Lecture Learning Objectives

ORGANIZATION OF THE HUMAN BODY & HOMEOSTASIS (REVIEW)

Upon completion of this unit and with review, the student will be able to
1. Define homeostasis, describe the general mechanisms by which it is maintained, and explain its importance to survival with at least one example.
2. Differentiate between aerobic and anaerobic cellular metabolism, between anabolic and catabolic reactions, and explain how several reactions can form a metabolic pathway.
3. Explain the role of enzymes in cellular metabolism and the factors that affect enzyme function.
4. Describe the general catabolic pathway for a molecule of protein, lipid, and glycogen as each is hydrolyzed to produce ATP.
5. Describe the role of ribosomes, both free and fixed, in protein synthesis.
6. Describe the structure and function of an array of eukaryotic cellular components, including the cytoskeleton.
7. Describe the properties of water as the physiological solvent, how body fluids are distributed within compartments, how the fluid composition differs between compartments, and the transport mechanisms that move water and other materials from one compartment to another.
8. Describe the general functions of each organ system.
9. Briefly describe the morphogenesis and differentiation of the 3 embryonic germ layers and list the tissue specializations that develop from these germ layers.

CELL MEMBRANE FUNCTION & ELECTROCHEMICAL SIGNALING

Upon completion of this unit and with review, the student will be able to
1. Describe the structure and function of cell membranes and intercellular junctions.
2. Describe the structure of biological membranes. Compare and contrast the mechanisms for the movement of materials across cell membranes in terms of their physical and chemical properties (active and passive transport).
3. Compare and contrast the steps in signal transduction for steroidal and non-steroidal chemical messages. Discuss the role of second-messenger systems in signal transduction.
4. Differentiate between chemically-gated, mechanically-gated, and voltage-gated ion channels.
5. Explain the characteristics of a polarized, depolarized and repolarized membrane. How are these changes in the transmembrane electrical potential accomplished? How is the transmembrane electrical potential utilized by cells?
6. Differentiate between a graded potential and an all-or-none action potential; and describe the events that lead to the conduction of a unidirectional action potential.
7. Define the terms neurotransmitter and threshold. Discuss examples of excitatory and inhibitory neurotransmitters, and the concept of a grand-synaptic potential.
8. Define neuropeptide, and describe the functions of this group of chemical messages.
9. Describe the sequence of events that occur at a chemical synapse, including the events which stop stimulation of the post-synaptic membrane.
10. Distinguish between excitatory and inhibitory post-synaptic potentials. Describe temporal summation, spatial summation and the components which comprise the grand synaptic potential.
11. Describe the anatomical and functional differences between myelinated and unmyelinated nerve fibers; and compare conduction of an impulse along these fibers.
12. Discuss how temperature, fiber diameter, and the presence of myelination affect speed of conduction along a nerve fiber.
ENDOCRINE PHYSIOLOGY

Upon completion of this unit, the student will be able to
1. Describe how hormones can be classified according to their chemical composition and corresponding action on target tissue cells.
2. Explain the three basic mechanisms that regulate hormone secretions, and how hormones are transported to target tissues.
3. Name and describe the locations of the major endocrine glands of the body, list the hormones they secrete, and the action(s) of each hormone.
4. Explain how the hypothalamus regulates hypophyseal secretions, with examples.
5. Discuss the hormonal regulation of the utilization of energy nutrients.
6. Distinguish between physical and psychological stress, and describe the sequence of changes associated with the general adaptation response.
7. Describe the direct nervous regulation of the adrenal medulla.
8. Explain how prostaglandins differ from hormones in general, and describe their functions.

FUNCTIONS OF THE AFFERENT AND EFFERENT DIVISIONS OF THE PERIPHERAL NERVOUS SYSTEM & SPECIAL SENSES

1. Compare and contrast exteroceptors, visceroreceptors, and proprioceptors, and describe their importance in homeostatic mechanisms.
2. Describe each of the 5 major receptor types, and the transduction of specific stimuli into receptor potentials.
3. Discuss the following features of the somatic senses: acuity, receptive field size, lateral inhibition, and projection.
4. Explain the phenomenon of sensory adaptation, and list the sensations in which adaptation occurs.
5. Discuss the anatomy and physiology of both slow and fast pain pathways, and the inherent mechanisms for natural pain control.
6. Describe the conduction pathways that lead to the perception of various stimuli (for the somatic and special senses).
7. Describe the general anatomical features of both divisions of the Autonomic NS
8. Relate neurotransmitter substances, membrane receptors and dual innervation of visceral organs to the normal function of the Autonomic Nervous System.
9. Describe the structure and function of the neuromuscular junction for skeletal muscles.

MUSCLE PHYSIOLOGY

Upon completion of this unit, the student will be able to
1. Compare and contrast the structure and function of skeletal, cardiac and smooth muscle tissues.
2. Describe the sequence of chemical and physical events that produce muscle contraction and relaxation.
3. Distinguish between the all-or-none and graded responses with neuronal stimulation of a skeletal muscle.
4. Explain how energy is supplied to the muscle fiber contraction mechanism, how oxygen debt develops, and how a muscle may become fatigued.
5. Discuss the mechanics of contraction in whole muscles, including the factors that determine tension.
6. Compare and contrast skeletal muscle fiber types, in terms of their structural and metabolic adaptations, and their response to “training”.
7. Discuss the various levels of control on the motor neurons that innervate skeletal muscle fibers, to include cortical (pyramidal), subcortical (extrapyramidal) and afferent (somatic receptors and proprioceptors) pathways.
8. Discuss the fundamental concepts and workings of the muscle spindle apparatus and golgi tendon organ in the control of skeletal muscle.
9. Describe the structural and functional differences between multi-unit and visceral (single-unit) smooth muscle, and between these smooth muscle types, cardiac muscle and skeletal muscle.

CARDIOVASCULAR PHYSIOLOGY and the BLOOD

Upon completion of this unit, the student will be able to
1. Discuss the normal cardiac cycle, and the function of autorhythmic tissues in the cardiac conduction system which coordinate cardiac function.
2. Discuss the mechanisms of intrinsic and extrinsic regulation on cardiac output (heart rate and stroke volume), including ANS reflexes.
3. Compare and contrast the function of autorhythmic and contractile cells in the heart.
4. Relate the mechanical events in the normal cardiac cycle to the electrical events recorded in an ECG.
5. Describe some of the common pathologic conditions that affect heart function.
6. Describe the relationship of blood pressure to cardiac output, blood volume, viscosity of blood, and peripheral resistance.
7. Describe the mechanisms that are responsible for maintaining arterial blood flow, and those that aid in returning venous blood to the heart.
8. Differentiate between local control (chemical and physical factors) and extrinsic control of arteriolar blood flow.
9. Discuss the mechanisms of regulating blood pressure.
10. Review the physiological processes involved in tissue fluid formation and return, and the possible causes of edema.
11. Describe the general characteristics of the formed elements of blood and blood plasma; and discuss the major functions of each.
13. Discuss the life cycle of a red blood cell (production, destruction, recycling), and the homeostatic regulation of RBC production.
14. Define hemostasis, and explain the 3 basic mechanisms that help to achieve it (blood vessel spasm, platelet plug formation, and coagulation), and the mechanism to later restore circulation to the area of damage.
15. Discuss the clinical uses of anticoagulants and clot dissolving chemicals.
16. Explain the genetic basis for blood typing.
17. Describe how blood reactions may occur between the fetal and maternal tissues.
RESPIRATORY PHYSIOLOGY

Upon completion of this unit the student will be able to
1. Differentiate between internal and external respiration.
2. Describe the structure and function of the respiratory membrane.
3. Describe the mechanics of normal breathing.
4. Discuss the intrinsic and extrinsic regulatory mechanisms that serve to match airflow with blood flow, for optimal gas exchange.
5. Define partial gas pressure, and describe the factors (4) that influence the diffusion of gasses across cell membranes.
6. Explain the mechanisms by which oxygen and carbon dioxide are transported in the blood.
7. Describe hemoglobin's response to changes in various physiological conditions, e.g. temperature, pH, oxygen, carbon dioxide, 2,3 DPG, etc.
8. Describe the function of carbonic anhydrase and the chloride shift, as they relate to carbon dioxide transport and exchange.
9. Discuss the location and function of the respiratory centers in the regulation of breathing, and the various factors (both at central and peripheral receptors) that affect these control centers.

URINARY PHYSIOLOGY; WATER & ELECTROLYTE BALANCE

Upon completion of this unit, the student will be able to
1. Review the anatomy and physiology of the organs of the urinary system, and the blood circulatory path through the kidney.
2. Review the functional unit of the kidney, and explain the 3 major steps in the production of urine and the mechanisms by which they occur.
3. Differentiate between cortical and juxtamedullary nephrons with respect to structure, location and function.
4. Discuss the significance and mechanisms of autoregulation (GFR) of the kidney.
5. Discuss the function of the renin-angiotensin-aldosterone system in the regulation of salt and water balance.
6. Explain the countercurrent mechanism and the role of the vasa recta for the concentration of urine under the influence of ADH (Vasopressin).
7. Discuss pathological states affecting urinary function.
8. Explain what is meant by water and electrolyte balance, and discuss the importance of this balance.
9. Review how the body fluids are distributed within compartments, how the fluid composition differs between compartments, and the transport mechanisms that move fluids from one compartment to another.
10. Describe the homeostatic mechanisms of water balance including the thirst mechanism.
11. Discuss the dietary and physiological factors that may contribute to fluctuations in body pH; and name the conditions in which body pH is abnormal.
12. Define buffer, and describe the chemical buffer systems that operate in different body fluids.
13. Explain how changing pH values of the body fluids may be minimized through the normal function of the respiratory center and kidneys.
14. Describe in detail the mechanisms involved in the tubular secretion of H+ with the corresponding conservation of base HCO₃⁻.
15. Compare and contrast the functions of the lungs, integument, kidneys, and alimentary canal as excretory organs.
DIGESTIVE PHYSIOLOGY

Upon completion of this unit, the student will be able to
1. Review the anatomy and physiology of the specialized segments along the alimentary canal and of the accessory organs to digestion, and briefly explain how these structures work to carry out the 5 major functions of the digestive system.
2. List the exocrine (enzymes, buffers, etc.) and endocrine (hormones) secretions of the various digestive organs; describe how their release is regulated by reflexes and negative feedback mechanisms, and the functions of each secretion.
3. Explain how both intrinsic (short) and extrinsic (long) digestive reflexes control digestive processes.
4. Review the mechanism of peristalsis.
5. Discuss the 3 phases of gastric regulation, and relate to the function of other digestive organs.
6. Discuss the factors involved in the normal regulation of hunger.
7. Discuss the functions of the liver related to nutrition and digestion, and the significance of the hepatic portal system.
8. Describe the composition of saliva and bile.
9. Describe the mechanisms of transport in the absorption of the products of digestion, water and minerals from the alimentary canal.
10. Describe the important characteristics of the principle vitamins and energy nutrients, and their major dietary sources.
11. Explain what is meant by "essential nutrient", and give some examples.
12. Discuss current major medical concerns related to nutrition in the U.S.

THE LYMPHATIC SYSTEM AND IMMUNITY

Upon completion of this unit, the student will be able to
1. Describe the structure and function of organs and tissues of the lymphatic system.
2. Differentiate between non-specific and specific defense of the body, and describe the means of non-specific resistance to invasion or disease, including inflammation.
3. Discuss the cells that are involved in specific immunity, and their functions in immune mechanisms.
4. Name the major types of immunoglobulins and discuss their basic structure and functions.
5. Compare and contrast interferon and complement enzymes in specific defense against disease.
6. Discuss the pivotal role of macrophages in self-recognition and defense against disease.
7. Distinguish between primary and secondary immune responses; distinguish between active and passive immunity, both naturally acquired and artificially acquired.
8. Describe the composition and functions of the reticuloendothelial system (mononuclear phagocytic system).
9. Describe the typical events in an allergic reaction.
10. Discuss the inflammation process and the significance of each physiological change.
Laboratory Learning Objectives

**Recommended Reading:** Knisely, Karin. *A Student Handbook for Writing in Biology* (available in the bookstore)

**SCIENTIFIC METHOD & INTRODUCTION TO ANALYTICAL SOFTWARE**

1. Describe the basic steps in the scientific method.
2. Discuss some of the pitfalls encountered in research and strategies to minimize biased results.
3. Distinguish between independent and dependent variables. What is the relationship between dependent variables and controlled variables?
4. Discuss the use of some of the graphic and statistical techniques used to present the results of scientific investigations.
5. Gain experience in organizing and executing teamwork in a research setting.
6. Design and execute an experiment based on a common question, in partial preparation for an independent group research project; utilizing equipment and materials available in the lab. (You will present the findings of your research project, both orally during a poster presentation and in a scientific paper, at the end of the quarter - SEE HANDOUT.)
7. Develop techniques in scientific writing to report results: construct appropriate figures to present data and use Excel and/or SPSS for statistical analysis.

**REACTIONS OF THE SKIN**

1. Consider the responsiveness of cells to local changes in their environment (intrinsic control in tissues/organs).
2. Review passive transport mechanisms in the context of tissue fluid formation and return.
3. Relate the structure of capillaries and arterioles to their function in controlling skin color and temperature.
4. Perform investigations that permit a discussion of the importance of capillary tone, and the local physical and chemical factors that affect capillary tone.
5. Perform investigations that demonstrate the response of capillaries and arterioles to heat, cold and other forms of physical stimulation.
6. Review the cellular processes during the inflammation response.

**BALANCE, COORDINATION and KINESTHETIC SENSE**

1. Review the types and functions of an array of sensory receptors.
2. Discuss the phenomena of sensory acuity, localization and adaptation, with respect to the perception of somatic sensations.
3. Differentiate between “sensation” and “perception”.
4. Perform investigations of acuity, localization and adaptation for somatic senses.
5. Distinguish between static and dynamic equilibrium, and describe the processing of information from the array of sensory systems in order to maintain balance.
6. Perform investigations of the sensory systems that enable normal balance and the coordination of appropriate voluntary muscle movements. Discuss your results.
7. Correctly interpret the results of experiments which attempt to mimic the effects of vestibular disturbance.
8. Test for and measure 2-point discrimination at three different locations on the skin, and discuss the relationship between sensory acuity and receptive field size.
9. Investigate kinesthesia utilizing large muscle groups.

**MUSCLE PHYSIOLOGY and ELECTROMYOGRAPHY (EMG)**

1. Discuss the factors that affect the strength of contraction in a whole muscle.
2. Discuss the possible causes of muscle fatigue.
3. Use recording equipment to describe and measure the events that occur during muscle contraction, and investigate the effect of load on muscle fiber recruitment.
4. Investigate and interpret data concerning the relationship between human body size and muscle strength.
5. Investigate and interpret data concerning the relationship between muscle strength and muscle endurance.
6. Conduct an experiment to construct and compare static and dynamic muscular fatigue curves.

**CARDIOVASCULAR PHYSIOLOGY; PULSE and BLOOD PRESSURE**

1. Record and interpret a normal 3-lead ECG, as it relates to the normal cardiac cycle.
2. Demonstrate and discuss the cardiac and other physiological changes associated with the Valsalva maneuver, and the mammalian diving reflex.
3. Describe the relationship of blood pressure to cardiac output, blood volume, viscosity of blood, and peripheral resistance.
4. Describe the mechanisms that are responsible for maintaining arterial blood flow, and those that aid in returning venous blood to the heart.
5. Differentiate between local control (chemical and physical factors) and extrinsic control of arteriolar blood flow.
6. Discuss the homeostatic mechanisms regulating blood pressure.
7. Review the physiological processes involved in tissue fluid formation and return, and the possible causes of edema.
8. Discuss the intrinsic and extrinsic regulation of cardiovascular function.
9. Measure and interpret changes in pulse, blood pressure and mean arterial pressure under different conditions related to body position and level of activity.
10. Listen to heart sounds and explain their cause related to the normal cardiac cycle.
RESPIRATORY VOLUMES and the REGULATION OF BREATHING

1. Discuss how the primary role of the respiratory system overlaps that of the circulatory system in helping to maintain homeostasis.
2. Discuss the 4 components of external respiration that support internal (cellular) respiration. Discuss the additional functions of the respiratory system, especially those related to maintaining homeostasis.
3. Review the anatomy of the respiratory system and mechanics of breathing.
4. Record and interpret respiratory movements using a pneumograph.
5. Define the components of total lung capacity.
6. Measure respiratory volumes using a handheld spirometer, and compare results with the expected values.
7. Measure the peak expiratory flow using a peak flow meter.
8. Discuss the changes that would be expected in respiratory volumes and peak flow in specific disease processes.

URINALYSIS

1. Review the 3 phases of urine formation in the kidneys.
2. Determine and analyze some of the physical and chemical characteristics of urine, and relate these to the function of the kidneys.

DIET ANALYSIS (optional; related to research project)

1. Accurately record your diet over a 3+ day period, and analyze using a computer software program.
2. Critique your eating habits and draw conclusions concerning your current nutritional status, energy balance, and personal recommendations for the future.

FITNESS EVALUATION (optional; related to research project)

1. Use a simple statistical analysis to determine resting heart rate, and interpret your results with respect to aerobic fitness level.
2. Determine body fat composition using skin-fold calipers, and formulate conclusions related to your average energy budget.
3. Measure flexibility and muscle strength and discuss the significance of your results.
4. Calculate the target heart rate for a particular fitness goal.