**EXAM 2**

## 2.1

**Q2.1.1 Short Answer:** Define a neuron.
*Answer:* 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

*Answer:* A

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

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

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

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

(A) Insulate axons
(B) Synthesize proteins
(C) Produce neurotransmitters
(D) Break down debris

*Answer:* A.

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

**Q2.1.8 Short Answer:** What are two similarities between neurons and other animal cells?
*Answer:* 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?
*Answer:* Producing energy for the cell.

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

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

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

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

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

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

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

*Answer:* B.

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

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

*Answer:* B.

**Q2.1.17 Short Answer:** What is the function of satellite cells in the PNS?
*Answer:* 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) Schwann Cells
(C) Microglia
(D) Satellite Cells

*Answer:* B.

**Q2.1.19 Short Answer:** What is the purpose of *phagocytosis* in the nervous system?
*Answer:* To remove cellular debris and pathogens.

**Q2.1.20 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.

*Answer:* C.

**Q2.1.21 Long Answer:** What evidence supports the notion that glial cells' malfunctioning may be contributing to Alzheimer's Disease? (Your answer needs to include beta amyloid, Tau, and the possible cause of Alzheimer's Disease.)
*Answer:* 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 _____, _____, and _____.
*Answer:* Multipolar, Bipolar, Unipolar.

**Q2.2.2 Fill in the Blank:** Neurons are based on _____ and _____.
*Answer:* Structure, function.

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

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

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

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

*Answer:* B.

## 2.3

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

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

**Q2.3.3 Fill in the Blank:** The *phospholipid bilayer* is made up of _____ and _____.
*Answer:* Hydrophilic, hydrophobic.

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

**Q2.3.5 Short Answer:** What is *diffusion*? What else is it also known as?
*Answer:* 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?
*Answer:* 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) _____

*Answer:* (for repolarization) the cell's charge declines.

(1) Differential Permeability ..... ____

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

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

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

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

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

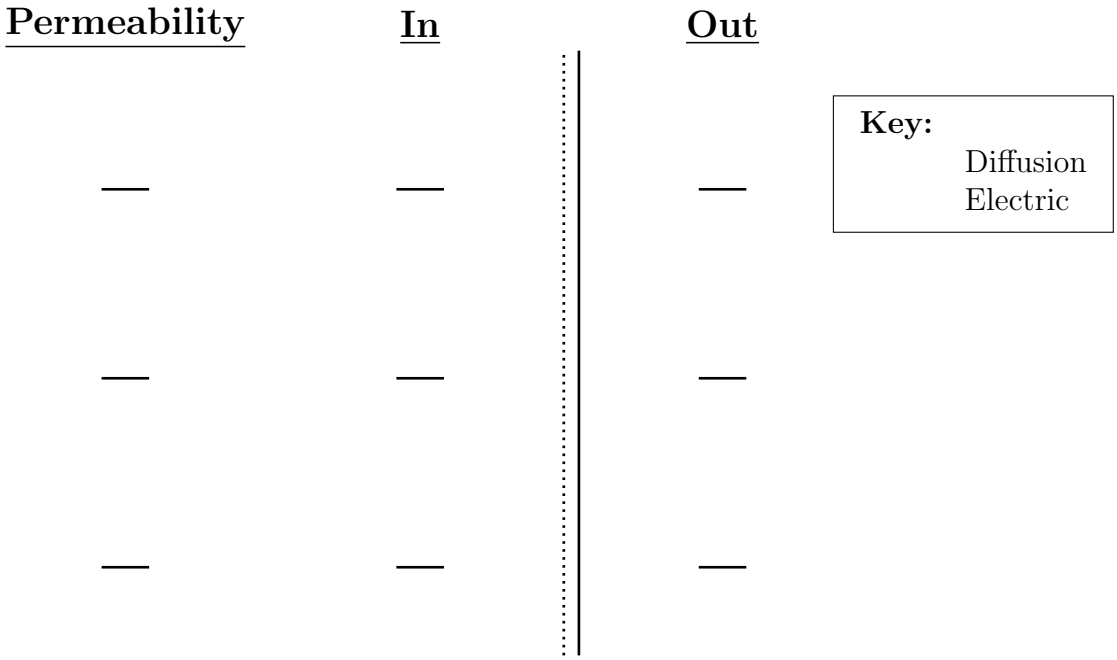
(7) Electrostatic Pressure ..... (a)

(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?
*Answer:* 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

*Answer:* C.

**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

*Answer:* D.

**Q2.3.12 Fill in the Blank:** The ratio of $Na^+$ to $K^+$ for the sodium-potassium pump is __ out for __ in.
*Answer:* 3:2.

**Q2.3.13 Short Answer:** What is the total voltage difference during an action potential and what does it mean?
*Answer:* There is a 110 mV difference between the inside and outside, representing the full reversal of charge.

**Q2.3.14 Short Answer:** What happens in a failed attempt at an action potential?
*Answer:* 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?
*Answer:* It drives ions toward the opposing charge, aiding in establishing the RMP.

**Q2.3.16 Short Answer:** State the equilibrium values for $K^+$ and $Na^+$.
*Answer:* It is the voltage at which the ion's driving force in equals the driving force out; typically, $K^+$ = -80 mV and $Na^+$ = +55 mV.

**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"?
*Answer:* 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?
*Answer:* $-70$ mV; it represents the voltage difference between the inside and outside of the cell at rest.

**Q2.3.19 Short Answer:** Name two key components of the cell membrane that help maintain the RMP.
*Answer:* The phospholipid bilayer and embedded proteins.

**Q2.3.20 Short Answer:** What is meant by semipermeability in the context of the cell membrane?
*Answer:* Only molecules that are lipid, lipid soluble, small, and neutral can cross the membrane.

**Q2.3.21 Short Answer:** List the four main functions of embedded proteins in the cell membrane.
*Answer:* They function as receptors, channels (including gated channels), pumps, and enzymes.

**Q2.3.22 Multiple Choice:** Differential permeability says that this ion is more permeable than others.

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

*Answer: B.*

**Q2.3.23 Short Answer:** How does diffusion contribute to the RMP?
*Answer:* Ions move from high to low concentration across the membrane.

**Q2.3.24 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.

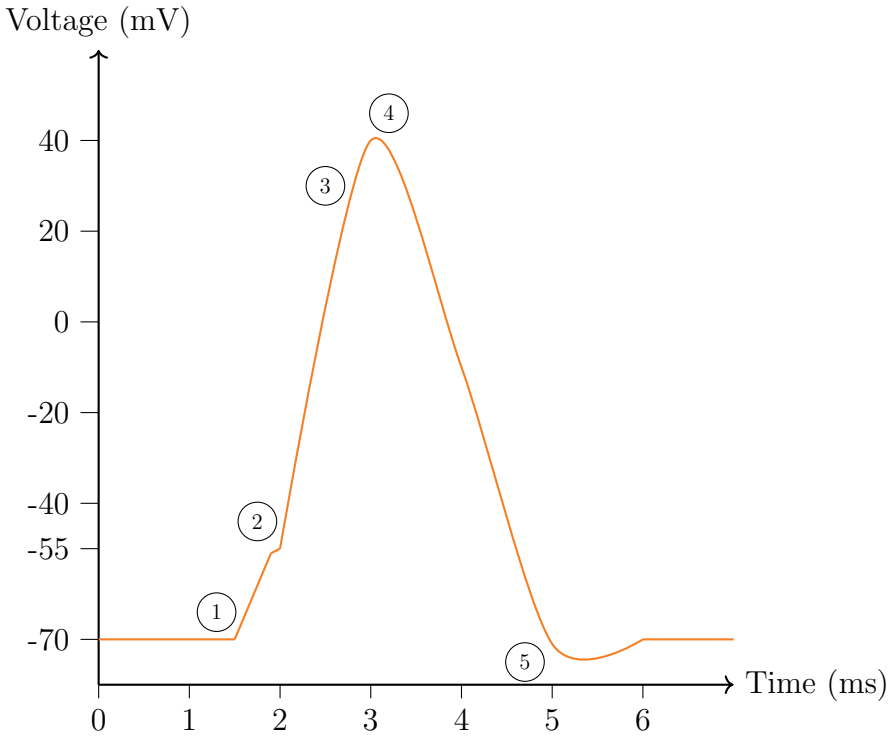
(C) The relationship between the amplitude of an action potential and the strength of the stimulus.

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

(E) None of the above.

*Answer: D.*

**Q2.3.25 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) $-80$ mV ..... (a)

**Q2.3.26 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.

*Answer:* B.

**Q2.3.27 Fill in the Blank:** The _____ is the site of action potential initiation in a neuron.
*Answer:* Axon hillock.

**Q2.3.28 Short Answer:** What is decremental conduction, and why does it occur?
*Answer:* Decremental conduction is the gradual weakening of a signal as it travels due to resistance and leakage.

**Q2.3.29 Short Answer:** Why does the action potential require active regeneration in unmyelinated axons?
*Answer:* Because it is regenerated at each point along the axon to prevent signal loss.

**Q2.3.30 Short Answer:** Why can't myelin sheaths extend indefinitely without nodes?
*Answer:* Because the decremental conduction would cause the action potential to weaken too much before reaching the end.

**Q2.3.31 Short Answer:** Explain multiple sclerosis in terms of saltatory conduction.
*Answer:* 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

*Answer:* C.

**Q2.4.2 Fill in the Blank:** The synaptic cleft is about _____ angstroms wide.
*Answer:* 20 Å. (I have 200 Å in my notes, but I think it's a typo. I Googled it, and it said 20 Å.)

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

(A) Voltage-gated $Ca^{+2}$ channels open.

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

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

(D) The synaptic vesicles dissolve.

*Answer:* A.

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

**Q2.4.5 Short Answer:** What is the function of docking proteins at the presynaptic membrane?
*Answer:* 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

*Answer:* D.

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

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

**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

*Answer:* C.

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

*Answer:* A.

**Q2.5.7 Short Answer:** How does binding to autoreceptors affect neurotransmitter release?
*Answer:* 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 _____.
*Answer:* Metabolism.

**Q2.5.9 Short Answer:** How do ionotropic and metabotropic synapses differ in terms of speed and duration?
*Answer:* 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.

*Answer:* B.

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

**Q2.5.12** **Short Answer:** What enzyme converts ATP to cAMP in the metabotropic signaling pathway?
*Answer:* Adenylate Cyclase.

**Q2.5.13** **Fill in the Blank:** The enzyme that metabolizes residual cAMP is called _____.
*Answer:* Phosphodiesterase.

**Q2.5.14** **Fill in the Blank:** _____ removes the phosphate and resets the channel in the metabotropic pathway.
*Answer:* Phosphoprotein phosphatase.

**Q2.5.15** **Short Answer:** Give an example of a neurotransmitter that works through an ionotropic synapse.
*Answer:* Acetylcholine (ACh).

**Q2.5.16** **Short Answer:** Give an example of a neuromodulator that works through a metabotropic synapse.
*Answer:* Dopamine.

**Q2.5.17** **Fill in the Blank:** The fine tuning of electrical signals is accomplished through presynaptic _____ and _____.
*Answer:* inhibition, facilitation.

**Q2.5.18** **Short Answer:** What happens during presynaptic inhibition?
*Answer:* The release of neurotransmitters is inhibited.

**Q2.5.19** **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)

**Q2.5.20 Fill in the Blank:** In the metabotropic signaling pathway, the _____ subunit of the G-protein binds to adenylate cyclase.
*Answer:* Alpha.

**Q2.5.21 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

*Answer:* A.

**Q2.5.22 Short Answer:** How does presynaptic facilitation affect neurotransmitter release?
*Answer:* It increases the amount of neurotransmitters released.

**Q2.5.23 Multiple Choice:** In gap junctions (electrical synapses), what crosses between neurons?

(A) Neurotransmitters

(B) Channels that allow direct electrical transmission

(C) Neuromodulators

(D) G-proteins

*Answer:* B.

**Q2.5.24 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

*Answer:* D.

**Q2.5.25 Short Answer:** Give an example of where electrical synapses are more common than in mammals.
*Answer:* Fish with simpler CNS.

## 2.6

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

**Choices**

(a) Voluntary control

(b) Purely motor

(c) Innervates striated muscles

(d) Functions as a whole

(e) More differentiated

(f) Relatively involuntary

(g) Contains both sensory and motor neurons

(h) Innervates smooth muscle, cardiac muscle, glands

(1) Somatic ..... (a, c, e, g)

(2) Autonomic ..... (b, d, f, h)

**Q2.6.2 Short Answer:** What types of tissues does the autonomic nervous system innervate?
*Answer:* Smooth muscle, cardiac muscle, and glands.

**Q2.6.3 Fill in the Blank:** Unlike the autonomic nervous system, the somatic nervous system includes both _____ and _____ neurons.
*Answer:* Sensory, motor.

**Q2.6.4 Multiple Choice:** Which system has more voluntary control?

(A) Somatic nervous system
(B) Autonomic nervous system
(C) Both have equal voluntary control
(D) Neither has voluntary control

*Answer:* A.

## 2.7

**Q2.7.1 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 Senses ..... (h)

**Q2.7.2 Short Answer:** Where are photoreceptors located in the visual system?
*Answer:* In the retina.

**Q2.7.3 Short Answer:** Where are hair cells found in the auditory system?
*Answer:* In the cochlea.

**Q2.7.4 Fill in the Blank:** _____ and _____ are both chemical senses that rely on chemicals binding to receptors.
*Answer:* Olfaction, gustation.

**Q2.7.5 Multiple Choice:** Which of the following is NOT a component of the somatosensory system?

(A) Proprioception
(B) Cutaneous senses
(C) Gustation
(D) Vestibular sensation

*Answer:* C.

**Q2.7.6 Short Answer:** Why are psychologists interested in sensory systems?
*Answer:* Because perceptions are the basis for behavior and mental processes.

**Q2.7.7 Fill in the Blank:** The difference between a physicist and psychologist studying sensory systems is that the physicist measures _____ while the psychologist measures _____.
*Answer:* stimulus, perceptions.

**Q2.7.8 Short Answer:** According to the notes, why is it important to understand that perceptions don't exactly match stimuli?
*Answer:* 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

*Answer:* A.

**Q2.8.2 Short Answer:** Compare and contrast the duration of effects in ionotropic versus metabotropic synapses.
*Answer:* Ionotropic synapses have fixed, rapid, and short effects, while metabotropic synapses have variable duration that can be very long.

**Q2.8.3 Fill in the Blank:** In an analogy explaining presynaptic facilitation, instead of 3 APs, the effect would seem like _____ APs.
*Answer:* 4.

**Q2.8.4 Multiple Choice:** Which of these statements best explains why sensory systems are important in psychology?

(A) Perceptions from sensory systems form the basis for behavior

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

(C) All psychological disorders involve sensory system dysfunction

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

*Answer:* A.

**Q2.8.5 Long Answer:** Describe the complete sequence of events in a metabotropic synapse, from neuromodulator binding to the resetting of the channel.
*Answer:* 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.