Course Description
BI 226. Anatomy and Physiology 1. 4 hours credit. This course will enable the student to develop an understanding of the principles in structure and function of the human body systems. The student will study basic chemistry, cells, tissues, and the following body systems: skeletal, muscular, nervous, and endocrine. The student will participate in three hours of lecture and three hours of laboratory per week. This is one semester of a two-semester course. This course must be taken in addition to BI 227 to be equivalent to BI 240. This course is an intermediate study designed primarily for pre-professional students in health-related fields. The department highly recommends AH 201 with C or better. The learning outcomes and competencies detailed in this outline meet, or exceed the learning outcomes and competencies specified by the Kansas Core Outcomes Project for this course, as approved by the Kansas Board of Regents (Transfers as BIO2030).

Required Materials
For complete material(s) information, refer to https://bookstore.butlercc.edu

Butler-Assessed Outcomes
The intention is for the student to be able to
1. Apply the concept that form dictates function within the human body to different situations.
2. Discuss how different body systems are interrelated.
3. Apply the concept of homeostasis to body systems.
4. Identify macroscopic and microscopic structures on slides, models, dissected/preserved specimens, and/or human cadaver.

Learning PACT Skills that will be developed and documented in this course
Through involvement in this course, the student will develop ability in the following PACT skill area(s):

Analytical Thinking Skills
- Critical thinking - Through the application of the scientific process to human anatomy and physiology, the student will develop the general concepts and skills
that can be applied and transferred to real life analytical types of situations in health-related fields.

Communication
- Reception and interpretation of messages - Through application of the scientific process to human anatomy and physiology, the student will be able to interpret and evaluate questions related to human anatomy and physiology.

Technology
- Discipline-specific technology - Through the use of proper microscope technique, the student will be able to identify tissues found in the human body.

Major Summative Assessment Task(s)
These Butler-assessed Outcome(s) and Learning PACT skill(s) will be demonstrated by
1. Completing the departmental final exam (A-skill) which involves real-world questions that students must interpret (C-Skill) and apply knowledge to demonstrate a comprehensive understanding of anatomy and physiology of the human body.
2. Demonstrating the ability to use the microscope (T-skill) to identify tissues found in the human body.

Skills or Competencies
These actions are essential to achieve the course outcomes:
1. Discuss homeostasis.
2. Use microscopes to inspect slides of human tissues.
3. Understand the chemical and metabolic basis of life.
4. Describe the structure and function(s) of a eukaryotic human cells and tissues.
5. Describe the structure and function(s) of these organ systems: integumentary, skeletal, muscular, nervous, endocrine, cardiovascular, lymphatic, respiratory, urinary, digestive, and reproductive.

Learning Units
I. Introduction to study of anatomy and physiology
   A. Define anatomy and physiology
   B. Describe processes or functions that are associated with living things: metabolism, excretion, movement, growth, differentiation/maturation, responsiveness, irritability, excitability, reproduction, evolution/adaptation, secretion, absorption, and circulation.
   C. Define homeostasis or dynamic equilibrium and stress
   D. Describe how nervous, endocrine and cardiovascular systems regulate homeostasis
   E. Define negative feedback mechanisms
   F. Describe these specific examples of negative feedback: blood pressure and blood glucose levels
   G. Define positive feedback mechanisms
   H. Describe these specific examples of positive feedback: uterine contractions during labor and coagulation of blood
I. Describe each level of the structural hierarchy from largest to smallest: organ system (and major functions), organ, tissue, cell, organelle, molecule, and atom

II. Directional terms and body cavities, cell, and microscope lab exercises
   A. Define the following terms: mid-sagittal plane, frontal/coronal plane, and transverse/horizontal, ventral/anterior, dorsal/posterior, superficial, deep, proximal, distal, inferior, superior, lateral, medial, parietal, and visceral
   B. Name one specific organ per line found in the dorsal cavity - cranial cavity and vertebral canal, and four specific organs in the ventral cavity - thoracic cavity, abdominal cavity, and pelvic cavity
   C. Identify on a diagram, write a description and functions for the following organelles: cell membrane, nucleus, nucleolus, cytoplasm, mitochondrion, Golgi complex, lysosome, ribosome, rough endoplasmic reticulum, smooth endoplasmic reticulum, vesicle, centrioles, microfilament, microtubules, cilia, and flagellum
   D. Define these terms: field of view or field, parfocal, and resolving power or resolution
   E. Identify and state the functions of these parts of the microscope: base, arm, ocular or eyepiece, body tube, rotating nosepiece, objective or lens, mechanical stage, mechanical stage knobs, coarse adjustment knob, fine adjustment knob, iris diaphragm/condenser, light source, and light switch
   F. Describe proper handling of the microscope and calculate total magnification

III. Chemistry
   A. Define atom and element
   B. Distinguish between protons, neutrons, and electrons
   C. Define atomic number, atomic mass, and isotopes
   D. Describe how to use the Periodic Table of Elements
   E. Draw and label two atoms
   F. Describe stability in an atom and the octet rule
   G. Show the bonding potentials for hydrogen, oxygen, nitrogen, and carbon
   H. Distinguish between molecular and structural formula
   I. Describe the ionic bond
   J. Diagram the atomic structure of two ionic compounds
   K. Define covalent bond
   L. Diagram the atomic structure of the covalent molecules carbon dioxide (CO₂) and nitrogen (N₂)
   M. Distinguish between nonpolar covalent bond and polar covalent bond
   N. Describe these properties of water: polarity, hydrogen bonding, and solvency
   O. Distinguish between solute, solvent, and solution
   P. Draw the atomic structure of a water molecule and label the slight electrical charges
   Q. Write the chemical reaction of the ionization of a water molecule
   R. Describe pH, acid, base, and buffer
S. Distinguish between inorganic and organic compounds
T. Identify the molecular and structural formulas for the following functional groups: hydroxyl (alcohol), methyl, amino, carboxyl (organic acid), and phosphate
U. Identify the monomers and polymers listed: carbohydrates-monosaccharides (glucose and fructose), disaccharides (sucrose), and polysaccharides (starch and glycogen); lipids- saturated fatty acid, unsaturated fatty acid, triglyceride, phospholipid (solubility differences), and cholesterol (steroid); proteins- amino acid, peptide bond, describe the four levels of structure in proteins: level of structure, number of amino acid chains, types of bonds present, shape, and ability to function, and denaturation; nucleic acid- list the components of a nucleotide, ATP or adenosine triphosphate, and compare the nucleic acids: DNA and RNA

IV. Metabolism
A. Define cellular respiration
B. Understand the general chemical equation for cellular respiration
C. Compare and contrast energy input, efficiency of energy production, oxygen use, by-products, and cellular location with respect to glycolysis, the Krebs’ (citric acid or TCA) cycle, and the electron transport chain
D. Distinguish between anaerobic and aerobic respiration

V. The cellular level of organization
A. Define eukaryote cell
B. Describe the functions of these organelles and know if there is a membrane present: nucleus, nucleolus, cytoplasm, mitochondrion, Golgi complex/apparatus, lysosome, rough endoplasmic reticulum, ribosome, smooth endoplasmic reticulum, centrioles, vesicle, microfilament, and microtubule
C. List the compounds found in the membranes of the cell
D. Describe the functions of the following membrane proteins: receptor protein (site/active site), enzyme, ion channel, gated ion channel or carrier protein, cell-identity markers, and cell-adhesion molecules
E. Know the difference between these surface extensions: microvilli, cilia and flagella
F. Compare passive to active forms of transportation of ions through the plasma membrane
G. Define these passive forms of transport: simple diffusion, facilitated diffusion, osmosis, and describe filtration and hydrostatic pressure
H. Describe the types of solutions: hypotonic, hypertonic, and isotonic
I. Describe the direction water flows across a selectively permeable membrane in hypotonic, hypertonic, and isotonic solutions
J. Define active transport and list examples
K. Define these types of bulk transport: phagocytosis, pinocytosis, and exocytosis
L. Define the process of protein synthesis: unraveling the DNA molecule, transcription, and translation
M. Explain how RNA is synthesized
N. Explain the roles of mRNA, rRNA, and tRNA in protein synthesis
O. Define these terms: cell division, mitosis and cytokinesis
P. Distinguish between normal cell division and cancerous cell division: rate of growth, maturation of cells, and contact inhibition

VI. Tissues
A. Define tissue and histology
B. Name the four major types of tissues and their generalized functions
C. Distinguish between the types of arrangement of cells: simple, stratified, and pseudostratified
D. Describe the three shapes of epithelial cells: squamous, cuboidal, columnar, and goblet cells
E. Describe three characteristics, not functions, of epithelial tissue
F. Define these terms: muscle fiber, striations, and intercalated disc
G. Distinguish between the muscle tissues: striations present, number of nuclei per cell/fiber, shape of fibers, and type of neural control
H. Define these terms; neuron, nerve fiber, and neuroglia
I. Describe matrix
J. List the chemical composition of ground substance in connective tissue
K. Describe three kinds of protein fibers found in matrix of connective tissues
L. Identify and state function(s) of the specific cells found in these connective tissues: areolar tissue, adipose tissue, dense tissue, cartilages, and bone tissues
M. List the locations of elastic cartilage and fibrocartilage
N. Know why is blood a type of connective tissue
O. Identify, state locations, and functions of these tissues: simple cuboidal epithelium, simple columnar epithelium, pseudostratified columnar epithelium, stratified squamous epithelium, smooth muscle tissue, skeletal muscle tissue, cardiac muscle tissue, areolar tissue, adipose tissue, dense tissue, hyaline cartilage, compact bone tissue, and nervous tissue

VII. Skeletal system
A. Describe at least five major functions of skeletal system
B. Describe the four types of bone cells
C. Describe the components of bone matrix
D. Describe the arrangement of spongy bone tissue as trabeculae
E. Label these structures of an osteon (functional unit of compact bone): osteonic/central canal, lamellae, osteocyte, canaliculi, and perforating canal
F. Define epiphysis, epiphyseal plate/line, and diaphysis
G. List the tissues found in bones and describe their arrangement: cartilages, dense tissues, compact and spongy bone tissues
H. Define ossification
I. Distinguish between intramembranous ossification and endochondral ossification
J. List the chemical agents that affect bone tissue development and how (building or reabsorption)
K. Describe how the hormone calcitriol (vitamin D₃) affects bone growth and development
L. Describe how calcitonin affects bone growth and development
M. Describe how parathyroid hormone affects bone growth and development
N. Describe the negative feedback mechanism for controlling blood calcium levels
O. Define the physiological classes of joints: diarthrosis, amphiarthrosis, and synarthrosis
P. Define the anatomical classes of joints: fibrous, cartilaginous, and synovial joint
Q. Distinguish these joints by the physiological and anatomical classes: suture, gomphosis, syndesmosis, synchondrosis, and synphysis
R. Describe these structures found in synovial joints: synovial membrane, articular cartilage, ligament, and accessory structures (meniscus, bursae, pad of adipose tissue)
S. List examples of these synovial joints: ball-and-socket, hinge, pivot, plane, saddle, and condyloid
T. Define the two major divisions of the skeletal system, axial and appendicular and list subdivisions within each
U. U. Define the following terms: alveolus, canal, condyle, crest, facet, fissure, foramen, fossa, head, meatus, process, sinus, spine, sulcus, trochanter, tubercle, and tuberosity
V. Identify the structures on the articulated skeleton, individual skulls, and individual in the axial skeleton: frontal bone: supraorbital foramen/notch, sinuses; nasal bone: lacrimal bone, lacrimal fossa/canal; sphenoid: optic foramen/canal, greater wing, lesser wing, sella turcica; ethmoid: perpendicular plate, cribriform plate with olfactory foramina, crista galli; vomer; zygomatic bone; maxilla, alveolar process, palatine process, infraorbital foramen; mandible: mental foramen, ramus, condyle, coronoid process; parietal bone: squamosal suture, sagittal suture; occipital: condyle, foramen magnum, lambdoid suture; temporal bone: external auditory meatus, mastoid process, carotid canal, jugular foramen, mandibular fossa, styloid process; palatine bone; hyoid bone; atlas: transverse foramen, superior articular facet; axis: dens, spinous process, superior articular facet; for all vertebrae: body, spinous process, vertebral foramen, transverse process, vertebral arch (lamina and pedicle); cervical vertebrae, transverse foramen; thoracic vertebrae, costal facet; lumbar vertebrae, superior articular facet; sacrum: posterior (dorsal) foramina, hiatus, canal median crest, anterior (ventral) foramina; coccyx; sternum: body, xiphoid process, manubrium; rib: body, head, neck, tubercle
W. Identify left and right structures on the skeleton, individual skulls, and individual in the appendicular skeleton: clavicle, acromial end, sternal end;
scapula, acromion, coracoid process, glenoid cavity, spine, infraspinatus fossa, supraspinatus fossa; humerus: coronoid fossa, deltooid tuberosity, greater tubercle, head, olecranon fossa, trochlea; ulna: coronoid process, olecranon, styloid process, trochlear notch, radial notch; radius: head, styloid process, tuberosity, ulnar notch; carpals; metacarpals; phalanges; ilium: acetabulum, crest, greater sciatic notch; ischium: obturator foramen, spine, tuberosity; pubis: acetabulum, obturator foramen, symphysis; femur: greater trochanter, head, neck, lateral condyle, lesser trochanter, medial condyle; patella; fibula: head, lateral malleolus; tibia: anterior crest, lateral condyle, medial condyle, medial malleolus, tuberosity; tarsals; metatarsals; and phalanges

VIII. Muscular system
A. List the five functions of the skeletal muscular system
B. List the characteristics of muscle cells: excitability, contractility, extensibility, and elasticity
C. Describe the general structure of a skeletal muscle organ (endomysium, perimysium, fascicle, epimysium. fasciae, tendons, and aponeurosis)
D. Describe the comprehensive microanatomy of the muscle cell to the level of sarcomere bands (sarcoplasm, glycogen, myoglobin, sarcolemma with transverse tubules, sarcoplasmic reticulum with terminal cisternae, thick filaments, myosin, thin filaments, actin, tropomyosin, troponin, A band, H and, I band, Z disc/line, and cross-bridge)
E. Define motor unit, its components, neuromuscular junction (synaptic knob, synaptic vesicles, synaptic cleft, junctional folds, receptor proteins, acetylcholine and acetylcholinesterase)
F. Describe the sequence of events for excitation, contraction, and relaxation
G. Define threshold stimulus, latent period and refractory period
H. Define muscle twitch, treppe, incomplete tetany and complete tetany
I. Describe the energy sources for muscle excitation, contraction and relaxation, initial (myokinase and creatine kinase), short-term or secondary, and long-term energy sources
J. Describe muscle fatigue and oxygen debt
K. Define the following terms: flexion, extension, abduction, adduction, elevation, depression, supination, pronation, plantar flexion, dorsiflexion, retraction, protraction, inversion, and eversion
L. Describe the origins and insertions for these muscles: sternocleidomastoid, pectoralis major, biceps brachii, triceps brachii, rectus abdominis, rectus femoris, and gastrocnemius
M. Identify locations and functions for these muscles: frontalis, orbicularis oculi, orbicularis oris, zygomatici, buccinator, temporalis, masseter, sternocleidomastoid, abdominal obliques, transversus abdominis, rectus abdominis, pectoralis major, pectoralis minor, serratus anterior, trapezius, teres major, rhomboids, rotator cuff: supraspinatus, infraspinatus, subscapularis and teres minor; latissimus dorsi, deltoid, triceps brachii,
brachialis, biceps brachii, brachioradialis, pronator teres, flexor carpi radialis, flexor carpi ulnaris, extensor carpi radialis longus, extensor carpi ulnaris, gluteus maximus, gluteus medius, tensor fascia latae, quadriceps femoris: rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius; sartorius, gracilis, adductor magnus, adductor longus, hamstrings: biceps femoris, semimembranosus, and semitendinosus; tibialis anterior, extensor digitorum longus, fibularis longus, gastrocnemius, and soleus

IX. Nervous System
I. Nerve cells
A. List and describe the anatomical and physiological divisions as well as the organs within them
B. Describe the following components of a neuron: cell body (soma), axon, dendrite, nucleolus, neurofibrils, axon hillock, and Nissl bodies
C. Distinguish these structural groups of neurons: multipolar neuron, bipolar neuron, and unipolar neuron
D. Distinguish between the three physiological types of neurons: sensory/afferent neurons, interneuron/association neurons, and motor/efferent neurons
E. Describe the components and functions of the neuroglia: oligodendrites, ependymal cells, microglia, astrocytes, satellite cells, and Schwann’s cells
F. Define myelinated and describe myelinated sheath, neurilemma, internodes, and nodes of Ranvier
G. Distinguish between white matter and gray matter in the spinal cord with respect to myelination
H. Describe the sodium potassium-pump, events of depolarization, action/local/resting membrane potential, repolarization, and refractory period with respect to electrical potential
I. Distinguish between impulse conduction along myelinated and unmyelinated fibers
J. Define and describe the components of the synapse between two neurons
K. Define neurotransmitter and name the four chemical types of neurotransmitters
L. Describe synaptic transmission
M. Give an example of an excitatory and inhibitory neurotransmitter (ie. ACh and GABA)
N. List the functions of the spinal cord
O. Describe the anatomy of the spinal cord
P. Distinguish between the ascending tracts and descending neural tracts
Q. Define meninges and list the three meningeal layers and spaces
R. Define nerve and describe the anatomic arrangement
S. Define spinal roots and distinguish between the anterior/ventral and posterior/dorsal roots
T. List the number of pairs in each section of spinal nerves
U. Define neural plexus and list the nerves in each
V. Define somatic/spinal reflex and describe the reflex arc
W. Distinguish between monosynaptic and polysynaptic reflexes
X. Describe decussation or crossing-over
Y. Distinguish between these pathways: posterior/dorsal columns, spinothalamic tracts, and the corticospinal tracts (number of nerves, where they cross/decussate, which roots, thalamus vs. internal capsule)

X. Nervous system II: Brain, cranial nerves, and autonomic nervous system
A. Define the following: longitudinal fissure, lateral sulcus, central sulcus, and gyrus (gyri)
B. List the structures located in these regions of the brain: forebrain, diencephalon, hindbrain, and brainstem
C. Describe the meninges covering the brain
D. Describe the arrangement of white matter and gray matter in the brain
E. Define ventricle
F. Define choroid plexus
G. List in sequence the structures involved in circulating cerebrospinal fluid
H. Describe the production of cerebrospinal fluid
I. List the functions of cerebrospinal fluid
J. Describe the functions and location of the insula
K. Describe the functions and location of the reticular formation
L. Describe the function of basal nuclei/ganglia and dopamine
M. Describe the functions and the components of the limbic system
N. Discuss the twelve pairs of cranial nerves
O. Describe visceral or autonomic reflexes
P. List the structures of the visceral (autonomic) reflex arc
Q. Define preganglionic and postganglionic neuron
R. Distinguish between the sympathetic and parasympathetic divisions of the autonomic nervous system: anatomical names, nerves, location of autonomic ganglia, postganglionic fiber secretion(s), general function(s), and specific actions
S. Describe cholinergic and adrenergic fibers and name their types of receptors
T. Define sensation
U. List the four requirements to experience a sensation
V. Describe the stimulus associated with these types of receptors: chemoreceptor, thermoreceptor, nociceptors, mechanoreceptors (baroreceptors), photoreceptors, and proprioceptors
W. Define these terms: afferent or sensory neuron, efferent or motor neuron, association or interneuron, soma, dendrite, axon, meninges, decussation or crossing-over, autonomic nervous system, somatic nervous system, receptor organ, myelin, Schwann cell, astrocyte, and nerve plexus
X. Identify and state the tissues present in these structures: dura mater, arachnoid mater, pia mater, and central canal
Y. Identify the structure and state the functions of these structures: dorsal column, ventral column, lateral column, dorsal horn, lateral horn, ventral horn, gray commissure, dorsal root, dorsal root ganglion, ventral root, spinal nerve,
cortex of cerebellum, arbor vitae of cerebellum, medulla oblongata, pons, cerebral peduncles, red nucleus, corpora quadrigemina, cerebral aqueduct, thalamus, hypothalamus, pituitary gland, pineal gland, lateral ventricles, third ventricle, fourth ventricle, corpus callosum, primary olfactory area of frontal lobe, Broca’s area of frontal lobe, primary motor area of frontal lobe, primary somesthetic area of parietal lobe, primary gustatory area of parietal lobe, primary auditory area of temporal lobe, Wernicke’s area, and primary visual cortex of occipital lobe

Z. Identify and state the specific functions for the twelve pairs of cranial nerves.
AA. Identify the following peripheral nerves: medial cutaneous nerve, axillary nerve, median nerve, musculocutaneous nerve, ulnar nerve, radial nerve, femoral nerve, saphenous nerve, obturator nerve, sciatic nerve, tibial nerve, common fibularis nerve, deep fibularis nerve, and superficial fibularis nerve

XI. Endocrine system
A. Identify and state hormones secreted by these glands: hypothalamus, anterior pituitary gland, posterior pituitary gland, pineal gland, thyroid gland, parathyroid glands, adrenal cortex, adrenal medulla, pancreas, ovaries, and testes
B. Distinguish between exocrine gland and endocrine glands (hypothalamus, anterior pituitary gland, posterior pituitary gland, pineal gland, thyroid gland, parathyroid glands, adrenal cortex, adrenal medulla, pancreas, ovaries, and testes)
C. Describe the general hormonal pathway: hormone, transport protein, target cell/tissue, receptor protein, hormone-receptor complex, and second messenger
D. Describe the steroid mode of action and non-steroid (monoamines, oligopeptides, polypeptides, and glycoproteins)
E. Describe the hormones, target organs and actions of these glands: hypothalamus, anterior pituitary gland, posterior pituitary gland, thyroid gland, parathyroid glands, adrenal gland, and pancreas
F. Describe types of hormone interactions and processes: permissive, antagonistic, and synergistic effects; negative feedback; and positive feedback
G. List chemical messengers secreted by tissues embedded within various organs: heart, liver, and kidneys

Learning Activities
Independent and collaborative learning activities will be assigned to assist the student to achieve the intended learning outcomes through lecture, lab, class discussion, group activities, written assignment, computer activities/simulations, textbook reading assignments, and other activities at the discretion of the instructor. These activities may be either face-to-face or online.
Grade Determination
The student will be evaluated on the basis of performance on the following: quizzes, hand-written assignments, on-line (via Connect) assignments, written assignments, oral presentations, lecture exams, and lab practicals.