

**A STUDENT STUDY GUIDE  
FOR  
BIOLOGY 2402: ANATOMY AND PHYSIOLOGY II**

**Biology 2402(1724) is a sequel to BIOLOGY 2401(1714): BASIC ANATOMY AND PHYSIOLOGY I with an emphasis on physiology. Designed for students in the Austin Community College Health Science Programs. It is essential to other courses in the Austin Community College Health Science programs.**

Prerequisite: BIOLOGY 2401(1714): BASIC ANATOMY AND PHYSIOLOGY I

**The following is an outline of the core knowledge in BIOLOGY 2402(1724): BASIC ANATOMY AND PHYSIOLOGY II. After completing each chapter you should be able to:**

(Ziser, 2004)

**The Human Body: An Orientation**

1. discuss the hierarchy of structural and functional organization found in living organisms.
2. use and manipulate the metric system.
3. discuss the body organ systems, their functions, and interrelationships
4. describe the homeostatic state (homeostasis) and conditions necessary to maintain it.
5. Recognize and explain the nature and usefulness of feedback mechanism and how these mechanisms act to maintain homeostasis.
6. use negative feedback systems to explain regulation of bodily processes and disease states
7. use positive feedback systems to explain regulation of bodily processes and disease states
8. explain how the scientific method can be used to discover basic principles of physiology.
9. discuss the importance of statistics in scientific experimentation.

**Chemistry Comes Alive**

1. distinguish between matter and energy.
2. define the types of energy - potential and kinetic.
3. describe the forms of energy.
4. identify by name and symbol the principal chemical elements of the human body.
5. distinguish between a compound, mixture, solution, colloid and suspension.
6. describe ionic, covalent and hydrogen bond formation.
7. define and explain the differences between synthesis, decomposition, exchange, and reversible reactions.
8. discuss factors that influence chemical reactions rates.
9. define and distinguish between inorganic and organic compounds.
10. discuss water as a solvent, suspending medium, chemical reactant, heat absorber, and lubricant.
11. list and compare the properties of salts, acids, bases, and buffers.
12. explain what is meant by pH and describe the pH scale.
13. compare the structure and function of carbohydrates, lipids, proteins and nucleic acids and their general roles in physiology.
14. describe in general terms the mechanism by which enzymes catalyze biochemical reactions.
15. describe the effects of pH and temperature on the rate of enzymes catalyzed reactions.
16. describe the role of cofactors and coenzymes in reactions.
17. explain the significance and importance of ATP. How is it produced and how is its energy liberated?

**Cells: The Living Units**

1. list the 3 major regions of a cell and a functional role for each.
2. describe in greater detail the structure of the plasma membrane including its chemical composition, the location of phospholipid, cholesterol, integral proteins
3. describe the functions of the plasma membrane and how its functions are related to its structure.
4. describe & distinguish between passive transport and active transport mechanisms.
5. describe diffusion and explain its physical basis.
6. for simple diffusion compare the rate of transport with molecular radius and lipid solubility.
7. describe other factors that influence the diffusion rate.
8. describe osmosis and osmotic pressure and the conditions required for it to occur.
9. describe isotonic, hypertonic, and hypotonic solutions and explain the response of cells when placed in such solutions.
10. describe facilitated diffusion using glucose as an example.

11. describe the characteristics of active transport systems
12. describe the characteristics of bulk transport including exocytosis and endocytosis (phagocytosis and pinocytosis).
13. compare the permeability of the cell membrane to  $K^+$  with that of  $Na^+$ .
14. discuss the function of the glycocalyx proteins.
15. describe the components of the cytoplasm.
16. for the following cytoplasmic organelles: mitochondria, ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, microfilament, microtubules, centrosomes & centrioles, cilia & flagella
  - a. given the name of the structure, be able to identify its function.
  - b. given a cellular process, be able to identify the structure responsible.
  - c. describe the structure of the named organelle.
  - d. given an electron micrograph, be able to identify the structure.
17. Describe the process of protein synthesis including transcription and translation
18. Describe the different kinds of cell to cell communication
19. What is membrane potential and why is it important
20. define the terms metabolism, anabolism, and catabolism.
21. describe the general characteristics of metabolic pathways and give some examples

### **Bones and Bony Tissue**

1. describe bone development (osteogenesis)
2. discuss the formation of bone with reference to intramembranous and endochondral ossification.
3. discuss the growth of bone with emphasis on the hormones involved.
4. describe bone homeostasis and homeostatic imbalances.
5. discuss the remodeling and repair of bone.

### **Muscles and Muscle Tissue**

1. describe the structure, contractile properties, and control mechanisms of skeletal muscle fiber.
2. describe the structural and functional interrelationships of myosin, actin, tropomyosin, and troponin in a relaxed muscle fiber and during a contraction.
3. describe the role of  $Ca^{++}$  in muscle contraction, including its location, mechanisms of release and return, and site of action during muscle contraction
4. explain the sliding filament theory of contraction.
5. explain the events that occur during cross-bridge cycles and the role of ATP in muscle contraction.
6. describe the structure and function of the neuromuscular junction
7. describe the structure, contractile properties, and control mechanisms of skeletal muscle organs.
8. define a motor unit, explain how motor units vary, and explain how the motor units are used to control muscle contraction.
9. describe and distinguish between twitch, graded responses, summation, tetanus, and treppe.
10. describe a twitch in relation to the phases of physiological activity occurring within the muscle cell.
11. distinguish between isometric and isotonic muscle contraction.
12. explain the adaptations of skeletal muscle to high energy demands (aerobic and anaerobic respiration and the difference between slow and fast twitch fibers.
13. explain the physiological basis of muscle fatigue.
14. describe the factors affecting the force, velocity, and duration of a muscle contraction.
15. explain the adaptations of the three major kinds of skeletal muscle fibers.
16. describe the structure, contractile properties, and control mechanisms of smooth muscle.
17. compare the general structure and function of cardiac muscle cells with striated and smooth muscle cells

### **Fundamentals of the Nervous System and Nervous Tissue**

1. explain the electrical activity in neurons.
2. describe the factors that generate a resting membrane potential
3. describe depolarization, hyperpolarization, and graded potentials.
4. describe the generation of an action potential including the significance of changes in the ionic permeabilities, the time base, after hyperpolarization, relative refractory period, absolute refractory

- period and threshold potential.
5. describe the effect on the resting membrane potential on a nerve cell of changes in the intracellular or extracellular concentrations of  $\text{Na}^+$  or  $\text{K}^+$  and on changes in the membrane permeability for  $\text{Na}^+$  or  $\text{K}^+$ .
  6. describe the effects of stimulus intensity and duration on nerve impulse conduction
  7. distinguish between an action potential and a nerve impulse
  8. describe the factors that affect the conduction velocity of a neuron
  9. describe factors that affect the rate of impulse conduction along an axon.
  10. describe the events between depolarization and the release of the neurotransmitter.
  11. describe synaptic transmission in electrical synapses and chemical synapses
  12. describe the general structure of a synapses including the presynaptic axon, synaptic terminal, synaptic vesicles, synaptic cleft, postsynaptic cell and subsynaptic membrane.
  13. describe how the neurotransmitter stimulates the postsynaptic cell and how the neurotransmitter is activated and inactivated.
  14. compare excitatory and inhibitory synapses including the potentials (EPSP's and IPSP's) they produce.
  15. explain how EPSP's and IPSP's can interact and explain the significance of spatial and temporal summation.
  16. describe the structure and general function of the major kinds of neurotransmitters.
  17. discuss the significance of receptor potentials.
  18. list and describe the 5 components of the reflex arc.
  19. describe a neuronal pool.

### **The Central Nervous System**

1. describe the brain in general terms, outlining the relative positions and general functions of the Cerebrum; white matter (tracts); cerebral nuclei Diencephalon; midbrain; pons; medulla oblongata; Cerebellum;
2. describe the spinal cord in general terms, outlining the relative position and general functions of the Gray matter; Spinal roots; ascending tracts; descending tracts
3. explain lateralization of brain function
4. Localize the limbic system and the reticular formation and explain the role of each functional system
5. Describe the function of the cerebrospinal fluid.
6. List and describe the functional areas of the cerebral cortex and their relation to sensory and motor functions
7. Describe the process of cerebellar processing of motor movements

### **The Peripheral Nervous System and Reflex Activity**

1. define the peripheral nervous system and its components
2. Compare and contrast the motor endings of somatic and autonomic nerve fibers
3. Distinguish between autonomic and somatic reflexes
4. Distinguish between cranial and spinal reflexes
5. Describe the segmental arrangement of peripheral nerves and its relation to skin dermatomes.
6. Describe the components of a reflex arc and its relation to spinal reflexes.
7. Describe how simple reflexes can be used in diagnosis.

### **The Autonomic Nervous System**

1. describe the structure of the sympathetic division of the autonomic nervous system and the general functions of this division.
2. describe the structures of the parasympathetic division of the autonomic system and the general functions of this division.
3. indicate the neurotransmitters of the preganglionic and postganglionic neurons of the sympathetic and parasympathetic systems.
4. explain how the cholinergic receptors are divided into two categories and describe the effects produced by stimulation of these receptors.
5. distinguish between the different kinds of adrenergic receptors, indicate their anatomic locations, and explain the physiological and clinical significance of these receptors.
6. explain the antagonistic, complementary, and cooperative effects of sympathetic and parasympathetic

innervation in different organs.

7. discuss some of the unique roles of the sympathetic division in thermoregulation, Renin release and Metabolic effects
8. describe the control of autonomic activities by reflex centers in the brain.
9. discuss homeostatic imbalances of the ANS

### **Neurotransmitters**

1. What is chemical signaling? List and describe the different categories of chemicals used for chemical signaling
2. How are neurotransmitters produced and how do they affect their target cell on the other side of the synapse
3. Describe a specific example of a stimulatory neurotransmitter and an inhibitory neurotransmitter in the PNS
4. Describe a specific example of a stimulatory neurotransmitter and an inhibitory neurotransmitter in the CNS
5. Describe a specific example of how drugs or toxins directly affect the action of a neurotransmitter in the PNS, in the CNS

### **The Special Senses**

1. Classify sensory receptors according to body location, structure, and stimulus detected
2. Define receptor potential and define adaptation
3. distinguish between a sensation and a perception
4. describe the sensory physiology of taste and olfaction.
5. describe the process of vision including; refraction, accommodation, depth perception, regulation of light and stimulation of the retina
6. explain how visual accommodation is achieved and explain the defects involved in myopia, hyperopia, and astigmatism.
7. compare and contrast the roles of rods and cones in producing a visual image.
8. discuss the way the brain processes visual information.
9. discuss static equilibrium and the function of the maculae.
10. discuss dynamic equilibrium and the function of the crista ampullaris.
11. describe the structures of the cochlea and explain how movements of the stapes against the oval window result in vibration of the basilar membrane.
12. explain how the organ of Corti converts (transduces) mechanical energy into electrical nerve impulses and explain how loudness and pitch perception are accomplished.

### **Neural Integration**

1. describe sensory integration at the receptor, circuit and perceptual levels
2. Be able to describe motor integration at the segmental, projection and program levels
3. Be able to describe examples of higher mental functions including; brain wave patterns, sleep, consciousness, memory, language, emotions and intelligence
4. Discuss the complexity of these brain activities compared to reflex arcs, and simple sensory and motor processing

### **The Endocrine System**

1. Compare and contrast how the nervous and endocrine systems function in coordination and control
2. Explain the similarities in how the nervous and endocrine systems function in coordination and control
3. Describe the general properties of hormones and how they function
  1. describe the different chemical classifications of hormones.
  2. distinguish between the way in which steroid hormones and amino acid derived hormones affect their target cells.
  3. discuss the effects of prostaglandins
  4. describe target cell specificity.
  5. describe the major ways endocrine glands can be "switched on and off".
  6. discuss hormones produced by endocrine organs other than the major endocrine organs.
  7. describe the mechanisms of hormone action and the changes produced by hormonal stimuli on their target cells.

10. explain how the concentrations of a hormone in the blood are regulated and how the effects of a hormone are influenced by its concentration.
11. explain the role of negative feedback in regulating hormone production.
12. discuss how stimuli from endocrine glands can cause hormone release
13. discuss the role of the nervous system in modulating hormone release
14. give specific examples of hormone interactions both as synergists and as antagonists
15. Discuss the major hormonal interactions that help to maintain blood calcium homeostasis
16. Discuss the major hormonal interactions that help to maintain blood sugar homeostasis including noting synergistic and antagonistic actions and their relationship to *Diabetes mellitis*

### **Blood & Hematology**

1. describe the properties of blood; its components, physical characteristics, volume, and functions.
2. describe the structure and the function of the formed elements of blood
3. explain the relationship between the shape of erythrocytes and its function
4. structure of hemoglobin including the number of globins, hemes, and iron atoms
5. describe the process of erythrocyte synthesis, and the role of erythropoietin in the process
6. discuss the body's requirement for iron, folic acid and vitamin B<sub>12</sub> for erythrocytes production
7. describe erythrocyte life span, their destruction, and disorders related directly to erythrocytes
8. name the different places in the body where leukocytes are made,
9. describe leukocytes life spans, their destruction, and disorders and diseases related to them
10. list the 3 major proteins of plasma, outline their function, state their percentage by weight in plasma, and distinguish between plasma and serum.
11. describe hemostasis: the formation and dissolution of a blood clot.
12. discuss the formation of a platelet plug
13. discuss clot retraction and fibrinolysis
14. describe the factors that limit clot formation in hemostasis
15. discuss the disorders of hemostasis
16. compare and contrast the formed elements of blood in terms of numbers, size, life spans and general functions
17. discuss blood transfusion, replacement, and typing.
18. discuss human blood groups and blood typing and transfusion reactions

### **The Cardiovascular System: The Heart**

1. describe the structural and functional properties of cardiac muscle.
2. discuss the microscopic properties of cardiac muscle that make it unique.
3. Describe the energy requirements of cardiac muscle cells
4. explain the mechanism of the origin and spread of the heart beat, including the properties of the pacemaker, conducting tissue, and cardiac muscle.
5. list the cause of the waves seen in the electrocardiogram (ECG).
6. describe how an ECG is taken and some of the common arrhythmias that can be detected.
7. describe the major events of the cardiac cycle including the relationship of the heart sounds, ECG, and pressure pulses to one another.
8. explain the causes of the two heart sounds and causes abnormal heart sounds.
9. describe the relationship between cardiac output, stroke volume, and heart rate.
10. describe the regulation of cardiac output.
11. describe the factors that regulate stroke volume.
12. describe the factors that regulate heart rate, including the visceroreceptors involved

### **The Cardiovascular System: Blood Vessels**

1. state the relationship between blood flow, blood pressure, and resistance.
2. state the effect that the length and radius of a vessel and the viscosity of the fluid have on the resistance of that vessel to fluid flow.
3. describe the structural and physiological differences between arteries and veins.
4. describe the factors which contribute to and regulate systemic blood pressure.
5. describe the factors which regulate the muscle tone of the arterioles and therefore the resistance to fluid flow.
6. describe the factors which regulate the blood volume
7. describe the neural controls which regulate systemic blood pressure
8. describe the chemical controls which regulate systemic blood pressure

9. explain why capillaries are considered the functional units of the circulatory system.
10. describe the structure and permeability properties of the capillary wall.
11. explain the roles of capillary hydrostatic and protein osmotic pressure in regulating the exchange of fluids between plasma and interstitial fluid and between interstitial fluid and intracellular fluid.

### **Nonspecific Defenses and the Immune System**

1. describe the mechanisms of nonspecific immunity.
2. discuss the surface membrane barriers (skin & mucous membranes)
3. discuss the nonspecific cellular and chemical defenses
4. describe phagocytosis as it relates to nonspecific cellular and chemical defenses
5. describe natural killer cells as they relate to nonspecific cellular and chemical defenses
6. describe inflammation as a mechanism of nonspecific immunity, including vasodilation, increased vessel permeability, & phagocyte activity
7. describe the antimicrobial substances as they relate to nonspecific immunity, including complement proteins and interferon &
8. describe fever as it relates to nonspecific immunity
9. describe the mechanisms of specific immunity.
10. define the terms: antigen, antibody, immunocompetence, B-cell, T-cell, & macrophage
11. describe the humoral immune response as it relates to specific immunity
12. contrast and compare active and passive humoral immunity
13. describe the classification and general functions of different classes of immunoglobulin (antibodies or Igs)
14. describe the cell-mediated immune response as it relates to specific immunity
15. Describe the functions of cytotoxic T-cells, helper T-cells, suppressor T-cells, & delayed hypersensitivity T-cells
16. List, describe and give some examples of various clinical applications from our knowledge of immunity

### **The Respiratory System**

1. describe the physical factors that influence pulmonary ventilation including respiratory passageway resistance, lung compliance, elasticity
2. discuss alveolar surface tension and the role of pulmonary surfactant in respiration
3. define the various respiratory volumes and capacities and how each can be used in diagnosis
4. describe how exchange of gases in the alveoli and in the tissues is the result of simple diffusion.
5. discuss the transport of oxygen and carbon dioxide in the blood.
6. describe the relationship between the binding of O<sub>2</sub> to hemoglobin and the role of carbon dioxide and myoglobin in oxygen unloading in the tissues
7. discuss impairments to oxygen transport (Hypoxias & CO poisoning)
8. explain the mechanism by which CO<sub>2</sub> is carried from tissues to the lungs including the role of carbonic anhydrase
9. describe the brainstem controls of pulmonary ventilation
10. explain how O<sub>2</sub>, CO<sub>2</sub>, and H<sup>+</sup> are monitored and how their concentrations affect pulmonary ventilation
11. discuss the effect of exercise on respiration.
12. describe homeostatic imbalances of respiration.

### **Digestive Physiology**

1. describe in general terms the major digestive functions of the organs of the gastrointestinal tract
2. describe the physical and chemical digestive processes that occur in these organs
3. discuss the neural and endocrine controls of digestive secretion
4. Describe the neural and/or hormonal mechanisms of cephalic, gastric, and intestinal phases of the control of gastric secretion.
5. describe the absorption occurring in the stomach
6. describe the chemical digestion occurring in the small intestine including the role of bile, the role of pancreatic juice and the role of intestinal enzymes
7. describe the processes of carbohydrate, lipid, protein and nucleic acid digestion as they occur in the mouth, stomach and duodenum.
8. describe the absorption process as it occurs in the small intestine

9. What kinds of nutrients are absorbed in other parts of the digestive tract

### **Nutrition, Metabolism, and Body Temperature Regulation**

1. explain the dietary source, uses, and dietary requirements for carbohydrates, lipids, proteins, vitamins, and minerals in the diet.
2. list the principal cellular uses of carbohydrates, lipids, proteins, vitamins, and minerals
3. list important sources and functions of vitamins, and the consequences of vitamin deficiencies
4. list the principal minerals essential for health
5. define the terms metabolism, anabolism, and catabolism.
6. describe the three major steps in the metabolism of energy-containing nutrients in the body.
7. discuss the three major steps in the metabolism of carbohydrates
8. describe the major steps in glycolysis and explain its importance
9. describe the major steps in the Krebs cycle and electron transport
10. describe the major steps in the electron transport chain
11. describe glycogenesis, glycogenolysis, and gluconeogenesis
12. describe lipid metabolism.
13. discuss lipogenesis, lipolysis, and ketogenesis
14. describe protein metabolism.
15. describe the dynamic catabolic-anabolic state of the body.
16. discuss the metabolic interconversions of carbohydrates, lipids, and proteins to meet the body's needs
17. describe the features of the absorptive state including the metabolism of fat, carbohydrates, and protein, and describing the role of insulin in the process
18. describe the effects of thyroxine on cell respiration and the relationship between thyroxine levels and the basal metabolic rate
19. describe the metabolic effects of sex hormones
20. describe the metabolic roles of the liver.
21. describe the factors that affect the body's energy input and output.
22. describe the basal metabolic rate (BMR) and the major factors that affect it.
23. describe the mechanism that maintain temperature homeostasis in hot and cold environments

### **Urinary Physiology**

1. describe the processes of urine formation ( glomerular filtration, tubular reabsorption, and tubular secretion)
2. describe the forces which drive glomerular filtration, and the permeability characteristics of the filtration barrier.
3. describe how the glomerular filtration rate is regulated, including the intrinsic controls of renal autoregulation and the extrinsic controls of the sympathetic nervous system
4. describe tubular reabsorption and the substances both actively and passively reabsorbed
5. discuss the fate of nonreabsorbed substances
6. describe the role of aldosterone and ADH in urine formation
7. describe tubular secretion
8. List and describe the normal constituents of urine
9. describe the regulation of urine concentration and volume.
10. define renal clearance and discuss its clinical significance.
11. give specific examples of major abnormal constituents of urine and the problems they might indicate

### **Fluid, Electrolyte, and Acid-Base Balance**

1. describe the water content of the body in terms of fluid compartments
2. discuss the composition of body fluids in each fluid compartment.
3. discuss the movement of body fluids between compartments and the major forces involved.
4. discuss sources and regulation of water exchange including sources and regulation of water intake and the sources and regulation of water output
5. discuss disorders of water balance such as dehydration, hypotonic hydration (water intoxication) and edema
6. define alkalosis and acidosis
7. describe the major chemical buffer systems of the body
8. discuss the respiratory components of acid-base balance and the regulation of  $[H^+]$
9. describe the role of the kidneys in the regulation of acid-base balance

10. describe the mechanism by which  $H^+$  secretion is linked to  $HCO_3^-$  reabsorption
11. distinguish between respiratory alkalosis and respiratory acidosis
12. distinguish between metabolic alkalosis and metabolic acidosis
13. discuss the respiratory and renal compensations of acid-base imbalances

### **Reproductive Physiology**

1. describe the source, actions and regulation of release of gonadotropin releasing hormone (GnRH), leutinizing hormone (LH), and follicle stimulating hormone (FSH) in the male.
2. describe the source, structure, mechanism of action and regulation of release of testosterone
3. describe the actions of testosterone on spermatogenesis, the male reproductive tract, the secondary sexual characteristics (including hair, muscle, larynx, and fat distribution), behavior, and its feedback effects on the anterior pituitary and hypothalamus
4. describe the hormonal regulation of the ovarian cycle.
5. discuss the hormonal events of the ovarian cycle including the changes in plasma concentrations of LH, FSH, estrogen and progesterone
6. describe the chronology of the uterine (menstrual) cycle including the menstrual phase(menses), proliferative phase, and secretory phase.
7. describe the biological actions of estrogens on the body
8. describe the biological actions of progesterone on the body

### **Human Genetics and Heredity**

1. define the words: homologues, alleles, homozygous, heterozygous, dominant, recessive, genotype, and phenotype.
2. describe sources of genetic variation.
3. describe types of inheritance including dominance, recessive traits, incomplete dominance, multiple alleles, sex linked traits and polygenic inheritance
4. describe the techniques available to monitor and test the developing embryo and fetus including amniocentesis and chorionic villi sampling