INTRODUCTION TO THE STUDENT

This syllabus is to be used as a general outline for the Anatomy and Physiology I course.

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Text: Marieb & Hoehn, HUMAN ANATOMY & PHYSIOLOGY, Pearson Publ.
SKELETAL SYSTEM OUTLINE

I. Functions of the Skeletal System
   A. Support
   B. Protection
      1. Movement
      2. Storage
      3. Hematopoiesis

II. Parts of the Skeletal System
   A. Cartilage
   B. Bone
   C. Tendons
      1. Definition
      2. Connective tissue type
   D. Ligaments
      1. Definition
      2. Connective tissue type

III. Cartilage
   A. Characteristics
   B. Types of Cartilage
      1. Hyaline
      2. Elastic
      3. Fibrocartilage
   C. Location in the Skeletal System

IV. Bone
   A. Classes of Bone
      1. Short
      2. Long
      3. Flat
      4. Irregular
   B. Types of Bone
      1. Compact – location
      2. Spongy – location
   C. Chemical Composition of Bone
      1. Organic
         a. Cells: osteoblasts, osteocytes, osteoclasts
         b. Osteoid: collagen fibers, ground substance
      2. Inorganic – Mineral salts: calcium phosphate (hydroxyapatites)
   D. Microscopic Anatomy of Compact Bone
      1. Osteon or Haversian System
         a. Structure
         b. Function
E. Microscopic Anatomy of Spongy Bone
   1. Structure
   2. Function

F. Development of the Bony Skeleton
   1. Intramembranous ossification – membrane bone
   2. Endochondral ossification – cartilage bone

G. Growth of Long Bone
   1. Longitudinal bone growth (length)
   2. Appositional bone growth (width)
   3. Hormonal, dietary and genetic influences in bone growth

H. Bone Remodeling
   1. Bone deposition
   2. Bone resorption
   3. Hormonal factors influencing bone remodeling
      a. Parathyroid
      b. Calcitonin
   4. Mechanical factors influencing bone remodeling – Wolff’s Law

I. Bone Fractures
   1. Types (simple, compound, etc.)
   2. Stages in fracture repair

J. Homeostatic Imbalances of Bone
   1. Osteoporosis
   2. Osteomalacia
   3. Rickets
   4. Paget’s disease

V. Articulations
   A. Definition
   B. Structural Classification
      1. Fibrous
      2. Cartilaginous
      3. Synovial (attention to structural detail)
   C. Functional Classification
      1. Synarthrosis
      2. Amphiarthrosis
      3. Diarthrosis
   D. Accessory Structures of Articulations
      1. Bursa
      2. Tendon sheaths
      3. Fatty pads
      4. Menisci
E. Inflammatory and Degenerative Disorders of Articulations and Accessory Structures
1. Bursitis
2. Tensosynovitis
3. Acute and chronic arthritis (osteoarthritis, rheumatoid arthritis, gouty arthritis, etc.)
SKELETAL SYSTEM OBJECTIVES

The student should be able to:

1. Describe the characteristics of bone as a class of connective tissue;
2. Describe the functions of the skeletal system;
3. Describe the types of bone found in the skeletal system;
4. Describe the macroscopic anatomy of a typical adult long bone;
5. Describe the microscopic anatomy of compact bone;
6. Describe the microscopic anatomy of spongy bone;
7. Describe the chemical composition of bone;
8. Describe red and yellow bone marrow and their functions;
9. Define and describe intramembranous ossification;
10. Define and describe endochondral ossification;
11. Define and describe longitudinal bone growth;
12. Define and describe appositional bone growth;
13. List and describe hormonal regulation of bone growth during youth;
14. Describe bone remodeling and its regulation (hormonal and mechanical);
15. Define a fracture and fracture types;
16. Describe the various stages of fracture repair;
17. Describe the causes and symptoms of rickets, osteomalacia, osteoporosis and Paget’s disease;
18. Define articulations and classify them structurally and functionally;
19. Describe the movements made possible by the various articulations;
20. Describe the structure and explain the importance of bursae, tendon sheaths, fatty pads and menisci;
21. Describe the causes and symptoms of joint inflammation and degeneration: acute and chronic arthritis, bursitis, tenosynovitis.
MUSCULAR SYSTEM OUTLINE

I. Definition of Muscle as a Primary Tissue Type

II. Types of Muscle
   A. Skeletal (striated, voluntary)
      1. Structure
      2. Location
   B. Cardiac (striated, involuntary)
      1. Structure
      2. Location
   C. Smooth (non-striated, involuntary)
      1. Structure
      2. Location

III. Intrinsic Characteristics of Muscle
    A. Excitability
    B. Extensibility
    C. Elasticity (recoil)
    D. Contractility

IV. General Characteristics of Skeletal Muscle
    A. Movement
    B. Posture Maintenance
    C. Joint Stability
    D. Heat Generation

V. Macroscopic Anatomy of Whole Skeletal Muscle
   A. Connective Tissue Coverings
      1. Deep fascia
      2. Epimysium
      3. Perimysium
      4. Endomysium
   B. Blood Supply
   C. Nerve Supply

VI. Skeletal Muscle Attachment to Bone
    A. Direct
    B. Indirect
       1. Tendon
       2. Aponeurosis

VII. Macroscopic Anatomy of a Skeletal Muscle Fiber
    A. Sarcolemma – T-Tubules
B. Sarcoplasm
  1. Sarcoplasmic reticulum
  2. Myofibrils – myofilaments

VIII. Myofilaments
A. Actin (thin)
  1. Structure
  2. Regulatory proteins
     a. Troponin
     b. Tropomyosin
B. Myosin (thick) – Structure

IX. Sarcomere
A. Definition
B. Structure
  1. A band
  2. I band
  3. Z line
  4. H zone
  5. M line

X. Contraction of Skeletal Muscle
A. Structure of Neuromuscular Junction (NMJ)
  1. Axolemma
  2. Synaptic cleft
  3. Sarcolemma (junctional folds)
B. Physiologic Activity at the Neuromuscular Junction
  1. Arrival of a nerve impulse at the axonal terminal
  2. Role of calcium in the release of the neurotransmitter, acetylcholine (Ach)
  3. Generation of mini end-plate potentials (MEPP) and action potentials (AP)
     in the muscle fiber
C. The Sliding Filament Theory
  1. Role of the sarcolemma, triads (T-tubules, sarcoplasmic reticulum) and
     regulatory proteins (troponin and tropomyosin)
     a. Cross-bridging
     b. Power strike
     c. Cross-bridge detachment
     d. “Cocking” of the myosin head
D. The role of ionic calcium in muscle contraction
  1. Calcium-ATP dependent pump
  2. Calsequestrin and Calmodulin
E. The Role of Acetylcholinesterase (Ach)
XI. Energy for Muscle Contraction
A. Creatine Phosphate (CP)
B. Aerobic Respiration – ATP Generation
C. Anaerobic Respiration
   1. Lactic acid generation
   2. Muscle fatigue
   3. Oxygen debt

XII. Factors that Influence the Force, Velocity and Duration of Muscle Contraction
A. Number of Muscle Fiber Stimulated
B. Relative Size of the Muscle
C. Series-Elastic Elements
D. Muscle Fiber Types (slow- and fast-twitch fibers)
E. Load (resistance)
F. Recruitment

XIII. Effects of Exercise

XIV. Cardiac Muscle

XV. Smooth Muscle

XVI. Homeostatic Imbalances of Muscle and Irregular Muscle Activity
A. Myasthenia Gravis
B. Muscular Dystrophy
C. Fasciculation
D. Fibrillations
E. Muscle Cramps
F. Rigor Mortis
MUSCULAR SYSTEM OBJECTIVES

The student should be able to:

1. Define muscle as a primary tissue type;
2. Compare the location, function, control and regenerative capacities of the three kinds of muscle tissue (skeletal, cardiac and smooth);
3. List the intrinsic characteristics and functions of skeletal muscle;
4. Describe the macroscopic anatomy of skeletal muscle including the connective tissue ensheathments (deep fascia, epimysium, perimysium and endomysium);
5. Describe the microscopic anatomy of a skeletal muscle fiber (sarcolemma, T-tubules, sarcoplasm, sarcoplasmic reticulum, myofibrils, myofilaments and sarcomeres);
6. Describe the structure of the neuromuscular junction (NMJ) and its physiologic importance in skeletal muscle contraction;
7. Describe the origin of the resting membrane potential (RMP);
8. Define graded potential, action potential and their relationship to skeletal muscle contraction;
9. Describe the physiologic events associated with the Sliding Filament Theory and the role of actin, myosin, tropomyosin, and troponin in the contraction of skeletal muscle;
10. Explain the role of calcium in skeletal muscle contraction and relaxation;
11. Discuss the origin and role of adenosine triphosphate (ATP) and creatine phosphate (CP) in skeletal muscle contraction;
12. Define primary and secondary energy sources for skeletal muscle contraction;
13. Compare aerobic and anaerobic respiration;
14. Define muscle fatigue and oxygen debt;
15. Distinguish between slow- and fast-twitch fibers;
16. Define the following: muscle cramps, fasciculations, fibrillations, muscular dystrophy and myasthenia gravis.
NERVOUS SYSTEM OUTLINE

I. Generalities
   A. Communication
   B. Integration

II. Classification of the Nervous System
   A. Central Nervous System (CNS)
      1. Brain
      2. Spinal Cord
   B. Peripheral Nervous System (PNS)
      1. Autonomic Nervous System
      2. Somatic Nervous System

III. Histology of the Nervous Tissue
   A. Supportive (Glial) cells
      1. Structure
      2. Location
   B. Neurons
      1. Structural classification
      2. Functional classification

IV. Neurophysiology
   A. Basic Principles of Electricity – Ohm’s Law
   B. Membrane Ion Channels
   C. Resting Membrane Potential (RMP)
   D. Changes in Resting Membrane Potentials
      1. Depolarization
      2. Repolarization
      3. Hyperpolarization
   E. Graded Potentials
      1. Generation
      2. Propagation
   F. Action Potentials
      1. Generation
      2. Propagation
   G. Chemical Synapses
      1. Excitatory Post Synaptic Potentials (EPSP)
      2. Inhibitory Post Synaptic Potentials (IPSP)
   H. Neural Integration – Temporal and Spatial Summation
   I. Neurotransmitters
      1. Structural classification
      2. Functional classification
   J. Fate of the Neurotransmitter
V. Central Nervous System (CNS) – Embryonic Development of the Human Brain and Spinal Cord

VI. Regions of the Brain
   A. Cerebral Hemispheres
   B. Basal Nuclei
   C. Diencephalon
      1. Epithalamus
      2. Thalamus
      3. Hypothalamus
   D. Brain Stem
      1. Midbrain
      2. Pons
      3. Medulla oblongata
   E. Cerebellum

VII. Ventricles of the Brain
   A. Laterial Ventricle
   B. Third Ventricle
   C. Cerebral Aqueduct
   D. Fourth Ventricle

VIII. Spinal Cord
   A. Gross Anatomy
   B. Cross-Sectional Anatomy

IX. Meninges
   A. Structure
   B. Function

X. Cerebrospinal Fluid (CSP)
   A. Composition
   B. Formation and Circulation
      1. Choroid plexuses – location
      2. Arachnoid villi – location
   C. Function

XI. Peripheral Nervous System (PNS)
   A. Sensory Receptors
      1. Structure
      2. Stimuli
      3. Location
B. Nerves
   1. Sensory
   2. Motor
   3. Mixed
C. Cranial Nerves
D. Spinal Nerves
E. Reflex Arc
   1. Components
   2. Types
      a. somatic
      b. autonomic
F. Somatic Nervous System
G. Autonomic Nervous System
   1. Sympathetic – origin, innervation, neurotransmitters and receptors
   2. Parasympathetic – origin, innervation, neurotransmitters and receptors

XII. Homeostatic Imbalances of the Nervous System (Multiple Sclerosis, ALS, etc.)
NERVOUS SYSTEM OBJECTIVES

The student should be able to:

1. Define nervous tissue as a primary tissue type;
2. Discuss the communicative and integrative functions of the Nervous System;
3. Compare the differences between supportive cells and neurons in terms of location, structure and function;
4. Explain the basic principles of electricity (Ohm’s Law: current, voltage and resistance);
5. Discuss the physiologic activities involved in the initiation and propagation of a nerve impulse (RMP, GP, AP);
6. Discuss the factors that influence the velocity of nerve impulse conduction (myelinization and axon diameter);
7. Describe the activity occurring at the synapse;
8. Explain post-synaptic potentials and neural integration (summation);
9. Discuss the embryonic development of the Central Nervous System (CNS);
10. Identify the adult brain structures;
11. Discuss the functions of the various brain structures;
12. Identify the neural canal regions;
13. Discuss the functions of the various neural canal regions;
14. Describe the anatomy of the spinal cord;
15. Discuss the functions of the spinal cord;
16. Identify the meninges;
17. Discuss the formation, composition and distribution of cerebrospinal fluid (CSF);
18. Identify the components of the Peripheral Nervous System (PNS);
19. Define and describe the various types of receptors;
20. Define and describe the various types of nerves;
21. Define a reflex and the components of a reflex arc;
22. Compare the functional differences between the Somatic Nervous System and the Autonomic Nervous System;
23. Compare the structural and functional differences between the sympathetic and parasympathetic divisions of the Autonomic Nervous System (ANS).
I. General Aspects – Interaction with the Nervous System – Coordination and Integration of Cellular Activity

II. Endocrine glands and Hormones
   A. Chemistry of Hormones
      1. Amino acid-based hormones
      2. Steroid hormones
      3. Eicosanoids – prostanoids and leukotrienes
   B. Target Cells and Receptors
      1. Up-regulation
      2. Down-regulation
   C. Effects of Hormonal Stimulation on Target Cells
   D. Mechanisms of Hormone Action
      1. Second messenger systems
         a. Adenylate cyclase system
         b. Polyphosphatidylinositol system
      2. Direct gene activation
   E. Control of Hormone Release
      1. Humoral stimuli
      2. Neural stimuli
      3. Hormonal stimuli
   F. Half-Life, Onset and Duration of Hormone Activity

III. Major Endocrine Organs
   A. Hypothalamus (neuroendocrine organ)
   B. Pituitary Gland (location)
      1. Adenohypophysis
         a. Growth Hormone (GH)
         b. Thyroid-Stimulating Hormone (TSH)
         c. Adrenocorticotropic Hormone (ACTH)
         d. Follicle-Stimulating Hormone (FSH)
         e. Luteinizing Hormone (LH)
         f. Prolactin (PRL)
      2. Neurohypophysis
         a. Oxytocin
         b. Antidiuretic Hormone (ADH)
   C. Thyroid Gland (location)
      1. Triiodothyronine (T)
      2. Thyroxine (T)
      3. Calcitonin (“C” cells of thyroid gland)
   D. Parathyroid Gland (location) – Parathyroid Hormone (PTH)
E. Adrenal Glands (location)
   1. Zona glomerulosa of adrenal cortex – mineralocorticoids (aldosterone)
   2. Zona fasciculate of adrenal cortex – glucocorticoids (cortisol)
   3. Zona reticularis – gonadocorticoids (androgens)
   4. Adrenal medulla
      a. Epinephrine
      b. Norepinephrine

F. Pancreas (location) – Islets of Langerhans
   1. Alpha cells (glucagon)
   2. Beta cells (insulin)

G. Gonads (location)
   1. Testes – Testosterone
   2. Ovaries
      a. Estrogen
      b. Progesterone

H. Pineal Gland (location) – Melatonin

I. Thymus Gland (location) – Thymosin

IV. Homeostatic Imbalances of the Endocrine System (Diabetes Mellitus, Cushing’s Disease, Addison’s Disease, etc.)


**ENDOCRINE SYSTEM OBJECTIVES**

The student should be able to:

1. Discuss the important differences between hormonal and neural controls of body function;
2. Describe the chemical classification of hormones;
3. Distinguish between circulating hormones (amino acid-based-, steroid hormones) and local hormones (eicosanoids);
4. Discuss the effects of hormonal stimulation on target cells and the two major mechanisms involved;
5. Explain how hormone release is regulated;
6. Discuss those factors that influence serum concentrations of circulating hormone;
7. List the major endocrine organs and describe their locations in the body;
8. For each of the following hormones, cite the gland of origin, the target organ(s) and discuss each of the hormones effects:
   a. Growth Hormone (GH)
   b. Thyroid-Stimulating Hormone (TSH)
   c. Adenocorticotropic Hormone (ACTH)
   d. Follicle-Stimulating Hormone (FSH)
   e. Luteinizing Hormone (LH)
   f. Prolactin (PRL)
   g. Oxytocin
   h. Antidiuretic Hormone (ADH)
   i. Triiodothyronine (T)
   j. Thyroxine (T)
   k. Calcitonin
   l. Parathyroid Hormone (PTH)
   m. Mineralocorticoids
   n. Glucocorticoids
   o. Gonadocorticoids
   p. Epinephrine
   q. Norepinephrine
   r. Glucagon
   s. Insulin
   t. Testosterone
   u. Estrogen
   v. Progesterone
   w. Melatonin
   x. Thymosin
9. Describe the major homeostatic imbalances of the Endocrine System such as diabetes mellitus, Cushing’s disease, Addison’s disease, etc.
REPRODUCTIVE SYSTEM OUTLINE

I. Introduction to the Reproductive System
   A. Comparisons of Benefits from Sexual vs. Asexual Reproduction
   B. Mitosis vs. Meiosis

II. Male Reproductive Anatomy
   A. Primary Sex Organs - Testes
      1. Seminiferous tubules
      2. Sertoli cells
      3. Leydig
   B. Accessory Sex Organs, Ducts and Glands
      1. Scrotum
      2. Penis
      3. Epididymis
      4. Vas (Ductus) deferens
      5. Ejaculatory duct
      6. Urethra
      7. Seminal vesicles
      8. Prostate
      9. Bulbourethral (Cowper’s) glands

III. Male Reproductive Physiology
   A. Spermatogenesis and Spermiogenesis
      1. Spermatogonia
      2. Primary spermatocytes
      3. Secondary spermatocytes
      4. Spermatids
      5. Spermatozoa
   B. Blood-Testis Barrier
   C. Hormonal Regulation of Male Reproductive Physiology
      1. Gonadotropin Releasing Hormone (GnRH)
      2. Follicle Stimulating Hormone (FSH)
      3. Luteinizing Hormone (=LCSH)
      4. Testosterone and Androgen Binding Protein (ABP)
      5. Inhibin
   D. Role of Accessory Gland Secretion
      1. Seminal Vesicle Secretions
      2. Prostatic Secretions
      3. Bulbourethral (Cowper’s) gland secretions
   E. Composition of Semen
F. Phases of the Male Sexual Response
   1. Erection – Role of the Autonomic Nervous System (ANS)
   2. Ejaculation – Role of the Autonomic Nervous System (ANS)
   3. Refractory period

G. Birth Control

IV. Disorders of the Male Reproductive System
   A. Infertility
   B. Impotence
   C. Cryptochidism
   D. Disorders of the Prostate (BHP and Cancer)
   E. Impotence
   F. Venereal Diseases

V. Female Reproductive Anatomy
   A. Primary Sex Organs – Ovaries
      1. regions
      2. follicles
      3. supportive ligaments
   B. Accessory Sex Organs, Ducts and Glands
      1. External genitalia (vulva)
         a. Mons pubis
         b. Labia majora and minora
         c. Clitoris
         d. Vestibule
      2. Vagina
      3. Uterus
         a. Regions
         b. Layers
         c. Supportive ligaments
      4. Uterine (Fallopian) tubes (=oviducts) – regions
      5. Vestibular glands
      6. Paraurethral (Skene’s) glands
      7. Mammary glands

VI. Female Reproductive Physiology
   A. Oogenesis
      1. Oogonia
      2. Primary oocytes
      3. Secondary oocytes
      4. Ovum
      5. Polar bodies
B. Hormonal Regulation of Female Reproductive Physiology
   1. Gonadotropin Releasing Hormone (GnRH)
   2. Follicle Stimulating Hormone (FSH)
   3. Estrogen
   4. Progesterone
   5. Inhibin
   6. Prolactin
C. Ovarian Cycle
   1. Follicular phase
   2. Ovulatory phase
   3. Luteal phase
D. Menstrual (=Uterine) Cycle
   1. Proliferative phase
   2. Secretory phase
   3. Menstrual phase
E. Fertilization and the Role of Human Chorionic Gonadotropin (HCG)
F. Lactation and Its Control
G. Phases of the Female Sexual Response
   1. Excitement
   2. Orgasm
H. Birth Control

VII. Disorders of the Female Reproductive System
A. Amenorrhea
B. Dysmenorrhea
C. Infertility
D. Endometriosis
E. Cancer
   1. Ovarian
   2. Cervical
   3. Breast
F. Venereal Diseases
REPRODUCTIVE SYSTEM OBJECTIVES

The student should be able to:

1. List the male reproductive organs;
2. Describe the scrotum and the role of the cremasteric and dartos muscles;
3. Describe the structure of the testes;
4. Describe spermatogenesis and spermiogenesis;
5. Describe the morphology of a mature sperm cell;
6. Trace the route of sperm from its site of production to the outside of the human body;
7. Describe the functions of the male accessory glands;
8. Describe the composition of semen;
9. Describe the structure of the penis;
10. Discuss erection and ejaculation and the influence of the Autonomic Nervous System (ANS);
11. List the hormones that influence male reproductive physiology and explain their physiologic effects;
12. Discuss male birth control;
13. Discuss the causes and symptoms of the various disorders and diseases of the Male Reproductive System;
14. List the female reproductive organs;
15. Describe the anatomy of the female external genitalia (=vulva);
16. Describe the anatomy of the uterine tubes, the uterus and the vagina;
17. Describe the anatomy and histology of the ovary;
18. Discuss oogenesis;
19. Discuss the phases of the ovarian cycle;
20. Discuss the phases of the menstrual cycle;
21. List the hormones that influence female reproductive physiology and explain their physiologic effects;
22. Explain the role of human chorionic gonadotropin (HCG);
23. Discuss female birth control;
24. Discuss the causes and symptoms of the various disorders and diseases of the Female Reproductive System.
## ANATOMY AND PHYSIOLOGY I LABORATORY OUTLINE

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<td>Cell Membrane; Active and Passive Transport</td>
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<td>3</td>
<td>Tissues: Epithelial, Connective</td>
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<td>Skeleton: Axial, Appendicular</td>
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<td>Brain: Sheep Dissection</td>
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<td><strong>Final Exam</strong></td>
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Written tests, lab practicals and quizzes: Scheduled appropriately throughout the semester.