory findings, and clinical signs and symptoms.
5. **Outcomes of Inflammation:** Summarize the possible outcomes of inflammation and discuss factors that determine which outcomes are seen in different circumstances.
6. **Morphologic Patterns of Inflammation:** Recognize and classify the major types of inflammatory lesions based on their histologic appearance and identify the cellular and protein constituents.
7. **Acute and Chronic Inflammation:** Compare and contrast acute and chronic inflammation with respect to cells involved, causative agents, Tissue injury, and outcomes.
8. **Defects in Leukocyte Function:** Discuss both inherited and acquired defects in leukocyte function.

C. Control of Cell Growth & Repair Objectives

Learning Goals: Apply knowledge of biochemistry and cell physiology to describe the pathogenic mechanisms of tissue regeneration, renewal, and repair as well as the pathologic aspects of repair.

1. **Stem Cells:** Compare and contrast embryonic and adult stem cells with respect to their ability to differentiate into different cell types.
2. **Cell Cycle:** Describe the stages of the cell cycle and explain the roles of cyclins, cyclin-dependent kinases, and other proteins in the regulation of the cell's progression through the cell cycle.
3. **Signaling Pathways:** Discuss the role of receptors, signal transduction pathways, and transcription factors in the regulation of cell growth.
4. **Growth Factors and Cytokines:** Discuss the importance of growth factors (epidermal growth factor, transforming growth factor, fibroblast growth factor 1 and 2, transforming growth factor α and β, platelet derived growth factor and vascular endothelial growth factor) and cytokines in both promoting and inhibiting growth.
5. **Extracellular Matrix:** List the important proteins of the extracellular matrix, describe the role of cell-matrix interaction in cell growth and differentiation.
6. **Angiogenesis:** Describe the mechanisms of angiogenesis, including the role of growth factors important to the process.
7. **Wound Healing:** Compare and contrast healing by primary union (first intention) and secondary union (second intention), discuss local and systemic factors that influence wound healing, and describe the pathologic aspects of repair.

D. Fluid and Hemodynamics

Learning Goals: Apply knowledge of the pathogenic mechanisms resulting in alterations in hemodynamics such as edema, hyperemia, congestion, hemorrhage, thrombosis, embolism, infarction, and shock. Describe the resulting pathogenesis at the cellular, tissue, and organism level describing clinical manifestations associated with these pathophysiologic changes.

1. **Edema** - Discuss the pathogenesis of edema, giving examples associated with the following mechanisms such as reduced plasma oncotic pressure, increased hydrostatic pressure, sodium retention, lymphatic obstruction, and vascular changes in inflammation being able to describe it as being systemic or localized. Compare edema in subcutaneous tissues, lung, and brain describing pathogenesis, morphologic changes, and clinical effects.
2. **Hyperemia and congestion** - Compare and contrast active hyperemia and passive congestion, in terms of mechanisms of development and clinically important examples. Describe chronic passive congestion of the skin, lungs, liver, kidneys, and spleen, in terms of morphologic features, functional alterations, and clinical effects.
3. **Hemorrhage** - Compare acute and chronic hemorrhage in terms of common causes, clinical manifestations, and compensatory mechanisms.
4. **Thrombosis** - Describe Virchow's triad in terms of thrombosis and the primary and secondary risk factors leading to the development of thrombi. Compare and contrast the etiology, pathogenesis, common sites/organs, morphologic appearance of venous and arterial thrombi. Distinguish type and size of vessel involved, local and distant effects, clinical and laboratory features, fate of lesions, and prognosis of venous and arterial thrombi.

5. **Embolism** - Compare and contrast pulmonary, systemic, fat, air, and amnionic fluid emboli with emphasis on defining morphologic features, etiologic/precipitating factors, organs commonly involved, type and size of vessels involved, complications, and clinical manifestations.
6. **Infarction** – Distinguish arterial and venous infarcts on the basis of location, pathogenesis, morphology, and clinical manifestations.
7. **Shock** – Describe and discuss the stages of shock such as nonprogressive, progressive, and irreversible in terms of pathophysiology, morphologic changes, and prognosis. Compare and contrast hypovolemic/hemorrhagic, cardiogenic, obstructive, septic, neurogenic, anaphylactic, and hypothalamic shock in terms of pathogenic mechanism, common causes, structural changes, functional changes, clinical features, and prognoses. List the morphologic changes and functional effects of shock on the lungs, kidneys, liver, adrenals, brain, and gastrointestinal tract.

E. Coagulation

Learning Goals: Apply knowledge of normal hemostasis, platelets, procoagulant and anticoagulant factors to describe disorders leading to abnormal bleeding and thrombosis, with emphasis on the use of laboratory tests for the diagnosis and management of these disorders.

1. **Platelets:** Describe the normal structure and function of platelets, with emphasis on quantitative and qualitative disorders leading to abnormal bleeding. Discuss platelet adhesion, activation and aggregation and their abnormalities.
2. **Thrombocytopenia:** Describe thrombocytopenia in terms of pathogenesis, clinical features, bone marrow morphology and laboratory findings.
3. **Thrombocytopenic Syndromes:** Compare and contrast immune thrombocytopenic purpura, heparin-induced thrombocytopenia, and drug induced thrombocytopenia.
4. **Thrombotic Microangiopathies:** Compare and contrast thrombotic thrombocytopenic purpura and hemolytic uremic syndrome with respect to clinical presentation, and laboratory findings.
5. **Secondary Hemostasis:** Outline the process of secondary hemostasis, in terms of intrinsic pathway, extrinsic pathway, common pathway, frbrin formation, and fibrinolysis.
6. **Mechanisms of Hypercoagulability:** Describe the pathogenesis of hypercoagulable states in terms of endothelial injury, stasis, and alterations in blood flow (Virchow's triad).
7. **Hypercoagulability:** Compare and contrast genetic and acquired hypercoagulable disorders in terms of risks, pathogenesis, clinical presentation, laboratory findings and clinical course.
8. **Inherited Hemophilia:** Compare and contrast the pathogenesis, clinical presentation, laboratory findings and clinical course of hemophilia A and hemophilia B.
9. **von Willebrand Disease:** Describe the pathogenesis, clinical presentation, laboratory findings and clinical course of von Willebrand disease.
10. **Disseminated Intravascular Coagulation:** Discuss disseminated intravascular coagulation in terms of etiologies, pathogenesis, clinical presentation, laboratory findings, and course.
11. **Anticoagulants and Anti-platelet Drugs:** Describe the mechanism(s) by which aspirin, NSAIDs, warfarin, heparin, and other anticoagulants affect either primary or secondary hemostasis and describe the use of the laboratory in monitoring them.
12. **Evaluation of Coagulopathies:** Discuss the use of coagulation and platelet function testing in the diagnosis of coagulopathies.

F. Genetics

Learning Goals - Apply knowledge of the genetic mechanisms of disease including modes of inheritance, chromosomal disorders, multifactorial inheritance disorders, mitochondrial disorders, and testing to discuss how changes in the genome can cause developmental and functional abnormalities at the cellular, tissue, and organism levels.

1. **Genetic Diseases** – Discuss different types of mutations that can occur in human genetic diseases. Describe simple autosomal dominant, simple autosomal recessive, and X-linked recessive giving an example of each.
2. **Modes of Inheritance** -Given family history involving a disease with classic mendelian inheritance or pedigree, predict the likelihood of various phenotypes and genotypes in family members indicating the most likely mode of inheritance such as autosomal dominant, autosomal recessive, sex-linked dominant, or sex-linked recessive.
3. **Chromosomal Disorders** - Describe Trisomy 21, 18, and 13 including pathogenesis, morphology, clinical presentation, clinical course, and complications.
4. **Multifactorial Inheritance Disorders** - Describe diseases with multifactorial inheritance (Diabetes mellitus, Rheumatoid arthritis) emphasizing the pathogenesis, morphology, laboratory studies and clinical presentation. Discuss how environmental factors can interact with genetic factors to produce or modulate disease.
5. **Mitochondrial Disorders** - Describe the modes of inheritance of mitochondrial disorders and give two examples of diseases associated with them.
6. **Testing** – Describe karyotyping, restriction fragment length polymorphism, polymerase chain reaction, and DNA sequencing in terms of methodology of performance of test, appropriateness in various types of clinical situations, and clinical implications.

G. Immunopathology

Learning Goals - Apply knowledge of basic mechanisms of immunology to explain how dysfunction can produce cellular injury, acute and chronic inflammation, autoimmunity, allergic reactions, and susceptibility to infection focusing on how excesses or deficiencies leads to disease.

1. **Major Histocompatibility Complex (MHC):** discuss and classify the MHC molecules as class I or II.
2. **Hypersensitivity Reactions:** compare and contrast the four types of hypersensitivity reactions in terms of type of reaction, prototypic disorder, immune mechanisms, mediators, pathologic lesions, and clinical disorders.
3. **Transplant Rejection:** compare and contrast hyperacute, acute, and chronic transplant rejection in terms of etiology, pathogenesis, and morphology.
4. **General Concepts of Autoimmune Diseases:** discuss the mechanisms of autoimmune diseases in terms of the breakdown of self-tolerance, environmental triggers, genetics and autoantibodies of diagnostic significance.
5. **Autoimmune Diseases:** describe, discuss, compare and contrast scleroderma, Sjogren syndrome, systemic lupus erythematosus, discoid lupus erythematosus, drug induced lupus erythematosus, and mixed connective tissue disease in terms of etiology, incidence, prevalence, genetic factors, age, gender, pathogenesis, anatomic distribution, morphology, associated disorders, laboratory findings, clinical course, and prognoses.
6. **Primary Immunodeficiencies:** describe, discuss, compare and contrast X-linked agammaglobulinemia of Bruton, common variable immunodeficiency, DiGeorge syndrome, severe combined Immunodeficiency syndrome, and Wiskott-Aldrich syndrome in terms of the genetics, etiology, pathogenesis, immunologic based deficiencies, clinical presentation, morphology, and complications.

7. **Secondary Immunodeficiencies:** Describe drugs, diseases and other etiologies resulting in immunosuppression. Describe acquired immunodeficiency syndrome (HIV infection, AIDS) in terms of epidemiology, diagnostic criteria, incidence, risk factors, pathogenesis, immunologic defects, associated infections and neoplasms, morphology, and clinical presentation.
8. **Amyloidosis:** describe and discuss amyloidosis with emphasis on pathogenesis, classification, morphology, and complications.

H. Neoplasia

Learning Goals: Apply knowledge of cell biology, environmental factors, immunology, and genetic basis of neoplasia to explain how these factors lead to neoplastic transformation and influence tumor morphology and biology.

1. **Carcinogenesis:** Describe the principles of carcinogenesis, including fundamental genetic changes, unregulated cell proliferation, monoclonal nature of tumor cells, and loss of apoptosis.
2. **Nomenclature and Morphologic Features:** Discuss the following terminology as applied to tumors: nomenclature of benign vs. malignant tumors (carcinoma, sarcoma, lymphoma/leukemia, etc.), anaplasia, dysplasia, and carcinoma in situ.
3. **Characteristics of Benign and Malignant Tumors:** Compare and contrast features of benign and malignant tumors (including tumor invasion vs. metastasis).
4. **Tumor Invasion:** Describe the mechanism for invasion including the function of e-cadherin and their significance in invasion of ECM and stromal response.
5. **Tumor Metastasis:** Discuss mechanisms by which tumors metastasize, factors which determine the site of metastasis (including the concept of "sentinel lymph node"), role of enzyme family of proteases, tumor location, and vascular drainage.
6. **Genetic Mutations:** List the most frequent alterations occurring in malignancies and categorize as to the following functions: oncogenes, tumor suppressor, genes regulating apoptosis, DNA repair genes, proto-oncogenes, and cellular signaling pathways and describe how the molecular changes lead to progression from normal epithelium to carcinoma.
7. **External Factors:** Describe the role of gender, age, diet, and environment in the development of malignancy.
8. **Tumor Markers:** Describe the following markers and association with tumor type- PSA, CEA, AFP, estrogen and progesterone receptor, alkaline phosphatase, and beta-hCG.
9. **Characteristics of Malignant Tumors:** Compare and contrast staging vs grading of tumors and define the terms *progression*, *genomic instability,* and *heterogeneity* as they relate to the behavior of tumor cells.
10. **Clinical Manifestations.** Describe paraneoplastic syndromes and clinical significance, and define cachexia and explain why it is encountered in cancer patients.
11. **Diagnostic Procedures:** Identify the different morphologic diagnostic procedures and laboratory methods used in the diagnosis of malignancies such as: cytology, FNAC, biopsy types (incisional, excisional).

I. Infectious Disease

Learning Goals: Apply knowledge of biochemistry, cellular physiology, and immunity to describe the pathogenic mechanisms involved in causing damage to cells, tissues and the organism as a whole, as well as clinical manifestations of viral, bacterial, fungal, prion, and parasitic infections.

1. **Viral Mechanisms:** Describe the mechanisms by which different viruses enter and damage cells.
2. **Patterns of Viral Infection:** Compare and contrast viruses that result in acute transient, chronic latent, chronic productive and transformative infections and describe how these differences result in different disease pathogenesis and morphologic features.
3. **Bacterial Mechanisms:** Describe the mechanisms by which bacteria damage cells and tissues, comparing mechanisms characteristic of infection with particular categories of bacteria.
4. **Transmission and Tissue Response to Bacterial Infection:** Describe the different patterns of transmission and the patterns of tissue response to bacterial infection as a function of the differences in organisms involved, the specific organ affected, and the manner by which the bacterium enters the organism.
5. **Special Stains for Bacteria:** Recognize and compare morphology and cell wall features of bacteria using gram stain, Warthin starry (silver) stain, Acid Fast stain, Partial Acid Fast stain, and periodic Acid Schiff stain.
6. **Fungal Infection and Histologic Response:** List the different types of fungal organisms that infect humans and compare and contrast the histologic features, staining characteristics, and resultant diseases with emphasis on: *Candida albicans, Cryptococcus neoformans,* Aspergillus, *Histoplasma capsulatum, coccidiodes immitis, Blastomyces dermatitis, Pneumocystis jiroveci,* and Zygomycetes.
7. **Fungal Infections in Immunosuppressed:** Compare and contrast the types of fungal infections that occur in the immunosuppressed with those that occur in immunocompetent patients with respect to the organisms involved, the mechanisms of organ damage and the resultant clinical manifestations.
8. **Parasitic Infections:** Identify classes of parasites that produce human disease, describe their life cycle within humans and other hosts, and the mechanisms by which they damage tissue and organs, with emphasis on the complications and outcomes.

J. Environmental Pathology

Learning Goals: Apply knowledge of biochemistry, physiology, and anatomy to describe the mechanisms leading to cell injury induced by exposure to external agents including environmental pollution, tobacco, alcohol, therapeutic drugs, drugs of abuse, radiation, and physical injury.

1. **Environmental Exposure:** Discuss the effects of environmental pollution (air pollution, metals, industrial and agricultural agents) as a cause of cellular injury and organ dysfunction.
2. **Tobacco Use:** Discuss the effects of tobacco use on health with emphasis on carcinogenesis as well as other related illnesses.
3. **Alcohol Use:** Discuss the morphology, clinical effects and comorbidities of alcohol use.
4. **Toxicity of Therapeutic Drugs:** Discuss potential toxic effect of therapeutic drugs on different tissues, distinguishing between idiosyncratic and dose-dependent effects.
5. **Drugs of Abuse:** Discuss the mechanisms responsible for the toxic effects of drugs of abuse with emphasis on morphology, clinical effects, and comorbidities.
6. **Radiation Exposure:** Discuss the mechanisms by which radiation damages cells and tissues. Compare and contrast the different forms of radiation produce different disease manifestations in different organ systems. Differentiate between localized and whole-body exposure.
7. **Mechanical Force Injury:** Compare and contrast the types of injury associated with mechanical force with respect to cause, physical appearance, effect on involved organs and the systemic response to massive trauma.
8. **Thermal Injury:** Compare and contrast the effects of localized vs systemic thermal injury with emphasis on morphology, clinical presentation, and comorbidities.

9. **Electrical Injuries:** Discuss the effects of electrical injuries in terms of pathophysiologic mechanisms, morphology, clinical effects and comorbidities.

K. Nutritional Disease

Learning Goals: Apply knowledge of biochemistry and physiology to explain the pathogenetic mechanisms resulting from nutritient deficiency and nutrient toxicity and the resulting pathology at the cellular, tissue, and organism levels

1. **Nutritional Deficiencies:** Compare and contrast primary and secondary dietary deficiencies.
2. **Severe Acute Malnutrition:** Compare and contrast the kwashiorkor, marasmus, and secondary protein energy malnutrition with emphasis on etiology, pathogenesis, laboratory findings, and clinical presentation and course.
3. **Malnutrition:** Discuss the pathologic consequences of malnutrition due to anorexia nervosa, bulimia, and cancer.
4. **Fat and Water Soluble Vitamin Deficiency:** Describe deficiencies of fat and water soluble vitamins with emphasis on morphology and clinical presentation.
5. **Vitamin Toxicity:** Describe vitamin toxicity with emphasis on morphology and clinical presentation.
6. **Obesity:** Discuss the etiology and pathogenesis of obesity, comparing and contrasting environmental and genetic factors, and describe the associated co-morbidities.
7. **Diet and Systemic Disease:** Discuss the effect of diet and nutritional state on systemic disease with emphasis on atherosclerosis and cancer.

L. Principles of Laboratory Testing

Learning Goals: Apply knowledge of disease mechanisms and organ system pathology to efficiently use laboratory testing to diagnose and monitor disease states, which should include an appreciation of pre- and postanalytical errors.

1. **Pre- and Postanalytical Errors:** Discuss possible errors occurring during specimen collection, patient identification, specimen handling, transportation, storage, and reporting of results.
2. **Sensitivity and Specificity:** Demonstrate the use of sensitivity and specificity in evaluating the ability of a laboratory test in differentiating disease versus non disease states.
3. **Reference Intervals:** Discuss the use of reference intervals in the diagnosis of disease.
4. **Test Utilization:** Discuss the use of laboratory tests in the diagnosis and management of diseases. Discuss the use of decision levels in clinical medicine. Describe the appropriate use of surgical pathology, frozen sections, cytopathology, and autopsies.

II. Systemic Pathology

A. Vascular Disease

Learning Goals: Apply knowledge of immunologic principles, inflammation, tissue repair, microbiological principles (if applicable) to explain the pathogenesis, clinical features, morphological features, complications, and laboratory diagnosis of atherosclerosis, various vasculitides, vascular tumors, and other vascular pathologies.

1. **Atherosclerosis:** Discuss risk factors and anatomic distribution of atherosclerosis, clinical complications (including peripheral vascular disease), and compare and contrast the following: atherosclerosis, arteriolosclerosis, and medial calcinosis.
2. **Categories of Vasculitis.** Describe infectious vasculitis and compare and contrast the vasculitides that occur in large, medium, and small vessels (giant cell arteritis**,** polyarteritis nodosa, hypersensitivity vasculitis, thromboangiitis obliterans, granulomatosis with polyangiitis).
3. **Other Disorders Involving the Aorta**. Compare and contrast the following with emphasis on etiology, type and distribution of affected vessels, and prognoses: atherosclerotic aneurysm, syphilitic aneurysm, aortic (dissecting) aneurysm, cystic medial necrosis, and congenital malformations.
4. **Other Disorders Involving Veins and Lymphatics.** Describe the following with emphasis on etiology, clinical features, and prognoses: varicose veins, thrombophlebitis, lymphangitis, lymphedema, and venous insufficiency.
5. **Raynaud phenomenon:** Describe differences between primary and secondary.
6. **Vascular Tumors:** Compare and contrast hemangioma, glomus tumor, Kaposi sarcoma, and angiosarcoma.

B. <u>Cardiac Disease</u>

Learning Goals: Apply knowledge of the structure and function of the heart to describe the pathogenesis, mechanisms, morphology, diagnostic criteria, laboratory findings, clinical presentation, and short and long-term complications of cardiac disease.

1. **Heart Failure:** Compare and contrast right heart versus left heart failure.
2. **Cardiomyopathy:** Compare and contrast dilated, restrictive, and hypertrophic cardiomyopathies.
3. **Ischemic Heart Disease:** Describe the pathogenesis atherosclerosis of coronary arteries with emphasis on the role of inflammation and acute plaque change.
4. **Angina:** Compare and contrast stable vs unstable angina.
5. **Myocardial Infarction:** Describe myocardial infarction with emphasis on pathogenesis, morphology, laboratory findings and complications and clinical presentation.
6. **Congenital Heart Disease:** Compare and contrast malformations associated with left-to-right shunts, right-to-left shunts, and shunt reversal.
7. **Hypertensive Heart Disease:** Compare and contrast the morphologic changes in the myocardium as a result of pulmonary hypertension and systemic hypertension.
8. **Valvular Heart Disease:** Describe the etiology, morphology, and clinical presentation of cardiac valve disease with respect to stenosis, insufficiency, and prolapse.
9. **Rheumatic Heart Disease:** Compare and contrast the findings of acute rheumatic fever and chronic rheumatic heart disease.
10. **Endocarditis:** Compare and contrast infective acute and subacute endocarditis with noninfective endocarditis.
11. **Myocarditis:** Describe the clinicopathologic features of myocarditis.
12. **Pericarditis:** Describe the common causes of pericarditis and the associated pathophysiologic features.

C. Hematopathology – White Blood Cells (WBCs), Leukemia, Lymphoma, MDS/MPN and Immunoproliferative Disorders

Learning Goals: Apply knowledge of the molecular basis of inflammation, genetics, and neoplasia to describe the clinical presentation, biologic behavior, morphologic appearance, classification, genetic abnormalities (as applicable), diagnostic assays (as applicable) including immunohistochemistry, flow cytometry, cytogenetics, and molecular diagnostics, immunophenotype, imaging (as applicable), staging, prognosis, and targeted therapy of inflammatory, neoplastic, and non-neoplastic hematologic disorders.

1. **Use of Laboratory and Imaging Services**: Make efficient use of the laboratory and imaging services, as applicable, in the diagnosis and management of hematologic diseases.
2. **Development of WBCs**: Describe the normal development of WBCs and define the morphology at each stage.
3. **Nonneoplastic and Inflammatory WBC Disorders:** Compare and contrast the etiology, morphology and consequences of nonneoplastic conditions including leukocytosis, neutrophilia, lymphocytosis, atypical lymphocytosis (including Infectious Mononucleosis), monocytosis, eosinophilia, basophilia, leukopenia, neutropenia, lymphopenia, and pancytopenia.
4. **Leukemoid Reaction**: Compare and contrast leukocytosis and leukemoid reaction with reference to etiology, morphology, workup, diagnosis, and treatment.
5. **Genetic Mutations in Hematologic Malignancy:** Compare and contrast Germline and Somatic Mutations, Translocations in Oncogenes, Dysregulation of Cell Proliferation or Cell Death in hematologic malignancies and give examples of diseases. Apply knowledge of general concepts of neoplasia to explain how genetic mutations can produce hematologic malignancies and define their clinical behavior.
6. **Overview of Leukemia and Lymphoma**: Apply knowledge of hematopoiesis to discuss the pathophysiologic basis for the classification of leukemias and lymphomas. Describe the WHO classification, clinical features, clinical behavior, morphology, grading and staging (as applicable) and diagnostic laboratory and molecular assays of neoplastic hematologic disorders and their targeted therapies. Understand the molecular pathogenesis of leukemias and lymphomas and how they can suggest targets for therapeutic intervention.
7. **Acute Leukemia**: Compare and contrast Acute Myeloid Leukemia and Acute Lymphocytic Leukemia.
8. **Chronic Leukemia**: Compare and contrast Chronic Myeloid Leukemia and Chronic Lymphocytic Leukemia.
9. **B-Cell and T-Cell leukemias**: Compare and contrast B-cell leukemia and T-cell leukemia.
10. **Hairy Cell Leukemia**: Describe the pathophysiology, clinical features, morphology, diagnosis, treatment and prognosis of Hairy Cell Leukemia.
11. **Bone Marrow Disorders**: Compare and contrast myelodysplastic syndromes, myeloproliferative neoplasms (including chronic myelogenous leukemia, polycythemia vera, and primary myelofibrosis).
12. **Lymphomas**: Compare and contrast Hodgkin and Non-Hodgkin Lymphomas (including follicular lymphoma, diffuse large B-cell lymphoma, small lymphocytic lymphoma/chronic lymphocytic leukemia), including classification, morphology, diagnostic assays, grading, staging, treatment, and prognosis. Describe B symptoms and their significance.

13. **Polycythemia Vera**: Describe Polycythemia Vera including morphology, diagnostic assays, treatment, complications, and stages of the disease
14. **Plasma Cell disorders**: Compare and contrast multiple myeloma and plasmacytoma, including clinical and radiologic findings, morphology, laboratory diagnostic assays, management, and prognosis.
15. **Extra nodal Lymphoma**: Compare and contrast nodal and extra nodal lymphomas with reference to clinical presentation, location, etiology, laboratory diagnosis, prognosis and treatment.

D. Hematopathology: Red Cell Disorders

Learning Goals: Apply knowledge of nutrition, biochemistry, erythropoiesis, and red blood cell structure and function to a discussion of hereditary, developmental, and chronic causes of anemia

1. **Laboratory:** Discuss the significance of the laboratory in the diagnosis of anemia with emphasis on interpreting the CBC, red cell parameters, RDW, reticulocyte count, and hemoglobin electrophoresis.
2. **Iron Deficiency:** Describe the role of iron in red cell development. Discuss the pathogenesis, laboratory findings, and clinical presentation of iron deficiency anemia.
3. **Acute Blood Loss:** Discuss the etiology, pathogenesis, laboratory findings, and clinical features of acute blood loss.
4. **Anemia of Red Cell Destruction:** Compare and contrast the laboratory findings and clinical presentation of anemias caused by shortened red cell survival with emphasis on hereditary versus acquired, intravascular versus hemolysis, and intrinsic.
5. **Vitamin B 12 and Folate Deficiencies**: Describe the roles of vitamin B12 and folate in red cell development. Describe the anemia caused by their deficiencies in terms of pathogenesis, laboratory findings, and clinical manifestations.
6. **Anemia of Chronic Disease:** Discuss the role of hepcidin as an iron regulator. Describe the anemia of chronic disease with emphasis on pathogenesis, laboratory findings, and clinical presentation.
7. **Aplastic Anemia:** Describe aplastic anemia in terms of pathogenesis, laboratory findings, and clinical presentation.
8. **Hemoglobinopathies and Thalassemia:** Describe the structural alterations and regulatory abnormalities associated with hemoglobinopathies and thalassemia, emphasizing genetics, pathogenesis, laboratory findings and clinical presentation.

E. Pulmonary Disease

Learning Goals: Apply knowledge of the epidemiology, etiology, pathogenesis, morphologic appearance, genetic abnormalities (if applicable), clinical features, diagnosis, prognosis, and complications of obstructive, restrictive, occupational, inflammatory, vascular, Collapse/fluids, neoplastic and non-neoplastic pulmonary/pleural diseases

1. **Obstructive and Restrictive Pulmonary Disease**: Compare and contrast the major differences between these diseases with emphasis on pulmonary function tests and laboratory findings.
2. **Obstructive Pulmonary Diseases:** Describe, discuss, compare and contrast the major differences between Emphysema, Chronic bronchitis, Asthma, Bronchiolitis Obliterans, Bronchiectasis focusing on etiology, pathogenesis, morphology, clinical features, clinical course, and complications.
3. **Restrictive pulmonary diseases:** Describe, discuss, compare and contrast Idiopathic pulmonary fibrosis, Connective tissue diseases effects on the lung (rheumatoid arthritis, systemic lupus

erythematous, progressive systemic sclerosis, and sarcoidosis), Honeycomb lung focusing on etiology, pathogenesis, morphology, clinical features, clinical course, and complications.

4. **Occupational pulmonary diseases:** Compare and contrast Coal workers pneumoconiosis, Silicosis, Asbestosis with focus on pathogenesis, morphology, clinical features, clinical course, and complications.
5. **Inflammatory Pulmonary Diseases:** Describe, discuss, compare and contrast Acute lung injury (ALI) and Acute respiratory distress syndrome (ARDS), Pneumonia, Hypersensitivity pneumonitis, Cystic fibrosis with emphasis on pathogenesis, inflammatory components, genetic abnormalities (with Cystic fibrosis), morphology, clinical features, laboratory findings, clinical course, and complications.
6. **Vascular Pulmonary Diseases**: Describe and discuss Pulmonary hypertension, Pulmonary embolism, hemorrhage, and infarction, Goodpasture syndrome with focus on pathogenesis, morphology, clinical features, clinical course, and complications.
7. **Collapse/Fluids:** Compare and contrast resorption (obstruction) atelectasis, compression atelectasis, contraction atelectasis, pleural effusions, pulmonary edema with emphasis on morphology, clinical features, clinical course, and complications.
8. **Neoplastic and Non-Neoplastic Pulmonary/Pleural Diseases:** define, describe, compare the clinical and histologic classifications of Hamartoma, Adenocarcinoma (bronchial and bronchoalveolar), Squamous cell carcinoma, Neuroendocrine tumors (small cell carcinoma and carcinoid), Large cell carcinoma, Metastatic tumor (sites of origins only), Solitary fibrous tumor, Malignant mesothelioma focusing on epidemiology, etiology, pathogenesis, major genetic mutations (where applicable), morphology, clinical features, clinical course, paraneoplastic syndromes, and prognoses.

F. Gastrointestinal Tract Disease

Learning Goals: Apply knowledge to epidemiology, etiology, pathogenesis, morphologic appearance, genetic abnormalities (if applicable), clinical features, diagnosis, prognosis, and complications of obstructive, diverticular, motor dysfunction (where applicable), vascular, inflammatory, Immune related disorders (where applicable) neoplastic and non-neoplastic diseases of the esophagus, gastric, small and large bowel.

Esophagus:

1. **Obstructive Esophageal Diseases:** compare and contrast stenosis (esophageal fibrosis-Scleroderma, radiation), mucosal webs, esophageal rings focusing on pathogenesis, morphology, clinical features, clinical course, and complications.
2. **Diverticular Esophageal Diseases:** compare and contrast Zenker, traction, epiphrenic esophageal diverticulum with emphasis on morphology, clinical features, clinical course, and complications.
3. **Motor Dysfunction Esophageal Diseases:** describe, discuss, compare and contrast achalasia, hiatal hernia, Mallory-Weiss tears focusing on etiology, pathogenesis, morphology, clinical features, clinical course, and complications.
4. **Inflammatory Esophageal Diseases:** describe, discuss, compare and contrast chemical and infectious esophagitis, reflux esophagitis (GERD) with complication leading to Barrett esophagus, eosinophilic esophagitis emphasizing inflammatory components, pathogenesis, morphology, clinical features, clinical course, complications, and risk of malignancy.
5. **Vascular Esophageal Diseases:** describe and discuss esophageal varices focusing on pathogenesis, morphology, clinical features, clinical course, and complications.
6. **Neoplastic Esophageal Diseases:** describe, discuss, compare and contrast squamous cell carcinoma to adenocarcinoma focusing on epidemiology, etiology, pathogenesis, morphology, clinical features, clinical course, metastatic features and prognoses.

Gastric:

1. **Inflammatory Gastric Diseases:** describe, discuss, compare and contrast acute gastritis, acute hemorrhagic gastritis, chronic gastritis(*Helicobacter pylori* and autoimmune) leading to atrophic

gastritis by focusing on inflammatory components, pathogenesis, morphology, clinical features, clinical course, complications, and risk of malignancy.

2. **Gastric Ulcers:** describe, discuss, compare and contrast Peptic ulcer disease (relate correlation to chronic gastritis, other risk factors and etiologies), Curling ulcers, and Cushing ulcers with emphasis on etiology, pathogenesis, morphology, clinical features, clinical course.
3. **Neoplastic and Non-Neoplastic Gastric Diseases:** describe, discuss, compare and contrast inflammatory polyps, hyperplasic polyps, gastric adenomas, adenocarcinoma (intestinal and diffuse) with relation to epidemiology, etiology, pathogenesis, morphology, clinical features, metastatic features (where applicable), clinical course, and prognoses.

Small and Large Intestine:

1. **Obstructive Intestinal Diseases:** compare and contrast hernias, adhesions, volvulus, and intussusception focusing on morphology, clinical features, clinical course, and complications.
2. **Vascular Intestinal Diseases:** compare and contrast ischemic bowel disease, angiodysplasia, hemorrhoids focusing on pathogenesis, morphology, clinical features, clinical course, and complications.
3. **Diverticular Intestinal Diseases:** compare and contrast Meckel's diverticulum and sigmoid diverticular disease with emphasis to etiology, morphology, clinical features, clinical course, and complications.
4. **Malabsorptive Intestinal Diseases:** compare and contrast celiac disease, celiac sprue, lactase deficiency, cystic fibrosis focusing on inflammatory components, genetic abnormalities (with Cystic fibrosis), morphology, clinical features, laboratory findings, clinical course, and complications.
5. **Inflammatory and Immune Related Intestinal Diseases:** describe, discuss, compare and contrast Idiopathic inflammatory bowel disease (Crohn's and ulcerative colitis) focusing on Immune/inflammatory components, pathogenesis, morphology, clinical features, clinical course, complications, and risk of malignancy. Describe and discuss acute appendicitis with respect to etiology, morphology, clinical features, laboratory findings, clinical course, and complications.
6. **Neoplastic and Non-Neoplastic Intestinal Diseases:** describe, discuss, compare and contrast inflammatory polyps, hamartomatous polyps, hyperplastic polyps, adenomatous polyps, familial adenomatous polyposis, hereditary non-polyposis colorectal cancer, adenocarcinoma in relation to epidemiology, etiology, pathogenesis, morphologic appearance, genetic mutations (multiple hits)/ syndromes (where applicable), clinical course, complications, metastatic features (where applicable), and prognosis.

G. Liver and Extrahepatic Biliary System Diseases

Learning Goals: Apply knowledge to the epidemiology, etiology, pathogenesis, morphologic appearance, genetic abnormalities (if applicable), clinical features, diagnosis, lab values, prognosis, and complications of jaundice, cholestasis, liver failure, cirrhosis, inflammatory, infectious, immunologic, Drug/toxic, circulatory, metabolic, and neoplastic liver and gall bladder diseases.

Liver:

1. **Liver Function Tests:** Make efficient use of the laboratory in the diagnosis and management of liver diseases focusing on aminotransferases, serum albumin, prothrombin time, serum ammonia, bile canaliculus enzymes, and bilirubin.
2. **Jaundice and Cholestasis:** Describe, discuss, compare and contrast prehepatic, hepatic, and post hepatic diseases leading to predominantly unconjugated hyperbilirubinemia or predominantly conjugated hyperbilirubinemia.
3. **Liver Failure:** Describe, compare and contrast acute and chronic liver dysfunction/failure, hepatorenal syndrome, hepatic encephalopathy with emphasis on laboratory findings, clinical features, clinical course, and complications.

4. **Cirrhosis:** Describe, compare and contrast compensated and decompensated cirrhosis with respect to pathogenesis, morphology, laboratory findings, clinical features, clinical course focusing on development of portal hypertension, splenomegaly, ascites, esophageal varices, hemorrhoids, caput medusa, gynecomastia, hypogonadism, spider angiomas.
5. **Infectious Liver Diseases:** Describe, discuss, compare and contrast viral hepatitis (A, B, C, D, and E) in terms of etiology, pathogenesis, serology/laboratory findings, morphology, clinical features, clinical course, and complications. Also describe and discuss ascending cholangitis and liver abscess in relation to etiology, pathogenesis, diagnostic findings, morphology, clinical features, clinical course, and complications.
6. **Immunologic Liver Diseases:** Describe, discuss, compare and contrast primary biliary cirrhosis, primary sclerosing cholangitis, autoimmune hepatitis in terms of etiology, pathogenesis, laboratory findings, morphology, clinical features, clinical course, and complications.
7. **Drug and Toxins:** Main drugs which cause damage to the liver, alcoholic liver disease, alcoholic steatohepatitis leading to cirrhosis, non-alcoholic steatohepatitis.
8. **Circulatory Liver Diseases:** Describe, discuss, compare and contrast infarction, portal vein thrombosis, hepatic passive congestion leading to nutmeg liver, Budd-Chiari syndrome in relation to etiology, pathogenesis, morphology, clinical features, clinical course, and complications.
9. **Metabolic Liver Diseases:** Describe, discuss, compare and contrast Wilson disease, hemochromatosis, α1-antitrypsin deficiency in terms of etiology, pathogenesis, laboratory findings, morphology, clinical features, clinical course, and complications.
10. **Neoplastic Liver Diseases:** Describe, discuss, compare and contrast hepatic adenoma, hepatocellular carcinoma, cholangiocarcinoma, metastatic carcinoma (sites of origin) focusing on epidemiology, etiology, pathogenesis, morphology, clinical features, clinical course, metastatic features (where applicable) and prognoses.

Gall Bladder:

1. **Cholelithiasis:** compare and contrast cholesterol, pigmented, mixed stones in terms of formation.
2. **Cholecystitis:** describe, discuss, compare and contrast acute calculous, acute acalculous, and chronic cholecystitis in terms of etiology, pathogenesis, laboratory findings, morphology, clinical features, clinical course, and complications.
3. **Neoplastic Gall bladder disease:** describe and discuss adenocarcinoma focusing on etiology, pathogenesis, morphology, clinical features, clinical course, metastatic features and prognoses.

H. Pancreatic Disease

Learning GoalS: Apply knowledge to the epidemiology, etiology, pathogenesis, morphologic appearance, genetic abnormalities (if applicable), clinical features, diagnosis, lab values, prognosis, and complications of pancreatitis, cystic fibrosis, and pancreatic carcinoma.

1. **Pancreatitis:** Compare and contrast acute pancreatitis and chronic pancreatitis with emphasis on etiology, pathogenesis, morphology, laboratory studies, clinical features, and complications.
2. **Cystic Fibrosis:** Describe and discuss cystic fibrosis in terms of genetics, primary defect, morphologic findings, laboratory findings, clinical course, and complication within the pancreas.
3. **Pancreatic Carcinoma:** Describe pancreatic carcinoma in terms of precursor lesions, molecular carcinogenesis, epidemiology, etiology, pathogenesis, morphology, clinical features and complications.

I. Genitourinary Disease Objectives

I. Male Reproductive – Prostate, Testes, and Penis

Learning Goals: Apply knowledge of the molecular and cellular origins of non-neoplastic and neoplastic disorders of the prostate, testis, and penis to summarize the epidemiology, clinical and pathologic features, and treatment of these diseases.

1. **Non-Neoplastic Disorders.** Describe the clinical course, symptoms, and complications of nodular hyperplasia, prostatitis, cryptorchidism, and testicular torsion.
2. **Prostatic Adenocarcinoma.** Describe laboratory diagnostics and grading.
3. **Testicular Tumors.** Compare and contrast the incidence, risk factors, and prognosis for: germ cell tumors, sex-cord tumors, and malignant lymphoma.
4. **Squamous Cell Carcinoma of the Penis and Scrotum.** Describe the etiology, laboratory diagnostics, and grading.

II. Bladder

Learning Goals: Apply knowledge of the innate and adaptive immunity, pathogenic organisms infecting the bladder, and knowledge of the molecular basis of neoplasia to describe the pathogenesis, epidemiology, and clinical course of cystitis and bladder cancer.

1. **Cystitis.** Compare and contrast infectious vs. interstitial cystitis in terms of etiology and complications.
2. **Bladder Tumors.** Compare and contrast urothelial carcinoma, squamous cell carcinoma, and adenocarcinoma of the bladder in terms of clinical and pathologic features.

III. Female Reproductive – Lower Genital Tract, Uterus, and Ovary

Learning Goals: Apply knowledge of uterine and cervical physiology, endocrinology, and anatomy to compare and contrast the clinical presentation and pathology of common nonneoplastic uterine and cervical disorders and apply knowledge of the molecular basis of neoplasia to describe the incidence, clinical features, and prognosis of ovarian and uterine tumors.

1. **Lower Genital Tract (Vulva, Vagina, and Cervix).** Describe infections in terms of common etiologic agents and prognosis.
2. **Cervical Cancer.** Describe the risk factors, precursor lesions, and pathogenesis.
3. **Non-Neoplastic Uterine Disorders.** Describe endometriosis in terms of pathogenesis and complications and endometrial hyperplasia in terms of etiology, classification, and relationship to malignancy.
4. **Uterine Tumors.** Describe endometrial carcinoma and leiomyomas in terms of risk factors and pathology.
5. **Ovarian Tumors.** Compare and contrast surface epithelial, sex cord-stromal, germ cell, and metastatic tumors in terms of age predilection, morphology, and hormonal effects.

J. Kidney Disease

Learning Goals: Apply knowledge of the structure and function of the kidney to describe the pathogenesis, mechanisms, diagnostic criteria, morphology, laboratory findings and clinical presentation of glomerular, tubular, and vascular diseases.

1. **Use of Laboratory**: Make efficient use of the laboratory in the diagnosis and management of kidney diseases.
2. **Renal Syndromes:** Compare and contrast nephritic and nephrotic syndromes and correlate them with their associated glomerulonephritides.
3. **Immune-Mediated Kidney Disease**: Compare and contrast the mechanisms of immune complex and antibody mediated glomerulonephritis.
4. **Nephropathy Associated with Systemic Disease:** Discuss nephropathy associated with systemic disorders (diabetes, hypertension, systemic lupus erythematosus, and amyloid deposition) including laboratory, morphologic and clinical findings.
5. **Renal Artery Occlusion:** Compare and contrast the causes of renal artery occlusion in terms of pathogenesis, morphology, and clinical presentation.
6. **Hemolytic Uremic Syndrome (HUS) and Thrombotic Thrombocytopenic Purpura (TTP):** Compare and contrast typical hemolytic uremic syndrome, atypical hemolytic uremic syndrome, and thrombotic thrombocytopenic purpura.
7. **Nephritis:** Compare and contrast acute pyelonephritis, chronic pyelonephritis, reflux nephropathy, and drug indued interstitial nephritis.
8. **Acute Tubular Injury:** Compare and contrast ischemic and nephrotoxic forms of acute tubular injury.
9. **Inherited Kidney Disorders:** Describe autosomal dominant polycystic kidney disease.
10. **Nephrolithiasis:** Describe the formation and complications of nephrolithiasis.
11. **Renal Cell Carcinoma:** Differentiate the three major types of renal cell carcinoma (clear cell, papillary, and chromophobe)

K. Breast Disease

Learning Goals: Apply knowledge of the cellular responses to injury, underlying etiology, and biologic and molecular basis of neoplasia to describe the clinical presentation, inheritance risk, biologic behavior, morphologic appearance, classification, morphology, diagnosis, prognosis, and therapy of neoplastic and nonneoplastic disorders of the breast. Describe the significance of the epidemiology, genetics, prognostic markers, demographics, hormonal influence, and premalignant lesions as risk factors for the development of breast cancer.

1. **Use of Laboratory and Imaging Services**: Make efficient use of the laboratory and imaging services (especially mammography) in the screening, diagnosis, and management of breast diseases.
2. **Clinical Presentation of nonneoplastic Breast Lesions:** Identify the most frequently diagnosed breast lesions by age of the patient based on the most common clinical presentations in males (including gynecomastia) versus females. Compare and contrast inflammatory lesions including acute mastitis, periductal mastitis and mammary duct ectasia. Compare and contrast fat necrosis with neoplastic breast lesions.
3. **Fibrocystic changes of the breast:** Compare and contrast the clinical significance of proliferative and nonproliferative fibrocystic change, with and without atypia, and describe how each of these changes and the family history affects the subsequent risk of progression to cancer of the spectrum of fibrocystic change.
4. **Fibroadenoma and Phyllodes Tumor**: Compare and contrast fibroadenoma and phyllodes tumor in terms of clinical features, morphologic findings, and prognosis.

5. **Carcinoma-in-Situ of the Breast**: Compare and contrast ductal carcinoma in situ (including its architectural subtypes comedocarcinoma, solid, cribriform, papillary, and micropapillary) and lobular carcinoma in situ (LCIS) in terms of incidence, epidemiology, clinical presentation, morphology, biomarker expression, pattern of spread, clinical course, treatment, and prognosis.
6. **Invasive Breast Cancer**: Compare and contrast invasive ductal carcinoma (NOS), invasive lobular carcinoma, medullary carcinoma, colloid (mucinous) carcinoma, tubular carcinoma, and metaplastic carcinoma of the breast in terms of incidence, clinical presentation, gross and microscopic morphology, grade, clinical course, prognostic indicators, treatment options.
7. **Breast Cancer Susceptibility Genes**: Describe the normal function of the gene product for common susceptibility genes, incidence of gene mutation, its association with cancer, percentage of hereditary breast cancer, and risk of breast cancer by age 70. Explain gene expression profiling and describe how each correlates with prognosis, risk of recurrence and response to therapy and prognosis.

L. Endocrine Disorders

Learning Goals: Apply knowledge of endocrine regulation by feedback mechanisms, histology, immunology, biological and molecular alterations to discuss clinical presentation, morphology and natural history of nonneoplastic and neoplastic disorders of endocrine glands. Compare and contrast the causes and laboratory findings of primary versus secondary hyperfunction and hypofunction.

1. **Use of Laboratory:** Make efficient use of the laboratory in diagnosis and management of endocrine diseases.
2. **Pituitary, Anterior, Hyperfunction:** Describe the clinical manifestations of pituitary mass effects. Discuss the clinical and laboratory findings and morphology of prolactinoma, somatotroph and corticotroph adenomas.
3. **Pituitary, Panhypopituitarism**: Describe the clinical manifestations, causes and laboratory findings.
4. **Pituitary, Posterior:** Compare and contrast diabetes insipidus with syndrome inappropriate antidiuretic hormone (SIADH) secretion including etiology, pathogenesis, clinical and laboratory findings.
5. **Thyroid Gland Nonneoplastic Diseases:** Discuss interpretation of laboratory function tests of hyperfunction versus hypofunction. Compare and contrast hyperthyroidism with hypothyroidism in terms of etiology, pathogenesis, clinical findings. Describe pathogenesis, morphology, laboratory findings and clinical course of Graves disease and Hashimoto thyroiditis.
6. **Thyroid Gland Neoplasms:** Describe follicular adenomas, and compare and contrast thyroid carcinomas, follicular, papillary, medullar and anaplastic types as to pathogenesis including genetic alterations, morphology and clinical course**.**
7. **Parathyroid Gland**: Compare and contrast primary, secondary and tertiary hyperparathyroidism as to etiology, pathogenesis, morphology, clinical and laboratory findings.
8. **Adrenal cortex, hypercortisolism (Cushing syndrome):** Describe pathogenesis morphologic and clinical features including laboratory findings and use of dexamethasone suppression test to distinguish etiologies.
9. **Adrenal cortex, hyperaldosteronism:** Compare and contrast etiologies, pathogenesis, morphology and laboratory findings of primary and secondary causes.
10. **Adrenocortical insufficiency:** Compare and contrast primary (Addison Disease) with secondary with emphasis on etiology and pathogenesis including Waterhouse- Frederickson syndrome and autoimmune syndromes, morphology, clinical course and laboratory findings.

11. **Adrenal medulla, pheochromocytoma:** Discuss the etiology, pathogenesis, clinical and laboratory findings

M. Diabetes

Learning Goals: Apply knowledge of the physiology of insulin and other endocrine pancreatic hormones to describe the pathogenesis, diagnostic criteria, morphology, pathogenesis, laboratory findings, clinical presentation and complications of the different types of diabetes mellitus.

1. **Classification:** Compare and contrast the distinguishing features of type 1, type 2, and gestational diabetes in terms of etiology, pathogenesis, genetics, environmental factors, and diagnostic criteria.
2. **Acute Metabolic Complications:** Compare and contrast acute complications in terms of pathogenesis, morphology, laboratory findings, clinical presentation, and role in mortality of diabetic ketoacidosis, hyperglycemic, hyperosmolar syndrome, and hypoglycemia.
3. **Pathogenesis of Chronic Complications:** Compare and contrast the metabolic mechanisms implicated in effects of hyperglycemia on peripheral tissues (formation of advanced glycation end products, activation of protein kinase C, and disturbances in the polyol pathways).
4. **Chronic Complications:** Describe the chronic complications of diabetes in terms of pathogenesis, morphology, laboratory findings, clinical presentation, and role in mortality.
5. **Laboratory:** Utilize and interpret laboratory tests in the screening, diagnosis, management of diabetes mellitus and gestational diabetes as well as their complications.
6. **Glycemic Control:** Discuss the role of tight glycemic control in the prevention of chronic complications.

N. Dermatopathology

Learning Goals: Apply knowledge of histology, cell biology, inflammation, immunology, and neoplasia to an understanding of the clinical presentation, biologic behavior, morphologic appearance, and classification of skin diseases.

1. **Terminology:** Define and use in proper context the following: *acantholysis, acanthosis, dyskeratosis, eczema, erosion, excoriation, exocytosis, hydropic swelling, hypergranulosis, hyperkeratosis, lentiginous, lichenification, macule, onycholysis, papillomatosis, papule, parakeratosis, plaque, psoriasis, pustule, scale, spongiosis, ulceration, vacuolization, vesicle, wheal*.
2. **Infectious Dermatoses**: Describe the etiologic agents, morphology, and clinical features of molluscum contagiosum, verruca vulgaris, and verruca plantaris.
3. **Acute Inflammatory Dermatoses**:
    a. **Eczema**. Describe the morphologic characteristics of acute, subacute, and chronic eczema and compare and contrast contact vs. atopic dermatitis with emphasis on previous antigen exposure and type of hypersensitivity reaction.
    b. **Erythema Multiforme**. Describe in terms of emphasis on pathogenesis, morphology, and clinical features.
4. **Chronic Inflammatory Dermatoses:** Describe the etiology, pathogenesis, and morphology of lichen simplex chronicus and psoriasis.
5. **Blistering (Bullous) Disorders:** Compare and contrast the pathogenesis, morphology, and clinical features of pemphigus vulgaris, bullous pemphigoid, and dermatitis herpetiformis.

6. **Disorders of pigmentation**: Compare and contrast albinism vs. vitiligo and lentigo vs. ephelides in terms of pathogenesis, morphology, and clinical features.
7. **Benign Epithelial Tumors**: Describe acrochordon (fibroepithelial polyp), epidermal inclusion cysts, seborrheic keratosis, and acanthosis with emphasis on morphology and clinical features (including disease associations).
8. **Dermal Lesions**: Describe the morphology and clinical features (including disease associations, if applicable) of dermatofibroma and xanthoma.
9. **Vascular lesions:** Describe the morphology and clinical features of hemangioma and pyogenic granuloma.
10. **Premalignant and Malignant Epidermal Tumors**: Describe the following with emphasis on pathology, morphology, and clinical features: keratoacanthoma, actinic keratosis, squamous cell carcinoma, and basal cell carcinoma.
11. **Melanocytic Nevi:** Compare and contrast the difference between junctional, compound, intradermal, congenital, acquired, Spitz, and dysplastic nevi in terms of morphology.
12. **Melanoma:** Describe malignant melanoma and acral-lentiginous melanoma with emphasis on risk factors, pathogenesis, and morphology, including staging and prognostic factors.

O. Joint Disease

Learning Goals: Apply knowledge of histology, immunology, microbiology and biological and molecular alterations to discuss clinical presentation, biological behavior, morphological appearance and natural history of nonneoplastic and neoplastic disorders of joints.

1. **Use of Laboratory:** Make efficient use of the laboratory including synovial fluid analysis and serology in diagnosis and management of joint diseases.
2. **Osteoarthritis:** Discuss the pathogenesis, morphology including distribution and clinical findings. Contrast with rheumatoid arthritis.
3. **Rheumatoid arthritis**: Describe etiology, pathogenesis, morphology, clinical findings including distribution and laboratory findings. Contrast with osteoarthritis.
4. **Seronegative spondyloarthropathies**: Compare and contrast morphologic and clinical features including laboratory findings of ankylosing spondylitis, reactive arthritis (Reiter syndrome), psoriatic arthritis, enteropathic arthritis.
5. **Crystal arthropathies:** Compare and contrast etiologies including primary and secondary causes, laboratory, morphologic, and clinical findings of gout and calcium pyrophosphate deposition disease (CPPD, pseudogout).
6. **Juvenile idiopathic arthritis:** Discuss the clinical presentation and laboratory findings**.**
7. **Infectious arthritis**: Compare and contrast clinical and laboratory features of suppurative and Lyme disease.
8. **Neoplasms of joints and related soft tissue:** Describe the pathogenesis, clinical findings and morphology of tenosynovial giant-cell tumor, localized and diffuse (pigmented villonodular synovitis and giant cell tumor of tendon sheath).

P. Bone Disease

Learning Goals: Apply knowledge of the molecular basis of genetics, inflammation, and neoplasia to describe the clinical presentation, biologic behavior, morphologic appearance, classification, genetic

abnormalities (if applicable), diagnosis, prognosis, and targeted therapy of inflammatory, neoplastic and non-neoplastic bone disorders.

1. **Use of Laboratory and Imaging Services**: Make efficient use of the laboratory and Imaging Services in the diagnosis and management of bone disorders.
2. **Genetically Predisposed Bone Disorders**: Compare and contrast achondroplasia, osteochondromatosis, osteopetrosis, enchondromatosis, and 0steogenesis imperfecta and correlate the entities with genetic abnormalities as applicable.
3. **Inflammatory disorders of bone**: Compare and contrast Brodie abscess and osteomyelitis (acute and chronic). Define Involucrum and Sequestrum.
4. **Fractures of bone:** Describe fractures (types, repairs, complications and healing process and factors that alter healing).
5. **Metabolic disorders of bone:** Compare and contrast Osteoporosis, Paget disease, hyperparathyroidism, and renal Osteodystrophy.
6. **Osteonecrosis (avascular necrosis) of Bone:** Describe pathophysiology, morphology and treatment of Avascular Necrosis of Bone.
7. **Categories of Bone Tumors**. Compare and contrast common bone tumors, neoplastic vs non-neoplastic, with reference to age distribution, etiology, site of origin, clinicopathologic features, genetic (as applicable) radiological features, treatment, and prognosis of each entity: fibrous dysplasia, osteoma, osteoblastoma, osteochondroma, chondroma, osteoid osteoma, osteosarcoma, chondrosarcoma, giant cell tumor of bone, Ewing sarcoma (including primitive neuroectodermal tumor (PNET).
8. **Metastatic Tumors**. Describe tumors that commonly metastasize to bone, and their associated radiologic findings (osteoblastic vs osteolytic lesions). Describe how immunohistochemistry can help differentiate the different metastases.

Q. Soft Tissue Disease

Learning Goals: Apply knowledge of the molecular basis of neoplasia to an understanding of the clinical presentation, biologic behavior, morphologic appearance, classification, diagnosis, prognosis, and therapy of benign and malignant soft tissue and joint neoplasms.

1. Describe the following tumors (masses) of joint and soft tissue in terms of biology (neoplastic versus non-neoplastic, benign versus malignant); epidemiology; etiology; cell type and site of origin; and clinical course:
   a. **Tumors of Adipose Tissue:** lipoma vs. liposarcoma
   b. **Fibrous Tumors:** fibroma vs. fibromatosis (plantar and palmar)
   c. **Skeletal Muscle Tumors and Tumor Like-Condition:** rhabdomyosarcoma and myositis ossificans
   d. **Smooth Muscle Tumors:** leiomyoma vs. leiomyosarcoma
   e. **Tumors of Uncertain Origin:** synovial sarcoma and undifferentiated pleomorphic sarcoma
   f. **Joint Tumors and Tumor-Like Conditions**: ganglion, synovial cyst, tenosynovial giant cell tumor
   g. **Peripheral Nerve Sheath Tumors**: schwannoma, neurofibroma, plexiform neurofibroma, traumatic neuroma

R. Head, Neck, and Special Sensory Organs Pathology

Learning Goals: Apply knowledge of histology and neoplasia to an understanding of head and neck precancerous and cancerous lesions; apply knowledge of the structure and function of the eye and general pathology concepts to discuss common ocular disorders.

1. **Head and Neck Lesions:** Describe in terms of etiology, pathogenesis, morphology, and clinical features: leukoplakia, squamous cell carcinoma (oral and laryngeal).
2. **Diabetes mellitus and the eye.** Describe the pathogenesis, clinical presentation, and clinical course of: cataract, glaucoma, proliferative retinopathy (neovascularization, vitreous hemorrhages, fibrosis, retinal detachment), nonproliferative retinopathy (microaneurysm, macular and retinal edema, and hard exudates).
3. **Hypertension and the eye.** Describe retinal vascular changes with emphasis on ophthalmoscopic findings.
4. **Age-related macular degeneration.** Describe the types, etiology, pathogenesis, morphology, and clinical course.
5. **Uveitis.** Describe disease associations.

S. Neuromuscular Disease

Learning Goals: Apply knowledge of the structure and function of the neuromuscular system to describe the pathogenesis, mechanisms, genetic abnormalities (as applicable), clinical presentation, morphology, diagnostic criteria, laboratory findings of neuromuscular diseases.

1. **Use of Laboratory**: Make efficient use of the laboratory (H&E, special stains, Electron Microscopy, genetic assays) in the diagnosis and management of neuromuscular diseases. Apply knowledge of clinical, anatomic, and neuropathologic principles to the diagnosis of neuromuscular disorders.
2. **Reactions of the motor Unit:** Compare and contrast demyelination, axonal degeneration, muscle fiber atrophy, nerve regeneration, and re-innervation of muscle.
3. **Neuropath**y: Compare and contrast the clinicopathologic features of the following:
   a. inflammatory neuropathies (including Guillain-Barre syndrome and demyelinating polyradiculoneuropathy)
   b. autoimmune neuropathy, and infectious neuropathy (including polyneuropathies due to leprosy (Hansen disease), diphtheria, and varicella-zoster virus)
   c. Hereditary motor and sensory neuropathies including Charcot-Marie-Tooth disease and Dejerine-Sottas disease
   d. Genetic and acquired metabolic diseases including leukodystrophies and diabetic neuropathy
   e. Traumatic neuropathies including traumatic, compression, Morton's neuroma
   f. Tumors of peripheral nerve: Compare and contrast the clinicopathologic features of neurofibromatosis types 1 and 2.
4. **Diseases of skeletal muscle**: Compare and contrast the clinicopathologic features of the following
   a. denervation atrophy (Spinal Muscular Atrophy)
   b. Myotonic dystrophy and Muscular dystrophies including Duchenne, and Becker's dystrophy
   c. Diseases of the neuromuscular junction (myasthenia gravis, Lambert-Eaton myasthenic syndrome)

T. Central Nervous System (CNS) Disease

Learning Goals: Apply knowledge of neuroanatomy, structure and function of the brain, inflammation, infection, neoplasia, and abnormal development as they relate to central nervous system disorders as enumerated.

1. **CNS Injury:** Explain the reactions of cells to injury (neurons, astrocytes, other glial cells).
2. **Anatomy:** Describe features unique to the CNS that affect clinical presentation of diseases, complicate outcomes, and affect therapy, including blood-brain barrier, CSF, localization of function, selective vulnerability, skull, vascular supply.
3. **Cerebral edema:** Compare and contrast vasogenic, cytotoxic, and interstitial.
4. **Hydrocephalus:** Describe communicating and noncommunicating hydrocephalus, with emphasis on etiology, morphology, and clinical course.
5. **Herniations:** Compare and contrast subfalcine, transtentorial, and tonsillar herniation, in terms of pathogenesis, morphology, clinical findings, and sequelae.
6. **Malformations and Developmental Disorders:** Describe the following in terms of relative frequency, pathogenesis, morphology, and clinical features: agenesis of corpus callosum, anencephaly, Chiari type I and type II (Arnold-Chiari) malformation, Dandy-Walker malformation, encephalocele, hydromyelia, meningomyelocele, spina bifida, syringomyelia.
7. **Perinatal Brain Injury:** Describe cerebral palsy, intraparenchymal hemorrhage, and infarcts in terms of pathogenesis, morphology, and clinical presentation and course.
8. **Trauma:** Identify and describe the types of skull fractures (displaced, diastatic) and parenchymal injuries (concussion, contusion, laceration, coup injury, contrecoup injury, hyperextension of the neck, and diffuse axonal injury) to include etiology, morphology, and clinical presentation.
9. **Traumatic Vascular Injury:** Compare and contrast epidural hematoma and subdural hematoma (acute and chronic) in terms of pathogenesis, morphology, and clinical presentation.
10. **Sequelae of Brain Trauma and Spinal Cord Injury:** Describe post-traumatic hydrocephalus, chronic traumatic encephalopathy, and spinal cord injury in terms of pathogenesis, morphology, and clinical presentation.
11. **Cerebrovascular Disease:** Explain cerebrovascular disease and compare and contrast global vs. focal cerebral ischemia and spinal cord infarction, in terms of pathogenesis, morphology, and clinical features.
12. **Hypertension:** Describe its effect on the brain and morphology of- arteriolosclerosis, lacunar infarcts, slit hemorrhages, hypertensive encephalopathy, Charcot-Bouchard aneurysms, and intracerebral hemorrhage.
13. **Intracranial Hemorrhage:** Explain causes of non-traumatic intraparenchymal hemorrhage (e.g. cerebral amyloid angiopathy) and subarachnoid hemorrhage (e.g. saccular aneurysms) including clinical features, pathogenesis, and morphology.
14. **Vascular Malformations:** Classify and describe the clinical features of arteriovenous malformations, cavernous malformation, capillary telangiectasias, and venous angiomas.
15. **Infections:** Compare and contrast the pathogenesis, causative organisms, laboratory findings, clinical presentation and course for acute pyogenic (bacterial) meningitis, acute aseptic (viral) meningitis, chronic bacterial meningitis (tuberculosis, neurosyphilis, neuroborreliosis), progressive multifocal leukoencephalopathy, and subacute sclerosing panencephalitis.
16. **Demyelinating Diseases:** Describe multiple sclerosis (MS) in terms of geographic distribution, etiology, pathogenesis, morphology, laboratory findings, and clinical course.
17. **Neurodegenerative Diseases:** Compare and contrast the following including etiology, pathogenesis, morphology, clinical presentation and course- Creutzfeldt-Jakob disease vs. variant Creutzfeldt-Jakob disease, Alzheimer disease, corticobasal degeneration, dementia with Lewy Bodies, Friedreich ataxia, Huntington disease, Parkinsonism / Parkinson disease, Pick disease, spinocerebellar ataxias, vascular dementia, amyotrophic lateral sclerosis (ALS).
18. **Tumors:** Compare and contrast the following neoplasms in terms of epidemiology, genetics, pathogenesis, morphology, clinical features, and prognosis- astrocytoma (infiltrating, all grades), medulloblastoma, meningioma**,** pilocytic astrocytoma, and metastatic tumors.

PHARMACOLOGY

LEARNING OBJECTIVES

General Principles

Autonomic Nervous System Drugs

Cardiovascular Drugs

Renal Drugs

Pulmonary Drugs

Antihistamines

Gastrointestinal Drugs

Drugs Acting on the Central Nervous System

Autacoids and Drugs Used to Treat Inflammation

Endocrine Pharmacology

Drugs Affecting Hemostasis and Blood Forming Organs

Immunosuppressive Drugs

Toxicology and Therapy of Intoxication

Antimicrobial Chemotherapy

Antineoplastic Chemoctherapy

Herbal Medicine and Natural Supplements

Introduction to the Pharmacology Section

The following should be addressed for each agent or class of agents listed in each section.

1. Define the mechanism of action, site of action and receptor(s) interactions.
2. Discuss any unique pharmacokinetic features of the drug.
3. Discuss the major adverse effects and contraindications.
4. Describe significant drug interactions.
5. Define the major therapeutic indications.

I. General Principles

A. Foundational Concepts

1. Define: pharmacology, pharmacokinetics, pharmacodynamics, pharmacogenomics, and toxicology.
2. Define: the terms “drug” and “receptor”.
3. Explain drug-receptor binding and the types of chemical forces that allow drugs to bind to receptors.
4. Distinguish between phase 1, phase 2, phase 3, and phase 4 in relation to clinical drug trials.
5. Explain what is meant by the chemical, generic, and proprietary/trade name of a drug.

B. Pharmacokinetic Principles

1. Define the processes of absorption, distribution, metabolism, and elimination.
2. Discuss weak acids and bases, the Henderson-Hasselbalch equation, and the relationship between pH and ionization of drugs on drug absorption.
3. Discuss the effect of lipid solubility of drug species, polar, and nonpolar drugs.
4. Identify the properties of biological membranes, mechanisms of drug movement across membranes, and differentiate between which are active and which are passive processes.
5. Explain the effects of pH on the distribution of drugs, in the context of stomach contents, urine, inflammation, and infection.
6. Identify factors affecting absorption.
7. Identify routes and special sites of absorption.
8. Explain the effects of plasma protein binding on drug distribution.
9. Describe the distribution of drugs into special compartments, with respect to the blood-brain barrier, tight endothelial junctions, bone, and placenta.
10. Discuss the importance of membrane transporters for both entry and efflux of drugs.
11. Identify and describe the major pathways of metabolism, including Phase I versus Phase II, general properties, oxidation, reduction, hydrolysis and conjugation: glucuronides, glycine, sulfate esters, acetylation, glutathione, mercapturic acids.
12. Explain the cytochrome P450 system in liver and other tissues. Know the major CYP450s involved in drug metabolism, including CYP1A2, CYP2D6, CYP2E1, and CYP3A4.
13. Explain enzyme induction and inhibition, including mechanisms, time course, clinical implications, and examples of common inducers and inhibitors.
14. Identify and describe concepts important for renal excretion, including role of filtration, secretion and reabsorption, molecular size, polarity, weak acids/bases, urine pH, and transporters, as well as the importance of plasma protein binding. (4.0)
15. Explain biliary/alimentary excretion, including biliary transport, direct secretion of drugs from blood to intestine, importance of plasma protein binding, molecular size, polarity, weak acids, and weak bases.
16. Explain the consequences of enterohepatic circulation and consequences of drug elimination when it is altered.
17. Explain the concept of clearance and the Cockcroft-Gault equation.
18. Compare and contrast capacity-limited elimination and flow-dependent elimination.

C. Quantitative Pharmacokinetics

1. Compare and contrast first order and zero-order kinetics.
2. Distinguish between one and two compartment systems and the impact on pharmacokinetic principles of absorption, distribution, and elimination.

3. Define and calculate volume of distribution (Vd), clearance (CL), rate of elimination, half-life(t1/2), bioavailability (F), area under the curve (AUC), first pass metabolism and extraction ratio (ER), and drug accumulation.
3. Identify the pharmacokinetic parameters that determine and can be estimated from the log C versus time plot.
4. Define steady-state and explain the time to steady state as a function of half-life for drugs eliminated via 1st order kinetics, as well as the effects of stopping or changing the dose or infusion or changing infusion rate.
6. Explain the rationale for the use of a maintenance dose and loading dose.

D. Pharmacodynamics/Drug Receptors

1. Identify the general types of drug receptors including those that: are associated with endogenous physiological regulatory molecules (e.g., G-protein coupled, ion channels, transmembrane-linked, nuclear hormone receptors and transcription factors), are associated with extracellular processes (e.g., inflammatory, immune responses), regulate ionic content (urinary, gastrointestinal tract).
2. Identify other types of drug targets (e.g., enzymes, nucleic acids, those utilized by anti-infective agents).
3. Identify drug actions not mediated by specific macromolecular targets (chelating agents, chemical neutralization, osmotic diuretics).
4. Explain the concepts of receptor down-regulation/desensitization and up-regulation/sensitization, and their relationship with agonist exposure.

E. Quantification of Drug Receptor Interactions

1. Define the pharmacologic terms agonist, partial agonist, inverse agonist, and antagonist.
2. Demonstrate typical graded log concentration (dose) response curves and differentiate among results expected for agonists, partial agonists, and inverse agonists.
5. Briefly explain theories or concepts that account for differences among drugs acting at the same receptor including affinity, receptor occupancy, intrinsic activity, efficacy, and potency.
6. Explain the various mechanisms of drug antagonists and differentiate the effects of competitive versus noncompetitive antagonists on log dose response curves for agonists.
6. Explain how partial agonists or inverse agonists can function activate or inhibit receptors.
7. On a population bases, explain the concept of the TD50.
8. Explain the calculation and clinical significance of the therapeutic index as it relates to patient safety.
9. Compare and contrast tolerance and sensitization to a drug and the describe both pharmacokinetic and pharmacodynamic changes that can produce tolerance or sensitization.

F. Pharmacogenetics/Genomics

1. Define pharmacogenetics, pharmacogenetic trait, pharmacogenomics, and personalized medicine and explain their clinical importance.
2. Identify well established pharmacogenetic polymorphisms that affect drug response, as well as drug disposition and toxicity.
3. Identify relevant sources of information for evolving pharmacogenetic information.

G. Drug Interactions

1. Discuss the overall clinical relevance of drug interactions for patient safety.

2. Identify relevant sources of information for searching drug-drug, drug-supplement, drug-food interactions.
3. Explain the concepts of drug summation, synergy, potentiation, and antagonism.
4. Describe the general mechanisms of drug interactions and cite examples for each of the following:
    a. interactions before/during drug administration
    b. drug interactions involving oral administration (drug binding in GI-tract, alteration in GI motility or pH, effects on intestinal microbiota)
    c. plasma protein binding displacement
    d. interactions associated with modified renal excretion
    e. interaction associated with drug metabolism including enzyme induction/inhibition
    f. pharmacodynamic interactions at the target organ

II. Autonomic Nervous Syustem Drugs

A. Drugs Actung at the Nerve Terminal

1. Discuss the operation of peripheral cholinergic and adrenergic nerve endings with respect to potential pharmacologic interventions involving synthesis, storage, release, and inactivation of neurotransmission.
2. Identify drugs that inhibit the neuronal release of acetylcholine (Ach)
   (botulinum toxins A and B)
3. Identify drugs that inhibit the inactivation of ACh.
   (acetylcholinesterase inhibitors (see below)
4. Identify drugs or substances that stimulate the neuronal release of NE.
   (ephedrine, amphetamine, tyramine)
5. Identify drugs that inhibit the NE transporter (NET)
    a. cocaine
    b. tricyclic antidepressants
    c. Serotonin norepinephrine re-uptake inhibitors SNRIs
6. Identify drugs that inhibit the vesicular storage of NE
   (valbenazine)

B. Direct-and-Indirect-Acting Cholinergic Agonists

1. Agents and classes:
    a. Muscarinic receptor agonists
       (bethanechol, pilocarpine, cevimeline)
    b. Nicotinic receptor agonists
       (nicotine, varenicline)
    c. Acetylcholinesterase inhibitors – Reversible, competitive inhibitors
       (Physostigmine, Neostigmine, Pyridostigmine)
    d. Acetylcholinesterase inhibitors – Organophosphates (irreversible inhibitors)
       (parathion, malathion, echothiophate, sarin, soman)
2. Identify the major clinical uses of muscarinic receptor agonists.
3. Describe the Black Box Warning for varenicline.
4. Discuss the binding of substrates and mechanism of action of acetylcholinesterase in order to differentiate among reversible and irreversible inhibitors.
5. Explain key pharmacokinetic differences between physostigmine and neostigmine.
6. Discuss the use of anticholinesterase agents as insecticides and chemical warfare agents.

C. Cholinergic Muscarinic Antagonist

1. Agents and classes:
   a. Muscarinic Receptor Antagonists
   (atropine, scopolamine, ipratropium, darifenacin, homatropine, oxybutynin, glycopyrrolate and others)
2. Explain why muscarinic recptor antagonists may cause or exacerbate xerostomia, blurred vision, photophobia, tachycardia, difficulty in micturition, hyperthermia, glaucoma, andmental confusion (elderly).
3. Explain the contraindication to the use of muscarinic receptor antagonists in glaucoma, gastrointestinal or urinary obstructive disease.
4. Describe clinical uses and differentiate among muscarinic receptor antagonists used in patients with bronchial asthma, overactive bladder, sialorrhea, motion sickness, and for ophthalmologic purposes.

D. Chloinergic Nicotinic Receptor Anatagonists

1. Agents and classes:
   a. Depolarizing-type neuromuscular blocking agents
   (succinylcholine)
   b. Competitive blockers (non-depolarizing)
   (mivacurium, vecuronium, atracurium, rocuronium)
2. Compare and contrast succinylcholine and competitive blockers with respect to:
   a. onset of action and disposition, including pharmacogenetic influences
   b. effects on the end plate potential.
   c. sequence and characteristics of paralysis.
   d. reversal of paralysis and response to acetylcholinesterase inhibition
   e. effects on autonomic nervous system ganglia and mast cell histamine release.
   f. adverse events and contraindications influencing patient safety.
   g. relationship with occurrence of malignant hyperthermia in susceptible patients.

E. Endogenous Catecholamines

1. Agents and classes:
   a. Catecholamines
   (epinephrine, norepinephrine, dopamine)
2. Discuss receptor selectivity and pharmacological effects of epinephrine, norepinephrine and dopamine.
3. Differentiate the effects of a low and high dose epinephrine.
4. Describe the use of epinephrine as a bronchodilator and for the treatment of anaphylactic shock.
5. Describe the use of norepinephrine for the treatment of shock and hypotensive states.
6. Discuss the use of dopamine for the treatment of shock and congestive heart failure.

F. Sympathomimetics

1. Agents and classes:
   a. Indirect-acting sympathomimetics
   (amphetamine, methamphetamine, other amphetamine analogues, cocaine, tyramine)
   b. Mixed sympathomimetics
   (ephedrine, pseudoephedrine)
2. Describe the role of tyramine in drug-food interactions.
3. Describe the mechanism of action and the use of pseudoephedrine as a decongestant.

H. Agents that target alpha-adrenergic receptors

1. Agents and classes:
    a. Alpha-receptor agonists
    (midodrine, pseudoephedrine, phenylephrine, oxymetazoline, tetrahydrozoline, clonidine, methyldopa, and others)
    b. Alpha-receptor antagonists
    (phentolamine, phenoxybenzamine, prazosin, terazosin, doxazosin, alfuzosin, silodosin, tamulosin and others)
2. Differentiate among the effects of nonselective and selective alpha receptor agonists.
3. Explain the use of alpha agonists to treat shock, orthostatic hypotension and nasal congestion.
4. Explain the use of selective alpha-2 agonists to treat hypertension.
5. Discuss the hypertensive crisis that can occur after the abrupt withdrawal of Clonidine.
6. Compare the effects of the non-selective and alpha-1 selective antagonists.
7. Describe the use of selective alpha-1 adrenergic antagonists for the treatment of hypertension and benign prostatic hypertrophy.
8. Explain the non-competitive nature of phenoxybenzamine and its use in the treatment of pheochromocytoma.

I. Agents that target beta-adrenergic receptors

1. Agents and classes:
    a. Beta-receptor agonists
    (isoproterenol, dobutamine, albuterol, salmeterol, formoterol, mirabegron and others)
    b. Beta-receptor antagonists
    (propranolol, nadolol, timolol, nadolol, sotalol, carvedilol, nebivolol, atenolol, metoprolol and others)
2. Compare the effects of non-selective, beta-2 and beta-3 selective agonists.
3. Explain the use of isoproterenol and dobutamine as cardiac stimulants.
4. Explain the use of albuterol, salmeterol, and formoterol for the treatment of asthma.
5. Describe the mechanism underlying the use of the beta-3 selective agonist mirabegron for the treatment of overactive bladder.
6. Compare and contrast the pharmacology and uses of non-selective beta antagonists with the cardioselective beta-1 antagonists.
7. Describe the use of beta receptor antagonists for the treatment of hypertension, myocardial infarction, cardiac arrhythmias and congestive heart failure.
8. Explain the contraindication for the use of non-selective beta antagonists in patients with asthma, peripheral vascular disease, and insulin-dependent diabetes mellitus.

III. Cardiovascular Drugs

A. Specific Drugs for Management of Cardiac Arrhythmias

1. Agents and classes:
    a. Class I (A, B & C)
    (procainamide, quinidine, lidocaine, mexiletine, flecainide, propafenone)
    b. Class II (Beta Blockers)
    (metoprolol, propranolol, esmolol, acebutolol, atenolol, bisoprolol, sotalol)
    c. Class III
    (sotalol, amiodarone, dronedarone, dofetilide, ibutelide)
    d. Class IV

(verapamil, diltiazem)

e. Class V Miscellaneous or unclassified antiarrhythmic drugs (digoxin, adenosine, magnesium)

2. Explain the alteration of cardiac electrical activity that causes the development of cardiac arrhythmias.
3. Describe drug-induced cardiac arrhythmias.
4. Discuss the pathophysiology of cardiac arrhythmias (abnormal automaticity,triggered arrhythmias, reentrant rhythms and abnormal impulse conduction).
5. Explain the indirect autonomic actions of antiarrhythmic drugs.
6. Explain the potential adverse effects and contraindications of antiarrhythmic drugs in the presence of heart block or congestive heart failure.
7. Discuss the classes of drugs that can produce long QT Syndrome.
8. Explain the use of anti-arrhythmic drugs presecurbed for premature atrial flutter, atrial tachycardia, AV nodal reentry arrhythmia, atrial fibrillation and ventricular tachycardia.

B. <u>Specific Drugs for Management of Heart Failure</u>

1. Agents and classes
    a. Angiotensin Converting Enzyme Inhibitors, ACEI (Captopril, enalapril, benazepril, fosinopril, lisinopril, quinapril, ramipiril)
    b. Diuretics (Furosemide, bumetanide, torsemide, ethacrynic acid, spironolactone)
    c. Vasodilators (Hydralazine, nitroglycerin, isosorbide dinitrate, isosorbide mononitrate
    d. PDE Inhibitors (Milrinone, inamrinone)
    e. Dobutamine
    f. Beta Blockers (Metoprolol, carvedilol)
    g. Digoxin
    h. Salcubitril/Valsartan
    i. Ivabradine
2. Explain which classes of drugs are used to treat the cardiac compensatory mechanism.
3. Discuss treatment protocols for the management of acute and chronic heart failure.
4. Explain the mechanism of action, indications and effects on cardiac physiology when prescribing digoxin.
5. Discuss the physiology and indications of positive inotropic drugs such as beta-adrenergic agonists and phosphodiesterase inhibitors for the treatment of heart failure.
6. Discuss the physiology and indications for beta adrenergic blockers, ACEI, vasodilators on cardiac function and ventricular wall remodeling.
7. Discuss why the ACEI are first line drugs used in congestive heart failure.
8. Describe the etiology of reentry arrhythmias caused by antiarrhythmic drugs .
9. Explain the use of Digoxin in congestive heart failure and for treatment of atrial arrhythmias.
10. Discuss indications of Salcubitril/ Valsartan for treatment of congestive heart failure.
11. Discuss the indications for Ivabradine for treatment of congestive heart failure
12. Discuss the four-stage progression of disease and therapy in congestive heart failure

A. <u>Specific Drugs for Management of Hypertension</u>

1. Agents and classes
    a. Angiotensin Receptor Blocking Drugs, ARBS
    (valsartan, telmisartan, losartan, irbesartan, eposartan)
    b. ACE Inhibitors
    (captopril, enalapril, benazepril, fosinopril, lisinopril, quinapril, ramipiril)
    c. Thiazide Diuretics
    (hydrochlorothiazde, HCTZ)
    d. Calcium Channel Blockers
    (*dihydropiridines:* amlodipine, felodipine, nicardipine, nifedipine, nimodipine; *non-dihydropyridines:* diltiazem, verapamil)
    e. Beta Blocker*s*
    (Beta 1 Selective: metoprolol, atenolol, bisoprodol; *vasodilatory:* carvedilol, labetalol, nebivolol, betaxolol; *Non-selective:* propranolol, timolol, pindolol, nadolol)
    f. Alpha1 Blockers
    (doxazosin, prazosin, terazosin)
    g. Central acting Adrenergic drugs, Alpha 2 agonists
    (clonidine, guanabenz, methyldopa)
    h. Vasodilator Drugs
    (hydralazine, minoxidil)
    i. Drugs for the Treatment of Hypertensive Crisis
    (sodium nitroprusside, diazoxide, fenoldopam)
2. Discuss the pathophysiology of hypertension including the role of the autonomic nervous system and renin angiotensin aldosterone system.
3. Discuss the appropriate pharmacologic treatment protocols for the different categories of hypertension.

B. <u>Drugs for the Management of Angina and Ischemic Heart Disease</u>

1. Agents and classes:
    a. Organic Nitrates
    (Nitroglycerin, isosorbide dinitrate, isosorbide mononitrate, amyl nitrate)
    b. Beta Blockers
    (Metoprolol, atenolol, timolol, propranolol)
    c. Calcium Channel Blockers
    (Verapamil, diltiazem, amlodipine, nifedipine, nicardipine)
    d. Vasdodilators
    (Ranozaline)
    e. Antiplatelet drugs
    (Aspirin, clopidogrel)
    f. Phosphodiesterase Inhibitors
    (Sildenafinl, Tadalafil, Vardenafil)
2. Discuss the effects of antianginal drugs on myocardial oxygen consumption (heart rate, myocardial wall tension and coronary artery blood flow).
3. Describe the action of antianginal drugs on the peripheral circulation and the effects on preload and afterload.

4. Explain the significance of "first pass effect" for orally administered drugs and the rationale for sublingual, transdermal and intranasal administration of nitrates.
5. Explain the problem of dosing and the development of tolerance with nitrate drugs.
6. Discuss the therapeutic uses of the different classes of antianginal drugs treatment regimens for exertional angina and vasospastic angina.
7. Discuss the use of beta blocker drugs for treatment of angina, as well as prophylaxis of myocardial infarction.

C. Drugs for the Management of Hyperlipidemias

1. Agents and classes:
   a. HMG CoA reductase inhibitors (Statins)
      (Lovastatin, Simvastatin, Rosuvastatin, Fluvastatin, Pravastatin)
   b. Bile acid binding resins
      (Cholestyramine, Colestipol)
   c. Fibrates
      (Gemfibrozil, Fenofibrate)
   d. Inhibitors of sterol absorption
      (Ezetimibe)
   e. Omega 3 Fatty acids
   f. Niacin
   g. PCSK9 Inhibitors
      (evolocumab)
2. Explain cholesterol synthesis, transport, export, excretion, and receptor mediated cellular uptake.
3. Discuss the use of drugs for different hyperlipidemias (I, II, III, IV and V) as well as changes in serum lipids for triglycerides, cholesterol, LDL, HDL, LDL, chylomicrons, and lipoproteins.
4. Discuss common drug interactions associated with the use of statins.
5. Explain the role of HMG CoA reductase Inhibitors for the treatment of atherosclerosis and indication for diabetes, and coronary artery disease.
6. Explain the common adverse effects of HMG Co A reductase inhibitors including hepatic disease, myopathy, and rhabdomyolysis.

IV. Renal Drugs

A. Drugs Affecting Renal Function, Water and Electrolyte Metabolism

1. Agents or Classes:
   a. desmopressin (dDAVP)
   b. vasopressin tolvaptan
   c. conivaptan
   d. demeclocycline
2. Explain how NSAIDs and clonidine can alter water reabsorption by the kidney.
3. Outline the signs, symptoms and treatment of the syndrome of inappropriate ADH secretion (SIADH) and discuss the toxicity of correcting dilutional hyponatremia with a vaptan or demeclocycline.

4. Describe the pharmacotherapy of central and nephrogenic diabetes insipidus.
5. Explain the mechanisms of chronic lithium dosing on renal water reabsorption (e.g., polydipsia, polyuria).

B. Diuretic Drugs

1. Agents or classes:
   a. carbonic anhydrase inhibitors (acetazolamide)
   b. loop diuretics (bumetanide, furosemide, ethacrynic acid)
   c. thiazides (hydrochlorothiazide)
   d. thiazide-like (chlorthalidone)
   e. aldosterone receptor antagonists (spironolactone, eplerenone)
   f. epithelial sodium channel inhibitors (amiloride, triamterene)
   g. osmotic diuretics (mannitol, glycerin)
2. Outline the changes that occur with electrolyte transport, pH balance, water reabsorption, and hemodynamics when specific diuretics inhibit kidney function.
3. Distinguish the effects of K+-sparing diuretics with a thiazide or loop diuretic.
4. Identify supplemental therapeutics that can prevent diuretic-induced hypokalemia.
5. Describe how other drugs or diseases can interfere with the effects of diuretics.
6. Identify adverse effects that can occur with diuretics, specifically in relation to metabolic imbalances, such as glucose, uric acid, lipids, and electrolytes.
7. Discuss the lack of efficacy of thiazide diuretics in reduced renal perfusion.
8. Discuss the role of salt restriction on diuretic potency and how loop diuretics can result in rebound hypernatremia.
9. Contrast the effects of loop versus thiazide diuretics on calcium homeostasis.

V. Pulmonary Drugs

A. Drugs for Management of Respiratory Diseases

1. Agents and classes
   a. Inhaled Corticosteriods (beclomethasone, fluticasone, budesonide, mometasone, ciclesonide)
   b. Short acting beta-2 agonists, SABA (albuterol, levalbuterol)
   c. Long acting beta-2 agonists, LABA (salmeterol, formoterol)
   d. Inhaled muscarinic antagonists (ipratropium, tiotropium)

e. Leukotriene synthesis inhibitors and receptor antagonists
(zafirlukast, montelukast)
f. Monoclonal antibodies
(omalizumab, venralizumab)

2. Identify the mechanism of action of each of the major classes of agents relative to the component of pathogenesis to distinguish between agents that modify the disease process versus those that relieve symptoms.
3. Distinguish the use of drugs to treat intermittent episodes of asthma from those used for persistent treatment and prevention.
4. Describe prevention of tolerance to beta-2 agonists.
5. Discuss the use of drugs in the treatment of COPD.

VI. Antihistamines

A. H1 Receptor Blockers

1. Agents and classes:
   a. First generation antihistamines
   (diphenhydramine, dimenhydrinate, hydroxyzine, promethazine)
   b. Second generation antihistamines
   (certirizine, loratadine, desloratadine, fexofenadine, azelastine)
2. Describe the actions of anti-histamines on the nervous system, cardiovascular system, bronchiolar smooth muscle, gastrointestinal tract smooth muscle, and secretory tissues.
3. Describe and explain the mechanism behind the "triple response" following the subcutaneous injection of histamine.
4. Distinguish how pharmacokinetic and pharmacodynamcs properties differ between first and second generation antihistamines.
5. Discuss the use of H1 and H2 receptor blockers, epinephrine, and corticosteroids in the treatment of anaphylactic shock.

VII. Gastrointestinal Drugs

A. Drugs Used for Treatment of Acid-Peptic Disease

- Agents or Classes:
  a. H2-receptor antagonists
  (cimetidine, famotidine, nizatidine)
  b. Proton Pump Inhibitors
  (omeprazole, esomeprazole, lansoprazole, rabeprazole, pantoprazole)
  c. Antacids
  (calcium carbonate, magnesium hydroxide, aluminum hydroxide, sodium bicarbonate)
  d. Mucosal protective agents
  (misoprostol, sucralfate)
  e. Antimicrobial agents
  (clarithromycin, metronidazole, amoxicillin, tetracycline)
  f. Colloidal bismuth compounds
  (Bismuth subsalicylate)

2. Identify the consequences of long-term use of proton pump inhibitors.
3. Compare and contrast the adverse effects, drug interactions, and contraindications between first and second generation H2-receptor antagonists.
4. Identify the Black box warnings for misoprostol.
5. Distinguish the agents used for triple, sequential, and quadruple therapy regimens for H. pylori eradication.

B. <u>Prokinetic Drugs and Laxatives</u>

1. Agents or classes:
    a. Cholinomimetic drugs
    (bethanechol, neostigmine)
    b. Dopamine receptor antagonists
    (metoclopramide, domperidone)
    c. Macrolides
    (erythromycin)
    d. Chloride channel activators
    (lubiprostone, linaclotide)
    e. Opioid antagonists
    (methylnaltrexone, alvimopan)
    f. Serotonergic agents
    (Tegaserod)
    g. Bulk-forming laxatives
    (psyllium, methylcellulose, polycarbophil)
    h. Stool Surfactants
    (docusate, glycerin, mineral oil)
    i. Osmotic laxatives
    (magnesium hydroxide, lactulose, sorbitol, magnesium citrate, polyethylene glycol)
    j. Stimulant laxatives
    (Aloe, senna, cascara, phenolphthalein, castor oil)
2. Discuss why some drugs are selective for upper GI motility disorders and why others are selective for lower GI motility disorders.
3. Distinguish between agents that mediate their effects through interaction with a specific receptor and those that do not.

C. <u>Anti-Diarrheal Drugs</u>

1. Agents and classes:
    a. Opioid agonists
    (loperamide, diphenoxylate)
    b. Somatostatin analogues
    (octreotide)
    c. Bile-salt binding resins
    (cholestyramine, colestipol)
    d. Colloidal Bismuth Compounds
    (bismuth salicylate)

e. Bulk-forming laxatives
(methylcellulose and others)

2. Distinguish between receptor-mediated and non-receptor-mediated anti-diarrheals.

D. <u>Treatment of Inflammatory Bowel Disease (IBD)</u>

1. Agents and classes:
   a. Aminosalicylates
   (5-aminosalicylic acid, sulfasalazine, olsalazine, balsalazide, mesalamine)
   b. Glucocorticoids
   (hydrocortisone, prednisone, prednisolone, budesonide)
   c. Antimetabolites
   (6-mecaptopureine, azathioprine, methotrexate)
   d. Monoclonal antibodies
   (infliximab, natalizumab, adalimumab, certolizumab, vedolizumab, ustekinumab)
2. Explain the routes of administration of drugs in each class used to treat inflammatory bowel disease.
3. Discuss the absorption and distribution of each class of drug used to treat inflammatory bowel disease and identify the impact on the choice of the route of administration.
4. Describe the mechanisms for bioactivation of the 5-aminosalicylic acid agents and identify the impact treatment of inflammatory bowel disease.
5. Distinguish agents that are used for the induction and maintenance of remission of inflammatory bowel conditions.

E. <u>Antiemetic drugs</u>

1. Agents and classes:
   a. Serotonergic agents
   (ondansetron, granisetron, dolasetron, palonosetron)
   b. Neurokinin agents
   (aprepitant)
   c. Phenothiazines
   (prochlorperazine, promethazine)
   d. Butyrophenones
   (droperidol)
   e. Substituted benzamides
   (metoclopramide, methobenzamide)
   f. Antihistamines and anticholinergics
   (diphenhydramine, dimenhydrinate, meclizine, scopolamine)
   g. Cannabinoids
   (dronabinol, nabilone)
2. Explain the use of multi-drug treatment of nausea and vomiting.
3. Discuss the use of anti-emetic drugs in the treatment of chemotherapy-induced nausea and vomiting versus those used for motion sickness.

F. <u>Treatment for Irritable Bowel Syndrome (IBS)</u>

1. Agents and classes:

a. Anticholinergics
(dicyclomine, hyoscyamine)
b. Tricyclic antidepressants
(amitriptyline, desipramine)
c. Serotonergic blockers/antagonists
(alosetron)
d. Serotonergic activators/agonists
(tegaserod)

2. Describe the role for laxatives and antidiarrheals in the management of IBS.
3. Identify laxatives and antidiarrheal commonly used to treat IBS symptoms.
4. Describe the characteristics of IBS and how each of the agents above is used to provide symptomatic relief.
5. Distinguish between the agents used to treat diarrhea-predominant IBS and constipation-predominant IBS.
6. Identify population specific considerations (i.e. age, gender) when using agents to treat IBS.

VIII. Drugs Acting on the Central Nervous System (CNS)

A. Endogenous Compounds and access to the CNS

1. Key endogenous regulators of the central nervous system:
(Dopamine, DA; Gamma-Aminobutyric Acid, GABA; Norepinephrine, NE; Dynorphins; Glycine; Acetylcholine, Ach; 5-Hydroxytryptamine, 5-HT; Glutamate; Substance P; Beta-Endorphin; Enkephalins; Histamine; and others.)
2. Describe the blood brain barrier and list the considerations that determine whether a drug will gain access to the central nervous system.

B. Drugs for the Treatment of Depression

1. Agents and Classes
a. Tricyclic antidepressants
(imipramine, desipramine, amitriptyline, nortriptyline, clomipramine)
b. Atypical antidepressants
(buproprion, trazodone, mirtazapine, brexanolone)
c. Selective serotonin reuptake inhibitors (SSRIs)
(fluoxetine, paroxetine, fluvoxamine, sertraline, citalopram, escitalopram, and others)
d. Selective norepinephrine/serotonin reuptake inhibitors (SNRIs)
(duloxetine, venlafaxine, desvenlafaxine, levomilnacipran, milnacipran)
e. Monoamine oxidase (MAO) inhibitors
(isocarboxazid, phenelzine, tranylcypromine, selegiline)
2. Explain the use of antidepressants (amitriptyline, nortriptyline, duloxetine, venlafxine, and milnacipran) for other indications, in particular neuropathic and chronic pain, generalized anxiety disorder, and fibromyalgia.
3. Describe major drug and food interactions for the antidepressants.
4. Define the serotonin syndrome and discuss its management and treatment.
5. Describe the FDA black box warning regarding the use of antidepressant drugs.

C. Antipsychotic Drugs

1. Agents and classes
   a. Typical antipsychotic drugs
      (chlorpromazine, fluphenazine, thioridazine, haloperidol)
   b. Atypical antipsychotic drugs
      (clozapine, risperidone, olanzapine, quetiapine, ziprasidone, aripiprazole, and others)
2. Explain uses of antipsychotic drugs for indications other than schizophrenia, in particular bipolar disorder, augmentation of effects of antidepressants, Gilles De La Tourette's syndrome)
3. Identify the time course, signs and symptoms of antipsychotic drug-induced dyskinesias (dystonia, akathisia, Parkinson-like symptoms, tardive dyskinesia), and discuss their management and treatment.
4. Define neuroleptic malignant syndrome and its management and treatment.
5. Describe the FDA black box warning regarding the use of antipsychotic drugs.

D. Drugs for the Treatment of Bipolar Disorder

1. Agents and classes
   a. Lithium
   b. Anticonvulsants
      (valproic acid, carbamazepine, lamotrigine)
   c. Atypical antipsychotics
      (risperidone, olanzapine, quetiapine, ziprasidone and others)
2. Differentiate lithium's adverse events from signs and symptoms of lithium overdose, and explain why lithium is contraindicated in patients with impaired renal function or cardiovascular disease.
3. Describe interactions of lithium with NSAIDs and diuretic drugs.

E. Drugs for the Treatment of Seizure Disorders

1. Agents and classes
   (phenytoin, carbamazepine, phenobarbital, topiramate, diazepam, lorazepam, clonazepam, valproic acid, lamotrigine, levetiracetam, ethosuximide, and others)
2. Identify the drugs of choice for the major seizure types.
3. Identify the pharmacokinetic factors (i.e., enzyme induction and inhibition) relevant to appropriate therapy with antiseizure drugs and interactions with drugs used to treat other conditions.
4. Be familiar with uses of antiseizure drugs for the treatment of other conditions.

F. Anxiolytic and Sedative/Hypnotics Drugs

1. Agents and classes
   a. Benzodiazepines
      (diazepam, clonazepam, chlordiazepoxide, lorazepam, oxazepam, alprazolam, temazepam, triazolam, and others)
   b. Benzodiazepine receptor agonists
      (zolpidem, zaleplon, eszopiclone)
   c. Buspirone
   d. Melatonin receptor agonists
      (ramelteon)
   e. Orexin receptor antagonists
      (suvorexant)
2. Distinguish the major classes of drugs for the treatment of insomnia and their cellular targets.

3. Discuss the effects of drugs that interact with benzodiazepine receptors on $GABA_A$ receptor function and their selectivity for different subunit subtypes.
4. Discuss the effects of drugs that interact with melatonin and orexin receptors.
5. Identify the signs and symptoms of benzodiazepine overdose and its treatment with flumazenil.
6. Explain the interactions of anxiolytic and sedative/hypnotic drugs with other central nervous system depressants.
7. Explain the dependence liability and withdrawal syndromes of the various classes of drugs of anxiolytic and sedative/hypnotic drugs.
8. Explain how pharmacokinetics of various benzodiazepines relates to their therapeutic utility.

G. <u>Muscle Relaxants</u>

1. Agents and classes
   a. Centrally acting
      (diazepam, baclofen, tizanidine, cyclobenzaprine, carisoprodol)
   b. Direct acting (dantrolene, botulinum toxin)
2. Identify drugs useful for treatment of spasticity, and compare and contrast the mechanisms of action and their adverse effects

H. <u>Drugs for the Treatment of Headache</u>

1. Agents and classes
   a. NSAIDS
   b. Analgesics
      (acetaminophen)
   b. Ergot alkaloids
      (ergotamine and others)
   c. Triptans
      (sumatriptan and others)
   d. Calcium gene related peptide (CGRP) receptor antagonists
      (Ubrogepant and others)
   e. β-Adrenergic antagonists
      (propranolol and others)
   f. Anticonvulsants
      (valproic acid, topiramate)
   g. Antibodies against CGRP receptors
      (erenumab and others)
   h. antidepressants
      (amitriptyline)
   i. Botlinum toxin
      (onabotulinumtoxinA)
2. Distinguish the major classes of drugs used for the prophylaxis of migraine headaches.
3. Distinguish the major classes of drugs for the treatment of chronic migraine headaches.
4. Compare and contrast the pharmacological properties of drugs used to treat acute migraine attacks.
5. Compare and contrast the pharmacological properties of the drugs used to prevent acute migraine attacks (i.e., prophylaxis).

I. Ethanol and Drugs for Treatment of Alcohol Use Disorder

1. Discuss the pharmacology/pharmacokinetics of ethanol.
2. Describe the acute and chronic organ toxicities of ethanol.
3. Identify the drugs with which ethanol shows cross-tolerance and cross-dependence.
4. Identify drugs, both prescription and over the counter that should not be combined with alcohol.
5. Identify the signs and symptoms of alcohol use disorder and the ethanol abstinence syndrome; and compare and contrast the latter with abstinence syndromes following chronic use of barbiturates, benzodiazepines, or opioids.
6. Discuss the use of benzodiazepines to prevent symptoms of acute alcohol withdrawal.
7. Explain the effects and the mechanistic rationale for the use of naltrexone, disulfiram, and acamprosate in the treatment of alcohol use disorder.

J. Opioids

1. Agents and classes
   a. Opioid agonists
      (morphine, hydromorphone, hydrocodone, oxycodone, methadone, meperidine, fentanyl, alfentanil, codeine, heroin)
   b. Opioid mixed agonists/antagonists
      (buprenorphine, butorphanol)
   c. Other
      (tramadol)
   c. Opioid antagonists
      (naloxone, naltrexone)
   d. Antitussives
      (codeine, dextromethorphan)
2. Discuss the pharmacological effects and sites of action of the prototype opioid agonist morphine, and its utility in relieving different types of pain.
3. Identify potential therapeutic actions of opioids, including analgesia, cardiovascular, and GI systems.
4. Explain the clinically relevant differences in pharmacology between morphine and the other full opioid agonists.
5. Explain how the pharmacokinetic processes affecting morphine, absorption, distribution, etabolism, and excretion are relevant to its therapeutic use.
6. Identify adverse effects of morphine on CNS, cardiovascular, GI-biliary, respiratory and genitourinary systems.
7. Identify the major drug interactions of morphine.
8. Identify the contraindications for morphine and its surrogates.
9. Identify the characteristics of opioid tolerance and physical/psychological dependence, and describe opioid abstinence syndrome that can occur following abrupt discontinuation of opioids or administration of opioid antagonists or partial agonists.
10. Identify the signs and symptoms of opioid overdose and how they are managed.
11. Discuss the advantages and disadvantages of combining opioids with acetaminophen or NSAIDS.
12. Explain how agonist-antagonists and partial agonists differ in their utility and adverse effect profile when compared to morphine.
13. Explain the pharmacokinetic differences between naloxone and naltrexone and how these determine the clinical use of these drugs.
14. Explain how the combination of naloxone with opiate analgesics in oral and sublingualpreparations permits opiate action, yet decreases abuse liability.
16. Discuss the rationale for using buprenorphine and methadone to treat opioid use disorder.
17. Rationalize using methadone for treatment of chronic pain.

J. Drugs of Abuse

1. Agents and classes
    a. Stimulants
    (amphetamine, methamphetamine, methylphenidate, cocaine, caffeine, nicotine)
    b. Hallucinogens
    c. Cannabinoids
    (cannabis/delta-9 tetrahydrocannabinol, synthetic cannabinoids)
2. Describe the addictive properties of nicotine and therapies to treat nicotine dependence, including varenicline, nicotine substitution products and bupropion.
3. Explain the psychological, physiological and pharmacologic effects of cannabis.

K. Drugs for Treatment of Parkinson Disease

1. Agents and classes
    a. Dopamine Precursor/peripheral decarboxylase inhibitor
    (L-dopa/carbidopa)
    b. Selective MAO-B Inhibitors
    (selegiline, rasagiline)
    c. Dopamine Receptor agonists
    (pramipexole, ropinirole, bromocriptine)
    d. NMDA-Glutamate Receptor Antagonist
    (amantadine)
    e. Anti-muscarinic
    (Benztropine, trihexyphenidyl)
    f. COMT inihibitor
    (entacapone)
2. Understand the role of dopamine loss and cholinergic/dopaminergic interactions in Parkinson Disease.
3. Identify the adverse effect profile of levodopa and how it is improved by combination with carbidopa.
4. Describe the use and effects of MAO and COMT inhibitors in Parkinson Disease.

L. Drugs for Treatment of Alzheimer's Disease

1. Agents and classes
    a. Cholinesterase inhibitors
    (Donepezil, galantamine, rivastigmine)
    b. NMDA receptor antagonist
    (memantine)

M. General Anesthetics

1. Agents and classes
    a. Inhalational
    (desflurane, isoflurane, sevoflurane, nitrous oxide)
    b. Parenteral agents
    (propofol, fentanyl, midazolam, ketamine)
2. Define MAC (minimal alveolar concentration), name the physical property of an Inhalation anesthetic that correlates best with its MAC, and explain how the concept of MAC is used in anesthesiology.
3. Explain the concept of the blood gas solubility coefficient and how it affects the speed of onset of inhalation anesthesia.

4. Outline the reasons for use of opioids in general anesthesia.
5. Describe the impact of redistribution kinetics on the action of intravenous anesthetics.
6. Describe the utility of nitrous oxide in terms of second gas effect and the potential for diffusion hypoxia.
8. Explain the pharmacological effects of the drugs in each class on pulmonary, cardiovascular, liver, and renal function.
9. Define *malignant hyperthermia*, list some common triggering agents, and discuss its prevention and treatment.

N. Local Anesthetics

1. Agents and classes
   a. Esters
      (procaine, benzocaine, cocaine, tetracaine)
   b. Amides
      (lidocaine, bupivacaine, mepivacaine, ropivacaine)
2. Explain how the actions of clinically used local anesthetics might be influenced by the frequency of impulse transmission in peripheral nerves, size and class of the peripheral axons, pH, and by vascularity of the injected area.
3. Explain the ionic basis of the action potential and the mechanism of action of local anesthetics.
4. Identify the common adverse effects of local anesthetics and indicate appropriate treatments should they occur.
5. Identify the significant differences in metabolism and hypersensitivity between amide and ester-type local anesthetics.
6. Identify the common routes of administration of local anesthetics.
7. Explain the use of vasoconstrictors to restrict local anesthetics to a desired site of action and indicate how these methods reduce systemic adverse effects.

IX. Autacoids and Drugs Used to Treat Inflammation

A. Drugs to Treat Inflammation

1. Agents and classes
   a. Non-selective NSAIDs
      (aspirin, naproxen, ibuprofen, diclofenac, ketorolac, and others)
   b. Selective NSAIDs
      (celecoxib, meloxicam, and others)
   c. Topical NSAIDs
      (diclofenac)
   d. Other
      (Colchicine)
2. Compare the mechanisms of action between selective and non-selective COX inhibitors.
3. Describe the differences in therapeutic effects between acetaminophen and NSAIDs.
4. Describe the effects NSAIDs have on coagulation, cardiovascular, renal, and gastrointestinal systems.
5. Explain the use of acid suppressive therapy for gastric cyto-protection when using COX1 Inhibitors.
6. Describe the FDA Black Box Warning for NSAIDs.
7. Compare the various therapeutic uses of NSAIDs and glucocorticoids.
8. Understand the mechanism behind the cardioprotective effects of aspirin.
9. Describe the benefits of using topical NSAIDs.
10. Identify the relative risk of NSAIDs for causing a cardiovascular event.

11. Describe the advantages and disadvantages of COX-2 inhibitors.
12. Describe the mechanism behind colchicine's anti-inflammatory effects.
13. Identify the various therapeutic uses of colchicine.
14. Discuss the dose adjustments for colchicine required during renal impairment.

B. Disease-Modifying Antirheumatic Drugs (DMARDs)

1. Agents and classes:
   a. Conventional synthetic DMARDs
      (methotrexate, hydroxychloroquine, leflunomide, and others)
   b. Biologic DMARDs
      (TNF-inhibitors, non-TNF inhibitors, and others)
   c. Targeted synthetic DMARDs
      (tofacitinib, baricitinib, and others)
3. Explain how various DMARDs are used for the treatment of rheumatoid arthritis.
4. Identify agents that may be used in combination for the treatment of rheumatoid arthritis.
5. Describe the monitoring parameters associated with each class.
6. Discuss the factors that must be considered for treatment selection.

X. Endocrine Pharmacology

A. Hypothalamus and Anterior Pituitary

1. Agents and classes:
   a. Growth hormone
      (somatropin)
   b. Insulin-like growth factor
      (mecasermin)
   c. Growth hormone release inhibitors
      (octreotide, lanreotide)
   d. Growth homone receptor antagonist
      (pegvisomant)
   e. Dopamine agonist/prolactin release inhibitors
      (bromocriptine, cabergoline)
2. Identify pharmacological agents that can induce hyperprolactinemia.

B. Posterior Pituitary Agents

1. Agents and classes:
   a. Antidiuretic hormone vasopressin
      (vasopressin, arginine vasopressin)
   b. Desmopressin analogeu
      (Desmopressin/DDAVP)

C. Adrenal Cortical Drugs and Hormones

1. Agents and classes:
   a. System glucocorticoids
      (cortisol, hydrocortisone, dexamethasone, prednisone, prednisolone, triamcinolone, Betamethasone, methylprednisolone)
   b. Mineralocorticoid

(fludrocortisone)
   c. Glucocorticoid and progesterone receptor antagonist (abortifacient) (mifepristone)
   d. Glucocorticoid synthesis inhibitors (metyrapone, ketoconazole)
2. Explain the actions of corticosteroids on intermediary metabolism, growth and development, electrolyte homeostasis, immune, and inflammatory responses.
3. Outline the adverse effects/contraindications related to corticosteroid use.
4. Outline the adverse effects of excessive mineralocorticoid activity.
5. Explain the rationale for alternate day therapy and the necessity for slow withdrawal following chronic therapy with glucocorticoids.

D. <u>Drugs for the Treatment of Thyroid Diseases</u>

1. Agents and classes:
   a. Thyroid agonists (T4: levothyroxine, T3: triiodothyronine; T3+T4: Armour thyroid; desiccated)
   b. Thioamides (methimazole; propylthiouracil)
   c. Iodine based (iodide salts, potassium Iodide, radioactive iodine (I^{131})
2. Distinguish between treatment for hypothyroidism and hyperthyroidism.
3. Explain the use of propranolol in the treatment of hyperthyroidism.

E. <u>Drugs for the Treatment of Osteoporosis and Disorders of Calcium Homeostasis</u>

1. Agents and classes:
   a. Synthetic parathyroid hormone (teriparatide acetate)
   b. Supplements (vitamin D, calcium gluconate,
   c. Vitamin D analogue (calcitriol)
   d. Calcimimetic (cinacalcet)
   a. Calcium regulating hormone (calcitonin)
   b. Selective Estrogen Receptor Modulator (raloxifene)
   c. Bisphosphonates (alendronate, etidronate, ibandronate, risedronate, zoledronate)
   d. RANKL inhibitor (denosumab)
2. Identify the available preparations of CT and 1,25-$(OH)_2$D and calcium supplements and side effects.
3. Explain the clinical value of bisphosphonates and calcitonin in the treatment of: hypercalcemia, Paget's disease, osteoporosis (postmenopausal and glucocorticoid-induced).

F. <u>Drugs for Treatment of Diabetes Mellitus</u>

1. Agents and classes:
   a. Insulin

(short-acting, rapid-acting, intermediate, long-acting, inhaled, and others)

b. Amylin analog
(pramlintide)
c. Biguanides
(Metformin)
d. SGLT2 inhibitors
(Canalgliflozin, dapagliflozin, empagliflozin, and others)
e. GLP-1 agonists
(exenatide, semaglutide, dulaglutide, and others)
f. DPP-IV inhibitors
(alogliptin, linagliptin, saxagliptin, sitagliptin)
g. Thiazolidinediones
(Pioglitazone, rosiglitazone)
h. Sulfonylureas
(glimepiride, glipizide, glyburide)
i. Glucagon

2. Distinguish between short-acting, rapid-acting, intermediate, long-acting, inhaled insulin relative to onset and duration of action.
3. Explain the clinical manifestations and management of hypoglycemia.
4. Discuss cardiovascular effects associated with thiazolidinediones.
5. Discuss the risk of joint pain associated with DPP-IV inhibitors.
6. Explain the differences in treatment modalities between Type I and II diabetes.
7. Identify the agents most likely to cause hypoglycemia.
8. Discuss the medications that are associated with Fournier's gangrene and limb amputations.
9. Review insulin regimens, dosing recommendations, and adjustment factors.

G. <u>Gonadal Hormones and Drugs</u>

1. Agents and classes
   a. Estrogens
   (ethinyl estradiol and others)
   b. Selective Estrogen Receptor Modulators (SERM)
   (tamoxifen, raloxifene, clomiphene and others)
   c. Estrogen antagonists
   (fulvestrant, tamoxifen, and others)
   d. Aromatase Inhibitors
   (anastrozole and others)
   i. Progestins
   (medroxyprogesterone, norgestrel, drospirenone, and others)
   e. Selective Progesterone Receptor Modulators (SPRM)
   (mifepristone)
   f. Androgens
   (testosterone, nandrolone, performance enhancing drugs, and others)
   g. Androgen receptor antagonist
   (bicalutamide, flutamide, and others)
   h. 5-alpha reductase inhibitors
   (finasteride and others)

2. Distinguish the unique pharmacokinetic properties of synthetic and natural estrogens
3. Describe the unique pharmacokinetic properties of androgens.
4. Distinguish when estrogens and progestins are used alone and in combination.
5. Identify agents used for post-coital contraception.
6. Describe additional therapeutic uses of hormonal contraceptives (e.g. dysmennorhea)
7. Explain the use of misoprostol in combination with mifepristone.
8. Explain the role of terbutaline for labor and delivery procedures.

H. Drugs That Affect the Urogenital System

1. Agents and classes
   a. Alpha adreneric antagonists
      (prazosin, terazosin, and others)
   b. 5-alpha reductase inhibitors
      (finasteride, dutasteride, and others)
   c. Anticholinergics
      (oxybutynin, tolterodine, and others)
   d. β3-Adrenergic Agonist
      (mirabergron)
   e. Phosphodiesterase inhibitors
      (sildenafil, vardenafil, and others)
   f. Prostaglandin E1
      (alprostadil)
2. Discuss the treatment options for benign prostatic hyperplasia (BPH).
3. Identify the treatment options used for urinary incontinence.
4. Explain the disadvantages of using anticholinergic agents in elderly patients
5. Compare the onset of action between 5-alpha reductase inhibitors and alpha antagonists.
6. Discuss potential drug interactions and adverse effects when using phosphodiesterase inhibitors.

XI. Drugs Affecting Hemostasis and Blood Forming Organs

A. Drugs for Treatment of Anemia and Neutropenia

1. Agents and classes:
   a. iron products
   b. erythropoietin
      (epoetin apha, darbepoetin alpha)
   c. folic acid
   d. granulocyte colony stimulating factor
      (filgrastim, pegfilgrastim)
   e. vitamin B12/ cyanocobalamin
   f. drug for platelet stimulation
      (romiplostim, eltrombopbag)
2. Identify the uses of oral and parenteral iron.
3. Understand the limitations of using folic acid to treat anemia.

B. Anticoagulant Drugs

1. Agents and classes:

a. Heparin, Enoxaparin, Fondaparinux
b. Warfarin
c. Dabatrigan, Rivaroxaban, Apixaban
d. Argatroban

2. Identify complications associated with heparin therapy (e.g., excessive bleeding) and heparin-induced thrombocytopenia with associated thrombosis.
3. Describe the monitoring of warfarin therapy using prothrombin time (PT), international normalized ration, and the indications for measuring warfarin levels.
4. Describe the use of protamine and vitamin K as antidotes to excessive bleeding caused by heparin and warfarin, respectively.
5. Describe drug-drug, drug-food, and drug-disease interactions with warfarin.
6. Discuss the approach to the management of the patient on short-term and long-term oralanticoagulation.

C. Antiplatelet Drugs

1. Agents and classes
   a. aspirin (acetylsalicylic acid)
   b. eptifibatide, abciximab, tirofiban
   c. clopidogrel, ticlodipine
2. Compare and contrast the mechanism of action for aspirin, clopidogrel, and abciximab.
3. Identify and describe the drug-drug, drug-food, and drug-disease interactions of each drug.
4. Explain how concomitant use of NSAIDS can interfere with the antiplatelet actions of aspirin.
5. Explain management of the patient on short-term and long-term antiplatelet therapy.
6. Explain the role of the platelet glycoprotein IIb/ IIIa inhibitors in the management of coronary disease.
7. Compare the effects of aspirin, ibuprofen, and propranolol for primary post MI prophylaxis.

D. Fibrolytic/Antifibrolytic Drugs

1. Agents and classes:
   a. urokinase
   b. tissue plasminogen activator
      (alteplase, reteplase, tenecteplase)
   c. aminocaproic acid
3. Relate the major adverse effects of thrombolytic drugs to their mechanism of action.
4. Identify primary contraindications for thrombolytic drugs.

XII. Immunosuppressive drugs

A. Agents and Classes of immunosuppressant

1. Cytotoxic agents
   (Azathioprine, cyclophosphamide, methotrexate)
2. Glucocorticoids
   (Prednisone)
3. Immunophilin ligands and calcineurin inhibitors
   (Cyclosporine, Tacrolimus, Sirolimus)
4. Interferons
   (IFN-alpha, INF-beta, INF-gamma)
5. Mycophenolate mofetil
6. Monoclonal Antibodies (MABs)

(bevacizumab, ranizumab, basiliximab, natalizumab, orelizumab)
7. VEGF-A antagonists
(aflibercept)
8. Glatiramer

B. Key Concepts in immunosuppressive therapy

1. Outline the general principles of immunosuppression and immunostimulation.
2. Identify the toxicities of calcineurin inhibitors.
3. Identify specific risks associated with use of immunosuppressant drugs.

XIII. Toxicology and Therapy of Intoxication

A. Key toxic agents:

1. heavy metals (lead, arsenic, mercury, etc.)
2. botulinum and other toxins
3. carbon monoxide
4. alcohols
5. ethylene glycol
6. salicylates
7. acetaminophen

B. Define fundamental toxicologic terms including:

i. Hazard
ii. Risk
iii. Measures of thresholds for toxicity

1. Explain the principles of bioactivation of chemicals to toxic species.
2. Identify pharmacological measures of treatment, including various antidotes, for human intoxication of the above agents.
3. Differentiate between mutagenicity and carcinogenicity, genotoxic and non-genotoxic carcinogens.

C. Toxidromes:

1. Describe basic approaches to stab ilizing, identifying and managing toxic exposures.
2. Define and identify common toxidromes and drug classes that are more commonly associated with poisoning episodes.
3. Explain interventions for the poinsoned patient that decontaminate, limit further gastrointestional absorption, or enhan ce elimination.

D. Antidotes:

1. Explain the limitations and clinical use of drugs used to specifically treat acute and chronic exposures to heavy metals (CaNa2-EDTA, dimercaprol, succimer, penicillamine, trientine, Deferoxamine).
2. Identify drugs and other substances used as specific antidotes for toxic pharmacologic effects.

XIV. Antimicrobial Chemotherapy

A. Basic Principles of Antimicrobial Therapy

1. Define antibiotics, selective toxicity, therapeutic index, bacteriostatic, and bactericidal.
2. Identify minimum inhibitory concentration (MIC) and minimum bactericidal Concentration (MBC) values.
3. Differentiate between synergism and antagonism.
4. Differentiate bacteriostatic and bactericidal antibiotics
5. Define the spectrum of activity for the classifications of antibiotics, understanding broad-spectrum, narrow-spectrum and use for Gram-positive organisms, Gram-negative organisms and anaerobes.
6. Explain the post-antibiotic effect.
7. Explain the time-dependent versus concentration-dependent effects of antibiotics.
8. Explain bacterial resistance and the mechanisms involved in acquiring bacterial resistance.
9. Discuss superinfection associated with antibiotics.
10. Describe the cross-sensitivity of the different antibiotic classifications.
11. Identify antimicrobial agents contraindicated for use during pregnancy.
12. Discuss the use of combination antibiotic therapy for polymicrobial infections by knowing the bacterial spectrum of each antibiotic class.
13. Define the following term prophylactic therapy, preemptive therapy, empirical therapy, definitive therapy, suppressive therapy.
14. Discuss the risk of pseudomembranous enterocolitis when prescribing clindamycin and other agents.

B. Cell Wall Synthesis Inhibitors

1. Agents and classes:

a. Natural Penicillins
(penicillin g, penicillin v, benzathine penicillin, procaine penicillin g)

b. Aminopenicillins
(amoxicillin, ampicillin)

c. Anti-staphylococcal Penicillins
(methicillin, oxacillin, cloxacillin, nafcillin, dicloxacillin)

d. Beta-Lactamase Resistant Penicillin Preparations
(amoxicillin/clavulanic acid, piperacillin /tazobactam, ampicillin/sulbactam, ticarcillin/clavulanic acid)

e. Antipseudomonal penicillin
(piperacillin, ticarcillin)

f. First Generation Cephalosporins
(cephalexin, cefadroxil, cefazolin)

h. Second Generation Cephalosporins
(cefuroxime, cefoxitin, cefotetan, cefprozil, and others)

I Third Generation Cephalosporins
(cefixime, ceftriaxone, cefotaxime, ceftazidime, cefdinir, and others)

j. Fourth Generations Cephalosporins
(cefepime)

k. Fifth Generation Cephalosporins
(ceftaroline)

l. Monobactams
(aztreonam)

m. Carbapenems
(imipenem/cilastatin, meropenem, ertapenem)

n. Glycopeptide
(vancomycin, oritavancin)
o. Lipopeptide
(daptomycin)
p. Miscellaneous
(linezolid, quinupristin/dalfopristin)

2. Describe the allergies associated with beta-lactam antibiotics.
3. Explain the pharmacologic basis of for combining imipenem and cilastatin.
4. Distinguish the use of oral and IV administration of vancomycin.
5. Distinguish treatments for community-acquired and hospital-acquired methicillin resistant staphylococcus aureus (MRSA).
6. Discuss the use of vancomycin for Hospital acquired MRSA and the common antibiotics used for community acquired MRSA
7. Discuss the spectrum of activity and pharmacokinetic properties of Linezolid and Quinupristin/Dalfopristin and their indication for Vancomycin Resistant Staphylococcus Aureus (VRSA) and Vancomycin Resistant Enterococcus (VRE).

C. <u>Protein Synthesis Inhibitors</u>

1. Agents and classes
a. Aminoglycosides
(neomycin, gentamicin, amikacin, tobramycin)
b. Macrolides
(erythromycin, azithromycin, clarithromycin)
c. Tetracycline
(doxycycline, minocycline, tetracycline, and others)
d. Miscellaneous:
(clindamycin)

D. <u>Inhibitors of Nucleic Acid Metabolism and Drugs Interfering with Intermediary Metabolism</u>

1. Agents and classes:
a. First Generation Fluoroquinolones
(ciprofloxacin, norfloxacin, ofloxacin)
b. Second Generation Fluoroquinolones
(levofloxacin)
c. Third Generation Fluoroquinolones
(moxifloxacin, gemifloxacin)
d. Metronidazole
e. Trimethoprim/Sulfamethoxazole
f. Rifampin
2. Distinguish the bacterial spectrum of activity between first, second, and third fluoroquinolones.
3. Discuss the black box warning associated with increased incidence of tendon rupture for certain patient populations
4. Discuss why fluoroquinolones must be avoided in patients with aortic aneurysm, peripheral vascular disease (PVD) as well as geriatric patients.
5. Describe the disulfiram-like reaction associated with metronidazole.
6. Describe the synergistic action when using the combination of sulfamethoxazole and trimethoprim
7. Discuss the drug interactions of rifampin associated with cytochrome P-450 enzyme induction.

E. Antifungal Drugs

1. Agents or Classes:
    a. Polyenes
    (amphotericin B, nystatin)
    b. Azoles
    (ketoconazole, fluconazole, itraconazole, voriconazole, efinaconazole, clotrimazole, miconazole, and others)
    c. Nucleoside Analogs
    (flucytosine)
    d. Echinocandins
    (caspofungin, micafungin, anidulafungin)
    e. Allyamines
    (terbinafine, naftifine)
    f. Other
    (ciclopirox)
2. Distinguish agents used for systemic, cutaneous, and mucocutaneous infections.
3. Described the importance and advantages of liposomal preparation of amphotericin B.

F. Antiviral Drugs

1. Agents and Classes:
    a. Medications for influenza
        i. Neuraminidase inhibitors
        (oseltamivir, zanamivir, peramivir and others)
        ii. Endonuclease inhibitors
        (baloxavir marboxil)
        iii. Inhibitors of M2 protein
        (Amantadine, rimantadine)
    b. Medications for hepatitis C
        i. NS5A inhibitors
        (Ledipasvir, omvitasvir, elbasvir, and others)
        ii. NS5B inhibitors
        (sofosbuvir, dasabuvir)
        iii. NS3/4A protease inhibitors
        (glecaprevir, paritaprevir, simprevir, and others)
    c. Medications for hepatitis B
        i. Pegylated interferon
        ii. Nucleotide analogs
        (entecavir, tenofovir, and others)
    d. Medications for herpes simplex virus 1 and 2 (HSV)
    (acyclovir, valacyclovir, foscarnet, famciclovir, trifluridine, and others)
    e. Medications for respiratory syncyctial virus (RSV)
    (ribavirin, palivizumab)
    f. Medications for cytomegalovirus (CMV)
    (ganciclovir, valganciclovir, foscarnet, and others)
    g. Varicella Zoster Virus (VZV)
    (alacyclovir, foscarnet)
    h. SARS-CoV-2 (4.0)
    (remdesivir, molnupiravir, paxlovid
2. Classify antiviral drugs based upon their site of inhibition in the viral replication cycle.

G. <u>Antiretroviral Drugs</u>

1. Agents and classes:
    a. Nucleoside reverse transcriptase inhibitors (NRTI)
    (Abacavir, lamivudine, tenofovir disoproxil fumarate, tenofovire alafenamide, emtricitabine)
    b. Non-nucleoside reverse transcriptase inhibitors (NNRTI)
    (efavirenz, doravirine, rilpivirine)
    c. Protease inhibitors (PI)
    (darunavir, ritonavir, atazanavir)
    d. Integrase strand transfer inhibitors (INSTI)
    (bictegravir, raltegravir, dolutegravir)
    e. Fusion inhibitors
    (enfuvirtide)
    f. Boosting agents
    (ritonavir and others)
    g. Co-receptor (CCR-5) antagonist
    (maraviroc)
2. Classify anti-HIV drugs based upon their site of inhibition in the viral replication cycle.
3. Discuss the use of combinations of different class of anti-HIV drugs.
4. Identify major drug interactions impacting podiatric practice when using HIV therapies.

H. <u>Antimycobacterial Drugs</u>

1. Agents and classes:
    i. Treatment of tuberculosis
    (isoniazid, rifampin, rifabutin, pyrazinamide, ethambutor, streptomycin)
    ii. Treatment of *M. avium* Complex (MAC)
    iii. Treatment of leprosy
    (dapsone, clofazimine, rifampin)

2. Discuss the first line antitubercular drugs.
3. Discuss the various phases of active- and slow-growing *Mycobacterium tuberculosis* and compare the relative effectiveness of various drugs.
4. Describe the drug interactions of rifampin with anticoagulants and other drugs, such as oral contraceptives.
5. Identify the drugs used for reversing the lepra reactions and the erythema nodosum leprosumreaction.
6. Explain the combination therapy regimen for treatment of leprosy.

I. <u>Antiparasitic Drugs</u>

1. Agents and Classes:
    a. Treatments of amebiasis, giardiais, and/or trichomoniasis
    (metronidazole, tinidazole, paromomycin, iodoquinol)
    b. Treatments of cryptosporidiosis, toxoplasmosis, and/or pneumocystitis
    (nitazoxanide, trimethoprim-sulfamethoxazole, pyrimethamine-sulfadiazine)
    c. Treatments for helminthictic infections
    (albendazole, mebendazole, ivermectin, pyrantel pamoate, praziquantel)
2. Identify the drugs of choice and alternate drugs available for treatment of diseases due to various helminthes.

3. Discuss the broad spectrum antihelminthic drugs and their spectrum of activity.
4. Discuss the opportunistic infections commonly known to occur in a patient with AIDS and the drugs used for their treatment.
5. **I**dentify the drugs of choice for treatment of asymptomatic, mild to moderate and severe intestinal disease and hepatic abscess due to *E. histolytica*.

XV. Antineoplastic Chemotherapy

A. Basic Principles of Cancer Chemotherapy

1. Explain the concept of "total cell kill" in cancer patients and the importance of primary, preparative, and adjuvant chemotherapy.
2. Define selective toxicity, cell doubling time, and growth fraction.
3. Define cell cycle specificity and classify anticancer drugs based on the cell cycle specificity.
4. Identify mechanisms of drug resistance in the treatment of cancers.
5. Discuss the principles of combination chemotherapy in the treatment of cancer.

B. Antineoplastic Drugs

1. Non cell cycle specific drugs
   a. alkylating agents
      (cyclophosphamide, cisplatin, carboplatin)
   b. nitrosoureas
      (procarbazine)
   c. antitumor antibiotics
      (actinomycin D, mitomycin, bleomycin, doxorubicin)
   d. anti-metabolites
      (cytarabine, 5-fluorouracil, gemcitabine, 6-mercaptopurine, 6-thioguanine)
   e. dihydrofolate reductase inhibitor
      (methotrexate)
   f. anti-hormone targets
      (tamoxifen, flutamide, anastrozole, leuprolide, goserelin, degarelix)
   g. monoclonal antibodies
      (rituximab, trastuzumab, bevacizumab, cetuximab, ipilimumab, and others)
   h. tyrosine kinase inhibitors
      (imatinib, gefitinib, sunitinib)
   i. 26S proteosome inhibitors
      (bortezomib)
   j. Poly-ADP ribose polymerase-1 (PARP-1) inhibitor
      (rucaparib)
   k. BH3-mimetics
      (venetoclax)
   l. Phosphoinositide 3-kinase inhibitor (P110δ) inhibitor
      (idelalisib)

2. Cell cycle specific drugs
   a. M-phase specific
      (vincristine, paclitaxel)
   b. S-phase specific
      (irinotecan, hydroxyurea)

c. G1 to S phase (palbociclib)
d. G1 arrest (temsirolimus)

C. Specific Agent Related Concepts

1. Discuss the bioactivation pathways required for the action of cyclophosphamide.
2. Discuss the differences in dosing for methotrexate in the treatment of cancer versus autoimmune diseases.
3. Describe the use of leucovorin rescue in high dose methotrexate therapy.
4. Identify the common toxicities within each drug class.
5. Identify the specific major toxicity or contraindications of individual anticancer drugs.

XVI. Herbal Medicine and Natural Supplements

A. Natural Products Used As Supplements For Medical Conditions

1. Agents and Classes:
   a. Bitter/Orange/Ephedra
   b. Glucosamine Chondroitin
   c. Green Tea
   d. Saw Palmetto
   e. St. John's Wort
   f. Tumeric/Curcumin
   g. Valerian
   h. Coenzyme Q10 (CoQ10)
   i. CBD/THC
   j. Melatonin
   k. Arginine
   l. Gingko
   m. Ginseng
   n. Kava
   o. Yohimbe

2. Discuss the concept that while there is evidence towards effectiveness for some herbal products, many have shown to have no beneficial effect.
3. Identify and discuss the serious drug interactions that occur between herbal products and prescription medicines.
4. Discuss the FDA regulation of dietary supplements and herbals and what that means regarding safety, efficacy, and content.
5. Identify sources of evidence-based information on dietary supplements and herbal products.

PHYSIOLOGY

LEARNING OBJECTIVES

Cell and Membrane

Neurophysiology

Muscle Physiology

Cardiovascular Physiology

Pulmonary Physiology

Renal Physiology

Gastrointestinal Physiology

Endocrine Physiology

Integration and Exercise Physiology

I. Cell Membranes and Bioelectricity

A. Body Fluid Compartments

1. Identify the main body volume compartments and their proportions and how body fat percentage influences water distribution.
2. Compare and contrast the movement between intracellular and extracellular compartments, caused by changes in extracellular fluid osmolality.
3. Given the composition and osmolality of a fluid, identify it as hypertonic, isotonic, or hypotonic relative to normal body fluids.
4. Predict the change in transcellular fluid exchange that occurs when a cell is placed in solutions with varying tonicities.
5. Identify major routes and normal ranges for water intake and loss, and predict how changes in these parameters affect the distribution of total body water.

B. Solutes and Solutions

1. Define *reflection coefficient* and explain how the relative permeability of a cell to water and solutes will generate an osmotic pressure.
2. Compare the effects of changes in concentration of an osmotically active solute with one that is osmotically inactive on the generation of osmotic pressure.
3. Identify the typical value and normal range for extracellular and interstitial fluid (plasma) concentrations of Na^+, K^+, H^+ (pH), HCO_3^-, Cl^-, Ca^{2+}, glucose, and their relative intracellular values.
4. Predict the relative change in extracellular volume, extracellular osmolality, intracellular volume, and intracellular osmolality caused by infusion of three liters of 0.9% NaCl, 0.45% NaCl, and 7.5% NaCl.

C. Transport systems

1. Differentiate between diffusion, facilitated diffusion, secondary active transport, primary active transport, symport (co-transport), antiport (exchange) and uniport.
2. Explain how the presence of specific membrane transport proteins (carriers and channels) facilitate the movement of hydrophilic solutes across a membrane.
3. Describe how the energy source for primary active transport differs from secondary active transport and be able to give examples of the types of solutes that can be transported in each case.
4. Explain how energy from the Na^+ and K^+ electrochemical gradients across the plasma membrane can be used to drive the net "uphill" (against a gradient) movement of other solutes (e.g., Na^+/glucose co-transport; Na^+/Ca^{2+} counter-transport).
5. Explain the role of aquaporins; in which cell/tissue types would you find high levels of their expression.
6. Describe the process of endo- or exocytosis and identify the types of molecules most likely to utilize these processes to cross a cell membrane.

D. Epithelial Cell

1. Describe transcellular transport and the functional significance of polarized distribution of various transport proteins to the apical or the basolateral cell membrane.
2. Describe paracellular transport and the role of the "tight" junctions in leaky and tight epithelia.
3. Describe the cellular mechanisms for transepithelial transport (absorption and secretion) of various types of ions and organic solutes and give specific examples of transport epithelia.

E. Electrochemical Equilibria

1. Define electrochemical equilibrium and describe the similarities and differences seen when non-electrolytes, ions, fluids, and gases are at equilibrium.
2. Use Fick's law of diffusion to predict whether changes in a type of solute, concentration (or pressure) gradient, surface area, and distance will cause a proportional or inversely proportional effect in the rate of diffusion for a given substance.
3. Explain how an electrical potential difference across a membrane will affect the driving force of charged solutes across that membrane.
4. Define *steady state* and differentiate it from equilibrium.
5. Explain how the Na^+/K^+ ATPase maintains steady-state ion contents, and its role in maintaining cell solute gradients and cell volume.
6. Explain the Nernst equation and describe how it uses ionic concentrations to predict the voltage that stops net ion flow when a given ionic species is at electrochemical equilibrium.
7. Explain how a resting membrane potential is generated and how it could change.
8. State the relative permeabilities for K^+, Na^+, Ca^{2+}, and Cl^- under resting conditions in a typical cell and predict how the membrane potential would change in response to changes in either ion permeability or ionic concentrations.
9. Explain how changes in extracellular K^+ have a greater effect on membrane potential than changes in extracellular Na^+.

F. Excitable Cells

1. Describe how myelination, cell diameter, internodal distance impact the rate of electrotonic conduction along with a membrane.
2. Compare and contrast the transfer of information between a presynaptic cell and a postsynaptic cell using a chemical synapse vs an electrical synapse or electrically coupled cells.
3. Compare and contrast the mechanisms by which ion-selective channels can be opened by extracellular ligands, intracellular ligands, stretch, and voltage.
4. Describe the properties of voltage-gated Na^+, K^+, and Ca^{2+} channels, and explain how voltage influences their gating, activation, and inactivation.
5. Define the concept of "excitability" with reference to an excitable cell.
6. Compare and contrast the ionic basis, and voltage changes over time, of the action potentials for neurons, skeletal, cardiac (contractile and pacemaker) and smooth muscle cells.

II. Neurophysiology

A. Electrophysiology

1. Distinguish between the changes in membrane potential caused by millisecond alterations in conductance (as in an action potential) with those caused by chronic changes in ionic concentrations.
2. Compare and contrast the generation and conduction of action potentials with that of graded potentials (excitatory and inhibitory postsynaptic potentials, and generator potentials), identifying the area on a neuron in which each is initially generated.
3. Identify how diameter and myelination lead to differences in conduction velocity, and the effects of demyelination on action potential propagation.
4. Describe the effects of hyper or hypokalemia, hyper or hypocalcemia, and hypoxia on the resting membrane potential and action potential.
5. Describe the effects of demyelination on action potential propagation and nerve conduction.

6. Describe the ionic basis for inhibitory and excitatory postsynaptic potentials, and explain how these changes can alter synaptic transmission.
7. Differentiate between postsynaptic inhibition and presynaptic inhibition and provide examples of each.
8. Describe the effects of hyperkalemia, hypercalcemia, and hypoxia on the resting membrane and action potential.

B. Neurochemistry

1. Compare and contrast electrical and chemical synaptic transmission based on velocity of conduction, fidelity, and the possibility for neuromodulation (facilitation or inhibition).
2. Describe chemical neurotransmission, listing in correct temporal sequence events, beginning with the arrival of a wave of depolarization at the presynaptic membrane and ending with a graded potential generated at the postsynaptic membrane.
3. Identify the characteristics of a neurotransmitter.

C. Spinal Cord Physiology

1. Describe the anatomical location, function, and afferent neurotransmission of muscle spindle and Golgi tendon organs.
2. Describe, in sequence, the events of the myotatic reflex (the patellar tendon reflex).
3. Compare and contrast the myotatic reflex with the inverse myotatic reflex and the role of the Golgi tendon organ in the latter.
4. Describe the role of the gamma efferent system in the stretch reflex, and explain the significance of alpha-gamma co-activation.
5. Describe the flexor reflex initiated by touching a hot stove, identifying the neuronal connections when pain is sensed, when flexor contraction occurs, and role of the crossed extensor reflex.

D. Nerve Conduction and EMG Studies

1. Compare and contrast the different EMG findings in neuropathy and myopathy.
2. Describe the physiological deficit of myasthenia gravis.

E. Brainstem Reflexes

1. Describe the function of the cardiovascular baroreceptor and respiratory stretch receptor.
2. Identify the stimulus and its receptor, the afferent pathway, the brain stem nuclei involved, the efferent pathway, and the resulting effect for each brain stem reflex.

F. Cerebrovascular System

1. Describe the local factors affecting brain blood flow, and contrast their effectiveness with that of autonomic regulation of cerebral blood flow.

III. Muscle Physiology

A. Skeletal Muscle Structure and Mechanism of Contraction

1. Describe the relationship of the myosin thick filament bare zone to the shape of the active length-tension relationship.
2. Describe and interpret the sequence of chemical and mechanical steps in the crossbridge cycle, and explain how the crossbridge cycle results in shortening of the muscle. Consider the role of the heavy and light chains of myosin.

B. Control of Skeletal Muscle Contraction

1. Describe the steps in excitation-contraction coupling in skeletal muscle, and describe the roles of the sarcolemma, transverse tubules, sarcoplasmic reticulum, thin filaments, and calcium ions.
2. Describe the roles of ATP in skeletal muscle contraction and relaxation.
3. Identify the steps, in sequence, involved in neuromuscular transmission in skeletal muscle, leading to contraction. Consider pathological states affecting this process.
4. Differentiate between an endplate potential and an action potential in skeletal muscle.
5. Identify the possible sites for blocking neuromuscular transmission in skeletal muscle, and describe the physiology effects of blocking these sites.

C. Mechanics and Energetics of Skeletal Muscle Contraction

1. Describe the relationship of preload, afterload, and total load in the time course of an isotonic contraction.
2. Differentiate between an isometric and isotonic contraction.
3. Differentiate between a twitch and a tetanus in skeletal muscle and explain why a twitch is smaller in amplitude than a tetanus.
4. Describe the molecular origin of the passive (resting), active, and total tension in the length-tension diagram.
5. Describe the force-velocity relationship in skeletal muscle.
6. Describe the influence of the series elastic element on contractile function.
7. Identify the energy sources of muscle contraction and their capacity to supply ATP for contraction.
8. Describe the effect of muscular fatigue on force of contraction.
9. Compare and contrast the structural, enzymatic, and functional features of fast-glycolytic and slow-oxidative fiber types in skeletal muscle.
10. Describe the role of the myosin crossbridges acting in parallel to determine active force, and the rate of crossbridge cycling to determine muscle speed of shortening and rate of ATP utilization during contraction.
11. Describe how weightlifting leads to parallel enlargement of sarcomeres and the generation of greater muscle force.
12. Define *motor unit* and describe the order of recruitment of motor units during skeletal muscle contraction of varying tension (Size principle).
13. Describe what neuromuscular information can be learned from an electromyographic (EMG) examination.
14. Describe the physiological deficit of myasthenia gravis and Lambert-Eaton syndrome.
15. Describe the pathophysiological basis of rigidity, spasticity, and muscle spasm.

D. Smooth Muscle

1. Compare and contrast the activation-contraction coupling of smooth muscle from that of skeletal muscle.
2. Compare and contrast smooth and skeletal and smooth muscle crossbridge cycling.
3. Explain why smooth muscles can develop and maintain force with a much lower rate of ATP hydrolysis than skeletal muscle.
4. Describe the distinguishing characteristics of multi-unit and unitary smooth muscles.

E. Cardiac Muscle

1. Compare and contrast the excitation-contraction coupling mechanism in cardiac muscle with that of skeletal muscle.
2. Describe the length-tension curve for cardiac muscle and skeletal muscle, showing the active and passive relationships.

3. Describe and interpret the relationship between an action potential and a twitch in cardiac muscle and explain how this prevents a tetanic contraction.
4. Describe the physiological consequences of the low-resistance pathways (gap junctions) between cardiac muscle cells.

IV. Cardiovascular (CARDIAC)

A. Characteristics of Cardiac Muscle

1. Describe the temporal relationship between an action potential in a cardiac muscle cell and the resulting contraction (twitch).
2. Explain how the prolonged refractory period prevents cardiac muscle from entering a state of sustained (tetanic) contraction.
3. Compare and contrast the steps in excitation-contraction coupling in cardiac muscle with those in skeletal muscle.
4. Describe the mechanisms by which calcium enters and exits the cytoplasm of cardiac muscle cells.
5. Explain how intracellular calcium concentration modulates the strength and duration of cardiac muscle contraction.
6. Describe role of gap junctions in making the heart a functional syncytium, and how it allows the production of a coordinated beat.

B. Electrophysiology of the Heart

1. Identify a typical recording of an action potential in cardiac myocytes and pacemaker cells.
2. Explain what controls the shapes of the action potentials of different cardiac cells.
3. Describe the ionic currents that contribute to each phase of cardiac action potentials and the ion channels involved.
4. Explain how differences in channel population influence the shape of the action potential in the nodal, atrial muscle, ventricular muscle, and Purkinje fiber cardiac cells.
5. Explain the basis for the long duration of the cardiac action potential, the resultant long refractory period, and their importance.
6. Describe the normal sequence of action potential conduction through the heart.
7. Explain the role of the AV node in slowing the conduction through the electrical pathway between the atria and the ventricles.
8. Identify cardiac cells that have the potential to act as a pacemaker, their spontaneous rates of depolarization, and humoral factors that influence their rate.
9. Explain the ionic mechanisms that regulate pacemaker automaticity and rhythmicity.
10. Describe the significance of “overdrive suppression” in the normal function of the heart.
11. Compare and contrast the sympathetic and parasympathetic nervous system influence on heart rate cardiac excitation, and the underlying ionic mechanisms.
12. Explain how factors that result in a less negative phase 4 potential alters ionic events in generation and conduction.
13. Define decremental conduction, re-entry, and circus movement and ectopic pacemaker activity.

C. The Normal and Abnormal Electrocardiogram (ECG)

1. Describe the electrode conventions used to standardize ECG measurements.
2. Identify the electrode placements and polarities for the 12 leads of a 12-lead electrocardiogram and the standard recording speed and sensitivity of the machine.
3. Identify and explain the relationship between the waves, intervals, and segments in relation to the electrical state of the heart.

4. Estimate heart rate and mean electrical axis of the heart from an ECG tracing and determine if the ECG shows normal sinus rhythm.

D. Cardiac Output and Venous Return

1. Define venous return and explain how it relates to cardiac output.
2. Explain how cardiac function (output) curves are generated and how factors that cause changes in contractility can alter the shape of cardiac function curves.
3. Describe the concept of "mean systemic filling pressure," its normal value, and how various factors can alter its value.
4. Describe the concept of "central venous pressure" and factors affecting it.
5. Describe effects of the skeletal muscle pump and the thoracic (respiratory) pump on venous return.
6. Explain how exercise affects venous return from the foot and leg.
7. Describe the changes in blood volume and pressure when a person moves from a supine to a standing position.
8. Predict how changes in total peripheral resistance, blood volume, and venous compliance influence the vascular function curve.
9. Explain how the intersection point of the cardiac function and vascular function (venous return) curves represent the steady-state cardiac output and central venous pressure under the conditions represented in the graph of the two curves.
10. Use the intersection point of the cardiac function curve and vascular function curve to predict how fluid volume deficiency or excess, heart failure, autonomic stimulation, and exercise will affect cardiac output and right atrial pressure.
11. Predict physiological compensations that would occur in response to the disturbances in #10.

E. Cardiac Function

1. Correlate the cellular characteristics of length, tension, and velocity of shortening with the intact ventricle characteristics of end-diastolic volume, pressure, and rate of pressure change.
2. Define cardiac output and describe how changes in heart rate and stroke volume affect it.
3. Define preload, afterload, contractility, and chamber compliance and how they impact stroke volume.
4. Explain how ventricular end-diastolic pressure, atrial pressure, and venous pressure all provide estimates of ventricular preload, as well as how ventricular end-diastolic pressure provides the most reliable estimate of these three parameters.
5. Explain the role of Starling's Law of the Heart in keeping the output of the left and right ventricles equal.
6. Compare how changes in preload and contractility influence ventricular force development.
7. Compare the O_2 consumption and energetic consequences of changes in either preload or contractility force modulation.
8. Explain how arterial pressure, ventricular wall thickness, left ventricular outflow tract and chamber sizes, and aortic valve competency influences afterload.
9. Explain how the calcium transient influences cardiac contractility and differs from events in skeletal muscle.
10. Differentiate between cardiac performance and cardiac contractility.
11. Describe the impact of changes in preload, afterload, contractility, and compliance in determining cardiac performance.
12. Explain how changes in sympathetic activity alter ventricular work, cardiac metabolism, oxygen consumption, and cardiac output.

13. Relate the ventricular pressure-volume loop to the phases and events of the cardiac cycle (ECG, valve movement, etc.).
14. Differentiate between stroke volume and stroke work, identifying both on a pressure-volume loop.

15. Define *ejection fraction* and calculate it from end-diastolic volume and stroke volume.
16. Describe the changes in pressure-volume loops that would result from changes in preload, afterload, or contractility, for one cycle and the achieved new steady state.
17. Explain how diastolic filling time and preload can be altered by the autonomic nervous system.

F. Cardiac Cycle

1. Explain how pressure changes between the cardiac chambers can explain the opening and closing of the cardiac valves.
2. Identify the relationship between atrial, ventricular, and aortic pressures, ventricular volume, heart sounds, and ECG events in the cardiac cycle.
3. Describe the phases of the cardiac cycle including the intervals of isovolumic contraction, rapid ejection, reduced ejection, isovolumic relaxation, rapid ventricle filling, reduced ventricular filling, and atrial contraction.
4. Describe the relationship between pressure and flow into and out of the left and right ventricles during each phase of the cardiac cycle.
5. Describe the timing and causes of the four heart sounds.

G. Cardiovascular Fluid Dynamics

1. Compare and contrast pressure, flow, and resistance in different segments of the vasculature.
2. Compare and contrast the systemic and pulmonary circulations with respect to blood flow, velocity, cross-sectional area, and volumes.
3. Explain how altering resistance affects blood flow to an organ.
4. Describe the factors that influence resistance to flow.
5. Describe the relationship between flow, velocity, and cross-sectional area.
6. Define laminar and turbulent flows and describe the factors that contribute to turbulence.

H. Arterial Pressure and the Circulation

1. Describe the organization of the circulatory system and explain how the systemic and pulmonary circulations are linked physically and physiologically.
2. Explain the components of an arterial blood pressure waveform.
3. Describe the estimation of blood pressure with a sphygmomanometer. Explain how it provides estimates of systolic and diastolic pressures.
4. Calculate the pulse pressure and estimate the mean arterial pressure given systolic and diastolic blood pressures.
5. Explain how arteries function as pressure reservoirs and aid blood flow to tissues after arteries are stretched in systole.
6. Describe how arterial systolic, diastolic, mean, and pulse pressure are affected by changes in stroke volume, heart rate, arterial compliance, and total peripheral resistance.
7. Explain why systolic arterial pressure, but not mean arterial pressure, is higher in leg arteries than in the aorta.
8. Predict the ratio of ankle-to-arm systolic arterial pressures in a healthy person.
9. Describe the effects of epinephrine, norepinephrine, angiotensin II, and vasopressin, nitric oxide, bradykinin, prostaglandins, and histamine on vascular tone.

I. The Microcirculation and Lymphatics

1. Explain how water and solutes traverse the capillary wall.
2. Identify the factors that affect the diffusion-mediated delivery of nutrients from the capillaries to the tissues [Fick's equation].
3. Describe how each component of the *Starling equation* influences fluid movement across the endothelium.
4. Explain the consequences of altering pressure or resistance in pre- and post-capillaryregions on capillary hydrostatic pressure and transmural fluid movement.
5. Identify critical functions of the lymphatic system in fat absorption, interstitial fluid reabsorption, and clearance of large proteins from the interstitial spaces.
6. Explain how edema develops in response to venous obstruction, lymphatic obstruction, increased capillary permeability, heart failure, tissue injury or allergic reaction, and malnutrition.

J. Regulation of Arterial Pressure

1. Describe the functional components of the baroreceptor reflex.
2. Describe the sequence of events in the baroreceptor reflex that occurs after an acute increase or decrease in arterial blood pressure, including receptor response, afferent nerve activity, CNS integration, efferent nerve activity to the SA node, ventricles, arterioles, venules, and hypothalamus.
3. Describe the sequence of events mediated by the cardiopulmonary (volume) reflex that occurs after an acute increase or decrease in arterial blood pressure and central venous pressure including receptor response, afferent nerve activity, CNS integration, efferent nerve activity to the heart, kidney, hypothalamus, and vasculature.
4. Compare and contrast the sympathetic and parasympathetic nervous system control of heart rate, contractility, total peripheral resistance, and venous capacitance.
5. Predict the cardiovascular consequence of altering sympathetic nerve activity and parasympathetic nerve activity.
6. Compare and contrast the relative contribution of short- and long-term mechanisms in blood pressure and blood volume regulation.
7. Describe the cardiovascular reflexes initiated by decreases in blood O_2 and increases in blood CO_2 and H^+
8. Identify the stimuli for the release and cardiovascular actions of angiotensin II, atrial and brain natriuretic peptides, bradykinin, and nitric oxide.

K. Local Control of Blood Flow

1. Explain autoregulation of blood flow.
2. Explain how metabolic regulation of blood flow accounts for active hyperemia and reactive hyperemia.
3. Describe the endothelial control of vascular smooth muscle function.
4. Describe the interaction of local, neural, and humoral control mechanisms, in the regulation of different vascular beds, e.g., CNS, coronary, renal muscle, cutaneous, splanchnic.
5. Describe the role of angiogenesis in providing a long-term match of tissue blood flow and metabolic need.

L. Circulatory Volume Contraction and Shock

1. Describe the direct cardiovascular consequences of the loss of 30% of the circulating blood volume on cardiac output, central venous pressure, and arterial pressure, and the compensatory mechanisms activated by these changes.

2. Identify positive feedback mechanisms activated during severe circulatory volume contraction.

M. Coronary and Skeletal Muscle Circulations

1. Describe how flow of blood to the ventricular myocardium occurs during diastole.
2. Identify the area of the ventricle most susceptible to ischemic damage and explain why the risk is increased at high heart rates.
3. Explain the mechanism whereby coronary blood flow is coupled to myocardial workload, and identify stimuli that cause increases in coronary blood flow to occur.
4. Explain how sympathetic stimulation alters heart rate, contractility and coronary vascular resistance, and directly and indirectly changes coronary blood flow.
5. Compare and contrast the neural and local control of skeletal muscle blood flow at rest and during exercise.
6. Compare and contrast the effect of phasic and sustained skeletal muscle contraction on extravascular compression of blood vessels and on central venous pressure.

V. Pulmonary Physiology

A. Pulmonary Mechanics

1. Explain how pleural pressure, alveolar pressure, airflow, and lung volume change during a normal quiet breathing cycle.
2. Identify the onset of inspiration, cessation of inspiration, and cessation of expiration on a diagram of pleural pressure, alveolar pressure, airflow, and lung volume during a normal quiet breathing cycle.
3. Define lung compliance and how it changes in a normal pulmonary pressure-volume curve.
4. Differentiate between lung compliance, chest wall compliance, and their combined compliance.
5. Using the pressure-volume curves, explain how compliance changes in obstructive and restrictive conditions (e.g., emphysema, pulmonary fibrosis or pneumonia).
6. Identify the forces that generate the negative intrapleural pressure when the lung is at functional residual capacity.
7. Predict the direction that the lung and chest wall will move if air is introduced into the pleural cavity (pneumothorax).
8. Describe and interpret a normal spirogram, identifying the four lung volumes and how these four volumes can be combined to form the four capacities.
9. Identify which lung volumes and capacities cannot be measured by spirometry.
10. Describe how changes in lung volumes occur in patients with obstructive and restrictive conditions.
11. Define how surface tension is altered by alveolar size and surfactants and how it affects lung mechanics.
12. Define atelectasis and explain the role of surfactant in preventing it.
13. Describe the effects of airway diameter and turbulent flow on airway resistance to air flow.
14. Describe how airway resistance alters dynamic lung compliance.
15. Describe how the following can be used to help diagnose specific respiratory conditions: forced vital capacity (FVC) timed forced expiratory volumes (FEVs), their ratio and a normal maximal effort flow-volume curve.

B. Alveolar Ventilation

1. Differentiate between anatomic dead space, physiologic dead space, wasted (dead space) ventilation, minute ventilation, and alveolar ventilation.

2. Define partial pressure and fractional concentration as they apply to gases in air.
3. List the normal fractional concentrations and sea level partial pressures for O_2, CO_2, and N_2.
4. Identify the normal airway, alveolar, arterial, and mixed venous P_{O_2} and P_{CO_2} values, as well as the normal arterial and mixed venous values for O_2 saturation, [HCO_3^-], and pH.
5. Describe the relationships between alveolar ventilation and arterial P_{CO_2}.
6. Describe how changes in alveolar ventilation will differently affect arterial P_{CO_2} and P_{O_2}.
7. Define hypoventilation, hyperventilation, hypercapnia, eupnea, hypopnea, hyperpnea.

C. <u>Pulmonary Circulation</u>

1. Compare and contrast the systemic and pulmonary circulations with respect to pressures, resistance to blood flow, and response to hypoxia.
2. Describe factors affecting pulmonary vascular resistance (pulmonary arterial blood pressure, cardiac output, lung volume) and their mechanisms (e.g., recruitment, distension, behavior of extra- and intra-alveolar blood vessels).
3. Describe the consequence of hypoxic pulmonary vasoconstriction on the distribution of pulmonary blood flow and the development of pulmonary hypertension
4. Explain the development of pulmonary edema by increased hydrostatic pressure, increased permeability, impaired lymphatic outflow and hemodilution (e.g., with saline volume resuscitation).

D. <u>Pulmonary Gas Exchange</u>

1. Identify the factors that affect diffusive transport of a gas between alveolar gas and pulmonary capillary blood.
2. Define and give examples of diffusion-limited and perfusion-limited exchange.
3. Explain the impact of differential solubilities of O_2 and CO_2 on their diffusion.
4. Describe the kinetics of oxygen transfer from alveolus to capillary and the concept of capillary reserve time.
5. Define factors that affect oxygen diffusing capacity of the respiratory membrane.
6. Define hypoxia and hyperoxia.
7. Explain why fluid does not usually accumulate in the interstitium of the lungs, using the components of the Starling equation.

E. <u>Ventilation Perfusion Relationship</u>

1. Describe the regional differences in alveolar ventilation and blood flow in a healthy upright lung and explain the basis for these differences.
2. Describe how the ventilation/perfusion ($\dot{V}_A/\dot{Q}$) ratio of an alveolar-capillary lung unit determines the P_{O_2} and P_{CO_2} of the blood emerging from that lung unit.
3. Explain how $\dot{V}_A/\dot{Q}$ relationship is affected by the vertical distribution of ventilation and perfusion in the healthy lung and its implication in disease states.
4. Explain how the presence of abnormally low and high $\dot{V}_A/\dot{Q}$ ratios in a person's lungs will affect arterial P_{O_2} and P_{CO_2}.
5. Describe how *right-to-left shunts*, *anatomic* and *physiological shunts*, and physiologic dead space cause abnormal $\dot{V}_A/\dot{Q}$ distribution, pulmonary gas exchange and arterial blood gases.
6. Describe the significance of an elevated (A-a) P_{O_2}.
7. Explain how the following can cause hypoxemia: hypoventilation, ventilation/perfusion mismatch, right-to-left shunt, diffusion impairment, and low P_{O_2}

F. Transport of oxygen and carbon dioxide

1. Define and explain the relationship among oxygen partial pressure, percent hemoglobin saturation, and oxygen content in blood.
2. Describe and interpret a hemoglobin-O_2 dissociation curve, showing the relationships between oxygen partial pressure, hemoglobin saturation, and blood oxygen content.
3. Outline the information that can be received from the following tests/devices: spirometer**,** arterial blood gas (ABG) analysis, pulse oximeter, transcutaneous oximeter
4. Explain the relationship between Po_2 and dissolved plasma O_2 content (Henry's Law).
5. Compare the relative amounts of O_2 carried bound to hemoglobin with that carried in the dissolved form under physiological condition.
6. Describe how the shape of the hemoglobin-O_2 dissociation curve influences the uptake and delivery of oxygen.
7. Define the P_{50} value of a hemoglobin-O_2 dissociation curve and describe its physiological significance.
8. Describe how the hemoglobin-O_2 dissociation curve is affected by changes in blood temperature, pH, PCO_2 (Bohr effect), and 2,3-DPG, and their physiological consequences.
9. Describe how anemia and carbon monoxide poisoning affect the shape of the hemoglobin-O_2 dissociation curve, PaO_2, and SaO_2.
10. Identify the forms in which CO_2 is carried in the blood, as well as the percentage of total CO_2 transported as each form.
11. Explain the importance of the chloride shift in the transport of CO_2 by the blood.
12. Identify the enzyme that is essential to normal CO_2 transport by the blood and its location.
13. Describe the hemoglobin-CO_2 dissociation curve, the effect of O_2 on this relationship (Haldane effect), and the significance of this effect in CO_2 discharge at the lungs.
14. Explain how the total gas pressure of the venous blood is sub-atmospheric and how this situation is accentuated when breathing 100% O_2.
15. Explain how breathing 100% O_2 can result in further arterial O_2 desaturation in hypoxemic patients who develop mucous plugging of their airways (absorption atelectasis).
16. Define respiratory acidosis and respiratory alkalosis.
17. Identify clinical examples of respiratory acidosis and respiratory alkalosis.
18. Describe the mechanism and function of respiratory acid-base compensations.

G. Respiratory Control

1. Describe the specific roles of groups of neurons that are involved in the generation and control of automatic cyclic breathing.
2. Identify examples of reflexes involving pulmonary receptors that influence breathing frequency and tidal volume, including the receptors and neural pathways involved.
3. Identify the anatomical locations of chemoreceptors sensitive to changes in arterial PO_2, PCO_2, and pH that participate in the control of ventilation and the relative importance of each in sensing alterations in blood gases.
4. Describe how changes in arterial PO_2 and PCO_2 alter alveolar ventilation, including the synergistic effects when both PO_2 and PCO_2 change.
5. Describe the respiratory drive in a COPD patient, and predict the change in respiratory drive when oxygen is given to a COPD patient.
6. Describe the significance of the feed-forward control of ventilation (central command) during exercise, and the effects of exercise on arterial and mixed venous PO_2, PCO_2, and pH.

7. Describe the effects of chronic inactivity on lung volumes, lung, and chest wall compliance, blood gases, and respiratory control.

H. Non-Respiratory Lung Function

1. Identify the mechanisms by which particles are cleared from the airways.
2. Describe how CFTR, an airway chloride channel, promotes a watery layer beneath the mucus layer to facilitate upward ciliary transport of mucus-trapped microbes and particulates.

VI. Renal Physiology

A. Renal Clearance

1. Define renal clearance of a compound and how specific compounds can be utilized to estimate glomerular filtration rate (GFR), renal plasma flow (RPF), and renal blood flow (RBF).
2. Calculate filtered load, secretion/excretion rates for an appropriate compound when given the plasma/urine concentrations and the urine flow rate.
3. Predict how changes in filtration, reabsorption, and secretion will affect renal excretion of compounds (e.g., creatinine, glucose, penicillin).
4. Relate the tubular load and excretion rate to plasma concentration based on the T_{max} of a compound (e.g., glucose, para-amino hippuric acid, creatinine, inulin).

B. Glomerular Filtration Rate and Renal Hemodynamics

1. Describe how changes to the structure of the glomerular filtration barrier can affect the GFR and lead to proteinuria.
2. Describe the effects of reductions in GFR on plasma creatinine concentrations.
3. Given a change in the capillary and Bowman's capsule hydrostatic and oncotic pressures, predict the direction of change in glomerular filtration rate.
4. Given a change in the relative resistances of the afferent and efferent arterioles, predict the effect on renal blood flow and GFR.
5. Describe the myogenic and tubulo-glomerular feedback mechanisms that mediate the autoregulation of renal plasma flow and glomerular filtration rate.
6. Predict the change in renal blood flow and glomerular filtration rate caused by an acute increase in renal sympathetic nerve activity, by increased levels of angiotensin II, or by increased levels of atrial natriuretic peptide.

C. Transport Properties of Nephron Segments

1. Describe the contribution of the major nephron segments to the reabsorption of the filtered load of solute and water.
2. Describe the effects of changes in peritubular capillary hydrostatic and colloid osmotic pressures on net proximal tubular fluid reabsorption.
3. Describe the cellular mechanisms for the transport of Na^+, Cl^-, K^+, HCO_3^- , Ca^{2+}, phosphate, organic solutes (e.g., glucose, amino acids, and urea), and water by the major tubular segments.
4. Describe the function of the following renal transporters and their predominant localization along the tubules with regard to nephron segment and apical versus basolateral membranes:
   - Transport ATPases (Na^+/K^+-ATPase, H^+/K^+-ATPase, H^+-ATPase, and Ca^{2+}-ATPase);
   - Ion and water channels (K^+, ENaC, Ca^{2+}, aquaporins);
   - Coupled transporters (Na^+-glucose, Na^+/H^+-antiporter, $Na^+/K^+/2Cl^-$ symporter, Na^+ phosphate symporter, Na^+-Cl^--symporter, Na^+-HCO_3^- symporters, Cl^-/HCO_3^- antiporter).
5. Describe the nephron sites and molecular mechanisms of action of the following classes of diuretics (osmotic, carbonic anhydrase inhibitors, loop, thiazide, K^+-sparing).

D. Urine Concentration and Dilution

1. Predict how changes in body fluid volume and osmolality caused by a net water loss or gain would alter the rate of urine production and the osmotic composition of the urine.
2. Predict how changes in body fluid volume and osmolality caused by a net NaCl loss or gain would alter the rate of urine production and the osmotic composition of the urine.
3. Explain the creation of the hypertonic renal interstitium, including the roles of the countercurrent multiplier, urea recycling, and the countercurrent exchanger.
4. Describe the role of the ascending limb of the loop of Henle in producing a high renal interstitial fluid osmolality.
5. Compare and contrast, beginning with the loop of Henle, the tubular fluid and interstitial fluid osmolality changes that allow either a dilute or a concentrated urine to be produced and excreted.
6. Describe the role of the thick limb $Na^+/K^+/2Cl^-$ (NKCC) transporter in maintaining the medullary osmotic gradient.
7. Predict the consequences on urine concentrating ability if blood flow to the medulla changes.
8. Describe the negative feedback control mechanisms for the two most powerful stimuli promoting ADH release.
9. Describe the cellular mechanism by which anti-diuretic hormone (ADH) increases permeability to water and urea, including the tubular section on which it acts, and how this leads to the production of concentrated urine.
10. Differentiate between central and nephrogenic diabetes insipidus and how plasma anti-diuretic hormone (ADH) levels can be different between the two.

E. Na^+ Balance and Regulation of Extracellular Fluid Balance

1. Identify the normal range of dietary sodium intake, sodium distribution in the body, and major routes of sodium excretion.
2. Calculate the normal filtered load of Na^+ and identify the tubular sites of Na^+ reabsorption.
3. Describe the regulation of Na^+ reabsorption along the nephron, including the effects of sympathetic nerves, angiotensin II, aldosterone, and atrial natriuretic peptide.
4. Describe the role of Na^+ in maintaining extracellular fluid volume.
5. Describe how Na^+ reabsorption in euvolemia is altered by volume depletion or volume expansion.
6. Describe the receptors involved in the monitoring of ECF volume (e.g., high-pressure baroreceptors and low-pressure cardiopulmonary stretch receptors), and describe the neural reflex regulation of renal Na^+ and water excretion.
7. Describe the role of the renin-angiotensin-aldosterone system in the regulation of renal Na^+ reabsorption.
8. Describe the role of the renin-angiotensin-aldosterone system in the regulation of systemic arterial blood pressure in volume-replete and volume-depleted states.
9. Explain the contribution of the kidneys to the hypervolemia that is characteristic of congestive heart failure.
10. Describe the roles of antidiuretic hormone, aldosterone, angiotensin, and atrial natriuretic hormone in the regulation of sodium balance.

F. K^+ Balance

1. Describe K^+ distribution within the body and identify major routes of K^+ loss from the body.
2. Describe the role of insulin and epinephrine in acutely shifting K^+ between intracellular and extracellular pools.
3. Describe the cellular K^+ shift caused by acid-base disturbances.
4. Identify the tubular sites of K^+ reabsorption and secretion.

5. Describe the factors that regulate K^+ secretion in the connecting/collecting tubule (e.g., aldosterone, plasma K^+)
5. Describe how changes in luminal fluid flow rate, Na^+ delivery and anion delivery affect K^+ secretion at connecting/collecting tubule.
6. Identify the normal range of dietary potassium intake, potassium distribution in the body, and routes of potassium excretion.
7. Explain how acute changes in aldosterone, insulin, and acid-base concentrations affect the plasma potassium concentration and the movement of potassium into and out of the intracellular compartment.
8. Describe the ongoing regulation of body potassium balance and plasma potassium levels by aldosterone through its actions on renal excretion, intestinal excretion, and dietary appetite/absorption.

G. <u>Ca^{2+} and Phosphate Balance</u>

1. Identify the normal range of dietary calcium intake, calcium distribution in the body.
2. Identify the major storage pools of Ca^{2+} and phosphate, as well as major routes of Ca^{2+} and phosphate loss from the body.
3. Identify the tubular sites of Ca^{2+} reabsorption and of phosphate reabsorption.
4. Describe the renal regulation of Ca^{2+} and phosphate transport by PTH, calcitonin, and 1,25-dihydroxyvitamin D (calcitriol) and distinguish from other factors, (e.g., ECF volume, acid-base disorders).
5. Describe the hormonal regulation of the plasma calcium concentration based on exchange with bone, renal excretion, and intestinal excretion and/or absorption.
6. Describe the role of the kidney in the production of 1,25-dihydroxy vitamin D (calcitriol).
7. Identify the normal range of dietary phosphate intake, phosphate distribution in the body, and routes of phosphate excretion.
8. Describe the regulation of the plasma phosphate concentration by parathyroid hormone, vitamin D, and calcitonin based on exchange with bone, renal excretion, intestinal excretion and/or absorption.

H. <u>Acid-Base Balance</u>

1. Identify the normal range of plasma pH values, and the upper and lower limits compatible with life.

2. Identify the magnitude and the time-course of the compensations that act to minimize change in pH of the body fluids, including buffers, respiratory adjustments, and renal adjustment, given a sudden increase or decrease in pH.
3. Describe the respiratory and renal regulation of the CO_2/HCO_3^- -buffer system, which allows a buffer with a pKa of 6.1 to be physiologically important in the maintenance of the normal plasma pH of 7.4.
4. Differentiate between CO_2-derived (volatile acid) and non-volatile acids (titratable and NH_4^+).
5. Calculate the filtered load of HCO_3^- and identify the major sites of reabsorption (and secretion) along the nephron.
6. Describe the cellular mechanisms responsible for net transepithelial movement of HCO_3^-, emphasizing the importance of H^+ secretory mechanisms in this process.
7. Describe how alterations in systemic acid-base balance alter the filtered load of HCO_3^- and its reabsorption/(H^+ secretion).
8. Describe how changes in ECF volume, aldosterone, and angiotensin II can secondarily lead to changes in systemic acid-base balance.

9. Describe the importance of urinary buffers, and the production and excretion of ammonia, in net acid excretion by the kidneys of non-volatile acids.
10. Differentiate between the reclamation of filtered bicarbonate and the formation of new bicarbonate.
11. Identify simple and mixed metabolic and respiratory acid-base disorders based on arterial gases, HCO_{3^-} and pH.
12. Explain the common causes of acid-base disturbances.

I. Integrative and Pathophysiological Aspects

1. Describe the relationships between sodium balance and plasma volume as they contribute to cardiovascular hemodynamics and arterial pressure.
2. Explain the role of the renin-angiotensin-aldosterone systems in the regulation of sodium balance and arterial pressure, with emphasis on the actions of angiotensin II on various target organs and tissues.
3. Describe how renal functions, including pressure diuresis and natriuresis, contribute to the long-term regulation of arterial pressure and how their impairments can contribute to the development and maintenance of hypertension.

VII. Gastrointestinal Physiology

A. Functions and Regulation of GI Tract

1. Describe the overall role of the gastrointestinal system with respect to the whole-body balance of water, electrolytes, carbohydrates, fats, and proteins.
2. Explain the processes of digestion, absorption, metabolic production, metabolic consumption, secretion, and excretion, related to carbohydrates, fats, and proteins.
3. Compare and contrast the sympathetic and parasympathetic modulation of the enteric nervous system and the effector organs of the GI tract.
4. Classify the following enteric nervous system neurotransmitters as excitatory or inhibitory in effect: norepinephrine, acetylcholine, NO, CCK, VIP, histamine, and somatostatin.
5. Define long reflex and short reflex with respect to the GI tract.
6. Describe the regulation of gastrointestinal function by neural, hormonal, paracrine and single-unit vascular smooth muscle mechanisms.
7. Define incretins and identify two gastrointestinal hormones that function in this manner.
8. Describe the effects of leptin and ghrelin in the regulation of satiety, food intake, and energy balance.

B. Salivary Gland

1. Examine the phases of salivary secretions, the ionic composition at varied flow rates, and the role of salivary mucus.

C. Esophagus

1. Identify the sequences involved in the swallowing reflex and describe the mechanisms which create the high basal tone observed in the upper esophageal sphincter (UES) and lower esophageal sphincter (LES) and the consequences of abnormal LES basal tone (in achalasia and gastroesophageal reflux disease GERD).

D. Stomach

1. Explain the storage, digestion, and motility roles of the stomach.
2. Identify the protein component of chief cell secretions.

3. Explain the role of the stomach in preventing pernicious anemia.
4. Identify the mechanism for damage to the gastric mucosal barrier by aspirin, NSAIDS, bile acids, and *Helicobacter pylori*.
5. Identify the causes of peptic ulcer disease.

E. Pancreas

1. Identify the major ionic and peptide/protein components secreted by the exocrine pancreas and their regulation by the ANS and the enterogastrones (CCK and secretin).
2. Compare and contrast the plasma and pancreatic concentrations of Na^+, Cl^-, and HCO_3^- at low secretion rates.
3. Describe the role of the ANS and the enterogastrones on the exocrine alkaline-rich secretions involved in neutralizing the gastric acidic chyme.
4. Describe the mechanisms by which chyme from the stomach is neutralized in the duodenum.

F. Bile

1. Identify the water, ionic, bile salt, and bilirubin components of bile as secreted by the liver, and explain the modification of bile as it is stored in the gall bladder.
2. Identify the cellular mechanisms for the hepatic uptake, conjugation, and secretion of bile salts and bilirubin and explain the modification of bile as it is stored in the gall bladder and the involvement of the enterohepatic circulation.
3. Explain the role of cholecystokinin (CCK) and secretin in the hepatic liver production of bile, the release of bile from the gall bladder, and the effects on the sphincter of the hepatopancreatic ampulla (sphincter of Oddi).

G. Small Intestine

1. Describe the role of the microvilli, the unstirred layer, and tight junctions in determining the rate at which glucose, amino acids, water, lipids, and electrolytes are absorbed.
2. Identify the types of carbohydrates in duodenal chyme and describe the mechanisms of digestion and absorption across the intestine, and explain the consequence of a deficiency in the enzyme lactase.
3. Identify the types of proteins and amino acids in duodenal chyme, and describe the mechanisms of digestion and absorption across the intestine.
4. Describe the mechanism of digestion and absorption of the different types of lipids in duodenal chyme.
5. Explain the effects of steatorrhea on absorption of lipid-soluble vitamins.
6. Describe the mechanisms of digestion and absorption across the intestine.
5. Explain the absorption of water-soluble vitamins, including the roles of salivary R protein and intrinsic factor in the absorption of vitamin B12.
6. Describe the pathways by which iron, and calcium are absorbed in the small intestine and colon.
7. Describe the cellular mechanisms of colonic sodium, potassium, and bicarbonate secretion, colonic bacterial metabolism (and their impact on intestinal gas formation, flatus) along with colonic production and absorption of SCFA.

H. Intestinal Motility

1. Describe the characteristics of the basic electrical rhythm (BER) of the small intestine, and explain its function in setting the frequency of smooth muscle contractile activity.
2. Compare and contrast the patterns of intestinal motility (segmentation, peristalsis) seen during the absorptive phase with that of the post-absorptive phase migrating motor complex (MMC) between meals.

3. Compare and contrast the effects of parasympathetic and sympathetic nervous activity in modulating small intestinal motility.
4. Describe the defecation reflex, resetting the ano-rectal angle and the neural control of defecation.

VIII. Endocrine Physiology

A. General Principles

1. Define *hormone, target cell, and receptor.*
2. Describe the principle of negative feedback, positive feedback, and feed-forward control of hormone secretion and provide an example of each.
3. Compare and contrast endocrine, paracrine, and autocrine based on the site of hormone release and the pathway to the target tissue and provide an example of each.
4. Describe major differences mechanisms of action of peptides, amines working through surface receptors and steroids, vitamin D, and thyroid hormones working through nuclear receptors.
5. Compare and contrast hormone actions that are exerted through changes in gene expression with those exerted through changes in protein phosphorylation and provide an example of each.
6. Describe the effects of plasma hormone binding proteins on access of hormones to their sites of action and degradation and on the regulation of hormone secretion.
7. Describe the effects of secretion, excretion, degradation, and volume of distribution on the concentration of a hormone in blood plasma.

B. Posterior Pituitary

1. Identify the stimuli for oxytocin release and the target organs and/or cell types for its action. Include its main actions at its targets.
2. Identify the stimuli for vasopressin (antidiuretic hormone, ADH) and the target organs and/or cell types for its action. Include its main actions at its targets.
3. Provide the physiological basis for the disease states caused by over-secretion and under-secretion of vasopressin (ADH), including their principal signs and symptoms.

C. Anterior Pituitary

1. Identify hypothalamic factors that control the secretion of each of the anterior pituitary hormones, and describe their route of transport from the hypothalamus to the anterior pituitary.
2. Describe the importance of pulsatile and diurnal secretion, and describe an example of each.
3. Predict the changes in secretory rates of hypothalamic, anterior pituitary, and target gland hormones caused by over-secretion or under-secretion of each of these hormones or receptor deficit for these hormones.
4. Describe the general structure and actions of the glycoprotein hormones, the POMC family of hormones, and the GH/prolactin family of hormones.
5. Describe and interpret the short-loop and long-loop negative feedback control of anterior pituitary hormone secretion.

D. Thyroid Gland

1. Outline the steps in the biosynthesis, storage, secretion, and regulation of triiodothyronine (T_3) and thyroxine (T_4).

2. Describe factors that control the synthesis, storage, and release of thyroid hormones and describe the importance of thyroid hormone binding in blood on free and total thyroid hormone levels.
3. Explain the significance of the conversion of T_4 to T_3 and reverse T_3 (rT_3) in extra-thyroidal tissues.
4. Describe the actions of thyroid hormones on development and metabolism.
5. Discuss the causes and consequences of over-secretion and under-secretion of thyroid hormones, and explain why either condition can cause an enlargement of the thyroid gland.

E. Parathyroid Gland

1. Describe the cells of origin, biosynthesis, and transport within the blood for parathyroid hormone.
2. Identify the target organs and cell types for parathyroid hormone and describe its effects on each.
3. Describe the functions of the osteoblasts and the osteoclasts in bone remodeling, and identify the factors that regulate their activities.
4. Identify the time course for the onset and duration for each of the biological actions of parathyroid hormone.
5. Describe the regulation of parathyroid hormone secretion and the role of the calcium-sensing receptor.
6. Describe the causes and consequences of over-secretion and under-secretion of parathyroid hormone.
7. Identify the sources of vitamin D, the biosynthetic pathway, and the organs involved in modifying it to the biologically active $1,25(OH_2)D_3$ (1-25 dihydroxy cholecalciferol) form.
8. Identify the target organs and cellular mechanisms of action for vitamin D.
9. Describe the negative feedback relationship between the parathyroid hormone and the biologically active form of vitamin D.
10. Describe the consequences of vitamin D deficiency and vitamin D excess.

F. Adrenal Gland

1. Identify the functional zones, innervation, and blood supply of the adrenal glands and the principal hormones secreted from each zone.
2. Describe the biosynthesis of the adrenal steroid hormones (glucocorticoids, mineralocorticoids, and androgens) and the key features that distinguish each class.
3. Describe the cellular mechanism of action of adrenal cortical hormones.
4. Describe the major metabolic actions of glucocorticoids on their target organs.
5. Describe the actions of glucocorticoid hormones in injury and stress.
6. Describe the components of the neuroendocrine axis that control glucocorticoid secretion and describe how factors in the internal and external environment influence the neuroendocrine axis.
7. Identify the causes and consequences of over-secretion and under-secretion of glucocorticoids and adrenal androgens.
8. Identify the major mineralocorticoids, their biological actions, and their target organs or tissues.
9. Identify the physiological stimuli that promote increased mineralocorticoid secretion, and relate these stimuli to regulation of sodium and potassium excretion.
10. Identify the causes and consequences of over-secretion and under-secretion of mineralocorticoids.
11. Describe the negative feedback control of aldosterone secretion.
12. Identify the chemical nature of catecholamines, their biosynthesis, mechanism of transport within the blood, and explain how they are degraded and removed from the body.
13. Describe the biological consequences of activation of the adrenal medulla, and identify the target organs or tissues for catecholamines.
14. Explain how epinephrine and norepinephrine can produce different effects in the same tissues.
15. Describe the change in the ratio of epinephrine to norepinephrine release from the adrenal medulla during sympathetic activation (fight and flight), or in prolonged food deprivation.

16. Identify the key stimuli causing catecholamine secretion.
17. List the factors that can modulate the secretory response and the responses of target tissues to adrenal catecholamines.

G. Pancreas

1. Identify the major hormones secreted from the endocrine pancreas, their cells of origin, and their chemical nature.
2. Describe the principal cellular actions of glucagon on its target organs.
3. Identify the time course for the onset and duration of the biological actions of glucagon.
4. Describe the control of glucagon secretion.
5. Describe the major cellular effects of insulin on its target organs, and the consequent changes in concentration of blood constituents.
6. Identify the time course for the onset and duration for the biological actions of insulin.
7. Describe the relationship between blood glucose concentrations and insulin secretion, and explain the roles of neural input and gastrointestinal hormones on insulin secretion.
8. Identify the factors that modulate the secretory response to insulin.
9. Describe the principal signs and symptoms of over-secretion, under-secretion or decreased sensitivity to insulin and the physiological basis for these.

H. Growth Hormone

1. Describe the relationship between growth hormone and the insulin-like growth factors and their binding proteins in the regulation of growth.
2. Describe the regulation of growth hormone secretion, and identify the roles of hypothalamic factors and IGF-I.
3. Identify the target organs or cell types for insulin-like growth factors that account for longitudinal growth.
4. Describe how thyroidal, gonadal, pancreatic, and adrenal hormones modulate growth.
5. Describe the nature and actions of local growth factors.

I. Endocrine Integration of Energy and Electrolyte Balance

1. Identify the normal range of plasma glucose concentrations, as well as the chemical forms and anatomical sites of storage pools for glucose and other metabolic substrates.
2. Identify the hormones that promote the influx and efflux of glucose, fat, and protein into and out of energy storage pools and their impact on the uptake of glucose by tissues.
3. Describe the specific actions for insulin, glucagon, glucocorticoids, catecholamines, growth hormone, and thyroid hormone in integrating energy and electrolyte balance.
4. Describe the changes in metabolic fuel utilization that occurs in long- and short-term fasting and in acute and sustained exercise, and describe how increases or decreases in hormone secretion produce these changes.
5. Describe the role of appetite and metabolic rate in the maintenance of long-term energy balance and fat storage.

J. Male Reproductive Physiology

1. Describe the endocrine regulation of testicular function: the role of the GnRH pulse generator, FSH, LH, testosterone, and inhibin.
2. Describe the cellular mechanism of action and effects of testosterone and dihydrotestosterone on their target organs.

K. Female Reproductive Physiology

1. Describe ovulation, as well as the formation and decline of the corpus luteum.
2. Explain the roles of pituitary hormones in the formation and decline of the corpus Luteum.
3. Identify the cells responsible for the biosynthesis of estrogen and progesterone, the mechanism of their transport in the blood, and explain how they are degraded and removed from the body.
4. Identify the target organs or cell types for estrogen action and describe its effects on each.
5. Describe the cellular mechanisms of action for estrogen.
6. Identify the principal physiological actions of progesterone, its target organs or cell types, and describe its effects on each and the importance of "estrogen priming."
7. Describe the cellular mechanisms of action for progesterone.

IX. Integration: Thermoregulation and Exercise Physiology

A. Thermoregulation

1. Explain thermal balance and feedback control of body core temperature. Consider heat production, heat loss, hypothalamic set point, feedback control, sensors, effectors, communication pathways, fever, and acclimatization to environmental temperature.
2. Compare and contrast the stability of body core with that of skin temperature, especially for lower extremity.
3. Explain the role of cutaneous blood flow and sweating on skin temperature.

B. Exercise

1. Describe the cardiovascular consequences of exercise on peripheral resistance, cardiac output, AV oxygen difference, and arterial pressure.
2. Explain the relative importance of neural and local control of blood flow to CNS, coronary, splanchnic, cutaneous, and skeletal muscle vascular beds in resting and active conditions e.g., aerobic exercise, anaerobic exercise, and digestion.
3. Define $\dot{V}_{O_2max}$ and identify situations in which it is limited by cardiac output and by pulmonary gas exchange. Consider effects of training on the heart and coronary circulation.
4. Identify the control mechanisms by which increases in minute ventilation and heart rate accompany exercise and how they can occur without any measurable change in arterial blood gas values.
5. Describe how frequent physical activity alters insulin sensitivity and glucose entry into cells.

BEHAVIORAL MEDICINE

LEARNING OBJECTIVES

Behavioral Medicine: Behavioral medicine is an interdisciplinary approach to healthcare involving the integration of biological, psychological, and social sciences to help inform culturally-sensitive care and mental health assessment while promoting treatment compliance, prevention, rehabilitation, and referral, as clinically indicated.

1. Understand and identify components of the Mental Status Exam.
2. Identify the diagnostic criteria for diagnosing depressive disorders as defined by the DSM.
3. Identify strategies for medical and behavioral management of depressive disorders and interdisciplinary referral, as needed.
4. Identify the diagnostic criteria for bipolar disorders as defined by the DSM.
5. Describe the importance of medications and behavioral modification in the management of mood disorders. Recognize potential risk behaviors and consequences of treatment non-adherence.
6. Recognize symptoms of anxiety disorders as described in the DSM.
7. Differentiate between functional and dysfunctional anxiety.
8. Identify symptoms, prognosis and treatment of *OCD*.
9. Identify strategies for medical and behavioral management of anxiety and interdisciplinary referral, as needed.
10. Recognize the impact of traumatic experience as they relate to diagnoses such as Acute Stress Disorder and Posttraumatic Stress Disorder. Identify options for trauma-informed care.
11. Explain the manifestations of adjustment disorders and recommendations for self-care and referral.
12. Identify psychoeducation specific to compliance with medication and potential pitfalls in prescribing psychotropic medications without a comprehensive psychiatric medical assessment.
13. Recognize primary counseling skills for patients presenting with psychosocial distress.
14. Recognize signs of developmental disabilities. Identify approaches to the management of conditions, including, intellectual disability, autism-spectrum disorders, and attention-deficit/hyperactivity disorder.
15. Define medical decision making capacity.
16. Discuss medical decision making versus competency. Recognize the need for interdisciplinary referral.
17. Differentiate between pseudodementia, delirium and dementia. Identify their distinctive etiologies.
18. Describe short and long-term consequences of anger and approaches to de-escalating agitation.
19. Describe nonpharmacologic measures to reduce agitation and aggression.
20. Describe signs of somatoform illnesses in contrast to symptoms factitious for secondary gain.
21. Describe signs of abuse in vulnerable adults. Identify referral options for safety and advocacy.
22. Describe signs of child abuse and neglect. Identify referral options for safety and advocacy.
23. Summarize the responsibility to report adult and child abuse neglect, and exploitation Identify state-specific protocol for mandated reporting.
24. Describe symptoms and diagnostic instruments used to evaluate adjustment disorders, anxiety disorders and mood disorders and recommendations for self-care and referral.
25. Describe the use and application of Cognitive Behavioral Therapy, Dialectical Behavior, Motivational Interviewing and interpersonal communication techniques.
26. Explain the emotional and psychological impact of chronic pain.
27. Recognize how manifestations of chronic conditions such as pain, stress, aging, diabetes affect the diagnosis and treatment of mental health conditions .
28. Recognize common signs of the impaired physician and professional burnout. Identify avenues for self-care.
29. Define criteria for substance use disorders as defined by the DSM. Identify referral options for substance use disorders.
30. Describe the importance of medications and behavioral modification in the management of schizophrenia and other psychotic disorders. Recognize potential consequences of untreated psychosis.
31. Identify the biological, psychological, and social components of the biopsychosocial model.
32. Recognize the importance of diversity awareness and sensitivity considering Social Determinants of health.

33. Recognize the importance of compassionate and respectful communication with those who self-identify as LGBTQIA. Describe risks of misattribution of symptoms to sexual orientation.
34. Identify dysfunctional patterns of sleep and strategies for improved sleep hygiene. Recognize potential consequences of disrupted sleep and the importance of behavioral modification before prescribing medication.
35. Describe locus of control and the stages of readiness for change as they relate to patient care and treatment compliance. Explain techniques for motivational interviewing.
36. Explain the five stages of grief as defined by the Kubler-Ross model as well as common end-of-life considerations and resources.

COMMUNITY HEALTH

LEARNING OBJECTIVES

Public Health

Biostatistics

Jurisprudence in Public and Community Health

Epidemiology

I. Public Health

1. Define:
    a. *illness*
    b. *disease*
    c. *quality assessment and assurance*
    d. *quality improvement*
2. Differentiate between health care, medical care, and public health.
3. Distinguish between epidemic, endemic, and pandemic.
4. Describe changes in disease patterns as health care has evolved in the United States:
    a. epidemics of acute infectious diseases affecting population groups
    b. acute infectious and traumatic events affecting individuals
    c. burden of chronic diseases
    d. special chronic diseases (related to genetic make-up, environmental hazards and individual lifestyle)
5. Discuss factors contributing to an increase in health care spending including predictors of health services utilization.
6. Describe the various categories of health insurance in the United States (e.g., Federal, military, private, etc.).
7. Explain the role of a Professional Review Organization (PRO) as it pertains to utilization review.
8. Describe the mission and basic layout of the US Department of Health and Human Services (DHHS).
9. Discuss various agencies in the US that provide or use public health services (e.g., Health and Medicine Division of the National Academies of Science [previously the Institute of Medicine], Department of Labor to include the Occupational Safety and Health Administration [OSHA], National Institutes of Health [NIH], Centers for Medicare and Medicaid Services [CMS], Center for Disease Control and Prevention [CDC], Food and Drug Administration [FDA], and the United States Preventive Services Task Force).
10. List and describe the ten essential public health services as they relate to the clinical practice of podiatric medicine.
11. Explain the goals and focus objectives of "Healthy People 2030".
12. Explain the function of state and local health departments.
13. Discuss the federal Occupational Safety and Health Administration's (OSHA) standards and guidelines for healthcare
14. Describe the various levels of prevention as they pertain to public health practice (i.e., primary, secondary, tertiary prevention, and maintenance or custodial care).
15. Recognize the impact of social determinants of health on the health and well-being of populations, as defined by the CDC.
16. Describe the five primary determinants of health of a population as recognized by CDC: Biology and genetics, individual behavior, social environment, physical environment, and health services.

II. Biostatistics

1. Define:
    a. inferential statistics
    b. descriptive statistics
    c. confidence interval
2. Define and calculate the measures of central tendency.
3. Define and calculate the measures of dispersion.
4. Differentiate continuous, discrete, ordinal (ranked), nominal (categorical), and dichotomous data types.

5. Compare normal, binomial, and skewed distributions.
6. Differentiate between independent and dependent variables.
7. Describe the role of hypothesis testing in research.
8. Differentiate clinical significance from statistical significance.
9. Discuss the importance of reliability and validity as they pertain to medical tests and research design.
10. Define the *p* value and describe its role in supporting or rejecting the null hypothesis.
11. Explain null and alternative hypotheses.
12. Distinguish between type one (alpha) and type two (beta) errors.
13. Describe the standard error of the mean and how this plays a role in the confidence interval.
14. Differentiate parametric versus non-parametric testing and recognize the indications for each test.
15. Describe the interrelationships among power, sample size, effect size, and statistical significance.

III. Jurisprudence in Public and Community Health

1. Differentiate between statutes and administrative regulations.
2. Discuss the importance of scope of practice in podiatric medicine.
3. Summarize healthcare privacy and security requirements under the Health Insurance Portability and Accountability Act (HIPAA).
4. Demonstrate understanding of laws regarding patient's right to control and access their protected health information.
5. Recognize situations that may give rise to an Emergency Medical Treatment and Active Labor Act (EMTALA) claim.
6. Provide examples of events that might result in disciplinary action by a professional licensing board.
7. Describe the purpose and reporting requirements of the National Practitioner Data Bank.
8. Distinguish between different business models (e.g., sole proprietor, partnership, corporation) in healthcare delivery.
9. Discuss the Healthcare Quality Improvement Act (HCQIA) and its role in peer-review and credentialing.
10. Describe fraud, waste and abuse within the healthcare business environment.
11. Differentiate between Physician Self-Referral (Stark Law) and the Anti-Kickback Statute.
12. Summarize the False Claims Act and Qui Tam enforcement.
13. Explain inurement laws and their impact on physician practice.
14. Recognize the legal ramifications and requirements associated with mandatory reporting of child abuse and neglect.
15. Discuss standard of care and negligence as they relate to medical malpractice.
16. Define statute of limitations.
17. Compare and contrast implied consent and informed consent.
18. Explain investigative procedure, deposition, and discovery as they relate to medical malpractice.
19. Define respondeat superior.
20. Describe the doctor patient relationship in the context of a contract.
21. Explain the importance of timely and accurate charting with respect to medical malpractice and billing.
22. Explain the purposes of quality improvement and risk management within a health care facility.
23. Recognize strategies for preventing medical error.
24. Describe the legal requirements for prescribing controlled substances.
25. Define advance directives and surrogate decision-making (e.g., health care power of attorney).

IV. Epidemiology

1. Define:
    a. epidemiology
        i. descriptive epidemiology
        ii. analytical epidemiology
    b. relative risk
    c. odds ratio
    d. hazard ratio
2. Differentiate between incidence and prevalence.
3. Differentiate between sensitivity and specificity and discuss the relationship to false positives and false negatives.
4. Differentiate between positive and negative predictive values of a diagnostic test.
5. Distinguish between crude rates and adjusted rates.
6. Describe the utility of receiver operating characteristic (ROC) curves.
7. Interpret likelihood ratios.
8. Differentiate between internal and external validity.
9. Recognize threats to internal and external validity.
10. Differentiate between observational and experimental studies.
11. Identify sources of, and means to control bias, including: randomization, blinding, and matching, etc.
12. Discuss the hierarchical levels of evidence of a study based on study design.
13. Differentiate between a systematic review, meta-analysis, Clinical Practice Guideline (CPG), Clinical Consensus Statement, Decision Analysis and Cost-effectiveness Analysis.
14. Interpret number needed to treat (NNT), number needed to prevent (NNP), and number needed to harm (NNH).
15. Describe the role of the Institutional Review Board (IRB).
16. Differentiate between clinical informed consent for treatment versus informed consent for inclusion as a research subject.
17. Apply the three bioethical principles (Respect for Persons, Beneficence, and Justice) that underlie human research, as described in the *Belmont Report*.

GERIATRICS

LEARNING OBJECTIVES

I. Geriatrics

1. Discuss the present and future care and economic issues resulting from demographics that reflect a steadily rising geriatric population within the U.S.
2. Apply principles of the biology of aging related to geriatric pharmacotherapy and diagnostic laboratory values, including recognition of concerns related to polypharmacy as it applies to medical management.
3. Explain the role of the podiatrist and other team members in a multi-disciplinary geriatric healthcare team.
4. Identify and discuss clinical situations wherein life expectancy, functional status, patient preference, and/or goals of care override standard recommendations for treatment in the geriatric patient.
5. Identify screening instruments and assessments tools for fall risk in the aging population. Identify modalities and approaches used for fall prevention in the elderly. Identify the major risk factors which predispose an elderly person to falling.
6. Identify key factors associated with the evaluation and management of urinary incontinence.
7. Discuss cognitive and behavioral disorders in the geriatric patient. Discuss the affect of cognitive behavior disorders on pain management.
8. List and differentiate between types of code status, healthcare proxies, and advanced directives as indicated by the clinician's state of practice/training.
9. Identify the place of service and the unique needs and regulations for each setting available to the geriatric patient. (Hospice, hospital, skilled nursing facility, assisted living, residential).
10. Describe methods for prevention of age-related adverse events in the aging population upon discharge from a hospital (delirium/confusion / falls / medication reconciliation/catheter related infection/ pressure ulcers).
11. Recognize signs of elder abuse and explain protocol for reporting abuse. Identify the key features of different types of elder abuse such as physical abuse, sexual abuse, emotional abuse, confinement, financial, and self-neglect etc.
12. Discuss the spectrum of end-of-life care as a positive, active treatment option for a patient with advanced disease.
13. Describe the evaluation and treatment of geriatric frailty syndrome, failure to thrive, and geriatric malnutrition.
14. Understanding the need to work with geriatric patients' support system (family/caregivers/patient advocate) as part of evaluating/determining decision-making capacity (particularly the need for determination for informed consent, and enacting proxies if patient determined to lack capacity).

MEDICINE

LEARNING OBJECTIVES

Infectious Diseases
Neurologic Disorders
Cardiovascular Disorders
Rheumatologic Disorders
Metabolic and Endocrine Disorders
Hematologic Disorders, Including Anemias and Leukemia
Immunologic Disorders (Allergic And Sensitivity Reactions, and Immunosuppressive States)
Respiratory Disorders (Including Asthma, Emphysema, Infectious Pneumonitis)
Behavioral Medicine (Depression, Abuse, Anger Disorders, and Noncompliant Patients)
Emergency Medicine (Medical/Surgical)
Dermatology
Gastroenterology
Geriatrics
Pre- and Postoperative Treatment

I. Infectious diseases

1. Interpret aspects of a focused history and physical to identify patients with infectious disease.
2. Analyze laboratory, physiologic, or imaging data that is utilized in diagnosing and recognizing infectious disease.
3. Describe potential host defenses and responses against an invading organism.
4. Define *fever of unknown origin (FUO*), list common causes, and describe how FUOs are classified.
5. Discuss the Centers for Disease Control and Prevention (CDC) guidelines for hand hygiene.

A. Bacterial

1. List common bacterial infections and the most likely causative organism in skin and joints.
2. Recommend proper antibiotic selection and usage for a given organism.
3. Discuss the etiology, presentation, diagnosis, and treatment of joint space infections and puncture wounds.
4. Classify osteomyelitis and puncture wounds.
5. List the symptoms of, and common antibiotics used for, the treatment of urinary tract infections.
6. List the treatment available for patients with sexually transmitted diseases.
7. Differentiate between colonization and infection in the diabetic foot ulcer.
8. Assess the need for the use of antibiotic prophylaxis, SCIP (Surgical Care Improvement Program).
9. Assess the various bite wounds with respect to prevalence, usual etiologic agents, risk of infection, treatment options, and potential complications.
10. Apply the IDSA (Infectious Disease Society of America) Guidelines in the workup and management of bacterial infection.

B. Viral

1. Identify incidence, prevalence, transmission, and pathology of HIV.
2. List the manifestations of AIDS on the lower extremity with respect to dermatological, neurological, vascular, and musculoskeletal findings.
3. Explain how the Absolute CD4 (T-helper) Lymphocyte Count, CD4 Lymphocytes, and Viral Load are used as predictors of outcome in HIV.
4. Discuss the basic principles of highly active antiretroviral therapy (HAART).
5. Describe preventive strategies for needlestick and sharps injuries intended to reduce the transmission of blood borne pathogens (hepatitis B, hepatitis C, and HIV).
6. Discuss basics of post-exposure prophylaxis, including indications, efficacy, and side effects of post-exposure prophylaxis for Hepatitis B and HIV/AIDS.
7. Discuss the route of transmission, incubation period, duration of illness, duration of viral duration of (uncomplicated) illness, and the timing of the “flu season”, lab diagnosis, and vaccination of the population.
8. Describe the diagnosis, clinical findings, prevention, treatment, and complications of HSVI & 2, Varicella and Zoster, Mononucleosis, CMV, and COVID.
9. Describe the diagnosis, clinical findings, prevention, treatment, and complications of measles, mumps, poliomyelitis, and rubella.
10. Describe the diagnosis, clinical findings, prevention, treatment, and complications of Dengue, Colorado Tick Fever, Hemorrhagic Fevers, and Yellow Fever.

C. Fungal and Mycobacterium

1. Outline the various presentations of tuberculosis TB and list the populations most at risk.
2. Explain the role of TB skin testing in tuberculosis TB screening and discuss conditions which may produce false negative or false positive results.

3. List the populations most at risk for tuberculosis (TB).
4. List the treatment and prophylaxis regimen for mycobacterium tuberculosis.
5. Differentiate between the manifestations and treatment of histoplasmosis, blastomycosis, sporotrichosis, candidiasis, aspergillosis, and cryptosporidiosis.

II. Neurologic Disorders

1. Explain the basic pathophysiology, diagnostic methods, and treatment regimens for the common neurologic podiatric complaints.
2. List the pathologies that can be diagnosed via nerve conduction velocity (NCV) and electromyography (EMG).
3. Assess the use of electromyography to evaluate peripheral neuropathies.
4. Describe the etiology, pathophysiology, clinical presentation, laboratory studies, diagnosis, treatment/management, course, complications, and prognosis in sciatic nerve damage.
5. Describe the etiology, pathophysiology, clinical presentation, laboratory studies, diagnosis, treatment/management, course, complications, and prognosis of diseases of the peripheral nerrvous system.
6. Describe the etiology, pathophysiology, clinical presentation, laboratory studies, diagnosis, treatment/management, course, complications, and prognosis of complex regional pain injuries I and II.
7. Classify neuropathy due to poison, deficiency states, and metabolic disorder; neuropathy secondary to neoplasm; inflammatory and infectious neuropathy; genetically determined neuropathy.
8. Assess the nature of sensory, motor, and autonomic neuropathies in the context of diabetes mellitus.
9. Describe Charcot neuroarthropathy, including definition, etiology, stages, clinical findings,diagnostic studies, differential diagnoses, diagnosis, concepts of treatment, and prognosis from a neurological perspective.
10. Differentiate common etiologies and clinical manifestations in radicular pain.
11. Describe Charcot-Marie-Tooth (CMT) disease including definition, etiology, types, clinical findings and treatment considerations.

A. Central Nervous System Disorders, Including Diseases of the Spinal Cord

1. Differentiate between the types of seizure disorders
2. Analyze the use of anticonvulsant medications in the perioperative period.
3. Demonstrate a neurologic examination with emphasis on reflex, sensory, and strength testing.
4. Describe the clinical manifestations of movement disorders, and their treatments.
5. Differentiate between the clinical presentation of upper motor versus lower motor neuron lesions.
6. Discuss features of coma with reference to the Glascow coma scale.
7. Explain the staging, diagnostic work-up, and treatment of the different types of dementia and pseudodementia.
8. Discuss clinical principles of acute and chronic pain management.
9. Describe the clinical manifestations, course of illness, treatment, and prognosis of demyelinating diseases.
10. Distinguish types of headaches.
11. Interpret relationships of findings on neurologic exam to segmental levels.
12. Differentiate between extramedullary and intramedullary lesions of the spinal cord.
13. Identify risk factors, diagnosis, and treatment for the different types of cerebrovascular accidents.
14. Discuss the clinical aspects of neurofibromatosis.
15. Explain the impact of neurodegenerative diseases on gait function.
16. List the etiologies, clinical features, and treatment of muscular dystrophies.

17. Describe the etiology, incidence, pathophysiology, clinical presentation, diagnosis, treatment, course, and prognosis of cerebral palsy.
18. Describe the incidence, etiology, pathophysiology, clinical presentation, laboratory studies, diagnosis, treatment/management, course, and prognosis of alcohol malnutrition polyneuropathy.
19. Define and describe the etiology, clinical presentation, diagnosis, course, treatment, prognosis of disorders of the neuromuscular junction with emphasis on myasthenia gravis.
20. Describe ALS (Amyotrophic Lateral Sclerosis) in clinical terms.

III. Cardiovascular Disorders

A. Major Cardiac

1. Describe the physiologic basis of congestive heart failure and relate specific principles of medical management.
2. Describe major cardiovascular diseases including endocarditis, valvular pathology, and cardiomyopathies, acute and chronic coronary heart disease, aortic dissection, and hypertension as they relate to specific principles of medical management.
3. Identify the major types of pediatric cardiac disorders with an emphasis on cyanotic versus acyanotic manifestations.
4. Assess the lower extremity manifestations associated with cardiovascular disease.
5. Explain how to perform a focused history and physical for the cardiac system.
6. Identify the laboratory, physiologic, or imaging data that is utilized in identifying cardiac pathology.
7. Identify the cardinal symptoms and signs of cardiac pathology.
8. Explain general concepts of electrocardiography (EKG) with emphasis on the presentation of malignant arrhythmias and ischemic heart disease.
9. Interpret EKG findings for the purpose of perioperative assessment.
10. Describe the management of atrial fibrillation from a clinical and pharmacologic standpoint in the perioperative period.
11. Explain the roles and pharmacology of commonly prescribed cardiac medications in the treatment of cardiac diseases.
12. Describe clinical manifestations and treatments of dyslipidemia.
13. Discuss the principles of Basic Life Support (BLS) and Advanced Cardiac Life Support (ACLS).
14. Discuss the standards for cardiac monitoring a patient under local, regional, and general anesthetics.
15. Explain the types and clinical manifestations of pericardial diseases
16. Discuss the pathogenesis of valvular heart disease and its relationship to endocarditis.
17. Discuss the evaluation and management of shock: hemorrhagic, hypovolemic, cardiogenic, septic and neurogenic shock.

B. Rheumatic Fever and Endocarditis

1. Describe the clinical manifestations of rheumatic fever and its clinical complications with an emphasis on valvular heart disease and endocarditis.
2. List the heart valves most affected by rheumatic fever in decreasing frequency.
3. Describe how the Jones Criteria is used to diagnose rheumatic fever, using “major” and “minor” criteria.
4. Describe appropriate treatment and prevention for rheumatic fever.
5. Explain the Duke criteria for evaluation and treatment of infective endocarditis.

C. Arterial, Venous, Lymphatic

1. Identify clinical signs and symptoms of venous insufficiency and classify according to the CEAP scale.
2. Identify the clinical findings and sequelae associated with venous disease.
3. Identify potential complications and recommend appropriate treatment concepts of venous insufficiency.
4. Identify potential complications of abdominal aortic aneurysm, arteriovenous malformations, and carotid artery disease.
5. Discuss the proper workup and instrumentation utilized in the noninvasive vascular exam.
6. Explain how to perform a focused history and physical, to identify patients with acute and/orchronic peripheral vascular disease.
7. Identify laboratory, physiologic, or imaging data that is utilized in identifying acute and/or chronic peripheral vascular disease.
8. Explain the cardinal symptoms and signs of acute and/or chronic peripheral vascular disease.
9. Determine, classify, and compare vascular disease in patients with and without diabetes mellitus.
10. Determine, classify, and compare and contrast conservative versus surgical treatments in peripheral vascular disease (PVD).
11. Describe the etiology, pathophysiology, differential diagnoses, and complications ofdeep venous thrombosis.
12. Describe the clinical findings of deep vein thrombosis (DVT), as well as laboratory studies and treatments (including both medical and surgical interventions).
13. Describe the etiologies, differential diagnoses, laboratory studies, and principles of management of localized edema.
14. Describe the etiologies, differential diagnoses, laboratory studies, and principles of treatment of primary and secondary lymphedema.
15. Explain acute arterial occlusion, including intrinsic and extrinsic etiology, reperfusion, clinical findings, diagnosis, management, and morbidity/mortality rates.
16. Describe the etiologies, clinical manifestations, and management of blue toe syndrome.
17. Describe the diagnosis, prognosis, surgical workup, and complications of aneurysms.

IV. Rheumatologic Disorders

1. Describe the clinical features and assessment of myopathies.
2. Discuss the definition, clinical manifestations, lab findings and treatment of idiopathic inflammatory myopathies.
3. Describe the demographics, clinical course, physical, radiographic, and laboratory findings and management of osteoarthritis, rheumatoid arthritis (RA), and seronegative spondyloarthropathies, crystal-induced and infectious arthritides.
4. Describe and define the demographics, clinical course, physical, radiographic and laboratory findings and management of systemic lupus erythematosus (SLE) and other connective tissue diseases.
5. Describe the demographics, clinical course, physical, radiographic, and laboratory findings and management of fibromyalgia.
6. Analyze the signs and symptoms of and polymyalgia rheumatica (PMR).Identify the most common infecting organisms responsible for infectious arthritis and their risk factors.
7. Interpret the findings within a synovial fluid sample.
8. Describe the etiology, clinical presentation, differential diagnoses, studies, diagnosis, treatment, and complications of vasculitis.

V. Metabolic and Endocrine Disorders

A. Diabetes

1. Identify the types of diabetes mellitus.
2. Describe clinical presentations of diabetes mellitus.
3. Outline the diagnostic process of interpretation of laboratory testing in diabetes mellitus.
4. Discuss diabetic emergencies involving ketoacidosis, hypoglycemia, and hyperglycemia.
5. Explain the basis for diabetic management in the following setting: outpatient, inpatient, and perioperative clinical scenarios.
6. Describe indications and contraindications for oral hypoglycemic and insulin therapies.
7. Explain medical management of serum glucose in the perioperative period.
8. Identify patient-physician educational strategies for diabetes, including the most recent nutritional guidelines.
9. Discuss microvascular and macrovascular complications of diabetes mellitus.
10. Discuss the pathogenesis, treatment, and prevention of diabetic nephropathy.
11. Discuss the pathogenesis and resulting effects of peripheral neuropathy.
12. Discuss the clinical features and management of diabetic foot infections and risk stratification.
13. Identify other types of infections in patients with diabetes aside from those in the lower extremity.

B. Gout and Pseudogout

1. Describe the etiology clinical presentation, differential diagnoses studies, diagnosis treatment, and complications of gout and calcium pyrophosphate crystal deposition (CPPD) disease.

C. Adrenal and Pituitary

1. Describe the diagnosis, clinical manifestations, and laboratory abnormalities in patients with pituitary and adrenal dysfunction.
2. Identify perioperative issues in patients with adrenal and pituitary dysfunction.
3. Explain the clinical and lab findings, differential diagnosis, treatment complications and prognosis of pheochromocytoma.
4. Describe and define diabetes insipidus and syndrome of inappropriate ADH.

D. Thyroid and Parathyroid

1. Correlate the clinical picture and physiological effects seen with hypo/hypersecretion of thyroid and parathyroid hormones.
2. Describe a perioperative management plan for a patient with hyper/hypothyroidism.
3. Discuss the etiology, clinical signs and symptoms, and treatment of thyroid and parathyroid disorders.

E. Renal

1. Explain the components and implications of the results of a urinalysis.
2. Identify clinical manifestations and etiology of nephrolithiasis.
3. Explain the clinical impact of end-stage renal disease on the lower extremity, including lower extremity surgical outcomes.
4. Evaluate the impact of renal disease on medication dosing.
5. Explain perioperative management of podiatric patients with renal disease.

6. Describe and identify the clinical, laboratory, physiologic or imaging data used in identifying acute kidney injury versus chronic renal disease.
7. Distinguish asymptomatic bacteriuria from a urinary tract infection.
8. Discuss nephrotic and nephritic syndrome.
9. Describe azotemia versus uremia.
10. Discuss the implications of the use of contrast agents in patients with acute kidney injury and chronic renal disease.

F. Fluid and Electrolyte Disorders

A. Explain the clinical implications and management of hypo/hypernatremia and hypo/hyperkalemia.
B. Discuss IV fluid management in the acute care and perioperative settings.
C. Discuss other electrolyte disorders including but not limited to magnesium, calcium and phosphorus.

G. Bone

1. Describe the dynamics of bone metabolism.
2. Describe metabolic bone disease, including types, pathology, appropriate tests, and treatment.
3. Explain the causes and mechanisms for osteoporosis and osteomalacia.
4. Discuss renal osteodystrophy.

VI. Hematologic Disorders, Including Anemias and Leukemia

1. Identify clinical implications of red blood cell, white blood cell and platelet abnormalities.
2. Describe the etiologies and treatment for a patient with thrombocytopenia.
3. Discuss the factors that lead to thrombosis.
4. Discuss the risks and benefits of transfusion therapy.
5. Discuss the etiologies, differential diagnoses, diagnostic workup, and treatment in a patient with normocytic, microcytic, or macrocytic anemias.
6. Explain the clinical manifestations and perioperative management of patients with sickle cell disease.
7. Identify the risks and benefits of narcotic pain medication in patients with sickle cell disease.
8. Discuss the clinical manifestations of leukemia, lymphoma, plasma cell disorders and implications or the podiatric patient.
9. Define hemostasis and discuss the role of vessels, platelets, and plasma proteins, as well as the natural anticoagulants and fibrinolytics in normal hemostasis.
10. Describe the clinical and laboratory significance of PT, PTT, TT, bleeding time, INR, and mixing study.

VII. Immunologic Disorders (Allergic and Sensitivity Reactions and Immunosuppressive States)

1. Define antigen, antibody, and immunoglobulin.
2. Describe antigen-antibody Immunofluorescence reactions of:
    a. Direct technique
    b. Indirect technique.
3. Describe the complement system, including classical and alternative complement pathway, and explain the biological significance of the complement system.
4. Describe the following cells involved in and their role in the immune response:

a. Neutrophils
b. Monocytes and macrophages
c. Lymphocytes
d. T-lymphocytes (T cell)
e. B-lymphocyte (B cell)
f. Basophils and mast cells
g. Eosinophiles

5. Describe allergies in terms of classification, clinical manifestations, complications, and treatment.
6. Define hypersensitivity and identify and describe the two major types.
7. Describe the types of allergic diseases (reactions) according to classification of Gell and Coombs and types (I, II, III, and IV).
8. Recognize and discuss the management of anaphylaxis and Type IV allergic reactions/delayed hypersensitivity response.
9. Discuss myeloproliferative disorders, including current classification.
10. Evaluate a patient with neutrophils and recommend the proper work-up to differentiate a reactive leukocytosis, chronic myelogenous leukemia and leukemoid reaction.
11. Evaluate thrombocytosis and understand the clinical significance of this finding.
12. Discuss the current concept of myelodysplastic syndromes.
13. Formulate a differential diagnosis for a patient with cytopenia.

VIII. Respiratory Disorders (Including Asthma, Emphysema, Infectious Pneumonitis)

1. Discuss clinical manifestations and treatment of chronic bronchitis and emphysema and asthma.
2. Identify the populations most at risk for the following types of pneumonia:
    a. *S. pneumoniae* (pneumococcus)
    b. *Mycoplasma pneumoniae*
    c. Influenza
    d. Gram negative bacilli
    e. Legionella pneumonia
    f. Viral
3. Discuss treatment approaches for pneumonias.
4. Discuss risk factors for DVT / Pulmonary Embolism (PE), including the Wells criteria.
5. Discuss preventive measures to reduce the risk of DVT.
6. Identify the most common area of the venous system contributing to venous thromboembolism.
7. Identify strengths and weaknesses of DVT diagnostic modalities.
8. Discuss the signs and symptoms that suggest PE.
9. Identify the laboratory tests appropriate for the diagnosis of PE.
10. Define the role of Imaging used in the diagnosis of PE.
11. Interpret a V/Q mismatch consistent with PE.
12. Discuss the mainstays of treatment for an acute PE.
13. Describe SIADH and hypertrophic osteoarthropathy as it relates to pulmonary disease.
14. Describe the following syndromes according to etiology, symptoms, signs, diagnosis, and treatment:
    a. Common cold/influenza/URI/laryngitis/epiglottitis
    b. Otitis media and externa
    c. Acute and chronic sinusitis
    d. Acute bronchitis
    e. Pleurisy
15. Describe the process of assessing the patency of an airway.
16. Discuss the common supplies and techniques in managing the airway in an emergent situation.
17. Describe how pulse oximetry assists in evaluating gas exchange.

18. Explain the clinical implications of arterial blood gas report relates to the patient's clinical status.
19. Compare and contrast the PFT abnormalities in relation to obstructive and restrictive lung diseases.
20. Discuss the clinical use of incentive spirometry.
21. Discuss the perioperative consideration for management of the patient with obstructive, restrictive and interstitial lung disease.
22. Define acute respiratory failure.
23. Discuss the presenting signs, symptoms, and labs for acute respiratory failure.
24. Discuss the approach to management of patients with acute respiratory failure.
25. Define acute respiratory distress syndrome (ARDS).
26. Discuss clinical manifestations and implications of obstructive sleep apnea.

IX. Emergency Medicine (Medical/Surgical)

1. List the components of the medical history and physical examination necessary for treatment of the emergency patient.
2. Differentiate between the signs and symptoms of cardiac and noncardiac chest pain.
3. Discuss signs and symptoms of chest pain due to gastrointestinal disorders, including esophageal disease (GERD, esophagitis, and esophageal dysmotility), biliary disease (cholecystitis and cholangitis), peptic ulcer disease, and pancreatitis.
4. Discuss signs and symptoms of chest pain due to musculoskeletal conditions, including costochondritis, rib fracture, myofascial pain syndromes, muscular strain, and herpes zoster.
5. Discuss signs and symptoms of chest pain due to psychogenic conditions.
6. Distinguish the common causes of abdominal pain based on history, physical exam, laboratory testing, and imaging procedures.
7. Discuss and evaluate the management of new onset fever in the Emergency Department setting.
8. Discuss the clinical manifestations, lab findings, and treatment of patients with sepsis syndromes.
9. Discuss venous stasis, postphlebitic syndrome, lymphedema, cellulitis, superficial thrombophlebitis, ruptured popliteal cysts, musculoskeletal injury, and arterial occlusive disorders as causes of unilateral lower extremity pain and swelling.
10. Describe the differential diagnosis, diagnostic studies, and treatment of acute back pain.
11. Describe the signs and symptoms of acute asthma, pulmonary embolism, and pneumothorax.
12. Describe the symptoms and management of hypertensive emergencies.
13. Explain the emergency management of gunshot wounds, lacerations, and crush injuries.
14. Describe the management of thermal injuries in the Emergency Department setting.
15. Discuss the etiology, symptoms, and treatment of syncope.
16. Explain the indications for immunoprophylaxis following possible tetanus or rabies exposure.
17. Explain the management of emergency scenarios in an outpatient setting.

X. Dermatology

A. Diagnosis

1. Explain the primary, secondary, and special lesions of the skin.
2. Describe the clinical presentations of psoriasis, lichen planus, allergic contact dermatitis, ichthyosis and hyperkeratotic disorders.
3. Identify the appropriate therapeutic agents for the disorders for eczema and papulosquamous dermatoses and hyperkeratotic conditions.
4. Describe the clinical presentations of atopic dermatitis and list the associated systemic features of atopy.

5. Describe the different types of contact dermatitis and how to perform patch testing.
6. Explain the clinical manifestations, etiology, diagnosis, and treatment of viral infections.
7. Explain the morphology, etiology, pathogenesis, and treatment of pedal verrucae.
8. Describe the differential diagnosis, pathophysiology, typical cutaneous presentations and treatments of syphilis, disseminated gonorrhea infection, human papillomavirus, and herpes simplex virus.
9. Explain the clinical manifestations, etiology, diagnosis, and treatment of cutaneous fungal infections.
10. Explain how to perform and interpret a KOH, fungal culture, and PAS.
11. Diagnose and develop an appropriate treatment plan for tinea pedis.
12. Explain how and when to use a Wood's light and how to interpret the results.
13. Describe the pathophysiology of thermal injuries, including systemic manifestations, clinical management and treatment.
14. Recommend a management plan for pedal hyperhidrosis and anhidrosis.
15. Identify the special sports related pedal skin problems.
16. Discuss the various xerotic disorders from common xerosis to ichthyosis, including treatment.
17. Differentiate mechanical versus genetic causes of hyperkeratotic lesions
18. Identify the genodermatoses, including associated systemic findings.

C. <u>Local and Systemic Manifestations</u>

1. Explain the relationship between diseases of internal organs and manifestations on the skin and nail:
    a. Endocrine
    b. Cardiac
    c. Rheumatologic
    d. Renal
    e. Pulmonary
    f. Internal malignancy
2. Explain the necessity to refer patients with underlying systemic diseases to a specialist for management of the primary disease.
3. Describe the following conditions:
    a. Drug reactions (Stevens Johnson syndrome and toxic epidermal necrolysis)
    b. Connective tissue disease
    c. Necrobiosis lipoidica diabeticorum
    d. Vitiligo
    e. Vasculitis
    f. Acanthosis nigricans

D. <u>Tumors</u>

a. Identify the clinical characteristics distinguishing a benign and malignant lesion.
b. List the types of benign, premalignant, and malignant skin tumors.
c. Describe the clinical features of basal cell carcinoma, squamous cell carcinoma, and malignant melanoma.
d. Explain the different types of skin biopsies.
e. Describe the following conditions:
    a. Bowen's disease
    b. Kaposi's sarcoma
    c. Mycosis Fungoides/Cutaneous T Cell Lymphoma
    d. Metastatic disease

E. **Special Disorders of Nails and Appendages of the Skin**

1. Discuss the diagnosis and treatment of onychocryptosis and paronychia.
2. Explain the nail unit's reaction patterns such as Beau's lines, pitting and onycholysis.
3. Describe the diagnosis and management of onychomycosis.
4. Identify and define the benign and malignant tumors of the nail and their management.
5. Identify the differential diagnosis of longitudinal melanonychia.
6. Recognize the clinical significance of splinter hemorrhage.

F. **Ulcers**

1. Describe the etiology and diagnosis, including predicting by location, of the different types of lower extremity ulcers:
    a. Arterial
    b. Venous
    c. Infectious
    d. Rheumatologic
    e. Malignant
    f. Traumatic
2. Explain the etiology and management of venous ulcers.
3. Explain the etiology and management of arterial ulcers.
4. Explain the etiology and management of ulcers in patients with diabetes mellitus.
5. Explain the etiology and management of neuropathic ulcers.

XI. Gastroenterology

1. Identify and evaluate the significance of abnormal liver functions tests.
2. Identify the clinical manifestations and treatment of acute and chronic hepatitis.
3. Identify the clinical manifestations and significance of pancreatitis.
4. Identify the clinical manifestations and significance of GI bleeding/peptic ulcer disease/GERD.
5. Identify the clinical manifestations and significance of Inflammatory Bowel Disease (IBD).
6. Identify the clinical manifestations and significance of colon cancer and its screening modalities.
7. Discuss the etiology, clinical manifestations, and treatment of *Clostridioides difficile* colitis.
8. Identify the clinical significance of post-operative constipation.
9. Discuss the clinical manifestations of celiac disease.
10. Discuss medical versus surgical causes of an acute abdomen.
11. Identify the clinical manifestations and treatment of biliary tract disease.

XII. Geriatrics

1. Identify and evaluate urinary incontinence and retention in the perioperative period.
2. Identify dementia, delirium, and depression in the perioperative period, with special emphasis on delirium postoperatively.
3. Explain the evaluation of age-associated medical and psycho-social issues.
4. Explain the recognition and prevention of deep tissue injury (decubitus) in the geriatric population.Recall the classification of pressure (decubitus) ulcerations.
   Explain the significance of advanced directives and the POLST (Physician Order for Life Sustaining Treatment) form for the geriatric patient.
5. Recognize the importance and clinical implications of vitamin D and iron insufficiency and deficiency.

6. Discuss the management of drugs and diagnostic laboratory findings in a geriatric population.
7. Explain the role of the podiatrist in a multidisciplinary geriatric health team.
8. Recognize the importance of a management plan for falls, balance, and gait disorders in the geriatric patient.
9. Explain the spectrum of institutional healthcare settings available to the geriatric patient.

XIII. Pre and Postoperative Assessment

1. Explain the indications for and evaluation of preoperative laboratory, physiologic, and imaging data.
2. Discuss the preoperative evaluation for cardiac risk.
3. Explain protocols for perioperative management of patients receiving anticoagulation therapy.
4. Explain evaluation of specific organ systems in the preoperative geriatric and pediatric patient.
5. Perform risk stratification and formulate a management plan for perioperative venous thromboembolism (VTE) prophylaxis.
6. Discuss the assessment of the following postoperative problems:
    a. Fever
    b. Altered mental status
    c. Fluid & electrolyte disturbances
    d. Acute kidney injury/Chronic renal disease
    e. Chest pain and shortness of breath
    f. Postoperative hypotension and hypertension
    g. Constipation/diarrhea
    h. Delirium
    i. Acute blood loss anemia
    j. Urinary retention
7. Explain the management of HPA axis suppression in patients on steroids in the perioperative period.

ORTHOPEDICS

LEARNING OBJECTIVES

Biomechanics

Pathomechanics

Sports Medicine

General Orthopedics

Pediatric Orthopedics

I. Biomechanics

A. Basic Terminology

1. Identify and describe motions, positions, and fixed positions that occur in each of the cardinal planes as they pertain to the lower extremity with emphasis on the foot and ankle.
2. Differentiate between the suffixes *-ion*, *-ed*, and *-us*.

B. Basic Mechanics

1. Define *center of mass* and *center of gravity*.
2. Define *torques*, *couples,* and *moments*.
3. Differentiate between energy, kinetic energy, and potential energy.
4. Identify the equations of rotational motion.
5. Define *linear motion* and identify the equations of linear motion.
6. Define *power and work, and describe the relationship between them*.
7. Discuss Newton's Laws of Motion and their application to the process of human gait.
8. Discuss the basic concepts of inertia, momentum, and motion as they relate to the lower extremity.
9. Explain the principle of conservation of angular momentum.
10. Differentiate between rotational and linear motion.
11. Explain the principle of conservation of linear motion.
12. Describe the relationship between kinetic and potential energy in gait.
13. Describe a stress/strain diagram.
14. Discuss the concept of friction as a force, and explain the laws of friction and coefficients of friction.
15. Differentiate between friction and shear forces.
16. Differentiate between scalar and vector quantities.
17. Describe the concept of a lever and the types of levers with reference to the lower extremity.
18. Identify and describe the different loading modesin the musculoskeletal system.

C. Tissue Physiology Mechanics

1. Explain functional adaptation of soft tissue (Davis' Law)
2. Describe basic elements of bone and tendon physics.
3. Differentiate between the behaviors of adult bones under different loading modes.
4. Explain combined loading of bone.
5. Explain functional adaption of bone (Wolff's Law).
6. Explain the effect of muscle contraction on bone.
7. Explain the relationship between the sarcomere and the development of muscle tension.
8. Describe the biomechanical properties of cartilage.
9. Describe the biomechanical properties and characteristics of ligaments and tendons.
10. Describe the length-tension relationship of muscles.
11. Compare and contrast single and multiple joint muscles.
12. Describe factors that affect mechanical efficiency.
13. Define *elastic response*.

D. Normal Compensation and Static Stance

1. Define *compensation* and distinguish normal and abnormal compensation.

2. Discuss the effect of deviation of the trunk or leg on the foot.
3. Discuss the effect of deviation in one part of the foot on the other.
4. Discuss the effect of deviation of the terrain on the foot.
5. Describe the distribution of body weight during static stance, including contraction of the gastrocnemius.
6. Explain osseous restraining mechanisms.
7. Compare and contrast the contributions of bone, muscles, and ligaments in stability during static stance.
8. Explain what happens when rotatory moments induced by ground reactive forces cannot be compensated.
9. Explain why subtalar and midtarsal joints are primarily involved in compensation.

E. <u>Forces and Functional Anatomy</u>

1. Explain the production of abnormal shear forces during propulsion.
2. Discuss the role of the swing limb in forward movement of the body.
3. Compare and contrast the structure and function of the medial and lateral columns of the foot.
4. Describe the effect that distortion of anatomy has on function.
5. Describe the locking function of the midtarsal joint and relate the midtarsal motion and position to subtalar joint (STJ) position.
6. Compare and contrast high and low gear axis of motion (Finn Bojsen-Møller).
7. Explain beam and truss and relate to contact and propulsion.
8. Explain the function of the plantar fascia (Windlass mechanism).
9. Describe and demonstrate the technique for the Hubscher maneuver/Jack's test.

F. <u>Manual Muscle Testing</u>

1. Describe the techniques used to test muscle strength for lower extremity muscles.
2. Discuss the standard five point grading scale used to evaluate muscle strength.

E. **<u>Gait</u>**

1. Describe the subdivision of gait into phases and periods.
2. Describe the periods of the stance phase of the gait cycle
3. Describe the contact, midstance and propulsion periods of the stance phase of the gait cycle.
4. Describe the contact, midstance, terminal stance and pre-swing periods of the stance phase of the gait cycle
5. Describe the contact, midstance, active propulsion and passive lift off periods of the stance phase of the gait cycle
6. Describe the swing phase of the gait cycle.
7. Define *cadence*, *step length, stride length and angle and base of gait*.
8. Define *velocity* and explain its relationship to gait.
9. Describe the relationship between limb length and cadence.
10. Describe the distribution of forces across the foot throughout the gait cycle.
11. Describe the role the leg and body play in participation and support of gait.
12. Identify the position and the motion of each joint in the lower extremity for any given point throughout the gait cycle, and the moments that are being applied during these phases.
13. Discuss the function of each muscle or muscle group throughout the gait cycle.
14. Describe the position of the first ray in each of the phases of the gait cycle and the moments that are being applied during these phases.

15. Discuss the role of the sesamoid apparatus throughout the gait cycle.
16. Describe the position of the forefoot to the ground in each of the phases of the gait cycle.
17. Identify and describe each body segment as it moves in the three body planes.
18. Describe function of the upper body to the lower body during gait.
19. Apply the concept of ground reactive force to abnormal positions of the foot throughout the gait cycle.

H. Phasic Muscle Activity

1. Differentiate between concentric, eccentric, and isometric muscle contractions and understand the roles that they play in gait.
2. Determine the type of muscle contraction that lower extremity muscles are undergoing during each phase of the gait cycle.
3. Identify the normal phasic muscle activity of the anterior thigh; medial thigh; posterior thigh; anterior leg; lateral leg; posterior leg; and intrinsic foot muscle groups during gait.
4. Differentiate between monophasic and biphasic muscle activity.
5. Describe the consequences of anterior leg muscle dysfunction relative to gait.
6. Describe the consequences of posterior leg muscle dysfunction relative to gait.
7. Describe the consequences of lateral leg muscle dysfunction relative to gait.
8. Discuss the consequences of intrinsic foot muscle dysfunction relative to gait.
9. Discuss the muscle dysfunction above the knee relative to gait.

I. Principles of Shock Absorption

1. Define shock absorption and identify the gait parameters that influence.
2. Describe the roles that the subtalar, ankle, knee, and hip joints play in shock absorption.
3. Explain the influence that timing sequence of the shock absorbing mechanism has on the body's ability to absorb shock.
4. Describe the pathology and parameters that may lead to poor shock absorption.
5. Describe the role of the plantar fat pad in shock absorption.
6. Describe the role that footwear plays in shock absorption.

J. Principles of Stability

1. Define *stability* and *instability*.
2. Describe the attributes of joint stability.
3. Describe the relationship the subtalar joint and midtarsal joint have with respect o stability.
4. Describe the role that the arch of the foot plays with respect to stability.
5. Define *joint hypermobility* and *joint congruity*.
6. Describe the role that the soft tissues have on stability.
7. Contrast and compare positive and negative mechanical advantages.
8. Explain the theory of proximal stability and apply it to the joints of the lower extremity.

K. Kinetics and Kinematics

1. Define *kinetics* and *kinematics*.
2. Define *inverse kinematics* and *forward kinematics*.
3. Interpret a kinematic graph.
4. Define *momentum* and explain its relation to any given point in the gait cycle.
5. Define *acceleration* and how it relates to the gait cycle.
6. Identify and explain the factors that influence a muscle's ability to produce power.

7. Define and distinguish between internal and external moments around a joint axis.
8. Discuss the moment of any given joint at any particular point in the gait cycle.
9. Define ground reactive force, ground reactive force vector, center of pressure, line of gravity, center of gravity, center of mass and center of force.
10. Explain ground reactive force and determine the position and orientation of the force with respect to the joints of the lower extremity during each phase of the gait cycle.

L. <u>Functional Axes and Planes of Motion</u>

1. Describe the cardinal and anatomic planes of the body.
2. Describe axis of motion.
3. Differentiate between uniaxial, biaxial, and triaxial joints.
4. Differentiate between uniplanar, biplanar, and triplanar joints.
5. Discuss the concept of planar dominance as it relates to a joint.
6. Describe the ankle joint axis in terms of orientation/location, and plane of motion.
7. Describe the subtalar joint axis in terms of orientation/location, and plane of motion.
8. Describe the midtarsal joint axes in terms of orientation/location, and plane of motion.
9. Describe the first ray axis in terms of orientation/location, and plane of motion
10. Describe the fifth ray axis in terms of orientation/location, and plane of motion.
11. Describe the first metatarsophalangeal joint axes in terms of orientation/location, and plane of motion.
12. Describe the role of the lesser metatarsophalangeal joint axes in terms of orientation/ location, and plane of motion.
13. Describe degrees of freedom of motion (rotation and translation).
14. Describe the motions involved in open and closed kinetic chain pronation and supination.

M. <u>Spine, Pelvis (SI)</u>

1. Identify and describe the axes of motion and biomechanics of the spine.
2. Define motion segment as it relates to spinal biomechanics.
3. Describe how the pathology at L4-L5 and L5-SI affect the biomechanics of the lower leg and foot.

N. <u>Hip Joint</u>

1. Describe the hip joint axes in terms of orientation/location, and plane of motion.
2. Describe and demonstrate the techniques used to measure sagittal, transverse and frontal plane hip range of motion.
3. State the normal sagittal, transverse and frontal plane ranges of motion for the hip.
4. Describe the anatomical limitations affecting hip flexion with the knee flexed and with the knee extended.
5. Describe the anatomical limitations affecting transverse plane hip range of motion with the hip flexed and with the hip extended.
6. Discuss the position and motion of the hip throughout the gait cycle.
7. Discuss neutral position versus closed-packed position of the hip.
8. Calculate the transverse plane neutral position of the hip.

O. <u>Functional Deviations of the Hip Joint</u>

1. Describe signs, symptoms, and gait changes associated with abnormal hip range of motion.
2. Discuss the various planal abnormalities about the hip, including coxa varum, coxa valgum.

P. Knee Joint

1. Describe the knee joint axes in terms of orientation/location, and plane of motion.
2. Discuss the position and motion of the knee throughout the gait cycle.
3. Discuss the relationship of knee joint function on the hip, leg, and foot.
4. Discuss the muscles governing knee joint function and describe their role during gait.
5. Discuss normal patellofemoral joint function.
6. Discuss the anatomic structures associated with stability and flexibility at the knee.
7. Describe and demonstrate the techniques used to measure knee range of motion.
8. Describe and demonstrate the techniques used to evaluate the frontal and sagittal plane position of the knee.
9. Differentiate between true tibial torsion and malleolar position.
10. Describe and demonstrate the technique used to measure malleolar position.
11. State normal values for malleolar position.

Q. Functional Deviations of the Knee

1. Discuss the planal abnormalities of the knee, including genu varum, tibial varum, genu valgum and tibial valgum, and genu recurvatum.
2. Describe signs, symptoms, and gait changes associated with abnormal knee position.
3. Discuss the effects of ankle equinus on the knee.
4. Discuss the effect of subtalar joint pronation and supination on the knee.
5. Describe etiologies, signs, symptoms, and gait changes associated with abnormal malleolar position.

R. Ankle Joint

1. Describe the ankle joint axis in terms of orientation/location, and plane of motion.
2. Describe and demonstrate the technique used to measure ankle joint dorsiflexion.
3. State normal ranges of motion for the ankle joint.
4. Discuss the position and motion of the ankle throughout the gait cycle.
5. Describe neutral position of the ankle joint.

S. Functional Deviations of the Ankle

1. Define equinus deformity of the ankle.
2. Describe the etiologies of ankle joint equinus.
3. Differentiate between the different types of equinus (bony block, gastrocnemius, gastro-soleus, and pseudoequinus).
4. Discuss the general clinical features associated with ankle equinus.
5. Discuss compensation mechanisms and associated gait patterns in the presence of equinus.
6. Discuss the biomechanical treatment principles for equinus.
7. Describe the radiographic manifestations of ankle joint equinus.

T. Subtalar Joint

1 Describe the subtalar joint axis in terms of orientation/location, and plane of motion.
2 Describe and demonstrate the technique used to measure subtalar joint motion.
3 Describe and demonstrate the technique used to measure and calculate subtalar joint neutral position.
4 State normal ranges of motion for the subtalar joint.

5 Discuss the position and motion of the subtalar joint throughout the gait cycle.
6. Differentiate between open and closed kinetic chain subtalar joint function.
7. Describe the anatomical limitations affecting subtalar joint range of motion.
8. Describe the concept of rotational equilibrium on subtalar joint function.

U. <u>Functional Deviations of the Subtalar Joint</u>

1. Describe the sagittal plane deviations of the subtalar joint axis and discuss the possible outcomes.
2. Describe the transverse plane deviations of the subtalar joint axis and discuss the possible outcomes.
3. Describe the effects of subtalar joint range of motion as a result of variations in the position of its axis.
4. Describe etiologies, signs, symptoms, and gait changes associated with abnormal subtalar joint.

V. <u>Rearfoot Deformities</u>

1. Differentiate between rearfoot varus and rearfoot valgus.
2. Identify and discuss the etiologies of rearfoot varus and rearfoot valgus.
3. Distinguish rearfoot varus from subtalar joint varus.
4. Distinguish rearfoot valgus from subtalar joint valgus.
5. Define and identify *tibial varum* and *tibial valgum*.
6. Differentiate between rearfoot valgus and *calcaneal valgus*.
7. Discuss how calcaneal varus may contribute to a rearfoot varus deformity.
8. Define and differentiate between resting calcaneal stance and neutral calcaneal stance position.
9. Describe and demonstrate the technique used to measure resting calcaneal stance position and neutral calcaneal stance position.
10. Define tibial influence, and its effect on rearfoot position.
11. Describe and demonstrate the technique used to measure tibial influence.
12. Discuss the impact of tibial influence on the subtalar joint's ability to compensate.
13. Identify and discuss possible scenarios that lead to an inverted, everted and perpendicular resting calcaneal stance position.
14. Discuss why neutral calcaneal stance position represents total rearfoot deformity.
15. Describe deformities that may cause abnormal stance positions.
16. Identify the compensations and possible outcomes for a rearfoot varus and rearfoot valgus.
17. Describe etiologies, signs, symptoms, and gait changes associated with rearfoot varus and rearfoot valgus.
18. Distinguish between fully compensated, partially compensated and uncompensated rearfoot varus.
19. Describe the radiographic manifestations of rearfoot varus and rearfoot valgus.
20. Discuss biomechanical treatment of rearfoot varus and rearfoot valgus.

W. <u>Midtarsal Joint</u>

1. Describe the midtarsal joint axes in terms of orientation/location, and plane of motion.
2. Describe and demonstrate the technique used to assess midtarsal joint motion.
3. Discuss the position and motion of the midtarsal throughout the gait cycle.
4. Explain how the midtarsal joint deformity results in a forefoot varus or forefoot valgus.
5. Describe and demonstrate the technique used to measure the forefoot to rearfoot relationship (maximally pronated/locked midtarsal joint).
6. State the values for the normal midtarsal joint position (forefoot to rearfoot relationship).
7. Describe the relationship between subtalar joint position and midtarsal joint motion.

8. Describe the function of the normal midtarsal joint throughout the gait cycle.
9. Discuss the locking mechanism of the midtarsal joint and the significance of the locking mechanism in normal gait.
10. Recognize alternate midtarsal joint axis theories/function models.

X. Functional Deviations of the Midtarsal Joint

1. Identify the sagittal and transverse plane deviations of the oblique midtarsal joint axis and discuss the possible outcomes.
2. Describe etiologies, signs, symptoms, and gait changes associated with abnormal midtarsal joint position and motion.
3. Discuss the biomechanical treatment implications of a foot with an altered planal dominance at the oblique midtarsal joint axis.

Y. Inverted Forefoot Deformities

1. Define and differentiate between types of inverted forefoot deformities, including forefoot varus, forefoot supinatus, metatarsus primus elevatus, plantarflexed lateral column.
2. Identify and discuss the etiologies of forefoot varus and forefoot supinatus.
3. Identify the signs, symptoms, and compensation patterns of the different inverted forefoot deformities.
4. Describe the radiological manifestations of the different inverted forefoot deformities.
5. Discuss biomechanical treatment for the different inverted forefoot deformities.

Z. Everted Forefoot Deformities

1. Define and differentiate between types of everted forefoot deformities, including forefoot valgus, plantarflexed first ray, dorsiflexed lateral column.
2. Identify and discuss a dorsiflexed cuboid.
3. Discuss the possible outcomes of a dorsiflexed cuboid.
4. Identify the compensations for forefoot valgus and plantarflexed first ray, and discuss the outcomes.
5. Identify and discuss the etiologies of forefoot valgus and plantarflexed first ray.
6. Discuss and differentiate between rigid and flexible plantarflexed first ray deformities.
7. Discuss and differentiate between rigid and flexible forefoot valgus deformities.
8. Identify the signs, symptoms, and compensation patterns of the different rigid and flexible everted forefoot deformities.
9. Describe the radiological manifestations of the different everted forefoot deformities.
10. Discuss biomechanical treatment for the different everted forefoot deformities.

AA. First Ray

1. Describe the first ray axis in terms of orientation/location, and plane of motion.
2. Describe and demonstrate the technique used to measure first ray motion.
3. Calculate first ray neutral position and determine the sagittal plane deformity.
4. State normal ranges of motion for the first ray.
5. Discuss the position and motion of the first ray throughout the gait cycle.
6. Define *metatarsus primus elevatus*.
7. Discuss the potential signs, symptoms and biomechanical compensations of metatarsus primus elevatus.
8. Differentiate between flexible and rigid sagittal plane first ray deformities.
9. Define *hypermobile first ray*.

10. Describe etiologies, signs, symptoms, and gait changes associated with abnormal first ray function.
11. Discuss the relationship between subtalar joint position and first ray motion.
12. Describe the radiological manifestations of the different first ray deformities.
13. Discuss biomechanical treatments for first ray deformities.
14. List biomechanical deformities that cause a hypermobile first ray.

BB. First Metatarsophalangeal Joint

1. Describe the first metatarsophalangeal joint axis in terms of orientation/location, and plane of motion.
2. Describe and demonstrate the technique used to measure first metatarsophalangeal joint motion (non-weight bearing and weight bearing).
3. State normal ranges of motion for the first metatarsophalangeal joint (non-weight bearing and weight bearing).
4. Discuss the position and motion of the first metatarsophalangeal joint throughout the gait cycle.
5. Discuss the effect of the first ray position on the first metatarsophalangeal joint range of motion.
6. Describe etiologies, signs, symptoms, and gait changes associated with abnormal first metatarsophalangeal joint range of motion.
7. Describe the role of the sesamoid apparatus in normal first metatarsophalangeal joint function.
8. Describe the radiological manifestations of the different first metatarsophalangeal joint deformities.
9. Discuss biomechanical treatments for first metatarsophalangeal joint deformities.

CC. Fifth Ray

1. Describe the fifth ray axis in terms of orientation/location, and plane of motion.
2. Describe etiologies, signs, symptoms, and gait changes associated with abnormal fifth ray function.
3. List the clinical signs and symptoms associated with a plantarflexed and dorsiflexed fifth ray.
4. Discuss the relationship between the calcaneal position and fifth ray position.
5. Describe the radiological manifestations of the different fifth ray deformities.
6. Discuss biomechanical treatments for fifth ray deformities.

DD. Central Rays and Digits

1. Identify the axis, location, and range of motion of the lesser metatarsophalangeal joints and digits.
2. Discuss the anatomical structures that contribute to normal digital stability.
3. Describe the normal and abnormal metatarsal parabola, including radiographic assessment of the parabola.
4. Describe the clinical signs and symptoms associated with an abnormal metatarsal parabola.
5. Describe etiologies, signs, symptoms, and gait changes associated with abnormal lesser metatarsophalangeal joint ranges of motion.
6. Describe etiologies, signs, symptoms, and gait changes associated with abnormal position and/or ranges of motion of the digits.
7. Describe the clinical findings and gait changes associated with a plantarflexed or dorsiflexed lesser metatarsal deformity.
8. Describe the radiological manifestations of the different central ray and digital deformities.
9. Discuss biomechanical treatments for central ray and digital deformities.

EE. Computerized Evaluation of Gait

1. Discuss when to measure motion, force, pressure and surfaces.
2. Discuss the indication, usage and pros and cons of the following techniques: Topographical Scanning Technique, Pressure Mapping Technique, Force Plate Measurement, Video Technique and 3-D kinematic analysis of gait.
3. Discuss the benefits of using the gait analysis lab in clinical cases.
4. Critically assess kinematic and kinetic values and their implications.

FF. Functional Deviations of Gait

1. Describe and differentiate abnormal gait findings associated with lower extremity biomechanical pathology.
2. Describe how asymmetry affects the gait cycle.
3. Define and describe antalgic and apropulsive gait.
4. Define and describe neuromuscular manifestations of abnormal gait (e.g. steppage, Trendelenburg, Parkinsonian, spastic diplegia, hemiplegia, waddling, ataxic).
5. Define and describe neuropathic effects on gait.
6. Describe calcaneus gait and discuss its possible causes.

GG. Biomechanical Radiographic Interpretation

1. Identify normal radiographic angles and joint relationships.
2. Describe the standard position for taking radiographs for biomechanical evaluation.
3. Identify radiographic signs of the rectus foot, pronated foot, and supinated foot.
4. Identify normal radiographic signs of sagittal, transverse, and frontal plane relationships in the foot.
5. Identify abnormal radiographic signs of sagittal, transverse, and frontal plane relationships in the foot.

HH. Orthoses

1. Define orthotics, prosthetics, and pedorthics.
2. Describe the supporting role the orthotist, prosthetist, and pedorthist play in assisting the podiatrist in treating foot disorders.
3. Define orthoses and describe the general purpose of orthoses.
4. Differentiate between and discuss uses of custom orthoses and prefabricated orthoses.
5. Identify and describe types of materials used for orthoses.
6. Describe indications and contraindications for foot orthoses to include functional, accommodative, pediatric, pronated, UCBL, plate and neutral shell types of foot orthoses.

II. Custom Functional Foot Orthoses

1. Explain the purpose and goals of functional foot orthoses.
2. Identify the component parts of functional foot orthoses.
3. Discuss the role of functional orthoses in managing biomechanical forefoot deformities.
4. Discuss the role of orthoses in resisting abnormal forces in the rearfoot (both pronatory and supinatory).
5. Describe how to incorporate motion into the rearfoot post of orthoses.
6. Describe the limiting effect of orthoses on subtalar joint motion.
7. Describe types of materials used for component parts of functional foot orthoses.
8. Discuss the effect of functional foot orthoses throughout the gait cycle.
9. Describe the pathologies that would benefit from functional foot orthoses.
10. Identify relative contraindications for functional foot orthoses.
11. Discuss indications for rigid, semirigid, and flexible shell materials.

12. Discuss the indications, limitations and materials for different functional foot orthoses based on shoe type
13. Discuss the effect of shoe characteristics and construction on functional foot orthoses.
14. Define and describe the indications, limitations and materials of pronated orthoses.

JJ. Accommodative Foot Orthoses (Custom)

1. Explain the purpose and goals of accommodative orthoses
2. Identify the component parts of accommodative orthoses.
3. Identify and differentiate types of materials used for accommodative orthoses.
4. Describe foot pathologies that would benefit from accommodative orthoses.
5. Identify relative contraindications for accommodative orthoses.

KK. Foot Impression Techniques

1. Describe and demonstrate the steps for performing both supine neutral suspension technique and prone neutral technique.
2. Discuss the advantages and disadvantages of various neutral position casting techniques.
3. Discuss the goals of plantarflexing the medial column during neutral position casting.
4. Describe the other types of casting techniques used to fabricate foot orthoses, including partial weight bearing, in-shoe, vacuum, computer imaging/scanning, rectus and pronated.
5. Evaluate a foot impression using a systematic approach.
6. Explain the effect of positioning technique errors on the foot impression.
7. Identify the biomechanical deformities based on the negative cast.
8. Recommend appropriate casting techniques, given a particular orthosis type.
9. Discuss the pros and cons of various impression materials.
10. Discuss the pros and cons of computerized impression techniques.

LL. Orthosis Prescription

1. List the purpose, indications and contraindications for the following foot orthotic modifications: plate additions, heel lift, metatarsal raise, top cover materials, forefoot extensions, those that improve first ray function, pronation reduction, and addressing equinus.
2. List the required components of a foot orthosis prescription.
3. Describe the effect that changing the thickness and width of an orthotic device has on foot function.
4. Discuss different posting techniques and corrections incorporated into a foot orthotic device. Discuss indications for modifications of positive cast work.
5. Explain the indications for rearfoot posting and factors determining how much the rearfoot should be posted and how much motion should be allowed in the rearfoot post.
6. Describe the effect of medial and lateral heel modifications on foot function.
7. Describe forefoot balancing techniques, including intrinsic and extrinsic posting, and explain when to balance in positions other than zero.
8. Differentiate between materials that are effective shock absorbers versus materials that provide total contact.

MM. Orthosis Fabrication

1. Discuss and understand the differences between positive and negative casts.
2. Discuss the difference between milled and vacuum pressed orthoses.
3. Discuss and understand the process of making 3-D printed orthoses.

NN. Orthoses Evaluation

1. Describe the technique used to fit an orthosis into the shoe.
2. Discuss the proper procedure in dispensing an orthosis to a patient.
3. Discuss the evaluation process for a patient who has been wearing an orthosis.

OO. Orthoses Troubleshooting

1. List casting errors that lead to orthosis problems.
2. Discuss the implications of a supinated longitudinal midtarsal joint; a dorsiflexed 4th and 5th metatarsophalangeal joint; a supinated oblique midtarsal joint axis; and a pronated subtalar joint axis in a negative cast.
3. Discuss the implications of choosing the wrong forefoot and rearfoot posts for an orthosis.
4. Discuss the implications of choosing the wrong heel cup height, rearfoot post motion, and/or arch fill.
5. Explain the possible ramifications of choosing the wrong material for an orthosis.
6. Suggest trouble shooting solutions for common problems encountered when wearing foot orthoses.

PP. Shoe Therapy

1. Describe the anatomy of a shoe.
2. Discuss the types of shoes used in the scope of the podiatric practice, including extra depth and custom molded and the indications of each.
3. Describe the important aspects of shoe construction including various last shapes and types of materials.
4. Discuss the various modifications that can be incorporated into shoe gear to assist with treatment of different foot and ankle disorders.
5. Describe the determinants of proper shoe fit.
6. Describe the different rocker modifications including their indications, that can be applied to a shoe.
7. Differentiate between a rocker and a metatarsal bar.
8. Describe a SACH heel (Solid Ankle Cushion Heel) including it functions, indications, and contraindications.
9. Recommend a shoe prescription for common podiatric pathologies.
10. Discuss the role of the insole in regard to shoe function, including the importance of a removable insole.
11. Discuss the normal tread pattern, and evaluate tread patterns for various types of function.
12. Identify different types of post-op shoes and discuss the indications, advantages and disadvantages of each.
13. Identify the types of forefoot off-loading shoes and discuss the advantages, disadvantages, and indications for each.
14. Identify various types of healing sandals and discuss the advantages, disadvantages, and indications for each.
15. Differentiate between a flange, a flare and a wedge, and discuss their indications.
16. List the height limitations for in-shoe and outersole shoe lifts.
17. Discuss the sole modifications that are required to use a full-length outersole lift.
18. Identify indications and contraindications for full-length lift versus a heel lift modification.
19. Discuss the indications for various pads including the following: tongue pad, metatarsal pad, unilateral and bilateral heel lifts, cobra, insole wedging, and Mayo pad.
20. Discuss methods and indications for widening the sole of the shoe.
21. Discuss the use of elastic laces and modified lacing techniques for specific pathologies.
22. Discuss the benefits of using bilaminar and trilaminar materials.

23. Discuss the indications for applying toe filler modifications to the insole of a shoe.

QQ. Custom Molded Shoes

1. Identify indications for custom molded shoes.
2. Identify the materials, technique, benefits, and limitations of bivalve casting.
3. Identify the materials, technique, benefits, and limitations of univalve casting.
4. Discuss the consequences of applying various casting techniques inappropriately.
5. Discuss the various positive last modifications applied in the manufacturing of custom molded shoes.

RR. Ankle-Foot Orthoses and Braces

1. Define an ankle-foot-orthosis (AFO) type device.
2. Discuss the function of and the therapeutic goals, indications and contraindications for a solid AFO.
3. Discuss the function of and the therapeutic goals, indications and contraindications for a Posterior Leaf Spring/Splint (PSL) AFO.
4. Discuss the function of and the therapeutic goals, indications and contraindications for a knee-ankle-foot-orthosis (KAFO).
5. Discuss the casting technique, indications and contraindications for a custom stirrup Orthosis (e.g., Richie brace).
6. Discuss the function of and the therapeutic goals, indications and contraindications for a patellar-tendon bearing brace.
7. Discuss the function of and the therapeutic goals, indications and contraindications for a custom gauntlet brace.
8. Discuss the casting technique, indications and limitations of a custom gauntlet brace.
9. Discuss the function of and the therapeutic goals, indications and contraindications for a Charcot Restraint Orthotic Walker (CROW).
10. Discuss the indications for a short leg versus long leg walking boot.
11. Discuss the function of and the therapeutic goals, indications and contraindications for a double upright brace.
12. Discuss the function of and the therapeutic goals, indications and contraindications for a hinged brace type AFO.
13. Discuss the function of and the therapeutic goals, indications and contraindications for a dorsiflexion assist AFO.
14. Discuss the function of and the therapeutic goals, indications and contraindications for a Tone Reducing Ankle-Foot Orthoses (TRAFO).

II. Pathomechanics

A. Digital Deformities

1. Describe in detail the origin, course, insertions, and functions of all tendons inserting into the lesser digits.
2. Explain the “rigid beam effect” of the extensor hood complex on digital function.
3. Describe the dynamic balance of tendons necessary for maintaining normal digital positioning during the normal gait cycle.
4. Describe the etiology and definition of Hammer Digit Syndrome.
5. Describe 3 major pathomechanical etiologies of hammer digit syndrome: Extensor Substitution, Flexor Substitution and Flexor Stabilization.
6. Explain other factors that could affect the etiology of hammer digit syndrome.

7. Describe associated foot deformities that may occur due to hammer digit syndrome.
8. Discuss the various conservative treatments of hammer digit syndrome.
9. Differentiate between the appearance of hammertoe, mallet toe and claw toe.
10. Differentiate between the pathomechanics of hammertoe, mallet toe and claw toe deformities.
11. Describe abductus and adductus deformities of the digits and explain their etiologies.
12. Describe digiti quinti varus deformities and the pathomechanics leading to the deformities.
13. Describe curly toe deformity and the pathomechanics leading to the deformities.
14. Describe hallux interphalangeus and the pathomechanics leading to the deformities.
15. Discuss digital pathologies associated with predislocation syndrome and metatarsophalangeal joint dislocation.

B. Hallux Abducto Valgus and Bunion Deformities

1. Describe the anatomical structures that govern the function of the first metatarsophalangeal joint.
2. Define hallux abducto valgus (HAV).
3. List the etiologies and pathomechanics of hallux abducto valgus.
4. Describe the adaptive soft tissue and osseous changes that could result from Hallux Abducto Valgus.
5. Relate how other lower extremity deformities contribute to the development of HAV.
6. Discuss the indications for treatment of Hallux Abducto Valgus deformities.
7. Discuss the conservative treatment options for Hallux Abducto Valgus deformities including indications and complications for each option.
8. Define and compare *tracking* and *trackbound* motion of the first metatarsophalangeal joint.
9. Describe crepitus of the first metatarsophalangeal joint.
10. Discuss first ray hypermobility/insuffiiciency as an etiology of HAV.

C. Hallux Limitus, Hallux Rigidus & Metatarsus Primus Elevatus

1. Define hallux limitus and hallux rigidus.
2. Distinguish between structural and functional hallux limitus.
3. List the etiologies and pathomechanics for hallux limitus and hallux rigidus.
4. Discuss first ray hypermobility/insuffiiciency as an etiology of hallux limitus and hallux rigidus.
5. Discuss the stages of hallux limitus and hallux rigidus.
6. List the clinical signs and symptoms associated with hallux limitus and rigidus.
7. Describe the compensatory mechanisms for hallux limitus and hallux rigidus.
8. Define Metatarsus Primus Elevatus.
9. Describe the etiologies of metatarsus primus elevatus.
10. Describe the clinical signs and symptoms associated with metatarsus primus elevatus.
11. Describe the compensatory mechanisms for Metatarsus Primus Elevatus.
12. Identify the conservative interventions for alleviation of symptoms associated with hallux limitus/rigidus.
13. Describe the principles of orthosis prescription writing for patients with hallux limitus, hallux rigidus and metatarsus primus elevatus.

D. Hallux Varus

1. Define *hallux varus*.
2. List the etiologies and pathomechanics of hallux varus.
3. Compare the juvenile and adult forms of hallux varus.
4. List the clinical signs and symptoms associated with hallux varus.
5. Identify the nonsurgical interventions for alleviation of symptoms associated with hallux varus.

E. Lesser Rays

1. List the anatomical structures that govern the function of the fifth metatarsophalangeal joint.
2. Describe the normal and abnormal metatarsal parabola, including radiographic assessment.
3. Describe the clinical signs and symptoms associated with an abnormal metatarsal parabola.
4. Identify the etiology and pathomechanics for a Tailor's bunion deformity.
5. List the clinical signs and symptoms associated with a plantarflexed and dorsiflexed fifth ray.
6. Describe the concept of splayfoot and its associated clinical features.
7. Describe plantarflexed and dorsiflexed lesser metatarsal deformities.
8. Describe the clinical signs and symptoms and gait changes associated with a plantarflexed and dorsiflexed lesser metatarsal.
9. List the causes of abnormal lesser metatarsal head shape.
10. Describe the clinical signs and symptoms associated with abnormal metatarsal head shape.
11. Recognize the pathomechanics associated with predislocation syndrome/plantar plate dysfunction.
12. Identify the principles of orthosis prescription-writing for a patient with forefoot pain.

F. Pes Cavus

1. Discuss the different etiologies and pathomechanics of pes cavus.
2. List and describe different neuromuscular disorders commonly associated with pes cavus.
3. List and describe the common clinical signs and symptoms associated with pes cavus.
4. Describe a diagnostic work-up of a patient with pes cavus.
5. Discuss nonsurgical treatment options for pes cavus.
6. Discuss planar dominance in pes cavus deformities
7. Discuss the management of neuromuscular pes cavus, when presented in a clinical scenario.
8. Identify the principles of orthosis prescription-writing for a patient with Pes Cavus.

G. Flatfoot Deformities

1. Describe different etiologies, including abnormal ontogeny, of flatfoot deformity.
2. Describe the pathomechanics of flatfoot deformity resulting from joint instability.
3. Describe clinical signs and symptoms of flatfoot deformities.
4. Discuss common nonsurgical treatment options for flatfoot deformities.
5. Discuss planar dominance in flatfoot deformities.

H. Heel Pain

1. Define *heel pain syndrome*.
2. Describe the various etiologies and pathomechanics of heel pain.
3. Identify the clinical signs and symptoms of heel pain.
4. Discuss nonsurgical treatment options for heel pain.
5. Discuss subjective and objective assessment methods to differentiate heel pain of systemic origin versus pathomechanical causes.

I. Sinus Tarsi Syndrome

1. Define sinus tarsi syndrome.
2. Describe the pathomechanics of sinus tarsi syndrome.
3. Discuss common history findings for sinus tarsi syndrome
4. List differential diagnoses for sinus tarsi syndrome
5. Identify the clinical signs and symptoms of sinus tarsi syndrome.

6. Discuss the non-surgical treatments for sinus tarsi syndrome.

J. Evaluation and Management of the "At Risk" Foot

1. Discuss the pathomechanical changes associate with neuropathic feet.
2. Describe the biomechanical management of the "at-risk foot" due to diabetes, peripheral vascular disease, neurological, or other metabolic disorders.
3. Discuss nonsurgical treatment options for the "at-risk foot."

K. Limb Length Discrepancy

1. Differentiate normal and abnormal variances in limb length.
2. Discuss etiologies of Limb Length Discrepancy (LLD).
3. Differentiate between structural and functional Limb Length Discrepancy (LLD).
4. Discuss biomechanical and radiographic techniques used to diagnose limb length discrepancy.
5. Describe how to differentiate between true limb length versus functional limb length.
6. List other points of evaluation to determine the presence of a limb length discrepancy.
7. Describe signs, symptoms, gait changes and effects on the body associated with asymmetrical limb length and scoliosis.
8. Identify and describe nonsurgical methods of relieving symptoms associated with LLD.

III. Sports Medicine

I. Sports Medicine Practice

1. Describe the psychological, social and physical characteristics unique to the sports medicine patient.
2. Differentiate between general medical History & Physical Examination versus a Sports Medicine History & Physical Examination.
3. Compare and differentiate the evaluation and management of the child athlete with that of an adult athlete.
4. Compare and contrast the approach and surgical management of the athlete patient versus the non-athlete patient.
5. Identify the effects of gender on training, conditioning, endurance, and injury.
6. Identify the assessment of field injured athlete.

A. The Female Athlete

1. Describe the psychological, sociological, and cultural challenges facing a female athlete.
2. Describe the problems associated with the female athlete triad.
3. Describe the effect of diet and eating disorders in the female athlete and their effects on the menstrual cycle.
4. Discuss the current trends in exercise during pregnancy in the female athlete.

B. The Aging Athlete

1. Describe the psychological, sociological, and cultural challenges facing an aging athlete.
2. Identify the effects of age on training, conditioning, endurance, and injury.
3. Identify the effects of chronic conditions and medications on the aging athlete.

D. The Child Athlete

1. Discuss the physical, anatomical, and biomechanical differences between the child/immature athlete and the adult athlete.
2. Describe and evaluate the general growth process and its effect on athletic participation.
3. Differentiate the anatomical areas of structural weakness in the child athlete.
4. Discuss the various injuries and conditions specific for the child athlete.
5. Describe the commonly encountered overuse injuries in the pediatric athlete.
6. Recommend treatment modalities and protocols for specific injuries common in the child athlete.
7. List the effects and limitations of training and conditioning in the child athlete.
8. Discuss the potential draw back(s) to early sport specialization.

F. Sports Nutrition

1. Describe the nutritional needs of the athlete and how they differ from the general population.
2. List indications and contraindications of the common nutritional supplements and fluid replacement products used by athletes.
3. Identify a variety of "doping" or banned substances used by athletes.

G. Techniques of Training

1. Discuss the basic training techniques and nomenclature used by athletes, such as long slow distance, intervals, tempo runs, circuit training, sets, and plyometrics.
2. Discuss the basic techniques and benefits of unique training forms such as dance, yoga, CrossFit, Pilates and martial arts.
3. Explain the principles of conditioning, stretching, and strength training.
4. List the factors affecting endurance and performance.
5. Discuss the rationale for sports-specific training.

H. Biomechanics of Running

1. Compare the differences between the walking and running gait cycle.
2. Recite the components of the support phase of the running gait cycle.
3. Distinguish the components of the non-support phase of the running gait cycle.
4. Describe how the loads through the foot differ between walking and running.
5. Compare the differences in phasic muscle activity in walking as compared to running.
6. Describe the abnormal running biomechanics and its relationship to athletic performance and the development of injury.
7. Compare and contrast the gait variances of shod versus barefoot running.
8. Describe and correctly evaluate a running shoe.
9. Produce an accurate patient prescription for the appropriate running shoe.

I. Foot Orthoses in the Athlete

1. Describe the unique considerations when prescribing orthoses for the sports medicine patient.
2. Outline the indications for various orthotic modifications used for treatment of specific sports injuries.
3. Differentiate between the specialized orthoses used in specific sports, such as skiing, marathon, track, cycling, dance, skating, and basketball.

J. Athletic Footwear

1. Describe the anatomy, construction, and function of a various athletic shoes, such as running, walking, court, turf, dance, tennis, basketball and cycling.

2. Discuss the current techniques and modifications used in the fabrication of athletic ootwear designed to reduce injuries and/or alter biomechanics.
3. Identify and describe common running shoe wear patterns and the biomechanical auses for each.
4. Recognize common problems encountered with basketball shoes and soccer cleats.
5. Define motion control and indications.

K. Sports Equipment & Training Aids

1. Explain basic bike fit techniques and describe the common lower extremity injuries seen with improper fit.
2. Describe the use of personal protective equipment related to various sports.

II. Sports Injuries

A. Asymmetry in the Athletic Patient

1. Explain the pathological basis of asymmetrical function and the presence or potential for injury.

B. Stress Fractures of the Lower Extremity

1. Discuss the pathomechanics of loads and their relationship to injury to bony tissues.
2. Describe how training errors, nutritional status, gender, age, overuse and other special considerations contribute to development of stress fracture.
3. Discuss the clinical presentation and management of metatarsal and tibial stress fracture.

C. Capsular/Joint Impingement Syndromes

1. Explain the pathomechanics producing impingement syndromes.
2. Differentiate between soft tissue impingement syndromes and bony impingement syndromes, such as Hallux IPJ, First MTPJ, lesser MTPJ's, calcaneocuboid joint (subluxed cuboid syndrome), subtalar joint (sinus tarsi syndrome), and ankle joint (anterior, posterior, medial and lateral impingement syndrome).

D. Lower Extremity Tendonopathy

1. Discuss the causes for acute or chronic injuries to specific tendons in the lower extremities.
2. Differentiate between the different types of tendinopathy, such as tendinosis, tenosynovitis, and enthesopathy.
3. Explain the relationship between abnormal biomechanical function and development of injury to specific tendons.
4. List the signs and symptoms associated with tendinopathy.
5. Describe the various methods of treatment for tendinopathy.
6. Discuss diagnostic imaging techniques used in the evaluation of tendinopathy.
7. Describe how training errors, nutritional status, gender, age, and other special considerations (e.g., antibiotics and steroid) contribute to development of tendinopathy.

E. Hip and Thigh

1. Describe clinical presentation, evaluation, and management of athletic injuries of the hip and thigh, such as trochanteric bursitis, iliotibial band friction syndrome, piriformis syndrome," snapping hip," hamstring strain, and quadriceps strain.
2. Discuss the pathomechanical factors contributing to sport specific hip and thigh injuries.

F. Knee

1. Define Runner's knee, Theater Sign, Q-Angle, VMO, Patella Alta, Jumper's Knee and House maid's knee.
2. Describe clinical presentation, evaluation, and management of athletic injuries of the knee, such as chondromalacia patella, patellofemoral joint syndrome, popliteal tendonitis, iliotibial band friction syndrome, meniscal tears, ACL and PCL tears, collateral ligament sprain, plica, impingement syndrome, patellar tendonitis ("jumper's knee"), and pes anserine bursitis.
3. Discuss the pathomechanical factors contributing to sport-specific knee injuries.
4. Describe and demonstrate the evaluation techniques used to determine the integrity of the patellar tendon, collateral ligaments, cruciate ligaments and menisci of the knee joint.
5. Discuss how the "Q" angle relates to patellar tracking.
6. Describe the effect of foot dysfunction on knee pathomechanics.

G. Leg

1. Define Tennis Leg, Thomson-Daugherty Test, Tendinosis, Paratenonitis, "Dancers tendonitis", Dreaded black line, Shin Splints and Fat Fracture.
2. Describe clinical presentation, evaluation, and management of athletic injuries of the leg, such as acute and chronic compartment syndromes, "shin splints" [i.e., anterior compartment myositis, deep posterior compartment myositis/Medial Tibial Stress Syndrome (MTSS)], peroneal tendonitis, and tibial stress fracture.
3. Discuss the pathomechanical factors contributing to sport-specific leg injuries.
4. Describe clinical presentation, evaluation, and management of tennis leg.

H. Ankle

1. Describe and demonstrate how to identify and assess the integrity of the lateral collateral ligaments of the ankle.
2. List the pathomechanical factors that may predispose patient to lateral ankle sprains.
3. Describe and demonstrate the clinical evaluation of lateral ankle sprains, including the need for assessment of non-ankle structures such as the base of the fifth metatarsal, anterior process of the calcaneus, Achilles tendon insertion, peroneal groove, and the proximal fibula.
4. Differentiate between types of ankle sprains, such as lateral, medial, and high ankle sprains.
5. Discuss of clinical presentation, imaging, and treatment of talar dome injury.
6. Describe the specialized radiographic techniques utilized to assess lateral ankle injuries and grade their severity.
7. Describe the treatment and return-to-activity protocols for lateral ankle injuries based on grade/severity of injury.
8. Describe the appropriate management of an acute and chronic ankle injury including pain and instability.
9. Describe and demonstrate how to identify and assess the integrity of eversion ankle sprains.
10. Describe the biomechanical etiology, clinical presentation, specialized radiographic findings, and the management of fibular (peroneal) tendon subluxation.
11. Assess along with the management of talar dome fractures.
12. Describe the clinical presentation and management of injuries to the os trigonum.
13. Describe the biomechanical etiology, clinical presentation, specialized radiographic findings, and the management of sport specific anterior and posterior impingement syndrome.

I. Rearfoot

1. Describe clinical presentation, evaluation, and management of athletic injuries of the rearfoot, such as Achilles tendinitis, Achilles tendon rupture, paratenonitis, adhesive tendinopathy, calcaneal stress fractures, calcaneal apophysitis, cuboid impingement syndrome, and plantar fasciitis.
2. Discuss the pathomechanical factors contributing to sport-specific rearfoot injuries.
3. Define Orthotripsy, Ski boot neuropraxia.
4. Describe the management and prevention of various nerve impingement syndromes.
5. Describe the clinical presentation, evaluation and management of retrocalcaneal exostosis (Haglund's deformity).

J. Midfoot

1. Define "Dancers fracture", Jones Fracture, "Cuboid Syndrome", "N spot" and Basketball foot.
2. Describe clinical presentation, evaluation, and management of athletic injuries of the midfoot, such as navicular stress fracture, and midfoot sprains.
3. Discuss the pathomechanical factors contributing to sport-specific midfoot injuries.

K. Forefoot

1. Define Tennis toe, Runners toe, Turf toe, Sand toe and Female athlete triad.
2. Describe clinical presentation, evaluation, and management of athletic injuries of the lesser metatarsal, such as stress fractures, avulsion fracture, capsulitis, and plantar plate rupture.
3. Describe clinical presentation, evaluation, and management of athletic injuries of the first metatarsophalangeal joint, including turf toe, soccer toe, sesamoiditis, plantar plate injuries, and impingement syndrome.
4. Discuss the pathomechanical factors contributing to sport-specific forefoot injuries.

L. Dermatology

1. Describe the etiology, clinical presentation, management, and prevention of sports-related dermatological conditions, such as subungual hematoma ("Tennis Toe"), blisters, fungal and bacterial infections, taping/bracing skin reactions, and dermal abrasions.
2. Discuss the implications of MRSA infections in the athlete.
3. Discuss the importance of the appropriate sport-related sock.

III. Physical Medicine and Rehabilitation

A. Patient Assessment

1. Define Rehabilitation, Athletic Trainer, and Physical Therapy.
2. Discuss the role of the physical therapy and physical medicine in the treatment of lower extremity pathology.
3. Distinguish which patients are appropriate for referral to physical therapy and/physical medicine.
4. Describe how to evaluate the range of motion of the joints of the lower extremities and distinguish between active and passive range of motion.
5. Assess muscular strength and power manually.
6. Identify the indications for additional objective testing of strength and power (e.g., isokinetic instrumentation and computerized gait analysis).
7. Describe the common goals of physical therapy for lower extremity conditions, including increasing mobility, promoting stability, reducing inflammation, pain spasm, edema, scar tissue

and adhesions; increasing ROM, strength, power, and endurance; and improving balance and proprioception.
8. Describe the methods for the determination of the patient's readiness to return to activities.

B. Physical Therapy Modalities

1. Describe the various types of active and passive range of motion exercises and their indications and contraindications.
2. List the indications and contraindications for the use of therapeutic cold and heat in the lower extremities.
3. Identify the indications and contraindications for phonophoresis, iontophoresis, electrical stimulation, and ultrasound.
4. Identify the indications and contraindications for massage, soft tissue mobilization, traction, and manipulation techniques of the lower extremities.
5. List the indication for hydrotherapy as it pertains to the treatment of lower extremity pathology.
6. Discuss the indications and contraindications of strength training and methods for specific muscle groups.
7. Discuss specific strengthening techniques such as isometric, isotonic, isokinetic, concentric/eccentric, and open and closed kinetic chain in the rehabilitation.
8. Describe the concepts of proprioceptive retraining of the lower extremities and its importance in injury management and prevention of further injury.
9. Write a therapeutic exercise prescription and a physical therapy prescription.
10. Discuss the indications and contraindications of intermittent compression as a modality.
11. List the compression garments and explain when to prescribe them as a treatment.

C. Rehabilitative Equipment

1. Discuss the indications, proper fit, proper use, and patient instructions for ambulatory assistive devices, including cane, crutches, walker, and wheelchair.
2. Describe the indications, contraindications, and adverse effects for the use of immobilizing devices such as casts, ambulatory boots, and CAM-walker boots.
3. Discuss the indications and contraindications for the use of a variety of available knee and ankle braces and supports.
4. Describe how to use the various assistive walking devices during stair ascent and descent.
5. Describe the proper progression of assistive walking device use during ambulation as a patient's condition or stability improves

IV. General Orthopedics and Disorders of Bone

A. Soft Tissue Neoplasms

1. Describe the general histopathological classification, etiology, and pathophysiology of soft tissue neoplasms.
2. Describe the diagnostic modalities utilized in assessing soft tissue neoplasms.
3. Discuss the clinical presentation and management of benign fibrous tumors, as well as malignant fibrosarcoma.
4. Discuss the clinical presentation and management of lipomatous tumors such as the lipoma and the malignant liposarcoma.
5. Discuss the clinical presentation and management of benign tumors of smooth muscle including the leiomyoma, as well as the malignant leiomyosarcoma.

6. Discuss the clinical presentation and management of benign tumors of skeletal muscle including the rhabdomyoma, as well as the malignant rhabdomyosarcoma.
7. Discuss the clinical presentation and management of benign tumors of the vasculature including hemangioma, pyogenic granuloma, glomus tumor, as well as the malignant angiosarcoma.
8. Discuss the clinical presentation and management of benign tumors of tendon and synovial tissue, including synovial cyst (ganglion), tenosynovial giant cell tumor (pigmented villonodular synovitis), as well as the malignant synovial sarcoma and clear cell sarcoma.
9. Describe the clinical presentation and management of benign tumors of nerve tissue, including nerve sheath ganglion, neurilemmoma, and neurofibroma.
10. Describe the clinical presentation and management of quasi-tumors of the foot, including foreign body inclusion cyst.

B. Osseous Neoplasms

1. Describe the clinical approach to the radiographic finding of an osseous neoplasm.
2. List the characteristics utilized to categorize osseous tumors.
3. Describe the most common benign osseous tumors, including osteoma, osteoid osteoma, chondroblastoma, enchondroma, chondromyxoid fibroma, osteochondroma, unicameral bone cyst, aneurysmal bone cyst, fibrous dysplasia, nonossifying fibroma, and intraosseous ganglion and lipoma, as well as their individual radiographic presentations.
4. Describe the most common malignant osseous tumors, including osteogenic sarcoma, chondrosarcoma, Ewing's sarcoma, fibrosarcoma, lymphoma, and myeloma, as well as their individual radiographic presentations.
5. Discuss the most common quasi-malignant osseous tumors, including giant cell tumor, as well as their individual radiographic presentations.
6. Describe the clinical and radiographic characteristics that allow the clinician to differentiate benign from malignant tumors.

C. Rheumatology

A. Systemic Sclerosis

1. Discuss scleroderma with regards to epidemiology, clinical presentation, diagnosis, treatment, and prognosis.
2. Describe Raynaud's phenomenon and differentiate Raynaud's phenomenon from Raynaud's disease.

B. Lupus Erythematosus

1. Discuss systemic lupus erythematosus (SLE) with regards to epidemiology, clinical presentation, diagnosis, treatment, and prognosis.

C. Polymyalgia Rheumatica and Giant Cell Arteritis

1. Discuss polymyalgia rheumatica with regard to epidemiology, clinical presentation, diagnosis, and treatment.
2. Discuss giant cell arteritis with regards to epidemiology, clinical presentation, complications, diagnosis, and treatment.
3. Compare and contrast polymyalgia rheumatica and giant cell arteritis with each other and with other rheumatologic diseases.

D. Fibromyalgia & Chronic Myofascial Pain

1. Discuss the epidemiology of fibromyalgia.
2. Discuss the diagnostic criteria for fibromyalgia.

3. Discuss disorders that are associated with fibromyalgia.
4. Describe the clinical presentation of fibromyalgia.
5. Define *trigger point* and discuss the clinical relevance of trigger points.
6. Outline treatment strategies for fibromyalgia.
7. Discuss other possible etiologies of myofascial pain.

E. Mechanical/Structural Conditions of the Spine

1. Describe the normal anatomy of the spine.
2. Describe the normal ontogeny of the spine.
3. Discuss the various etiologies and types of scoliosis including the possible locations for the deformity.
4. Discuss the signs and symptoms associated with scoliosis.
5. Describe and perform a screening exam for scoliosis.
6. Discuss radiographic techniques to diagnose scoliosis.
7. Describe common gait changes associated with scoliosis.
8. Describe the effects on the rest of the body of eliminating compensatory changes in the feet for patients with scoliosis.
9. Discuss the clinical findings, associated function and/or gait disturbances, and treatment of adult spinal disorders, including spinal osteoarthritis, spinal stenosis, kyphosis, herniated intervertebral disk and lumbosacral strain, cervical strain, cervical spondylosis, whiplash cervical injury, fracture of spinal process, flexion fracture of the neck, partial dislocation from hyperextension injury, atlas fracture,and odontoid process fracture.
10. Describe the dynamics of lordosis and kyphosis in static stance and gait.

F. Mechanical and Structural Conditions of the Hip

1. Measure the ranges of motion for the hip.
2. Evaluate the strength of the muscles crossing the hip joint.
3. Evaluate the effect of the hamstrings on the amount of hip flexion available.
4. Evaluate the effect of the quadriceps on the amount of hip extension available.
5. Evaluate a patient for the presence of coxa varum or coxa valgum.
6. Discuss the effect of coxa varum and coxa valgum on the gait cycle.
7. Evaluate a patient for iliotibial band syndrome and discuss biomechanical etiologies or factors associated with this diagnosis.
8. Describe the clinical findings, associated function and/or gait disturbances, and treatment of adult hip disorders including osteoarthritis, trochanteric bursitis, acute fracture and/or dislocation, and hip replacement.

G. Mechanical and Structural Conditions of the Knee

1. Evaluate the knee to determine the integrity of the collateral ligaments (varus and valgus stress test).
2. Evaluate the knee to determine the integrity of the cruciate ligaments (anterior and posterior drawer test).
3. Evaluate the knee to determine the integrity of the menisci of the knee.
4. Evaluate a patient for the presence of genu varum or genu valgum.
5. Determine the Q angle on a patient.
6. Evaluate a patient for "tracking" of the patella.
7. Identify and describe the signs and symptoms of chondromalacia patella.

8. Evaluate a patient for quadriceps tone and the presence of chondromalacia patella.
9. Evaluate a patient for pes anserine bursitis and discuss possible biomechanical etiologies associated with this diagnosis.
10. Differentiate between patello-femoral syndrome and chondromalacia patella.
11. Evaluate the muscles crossing the knee joint.
12. Describe the clinical findings, associated function and/or gait disturbances, and treatment of adult knee disorders including Baker's cyst, prepatellar bursitis and infrapatellar bursitis, sprain/rupture of the collateral ligaments, sprain/rupture of the cruciate ligaments, tear/rupture of the menisci, osteoarthritis with or without loose bodies, and knee joint replacement.
13. Describe synovial joint examination, technique, and analysis.

H. Bone Healing and Facture Management

1. Discuss the development and pathomechanic implications of stress reaction and stress fracture.
2. Discuss tissue healing principles and bone healing/remodeling.
3. Discuss the common fracture types and management.
4. Discuss the common diagnostic tests used in the diagnosis of orthopedic pathology.
5. Discuss the general conservative and operative management of orthopedic disorders.
6. Discuss the regional interdependence and its implications in treating orthopedic pathology.
7. Discuss pathophysiology of bone healing and fracture management.

I. Orthopedic Strapping

1. Discuss the indications, contraindications, and alternatives for orthopedic strapping.
2. Identify the materials and basic techniques for orthopedic strapping.

J. Orthopedic Padding

1. Discuss the indications, contraindications, and applications for paddings.
2. Discuss the alternatives, if any, for Scaphoid pad metatarsal pad, metatarsal raise, dancer's/sesamoid pad, heel lift, longitudinal arch pad, mayo pad, cuboid pad, varus/valgus pad, morton's extension, reverse morton's extension, digital/ buttress/crest pad, and horseshoe pad.
3. Identify the materials available for orthopedic padding.
4. Apply a Scaphoid pad, metatarsal pad, metatarsal raise, dancer's/sesamoid pad, heel lift, longitudinal arch pad, mayo pad, cuboid pad, varus/valgus pad, morton's extension, reverse morton's extension, digital/ buttress/crest pad, and horseshoe pad.

V. Pediatric Orthopedics

I. Prenatal Development, Birth, and Perinatal Development

1. Describe normal prenatal development.
2. Describe embryology, ontogeny, and developmental changes in the lower extremities.
3. Describe normal gestational factors.
4. List the important milestones of each trimester.
5. Describe both normal and abnormal labor and delivery.
6. List important differential factors, implications, and variations in the normal and abnormal birth process.

7. Review significant factors that affect neurological maturation.
8. Describe normal neonatal development.
9. Discuss perinatal development as a function of neurological maturation.
10. Given a description of a newborn, determine the APGAR score and discuss the significance of the score.
11. Describe maternal health as related to age, weight, smoking, fetal alcohol syndrome, diabetes, hypertension, HIV status and substance abuse.

A. Pediatric History

1. Discuss the chronology of the complaint, including any functional limitations associated with the chief complaint
2. Discuss prior assessment, advice given, and any prior treatment, of the child by other health care providers
3. Discuss the developmental landmarks and provide normal ages for each of the landmarks to be achieved.
4. Obtain a family history including number, age, and significant medical history of siblings and adult history information.
5. Discuss the systems review in the pediatric patient.
6. Discuss the relevance of the medication allergy and immunization histories.
7. Discuss comorbidities found in children that make their treatment unique.
8. Discuss diseases unique to infancy and childhood, such as measles, mumps, rubella, chicken pox, fifths disease, rheumatic fever, and polio.
9. Discuss problems associated with the patient not being the historian when executing a medical history.

B. Pediatric General Physical Examination

1. Recognize the differences in general physical examination results for an infant, toddler, and child compared to an adult.
2. Describe techniques used to obtain vital signs in the infant, toddler, and older child.
3. Provide age-related normal values for vital signs.
4. Provide possible etiologies, given an abnormal vital sign.
5. Discuss the significance of including and evaluating height and weight as part of the vital signs.
6. Discuss the evaluation of the skin including color, temperature, texture, and adnexa.
7. Discuss the skin as a marker for disease, including the importance of a lumbosacral skin lesion with respect to tethered cord syndrome
8. Discuss the differences in the neurologic examination for children of different ages, including evaluation of primitive reflexes, postural reflexes, Gower's sign, and signs of hyopotonia and hypertonia.

C. Osseous Growth Centers

1. Identify osseous growth centers and chronological presentation.
2. Identify and describe bones that are present at birth.
3. List and describe the appearance and chronological presentation of bones after birth.
4. List and identify the appearance of sesamoids, epiphyseal plates, and apophysis in the pediatric foot.
5. Identify and describe normal variants that may be confused as pathology.
6. Discuss the histology and physiology of the growth plate.

D. Osteochondroses

1. Define *osteochondroses*.
2. Distinguish between true osteochondroses and related conditions such as calcaneal Apohysitis.
3. Compare the mechanisms that may cause osteochondroses.
4. State the incidence of the common osteochondroses.
5. Indicate clinical significance of common osteochondroses.
6. List treatment options in the osteochondroses.

E. Common Accessory Bones

1. List the common accessory bones of the pediatric foot.
2. List and describe the appearance and chronological presentation of the accessory bones.
3. Recognize radiographic appearance of common accessory bones.
4. Indicate the clinical significance of accessory bones.

G. General Disease/Metabolic Disease/ Genetic Disease/Congenital Problems

1. Describe anemia, lead poisoning, bone dysplasia, bone tumors, fracture management, rickets, Blount's disease and osteogenesis imperfecta as conditions associated with delayed bone maturation, metaphyseal and epiphyseal abnormalities.

H. Pediatric Arthritides and Infections

1. Discuss pain in the child and provide an algorithmic approach to pain.
2. Discuss "growing pains."
3. Define *juvenile myalgia*.
4. Discuss the signs, symptoms, diagnostic techniques, and treatment for the systemic form of juvenile idiopathic arthritis.
5. Define *rheumatic fever*.
6. Define *juvenile* idiopathic *arthritis*.
7. Compare and contrast juvenile idiopathic arthritis to other inflammatory processes.
8. Summarize the value of lab tests used to diagnose juvenile idiopathic arthritis.
9. State the clinical presentation of juvenile idiopathic arthritis.
10. List the common treatment regimens in juvenile r idiopathic arthritis.
11. Discuss the Polyarticular variants of Juvenile idiopathic Arthritis.
12. Discuss the Pauciarticular variants of Juvenile idiopathic Arthritis.
13. Discuss the less common pediatric collagen vascular syndromes.
14. Define Septic Arthritis.
15. Differentiate Septic Arthritis from Juvenile idiopathic Arthritis or osteomyelitis.
16. State lab tests needed to diagnose pediatric septic arthritis.
17. Explain the clinical significance of septic arthritis.
18. Define pediatric hematogenous osteomyelitis.
19. State lab tests needed to diagnose pediatric hematogenous osteomyelitis.
20. Differentiate pediatric hematogenous osteomyelitis from juvenile idiopathic arthritis.
21. Summarize the clinical significance of hematogenous osteomyelitis.
22. Discuss the etiology and pathology involved with hematogenous osteomyelitis.
23. Discuss the signs, symptoms, pathology, diagnostic techniques, treatment, and prognosis of early acute osteomyelitis.

24. Discuss the signs, symptoms, pathology, diagnostic techniques, treatment, and prognosis of late acute osteomyelitis.
25. Discuss the signs, symptoms pathology, diagnostic techniques, treatment, and prognosis of subacute (chronic attenuated) osteomyelitis.
26. Outline clinical work-up for suspected osteomyelitis.
27. Outline laboratory work-up for suspected osteomyelitis.
28. Outline imaging work-up for suspected osteomyelitis.
29. Outline a treatment plan for osteomyelitis including antibiosis and surgical intervention.

I. Neuromuscular Diseases

1. Define *static encephalopathy (also known as cerebral palsy*.
2. Discuss the etiologies of *static encephalopathy*.
3. Discuss motor and sensory changes associated with neurological/neuromuscular diseases.
4. Discuss the orthopedic sequelae of*static encephalopathy.*
5. Discuss the basic treatment for*static encephalopathy*.
6. Discuss the types of hereditary sensorimotor neuropathies.
7. Discuss the clinical picture associated with hereditary sensorimotor neuropathies.
8. Discuss the basic treatment of hereditary sensorimotor neuropathies.
9. Discuss the types of muscular dystrophies.
10. Discuss the clinical picture associated with muscular dystrophy.
11. Discuss principles of management of muscular dystrophy.
12. List common congenital medical problems, such as Down syndrome, Ehler-Danlos syndrome, hypotonia, and neuromuscular disease.
13. Describe and discuss the causes/mechanisms for spasticity, athetosis, paresis, ataxia, paralysis, atonia, ballismus, and rigidity.
14. Describe gait changes associated with neurological/neuromuscular diseases, including*static encephalopathy,* Guillain-Barre, muscular dystrophy, Charcot-Marie-Tooth, post-cerebral vascular accident, Tabes dorsalis.
15. Describe circumducted gait, cerebellar gait, foot slap, Trendelenberg gait, drop foot, spastic gait (hemiparetic gait, scissors gait) and calcaneus gait and explain why each occurs.
16. Discuss in general terms the treatment options available for pediatric gait problems associated with neurological/neuromuscular diseases.
17. Recognize, identify, and describe the lower extremity manifestations and the signs and symptoms and be able to suspect the neuromuscular, upper motor neuron and lower motor neuron disorders found in children including, *static encephalopathy*, tethered cord syndrome, spina bifida and disastametamyelia, muscular dystrophies, myopathies, peripheral neuropathies, hypotonia, Down Syndrome, Prader-Willi Syndrome, achondroplasia, Apert Syndrome, Nail-patella Syndrome, Morquio Syndrome, Mafucci Syndrome, Fetal Alcohol Syndrome, Marfan's Syndrome, osteogenesis imperfect, and Ehlers-Danlos Syndrome.
18. Discuss the need for referral of the patient with congenital medical problems.
19. Discuss the techniques used to determine muscle tone.
20. Discuss the techniques used to determine muscle strength.
21. Discuss the technique and location used for evaluation of deep tendon reflexes.
22. Discuss techniques and locations for superficial reflexes.
23. Discuss gait evaluation as a component of the neuromuscular examination.

J. Metatarsus Adductus

1. Define *metatarsus adductus*.
2. Explain the etiological factors seen in metatarsus adductus.
3. Describe the clinical appearance of metatarsus adductus.
4. Describe the radiographic appearance of metatarsus adductus.
5. Differentiate metatarsus adductus from other forefoot pathologies such as forefoot Adductus, talipes equinovarus andt skewfoot .
6. Identify the patients that benefit from conservative treatment for metatarsus adductus.
7. List the potential complications from cast therapy for metatarsus adductus.
8. Identify which patient may need surgical correction for metatarsus adductus.
9. Discuss significant familial factors associated with the chance of occurrence for metatarsus adductus.
10. Discuss the physical exam findings associated with metatarsus adductus.
11. Discuss comorbidities associated with metatarsus adductus.
12. Provide a step-wise treatment plan for metatarsus adductus.
13. Discuss the evaluation of the patient's response to treatment to determine resolution of the metatarsus adductus.
14. Discuss conservative measures, including manipulation and casting, shoe gear and bracing, for the treatment of metatarsus adductus.
15. Provide a step-wise treatment plan for metatarsus adductus.
16. Discuss the evaluation of the patient's response to treatment to determine resolution of the metatarsus adductus.
17. Discuss surgical options available based on the patient's age and the severity of the metatarsus adductus.
18. Discuss possible long-term sequelae of residual metatarsus adductus.

K. Talipes Equinovarus

1. Define *talipes equinovarus*.
2. List the etiological factors of talipes equinovarus.
3. Review the pathological anatomy of talipes equinovarus.
4. Describe the clinical presentation of talipes equinovarus.
5. List the four component deformities of talipes equinovarus.
6. Discuss the familial factors for talipes equinovarus.
7. List the four different types of talipes equinovarus and discuss the comorbidities, response to therapy, and other factors associated with type.
8. Discuss the radiographic findings associated with talipes equinovarus.
9. Discuss the techniques used in the radiographic evaluation of talipes equinovarus.
10. List and describe the conservative treatments for talipes equinovarus.
11. Describe the Ponseti technique for talipes equinovarus correction including casting technique, surgical intervention and long term bracing.
12. Discuss complications of treatment for talipes equinovarus.
13. Outline the order of approach to the deformities involved in talipes equinovarus when treated withthe Ponseti technique.
14. Discuss the possible complications of treatments for talipes equinovarus.
15. Discuss the possible sequelae to talipes equinovarus.
16. List and describe surgical approaches and procedures, for complicated and uncomplicated TEV.

L. Congenital Dislocated Hip

1. Define *developmental dysplasia of the hip (DDH)*.

2. Identify the incidence and etiology of developmental dysplasia of the hip.
3. Summarize the clinical findings seen in developmental dysplasia of the hip.
4. Describe, and explain the significance of, limitation of abduction, asymmetrical gluteal folds, trendelenberg, sign, anchor sign, and perineal angle.
5. Describe the Ortolani test and discuss its clinical significance.
6. Describe the Barlow test and discuss its clinical significance.
7. Describe the Galleazzi/Allis test and discuss the clinical significance.
8. Discuss the radiographic views required, as well as evaluation and interpretation, for DDH, including Shenton's line, Perkin's line, and acetabular index.
9. Discuss the use of dynamic ultrasound for evaluating suspected developmental dysplasia of the hip.
10. Describe the Thomas test and discuss its clinical significance.
11. Describe the Ely test and discuss its clinical significance.
12. Describe the Ober test and discuss its clinical significance.
13. Discuss imaging techniques used to evaluate for a developmental dysplasia of the hip.
14. List and describe treatments available for developmental dysplasia of the hip, including success rates and possible long-term sequela.
15. Discuss the incidence of any comorbidities associated with developmental dysplasia of the hip.

II. Sagittal, Frontal, and Tranverse Plane Deformities of the Hip, Knee, and Foot

1. Recognize the normal position of the newborn hip, knee, and foot.
2. State the normal position of the pre-walker's hip, knee, and foot.
3. Describe the normal position of the beginning walker's hip, knee, and foot.
4. Describe the normal position of the toddler's hip, knee, and foot.

A. Hip Joint

1. Discuss normal transverse and frontal plane development of the hip and femur.
2. Describe the gait pattern associated with femoral antetorsion.
3. Describe the gait pattern associated with femoral retrotorsion.
4. Describe the gait pattern associated with femoral anteversion.
5. Describe the gait pattern associated with femoral retroversion.
6. Discuss the possible treatments for versional and torsional problems.
7. Discuss the normal frontal plane development of the femur.
8. Provide normal values for the angle of inclination related to age.
9. Define *coxa varum* and discuss associated deformities and gait abnormalities.
10. Define *coxa valgum* and discuss associated deformities and gait abnormalities.
11. Discuss treatments available for coxa varum and coxa valgum.
12. Compare the internal and external transverse plane hip pathology.
13. Discuss transverse plane hip range of motion, including logic and techniques for measuring with the hip flexed and the hip extended, age-related normal values, and clinical significance of abnormal findings.
14. Discuss frontal plane hip range of motion including method of measurement, age-related normal values, and discuss clinical significance of abnormal findings.
15. Discuss sagittal plane hip range of motion including method of measurement, age-related normal values, and clinical significance of abnormal findings.

B. Knee Joint

1. Discuss the normal frontal plane development of the knee/tibial segment.

2. Discuss the physical exam findings associated with tibial varum.
3. Discuss possible etiologies of pathological tibial varum.
4. Describe the pathological process involved in Blount's disease.
5. Describe the resultant gait and possible long-term sequelae of pathological tibial varum.
6. Differentiate between genu varum and tibial varum.
7. Discuss the physical exam findings associated with tibial valgum.
8. Discuss possible etiologies for pathologies tibial valgum and genu valgum.
9. Discuss the resultant gait and possible long-term sequelae of pathological tibial valgum or genu valgum.
10. Describe the method used to evaluate tibial torsion and provide normal values for the clinical measurements.
11. Differentiate between tibial torsion and malleolar position.
12. Discuss the normal transverse plane development of the tibia.
13. Discuss tibial torsion including method or measurement, age-related normal values, and clinical significance of abnormal findings.
14. Discuss knee motion including method of measurement, age-related normal values, and clinical significance of abnormal findings.
15. Discuss the normal frontal plane development of the knee/tibial segment.
16. Define pseudotorsion (internal genicular position) and how to differentiate it from Internal tibial torsion.
17. Discuss pseudotorsion including method of measurement, age related normal values and clinical significance of abnormal values
18. Discuss the treatments available for pseudotorsion.

C. <u>Pediatric Gait</u>

1. Describe normal and abnormal gait as a function of age.
2. Identify and discuss abnormal gait for pediatric age.
3. Recognize, identify, describe, and evaluate deviations from normal gait, including their management.
4. Recognize, identify, describe, and evaluate causes of toe-walking and their management in children.
5. Summarize the use of external devices for assistance in pediatric gait.

D. <u>Intoe Gait</u>

1. Differentiate between physiological in-toe gait and pathological in-toe gait.
2. Discuss early childhood gait as a function of anatomical position and neuromuscular development.
3. Describe the pediatric entity of in-toe gait.
4. List the etiology and incidence of in-toe gait.
5. Discuss transverse plane changes related to in-toe gait.
6. List and describe the non-ambulatory devices used in the treatment of in-toe gait.
7. List and describe the orthotic devices used in the treatment of in-toe gait.
8. Compare treatment versus benign neglect for in-toe gait.
9. Describe the potential complications of the treatment of in-toe gait.
10. Identify and describe appropriate footwear for children and the types, and indications for, prescription footwear in the management of pedal pathology.

E. Flatfoot Deformities

1. Differentiate between flexible and rigid flatfoot deformities, and between congenital and acquired flatfoot deformities.
2. Define *talipes calcaneovalgus*.
3. Discuss possible etiologies for talipes calcaneovalgus.
4. Discuss the physical findings associated with talipes calcaneovalgus.
5. Discuss the radiographic findings for talipes calcaneovalgus.
6. Provide a treatment plan for a patient with talipes calcaneovalgus.
7. Differentiate between talipes calcaneovalgus and congenital convex pes valgus.
8. Describe the soft tissue and bony pathology involved in talipes calcaneovalgus, as well as any associated deformities.
9. Describe any long-term sequelae associated with talipes calcaneovalgus.
10. List the physical examination tests used to determine the presence of ligamentous laxity.
11. Discuss the signs and symptoms associated with ligamentous laxity.
12. List any associated systemic pathologies associated with ligamentous laxity such as trisomy 21(Down's Syndrome), and neuromuscular diseases.
13. List common biomechanical deformities associated with flexible flatfoot.
14. Describe treatments available for flexible flatfoot.
15. Define congenital vertical talus(congenital convex pes valgus) and list the synonyms for this deformity.
16. Discuss possible etiologies for congenital vertical talus (congenital convex pes valgus.)
17. Discuss the physical exam findings associated with congenital vertical talus (congenital convex pes valgus.)
18. Describe the soft tissue and bony pathology involved in congenital vertical talus (congenital convex pes Valgus), as well as any associated pathology.
19. Describe the radiographic findings associated with congenital vertical talus (congenital convex pes valgus.)
20. List and describe choices of treatments for congenital vertical talus (congenital convex pes valgus), and describe any long-term sequelae associated with the deformity.
21. Describe the surgical procedures used in the treatment of congenital vertical talus (congenital convex pes valgus).
22. Define *oblique talus* and differentiate from vertical talus.
23. Describe the etiology, diagnosis, examination, and treatment of oblique talus.
24. Define *tarsal coalition*.
25. Describe the signs and symptoms associated with tarsal coalitions.
26. List the different types of coalitions in order of their frequency of occurrence.
27. Discuss pertinent radiographic projections and expected findings for each of the tarsal coalitions.
28. Discuss more advanced imaging techniques that may be used for the evaluation of tarsal coalitions.
29. List and discuss conservative and surgical options for each of the tarsal coalitions.
30. Describe the long-term sequelae for tarsal coalitions.
31. Discuss peroneal spastic flatfoot as a symptom of tarsal coalitions.
32. Discuss the diagnosis, treatment, and other etiologies of peroneal spastic flatfoot.
33. Define *flexible pes planus*.
34. Describe flexible pes planus in the pediatric patient.
35. List the etiologies for flexible pes planus.
36. Describe the clinical and radiographic findings in flexible juvenile pes planus.
37. List the common conservative treatment plans for juvenile pes planus.
38. Differentiate treatment plans for flexible and rigid pes planus.

39. Describe the orthotic control and devices used for juvenile pes planus.
40. Describe the treatment of the asymptomatic severe juvenile pes planus.
41. Review the non-treatment of the mild flexible pes planus.
42. Differentiate pes planus from normal childhood ontogeny.
43. Define *rigid pes planus*.
44. List the possible etiologies for rigid pes planus.
45. Describe the clinical findings in pes planus.
46. Describe the radiographic evaluation of rigid pes planus.
47. State the natural history of rigid pes planus.
48. Describe orthotic control devices and other conservative treatment (e.g., shoes, shoe modification, bracing) prescribed in the treatment of rigid pes planus.

F. Cavus Deformities

1. Recognize pes cavus (congenital cavus, calcaneocavus, and cavovarus).
2. Describe the Lateral Coleman Block Test. How is it used preoperatively?
3. Describe the soft tissue and bony involvement in the cavovarus deformity.
4. Describe any other pathology associated with cavovarus deformity.
5. Describe the treatment options for cavovarus.
6. Describe the appearance of the cavoadductus foot type.
7. Describe the soft tissue and bony involvement in the cavoadductus deformity.
8. Describe any other pathology associated with cavoadductus deformity.
9. Discuss treatment options for cavoadductus.
10. Describe the appearance of the calcaneocavus foot type.
11. Describe the soft tissue and bony involvement in the calcaneocavus deformit.
12. Describe pathology associated with calcaneocavus.
13. Discuss treatment option for calcaneocavus.
14. Discuss the likelihood of a concurrent neurological disease with the presence of a cavus foot deformity.
15. Discuss the significance of a unilateral, acquired cavus foot deformity versus a bilateral, acquired cavus foot deformity.
16. Outline the neurological and/or neuromuscular diseases associated with cavus foot deformity.

III. Juvenile Hallux Valgus and Digital Deformities

1. Identify common congenital digital deformities.
2. Recognize the etiological factors in congenital digital deformities.
3. Describe the conservative management of digital deformities.
4. Outline common surgical approaches for juvenile digital deformity.
5. Define and discuss *congenital hallux valgus*.
6. Define and discuss *infantile hallux valgus*.
7. Define and discuss *juvenile hallux valgus*.
8. Define and discuss *adolescent hallux valgus*.
9. Discuss the clinical recognition of hallux valgus.
10. Outline the radiographic interpretation of hallux valgus.
11. Discuss clinical and surgical decision making for the treatment of hallux valgus.
12. Describe and discuss the sagittal plane deformities of the second and fourth toes.
13. Describe and discuss the varus rotation deformities of the third and fourth toes.
14. Discuss surgical decision making for the treatment of second, third, and fourth toe digital deformities.
15. Define digiti quinti varus.

16. Define hallux abducto valgus.
17. Define hallux varus.
18. Define curly toe.

19. Describe and discuss the etiology, clinical appearance, radiographic assessment, and treatment of polydactyly, brachymetatarsia, and syndactaly.
20. Discuss the etiologies of macrodactyly.

IV. Pediatric Trauma and Child Abuse

1. Discuss the physician's role and legal responsibilities in suspected child abuse.
2. Discuss the different types of child abuse and the signs and symptoms of each type.
3. Discuss the common fracture types associated with child abuse.

RADIOLOGY

LEARNING OBJECTIVES

1. Describe the components of a lower extremity x-ray unit, including tubehead, beam limitation devices, and control panel.
2. Describe in detail basic x-ray tubehead components, including:
    a. cathode with filament(s), focusing cup, anode with embedded target, anode angle, window, filtration, tube housing, and collimator;
    b. rotating versus stationary anodes;
    c. line-focus principle and central ray.
3. Describe x-ray production in terms of:
    a. cathode interactions: thermionic emission and space charge formation;
    b. functional cathode design considerations: focusing cup;
    c. functional anode design considerations: stationary versus rotating, line-focus principle;
    d. anode angle, the line focus principle, and the effect on image sharpness versus heel effect;
    e. anode interactions: Bremsstralung and characteristic x-ray production;
    f. significance of milliamperage and kilovoltage.
4. Define x-ray beam intensity in terms of photonic quantity and quality and units of measure.
5. Illustrate how the following basic factors affect beam intensity:
    a. intensity = quantity x quality of photons in beam
    b. units of exposure (Roentgens)
    c. heel effect (non-uniform intensity)
6. Identify and describe three major factors that affect x-ray beam intensity via photon quantity:
    a. kVp
    b. mA
    c. distance
7. Identify and describe the primary factor that affects x-ray beam quality:
    a. kVp
8. Compare and contrast the major interactions of diagnostic x-rays within matter, centering on the concepts of penetration, attenuation, photoelectric interactions and Compton scattering.
9. Relate the significance of photoelectric interactions and Compton scattering in terms of safety and image quality.
10. Define the following terms used to quantify radiation absorption in matter and biologic systems:
    a. Gray (Rad)
    b. Sievert (Rem)
11. Define *exposure*, *absorbed dose*, *dose equivalent.*
12. Discuss the advantages and disadvantages between film, CR, and DR image receptors
13. Discuss fluoroscopic image intensifiers in terms of basic construction *and* how they work:
    a. input phosphor
    b. photocathode
    c. output phosphor
    d. focusing lens
    e. television image monitoring
14. Discuss basic scatter radiation “maps” and explain where to stand relative to orientation of tube head and image intensifier.
15. List/Identify basic determinants of scatter radiation.
16. Define radiographic image *density (brightness)*.
17. Discuss the factors that influence radiographic image density/brightness, and how they affect it, including:
    a. milliamperage, mAs;
    b. distance;
    c. kilovoltage, kVp;

d. 15% rule

18. Define radiographic contrast.
19. Correlate basic subject factors with their influence on final image contrast, including:
    a. Image contrast as defined by thickness differences
    b. density differences
    c. effects of kilovoltage
20. Describe digital radiographic aritifacts.
21. List the factors that typically result in images being too light or too dark.
22. Explain image detail and identify the factors that influence appearance.
23. Identify the basic causes for a blurred image, and alteration of an object's shape or position.
    a. motion blur
    b. geometric factors
24. Define distortion and identify factors that influence its appearance.
25. *Radiation Safety:* Discuss the biological effects of ionizing radiation, and how radiation may affect the human body.
    a. Recount the basic molecular and macromolecular effects of ionizing radiation within the cell, both direct and indirect.
    b. Distinguish between threshold and non-threshold dose/response curves.
    c. Contrast the relative/differential radiosensitivity of somatic cells.
    d. Compare and contrast deterministic and stochastic effects of radiation.
    e. Compare and contrast acute and long-term effects of ionizing radiation.
    f. Discuss the major early (acute) effects of ionizing radiation on the human body.
    g. Discuss the late (long term) effects of ionizing radiation.
26. Radiation Safety: Minimizing Effects of Radiation - Enumerate principles and basic techniques available to reduce exposure to patients and operators.
    a. Explain how time, distance, and shielding from a radiation source generally influence the amount of exposure.
    b. Explain the "ALARA" principle.
    c. Outline the adverse effects of improper collimation
27. Describe the different types of radiation protective clothing and explain protective barriers and radiation dosimetry badges.
28. Define dose limits as they apply to current annual dose limits of thyroid, skin, hands, and feet; lens of the eye; cumulative lifetime; and whole body dose limits for radiation workers, the general public, and the fetus.
29. Define position*,* projection*, and* view*.*
30. Explain the significance of positioning the foot and ankle in the angle and base of gait.
31. For each of the following weight bearing & non-weight bearing **views**:
    Foot: dorsoplantar (A-P), lateral, lateral oblique, medial oblique, calcaneal axial (Harris-Beath), and axial sesamoid
    Ankle: anteroposterior, mortise, medial oblique, lateral oblique, lateral, lateral stress, anterior stress, and inversion stress
    A) Describe the proper technique
    B) List and discuss indications
    C) Identify the normal radiographic anatomy
32. For the forefoot, midfoot, & rearfoot angles in the transverse, frontal, and sagittal plane:
    A) Identify the angles/axes and measurements
    B) Discern normal from abnormal
    C) Recognize the angular characteristics and how they change in the various pathologies (flatfoot, cavus foot, metatarsus adductus, etc.)

33. Relate typical changes associated with various foot deformities, such as: flatfoot, cavus foot, vertical talus, metatarsus adductus, clubfoot, and hallux valgus.
34. Identify the accessory ossicles of the foot and ankle.
35. Describe the age of appearance, variants, and completion of ossification of the primary and secondary ossification centers of the foot and ankle for both male and females.
36. List the major disorders affecting acceleration and delay in osseous maturation.
37. For the following advanced imaging studies, Tc-99 MDP, Tc -99 HMPAO, indium-111, sequential sulfur colloid/WBC scanning, hybrid SPECT/CT scanning, hybrid FDG-PET/CT & hybrid PET/MRI scanning:
    a. Explain the basic techniques of administration, optimal scan times, and general indications and contraindications
38. Explain the basic interpretation of nuclear medicine studies as they apply to complicated diabetic foot infections and Charcot neuroarthropathy
40. Discuss the basic principles and application of ultrasound as applied to foot and ankle musculoskeletal imaging.
41. Identify the main components and functions of the ultrasound and the effects of probe frequency on depth penetration and spatial resolution.
42. Identify and describe anisotropy; edge shadowing, posterior acoustic enhancement; posterior acoustic shadowing; partial volume artifact; and reverberation.
43. Define *hyperechoic*, *anechoic*, *hypoechoic*, *fibrillar*, and *isoechoic*.
44. Describe the main indications and limitations of musculoskeletal diagnostic ultrasound.
45. Recognize the normal *and* pathologic ultrasound appearance on short axis and longitudinal axis of:
    a. plantar fascia, plantar fasciosis, and fascial rupture
    b. Achilles tendon, tendinosis, complete rupture
    c. fluid-filled soft tissue mass
    d. foreign body
46. Discuss the principles of sectional x-ray imaging that forms the basis for CT scanning.
47. Identify sectional anatomy and imaging planes as seen on CT/MRI sections.
48. List basic pedal indications and contraindications for CT scanning.
49. Discuss MRI of the foot and ankle in terms of indications and contraindications.
50. Identify T1, T2W & STIR images with respect to normal anatomy.
51. Identify T1, T2W & STIR images with respect to the following pathologies:
    a. Tumor/tumor-like lesions
        i. lipoma – ST
        ii. Morton's neuroma
        iii. plantar fibroma
        iv. ganglionic cyst
        v. pigmented villonodular synovitis (PVNS)
        vi. giant cell tumor of tendon sheath
    b. Tendonopathy
        i. Achilles tendon
        ii. posterior tibial tendon
        iii. peroneal (Fibularis)
    c. Trauma
        i. fractures
        ii. OCD
        iii. AVN
        iv. Lisfranc injuries
        v. ankle ligament sprain
    d. Infections
        i. soft tissue, abscess, cellulitis

ii. bone acute and chronic osteomyelitis

e. Miscellaneous
   i. plantar fasciitis
   ii. Charcot joint disease
   iii. tarsal coalition
   iv. foreign body

52. List indications and contraindications for the use of contrast (gadolinium) in MR imaging.
53. Recognize comminuted (butterfly fragment), greenstick, torus, impaction, distraction, avulsion, stress, pathological, displaced, non-displaced, angulated, rotated, complete, incomplete fractures.
54. Explain what is meant by apposition and alignment of fractures in terms of angulation, rotation, displacement, and distraction.
55. Describe *congruity, dislocation, subluxation, diastasis,* and *effusion* as related to the radiographic appearance of joints.
56. Identify & describe transverse, oblique, spiral, and intra-articular and extra-articular fracture patterns**.**
57. Identify and describe delayed union, nonunion (hypertrophic, and atrophic), malunion, and pseudoarthrosis, in relation to improper fracture healing.
58. Classify and identify on radiographic ankle images talar dome fractures using the Berndt-Harty grading system.
59. Classify and identify calcaneal joint depression fractures using the Sanders CT system.
60. Define and identify *Hawkins' sign.*
61. Describe and identify on x-ray the Salter-Harris classification of epiphyseal plate fractures.
62. Describe and identify the imaging findings of avascular necrosis (osteonecrosis) in both adult and pediatric bone.
63. Identify the location and etiology of Legg-Calve-Perthes, Osgood-Schlatter, Blount's, Sever's, Kohler's, Iselin's, Freiberg's, Renandier's/Treve's, and Diaz' diseases.
64. Discuss the *four* stages of the Eichenholtz radiographic classification of neuropathic bone disease (Charcot), along with the clinic-radiographic correlation with each stage.
65. Describe the radiographic presentations of osteomyelitis in terms of acute, subacute, or chronic (involucrum, cloaca, sequestrum); and hematogenous vs. direct extension/direct inoculation.
66. Identify and describe the radiographic changes of pyogenic septic arthritis.
67. Identify and describe the radiographic changes of soft tissue infections (emphysema, obliteration of fascial planes, ulceration, sinus track).
68. Discuss the appropriate use of radiographic modalities for diagnosis of osteomyelitis and its differentiation from neuropathic bone disease and diabetic osteolysis.
69. Identify on radiograph image the features of the following pedal arthropathies:
    a. Rheumatoid arthritis
    b. Seronegative spondyloarthropathies
    c. Gout/tophaceous gout
    d. CPPD/Pseudogout/chondocalcinosis
    e. Diffuse idiopathic skeletal hyperostosis (DISH)
    f. Osteoarthritis
70. Identify typical radiographic features, and distinguish between generalized (bilateral) regional (unilateral), and local/focal osteopenia.
71. Radiographically differentiate between rickets, osteomalacia, and scurvy.
72. Delineate the basic radiographic features of primary & secondary hyperparathyroidism.
73. Identify and describe the radiographic features of renal osteodystrophy.
74. Identify and describe the radiographic features of Paget's disease.
75. Identify and describe the radiographic features of pedal acromegaly.
76. List the basic differentials for generalized periostitis.

77. Describe and recognize the basic radiographic features of sickle-cell disease (infarcts/decreased bone density)/beta thalassemia (decreased bone density).
78. Identify and describe the typical radiographic features of enostosis, lead intoxication, osteopetrosis, melorheostosis, osteopoikilosis, osteopathia striata.
79. Identify the radiographic features of myositis ossificans.
80. Describe and radiographically delineate Monckeberg medial calcific sclerosis, ASO/atherosclerosis, and phleboliths.
81. Describe, identify, and differentiate between the general radiographic features of slow-growing vs. aggressive bone tumor and tumor-like conditions in relation to margins (zone of transition), appearance of bone matrix, and periosteal reaction.
82. Identify and describe the radiographic characteristics of the following bone tumors and/or tumor-like lesions:
    a. Cartilaginous
        i. Osteochondroma & subungual exostosis
        ii. enchondroma
        iii. chondroblastoma
        iv. chondromyxoid fibroma
    b. Fibrous
        i. nonossifying fibroma
        ii. fibrous cortical defect
        iii. fibrous dysplasia
    c. Osseous
        i. osteoid osteoma
        ii. osteoblastoma
        iii. bone island
        iv. bone infarction
    d. Malignant
        i. Ewing's sarcoma
        ii. chondrosarcoma
        iii. conventional osteogenic sarcoma
        iv. metastases
    e. Miscellaneous
        i. solitary (unicameral) bone cyst
        ii. intraosseous lipoma
        iii. aneurysmal bone cyst
        iv. giant cell tumor
        v. bone abscess (including Brodie's abscess)
83. Identify the plain film radiographic characteristics of tarsal coalitions.

SURGERY and ANESTHESIOLOGY

LEARNING OBJECTIVES

Anesthesiology

Hospital Protocol

Tumor Surgery

Operating Room Technique

Postoperative Complications

First Metatarsal Surgery

Lesser Digital Surgery

Flat Foot Surgery

Cavus Foot Surgery

Equinus Conditions and Surgery

Traumatology

Nerve Surgery

Heel Surgery

Soft Tissue Surgery

Specific Conditions Involving Surgery

Pediatric Surgery

General Surgical Conditions

Tarsal Coalitions

Arthroscopy and Endoscopy of the Foot and Ankle

I. Anesthesiology

A. Perioperative Management of the surgical patient

1. Describe the components of pre-anesthetic evaluation, including importance and application to the ASA Physical Classification System.
2. Describe anesthetic implications for the common disease states affecting the cardiovascular, pulmonary, neurologic, metabolic and endocrine, hepatic and renal, hemopoietic and musculoskeletal systems.
3. Discuss the impact of perioperative medications on outpatients and inpatients with co-existing disease.
4. Discuss allergic reaction prophylaxis and infection prophylaxis with respect to the anesthetic patient.

B. Intra-operative Management of the Surgical Patient

1. Describe the indications for and goals of monitoring for patients undergoing procedures under local, regional, and general anesthesia.
2. Describe indications for the following types of monitors in anesthesia:
    a. blood pressure
    b. pulse oximetry
    c. EKG
    d. temperature (aural and esophageal)
    e. capnography
    f. neuromuscular injury that may result from poor positioning

C. Airway Management for Patients Undergoing Anesthesia

1. Discuss assessment methods for airway patency and classify common airway systems.
2. Describe conditions that predispose a patient to airway impairment.

D. Local Anesthesia

1. Classify nerve fiber in relation to local anesthetic actions.
2. Make pharmacologic recommendations for the use of amide and ester local anesthetic for plain and non-plain solutions in podiatric medicine, including mechanism of action, pharmacodynamics, and pharmacokinetics.
3. Identify known toxic doses for local anesthetics used in podiatric medicine, and recognize signs, symptoms, and management of toxic reaction to local anesthesia.
4. Differentiate between toxic and allergic reaction to local anesthesia, including clinical findings, and management of anaphylactic shock.

E. Intravenous Anesthesia

1. Explain the concept of “ideal” anesthetic, and describe advantages and disadvantages of IV anesthetics.
2. Distinguish between opioid and non-opioid IV anesthetics.
3. Recall the pharmacology, including mechanism of action, pharmacodynamics, pharmacokinetics, clinical uses, contraindications, and adverse effects of benzodiazepines, barbiturates, etomidate, and Ketamine.

4. Recall the pharmacology, including the mechanism of action, pharmacodynamics, pharmacokinetics, clinical uses, contraindications, and adverse effects of Fentanyl, meperidine and morphine.
5. Give examples of opioid antagonists and mixed agonist antagonist opioids.
6. Describe indications and goals of Total IV Anesthesia (TIVA).

F. General Anesthesia

1. Define *general anesthesia* and describe its advantages and disadvantages.
2. Describe the general mechanism of action, stages, and planes of general anesthetics.
3. Recall the pharmacology, including the mechanism of action, pharmacodynamics, harmacokinetics, and toxicity of N2O and volatile anesthetics.
4. Describe risks and benefits of inhaled anesthetics, including risk for developing malignant hyperthermia, manifestations, and treatment.
5. Recall the pharmacology, including mechanism of action, pharmacokinetics, pharmacodynamics, clinical uses, and contra-indications of the commonly used muscle relaxants.
6. Describe the use and limitations for monitoring neuromuscular blockade, and identify drugs used to reverse neuromuscular blockade.

G. Regional Anesthesia

1. Recall the anatomy of the spinal column and peripheral nervous system in relation to administration.
2. Describe the advantages and disadvantages of administering regional anesthesia, including associated safety issues.
3. Describe principles of neuraxial anesthesia, including the indications and contra-indications, physiologic effects and mechanism of action, effect of position, complications, and drugs utilized for spinal anesthesia.
4. Describe indications, contra-indications, physiologic effects, mechanism of action, complications, and drugs utilized for epidural anesthesia.
5. Indicate general principles of peripheral nerve blockade, including indications, contra-indications, and complications.
6. Describe the common local anesthetic agents used in and the techniques used for the common regional blocks of the lower extremity, including sciatic, femoral, popliteal, common peroneal, posterior tibial, sural, saphenous, and Bier block.

II. Hospital Protocol

A. Charting and Orders

1. Explain essential components of admission history and physical notes.
2. Explain essential components of a pre-operative note, post-operative note, and operative report.
3. Explain essential components of admission orders, peri-operative orders, pre-operative orders, and post-operative orders.

B. Informed Consent

1. Explain informed consent, including medico-legal implications.
2. Identify the party that may give informed consent, and in what circumstances it is required.

C. Admitting and Consulting Protocol

1. Describe regulations (ex. JCAHO) pertaining to podiatric physicians performing histories and physicals for the purposes of hospital admission.

D. Organization of Hospital Staff

1. Differentiate between hospital medical staff and other staff, such as allied health.
2. Explain principles of granting hospital privileges to clinical staff.
3. Describe clinical privileges granted to hospital staff, including:
    a. active
    b. admitting
    c. consulting
    d. courtesy
    e. surgical

III. Tumor Surgery

A. Biopsy Techniques

1. Describe general indications for performing biopsies.
2. Differentiate between excisional, incisional, punch, shave, fine needle, and needle core biopsies.
3. Summarize indications and contra-indications for excisional, incisional, punch, shave, fine needle, and needle core biopsies.

B. Soft Tissue Tumors

1. Demonstrate knowledge of clinical and radiographic differences between malignant and benign soft tissue tumors.
2. Describe the salient clinical features and surgical treatment of the following types of malignant lesions of fat, muscle, and nerve origin of:
    a. liposarcoma
    b. rhabdomyosarcoma
    c. neurofibrosarcoma
3. Explain the significance of skin metastases in terms of primary disease state, and identify the most common primary lesions in males and females that give rise to metastases to the skin.

C. Bone Tumors

1. Demonstrate knowledge of clinical and radiographic differences between malignant and benign bone tumors.
2. Describe the salient clinical features and surgical treatment of the following types of benign bone tumors:
    a. chondroma
    b. chondroblastoma
    c. enchondroma
    d. ossifying and non-ossifying fibroma
    e. anneurysmal and unicameral bone cysts
    f. osteoid osteoma
    g. osteoblastoma
    h. osteochondroma

i. multiple hereditary exostosis
j. giant cell tumor
k. intraosseous ganglion
l. intraosseous lipoma

D. General Principles of Cancer Staging

1. Describe the staging of cancer via the TNM System.
2. Describe the role of the American Cancer Society in staging various cancers that affect the skin and musculoskeletal systems.

IV. Operating Room Technique

A. Asepsis

1. Explain Universal Precautions and their application to sterile technique and within the OR environment.
2. Describe and apply essential components of sterile technique.
3. Describe and apply the concept of "Surgical Conscience" and explain potential consequences of breeches in sterile technique, with respect to self and operating field.
4. Explain routine and biohazard waste handling procedures, as well as general cleaning standards for the OR.
5. Discuss principles of asepsis, sterilization, and autoclaving.

B. Instrumentation

1. Classify, including uses of non-power instrumentation commonly found in a basic foot/ankle surgery tray.

C. AO Technique/External Fixation Principles

1. Explain principles of AO fixation.
2. Discuss the application of AO technique to foot and ankle surgery and its role in bone healing.
3. Describe the mechanical basis of stable and rigid internal fixation.
4. Explain "lag screw" and the techniques utilized in insertion.
5. Describe the concepts and techniques utilized in static and dynamic interfragmental compression.
6. Explain and apply indications for different types of plates and screws.
7. Identify and describe instrumentation found in the Mini, Small, and Large Fragment, and Cannulated AO Sets.
8. Explain the principles and techniques that dictate the use of K wires and cerclage wires.
9. Explain the principles and types of external fixation devices used in foot and ankle surgery.
10. Describe the role of immobilization in foot and ankle surgery.

D. Sutures/Technique

1. Explain general principles of usage of the following sutures in foot and ankle surgery:
    a. stainless steel wire
    b. nylon, polyester
    c. polyethylene
    d. polypropylene

e. polyglycolic acid
f. polydioxanone

2. Classify and describe commonly used suture material utilized in foot and ankle surgery.
3. Describe biological and mechanical properties of absorbable and non-absorbable sutures.
4. Discuss surgical needles commonly used in foot and ankle surgery, including material used for construction, and classify them according to needle type, size, curvature, and cross-section, with reference to the needle coding system.
5. Describe the commonly used suture techniques in foot and ankle surgery, including the use and performance of the following techniques: simple, mattress (vertical and horizontal), retention (superficial and deep), subcuticular, and running.
6. Describe indications for Kessler, Bunnell, and Krakow suture technique in foot and ankle surgery, as well as other types of techniques used in tendon repair.
7. Explain general principles and instrumentation and techniques which may be used for repairing:
    a. tendon:tendon
    b. tendon:bone
    c. soft tissue anchor:bone

E. Other Biomaterials

1. Describe physical and mechanical properties of materials used for implants in foot and ankle surgery.
2. Describe physical and mechanical properties of non-metallic materials used in foot and ankle surgery.
3. Describe physical and mechanical properties of bone graft materials and substances used in foot and ankle surgery.
4. Describe the use of topical hemostatic agents used in foot and ankle surgery.
5. Describe the indications for and types of bone stimulators used in foot and ankle surgery.
6. Explain basic principles and functions of surgical dressings, including description of dressing materials and the anatomy of a surgical dressing.

V. Postoperative Complications

A. Systemic Medical (Inpatient Only)

1. Identify and recognize the causes of altered mental status of a patient in the postoperative period.
2. Identify and recognize the causes, signs, symptoms, and sources of postoperative dehydration.
3. Identify and recognize potential causes, signs and symptoms of chest pain (Atelectasis versus MI versus PE versus Other) in the postoperative period.
4. Identify the causes, signs, symptoms and diagnostic indicators of postoperative urinary tract infection.
5. Identify and recognize the causes, signs, symptoms and diagnostic indicators of postoperative blood glucose anomalies (diabetic ketoacidosis, hypoglycemia).

B. Outpatient and Inpatient

1. Identify and recognize the causes, risk factors, signs/symptoms and management strategies of postoperative gastrointestinal pathology including:
    a. constipation
    b. fecal impaction

c. nausea
d. vomiting
e. diarrhea (pseudomembranous colitis secondary to antibiotic)
f. management strategies
g. superficial phlebitis
h. deep venous thrombosis
i. pulmonary embolism

2. Identify and recognize the causes and risk factors of postoperative fever, and recommend management strategies for:
    a. atelectasis and pneumonia (aspiration)
    b. DVT, infection at the surgical site
    c. other infection (UTI/catheter)
    d. medication related (anticholinergic)
3. Identify and recognize the causes, risk factors and signs/symptoms of normal postoperative blood loss versus excessive blood loss secondary to bleeding disorders and coagulopathies.
4. Understand and recommend management strategies for abnormal postoperative bleeding.
5. Distinguish between normal postoperative pain and intractable allodynia.
6. Identify and recognize causes, risk factors, and signs/symptoms of intractable postoperative pain including:
    a. CRPS
    b. post-tourniquet compression neuralgia
    c. bandage/cast related pain

C. <u>Foot and Ankle Specific</u>

1. Identify, recognize causes, risk factors and signs/symptoms of causes for postoperative ischemia, and recommend management strategies, for:
    a. digital and total limb ischemia
    b. wound/surgical site infections
2. Identify and recognize causes, risk factors and signs/symptoms of postoperative wound/skin complications, and recommend management strategies, including:
    a. excessive edema
    b. hematoma
    c. seroma
    d. suture abscess
    e. wound dehiscence
    f. hypertrophic/keloid scar
3. Identify and recognize causes, risk factors and signs/symptoms of complications associated with bone healing, including:
    a. nonunion (septic and aseptic)
    b. delayed union
    c. malunion
4. Identify and recognize causes, risk factors, and signs/symptoms of hardware complications, including pin site complications and internal/external hardware failure.
5. Understand and recommend management strategies for hardware complications.
6. Identify and recognize causes, risk factors, and signs/symptoms, of postoperative vascular necrosis.
7. Identify and recognize causes, risk factors, and signs/symptoms of specific foot and ankle surgery related complications, including:
    a. transfer lesions

b. alignment complications (under/over correction)
c. capsulitis and joint stiffness, and
d. bandage/cast attributed wounds.

VI. First Metatarsal Surgery

A. Base Procedures of the First Metatarsal for the Correction of Hallux Valgus

1. Explain procedures, indications, and contraindications for performing base osteotomies of the First metatarsal to correct hallux valgus deformity, including the concepts of osteotomy design and use of axis guides.
2. Explain the hinge axis concept including the components of the hinge, the placement of the hinge/axis, the motion about the hinge, and the orientation of the axis.
3. Identify potential complications that arise from performing base osteotomies to correct hallux valgus deformity.
4. Recommend the post-op course when performing base procedures.

B. First Metatarsal Cuneiform Arthrodesis (Lapidus) for the Correction of Hallux Valgus Deformity

1. Describe indications, contraindications, and techniques for performing first metatarsal cuneiform arthrodesis.
2. Identify potential complications that arise from performing first metatarsal surgeries for the Lapidus type procedure.
3. Identify metatarsal cuneiform joint instability/hypermobility.
4. Identify clinical and radiographic frontal plane deformity at the metatarsal cuneiform joint.
5. Recognize operating systems for multiplanar deformity correction at first metatarsal cuneiform joint.
6. Understand the post-op management of the first metatarsal cuneiform arthrodesis.

C. Etiology and Radiographic Assessment of Hallux Valgus Deformity

1. Explain and recognize the etiology of hallux valgus deformity, including the biomechanics, heredity, inflammatory rheumatogic diseases, neurological disorders, environmental factors, trauma, and surgical complications.
2. Explain the importance in performing a clinical and physical evaluation of a patient with hallux valgus deformity.
3. Describe normal and abnormal angles used in the radiographic evaluation of a hallux abducto valgus deformity in transverse, sagittal, and frontal planes, including metatarsus adductus angle, IM angle, hallux abductus angle, PASA, DASA, hallux abductus interphalangeus angle, metatarsal protrusion distance, phalangeal length and sesamoid position.
4. Recognize and distinguish frontal plane deformity associated with hallux valgus.
5. Recognize imaging techniques (cone beam ct) for evaluation of frontal plane deformity of the first metatarsal.

D. Soft Tissue Procedures for Correction of Hallux Valgus Deformity

1. Describe the surgical anatomy of the first metatarsal and sesamoid complex, as well as the ligamentous attachments of the first MTPJ.

2. Describe soft tissue procedures utilized in correction of hallux valgus deformity, including muscle tendon balancing procedures and the concepts of the lateral release including the ligamentous attachments of the first MTPJ.
3. Identify the role of lateral soft tissue release as a component in surgical management of hallux valgus on the frontal and transverse plane.

E. Phalangeal Osteotomies Utilized as a Component in Hallux Valgus Management

1. Identify structural deformities of the proximal phalanx, to include hallux interphalangeus, elongated proximal phalanx and possible adaptive remodeling of the base of the proximal phalanx (DASA).
2. Describe phalangeal osteotomies that address structural deformities of the proximal phalanx.
3. Recognize hammered hallux as deformity of the great toe.
4. Summarize indications for hallux IPJ fusion.

F. Distal Osteotomies of the First Metatarsal for the Correction of Hallux Valgus Deformity

1. Summarize and describe the procedures, indications, and contraindications of distal osteotomies as procedures used in correction of hallux valgus deformity.
2. Describe which planes of deformity are addressed with specific distal osteotomies.
3. Describe distal osteotomy modifications that address multi-planar deformity.
4. Describe minimally invasive distal osteotomies in the surgical management of hallux vallgus.
5. Describe and recognize fixation modalities for distal osteotomy hallux vallgus management.
6. Identify the potential complications specific to any of the distal osteotomies used to correct hallux valgus deformities.

G. Shaft Osteotomies of the First Metatarsal for the Correction of Hallux Valgus Deformity

1. Summarize the procedures, indications, and contraindications of the shaft osteotomies of the first metatarsal as procedures used in correction of the hallux valgus deformity.
2. Recognize planal deformity correction with midshaft first metatarsal osteotomies.
3. Identify the potential complications specific to any of the shaft osteotomies of the first metatarsal used to correct hallux valgus deformities.

H. Hallux Varus

1. Explain the etiology of the pathomechanics, including iatrogenic versus non-iatrogenic, of hallux varus deformity.
2. Describe the treatment plan to correct hallux varus deformity including surgical techniques, both soft tissue and osseous.

I. Hallux Limitus/Rigidus

1. Discuss the pathomechanics, etiology, and clinical presentation of hallux limitus and hallux rigidus.
2. Describe joint preserving surgical procedures used to correct hallux limitus/rigidus including cheilectomy, and osteotomy.
3. Describe procedures used for joint resection including arthroplasty, interposition arthroplasty, and replacement arthroplasty for hallux limitus/rigidus.
4. Describe the role of the first MTPJ Fusion for hallux limitus/rigidus.
5. Identify postoperative complications that may result from surgery for hallux limitus/rigidus.

J. Juvenile Hallux Valgus

1. Explain etiologies for juvenile hallux valgus deformity and the mechanism of action.
2. Identify growth plate status when planning Juvenile Hallux Valgus surgery.
3. Describe indications and contraindications for performing juvenile hallux valgus surgery, including muscle tendon balance procedures, base osteotomies, head osteotomies, epiphysiodeses, and ancillary procedures.
4. Identify postoperative complications following juvenile hallux valgus surgery.

VII. Lesser Digital Surgery

1. Identify, classify, and evaluate lesser (2–5) digital deformities and conditions.
2. Evaluate the pathophysiology or pathomechanics of digital deformity, including effects of equinus, pes cavus and extensor substitution; flatfoot and flexor stabilization; muscle weakness and flexor substitution; and first ray instability and load transfer on digital deformity.
3. Discuss regional anatomy of the lesser digits.
4. Recognize the soft tissue anatomy that act as the stabilizer of the metatarsal phalangeal joint.
    A. Plantar Plate
    B. Describe and interpret the Lachman test to assess the plantar plate
    C. Recognize and describe plantar and dorsal techniques for assessment and repair of the plantar plate
5. Discuss the technique, indications, contraindications, advantages, and disadvantages of each digital procedure.
    a. Soft tissue digital procedures:
        i. capsulotomy
        ii. tenotomy
        iii. tenectomy
        iv. tendon lengthening
            a) "Z" type
            b) extensor recession
    b. MTPJ sequential release:
        i. Kelikian push-up test between step evaluation
        ii. sequential steps: dorsal capsule, extensor brevis, collateral ligaments, flexor plate (plantar capsule release), extensor longus
    c. Tendon transfers:
        i. flexor tendon transfer (ex. Girdlestone)
        ii. extensor tendon transfer, Hibbs
    d. Syndactylism
    e. Osseous digital procedures:
        i. ostectomy/exostectomy/condylectomy
        ii. phalangectomy: partial/complete
        iii. arthroplasty (IPJ)
        iv. PIPJ implant arthroplasty
        v. diaphysectomy
        vi. phalangeal osteotomy
        vii. arthrodesis fusion (IPJ)
        viii. amputation
            a) partial: terminal Symes
            b) complete

1) transphalangeal
2) MTPJ
3) Partial ray

6. Discuss normal and abnormal aspects of the history and physical examination, including laboratory studies, diagnostic tests, or imaging studies that influence treatment plan.
7. Explain the instrumentation and material needs for performance of digital procedures.
8. Explain fixation and techniques, including physical characteristics, advantages/disadvantages, indications/contraindications, and applications.
9. Discuss the perioperative care requirements and postoperative management of each lesser digit procedure including abnormal aspects of the history and physical examination, including laboratory studies, diagnostic tests, or imaging studies that influence treatment plan.
10. Explain the potential complications of each digital procedure and its management.

A. <u>Central Metatarsal Surgery (Surgery Distal to the Tarsometatarsal Joints of Rays 2, 3, and 4)</u>

1. Evaluate the central (2–4) metatarsal deformities and conditions:
    a. shortened metatarsal
    b. elongated metatarsal (transverse plane digital deviation with Kelikian push-up test)
    c. plantarflexed metatarsal
    d. prominent plantar condyle
    e. MTPJ stress syndrome
        i. predislocation phase
        ii. dislocation phase
    f. dislocated MTPJ
    g. arthritic MTPJ
    h. rupture of plantar plate
2. Explain pathophysiology or pathomechanics of the metatarsal deformity, including the effect of equinus, pes cavus, and extensor substitution; flatfoot and flexor stabilization; muscle weakness and flexor substitution; and first ray instability and load transfer on digital deformity.
3. Discuss the regional anatomy of the lesser metatarsals.
4. Discuss the indications, contraindications, advantages, and disadvantages of each metatarsal procedure.
    a. central metatarsal procedures:
        i. various metatarsal shortening osteotomy (Weil, stepdown, chevron, etc.)
        ii. metatarsal lengthening procedures
            a) sagittal “Z” lengthening osteotomy
            b) cylindrical lengthening osteotomy with bone graft
            c) callous distraction (refer to section on congenital deformity)
    b. metatarsal adductus procedures, including multiple osteotomy management of metatarsus adductus
    c. metatarsal resection (eliminating) procedures:
        i. partial metatarsal head resection (MTPJ arthroplasty)
            a. distal metatarsal head (hemi (4 mm) joint resection)
            b. plantar condylectomy, including MTPJ implant arthroplasty
        ii. metatarsal head resection
            a. single
            b. multiple: pan metatarsal head resection
        iii. amputation
            a) isolated lesser ray amputation,
            b) transmetatarsal amputation (TMA)

c) Lisfranc amputation
d) chopart amputation

iv. lesser tarsometatarsal arthrodesis

5. Explain the instrumentation and material needs for performance of metatarsal procedures.
6. Explain the fixation techniques, including physical characteristics, advantages/disadvantages, indications/contraindications.
7. Discuss the perioperative care requirements and postoperative management of each metatarsal procedure including abnormal aspects of the history and physical examination, including laboratory studies, diagnostic tests, or imaging studies that influence treatment plan.
8. Explain potential complications of each metatarsal procedure and its management.

B. Fifth Metatarsal Surgery (Surgery Distal to the Tarsometatarsal Joint of Ray 5)

1. Discuss regional anatomy of the 5th metatarsal.
2. Discuss the pathophysiology or pathomechanics of the Tailor's Bunionette Deformity.
3. Identify, classify, and evaluate level(s) of the following fifth metatarsal deformities and conditions:
    a. Tailor's Bunionette deformity
        i. soft tissue deformity: bursitis, neuritis lateral to fifth met head
        ii. enlarged lateral condyle
        iii. lateral bowing of distal metatarsal shaft (lateral deviation angle increased)
        iv. lateral splaying of fifth metatarsal at metatarsal base (intermetatarsal angle increased)
    b. Arthritis Fifth MTPJ
4. Discuss the indications, contraindications, advantages, and disadvantages of fifth metatarsal procedures:
    a. bunionectomy of the fifth metatarsal without osteotomy
    b. bunionectomy of the fifth metatarsal with osteotomy
        i. distal shaft/head osteotomy
        ii. proximal base/shaft osteotomy
    c. metatarsal head resection
5. Explain fixation and techniques to fifth metatarsal surgery, including physical characteristics, advantages/disadvantages, indications/contraindications.
6. Discuss perioperative care requirements and postoperative management of each fifth metatarsal procedure including abnormal aspects of the history and physical examination, including laboratory studies, diagnostic tests, or imaging studies that influence treatment plan.
7. Explain potential complications of each fifth metatarsal procedure and its management.

VIII. Flat Foot Surgery

1. Recognize that there is not universal terminology when referring to Adult flatfoot deformity.
    i. Posterior Tibial Tendon Dysfunction (PTTD)
    ii. Adult Acquired Flat Foot
    iii. Progressive Collapsing Foot Deformity
2. Recognize characteristic clinical findings associated with flatfoot, including everted heel, abduction of the forefoot on the rearfoot, collapse of the medial column, flexibility, and rigidity.
3. Recognize, evaluate and diagnose ankle equinus as either a primary force or secondary adaptation with flat foot.
4. Identify etiological factors that require compensation and result in flatfoot deformity.

5. Explain planal dominance and determine the primary plane of compensation.
6. Perform a biomechanical evaluation for flat foot and correlate radiographic findings.
7. Differentiate a flexible versus rigid adult acquired flatfoot and determine the etiology.
8. Identify the pathologic collapsing pes valgus foot that requires surgical treatment (deformity, instability, pain, progression).
9. Recognize progressive flat foot deformity that results in compromise of the superficial and deep deltoid and spring ligament.
10. Recognize valgus ankle deformity as an end stage of progressive flat foot deformity.
11. Understand staging/classification of the adult flatfoot deformity to determine surgical management.
12. Explain the pathology of ankle equinus and its surgical management.
13. Describe indications for medial column soft tissue procedures utilized for flat foot (pes valgus deformity).
14. Describe the indications and surgical mechanics of lateral column lengthening (Evan's) and medial displacement calcaneal osteotomy (MDCO) for flat foot deformity.
15. Identify and understand the role of hindfoot fusion for progressive flatfoot deformity.
16. Describe indications for medial column osseous procedures utilized for flat foot (pes valgus deformity).
17. Describe indications, techniques, and implants utilized for subtalar arthroereisis.
18. Explain extraarticular calcaneal osteotomies with an arthroereisis effect on the subtalar joint.

IX. Pes Cavus Foot Surgery

A. Perioperative Management of the Surgical Patient

1. Define, describe, and identify a pes cavus foot both clinically and radiographically.
2. Classify pes cavus foot as flexible or rigid.
3. Recognize the pes cavus foot and its possible association with neuro-muscular disorders.
4. Identify neurologic conditions associated with pes cavus foot as progressive or static.
5. Classify pes cavus as congenital or acquired lesser tarsus cavus and forefoot cavus.
6. Recognize and understand pseudo equinus associated with pes cavus.
7. Describe and interpret the Coleman block test for evaluation of pes cavus.
8. Delineate the flexible and rigid components of pes cavus for surgical decision making.
9. Describe indications for and recommend soft tissue release as a component of pes cavus surgery.
10. Describe indications for and recommend specific tendon transfer procedures for muscle imbalance associated with pes cavus.
11. Describe indications and role of metatarsal osteotomies in the surgical management of anterior pes cavus.
12. Recognize and recommend midtarsal osteotomies for pes cavus.
13. Recognize and recommend calcaneal osteotomy for pes cavus.
14. Recognize and recommend arthrodesis procedures for rigid and or arthritic pes cavus.
15. Evaluate digital deformity associated with pes cavus and recommend surgical treatment options based on etiology and muscular imbalance.
16. Recognize lateral ankle instability associated with pes cavus deformity.

X. Equinus Conditions and Surgery

1. Describe the anatomy and function of the triceps surae and Achilles tendon.

2. Define equinus and differentiate muscular from osseous equinus or combined muscular-osseous equinus.
3. Perform and interpret the Silfverskiold test.
4. Identify proximal and distal compensations for equinus deformity.
5. Identify spastic and non-spastic equinus.
6. Understand and recommend conservative treatment modalities when appropriate for equinus deformities.
7. Describe the indications and various surgical techniques for a gastrocnemius recession.
8. Describe the indications and various surgical techniques for Achilles tendon tenotomies and lengthening procedures for gastrosoleus equinus.
9. Describe and recommend anterior advancement Achilles tendon procedures for gastrosoleus equinus.
10. Describe and recommend talotibial exostosis or other osseous block resection for osseous equinus.

XI. Traumatology

A. General Principles of Management of the Traumatized Patient

1. Describe the basic concepts of initial patient evaluation and emergency triage.

B. General Principles of Fracture Management

1. Evaluate radiographs, CT, MRI, as well as other special imaging modalities to identify forefoot, midfoot, and rearfoot trauma.
2. Describe the concepts of closed reduction, percutaneous fixation, and external fixation.
3. Discuss the determination for a closed reduction versus an open reduction.
4. Explain the concepts of open reduction and internal fixation.

C. Open Fracture Management, Including Gunshot Wounds

1. Discuss basic management of soft tissue trauma, including imaging, wound care, tetanus and appropriate antibiotic prophylaxis.
2. Describe the Gustillo and Anderson classification and its significance in the treatment and management of soft tissue injuries involving bone.
3. Recognize the basic characteristics of particular soft tissue wounds.
4. Describe and select appropriate wound treatment and the types of closure techniques.

D. Digital Trauma

1. Discuss common mechanisms and configurations of digital fractures.
2. Describe the concepts of closed reduction and open reduction of digital fractures.
3. Describe the long-term complications of digital fractures.
4. Describe appropriate management of nail trauma, including subungual hematoma, nail bed laceration with and without fracture.

E. First Metatarsal Fractures

1. Recognize and evaluate the basic clinical and imaging characteristics to enable appropriate treatment in reference to closed versus open reduction.
2. Describe the advantages and disadvantages of conservative versus surgical treatment in first metatarsal fractures.

3. Describe the external and internal fixation principles in reference to the first metatarsal.
4. Describe common metatarsal anatomical fracture types, including neck, midshaft, and base fractures; as well as joint dislocations, intra-articular fractures and avulsion fractures.
5. Describe common metatarsal fracture subtypes and discuss appropriate treatment and common long-term complications associated with such trauma.

F. Central Metatarsal Fractures (2, 3, 4)

1. Recognize and evaluate the basic clinical and imaging characteristics to enable appropriate treatment in reference to closed versus open reduction.
2. Describe the advantages and disadvantages of conservative versus surgical treatment in central metatarsal fractures.
3. Describe the external and internal fixation principles in reference to metatarsals.
4. Describe common metatarsal anatomical fracture types, including neck, midshaft, and base fractures; as well as joint dislocations, intra-articular fractures and avulsion fractures.
5. Describe common metatarsal fracture subtypes and discuss appropriate treatment and common long-term complications associated with such trauma.

G. Fifth Metatarsal Fractures

1. Differentiate between head, midshaft, proximal shaft, base, and avulsion fifth metatarsal fractures.
2. Differentiate between Zone I, II, III proximal fifth metatarsal fractures.
3. Recognize and evaluate the basic clinical and imaging characteristics to enable appropriate treatment in reference to closed versus surgical treatment.
4. Describe the advantages and disadvantages of conservative versus surgical treatment in fifth metatarsal fractures.
5. Describe the external and internal fixation principles in reference to the fifth metatarsal.
6. Describe the complications and concerns with avascular nonunion of a Jones fracture.

H. Lis Franc's Fracture

1. Understand the anatomy of the tarsometatarsal area as it relates to Lis Franc joint stability.
2. Recognize Lis Franc injuries and classify the injury pattern.
3. Discuss the basic principles of closed reduction of Lis Franc's fractures.
4. Recognize and evaluate the basic clinical and imaging characteristics to enable appropriate treatment in reference to closed versus open reduction.
5. Describe the advantages and disadvantages of conservative versus surgical treatment in Lis Franc's fractures.
6. Describe internal and external fixation techniques and principles in reference to the Lis Franc fracture.
7. Describe common Lis Franc fracture subtypes and discuss appropriate treatment and common long-term complications associated with such trauma.

I. Midfoot Fractures (Navicular, Cuneiforms, Cuboid)

1. Discuss the basic classifications and mechanisms of midfoot fractures.
2. Recognize and evaluate the basic clinical and imaging characteristics to enable appropriate treatment in reference to closed versus open reduction.
3. Describe the advantages and disadvantages of conservative versus surgical treatment in midfoot fractures.

4. Describe internal and external fixation principles in reference to the midfoot.

J. Calcaneal Fracture

1. Describe the normal anatomy of the calcaneus and the surrounding structures.
2. Understand the pathomechanics associated with intra-articular calcaneal fractures.
3. Be able to differentiate intra-articular versus extra-articular calcaneal fractures using imaging.
4. Discuss common mechanisms of injury associated with calcaneal fractures and describe the most common classification schemes and incidence of associated injuries.
5. Describe the most useful imaging modalities to ensure appropriate management.
6. Evaluate common radiographic angles, such as Gissane's and Bohler's angle, and explain the implications of the normal and abnormal values of each.
7. Describe the common classifications of Rowe, Essex-Lopresti, and Sanders.
8. Discuss contra-indications to surgical treatment with calcaneal fractures.
9. Describe the advantages and disadvantages of conservative versus surgical treatment of calcaneal fractures.
10. Describe external fixation and internal fixation principles in reference to calcaneal fractures.
11. Understand the importance of surgical decision making in regard to timing of surgical intervention of calcaneal fractures.
12. Describe the common short-term and long-term complications associated with calcaneal fractures.

K. Talar Fractures

1. Describe normal talar anatomy, including vascular supply.
2. Describe the pathophysiology of talar avascular necrosis and explain clinical and imaging characteristics to aide in the diagnosis and treatment.
3. Recognize the various types of talus fractures and how they impact treatment and prognosis.
4. Describe the Hawkins talar fracture classification and the sequella of these injuries.
5. Describe the advantages and disadvantages of conservative versus surgical treatment of talus fractures.
6. Describe external fixation and internal fixation principles in reference talus fractures.
7. Describe the common short-term and long-term complications associated with trauma and fracture of the talus.

L. Ankle Fractures

1. Describe the osseous and soft tissue anatomy of the ankle joint complex.
2. Explain the Lauge-Hansen and Denis Weber ankle fracture classification schemes.
3. Describe the advantages and disadvantages of conservative versus surgical treatment of ankle fractures.
4. Recognize and categorize different ankle fracture types, using imaging modalities.
5. Describe basic principles of appropriate internal and external fixation in reference to ankle fractures.
6. Describe the common short-term and long-term complications associated with trauma and fracture of the ankle.

M. Pilon Fractures

1. Explain the difference between pilon fracture and ankle fractures.
2. Understand the importance of surgical timing and staging of pilon fractures.

3. Describe the advantages and disadvantages of conservative versus surgical treatment of pilon fractures.
4. Recognize and classify pilon fracture types, using imaging modalities.
5. Describe basic principles of appropriate internal and external fixation in reference to pilon fractures.
6. Describe the common short-term and long-term complications associated with pilon fractures.

N. Physeal Plate injuries

1. Discuss basic anatomical characteristics of pediatric anatomy associated with physeal injuries.
2. Recognize specific growth plate patterns as they relate to fractures around the foot and ankle.
3. Describe the Salter-Harris classification schemes used to describe physeal injuries and evaluate imaging modalities used to classify such injuries.
4. Describe the advantages and disadvantages of conservative versus surgical treatment of physeal injuries.
5. Describe external fixation and internal fixation principles in reference to physeal plate injuries including the importance of understanding iatrogenic injuries to the growth plate.
6. Discuss common sequelae associated with physeal injuries including long-term complications.

O. Compartment Syndrome

1. Describe the mechanism of compartment syndromes (acute, traumatic, or chronic, exertional).
2. Discuss clinical signs and symptoms including physical evaluation and pressure testing of compartment syndromes.
3. Describe the treatment options of compartment syndromes.
4. Describe the challenges of nerve damage and muscle tissue loss defects.

P. Acute and Chronic Tendon Trauma

1. Discuss basic tendon anatomy and physiology of the foot and ankle.
2. Describe the normal phases of tendon healing and explain how local and systemic factors may augment the healing process.
3. Recognize the clinical signs and symptoms of acute and chronic tendon injuries of the foot and ankle.
4. Discuss the most appropriate imaging modalities to aide in the evaluation and treatment of tendon trauma of the lower extremity.
5. Describe the advantages and disadvantages of conservative versus surgical treatment and the surgical technique in tendon pathology including:
    a. Achilles Tendon Rupture
    b. Peroneal tendon subluxation
    c. Tendon tears
    d. Chronic and acute tendon ruptures

Q. Ankle Sprains and Talar Dome Injuries, Lateral Ankle Instability

1. Describe normal ankle and subtalar joint anatomy.
2. Describe the biomechanics of ankle and subtalar joint dislocations.
3. Describe clinical and imaging characteristics to aid in the diagnosis and treatment.
4. Describe the common talar dome injury classification schemes.

5. Describe and select appropriate surgical and conservative treatment options of talar fractures, including osteochondral lesions.
6. Discuss long-term sequelae of osteochondral lesions.
7. Describe ankle stabilization procedures including primary anatomic repair, anatomic reconstruction, non-anatomic reconstruction.

R. Thermal Injuries

1. Describe the types and classifications of burns, thermal necrosis and frostbite.
2. Discuss the importance of host response, circulation, wound healing, risk factors, and infections.
3. Describe the options and materials available for skin substitutes and grafting.
4. Describe the challenges of tissue loss defects.

S. Puncture Wounds

1. Describe the complications of foreign body and marine puncture wounds and infections.
2. Discuss the importance of host response, risk factors in reference to the development, and management of postoperative infections.
3. Recognize the basic characteristics of edema, hematoma, and infections and formulate appropriate evaluation and treatment options for each.
4. Describe the treatment of infected wounds and human, animal, and insect bites.

XII. Nerve Surgery

A. Nerves of the Lower Leg, Ankle, and Foot

1. Identify, classify, and evaluate nerve entrapments that affect the foot and ankle.
2. Discuss gross and microscopic lower extremity regional neuroanatomy.
3. Discuss the pathophysiology of mechanically and metabolically induced neuropathy and classification of nerve injury, specifically Seddon and Sunderland Classification.
4. Discuss the normal and abnormal aspects of history and physical examination, including laboratory studies, and diagnostic tests (electrodiagnostic testing and imaging studies) based upon the chief complaint.
5. Discuss neurological surgical procedures, including neurolysis, neurectomy, and neurectomy with implantation.
6. Discuss the indications, contraindications, advantages, and disadvantages, of neurolysis, neurectomy, and neurectomy with implantation.
7. Discuss the potential complications of nerve surgery, such as amputation neuroma and complex regional pain syndrome, and its management.

XIII. Heel Surgery

1. Explain the etiology and pathogenesis of common heel deformities, including heel spurs and heel pain syndrome and plantar fasciitis.
2. Explain the etiology and classification of heel pain, including anatomical consideration, biomechanical and systemic causes.
3. Explain the incidence of heel pain syndrome and its clinical and radiographic evaluation.
4. Explain the surgical treatment of heel spur surgery, including indications, contraindications, procedures, and complications.

5. Explain the surgical approaches to the plantar fasciotomy, heel spur surgery, and the complications that can occur in both.
6. Discuss new forms of treatment, including low/high wave electromagnetic shock herapy, as well as autologous platelet concentration injections.

A. Haglunds Deformity

1. Explain the etiology of Haglund's deformity, including biomechanical and systematic causes, as well as anatomical considerations.
2. Explain the evaluation of a patient with Haglund's deformity, both clinically and radiographically, in a differential diagnosis.
3. Explain the surgical treatment including indications, contraindications, procedures, and complications of Haglund's deformity.

B. Retrocalcaneal Exostosis and Tendo Achilles Calcifications

1. Explain the etiology and pathogenesis of the retrocalcaneal exostosis and the tendo achilles calcifications, including biomechanical and systematic causes.
2. Explain the clinical and radiographic evaluations of retrocalcaneal and tendo achilles calcifications.
3. Explain surgical treatment including indications, contraindications, procedures, and complications of the retrocalcaneal exostosis.

XIV. Soft Tissue Surgery

A. Nail Surgery: Chemical and Non-chemical Procedure

1. Identify and describe normal nail unit anatomy.
2. Explain indications for nail surgery, including identification of various types of nail pathology that may require surgical intervention.
3. Discuss basic contraindications, as well as risks associated with nail surgery.
4. Correlate appropriate nail procedure to underlying nail pathology.
5. Explain the difference between elective and nonelective nail procedures.
6. Identify various local anesthetic techniques, including type of anesthetic agent used for nail procedures.
7. Describe skin plasties used to address nail pathology.
8. Explain the terminology differences between matrixectomy, I&D, and avulsion (partial and total).
9. Describe the surgical techniques for both partial and total nail avulsion.
10. Differentiate between chemical and nonchemical matrixectomy, and explain advantages and disadvantages of the various surgical matrixectomy techniques.
11. Identify the chemicals used for chemical matrixectomy.
12. Describe surgical technique and necessary instrumentation for both partial and total chemical matrixectomy.
13. Describe the nonchemical matrixectomy procedures.
14. Explain and describe the clinical features of nail unit lesions that require biopsy.
15. Describe nail unit biopsy techniques.
16. Describe appropriate postoperative care following various nail procedures.
17. Explain complications that may occur following nail matrixectomy including recurrence, bleeding, extended healing times, scar formation, swelling, pain, infection, residual dystrophy, excessive granulation tissue, deformity of the nail bed.

B. Subungual Exostosis

1. Explain the pathoanatomy of subungual exostosis and the corresponding nail pathology associated with it.
2. Explain the origin of subungual exostosis.
3. Explain surgical technique and instrumentation used to resect/remove the subungual exostosis.
4. Discuss complications associated with resection of subungual exostosis.

C. Verruca Surgery

1. Explain the etiology of pedal verruca.
2. List the differential diagnosis for both benign and malignant pedal verruca.
3. List the clinical characteristics of verruca, including divergent skin lines, pin-point bleeding with debridement, and pain with lateral pressure.
4. Explain the treatment options available and commonly used for pedal verruca.
5. List complications associated with surgical management of verruca to include scarring, recurrence, delayed healing, infection, pain, and swelling.

D. Ossicle/Sesamoid Surgery

1. Identify pathology requiring excision of a pedal ossicle.
2. Differentiate normal variants from pathologic ossicles or sesamoids and explain the cause of such pathology.
3. Explain the surgical approach, technique, postoperative management, and complications following ossicle excision.

XV. Specific Conditions Involving Surgery

A. Surgical Considerations and Surgery for the Rheumatory Arthritic patient

1. Discuss the surgical considerations of medications and systemic disease.
2. Recognize the advantages and disadvantages of implants versus fusions.
3. Describe the procedure of pan metatarsal head resection.

B. Surgical Considerations and Surgery for the Diabetic Patient (Including Charcot Reconstruction)

1. Describe the basic indications and risks for diabetic patients.
2. Describe surgical options of muscular imbalance, including tenotomy and tendon transfers.
3. Discuss the advantages and disadvantages of internal and external fixation.
4. Describe the complications and management of diabetic reconstruction surgeries.

C. Surgical Infections (Soft tissue/Bone) and Amputations

1. Discuss diabetes and lower extremity healing.
2. Describe tests for wound healing including arterial, venous, and oxygenation.
3. Describe the treatment options for patient with peripheral arterial disease of the lower extremity.
4. Choose the appropriate surgical procedure for various foot or leg ulcers.
5. Discuss the diagnosis and treatment of osteomyelitis, including bone scan, MRI, biopsy, excision, and plastic reconstruction.

D. Neurologic Conditions Amenable to Surgery

1. Discuss the clinical presentation and examination of nerve degeneration, including gait.
2. Describe muscle tendon imbalance and joint abnormalities.
3. Recognize the advantages and disadvantages of tendon transfers and joint arthrodesis.
4. Propose acceptable postoperative protocol and expectations for various procedures.

XVI. Pediatric Surgery

A. General

1. Demonstrate knowledge of the developmental milestones of the pediatric patient.
2. Discuss the clinical assessment of a pediatric patient including patient history, family history, and physical exam.
3. Discuss the perioperative management of a pediatric patient including pain control.

B. Juvenile Hallux Abducto Valgus

1. Describe the etiology of juvenile hallux abducto valgus.
2. Discuss the physical exam and exam findings for juvenile hallux abducto valgus.
3. Describe radiologic exam findings for juvenile hallux abducto valgus.
4. Discuss surgical procedures for the correction of juvenile hallux abducto valgus.
5. Demonstrate knowledge of possible complications of the surgical correction of juvenile hallux abducto valgus.

C. Digital Deformities

1. Discuss the physical and radiographic findings in juveniles with various lesser toe deformities.
2. Describe surgical procedures for correction of digital deformities in the pediatric patient including potential complications and outcomes.
3. Demonstrate knowledge of physical and radiologic exam findings of ectrodactyly, syndactyly, and polydactyly deformities including surgical interventions and potential complications and outcomes.

D. Brachymetatarsia

1. Discuss the possible etiologies of brachymetatarsia.
2. Demonstrate the clinical evaluation of brachymetatarsia including history, physical examination, and radiographic evaluation.
3. Demonstrate knowledge of surgical procedures for the correction of brachymetatarsia including callous distraction and one step bone grafting and their potential complications.

E. Metatarsus Adductus

1. Discuss the etiology of metatarsus adductus.
2. Demonstrate knowledge of the clinical evaluation of metatarsus adductus including gait, physical findings, and radiographic findings.
3. Demonstrate knowledge of the surgical correction of metatarsus adductus including soft tissue procedures (tendon releases/transfers, capsulotomies- Thompson, Heyman Herndon Strong), osteotomies, including metatarsal and midfoot osteotomies.

F. Congenital Pes Planus

1. Demonstrate knowledge of the similarities and differences between a flexible and rigid pediatric pes planus deformity.
2. Demonstrate knowledge of the clinical evaluation including history, physical exam findings, gait, and radiographic findings of a flexible pediatric pes planus.
3. Demonstrate knowledge of the surgical options used in the treatment of a flexible pediatric pes planus.
4. Demonstrate knowledge of the clinical evaluation including history, physical exam findings, gait, and radiographic findings of a rigid pes planus (tarsal coalition).
5. Demonstrate knowledge of the surgical options used in the treatment of a rigid pediatric pes planus (tarsal coalition).
6. Describe planal dominance.
7. Discuss the long-term outcomes and possible complications of surgical correction of flexible and rigid pediatric pes planus.

G. Vertical Talus

1. Discuss the etiology of vertical talus.
2. Identify vertical talus upon physical examination and radiographically.
3. Demonstrate knowledge of the various surgical procedures for the correction of vertical talus and their outcomes and potential complications.

H. Clubfoot

1. Discuss the etiology of clubfoot deformity.
2. Describe the anatomic abnormalities of a clubfoot deformity in the infant and child.
3. Demonstrate knowledge of a clubfoot deformity both on physical and radiographic exam.
4. Describe the Ponseti technique for treatment of a clubfoot.
5. Demonstrate knowledge of the surgical treatment of the clubfoot in the infant including soft tissue release.
6. Demonstrate knowledge of the surgical treatment of the clubfoot in the child including soft tissue and osseous procedures.
7. Discuss the long-term outcomes and potential complications of a clubfoot.

XVII. General Surgical Principles

A. Instruments and Materials

1. List and describe methods of obtaining hemostasis including tourniquets, bovies, and hemostatic agents and discuss the safety concerns of each.
2. List the types of surgical drains utilized in surgery.

B. Perioperative Management

1. List the elements of a preoperative history and physical and the implications if the patients have comorbidities, including diabetes, hypertension, renal disease, and heart disease.
2. Discuss the proper use and selection of fluids and electrolyte management in the perioperative patient.
3. Discuss blood typing, the various blood products, proper administration including adjunctive medication administration, and transfusion reactions.

4. Identify and discuss commonly prescribed medications, including narcotics and antibiotics in the management of the perioperative patient along with their indications, contraindications, and alternatives.

XVIII. Tarsal Coalitions

1. Differentiate between a fibrous, cartilaginous, and bony coalition.
2. Describe the signs, symptoms, gait, and physical examination findings of talo-navicular, calcaneo-cuboid, calcaneo-navicular, and talo-calcaneal coalitions.
3. Describe the radiographic, CT or MRI findings as related to each specific tarsal coalition.
4. Describe the surgical approaches to the correction of tarsal coalitions.

XIX. Arthroscopy and Endoscopy of the Foot and Ankle

A. Principles

1. Explain the basic principles of arthroscopy and endoscopy.
2. Explain arthroscope visualization concepts including field of view, inclination of view, and clarity.
3. Discuss the concepts of arthroscopic movement including positioning, sweeping, angulation (obliquity), triangulation, and rotation.

B. Preoperative Evaluation

1. Demonstrate knowledge on general indications for arthroscopic surgery.
2. Explain the absolute and relative contraindications to arthroscopic surgery.
3. Demonstrate knowledge of the clinical evaluation including the patient history and physical examination of the ankle and foot in the preoperative evaluation for arthroscopic/endoscopic procedures.

C. Imaging

1. Demonstrate knowledge of the role of other ancillary forms of imaging of the foot and ankle such as stress radiographs, arthrography, nuclear medicine, ultrasound, CT, and MRI with respect to preoperative evaluation for arthroscopic/endoscopic foot and ankle surgery.

D. Diagnostic Arthroscopic Examination (Ankle Arthroscopy)

1. Identify the anatomic location and underlying correlative anatomy of the common portals used in ankle arthroscopy.
2. Explain the 21-point arthroscopic ankle examination.

E. Soft Tissue Lesions

1. Explain the pathogenesis, identify the arthroscopic appearance, and describe the arthroscopic management techniques for forms of soft tissue ankle pathology.

F. Osteochondral Pathology

1. Explain the pathogenesis, identify the arthroscopic appearance, and describe the arthroscopic management techniques for forms of osteochondral pathology, including surface defects, osteochondritis dessicans, loose bodies, osteophytes, talar dome cysts/lesions, arthritis.

G. Other Joint Arthroscopy

1. Explain the indications, rationale, and methods for subtalar joint arthroscopy.

N. Complications in Ankle and Foot Arthroscopy

1. Identify and discuss the more common complications that may occur following foot and ankle arthroscopy.

O. Endoscopic Procedures

1. Demonstrate knowledge of the soft tissue pathologies treatable with endoscopic surgical methods.

APPENDIX I: Bloom's Taxonomy

Bloom's Taxonomy (1954) and the 6 levels of the cognitive domain - According to Kretchmar the intention of the taxonomy was to classify the change in a person created by an educational experience (2008). In this case we are focusing only on changes within the cognitive domain, which are in 6 different hierarchical levels. Although many researchers have agreed upon the hierarchical nature of the first four levels there continues to be debate around the last two levels synthesis and evaluation and whether they are in fact hierarchical or perhaps they are equal but different types of complex thinking. Many researchers have compared synthesis with creative thinking and evaluation with critical thinking. The revised taxonomy has placed these categories in the reverse order. Although it was noted by the original authors of the taxonomy that perhaps evaluation was not in fact hierarchal it is the last level in the original taxonomy, as seen below:

Level 1—Knowledge The first level of Bloom's Taxonomy within the cognitive domain. At this level, instruction should focus in on enabling learners to remember, or recognize concepts, processes, procedures, theories, or facts. This level includes both factual knowledge and more abstract knowledge or knowledge of universals (e.g., theories) or ways and means of dealing with specifics (e.g., recognizing how our educational system has evolved) (Kretchmar, 2008).	**Knowledge Verbs include:** Arrange Define Describe Duplicate, Repeat Identify Label List Match Name Order Recall Recognize Record Relate Remember re-order Reproduce Select State
Level 2—Comprehension This is the second level of Bloom's Taxonomy within the cognitive domain. At this level, instruction should focus in on enabling learners to translate facts into their own words, understanding the interrelations enough to form opinions, make predictions, and make judgments because the information has been integrated into their "own frame of reference" and they can apply the knowledge as they have been shown (or similarly to how they have been shown) to apply it (Reeves, p. 610).	**Comprehension Verbs** Classify Convert Defend Describe Discuss Distinguish Examples Explain Generalize Infer Paraphrase Predict Provide Review

	Rewrite Summarize Translate
Level 3—Application This is the third level of Bloom's Taxonomy within the cognitive domain. At this level, instruction should focus in on enabling learners to apply their new knowledge within situations beyond what they have seen in the classroom setting. This is the beginning of critical thinking through basic problem solving and the demonstration of transfer of learning.	**Application Verbs** Apply Change Compute Create Demonstrate Employ Illustrate Interpret Manipulate Modify Practice Prepare Produce Relate show Sketch Solve Use
Level 4—Analysis This is the fourth level of Bloom's Taxonomy within the cognitive domain. At this level, instruction should focus in on enabling learners to breakdown their acquired knowledge into parts through the consideration of elements, the relationships of those elements, and the organizing principles. Key to this level within the cognitive domain is the act of deductive and inductive thought processes.	**Analysis Verbs** Analyze Appraise Breakdown Calculate Categorize Compare Contrast Diagram Differentiate Distinguish Examine Experiment Illustrate Model Question Relate Separate Subdivide
Level 5—Synthesis (Creative Thinking) This is the fifth level of Bloom's Taxonomy within the cognitive domain. Many researchers have compared this level of the cognitive domain to creative thinking. Therefore, at this level, instruction should focus in on enabling learners to be able to take the breakdown of parts from the analysis phase and form new relations, a new whole resulting in a creative solution to a	**Synthesis Verbs** Arrange Assemble Combine Compose Construct Create Design Develop

proposed problem, which was not covered within the classroom setting.	Formulate Generate Rearrange Reconstruct Relate Reorganize Revise Re-write Solve synthesize
Level 6—Evaluation (Critical Thinking) This is the six level of Bloom's Taxonomy within the cognitive domain. Many researchers have compared this level of the cognitive domain to critical thinking. Therefore, at this level, instruction should focus in on enabling learners to be able to take the breakdown of parts from the analysis phase and form new relations through the process of evaluation by using a set of content specific criteria.	**Evaluation Verbs** Appraise Argue Assess Compare Conclude Contrast Defend Evaluate Judge Justify Interpret Support

Sources:
Kretchmar, J. (2008). Taxonomy of Educational Objectives - The Cognitive Domain. In, *Taxonomy of Educational Objectives-Cognitive Domain -- Research Starters Education* (p. 1). Great Neck Publishing. Retrieved from EBSCO*host*.

Reeves; M, F. (n.d). An Application of Bloom's Taxonomy to the Teaching of Business Ethics. *Journal of Business Ethics*, 9(7), 609. Retrieved from EBSCO*host*.

APPENDIX III: AACPM Council of Faculties

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