SYLLABUS

UNIVERSITY OF MISSISSIPPI

SCHOOL OF DENTISTRY and SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF PHYSIOLOGY & BIOPHYSICS

PHYSIOLOGY 625 / 725

2009-2010

Fall and Spring Semesters

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PHYSIOLOGY 625 / 725

FALL-SPRING SEMESTERS, 2009-2010

COURSE DESCRIPTION

Physiology 625 is designed to provide the student with knowledge of the basic functions of the cells, tissues, organs and organ systems, and how they interrelate to accomplish the many and diverse functions of the human body.

EVALUATION MECHANISM

The grades will be based upon written examinations and daily quizes. There will be six one hour exams (total of ~276 points) during the course and a comprehensive final exam (100 points) at the end of the course. In addition, there will be a one question quiz for each hour of lecture. The quiz questions can include any material presented previously in a given block as well as material that will be presented on the day of the quiz. The six block exams will account for ~63% of the total grade, the final exam for ~21%, and the daily quizzes will account for ~16% of the total grade. The number of questions on the various tests/quizzes will be as follows:

Block	Instructor(s)	Block exams	Daily quiz	Bonus pts
1	Adair	40	10	1
2	Adair	40	9	1
3	Alexander	55	14	2
4	Drummond/Stec	60	16	2
5	Dzielak	45	12	1
6	Ryan/Maric	55	14	2
Final	All instructors	100		
Total		395	75	9

The grades from the block exams, final, and daily quizzes will be checked against the distribution curve of grades for the entire class. A student will not be failed unless his or her grade falls very low on the lower limb of the distribution curve. That is, as long as a student's performance is not distinctly inferior to that of the vast majority of other students, he or she will not receive a failing grade.

The types of questions that will be given on the exams and final are similar to those used on the physiology portion of the National Board Dental Examinations. Each question will count the same as other questions for a given exam, but material considered to be more important by the individual instructors will be represented most heavily on the exams.

The rules of the school are that each student must attend all lectures and must be present for at least 80% of lectures to be eligible to take the exams. We have been asked to enforce this rule rigidly. Apart from the necessity to follow this rule, the spirit of the class is greatly enhanced by the presence of all students at all teaching exercises.

COURSE AND INSTRUCTOR EVALUATION

The student will have an opportunity to evaluate the instructor(s) immediately after each of the six exams as well as the entire course after the final exam. It is hoped that the student will perform this task with great objectivity because the evaluations play an important role in our quest to achieve excellence in the course.

REQUIRED COURSE MATERIALS

None

REQUIRED ETEXT

Textbook of Medical Physiology, A.C. Guyton and J.E. Hall, 11th Edition, Elsevier/Saunders, 2005.

RECOMMENDED TEXTS/READINGS

Previous exams will be provided.

SPECIFIC OBJECTIVES

PART 1. Introduction, Nerve, Muscle, Heart
Chapters 1, 4-11

- Understand the overall objectives of the course and why the course is important to dental education.
- Understand that the specific objectives for each session are to be used as a study guide and that additional objectives may be added at the discretion of the instructors.
- Understand that the evaluations of individual instructors are critical to the overall quality of the course.
- Define the term "physiology."
- Identify the basic functional unit of the body and recognize its characteristics.
- Identify the fluid mass that makes up the internal environment and define the term "homeostasis."
- Identify the major homeostatic functions of the body.
- Identify the major characteristics and activities of the important functional components of the human body.

- Explain the differences between the intracellular and extracellular fluids.
- Explain the importance of negative feedback as the basis of most control systems.
- Describe what is meant by the "gain" of a control system and be able to calculate the gain of a system.
- Describe the important differences between the extracellular fluid compartment and the intracellular fluid.
- Describe simple and carrier-mediated facilitated diffusion, indicating how the processes occur and the factors that affect them.
- Explain why both facilitated diffusion and active transport "saturate"--that is, why do each of these reach a maximum rate at which they can transport substances.
- Explain how ions pass through the cell membrane and what is meant by gating of protein transport channels. Also, explain voltage gating and ligand gating.
- Explain osmosis and differentiate between isotonicity, hypotonicity and hypertonicity.
- Explain the mechanism and importance of osmotic equilibrium between the intracellular and extracellular fluids.
- Describe the basic mechanisms of active transport, and show how it differs from diffusion and carrier-mediated facilitated diffusion.
- Describe the active transport of the major electrolytes, of sugars and of amino acids.
- Explain how substances are transported across a layer of cells.
- Describe the basic physics of membrane potentials and the role of diffusion and active transport in the development of membrane potential.
- Know how to calculate the Nernst potentials for sodium and potassium for the normal nerve.
- Describe the resting membrane potential and explain the contributions of sodium and potassium ions, the sodium pump, and the cell membrane to the production and maintenance of the resting membrane potential.
- Explain why the sodium-potassium pump is called an electrogenic pump.
- Identify the major features of the action potential and explain the mechanism of its formation in terms of membrane permeability to sodium ions in the process of depolarization, repolarization, refractoriness and formation of the action potential. Also, describe the involvement of potassium conductance.
- Explain the means by which action potentials are propagated along the nerve axon.
- Describe the re-excitation process that occurs in some tissues, such as the heart and some smooth-muscle organs, that causes repetitive discharge.
- Describe the basic anatomy of the nerve cell and axon.
- List the various kinds of stimuli that may cause an action potential and explain the functions of a transmitter substance.
- Identify the major characteristics of nerve conduction, identifying the factors which can alter conduction velocity, the function of the myelin sheath, and explaining how a nerve bundle may conduct signals of stimuli of different intensities.
- Describe how action potentials may be recorded.

- Describe the gross and microscopic structure of skeletal muscle, a muscle fiber, a sarcomere and a myofibril.
- Identify the spatial arrangement of actin and myosin filaments and explain the sliding mechanism of contraction in molecular terms and the ratchet theory of contraction.
- Explain how multiple myosin molecules combine with each other to form the myosin filament.
- Give the postulated steps for the mechanism by which ATP is used as an energy source to cause the power stroke of the myosin heads.
- Explain why the strength of contraction of a skeletal muscle fiber is determined by the degree of overlap of the actin and myosin filaments. Also, what is the relationship between sarcomere length and strength of contraction?
- Explain the anatomy and physiology of excitation-contraction coupling.
- Explain the postulated mechanism by which calcium ions cause muscle contraction.
- Describe a motor unit.
- Describe the muscle twitch and differentiate between isometric and isotonic contractions.
- Describe those factors that affect the force of contraction of a skeletal muscle and explain their importance in the control of muscle tension.
- Explain what is meant by tetanization during muscle contraction and what causes this.
- Describe the mechanism of muscle fatigue, the effects of exercise, and the consequences of denervation of muscle.
- Describe the physiologic anatomy of the neuromuscular junction and explain how it conducts a nerve action potential to a muscle fiber.
- Describe the disease myasthenia gravis, its cause, and its treatment.
- Explain how acetylcholine is secreted by the axon terminals, how it is destroyed by acetylcholinesterase, and how it excites the muscle fiber.
- Explain the differences between multiunit smooth muscle and visceral smooth muscle.
- Describe the chemical and physical differences between smooth muscle contraction and skeletal muscle contraction. Also, how do the action potentials of smooth muscle differ from those of skeletal muscle?
- Explain the interrelationships of actin and myosin fibrils during smooth muscle contraction.
- Describe the role of calcium ions in the generation of the smooth muscle action potential.
- Explain how slow waves cause rhythmical contraction in some smooth muscle masses.
- Explain the difference between the manner in which calcium ions cause contraction of smooth muscle and the manner in which they cause contraction of skeletal muscle.
- Explain why nervous stimulation of some smooth muscle causes excitation while it causes inhibition of other smooth muscle.
- Explain the importance of smooth muscle tone of different organs and how tone is achieved.
- Identify the atria, ventricles and valves of the heart, and indicate the pathway of blood flow through the chambers of the heart.

- Describe the anatomy and function of cardiac muscle, comparing and contrasting it with skeletal muscle and smooth muscle, especially in terms of action potentials and excitation-contraction coupling.
- Explain what is meant by the atrial cardiac muscle syncytium and the ventricular cardiac muscle syncytium.
- Describe the action potential of ventricular muscle and explain its molecular basis.
- Describe the four heart valves and their relationship to the heart sounds and to the mechanical events during the cardiac cycle.
- Explain the two basic defects of valvular function and how they may contribute to pulmonary edema.
- Describe the cardiac cycle, correlating the electrical, mechanical and hemodynamic events in the chambers of the heart and in the vena cava and the aorta.
- Define and understand the following terms: end-diastolic volume, end-systolic volume, and stroke volume output.
- Recall and explain the Frank-Starling law of the heart and its relationship to heart failure.
- Explain the effect that changing the arterial pressure load has on the cardiac output.
- Identify the pacemaker node and explain its function and the molecular basis of its rhythmic activity.
- Explain why the sinoatrial node is the "pacemaker" of the human heart, and indicate the consequences of blocking the conduction between the sinoatrial node and the atria, and between the atria and the ventricles.
- Describe the conduction of the action potential from its origin to the ventricular myocardium; identify the various anatomical pathways, nodes and their roles in the conduction of the cardiac action potential.
- Describe the effects of blockage of the conduction system, explaining the origin and effects of circus movements, atrial flutter and atrial and ventricular fibrillation.
- Describe the effects of parasympathetic stimulation on cardiac rhythmicity and conduction of the cardiac impulse through the conductive system of the heart.
- Describe the characteristics of atrial flutter and atrial fibrillation.
- Understand the mechanism of ventricular fibrillation and how 60-cycle alternating current elicits ventricular fibrillation.
- Explain why a very strong electrical shock to the heart is capable of causing defibrillation, whereas weak electrical shock is a very common cause of fibrillation.
- Explain why it is important that all parts of the ventricles receive the cardiac impulse simultaneously.
- Identify the components of the electrocardiogram and relate these to the electrical events in the heart.
- Explain what is meant by a depolarization wave and by a repolarization wave in the electrocardiogram and know which of the normal electrocardiographic waves represent depolarization and which represent repolarization.
- Draw a diagram of the heart showing the flow of current around the ventricles when they are approximately half depolarized.

- Identify electrocardiograms caused by partial atrioventricular block, atrial premature contraction, complete atrioventricular block, premature ventricular contractions, ventricular paroxysmal tachycardia, atrial fibrillation, atrial flutter, and ventricular fibrillation.
- Explain what is meant by the mean electrical axis of the ventricles and why this deviates to the left in both hypertrophy of the left ventricle and left bundle branch block.
- Explain what is meant by the current of injury in the electrocardiogram and how it can be used to determine the locus of a myocardial infarct in the heart.

PART 2. Gastrointestinal Physiology and Temperature Regulation Chapters 62-66, 73

- Identify the basic structures of the gastrointestinal tract and describe the structure of the wall of the gut, including the muscular layers and the nerve plexus.
- Describe the two basic movements of the gastrointestinal tract and the effects of the sympathetic and parasympathetic nervous systems.
- Describe the basic mechanism of swallowing and the nervous control of the initiation of swallowing, the esophageal phase of swallowing, and the functions of the esophagus and gastroesophageal constrictor.
- Describe the three motor functions of the stomach and identify those factors that influence the emptying of the stomach.
- Describe the movements of the small intestine and how they are controlled.
- Describe the mixing and propulsive movements of the large intestine and the act of defecation.
- Explain the function and mechanisms of antiperistalsis, vomiting, the gastrocolic and duodenocolic reflexes, the peritoneal reflex and the mucosal reflex.
- Describe the secretion, mechanisms of secretion and the control of secretion of the salivary glands, the esophagus, the liver, pancreas, small intestine and the large intestine.
- Describe the cellular mechanisms of secretion by mucous, tubular and compound glands.
- Describe the identity, cellular location and function of the pumps and channels that function to cause fluid to be secreted into the gut lumen.
- Describe the identity, cellular location and function of pumps and channels that serve to acidify and buffer intestinal contents.
- Define digestion and assimilation as they relate to the provision of nutrients to the body.
- Identify the common polysaccharides, disaccharides and monosaccharides in the diet and explain the chemical relationship among these three types of carbohydrates.
- Identify the enzymes and steps involved in the digestion of carbohydrates.
- Describe the structure of the absorptive epithelium of the small intestine.
- Describe the function and location of the pumps and channels that transport salt and fluid from the gut lumen.
- Describe the structure and mechanism of the absorption of the three major monosaccharides and describe their fate in the body.

- Identify the mechanisms for the regulation of the blood glucose concentration.
- Identify the basic structure of neutral fats in the diet.
- Describe the enzymes and the steps in the digestion of fats, including the role of the bile salts and the micelles.
- Describe the process of the absorption of fatty acids and glycerides, including the formation of chylomicrons and the role of the lacteals in the transport of chylomicrons to fat tissue and the liver.
- Explain how fatty acids are transported in the blood from one area of the body to another.
- Describe the basic structure of protein and identify the enzymes and steps in the process of digestion of proteins.
- Describe how amino acids are absorbed from the gastrointestinal tract, how they are transported and their fate, identifying the roles of the liver, tissue cells and cortisol in the control of blood amino acid concentration.
- Describe the absorption of ions and water in the gastrointestinal tract.
- Explain why blood flow through the skin is so variable and why it is controlled almost entirely by the nervous system in contrast to most other tissues in which blood flow is controlled mainly by local regulatory factors.
- Explain the control of skin temperature by the temperature control center of the hypothalamus.
- Describe the vasoconstrictor and vasodilator mechanisms for skin blood flow control.
- List the normal range of body temperature and describe the magnitude of the effects on temperature of various environmental and activity factors.
- Define and describe the mechanisms of heat transfer between the body and its environment.
- Describe the regulation of body temperature by sweating, cutaneous blood flow, the peripheral and central nervous systems, and hormonal systems.
- Describe and contrast the effects of pyrogens, environment, and antipyretics on body temperature and its regulation.
- Describe the mechanisms by which xerostomia leads to caries, based on reading and the clinical correlation.

PART 3. Circulation - Hemostasis
Chapters 14-24, 36

- Describe the anatomical arrangement of the systemic and pulmonary circulatory systems, noting the distribution of blood volume in each part.
- Describe the functions of large arteries, small arteries, arterioles, and capillaries
- Explain how pressure, flow, and resistance may differ between different parts of the circulatory system.
- Describe the effect of hematocrit on blood viscosity.
- Define the mathematical relationship between pressure, flow, and resistance.
- Describe how blood flow can be measured.

- Define blood pressure, describe how it can be measured, and indicate its normal range in humans.
- Define conductance and describe the mathematical relationship between resistance and conductance.
- Define Poiseuille's law and explain how each factor alters resistance.
- Describe the effects of sympathetic nervous stimulation on vascular resistance and tissue blood flow.
- Define vascular distensibility and vascular compliance and contrast these properties in the arterial and venous sides of the circulation.
- Describe the pressure-volume curves for the arterial and venous vasculature and discuss the effect of sympathetic stimulation on these curves.
- Describe the veins and their functions including the effects of hydrostatic pressure and the anatomical arrangement of the venous valves and their function.
- Discuss the factors that affect pulse pressure, and how pulse pressure changes in different parts of the circulatory system.
- Describe two ways that arterial pressure can be measured.
- Describe the anatomical arrangement of arterioles, capillaries, and venules, and the regulation of flow through these vessels.
- Describe the dynamics of capillary fluid exchange, identifying the various factors that affect the rate of fluid transfer through the capillary wall.
- Describe the structural arrangement of the interstitium, and the process by which fluid moves through the interstitium.
- Calculate the net rate of fluid transfer through the capillary wall.
- Predict the consequences of disruption of the normal equilibrium of capillary fluid exchange.
- Describe the contribution of the lymphatic system to fluid exchange and the principle functions of the lymphatic system.
- Describe the factors that determine lymph flow and recall the roles of the lymphatic capillaries and larger lymph vessels.
- Explain how local control of blood flow is regulated in response to tissue metabolic needs.
- Explain the theories for acute control of local blood flow.
- Explain the mechanisms of long-term blood flow regulation.
- Define the term angiogenesis and describe the most likely conditions that may cause it.
- Describe several vasoconstrictors and vasodilator substances that are important in the humoral regulation of the circulation.
- Describe the rapidly acting nervous mechanisms for arterial pressure control including the arterial baroreceptor control system, the CNS ischemic response, and the Bainbridge reflex.
- Describe the hormonal mechanisms for rapid arterial pressure control including the norepinephrine-epinephrine vasoconstrictor mechanism, the role of vasopressin, and the renin-angiotensin vasoconstrictor mechanism.

- Describe the anatomical arrangement of sympathetic and parasympathetic nervous system innervation to the circulation.
- Describe the capillary fluid shift mechanism for arterial pressure regulation.
- Describe the renal body fluid system for arterial pressure control and define pressure diuresis and pressure natriuresis.
- Describe the graphical analysis of pressure control by the renal body fluid feedback mechanism and define the infinite gain principle.
- Define the two determinants of long-term arterial pressure level.
- Describe the sequential steps by which increased extracellular fluid volume increases arterial pressure.
- Describe the role of the renin-angiotensin system in short-term and long-term arterial pressure control as well as its role in maintaining a normal arterial pressure with variations in salt intake.
- Define hypertension and list its basic causes.
- Describe the sequential events in the development of volume-loading hypertension and include an example.
- Describe the sequential events in the development of vasoconstrictor hypertension giving several examples of agents that will increase arterial pressure.
- Give an example of a type of hypertension that has both volume-loading and vasoconstrictor components.
- Define essential hypertension and list some of its characteristics.
- Describe the physical effects of hypertension on the body.
- Define cardiac output and list the normal values for healthy humans.
- Describe the relationship of arterial pressure to cardiac output and total peripheral resistance.
- Describe the role of the heart and the peripheral tissues in cardiac output regulation.
- List and explain the various factors that cause the large increases in cardiac output that occur during strenuous exercise.
- Discuss the various causes and conditions that lead to greatly decreased cardiac output as well as those which lead to increased cardiac output.
- Describe two methods for measuring cardiac output.
- Define circulatory shock.
- List and explain the various negative feedback mechanisms that help to compensate for circulatory shock.
- List and explain the important positive feedback mechanisms that occur in circulatory shock and can lead to progressive shock.
- Explain what causes shock in its extremely severe stages to become irreversible.
- Explain the causes of the development of anaphylactic shock.
- Explain the causes and special features of septic shock.

- Describe the effects of shock on the body.
- Describe the difference between the blood flow through an exercising muscle compared to that of the resting muscle.
- Describe the local regulation and nervous control of blood flow through the skeletal muscles.
- Explain the circulatory adjustments that occur during exercise.
- Discuss the role of the sympathetic nervous system during exercise.
- Explain the relative roles of tissue carbon dioxide, tissue hydrogen ion concentration, and tissue oxygen concentration in the control of cerebral blood flow.
- Define the normal blood flow through the coronary system and how much this blood flow can increase during exercise.
- Explain the control of coronary blood flow including oxygen demand and nervous control of blood flow.
- Define atherosclerosis.
- Describe what happens when an acute coronary occlusion occurs; describe recovery from this occlusion by the development of collateral vessels.
- Define myocardial infarction.
- Define angina pectoris and explain the peculiar distribution of pain in this condition.
- Define the four major causes of death following acute myocardial infarction.
- Describe two surgical procedures that are commonly used to treat coronary artery disease.
- Explain the cause of the first and second heart sounds.
- Define the cause of rheumatic valvular heart disease and explain the difference between valvular stenosis and valvular regurgitation.
- Describe the heart murmurs caused by different valvular lesions.
- Describe the dynamics of the circulation in aortic stenosis, aortic regurgitation, mitral stenosis, and mitral regurgitation.
- Describe the cause and circulatory effects of patent ductus arteriosus.
- Describe the sequential changes that occur in circulatory function after the development of acute cardiac failure and subsequent recovery of circulatory function.
- Explain why moderate fluid retention can be of value in helping the circulatory system to compensate for moderate degrees of heart failure, whereas extreme retention of fluid in severe degrees of heart failure can be lethal.
- Describe the specific characteristics of unilateral left heart failure. Explain why pulmonary edema is usually worse in unilateral left heart failure than in generalized heart failure.
- Name the three different types of cardiac failure and the physiological classification of failure and state the cause of each of these types.
- Define cardiogenic shock and describe why this condition frequently leads to a vicious cycle of cardiac deterioration.
- Define cardiac reserve and describe some of the causes of very low cardiac reserve.

- Describe the congenital abnormality of the heart called tetralogy of Fallot. Explain why this is a right to left shunt and why it is so detrimental to the circulatory system.

Hemostasis

- Explain the role of vascular spasm in hemostasis.
- Explain how platelet plugs contribute to hemostasis.
- Name the three principal stages of the blood coagulation mechanism.
- Know the source of prothrombin, and what causes it to be converted to thrombin.
- Understand how thrombin converts fibrinogen into fibrin.
- Understand the role of platelets in clot retraction.
- Understand the principal differences between the extrinsic and intrinsic mechanisms for the formation of prothrombin activator.
- List the special roles of factor XII and platelets in the intrinsic mechanism for initiating clotting.
- Know the relationship of factor VIII to hemophilia.
- Explain how tissue trauma leads to clotting.
- Explain how each of the following factors helps prevent clotting in the normal vascular system: endothelial surface factors, antithrombin III, and heparin.
- Explain the role of plasmin in the lysis of blood clots.
- Explain the cause of bleeding in each of the following conditions: vitamin K deficiency, hemophilia, and thrombocytopenia.
- Explain the basic causes of thromboembolic conditions.
- Explain the genesis of pulmonary embolism.

PART 4. Renal, Respiration, and Aviation Chapters 25-31 and 37-42

- Describe the principle structures of the respiratory system and recall the major functions of the system.
- Describe at least four functions of the nose and explain how the nose is anatomically suited to achieve these functions.
- Describe the functions of the pharynx and larynx.
- Describe the mechanisms and functions of the cough and sneeze reflexes.
- Explain the movement of air into and out of the lungs, identifying the inspiratory and expiratory muscles and their functions.
- Describe the changes in alveolar and intrapleural pressures during inspiration and expiration.

- Recall the various lung volumes, their values and how they are measured.
- Define minute respiratory volume.
- Explain the principle of partial pressures.
- Explain how pressure, flow, and resistance may differ between the systemic and pulmonary circulations.
- Describe the effect that vertical hydrostatic pressure gradients in the lung have on regional pulmonary blood flow.
- Define the three patterns (zones) of blood flow in the lung and describe factors that can change these patterns.
- Recall the partial pressures of the major gases in atmospheric and alveolar air.
- Describe the exchange of alveolar air with atmospheric air.
- Explain the diffusion of gases at the alveolar membrane and factors that affect the diffusion of gases.
- Use his knowledge of the principles of diffusion and solubility of gases to explain how oxygen and carbon dioxide move from alveoli to blood and from blood to tissue or vice versa.
- Describe the usefulness of knowing the ventilation-perfusion ratio for the lung.
- Explain how oxygen is transported by hemoglobin and the relationship between the partial pressure of oxygen and hemoglobin saturation, i.e., the oxygen-hemoglobin dissociation curve.
- Describe and explain the adverse effects of carbon monoxide poisoning.
- Describe the transport of carbon dioxide in the blood, the formation of carbaminohemoglobin and bicarbonate ion in the blood and the release of carbon dioxide at the alveolus.
- Locate the control center for respiration and explain the current theory of the mechanism of its oscillatory cycle of inspiration and expiration.
- Describe and indicate the nature of the signals to and from the respiratory center and explain the Hering-Breuer (Lung-stretch) reflex.
- Describe the mechanisms whereby carbon dioxide and hydrogen ions control the alveolar ventilation and, conversely, how carbon dioxide concentration in the blood and hydrogen ion concentration in the extracellular fluid are controlled by alveolar ventilation.
- Explain the oxygen-associated chemoreceptor mechanism for the regulation of alveolar ventilation.
- Identify and explain the two mechanisms postulated for the effects of exercise on alveolar ventilation.
- Describe how the following factors affect respiration: arterial blood pressure, psychic stimuli, sensory impulses and speech.
- Explain the four types of hypoxia and their causes and list the three ways in which oxygen therapy assists hypoxic patients.
- Define dyspnea and identify its causes.
- Explain how pneumonia, pulmonary edema, emphysema, atelectasis and asthma affect alveolar ventilation and air movement.

- Describe the effects of high altitude on the partial pressure of alveolar oxygen and explain how water vapor and carbon dioxide compound the problem.
- Explain the process of acclimatization to high altitude.
- Explain how breathing pure oxygen can increase the altitude at which one can survive.
- Describe and explain the problems in accommodating to a "weightful" state after a prolonged period of weightlessness.
- Recall the major physiologic problems that continue to impede travel in space.
- Describe the effects of high pressures of oxygen and nitrogen on the body and explain how they can be overcome or prevented.
- Describe the cause, effects, and prevention of decompression sickness.
- Recall the major body fluid compartments and list their normal values.
- Understand the dilution principle for calculating the various body fluid volumes.
- Identify the ideal characteristics of a substance used to calculate the volume of a body fluid compartment.
- Explain how the body regulates blood volume.
- Explain the importance of the sodium ion concentration in the regulation of extracellular fluid osmolality.
- Recall two mechanisms that are important for the regulation of extracellular osmolarity.
- Define edema and discuss four factors that contribute to the formation of edema.
- Describe the concept of a "safety factor against edema" and discuss three of the major safety factors.
- Describe the overall structure of the kidney and its basic unit, the nephron.
- Explain the functions of the nephron including glomerular filtration, tubular reabsorption and tubular secretion for all the major ions and solutes.
- Explain how the processing of fluid by the kidney is regulated, indicating the major effects of arterial pressure.
- Explain the mechanisms involved in the autoregulation of renal blood flow and glomerular filtration rate.
- Explain and calculate renal clearance and renal blood flow, given the essential data.
- Describe the role of antidiuretic hormone in the control of urine osmolarity.
- Identify the origin of antidiuretic hormone and describe its secretion and the factors that regulate that secretion.
- Explain the countercurrent mechanism for conserving water.
- Describe the mechanism.
- Explain the role of aldosterone in the control of potassium ion concentration in the extracellular fluid.
- Define and explain the concepts of an acid, a base, pH and buffers and identify the major buffer systems in the extracellular fluid.

- Explain how ventilation influences pH and how pH affects ventilation.
- Describe how the kidney responds to conditions of acidity and alkalinity. Define acidosis and alkalosis.
- Describe and explain the effects of "renal shutdown" as well as acute and chronic glomerulonephritis.
- Explain the principles of hemodialysis.
- Describe the process of micturition.

PART 5. Central Nervous System, Special Senses Chapters 45-61

- Describe four main functions of the nervous system.
- Describe and explain the significance of the three major levels of organization of the central nervous system.
- Describe the important parts of a neuron, and their function.
- Describe the important parts of a synapse, and their function.
- Provide examples of important synaptic transmitters, and whether they are excitatory, inhibitory, or both.
- Explain how excitatory and inhibitory post-synaptic potentials are produced.
- Explain the role of dendrites and electrotonic conduction in synaptic transmission.
- Explain how spatial and temporal summation work to produce an action potential in the post synaptic neuron.
- Describe the five types of sensory receptors, and the basis of their differential sensitivities.
- Explain how sensory stimuli are converged (transduced) into nerve impulses.
- Describe the phenomena of sensory adaptation, and its significance.
- Describe the general system for classification of nerve fibers.
- Describe the anatomical and functional characteristics of the dorsal columns and the spinothalamic systems of somesthetic sensation, comparing them in terms of discreteness of signal transmission, the speed of transmission, and the modalities of sensation transmitted.
- Describe the function of the thalamus, and the somatic sensory and association areas of the cortex in the interpretation of tactile stimuli.
- Describe the "purpose" of pain, and the stimuli that cause it.
- Distinguish between the two types of pain in terms of their latency, quality, ability to be localized, and the nerve fibers and nervous pathways with which they are transmitted.
- Describe how the transmission of pain is controlled.
- Describe the two pathways of visceral pain, and their role in localization of the pain.
- The following three objectives related to teeth are not in the text:

1. Describe the innervation of teeth.
2. Describe the sensations that arise from teeth.
3. Describe how pain may arise from exposed dentin, and from the pulp.

- Describe the components and organization of the spinal cord at the segmental level.
- Describe the structure and function of the muscle spindle.
- Describe the operation of the muscle spindle (myotactic) reflex, and its role in the control of muscle contraction.
- Describe the significance of the myotatic reflex in evaluating neurological function.
- Describe the tendon reflex and its function.
- Explain the flexor and crossed extensor reflexes, and the role of reciprocal inhibition.
- Describe the anatomical components of the vestibular apparatus and the function of the sensory structures they contain.
- Describe how equilibrium is maintained by input from the vestibular apparatus and elsewhere.
- Describe the general role of brainstem nuclei in motor control
- Describe the major areas of the cerebral cortex involved in motor control, the type of movements that they are responsible for, and the consequences of their destruction.
- Describe the connections between the motor cortex and spinal cord and their operation.
- Describe the role of the cerebellum in motor control, including how muscle control is affected by its absence or dysfunction.
- Describe the role of the basal ganglia in motor control, the type of movements that they are responsible for, and how motor control is affected by their dysfunction.
- Describe the function of cortical association areas, Wernicke's area, and the prefrontal cortex, and the consequences of their destruction or dysfunction.
- Distinguish between immediate, short-term, and long-term memory, and describe the mechanisms that may mediate them.
- Describe synaptic mechanisms of memory (facilitation and habituation) identified in *Aplysia.*
- Explain the roles of codification and consolidation in the formation of memories.
- Distinguish between anterograde and retrograde amnesia.
- Describe the systems responsible for the activation of the cerebral cortex, and the production of sleep.
- Describe the basic functions of the limbic system and hypothalamus.
- Describe the function of the autonomic nervous system.
- Describe the anatomy of the sympathetic and parasympathetic nervous systems, indicating their relationship to the spinal cord and the arrangement of their preganglionic and postganglionic neurons.
- Identify the transmitter substances released by the postganglionic fibers of each system.

- Recall the effects of the sympathetic and parasympathetic nervous systems on the major target organs of the body and on the body as a whole.
- Identify the important autonomic centers of the brain stem and describe the role of the hypothalamus in cardiovascular regulation, regulation of body temperature, body water, feeding, excitement, rage and endocrine function.
- Explain how sympathetic and parasympathetic tone can allow the sympathetic and parasympathetic systems to cause both excitation and inhibition of an organ.
- Describe the function of the blood brain barrier.
- Describe the anatomy of the eye, explaining its optics and the defects of hypermetropia, myopia and astigmatism and describe how these defects are corrected.
- Describe the microscopic structure of the retina.
- Explain what happens to the depth of focus of the eye's focusing system when the pupillary aperture becomes very small.
- Describe the chemistry of rod excitation and explain fusion of flickering images, light and dark adaptation.
- Describe the formation of rhodopsin after it has been decomposed in bright light.
- Describe how color and intensity are detected and explain color blindness.
- Describe the factors influencing visual acuity and depth perception.
- Explain how the receptor potential in the rods differ from the generation of a receptor potential in most sensory receptors of the body. Explain the mechanism for generating this potential.
- Describe the optic pathways from the retina, explaining how the retina, lateral geniculate body, visual cortex and basal regions of the brain contribute to visual discrimination.
- Describe a normal visual field and predict the effects of visual fields of destruction for the optic nerve, the optic chiasm and the optic tract.
- Explain the function of lateral inhibition in the retina as a means for highlighting contrasts in the visual scene.
- Explain the feedback mechanism that causes involuntary fixation.
- Describe how the eyes are positioned and focused and how the diameter of the pupil is controlled.
- Describe the general structure of the ear, explaining the functions of the tympanic membrane, the bones of the skull and ossicles in the detection of sound.
- Describe the structure of the cochlea and the organ of Corti, explaining how sound is conducted in the inner ear, the phenomenon of resonance and how pitch and loudness are determined by the inner ear.
- Describe the mechanisms of conduction and nerve deafness.
- Describe the taste bud and identify the four primary taste sensations.
- Indicate the importance of the sense of smell to taste and the functions of taste in humans.
- Describe the neural pathways for taste in the central nervous system.
- Describe the olfactory epithelium, the primary sensations of smell, and the phenomena of adaptation and odor masking.

- Describe the known pathways in the central nervous system for olfaction.

PART 6. Endocrinology, Reproduction, and Sports Physiology Chapters 74-84

- Define a hormone and classify by chemical structure.
- Identify and describe the two general mechanisms of hormone action and classify hormones by their mechanism of action.
- Identify the six anterior pituitary hormones and, for each, identify the effects or functions, how its secretion is controlled, and abnormalities resulting from deficiency or excess of hormone production.
- Describe and explain the function of the hypothalamus in the control of anterior pituitary hormone secretion.
- Describe the regulation of posterior pituitary hormone secretion.
- Describe the regulation of secretion of antidiuretic hormone.
- Describe the role of antidiuretic hormone in the control of osmolality and blood pressure.
- Describe the regulation of secretion and effects of growth hormone.
- Describe the anatomy of the thyroid gland and outline the steps in the synthesis and storage and release of thyroxin and triiodothyronine.
- Explain the effects of thyroxin on total body metabolism, the cardiovascular system, the nervous system and the gastrointestinal tract.
- Explain the regulation of thyroid hormone secretion.
- Explain the causes and effects of hyperthyroidism, exophthalmos, hypothyroidism and goiter.
- Describe the structure of the adrenal glands, indicating the medulla and the three layers of the adrenal cortex and their respective hormone secretions.
- Identify the important mineralocorticoids and identify the mechanism of action and the renal tubular effects of aldosterone on sodium, potassium, chloride, and water transport.
- Describe the role of aldosterone in the regulation of extracellular fluid volume.
- Explain how aldosterone secretion is regulated by plasma potassium ion and by extracellular fluid volume via the renin-angiotensin system.
- Describe the effects of glucocorticoids on glucose, fat and protein metabolism and on lysosomal stabilization.
- Explain how glucocorticoid secretion is regulated.
- Explain the significance of androgen secretion by the adrenal cortex.
- Indicate the consequences of hyposecretion and hypersecretion of the adrenocortical hormones.
- Identify the endocrine cells of the islets of Langerhans and their respective hormones.
- Describe the basic function and mechanism of action of insulin and explain the effects of insulin on blood glucose concentration, glucose, fat and protein metabolism, and on growth.
- Explain how insulin secretion is regulated.

- Describe the cause, effects and treatment of diabetes mellitus.
- Identify the effects of hyperinsulinism.
- Describe the mechanism of action and effects of glucagon and explain how glucagon secretion is regulated.
- Describe the interactive role of insulin and glucagon in the regulation of blood glucose concentration.
- Describe the role of growth hormone and cortisol in the regulation of blood glucose concentration.
- Identify the functions of calcium in the body and explain the relationship between calcium ions and phosphate ions.
- Describe the absorption, utilization, and extraction of Ca^{++} and HPO_4--, indicating the roles of parathyroid hormone and Vitamin D.
- Identify the sources of Vitamin D and the steps in its activation, and explain the feedback control effects of 25-hydroxycholecalciferol and parathyroid hormone.
- Describe the mechanism of function of Vitamin D.
- Identify the basic structure of bone and its chemical composition and explain the deposition and resorption of bone and how the balance is regulated.
- Describe the origin, effects and control of parathyroid hormone.
- Describe the consequences of hypersecretion and hyposecretion of parathyroid hormone.
- Explain the causes and consequences of rickets.
- Describe the origin, function and control of calcitonin secretion.
- Describe the functions of the teeth and the structure and functions of the various structural elements of teeth.
- Describe the processes of formation, eruption, development and mineral exchange in teeth.
- Describe the causes and consequences of malocclusion and caries.
- Describe the structure of a sperm, indicating the functions of the head and tail of the sperm.
- Describe the location of and steps in the formation and maturation of sperm, identifying the stages of spermatogenesis and the number of chromosomes in each stage.
- Explain how the sperm determines the sex of the offspring.
- Describe the steps in the male sexual act, indicating the roles of the vas deferens, the urethra, the glans and erectile tissue of the penis, and the bulbourethral glands.
- Explain the function of the nervous system in the male sexual act.
- Describe the composition of semen.
- Identify the causes of male sterility.
- Describe the process of puberty in the male, explaining the functions of follicle-stimulating hormone, luteinizing hormone and the interstitial cells of the seminiferous tubules in the development of primary and secondary male sex characteristics.

- Describe the ovaries and the growth of the follicle to ovulation, indicating the stages in the development of the ovum, its chromosomal complement at each stage, and the functions of the granulosal cells of the follicle.
- Describe the transport of the ovum in the Fallopian tube and explain the major causes of female sterility.
- Describe the female sexual act and the roles of Bartholin's glands and the clitoris.
- Identify the functions of follicle-stimulating hormone and luteinizing hormone, estrogen and progesterone and explain the female menstrual cycle, correlating the secretion of gonadotropins, estrogen and progesterone with the endometrial changes during the cycle.
- Describe the factors that bring about menopause.
- Indicate when, in menstrual cycle, the female is fertile and explain how hormones are used to prevent fertility.
- Describe the fertilization of the ovum.
- Describe the transport and implantation of the developing ovum.
- Describe the processes that lead to the nutrition of the early developing ovum.
- Describe diffusion of oxygen and carbon dioxide through the placenta.
- Explain the role of human chorionic gonadotropin in the maintenance of pregnancy and during the first few weeks after fertilization.
- Discuss the factors that increase uterine motility during the end of pregnancy.
- Discuss the mechanics of parturition.
- Discuss the factors that cause growth and development of the breasts and their glandular apparatus.
- Explain the changes in pressure in different parts of the circulatory system immediately after birth.
- Discuss the differences between male and female athletes.
- What is the relationship between muscle cross-sectional area and muscle strength?
- How does muscle power differ from muscle strength?
- Characterize the three important metabolic systems that supply energy and exercise.
- Explain the mechanisms for recovery of each of the above three metabolic systems after they are depleted.
- Describe approximately how much the untrained person and the trained person can increase their rates of oxygen consumption above the resting level during maximum exercise.
- Explain the relationship between work output, oxygen consumption and cardiac output during exercise.
- Discuss the perils of excess body heat during exercise.
- Discuss the problems of fluid and electrolyte loss during exercise and discuss the replacement.