Below is a table display showing you the eight modules and topics covered in the IP Exercise Sheets, which begin on the next page.

<table>
<thead>
<tr>
<th>Module</th>
<th>Exercise Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Muscular System</td>
<td>Neuromuscular Junction</td>
</tr>
<tr>
<td></td>
<td>Sliding Filament Theory</td>
</tr>
<tr>
<td></td>
<td>Contraction of Whole Muscle</td>
</tr>
<tr>
<td>The Nervous System</td>
<td>Ion Channels</td>
</tr>
<tr>
<td></td>
<td>Membrane Potential</td>
</tr>
<tr>
<td></td>
<td>The Action Potential</td>
</tr>
<tr>
<td>The Nervous System II</td>
<td>Ion Channels</td>
</tr>
<tr>
<td></td>
<td>Synaptic Transmission</td>
</tr>
<tr>
<td></td>
<td>Synaptic Potentials and Cellular Integration</td>
</tr>
<tr>
<td>The Cardiovascular System: The Heart</td>
<td>Intrinsc Conduction System and Cardiac Action Potential</td>
</tr>
<tr>
<td></td>
<td>Cardiac Cycle</td>
</tr>
<tr>
<td></td>
<td>Cardiac Output</td>
</tr>
<tr>
<td>The Cardiovascular System: Blood Vessels</td>
<td>Factors that Affect Blood Pressure</td>
</tr>
<tr>
<td></td>
<td>Blood Pressure Regulation</td>
</tr>
<tr>
<td></td>
<td>Autoregulation and Capillary Dynamics</td>
</tr>
<tr>
<td>The Respiratory System</td>
<td>Pulmonary Ventilation</td>
</tr>
<tr>
<td></td>
<td>Gas Exchange</td>
</tr>
<tr>
<td></td>
<td>Control of Respiration</td>
</tr>
<tr>
<td>The Urinary System</td>
<td>Glomerular Filtration</td>
</tr>
<tr>
<td></td>
<td>Early Filtrate Processing</td>
</tr>
<tr>
<td></td>
<td>Late Filtrate Processing</td>
</tr>
<tr>
<td>Fluid, Electrolyte, and Acid-Base Balance</td>
<td>Introduction to Body Fluids</td>
</tr>
<tr>
<td></td>
<td>Water Homeostasis</td>
</tr>
<tr>
<td></td>
<td>Acid-Base Homeostasis</td>
</tr>
<tr>
<td>The Endocrine System</td>
<td>Endocrine System Review</td>
</tr>
<tr>
<td></td>
<td>Biochemistry, Secretion and Transport of Hormones</td>
</tr>
<tr>
<td></td>
<td>The Actions of Hormones on Target Cells</td>
</tr>
<tr>
<td></td>
<td>The Hypothalamic-Pituitary Axis</td>
</tr>
<tr>
<td></td>
<td>Response to Stress</td>
</tr>
<tr>
<td>The Digestive System</td>
<td>Anatomy Review</td>
</tr>
<tr>
<td></td>
<td>Control of the Digestive System</td>
</tr>
<tr>
<td></td>
<td>Motility</td>
</tr>
<tr>
<td></td>
<td>Secretion</td>
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<tr>
<td></td>
<td>Digestion and Absorption</td>
</tr>
</tbody>
</table>
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 opens 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: Sliding Filament Theory

1. a. The thick filament is composed of what molecule?
   ____________________________

   b. Flexing the head of this molecule provides what is known as the
   ____________________________.

2. The cross bridge (myosin head) contains binding sites for what two molecules?
   a. 

   b. 

3. Three molecules make up the thin filament.
   a. Which molecule has a binding site for myosin cross bridges?
   ____________________________

   b. Which molecule covers this binding site?
   _______________________________________________________

   c. Which molecule has a binding site for calcium ions?
   _______________________________________________________

4. What molecule must bind to the cross bridge in order for it to disconnect with actin?
   ____________________________

5. Hydrolysis of the molecule in question 4 returns the myosin molecule to the
   ____________________________ confirmation.

6. Binding of the cross bridges sequentially prevents _____________________
of the thin filament.

7. Name three roles for ATP in the contraction of muscle.
8. What molecule is connected to the Z line? _________________________

9. Which of the following shorten during contraction? (may be more than one)
   a. Thin filament
   b. Sarcomere
   c. H zone
   d. Thick filament

10. a. What is the name of the condition in which muscles become rigid after death? _________________________________
    b. What is this condition due to?
The Muscular System: Contraction of Whole Muscle

1. Which of the following contract in an all or none fashion?
   a. Whole muscle
   b. Single muscle fiber

2. The development of tension in a muscle, in response to a stimulus above threshold, is called a ________________________________.

3. Identify the three phases of a muscle twitch from the following definitions:
   a. Sarcomeres shorten ________________________________
   b. Sarcomeres return to resting length __________________________
   c. Sarcomeres at resting length ________________________________

4. a. Temporal summation results from:
   b. In temporal summation, you must ______ (↑or↓) the time interval between stimuli.

5. Below is a list of the five phases of temporal summation. Put in the correct order and describe each stage.

<table>
<thead>
<tr>
<th>Order</th>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fatigue</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Incomplete tetanus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treppe</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complete tetanus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temporal summation</td>
<td></td>
</tr>
</tbody>
</table>
6. In the Motor Unit Summation section, how many motor units were required to lift the weights when:

a. the weight was 160? ______________________

b. the weight was 80? ______________________

7. In the next lab simulation, what was:

a. the threshold stimulus? ______ V

b. voltage when recruitment was obvious? ______ V

c. voltage when all motor units were recruited? ______ V

8. a. In the Length-Tension Relationship experiment, at what degree of stretch was the maximum tension developed? _______________________________

b. What would congestive heart failure be an example of?

__________________________________________
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?
   a. 
   b. 
   c. 

3. Channels can be classified as either active or passive 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:

<table>
<thead>
<tr>
<th>Channels</th>
<th>Areas on the neuron</th>
<th>Type of potential</th>
</tr>
</thead>
</table>
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 (active or passive) through which chloride ions could pass into the cell through.

a. 

b. 

c. The Japanese puffer fish contains a deadly toxin (tetrodotoxin). What type of 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):

<table>
<thead>
<tr>
<th>Ion</th>
<th>Intracellular</th>
<th>Extracellular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium (Na+)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium (K+)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride (Cl–)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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?
   a.
   b.

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 opposes 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: 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?

1. ________________________________

2. ________________________________

b. Conduction along a myelinated axon is called

__________________________ conduction.

8. a. Name the disease whose symptoms include loss of vision and increasing muscle weakness: ________________________(from the quiz section)

b. What does this disease destroy? ________________________________

c. How does this stop an action potential?
The Nervous System II: Ion Channels

1. List four neurotransmitters that bind to ion channels, these neurotransmitters are called ___________________________-acting neurotransmitters.

   a. 

   b. 

   c. 

   d. 

2. a. The binding of ACh opens ion channels in the dendrites or cell body that permits both _______ and ____________ to move through them.

   b. Which ion would move into the cell? ______________ out of the cell?

   c. Which ion has the greatest electrochemical gradient? ______________

   d. The net movement of these two ions would do what to the cell?

   ___________________

   e. This would be called an ____________________________ postsynaptic potential, or ____________________.

3. a. An inhibitory postsynaptic potential (IPSP) causes a neuron to

   ____________________.
b. An example of a neurotransmitter that causes an IPSP is ____________.

c. What type of ions move into the cell in response to this neurotransmitter?

______________.

4. a. Norepinephrine binds to a receptor that is separate from the ion channel.

This is known as a/an _______________________ - acting neurotransmitter.

b. Norepinephrine is known as the _________________________ messenger.

c. The receptor is coupled to the ion channel by a _________________.

5. a. This activates an enzyme which induces the production of a

______________ messenger.

b. An intracellular enzyme is activated and ____________________ the ion channel.

c. As a result of this sequence of events, what channels are closed?

____________________

d. What does this do to the neuron? ________________________________

6. Name three neurotransmitters that can only act indirectly.

a. 

b.

b. 

c.

7. Which of the four neurotransmitters mentioned in question 1 can also act indirectly?
8. Which one of the four neurotransmitters mentioned in question 1 can only act directly? ______________________
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.

   a. ________________

   b. ________________

6. The response on the postsynaptic cell depends on two factors:

   a. ________________

   b. ________________
7. Name the two types of cholinergic receptors and indicate where these are found.

<table>
<thead>
<tr>
<th>Type</th>
<th>Found</th>
</tr>
</thead>
<tbody>
<tr>
<td>excitatory</td>
<td>inhibitory:</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Type</th>
<th>Found</th>
</tr>
</thead>
<tbody>
<tr>
<td>α1</td>
<td></td>
</tr>
<tr>
<td>β1</td>
<td></td>
</tr>
<tr>
<td>β2</td>
<td></td>
</tr>
</tbody>
</table>

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:

    a.

    b.

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

______________.
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:

<table>
<thead>
<tr>
<th></th>
<th>Action Potential</th>
<th>Synaptic Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depolarization/ hyperpolarizations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnitude</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Cardiovascular System, The Heart:

Intrinsic Conduction System and Cardiac Action Potential

1. List the functions for the following parts of the intrinsic conduction system:
   
a. SA node ____________________________

   b. AV node ____________________________

   c. AV bundle (bundle of His) ____________________________

   d. Purkinje fibers ____________________________

2. On an ECG, what do the following wave forms reflect?
   
a. P wave ____________________________

   b. QRS complex ____________________________

   c. T wave ____________________________

3. A left bundle branch block would have a wider than normal _____________.

4. How do the waves of depolarization, generated by the autorhythmic cells spread to the muscle cells?

5. Name the three channels essential for generating an action potential. Which way do the ions move? (Circle into or out of)?
   
a. ________________ channels into / out of the cell

   b. ________________ channels into / out of the cell

   c. ________________ channels into / out of the cell
6. The pacemaker potential is due to a __________ efflux of _______ ions compared to a normal influx of _______ ions.

7. Threshold for the SA node is at ______ mV. What channels open causing depolarization? ________________

8. The reversal of membrane potential causes the ______ channels to open causing the ______________ of the membrane.

9. Gap junctions allow what cations to pass into the cardiac contractile cells causing the opening of voltage gated sodium channels?

10. State the voltage-gated channels responsible for the following stages of the action potential in cardiac contractile cells.

    a. Depolarization _____________________________

    b. Plateau _____________________________

    c. Repolarization _____________________________
The Cardiovascular System, The Heart: Cardiac Cycle

1. Valves open in response to ______________________ on their two sides.

2. List the chambers/vessels that the four valves connect:

<table>
<thead>
<tr>
<th>Chamber</th>
<th>Chamber/Vessel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pulmonary Semilunar</td>
</tr>
<tr>
<td></td>
<td>Aortic Semilunar</td>
</tr>
<tr>
<td></td>
<td>Bicuspid</td>
</tr>
<tr>
<td></td>
<td>Tricuspid</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th></th>
<th>AV valves</th>
<th>Semilunar valves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventricular Filling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isovolumetric Contraction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventricular Ejection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isovolumetric Relaxation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Cardiovascular System, The Heart: Cardiac Output

1. Define Cardiac Output (CO).

2. Write the equation for CO.


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.
<table>
<thead>
<tr>
<th>HR</th>
<th>SV</th>
<th>CO</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ↑ SNS</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>b. ↑ Venous return</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>c. Exercise</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>d. ↑ Calcium</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>e. ↓ HR</td>
<td>___</td>
<td>___</td>
</tr>
</tbody>
</table>

8. Why would stroke volume increase with an increase in the sympathetic nervous system or an increase 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 Cardiovascular System, Blood Vessels: Factors That Affect Blood Pressure

1. What are the three main factors that influence total peripheral resistance (TPR)?
   a. 
   b. 
   c. 

2. Name three hormones that act as vasoconstrictors.
   a. 
   b. 
   c. 

3. Name two hormones that directly increase blood volume.
   a. 
   b. 

4. Track the effect on blood pressure by reducing venous return. Go through all the steps.
   \[ \downarrow \text{VR} \rightarrow \]

5. Categorize the following into:
   A. Factors which increase blood pressure
   B. Factors that decrease blood pressure
Use arrows in the spaces for questions 6 through 10.

6. A ↓ in hematocrit will result in ____ blood viscosity and ____ blood pressure.

7. An ↑ in fatty tissue will result in _____ total vessel length and an ___ blood pressure.

8. Arteriosclerosis will result in ____ vessel elasticity and an _____ blood pressure.

9. Excessive sweating will result in a short term ____ in blood volume

and a ____ in blood pressure.

10. An ↑ in epinephrine will result in ____ vessel diameter and an ____ in blood pressure.
The Cardiovascular System, Blood Vessels: Blood Pressure Regulation

1. a. Short term mechanisms for regulating blood pressure include regulating what three things?
   1.
   2.
   3.

   b. Long term mechanisms will regulate ________________________________.

2. Two major arterial baroreceptors are located where?
   a.
   b.

3. Using up and down arrows, show the effect of increased blood pressure (BP) on the impulses sent to the brain, the effect on the parasympathetic (PNS) and sympathetic (SNS) nervous systems and the resulting change in blood pressure.

   \[ \uparrow \text{BP} \rightarrow \text{_____ impulses} \rightarrow \text{_____ PNS and _____ SNS} \rightarrow \text{_____ BP} \]

4. As a result of these changes in the PNS and SNS, list two effects on the heart and one on blood vessels.

   Heart:

   Blood vessels:

5. Similar to question 3, show the effect of decreasing blood pressure.
\[ \uparrow \text{BP} \rightarrow \text{_____ impulses} \rightarrow \text{_____ PNS and _____ SNS} \rightarrow \text{_____ BP} \]

6. In addition to effects on the heart and blood vessels, what hormones were released from the adrenal gland? _________________________________

and _________________________________

7. a. What cells in the kidney monitor low blood pressure? _________________

b. What enzyme is released as a result of low blood pressure? _________________

c. What does this enzyme act on in the blood? _________________

8. Name two effects of Angiotensin II.

   a. ________________________________

   b. ________________________________

9. a. The main effect of aldosterone is: ________________________________

   b. How does this increase blood volume? ________________________________

10. a. What other hormone will increase water reabsorption from the kidney?

    ________________________________

   b. What is the major stimulus for this hormone? ________________________________
The Cardiovascular System, Blood Vessels:
Autoregulation and Capillary Dynamics

1. a. What regulates the flow of blood into true capillaries? ________________
   
b. If all sphincters are closed, blood is ___________ to the venules through
   ___________ capillaries.

2. Use arrows to show whether high or low levels of the following would cause the feeder arterioles to
dilate and the sphincters to relax:
   
a. O2 ________ c. pH ________
   
b. CO2 ________ d. nutrients ________

3. Physical factors also act as regulatory stimuli. How would the following affect arterioles?
   
a. Decreased blood pressure ____________________
   
b. Increased blood pressure ____________________

4. Name three structural characteristics of capillaries which allow for passage of materials out of the
capillaries.
   
a.
   
b.
   
c.

5. a. Diffusion accounts for the passage of _____________________.
   
b. Non-lipid soluble molecules move by _____________________.
   
c. Water-soluble solutes, such as amino acids and sugars, move through
6. Bulk fluid flows cause _____________ at the arterial end and
_______________ at the venous end of the capillary.

7. a. In a capillary, what is equivalent to hydrostatic pressure?

b. Why is hydrostatic pressure low in the interstitial fluid?

c. Net hydrostatic pressure tends to move fluid ______ the capillary.

8. a. Osmotic (or Colloid Osmotic) pressure in the capillaries is _______________ compared to
the interstitium.

b. Net osmotic pressure tends to move fluid _________ the capillaries.

9. Given a net hydrostatic pressure of 34 mmHg and a net osmotic pressure
of 22 mmHg, the force favoring filtration would equal _____ mmHg.

10. Indicate which of the following which move through the capillary walls by diffusion and which move
through fenestrations and/or clefts:

   a. Butter:

   b. Fish:

   c. Cola:

   d. Potatoes:
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 the muscles 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?

    __________________________ pressure

   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?
b. To airflow? ____ (use arrows)

7. Name two other important factors that play roles in ventilation:
   a. 
   b. 

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 Respiratory System: Gas Exchange

1. The atmosphere is a mixture of gases. Write down the percentages for:
   a. $\text{O}_2$ ___________
   b. $\text{CO}_2$ ___________
   c. $\text{N}_2$ ___________
   d. $\text{H}_2\text{O}$ ___________

2. Calculate the partial pressures of the following gases at both atmospheric pressures:

   \[
   \begin{array}{cc}
   760 \text{ mmHg} & 747 \text{ mmHg} \\
   \end{array}
   \]

   a. $\text{O}_2$ ___________ ___________
   b. $\text{CO}_2$ ___________ ___________
   c. $\text{N}_2$ ___________ ___________
   d. $\text{H}_2\text{O}$ ___________ ___________

3. What is the atmospheric pressure on the top of Mt. Whitney? ___________

4. Calculate the partial pressure of $\text{O}_2$ 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?
   a. 
   b. 
   c. 

8. When airflow is restricted so that the partial pressure of O\textsubscript{2} is low and CO\textsubscript{2} is high, what happens to the:
   a. arterioles? ________________
   b. bronchioles? ________________

9. Internal respiration depends on three factors - list them.
   a. 
   b. 
   c. 

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: Control of Respiration

1. a. Where is the inspiratory center located in the medulla? _______________

   b. Where is the expiratory center located in the medulla? _______________

2. What modifies these medullary centers?
   a. 
   b. 

3. What is the most important stimulus controlling ventilation? ___________

4. What ion directly stimulates the central chemoreceptors? _____________

5. Arterial Po2 must drop below what to stimulate the peripheral chemoreceptors? ___________

6. If a person hyperventilates what will happen to the following in the blood?
   a. Pco2 _____________
   b. pH _____________

7. If a person hypoventilates what will happen to the following in the blood?
   a. Po2 _____________
   b. Pco2 _____________

8. a. What does lung hyperinflation stimulate? _________________________

   b. The effect on inspiration is _________________________.

   c. What is this reflex called? _________________________
9. Dust, smoke, and noxious fumes will stimulate receptors in airways.
   
   a. Name the receptors. _________________________
   
   b. Explain the protective reflexes.

10. Name four of the six factors that probably increase ventilation during exercise.
   
   a. 
   
   b. 
   
   c. 
   
   d.
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:
   a.
   b.
   c.
   d.

4. Blood pressure in the glomerulus is about _____ mmHg.

5. What two pressures oppose filtration and what are their values?
   a.
   b.

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? _____ in 24 hours

8. In an exercising individual the afferent arteriole will dilate or constrict (circle one) to avoid excess fluid loss.

9. Two mechanisms that provide autoregulatory control over renal processes include:
   a.
   b.

10. High osmolarity (or high Na\(^+\) and Cl\(^-\)) in the ascending loop of Henle will cause afferent arterioles to dilate or constrict (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?
a.

b.
The Urinary System: Early Filtrate Processing
1. What are the two reabsorption pathways through the tubular cell barrier?
   a. 
   b. 

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 late distal tubules and cortical collecting ducts and describe their function.
   a. 
   b. 

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 osmolality 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:

<table>
<thead>
<tr>
<th>Hydration</th>
<th>ADH</th>
<th>Urine Osmolarity</th>
<th>Urine Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dehydration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overhydration</td>
<td></td>
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</tr>
</tbody>
</table>

7. a. Urine with a “high normal osmolarity” and containing RBC’s and protein would indicate: _______________

   b. Urine with a very high osmolality 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.
   
a.
   
b.
   
c.
   
d.

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:

   a. 
   
   b. 
   
   c. 
   
   d. 

9. Osmosis: When more solute particles are added to one side of a container with a semipermeable 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.

<table>
<thead>
<tr>
<th>Disturbance</th>
<th>Volume</th>
<th>Osmolarity</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypervolemia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypovolemia</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Overhydration</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Dehydration</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. What are the four primary mechanisms to regulate fluid homeostasis?
   a. 
   b. 
   c. 
   d. 

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:
   a. 
   b. 
   c. 

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. 
   c. 
   d. 

   e. 
   f. 
   g.
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 blood 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: Acid-Base Homeostasis

1. List the three important buffer systems in the body:
   a. 
   b. 
   c. 

2. Write the equation showing the relationship of CO2 and H2O levels with bicarbonate and hydrogen ion levels:
   \[ \text{CO}_2 + \text{H}_2\text{O} \leftrightarrow \text{H}_2\text{CO}_3 \leftrightarrow \text{HCO}_3^- \]

3. A decrease in respiration will result in _____ CO\(_2\) and will shift the equation to the _______, resulting in an increase in _____ ions, making the plasma more _______.

4. When body pH is decreased, what are the three compensatory renal mechanisms to restore pH?
   a. 
   b. 
   c. 

5. a. Normal arterial pH is ________ to ________.
   b. What is the pH in alkalosis? ________________
   c. What is the pH in acidosis? ________________

6. With ketoacidosis, show what happens to the following:
   a. ______ Plasma pH
   b. ______ (Left or right) shift of the carbonic acid/bicarbonate system
   c. ______ Bicarbonate levels
   d. ______ Respiratory rate
   e. ______ Renal excretion of H+

7. With metabolic alkalosis, show what happens to the following:
8. With respiratory acidosis, show what happens to the following:
   a. _______ Plasma pH
   b. _______ (Left or right) shift
   c. _______ Bicarbonate levels
   d. _______ Respiratory rate
   e. _______ Renal excretion of bicarbonate

9. With respiratory alkalosis, show what happens to the following:
   a. _______ Plasma pH
   b. _______ (Left or right) shift
   c. _______ Respiratory rate
   d. _______ Renal excretion of bicarbonate
   e. _______ Renal excretion of H+
Endocrine System: Endocrine System Review

1. Hormones act at specific target organs because these organs contain _______ specific for the hormones.

2. Growth hormone, secreted by the _____ _______ gland, stimulates growth of bones and muscle by activating intermediary proteins called ________________.

3. ________ (hormone) from the anterior pituitary stimulates secretion of cortisol from the ______ _______ (gland). The anterior pituitary consists of _______ tissue.

4. The parafollicular or C-cells of the ____________ gland produce __________, a peptide hormone that lowers plasma calcium levels.

5. Hormones secreted by the pancreatic islets of the pancreas include ___________ from the α cells and _______________ from the β cells. Which of these hormones raise blood glucose levels?

6. Specialized muscle cells in the heart produce ______ (hormone), which increases excretion of ______ (electrolyte) by the kidneys.

7. __________ (hormone) promotes the final conversion of vitamin D to ___________ in the kidney.

8. __________ (hormone) produced by G-cells in the pyloric antrum stimulates _____ secretion in the stomach.

9. One ventral hypothalamic hormone (__________) is essential for the stress response and another (__________) inhibits release of prolactin.

10. __________ (hormone) is a stimulus for sperm production in the male and maturation of ovarian follicles in the female.

11. ________, secreted by the pineal gland, helps regulate body activities with the light-dark cycle.

12. The zona glomerulosa of the adrenal cortex primarily produces the hormone ____________, which acts on the ________ (organ) to increase ___ (electrolyte) reabsorption.

13. _______ _______ (gland) is a modified sympathetic ganglion producing the amine hormones known as ________________. This category of amine hormones includes both __________ and ____________ (two hormones).

14. The _______ (organ) produces a steroid hormone called ____________ in the interstitial cells and a peptide hormone called ___________ that inhibits FSH.

15. Large follicles in this gland (__________) contain a protein colloid called _______________ from which the hormones ______ and ______ are made. These hormones regulate many metabolic functions and are important for nervous system development and growth.

16. Nuclei in the ventral hypothalamus produce two hormones that are stored in the posterior pituitary. Name the two nuclei that produce these hormones and name the two hormones, one of which is important for water balance.
1. Place the following hormones into one of the three categories of hormones (peptides, amines or steroids): T4 (thyroxin), estradiol, norepinephrine, insulin, aldosterone, glucagon, cortisol, growth hormone, T3 (triiodothyronine), epinephrine, testosterone and vasopressin (ADH).

<table>
<thead>
<tr>
<th>Peptides</th>
<th>Amines</th>
<th>Steroids</th>
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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 ____. T3 consists of two _______ molecules plus ___ iodine molecules and is (more or less) abundant than T4. 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 T3 & T4 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  → ______________
     amino 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?
     Sympathetic  → ______________
     Parasympathetic  → ______________
   - 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:

------------------------------------------------------------------

------------------------------------------------------------------

------------------------------------------------------------------
Endocrine System: The Hypothalamic – Pituitary Axis

1. The anterior pituitary is composed of __________ tissue. Name the six classic hormones whose functions are well known.
   a.
   b.
   c.
   d.
   e.
   f.

2. TRH, GNRH, CRH etc. are known as __________ hypothalamic hormones which regulate the function of the ________ pituitary. These hormones are released into capillary beds and carried directly to the pituitary by the __________ ________ located in the ________________.

3. __________ and ____________, the posterior pituitary hormones are synthesized in the __________ and __________ nuclei of the hypothalamus. They are stored in the axon terminals located in the __________ pituitary. Similar to neurotransmitters, an ________ in the neuron causes their release.

4. In negative feedback, the target hormone feeds back to alter the release of the anterior or hypothalamic hormones thus (increasing or decreasing) its own release.

5. Give an example of a hormone that has negative feedback mainly to the anterior pituitary.

6. Prolactin is unique in that the main ventral hypothalamic hormone regulating its secretion (__________), inhibits its release. __________ (hormone) increases prolactin release. Very high levels of this hormone during pregnancy actually block the effect of prolactin on milk production.

7. __________ hormones are necessary for the release of __________ hormone. This is an example of modulation of a hormone by a target hormone of another series.

8. Suckling of an infant causes milk letdown by stimulating what hormone? ____________

9. Cortisol release is synchronized by the light/dark cycle and has a 24 hour pattern of secretion known as a ____________ rhythm. Levels are highest at what part of the day? ____________
10. Besides controlling levels of T3 and T4, TSH also promotes __________ of the thyroid gland. T3 and T4 are carried in the bloodstream bound to __________ ________ because they are (hydrophilic or lipophilic).

11. T3 and T4 enter the target cells by __________ and bind to receptors located ______________. T3 and T4 are synthesized from ___________ and __________.

12. Which of the following would be symptoms of hypothyroidism also known as __________?
   - lethargy or hyperexcitability
   - high BMR or low BMR
   - high heart rate or low to normal heart rate
   - feeling cold or sweating
   - weight loss or weight gain

13. Lack of dietary iodine would cause (primary or secondary) hypothyroidism and the patient would probably get an iodine-deficient __________.

14. Graves’ disease is the most common cause of primary ___________________. The body secretes ___________ __________ ____________, which mimics the action of TSH and thus may cause a __________ as well as high levels of thyroid hormones.
Endocrine System: Response to Stress

1. What two body systems work together to provide well coordinated, generalized, nonspecific responses to combat stress? ____________ and ____________

2. Increased levels of what three hormones indicate that an individual is experiencing stress? ____________, ____________ and ____________

3. In the nervous system’s response to stress, ____________ and ____________ exert many effects on the body. Choose the correct response in the pairs listed.
   - ↑ or ↓ CO
   - ↑ or ↓ ventilation
   - ↑ or ↓ BP
   - ↑ or ↓ plasma levels of glucose, fatty acids etc

4. In response to stress, the hypothalamus increases the release of CRH, which increases ________ from the anterior pituitary and ___________ from the adrenal cortex. These hormones prolong the response to stress provided by the nervous system.

5. Cortisol enhances _______________ (in vessels) to help maintain blood pressure and also (increases or inhibits) the inflammation and immune response.

6. Besides cortisol, the adrenal cortex releases _______________, which promotes salt and water retention, which helps maintain blood volume and blood pressure.

7. ______________ (posterior pituitary hormone) also aids in the stress response by promoting water retention and at high levels it is a potent ______________. Both of these help maintain blood pressure.

8. Epinephrine is a (lipophilic or hydrophilic) hormone. Thus it (does or does not) require a protein carrier and the receptors at the target cell are located ______________. Epinephrine is synthesized from ______________ and has a very short half-life of ______.

9. ______________ is a condition in which there is hypersecretion of catecholamines by a tumor in the adrenal medulla. Which of the following symptoms would be present in a patient with this condition?
   - sweating or cool dry skin
   - ↓ BP or ↑ BP
   - ↓ blood glucose or ↑ blood glucose
   - ↑ HR or ↓ HR
   - ↑ TPR or ↓ TPR
10. Cortisol is a (lipophilic or hydrophilic) hormone. Thus it (does or does not) require a protein carrier and the receptors on the target organ are located ______________. Cortisol is synthesized from ______________ and has a half-life of __________.

11. Hypercortisolism is better known as ______________, which is due to a hypersecreting tumor in the anterior pituitary. What hormone is being hypersecreted? ______________. Hypercortisolism from all other causes, such as glucocorticoid drugs, is known as ______________.

12. Primary adrenal insufficiency is better known as ______________. What two hormones are deficient? ______________ and ______________

13. The following symptoms would be characteristic of which disease? ______________
   Low blood pressure, decreased plasma sodium and hypoglycemia

14. The following symptoms would be characteristic of which disease? ______________
   high blood pressure, poor wound healing and hyperglycemia

15. Classify the following as either part of the rapid response (R) to stress mediated by the sympathetic nervous system or the prolonged (P) response of the endocrine system: maintains gas exchange
   ______
   maintains fuel levels ______
   maintains body defenses ______
   redirects blood flow ______
   makes fuel available ______
The Digestive System: Anatomy Review

1. List two main divisions of the digestive system.
   a. _______________________
   b. _______________________

2. The four main layers of the digestive tract wall are
   a. __________.
   b. __________.
   c. __________.
   d. __________.
3. Label the diagram below with the four main layers you listed in question 6.

4. The mucosa includes a type of columnar ________that forms the inner lining of the lumen

5. Blood and lymph vessels of the mucosa are found in its ________ ________ connective tissue layer.

6. The smooth muscle layer of the mucosa is called the ________ ________.

7. The function of epithelial goblet cells is to secrete ________.

8. ________ cells of the mucosa secrete hormones into the blood.

9. Absorption of nutrients occurs through the mucosal epithelium and into either ________ or ________ vessels.
10. Label the vessels you listed in question 13 in the diagram below.

![Diagram](image)

11. The muscularis mucosa has both ________ and ________ fibers that function in moving the villi to aid in digestion and absorption.

12. The built-in (intrinsic) network of nerve cells in the submucosa is the ______ ______.

13. The two types of movements produced by contractions of the muscularis externa are ______________ and ______________.

14. The network of neurons in between the two muscle layers of the muscularis externa is the ______________ ______________.

15. The mouth, with its _____ _____ epithelium, is involved in both chemical and _____ digestion.
16. List the four regions of the stomach:
   a. __________
   b. __________
   c. __________
   d. __________

17. List the three sheets of muscle in the stomach’s muscularis externa:
   a. __________
   b. __________
   c. __________

18. Label the three sheets of muscle in the stomach’s muscularis externa in the diagram below.
19. List, in order from the pylorus to the colon, the three regions of the small intestine:
   a. ______________
   b. ______________
   c. ______________

20. From largest to smallest, list the three modifications of the small intestine’s inner wall that function to increase surface area:
   a. ______________
   b. ______________
   c. ______________

21. Label two of the modifications of the intestine to increase surface area in the diagram below.

22. The microvilli of the small intestine’s epithelial cells form the ______ border.

23. The large intestine absorbs __________, __________, and __________.

24. Starting from the ileocecal valve, trace the path of undigested material through the large intestine.
25. The anus is lined with ______ _______ epithelium.

26. List the 6 sphincters of the digestive tract:
   a. _______
   b. _______
   c. _______
   d. _______
   e. _______

27. The single digestive function of the liver is to produce _____.

28. The main digestive enzyme-producing organ in the body is the ______.

29. Three pairs of _____ _____ function to moisten food in the mouth.
The Digestive System: Control of the Digestive System

1. List the primary two mechanisms that control the motility and secretion of the digestive system.
   a. ______________________
   b. ______________________

2. List the three phases of digestive system processes
   a. __________.
   b. __________
   c. __________

3. The __________ nerve triggers the responses during the cephalic phase of digestion.

4. The stimulation of __________ receptors triggers the gastric phase of digestion.

5. List the 4 main responses during the intestinal phase of digestion
   a. __________.
   b. __________.
   c. __________.
   d. __________.

6. The small intestine typically________.
   a. slows gastric emptying
   b. accelerates gastric emptying
   c. has no effect on gastric emptying

7. The __________ and __________ __________ nerves carry parasympathetic impulses to the enteric nervous system.

8. Sympathetic NS innervation of the digestive tract is via__________ fibers.
   c. preganglionic
   d. postganglionic

9. The __________ and __________ plexuses are the two components of the enteric nervous system.

10. Digestive system reflexes that involve the brain are called ______ ________.
11. A meal consisting largely of fatty foods will take __________ to digest than a meal consisting of mainly of starchy foods.
   a. a longer time
   b. a shorter time
   c. the same time

12. All preganglionic ANS fibers release _______ while only postganglionic fibers of the sympathetic division release __________.

13. Which of the following neurotransmitters stimulates smooth muscle contraction in the digestive tract?
   a. VIP
   b. norepinephrine
   c. NO
   d. ACh

14. ______ slow intestinal motility and cause the pyloric sphincter to contract.

15. List 5 peptide hormones of the GI tract:
   a. __________
   b. __________
   c. __________
   d. __________

16. List four functions of duodenal CCK.
   a. __________
   b. __________
   c. __________
   d. __________

17. Secretin stimulates gastric HCl secretion.
   a. True
   b. False
18. GIP stimulates the pancreas to secrete_________.

19. ______ stimulates motility of the intestine, thereby moving its contents toward the terminal ileum.

20. _______ occurs when the combined action of two hormones is greater than the sum of their individual effects.
The Digestive System: Motility

1. The process by which food is received into the GI tract via the mouth is called ____________________.

2. The esophagus is digestive in function.
   a. True 
   b. False

3. Swallowing has both voluntary and involuntary components
   a. True 
   b. False

4. The function of the epiglottis is to prevent a bolus from entering the ______.

5. The first wave of contraction of the esophageal muscles is called ______ ______.

6. If a food bolus does not make it all the way to the stomach, ________ peristalsis forces the bolus the remainder of the way.

7. Peristaltic contractions of the stomach occur about _____ times per minute when food makes it into the body & fundus.

8. The frequency of peristaltic contractions is regulated by ________ cells.

9. Gastric emptying would be slowed by which of the following:
   a. Fats in the duodenum
   b. Acids in the duodenum
   c. Hypertonic solutions in the duodenum
   d. Distention of the duodenum
   e. All of the above

10. ______ regulate gastric juice secretion during the cephalic phase.

11. *Now would be a great time to fill in the interactive table on page 7 of the Motility topic.

12. The cephalic phase of digestion is regulated by short reflexes
   a. True 
   b. False.
13. The _______ nerve carries electrical signals from the brain to the stomach.

14. The hormone ______ regulates gastric secretion during the gastric phase of digestion.

15. Gastric motility ________ as the stomach begins to receive food.

16. The hormone ______ released by the duodenum cause gastric motility to decrease when fats are present in the duodenum.

17. The hormone _______ causes the gall bladder to contract and release bile into the small intestine.

18. The ________ reflex describes the communication between the intestine and the stomach.

19. Sympathetic nervous system stimulation ________ digestive system activity.

20. The motility process illustrated below is _________.

21. Segmentation moves chyme in only one direction.
   a. True
   b. False

22. The frequency of segmentation contractions is greatest in the ______.

23. _____ reflexes stimulate the ileum to increase activity when food is in the stomach.

24. The hormone __________ causes the ileocecal sphincter to relax during the gastric phase.

25. During the inter-digestive period, ________ ________ ________ occur about once every 90 minutes to move undigested materials toward the terminal ileum.

26. Migrating motility complexes are controlled by the central nervous system
   a. True
   b. False

27. List the two major functions of the large intestine.
28. Pockets formed by the contractions of the transverse and descending colon musculature are called ________.

29. Sustained, intense propulsive peristaltic contractions of the large intestine are called __________ _________.

30. Which of the following is under voluntary control?
   a. Internal anal sphincter
   b. External anal sphincter

31. Only about _______ ml of the 500 ml of chyme that entered the colon is voided as feces.

32. Place the following labels on the large intestine figure below:
   Cecum, ascending colon, transverse colon, descending colon, sigmoid colon, rectum, haustra, appendix

33. The ________ reflex stimulates mass movements of the colon.

34. List three emotions that may produce constipation
   a. _______
b. ______

c. ______.

35. The vomiting reflex is coordinated in the ________.

36. Which of the following is not typically a stimulus for the vomiting reflex?
   a. Noxious chemicals
   b. Abnormal vestibular stimulation
   c. Sudden injury to the testes
   d. Sleep
The Digestive System: Secretion

1. Of the approximately 9.0 L of fluids contained in the digestive tract daily, only __________ L are eliminated with the feces.

2. Of the approximately 800 g of food ingested during a typical day, only about _____ g are eliminated as undigested food in the feces.

3. Label the parotid, submandibular, and sublingual salivary glands in the figure below:
4. List the four major functions of saliva.
   a. __________
   b. __________
   c. __________
   d. __________

5. Parasympathetic innervation to the salivary glands is transmitted by cranial nerves number _______ and _______.

6. Both the sympathetic and parasympathetic divisions of the ANS stimulate the salivary glands.
   a. True
   b. False

7. _______ division innervation stimulates watery, enzyme-rich saliva secretion, whereas _______ division innervation stimulates a mucus-rich, more viscous saliva secretion.

8. Label the figure below with the terms parasympathetic and sympathetic.
9. The esophagus secretes digestive enzymes.
   a. True
   b. False
10. The four main components of gastric juice are:
   a. __________
   b. __________
   c. __________
   d. __________

11. Gastrin is released from the ______ region of the stomach.

12. Place the following labels on the figure below:
   - parietal cell: HCl + IF
   - chief cell: pepsinogen
   - paracrine cell: histamine
   - mucus neck cells

13. Gastrin producing G-cells are found in the gastric glands located in the _______ region of the stomach.

14. List the only two substances that are absorbed across the stomach’s mucosal epithelium
15. HCl in the stomach produces a pH of between _______ in the luminal fluid.

16. Which of the following is a function of HCl in the stomach?
   a. Activates pepsinogen
   b. Breaks down cell walls
   c. Kills most bacteria
   d. Denatures proteins in food
   e. All of the above are functions of HCl

17. Without _______ _______, vitamin B\textsubscript{12}, necessary for normal RBC development, can not be absorbed by the intestine.

18. List the two secretions that stimulate HCl release from parietal cells.
   a. __________
   b. __________

19. During the cephalic phase _________ neural reflexes stimulate an increased production of gastric juice.

20. Lipids in the intestine cause the release of the hormone_______, while acid in the intestine causes the release of _______.

21. Match the following pairs of terms:
   CCK & secretin - bicarbonate pancreatic juice & enzyme-rich pancreatic juice

22. List the three major proteases (inactive forms) secreted by the exocrine pancreas
   a. ________
   b. ________
   c. ________

23. Intestinal ________ converts (activates) trypsinogen into trypsin.

24. The pancreatic hormone ________ regulates the absorptive state, while ________ regulates the post-absorptive state.
25. List the four organic components of bile:
   a. ________
   b. ________
   c. ________
   d. ________

26. Intestinal digestive enzymes that are embedded in the epithelial microvilli membranes are called ________ ________ enzymes.

27. The intestinal hormone ______ causes contraction of the gall bladder and release of bile into the duodenum.

28. ________ ________ protects the wall of the large intestine from mechanical damage and from damage by bacterial acid.
The Digestive System: Digestion and Absorption

1. List the three major nutrient classes (a.k.a. macronutrients).
   
   __________
   __________
   __________

2. Which of the following carbohydrates is NOT a disaccharide?
   
   maltose
   lactose
   starch
   sucrose

3. Match the following pairs of molecules with their monomers by placing the number next to the matching letter:
   
   Sucrose __________
   Maltose __________
   Starch __________
   Lactose __________

   The monomers:
   1. Many glucose monomers
   2. glucose + fructose
   3. glucose + galactose
   4. glucose + glucose

4. The breakdown products (monomers) of proteins are __________ __________.

5. The breakdown products of triglycerides include monoglycerides and __________ __________.

6. Place the following labels on the diagram below:
   
   o maltose
7. Once food is acidified in the stomach, amylase continues to digest starch.
   a. True
   b. False

8. The digestive enzyme ________ begins the breakdown of proteins in the stomach.

9. Pepsin is inactivated in the duodenum.
   a. True
   b. False

10. Pancreatic __________ is responsible for the majority of fat digestion.

11. Most water and salt are absorbed in the colon.
   a. True
   b. False

12. The active transport of sodium is necessary for water absorption in the small intestine.
13. The final digestion of carbohydrates is accomplished with ______ ______ enzymes.

14. Which of the following is NOT a brush border enzyme?
   a. Amylase
   b. Sucrase
   c. Dextrinase
   d. Glucoamylase
15. Place the following labels on the figure below:

Luminal side
Facilitated diffusion transporter
Basolateral side

16. List the three major pancreatic proteases.
   a. __________
   b. __________
   c. __________

17. Only single amino acids are absorbed in the small intestine.
   a. True
   b. False

18. List the two main brush border proteases
19. List the two mechanisms that help to increase the surface area of lipids for subsequent digestion with pancreatic lipase.
   a. __________
   b. __________

20. Bile salts surround monoglycerides and free fatty acids to form tiny droplets called ________.

21. Triglycerides combine with lipoproteins inside the intestinal epithelial cells to form __________.

22. Chylomicrons exit the intestinal epithelial cells and then enter the ________ lymphatic capillaries.

23. The colon epithelium produces substantial amounts of digestive enzymes.
   a. True
   b. False

24. Colic bacteria produce substantial quantities of ________ ____ as a by product of their metabolism.

25. List the three main substances that are absorbed in the large intestine.
   a. __________
   b. __________
   c. __________