

Medical Anatomy and Physiology, Advanced

Exam Information	Description
Exam number 703 Items 100 National Career Cluster Healthcare & Human Services Certification available Yes	An Advanced Medical Anatomy and Physiology course. This course is a college level Anatomy & Physiology course that teaches in-depth body structures and functions preparatory for further healthcare training programs or careers.

Exam Blueprint and Performance Skills

Standard	Percentage of exam score
1. Body Plan and Organization	3%
2. Inorganic Chemistry	4%
3. Organic Chemistry	2%
4. Cells	2%
5. Tissues	2%
6. Integumentary System	3%
7. Skeletal System	8%
8. Muscular System I	3%
9. Muscular System II	17%
10. Muscular System III	5%

11. Endocrine System	7%
12. Cardiovascular System I	12%
13. Cardiovascular System II	10%
14. Respiratory System	8%
15. Digestive System	5%
16. Urinary System	7%
17. Reproduction System	2%

Standard 1 - Body Plan and Organization (3% of exam score)

Candidates will develop and utilize models to describe the body plan, organization, and a stable internal environment (homeostasis).

Objective 1 Contrast the sciences of anatomy and physiology.

Objective 2 Describe the six levels of structural organization of the human body and their interrelationship.

1. Chemical
2. Cellular
3. Tissue
4. Organ
5. System
6. Organism

Objective 3 Define anatomical position and identify commonly used planes in gross anatomy and/or imaging.

1. Sagittal
 - a. Midsagittal
 - b. Parasagittal
2. Transverse (horizontal)
3. Frontal (coronal)
4. Oblique

Objective 4 Apply directional terms used in human anatomy.

1. Posterior/Anterior
2. Medial/Lateral
3. Proximal/Distal
4. Superficial/Deep
5. Superior/Inferior
6. Cranial/Caudal
7. Ventral/Dorsal
8. Ipsilateral/Contralateral
9. Parietal/Visceral

Objective 5 Apply regional terms used in human anatomy.

1. Head (cephalic)
 - a. Skull (cranial)
 - b. Base of skull (occipital)
2. Face (facial)
 - a. Forehead (frontal)
 - b. Temple (temporal)
 - c. Eye (orbital, ocular)
 - d. Ear (otic)
 - e. Cheek (buccal)

- f. Nose (nasal)
- g. Mouth (oral)
- h. Chin (mental)
- 3. Neck (cervical)
- 4. Spinal column (vertebral)
- 5. Trunk
 - a. Chest (thoracic)
 - i. Breastbone (sternal)
 - ii. Breast (mammary)
 - iii. Shoulder blade (scapular)
 - iv. Back (dorsal)
 - b. Abdomen (abdominal)
 - i. Navel (umbilical)
 - ii. Hip (coxal)
 - iii. Loin (lumbar)
 - iv. Between hips (sacral)
 - c. Pelvis (pelvic)
 - i. Groin (inguinal)
 - ii. Pubis (pubic)
 - iii. Buttock (gluteal)
 - iv. Perineal
- 6. Upper Extremity
 - a. Armpit (axillary)
 - b. Arm (brachial)
 - c. Front of elbow (antecubital)
 - d. Back of elbow (olecranal, cubital)
 - e. Forearm (antebrachial)
 - f. Wrist (carpal)
 - g. Hand (manual)
 - i. Thumb (pollux)
 - ii. Palm (palmar, volar)
 - iii. Back of hand (dorsum)
 - iv. Fingers (digital, phalangeal)
- 7. Lower Extremity
 - a. Thigh (femoral)
 - b. Knee
 - i. Anterior surface (patellar)
 - ii. Posterior surface (popliteal)
 - c. Leg (crural)
 - i. Calf (sural)
 - d. Foot (pedal)
 - i. Ankle (tarsal)
 - ii. Sole (plantar)
 - iii. Top of foot (dorsum)
 - iv. Heel (calcaneal)
 - v. Toes (digital, phalangeal)
 - vi. Great toe (hallux)

Objective 6 Identify the body cavities and locate the following organs within each cavity.

- 1. Dorsal Cavity
 - a. Vertebral (spinal) -spinal cord
 - b. Cranial-brain

2. Ventral Cavity
 - a. Thoracic
 - i. Mediastinum-heart, bronchi, esophagus, thymus.
 - ii. Pericardial-heart
 - iii. Pleural-lungs
3. Abdominopelvic Cavity
 - a. Abdominal-liver, spleen, intestines, kidneys, stomach, pancreas
 - b. Pelvic-intestines, urinary bladder, sex organs

Objective 7 Identify the four abdominopelvic quadrants and the nine abdominopelvic regions and locate the major organ(s) in each.

1. Quadrants
 - a. RUQ-right upper quadrant-liver, gallbladder, right kidney
 - b. RLQ-right lower quadrant-cecum, appendix, right ovary
 - c. LUQ-left upper quadrant-spleen, stomach, pancreas, left kidney.
 - d. LLQ-lower left quadrant-left ovary
2. Regions
 - a. Right/Left hypochondriac
 - b. Right/Left lumbar
 - c. Right/Left inguinal (iliac)
 - d. Epigastric
 - e. Umbilical
 - f. Hypogastric (pubic)

Objective 8 Define and describe the mechanism of homeostasis.

1. Receptors
2. Control centers
3. Effectors

Objective 9 Compare and contrast negative and positive feedback mechanisms to maintain homeostasis. Give examples of each.

1. Positive feedback (induce or stimulates)
 - a. Examples:
 - i. childbirth
 - ii. breast feeding
 - iii. blood clotting
 - iv. severe bleeding
2. Negative feedback (inhibits or reverses)
 - a. Examples:
 - i. blood pressure
 - ii. blood glucose
 - iii. thermoregulation
 - iv. water balance (thirst)

Standard 2 - Inorganic Chemistry (4%)

Candidates will construct an explanation of the basic principles of body chemistry (matter, structure, and function).

Objective 1 Review the following terms and concepts.

1. States of Matter
2. Elements
3. Basic components of the atom
 - a. Nucleus
 - b. Electrons
 - c. Protons
 - d. Neutrons
4. Metabolism
 - a. Anabolic
 - b. Catabolic

Objective 2 Identify the major, lesser, and trace elements in the body and their chemical symbols.

1. Major
 - a. Carbon (C)
 - b. Hydrogen (H)
 - c. Oxygen (O)
 - d. Nitrogen (N)
2. Lesser
 - a. Sodium (Na)
 - b. Chlorine (Cl)
 - c. Potassium (K)
 - d. Calcium (Ca)
3. Trace
 - a. Helium (He)
 - b. Lithium (Li)
 - c. Beryllium (Be)
 - d. Boron (B)
 - e. Fluorine (F)
 - f. Neon (Ne)
 - g. Magnesium (Mg)
 - h. Aluminum (Al)
 - i. Silicon (Si)
 - j. Phosphorus (P)
 - k. Sulfur (S)
 - l. Argon (Ar)
 - m. Iron (Fe)
 - n. Selenium (Se)
 - o. Bromine (Br)
 - p. Krypton (Kr)
 - q. Iodine (I)
 - r. Xenon (Xe)

Objective 3 Differentiate between atomic number, mass number, and atomic mass using the periodic table.

Objective 4 Define isotopes and distinguish between stable isotopes and radioisotopes.

Objective 5 Define valence and electronegativity, and describe how they relate to the position of an element on the periodic table.

Objective 6 Describe the characteristics and strength of different chemical bonds.

1. Ionic (cation, anion)
2. Covalent
 - a. Non-polar
 - i. Single
 - ii. Double
 - iii. Triple
 - b. Polar
3. Hydrogen

Objective 7 Describe the properties of water and how it is utilized in the human body.

1. Universal solvent
2. Transport
3. Lubricant
4. Heat capacity
5. Chemical reactions

Objective 8 Define acid, and base, and describe the pH scale.

1. Acidic
 - a. Hydrogen (proton) donor
2. Basic (alkaline)
 - a. Hydrogen (proton) acceptor
3. Neutral
4. Blood pH = 7.35 to 7.45

Objective 9 Define a pH buffer and explain the role of the carbonic acid/bicarbonate buffer system. $\text{H}_2\text{O} + \text{CO}_2 \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^-$

Standard 3 - Organic Chemistry (2%)

Candidates will construct an explanation of the basic principles of inorganic/organic body chemistry (matter, structure, and function).

Objective 1 Distinguish between:

1. Inorganic compounds-do not contain carbon, small molecules, usually form ionic bonds
2. Organic compounds-usually contain carbon, large molecules, form covalent bonds, flammable

Objective 2 Compare and contrast how anabolic and catabolic processes form monomers and polymers.

1. Dehydration synthesis
2. Hydrolysis

Objective 3 Describe the naming, structure, and functions of carbohydrates and give an example of each:

1. Monosaccharides (monomer)

- a. Hexose
 - i. Glucose
 - ii. Fructose
2. Galactose
 - a. Pentose
 - i. Deoxyribose
 - ii. Ribose
3. Disaccharides
 - a. Sucrose (glucose + fructose)
 - b. Lactose (glucose + galactose)
 - c. Maltose (glucose + glucose)
4. Polysaccharides (polymer)
 - a. Glycogen
 - b. Amylose - starch
 - c. Cellulose - fiber

Objective 4 Assist the patient with ambulatory devices.

1. Amino Acids (monomer)
 - a. Carboxyl
 - b. R-Group (20 unique groups)
 - c. Amino group
2. Bonds
 - a. Peptide
 - b. Dipeptide
 - c. Polypeptide
3. Levels of protein structure
 - a. Primary
 - b. Secondary
 - c. Tertiary
 - d. Quaternary
4. Enzymes

Objective 5 Describe the structures and functions of lipids and give an example of each:

1. Fatty acids (monomer)
 - a. Saturated
 - b. Unsaturated
 - i. Monounsaturated
 - ii. Polyunsaturated
2. Triglycerides
3. Steroids

Objective 6 Describe the structures and functions of nucleic acids and give an example of each:

1. Nitrogenous Bases
 - a. Adenine
 - b. Guanine
 - c. Thymine
 - d. Cytosine
 - e. Uracil
2. Nucleotide (monomer) = base + sugar + phosphate

3. RNA and DNA (polymer)

Objective 7 Describe the structure and function of phospholipids.

Objective 8 Describe the structure and function of glycolipids and glycoproteins as cell surface markers.

Standard 4 - Cells (2%)

Candidates will construct and develop models to describe basic structures and functions of cells.

Objective 1 Identify the principal parts of a generalized animal cell and their functions.

1. Nucleus
 - a. Nucleolus
 - b. Chromosome
 - i. Chromatin
 - ii. Gene (DNA, RNA)
2. Cytoplasm
 - a. Cytosol
 - b. Organelles
 - i. Ribosome
 - ii. Endoplasmic Reticulum (smooth, rough)
 - iii. Golgi complex (body)
 - iv. Lysosome
 - v. Mitochondria
 - vi. Centrosome (centrioles)
 - vii. Cytoskeleton
 - viii. Cilia
 - ix. Flagella
 - x. Peroxisome
3. Cell membrane
 - a. Phospholipids
 - b. Cholesterol
 - c. Glycoproteins
 - d. Glycolipids
 - e. Protein channels

Objective 2 Describe a selectively permeable membrane and factors which influence permeability.

Objective 3 Contrast intracellular and extracellular fluid in terms of location and composition.

Objective 4 Describe each of the following cellular transport processes and classify them as active or passive.

1. Passive processes
 - a. Simple diffusion
 - b. Facilitated diffusion
 - c. Filtration (dialysis)
 - d. Osmosis
2. Active processes
 - a. Endocytosis
 - i. Phagocytosis
 - ii. Pinocytosis
 - iii. Receptor mediated
 - b. Exocytosis
 - c. Secondary Active Transport
 - i. Antiport
 - ii. Symport
 - d. Sodium/Potassium pump

Objective 5 Compare and contrast the osmotic effects that occur when a cell is placed in the following solutions:

1. Isotonic
2. Hypotonic
3. Hypertonic

Objective 6 Describe how and where the body produces energy during cellular respiration.
ATP ADP + P + ENERGY

1. Glycolysis (anaerobic)
2. Formation of acetyl coenzyme A/lactic acid (aerobic vs anaerobic pathways)
3. Citric Acid Cycle (Krebs)
4. Electron Transport Chain

Objective 7 Sequence the steps of the cell cycle. Compare and contrast mitosis and meiosis.

1. Interphase
 - a. G0
 - b. G1
 - c. S
 - d. G2
2. Mitosis
 - a. Prophase
 - b. Metaphase
 - c. Anaphase
 - d. Telophase
 - e. Cytokinesis
3. Meiosis
 - a. Prophase I & II
 - b. Metaphase I & II
 - c. Anaphase I & II
 - d. Telophase I & II
 - e. Cytokinesis

Objective 8 Describe the process of transcription and translation in relationship to protein synthesis.

Objective 9 Describe the process of DNA replication.

Standard 5 - Tissues (2%)

Candidates will plan and carry out an investigation to compare and contrast the basic structures and functions of tissues.

Objective 1 Identify and describe the general characteristics and functions of each of the four principal types of tissues.

1. Cutting instruments
 - a. Scissor (bandage, suture)
 - b. Scalpel
2. Grasping and clamping
 - a. Hemostat
 - b. Forceps
 - c. Towel clamp
3. Probing and dilating
 - a. Scope
 - b. Speculum
 - c. Punch (biopsy)
4. Suture materials
 - a. Sutures (absorbable, non-absorbable)
 - b. Suture needles
 - c. Needle holder
 - d. Steri-strips
 - e. Staples
 - f. Skin glue

Objective 2 Describe the naming, structural features, and locations of epithelial tissue.

1. Obtain a patient consent form.
2. Explain pre- and post-procedure care and education to the patient.
3. Demonstrate a surgical hand wash.
4. Demonstrate applying sterile gloves.
5. Demonstrate creating a sterile field and opening a sterile pack.
6. Describe ways of maintaining the sterile field.
7. Demonstrate the ability to assist with procedures, including skin preparation.
8. Demonstrate sterile dressing changes.
9. Demonstrate suture and staple removal techniques.

Objective 3 Describe the structural features, types, and locations of connective tissue.

1. Cells
2. Extracellular matrix
 - a. Fibers
 - b. Ground substance
3. Types of connective tissue
 - a. Loose
 - i. Areolar

- ii. Adipose
 - iii. Reticular
- b. Dense
 - i. Regular
 - ii. Irregular
 - iii. Elastic
- c. Cartilage
 - i. Hyaline
 - ii. Fibrocartilage
 - iii. Elastic
- d. Blood
- e. Bone
- f. Lymph

Objective 4 Describe the five main types of cellular junctions.

1. Tight
2. Gap
3. Adherens
4. Desmosomes
5. Hemidesmosomes

Objective 5 Compare and contrast epithelial and connective tissue membranes.

1. Cutaneous
2. Serous
3. Mucous
4. Synovial – connective only

Objective 6 Compare and contrast skeletal, cardiac, and smooth muscle tissue.

1. Voluntary vs. involuntary
2. Striated vs. non-striated
3. Location and number of nuclei

Objective 7 Describe and identify the key features of nervous tissue.

1. Neuron
2. Glial cells

Standard 6 - Integumentary System (3%)

Candidates will plan and carry out an investigation to compare and contrast the basic structures and functions of the integumentary system.

Objective 1 Describe the general structures and functions of the integumentary system.

Objective 2 Identify and describe the tissue types of the epidermis. Identify and describe layers of the epidermis. Differentiate between thick and thin skin. Describe renewal of the epidermis.

Objective 3 Explain how each cell type (stem cells, keratinocytes, melanocytes, Langerhans cells, Merkel cells and discs) and substances (keratin, extracellular lipids) contribute to the function of the epidermis.

Objective 4 Identify and describe the dermis and its layers. Know the tissue types of each layer.

Objective 5 Identify and describe the hypodermis/subcutaneous layer. Know the tissue types of the hypodermis.

Objective 6 Identify exocrine glands of the integumentary system and describe their function.

1. Sudoriferous
 - a. Eccrine
 - b. Apocrine
2. Sebaceous
3. Ceruminous

Objective 7 Identify nerve endings of the integumentary system and describe their functions.

1. Meissner's corpuscles
2. Merkel disk
3. Free nerve endings
4. Pacinian corpuscles
5. Ruffini ending

Objective 8 Describe the structures and functions of accessory structures of the integumentary system.

1. Hair
2. Nails

Objective 9 Explain the role of skin in the maintenance of body temperature (thermoregulation).

Standard 7 - Skeletal System (8%)

Candidates will develop and use models to relate the structure of the skeletal system to its functional role in movement, protection, and support.

Objective 1 Describe the general functions of the skeletal system.

Objective 2 List the cellular components of bone tissue. List the extracellular components of bone tissue.

1. Cells
 - a. Osteogenic
 - b. Osteoblasts
 - c. Osteocytes
 - d. Osteoclasts
2. Extracellular matrix

- a. Organic (ex. collagen)
- b. Inorganic (ex. hydroxyapatite)

Objective 3 Compare and contrast compact and spongy bones.

Objective 4 Describe the roles and location of the following skeletal connective tissues:

1. Dense regular
 - a. Ligaments
 - b. Tendons
2. Dense irregular
 - a. Periosteum
 - b. Endosteum
3. Cartilage
 - a. Hyaline (articular)
 - b. Fibrocartilage
 - c. Elastic

Objective 5 Identify the features of a long bone.

1. Periosteum
2. Diaphysis
3. Metaphysis
4. Epiphysis
5. Epiphyseal plate/line (growth plate)
6. Medullary cavity
7. Red marrow
8. Yellow marrow
9. Articular cartilage
10. Endosteum
11. Compact bone
12. Spongy bone

Objective 6 Compare and contrast endochondral and intramembranous ossification.

Objective 7 Explain how hormones are involved in bone growth and maintenance. Explain how hypercalcemia and hypocalcemia cause the release of calcitonin, parathyroid hormone and calcitriol in regulation of bone remodeling and blood calcium.

Objective 8 Define and locate bone markings including:

1. Condyle
2. Epicondyle
3. Facet
4. Fissure
5. Foramen
6. Fossa
7. Head
8. Meatus
9. Process

10. Spine
11. Sulcus
12. Trochanter
13. Trochlea
14. Tubercle
15. Tuberosity

Objective 9 Locate the following bones of the axial and appendicular skeletons.

1. Axial Skeleton
 - a. Mandible
 - b. Maxilla
 - c. Zygomatic
 - d. Frontal
 - e. Parietal
 - f. Occipital
 - g. Sphenoid
 - h. Ethmoid
 - i. Hyoid
 - j. Temporal
 - k. Vertebrae (lamina, body, pedicle, spinous process, transverse process)
 - i. Cervical
 - ii. Thoracic
 - iii. Lumbar
 - iv. Sacral
 - v. Coccygeal
 - l. Ribs
 - m. Sternum
2. Appendicular System
 - a. Clavicle
 - b. Scapula
 - c. Pubic bone
 - d. Ilium
 - e. Ischium
 - f. Pubis
 - g. Femur
 - h. Patella
 - i. Tibia
 - j. Fibula
 - k. Tarsals
 - l. Metatarsals
 - m. Phalanges
 - n. Humerus
 - o. Ulna
 - p. Radius
 - q. Carpals
 - r. Metacarpals
 - s. Phalanges

Objective 10 Compare and contrast functional and anatomical (structural) classification of joints.

1. Structural:
 - a. Fibrous

- b. Synovial
- c. Cartilaginous
- 2. Functional:
 - a. Amphiarthrotic
 - b. Diarthrotic
 - c. Synarthrotic

Objective 11 Describe the different movements of a joint.

- 1. Flexion/extension/hyperextension
- 2. Abduction/adduction/circumduction
- 3. Pronation/supination
- 4. Internal (medial) and external (lateral) rotation
- 5. Plantarflexion/dorsiflexion

Standard 8 - Muscular System I (3%)

Candidates will develop and use models to relate the structure of the muscular system to its functional role in movement, protection, and support.

Objective 1 Describe the general functions of the muscular system.

Objective 2 Contrast the general location, microscopic appearance, control, and functions of the three specific types of muscle tissue.

- 1. Skeletal
- 2. Smooth
- 3. Cardiac

Objective 3 Describe muscle organization and structure.

- 1. Sarcomere
- 2. Myofibril
- 3. Muscle cell (muscle fiber)
- 4. Sarcolemma
- 5. Sarcoplasm
- 6. Transverse tubules (T-tubules)
- 7. Sarcoplasmic reticulum
- 8. Triad
- 9. Fascicle
- 10. Endomysium
- 11. Perimysium
- 12. Epimysium

Objective 4 Learn basic first aid skills

1. Myofilaments
 - a. Actin (thin)
 - i. Troponin
 - ii. Tropomyosin
 - b. Myosin (thick)
2. Bands and zones
 - a. A-band
 - b. I-band
 - c. Z-disc
 - d. H-zone
 - e. M-line

Objective 5 Label the components of the neuromuscular junction on a diagram and explain the role in triggering muscle contraction.

Objective 6 List the sequence of events from muscle cell action potential to the contraction of muscle.

1. Nerve impulse (action potential)
2. Acetylcholine (Ach) - neurotransmitter
3. Muscle contraction stimulated

Objective 7 Describe the sliding filament model of muscle contraction.

Objective 8 Explain the role of other molecules like creatine and myoglobin in energy metabolism.

Objective 9 Define and describe the terms origin, insertion, action, prime mover, agonist, antagonist, synergist, and fixator.

Objective 10 Explain how the following terms are used to name muscles and provide an example of each:

1. Location
2. Shape
3. Size
4. Number of origins
5. Direction of fibers
6. Origin and insertion
7. Action

Objective 11 Identify the following muscles including their location, origin/insertion, and action.

1. Upper Extremity
 - a. Rotator cuff
 - i. Supraspinatus
 - ii. Infraspinatus
 - iii. Teres minor
 - iv. Subscapularis
 - b. Deltoid
 - c. Pectoralis Major
 - d. Latissimus Dorsi

- e. Triceps Brachii
- f. Biceps Brachii
- g. Brachialis
- h. Brachioradialis
- i. Wrist flexors
- j. Wrist extensors
- 2. Lower Extremity
 - a. Iliopsoas
 - b. Gluteus Maximus
 - c. Gluteus Medius
 - d. Sartorius
 - e. Hip adductors
 - f. Quadriceps
 - i. Rectus femoris
 - ii. Vastus medialis
 - iii. Vastus lateralis
 - iv. Vastus intermedius
 - g. Hamstrings
 - i. Biceps femoris
 - ii. Semimembranosus
 - iii. Semitendinosus
 - h. Gastrocnemius
 - i. Soleus
 - j. Tibialis Anterior
 - k. Tibialis Posterior
 - l. Peroneal (fibular) group
- 3. Head/neck/trunk
 - a. Masseter
 - b. Sternocleidomastoid
 - c. Trapezius
 - d. Diaphragm
 - e. Intercostals
 - f. Rectus Abdominis
 - g. Internal/External Oblique
 - h. Transverse Abdominus
 - i. Erector Spinae

Standard 9 - Muscular System II (17%)

Candidates will develop and use models to relate the structure of the nervous system and its functional roles in detection, interpretation and response to information.

Objective 1 Distinguish between the sensory and motor (somatic and autonomic) divisions of the nervous system and the terminology associated

- 1. Ganglion vs nuclei
- 2. Tracts vs nerves
- 3. Gyrus vs sulcus vs fissure

Objective 2 Compare and contrast characteristics of the two cell types of the nervous system: neurons and glial cells.

1. Neurons
 - a. Cell body
 - b. Axon
 - c. Dendrite
2. Glial Cells
 - a. Central Nervous System (CNS)
 - i. Astrocytes
 - ii. Microglia
 - iii. Oligodendrocytes
 - iv. Ependymal cells
3. Peripheral Nervous System (PNS)
 - a. Schwann cells
 - b. Satellite cells

Objective 3 Compare and contrast concentration gradient and electrical forces. Apply these principles to the movement of ions across the cell membrane.

Objective 4 List and describe the sequence of events in the action potential. Label a diagram of the action potential including: threshold, depolarization, repolarization, hyperpolarization, and absolute and relative refractory periods.

Objective 5 List and describe in order the sequence of events at the synapse. Begin with the arrival of the action potential and end with the effect of neurotransmission on the postsynaptic cell.

1. Action potential arrival at presynaptic cell
2. Neurotransmitter release into synaptic space
3. Neurotransmitter binds with post synaptic receptor causing a biochemical change

Objective 6 Identify the following neurotransmitters:

1. Acetylcholine (ACh)
2. Dopamine
3. Serotonin
4. Epinephrine
5. Norepinephrine

Objective 7 Compare and contrast the effects of graded potentials (Excitatory Post Synaptic Potential [EPSP] and Inhibitory Post Synaptic Potential [IPSP]) on action potentials.

Objective 8 Describe the gross anatomy of the spinal cord and spinal nerves.

1. Differentiate between gray and white matter.
2. Understand the relationship of the spinal cord and spinal nerves to the bony vertebrae surrounding them.
3. Label on a diagram the following structures associated with the spinal cord:
 - a. Lateral corticospinal tract
 - b. Posterior column
 - c. Spinothalamic tract
 - d. Dorsal/lateral/ventral horns
 - e. Dorsal root ganglia
 - f. Dorsal/ventral roots

- g. Spinal nerves

Objective 9 Identify and describe the structures and functions of the brain.

1. Cerebrum
 - a. Frontal
 - i. Pre-central gyrus (motor homunculus)
 - b. Parietal
 - i. Post-central gyrus (sensory homunculus)
 - c. Temporal
 - d. Occipital
2. Cerebellum
3. Brain stem
 - a. Medulla oblongata
 - b. Pons
 - c. Midbrain
4. Diencephalon
 - a. Thalamus
 - b. Hypothalamus
5. Gray/white matter organization
6. Brain Landmarks
 - a. Fissures
 - b. Medial Longitudinal
 - c. Lateral
 - d. Transverse
7. Gyri
 - a. Pre-central
 - b. Post-central
8. Sulci
 - a. Central
 - b. Parieto-occipital
9. Other
 - a. Corpus Collosum
 - b. Limbic System

Objective 10 Describe the anatomy and physiology of the sympathetic nervous system. In the description of the anatomy, include the location and length of preganglionic and postganglionic neurons and synapses. In the description of the physiology, include the activity of various organs innervated by the autonomic nervous system.

Objective 11 Describe the anatomy and physiology of the parasympathetic nervous system. In the description of the anatomy, include the location and length of preganglionic and postganglionic neurons and synapses. In the description of the physiology, include the activity of various organs innervated by the autonomic nervous system.

Objective 12 Identify the effectors of the autonomic nervous system. Identify the effectors of the somatic nervous system. Compare and contrast these.

Objective 13 Identify the three meninges. For each meninx, be able to describe its anatomical relationship to the skull, to the brain, and to the other meninges.

1. Dura Mater
2. Arachnoid
3. Pia Mater

Objective 14 Describe cerebrospinal fluid. Identify locations where it is made; where it circulates; and where it is resorbed into the bloodstream.

1. Choroid plexus
2. Lateral Ventricles (2)
3. Third Ventricle
4. Aqueduct
5. Fourth Ventricle
6. Subarachnoid space
7. Arachnoid villi

Objective 15 Describe the structure and function of the blood-brain barrier.

Objective 16 List the twelve cranial nerves. Correctly identify and associate their names and numbers. State a function for each and whether it is sensory, motor, or mixed.

1. I- Olfactory
2. II – Optic
3. III- Oculomotor
4. IV – Trochlear
5. V- Trigeminal
6. VI – Abducens
7. VII – Facial
8. VIII – Vestibulocochlear (acoustic)
9. IX – Glossopharyngeal
10. X- Vagus
11. XI – Accessory (spinal)
12. XII - Hypoglossal

Objective 17 Compare and contrast upper and lower motor neurons and. Describe the motor systems and pathways.

1. Pre-central gyrus
2. Pyramids
3. Lateral corticospinal tract
4. Effector

Objective 18 Identify the general features of a sensory system.

1. Define transduction.
2. Describe the sensory pathways for pain and temperature vs touch.
 - a. Pain and temperature
 - b. Receptor
 - c. Sensory nerve
 - d. Dorsal root ganglion
 - e. Dorsal horn
 - f. Lateral spinothalamic tract (crosses in spinal cord)
 - g. Thalamus
 - h. Post-central gyrus

3. Touch
 - a. Receptor
 - b. Sensory nerve
 - c. Dorsal root ganglion
 - d. Dorsal horn
 - e. Posterior column
 - f. Crosses in the medulla
 - g. Thalamus
 - h. Post-central gyrus

Objective 19 Define each of the following three categories of sensory receptors:

1. Exteroceptor
2. Interoceptor
3. Proprioceptor

Objective 20 Compare and contrast the following sensory receptors:

1. Mechanoreceptors
2. Thermoreceptors
3. Nociceptors
4. Photoreceptors
5. Chemoreceptors
6. Osmoreceptors

Objective 21 Investigate dermatomes and their importance to nerve injury.

Examples:

1. C6 – thumb
2. T4- nipple line
3. T10- umbilicus
4. L2-L5 – lower limbs

Standard 10 - Muscular System III (5%)

Candidates will construct an explanation about the cause-and-effect relationship of the reflex arc and special senses related to the detection, interpretation, and response to information.

Objective 1 Explain the role of each of the components of a reflex arc.

1. Reflexarc
 - a. Receptor
 - b. Sensory neuron
 - c. Association (interneuron) neuron
 - d. Motor neuron
 - e. Effector

Objective 2 Describe examples of common reflexes

1. Stretch reflex

2. Flexor (withdrawal) reflex
3. Cross extensor reflex

Objective 3 Label the components of the eye and describe the neural pathway to the brain.

1. Accessory structures
 - a. Eyelid
 - b. Conjunctiva
 - c. Lacrimal apparatus
 - d. Extrinsic muscles
2. Layers of the eyeball
 - a. Fibrous tunic
 - i. Sclera
 - ii. Cornea
 - b. Vascular tunic
 - i. Choroid
 - ii. Ciliary body
 - iii. Iris
 - iv. Lens
 - v. Pupil
 - c. Nervous tunic
 - i. Retina
 - ii. Rods
 - iii. Cones
 - d. Neural pathway
 - i. Photoreceptor
 - ii. Optic nerve
 - iii. Optic chiasm
 - iv. Thalamus
 - v. Occipital lobe

Objective 4 Explain the location and function of olfactory receptors. Describe the neural pathway to the brain.

1. Olfactory receptors
2. Olfactory nerve
3. Olfactory bulb
4. Olfactory tract
5. Olfactory cortex of the temporal lobe

Objective 5 Explain the location and function of gustatory receptors. Describe the neural pathway to the brain.

1. Gustatory receptors
 - a. Fungiform papillae
 - b. Foliate papillae
 - c. Vallate papillae
2. Cranial nerve VII, IX, X
3. Medulla
4. Thalamus
5. Post-central gyrus

Objective 6 Identify the principal anatomical structures of the ear, follow the sound conduction pathway from the auricle to the fluids of the inner ear, and describe the neural pathway to the brain.

1. Outer ear
 - a. Auricle
 - b. Auditory Canal
2. Middle ear
 - a. Tympanic cavity
 - b. Tympanic membrane
 - c. Auditory (Eustachian) tube
 - d. Auditory ossicles
 - i. Malleus
 - ii. Incus
 - iii. Stapes
3. Inner Ear
 - a. Oval window
 - b. Round window
 - c. Bony labyrinth
 - d. Utricle
 - e. Saccule
 - f. Semicircular canals
 - g. Vestibule
 - h. Cochlea & Organ of Corti
 - i. Vestibular duct (scala vestibuli)
 - j. Tympanic duct (scala tympani)
4. Neural Pathway Receptors (hair cells)
5. Cranial nerve VIII
6. Medulla
7. Thalamus
8. Temporal lobe

Objective 7 Explain the coding of pitch and loudness in the auditory system.

Objective 8 For the vestibular system, compare and contrast static vs. dynamic equilibrium. Describe the neural pathway to the brain.

1. Receptors (hair cells)
2. Cranial nerve VIII
3. Medulla
4. Thalamus
5. Somatosensory cortex

Standard 11 - Endocrine System (7%)

Candidates will investigate and analyze how the hormones of the endocrine system regulate (effect) physical and chemical processes to maintain homeostasis.

Objective 1 Describe the functions of the endocrine system.

Objective 2 Describe and analyze the following endocrine terminology and concepts.

1. Hormone
2. Target cells
 - a. Autocrine
 - b. Paracrine
 - c. Endocrine
3. Permissive, synergistic, and antagonistic effects
4. Water soluble vs lipid soluble
5. Target cell response
 - a. Up regulation
 - b. Down regulation
6. Primary vs secondary endocrine glands

Objective 3 Diagram the location, secretion, and functions of the hypothalamus.

1. Growth Hormone Releasing Hormone (GHRH)-targets anterior pituitary
2. Thyrotropin Releasing Hormone (TRH)-targets anterior pituitary
3. Corticotrophic Releasing Hormone (CRH)-targets anterior pituitary
4. Gonadotropic Releasing Hormone (GnRH) – targets anterior pituitary
5. Prolactin Releasing Hormone (PRL) – targets anterior pituitary
6. Antidiuretic Hormone (ADH)
 - a. Produced in hypothalamus
 - b. Stored in and released from the posterior pituitary
7. Oxytocin Hormone (Oxt)
 - a. Produced in hypothalamus
 - b. Stored in and released from the posterior pituitary

Objective 4 Diagram the location, secretion, and functions of the pituitary gland.

1.

Objective 5 Describe the anatomical and physiological relationships between the pituitary (which includes the adenohypophysis and the neurohypophysis) and the hypothalamus.

Objective 6 Learn basic first aid skills

1. Structures
 - a. Follicle cells
 - b. Parafollicular cells
 - c. Thyroid follicle
 - d. Isthmus
2. Hormones
 - a. Thyroxine (T4)
 - i. Follicular cells
 - ii. Targets cells increasing metabolism
 - b. Triiodothyronine (T3)
 - i. Follicular cells
 - ii. Targets cells increasing metabolism
 - c. Calcitonin
 - i. Parafollicular cells
 - ii. Lowers blood calcium

Objective 7 Describe the location, secretion, and functions of the parathyroid gland.

1. Parathyroid hormone
2. Chief cells
3. Increases blood calcium

Objective 8 Describe the antagonistic relationship between calcitonin and parathyroid hormone in regulating blood calcium.

Objective 9 Describe the location and structures of the adrenal gland. List the hormones produced and target cells.

1. Adrenal cortex
 - a. Zona glomerulosa – mineralocorticoids – aldosterone
 - b. Zona fasciculata – glucocorticoids – cortisol
 - c. Zona reticularis- gonadocorticoids - androgens
2. Adrenal medulla
 - a. Catecholamines
 - i. Epinephrine
 - ii. Norepinephrine

Objective 10 Describe the renin-angiotensin-aldosterone system (RAAS) and its role in regulating blood pressure.

Objective 11 Describe the location and structures of the pancreas. List the hormones produced and their functions. Describe the antagonistic relationship between glucagon and insulin in regulating blood glucose.

1. Structures
 - a. Head
 - b. Body
 - c. Tail
 - d. Pancreatic Acini – exocrine – digestive function
2. Pancreatic Islets
 - a. Alpha – glucagon – increases glucose levels
 - b. Beta – insulin – decreases glucose levels

Objective 12 Describe the location, secretion, and functions of the pineal gland.

1. Melatonin – regulates sleep/wake cycle

Objective 13 Describe the location, secretion, and functions of the thymus gland.

1. Thymosin: T-lymphocyte maturation

Objective 14 Describe the location, secretion, and functions of the gonads.

1. Ovaries: estrogen, progesterone
2. Testes: testosterone

Standard 12 - Cardiovascular System I (12%)

Candidates will obtain, evaluate and communicate information that explains the structure and functions of whole blood components, including the lymphatic system and the effects on immunity.

Objective 1 Identify and describe the components of whole blood.

1. Erythrocytes
2. Leukocytes
3. Thrombocytes (platelets)
4. Plasma
 - a. Water
 - b. Proteins
 - c. Nutrients
 - d. Hormones

Objective 2 Describe hematopoiesis including erythropoiesis.

Objective 3 Describe the structure and function of the red blood cells (RBCs).

1. Physical characteristics
2. Hemoglobin
3. Hematocrit
4. Antigens
 - a. ABO
 - b. Rh

Objective 4 Define leukocyte and identify the various types of white blood cells normally present in the blood.

1. Leukocytes
 - a. Granulocytes
 - i. Neutrophils
 - ii. Basophils
 - iii. Eosinophils
2. Agranulocytes
 - a. Monocytes
 - b. Lymphocytes
 - i. B-cells
 - ii. T-cells

Objective 5 Identify the production and functions of thrombocytes.

Objective 6 Define hemostasis and describe the three mechanisms that contribute to hemostasis. Describe fibrinolysis.

1. Vascular spasm
2. Platelet plug formation
3. Coagulation

- a. Intrinsic
- b. Extrinsic
- c. Common final pathway
- 4. Anti-coagulation (fibrinolysis)

Objective 7 Describe the structures and functions of the lymphatic system. Explain how lymph is formed and how it circulates.

- 1. Structures
 - a. Primary lymph organs
 - i. Thymus
 - ii. Bone marrow
 - b. Secondary lymph organs
 - i. Lymph nodes
 - 1. Cervical
 - 2. Submandibular
 - 3. Axillary
 - 4. Inguinal
 - c. Spleen
 - d. Appendix
 - e. Tonsils
- 2. Functions
 - a. Lipid transport
 - b. Interstitial fluid drainage
 - c. Immunity
- 3. Circulation
 - a. Lymph capillaries
 - b. Lymph vessels
 - c. Lymphatic ducts

Objective 8 Define the following terms as they apply to immunity.

- 1. Antigen
 - a. Epitope
- 2. Antibody

Objective 9 Describe innate immunity and give examples of common mechanisms.

- 1. Barriers
 - a. Physical
 - b. Chemical
- 2. Fever and Inflammation
- 3. Complement system
- 4. Phagocytosis

Objective 10 Describe adaptive immunity and give examples of common mechanisms. Describe the roles of T-cells and B-cells in the immune response.

- 1. Cell-mediated
 - a. T- cytotoxic
 - b. T- helper
 - c. Memory cells
- 2. Antibody mediated (humoral)
 - a. B-cells

- b. Plasma cells
- c. T-helper
- d. Memory cells

Objective 11 Distinguish between active and passive immunity and natural vs. artificial acquisition of immunity.

Objective 12 Describe the basic structure and functions of an antibody. Identify and describe the five classes of antibodies.

- 1. IgG
- 2. IgM
- 3. IgE
- 4. IgD
- 5. IgA

Objective 13 Contrast the primary and secondary immune responses.

Standard 13 - Cardiovascular System II (10%)

Candidates will develop and use a model to describe the structures and functions of the cardiovascular system.

Objective 1 List the general functions of the cardiovascular system.

Objective 2 Describe the general shape and location of the heart.

Objective 3 Describe the major structures of the heart.

- 1. Layers/membranes
 - a. Endocardium
 - b. Myocardium
 - c. Epicardium (visceral pericardium)
 - d. Parietal Pericardium
 - e. Pericardial fluid
- 2. Chambers
 - a. Atria
 - b. Ventricles
- 3. Great blood vessels
 - a. Superior vena cava
 - b. Inferior vena cava
 - c. Pulmonary trunk
 - d. Pulmonary arteries
 - e. Pulmonary veins
 - f. Aorta
- 4. Valves
 - a. Right atrioventricular (AV), tricuspid

- b. Pulmonary semilunar
- c. Left atrioventricular (AV), bicuspid (mitral)
- d. Aortic semilunar

Objective 4 Describe the pattern of blood flow in relation to the great vessels, valves, and chambers of the heart. State when each valve is open or closed during blood flow.

Objective 5 Identify and describe the conduction system of the heart and trace the pathway.

- 1. Sinoatrial (SA) node
- 2. Atrioventricular (AV) node
- 3. AV bundle (Bundle of His)
- 4. Bundle branches
- 5. Purkinje fibers

Objective 6 Given a diagram of an electrocardiogram, state the name of each waveform. Explain what is happening at each stage of the electrocardiogram.

Objective 7 Compare and contrast the action potential of an autorhythmic cell and a myocardial cell.

Objective 8 Describe the parasympathetic and sympathetic innervation of the heart.

Objective 9 Sequence the principal events of the cardiac cycle in terms of systole and diastole.

Objective 10 Define the following cardiac function measurements:

- 1. Heart rate
- 2. Stroke volume
- 3. End-diastolic volume
- 4. End-systolic volume
- 5. Ejection Fraction
- 6. Cardiac output

Objective 11 Describe the histology of arteries and veins. Compare and contrast the microscopic structure of arteries and veins.

- 1. Tunica Externa
- 2. Tunica Media
- 3. Tunica Interna

Objective 12 Describe the histology and anatomy of capillaries. Name three types of capillaries, location, and distinguishing characteristics.

- 1. Continuous – commonly found throughout the body
- 2. Fenestrated - kidneys
- 3. Sinusoid – spleen, liver, bone marrow

Objective 13 Explain the process of capillary exchange of nutrients, gases, and wastes. Describe Starling's Law of the Capillary.

Objective 14 Identify the major arteries of the human body. Define: anastomosis.

1. Carotids
2. Subclavian
3. Brachiocephalic
4. Brachial
5. Radial
6. Aorta
 - a. Ascending
 - b. Arch
 - c. Descending
 - d. Thoracic
 - e. Abdominal
7. Renal
8. Iliac (common, internal, external)
9. Femoral
10. Popliteal

Objective 15 Identify the major veins of the human body.

1. Jugular
2. Subclavian
3. Brachiocephalic
4. Brachial
5. Radial
6. Vena Cava (superior, inferior)
7. Renal
8. Iliac (common, internal, external)
9. Femoral
10. Popliteal

Objective 16 Name the parts of the coronary circulation.

1. Coronary arteries
 - a. Right coronary artery
 - b. Marginal artery
 - c. Posterior interventricular
 - d. Left coronary artery
 - e. Anterior interventricular (LAD)
 - f. Circumflex
2. Coronary veins
 - a. Great cardiac vein
 - b. Anterior cardiac vein
 - c. Middle cardiac vein
 - d. Small cardiac vein
3. Coronary sinus

Objective 17 Contrast pulmonary and systemic circulation.

Objective 18 Compare and contrast fetal circulation to adult blood flow.

Standard 14 - Respiratory System (8%)

Candidates will construct an explanation describing the structures and functions associated with the respiratory system.

Objective 1 List the functions of the respiratory system.

Objective 2 List each of the structures through which air passes during inspiration. Differentiate them into upper and lower respiratory tracts and conducting and respiratory zones.

1. Structures
 - a. Nose/mouth
 - b. Pharynx
 - i. Nasopharynx
 - ii. Oropharynx
 - iii. Laryngopharynx
 - c. Larynx
 - d. Trachea
 - e. Primary Bronchi
 - f. Secondary Bronchi
 - g. Tertiary Bronchi
 - h. Bronchioles
 - i. Terminal bronchioles
 - j. Respiratory bronchioles
 - k. Alveolar duct
 - l. Alveolar sacs
 - m. Alveoli
2. Upper Respiratory tracts – structures superior to the larynx
3. Lower Respiratory tracts – structures inferior to the larynx
4. Conducting zone – nose to terminal bronchioles
5. Respiratory zone – respiratory bronchioles to alveoli

Objective 3 Identify the following structures associated with the larynx.

1. Epiglottis
2. Glottis
3. Hyoid bone
4. Vocal cords

Objective 4 Identify the trachea and its anatomic features.

1. Carina
2. Cartilage rings

Objective 5 Identify the gross anatomical features and the coverings of the lungs.

1. Apex
2. Base
3. Lobes

4. Fissures
5. Cardiac notch
6. Hilum
7. Visceral pleura
8. Parietal pleura
9. Pleural cavity
10. Pleural fluid

Objective 6 Describe the muscles of respiration and their innervation.

1. Diaphragm – phrenic nerve
2. External and Internal Intercostals

Objective 7 Learn basic first aid skills

1. Pseudostratified columnar ciliated epithelium
 - a. Goblet cells
2. C-shaped hyaline cartilage of the trachea
3. Smooth muscle of the bronchi and bronchioles
4. Type 1 alveolar cells
5. Type 2 alveolar cells
6. Alveolar macrophages
7. Alveolar-capillary membrane
 - a. Simple squamous endothelium

Objective 8 Define pulmonary ventilation, inspiration, and expiration.

Objective 9 Define and apply Boyle's Law and its impact of volume and pressure related to inspiration and expiration.

Objective 10 State the four respiratory volumes and four respiratory capacities. Identify each of these on a spirogram.

1. Tidal volume (TV)
2. Inspiratory reserve volume (IRV)
3. Expiratory reserve volume (ERV)
4. Residual volume (RV)
5. Vital capacity (VC)
6. Inspiratory capacity (IC)
7. Functional residual capacity (FRC)
8. Total lung capacity (TLC)

Objective 11 State Henry's Law and Dalton's Law. Explain how partial gas pressures are relevant to external and internal respiration.

Objective 12 State the ways oxygen and carbon dioxide are carried in the blood.

Objective 13 State the chemical equation which describes the relationship between carbon dioxide, bicarbonate ion, and carbonic acid in blood. Predict how raising and lowering pH or carbon dioxide concentration will affect respiration rate.

Objective 14 State the location and function of the respiratory control centers.

1. Medulla rhythmicity area
 - a. Inspiratory center
 - b. Expiratory center
2. Pons
 - a. Pneumotaxic
 - b. Apneustic

Objective 15 Summarize the embryonic development of the respiratory system. Explain the role of surfactant.

Standard 15 - Digestive System (5%)

Candidates will ask questions to construct an explanation to describe the structures and functions associated with the digestive system.

Objective 1 Describe the functions of the digestive system.

Objective 2 Identify the major and accessory structures of the digestive system.

1. Alimentary canal structures
 - a. Mouth
 - b. Pharynx
 - c. Esophagus
 - d. Stomach
 - e. Small intestines
 - f. Large intestines
 - g. Rectum
 - h. Anus
2. Accessory structures
 - a. Salivary glands (parotid)
 - b. Teeth
 - c. Pancreas
 - d. Gallbladder
 - e. Liver

Objective 3 Describe and recognize the histology of the alimentary canal (gastrointestinal system). Identify and describe the function of the following layers: mucosa, submucosa, muscularis, serosa.

Objective 4 Describe the anatomy and functions of oral cavity structures.

1. Tongue
2. Taste buds
3. Teeth
 - a. Deciduous
 - b. Permanent
 - c. Parts of a typical tooth.
 - i. Crown
 - ii. Neck
 - iii. Root
 - iv. Gingiva
 - v. Periodontal ligament
 - vi. Enamel
 - vii. Dentin
 - viii. Pulp
 - ix. Root canal
 - d. Salivary Glands
 - i. Parotid
 - ii. Submandibular
 - iii. Sublingual
 - e. Enzymes
 - i. Salivary amylase

Objective 5 Describe the anatomy and functions of the pharynx.

1. Nasopharynx
2. Oropharynx
3. Laryngopharynx

Objective 6 Describe the anatomy and functions of the esophagus.

1. Sphincters
 - a. Upper
 - b. Lower
2. Smooth vs voluntary muscle
3. Swallowing (deglutition) stages
4. Voluntary
5. Pharyngeal
6. Esophageal

Objective 7 Describe anatomy, histology and function of the stomach. Explain the function, production, and regulation of hydrochloric acid (HCl) secretion.

1. Anatomy
 - a. Fundus
 - b. Cardia
 - c. Body
 - d. Pyloric antrum
 - e. Pylorus
 - f. Pyloric canal
 - g. Rugae
 - h. Cardiac sphincter

- i. Pyloric sphincter
- 2. Histology
 - a. Gastric pits
 - i. Parietal cells – secretes hydrochloric acid (HCl), and intrinsic factor
 - ii. Chief cells – secretes pepsinogen and lipase
 - iii. Mucous neck cells – secretes mucous
 - iv. G cells – secretes gastrin

Objective 8 Learn basic first aid skills

- 1. Anatomy:
 - a. Duodenum
 - b. Jejunum
 - c. Ileum
- 2. Histology:
 - a. Plicae circularis
 - b. Villi
 - c. Microvilli
 - d. Cells
 - i. Enterocytes – absorb nutrients
 - 1. Carbohydrates
 - 2. Proteins
 - 3. Lipids
 - a. lacteals
 - ii. Goblet cells – secretes mucous
 - iii. Paneth cells – enzymes, phagocytes
 - iv. Enteroendocrine – secretes hormones

Objective 9 Describe anatomy, histology and function of the large intestine.

- 1. Anatomy
 - a. Ileocecal valve
 - b. Cecum
 - c. Appendix
 - d. Ascending colon
 - e. Transverse colon
 - f. Descending colon
 - g. Sigmoid colon
 - h. Rectum
 - i. Anus
 - i. External sphincter
 - ii. Internal sphincter
 - iii. Defecation reflex
- 2. Histology
 - a. Taeniae coli
 - b. Haustra
 - c. Intestinal glands
 - i. Absorptive cells – absorb water
 - ii. Goblet cells – secrete mucous

Objective 10 Describe anatomy, histology and function of the liver and gall bladder.

- 1. Anatomy

- a. Gall bladder
- b. Liver
 - i. Right and left lobes
 - ii. Caudate and quadrate lobes
 - iii. Ligaments
 1. Falciform
 2. Coronary
 3. Round
 - iv. Lobules
 - v. Hepatic triad
 1. Branch of hepatic artery
 2. Branch of hepatic portal vein
 3. Bile duct
 - vi. Acini
2. Histology
 - a. Sinusoids
 - b. Bile canaliculi
 - c. Cells
 - i. Hepatocytes – inactivates toxins, produces bile, metabolizes carbohydrates, lipids, and proteins, protein production
 - ii. Kupffer cells – macrophage

Objective 11 Diagram the pathway of bile flow from the liver to the duodenum.

1. Right and left hepatic ducts
2. Common hepatic duct
3. Cystic duct (to the gall bladder)
4. Common bile duct
5. Duodenum

Objective 12 Learn basic first aid skills

1. Anatomy
 - a. Head
 - b. Tail
 - c. Body
 - d. Pancreatic duct
2. Histology
 - a. Islet cells – endocrine function
 - b. Acini cells – exocrine secretions
 - i. Amylase
 - ii. Lipase
 - iii. Sodium bicarbonate
 - iv. Protein and nucleic acid enzymes

Objective 13 Compare and contrast mechanical and chemical digestion.

Objective 14 Define the following motility functions:

1. Peristalsis
2. Segmentation
3. Migrating myoelectric complex
4. Mass movement

Standard 16 - Urinary System (7%)

Candidates will obtain, evaluate and communicate information about the structures and functions associated with the urinary system.

Objective 1 Describe the general functions of the urinary system.

Objective 2 Identify the major structures and locations of the components of the urinary system.

1. Kidneys
 - a. Retroperitoneal
 - b. Area of inferior thoracic vertebrae (T11-T12) and superior lumbar vertebrae (L1-L2)
 - c. R. kidney slightly lower than left due to space taken up by liver
2. Ureters
 - a. Tubes that connect the kidneys to the bladder
 - b. Retroperitoneal
3. Bladder
 - a. Hollow, distensible organ in pelvic cavity
4. Urethra

Objective 3 Describe the external and internal anatomy of the kidney.

1. External kidney
 - a. Renal capsule
 - b. Adipose capsule
 - c. Renal fascia
2. Internal kidney
 - a. Renal cortex
 - b. Renal medulla
 - c. Renal pyramids
 - d. Renal columns
 - e. Renal pelvis
 - f. Nephron
 - g. Renal papillae
 - h. Calyces
 - i. Minor
 - ii. Major

Objective 4 Trace the path of blood flow through the kidneys. Explain what makes the vascular system of the kidneys unique compared to other organs.

1. Abdominal aorta
2. Renal artery
3. Segmental arteries
4. Interlobar arteries
5. Arcuate arteries
6. Cortical radiate arteries
7. Afferent arterioles
8. Glomerular capillaries
9. Efferent arterioles *only arteriole in the body that leaves a capillary

10. Peritubular capillaries (including vasa recta in juxtamedullary nephrons)
11. Cortical radiate veins
12. Arcuate veins
13. Interlobar veins
14. Renal vein
15. Inferior vena cava

Objective 5 Identify the structures that comprise the nephron. Differentiate between cortical and juxtamedullary nephrons. Identify 3 basic functions performed by the nephrons (glomerulus and renal tubules).

1. Kidney nephrons
 - a. Cortical nephron – most common
 - b. Juxtamedullary nephron – concentrates urine
2. Nephron structures
 - a. Renal corpuscle
 - i. Glomerulus
 - ii. Glomerular (Bowman's) capsule
 - b. Renal tubules
 - i. Proximal convoluted tubule
 - ii. Descending limb
 - iii. Nephron loop
 - iv. Ascending limb
 - v. Distal convoluted tubule
 - vi. Collecting duct
3. Functions
 - a. Glomerular filtration
 - b. Tubular reabsorption
 - c. Tubular secretion

Objective 6 Describe the structures and pressures which contribute to the filtering of blood through the glomerular membrane.

1. Structures
 - a. Three layers of glomerular membrane:
 - i. Fenestrated capillaries
 - ii. Basal lamina
 - iii. Podocytes
 1. Pedicels
 2. Filtration slits
2. Pressures
 - a. Net filtration pressure
 - i. Glomerular blood hydrostatic pressure
 - ii. Blood colloid osmotic pressure
 - iii. Capsular hydrostatic pressure

Objective 7 Identify and describe the three regulatory mechanisms to control the glomerular filtration rate (GFR).

1. Renal autoregulation
 - a. Tubuloglomerular feedback
 - b. Juxtaglomerular apparatus
2. Neural regulation
3. Hormonal regulation

- a. Angiotensin II
- b. Atrial natriuretic peptide (ANP)

Objective 8 Compare and contrast tubular reabsorption and secretion

- 1. Reabsorption
 - a. Tubules to blood
 - b. Majority of solutes and water reabsorbed in the proximal convoluted tubule.
 - c. Reabsorptive cells: cuboidal epithelium with microvilli
 - d. Transport maximum
 - e. Water reabsorption
 - i. Obligatory reabsorption
 - ii. Facultative absorption
- 2. Tubular secretion
 - a. Blood to tubules
 - i. Secreted substances include H^+ , K^+ , NH_4^+ , creatinine, some drugs

Objective 9 Explain the countercurrent multiplier. Describe how the countercurrent multiplier helps regulate blood osmolarity. Describe the countercurrent exchange mechanism and how it assists with water reabsorption.

Objective 10 Describe the anatomy of the ureters. Identify structures and mechanisms that assist with the flow of urine through the ureters. Compare and contrast male and female urethras.

- 1. Anatomy
 - a. Retroperitoneal
 - b. 10-12 inches long
 - c. Attach to posterior base of the bladder
- 2. Urine flow
 - a. Smooth muscle in ureters assist with peristaltic contractions
 - b. Gravity
 - c. Hydrostatic pressure
- 3. Male and female urethras
 - a. Male
 - i. 3 regions: prostatic, membranous, spongy
 - ii. Also has reproductive functions
 - iii. 20 cm in length
 - b. Female
 - i. External opening between the clitoris and vaginal opening
 - ii. 4 cm
 - iii. Closer proximity to anus

Objective 11 Describe the anatomy of the bladder. Explain the micturition reflex.

- 1. Anatomy
 - a. Hollow, distensible organ
 - b. Posterior to pubic symphysis in pelvic cavity
 - c. Female bladder is slightly smaller than males (uterus takes up space)
 - d. Rugae (folds)
 - e. Transitional epithelium
 - f. Detrusor muscle
 - g. Trigone (comprised of 2 ureters and urethra at the base of the bladder)
 - h. Internal and external sphincters
- 2. Micturition

Objective 12 Describe physical and chemical characteristics of urine.

Objective 13 Compare the water and electrolyte concentrations in intra- and extracellular compartments.

1. Water distribution in the body
 - a. $\frac{2}{3}$ intracellular
 - b. $\frac{1}{3}$ extracellular
2. Ion concentration
 - a. Extracellular ions
 - i. Sodium
 - ii. Chloride
 - iii. Bicarbonate
 - iv. Calcium
 - b. Intracellular ions
 - i. Protein anions
 - ii. Potassium
 - iii. Magnesium
 - iv. Phosphate
 - v. Sulfate

Objective 14 Characterize the role of buffers, ventilation, and renal function in maintaining acid-base homeostasis.

Standard 17 - Reproductive System (2%)

Candidates will develop and use models to describe the structures and functions associated with the reproductive system.

Objective 1 List the functions of the reproductive system.

1.

Objective 2 Identify male & female reproductive system anatomy.

1. Male:
 - a. Testes
 - b. Spermatic cord
 - c. Ductus deferens (vas deferens)
 - d. Scrotum
 - e. Dartos muscle
 - f. Cremaster muscle
 - g. Epididymis
 - h. Urethra
 - i. Prostate gland
 - j. Seminal vesicles
 - k. Bulbourethral (Cowper's) gland
 - l. Penis
 - m. Corpus spongiosum

- n. Corpora cavernosa
- o. Glans penis
- p. Prepuce (foreskin)
- q. Seminiferous tubules
- r. Rete testis
- 2. Female:
 - a. Ovaries
 - b. Uterine (Fallopian) tubes
 - i. Infundibulum and fimbriae
 - ii. Ampulla
 - iii. Isthmus
 - c. Uterus
 - i. Endometrium
 - 1. Simple columnar epithelium
 - 2. Stratum functionalis
 - 3. Stratum basalis
 - 4. Straight arterioles
 - 5. Spiral arterioles
 - ii. Myometrium
 - iii. Perimetrium
 - d. Clitoris
 - e. Cervix
 - f. Vagina
 - g. Labia minora
 - h. Labia majora
 - i. Perineum
 - j. Mons pubis
 - k. Mammary glands
 - i. Alveolar glands
 - ii. Myoepithelial cells
 - iii. Areola
 - iv. Suspensory ligaments (Cooper's ligaments)

Objective 3 Characterize the process of spermatogenesis and the pathway from sperm production to release through ejaculation. Describe the role of accessory glands in the production of reproductive fluids (semen, pre-ejaculate).

- 1. Spermatogenesis:
 - a. Spermatogonia -> primary spermatocyte -> secondary spermatocyte -> spermatids -> spermatozoon
- 2. Pathway:
 - a. Seminiferous tubules -> rete testis -> efferent ducts -> epididymis -> ductus deferens -> ejaculatory duct -> urethra -> ejaculation
- 3. Glands:
 - a. Bulbourethral (Cowper's) glands: secrete alkaline lubricant for urethra and buffer pH (pre-ejaculate)
 - b. Seminal vesicles: contribute to semen
 - c. Prostate gland: contribute to semen

Objective 4 Identify and describe the stages of the ovarian cycle including oogenesis and follicular development. Describe female gamete transport and the organs involved.

- 1. Follicular development

- a. Primordial follicles -> primary follicle -> secondary follicle -> mature follicle -> corpus hemorrhagicum -> corpus luteum -> corpus albicans
- 2. Gamete transport
 - a. Ovary -> fimbriae -> uterine tube -> uterus
- 3. Oocyte development:
 - a. Primary oocyte
 - b. Secondary oocyte
 - c. Ovum

Objective 5 Identify and describe the phases of the uterine cycle including histology and blood supply.

- 1. Endometrium
 - a. Simple columnar epithelium (shed during menstruation)
 - b. Stratum functionalis (shed during menstruation)
 - c. Stratum basalis
- 2. Blood supply
 - a. Straight arterioles
 - b. Spiral arteries
- 3. Uterine phases and key days:
 - a. Menstrual phase - stratum functionalis and spiral arterioles are shed
 - b. Proliferative phase - spiral arterioles are rebuilt and proliferating stratum functionalis
 - c. Secretory phase
 - d. Day 1 - first day of menstrual flow
 - e. Day 14 -ovulation

Objective 6 Relate the impact of hormone secretions to the timeline of the uterine and ovarian cycles.

- 1. Hormones to include:
 - a. Estrogen- influences the proliferative phase
 - b. Progesterone – influences secretory phase
 - c. Luteinizing hormone (LH) – influences ovulation
 - d. Follicle stimulating hormone (FSH) – influences gamete maturation

Objective 7 Compare and contrast the process of meiosis and gametogenesis for male and female gametes. Define crossing-over.

Objective 8 Explain the process of conception, including coitus, sperm capacitation, slow block to polyspermy, and fertilization. Describe embryonic events from fertilization to gastrulation and the development of extra-embryonic membranes. Describe fetal events from gastrulation to organogenesis.

- 1. Key items:
 - a. Zygote (day 0)
 - b. Blastocyst (~ day 5)
 - c. Implantation (~ day 7)
 - d. Gastrulation (~ day 16)
 - e. Fetal period versus embryonic period
 - f. Placental development

Objective 9 Describe the role of the following hormones in reproduction:

1. Human Chorionic Gonadotropin (hCG) – released by chorionic membrane and acts on the gonads (corpus luteum). Maintains corpus luteum activity following implantation if pregnancy occurs.
2. Relaxin – released by placenta and relaxes pubic symphysis and cervix to aid dilation for delivery.
3. Human Chorionic Somatomammotropin (hCS) – alters maternal metabolism for increased nutritional requirements of the fetus.
4. Corticotrophic Releasing Hormone (CRH) – role of birth and increased cortisol secretion from adrenal cortex

Objective 10 Describe the stages of labor and the hormones involved. Describe labor and suckling as an example of a positive feedback loop and include the hormones involved.

1. Labor stages:
 - a. Dilation stage – uterine contractions and oxytocin release leading to dilation of the cervix
 - b. Expulsion stage – end of dilation stage to delivery
 - c. Placental stage – after delivery to expelling of the placenta
2. Suckling:
 - a. Oxytocin – milk release
 - b. Prolactin – milk production

Objective 11 Describe the role of the endocrine system and other factors in male and female puberty. Identify male and female primary and secondary sexual characteristics.

Performance Skills

1. Create a detailed Personal Healthcare Career Plan.
 - a. What is your healthcare career goal?
 - b. Reflect on what you have done so far to prepare for that career. Include coursework, HOSA, internships, employment, volunteerism, etc.
 - c. Define the steps/requirements or additional training that you will need to complete following high school.
 - d. Determine the durable skills that your career will need.
 - e. How do you plan to finance any additional school or training needed?
2. Demonstrate a clinical assessment for each of the twelve cranial nerves. Differentiate whether it is testing sensory pathways, motor pathways, or both.
3. Create a research-based poster. Determine a health-related topic and pose a research question. Using scientific methods conduct your research. When complete, create a poster to include a title, abstract, methods, results, conclusions, references, and images. (Use HOSA Research Poster competitive guidelines for reference.)

Durable Skills

1. Professionalism
2. Collaboration
3. Communication
4. Leadership
5. Innovation
6. Adaptability

KEY VOCABULARY CLARIFICATIONS

- adenohypophysis:** The anterior part of the pituitary gland.
- anastomosis:** A connection between two blood vessels that are usually separate.
- apneustic:** Refers to a center in the pons that helps control breathing.
- autorhythmic:** Cells that can generate their own electrical impulses, like certain heart cells.
- Boyle's Law:** A law in physics that describes how the pressure and volume of a gas are inversely related (as volume increases, pressure decreases, and vice versa). This is important for understanding how air moves in and out of the lungs.
- buffer:** A substance that helps to maintain a stable pH by resisting changes in acidity or alkalinity.
- dermatome:** Specific area of skin that is mainly supplied by a single spinal nerve.
- erythropoiesis:** The process of producing red blood cells.
- fibrinolysis:** The process of breaking down blood clots.
- filtration:** The process of separating substances in a solution by passing them through a filter.
- gastrulation:** An early stage of embryonic development where the three primary germ layers are formed.
- Glomerular (Bowman's) capsule:** A cup-shaped structure surrounding the glomerulus in the kidney where filtration occurs.
- gustatory:** Relating to the sense of taste.
- hematopoiesis:** The process of forming all types of blood cells.
- Henry's Law:** A law that states that the amount of gas dissolved in a liquid is proportional to its partial pressure above the liquid. This is relevant for gas exchange in the lungs and tissues.
- homunculus:** A distorted representation of the human body, reflecting the relative amount of cortical brain area devoted to sensory perception or motor control of different body parts.
- hypophyseal:** Relating to the pituitary gland.
- hypothalamus:** A region of the brain that controls many bodily functions, including hormone release from the pituitary gland.
- juxtamedullary:** A type of nephron in the kidney with a long loop of Henle that helps concentrate urine.
- Langerhans cells:** Immune cells found in the epidermis.
- Merkel cells:** Sensory cells in the epidermis that detect touch.
- myoepithelial cells:** Cells that surround glands and help in the expulsion of secretions, such as milk from mammary glands.
- neurohypophysis:** The posterior part of the pituitary gland.
- spirogram:** A graph that records lung volumes and capacities during breathing.
- Starling's Law of the Capillary:** Describes the movement of fluid across capillary walls based on hydrostatic and osmotic pressures.
- tracts:** Bundles of nerve fibers in the central nervous system.
- transduction:** The process by which sensory receptors convert a stimulus into an electrical signal.
- visceral:** Pertaining to the organs within a body cavity.