Human Physiology (BIO 327.001)
Summer II Semester 2018
Miller Science Building, Room 233
MTWR 1230 – 225pm

Instructor: Dr. Kevin Langford
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Course Description: This course is designed for advanced biology majors and pre-health professions students. While we will focus on learning the functioning systems of the body in a separate manner, while appreciating the integrated nature of the functional machine that is the human body. Three semester hours, three hours lecture per week. Functions of the major systems of the body. Not open to students who have received credit for BIO 238.

Pre-requisite(s):
- Bio 130 with a minimum of a C
- Bio 133 with a minimum of a C


Program Learning Outcomes:

Each of the student learning outcomes listed below address the Biology Department Program Learning Outcome #1: Demonstrate a good knowledge base in biological concepts and be able to integrate knowledge with critical thinking skills to become problem solvers. Knowledge base will include: levels of complexity (molecular/cellular through population/communities/ecosystems); biological principles and processes.

Course Objectives:

- Provide students with an understanding of the integrative nature of the biological functions of the human body (i.e., homeostasis).
- Provide students with an understanding of the function of each organ system in the human body with the focus on the underlying biochemical mechanisms that create a particular function.
- Compare and contrast clinical abnormalities with normal physiological functions.
Student Learning Outcomes (Course Competencies):
Student understanding will be evaluated with comprehensive exams (i.e., multiple choice, short answer, and essay questions) surveying in detail the material to be mastered. Students who successfully complete human physiology will be able to:

**Homeostasis**

- Define homeostasis, and identify the components of negative feedback loops.
- Explain the role of antagonistic effectors in maintaining homeostasis, and the nature of positive feedback loops.
- Give examples of how negative feedback loops involving the nervous and endocrine systems help to maintain homeostasis.

**Transport Mechanisms**

- Describe the intracellular and extracellular compartments of the body.
- Identify the components of passive transport, and distinguish passive from active transport.
- Define diffusion and describe the factors that influence the rate of diffusion.
- Define osmosis, describe the conditions required for it to occur, and explain how osmosis relates to osmolality and osmotic pressure.
- Explain the nature and significance of hypotonic, isotonic, and hypertonic solutions.
- Describe the characteristics of carrier-mediated transport, and distinguish between simple diffusion, facilitated diffusion, and active transport.
- Explain the action and significance of the Ca2+ pump and the Na+/K+ pumps.

**Membrane Potential**

- Describe the equilibrium potentials for Na+ and K+
- Describe the membrane potential and explain how it is produced.

**Neurons and Supporting Cells**

- Describe the different types of neurons and supporting cells, and identify their functions.
- Identify the myelin sheath and describe how it is formed in the CNS and PNS.
- Describe the nature and significance of the blood-brain barrier.
Electrical Activity of Axons

- Step-by-step, explain how an action potential is produced.
- Describe the characteristics of action potentials and explain how they are conducted by unmyelinated and myelinated axons.
- Describe the structure and function of electrical and chemical synapses.
- Identify the nature of excitatory and inhibitory postsynaptic potentials.
- Explain how ligand-gated channels produce synaptic potentials, using the nicotinic ACh receptor as an example.
- Explain how G-protein-coupled channels produce synaptic potentials, using the muscarinic Ach receptor as an example.
- Describe the action and significance of acetylcholinesterase.
- Identify the monoamine neurotransmitters and explain how they are inactivated at the synapse.
- Identify two neural pathways in the brain that use dopamine as a neurotransmitter, and explain their significance.
- Explain the action and significance of GABA and glycine as inhibitory neurotransmitters.
- Describe some of the other categories of neurotransmitters in the CNS.

Synaptic Integration

- Explain the nature of spatial and temporal summation at the synapse.
- Describe long-term potentiation and depression, and explain the nature of postsynaptic and presynaptic inhibition.

Skeletal Muscles

- Describe the different levels of muscle structure, and the actions of skeletal muscles
- Describe motor units, and explain the significance of recruitment of motor units

Mechanisms of Contraction

- Describe the banding pattern of a myofibril, and how these bands change length during muscle contraction
- Explain the cross-bridge cycle and the sliding filament theory of contraction
- Explain excitation-contraction coupling in skeletal muscles

Contractions of Skeletal Muscles

- Distinguish between the different types of muscle contractions
- Identify the series elastic component, and explain the length-tension relationship in striated muscles
Energy Requirements of Skeletal Muscles

- Distinguish the different types of skeletal muscle fibers
- Describe aerobic capacity, lactate threshold, and muscle fatigue
- Explain how exercise training affects skeletal muscles

Neural Control of Skeletal Muscles

- Describe the components of monosynaptic muscle stretch reflexes, including the role of gamma motoneurons
- Describe the effects of Golgi tendon organs
- Explain reciprocal innervation of skeletal muscles

Cardiac and Smooth Muscle

- Describe the characteristics of cardiac muscle and how these compare to those of skeletal muscle
- Describe the structure of smooth muscle and explain how its contractions are regulated

Divisions of the Autonomic Nervous System

- Describe the structure of the sympathetic and parasympathetic divisions of the autonomic system
- Explain the relationships between the sympathetic division and the adrenal medulla

Functions of the Autonomic Nervous System

- Identify the neurotransmitters of the sympathetic and parasympathetic divisions, and the hormone released by the adrenal medulla
- Describe the effects of adrenergic stimulation on different organs, and identify the types of adrenergic receptors involved
- Describe the effects of parasympathetic nerve regulation, and explain how atropine and related drugs affect this regulation

Functions and Components of the Circulatory System

- Identify the functions and components of the circulatory system
- Describe the relationship between interstitial fluid, plasma, and lymph
Composition of the Blood

- Distinguish between the different formed elements of the blood
- Describe the regulation of red and white blood cell production
- Explain blood typing and blood clotting

Structure of the Heart

- Describe the structure of the heart and its components
- Distinguish between the systemic and the pulmonary circulation

Cardiac Cycle and Heart Sounds

- Describe the different phases of the cardiac cycle
- Relate the cardiac cycle to the production of the heart sounds

Electrical Activity of the Heart and the Electrocardiogram (EKG)

- Describe the pacemaker potential and the myocardial action potential
- Describe the components of the ECG and their relationships to the cardiac cycle

Blood Vessels

- Compare the structure and function of arteries and veins, and the significance of the skeletal muscle pumps
- Describe the structures and functions of different types of capillaries

Atherosclerosis and Cardiac Arrhythmias

- Explain the causes and dangers of atherosclerosis
- Explain the cause and significance of angina pectoris
- Describe how different arrhythmias affect the ECG

Lymphatic System

- Explain how the lymph and lymphatic system relate to the blood and cardiovascular system
- Describe the function of lymph nodes and lymphatic organs

Defense Mechanisms

- Describe the different elements of the innate immune system
- Describe the nature of antigens, lymphocytes, and lymphoid organs
- Explain the events that occur in a local inflammation
Functions of B Lymphocytes

- Describe B lymphocytes and antibodies and explain how they function
- Describe the complement system and explain its functions

Functions of T Lymphocytes

- Identify the different T lymphocytes and their functions
- Explain how T cells become activated and how they function in immunity

Active and Passive Immunity

- Explain how active immunity is produced, using the clonal selection theory
- Explain how passive immunity is produced

Tumor Immunology

- Explain the relationship between the immune system and cancer

Diseases Caused by the Immune System

- Explain the nature of autoimmune diseases
- Explain immediate and delayed hypersensitivity

Cardiac Output

- Describe the extrinsic regulation of cardiac rate and contractility.
- Explain the relationship between stroke volume and venous return.
- Explain the Frank-Starling law of the heart.

Blood Volume

- Explain the forces that act in capillaries and how edema can be produced.
- Explain how the kidneys regulate blood volume, and the hormonal regulation of this process.

Vascular Resistance to Blood Flow

- Describe the factors that affect blood flow through vessels.

Blood Flow to the Heart, Skeletal Muscles, Brain and Skin

- Explain the mechanisms that regulate blood flow to the heart and skeletal muscles.
• Describe the circulatory changes that occur during exercise.
• Explain how blood flow to the brain is regulated.
• Explain how blood flow to the skin is regulated.

Blood Pressure

• Explain how blood pressure is regulated.
• Describe how blood pressure is measured.
• Describe the causes and dangers of hypertension.
• Describe the causes and dangers of circulatory shock.

The Respiratory System

• Describe the structures and functions of the conducting and respiratory zones of the lungs
• Describe the location and significance of the pleural membranes

Physical Aspects of Ventilation

• Explain how intrapleural and intrapulmonary pressures change during breathing
• Explain how lung compliance, elasticity, and surface tension affect breathing, and the significance of pulmonary surfactant

Mechanics of Breathing

• Explain how inspiration and expiration are accomplished
• Describe lung volumes and capacities, and explain how pulmonary function tests relate to pulmonary disorders

Gas Exchange in the Lungs

• Explain how partial gas pressures are calculated, and their significance in measurements of arterial blood gases
• Describe the factors that influence the partial pressure of blood gases and the total content of oxygen in the blood

Regulation of Breathing

• Explain how ventilation is regulated by the CNS
• Explain how blood gases and pH influence ventilation

Hemoglobin and Oxygen Transport

• Describe the changes in percent oxyhemoglobin as a function of arterial PO2 and explain how this relates to oxygen transport
- Describe the various conditions that influence the oxyhemoglobin dissociation curve and oxygen transport

**Carbon Dioxide Transport**

- Explain how carbon dioxide is transported by the blood
- Explain the relationship between blood levels of carbon dioxide and the blood pH

**Acid-Base Balance in the Blood**

- Describe the acid-base balance of the blood, and how it is influenced by the respiratory system

**Structure and Function of the Kidneys**

- Describe the gross and microscopic structure of the kidney
- Trace the flow of blood and filtrate through the kidney

**Glomerular Filtration**

- Describe glomerular filtration and the structures involved
- Explain the significance of the glomerular filtration rate and how it is regulated

**Reabsorption of Salt and Water**

- Describe the salt and water reabsorption properties of each nephron segment
- Explain the countercurrent multiplier system
- Explain how ADH acts to promote water reabsorption

**Renal Plasma Clearance**

- Explain how renal plasma clearance is affected by reabsorption and secretion, and how it is used to measure GFR and total renal blood flow
- Define transport maximum and renal plasma threshold, and explain their significance

**Renal Control of Electrolyte and Acid-Base Balance**

- Explain how the renal excretion and reabsorption of Na+, K+, and H+, is regulated by the renin-angiotensin aldosterone system
- Explain how the kidneys reabsorb bicarbonate, and how the kidneys contribute to the regulation of acid/base balance
**Tentative Lecture Schedule**

Note: Lecture topics and dates may be changed during the course of the semester at the instructor's discretion. The class will be notified of any changes to the syllabus via D2L email.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic(s)</th>
<th>Pages</th>
<th>Chapters</th>
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</thead>
<tbody>
<tr>
<td>July 10 - July 16</td>
<td>Introduction / Homeostasis (podcast)</td>
<td>6-10</td>
<td>1</td>
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<tr>
<td></td>
<td>Transport Mechanisms</td>
<td>132-140</td>
<td>6</td>
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<tr>
<td></td>
<td>Transport Mechanisms</td>
<td>140-147</td>
<td>6</td>
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<td>Membrane Potential</td>
<td>147-153</td>
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<td></td>
<td>Neurons and Neuroglia</td>
<td>162-164</td>
<td>7</td>
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<td></td>
<td>Myelinated Nerves / Action Potentials</td>
<td>164-178</td>
<td>7</td>
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<td></td>
<td>Synapses: Electrical / Chemical</td>
<td>178-182</td>
<td>7</td>
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<tr>
<td></td>
<td>Synapses: Neurotransmitters</td>
<td>182-194</td>
<td>7</td>
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<tr>
<td></td>
<td>Synapses: Synaptic Integration</td>
<td>194-196</td>
<td>7</td>
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<td></td>
<td>Skeletal Muscle: Structure and Organization</td>
<td>348-351</td>
<td>12</td>
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<td>Contraction Mechanisms</td>
<td>352-356</td>
<td>12</td>
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<td><strong>July 17 - Unit I Exam - Chapters 1, 6, 7, 12</strong></td>
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<td>12</td>
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<td>July 16-July 23</td>
<td>Contraction Mechanisms</td>
<td>357-364</td>
<td>12</td>
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<td>Slow and Fast Twitch Fibers</td>
<td>366-368</td>
<td>12</td>
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<td>Cardiac and Smooth Muscle</td>
<td>376-381</td>
<td>12</td>
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<td>Motor Reflexes: Somatic / Autonomic</td>
<td>236-237</td>
<td>9</td>
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<td></td>
<td>Autonomic NS: Organization</td>
<td>238-242</td>
<td>9</td>
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<td>Autonomic NS: Function</td>
<td>242-252</td>
<td>9</td>
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<td>Blood: Erythrocytes and Leukocytes</td>
<td>239-394</td>
<td>13a</td>
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<td>Blood: Clotting Mechanisms</td>
<td>398-402</td>
<td>13a</td>
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<td>Immune system</td>
<td>474-499</td>
<td>15</td>
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<td>Allergies</td>
<td>501-503</td>
<td>15</td>
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<td><strong>July 25 - Unit II Exam - Chapters 12, 9, 13, 15 (+ 10% Cumulative)</strong></td>
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<td>14</td>
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<td>July 24 - July 31</td>
<td>ABO, RH Blood Antigens</td>
<td>396-398</td>
<td>13b</td>
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<td>Heart Structure / Cardiac Cycle</td>
<td>402-407</td>
<td>13b</td>
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<td>Conduction System</td>
<td>408-413</td>
<td>13b</td>
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<td>Atherosclerosis and Arrhythmias</td>
<td>419-426</td>
<td>13b</td>
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<td>Cardiac Output / Blood Volume</td>
<td>434-440</td>
<td>14</td>
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<td>Regulation: Blood Flow</td>
<td>441-454</td>
<td>14</td>
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Attendance Policy:

Attendance is expected and encouraged for all lectures. At the beginning of each lecture, students will be required to sign his/her name on a circulated attendance sheet (placed at the front of the classroom). *Failure to sign your name will be considered an absence even if you were in class.*

For excused absences (as determined at my discretion), I will adhere to the University policy on attendance and absences.

**Make-up Exams:** Students with *excused absences ONLY* will be allowed to make-up missed exams.

- The determination of an absence as excused or unexcused will be at my discretion.
- Make-up exams will be entirely an essay exam format.
- A make-up exam must be taken within three weeks of the missed exam.
- All missed exams **MUST BE COMPLETED** prior to dead week.
- The Final Exam must be taken on the day and time assigned. **NO EXCEPTIONS!**
Grading policy:

400 total points are available from the lecture component of the course. There will be three, 100 point lecture exams and a 100 point final exam. With the exception of the first exam, all additional exams will contain 10% comprehensive material from information previously covered earlier in the semester.

<table>
<thead>
<tr>
<th>Component</th>
<th>Points</th>
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<tbody>
<tr>
<td>Lecture Exams</td>
<td>300</td>
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<tr>
<td>Quizzes</td>
<td>100</td>
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<tr>
<td>Final Exam</td>
<td>100</td>
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500 total possible points from lecture

Final grades for the course will be assigned as follows:

- **A** = 100-89.5% (500 – 447.5 points)
- **B** = 89-79.5% (447.4 – 397.5)
- **C** = 79-69.5% (397.4 – 347.5)
- **D** = 69-59.5% (347.4 – 297.5)
- **F** = <59.5% (< 297.4)

Academic Integrity (A-9.1):

Academic integrity is a responsibility of all university faculty and students. Faculty members promote academic integrity in multiple ways including instruction on the components of academic honesty, as well as abiding by university policy on penalties for cheating and plagiarism.

**Definition of Academic Dishonesty**

Academic dishonesty includes both cheating and plagiarism. Cheating includes but is not limited to (1) using or attempting to use unauthorized materials to aid in achieving a better grade on a component of a class; (2) the falsification or invention of any information, including citations, on an assigned exercise; and/or (3) helping or attempting to help another in an act of cheating or plagiarism. Plagiarism is presenting the words or ideas of another person as if they were your own. Examples of plagiarism are (1) submitting an assignment as if it were one’s own work when, in fact, it is at least partly the work of another; (2) submitting a work that has been purchased or otherwise obtained form an internet source or another source; and (3) incorporating the worlds or ideas of an author into one’s paper without giving the author due credit.

Please read the complete policy at [www.sfasu.edu/policies/academic_integrity.asp](http://www.sfasu.edu/policies/academic_integrity.asp)
Withheld Grades Semester Grades Policy (A-54):

Ordinarily, at the discretion of the instructor of record and with the approval of the academic chair/director, a grade of WH will be assigned only if the student cannot complete the course work because of unavoidable circumstances. Students must complete the work within one calendar year from the end of the semester in which they received a WH, or the grade automatically becomes an F. If students register for the same course in future terms, the WH will automatically become an F and will be counted as a repeated course for the purpose of computing the grade point average.

Students with Disabilities:

To obtain disability related accommodations, alternate formats and/or auxiliary aids, students with disabilities must contact the Office of Disability Services (ODS), Human Services Building, and Room 325, 468/3004 / 468-1004 (TDD) as early as possible in the semester. Once verified, ODS will notify the course instructor and outline the accommodation and/or auxiliary aids to be provided. Failure to request services in a timely manner may delay your accommodations. For additional information, go to www.sfasu.edu/disabilityservices/

Acceptable Student Behavior (D-34.1):

Classroom behavior should not interfere with the instructor’s ability to conduct the class or the ability of other students to learn from the instructional program (see the Student Conduct Code, policy D-34.1). Unacceptable or disruptive behavior will not be tolerated. Students who disrupt the learning environment may be asked to leave class and may be subject to judicial, academic or other penalties. This prohibition applies to all instructional forums, including electronic, classroom, labs, discussion groups, field trips, etc. The instructor shall have full discretion over what behavior is appropriate/inappropriate in the classroom. Students who do not attend class regularly or who perform poorly on class projects/exams may be referred to the Early Alert Program. This program provides students with recommendations for resources or other assistance that is available to help SFA students succeed.