EXAM 2

2.1

Q2.1.1 Short Answer: Define a neuron.
Basic information processing unit of the nervous system.

Q2.1.2 Multiple Choice: Which cell type forms the myelin sheath in the CNS?

(A) *Oligodendrocytes* (B) Schwann Cells

(C) Astrocytes (D) Satellite Cells

Q2.1.3 Fill in the Blank: The process by which microglia remove debris is called *phagocytosis*.

Q2.1.4 Short Answer: Name two functions of astrocytes.
Provide structural support and deliver nutrients to neurons.

Q2.1.5 Fill in the Blank: *Schwann Cells* are responsible for myelination in the PNS.

Q2.1.6 Multiple Choice: What is one function of myelin?

(A) *Insulate axons* (B) Synthesize proteins

(C) Produce neurotransmitters (D) Break down debris

Q2.1.7 Fill in the Blank: Glial cells compose about half of nervous tissue volume, but are approximately *10-50* times more numerous than neurons.

Q2.1.8 Short Answer: What are two similarities between neurons and other animal cells?
They have a cell membrane, a nucleus, and a variety of organelles.

Q2.1.9 Short Answer: In neurons, what is the primary role of mitochondria?
Producing energy for the cell.

Q2.1.10 Fill in the Blank: The organelle responsible for protein synthesis in neurons is the *Endoplasmic Reticulum*.

Q2.1.11 Fill in the Blank: The *Golgi Apparatus* packages neurotransmitters for transport.

Q2.1.12 Fill in the Blank: Organelles that break down waste products in neurons are called *Lysosomes*.

Q2.1.13 Short Answer: What distinguishes the morphology of neurons from typical animal cells?
Neurons have long processes (axons and dendrites) specialized for signal transmission.

Q2.1.14 Fill in the Blank: Neurons communicate via an *electrochemical* process.

Q2.1.15 Multiple Choice: Which cell type is primarily responsible for debris removal in the CNS?

(A) *Microglia*
(B) Astrocytes
(C) Oligodendrocytes
(D) Satellite Cells

Q2.1.16 Multiple Choice: Which cells line the ventricles and help form CSF?

(A) Astrocytes
(B) *Ependymal Glia*
(C) Schwann Cells
(D) Microglia

Q2.1.17 Short Answer: What is the function of satellite cells in the PNS?
They provide nutrients and physical support to neurons.

Q2.1.18 Multiple Choice: Which glial cell in the PNS is notably associated with neuronal regeneration?

(A) Oligodendrocytes
(B) Microglia
(C) Satellite Cells
(D) *Schwann Cells*

Q2.1.19 Multiple Choice: What happens during maintenance of internal consistency?

(A) Microglia remove cellular debris.
(B) Oligodendrocytes myelinate axons.
(C) *Astrocytes absorb excess potassium ions.*
(D) Schwann cells provide nutrients to neurons.

Q2.1.20 Long Answer: What evidence supports the notion that glial cells' malfunctioning may be contributing to Alzheimer's Disease? (Your answer must include beta amyloid, Tau, and the possible cause of Alzheimer's Disease.)
Glial cells normally remove beta amyloid plaques, but if it builds up too much outside the cell, Tau builds up inside the cell. This leads to inflammation, which may be the problem of Alzheimer's Disease.

2.2

Q2.2.1 Fill in the Blank: The three structural classifications of neurons are *unipolar*, *bipolar*, and *multipolar*.

Q2.2.2 Fill in the Blank: Neurons are based on *structure* and *function*

Q2.2.3 Fill in the Blank: Sensory neurons carry information from the *PNS* to the *CNS*.

Q2.2.4 Short Answer: What is the primary function of motor neurons?
To carry information from the CNS to muscles and glands.

Q2.2.5 Multiple Choice: What does "Efferent" mean?

(A) Incoming (B) Sensory (C) Motor (D) *Outgoing*

2.3

Q2.3.1 Short Answer: What are the 2 systems of neuronal communication?
Binary and analogue

Q2.3.2 Fill in the Blank: A stronger-than-normal stimulus is required to cause another action potential during the *relative refractory period* because of hyperpolarization.

Q2.3.3 Fill in the Blank: The *phospholipid bilayer* is made up of *hydrophilic heads* and *hydrophobic tails*.

Q2.3.4 Fill in the Blank: The period during which no amount of stimulation can cause another action potential is called the *absolute refractory period*.

Q2.3.5 Short Answer: What is *diffusion*? What else is it also known as?
The movement of ions from high to low concentration; also known as the concentration gradient.

Q2.3.6 Short Answer: What is the threshold of excitation, and what happens when it is reached?
The threshold of excitation is +15 mV. When it is reached, an action potential is generated.

Q2.3.7 Matching: Match the following terms with their definitions.

Choices

(a) Ions move toward the opposing charge.

(b) The charge the ion "prefers" to be at.

(c) Cell is resistant to reexciation for some time after AP.

(d) The cell membrane is more open to some ions than others.

(e) −70 mV (relative to outside).

(f) The overshoot of negative voltage after an AP.

(g) Costs 1 ATP.

(h) The phase where there is a jump in voltage after +15 mV is reached.

(i) The minimum amount needed to generate an action potential. (+15 mV)

(j) *The cell's charge declines.*

(1) Differential Permeability ..... *(d)*

(2) Resting Membrane Potential ..... *(e)*

(3) Threshold of Excitation ..... *(i)*

(4) Depolarization ..... *(h)*

(5) Repolarization ..... *(j)*

(6) Hyperpolarization ..... *(f)*

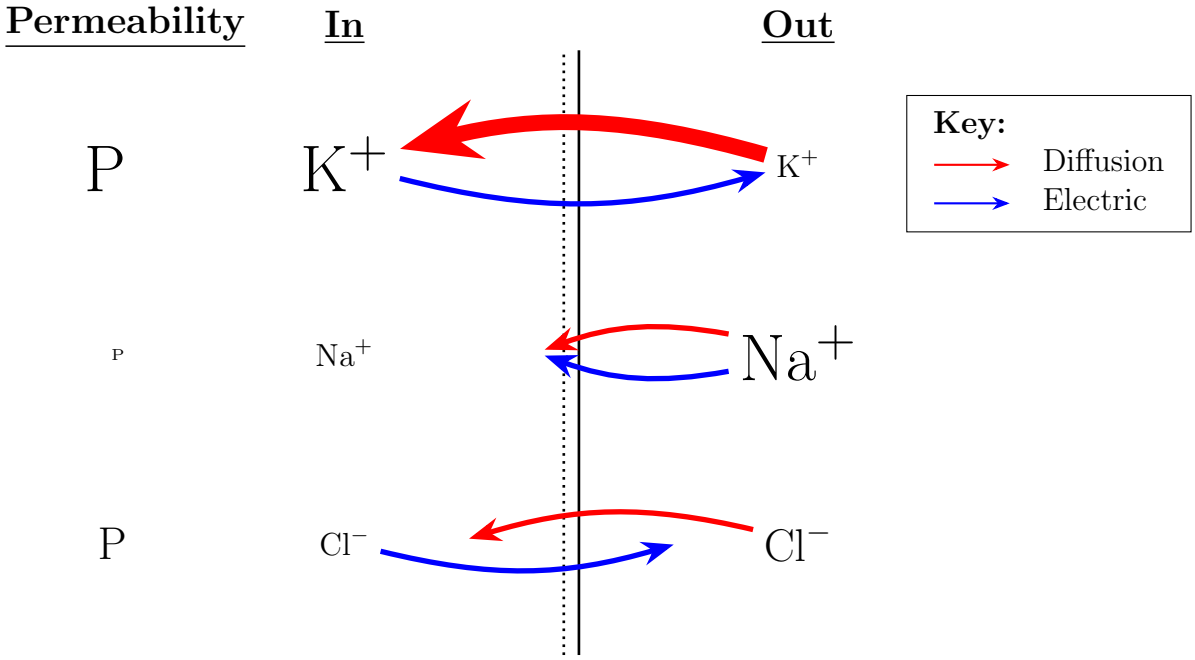
(7) Electrostatic Pressure ..... *(a)*

(8) Equilibrium Potential ..... *(b)*

(9) Sodium Potassium Pump ..... *(g)*

(10) Refractory Period ..... *(c)*

Q2.3.8 Fill in the Blank: Fill out the following diagram of the resting membrane potential of a neuron. Draw the size of each and permeability ion to "scale", and draw the diffusion and electric arrows with the appropriate directions.



Q2.3.9 Short Answer: Why don't the Na^+ channels reopen during repolarization? (Question directly from notes.)
Because of the refractory period.

Q2.3.10 Multiple Choice: During which phase of the action potential is a neuron unable to fire another action potential, no matter how strong the stimulus?

(A) Depolarization
(B) Repolarization
(C) *Absolute refractory period*
(D) Relative refractory period

Q2.3.11 Multiple Choice: How can an all-or-none action potential signal convey information about stimulus intensity?

(A) By increasing the amplitude of the action potentials.
(B) By decreasing the duration of action potentials.
(C) By changing the direction of action potentials.
(D) *By increasing the frequency of action potentials.*

Q2.3.12 Short Answer: What are equilibrium values?
It is the voltage at which the ion's driving force in equals the driving force out.

Q2.3.13 Fill in the Blank: The ratio of Na^+ to K^+ for the sodium-potassium pump is *3* out for *2* in.

Q2.3.14 Short Answer: What happens in a failed attempt at an action potential?
The threshold is not reached; the membrane potential may change slightly but returns to -70 mV.

Q2.3.15 Short Answer: What role does electrostatic pressure play in neuronal membrane potential?
It drives ions toward the opposing charge, aiding in establishing the RMP.

Q2.3.16 Fill in the Blank: The equilibrium values for K^+ and Na^+ are -80 *mV* and $+55$ *mV*, respectively.[1]

Q2.3.17 Short Answer: *Saltatory conduction* is the process of action potentials "jumping" from node to node. Why do people describe this process as "jumping"?
Because the action potential is regenerated only at each node, so it appears to jump along the axon.

Q2.3.18 Short Answer: What is the resting membrane potential (RMP) of a neuron and what does it represent?
-70 mV; it represents the voltage difference between the inside and outside of the cell at rest.

Q2.3.19 Short Answer: What is meant by semipermeability in the context of the cell membrane?
Only molecules that are lipid, lipid soluble, small, and neutral can cross the membrane.

Q2.3.20 Short Answer: List the four main functions of embedded proteins in the cell membrane.
They function as receptors, channels (including gated channels), pumps, and enzymes.

Q2.3.21 Multiple Choice: Differential permeability says that this ion is more permeable than others.

(A) Na^+ (B) *K^+* (C) Cl^- (D) Ca^{2+}

Q2.3.22 Short Answer: How does diffusion contribute to the RMP?
Ions move from high to low concentration across the membrane.

Q2.3.23 Multiple Choice: What is the rate law?

(A) The speed at which a neuron conducts an action potential along its axon.

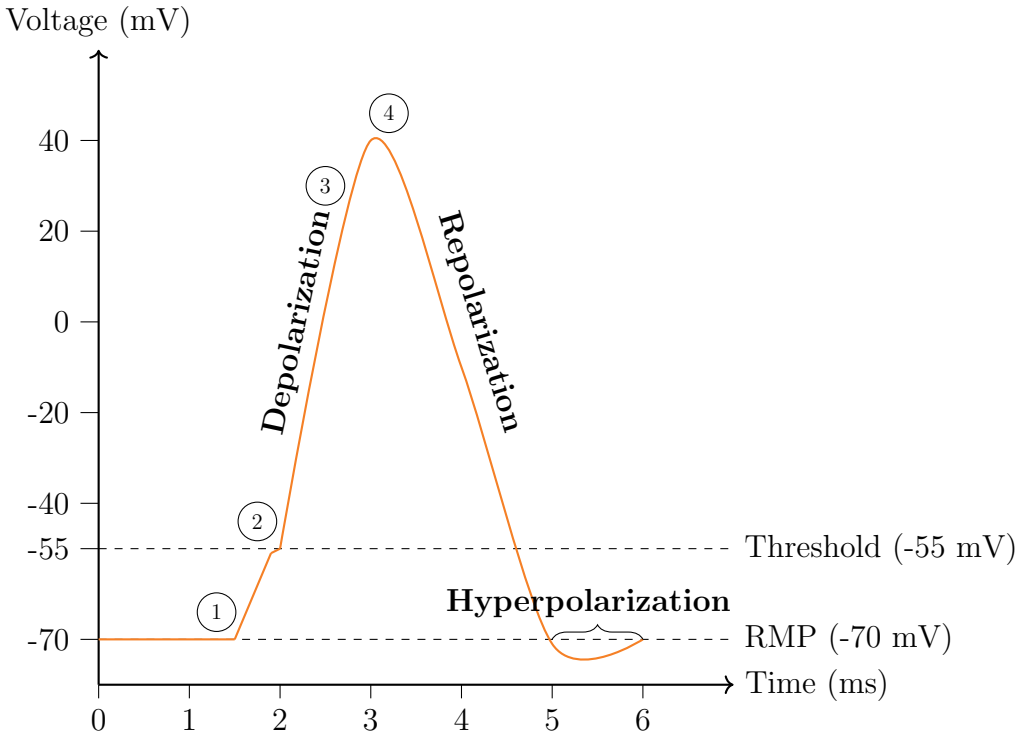
(B) The time delay between the onset of a stimulus and the initiation of an action potential.

(C) The relationship between the amplitude of an action potential and the strength of the stimulus.

(D) *Variations in the intensity of a stimulus are represented by the rate of action potentials.*

[1] *NOTE:* I found a paper online that said -90 mV and $+65$ mV, respectively, so I don't know if these are correct.

Q2.3.24 Matching: For the diagram below, identify the processes of an action potential at each labeled phase.



Choices

(a) Potassium channels close.

(b) Resting potential.

(c) Potassium channels open.

(d) Opens sodium channels.

(e) Sodium channels close.

(1) −70 mV ..... *(b)*

(2) −55 mV ..... *(d)*

(3) +35 mV ..... *(c)*

(4) +40 mV ..... *(e)*

(5) −75 mV ..... *(a)*

Q2.3.25 Multiple Choice: What is the main advantage of saltatory conduction in myelinated axons?

(A) It eliminates the need for Na^+ channels.

(B) *It increases conduction speed and reduces energy expenditure.*

(C) It allows action potentials to travel in both directions.

(D) It prevents action potentials from occurring at all.

Q2.3.26 Fill in the Blank: The *axon hillock* is the site of action potential initiation in a neuron.

Q2.3.27 Short Answer: What is decremental conduction, and why does it occur?
Decremental conduction is the gradual weakening of a signal as it travels due to resistance and leakage.

Q2.3.28 Short Answer: Why does the action potential require active regeneration in unmyelinated axons?
Because it is regenerated at each point along the axon to prevent signal loss.

Q2.3.29 Short Answer: Why can't myelin sheaths extend indefinitely without nodes?
Because the decremental conduction would cause the action potential to weaken too much before reaching the end.

Q2.3.30 Short Answer: Explain multiple sclerosis in terms of saltatory conduction.
Because saltatory conduction is what neurons that have myelin sheaths use to conduct action potentials, multiple sclerosis, which destroys myelin, disrupts this process.

2.4

Q2.4.1 Multiple Choice: An *angstrom* (Å) is a unit of measurement equivalent to

(A) 10^{-6} mm (B) 10^{-5} mm (C) 10^{-7} *mm* (D) 10^{-9} mm

Q2.4.2 Fill in the Blank: The synaptic cleft is about *20 Å* angstroms wide.

Q2.4.3 Multiple Choice: What happens FIRST when an action potential reaches the presynaptic terminal?

(A) The Na^+/K^+ pump is activated.

(B) The postsynaptic neuron immediately fires an action potential.

(C) *Voltage-gated Ca^{2+} channels open.*

(D) The synaptic vesicles dissolve.

Q2.4.4 Fill in the Blank: Neurotransmitters are released into the *synaptic cleft* when synaptic vesicles fuse with the presynaptic membrane.

Q2.4.5 Short Answer: What is the function of docking proteins at the presynaptic membrane?
They hold synaptic vesicles in place until an action potential triggers neurotransmitter release.

2.5

Q2.5.1 Multiple Choice: Which of the following is an excitatory postsynaptic potential (EPSP)?

(A) Opening of K^+ channels

(B) Binding of neurotransmitters to autoreceptors

(C) Metabolism of neurotransmitters

(D) *Opening of Na^+ channels*

Q2.5.2 Fill in the Blank: The three possible fates of neurotransmitters after release are *active reuptake* , *metabolism*, and *binding to autoreceptors*.

Q2.5.3 Fill in the Blank: When a neurotransmitter causes the opening of Na^+ channels, this creates a(n) *excitatory* post-synaptic potential.

Q2.5.4 Multiple Choice: What occurs during an inhibitory post-synaptic potential (IPSP)?

(A) Opening of K^+ channels, allowing potassium to enter the cell

(B) Opening of Na^+ channels, bringing the cell closer to threshold

(C) *Opening of K^+ channels, allowing potassium to leave the cell*

(D) Closing of all ion channels

Q2.5.5 Short Answer: Where does the summation of EPSPs and IPSPs occur in a neuron?
At the axon hillock.

Q2.5.6 Multiple Choice: What is the primary difference between ionotropic and metabotropic synapses?

(A) *Ionotropic causes direct ion exchange, metabotropic uses secondary messengers*

(B) Ionotropic uses ATP, metabotropic doesn't

(C) Ionotropic is slower, metabotropic is faster

(D) Ionotropic uses multiple neurotransmitters, metabotropic uses only one

Q2.5.7 Short Answer: How does binding to autoreceptors affect neurotransmitter release?
It inhibits the release of more neurotransmitters.

Q2.5.8 Fill in the Blank: The enzyme that breaks down neurotransmitters as part of their post-release fate is involved in *metabolism*.

Q2.5.9 Short Answer: How do ionotropic and metabotropic synapses differ in terms of speed and duration?
Ionotropic synapses produce rapid and short effects by directly opening ion channels, while metabotropic synapses have slower, longer-lasting effects through secondary messenger pathways.

Q2.5.10 Multiple Choice: What role does cAMP play in metabotropic synapses?

(A) It binds directly to ion channels to open them.

(B) *It activates Protein Kinase A, which leads to phosphorylation.*

(C) It metabolizes excess neurotransmitters.

(D) It breaks down ATP into ADP.

Q2.5.11 Fill in the Blank: The enzyme *adenylate cyclase* converts ATP into cAMP in metabotropic signaling.

Q2.5.12 Fill in the Blank: The enzyme that metabolizes residual cAMP is called *phosphodiesterase*.

Q2.5.13 Fill in the Blank: *Phosphoprotein phosphatase* removes the phosphate and resets the channel in the metabotropic pathway.

Q2.5.14 Fill in the Blank: The fine tuning of electrical signals is accomplished through presynaptic *inhibition* and *facilitation*.

Q2.5.15 Fill in the Blank: In the metabotropic signaling pathway, the *alpha (α)* subunit of the G-protein binds to adenylate cyclase.

Q2.5.16 Multiple Choice: What is the function of Protein Kinase A in metabotropic signaling?

(A) *It causes subunits to dissociate and converts ATP to ADP.*

(B) It converts ATP to cAMP.

(C) It opens ion channels directly.

(D) It breaks down excess neurotransmitters.

Q2.5.17 Matching: Match each characteristic with either ionotropic or metabotropic synapses.

Choices

(a) No change in metabolism

(b) Variable duration (can be very long)

(c) At least 2 neuromodulator molecules bind to receptor

(d) Fixed duration (rapid and short)

(e) Direct change of ions

(f) Indirect exchange of ions

(g) 1 neurotransmitter binds to 1 receptor

(h) Actual change in cellular metabolism

(1) Ionotropic ..... *(a), (d), (e), (g)*

(2) Metabotropic ..... *(b), (c), (f), (h)*

Q2.5.18 Short Answer: How does presynaptic facilitation affect neurotransmitter release?
It increases the amount of neurotransmitters released.

Q2.5.19 Multiple Choice: In gap junctions, what crosses between neurons?

(A) Neurotransmitters.

(B) *Channels that allow direct electrical transmission.*

(C) Neuromodulators.

(D) The $G_{\beta\gamma}$ complex from the G-protein.

Q2.5.20 Multiple Choice: Which of the following is NOT a characteristic of electrical synapses?

(A) They are very fast.

(B) They lack neurotransmitters.

(C) They cannot be facilitated or inhibited.

(D) *They are common in the mammalian brain.*

Q2.5.21 Short Answer: Give an example of where electrical synapses are more common than in mammals.
Fish with simpler CNS.

2.6

Q2.6.1 Matching: Match each characteristic with either the somatic or autonomic nervous system.

Choices

(a) Innervates striated muscles

(b) Functions as a whole

(c) Contains both sensory and motor neurons

(d) More differentiated

(e) Purely motor

(f) Relatively involuntary

(g) Innervates smooth muscle, cardiac muscle, glands

(h) Voluntary control

(1) Somatic ..... *(a), (c), (d), (h)*

(2) Autonomic ..... *(b), (e), (f), (g)*

2.7

Q2.7.1 Short Answer: Where are photoreceptors located in the visual system?
In the retina.

Q2.7.2 Short Answer: Where are hair cells found in the auditory system?
In the cochlea.

Q2.7.3 Multiple Choice: Which of the following is NOT a component of the somatosensory system?

(A) Proprioception

(B) Cutaneous senses

(C) *Gustation*

(D) Vestibular sensation

Q2.7.4 Matching: Match each sensory system with its receptor or mechanism.

Choices

(a) Light waves hit photoreceptors

(b) Chemicals bind to receptors (in the nose)

(c) Sound waves vibrate hair cells

(d) Sense of body position

(e) Chemicals bind to receptors (in the mouth)

(f) Sense of movement

(g) Balance

(h) Touch, temperature, pain

(1) Vision ..... *(a)*

(2) Vestibular Sensation ..... *(g)*

(3) Audition ..... *(c)*

(4) Kinesthesis ..... *(f)*

(5) Olfaction ..... *(b)*

(6) Gustation ..... *(e)*

(7) Proprioception ..... *(d)*

(8) Cutaneous ..... *(h)*

Q2.7.5 Fill in the Blank: The difference between a physicist and psychologist studying sensory systems is that the physicist measures *stimulus* while the psychologist measures *perceptions*.

Q2.7.6 Short Answer: According to the notes, why is it important to understand that perceptions don't exactly match stimuli?
Because perceptions (not actual stimuli) form the basis of behavior, such as when someone drives through a red light believing it was green.

2.8

Q2.8.1 Multiple Choice: What process might affect calcium channels during presynaptic inhibition?

(A) *Some Ca^{2+} channels that would normally open remain closed.*

(B) More Ca^{2+} channels open than usual.

(C) Ca^{2+} is pumped out of the cell more quickly.

(D) Ca^{2+} channels are replaced with Na^{+} channels.

Q2.8.2 Fill in the Blank: In an analogy explaining presynaptic facilitation, instead of 3 APs, the effect would seem like *4 or 5* APs.

Q2.8.3 Multiple Choice: Which of these statements best explains why sensory systems are important in psychology?

(A) Sensory systems are the only way to measure brain activity

(B) All psychological disorders involve sensory system dysfunction

(C) *Perceptions from sensory systems form the basis for behavior*

(D) Sensory systems are the most complex part of the nervous system

Q2.8.4 Long Answer: Describe the complete sequence of events in a metabotropic synapse, from neuromodulator binding to the resetting of the channel.
The neuromodulator binds to a receptor initiating the process. This activates a G-protein, causing its alpha subunit to bind to adenylate cyclase. Adenylate cyclase converts ATP to cAMP, which activates Protein Kinase A. This causes 2 subunits to dissociate, removing inhibition from the catalytic portion and allowing it to convert ATP to ADP, producing a phosphate group. The process ends when the neuromodulator dissociates, stopping cAMP production. Then phosphodiesterase metabolizes residual cAMP and phosphoprotein phosphatase removes the phosphate and resets the channel.

2.9

Q2.9.1 Multiple Choice: What is the range of the Electromagnetic Spectrum?

(A) 380-760 μm

(B) *380-760 nm*

(C) 380-760 mm

(D) 420-690 Å

Q2.9.2 Short Answer: What are the 3 types of cones in the retina? What colors do they respond to?
S-cones (Blue), M-cones (medium wavelengths), L-cones (long wavelengths).

Q2.9.3 Multiple Choice: Rods are sensitive to _____ light levels, whereas cones are sensitive to _____.

(A) high; low
(B) *low; color*
(C) bright; dim
(D) color; brightness

Q2.9.4 Short Answer: What is the problem of univariance, and how do we overcome it?
A single type of photoreceptor (cone or rod) cannot differentiate between changes in wavelength and intensity of light; we developed multiple cones to overcome it.

Q2.9.5 Multiple Choice: What is the trichromatic theory of color vision?

(A) The retina contains 3 types of rods, each sensitive to a different range of wavelengths.
(B) The retina contains 3 types of cones, each sensitive to the same range of wavelengths.
(C) *The retina contains 3 types of cones, each sensitive to a different range of wavelengths.*
(D) The retina contains 3 types of rods, each sensitive to the same range of wavelengths.

Q2.9.6 Fill in the Blank: Russians use the word *siniy* to describe the dark blue, and *goluboy* for light blue.

Q2.9.7 Short Answer: What is top-down processing?
When the brain uses knowledge and expectations to interpret sensory information.

Q2.9.8 Short Answer: What is bottom-up processing?
When the brain uses sensory information to form perceptions.

Q2.9.9 Fill in the Blank: Background changes your *color (OR size)* perception.[2]

Q2.9.10 Short Answer: What does the research from Radel and Clement-Guillotin tell us about how hungry people perceive words?
They "see food words better."

[2]Because a circle surrounded by larger circles will look smaller than the same circle surrounded by smaller circles.