NORTHWESTERN CONNECTICUT COMMUNITY COLLEGE

COURSE SYLLABUS

Course Title: Anatomy & Physiology II **Course #:** BIO* 212

Course Description: Four (4) semester hours (3 class hours; 3 laboratory hours).
A study of the structure and function of the human body. Includes a detailed analysis of the nervous, endocrine, digestive, respiratory, circulatory, lymphatic, urinary and reproductive systems. Emphasis is placed on the interrelationships of the systems.

Pre-requisite/Co-requisite: Prerequisite: BIO* 211 and CHE* 111

Goals:

1. To investigate and integrate the functions and microscopic and gross structure of the systems listed in the description.
2. To apply knowledge of cytology and histology to organ and system structure and function.
3. To apply appropriate technical and medical terminology to basic body structures and functions.
4. To acquaint the student with the more common abnormal and pathological conditions of each system considered.
5. To provide the student with a comprehensive understanding of the structure and function of mammalian systems.
6. To apply knowledge of physiological principles to organs and organ systems and to investigate the inter-relationships between the body systems.
7. To study and integrate the structure and function of the nervous, endocrine, lymphatic, cardiovascular, digestive, respiratory, urinary and reproductive systems.
8. To consider discords and clinical syndromes associated with specific systems as they pertain to both human and veterinary medicine.

Outcomes: At the end of this course students should be able to:

NERVOUS SYSTEM

1. Physiology of sensory & motor pathways in the brain & spinal cord	1. Describe the locations and functions of the first-, second-, and third-order neurons in a sensory pathway. 2. Describe the locations and functions of the upper and lower motor neurons in a motor pathway. 3. Explain how decussation occurs in sensory and motor pathways & predict how decussation impacts the correlation of brain damage and symptoms in stroke patients. 4. Starting with a stimulus, create a scenario detailing the pathway beginning with a receptor and first-order neuron that carries the impulse to the brain. Discuss interpretation in the brain and discuss the motor pathway that carries an impulse to skeletal muscle to produce a response.
2. Functions of the autonomic nervous system	1. Discuss the two divisions of the autonomic nervous system and the general physiological roles of each. 2. Contrast the anatomy of the parasympathetic and sympathetic systems, including central nervous system outflow locations,

	ganglia locations, pre- and post-ganglionic neuron relative lengths, and ganglionic and effector neurotransmitters. 3. Describe examples of specific effectors dually innervated by the two branches of the autonomic nervous system and explain how each branch influences function in a given effector. 4. Describe examples of effectors innervated by only the sympathetic branch or the parasympathetic branch of the nervous system and explain how that branch by itself influences function in a given effector. 5. Contrast sympathetic innervations of the adrenal gland with sympathetic innervations of other effectors. 6. Describe visceral reflex arcs, including structural and functional details of sensory and motor (autonomic) components. 7. Differentiate between cholinergic and adrenergic nerve fibers and discuss the physiological interactions of transmitters released by these neurons with specific cholinergic and adrenergic receptor subtypes. 8. Propose clinical uses of specific drugs that act at cholinergic and adrenergic receptor subtypes. 9. Identify major parasympathetic and/or sympathetic physiological effects on target organ.
3. Comparisons of somatic & autonomic nervous systems	1. Distinguish between the effectors of the somatic and autonomic nervous systems. 2. Contrast the cellular anatomy of the somatic and autonomic motor pathways. 3. Identify the neurotransmitters released at synapses with effector organs in the somatic and autonomic motor pathways and classify each effector response as excitatory or inhibitory.
4. Application of homeostatic mechanisms	1. Provide specific examples to demonstrate how the nervous system responds to maintain homeostasis in the body. 2. Explain how the nervous system relates to other body systems to maintain homeostasis.
5. Predictions related to homeostatic imbalance, including disease states & disorders	1. Predict factors or situations affecting the nervous system that could disrupt homeostasis. 2. Predict the types of problems that would occur in the body if the nervous system could not maintain homeostasis.

SPECIAL SENSES – covered in lab

1. Gross & microscopic anatomy of the eye	Identify the accessory eye structures, the tunics, the optical components and the neural components of the eye.

2. Roles of specific tissues of the eye in vision	1. Describe the functions of the accessory structures of the eye. 2. Trace the path of light as it passes through the eye to the retina and the path of nerve impulses from the retina to various parts of the brain. 3. Describe the structure of the retina and the cells that compose it. 4. Describe how light activates photoreceptors. 5. Explain how the optical system of the eye creates an image on the retina. 6. Compare and contrast the function of rods and cones in vision. 7. Explain the process of light and dark adaption. 8. Relate changes in the anatomy of the eye to changes in vision.
3. Olfactory receptors & their role in smell	1. Identify the location of olfactory receptors. 2. Explain how odorants activate olfactory receptors. 3. Describe the path of nerve impulses from the olfactory receptors to various parts of the brain.
4. Gustatory receptors & their role in taste	1. Identify the location and structure of taste buds. 2. Explain how dissolved chemicals activate gustatory receptors. 3. Describe the path the nerve impulses from the gustatory receptors to various parts of the brain. 4. Describe the five primary taste sensations.
5. General gross & microscopic anatomy of the hearing & accessory structures of the ear	Identify the hearing structures of the outer, middle and inner ear.
6. Roles of specific tissues of the ear in hearing	1. Describe how the various structures of the outer, middle, and inner ear function in hearing. 2. Describe the sound conduction pathway from the auricle to the fluids of the inner ear and the path of nerve impulses from the spiral organ to various parts of the brain. 3. Explain how the structures of the ear enable differentiation of pitch and loudness of sounds.
7. Roles of the accessory structures	1. Describe the functions of the ceruminous glands. 2. Describe the role of the auditory tube in drainage and equalization of pressure in the middle ear.
	1. Distinguish between static and dynamic equilibrium.

8. Role of the ear in equilibrium	2. Describe the structure of the maculae and their function in static equilibrium. 3. Describe the structure of the crista ampullaris and its function in dynamic equilibrium.
9. Application of homeostatic mechanisms	1. Provide specific examples to demonstrate how the special sense organs respond to maintain homeostasis in the body. 2. Explain how the special sense organs relate to other body organs and systems to maintain homeostasis.
10. Predictions related to homeostatic imbalance, including disease states & disorders	1. Predict factors or situations affecting the special sense organs that could disrupt homeostasis. 2. Predict the types of problems that would occur in the body if the special sense organs could not maintain homeostasis. 3. Identify and discuss the causes and effects of specific disorders of the eye and ear including but not limited to presbyopia, hypermitropia astigmatism, cataracts detached retina, otitis media, conductive hearing loss, nerve deafness.

ENDOCRINE SYSTEM

1. General functions of the endocrine system	1. Determine the major functions of the endocrine system. 2. Define the terms hormone, endocrine gland, endocrine tissue (organ), and target cell. 3. Compare and contrast how the nervous and endocrine systems control body function, with emphasis on the mechanisms by which the controlling signals are transferred through the body and the time course of the response(s) and action(s).
2. Chemical classification of hormones & mechanism of hormone actions at receptors	1. Identify the major chemical classes of hormones found in the human body. 2. Describe how each class is transported in the blood. 3. Compare and contrast the types of receptors (cell membrane or intracellular) that each class binds to. 4. Compare and contrast the mechanism of response that each class elicits (i.e., change in gene expression or change in an intracellular pathway via phosphorylation mechanism) and relate the response mechanism to the biochemical nature of the hormone molecule.
3. Control of hormone secretion	1. Identify and describe several types of stimuli that control production and secretion of hormones.

	2. Describe the roles of negative and positive feedback in controlling hormone release in each hormone system.
4. Control by the hypothalamus & pituitary gland	1. Determine the locations of and the anatomical relationships between the hypothalamus, anterior pituitary and posterior pituitary glands. 2. Define the terms releasing hormone, inhibiting hormone and tropic hormone. 3. Explain the role of the hypothalamus in the release of anterior pituitary hormones. 4. Explain the role of the hypothalamus in the production and release of posterior pituitary hormones.
5. Identity, source, secretory control, & functional roles of the major hormones produced by the body	Use the hormones below (grouped by organs) to perform: • Pituitary: growth hormone, thyroid-stimulating hormone, luteinizing hormone, follicle stimulating hormone, prolactin, adrenocorticotropic hormone, oxytocin, antidiuretic hormone (or vasopressin) • Thyroid gland: thyroxine, triiodothyronine, calcitonin • Parathyroid gland: parathyroid hormone • Adrenal gland: glucocorticoids (cortisol, mineralocorticoids (aldosterone), gonadocorticoids, epinephrine, norepinephrine • Testis: testosterone, inhibin • Ovary: estrogen, progesterone, inhibin • Pancreas: insulin, glucagon • Some may be covered in other modules: o Kidney: erythropoietin, calcitriol (Vitamin D) o Thymus: thymosin o Heart: atrial natriuretic peptide o Gastrointestinal tract: gastrin, secretin, cholecystokinin, motilin, gastric inhibiting peptide o Adipose tissue: leptin, resistin o Placenta: estrogen, progesterone, human chorionic gonadotropin a. Identify the stimulus for release of the hormone. b. Identify the gland or endocrine tissue/organ and the cells within that gland/tissue/organ that produce the hormone. c. Identify the target tissue or cells for the hormone and describe the effect(s) of the hormone on the target tissue or cells and identify the hormone(s) and other mechanisms that replicate hormone release. d. Predict the larger effect that fluctuations in the hormone level will have on conditions (variables) within the body. e. Analyze flowcharts to identify and determine the specific components and relationships of each hormone system.
6. Local hormones (paracrines & autocrines) & growth factors	1. Define the terms paracrine and autocrine. 2. List two major types of eicosanoids and discuss their production and functions.

	3. Discuss the production and function of growth factors. 4. Justify whether or not paracrines, autocrines and growth factors should be considered to be part of the endocrine system.
7. Hormonal response to stress	1. Describe the three stages of the stress response (general adaptation syndrome). 2. Identify the hormones released during short-term stress and describe the hormonal actions. 3. Identify the major hormones released during long-term stress and describe the hormonal actions.
8. Application of homeostatic mechanisms	1. Provide specific examples to demonstrate how the endocrine organs respond to maintain homeostasis in the body. 2. Explain how the endocrine organs relate to other body organs and systems to maintain homeostasis.
9. Predictions related to homeostatic imbalance, including disease states & disorders	1. Predict factors or situations affecting the endocrine organs that could disrupt homeostasis. 2. Predict the effect of disorders associated with excess or deficit of specific hormone including, but not limited to, hypo- and hyperthyroidism, Cushings' and Addisons' disease, giantism and pituitary dwarfism, diabetes mellitus types I and II, and diabetes insipidus and SIADH.

CARDIOVASCULAR SYSTEM

1. General functions of the cardiovascular system	Describe the major functions of the cardiovascular system.
2. Composition of blood plasma	Describe the overall composition of plasma, including the major types of plasma proteins, their functions and where in the body they are produced.

3. Identity, microscopic anatomy, numbers, formation, & functional roles of the formed elements of blood	1. With respect to the structure and numbers of formed elements in blood: a. Identify microscopically each of the following: erythrocytes (red blood cells or RBCs), the five types of leukocytes (white blood cells or WBCs), and thrombocytes (platelets). b. Compare and contrast the morphological features of erythrocytes and the five types of leukocytes. c. State the normal ranges for erythrocyte counts and hematocrit (both male and female), total leukocyte count, and platelet count. Interpret CBC blood test results to determine if the values are normal or show anemia, leukopenia, leukocytosis, thrombocytopenia, thrombocytosis, polycythemia (normal values are not provided). d. Identify the five types of leukocytes in order of their relative prevalence in normal blood and classify each type as granulocyte or agranulocyte. e. Explain how platelets differ structurally from the other formed elements of the blood. 2. With respect to development of formed elements: a. Describe the location of hemotopoiesis and the significance of the pluripotent stem cell (hemocytoblast). b. Explain the basic process of erythropoiesis, the significance of the normoblast and reticulocyte, and regulation through erythropoietin. c. Compare myeloid and lymphoid in leukopoiesis of cell lines. d. Discuss the role of the megakaryocyte in the formation of platelets. 3. With respect to the functional roles of formed elements: a. Identify the function of red blood cells. b. Identify the structure and function of hemoglobin, as well as its breakdown products. c. Identify functions for each of the five major types of leukocytes as well as the two major subtypes of lymphocytes (T and B). d. State the function of platelets.
4. Hemostasis, including coagulation of blood	1. Distinguish between the terms hemostasis and coagulation. 2. With respect to the phases of hemostasis: a. Describe the vascular phase including the role of endothelial cells. b. Identify the role of platelets and the steps involved in the formation of the platelet plug. c. Determine the steps and sequence involved in the formation of the insoluble fibrin clot. d. Differentiate between the intrinsic and extrinsic clotting mechanisms and the factors that initiate each. 3. Determine how the positive feedback loops in the platelet and coagulation phases promote hemostasis and may lead to thrombus formation. 4. Explain the role of calcium ions and vitamin K in blood clotting.

	5. Discuss the process of fibrinolysis, including the roles of plasminogen, tissue plasminogen activator and plasmin, and their roll in treating ischemic stroke. 6. Predict the consequences of deficits in specific clotting factors. 7. Identify specific coagulation disorders including hemophilia A and B, Von Wallebrands, disseminated mitravascular coagulation, thrombus, and embolus. 8. Explain the mechanisms of action and give examples of procoagulants, anticoagulants, and fibrinolytic drugs.
5. ABO & Rh blood grouping	1. Explain the role of surface antigens on RBCs in determining blood groups. 2. Identify the type of antigen and the type of antibodies present in each ABO blood type. 3. Describe how the presence or absence of Rh antigen results in blood being classified as positive or negative. 4. Distinguish between the development of anti-Rh antibodies and the development of anti-A and anti-B antibodies. 5. Predict which blood types are compatible with what happens when the incorrect ABO or Rh blood type is transfused. 6. State which blood type is considered the universal donor and which blood type is considered the universal recipient, and explain why.
6. Gross & microscopic anatomy of the heart	1. Describe the position of the heart in the thoracic cavity. 2. On the external heart identify the location of the four chambers as well as the coronary sulcus, anterior interventricular sulcus, and posterior interventricular sulcus. 3. Identify and describe the function of the primary internal structures of the heart, including chambers, septa, valves, papillary muscles, chordate tendineae, and venous and arterial openings. 4. Compare and contrast the structure and function of the atrioventricular and the semilunar valves. 5. Describe the layers of the pericardium and the location of the pericardial cavity. 6. Identify myocardium and describe its histological structure, including the significance of intercalated discs. 7. Identify the structure and significance of the endocardium.

	8. Identify the right and left coronary arteries and their branches, the cardiac veins, and the coronary sinus, and describe coronary circulation.
7. Physiology of cardiac muscle contraction.	1. Identify the phases of the cardiac muscle action potential and explain the ion movements that occur in each phase. 2. Contrast the way action potentials are generated in cardiac pacemaker cells, in cardiac contractile cells and in skeletal muscle cells. 3. Identify the significance of the plateau phase in the action potential of a cardiac contractile cell. 4. Compare and contrast cardiac muscle contraction and skeletal muscle contraction. 5. Compare and contrast the role of nerves in the depolarization of cardiac pacemaker cells, ventricular contractile cells, and skeletal muscle cells.
8. Blood flow through the heart	1. Identify the major blood vessels entering and leaving the heart and classify them as either an artery or a vein and as containing either oxygen-rich or oxygen-poor blood. 2. Describe blood flow through the heart naming all chambers and valves passed. 3. Explain the major factors that aid in movement of blood through the heart and produce one-way flow. 4. Explain how the heart is a double pump and why this is significant.
9. Conduction system of the heart & the electrocardiogram	1. With respect to the conduction system of the heart: a. List the parts of the conduction system and explain how the system functions. b. Define automaticity and explain why the SA node normally paces the heart. c. Analyze the effect of deficits in specific components in the cardiac conduction cycle and how the cardiac conduction system produces efficient pumping of blood. d. Describe the role of the autonomic nervous system in the regulation of cardiac function. 2. With respect to the electrocardiogram (EKG or ECG): a. Identify the waveforms in a normal EKG. b. Relate the waveforms to atrial and ventricular depolarization and repolarization and to the activity of the conduction system.
10. Cardiac cycle	1. Define cardiac cycle, systole, and diastole. 2. Describe the phases of the cardiac cycle including ventricular filling, isovolumetric contraction, ventricular ejection, and isovolumetric relaxation.

	3. Relate the EKG waveforms to the normal mechanical events of the cardiac cycle. 4. Explain how atrial systole is related to ventricular filling. 5. Relate the opening and closing of specific heart valves in each phase of the cardiac cycle to pressure changes in the heart chambers. 6. Relate the heart sounds to the events of the cardiac cycle. 7. Define systolic and diastolic blood pressure and interpret a graph of aortic pressure versus time during the cardiac cycle. 8. Compare and contrast pressure and volume changes of the left and right ventricles during one cardiac cycle. 9. Given the heart rate, calculate the length of one cardiac cycle.
11. Regulation of cardiac output, stroke volume, & heart rate	1. With respect to cardiac output (CO): a. Define cardiac output, and state its units of measurement. b. Calculate cardiac output, given stroke volume and heart rate. c. Predict how changes in heart rate (HR) and/or stroke volume (SV) will affect cardiac output. d. Calculate cardiac reserve and determine its significance. 2. With respect to stroke volume (SV): a. Define end diastolic volume (EDV) and end systolic volume (ESV) and calculate stroke volume (SV) given values for EDV & ESV. b. Define venous return, preload and afterload, and explain the factors that affect them as well as how each of them affects EDV, ESV and SV. c. Demonstrate the significance of the Frank-Sterling inotropic agents on SV. d. Predict the effect of specific positive and negative inotropic agents on SV. 3. With respect to HR: a. Discuss the influence of positive and negative chronotropic agents on HR. b. Predict the effect on cardiac output when changes in HR, venous return, exercise, and an increase in parasympathetic activity occur.

12. Anatomy & functional roles of the different types of blood vessels	1. Compare and contrast the structure of arteries and veins and arterioles and venules. 2. With respect to arteries and veins: a. Identify the types of arteries and veins. b. Correlate the anatomical structure of each type of blood vessel with its function. c. Define vasoconstriction, vasodilation, and venoconstriction and identify their significance 3. Describe the role of arterioles in regulating tissue blood flow and systemic arterial blood pressure. 4. With respect to capillaries: a. Identify how the composition of capillary walls differs from that of other blood vessels. b. Identify types of capillaries and state where in the body each type is found. c. Correlate the anatomical structure of capillaries with their functions. 5. Describe the location and function of the venous reserve. 6. Define anastomosis and explain the significance of anastomoses, such as the Circle of Willis. 7. Identify the major arteries and veins.
13. Pattern of blood circulation throughout the body, including systemic, pulmonary, coronary, hepatic portal, & fetal circulations	1. With respect to the systemic and pulmonary circuits: a. Describe the systemic and pulmonary circuits and discuss the functions of each. b. State which blood vessel type carries oxygen-rich blood and which type carries oxygen-poor blood in each circuit. 2. With respect to the coronary circulation: a. Trace blood flow through the coronary circulation from the aorta to the right atrium. b. Discuss the significance of collateral coronary circulation. 3. With respect to the hepatic portal circulation: a. Identify the abdominal veins that coalesce to form the hepatic portal vein, and list additional veins that empty into it. b. Explain how the hepatic portal circulation serves the liver. 4. With respect to the fetal circulation: a. Describe the role of the placenta and umbilical blood vessels in fetal circulation. b. Identify the ductus venosus, foramen ovale, and ductus arteriosus and explain their roles in fetal circulation. c. Trace the pathway of blood flow from the placenta through the fetal heart and body and back to the placenta. d. For each umbilical vessel and the major fetal blood vessels, state whether each vessel carries oxygen-rich, oxygen-poor or mixed blood, and explain why

	e. With respect to the umbilical vessels, ductus venosus, ductus arteriosus and foramen ovale, describe the changes associated with birth and the ultimate postnatal fate of these structures. f. Compare and contrast prenatal and postnatal circulatory pathways.
14. Blood pressure & its functional interrelationships with cardiac output, peripheral resistance, & hemodynamics	1. Define blood flow, blood pressure, and peripheral resistance. 2. State and interpret the equation that relates blood flow to pressure and resistance. 3. List the local, hormonal and neuronal factors that affect peripheral resistance and explain the importance of each. 4. Interpret relevant graphs to explain the relationships between vessel diameter, cross-sectional area, blood pressure, and blood velocity. 5. Using a graph of pressures within the systemic circuit, interpret the pressure changes that occur in the arteries, capillaries, and veins. 6. Given values for systolic and diastolic blood pressure, calculate pulse pressure (PP) and mean arterial pressure (MAP). 7. With respect to capillary exchange: a. Explain the role of diffusion in capillary exchange of gases, nutrients, and wastes. b. Explain the roles of filtration and reabsorption in capillary exchange of fluid. c. Calculate net filtration pressure and identify factors that would impair tissue perfusion. d. Describe how net filtration pressure across the capillary wall determines movement of fluid across the capillary wall. e. Relate net filtration pressure to potential edema and the need for a functional lymphatic system. 8. Discuss how muscular compression and the respiratory pump aid venous return. 9. With respect to autoregulation: a. Explain how autoregulation controls blood flow to individual tissues. b. Explain the role of the precapillary sphincter in autoregulation. c. List some chemicals that cause vasodilation and explain when they are active. d. List some chemicals that cause vasoconstriction and explain when they are active. 10. With respect to regulation of blood pressure: a. During the baroreceptor reflex, explain how cardiac output and peripheral resistance are regulated to maintain adequate blood pressure on a moment-to-moment basis.

	b. During the chemoreceptor reflex, explain how the respiratory and cardiovascular systems are coordinated to provide flow and oxygen to body tissues. c. Explain the role of thesympathetic nervous system in regulation of blood pressure and volume. d. Explain the role of hormones in regulation of blood pressure, including the mechanism by which specific hormones affect preload, heart rate, inotropic state, or vascular resistance.
15. Application of homeostatic mechanisms	1. Provide specific examples to demonstrate how the cardiovascular system responds to maintain homeostasis in the body. 2. Explain how the cardiovascular system relates to other body systems to maintain homeostasis. 3. Define shock and analyze situations to determine the type of such in cardiogenic, hypovolumic, anaphylactic, septic, and neruogenic shock.
16. Predictions related to homeostatic imbalance, including disease states & disorders	1. Predict factors or situations affecting the cardiovascular system that could disrupt homeostasis. 2. Predict the types of problems that would occur in the body if the cardiovascular system could not maintain homeostasis. Specifically predict the consequences of right versus left ventricular heart failure. 3. Analyze ECG strips to determine the cause of specific dysrhythmias including junctional rhythms, heart block (1st, 2nd, and 3rd degree), atrial fibrillation, PVCs, ventricular fibrillation, sinus bradycardia, sinus tachycardia, and asystole.

LYMPHATIC SYSTEM & IMMUNITY

1. General functions of the lymphatic system	Describe the major functions of the lymphatic system.
2. Lymph & lymphatic vessels	1. Compare and contrast whole blood, plasma, interstitial fluid, and lymph. 2. Compare and contrast lymphatic vessels and blood vessels in terms of structure and function. 3. Describe the path of lymph circulation. 4. Describe the mechanisms of lymph formation & circulation.
3. Lymphatic cells, tissues, & organs	1. Describe the basic structure and cellular composition of lymphatic tissue and correlate it to the overall functions of the lymphatic system. 2. For the lymph nodes, thymus, spleen, tonsils and other aggregations of mucosae-associated lymphatic tissue (MALT):

	a. Identify and describe the gross anatomical features of each organ or tissue. b. Identify and describe the microscopic anatomy of each organ or tissue. c. Describe the location in the body of each organ or tissue. d. Describe the function of each organ or tissue.
4. Introduction to innate (nonspecific) defenses & adaptive (specific) defenses	1. Compare and contrast innate (nonspecific) defenses with adaptive (specific) defenses. 2. Define immunity and the immune system. 3. Describe the roles of various types of leukocytes in innate and adaptive body defenses. 4. Analyze ways in which the innate and adaptive body defenses cooperate to enhance the overall resistance to disease.
5. Innate (nonspecific) defenses	1. Identify the surface membrane barriers and describe their physical, chemical, and microbiological mechanisms of defense. 2. Define diapedesis, chemotaxis, opsonization, and membrane attack complex and explain their importance for innate defenses. 3. Describe the steps involved in phagocytosis and provide examples of important phagocytic cells in the body. 4. Identify natural killer cells and their function. 5. Explain how complement and interferon function in body defense. 6. Explain the role of pattern-recognition receptors in innate defenses. 7. With respect to the inflammatory response: a. Describe the mechanisms of inflammation initiation. b. Summarize the cells and chemicals involved in the inflammatory process. c. Identify and explain the cause of the four cardinal signs of inflammation. d. Explain why inflammation can be beneficial. 8. With respect to fever: a. Describe the mechanism of fever and the role of pyrogens. b. Explain why fever can be beneficial.
6. Overview of adaptive (specific) defenses	1. Distinguish between humoral and cell-mediated immunity. 2. Describe the immunological memory (anamnestic) response.
7. Antigens & antigen processing	1. Define antigen and antigen receptor.

	2. Distinguish among complete antigens, haptens, antigenic determinants and self-antigens. 3. With respect to major histocompatibility complex (MHC): a. Define MHC. b. Differentiate between class I and class II MHC and MHC proteins. c. Explain the function of class I and class II MHC in adaptive immunity. 4. Discuss the source of antigen receptor diversity. 5. Explain the role of antigen-presenting cells (APCs) and provide examples of cells that function as APCs.
8. Lymphocytes & their role in adaptive immunity	1. Distinguish among the various types of lymphocytes, including helper T cells, cytotoxic T cells, regulatory (or suppressor) T cells, B cells, plasma cells, and memory cells. 2. With respect to B cells and T cells: a. Define immunocompetence and self tolerance and distinguish between naïve and activated immune cells. b. Compare and contrast the sites where the cells originate and achieve their immunocompetence, and the primary location of the immunocompetent cells in the body. c. Compare and contrast the mechanisms of antigen challenge and the clonal selection processes, including effector cells, helper cells, memory cells, and important cytokines. d. Compare and contrast the defense mechanisms and functions. 3. Recognize the contribution of clonal deletion to immunity.
9. Antibodies & their role in adaptive immunity	1. Describe antibody structure. 2. Describe mechanisms of antibody action and correlate mechanisms with effector functions. 3. Identify the five classes of antibodies and discuss structural and functional features that distinguish each class. 4. Interpret a graph of the primary and secondary immune response, in terms of the relative concentrations of different classes of antibodies produced over time.

10. Applied immunology	1. Distinguish between active and passive immunity. 2. Describe natural and artificial examples of both active and passive immunity. 3. Provide examples of how applied immunology can be used to diagnose, treat and prevent diseases.
11. Application of homeostatic mechanisms	1. Provide specific examples to demonstrate how the lymphatic and immune systems respond to maintain homeostasis in the body. 2. Explain how the lymphatic and immune systems relate to other body systems to maintain homeostasis.
12. Predictions related to homeostatic imbalance, including disease states & disorders	1. Predict factors or situations affecting the lymphatic and immune systems that could disrupt homeostasis. 2. Predict the types of problems that would occur in the body if the lymphatic and immune systems could not maintain homeostasis. 3. Predict the consequences of obstruction of lymphatic drainage. Explain the role of lymph nodes in cancer staging. 4. Identify specific autoimmune disorders and predict consequences of the presence of autoantibodies associated with disorders such as systemic lupus erythematosis.

RESPIRATORY SYSTEM

1. General functions of the respiratory system	1. Describe the major function of the respiratory system. 2. Describe the four respiratory processes – ventilation, external respiration (gas exchange at lung), internal respiration (gas exchange at body tissues), and cellular respiration.
2. Gross & microscopic anatomy of the respiratory tract & related organs	1. Distinguish between the upper and lower respiratory tracts. 2. Distinguish between the conducting and respiratory zones of the respiratory tract. 3. List, in order, the respiratory structures that air passes through during inspiration. 4. For each of the following – nasal cavities, paranasal sinuses, pharynx, larynx, trachea, bronchi, lungs, pleural membranes, pulmonary blood vessels and nerves, thoracic and pleural cavities, and diaphragm: a. Identify each structure. b. Describe the gross anatomical features of each structure. c. State the function of each structure. 5. Relate the anatomical structures of the respiratory system to adjacent organs and tissues.

	6. For each of the following – respiratory (nasal) mucosa, the layers of the tracheal wall, the bronchi and bronchioles, the three cell types found in alveoli, and the respiratory membrane: a. Identify each structure. b. Describe the microscopic anatomy of each structure. c. State the function of each structure. 7. Identify the changes in epithelial and connective tissue seen in various portions of the air passageways and relate these changes to function.
3. Mechanisms of pulmonary ventilation	1. Define pulmonary ventilation, inspiration, and expiration. 2. Identify the muscles used during quiet inspiration, during forced inspiration, and during forced expiration, as well as the nerves responsible for stimulating those muscles. 3. Define and state relative values for atmospheric pressure, intrapulmonary pressure, intrapleural pressure, and transpulmonary pressure. 4. State Boyle's Law and relate this law to the specific sequence of events (muscle contractions/relaxations and pressure/volume changes) causing inspiration and expiration. 5. Explain how each of the following affect pulmonary ventilation: bronchiolar smooth muscle contractions, lung and thoracic wall compliance and recoil, and pulmonary surfactant and alveolar surface tension. 6. Describe the forces that tend to collapse the lungs and those that normally oppose or prevent collapse.
4. Pulmonary air volumes & capacities	1. Define, identify, and determine values for the respiratory volumes (IRV, TV, ERV, and RV) and the respiratory capacities (IC, FRC, VC, and TLC). 2. Define and calculate values for minute ventilation and alveolar ventilation. 3. Define anatomical dead space and explain the effect of anatomical dead space on alveolar ventilation and on the composition of alveolar and expired air.
5. Mechanisms of gas exchange in the lungs & tissues	1. Predict how Dalton's Law, Charles' Law, and Henry's Law relate to the events of external and internal respiration and to the amounts of oxygen and carbon dioxide dissolved in plasma under different conditions. 2. With respect to external respiration: a. Describe oxygen and carbon dioxide concentration gradients and net gas movement. b. Analyze how oxygen and carbon dioxide movements are affected by changes in partial pressure gradients (e.g., at

	high altitude), surface area, diffusion distance, and solubility and molecular weight of the gases. c. Recognize the mechanisms of ventilation-perfusion coupling and predict the effect that reduced alveolar ventilation has on pulmonary blood flow and the effect that reduced pulmonary blood flow has on bronchiole diameter and alveolar ventilation. 3. With respect to internal respiration: a. Determine the locations where oxygen and carbon dioxide concentration gradients are highest and lowest and predict net gas movements. b. Explain the factors that maintain oxygen and carbon dioxide gradients between blood and tissue cells.
6. Mechanisms of gas transport in the blood	1. With respect to oxygen transport: a. Describe the ways in which oxygen is transported in blood and discuss the relative importance of each to total oxygen transport. b. Predict how raising or lowering the partial pressure of oxygen will shift the equilibrium 2. With respect to the oxygen-hemoglobin saturation curve: a. Interpret the curve at low and high partial pressures of oxygen. b. List factors that shift the curve down and to the right, and explain how this results in increased oxygen delivery to the tissues. c. List factors that shift the curve up and to the left, and explain how this facilitates oxygen binding to hemoglobin in the lungs. d. Describe the oxygen-fetal hemoglobin saturation curve and its impact on oxygen delivery to fetal tissues. 3. With respect to carbon dioxide transport: a. Describe the ways in which carbon dioxide is transported in blood and discuss the relative importance of each to total carbon dioxide transport. b. Identify the reversible chemical equation for the reaction of carbon dioxide and water to carbonic acid and then to hydrogen ion and bicarbonate ion. c. Explain the relationship between pH and hydrogen ion concentration. d. Predict how changing the partial pressure of carbon dioxide will affect the pH and the concentration bicarbonate ions in the plasma. e. Predict how changing the pH or the concentration of bicarbonate ions will affect the partial pressure of carbon dioxide in the plasma. f. State the reversible chemical equation for carbon dioxide binding to deoxyhemoglobin and predict how changing carbon dioxide concentrations will affect deoxyhemoglobin levels in the tissues and the lungs. g. Explain how each of the following relates to carbon dioxide transport: carbonic anhydrase, hydrogen ions binding to

	hemoglobin and plasma proteins, the chloride ion shift, and the oxygen-hemoglobin saturation level.
7. Control of pulmonary ventilation	1. Describe the locations and functions of the brainstem respiratory system. 2. Identify the major chemical and neural stimuli to the respiratory centers. 3. Compare and contrast the central and peripheral chemoreceptors. 4. Define hyperventilation, hypoventilation, panting, eupnea, hyperpnea and apnea. 5. Explain why it is possible to hold one's breath longer after hyperventilating than after eupnea.
8. Application of homeostatic mechanisms	1. Provide specific examples to demonstrate how the respiratory system responds to maintain homeostasis in the body. 2. Explain how the respiratory system relates to other body systems to maintain homeostasis.
9. Predictions related to homeostatic imbalance, including disease states & disorders	1. Predict factors or situations affecting the respiratory system that could disrupt homeostasis. 2. Predict the types of problems that would occur in the body if the respiratory system could not maintain homeostasis. 3. Identify the consequences of smoking on the respiratory system and on other systems of the body. 4. Predict the consequences of the following pathologies: emphysema, asthma, lung cancer, pulmonary edema, pulmonary fibrosis, and pneumonia.

DIGESTIVE SYSTEM

1. General functions of the digestive system	Describe the major functions of the digestive system.
2. Gross & microscopic anatomy of the alimentary canal	1. With respect to the wall of the alimentary canal: a. Identify, and describe the histological structure and the function of, each of the four layers of the wall – the mucosa, the submucosa, the muscularis externa, and the serosa (visceral peritoneum). b. Describe regional specializations in the histological structure of the alimentary canal and relate these specializations to the functions of the particular organs in which they are located. 2. With respect to the oral cavity: a. Identify the boundaries of the oral cavity.

	b. Identify the hard and soft palates and discuss their functions. c. Describe the structures of the tongue, including taste buds and papillae, and discuss their functions. d. Identify the different types of teeth and discuss their functions. e. Identify dental formulas for both deciduous and permanent teeth. f. Identify the anatomical structures of a tooth. 3. Identify the naso-, oro- and laryngopharynx and classify these regions with respect to passage of food and/or air through them. 4. With respect to the esophagus: a. Describe the structure and discuss the function of the upper esophageal and lower esophageal (cardiac) sphincters. b. Describe the locations of skeletal and smooth muscle within the wall of the esophagus. 5. With respect to the stomach: a. Describe the structure and discuss the function of the cardiac and pyloric sphincters. b. Identify the structure and discuss the function of the cardiac region, the fundus, the body and the pyloric region of the stomach. c. Identify the significance of rugae. d. Discuss the function of the oblique muscle layer of the stomach. e. Identify the structure of a gastric gland including the location of the chief (zymogenic) cells, parietal (oxynic) cells, enteroendocrine cells, and mucous cells, and discuss the functions of these different cell types. 6. With respect to the small intesting: a. Identify the location and discuss the relative length and the functions of the duodenum, jejunum, and ileum. b. Identify and discuss the histology and functions of the plicae circulars, villi, and microvilli. c. Identify Brunner's glands (duodenal glands) in the duodenum and Crypts of Leiberkuhn (intestinal glands) in all portions of the small intestine, and discuss the function of these glands. 7. With respect to the large intestine: a. Describe the structure and discuss the function of the ileocecal valve and the internal and external anal sphincters. b. Identify the location and discuss the functions of the cecum and appendix, the ascending, transverse, descending, and sigmoid colon, the rectum, and the anus. c. Identify and discuss the functions of teniae coli, haustra, and epiploic appendages.
	1. With respect to the salivary glands:

3. Gross & microscopic anatomy of the accessory glands and organs	a. Describe the location of the parotid, submandibular, and sublingual glands and their respective ducts. b. Contrast the histology and the products of the serous cells and the mucous cells. 2. With respect to the liver: a. Identify the individual lobes of the liver. b. Identify the coronary ligament, falciform ligament, and round ligament (ligamentum teres). c. Identify the hepatic artery, hepatic portal vein, and hepatic vein and discuss the function of each of those blood vessels. d. Identify the histological components of a liver lobule (including hepatocytes, hepatic sinusoids, Kupffer cells, bile canaliculi, central vein, and the components of a hepatic triad) and discuss the function of each. e. Identify the hepatic duct, cystic duct, gallbladder, common bile duct, sphincter of the hepatopancreatic ampulla (ampulla of Vater and sphincter of Oddi) and discuss the roles of those structures in the flow of bile. 3. With respect to the pancreas: a. Identify the head, body and tail of the pancreas. b. Identify the pancreatic acini and discuss their functions. c. Identify the pancreatic islets and discuss their functions. d. Identify the pancreatic duct and the hepatopancreatic sphincter and discuss their roles in the flow of pancreatic enzymes.
4. Peritoneum & mesenteries	1. Describe the histology of the visceral and parietal peritoneum. 2. Differentiate between intraperitoneal and retroperitoneal location of digestive structures. 3. Identify the mesentery proper and the mesocolon and explain their function.
5. Motility in the alimentary canal	1. Identify the structures involved in the process of deglutition and explain how they function, including the changes in position of the glottis and larynx that prevent aspiration. 2. Define the terms peristalsis, segmentation, migrating myoelectric complex, and mass movement, and discuss the role that these activities play in the function of various regions of the alimentary canal. 3. Explain how volume, chemical composition, and osmolarity of the chime affect motility in the stomach and in the duodenum. 4. With respect to the processes of defecation: a. Describe the defecation reflex and the function of the internal and external anal sphincters. b. Explain the effect of rectal distension in the defecation reflex. c. Discuss the conscious control of the defecation reflex.

	d. Discuss the specific role of the sympathetic and parasympathetic nervous system in the reflex. e. Explain the Valsalva maneuver and the effects it has on the process of defecation and on the cardiovascular system.
6. Mechanical & chemical processes of digestion	1. With respect to mechanical digestion: a. Define mechanical digestion. b. List the organs and structures of the digestive system that function in mechanical digestion and explain the details of the process for each. 2. With respect to enzymatic hydrolysis: a. Define enzymatic hydrolysis. b. List the organs and structures of the digestive system that function in enzymatic hydrolysis. c. List the enzymes used in enzymatic hydrolysis. d. Discuss the activation of specific enzymes, where applicable. e. List the substrates and products of enzymatic hydrolysis for each enzyme. f. Discuss the mechanisms used to regulate secretion and/or activation of each enzyme. 3. Discuss the function, production, and regulation of secretion of hydrochloric acid (HCl). 4. With respect to the process of emulsification: a. Define emulsification and describe the process. b. List the organs and structures of the digestive system that function in the process of emulsification.
7. Processes of absorption	1. With respect to monosaccharides, peptides and amino acids, and fatty acids and monoglycerides: a. List the organs and specific structures involved in the absorption of each of these types of nutrient. b. Explain the processes involved in absorption of each type of nutrient. 2. Discuss the absorption of fat-soluble and water-soluble vitamins and the absorption of vitamin B_{12}. 3. Discuss the enterohepatic circulation of bile salts.
8. Hormonal & neural regulation of digestive processes	1. List the components of both a short reflex and a long reflex in the digestive system. 2. Discuss regulation of reflexes by the enteric nervous system and the parasympathetic nervous system. 3. Explain the effect of the cephalic phase of regulation on the mucous glands. 4. Explain the effect of the cephalic phase, gastric phase, and intestinal phase on the functions of the stomach and give examples for each phase.

	5. Distinguish between the cephalic phase, gastric phase, and intestinal phase on the functions of the small intestine and give examples for each phase. 6. With respect to the following hormones or paracrine agents – gastrin, cholecystokinin, secretin, glucose-dependent insulinotropic peptide, histamine, somatostatin, and motillin: a. State the organ or structure that produces each hormone or agent. b. State the target organ for each hormone or agent. c. Describe the action of each hormone or agent.
9. Application of homeostatic mechanisms	1. Provide specific examples to demonstrate how the digestive system responds to maintain homeostasis in the body. 2. Explain how the digestive system relates to other body systems to maintain homeostasis.
10. Predictions related to homeostatic imbalance, including disease states & disorders	1. Predict factors or situations affecting the digestive system that could disrupt homeostasis. 2. Predict the types of problems that would occur in the body if the digestive system could not maintain homeostasis. 3. Predict the consequences of the following pathologies: cirrhosis of the liver and liver failure, malabsorption, Crohn's disease, diarrhea, constipation, pancreatitis, and gallbladder disease. Indicate how each pathology would be recognized.

METABOLISM

1. Nutrition	1. With respect to nutrients: a. Define nutrient, essential nutrient and non-essential nutrient. b. List the six main classes of nutrients. c. For carbohydrates, fats, and proteins – list their dietary sources, state their energy yields per gram, and discuss their common uses in the body. d. Classify vitamins as either fat-soluble or water-soluble and discuss the major uses of each vitamin in the body. e. List the important dietary minerals and describe the major uses of each mineral in the body. 2. Describe the components of a balanced diet including the concept of recommended daily amounts. 3. Discuss appetite control, including its regulation by hormones. 4. Explain the significance of nitrogen balance in a healthy diet.
2. Introduction to metabolism	1. Define metabolism, anabolism and catabolism. 2. Provide examples of anabolic and catabolic reactions.

	3. Compare and contrast the roles of enzymes and coenzymes in metabolism. 4. Explain the roles of coenzyme A, NAD, and FAD in metabolism. 5. Describe the processes of oxidation, reduction, decarboxylation, and phosphorylation.
3. Cellular respiration & the catabolism & anabolism of carbohydrates, lipids, & proteins	1. With respect to carbohydrate metabolism: a. State the overall reaction for glucose catabolism. b. Describe the processes of glycolysis, formation of acetyl CoA, the Kreb's (TCA) cycle, and the electron transport chain, including the substrates and products of each, their locations within the cell and the energy yield of each process. c. Describe the process of chemiosmosis and its role in ATP production. d. Describe the anaerobic process for generating ATP, including conditions under which it occurs and its products and their functions. e. Describe the processes of glycogenesis, glycogenolysis, and gluconeogenesis, including the substrates and products of each. f. Describe the role of hormones (such as cortisol, growth hormone, thyroid hormone, insulin, glucagon and norepinephrine) in regulation of carbohydrate catabolism and anabolism. g. Predict the metabolic conditions that would favor each of the following processes: glycogenesis, glycogenolysis and gluconeogenesis. 2. With respect to protein and amino acid metabolism: a. Describe the basic process of protein synthesis. b. Describe the process of deamination and its importance in gluconeogenesis and the interconversion of nutrients. c. Describe the process of transamination in the interconversion of nutrients. d. Explain how protein catabolism leads to ATP production. e. Describe the effect of protein metabolism on ammonia and urea production. f. Describe the role of hormones (such as cortisol, human growth hormone and insulin) in regulation of protein catabolism and anabolism. 3. With respect to fat metabolism: a. Name essential fatty acids and their functions. b. Describe the basic process of lipogenesis and lipolysis. c. Describe the role of hormones (such as cortisol, human growth hormone and thyroid hormone) in regulation of lipogenesis and lypolysis. d. Summarize the overall process of the beta oxidation of fatty acids and explain how it relates to ketogenesis & ketoacidosis. e. Describe the nutrient interconversion pathways that involve fats.

	f. Compare and contrast the structure and function of different types of lipoproteins in the body.
4. Metabolic roles of body organs	1. Describe the role of the liver in metabolism. 2. Explain the role of adipose tissue in metabolism. 3. Describe the role of skeletal muscle in metabolism.
5. Energy balance & thermoregulation	1. Compare and contrast the processes that occur in the absorptive and post-absorptive states. 2. Explain the role of cortisol, human growth hormone, thyroid hormone, insulin and glucagon in the absorptive and post-absorptive states. 3. Explain the significance of glucose-sparing for neural tissue in the post-absorptive state. 4. Define calorie and kilocalorie. 5. Discuss the importance of energy (caloric) balance in maintaining healthy body weight. 6. Define metabolic rate and basal metabolic rate. 7. Describe factors that affect metabolic rate. 8. Explain the importance of thermoregulation in the body.
6. Application of homeostatic mechanisms	1. Provide specific examples to demonstrate how metabolic processes respond to maintain homeostasis in the body. 2. Explain the role of metabolism as it relates to other body systems to maintain homeostasis.
7. Predictions related to homeostatic imbalance, including disease states & disorders	1. Predict factors or situations affecting metabolism that could disrupt homeostasis. 2. Predict the types of problems that would occur in the body if metabolic processes could not maintain homeostasis.

URINARY SYSTEM

1. General functions of the urinary system	Describe the major functions of the urinary system.
2. Gross & microscopic anatomy of the urinary tract, including detailed histology of the nephron	1. With respect to gross anatomy of the urinary tract: a. Describe the external structure of the kidney, including its location, support structures and covering. b. Identify, and describe the structure and location of, the ureters, urinary bladder and urethra. c. Compare and contrast the male and female urethras. d. Identify the major internal divisions and structures of the renal tissue. e. Identify the major blood vessels associated with the kidney. 2. Trace the path of blood through the kidney. 3. With respect to the nephron and collecting system: a. Identify the major structures and subdivisions of the renal corpuscles, renal tubules and renal capillaries. b. Compare and contrast cortical and juxtamedullary nephrons. c. Compare and contrast the structure and function of glomerular and peritubular capillaries. d. Identify the location, structures and cells of the juxtaglomerular apparatus. 4. With respect to the histology of the kidney: a. Describe the histological structure of the proximal convoluted tubule, loop of Henle, distal convoluted tubule, and collecting duct. b. Distinguish histologically between renal cortex and medulla. 5. Trace the path of filtrate/urine from the renal corpuscle to the urethral opening.
3. Functional process of urine formation, including filtration, reabsorption, & secretion	1. List the three major processes in urine formation and where each occurs in the nephron and collecting system. 2. With respect to filtration: a. Describe the structure of the filtration membrane. b. Explain the anatomical features that create high glomerular capillary blood pressure and explain why this blood pressure is significant for urine formation. c. Describe the hydrostatic and colloid osmotic forces that favor and oppose filtration. d. Describe glomerular filtration rate (GFR), state the average value of GFR, and explain how clearance rate can be used to measure GFR. e. Predict specific factors that will increase or decrease GFR. 3. With respect to reabsorption: a. List specific transport mechanisms occurring in different parts of the nephron, including active transport, osmosis,

	facilitated diffusion, passive electrochemical gradients, receptor-mediated endocytosis, and transcytosis. b. List the different membrane proteins of the nephron, including aquaporins, channels, transporters, and ATPase pumps. c. Compare and contrast passive and active tubular reabosorption. d. Describe how and where water, organic compounds, and ions are reabsorbed in the nephron. e. Explain why the differential permeability or impermeability of specific sections of the nephron tubules is necessary for urine formation. f. Explain the role of the loop of Henle, the vasa recta, and the countercurrent multiplication mechanism in the concentration of urine. g. State the percent of filtrate that is normally reabsorbed and explain why the process of reabsorption is so important. 4. With respect to tubular secretion: a. List the location(s) in the nephron where tubular secretion occurs. b. Describe the physiological processes involved in eliminating drugs, wastes and excess ions. 5. Compare and contrast reabsorption and tubular secretion, with respect to direction of solute movement, strength of concentration gradients, and energy required. 6. Explain how the three processes in urine formation determine the rate of excretion of any solute. 7. Compare and contrast blood plasma, glomerular filtrate, and urine and then relate their differences to function of the nephron. 8. Determine the physical and chemical properties of a urine sample and relate these properties to normal urine composition.
4. Factors regulating & altering urine volume & composition, including the rennin-angiotensin system & the roles of aldosterone, antidiuretic hormone, & the natriuretic peptides	1. With respect to autoregulation: a. Describe the myogenic and tubuloglomerular feedback mechanisms and explain how they affect urine volume and composition. b. Describe the function of the juxtaglomerular apparatus. 2. Describe how each of the following functions in the extrinsic control of GFR: renin-angiotensin mechanism, natriuretic peptides, and sympathetic adrenergic activity. 3. Describe how each of the following works to regulate reabsorption and secretion, so as to affect urine volume and composition: renin-angiotensin system, aldosterone, antidiuretic hormone, and natriuretic peptides. 4. Predict specific factors involved in creating dilute versus concentrated urine.

	5. Explain the mechanism of action of diuretics.
5. Additional endocrine activities of the kidney	1. Describe the role of kidney in vitamin D activation. 2. Describe the role of kidney in regulating erythropoiesis.
6. Innervation & control of the urinary bladder	1. Describe the function of the ureters, urinary bladder and urethra. 2. Describe the micturition reflex. 3. Describe voluntary and involuntary neural control of micturition. 4. Relate the anatomy and histology of the bladder to its function.
7. Application of homeostatic mechanisms	1. Provide specific examples to demonstrate how the urinary system responds to maintain homeostasis in the body. 2. Explain how the urinary system relates to other body systems to maintain homeostasis.
8. Predictions related to homeostatic imbalance, including disease states & disorders	1. Predict factors or situations affecting the urinary system that could disrupt homeostasis. 2. Predict the types of problems that would occur in the body if the urinary system could not maintain homeostasis. 3. Predict the effect of the following: chronic kidney failure, acute kidney failure, kidney stones, glomerulonephritis, pyelonephritis, and cystitis.

FLUID/ELECTROLYTES & ACID/BASE BALANCE

1. Regulation of water intake & output	1. Identify and describe the routes of water entry into the body and state representative volumes for each. 2. Identify and describe the routes of water loss from the body and state representative volumes for each. 3. Describe the mechanisms used to regulate water intake. 4. Describe the mechanisms used to regulate water output.
2. Description of the major fluid compartments	Describe the fluid compartments (including the subdivisions of the extracellular fluid) and state the relative volumes of each.

3. Chemical composition of the major compartment fluids	1. Define electrolyte. 2. Compare and contrast the relative concentrations of major electrolytes in intracellular and extracellular fluids. 3. Describe the function(s) of each abundant electrolyte found in body fluids, including sodium, chloride, potassium, phosphate and calcium. 4. Describe hormonal regulation of electrolyte levels in the plasma, including sodium, chloride, potassium, phosphate and calcium.
4. Movement between the major fluid compartments	1. Explain the role of electrolytes and non-electrolytes in the determination of osmotic pressure. 2. Describe the forces that affect capillary filtration, including the determinants of each force. 3. Compare and contrast the roles that osmosis and capillary filtration play in the movement of fluids between compartments. 4. Describe the role of “capillary permeability” in fluid movement across the capillary wall. 5. Explain how dehydration and overhydration (water intoxication) develop and how fluids shift between the three major body compartments during each.
5. Buffer systems & their roles in acid/base balance	1. Define acid, base, pH and buffer. 2. State the normal pH range for arterial blood. 3. With respect to the bicarbonate buffer system, the phosphate buffer system and the protein buffer system: a. State the chemical equation for each buffer system. b. Explain the role of each buffer system in regulation of blood, interstitial fluid, and intracellular pH, including how each system responds to increases or decreases in pH. 4. Explain the role of hemoglobin in pH buffering.
6. Role of the respiratory & urinary systems in acid/base balance	1. State the normal ranges for PCO_2 and HCO_3^- in arterial blood and summarize their relationships to blood pH. 2. Describe the role of the respiratory system in regulation of blood pH and predict how hypo- and hyperventilation will affect blood pH. 3. Explain the mechanisms by which the kidneys secrete hydrogen ions, and how this process affects blood pH. 4. Explain the mechanisms by which the kidneys retain bicarbonate ions, and how this process affects blood pH.

	5. Discuss the concept of compensation to correct respiratory and metabolic acidosis and alkalosis. 6. Given appropriate arterial blood gas values, determine whether a patient has normal blood pH or is in respiratory acidosis or alkalosis or is in metabolic acidosis or alkalosis, and whether the acidosis/alkalosis is partially or fully compensated or uncompensated.
7. Application of homeostatic mechanisms	1. Provide specific examples to demonstrate how the cardiovascular, endocrine, respiratory, and urinary systems respond to maintain homeostasis of electrolyte concentrations and pH of body fluids. 2. Provide specific examples to demonstrate how the cardiovascular, endocrine, respiratory, and urinary systems respond to maintain homeostasis of electrolyte concentrations and pH of body fluids. 3. Explain how fluid volumes and distribution contribute to the maintenance of homeostasis in other body systems. 4. Explain how electrolyte concentrations and body fluid pH contribute to the maintenance of homeostasis in other body systems.
8. Predictions related to homeostatic imbalance, including disease states & disorders	1. Predict factors or situations that would lead to a disruption of homeostasis by affecting the volume or composition of body fluids. 2. Predict factors or situations that would lead to a disruption of homeostasis by causing respiratory acidosis, respiratory alkalosis, metabolic acidosis, or metabolic alkalosis. 3. Predict the types of problems that would occur in the body if the volume and composition of body fluids were not maintained within normal homeostatic ranges. 4. Predict the types of problems that would occur in the body if body fluid pH were not maintained within the normal homeostatic range.

REPRODUCTIVE SYSTEM

1. General functions of the male & female reproductive systems	Describe the major functions of the male and female reproductive systems.
2. Gross & microscopic anatomy of the male & female reproductive systems	1. With respect to the gross anatomy, identify and describe the anatomy of the male and female reproductive system, including the gonads, ducts, accessory glands, associated support structures, and external genitalia. 2. With reference to microscopic anatomy: a. Identify and describe the reproductive and supporting cells of the seminiferous tubules of the testis. b. Identify and describe the different stages of follicular development in the ovary, including the preovulatory follicle and the corpus luteum. c. Identify and describe the histology of the uterine wall.
3. Gametogenesis	1. Contrast the overall processes of mitosis and meiosis. 2. Relate the general stages of meiosis to the specific processes of spermatogenesis and oogenesis. 3. Contrast the process and the final products of spermatogenesis and oogenesis.
4. Specific roles of the female reproductive organs	1. Describe the pathway of the ovum from the ovary to the uterus. 2. Describe the ovarian cycle and relate the events of the ovarian cycle to oogenesis. 3. Describe the events of the uterine cycle. 4. Analyze graphs depicting the typical female monthly sexual cycle and correlate ovarian activity, hormonal changes, and uterine events. 5. Explain why changes in cervical mucus can predict a woman's monthly fertility. 6. Provide examples of how birth control methods relate to normal reproductive function.
5. Specific roles of the male reproductive organs	1. Discuss the relationship between the location of the testes and sperm production. 2. Explain the role of the sustentacular cells and interstitial cells in sperm production. 3. Describe the pathway of sperm from the seminiferous tubules to the external urethral orifice of the penis. 4. Identify and describe the organs involved in semen production.

	5. Discuss the composition of semen and its role in sperm function.
6. Regulation of reproductive system functions	1. State the functions of gonadotropin releasing hormone, follicle stimulating hormone, luteinizing hormone, inhibin, testosterone, estrogen and progesterone. 2. Compare and contrast endocrine regulation of spermatogenesis and oogenesis. 3. Compare and contrast the events and endocrine regulation of female and male puberty. 4. Define secondary sex characteristics and describe their role in reproductive system function. 5. Compare and contrast female and male sexual responses. 6. Define menopause, describe the physiological changes associated with menopause, and explain the fertility changes that precede menopause.
7. Conception, pregnancy, & embryological & fetal development	1. Describe conception, including sperm capacitation, acrosomal reaction, sperm penetration, cortical reaction, and fusion of pronuclei. 2. Define fertilization. 3. Describe the major events of embryonic and fetal development. 4. Describe the formation and function of the placenta and extraembryonic membranes. 5. Describe the hormonal changes during pregnancy and the effect of these hormones. 6. Describe the functional changes in the maternal reproductive, endocrine, cardiovascular, respiratory, digestive, and urinary systems during pregnancy.
8. Parturition & labor	1. Explain the hormonal events that initiate and regulate labor. 2. Describe the three stages of labor.
9. Mammary glands & lactation	1. Describe the structure and the function of the mammary glands. 2. Describe the hormonal regulation of lactation.
10. Application of homeostatic mechanisms	1. Provide specific examples to demonstrate how the reproductive system responds to maintain homeostasis in the body. 2. Explain how the reproductive system relates to other body systems to maintain homeostasis.

11. Predictions related to homeostatic imbalance, including disease states & disorders	1. Predict factors or situations affecting the reproductive system that could disrupt homeostasis. 2. Predict the types of problems that would occur in the body if the reproductive system could not maintain homeostasis.
Homeostasis of the body	
1. Body system interdependence and interaction	Explain how a controlled condition such as electrolyte or glucose levels are maintained from ingestion, absorption, regulation, metabolism and cellular utilization and excretion through the interaction of digestive, circulatory, nervous systems, endocrine, renal systems.
2. Pathophysiology application	Apply the principles of the normal physiology to a disease application for electrolyte or glucose homeostasis