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1. **Nervous Sys. I: Action Potential; Ion Channels; Membrane Potential**
2. **Nervoous Sys. II: Synaptic Potentials and Cellular Integration,; Synaptic Transmission**
3. **Endocrine Sys.: Biochemistry, Secretion and Transport of Hormones; Actions of Hormones**
4. **Muscular Sys.: Neuromuscular Junction; Muscle Metabolism**
5. **CV Sys.: Cardiac Cycle; Measuring Blood Pressure; Cardiac Output**
6. **Immune Sys.: Innate Host Defenses; Humoral Immunity; Cellular Immunity**
7. **Respiratory Sys.: Gas Exchange, Pulmonary Ventilation**
8. **Urinary Sys.: Glomerular Filtration; Early Filtrate Processing; Late Filtrate Processing**
9. **Fluid, Electrolyte, and Acid Base Balance: Body Fluids; Water Homeostasis; Elec. Homeostasis**

The Nervous System: The Action Potential

1. a. The action potential changes the membrane potential from _____ mV (resting) to _____ mV and back again to the resting membrane potential.
   b. This results from a change in membrane permeability first to _____ then to _____ due to the opening of what type of ion channels? _____
2. a. Where is the density of voltage-gated Na^+ channels the greatest?
   b. What areas of the neuron generate signals that open these voltage-gated channels?
   c. Opening of these channels causes the membrane to _____ (voltage change).
3. a. If the membrane reaches the trigger point, known as ___, what electrical potential will be generated?
   b. During the depolarization phase, voltage-gated _____ channels open and ____enters the cell.
4. What are the two processes that stop the potential from rising above +30 mV?
5. a. The opening of voltage-gated K^+ channels cause the membrane to _____.
   b. Does K^+ move into or out of the cell? _____
   c. If the membrane potential becomes more negative than –70 mV, this is called _____.
   d. This potential is caused by what characteristic of K^+ permeability?
6. a. After an action potential, the neuron cannot generate another action potential because _____ channels are inactive. This period is called the _____ period.
   b. During the _____ period, the cell can generate another action potential but only if the membrane is _____ (more or less) depolarized.
7. a. Conduction velocity along the axon is increased by what two characteristics?
   b. Conduction along a myelinated axon is called _____ conduction.
8. a. Name the disease whose symptoms include loss of vision and increasing muscle weakness.
   b. What does this disease destroy?
   c. How does this stop an action potential?

The Nervous System: Ion Channels

1. What structures in the cell membrane function as ion channels?
2. Ion channels are selective for specific ions. What three characteristics of the ions are important for this selectivity?
3. Channels can be classified as either gated or nongated channels. A sodium channel that is always open would be classified as a/an _____channel.
4. Would sodium ions move into or out of the neuron through these channels?
5. Voltage-gated potassium channels open at what voltage? _____ mV
6. Acetylcholine (ACh) and GABA are neurotransmitters that open chemically-gated channels. What ions pass into the cell when these channels are activated?
   a. ACh: _____ ions b. GABA: _____ ions
7. Ion channels are regionally located and functionally unique. List all the areas on the neuron and the type of potential dependent on the following types of ion channels:

Channels	**Areas on the neuron**	**Type of potential**
Nongated		
Chemically-gated		
Voltage-gated		

8. From the quiz, place an "X" by the characteristics of voltage-gated sodium channels.
   _____ Always open _____ Found along the axon
   _____ Important for action potential _____ Opened and closed by gates
   _____ Found on the dendrites and cell bodies _____ Important for resting membrane potential
9. Name two channels (gated or nongated) through which chloride ions could pass into the cell through
10. a. The Japanese puffer fish contains a deadly toxin (tetrodotoxin). What channels does this toxin block?
    b. What potential would this toxin block? _____
    c. What specifically would cause death? _____

The Nervous System: Membrane Potential

1. Record the intracellular and extracellular concentrations of the following ions (mM/L):

	Intracellular	**Extracellular**
Sodium (Na^+)		
Potassium (K^+)		
Chloride (Cl^-)		

2. Excitable cells, like neurons, are more permeable to _____ than to _____.
3. How would the following alterations affect the membrane permeability to K^+? Use arrows to indicate the change in permeability.
   a. An increase in the number of passive K^+ channels _____
   b. Opening of voltage-gated K^+ channels _____
   c. Closing of voltage-gated K^+ channels _____
4. a. What acts as a chemical force that pushes K^+ out of the cell? _____
   b. What force tends to pull K^+ back into the cell? _____
5. When the two forces listed above are equal and opposite in a cell permeable only to K^+, this is called the _____ potential for K^+ which is _____ mV.
6. In an excitable cell, also permeable to Na^+ and Cl^-, the gradients mentioned in question 4 would both tend to move Na^+ _____ the cell.
7. Would the gradients in question 4 promote or oppose the movement of Cl^- into the cell?
8. Since the neuron is permeable to Na^+ as well as K^+, the resting membrane potential is not equal to the equilibrium potential for K^+, instead it is ____ mV.
9. What compensates for the movement (leakage) of Na^+ and K^+ ions? _____
10. What will happen to the resting membrane potential of an excitable cell if: (Write pos or neg to indicate which way the membrane potential would change.)
    a. ↑ extracellular fluid concentration of K^+ _____
    b. ↓ extracellular fluid concentration of K^+ _____
    c. ↑ extracellular fluid concentration of Na^+ _____
    d. ↓ number of passive Na^+ channels _____
    e. open voltage-gated K^+ channels _____
    f. open voltage-gated Na^+ channels _____

The Nervous System II: Synaptic Potentials and Cellular Integration

1. Enhanced postsynaptic potentials are due to increased _____ entering the terminal as a result of ____.
2. Presynaptic inhibition is due to decreased _____ entering the terminal as a result of ___.
3. a. Synaptic potentials are also known as ___ potentials.
   b. They _____ as they travel away from the synapse.
4. a. Increasing the number of action potentials on an axon in a given period of time would cause _____ summation.
   b. Increasing the number of synapses from different neurons would cause ____ summation.
5. The magnitude of the EPSPs may be reduced (thus affecting their ability to generate and their action potential) by adding _____ potentials, or _____s.
6. Inhibitory synapses would have the maximum effect if located where?

7. From the quiz, how many impulses did it take to cause an action potential:
   a. From the axon the furthest away from the cell body? _____
   b. From the axon located on the cell body? _____
8. Pulses from how many neurons were required to stimulate the postsynaptic neuron? _____
9. Compare action potentials and synaptic potentials:

	Action Potential	**Synaptic Potential**
Function		
Depolarization/ hyperpolarizations		
Magnitude		

The Nervous System II: Synaptic Transmission

1. What channels in the presynaptic neuron open up in response to an action potential?
2. The presence of what ion inside the cell causes the synaptic vesicles to fuse with the membrane?
3. a. What is the name for the chemicals stored in the synaptic vesicles?
   b. What do these chemicals diffuse across? _____
   c. Where do these chemicals bind to receptors? _____
4. What type of gated channels do these chemicals open? _____
5. Name two ways these chemicals can be removed from the synaptic cleft.
6. The response on the postsynaptic cell depends on two factors:
7. Name the two types of cholinergic receptors and indicate where these are found.

Type	**Found**
	excitatory: inhibitory:

8. Indicate where the following three adrenergic receptors are found:

$\alpha 1$	
$\beta 1$	
$\beta 2$	

9. Autonomic nerves innervate what three things?
10. The most common excitatory neurotransmitter in the CNS is
11. Two major inhibitory neurotransmitters in the CNS are:
12. Name a drug that alters synaptic transmission in the following ways:
    a. blocks the action of the neurotransmitter at the postsynaptic membrane _____.
    b. blocks the reuptake of the neurotransmitter at the presynaptic membrane _____.
    c. blocks the release of the neurotransmitter _____ and _____.

Endocrine System: Biochemistry, Secretion and Transport of Hormones

1. Place the following hormones into one of the three categories of hormones (peptides, amines or steroids): T_4 (thyroxin), estradiol, norepinephrine, insulin, aldosterone, glucagon, cortisol, growth hormone, T_3 (triiodothyronine), epinephrine, testosterone and vasopressin (ADH).

Peptides	Amines	Steroids

2. Peptide hormones are synthesized as large precursor hormones called _____. The hormones (or prohormones) are stored in _____ _____ and released from the cell by _____. Do peptide hormones require a carrier in the blood stream?
3. Catecholemines are produced in the _____ of the adrenal gland and are classified as _____ hormones since they are derived from _____. Stimulation of the chromaffin cells causes an influx of _____ ions, which causes the vesicles to merge with the plasma membrane and release the hormone by _____. Are catecholemines water-soluble or lipid-soluble?
4. Thyroid hormones include two molecules called _____and ____. T_3 consists of two _____ molecules plus ___ iodine molecules and is (more or less) abundant than T_4. Are carriers required for the transport of thyroid hormones?
5. All steroid hormones are derived from _____, which steroid hormone is produced is determined by the _____ present in the cell. The common precursor molecule for all steroid hormones is _____. Steroid hormones enter the blood stream by _____ and _____ (do or do not) require a carrier. The rate of secretion of steroid hormones is (faster or slower) than catecholemines because steroid hormones are not _____.
6. Preganglionic sympathetic fibers trigger the release of _____ and _____ (hormones) from the _____ _____ (gland), this is an example of neural regulation of hormone secretion.
7. Two examples of hormonal regulation of hormone secretion include: 1) the negative feedback of T_3 & T_4 to decrease _____ levels; and 2) the negative feedback of cortisol which decreases both _____ and _____ levels.
8. Besides increased levels of plasma glucose and amino acids (humoral regulation), increased levels of both _____ (hormone) and the _____ nervous system increase plasma insulin levels.
9. Some hormones are released in rhythmic 24 hour patterns know as _____ rhythms. _____ is a hormone where stressful stimuli can override this pattern and increase the plasma hormone levels. In contrast, _____ hormones (amine hormones) are an example where large amounts of the hormones are bound to carrier proteins in the plasma forming a large circulating reservoir. Thus, acute changes do not produce large changes in the plasma level of this hormone.
10. The _____ and _____ are the major organs that metabolize hormones. The type of hormone determines how fast they are metabolized. _____ and _____ are rapidly metabolized, while _____ and _____ take longer to metabolize.

Endocrine System: The Actions of Hormones on Target Cells

1. The receptor is activated by the input signal that is the _____.
   This signal causes a biochemical change in the cell. Name three of the five possible changes listed
2. Water soluble proteins such as ____ and _____ bind to receptors located where on the cell?
3. G proteins:
   -What is bound to the G protein in the inactive state? _____ In the active state? _____
   -What catalyzes the conversion of ATP to cAMP? _____ _____
   -What is known as the first messenger? _____Second messenger? _____
   -A molecule of cAMP activates _____, which can phosphorylate many proteins.
   -A single molecule of a hormone can have a large effect on the cell due to this process called _____.
   -What is the enzyme that inactivates cAMP? _____
4. Insulin: -Insulin decreases plasma glucose, amino acids and fatty acids by stimulating the conversion of them to their storage form.
   - Name these storage forms.glucose → ____mino acids → ____fatty acids → _____
   - Conversion to the storage form is known as _____ metabolism.
   - After a meal, high levels of glucose, amino acids and fatty acids lead to a/an (decrease or increase) in insulin secretion.

-The autonomic nervous system also regulates insulin secretion. What effects would the sympathetic and parasympathetic system have on insulin secretion?
-Insulin travels in the blood and binds to what type of receptors on the cell membrane? _____
-What is the approximate half-life of insulin? _____
-What hormone increases plasma glucose levels? _____ This hormone breaks down the storage forms and this is known as _____ metabolism.

5. Diabetes: -Type (1 or 2) diabetes is characterized by a resistance of the target cells to insulin. Plasma insulin levels are normal or high. -In type 1 diabetes, the lack of insulin and glycogenolysis in the liver leads to (hypoglycemia or hyperglycemia).- With the increase in filtration of glucose at the kidneys the carriers become ____ and glucose appears in the urine, also known as _____.-Glucose acts as an _____ _____ leading to increased urine flow.-Increased lipolysis produces an increase in _____ _____ which when used as fuel produces ____.- The presence of these in plasma and urine is known respectively as _____ and _____.
6. -Lipid soluble hormones such as _____ and _____ hormone bind to receptors located _____.
-Once the hormone binds to the receptor, the _____ dissociates from the receptor complex.
-The hormone receptor complexes act as _____ _____.
-The receptor-hormone complex then binds to _____.
-The mRNA produces _____ that catalyze biochemical reactions in the cell.
7. Cortisol is classified as a _____ hormone. Name 4 major actions of Cortisol.
These actions are important for the stress response.
8. The main function of thyroid hormones is: _____.
Three other specific functions include:

The Muscular System: Neuromuscular Junction

1. What insulates each muscle cell? _____
2. Synaptic vesicles in the axon terminal of a motor neuron contain what neurotransmitter?
3. An action potential in the axon terminal of a motor neuron opens what type of ion channels?
4. By what means of membrane transport does the neurotransmitter leave the axon terminal?
5. Binding of neurotransmitter to the receptors on the motor endplate open what type of ion channels?
6. Opening of these channels leads to _____ of the motor endplate.
7. How is the neurotransmitter removed from the synaptic cleft?
8. As a result of question 6, an action potential is propagated along the _____ of the muscle cell and down the _____ into the cell.
9. The result of this action potential releases what ion from the terminal cisternae? _____
10. a. What effect did molecule "X" in the quiz have on the muscle contraction?
b. Explain its mechanism of action.
c. What drug did molecule "X" act like? _____
11. a. What effect did molecule "Y" have on the muscle contraction?
b. Explain its mechanism of action.
c. What drug did molecule "Y" act like? _____
12. a. What effect did molecule "Z" have on the muscle contraction?
b. Explain its mechanism of action.
c. What drug did molecule "Z" act like? _____

The Muscular System: Muscle Metabolism

1. List the three roles of ATP in muscle contraction:
2. Potential energy in ATP is released when the high-energy bond is broken by a process called _____.
Write the end products of this process: ATP (+ H_2O) $\rightarrow$ _____
3. Rebuilding ADP into ATP with a new source of energy is carried out by a process called _____.
Write the equation for this process: _____ $\rightarrow$ ATP (+ H_2O)
4. List the three processes used to synthesize additional ATP when ATP supplies are low:
5. An immediate source of energy is _____ (CP), but the supplies are limited and rapidly depleted.
One molecule of CP produces ___ ATP.
6. Glucose is a major source of energy for synthesizing ATP. List the two sources of glucose:
7. _____ is the process that breaks down glucose.

Name two products of the breakdown of glucose: If oxygen is not available, pyruvic acid is converted to ____ acid, which is the end product of _____ respiration.

8. If oxygen is available, the process is known as ____ respiration.
Name two sources of oxygen: The aerobic pathway consists of glycolysis + _____ + _____. The net result of one glucose molecule is ___ ATP.
9. The process of restoring the depleted energy reserves after exercise is called _____.
Name four processes that occur during this time:
10. Put the following characteristics under the correct fiber type:
- Krebs cycle and oxidative phosphorylation
- uses glycolysis
- fatigue rapidly
- high endurance
- few capillaries
- many capillaries
- much myoglobin
- little myoglobin
- long-distance runner
- sprinter
- light in color—large diameter
- red in color—small diameter

Red Slow-Twitch Fibers	White Fast-Twitch Fibers

The Cardiovascular System: Cardiac Cycle

1. Valves open in response to _____ on their two sides.
2. List the chambers/vessels that the four valves connect:

Chamber		**Chamber/Vessel**
	Pulmonary Semilunar	
	Aortic Semilunar	
	Mitral	
	Tricuspid	

3. a. Ventricular filling occurs during _____ ventricular _____.
b. Blood flows through the _____ or _____ valves into the ventricles.
4. During Ventricular Systole, what closes the AV valves?
5. During Ventricular Systole, what opens the semilunar valves?

6. During Isovolumetric Relaxation, what closes the semilunar valves?
7. During Isovolumetric Relaxation, what opens the AV valves?
8. Why is hypertension hard on the heart?
9. Looking at the ventricular volume graph, the stroke volume is approximately how many ml? _____
10. During the four phases listed below, state whether the AV and semilunar valves are opened or closed:

	AV valves	**Semilunar valves**
Ventricular Filling		
Isovolumetric Contraction		

Ventricular Ejection		
Isovolumetric Relaxation		

The Cardiovascular System: Measuring Blood Pressure

1. Blood flow is generated by the _____. Blood pressure results when that flow encounters _____ from the vessel walls.
2. Blood pressure is expressed in _____ of mercury and is written as _____.
3. Blood flows in layers within the lumen of blood vessels with the layers in the middle of the lumen flowing fastest. This is known as _____ flow.
4. Blood pressure fluctuates with each heartbeat. The pulse you feel in your wrist is a _____ created by the contracting heart ejecting blood.
5. The maximum pressure exerted by blood against the artery wall is known as _____ pressure (SP) and is the result of ventricular _____. Normal SP is about _____ mmHg.
6. What does the dicrotic notch represent?
7. _____ pressure (DP) is the lowest pressure in the artery and is a result of ventricular _____. Normal DP is about _____ mmHg.
8. Pulse pressure (PP) is the difference between _____ pressure and _____ pressure. Write the equation for pulse pressure: PP = _____
9. Mean arterial pressure (MAP) is the calculated average pressure in the arteries. It is closer to the diastolic pressure because the heart spends more time in _____. Write the equation for mean arterial pressure: MAP = _____
10. When taking blood pressure, inflate the cuff so that blood flow is _____ in the blood vessel. Open the valve slowly, releasing the pressure. The first sound you hear through the stethoscope is recorded as the _____ pressure. The sounds you hear are due to the _____ of the blood. When you don't hear any sounds, this is recorded as the _____ pressure. For questions 11 and 12, calculate PP and MAP, given SP = 130 mmHg and DP = 70 mmHg (see Quiz section for an example).
11. PP = _____
12. MAP = _____

The Cardiovascular System: Cardiac Output

1. Define Cardiac Output (CO).
2. Write the equation for CO.
3. Define Stroke Volume (SV).
4. Write the equation for SV.
5. Write the normal values (include correct units) for the following:
   a. HR (heart rate) = _____ b. SV (stroke volume) = _____
   c. EDV (end diastolic volume) = _____ d. ESV (end systolic volume) = _____
6. Given the values for HR and SV, calculate cardiac output: CO =
7. Explain how the following factors affect HR, SV, and CO by placing arrows (↑, ↓, or ↔ for no change) under them.

	HR	SV	CO
a. ↑ SNS	____	____	____
b. ↑Venous return	____	____	____
c. Exercise	____	____	____
d. ↑ Calcium	____	____	____
e. ↓ HR	____	____	____

8. Why would stroke volume increase with an increase in the sympathetic nervous system or in calcium?
9. Why would stroke volume increase when heart rate slows down?
10. If stroke volume is 75 ml/beat and heart rate is 80 beats/min, how many of the soda bottles would equal the correct volume (from the quiz)? _____

The Immune System: Innate Host Defenses

1. Name the two major categories of innate (nonspecific) defenses:
2. Surface barriers include the _____ and _____ of the respiratory, gastrointestinal and genitourinary tracts.
3. List the three properties of skin that help it resist invasion:
4. The mucus membranes not only provide a barrier, but they also produce a variety of protective chemicals. For example, the stomach secretes _____ enzymes and has a very _____ pH. The respiratory and digestive tracts are lined with _____ that traps pathogens.
5. Once the surface barrier has been broken, the second line of defense, the innate internal defense system (nonspecific defense system), attempts to limit the spread of pathogens. Name the 5 components of the innate internal defense system:
6. Neutrophils and monocytes/macrophages (monocytes develop into macrophages in the tissue) are the two types of phagocytes discussed. Answer the following questions by circling the correct answer.
   Which phagocyte is most abundant? Neutrophil or Monocyte
   Which phagocytizes more pathogens? Neutrophil or Macrophage
   Which cell is not found in healthy tissue? Neutrophil or Macrophage
7. A phagocyte recognizes and binds to molecules found on pathogens using special membrane receptors, such as the _____ receptor and the _____ (____) receptor.
8. At least 10 different TLRs have been identified on human phagocytes. Two reactions are triggered when TLRs recognize a pathogen:
9. A phagocyte engulfs a pathogen and brings it inside the phagocyte in a vesicle called a _____, which later fuses with a lysosome and is then called a _____.
10. Name three ways the pathogen is destroyed:
11. Many pathogens have evolved strategies to avoid being killed by phagocytes. For example, some bacteria enclose themselves in capsules. _____ is a process of coating bacteria to enhance phagocytosis by a macrophage. Phagocytes have receptors that can attach to opsonins on the bacteria. Two factors can act as opsonins:
12. Certain _____ (from the adaptive defense system) can enhance the killing process within a macrophage. This happens when the macrophage presents antigens from the bacteria to this cell. This is an example of the interaction between the innate and adaptive defense systems.
13. _____ cells are a type of lymphocyte, but, unlike the B and T cells, they are not specific. However, they can still recognize abnormal cells. T cells look for the presence of abnormal antigens on the cell surface, while these cells look for the _____ of normally occurring self-proteins.
14. NK cells kill like _____ T cells; direct contact with a target cell causes it to undergo _____, a form of cellular suicide.
15. Name the two types of antimicrobial proteins:
16. Interferons are cytokines that do the following three things:
17. What causes a cell to secrete interferons? _____
18. The interferons secreted by this cell bind to receptors on nearby cells, causing these nearby cells to produce proteins that _____ by degrading _____ and preventing synthesis of _____.
19. The complement system is a cascade of interdependent proteins which enhance both the innate and adaptive defenses. When activated, these proteins can:
20. Both adaptive and innate defense systems can activate this cascade via several pathways. For example:
    • _____ on cells activate the cascade via the classical pathway.
    • _____ bind to sugars on the surface of bacteria (_____ pathway).
    • A lack of _____ proteins on body cells active the alternative pathway.
21. All three pathways cause activation of the C3 protein, which splits into two fragments, C3b and C3a. What do these fragments do?
    • C3a causes _____. • C3b causes _____.
22. C3b cleaves C5 into two parts:
    • C5a causes _____.
    • C5b combines with other complement proteins to form the ___ (____), which causes the cell to lyse.
23. Name the four cardinal signs of inflammation:
24. The purpose of inflammation is to bring _____ and _____ into an injured area. This action accomplishes three things:
    • Prevents _____ • Disposes of _____

• Sets the stage for _____

25. When tissues are injured, macrophages release chemical mediators, called inflammatory mediators. These chemical mediators cause two key effects:
• _____, which causes redness and heat; _____, which causes swelling and, thus, pain.
26. These chemical mediators activate cell adhesion molecules on endothelial cells. _____ is the process where neutrophils and monocytes bind to these cell adhesion molecules. When neutrophils bind to these molecules, they are activated and leave the blood vessel by a process called ____. Once in the tissue, the neutrophils follow a chemical trail to the site of infection. This process is called ___.
27. The leakiness of the capillaries allows plasma and proteins to leak into the injured area. What three important classes of proteins enter the affected area?
28. In addition to the complement system, other chemicals act as inflammatory mediators:_____
29. Bacterial components and cytokines act as ____, which cause the body's thermostat to set its temperature higher, thus causing a ____. This elevated body temperature helps our defense system because: _____.

The Immune System: Humoral Immunity

1. Antibodies can be found on the plasma membrane of _____ (where they act as antigen receptors) or free in the extracellular fluid, here they are known as _____.
2. Antibodies consist of two types of polypeptide chains:
• Two _____ chains—located on the inside of the Y-shaped molecule
• Two _____ chains—located on the outside of the Y-shaped molecule
The chains are held together by _____ bonds.
3. Each chain has a _____ region which is unique for each antigen and a _____ region which is the same for each antibody in a given class of antibodies.
4. Each arm of the Y-shaped antibody has identical _____ sites. The shape of these sites must match the shape of the _____ on the antigen in order to bind.
5. The <u>stem</u> of the Y-shaped antibody determines how it will interact with other components of the immune system. Complete the following examples given in this topic:
• Whether the antibody remains _____ to the B cell
• Whether it activates the _____ system
• Whether it acts as an _____ to promote phagocytosis
• Whether it can be joined with other antibodies to form a _____ (pair) or _____ (5 antibodies)
• Determines the _____ pattern—how it travels through the body
6. Name the five classes of antibodies, each with a distinct type of stem: _____
7. Complete the list of four contributions of IgG antibodies:
• Constitutes the _____ of circulating antibodies
• Formed in the late _____ and throughout the _____ immune response
• Provides _____ to the fetus
• Can be transferred from one individual to another (example of _____ immunity)
8. Match the characteristics listed below to the correct antibody. Choose either IgM or IgA.
• These antibodies are found in secretions of tears, sweat, and saliva _____
• First antibodies secreted in response to a new antigen _____
• Retained as monomers on the surface of B cells _____
• Found in the mucosa of the gastrointestinal tract _____
• Found in breast milk _____
• Secreted as pentomers _____
9. IgE is produced as a result of the body's infestation with _____. Which white blood cell is important to combat this infestation? _____. List the two key factors in the production of IgE.
10. In modern, industrialized countries, the most common function of IgE is its role in _____ responses. When exposed to an _____ such as pollen, the body makes IgE antibodies.
11. The first exposure to an antigen is called _____. As a result, IgE antibodies are present on _____ and _____. During the second exposure, the allergen causes the release of _____ and other inflammatory mediators.
12. As a result of the actions of the chemical released in question 11, the affected person gets a runny nose (due to _____) and has difficulty breathing (due to _____).
13. _____are drugs that bind and block histamine receptors, thus alleviating the allergy symptoms.
14. Allergic reactions to peanuts can be very serious, causing a systemic allergic reaction known as _____.

15. IgD antibodies are located on the surface of __ cells and act as an antigen receptor. They participate in activating the _____ cell.
16. There are four general ways that antibodies work (to remember: PLAN). Fill in the following:
    • P—act as opsonins to destroy pathogens by _____
    • L—initiate complement activation resulting in _____ of the pathogen
    • A—cause _____, the clumping of molecules, which enhances phagocytosis
    • N—cause _____, which prevents toxins and viruses from interacting with body cells
17. List the 3 key points for B cell activation:
    • B cells respond to _____ antigens.
    • These antigens are concentrated in the _____.
    • B and T cells continually ___ and congregate in the _____ (where the antigens are concentrated).
18. When naïve B cells encounter their specific antigen (usually in the ____ of the lymph node), the antigen is brought into the B cell by _____. The peptide fragments of the antigen are displayed on the surface of the cell bound to _____ proteins.
19. B cells then migrate deeper into the cortex where T cells are found. In most cases, full activation of B cells requires the assistance of ____ cells. These are known as "T cell-___ antigens."
20. If the T cell recognizes the antigenic fragment bound to the ___ protein on the B cell, the T cell binds to the B cell and ___ are released from the T cell. The exchange of signals between the B and T cells is called _____.
21. ____ cells are not needed for certain antigens such as polysaccharides. These antigens are known as "T cell-___ antigens." These are generally (stronger or weaker) responses.
22. When the antigen has selected an appropriate B cell, the B cell will produce effector cells. Some B cells will move deeper into the ____ and begin to secrete __ antibodies, while others move to germinal centers.
23. Name the three events (summarized below) that happen in the germinal centers to the offspring of the original, activated B cell:
    • _____; results in antibodies that are highly selective for the antigen
    • _____; results in the cells producing IgG, IgA or IgE antibodies
    • _____; results in cells becoming plasma cells or memory cells
24. Humoral immunity can be acquired either actively or passively. Define each and give an example of the naturally and artificially acquired forms.
    Active Immunity: _____
        • Naturally acquired: _____
        • Artificially acquired: _____
    Passive Immunity: _____
        • Naturally acquired: _____
        • Artificially acquired: _____

The Immune System: Cellular Immunity

1. Cytokines are small proteins that transfer information within the immune system. List the actions of cytokines given in this Topic:
2. Interleukin-1, a cytokine, acts as a chemical alarm to alert the immune system to the presence of a pathogen. List the three actions given for interleukin-1 in this Topic:
3. Interleukin-2, released by helper T cells, causes proliferation of activated lymphocytes. This process is called:
4. The two major classes of lymphocytes that mediate cellular immunity are based on the presence of surface proteins called _____ proteins. The most common are those with the _____ markers.
5. Below are the two major classes of cells with CD protein markers. List what the cells become and what class of MHC proteins they bind.
    CD4 cells: - most become _____ cells
    but some become _____ cells
    - bind to _____ MHC proteins
    CD8 cells: - all become _____ cells
    - bind to _____ MHC proteins
6. The HIV virus binds to CD4 surface proteins and destroys the _____ cells.
7. The ___ proteins are one major class of self-antigens. Thus, before an organ transplant, the donor's and the recipient's ____ proteins are matched as closely as possible to decrease the chance of organ _____.

8. _____ cells circulate through the body searching for infected or cancerous cells by examining the antigenic determinant on ___ MHC proteins on the cell surface. Fragments of _____, degraded proteins are loaded unto these proteins in the endoplasmic reticulum. If the antigenic peptide is a ____ antigen, the body cell will be destroyed.
9. Unlike class I MHC proteins, which can be displayed on any nucleated cell, class II MHC proteins are only displayed on select cells. Name the antigen-presenting cells that have class II MHC proteins:
These cells communicate with CD4 cells, which will become _____ cells. Antigens presented on class II cells are _____antigens.
10. Class II MHC's are produced in the __ and pick up the exogenous antigens when they fuse with the __.
11. Name two results of presenting the exogenous antigen on class II MHC proteins:
• CD4 cells are converted to helper T cells when _____ cells and ____ present the antigen.
• ___cells and _____ present antigens to helper T cells to request further activation.
12. Dendritic cells are responsible for activating most T cells. Choose an answer for each of the following:
• They can capture antigens found _____ (extracellularly, intracellularly, or both).
• They can activate _____ (CD4, CD8, or both CD4 and CD8) cells.
• They can express _____ (MHC I, MHC II, or both MHC I and MHC II) proteins.
13. Exception: Normally, when cells express endogenous foreign antigens on class I MCH proteins on their cell membrane, they are marked for destruction. This is not true for _____ cells. On these cells the presentation acts as an activation signal for _____ cells.
14. List the two steps necessary for T cell activation:
15. Once T cells are activated they undergo proliferation (called: _____ _____) and differentiation. _____, a type of cytokine, is necessary for the proliferation.
16. Antigen-presenting cells will express co-stimulatory molecules when they have been signaled by the _____defense mechanisms that an infection is present. However, if there is no infection, the antigens on the MHC protein are likely to be ____. Thus, without co-stimulation, the T cells become inactivated, a process called _____.
17. There are two ways to induce a process of self-destruction in a cell, which is called _____: • *Cytotoxic T* cells look for the presence of MHCs with foreign antigens and release ____ and ___or they bind to an ____ _____ receptor (Fas receptor) on the surface of the cell.
• *Natural killer cells* look for the absence of ____ and are thus able to eliminate abnormal cells that cytotoxic T cells cannot detect.
18. Helper T cells are critical for the activation of _____cells and _____ T cells.
19. The helper T cell can help activate the CD8 cell to become a _____ T cell in two ways:
• It stimulates the dendritic cells to express additional _____molecules
• It secretes _____ (including interleukin-2) to help activation
20. T_H1 cells secrete _____ interferons, which increase the effectiveness of _____ and _____ T cells. T_H2 cells secrete interleukins _____ and _____, which promote activation of B cells.
21. Regulatory T cells suppress the activity of other T cells by direct _____ contact or by releasing _____. They are important in helping to prevent _____ diseases.

The Respiratory System: Gas Exchange

1. The atmosphere is a mixture of gases. Write down the percentages for:
a. O_2 _____b. CO_2 _____c. N_2 _____d. H_2O _____
2. Calculate the partial pressures of the following gases at both atmospheric pressures:

	760 mmHg	747 mmHg
a. O_2	_____	_____
b. CO_2	_____	_____
c. N_2	_____	_____
d. H_2O	_____	_____

3. What is the atmospheric pressure on the top of Mt. Whitney? _____
4. Calculate the partial pressure of O_2 on the top of Mt. Whitney. _____mmHg
5. a. Why does more CO_2 than O_2 dissolve in liquid when both gases are at the same pressure?
b. Name the law that explains this. _____
6. Efficient external respiration depends on three main factors - list them.

7. What three factors cause the partial pressures of gases in the alveoli to differ from pressures in the atmosphere?
8. When airflow is restricted so that the partial pressure of O_2 is low and CO_2 is high, what happens to the:
   a. arterioles? _____ b. bronchioles? _____
9. Internal respiration depends on three factors - list them.
10. The planet Pneumo has a total atmospheric pressure of 900 mmHg. Oxygen and carbon dioxide each constitute 30% of the atmosphere.
    a. What is the partial pressure of oxygen on the planet Pneumo? _____
    b. Which gas would be found in the highest concentration in your blood?

The Respiratory System: Pulmonary Ventilation

1. a. The relationship between pressure and volume is known as _____ Law.
   b. Indicate the relationship with arrows below
   1. ↑ volume → ____ pressure 2. ↓ volume → ____ pressure
2. Mark "I" for the muscles that control inspiration and "E" for those which control forceful expiration.
   a. ____ Diaphragm b. ____ Internal intercostals
   c. ____ External oblique and rectus abdominus d. ____ External intercostals
3. Intrapulmonary pressure ____s (↑ or ↓) during inspiration.
4. a. What pressure is always negative and helps to keep the lungs inflated?
   b. It is most negative during _____.
5. a. If transpulmonary pressure equals zero, what will happen to the lungs?
   b. This is known as a _____.
6. a. When the bronchiole constricts, what will happen to resistance? ____ (use arrows)
   b. To airflow? ____ (use arrows)
7. Name two other important factors that play roles in ventilation:

For 8 through 10 fill in *constrict* or *dilate*, then ↑ and ↓ arrows:

8. Histamine will _____ bronchioles → ____ resistance →____ airflow
9. Epinephrine will _____ bronchioles → ____ resistance → ____ airflow
10. Acetylcholine will _____ bronchioles → ____ resistance → ____ airflow
11. Fibrosis will (↑ or ↓) ___ compliance making it _____ to inflate the lungs.
12. A decrease in surfactant will result in a ____ (↑ or ↓) in compliance.

The Urinary System: Glomerular Filtration

1. What force drives filtration at the glomerulus?_____
2. Glomerular filtration is a process of _____driven by the _____ of the blood.
3. Common components of the filtrate are divided into four categories on the CD program. These include: _____
4. Blood pressure in the glomerulus is about _____ mmHg.
5. What two pressures oppose filtration and what are their values?
6. What is the normal net filtration pressure? _____ mmHg
7. With a glomerular filtration rate of 125 ml/min, how much plasma would be filtered per day? _____
8. In an exercising individual the afferent arteriole will <u>dilate</u> or <u>constrict</u> (circle one) to avoid excess fluid loss.
9. Two mechanisms that provide autoregulatory control over renal processes include: _____
10. High osmolarity (or high Na^+ and Cl^-) in the ascending loop of Henle will cause afferent arterioles to <u>dilate</u> or <u>constrict</u> (circle one) by releasing _____.
11. In periods of extreme stress, the sympathetic nervous system will override autoregulation. An increase in sympathetic flow to the kidney will result in what two important effects that will aid maintenance of blood pressure?

The Urinary System: Early Filtrate Processing

1. What are the two reabsorption pathways through the tubular cell barrier?
2. How can we cause water to diffuse from the lumen into the interstitial space?
3. Transport of what ion could cause the diffusion in question 2?
4. Summarize reabsorption in the proximal tubule.
5. What percent of the filtrate is reabsorbed in the proximal tubule? _____%

6. The simple squamous cells of the thin descending loop are permeable to __ but impermeable to ___.
7. The ascending limb of the loop of Henle is permeable to _____ but impermeable to ____.
8. What is the role of the loop of Henle?
9. What is the role of the Vasa Recta?
10. From the quiz section, what does furosemide do?
11. If you increase furosemide, what would happen to the following? (↑ or ↓)
    a. ____ Na^+-K^+-$2Cl^-$ cotransport
    b. ____ Na^+-K^+-$2Cl^-$ retained in tubule
    c. ____ interstitial osmolarity
    d. ____ water reabsorption in descending limb
    e. ____ filtrate and volume flow
    f. ____ urine output
    g. ____ loss of body water and electrolytes

The Urinary System: Late Filtrate Processing

1. Name the two types of cells in the cortical collecting ducts and describe their function.
2. a. Aldosterone is stimulated by an increase or decrease in what ions?1. _____2. _____
   b. What does aldosterone increase in the basolateral membrane?
3. What does antidiuretic hormone (ADH) increase in the luminal membrane?
4. In dehydration and overhydration, what would be the levels of:
   a. ADH? _____ dehydration _____ overhydration (↑ or ↓)
   b. Aldosterone? _____ dehydration _____ overhydration (↑ or ↓)
5. Describe what moves out of the tubule and what the osmolartity would be in the following nephron segments:
   a. Proximal tubule _____ moves out _____ mOsm
   b. Descending limb _____ moves out _____ mOsm
   c. Ascending limb _____ moves out _____ mOsm
   d. Late distal tubule _____ moves out _____ mOsm
6. a. By the medullary collecting duct, only _____% of the filtrate remains.
   b. Under the following conditions, report the levels of ADH and subsequent urine osmolarity and flow rate:

Hydration	ADH	Urine Osmolarity	Urine Volume
Normal			
Dehydration			
Overhydration			

7. a. Urine with a "high normal osmolarity"and containing RBC's and protein indicates: _____
   b. Urine with a very high osmolartiy and glucose would indicate: _____
   c. Urine with a very low osmolarity and high volume would indicate: _____
8. An increase in plasma potassium levels would lead to what changes in the following? (↑ or ↓)
   a. _____ Aldosterone levels
   b. _____ Potassium excretion
   c. _____ Sodium excretion
   d. _____ Interstitial osmolarity
   e. _____ Urine volume

Fluid, Electrolyte, and Acid-Base Balance: Introduction to Body Fluids

1. a. Where are fluids absorbed? _____
   b. Where are excess fluids and electrolytes lost?_____
2. Name four of the six functions of water.
3. a. The amount of water in the body depends on the amount of _____.
   b. From the CD, list the person with the highest and lowest percentage of water and give the percentage.
      1. Highest _____ _____%
      2. Lowest _____ _____%
4. List the three fluid compartments and the percentage of total body water in each.
   a. _____ _____%
   b. _____ _____%
   c. _____ _____%

5. Give an example of each of the following solutes:
   a. Ions/electrolytes _____b. Colloids _____c. Nonelectrolytes _____
6. List the major extracellular and intracellular cations and anions
   a. Extracellular cations: _____ anions: _____
   b. Intracellular cations: _____ anions: _____
7. Within a fluid compartment, the total number of _____ must be equal to the total number of _____.
8. Name four of the seven functions given for electrolytes:
9. Osmosis: When more solute particles are added to one side of a container with a selectively permeable membrane, which way will the water move?
10. What happens to a patient's red blood cells when the following solutions are given:
    a. Hypotonic solution _____
    b. Hypertonic solution _____
    c. Isotonic solution _____

Fluid, Electrolyte, and Acid-Base Balance: Water Homeostasis

1. Below are listed the four examples of disturbances in water homeostasis. Indicate if there is an increase (↑), decrease (↓), or no change (↔) in volume and osmolarity. Give an example of each.

Disturbance	**Volume**	**Osmolarity**	**Example**
Hypervolemia			
Hypovolemia			
Overhydration			
Dehydration			

2. What are the four primary mechanisms to regulate fluid homeostasis?
3. Answer the following questions on antidiuretic hormone (ADH):
   a. What is the major stimulus? _____
   b. What is the direct effect of the hormone? _____
   c. What effect will this have on plasma volume and osmolarity? _____
   d. What effect will this have on urine volume and osmolarity? _____
4. List three ways dehydration leads to increased thirst:
5. Answer the following questions on the Renin-Angiotensin-Aldosterone System.
   a. What enzyme is released from the kidney in response to decreased blood pressure? _____
   b. What enzyme converts angiotensin I to angiotensin II? _____
   c. What are two effects of angiotensin II?
   d. How does aldosterone cause more sodium to be reabsorbed in the kidney?
   e. As a result, what happens to blood volume and blood pressure? _____
6. a. A decrease in blood volume and pressure will lead to a/an ___ in the sympathetic nervous system (SNS).
   b. This will result in a decrease (↓), and increase (↑), or no change (↔) in the following:
      1. Afferent arteriolar constriction
      2. Blood flow to the glomerulus
      3. Urine loss 4. Renin release
7. a. Diabetes insipidus is due to _____.
   b. What will happen to the following: 1. Urine output 2. Plasma sodium 3. Plasma osmolarity 4. Thirst

Fluid, Electrolyte, and Acid-Base Balance: Electrolyte Homeostasis

1. Electrolytes enter the body in the food we eat and the beverages we drink. What is the main way they leave the body?
2. Movement of electrolytes and water between intracellular and interstitial fluid:

Electrolytes move across the cell membrane with (along) their concentration gradient through _____ and against their concentration gradients through _____.
Electrolyte concentrations affect the movement of water between the intracellular and interstitial fluid. Increasing the sodium concentration in the interstitial fluid will cause water to move (into or out of) the cell. This process is called _____.

3. Factors that affect the movement of water between the plasma and the interstitial fluid:
Plasma proteins are too big to move out of the vessel wall; therefore, they would cause water to move (into or out of) the plasma. This is due to the osmotic effect of the proteins, called _____ pressure.
The blood pressure in the vessels force fluid (into or out of) the blood vessels. This force is called _____pressure.

4. The exchange of fluids between the interstitial fluid and plasma is known as _____.
At the arterial end of the capillary, _____ pressure is greater than the _____ pressure and fluid moves (out of or into) the plasma.
At the venous end of the capillary, _____ pressure is greater than the _____ pressure and fluid moves (out of or into) the plasma.

5. Altering the sodium concentration:
An increase in the plasma sodium concentration would cause a/an (decrease or increase) in interstitial sodium concentration, and _____would follow.
An increase in sodium in the interstitial fluid would cause the cells to (swell or shrink).

6. Edema is caused by _____ in the interstitial compartment.
The four causes of edema are:
1. _____ (for example, liver failure)
2. _____ (for example, hypertension)
3. _____ (for example, sprained ankle)
4. _____ (for example, surgical removal of lymph nodes)

7. What ion in the plasma has the most significant effect on the extracellular fluid? _____.
What is the normal concentration of this ion in the plasma? ___ – ___ mEq/L
A decrease in plasma levels of this ion is called _____.
An increase in plasma levels is called _____.

8. What hormone acts in the kidney to reabsorb sodium? _____
What is the major stimulus for the release of this hormone? _____

9. What hormone is necessary for water to be reabsorbed in the kidney? _____

10. An increase in aldosterone will (increase or decrease) plasma levels of potassium.
Some diuretics will cause an (increase or decrease) in plasma levels of potassium.
The normal plasma concentration of potassium is ___ – ___ mEq/L.

11. Hyperkalemia could be due to (acidosis or alkalosis), kidney failure, or increased potassium intake.
Hypokalemia could be due to (acidosis or alkalosis), diuretics, decreased potassium intake, or _____.

12. Normal plasma calcium levels are __ – __ mg/dl. Muscle spasms and tetanus can result from (hypercalcemia or hypocalcemia).

13. Hormone control of plasma calcium levels:_____ lowers plasma calcium levels by inhibiting osteoclasts and stimulating osteoblasts._____ increases plasma calcium levels by increasing osteoclasts in the bone, working through vitamin D and working on calcium reabsorption in the kidney.

14. Mrs. Jones has congestive heart failure, hypertension, and a decreased glomerular filtration rate.
Check the correct answers: (Quiz section)
Edema: ___ no edema or ___ severe edema
Effect on kidneys: ___↓ urine volume or ___↑ urine volume
Cause of the edema: ___ ↓ colloid osmotic pressure or ___ ↑ hydrostatic pressure

15. Currently in the ER, Leonard also has congestive heart failure and is on diuretics. His symptoms include muscle weakness and heart palpitations. What is his diagnosis? _____ (Quiz section)