CHAPTER 17, BLOOD

Overview: Blood Composition and Functions

Components
1. Explain why blood is considered to be a connective tissue.
2. Define the following terms: formed elements, plasma, erythrocytes, leukocytes, platelets, hematocrit, and buffy coat.

Physical Characteristics and Volume
3. Describe the physical characteristics of blood. Include the following in your discussion: color, viscosity, pH, volume (male and female) and temperature.

Functions
4. Describe 3 distributive, 3 regulatory and 2 protective functions of blood.

Blood Plasma
5. Describe the appearance of plasma.
6. Identify the main constituents of plasma, including the solvent and important solutes.
7. Identify the 3 main types of plasma proteins and describe their primary functions.

Formed Elements
8. Name the 3 main classes of formed elements.

Erythrocytes
9. Identify the percentage of whole blood occupied by erythrocytes and the average number found in 1 µL of blood.
10. Identify the function of erythrocytes.
11. Describe the shape of an erythrocyte. Identify the advantages of this shape.
12. Describe the interior of a red blood cell in terms of its nuclear and organellar content. Explain the functional advantage of this situation.
13. Describe the structure of hemoglobin. Describe the role of hemoglobin in oxygen transport. Include the following terms in your discussion: oxyhemoglobin, deoxyhemoglobin, and reduced hemoglobin.
14. Describe the role of hemoglobin in carbon dioxide transport. Include the term carbaminohemoglobin in your discussion.
15. Define hematopoiesis (hemopoiesis). Identify the adult bones where it occurs.
16. Define erythropoiesis. Explain the role erythropoietin (EPO) plays in erythropoiesis. Identify EPO’s site of formation, triggers of formation, site of action, and function.
17. Identify the major organ where erythrocyte destruction takes place. Identify the primary cell involved in the destruction. Describe what happens to the components of a destroyed erythrocyte. Discuss what happens to the globin, heme bilirubin, and iron.

Leukocytes
18. Identify the percentage of whole blood occupied by leukocytes and the average number found in 1 µL of blood.
19. Identify the basic functions and properties of leukocytes.
20. Classify leukocytes as granulocytes and agranulocytes.
21. List the leukocytes in the normal order of abundance (i.e., % of circulating WBCs).
22. Describe the structure and function of the different leukocytes.
23. Define leukopoiesis.

Platelets
24. Describe the structural appearance and basic function of platelets.
25. Identify how many platelets are found in 1 µL of blood.
Hemostasis
26. Define hemostasis and identify its 3 stages.

Vascular Spasm
27. Describe the process of vascular spasm. Include its triggers and its function.

Platelet Plug Formation
28. Describe the formation of a platelet plug. Include its primary trigger and its function.

Coagulation
29. Describe the purpose of coagulation.
30. Describe the final 3 steps in the formation of a blood clot. Include the following in your discussion: prothrombin activator, prothrombin, thrombin, fibrinogen, and fibrin mesh.
31. Identify the 2 pathways that lead to the production of prothrombin activator.
32. Identify the organ involved in the production of most clotting factors. Identify the vitamin necessary for their production.

Fibrinolysis
33. Explain how fibrinolysis occurs. Include the following terms in your discussion: plasmin, plasminogen, and tissue plasminogen activator.

CHAPTER 18, THE CARDIOVASCULAR SYSTEM: THE HEART

Heart Anatomy

Size, Location, and Orientation
1. Describe the shape of the heart. Use the terms apex and base in your discussion.
2. Describe the heart’s position in the mediastinum. Describe the position of the heart relative to the lungs, diaphragm, vertebral column, sternum, and esophagus.

Coverings of the Heart
3. Describe the structure, position, and functions of the fibrous pericardium and serous pericardium.

Layers of the Heart Wall
4. Identify the 3 layers of the heart wall. Describe their primary composition and functions.

Chambers and Associated Great Vessels
5. Identify the 4 heart chambers and describe their relative positions.
6. Describe the structure and function of the atria.
7. Identify the 3 vessels that empty into the right atrium. Identify what body regions they drain and describe their O₂ and CO₂ content.
8. Identify the 4 vessels that empty into the left atrium. Identify the organs they drain and describe their O₂ and CO₂ content.
9. Describe the structure function of the ventricles.

Pathway of Blood through the Heart
10. Define the pulmonary and systemic circuits.
11. Describe the pathway of blood as it completes a round trip through the pulmonary and systemic circuits beginning and ending in the right atrium.
12. Compare the pulmonary and systemic circuits in terms of length, pressure, volume, resistance, arterial gas content, and venous gas content.

Coronary Circulation
13. Define coronary circulation. Describe the location and function of the left and right coronary arteries and coronary sinus.
Heart Valves
14. Identify the 2 atrioventricular valves and describe their function.
15. Describe the structure and function of the chordae tendineae and papillary muscles.
16. Explain how pressure differences between the atria and ventricles are responsible for valve opening and closing.
17. Identify the 2 semilunar valves and describe their function.
18. Explain how pressure differences between the ventricles and the aortic and pulmonary trunks are responsible for valve opening and closing.

Heart Physiology
Electrical Events
19. Identify and describe the heart’s intrinsic cardiac conduction system.
20. Identify 2 ways in which cardiac autorhythmic cells differ from cardiac contractile cells.
21. Identify and locate the 5 groups of autorhythmic cardiac cells.
22. Describe the location of the SA node and explain why it is the pacemaker of the heart.
23. Describe the location of the atrioventricular node.
24. Explain the significance of the delay in impulse conduction at the AV node.
25. Explain the significance of the fact that the AV bundle is the only electrical connection between the atria and the ventricles.
26. Describe the cardioacceleratory center and its effect on the SA node’s depolarization rate.
27. Describe the cardioinhibitory center and its effect on the SA node’s depolarization rate.
28. Explain how the cardioacceleratory and cardioinhibitory centers differ in terms of divisions of the autonomic nervous system and regions of the heart innervated.

Mechanical Events: The Cardiac Cycle
29. Define cardiac cycle, systole and diastole.
30. Identify the 4 major phases of the cardiac cycle.
31. Describe each phase of the cardiac cycle. In your discussion describe what is happening to ventricular volume and pressure, whether the atria are in systole or diastole, whether the ventricles are in systole or diastole, whether the atrioventricular valves are open or closed, whether the semilunar valves are open or closed. Also include in your discussion a comparison of the pressures in the left atrium, left ventricle, and aorta.
32. Define end diastolic volume.
33. Define end systolic volume.

Cardiac Output
34. Define cardiac output and express it as a mathematical equation.
35. Define stroke volume and express it as a mathematical equation.
36. Identify the 2 primary factors that influence end diastolic volume.
37. Identify the 2 primary factors that influence end systolic volume.
38. Define preload and venous return. Explain the relationship between venous return, end diastolic volume, preload, and stroke volume.
39. Define the Frank-Starling law of the heart.
40. Define contractility. Explain the relationship between contractility, end systolic volume, and stroke volume.
41. Define afterload. Explain the relationship between arterial blood pressure, afterload, end systolic volume, and stroke volume.
42. Define heart rate.
43. Describe the effect of the following on heart rate: cardioacceleratory activity, norepinephrine, cardioinhibitory activity, acetylcholine, and epinephrine.

CHAPTER 19, THE CARDIOVASCULAR SYSTEM: BLOOD VESSELS

**Part 1: Overview of Blood Vessel Structure and Function**

1. Identify the 3 major types of blood vessels.

**Structure of Blood Vessel Walls**

2. Identify the 3 tunics typically found in arteries and veins. Describe the structure and function of each.

**Arterial System**

3. Identify the 3 major types of arteries. Describe the structure and function of each.

**Capillaries**

4. Describe the basic structure and function of capillaries.

**Types of Capillaries**

5. Identify the 3 types of capillaries. Describe the structure, locations, and function of each.

**Capillary Beds**

6. Describe capillary beds. Include the following terms in your discussion: true capillaries, vascular shunt, and precapillary sphincters. Identify the triggers for precapillary sphincter contraction and relaxation.

**Venous System**

**Venules**

7. Describe the basic structure of a venule.

**Veins**

8. Describe the basic structure of veins. Compare them with arteries in terms of the following: size and composition of the tunics, elasticity, distensibility, pressure, resistance, valves, and volume.

**Part 2: Physiology of Circulation**

**Introduction to Blood Flow, Blood Pressure, and Resistance**

**Definition of Terms**

9. Define blood flow and blood pressure.
10. Define peripheral resistance and identify its 3 primary sources.
11. Define viscosity. Identify its primary source and its relationship to peripheral resistance.
12. Explain the relationship between total vessel length and peripheral resistance.
13. Explain the relationship between blood vessel diameter and peripheral resistance and explain why vessel diameter is the most important source of resistance.

**Relationship between Flow, Pressure, and Resistance**

14. Explain the relationship between blood flow and BP.
15. Explain the relationship between blood flow and vascular resistance.

**Systemic Blood Pressure**

16. Identify the blood vessel with the highest BP. Explain why its pressure is so high.
17. Identify the BP in the right atrium.

**Arterial Blood Pressure**

18. Define systolic pressure and diastolic pressure and explain why arterial pressure is pulsatile.
19. Explain the relationship between arterial pressure and distance from the heart.
Capillary Blood Pressure
20. Compare capillary BP to arterial BP and explain why low capillary BP is advantageous.

Venous Blood Pressure
21. Compare venous BP to arterial and capillary BP.
22. Explain why venous BP is so low and identify the problem this creates.
23. Explain how venous return is affected by respiratory and skeletal muscle pumps.

Maintaining Blood Pressure
24. Identify the 3 primary factors influencing BP and explain how BP varies with each of them.

Short-Term Mechanisms: Neural Controls
25. Identify the 2 main goals of short term BP regulation.
26. Describe the location and function of the vasomotor center and define vasomotor tone.
27. Describe the location and function of baroreceptors.
28. Describe the baroreceptor reflex response to a high rise in arterial BP. In your explanation, discuss how the following change during the response: vasomotor center activity, vasomotor tone, arterial diameter, peripheral resistance, venous diameter, venous return, cardioacceleratory center activity, cardioinhibitory center activity, heart rate, contractility, stroke volume, and cardiac output.

Short-Term Mechanisms: Hormonal Controls
29. Identify the primary adrenal medulla hormones and discuss their site of production, triggers for release, and effect on blood pressure.

Long-Term Mechanisms: Renal Regulation
30. Discuss how the direct renal mechanism alters blood volume. Include the triggers and the response in your discussion.
31. Describe the renin-angiotensin mechanism. Include the following in your discussion: renin, angiotensin II, aldosterone, and antidiuretic hormone.

Blood Flow Through Body Tissues: Tissue Perfusion
32. Identify several reasons why adequate tissue perfusion is essential.

Velocity of Blood Flow
33. Describe how total cross-sectional area differs in arteries, capillaries, and veins and describe the relationship between blood velocity and total vessel x-sectional area.

Autoregulation: Local Regulation of Blood Flow
34. Define autoregulation and identify several metabolites that act as autoregulatory stimuli and increase tissue blood flow.

Blood Flow through Capillaries and Capillary Dynamics
35. Identify the mechanism that drives the exchange of gases, nutrients, and wastes between blood and interstitial fluid.
36. Identify and describe the 4 forces that affect the bulk flow of fluid between blood and the interstitial fluid.
37. Define net filtration pressure and discuss its significance.
38. Define filtration and reabsorption.

CHAPTER 20, THE LYMPHATIC SYSTEM AND LYMPHOID ORGANS AND TISSUES
1. Identify the 2 basic components of the lymphatic system and give their functions.

**Lymphatic Vessels**
2. Describe the basic function of lymphatic vessels and define lymph.

**Distribution and Structure of Lymphatic Vessels**
3. Identify the 4 basic types of lymphatic vessels.
4. Describe the structure and locations of lymphatic capillaries and how they differ from blood capillaries.
5. Define lacteals and discuss their location and function.
6. Describe the basic structure and function of lymphatic collecting vessels and trunks.
7. Identify the 2 lymphatic ducts and compare their size, location, and function.

**Lymph Transport**
8. Describe the 4 primary mechanisms responsible for lymph flow.

**Lymphoid Cells and Tissues**

**Lymphoid Cells**
9. Identify the 2 main classes of lymphocytes and give their basic functions.
10. Describe the basic function of macrophages, dendritic cells, and reticular cells.

**Lymphoid Tissue**
11. Describe the 2 basic functions of lymphoid tissue.
12. Describe the structure, locations, and functions of diffuse lymphatic tissue and lymphoid follicles.

**Lymph Nodes**
13. Describe the 2 basic functions of lymph nodes.
14. Identify the 3 body regions that contain large clusters of superficial lymph nodes.

**Structure of a Lymph Node**
15. Describe the structure of a lymph node. Include the following terms in your discussion: capsule, trabeculae, hilum, cortex, medulla, medullary cords, and lymph sinuses.

**Circulation in the Lymph Nodes**
16. Describe the flow of lymph through a lymph node. Include the following terms in your discussion: afferent lymphatic vessels, subcapsular sinus, lymph sinuses, and efferent lymphatic vessels.
17. Describe what happens to lymph as it flows through a lymph node.
18. Compare the number of afferent and efferent lymphatic vessels and identify the inherent advantage of the difference.

**Other Lymphoid Organs**
19. Identify the common structural feature to lymphoid organs.

**Spleen**
20. Describe the location and functions of the spleen.
21. Describe the structure of the spleen. Include the following terms in your discussion: capsule, trabeculae, reticular fibers, lymphocytes, white pulp, red pulp, venous sinuses, and splenic cords.

**Thymus**
22. Describe the location, structure and function of the thymus.

**Tonsils**
23. Identify the 3 major tonsils and describe their locations and functions.

**Aggregates of Lymphoid Follicles**
24. Describe the location, structure, and function of Peyer’s patches.
25. Describe the location, structure and functions of the appendix.
26. Define MALT.

CHAPTER 21, THE IMMUNE SYSTEM: INNATE AND ADAPTIVE BODY DEFENSES

1. Define immunity
2. Identify the 2 major branches of the immune system.

Part 1: Innate Defenses

3. Define pathogen and identify the body’s first and second lines of defense against pathogens.

Surface Barriers: Skin and Mucosae

4. Identify the physical characteristics of skin that make it a pathogen barrier.
5. Provide examples of how the mucosae of each of the body’s tracts (digestive, respiratory, urinary, and reproductive) help prevent pathogen entry and limit pathogen growth.

Internal Defenses: Cells and Chemicals

Phagocytes

6. Identify the chief type of phagocyte and the cell from which it derives.
7. Describe the mechanism of phagocytosis. Include the following terms in your discussion: adherence, opsonization, phagosome, lysosome, and lysosomal enzymes.

Natural Killer Cells

8. Describe the basic function of natural killer cells.

Inflammation: Tissue Response to Injury

9. Identify some basic triggers for the inflammatory response.
10. Identify signs of inflammation.
11. Identify several varieties of cells that release inflammatory mediators.
12. Describe how inflammatory mediators affect local vascular resistance, blood flow, and capillary permeability and explain how these changes are beneficial.

Antimicrobial Proteins

13. Describe the basic function of interferons.
14. Describe the basic function of the complement system.

Fever

15. Define fever and pyrogen and identify a benefit of a mild fever.

Part 2: Adaptive Defenses

16. Explain why adaptive immunity is specific systemic, and exhibits memory. Contrast this with innate immunity.
17. Identify the 2 divisions of adaptive immunity and identify each division protects against.

Antigens

18. Define antigen.

Self-Antigens: MHC Proteins

20. Define MHC protein and identify the 2 types of MHC proteins.

Cells of the Adaptive Immune System: An Overview

21. Identify the 3 major cell types of the adaptive immune system.

Lymphocytes

22. Define immunocompetence and explain why it is essential to lymphocyte function.
23. Define self-tolerance and explain why it is essential to lymphocyte function.
24. Describe the receptors on the surface of a single lymphocyte in terms of their abundance and diversity. Explain how this relates to the lymphocyte’s specificity.
25. Explain what is meant by naïve T and B lymphocytes. Identify the typical destinations of naïve T and B lymphocytes.

**Antigen-Presenting Cells**
26. Identify the main function of APCs and identify the 3 primary types of APCs.
27. Correlate the distribution of these cells in the body with their function.
28. Describe the interaction between APCs and T lymphocytes. Identify where such interactions are likely to take place.

**Humoral Immune Response**
29. Define antigen challenge and identify the locations where it occurs.

**Clonal Selection and Differentiation of B Cells**
30. Describe the process of clonal selection. Include the functions of plasma cells and memory cells.

**Immunological Memory**
31. Describe the primary immune response. Indicate the typical lengths of the lag time and be able to graphically relate levels of plasma antibodies with time.
32. Describe the secondary immune response. Indicate the typical lengths of the lag time and be able to graphically relate levels of plasma antibodies with time.

**Active and Passive Humoral Immunity**
33. Define active humoral immunity and differentiate between natural active humoral immunity and artificial active humoral immunity.
34. Define passive humoral immunity and differentiate between natural passive humoral immunity and artificial passive humoral immunity.

**Antibodies**
35. Describe the basic structure and functions of antibodies.
36. Define antigen-antibody complex.
37. Describe how antibodies can neutralize toxins and viruses.
38. Describe how antibodies can cause agglutination and precipitation.
39. Describe how antibodies activate complement and how this can lead to lysis.
40. Describe how antibodies enhance phagocytosis.
41. Describe how antibodies enhance inflammation.

**Cell-Mediated Immune Response**
42. Identify a major limitation of the humoral immune response.
43. Describe the basic function of the cell-mediated immune response.

**Clonal Selection and Differentiation of T Cells**
44. Identify the 2 things that a T cell recognizes as it is activated by an infected cell.
45. Identify the cell types that harbor MHC I proteins on their surface.
46. Identify the variety of T cell that interacts with MHC I proteins.
47. Describe the basic function of MHC I proteins.
48. Explain why a normal body cell will display fragments of self-proteins on its surface MHC I proteins.
49. Define endogenous antigen. Explain why it is important that infected cells will display endogenous antigens on their surface MHC I proteins.
50. Identify the cell types that harbor MHC II proteins on their surface.
51. Identify the variety of T cell that interacts with MHC II proteins.
52. Define exogenous antigen. Explain why it important that APCs display exogenous antigens on their surface MHC II proteins.
53. Identify the 2 basic steps of T cell activation.
54. Describe the process of co-stimulation. Explain why co-stimulation is necessary.
55. Describe what happens to a naïve T cell once it has bound an antigen and received co-stimulatory signals.
56. Describe the long term outlook for effector T cells and memory T cells once the immune response is finished.
57. Define cytokine. Identify some basic functions of cytokines.

**Specific Effector T Cell Roles**
58. Describe the basic function of Helper T cells. Include MHC II proteins, B cells, macrophages, granulocytes, and cytokines in your discussion.
59. Describe the basic function of Cytotoxic T cells. Include the targets of Cytotoxic T cells, MHC I proteins, perforins, granzymes, and apoptosis in your discussion.
60. Contrast how Cytotoxic T cells target foreign/infected cells with the mechanism used by natural killer cells. Include the term immune surveillance in your discussion.
61. Describe the basic function of Regulatory T cells.

**CHAPTER 22, THE RESPIRATORY SYSTEM**
1. Identify the basic function of the respiratory system.
2. Define pulmonary ventilation, external respiration, internal respiration, and cellular respiration.

**Functional Anatomy of the Respiratory System**
3. Identify the 2 major functional zones (including their organs and functions) of the respiratory system.

**The Nose and Paranasal Sinuses**
4. Describe the basic anatomical structure of the nasal cavity and how the respiratory mucosa contributes to the filtration, warming, and humidification of inspired air.
5. Describe the basic structure and function of the 3 pairs of nasal conchae.
6. Describe the locations and functions of the paranasal sinuses.

**The Pharynx**
7. Identify the 3 basic regions of the pharynx and describe their basic structure and function.

**The Larynx**
8. Identify the 3 basic functions of the larynx.
9. Describe the basic anatomical structure of the larynx.
10. Describe the function of the epiglottis and how it differs from other laryngeal cartilages.
11. Identify the basic functions of the vocal folds and the vestibular folds.

**The Trachea**
12. Describe the location, structure, and function of the trachea.

**The Bronchi and Subdivisions**
13. Describe the basic branching pattern of the conducting zone.
14. Describe the how the following change as the conducting zone branches: structural support, epithelium, and relative amount of smooth muscle.
15. Describe the basic branching pattern of the respiratory zone. Include the following terms in your discussion: respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli.
16. Describe the structure and function of the respiratory membrane. Include the following in your discussion: type I alveolar cells, pulmonary capillaries, basement membranes.
17. Identify the location and function of type II alveolar cells.
18. Explain why the bronchial tree is encased in elastic fibers.
19. Describe the function of alveolar macrophages.

**The Lungs and Pleurae**
20. Describe the pleural membranes and their relationship to the lung. Include the following in your description: parietal pleura, visceral pleura, pleural cavity, and pleural fluid.
21. Identify the functions of pleural fluid.

**Mechanics of Breathing**
22. Define pulmonary ventilation, expiration, and inspiration.

**Pressure Relationships in the Thoracic Cavity**
23. Define atmospheric pressure. Identify the normal value of atmospheric pressure (at sea level) in mmHg and in atmosphere units.
24. Define intrapulmonary pressure.
25. Define intrapleural pressure. Identify the relationship between intrapleural and intrapulmonary pressure.
26. Define transpulmonary pressure and explain its significance.

**Pulmonary Ventilation**
27. Put the following in the correct order that they occur during inspiration or expiration: air flow, volume change, pressure change.
28. Describe the relationship between pressure and volume as given by Boyle’s law.
29. Identify the major muscles of quiet inspiration.
30. Describe the action of the diaphragm and external intercostals during inspiration. Discuss the effect their contraction has on thoracic volume, lung volume, and intrapulmonary pressure.
31. Identify the relationship between atmospheric pressure, intrapulmonary pressure, and intrapleural pressure during inspiration.
32. Explain how the sternocleidomastoids, scalenes, pectoralis minor, and erector spinae can contribute to a more vigorous inspiration.
33. Discuss the roles that muscle contraction and elasticity play during quiet expiration.
34. Describe the action of the diaphragm and external intercostals during expiration. Discuss the effect their relaxation has on thoracic volume, lung volume, and intrapulmonary pressure.
35. Identify the relationship between atmospheric pressure, intrapulmonary pressure, and intrapleural pressure during expiration.
36. Explain how the transversus abdominis, external obliques, internal obliques, and internal intercostals can contribute to a more vigorous expiration.

**Physical Factors Influencing Pulmonary Ventilation**
37. Identify 2 reasons why airway resistance is insignificant in normal individuals.
38. Define surface tension and explain why high alveolar surface tension can be problematic.
39. Explain the effect surfactant has on alveolar surface tension.
40. Define lung compliance.
41. Identify the relationship between lung compliance and the ease of inspiration.
42. Identify the relationship between thoracic compliance and the ease of inspiration.

**Gas Exchange Between the Blood, Lungs, and Tissues**
**Basic Properties of Gases**
43. Provide the approximate percentages of atmospheric gas composed of each of the following gases: N₂, O₂, CO₂, and H₂O.
44. Compare the solubility of the following gases: N₂, O₂, and CO₂.

**Composition of Alveolar Gas**
45. Provide the approximate percentages of alveolar gas composed of each of the following gases: N₂, O₂, CO₂, and H₂O.

**External Respiration**
46. Describe the movement of O₂ and CO₂ that occurs during external respiration.
47. Identify the 3 main factors that influence the pulmonary exchange of O₂ and CO₂.
48. Provide the PO₂ values for the pulmonary arteries, alveoli, and pulmonary veins and explain why they differ in these locations.
49. Provide the PCO₂ values for the pulmonary arteries, alveoli, and pulmonary veins and explain why they differ in these locations.
50. Explain how alveolar ventilation and pulmonary perfusion are synchronized.
51. Describe the thickness and total surface area of the respiratory membrane and the effect on pulmonary gas exchange.

**Internal Respiration**
52. Describe the movement of O₂ and CO₂ that occurs during internal respiration.
53. Provide the PO₂ values for the systemic arteries, systemic tissues, and systemic veins and explain why they differ in these locations.
54. Provide the PCO₂ values for the systemic arteries, systemic tissues, and systemic veins and explain why they differ in these locations.

**Transport of Respiratory Gases by Blood**

**Oxygen Transport**
55. Describe the 2 ways that O₂ is carried in the blood. Identify the percentage of O₂ carried in each manner.
56. Define oxyhemoglobin, deoxyhemoglobin, and reduced hemoglobin.
57. Illustrate the loading and unloading of hemoglobin with O₂ in a single equation.
58. Differentiate between saturated and partially saturated hemoglobin.
59. Provide values for hemoglobin saturation in systemic arterial blood and venous blood.
60. Identify the relationship between temperature and hemoglobin’s affinity for O₂.
61. Identify the relationship between pH and hemoglobin’s affinity for O₂.
62. Identify the relationship between PCO₂ and hemoglobin’s affinity for O₂.

**Carbon Dioxide Transport**
63. Describe the 3 ways that CO₂ is carried in the blood. Identify the percentage of CO₂ carried in each manner.
64. Define carbaminohemoglobin and illustrate its formation and dissolution in a single equation.
65. Illustrate the formation of bicarbonate with a single equation.
66. Identify the enzyme that catalyzes bicarbonate formation and the primary site of bicarbonate formation.
67. Describe how CO₂ is “released” from bicarbonate in the pulmonary capillaries.
68. Identify the relationship between plasma PCO₂ and plasma pH.

**Control of Respiration**
Neural Mechanisms
69. Identify the 2 medullary respiratory centers and identify the primary generator of respiratory rhythm.
70. Describe the basic function of the VRG inspiratory neurons and the VRG expiratory neurons.
71. Identify the nerves that excite the diaphragm and external intercostals.
72. Identify the function of the dorsal and pontine respiratory groups.

Factors Influencing Breathing Rate and Depth
73. Define chemoreceptors. Identify the 2 varieties and their locations and functions.
74. Explain how a rise in arterial $P_{CO_2}$ will cause a decrease in CSF pH.
75. Identify the relationship between CSF pH and respiratory rate.
76. Explain why arterial $P_{O_2}$ does not normally have an effect on respiratory rate.
77. Identify the relationship between arterial pH and respiratory rate and provide examples of respiratory and non-respiratory changes in arterial pH.

CHAPTER 23, THE DIGESTIVE SYSTEM
Part 1: Overview of the Digestive System
1. Identify the 2 main divisions of the digestive system.
2. Identify the 6 major organs of the alimentary canal and the 6 accessory digestive organs.

Digestive System Organs: Relationship
Relationship of the Digestive Organs to the Peritoneum
3. Describe the location of the visceral peritoneum and of the parietal peritoneum.
4. Describe the relationship of the 2 peritoneal cavities. Include the position of the peritoneal cavity and function of peritoneal fluid in your discussion.
5. Define mesentery and identify its function.
6. Differentiate between retroperitoneal organs and peritoneal organs.

Histology of the Alimentary Canal
7. Identify the 4 basic layers of the alimentary canal. Describe their basic location, structure, and functions.

Part 2: Functional Anatomy of the Digestive System
The Mouth and Associated Organs
The Mouth
8. Describe the structure, function, and components of the oral/buccal cavity.
The Tongue
9. Describe the structure and functions of the tongue.
The Salivary Glands
10. Identify the major functions of saliva.
11. Identify the location and function of the intrinsic salivary glands.
12. Describe the locations, and functions of the 3 pairs of extrinsic salivary glands.
The Pharynx
13. Identify the 3 regions of the pharynx and identify which are food passageways.
The Esophagus
14. Describe the location, structure and function of the esophagus.
15. Describe the location and function of the cardiac sphincter.

Digestive Processes: Mouth to Esophagus
16. Identify the 3 basic digestive processes that occur in the mouth.
17. Identify the digestive process that occurs in the pharynx and esophagus.
18. Define mastication and deglutition.

**The Stomach**
19. Identify the basic functions of the stomach.
20. Define chyme.
21. Describe the location and structure of the stomach.

**Microscopic Anatomy**
22. Identify the 4 layers of the stomach wall.
23. Explain how the muscularis externa is unique and describe its function.
24. Describe the lining epithelium of the stomach and identify its function.
25. Describe gastric pits and gastric glands and identify the 4 main types of gastric gland cells.
26. Identify the secretory products of gastric glands and describe their function.

**Digestive Processes Occurring in the Stomach**
27. Describe the process of protein digestion that occurs in the stomach.
28. Identify the 3 phases of gastric secretion. Identify which is the most important.
29. Describe the cephalic, gastric, and intestinal phases of gastric secretion.

**The Small Intestine and Associated Structures**

**The Small Intestine**
30. Describe the location, structure, and functions of the small intestine.
31. Identify the 3 major regions of the small intestine.
32. Describe the structure and function of the duodenum, jejunum and ileum.
33. Identify 3 structural features that maximize the surface area of the small intestine.
34. Describe the structure and function of intestinal circular folds.
35. Describe the structure and function of intestinal villi.
36. Describe the structure and function of the intestinal brush border.
37. Describe the structure of the small intestine mucosa.
38. Discuss the composition and functions of intestinal juice.

**The Liver and Gallbladder**
39. Identify the digestive function and non-digestive functions of the liver.
40. Describe the location and structure of the liver.
41. Describe the structure of the liver lobule.
42. Describe the basic composition of bile and explain the function of bile salts.
43. Describe the functions of the gallbladder.

**The Pancreas**
44. Describe the location and gross anatomy of the pancreas.
45. Identify the primary exocrine function of the pancreas.
46. Describe pancreatic acini.
47. Describe the flow of pancreatic juice and enzymes from their site of production to the duodenum.
48. Define pancreatic islets and describe their primary function. Include the functions of the following in your discussion: alpha cells, beta cells, insulin, and glucagon.
49. Describe the composition and function of pancreatic juice.

**Regulation of Bile and Pancreatic Secretion and Entry into the Small Intestine**
50. Identify the stimulus for secretin release and the effect of secretin on bile production.
51. Describe the effect of cholecystokinin on the gallbladder and hepatopancreatic sphincter.
52. Identify the stimulus for cholecystokinin release and discuss how this relates to the function of bile.
53. Describe the effect of cholecystokinin and secretin on the secretion of pancreatic juice. Identify the triggers for the release of cholecystokinin and secretin and discuss how they relate to the function of pancreatic juice.

**Digestive Processes Occurring in the Small Intestine**

54. Briefly describe the chemical digestion that occurs in the small intestine. Include the roles of the pancreas and the brush border in your discussion.
55. Briefly describe the mechanical digestion and propulsion that occurs in the small intestine.
56. Briefly describe the process of nutrient absorption occurring in the small intestine.

**The Large Intestine**

57. Identify the location, structure and primary functions of the large intestine.
58. Discuss how the histology of the large intestine differs from that of the small intestine and how it relates to their respective functions.

**Digestive Processes Occurring in the Large Intestine**

59. Describe the motility of the large intestine.
60. Describe the defecation reflex.

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**CHAPTER 25, THE URINARY SYSTEM**

1. Identify the primary organs of the urinary system.
2. Identify the function of the kidneys.

**Kidney Anatomy**

**Location and External Anatomy**

3. Describe the location, external anatomy and coverings of the kidneys.

**Internal Anatomy**

4. Describe the internal appearance of the kidney as seen in a frontal section.

**Blood and Nerve Supply**

5. Describe the path of blood flow through the kidney. Include the following terms in your discussion: renal artery, segmental artery, interlobar artery, cortical radiate artery, afferent arteriole, glomerulus, efferent arteriole, peritubular capillaries, vasa recta, cortical radiate vein, arcuate vein, interlobar vein, and renal vein.

**Nephrons**

6. Identify the function of a nephron and identify the 5 components of a nephron.
7. Describe the structure of the glomerular capsule and its relationship with the glomerulus.
8. Describe the structure of the proximal convoluted tubule, loop of Henle, and distal convoluted tubule.
9. Describe the relationship between nephrons and collecting ducts.
10. Differentiate between cortical nephrons and juxtamedullary nephrons.
11. Explain how glomerular capillary beds differ from other systemic capillary beds.
12. Explain how high glomerular blood pressure is achieved and why it is important.
13. Describe the location, structure, and function of the peritubular capillaries and vasa recta.
14. Identify the 3 layers of the filtration membrane and state its basic function.

**Kidney Physiology: Mechanisms of Urine Formation**
15. Compare blood plasma, filtrate, and urine.
16. Identify the 3 major processes involved in the formation of urine and the regulation of blood composition.

**Step 1: Glomerular Filtration**
17. Define glomerular filtration and explain why the glomerular capillaries are more efficient at filtration than are other capillary beds.
18. Identify the chief force promoting the movement of fluid and solutes out of the blood and into the capsular space and identify the 2 forces that oppose the movement of fluid and solutes out of the blood and into the capsular space.
19. Define glomerular filtration rate and identify the 3 major factors affecting GFR.
20. Identify the main purpose of the intrinsic mechanisms that regulate GFR.
21. Identify the main purpose of the extrinsic mechanisms that regulate GFR.
22. Explain the myogenic mechanism of renal autoregulation.
23. Explain the tubuloglomerular feedback mechanism of renal autoregulation.
24. Explain how activation of the sympathetic nervous system affects GFR and BP.
25. Explain how the renin-angiotensin mechanism affects GFR and BP.

**Step 2: Tubular Reabsorption**
26. Define tubular reabsorption and explain where it occurs and why it is necessary.
27. Identify the 3 barriers that a reabsorbed substance must pass through as it travels from the filtrate to the blood.
28. Identify some solutes that are normally totally reabsorbed from the filtrate.
29. Describe the mechanism of sodium reabsorption.
30. Explain how the reabsorption of sodium facilitates reabsorption of other solutes.
31. Describe the process of obligatory water reabsorption.
32. Define secondary active transport. Provide an example of a substance reabsorbed in this manner and describe the mechanism.
33. Identify the 3 basic reasons that can preclude substances from being reabsorbed.
34. Explain how aldosterone and parathyroid hormone affect reabsorption in the distal convoluted tubule.
35. Explain how antidiuretic hormone affects water reabsorption in the collecting duct.

**Step 3: Tubular Secretion**
36. Define tubular secretion and identify the major portion of the nephron where it occurs and explain why tubular secretion is necessary.

**Regulation of Urine Concentration and Volume**
37. Define osmolality and explain why it is important to maintain body fluid osmolality.
38. Describe the process of facultative water reabsorption.

**Urine**
**Chemical Composition**
39. Describe the normal chemical composition of urine in terms of solvent, nitrogenous wastes, and other solutes.

**Ureters**
40. Describe the location, structure and function of the ureters.

**Urinary Bladder**
41. Describe the location, structure, and function of the urinary bladder.

**Urethra**
42. Describe the location, structure and functions of the male urethra.
43. Describe the location, structure and functions of the female urethra.

Micturition
44. Define micturition and describe the micturition reflex.

CHAPTER 27, THE REPRODUCTIVE SYSTEM
1. Define gonad and identify the male and female gonads and their basic functions.
2. Define gamete and identify the male and female gametes.

Anatomy of the Male Reproductive System

The Scrotum
3. Describe the location of the scrotum and explain the advantage of this location.

The Testes
4. Describe the location and basic structure of the testes.
5. Identify the function of the seminiferous tubules.
6. Identify the function of the interstitial cells.
7. Describe the unique characteristic and advantage of the vascular supply to the testis.
8. Describe the structure of the spermatic cord.

The Penis
9. Identify the reproductive function of the penis.
10. Describe the gross anatomy of the penis.

The Male Duct System
11. Identify the 4 male reproductive accessory ducts from proximal to distal.
12. Describe the location, structure and function of the epididymides.
13. Describe the location, structure, and function of the ductus deferentia.
14. Identify the 3 portions of the male urethra explain its reproductive function.

Accessory Glands
15. Identify the male reproductive accessory glands.
16. Describe the location, structure, and function of the seminal vesicles.
17. Describe the location, structure, and function of the prostate gland.
18. Describe the location and function of the bulbourethral glands.

Semen
19. Identify the approximate percentage of semen contributed by the testes, seminal vesicles, and prostate gland.
20. Identify the function of semen and give a typical number of sperm in 1 mL of semen.

Physiology of the Male Reproductive System

Male Sexual Response
21. Describe the physiological mechanism of erection.
22. Describe the physiological mechanism of ejaculation.

Spermatogenesis
23. Define spermatogenesis, mitosis, and meiosis.
24. Discuss the difference between diploid cells and haploid cells.
25. Discuss the process of spermatogonium formation.
26. Describe the process of meiosis in males.
27. Explain the process of spermiogenesis and describe the morphological changes that occur as a spermatid becomes a spermatozoon.
28. Describe the role that sustentacular cells play in spermatogenesis.
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Hormonal Regulation of Male Reproductive Function
29. Describe the brain-testicular axis. Include the following terms in your discussion: hypothalamus, gonadotropin-releasing hormone, follicle-stimulating hormone, luteinizing hormone, anterior pituitary gland, sustentacular cells, androgen binding protein, interstitial cells, and testosterone.
30. Describe the feedback mechanism regulating sperm and testosterone production.
31. Describe the somatic effects of testosterone and its influence on male secondary sexual characteristics.

Anatomy of the Female Reproductive System
32. Identify the female principal sex organs and give their 2 primary functions.
33. Identify the organs that constitute the female internal genitalia.

The Ovaries
34. Describe the location, support, structure and function of the ovaries.
35. Describe the basic structure and function of an ovarian follicle and identify and differentiate the 4 basic types of ovarian follicles.
36. Define ovulation and corpus luteum.

The Female Duct System
37. Describe the location, function, and structure of the uterine tubes.
38. Describe the location, function, and structure of the uterus.
39. Describe the location, function, and structure of the vagina.

The External Genitalia and Female Perineum
40. Identify the structures that constitute the vulva.

Physiology of the Female Reproductive System
Oogenesis
41. Define oogenesis and describe its stages, mechanism, and timing.
42. Compare and contrast oogenesis with spermatogenesis.

The Ovarian Cycle
43. Define ovarian cycle and identify its 2 phases.
44. Describe the follicular phase of the ovarian cycle.
45. Describe the act of ovulation. Include its timing and its trigger in your discussion.
46. Describe the luteal phase of the ovarian cycle.

Hormonal Regulation of the Ovarian Cycle
47. Describe the hormonal control of the ovarian cycle. Include the following terms in your discussion: hypothalamus, gonadotropin-releasing hormone, anterior pituitary gland, follicle-stimulating hormone, luteinizing hormone, ovarian follicles, estrogen, corpus luteum, and progesterone.
48. Identify the 3 events triggered by the mid-cycle surge in LH.
49. Describe the fate of the corpus luteum if pregnancy does not occur.
50. Describe the fate of the corpus luteum if pregnancy does occur. Include the role of human chorionic gonadotropin in your discussion.

The Uterine (Menstrual) Cycle
51. Define the uterine cycle and identify its 3 phases.
52. Describe the events and causes of the menstrual phase of the uterine cycle.
53. Describe the events and causes of the proliferative phase of the uterine cycle.
54. Describe the events and causes of the secretory phase of the uterine cycle.