Cell structure

Question 1

Which of the following would be most reliably used to identify animal cells?

A) Cells clump into tissues
B) The cells move
C) Lack of identifiable cell wall
D) Cells appear multinucleate
E) The cells are larger than 5 μm in diameter

A) This answer is incorrect. While animal cells often form tissues, this is not a unique feature of animal cells. Many plant and fungal cells also aggregate into tissues, so this characteristic does not reliably distinguish animal cells from other eukaryotic cells.

B) This answer is incorrect. While some animal cells (e.g., muscle cells or immune cells) can exhibit movement, not all animal cells are motile. Additionally, certain other eukaryotic cells, such as some protists and sperm cells from plants, can move as well. Movement is not a definitive identifier of animal cells.

C) This is the correct answer. One reliable characteristic of animal cells is the absence of a rigid cell wall, which is present in plant, fungal, and some prokaryotic cells. Animal cells only have a flexible plasma membrane, making the lack of a cell wall a key distinguishing feature.

D) This answer is incorrect. While some animal cells, such as skeletal muscle cells, can be multinucleate, this is not a general feature of all animal cells. Many animal cells contain only a single nucleus. Additionally, some fungal cells can also be multinucleate, so this characteristic is not unique to animal cells.

E) This answer is incorrect. While animal cells are typically larger than 5 μm, this size range also applies to many other types of eukaryotic cells, including plant, fungal, and protist cells. Size alone is not a reliable identifier of animal cells.

Question 2

Which combination of features is found in all prokaryotes?

A) Flagella, Ribosomes, Cell wall, Circular DNA
B) Circular DNA, Ribosomes, Cell wall
C) Circular DNA, Flagella, Peroxisomes, Cell wall
D) Cilia, Ribosomes, Circular DNA, Cell wall
E) Peroxisomes, Ribosomes, Cilia

A) While prokaryotes do have ribosomes, a cell wall, and circular DNA, not all prokaryotes possess flagella. Flagella are used for movement, but they are not present in every prokaryote, so this combination isn't universally applicable. This answer is incorrect.

B) All prokaryotes have circular DNA (in the nucleoid), ribosomes for protein synthesis, and a cell wall that gives structure to the cell (though the composition of the cell wall may vary between bacteria and archaea). This combination covers features found in all prokaryotes. This is the correct answer.

C) While circular DNA and a cell wall are present in all prokaryotes, peroxisomes are not found in prokaryotes. Peroxisomes are membrane-bound organelles found in eukaryotic cells. Additionally, not all prokaryotes have flagella. This answer is incorrect.

D) Prokaryotes have ribosomes, circular DNA, and a cell wall, but they do not have cilia. Cilia are found in some eukaryotic cells, not in prokaryotes. Prokaryotic cells use flagella for movement if they have any external appendages. This answer is incorrect.

E) While prokaryotes do have ribosomes, they do not have peroxisomes or cilia. Peroxisomes are found in eukaryotes, and cilia are also exclusive to certain eukaryotic cells, making this combination inapplicable to prokaryotes. This answer is incorrect.

Question 3

Which of the following is true about mitochondria and chloroplasts?

A) Only one has a double membrane
B) Only one has its own DNA
C) Only one can survive outside its host cell
D) Neither has a larger inner membrane than outer membrane
E) Both respond to the oxidative balance of a cell

A) This answer is incorrect. Both mitochondria and chloroplasts have a double membrane. Mitochondria have an outer membrane and a highly folded inner membrane (cristae), while chloroplasts also have an outer membrane and an inner membrane. This shared feature is crucial for their respective functions in energy metabolism and photosynthesis.

B) This answer is incorrect. Both mitochondria and chloroplasts contain their own circular DNA. This is a key aspect of the endosymbiotic theory, which suggests that both organelles originated from free-living prokaryotes. They use their DNA to produce some of their own proteins independently of the host cell.

C) This answer is incorrect. Neither mitochondria nor chloroplasts can survive independently outside their host cell. Although they evolved from free-living bacteria, they are now highly specialized organelles that rely on the host cell for many functions, including protection, nutrients, and some protein synthesis.

D) This answer is incorrect. Mitochondria have a larger inner membrane surface area than their outer membrane due to the extensive folding of the inner membrane into structures called cristae. Chloroplasts have an intricate internal membrane system, including thylakoid membranes, that also increases surface area. Thus, this statement is false.

E) This is the correct answer. Both mitochondria and chloroplasts are involved in cellular redox reactions and respond to changes in the oxidative balance of the cell. Mitochondria are central to oxidative phosphorylation and ATP production, while chloroplasts are involved in photosynthesis and can also influence oxidative stress responses. Their function is closely tied to the cell's redox environment.

Question 4

Which of the following is most false about heterochromatin?

A) It is relatively unpackaged
B) It always contains DNA & Protein
C) It is found more predominantly at the edges of the nucleus
D) Is found at the centre of the cell involved in ribosome synthesis
E) It stains darkly on a micrograph.

A) This answer is most false and correct for the question. Heterochromatin is actually highly compacted, not unpackaged. It is tightly packed DNA that is transcriptionally inactive or less active, in contrast to euchromatin, which is loosely packed and more transcriptionally active. This statement is the most inaccurate regarding heterochromatin.

B) This answer is incorrect (i.e., true about heterochromatin). Like all chromatin, heterochromatin is made of DNA and associated proteins, such as histones. This statement accurately describes the basic composition of heterochromatin and is not false. Try again!

C) This answer is incorrect (i.e., true about heterochromatin). Heterochromatin is often found at the periphery of the nucleus, attached to the nuclear envelope. Its position helps to compartmentalize inactive regions of the genome. Therefore, this statement is true and not the most false. Try again!

D) This answer is incorrect (i.e., true about heterochromatin). Heterochromatin is not involved in ribosome synthesis, which occurs in the nucleolus. Ribosome synthesis is more related to euchromatin in the nucleolus, where rRNA genes are transcribed. However, this statement doesn't describe heterochromatin's role or location. Try again!

E) This answer is incorrect (i.e., true about heterochromatin). Heterochromatin appears darkly stained on electron micrographs because of its dense, tightly packed structure. This high level of compaction increases the contrast in staining techniques, making it easily identifiable. Therefore, this statement is true and not false. Try again!

Question 5

Which of the following magnifications would enable you to see cell nuclei, but not bacteria?

A) 16x ocular lens and 80x objective lens
B) 8x ocular lens and 4x objective lens
C) 4x ocular lens and 20x objective lens
D) 16x ocular lens and 160x objective lens
E) 8x ocular lens and 40x objective lens

A) To calculate the overall magnification, multiply the two lens magnifications together. At 1280x magnification you would be able to see bacteria, so this answer is wrong. Try again!

B) To calculate the overall magnification, multiply the two lens magnifications together. At 32x magnification you would not be able to see cell nuclei, so this answer is wrong. Try again!

C) To calculate the overall magnification, multiply the two lens magnifications together. At 80x magnification you would just about be able to see cell nuclei, but not easily, so this answer is partially correct. Try again!

D) To calculate the overall magnification, multiply the two lens magnifications together. At 2560x magnification you would easily be able to see bacteria, so this answer is wrong. Try again!

E) To calculate the overall magnification, multiply the two lens magnifications together. At 320x magnification you would be able to see nuclei but not bacteria, so this answer is correct. Well done!

Question 6

Which of the following is NOT an advantage of transmission light microscopy over other types of microscope?

A) You can use a wide variety of staining techniques
B) The equipment is relatively cheap
C) You can visualise transparent objects
D) Your sample can be viewed alive (without fixing)
E) It is quick and easy to prepare samples

A) This answer is an advantage of transmission light microscopy. One of the advantages of transmission light microscopy is the ability to use various staining techniques to enhance contrast and visualise different cellular structures. Therefore, this statement does not represent a disadvantage of transmission light microscopy. Try again.

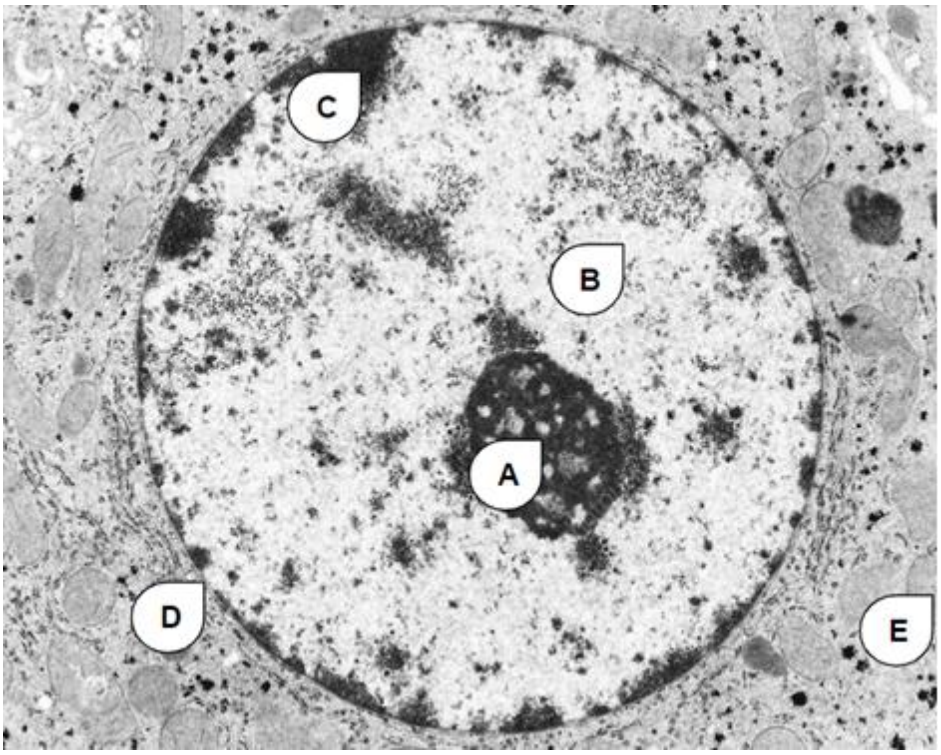
B) This answer is an advantage of transmission light microscopy compared to more advanced techniques like electron microscopy or confocal microscopy, which are very expensive. Try again.

C) Well done. Transparent objects, like many animal cells, are poorly visualised by transmission light microscopy alone. Without staining or other non-transparent objects, all we see is white light.

D) Your sample can be viewed alive (without fixing)
Feedback: This answer is an advantage of transmission light microscopy compared with other types of microscopy. Many coloured living cells -such as protists- can be effectively viewed alive using transmission light microscopy. Try again.

E) It is quick and easy to prepare samples
Feedback: This answer is sometimes an advantage of transmission light microscopy, so this answer is partially correct and incorrect. Transmission light microscopy can range from as simple as placing an object on a slide to sophisticated and lengthy staining and fixing techniques.

Question 7



Which letter indicates heterochromatin on the diagram above?

A) You have picked a darkly stained region in the middle of the nucleus, but this is the nucleolus, not heterochromatin. The nucleolus is involved in RNA production and ribosome synthesis. Try again!

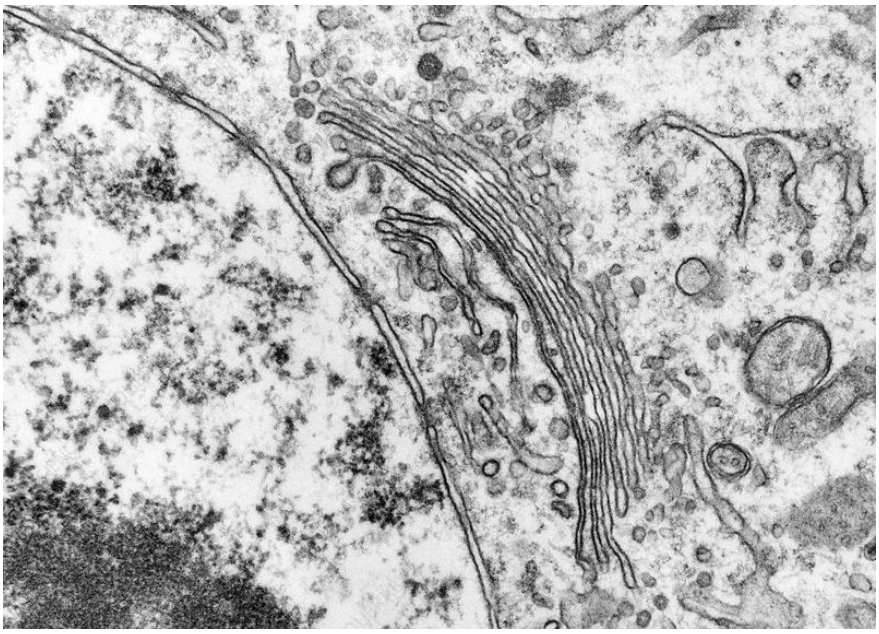
B) This area is in the nucleus, but is lightly stained. Light staining means there is not much material present. Heterochormatin is quite dense and so would stain more. Try again!

C) Well done. This is a heavily stained area within the nucleus, and heterochromatin stains heavily because it is highly condensed. It is quite common to see lots of heterochromatin close to the nuclear envelope, like on this micrograph.

D) Sorry, you've selected the label that indicates the nuclear envelope. Heterochromatin is found within the nucleus, not in the nuclear envelope. Try again!

E) You have selected a vesicle that is outside the nucleus. The nucleus is the large round object in the centre of the micrograph. Heterochromatin is found within the nucleus. Try again!

Question 8



Which of the following is most true about the transmission electron micrograph shown above?

A) The nucleus is on the right of the image
B) The trans face of the golgi has less darkly stained membranes than the cis face
C) We cannot identify the nuclear pores at this magnification
D) It is unusual to see golgi apparatus so near to the nucleus
E) The rough endoplasmic reticulum is clearly visible

A) The nucleus is on the left of this image, separated by the double membrane that runs from the top left corner to the bottom middle of the micrograph. Try again.

B) The 'cis' face of golgi is that facing the nucleus, which is on the left. These membranes are darker, suggesting they have higher protein content. The 'trans' facing side is on the right, where the membranes are less heavily stained, as the statement says. Well done.

C) We can see the nuclear pores. These are shown on the double membrane that runs from the top left corner to the bottom middle of the micrograph. The pores are where the double membrane pinches together with some darkly staining proteins associated Try again.

D) Golgi is in the centre-right of the micrograph and is very close to the nucleus. This is actually very common in cells. Try again.

E) There is little to no rough endoplasmic reticulum on this micrograph. Perhaps you confused rough ER with golgi apparatus? Try again.

Question 9

A eukaryotic cell exhibits abnormal protein folding, leading to dysfunctional enzymes and impaired lipid synthesis. Additionally, the cell struggles to detoxify harmful substances. Which combination of organelles is most likely involved in these malfunctions?

A) Rough Endoplasmic Reticulum and Lysosome
B) Smooth Endoplasmic Reticulum and Golgi Apparatus
C) Rough Endoplasmic Reticulum and Peroxisome
D) Smooth Endoplasmic Reticulum and Peroxisome
E) Mitochondrion and Golgi Apparatus

A) The Rough Endoplasmic Reticulum (RER) is involved in protein synthesis and folding, so it could contribute to abnormal protein folding. However, lysosomes are primarily involved in waste digestion and recycling cellular components, not lipid synthesis or detoxification. Therefore, this answer only addresses part of the problem and is incorrect.

B) The Smooth Endoplasmic Reticulum (SER) is responsible for lipid synthesis and detoxification, making it a good candidate for the cell's lipid and detoxification issues. However, the Golgi apparatus is mainly responsible for modifying, sorting, and packaging proteins rather than directly handling protein folding or lipid synthesis. Therefore, this answer is partially correct but not the best choice.

C) The Rough Endoplasmic Reticulum (RER) deals with protein folding, but the Peroxisome is primarily involved in detoxifying harmful substances and lipid metabolism. While peroxisomes contribute to lipid breakdown and detoxification, the RER doesn't play a major role in lipid synthesis. Hence, this is close but not fully correct.

D) This is the correct answer. The Smooth Endoplasmic Reticulum (SER) is essential for lipid synthesis and detoxification, addressing both lipid synthesis and detoxification issues. The Peroxisome also plays a key role in lipid metabolism and detoxifying substances, making this combination the most appropriate for the malfunctions described.

E) Mitochondria are responsible for producing energy (ATP) through cellular respiration, and the Golgi apparatus is involved in modifying and packaging proteins. Neither organelle plays a direct role in lipid synthesis or detoxification, so this combination does not address the cell's issues and is incorrect.

Question 10

A cell biologist is investigating a disruption in protein secretion and intracellular transport within a eukaryotic cell. Which part of the endomembrane system is **least likely** to be directly involved in this malfunction?

A) Rough Endoplasmic Reticulum, because it synthesises and folds proteins
B) Golgi Apparatus, because it modifies, sorts, and packages proteins for secretion
C) Lysosome, because it degrades waste and worn-out organelles
D) Smooth Endoplasmic Reticulum, because it synthesises lipids and detoxifies substances
E) Vesicles, because they transport materials between the different compartments of the endomembrane system

A) This answer is incorrect. The Rough Endoplasmic Reticulum (RER) is crucial for protein synthesis and folding, particularly for proteins that are secreted or sent to the cell membrane. If there is a disruption in protein secretion, the RER would likely be directly involved in this malfunction, making this option not the least likely to be involved.

B) This answer is incorrect. The Golgi Apparatus plays a key role in modifying, sorting, and packaging proteins for secretion. If there is a disruption in protein secretion, the Golgi would definitely be implicated in this process, meaning this option is also not the least likely to be involved.

C) This answer is correct. While lysosomes are important for degradation and recycling within the cell, they are not directly involved in protein secretion or intracellular transport. If the focus is specifically on protein secretion, the lysosome would be the least likely to be involved in this malfunction.

D) This answer is incorrect. The Smooth Endoplasmic Reticulum (SER) is involved in lipid synthesis and detoxification, but it does not directly participate in protein secretion. However, since the malfunction is focused on protein secretion, the SER is less likely to be implicated than other parts of the endomembrane system, but it is not the least likely when compared to the lysosome.

E) This answer is incorrect. Vesicles are critical for transporting proteins and lipids between different compartments of the endomembrane system, including from the RER to the Golgi Apparatus and from the Golgi to the cell membrane. Therefore, vesicles are directly involved in protein secretion and transport, making this option not the least likely to be involved.

Neuromuscular physiology

Question 1

Which of the following correctly describes the function of a specific neuronal structure?

a. Dendrites generate action potentials and transmit them to the axon terminals.
b. Axon terminals receive signals from other neurons and integrate incoming information.
c. The axon hillock is the site where graded potentials are converted into an action potential if the threshold is reached.
d. The myelin sheath directly transmits electrical impulses from one node of Ranvier to the next.
e. The nucleus of the neuron generates neurotransmitters and releases them into the synapse.

A) Incorrect – Dendrites do not generate action potentials. Instead, they receive signals (often graded potentials) from other neurons and transmit them toward the cell body. Action potentials are initiated at the axon hillock, not in the dendrites.
B) Incorrect – Axon terminals do not receive or integrate signals; they are responsible for releasing neurotransmitters into the synaptic cleft to communicate with the next neuron. Signal reception and integration occur at the dendrites and soma.
C) Correct – The axon hillock is the trigger zone where incoming graded potentials are summed. If the threshold potential is reached, a full action potential is generated and transmitted down the axon.
D) Incorrect – The myelin sheath does not transmit impulses directly. Instead, it acts as an insulator, allowing the saltatory conduction of action potentials by forcing them to "jump" between nodes of Ranvier, where ion exchange occurs.
E) Incorrect – The nucleus contains the genetic material and regulates protein synthesis, but it does not directly generate or release neurotransmitters. Neurotransmitters are synthesized in the cell body or axon terminals and stored in synaptic vesicles for release.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 2

Which of the following best explains why the resting membrane potential of a typical neuron is approximately -70 mV?

a. The sodium-potassium pump moves more positively charged ions into the neuron than out, making the inside negative.
b. The action of voltage-gated sodium channels keeps the resting membrane potential stable at -70 mV.
c. Negatively charged proteins actively move across the membrane to maintain the negative resting potential.
d. Potassium ions leak out of the neuron more easily than sodium ions leak in, creating a net negative charge inside the cell.
e. Chloride ions continuously enter the neuron at rest, making the inside more negative than the outside.

A) Incorrect – The sodium-potassium pump does contribute to the resting potential, but it moves 3 Na^+ out for every 2 K^+ in, making the inside of the cell more negative by removing more positive charge than it brings in. However, this is not the main reason for the resting membrane potential.

B) Incorrect – Voltage-gated sodium channels are mostly closed at resting potential and play a role only during action potential generation, not in maintaining the resting membrane potential.

C) Incorrect – While negatively charged proteins inside the cell do contribute to the negative resting potential, they are too large to cross the membrane and do not actively move to maintain the charge.

D) Correct – The selective permeability of the membrane to potassium is the key factor in generating the resting potential. Potassium ions (K^+) leak out of the neuron through potassium leak channels more easily than sodium (Na^+) leaks in. This loss of positive charge makes the inside of the neuron more negative relative to the outside.

E) Incorrect – While chloride (Cl^-) ions can enter the neuron, they do not drive the resting potential. The primary mechanism is K^+ efflux through leak channels, not Cl^- influx.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 3

A researcher applies a drug that selectively blocks voltage-gated sodium channels in a neuron. Which of the following would most likely occur?

a. The neuron will be unaffected because potassium channels are still functional.
b. The neuron will still generate an action potential, but it will propagate more slowly.
c. The neuron will fire an action potential, but repolarization will be delayed.
d. The neuron will remain permanently depolarized because it cannot repolarize.
e. The neuron will still depolarize if stimulated, but it will fail to fire an action potential.

A) Incorrect – Potassium (K^+) channels help with repolarization, but an action potential cannot start without sodium (Na^+) influx. Therefore, the neuron would be affected and fail to fire an action potential.

B) Incorrect – Action potentials rely on the opening of voltage-gated sodium (Na^+) channels for depolarization. Blocking these channels prevents action potential initiation, rather than just slowing its propagation.

C) Incorrect – Repolarization primarily depends on voltage-gated potassium (K^+) channels, not sodium channels. If the action potential were generated, repolarization would still occur normally.

D) Incorrect – Even if sodium channels are blocked, the neuron would not remain permanently depolarized. The resting membrane potential is maintained by the sodium-potassium pump and K^+ leak channels, so the neuron would stay at its resting potential rather than remaining depolarized.

E) Correct – Without voltage-gated sodium channels, the neuron can still depolarize slightly due to excitatory stimuli, but it cannot reach the threshold needed to generate an action potential. This is because Na^+ influx is the main driver of rapid depolarization.

Question 4

A patient suffers a spinal cord injury that disrupts communication between sensory and motor neurons but leaves sensory neuron function intact. Based on this, which of the following statements is most likely true?

a. The patient will still be able to move their limbs voluntarily, but they will not feel any external stimuli.
b. The patient will have no movement in response to stimuli, but they will still be able to feel sensations normally.
c. The patient will still be able to reflexively withdraw from a painful stimulus, but they will not consciously perceive it.
d. The patient will be able to move voluntarily but will be unable to respond to reflex stimuli.
e. The patient's motor neurons are unaffected, so they will retain both voluntary and reflexive movement.

A) Incorrect – If the injury disrupts communication between sensory and motor neurons, the patient would lose motor control rather than sensory function. They would still feel sensations, but their ability to generate movement would be impaired.

B) Incorrect – If sensory neurons are intact, the patient will still feel sensations. However, their motor neurons cannot receive commands from the brain, meaning voluntary movement is impaired.
C) Correct – Reflex arcs can bypass the brain and involve only sensory, relay, and motor neurons in the spinal cord. Since the sensory neurons are still functional, reflex actions can occur without conscious perception. However, the brain wouldn't receive the sensory input due to disrupted communication, meaning the patient wouldn't be aware of the stimulus.
D) Incorrect – Reflex responses do not require voluntary control; they are mediated by relay neurons in the spinal cord. If communication between sensory and motor neurons is disrupted, reflexes may still function, but voluntary movement will be lost.
E) Incorrect – The injury disrupts the pathway between neurons, meaning motor function is impaired even if the motor neurons themselves are undamaged. Reflexive and voluntary movement both require a functioning neural circuit.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 5

A patient suffers damage to a specific part of their nervous system, resulting in loss of involuntary control over heart rate and digestion, but their ability to move voluntarily remains intact. Based on this, which part of the nervous system is most likely affected?

a. The autonomic nervous system, because it regulates involuntary functions like heart rate and digestion.
b. The somatic nervous system, because it controls both voluntary movement and involuntary reflexes.
c. The sympathetic nervous system, because it is the only branch responsible for involuntary organ control.
d. The parasympathetic nervous system, because it directly controls both voluntary and involuntary processes.
e. The spinal cord, because all nervous system signals, voluntary or involuntary, pass through it.

A) Correct – The autonomic nervous system (ANS) regulates involuntary functions like heart rate, digestion, and respiration. Since these functions are impaired but voluntary movement is intact, this suggests damage to the ANS, not the somatic system.

B) Incorrect – The somatic nervous system controls voluntary movement (e.g., skeletal muscle contractions) and some reflexes, but not involuntary functions like heart rate and digestion. Since these are affected in the patient, the somatic nervous system is not the cause of the problem.

C) Incorrect – The sympathetic nervous system is one part of the autonomic nervous system, but not the only one responsible for involuntary organ control. The parasympathetic nervous system also plays a role. Damage to both branches of the ANS would be needed to cause this type of dysfunction.

D) Incorrect – The parasympathetic nervous system is part of the autonomic nervous system, but it does not control voluntary movements. Since voluntary movement is unaffected in the patient, this cannot be the correct answer.

E) Incorrect – While the spinal cord is important for signal transmission, damage to the spinal cord would likely affect both voluntary and involuntary functions. Since voluntary movement is still intact in the patient, the issue is more specific to the autonomic nervous system.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 6

A scientist applies a toxin that prevents voltage-gated calcium (Ca^{2+}) channels from opening in the presynaptic neuron. Which of the following will most likely occur?

a. The action potential will fail to reach the axon terminal, preventing synaptic transmission.
b. Neurotransmitters will still be released, but the postsynaptic neuron will not respond.
c. Neurotransmitter release will be blocked, preventing signal transmission across the synapse.
d. The postsynaptic neuron will generate an action potential, but it will be weaker than normal.
e. The toxin will have no effect because synaptic transmission is driven by sodium (Na^{+}) influx.

A) Incorrect – The action potential itself depends on sodium (Na^{+}) and potassium (K^{+}) channels, not calcium channels. It will still reach the axon terminal, but neurotransmitter release will be affected.

B) Incorrect – Neurotransmitter release depends on Ca^{2+} influx. If voltage-gated Ca^{2+} channels are blocked, no neurotransmitters will be released. This means the postsynaptic neuron will receive no signal at all.

C) Correct – In normal synaptic transmission, Ca^{2+} influx triggers the exocytosis of neurotransmitter-containing vesicles. Blocking voltage-gated Ca^{2+} channels prevents neurotransmitter release, stopping signal transmission across the synapse.

D) Incorrect – If neurotransmitters are not released, the postsynaptic neuron won't depolarize at all, meaning no action potential can be generated. A "weaker" action potential isn't possible, as action potentials follow the all-or-nothing principle.

E) Incorrect – While sodium (Na^{+}) influx is crucial for the action potential in the presynaptic neuron, synaptic transmission itself depends on calcium (Ca^{2+})-mediated neurotransmitter release. Without Ca^{2+}, neurotransmission fails.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 7

A neuron is experimentally treated with a drug that prevents neurotransmitter reuptake at the synapse. Which of the following is the most likely effect on synaptic transmission?

a. Neurotransmitters will accumulate in the synaptic cleft, leading to prolonged stimulation of the postsynaptic neuron.
b. The presynaptic neuron will be unable to release neurotransmitters, preventing synaptic transmission.
c. The postsynaptic neuron will immediately stop responding to neurotransmitters, blocking signal transmission.
d. The action potential in the presynaptic neuron will not reach the axon terminal, halting neurotransmitter release.
e. The neurotransmitters will degrade instantly, making synaptic transmission weaker than normal.

A) Correct – Normally, neurotransmitters are removed from the synaptic cleft via reuptake transporters or enzymatic breakdown. Blocking reuptake means neurotransmitters remain in the cleft longer, leading to prolonged activation of receptors on the postsynaptic neuron. This is how some drugs (e.g., SSRIs for serotonin) enhance neurotransmission.

B) Incorrect – Neurotransmitter release depends on Ca^{2+} influx, not reuptake. The presynaptic neuron can still release neurotransmitters, but they won't be efficiently removed from the synapse.

C) Incorrect – The opposite is true: The postsynaptic neuron will experience prolonged activation, not immediate cessation of response. Since neurotransmitters are not removed efficiently, they will keep binding to receptors and enhance signaling.

D) Incorrect – The action potential in the presynaptic neuron is unaffected. It still reaches the axon terminal and triggers neurotransmitter release. The issue is neurotransmitter clearance, not action potential propagation.

E) Incorrect – Neurotransmitters do not degrade instantly; they are either broken down by enzymes (e.g., acetylcholinesterase for acetylcholine) or taken back into the presynaptic neuron. Blocking reuptake would make transmission stronger and longer-lasting, not weaker.

Question 8

Which of the following statements correctly distinguishes between smooth, skeletal (striated), and cardiac muscle tissue?

a. Skeletal and cardiac muscles are both voluntary, while smooth muscle is involuntary.
b. Cardiac muscle does not require ATP for contraction, as it has pacemaker cells that generate electrical impulses.
c. Skeletal muscle has intercalated discs, allowing synchronized contractions like cardiac muscle.
d. Smooth muscle contracts the fastest, followed by cardiac muscle, with skeletal muscle being the slowest.
e. Smooth muscle lacks sarcomeres, giving it a non-striated appearance under a microscope.

A) Incorrect – Only skeletal muscle is voluntary. Both cardiac and smooth muscle are involuntary, meaning they contract without conscious control. Cardiac muscle has intrinsic pacemaker activity, while smooth muscle is controlled by the autonomic nervous system.

B) Incorrect – Cardiac muscle absolutely requires ATP for contraction. While pacemaker cells generate electrical impulses, the mechanical contraction still depends on ATP-driven cross-bridge cycling between actin and myosin.

C) Incorrect – Intercalated discs are unique to cardiac muscle, not skeletal muscle. These specialized structures contain gap junctions and desmosomes, allowing synchronized electrical and mechanical activity in the heart. Skeletal muscle fibers are independent and do not require intercalated discs.

D) Incorrect – Skeletal muscle contracts the fastest, followed by cardiac muscle, while smooth muscle is the slowest. Smooth muscle contractions are slow but energy-efficient, making them ideal for functions like peristalsis and blood vessel regulation.

E) Correct – Smooth muscle does not contain sarcomeres, which is why it appears non-striated under a microscope. Instead, its actin and myosin filaments are arranged in a random, crisscross pattern, allowing for slow, sustained contractions.

Question 9

Which of the following correctly describes a step in the process of muscle contraction initiation?

a. The sarcoplasmic reticulum (SR) releases sodium (Na^+) ions, which trigger troponin binding and exposure of myosin-binding sites.
b. Calcium (Ca^{2+}) ions bind to myosin, causing a conformational change that allows crossbridge formation.
c. ATP hydrolysis directly triggers the power stroke, pulling actin toward the sarcomere center.
d. The myosin head remains permanently bound to actin after contraction unless forcibly detached by an external force.
e. The T-tubules transmit the action potential deep into the muscle fiber, leading to calcium release from the sarcoplasmic reticulum.

A) Incorrect – The sarcoplasmic reticulum (SR) releases calcium (Ca^{2+}) ions, not sodium (Na^+). Calcium is essential for binding to troponin, which then shifts tropomyosin and exposes the myosin-binding sites on actin. Sodium is involved in nerve signal propagation, not direct contraction triggering.

B) Incorrect – Calcium binds to troponin, not myosin. This causes a conformational shift in tropomyosin, which exposes the myosin-binding sites on actin, allowing the crossbridge cycle to begin.

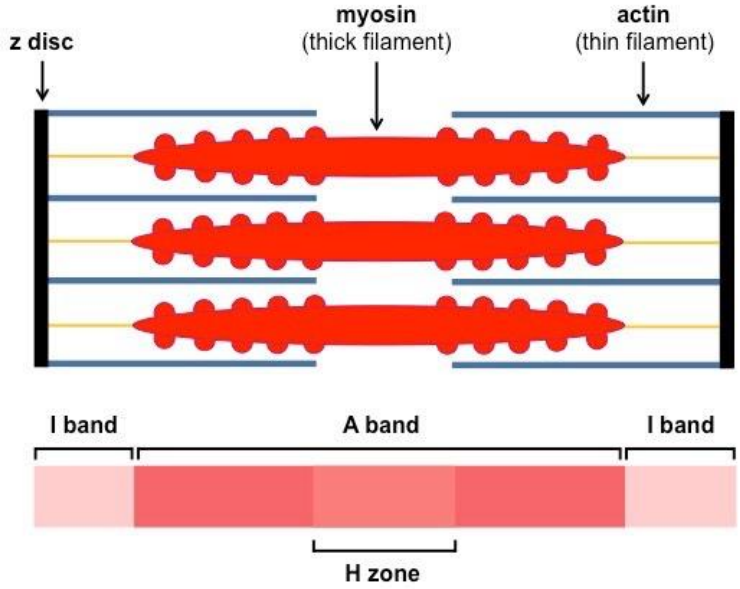
C) Incorrect – ATP hydrolysis does not trigger the power stroke. Instead, ATP hydrolysis energizes the myosin head, preparing it for attachment. The actual power stroke occurs when ADP and Pi are released from the myosin head, pulling actin toward the sarcomere center.

D) Incorrect – Myosin remains attached to actin only until a new ATP molecule binds. ATP binding causes myosin to detach from actin. If no ATP is available (such as after death), myosin stays bound, leading to rigor mortis.

E) Correct – T-tubules (transverse tubules) are invaginations of the sarcolemma that transmit the action potential deep into the muscle fiber. This electrical signal triggers calcium release from the sarcoplasmic reticulum, which is essential for muscle contraction.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 10



Sarcomere structure is shown in the image above. Which of the following statements correctly describes the changes that occur in the sarcomere during muscle contraction?

a. The A-band shortens, causing the muscle to contract.
b. The I-band and H-zone decrease in size, while the A-band remains unchanged.
c. The Z-discs move farther apart, elongating the sarcomere.
d. The H-zone remains unchanged, but the I-band decreases in size.
e. Both actin and myosin filaments shorten, leading to muscle contraction.

A) Incorrect – The A-band represents the entire length of the myosin filaments, which do not change length during contraction. Instead, actin slides over myosin, reducing the size of the I-band and H-zone.

B) Correct – During contraction, actin filaments slide inward, making the I-band (actin-only region) and H-zone (myosin-only region) smaller. The A-band (entire myosin length) stays the same, confirming the sliding filament model.

C) Incorrect – Z-discs move closer together, not farther apart. Since sarcomeres are the functional contractile units, their shortening leads to overall muscle contraction.

D) Incorrect – The H-zone also decreases during contraction. The H-zone represents the region where only myosin is present, and as actin slides inward, the H-zone becomes smaller or even disappears in fully contracted muscle.

E) Incorrect – Neither actin nor myosin filaments change length. Instead, they slide past each other, shortening the sarcomere but keeping their individual filament lengths constant.

Biological molecules

Question 1

Which of the following statements correctly describes the nature of bonding in biological molecules?

A) Hydrogen bonds are the primary forces stabilising the phosphodiester bonds between nucleotides in DNA.
B) Covalent bonds are responsible for maintaining the secondary structure of proteins, such as alpha helices and beta sheets.
C) Van der Waals forces and hydrophobic interactions contribute significantly to the stabilisation of lipid bilayers in cell membranes.
D) Ionic bonds are stronger than covalent bonds in aqueous environments due to their electrostatic nature.

A) Phosphodiester bonds, which link nucleotides together in the backbone of DNA, are covalent bonds. Hydrogen bonds stabilise the base-pairing between complementary strands of DNA (A-T, C-G), not the phosphodiester bonds in the backbone. Try again!

B) The secondary structure of proteins, such as alpha helices and beta sheets, is primarily stabilised by hydrogen bonds between the backbone atoms (carbonyl oxygen and amide hydrogen). Covalent bonds (peptide bonds) are involved in linking amino acids in the primary structure, not in stabilising secondary structures. Try again!

C) Correct! Lipid bilayers are primarily stabilised by hydrophobic interactions between the fatty acid tails of lipids, which aggregate to avoid water. Van der Waals forces also play a role in stabilising these interactions between nonpolar lipid tails. The hydrophilic heads interact with water, while the tails cluster due to hydrophobic forces, leading to the formation of the bilayer.

D) In aqueous environments, ionic bonds are actually weaker than covalent bonds. Water molecules can shield charged ions (through hydration shells), reducing the strength of ionic interactions. Covalent bonds, which involve sharing of electrons, remain strong in water and are typically much stronger than ionic bonds in such environments.

Question 2

Which of the following statements correctly describes a feature of protein structure?

A) The primary structure of a protein is stabilised solely by hydrogen bonds between amino acid residues.
B) Tertiary structure refers to the arrangement of multiple polypeptide subunits in a protein complex.
C) Secondary structure includes alpha helices and beta sheets, which are stabilised by hydrogen bonding between the backbone atoms of the polypeptide chain.
D) Disulfide bonds contribute to the quaternary structure of proteins by stabilising interactions between individual polypeptide chains.

A) Incorrect. The primary structure of a protein refers to the linear sequence of amino acids linked by peptide bonds (covalent bonds), not hydrogen bonds. Hydrogen bonds stabilise higher levels of protein structure, such as secondary, tertiary, and quaternary structures.

B) Incorrect. Tertiary structure describes the three-dimensional folding of a single polypeptide chain, stabilised by interactions like hydrophobic interactions, hydrogen bonds, ionic bonds, and disulfide bonds. The arrangement of multiple polypeptide subunits is a feature of the quaternary structure, not tertiary.

C) Correct! Secondary structure consists of regular patterns such as alpha helices and beta sheets, stabilised by hydrogen bonds between the carbonyl oxygen and amide hydrogen of the polypeptide backbone. These hydrogen bonds do not involve the side chains but rather the repeating backbone structure.

D) Partially correct but misleading. Disulfide bonds can indeed stabilise interactions between individual polypeptide chains in quaternary structure (as seen in some multi-chain proteins). However, they also play a crucial role in stabilising tertiary structure within a single polypeptide chain by linking different parts of the same chain. Thus, disulfide bonds can stabilise both tertiary and quaternary structures, but this answer oversimplifies their role. Try again!

Question 3

Which of the following is NOT a reason proteins are slow to be digested?

A) Proteins tend to have hydrophilic residues on the outside
B) Varying amino acid R-groups increase the variety of enzymes needed
C) High bond-energy of the C-N bond
D) The secondary structures of proteins hinder their digestion
E) Proteins are often cross-linked with disulfide bridges

a) While proteins often have hydrophilic residues on their outer surfaces to interact with aqueous environments, these do not slow down digestion. The hydrophilic exterior actually facilitates interaction with digestive enzymes. This is therefore the correct answer, well done!

b) Varying amino acid R-groups slows down digestion, because it allows proteins to have very complex shapes which are difficult to digest. Look for a reason that enables enzymes to work. Try again.

c) This is a questionable answer. Strong C-N (peptide) bonds do contribute to the stability of proteins, but the bond energy is not the main reason for the slow digestion of proteins. Proteolytic enzymes, like pepsin and trypsin, are highly specialised in breaking peptide bonds efficiently. There is another answer that actually enables digestive enzymes. Try again.

d) This is true. The secondary structures of proteins, like alpha helices and beta sheets, are stabilised by hydrogen bonds, which can make the protein less accessible to enzymes. Proteins need to be unfolded (denatured) before proteases can efficiently hydrolyze peptide bonds. Therefore, this is a reason proteins are slow to be digested, making this answer incorrect in terms of the question. Try again.

e) This is true. Disulfide bridges between cysteine residues form covalent bonds that add significant stability to protein structures, making them more resistant to degradation. These bonds need to be reduced or broken before digestion can proceed effectively. Therefore, this is a reason for slow digestion of proteins, making this answer incorrect for the question. Try again.

Question 4

Which of the following fatty acids would have the lowest melting point?

A) trans- Δ9 hexadecenoic acid
B) octadecenoic acid
C) trans- Δ9 octadecenoic acid
D) cis- Δ9 hexadecenoic acid
E) cis- Δ9 octadecenoic acid

a) Incorrect. Trans fatty acids have straighter chains compared to their cis counterparts, which allows for tighter packing of molecules, similar to saturated fats. This results in higher melting points.

b) Incorrect. Saturated molecules and longer chained molecules tend to have higher melting points. Octadecenoic acid would therefore have a relatively high melting point.

c) Incorrect. The trans configuration allows for tighter packing of the fatty acid chains, resulting in a higher melting point than the cis isomer.

d) Correct! Shorter chains allow for fewer van der waal interactions, lowering melting points. Cis fatty acids have a kink in their structure due to the double bond, which prevents tight packing and lowers the melting point. With 16 carbons and a cis double bond at the 9th carbon, this fatty acid is shorter than the 18-carbon fatty acids, making it have a lower melting point than longer fatty acids.

e) Incorrect. This is an unsaturated fatty acid with a cis double bond, which lowers its melting point compared to trans or saturated fatty acids. However, it has 18 carbons, which makes it longer than the cis-Δ9 hexadecenoic acid (16 carbons). The longer chain increases intermolecular forces, raising the melting point slightly compared to the shorter, 16-carbon cis-fatty acid.

Question 5

Which of the following does not help explain why lipid bilayers spontaneously form?

a) Hydrophobic tails like to aggregate together
b) Hydrophilic head groups like to be surrounded by water
c) Proteins are embedded within membranes
d) Phospholipids can move past each other easily (are fluid) at normal temperatures

a) Incorrect. This is a key reason why lipid bilayers spontaneously form. The hydrophobic effect drives the aggregation of the fatty acid tails in water, minimising their exposure to the aqueous environment. By clustering together, the hydrophobic tails reduce contact with water, which is energetically favourable. This answer helps explain bilayer formation, so it is not the correct choice for what does not explain spontaneous formation.

b) Incorrect. This is another crucial factor in the spontaneous formation of lipid bilayers. The hydrophilic head groups are attracted to the aqueous environment and prefer to be in contact with water. This aligns with the natural arrangement of phospholipids in a bilayer, where the hydrophilic heads face the water on both sides. This helps explain bilayer formation, so it is not the correct choice for what does not explain the process.

c) Correct. While proteins are indeed embedded in membranes and play important functional roles (such as transport, signalling, and structural support), this fact does not explain why lipid bilayers spontaneously form. The spontaneous formation of the bilayer is primarily driven by the properties of phospholipids themselves (hydrophobic tails and hydrophilic heads), and the presence of proteins does not contribute directly to the spontaneous process. This is the correct answer because it does not explain the self-assembly of the bilayer.

d) Incorrect. The fluidity of phospholipids at normal temperatures is important for the function and dynamics of the membrane, but it also indirectly contributes to the spontaneous formation of the bilayer. Phospholipids can move laterally within the bilayer, which helps to stabilise the membrane and makes it flexible. While not the primary reason for spontaneous formation, fluidity does aid in maintaining the structure once it has formed, so this helps to explain bilayer formation.

Question 6

Which of the following is most true of membrane phospholipids?

a) The are ions
b) They contain three fatty acid tails
c) They have a slightly polar head-group
d) They form lots of hydrogen bonds with water
e) They contain hydrophobic regions

a) Incorrect. Phospholipids are not ions. While they have polar (hydrophilic) head groups that interact with water and can be charged (due to phosphate groups), phospholipids themselves are classified as amphipathic molecules, not ions. They possess both hydrophobic and hydrophilic regions but do not behave as free ions in solution.

b) Incorrect. Phospholipids typically contain two fatty acid tails attached to a glycerol backbone. The third position on the glycerol is occupied by a phosphate group attached to a head group, not a fatty acid. This configuration is different from triglycerides, which have three fatty acid tails.

c) Incorrect. The head group of a phospholipid is highly polar due to the phosphate group and, in some cases, additional charged groups like choline. It interacts strongly with water and other polar substances. Describing the head group as "slightly polar" understates its polarity. This answer is not the most accurate description of membrane phospholipids.

d) Partially Correct, but Misleading. The polar head group of phospholipids can form some hydrogen bonds with water, but the interaction is mainly electrostatic (between the polar head group and water). The fatty acid tails are hydrophobic and do not form hydrogen bonds. Therefore, phospholipids do interact with water but primarily through electrostatic interactions rather than large numbers of hydrogen bonds. This answer does not fully capture the nature of phospholipid interactions with water. Try again!

e) Correct. This is the most accurate statement about membrane phospholipids. Phospholipids have hydrophobic fatty acid tails, which avoid contact with water and aggregate in the interior of the lipid bilayer. This amphipathic nature, with hydrophilic head groups and hydrophobic tails, is critical for the formation of cell membranes. This answer best captures the essential structural property of phospholipids.

Question 7

Which statement is most true?

A) All biological molecules form polymers AND cellulose is crystalline
B) Polysaccharides have high melting points AND glucose forms ring structures
C) Carbohydrates form helices AND carbohydrates form ring-structures
D) Glycogen is crystalline AND glucose forms ring structures
E) Glycogen is crystalline AND carbohydrates form ring-structures

a) Incorrect. While it is true that cellulose is crystalline due to its highly ordered structure, it is not true that all biological molecules form polymers. For instance, many biological molecules, such as lipids and some vitamins, are not polymers. Thus, this statement is only partially accurate, making it not the most true.

b) Correct. Glucose does indeed form ring structures in solution, and polysaccharides generally have such high melting points they oxidise first. Polysaccharides, being large and complex molecules, often decompose before reaching high melting points.

c) Partially Correct. Some carbohydrates do indeed form ring structures (e.g., glucose in its cyclic form), but not all do. Carbohydrates themselves do not typically form helical structures; instead, polysaccharides like amylose (a form of starch) may form helices, but this is not true for all carbohydrates. Therefore, this statement is not entirely accurate.

d) Incorrect. Glycogen is not crystalline; it is a highly branched polysaccharide and is more amorphous in nature. On the other hand, glucose does indeed form ring structures in solution. The incorrectness of the first part of the statement makes this option not the most true.

e) Incorrect. As mentioned, glycogen is not crystalline; it has a more amorphous structure due to its branching. However, it is true that carbohydrates typically form ring structures in solution. The inaccuracy regarding glycogen's structure makes this statement not the most true.

Question 8

Which of the following statements is correct regarding the properties and behaviour of monosaccharides and disaccharides?

A) In an aqueous solution, disaccharides typically exist in a linear form, while monosaccharides primarily adopt a cyclic structure.
B) Monosaccharides can undergo oxidation to form sugar alcohols, whereas disaccharides cannot be oxidised due to the glycosidic bond.
C) Lactose intolerance is due to the inability to break the β-1,6 glycosidic bond between glucose and galactose.
D) Mutarotation is observed in both monosaccharides and disaccharides because they can open and close between linear and cyclic forms.

A) Incorrect. Both monosaccharides and disaccharides can adopt cyclic forms in aqueous solutions. Monosaccharides like glucose primarily exist in a cyclic structure (hemiacetal form), and disaccharides like sucrose also adopt cyclic structures. Monosaccharides can interconvert between linear and cyclic forms, but disaccharides are locked in their glycosidic bond.

B) Incorrect. While monosaccharides can undergo oxidation (such as glucose forming gluconic acid), disaccharides can also be oxidised under certain conditions. For example, reducing sugars (disaccharides with a free anomeric carbon, like lactose) can be oxidised. The glycosidic bond does not prevent oxidation unless both anomeric carbons are involved in the bond (like in sucrose).

C) Incorrect. Lactose intolerance results from the inability to break the β-1,4 glycosidic bond between glucose and galactose, not a β-1,6 bond. The enzyme lactase is needed to hydrolyze this specific β-1,4 bond.

D) Correct. Mutarotation refers to the change in the optical rotation of a solution due to the interconversion between different anomeric forms (α and β) of a sugar. Monosaccharides like glucose undergo mutarotation because they can freely open into the linear form and then cyclize again. Disaccharides that have a free anomeric carbon (like lactose) can also exhibit mutarotation, but non-reducing sugars like sucrose do not show this behaviour.

Question 9

Long chain fatty acids…

A) …are found abundantly in milk
B) …have high viscosity
C) …contain 14-16 carbons
D) …contain ester bonds
E) …contain no double bonds

a) Incorrect. Milk is rich in short- and medium-chain fatty acids, especially those with 4 to 12 carbons. Long-chain fatty acids (LCFAs), typically 14 or more carbons, are more commonly found in foods like meat, fish, and certain oils, rather than milk.

b) Correct. Long-chain fatty acids tend to have higher viscosity compared to shorter-chain fatty acids due to stronger van der Waals interactions between their longer hydrocarbon chains, which increases intermolecular forces and makes them more resistant to flow.

c) Partially Correct. Long-chain fatty acids typically range from 14 to 24 carbons. The statement isn't entirely wrong, but it oversimplifies the range, as long-chain fatty acids can contain more than 16 carbons. The lower end of long-chain fatty acids does include 14-16 carbon chains, such as myristic acid (14 carbons) and palmitic acid (16 carbons). Try again!

d) Incorrect. Long-chain fatty acids themselves do not contain ester bonds. However, they form ester bonds when they combine with glycerol to form triglycerides or phospholipids. The fatty acid molecule itself only contains a carboxyl group (-COOH) and a hydrocarbon chain.

e) Incorrect. Long-chain fatty acids can be either saturated or unsaturated. Saturated fatty acids have no double bonds, but unsaturated long-chain fatty acids (like oleic acid or linoleic acid) contain one or more double bonds in their hydrocarbon chains. Therefore, this statement is inaccurate as it disregards the existence of unsaturated long-chain fatty acids.

Question 10

The melting point range for pure saturated phosphatidylcholine (a membrane phospholipid) is 50-52 ^{o}C. Which is a sensible melting point range for 95% cis-unsaturated phosphatidylcholine with 5% cholesterol?

a) 38-40 ^{o}C
b) 48-50 ^{o}C
c) 30-40 ^{o}C
d) 68-70 ^{o}C
e) 60-70 ^{o}C

a) Partially Correct. Cis-unsaturated fatty acids introduce kinks in the phospholipid tails, which disrupts the packing of molecules and lowers the melting point of the lipid bilayer. The presence of 95% cis-unsaturated phosphatidylcholine would significantly reduce the melting point relative to saturated phosphatidylcholine, making 38-40°C a reasonable range. However, mixtures of substances tend to broaden melting points, which cholesterol would do in this context. Try again!

b) Incorrect. While this melting point range is lower than the original 50-52°C, it is not low enough to account for the significant presence of cis-unsaturated phosphatidylcholine. Unsaturated lipids typically have much lower melting points due to their disrupted packing, so a melting point in this range would be expected for partially unsaturated or slightly modified saturated lipids, not for a sample with 95% unsaturation.

c) Correct. A mixture of 95% cis-unsaturated phosphatidylcholine would drastically lower the melting point compared to its saturated counterpart. Mixtures of substances tend to broaden melting points, which cholesterol would do in this context.

d) Incorrect. This range is too high. A mixture with such a high percentage of unsaturated phosphatidylcholine would not have a melting point this high. In fact, unsaturated phospholipids lower the melting point by introducing disorder into the structure. This range might be more appropriate for lipids with a higher concentration of cholesterol or saturated fatty acids, which increase the rigidity of the lipid bilayer.

e) Incorrect. This melting point range is significantly higher than expected for a lipid mixture with such a high content of cis-unsaturated phosphatidylcholine. The presence of unsaturated fatty acids disrupts tight packing and typically results in lower melting points, not higher ones. This range would only make sense if there was a high proportion of saturated lipids or cholesterol, which is not the case here.

DNA Structure, transcription & protein synthesis

Question 1

Which of the following will have the highest melting point:

A)	B)	C)	D)	E)
AGCTCA |||||| TCGAGT	AGCTCA |||||| TCGTGT	AGCTCAA ||||||| TCGAGTT	AGTTCAA ||||||| TCATGTT	AGCTCAA ||||||| TCGTGTT

A) Have a look again and consider the length of the DNA segment. How will length affect melting point?

B) Have a look again and consider the length of the DNA segment. How will length affect melting point?

C) Well done. This is a longer DNA segment and all the base pairs match, so has the most H-bonds aligned. More H-bonds means a higher melting point.

D) Have a look closely at the base pairing in your choice. What you selected will lead to fewer hydrogen bonds than another option. Try again.

E) Have a look closely at the base pairing in your choice. What you selected will lead to fewer hydrogen bonds than another option. Try again.

Question 2

Uracil base pairs with adenine because...

A) Both can form no more than 2 hydrogen bonds
B) Both can form no more than 3 hydrogen bonds
C) It has a similar structure to cytosine
D) They have a similar structure
E) It has a similar structure to thymine

A) Both can form no more than 2 hydrogen bonds
This is partially correct but incomplete. Uracil and adenine form two hydrogen bonds, which is true. However, this option does not fully explain why uracil pairs with adenine.

B) Both can form no more than 3 hydrogen bonds
This is incorrect. Uracil and adenine form only two hydrogen bonds. Adenine and thymine, which are in DNA, form three hydrogen bonds with each other.

C) It has a similar structure to cytosine
This is incorrect. Uracil does not have a similar structure to cytosine. While cytosine and uracil both contain a pyrimidine ring, cytosine pairs with guanine, not adenine.

D) They have a similar structure
No, uracil and adenine have quite different structures; one is a pyrimidine and one a purine. Base pairs must be complementary to pair, not similar. Try again.

E) It has a similar structure to thymine
This is the correct answer. Uracil has a similar structure to thymine, as both are pyrimidines and differ only by the presence of a methyl group in thymine. This similarity explains why uracil can pair with adenine in RNA, just as thymine pairs with adenine in DNA.

Question 3

Which of the following would violate the central dogma of molecular biology the most?

A) Protein catalysing DNA production
B) DNA carrying the code for protein production
C) RNA acting as a template for DNA production
D) Protein acting as a template for RNA production
E) DNA carrying the code for RNA production

A) This option would not violate the central dogma because proteins often act as enzymes in various biological processes, including DNA replication and repair. However, proteins do not serve as a template for DNA production, which is the key concept behind the central dogma. Try again.

B) This option is consistent with the central dogma of molecular biology, which states that DNA holds the genetic information needed to produce proteins through transcription into RNA and translation into proteins. Therefore, this does not violate the central dogma. Try again.

C) While this process (reverse transcription) may seem like a violation, it actually occurs in nature, such as in retroviruses (e.g., HIV), and is accepted as an exception to the central dogma. Try again.Though it seems contradictory, reverse transcription does not fundamentally violate the central principle, as it follows a biologically understood pathway.

D) This is the most significant violation of the central dogma, well done. Proteins do not serve as templates for the production of nucleic acids, and no known biological process involves information flowing from protein to RNA. The central dogma strictly prohibits such a reverse flow of information from proteins back to nucleic acids.

E) This option aligns with the central dogma, as it describes the process of transcription, where DNA is used to produce RNA. This is a fundamental part of gene expression and does not violate the central dogma. Try again.

Question 4

Which of the following is the normal order of protein production for extracellular export?

A) Ribosome; Endoplasmic reticulum; cis-golgi cisternae; trans-golgi cisternae; endosomal vesicle; cell membrane fusion.
B) Endoplasmic reticulum; Ribosome; trans-golgi cisternae; cis-golgi cisternae; endosomal vesicle; cell membrane fusion.
C) Ribosome; Endoplasmic reticulum; endosomal vesicle; trans-golgi cisternae; cis-golgi cisternae; cell membrane fusion.
D) Ribosome; Endosomal vesicle; Endoplasmic reticulum; trans-golgi cisternae; cis-golgi cisternae; Cell membrane fusion.
E) Ribosome; Endoplasmic reticulum; endosomal vesicle; cell membrane fusion, cis-golgi cisternae; trans-golgi cisternae.

A) This is the correct order for the production and export of proteins destined for extracellular export. Proteins are synthesised on ribosomes associated with the rough endoplasmic reticulum (ER). Afterward, they are transported through the cis-Golgi network to the trans-Golgi network. The trans-Golgi then packages them into vesicles that fuse with the cell membrane for export. Great choice!

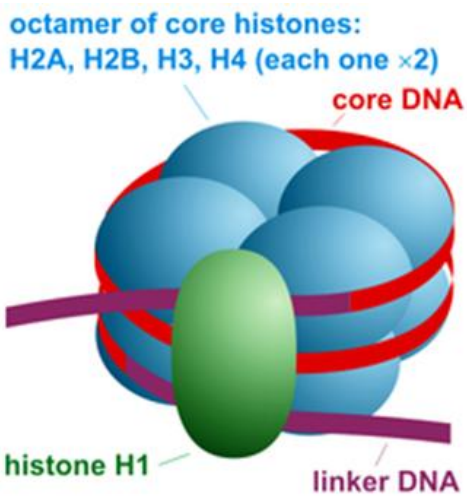
B) This option incorrectly places the ribosome after the endoplasmic reticulum. Protein synthesis begins on the ribosome, which is either free or attached to the rough ER. Additionally, the trans-Golgi should follow the cis-Golgi, not precede it. These errors make this order incorrect.

C) This option incorrectly places the endosomal vesicle before the Golgi apparatus. In the correct process, proteins pass through the Golgi apparatus (starting with the cis-Golgi) before being packaged into vesicles. This disruption in the sequence makes this choice incorrect.

D) This option is incorrect because it places the endosomal vesicle before the ER, which is not part of the protein synthesis pathway. Protein synthesis happens in the ribosome and ER before it reaches the Golgi apparatus. The sequence here is significantly out of order.

E) This option has a significant error by placing the endosomal vesicle and cell membrane fusion before the cis-Golgi and trans-Golgi cisternae. The proteins must first pass through the Golgi for processing and packaging before being sent in vesicles for export. Therefore, this is not the correct order.

Question 5



Which of the following is NOT a property of histones?

A) They assist in condensing chromatin into visible chromosomes.
B) Histones are made of protein.
C) Histones are positively charged.
D) They are similar in structure to each other.
E) There are 9 histones associated with every core DNA section.

A) This is a true statement. Histones play a key role in the compaction of chromatin, allowing the long strands of DNA to be packed tightly into chromosomes during cell division. They facilitate the condensation of chromatin by forming nucleosomes, the fundamental units of chromatin structure. Try again!

B) This is a true statement. Histones are a family of proteins that help organize and package DNA in the nucleus. They form complexes with DNA and are crucial for the regulation of gene expression and chromatin structure. Try again!

C) This is a true statement. Histones have a high proportion of positively charged amino acids (like lysine and arginine), which allow them to bind tightly to the negatively charged phosphate backbone of DNA. This electrostatic interaction is important for their role in chromatin structure. Try again!

D) Well done, this is statement is most false. Although histones 2-4 share a similar structural motif known as the "histone fold", they can be classified into different types (e.g., H2A, H2B, H3, H4 & H1). The structural similarities allow histones to form nucleosomes, but each is different.

E) This statement is partially false. There are 8 histones in the core nucleosome, consisting of two copies each of H2A, H2B, H3, and H4. A ninth histone, H1, is sometimes associated with

the linker DNA outside the nucleosome, but it is not part of the core histone octamer. One of the other statements is more false.

Question 6

Which of the following is not part of a gene?

A) Promoter
B) Start codon
C) Intron
D) Stop codon
E) Transcription factor

A) The promoter is a crucial part of a gene. It is a regulatory region located upstream of the coding sequence and is essential for initiating transcription. It is not translated into protein but is essential for the gene's expression.

B) The start codon is an important part of a gene. It is the first codon of the mRNA transcript that is recognized by the ribosome to begin translation. It signals the start of the protein-coding sequence.

C) Introns are indeed part of a gene. They are non-coding sequences within a gene that are transcribed into pre-mRNA but are removed during the RNA splicing process before the mRNA is translated into protein.

D) The stop codon is an integral part of a gene. It signals the end of the protein-coding sequence and prompts the termination of translation.

E) This is the correct answer. Transcription factors are not part of a gene itself; rather, they are proteins that bind to specific DNA sequences to regulate the transcription of genes. They play a role in controlling gene expression but are not encoded by the gene.

Question 7

Which follows from the fact that DNA is replicated semi-conservatively?

A) All cells contain DNA from the previous 2 generations
B) All cells contain heavy DNA
C) All cells contain DNA from the previous generation
D) All cells contain light DNA
E) All cells contain no DNA from 3 generations ago

A) This is incorrect. In semi-conservative DNA replication, each new DNA molecule consists of one original (parental) strand and one newly synthesised strand. Therefore, each cell contains DNA from only the previous generation, not from two generations ago. The term "semi-conservative" implies that half of the DNA is conserved from the immediate previous generation, not multiple generations.

B) This is incorrect. This answer likely refers to the famous Meselson-Stahl experiment, which used "heavy" nitrogen to demonstrate semi-conservative replication. However, in normal biological conditions, DNA is not classified as "heavy." After replication, the newly synthesised strand contains lighter elements (due to regular nitrogen or carbon). Not all cells contain "heavy" DNA, as only one strand could be labelled "heavy" in such experiments.

C) This is the correct answer. Semi-conservative replication means that each newly formed DNA molecule retains one of the original parental strands, which comes from the previous generation. As a result, each new cell contains one strand of DNA that is directly inherited from the DNA of the previous generation, making this statement accurate.

D) This is incorrect. Similar to the "heavy DNA" explanation, this likely stems from experimental terminology. In reality, after semi-conservative replication, each DNA molecule contains one parental strand and one newly synthesised strand, so cells contain both "old" and "new" DNA strands. Thus, not all DNA would be classified as "light" based on this process.

E) This is incorrect. Although each new DNA molecule consists of one parental and one newly synthesised strand, cells do contain DNA that can be traced back several generations through the conserved parental strand. The semi-conservative nature of replication allows some DNA from multiple generations ago to persist through the original strands being passed down, so cells do contain DNA that originated more than 3 generations ago.

Question 8

In a eukaryotic cell, the processes of DNA replication, transcription, and translation are compartmentalised to specific organelles or regions. Which of the following accurately describes not only the primary locations but also the involvement of key associated structures in each of these processes?

A) DNA replication in the nucleus; transcription in the nucleolus; translation on cytoplasmic ribosomes and mitochondria
B) DNA replication in the nucleus and mitochondria; transcription in the nucleus and mitochondria; translation on cytosolic ribosomes and mitochondrial ribosomes
C) DNA replication in the rough ER; transcription in the nucleoplasm; translation in the peroxisomes and free ribosomes
D) DNA replication in the nucleoplasm and mitochondrial matrix; transcription in the nucleus and cytosol; translation on ribosomes associated with the rough ER
E) DNA replication in the nuclear envelope; transcription in the Golgi apparatus; translation in the rough ER and chloroplasts

A) This is **incorrect**. While DNA replication occurs in the nucleus, **transcription does not occur in the nucleolus**. The nucleolus is involved in the synthesis of rRNA, not general mRNA transcription. Translation does occur on cytoplasmic ribosomes and mitochondrial ribosomes, but the misplacement of transcription in the nucleolus makes this option wrong.

B) This is the **correct** answer, well done. DNA replication happens in the **nucleus** (for nuclear DNA) and the **mitochondria** (for mitochondrial DNA). Transcription takes place in both the **nucleus** for nuclear genes and in the **mitochondria** for mitochondrial genes. Translation occurs on **cytosolic ribosomes** (either free or associated with the rough ER) and on **mitochondrial ribosomes** for mitochondrial-encoded proteins. This choice accurately reflects the compartments and structures involved.

C) This is **incorrect**. DNA replication does not occur in the rough ER, and transcription happens in the **nucleus** (not specifically the nucleoplasm). Additionally, **translation does not occur in peroxisomes**—peroxisomes are involved in lipid metabolism and detoxification, not protein synthesis. Translation occurs on ribosomes in the cytoplasm or associated with the rough ER.

D) This is **incorrect**. DNA replication does occur in the **nucleoplasm** and **mitochondrial matrix**, but **transcription does not occur in the cytosol**. Transcription occurs in the nucleus (for nuclear genes) and in the mitochondria (for mitochondrial genes). The placement of transcription in the cytosol makes this option inaccurate.

E) This is **incorrect**. DNA replication occurs in the **nucleus**, not in the nuclear envelope. Transcription does not occur in the Golgi apparatus, which is involved in protein sorting and modification, not in nucleic acid processing. Translation does happen on ribosomes associated with the rough ER, but **chloroplasts** are present only in plant cells, making this a very narrow and incomplete answer for a general eukaryotic cell.

Question 9

Which of the following are part of an open reading frame (ORF)?

I. Promoter
II. 3' untranslated region
III. Introns
IV. Exons
V. 5' G cap

A) IV only
B) I, II, III, & IV
C) III & IV
D) II, III, & IV
E) II, III, VI, & V

A) The open reading frame encompasses everything from start to stop codon, not just protein coding regions. It encompasses all the code that is transcribed. Try again!
B) The open reading frame encompasses everything from start to stop codon; it encompasses all the code that is transcribed. At least one of the parts of a gene that you selected are not transcribed.
C) The open reading frame encompasses everything from start to stop codon, not just introns and exons. It encompasses all the code that is transcribed. Try again!
D) Well done. The open reading frame encompasses everything from start to stop codon; it encompasses all the code that is transcribed.
E) The open reading frame encompasses everything from start to stop codon; it encompasses all the code that is transcribed. At least one of the options you selected are not transcribed from DNA.

Question 10

Which of the following describes the order of events that occur to an individual tRNA during translation: I. tRNA moves to E-site; II. tRNA moves to A-site; III. tRNA moves to P-site; IV. Polypeptide is transferred to tRNA; V.Polypeptide is transferred from tRNA

A) III, IV, II, V, I
B) III, V, II, IV, I
C) II, IV, III, V, I
D) IV, II, III, I, V

A) This answer is incorrect. The process starts with the tRNA moving to the **A-site** (not the P-site), where it binds to the mRNA codon. The correct sequence of events should follow the

natural progression of tRNA through the ribosome's sites (A-site, P-site, E-site) during translation.

B) This answer is incorrect. The tRNA first binds to the **A-site** (not the P-site), and the polypeptide is transferred **to** the tRNA in the A-site from the tRNA in the P-site. The order of events for transferring the polypeptide is incorrect here, and the overall progression through the ribosomal sites is out of order.

C) This is the **correct** answer. The correct sequence during translation is as follows:

1. The tRNA first moves to the **A-site** (II).
2. The **polypeptide is transferred to the tRNA** in the A-site (IV).
3. The tRNA then shifts to the **P-site** (III), where the growing polypeptide chain is held.
4. The **polypeptide is transferred from the tRNA** in the P-site to the new tRNA in the A-site (V).
5. Finally, the tRNA moves to the **E-site** (I) and exits the ribosome.

This sequence accurately describes the progression of an individual tRNA during translation.

D) This answer is incorrect. The event of **polypeptide transfer to the tRNA** (IV) happens after the tRNA moves to the A-site, but the rest of the sequence is out of order. Specifically, the transfer of the polypeptide from the tRNA (V) occurs before the tRNA moves to the E-site (I), not after.

Cell types and differentiation

Question 1

Cellular differentiation is a process that allows a cell to specialise for a specific function. Which of the following best explains how cellular differentiation occurs in multicellular organisms?

A) All genes in a cell are expressed simultaneously, allowing the cell to perform multiple functions.
B) Differentiation occurs when cells lose their ability to divide and therefore become specialised.
C) Each cell type has a completely different set of DNA, which determines its specialised function.
D) Cells differentiate by permanently altering their DNA sequence to match their function.
E) Cells differentiate by selectively expressing only the genes that are necessary for their specific function.

A) This option is misleading because not all genes are expressed simultaneously in a cell. Cellular differentiation depends on selective gene expression, where certain genes are activated while others are repressed. Expressing all genes at once would lead to dysfunction. Try again.

B) While differentiated cells often lose their ability to divide, it is not the cause of differentiation. Differentiation is driven by gene expression patterns, not by the cessation of cell division. Try again.

C) All cells in an organism (except for reproductive cells and a few specialised exceptions) contain the same DNA. Differentiation is due to differences in gene expression, not the presence of different DNA in each cell. Try again.

D) Cellular differentiation does not involve permanently altering the DNA sequence. Instead, it involves changes in gene expression regulated by epigenetic factors, transcription factors, and other regulatory mechanisms. The DNA sequence remains the same. Try again.

E) Cells differentiate by selectively expressing specific genes necessary for their function. This regulation of gene expression allows cells to become specialised, even though they all contain the same DNA. Correct.

Question 2

Which of the following statements best distinguishes between cellular specialisation and cellular differentiation?

A) Cellular specialisation involves the process of gene expression, while cellular differentiation occurs after specialisation.
B) Cellular differentiation results in a change in the DNA of the cell, whereas cellular specialisation involves changes in the environment around the cell.
C) Cellular specialisation is a temporary change in a cell's function, while cellular differentiation is permanent.
D) Both cellular differentiation and cellular specialisation are the same processes that refer to the division of labour among cells.
E) Cellular differentiation is where cells acquire a specific fate, while cellular specialisation is where cells take a specific role.

A) Cellular specialisation does not involve gene expression directly; rather, it refers to a cell performing a specific function. Differentiation precedes specialisation, as it is the process by which a cell becomes capable of performing its specific function. Try again.

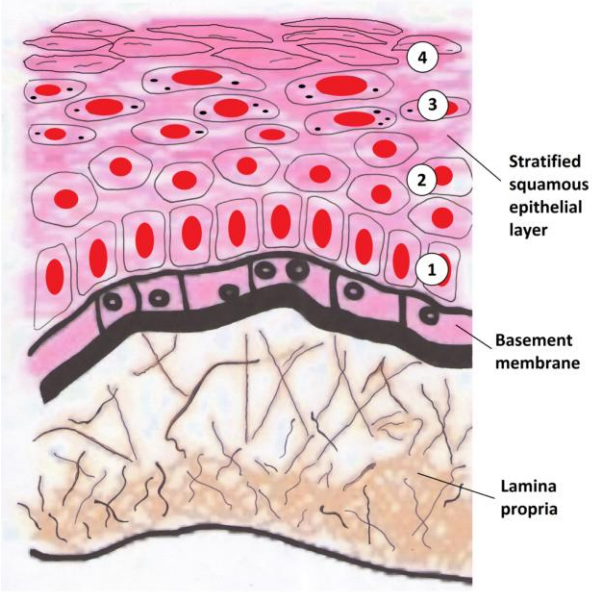
B) Cellular differentiation does not result in changes to a cell's DNA sequence. Both differentiation and specialisation are driven by changes in gene expression, not by altering the DNA or external environmental factors alone. Try again.

C) Cellular specialisation is typically a stable and permanent feature in multicellular organisms, not a temporary one. Differentiation is a one-time process that leads to specialisation, which remains consistent unless the cell de-differentiates in certain circumstances (like stem cells). Try again.

D) Though related, cellular differentiation and specialisation are not the same processes. Differentiation refers to the process by which cells acquire their specialised roles, while specialisation describes the state of a cell that has already achieved its specific function. Try again.

E) Cellular differentiation is the process by which cells become different through selective gene expression. Cells often look identical once differentiated, however. Cellular specialisation refers to the final step in cell development, taking-on their specialised function. Specialised cells usually appear very distinct. Correct.

Question 3



Which of the statements below is most true?

A) The cells at point 3 are more specialised than at point 2
B) The basement membrane below 1 is made of stem cells
C) Lying below the mucosa, the lamina propria contains the least differentiated cells
D) The cells at stage 4 are more differentiated than at stage 3
E) The cells at stage 1 show the highest level of specialisation

A) Yes, as we move up through the numbers 1-3, the tissues becomes more specialised, taking-on a more squamous structure. Well done!

B) Incorrect, the basement membrane is not itself made of cells. Instead, undifferentiated stem cells often sit touching the basement membrane.

C) No, the lamina propria is another tissue layer entirely, containing a raft of other cell types, often specialised.

D) No, differentiation begins before we see large anatomical changes to cells. The cells at 3 are already fully specialised. At 4, most of the cells are dead!

E) No, the exact opposite is true! Cells that lie against the basement membrane are often relatively unspecialised.

Question 4

Totipotent stem cells have the potential to develop into any cell type, while multipotent stem cells can only differentiate into a limited range of cell types within a specific tissue or organ. Considering this, which of the following statements best describes the locations and functions of totipotent and multipotent stem cells?

A) Totipotent stem cells are found in adult tissues like the bone marrow, while multipotent stem cells are only present in embryos.
B) Multipotent stem cells are found only in embryonic development, while totipotent stem cells are distributed across adult tissues, where they aid in tissue repair.
C) Totipotent stem cells are found in the early stages of embryonic development, while multipotent stem cells are located in specific adult tissues like bone marrow, skin, and the intestines.
D) Totipotent stem cells are found in adult tissues with rapid turnover, like the skin and intestines, while multipotent stem cells are found in slow-renewing tissues like the brain.
E) Totipotent and multipotent stem cells are interchangeable and can be found in any tissue, contributing equally to the maintenance and repair of adult tissues.

A) Totipotent stem cells are not found in adult tissues like the bone marrow. They exist only in the earliest stages of embryonic development (up to the morula stage). Multipotent stem cells, however, are present in adult tissues such as the bone marrow, skin, and intestines, where they play a role in tissue maintenance and repair.

B) This answer reverses the locations of totipotent and multipotent stem cells. Totipotent stem cells are only present in the early embryo, not in adult tissues. Multipotent stem cells, on the other hand, are found in adult tissues like bone marrow and skin, where they support specific tissue regeneration.

C) Totipotent stem cells are only found in the early stages of embryonic development and have the potential to form all types of cells, including extraembryonic tissues. Multipotent stem cells are present in adult tissues, such as bone marrow, skin, and the intestines, where they can differentiate into a limited range of cells needed for tissue repair and regeneration.

D) Totipotent stem cells are not found in adult tissues, regardless of the turnover rate. Totipotency is limited to the very early embryo. Multipotent stem cells, however, can be found in both fast-renewing tissues (like skin and intestines) and slower-renewing tissues (like the brain).

E) Totipotent and multipotent stem cells are not interchangeable. Totipotent stem cells exist only in the earliest stages of development and can form any cell type, while multipotent stem cells are found in specific adult tissues and are restricted to generating a limited range of cell types within those tissues.

Question 5

Which of the following best describes the difference between cells, tissues, and organs in the human body?

A) **Cells are groups of tissues that perform a specific function, while organs are made of a single type of tissue.**
B) **Tissues are groups of cells working together to perform a specific function, and multiple tissues form an organ.**
C) **Organs are single-celled structures, tissues are larger than organs, and cells make up both tissues and organs.**
D) **Cells make up organs directly, bypassing the tissue level of organisation.**
E) **Tissues are single cells that operate independently, while organs are composed of multiple independent cells.**

A) This reverses the relationship. *Cells* are the basic units that combine to form *tissues*, not the other way around. Also, organs are made up of multiple tissues, not just one.

B) This is the accurate explanation. Cells group together to form tissues, and multiple types of tissues work together to form organs, which perform specific functions in the body.

C) Organs are not single-celled structures. They are complex structures made of multiple types of tissues, each of which is made up of many cells. This answer misunderstands the size and complexity of organs relative to cells and tissues.

D) Cells do not directly form organs. There is an intermediate step—*tissues*. Cells first organize into tissues, which then combine to form organs.

E) This mischaracterizes both tissues and organs. Tissues are not single cells; they are groups of similar cells working together. Organs are composed of tissues, not independent cells.

Question 6

Gastrulation is a crucial phase in early embryonic development during which the three germ layers—ectoderm, mesoderm, and endoderm—are formed. Each layer gives rise to specific tissues and organs in the body. Which of the following best describes the relationship between these germ layers and the structures they form?

A) The ectoderm forms the digestive and respiratory systems, the mesoderm forms the skin and nervous system, and the endoderm forms bones and muscles.
B) The ectoderm forms the skin and nervous system, the mesoderm forms muscles, bones, and the circulatory system, and the endoderm forms the digestive tract and lungs.
C) The ectoderm forms muscles and blood, the mesoderm forms the heart and brain, and the endoderm forms the kidneys and liver.
D) The ectoderm forms the circulatory system, the mesoderm forms the digestive and respiratory systems, and the endoderm forms muscles and bones.
E) The ectoderm, mesoderm, and endoderm are not associated with specific organs and tissues, but rather play a general role in supporting embryonic development.

A) This answer confuses the roles of the germ layers. The ectoderm does not form the digestive or respiratory systems—those are derived from the endoderm. The mesoderm does not form the skin or nervous system, and the endoderm does not give rise to bones and muscles.

B) The ectoderm forms the outermost layer, giving rise to the skin, nervous system, and some sensory organs. The mesoderm gives rise to muscles, bones, the circulatory system, and other structures. The endoderm forms the inner lining of the digestive tract, lungs, and other internal organs.

C) The ectoderm does not form muscles or blood, and the mesoderm is responsible for forming the heart, but not the brain, which is derived from the ectoderm. The endoderm does form the liver, but not the kidneys (which are formed from mesoderm).

D) The ectoderm does not form the circulatory system, which is derived from the mesoderm. The mesoderm does not form the digestive and respiratory systems, which are derived from the endoderm, and the endoderm does not form muscles and bones, which are derived from the mesoderm.

E) Each of the three germ layers has a very specific role in giving rise to particular tissues and organs. The ectoderm, mesoderm, and endoderm each contribute to different parts of the body, and their roles are not merely general or supportive.

Question 7

Which of the following statements about columnar epithelial cells is NOT accurate regarding their structure or function in the body?

A) Columnar epithelial cells often have microvilli on their apical surface to increase surface area for absorption.
B) These cells are typically involved in secretion and absorption, particularly in the digestive tract.
C) Columnar epithelial cells can be ciliated, aiding in the movement of mucus in the respiratory tract.
D) They are characterised by a flat, thin shape that allows for rapid diffusion of gases and small molecules.
E) Columnar epithelial cells can form specialised structures like goblet cells, which secrete mucus.

A) This statement is accurate, try again. Many columnar epithelial cells, especially in the intestines, have microvilli that enhance their absorptive capacity.
B) This statement is accurate, try again. Columnar epithelial cells play significant roles in both secretion and absorption, especially in regions like the intestines.
C) Wrong choice; this is true. Ciliated columnar epithelial cells are found in the respiratory tract and help move mucus and trapped particles out of the airways.
D) Correct! This statement is NOT accurate. Columnar epithelial cells are not flat or thin; instead, they are taller than they are wide, which distinguishes them from squamous epithelial cells that are flat and facilitate rapid diffusion.
E) This statement is accurate, try again Goblet cells, which are modified columnar epithelial cells, secrete mucus and are commonly found in the respiratory and intestinal tracts, aiding in protection and lubrication.

Question 8

Which of the following statements about stratified tissue types is NOT correct in describing their structure or function in the body?

A) Stratified epithelial tissues are composed of multiple layers of cells, providing protection against mechanical stress and abrasion.
B) Stratified squamous epithelium is the only type of stratified tissue found in the human body.
C) Stratified tissues can be found in areas of the body that experience frequent friction or injury, such as the skin and the lining of the mouth.
D) Stratified cuboidal epithelium is a rare type of stratified tissue primarily found in some sweat glands and mammary glands.
E) The primary function of stratified tissues is to facilitate rapid absorption and secretion.

A) Incorrect. This statement is accurate. The multi-layered structure of stratified epithelial tissues, particularly stratified squamous epithelium, serves to protect underlying tissues from damage due to abrasion and mechanical stress.

B) Correct! This statement is NOT accurate. While stratified squamous epithelium is a common type, there are other forms of stratified tissue, such as stratified cuboidal epithelium and stratified columnar epithelium.

C) Incorrect. This statement is accurate. Stratified tissues, particularly stratified squamous epithelium, are indeed located in areas that endure friction and potential injury, providing protective barriers.

D) Incorrect. This statement is accurate. Stratified cuboidal epithelium is indeed relatively rare and is typically found in the ducts of sweat glands and mammary glands, contributing to secretion.

E) Incorrect. This statement is not true for stratified tissues. The primary function of stratified tissues is protection, while simple epithelial tissues are more suited for absorption and secretion due to their single-layer structure.

Question 9

Which of the following pairs of tissue types and their primary functions is NOT accurately matched?

A) Simple squamous epithelium – facilitates rapid diffusion and filtration due to its thin structure.
B) Cardiac muscle – responsible for involuntary contractions that pump blood throughout the body.
C) Stratified columnar epithelium – primarily involved in secretion and absorption in the respiratory tract.
D) Adipose tissue – stores energy in the form of fat and provides insulation and cushioning for organs.
E) Hyaline cartilage – provides flexible support and reduces friction between bony surfaces in joints.

A) Incorrect. This pairing is accurate. Simple squamous epithelium, with its single layer of flat cells, is ideal for processes such as diffusion and filtration, found in locations like the alveoli of the lungs and capillary walls.

B) Incorrect. This pairing is accurate. Cardiac muscle is specialised for involuntary contractions that pump blood and is found exclusively in the heart.

C) Correct! This pairing is NOT accurately matched. Stratified columnar epithelium is mainly found in certain glandular ducts and the male urethra, not in the respiratory tract. The respiratory tract typically features pseudostratified columnar epithelium, which is involved in secretion and movement of mucus.

D) Incorrect. This pairing is accurate. Adipose tissue serves as energy storage, insulation, and cushioning for various organs in the body, such as around the kidneys and beneath the skin.

E) Incorrect. This pairing is somewhat misleading. While hyaline cartilage does provide support and helps reduce friction at joint surfaces, it is not particularly "flexible" in the way that elastic cartilage is. However, it is accurate to say it provides support and cushioning at joints.

Question 10

Tight junctions form a barrier that prevents the passage of molecules between cells, helping to maintain distinct compartments. Which of the following would NOT be a consequence of tight junction failure?

A) Uncontrolled movement of substances across epithelial layers, leading to increased tissue permeability.
B) Breakdown of the blood-brain barrier, allowing harmful molecules to infiltrate the brain.
C) Alteration of cellular organisation, disrupting the polarity of epithelial cells.
D) Decreased vascularisation of tissue, leading to hypoxia.
E) Impaired intestinal barrier function, potentially allowing bacteria and toxins to enter surrounding tissues.

A) Incorrect. One of the primary consequences of tight junction failure is increased permeability, as the barrier that normally regulates the movement of molecules between cells breaks down.
B) Incorrect. Tight junctions are essential for maintaining the blood-brain barrier, and their failure can lead to harmful substances entering the brain, posing significant health risks.
C) Incorrect. Tight junctions help maintain cell polarity, so their failure can lead to disorganised cellular structure, impairing the directional transport of molecules in epithelial layers.
D) Correct! Failure of tight junctions does not affect vascularisation directly. Capillaries don't use tight junctions to bind together.
E) Incorrect. Tight junction failure in the intestines can lead to "leaky gut," where harmful substances can bypass the epithelial barrier, leading to inflammation and other health issues.

Membrane Transport and Osmosis

Question 1

A chloroplast has a diameter of 2.3 μm, whereas a mitochondrion has a diameter of 0.8 μm. How much faster would you predict CO_2 to diffuse into a chloroplast than into a mitochondrion?

A) 2.8 times faster
B) 3.1 times faster
C) 9.6 times faster
D) 8.3 times faster
E) 23.7 times faster

A) This is incorrect. The rate of diffusion depends on surface area, which would be significantly greater than 2.8 times larger. Diffusion rates are typically related to the surface area-to-volume ratio.

B) This is incorrect. The rate of diffusion depends on surface area, which would be significantly greater than 3.1 times larger. Diffusion rates are typically related to the surface area-to-volume ratio.

C) This option is incorrect, though it is fairly close. Diffusion rates are typically proportional to the surface area.

D) This is the correct answer. Diffusion rates are often proportional to the surface area. Since surface area is proportional to the square of the radius, a chloroplast with a diameter of 2.3 μm has a significantly larger surface area than a mitochondrion with a diameter of 0.8 μm. The diffusion rate is approximately 8.3 times faster based on this difference in size.

E) This is incorrect. The rate of diffusion depends on surface area, which would be significantly smaller than 23.7 times larger. Diffusion rates are typically related to the surface area-to-volume ratio.

Question 2

Which of the following does not increase the rate of diffusion?

A) Increasing distance of diffusion
B) Increasing concentration gradient
C) Decreasing particle size
D) Increasing surface area for diffusion
E) Increasing surface area

A) This is the correct answer. Increasing the distance over which diffusion must occur will decrease the rate of diffusion, as particles will take longer to travel a greater distance. Shorter distances speed up diffusion.

B) This option is incorrect. Increasing the concentration gradient (the difference in concentration between two regions) will increase the rate of diffusion. A steeper gradient results in faster movement of particles from a high concentration area to a low concentration area.

C) This option is incorrect. Smaller particles diffuse faster than larger ones because they encounter less resistance as they move. Therefore, decreasing particle size increases the rate of diffusion.

D) This option is incorrect. Increasing the surface area available for diffusion allows more particles to diffuse simultaneously, which increases the overall rate of diffusion.

E) This option is incorrect but very similar to option D. Like in option D, increasing the surface area for diffusion enhances the rate of diffusion, as more space is available for particles to move across the membrane or barrier.

Question 3

Facilitatory proteins cannot transport which of the following across a biological membrane?

A) Oxygen AND Protein
B) Chloride
C) Chloride AND Protein
D) Water AND Protein
E) Protein

A) This option is incorrect. Facilitatory proteins (such as channels and carriers) are involved in the transport of molecules that are typically large or charged. Oxygen, being a small and nonpolar molecule, can diffuse across the membrane without assistance, while proteins are too large for most facilitated transport mechanisms.

B) This option is incorrect. Facilitatory proteins, such as ion channels or transporters, specifically help charged ions like chloride (Cl^-) to move across membranes, since ions cannot easily pass through the hydrophobic core of the lipid bilayer.

C) This option is incorrect. While chloride ions require facilitated transport, proteins are far too large to be transported by typical facilitatory proteins, so this is a partially correct answer. However, facilitatory proteins do allow the passage of chloride ions.

D) This option is incorrect. Water can be transported across the membrane via aquaporins, which are a type of facilitatory protein. However, proteins are too large to be transported by facilitatory proteins.

E) This is the correct answer. Proteins are large macromolecules, and facilitatory proteins cannot typically transport entire proteins across membranes. Transport of proteins across membranes usually requires specialised mechanisms like translocation channels or vesicular transport.

Question 4

The equation for water potential is given by the following formula:
Water Potential = Solute potential + Pressure potential

Which statement is always true?

A) Water potential is always positive
B) Hypotonic solutions have a positive water potential
C) Cells always have negative solute potential
D) Hypotonic solutions have a negative water potential
E) Cells in isotonic solutions have a water potential of zero

A) This option is incorrect. Water potential can be either positive, negative, or zero. In most biological contexts, water potential is often negative due to the negative solute potential in cells and tissues. Only under certain conditions, such as in pressurised systems, can water potential be positive.

B) This is incorrect. Hypotonic solutions usually have a higher (less negative) water potential compared to hypertonic solutions, but not necessarily a positive one. In biological systems, even hypotonic solutions often have a slightly negative water potential because of the solutes they contain, though it is closer to zero than hypertonic solutions.

C) This is the correct answer. Cells typically contain solutes, and because solute potential (osmotic potential) becomes more negative as solute concentration increases, the solute potential in cells is almost always negative.

D) This is incorrect. Hypotonic solutions may have a less negative water potential than the cells they surround, but they don't necessarily have a highly negative water potential. The key characteristic of a hypotonic solution is that its water potential is higher (less negative) than the water potential inside the cell, driving water into the cell.

E) This option is incorrect. In an isotonic solution, there is no net movement of water into or out of the cell, but this does not mean the water potential is exactly zero. The solute and pressure potentials balance out such that the water potentials inside and outside the cell are equal, but both can still be negative.

Question 5

Which of the following is true about water potential in blood?

A) The water potential in blood is always positive due to its high water content.
B) Red blood cells in hypertonic plasma will gain water to balance the water potential.
C) The solute potential in blood plasma is usually negative, reducing overall water potential.
D) Water potential in the blood is highest in veins due to low pressure.
E) Water moves out of capillaries into tissues when the water potential in the blood is lower than in the surrounding tissues.

A) This option is incorrect. Water potential in biological fluids, including blood, is typically negative due to the presence of solutes such as salts, proteins, and other molecules. Even though blood has a high water content, solutes decrease the overall water potential.

B) This is incorrect. In hypertonic plasma, the water potential outside the red blood cells is lower (more negative), which causes water to move out of the cells, leading to cell shrinkage (crenation), not water gain.

C) This is correct. The solute potential (or osmotic potential) in blood plasma is negative due to the presence of dissolved ions, proteins, and other molecules. This decreases the overall water potential, which is why water tends to move into the blood from areas of higher (less negative) water potential.

D) This is incorrect. Water potential is influenced by both solute concentration and pressure. In veins, the blood pressure is lower, but the water potential is not necessarily highest there. In fact, due to solutes and other factors, water potential may still be negative in veins.

E) This is incorrect. Water moves into tissues from capillaries when the water potential in the tissues is lower (more negative) than in the blood. Conversely, water moves from tissues into capillaries when the blood has a lower water potential.

Question 6

A cell biologist is studying the effects of various tonicities on a particular type of animal cell placed in different solutions. Which of the following statements about tonicity is most incorrect regarding its effects on the cell?

A) In a hypertonic solution, water moves out of the cell, causing it to shrink.
B) In a hypotonic solution, water moves into the cell, potentially causing it to swell and burst.
C) Isotonic solutions maintain the cell's size and shape by balancing water movement.
D) A cell in a hypertonic solution will undergo plasmolysis, which is only relevant to plant cells.
E) Tonicity affects the net movement of water across the cell membrane through osmosis.

A) Sorry, this statement is correct. In a hypertonic solution, the external environment has a lower water potential (higher solute concentration) than inside the cell, causing water to leave the cell by osmosis. This results in the cell shrinking, a process known as crenation in animal cells. Try again!

B) Sorry, this option is correct. In a hypotonic solution, the external environment has a higher water potential (lower solute concentration) than inside the cell, leading to water moving into the cell. Animal cells can swell and may even burst (lyse) due to the lack of a rigid cell wall. Try again!

C) Sorry, this option is correct. In an isotonic solution, the solute concentration inside and outside the cell is equal, so there is no net movement of water. This maintains the cell's size and shape, as water moves equally in both directions. Try again!

D) This is the most incorrect answer, well done! Plasmolysis is a term specific to plant cells, where the cell membrane pulls away from the cell wall due to water loss in a hypertonic solution. Animal cells lack a cell wall, so they shrink (crenate) in hypertonic solutions but do not undergo plasmolysis. Therefore, this statement is inaccurate when applied to animal cells.

E) Sorry, this option is correct. Tonicity refers to the relative concentration of solutes outside versus inside the cell, which affects water movement. Osmosis is the process by which water moves across the membrane in response to differences in solute concentration. Try again!

Question 7

Which statement about active transport is most false?

A) It only transports substances against their concentration gradient.
B) If a process doesn't use energy, then it's not classed as active.
C) One ATP-dependent process is often used to drive other processes.
D) Active transport involves protein conformational changes.
E) Many small ionic substances are transported by active transport.

A) This answer is most false and correct for the question. While active transport primarily moves substances against their concentration gradient (from low to high concentration), the wording suggests exclusivity. Some forms of active transport can also involve the movement of substances down their concentration gradient as part of secondary active transport processes (coupled transport). Therefore, this statement can be misleading.

B) This answer is incorrect (i.e., true about active transport). This statement accurately describes active transport, as it explicitly requires energy (usually from ATP) to move substances against their concentration gradient. Hence, this statement is true and not the most false.

C) This answer is incorrect (i.e., true about active transport). Active transport often involves ATP-dependent processes that can create gradients, which are then used to drive other transport mechanisms (such as secondary active transport). This statement correctly describes a characteristic of active transport and is not false.

D) This answer is incorrect (i.e., true about active transport). Active transport mechanisms, particularly those involving transport proteins (like pumps), rely on conformational changes in these proteins to facilitate the movement of substances across the membrane. This statement accurately reflects a key aspect of active transport and is not false.

E) This answer is incorrect (i.e., true about active transport). Active transport is indeed used to transport many small ionic substances, such as sodium (Na^+) and potassium (K^+), against their concentration gradients. This statement is true and not the most false.

Question 8

Which of the following is NOT a feature of steroid hormones?

A. They have nuclear receptors
B. They act via transcription factors
C. They are hydrophobic
D. They increase [cyclic AMP]
E. They are slow-acting

A) This answer is incorrect (i.e., true about steroid hormones). Steroid hormones typically bind to nuclear receptors, which allows them to influence gene expression directly. Therefore, this statement accurately describes a feature of steroid hormones and is not the answer to the question.

B) This answer is incorrect (i.e., true about steroid hormones). Steroid hormones act through transcription factors after binding to their nuclear receptors, which then regulate gene expression. This statement is a true feature of steroid hormones and does not answer the question.

C) This answer is incorrect (i.e., true about steroid hormones). Steroid hormones are indeed hydrophobic, which allows them to pass through cell membranes easily. This characteristic is a defining feature of steroid hormones and is not the answer to the question.

D) This answer is correct. Steroid hormones do not typically increase cyclic AMP (cAMP) levels directly. Instead, cAMP is primarily associated with peptide hormones and other signaling molecules that use G protein-coupled receptors. Therefore, this statement is NOT a feature of steroid hormones, making it the correct answer to the question.

E) This answer is incorrect (i.e., true about steroid hormones). Steroid hormones are generally considered slow-acting because they modulate gene expression and cellular functions over longer time frames compared to peptide hormones. This characteristic accurately describes steroid hormones and is not the answer to the question.

Question 9

Which of the following is *most false* about functional membrane receptors, like G-protein coupled receptors (GPCRs)?

A) They are always membrane associated
B) They lead to most proteins being activated
C) They always have a ligand binding domain
D) They amplify signals
E) They act via secondary messengers

A) This option is incorrect. GPCRs are indeed membrane-associated receptors that span the cell membrane. Their function involves interacting with external signals and initiating intracellular signalling cascades, so this statement is true.

B) This is the most false statement and the correct answer. GPCRs activate specific signalling pathways by interacting with a subset of proteins (such as G-proteins and enzymes), but they do not lead to most proteins being activated. Only certain proteins involved in the pathway are activated, making this statement a major misconception.

C) This option is incorrect. GPCRs, by definition, have a ligand-binding domain that allows them to detect external signals like hormones or neurotransmitters. This binding triggers the signalling cascade inside the cell, so this statement is true.

D) This option is incorrect. GPCRs are known for their ability to amplify signals. A single ligand binding to a GPCR can activate multiple G-proteins, leading to a large downstream response. This amplification is a key feature of GPCR signalling, so this statement is true.

E) This option is incorrect. GPCRs often work through secondary messengers, such as cyclic AMP (cAMP) or calcium ions, to propagate and amplify the signal within the cell. This is a defining characteristic of how GPCRs function, making this statement true.

Question 10

Which of the following is being described below?

'The channel is opened dependent on the ionic status on one side of the membrane'.

A) Voltage gated channel
B) Ligand gated channel
C) Porin
D) Mechanically gated channel
E) Symport-mediated channel

A) This is the correct answer, well done. Voltage-gated channels open or close in response to changes in the membrane potential (the ionic status across the membrane). They are crucial in processes like nerve impulse transmission and muscle contraction, where shifts in ion concentration lead to the opening of these channels.

B) This option is incorrect. Ligand-gated channels open in response to the binding of a specific molecule (ligand), such as a neurotransmitter, rather than being directly influenced by the ionic status or membrane potential. Therefore, this doesn't match the description.

C) This option is incorrect. Porins are large, non-specific channels typically found in the outer membranes of bacteria, mitochondria, or chloroplasts, allowing passive diffusion of molecules. They are not dependent on ionic status but rather allow substances like ions, sugars, and nucleotides to pass through passively.

D) This option is incorrect. Mechanically gated channels open in response to mechanical forces such as stretch, pressure, or vibration, not the ionic status of one side of the membrane. They are involved in processes like touch or hearing, where physical stimuli open the channel.

E) This option is incorrect. Symport-mediated channels (or symporters) transport two substances in the same direction across the membrane, typically one being an ion like Na^+ or H^+ and the other a molecule like glucose. However, their opening or function isn't directly dependent on the ionic status on one side of the membrane, but on the coupled movement of two substances.

Cell cycle & cell division

Question 1

Which of the following correctly describes the sequence of events in the eukaryotic cell cycle?

A. S → G2 → G1 → M → Cytokinesis
B. G1 → S → G2 → M → Cytokinesis
C. G2 → M → Cytokinesis → G1 → S
D. M → Cytokinesis → G1 → G2 → S
E. G1 → G2 → S → M → Cytokinesis

A. This sequence is incorrect because it does not start with G1, the initial growth phase where the cell prepares for DNA replication. Additionally, G1 occurs before S phase.

B. Correct! This is the proper order of the eukaryotic cell cycle. G1 is the initial growth phase, S phase involves DNA synthesis, G2 is the second growth phase, M is mitosis, and Cytokinesis is the division of the cytoplasm.

C. Incorrect. While G2 transitions into mitosis (M phase) and cytokinesis follows M, this answer skips the start of the cycle (G1) and misplaces S phase, which occurs before G2.

D. Incorrect. While M and cytokinesis are correctly placed, G1 is always followed by S phase, not G2.

E. Incorrect. G1 and G2 phases are both growth phases, but they are separated by the S phase where DNA synthesis occurs. G2 cannot precede S phase.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 2

Which of the following is the most accurate difference between cells in G1 & G2?

A. G2 cells are twice as large
B. G2 cells have twice as many chromosomes
C. G2 cells have twice as many organelles
D. G2 cells have twice as much ATP
E. G2 cells have twice as much DNA

A. Incorrect. While cells grow in size during the cell cycle, G2 cells are not necessarily twice as large as G1 cells. Cell growth is proportional and depends on the cell type, but it is not a defining feature of the difference between G1 and G2.

B. Incorrect. The number of chromosomes remains the same throughout the cell cycle. In G2, each chromosome consists of two sister chromatids due to DNA replication, but the total chromosome count does not change.

C. Incorrect. While organelles may be duplicated during G2 to prepare for cell division, the number of organelles is not consistently doubled and is not the most accurate distinction between G1 and G2 cells.

D. Incorrect. ATP levels may fluctuate throughout the cell cycle, but the difference in ATP content is not a defining characteristic of G1 and G2 cells. Energy requirements depend on the specific cellular activities occurring in each phase.

E. Correct. The most accurate difference between G1 and G2 cells is the amount of DNA. During G1, the cell contains a single copy of its genome. After DNA replication in the S phase, G2 cells have twice as much DNA as G1 cells, as each chromosome now consists of two sister chromatids.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 3

Which of the following is NOT a requirement for a cell to progress through the mitotic cell cycle?

A. DNA is copied
B. Exogenous growth factors present
C. DNA is healthy
D. Cell is large
E. Chromosome number is even

A. Incorrect. DNA replication is an essential requirement for a cell to progress through the mitotic cell cycle. Without copying its DNA during the S phase, the cell cannot ensure proper distribution of genetic material during mitosis.

B. Somewhat correct. While growth factors may be important to stimulate cell division in some contexts, they are not strictly required for the cell cycle itself to proceed once it is initiated. Some cells, particularly those in culture or under specific physiological conditions, can progress without external growth factors. See if you can find the even more correct answer!

C. Incorrect. The cell cycle includes checkpoints, such as the G1/S and G2/M checkpoints, which ensure that the DNA is intact and free of damage before progression. If the DNA is unhealthy, the cell may arrest the cycle to repair it or undergo apoptosis.

D. Incorrect. Cell size is monitored at the G1/S checkpoint to ensure that the cell has grown sufficiently to divide. If the cell is not large enough, progression through the cycle is halted until adequate growth is achieved.

E. Correct, well done! The chromosome number does not have to be even for a cell to progress through the mitotic cell cycle, but DNA does have to be copied properly. Most cells with uneven numbers of chromosomes cannot undergo meiosis, however, often leading to sterility.

Question 4

Which of the following takes place during mitosis prophase?

I. DNA replication
II. Spindle formation
III. Organelle replication
IV. Chromatid separation
V. Recombination of homologous chromosomes

A. II only
B. IV only
C. I & II
D. I, II & III
E. II & V

A. Correct. During prophase of mitosis, the spindle apparatus begins to form as microtubules emerge from the centrosomes. None of the other listed processes occur during this phase.

B. Incorrect. Chromatid separation occurs during anaphase, not during prophase. In prophase, sister chromatids are still attached at the centromere and have not yet begun to separate.

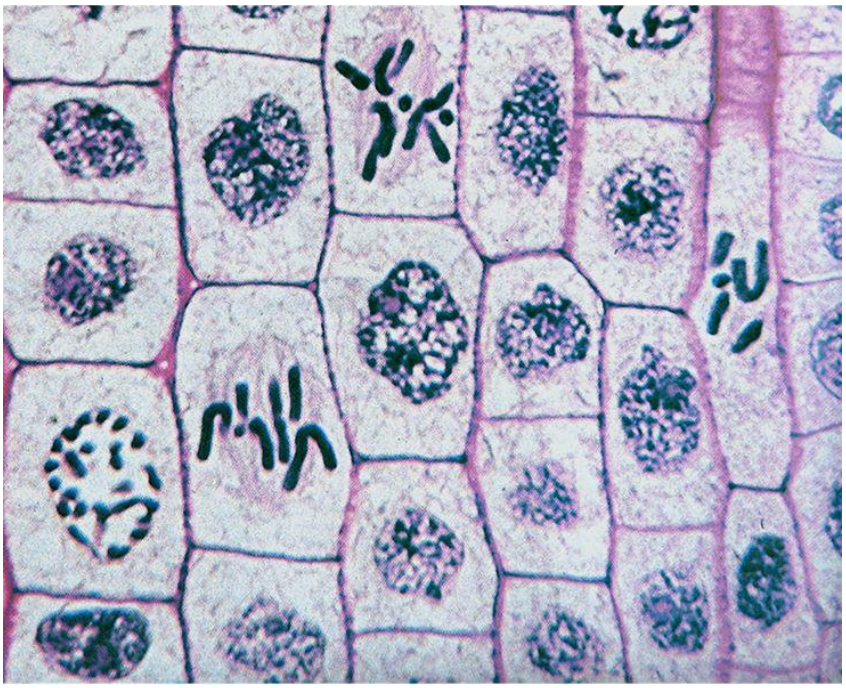
C. Incorrect. While spindle formation (II) does occur during prophase, DNA replication (I) happens during the S phase of the cell cycle, well before mitosis begins.

D. Incorrect. While spindle formation (II) occurs in prophase, neither DNA replication (I) nor organelle replication (III) happens during this phase. DNA replication occurs during the S phase, and organelle replication typically occurs during G1 and G2 phases.

E. Incorrect. Spindle formation (II) does occur in prophase, but recombination of homologous chromosomes (V) is a feature of prophase I of meiosis, not mitosis. During mitosis, homologous chromosomes do not pair or recombine.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 5



Which is the most common phase of the cell cycle shown on the image above?

A. Anaphase
B. Prophase
C. Metaphase
D. Interphase
E. Telophase

A. Incorrect. While anaphase is an important phase of mitosis, it is a brief stage during which sister chromatids are pulled apart to opposite poles. Most cells are not in this phase, even in tissues with actively dividing cells.

B. Incorrect. Prophase, the first stage of mitosis, involves chromatin condensation and spindle formation. However, like other phases of mitosis, it is relatively short compared to interphase, so it is not the most common phase observed in most tissues.

C. Incorrect. In metaphase, chromosomes align at the metaphase plate. This is another short phase of mitosis, and only a small proportion of cells in a tissue are likely to be in metaphase at any given time.

D. Correct. Interphase is by far the longest phase of the cell cycle, during which the cell grows, performs its regular functions, and prepares for division by replicating DNA (S phase). Most cells in a typical tissue layer are in interphase, especially in non-meristematic plant tissues.

E. Incorrect. Telophase, the final stage of mitosis, involves the reformation of the nuclear envelope and decondensation of chromosomes. Like the other phases of mitosis, it is relatively short and not the most common phase observed.

Question 6

Using a light microscope, which of the following can be best used to differentiate between late metaphase and early anaphase?

A. Spindle fibre formation
B. Sister chromatids together vs. separated
C. Metaphase checkpoint passed
D. Nuclear scaffold dissolved or formed
E. The level of chromatin condensation

A. Incorrect. Spindle fibre formation occurs earlier in mitosis, specifically during prophase and metaphase. The presence of spindle fibres does not help differentiate late metaphase from early anaphase, as they are present in both stages.

B. Correct. The key distinction between late metaphase and early anaphase is the state of the sister chromatids. In late metaphase, sister chromatids are aligned at the metaphase plate but remain attached. In early anaphase, sister chromatids have separated and are moving toward opposite poles.

C. Incorrect. While passing the metaphase checkpoint is essential for the transition from metaphase to anaphase, it is not something directly observable using a light microscope. This is a molecular process rather than a structural change.

D. Incorrect. The nuclear scaffold dissolves earlier in mitosis, during prophase, and does not reform until after mitosis, during telophase. It is not a distinguishing feature of metaphase or anaphase.

E. Incorrect. Chromatin condensation reaches its maximum during prophase and metaphase and remains at this level throughout anaphase. The level of chromatin condensation does not change significantly between late metaphase and early anaphase.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 7

Using a light microscope, which of the following can be best used to differentiate between telophase and early G1?

A. Spindle fibre formation
B. Sister chromatids together vs. separated
C. Cytokinesis
D. Metaphase checkpoint passed
E. The level of chromatin condensation

A. Incorrect. Spindle fibres are disassembled during telophase, so their formation is not relevant to distinguishing telophase from early G1. By early G1, the spindle fibres are no longer present.

B. Incorrect. Sister chromatids separate during anaphase and remain as individual chromosomes during both telophase and early G1. This feature does not help distinguish between these two stages.

C. Incorrect. Whilst cytokinesis occurs at the right stage (between the two phases), cytokinesis itself is virtually impossible to see down a light microscope. This is because the cell membrane is very difficult to see in most cells at ordinary magnification without staining.

D. Incorrect. The metaphase checkpoint is relevant to the transition from metaphase to anaphase, not to the distinction between telophase and early G1. This is a molecular event and not visible under a light microscope.

E. Correct. Chromatin decondenses during telophase and so is a good measure of whether telophase is still occurring. Observing cytokinesis is often very difficult, so chromatin condensation is a better measure.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 8

Select the answer that provides the correct words to complete the sentence. During prophase one of meiosis, _____ chromosomes join to form a _____. At anaphase one, _____ can be seen, as the chromosomes separate.

A. Diploid; synapsis; chiasmata
B. Homologous; synapsis; crossing-over
C. Diploid; bivalent; crossing-over
D. Homologous; bivalent; chiasmata
E. Diploid; bivalent; chiasmata

A. Incorrect. While synapsis occurs during prophase I of meiosis, the term "diploid chromosomes" is imprecise and does not describe the homologous chromosomes that pair during this phase. Additionally, chiasmata are visible during metaphase I and anaphase I but not directly related to chromosome separation.

B. Incorrect. Homologous chromosomes do undergo synapsis during prophase I, but "crossing-over" refers to the exchange of genetic material, not the separation of chromosomes at anaphase I. The correct term for what can be observed at anaphase I is "chiasmata."

C. Incorrect. While "bivalent" correctly describes the paired homologous chromosomes during prophase I, the use of "diploid chromosomes" is imprecise. Additionally, "crossing-over" does not describe the separation of chromosomes at anaphase I.

D. Correct. During prophase I, homologous chromosomes pair to form a bivalent (a structure of two homologous chromosomes joined together). At anaphase I, chiasmata (the points of crossing-over) can be seen as the homologous chromosomes separate.

E. Incorrect. Although "bivalent" and "chiasmata" are correct terms, the use of "diploid chromosomes" is inaccurate when describing homologous chromosomes pairing during prophase I. Homologous chromosomes are a more precise term.

Question 9

A tetraploid cell contains 24 chromosomes. After meiosis, how many chromosomes will the gametes of this cell have?

A. 3
B. 6
C. 12
D. 24
E. 48

A. Incorrect. A tetraploid cell contains 24 chromosomes, so after meiosis, the chromosome number is reduced to half of the diploid chromosome number, not a quarter. This answer is far too low.

B. Incorrect. A tetraploid cell has 24 chromosomes, meaning the diploid number is 12. Gametes will have half the diploid number, which is 12, not 6.

C. Correct. Meiosis reduces the chromosome number by half. For a tetraploid cell with 24 chromosomes, the diploid number is 12, and the haploid gametes will have 12 chromosomes each.

D. Incorrect. This answer represents the total chromosome count of the tetraploid cell. After meiosis, gametes will have half the diploid number, which is 12, not the full tetraploid count.

E. Incorrect. This answer assumes the chromosome number doubles, which does not occur in meiosis. Instead, meiosis reduces the chromosome number by half.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 10

Which of the following human karyotypes would typically appear female?

I. 45X
II. 46XY
III. 46XX
IV. 47XXY
V. 47XXX

A. II & IV
B. III & IV
C. I, III, & V
D. III, IV, & V
E. I & III

A. Incorrect. Karyotype **46XY** represents a typical male individual, and **47XXY** corresponds to Klinefelter syndrome, where individuals are male due to the presence of the Y chromosome. Individuals with Klinefelter syndrome often present with mild feminisation, such as reduced hairiness.

B. Incorrect. While **46XX** represents a typical female karyotype, **47XXY** corresponds to Klinefelter syndrome, which results in individuals who male due to the presence of the Y chromosome. Individuals with Klinefelter syndrome often present with mild feminisation, such as reduced hairiness.

C. Correct.

- **45X** (Turner syndrome): Individuals with this karyotype lack a second sex chromosome and generally develop as females.
- **46XX**: This is the typical karyotype for females.
- **47XXX**: This karyotype, known as Triple X syndrome, results in individuals who are female.

D. Incorrect. While **46XX** and **47XXX** represent female karyotypes, **47XXY** is associated with Klinefelter syndrome which results in individuals who are male due to the presence of the Y chromosome. Individuals with Klinefelter syndrome often present with mild feminisation, such as reduced hairiness.

E. Incorrect. While **45X** (Turner syndrome) and **46XX** represent female karyotypes, this answer excludes **47XXX**, which also results in a female appearance.

Enzymes and Cellular respiration

Question 1

Which of the following best distinguishes the induced fit model from the lock and key model of enzyme function?

a. The induced fit model applies only to enzymes that require cofactors, whereas the lock and key model applies to all other enzymes.
b. The lock and key model explains enzyme specificity, while the induced fit model explains catalytic efficiency.
c. The induced fit model proposes that the enzyme's active site changes shape to accommodate the substrate, while the lock and key model suggests the active site has a rigid, pre-formed structure complementary to the substrate.
d. Both models propose identical mechanisms of enzyme-substrate binding, but differ in their explanations of product release.
e. The lock and key model is outdated and incorrect, while the induced fit model is the universally accepted mechanism of enzyme function.

A. Incorrect. Both models are general explanations for enzyme-substrate interaction and are not tied to the requirement of cofactors. Cofactors are separate entities that may assist enzymatic activity but do not determine the choice of model.

B. Partially correct but misleading. While the lock and key model primarily emphasizes specificity, the induced fit model also accounts for specificity alongside catalytic efficiency. This distinction does not fully capture the difference between the models.

C. Correct. This accurately highlights the main distinction. The lock and key model assumes a static, complementary active site, whereas the induced fit model emphasizes flexibility and conformational changes during substrate binding.

D. Incorrect. The two models describe fundamentally different visions of enzyme-substrate binding, not just differences in product release.

E. Incorrect. The lock and key model is not "incorrect" but is considered less comprehensive than the induced fit model. Both models are valid in different contexts, with the induced fit model being more widely applicable in modern enzymology.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 2

Which of the following is most false?

a. Enzymes lower activation energy
b. Enzymes alter the reaction mechanism
c. Enzymes do not alter ΔG for a reaction
d. Enzymes increase reaction velocity by over ten times
e. Enzymes denature above 37 ^{O}C

a. Enzymes lower activation energy:
This statement is true. Enzymes catalyze reactions by lowering the activation energy, which facilitates the reaction's progress. Try again!

b. Enzymes alter the reaction mechanism:
This statement is true. Enzymes provide an alternative pathway (reaction mechanism) with a lower activation energy, thereby increasing reaction rates. Try again!

c. Enzymes do not alter ΔG for a reaction:
This statement is true. Enzymes accelerate reactions without changing the free energy change (ΔG) of the reaction. Try again!

d. Enzymes increase reaction velocity by over ten times:
This statement is true. Enzymes can increase reaction rates by factors of up to millions of times, making this statement correct. Try again!

e. Enzymes denature above 37°C:
This statement is the most false. Whilst some human enzymes might lose functionality at temperatures above 37°C, enzymes from many other organisms (e.g., *Taq polymerase*) remain active at much higher temperatures. Additionally, many human enzymes only begin denaturing at significantly higher temperatures.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 3

Which is the most accurate description of a *coenzyme*?

a. An organic compound that is associated with an enzyme
b. An organic molecule that assists an enzyme in its function
c. A chemical that is required for catalysis
d. A molecule that interacts with enzymes
e. A chemical species that chaperones substrate, thus increasing the rate of reaction

a. An organic compound that is associated with an enzyme
While this statement is partially correct, it is too broad to accurately define a coenzyme. Other organic compounds, like prosthetic groups, are also associated with enzymes but are distinct from coenzymes. Coenzymes specifically assist with catalytic activity, which this definition does not emphasize.

b. An organic molecule that assists an enzyme in its function
This is the most accurate and complete description of a coenzyme. It highlights the key roles of coenzymes, including assisting enzymes in performing catalysis.

c. A chemical that is required for catalysis
This description is imprecise. Not all chemicals required for catalysis are coenzymes—other molecules like metal ions (cofactors) also play such roles. Additionally, this statement fails to specify that coenzymes are organic molecules.

d. A molecule that interacts with enzymes
This is overly vague and applies to many molecules, including substrates, inhibitors, and activators, not just coenzymes. It does not adequately describe the specific role of a coenzyme.

e. A chemical species that chaperones substrate, thus increasing the rate of reaction
This is incorrect and misleading. Coenzymes do not "chaperone" substrates. Instead, they participate in the reaction by transferring chemical groups or electrons. This description fails to capture the specific mechanism of coenzymes and uses terminology that could confuse learners.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 4

Which of the following statements about enzyme inhibitors is most false?

a. They all interact directly with the enzyme
b. They all reduce enzyme activity at any given substrate concentration
c. They are sometimes released from the enzyme
d. They all lead to some conformational change in the enzyme
e. They all act at or near the active site

a. They all interact directly with the enzyme
Traditionally defined inhibitors all interact directly with enzyme in some way, even if it is not at the active site. Other substances that disrupt enzymes from a distance or reduce cofactor availability -for instance- might be inhibitory, but that isn't quite the same as an inhibitor. Try again!

b. They all reduce enzyme activity at any given substrate concentration
This statement is true for all inhibitors, as their defining characteristic is the reduction of enzyme activity. Competitive, non-competitive, and uncompetitive inhibitors all decrease enzyme activity, though the mechanisms differ.

c. They are sometimes released from the enzyme
This statement is true. Reversible inhibitors can bind to and dissociate from the enzyme. Irreversible inhibitors, on the other hand, permanently bind to the enzyme.

d. They all lead to some conformational change in the enzyme
This statement is false for some inhibitors, but it is not the "most false". Competitive inhibitors, for example, do not necessarily induce conformational changes, as they simply block the active site. Non-competitive and allosteric inhibitors, however, often do cause conformational changes.

e. They all act at or near the active site
This is false, well done! While competitive inhibitors act at the active site, non-competitive and allosteric inhibitors bind to other parts of the enzyme, affecting its activity indirectly.

Question 5

Which of the following statements about enzymes and reversible reactions is most accurate?

a. Enzymes alter the Gibbs free energy of reversible reactions, enabling equilibrium to be reached faster.
b. Enzymes catalyze reversible reactions by lowering the activation energy of the forward reaction more than the reverse reaction, favoring product formation.
c. Enzymes affect the rate at which equilibrium is achieved in reversible reactions but not the equilibrium constant itself.
d. Enzymes catalyze reversible reactions only when the equilibrium constant (Keq) is greater than 1.
e. Enzymes ensure that reversible reactions proceed equally in both directions regardless of the thermodynamic favorability.

A. Incorrect. Enzymes do not alter the Gibbs free energy (ΔG) of a reaction. ΔG determines spontaneity and equilibrium, which are unaffected by enzymes. Enzymes only lower the activation energy for both forward and reverse reactions.

B. Incorrect. Enzymes lower the activation energy equally for both the forward and reverse reactions, depending on the reaction conditions. They do not inherently favor product formation or change the equilibrium position.

C. Correct. This accurately reflects the role of enzymes. They speed up both the forward and reverse reactions without altering the equilibrium constant or the thermodynamic favorability of the reaction.

D. Incorrect. Enzymes can catalyze reversible reactions regardless of the equilibrium constant (Keq). The magnitude of Keq depends on the Gibbs free energy change, not the enzyme's activity.

E. Incorrect. While enzymes speed up both reaction directions, the extent to which the reaction proceeds in each direction is determined by thermodynamic factors, not the enzyme itself. Enzymes cannot force reactions to proceed equally if one direction is thermodynamically unfavorable.

Question 6

Which of the following correctly identifies the locations of the listed processes within a mitochondrion?

a. Glycolysis occurs in the mitochondrial matrix, while the electron transport chain is located on the outer mitochondrial membrane.
b. The citric acid cycle takes place in the intermembrane space, and oxidative phosphorylation occurs in the mitochondrial matrix.
c. Pyruvate oxidation occurs in the mitochondrial matrix, while ATP synthesis is driven by a proton gradient across the inner mitochondrial membrane.
d. The electron transport chain is embedded in the mitochondrial matrix, and NADH oxidation occurs in the cytosol.
e. The proton gradient required for ATP synthesis is established across the outer mitochondrial membrane, and the citric acid cycle occurs in the mitochondrial intermembrane space.

A. Incorrect. Glycolysis occurs in the cytosol, not the mitochondrial matrix. The electron transport chain is embedded in the inner mitochondrial membrane, not the outer membrane.

B. Incorrect. The citric acid cycle occurs in the mitochondrial matrix, not the intermembrane space. Oxidative phosphorylation involves both the inner mitochondrial membrane (electron transport chain) and ATP synthase, not solely the matrix.

C. Correct. Pyruvate oxidation occurs in the mitochondrial matrix, where pyruvate is converted to acetyl-CoA. ATP synthesis is driven by the proton gradient established across the inner mitochondrial membrane by the electron transport chain.

D. Incorrect. The electron transport chain is embedded in the inner mitochondrial membrane, not the matrix. NADH oxidation primarily occurs in the mitochondrial matrix as part of the electron transport chain, not in the cytosol.

E. Incorrect. The proton gradient required for ATP synthesis is established across the inner mitochondrial membrane, not the outer membrane. The citric acid cycle occurs in the mitochondrial matrix, not in the intermembrane space.

Question 7

What is the role of hexose kinase?

a. Making NADH
b. Making ATP
c. Phosphorylating fructose 1,6 bisphosphate
d. Oxidising glucose
e. Phosphorylating glucose

a. Making NADH
Feedback: This is incorrect. Hexose kinase does not directly participate in NADH production. NADH is typically generated during glycolysis in later steps, such as the conversion of glyceraldehyde-3-phosphate to 1,3-bisphosphoglycerate by glyceraldehyde-3-phosphate dehydrogenase.

b. Making ATP
Feedback: This is incorrect. Hexose kinase consumes ATP to phosphorylate glucose. ATP production occurs later in glycolysis, for example, during substrate-level phosphorylation steps.

c. Phosphorylating fructose 1,6-bisphosphate
Feedback: This is incorrect. The phosphorylation of fructose 6-phosphate to fructose 1,6-bisphosphate is catalyzed by phosphofructokinase, not hexose kinase. Hexose kinase specifically phosphorylates glucose.

d. Oxidising glucose
Feedback: This is incorrect. Hexose kinase does not oxidize glucose. Oxidation of glucose occurs in subsequent glycolytic steps and the citric acid cycle.

e. Phosphorylating glucose
Feedback: This is correct. Hexose kinase catalyzes the phosphorylation of glucose to glucose-6-phosphate, a key step in glycolysis. This reaction helps trap glucose in the cell and primes it for further metabolism.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 8

Which of the following statements about oxidative phosphorylation is most false?

a. It produces more ATP than substrate level phosphorylation in most animals.
b. It can occur at the same time as anaerobic respiration
c. It is dependent on hydrogen carriers
d. It involves transferring phosphate from ATP
e. The process must include a membrane-contained system.

a. It produces more ATP than substrate-level phosphorylation in most animals.
Feedback: This is true. Oxidative phosphorylation produces the majority of ATP in aerobic respiration, significantly more than substrate-level phosphorylation. Therefore, this is not the "most false" statement.

b. It can occur at the same time as anaerobic respiration.
Feedback: This is false, but not the "most false." Oxidative phosphorylation depends on oxygen as the terminal electron acceptor. Anaerobic respiration occurs in oxygen-limited conditions and does not involve oxidative phosphorylation.

c. It is dependent on hydrogen carriers.
Feedback: This is true. Oxidative phosphorylation relies on hydrogen carriers like NADH and $FADH_2$, which donate electrons to the electron transport chain. Therefore, this statement is not false.

d. It involves transferring phosphate from ATP.
Feedback: This is the "most false" statement. Oxidative phosphorylation synthesizes ATP from ADP and inorganic phosphate using the energy generated by the electron transport chain. It does not transfer phosphate from ATP but rather produces it.

e. The process must include a membrane-contained system.
Feedback: This is true. Oxidative phosphorylation requires a membrane system (such as the inner mitochondrial membrane in eukaryotes) to establish a proton gradient essential for ATP synthesis. Therefore, this statement is not false.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 9

Which order is correct, ordering molecules from most to least reducing potential?

a. $NADH + H^+$, $FADH_2$, Oxygen
b. Oxygen, $FADH_2$, $NADH + H^+$
c. $FADH_2$, Oxygen, $NADH + H^+$
d. Oxygen, $NADH + H^+$, $FADH_2$
e. $FADH_2$, $NADH + H^+$, Oxygen

a. $NADH + H^+$, $FADH_2$, Oxygen
Feedback: This is correct. $NADH + H^+$ has the highest reducing potential, followed by $FADH_2$, with oxygen having the lowest (acting as the terminal electron acceptor in the electron transport chain). This is the correct order based on their standard reduction potentials.

b. Oxygen, $FADH_2$, $NADH + H^+$
Feedback: This is incorrect. Oxygen has the lowest reducing potential because it is the ultimate electron acceptor, not a strong reducing agent. $NADH + H^+$ should be listed first, as it has the most reducing potential.

c. $FADH_2$, Oxygen, $NADH + H^+$
Feedback: This is incorrect. While $FADH_2$ is more reducing than oxygen, it is less reducing than $NADH + H^+$. $NADH + H^+$ should precede $FADH_2$ in the correct order.

d. Oxygen, $NADH + H^+$, $FADH_2$
Feedback: This is incorrect. Oxygen has the lowest reducing potential and should be listed last, as it is the terminal electron acceptor. $NADH + H^+$ should be listed first as the most reducing molecule.

e. $FADH_2$, $NADH + H^+$, Oxygen
Feedback: This is incorrect. While $FADH_2$ is more reducing than oxygen, it is less reducing than $NADH + H^+$. The correct order should be $NADH + H^+$, $FADH_2$, then oxygen.

Question 10

Which of the following is NOT a difference between substrate-level phosphorylation and oxidative phosphorylation?

a. One relies on proton motive force, whilst the other does not.
b. One produces ATP, whereas the other produces ADP.
c. One relies on kinases, whereas the other relies on ATP synthase.
d. One requires electron transport chain function, whereas the other does not.
e. One produces far more ATP during aerobic respiration.

A. Incorrect. Glycolysis occurs in the cytosol, not the mitochondrial matrix. The electron transport chain is embedded in the inner mitochondrial membrane, not the outer membrane.

B. Incorrect. The citric acid cycle occurs in the mitochondrial matrix, not the intermembrane space. Oxidative phosphorylation involves both the inner mitochondrial membrane (electron transport chain) and ATP synthase, not solely the matrix.

C. Correct. Pyruvate oxidation occurs in the mitochondrial matrix, where pyruvate is converted to acetyl-CoA. ATP synthesis is driven by the proton gradient established across the inner mitochondrial membrane by the electron transport chain.

D. Incorrect. The electron transport chain is embedded in the inner mitochondrial membrane, not the matrix. NADH oxidation primarily occurs in the mitochondrial matrix as part of the electron transport chain, not in the cytosol.

E. Incorrect. The proton gradient required for ATP synthesis is established across the inner mitochondrial membrane, not the outer membrane. The citric acid cycle occurs in the mitochondrial matrix, not in the intermembrane space.

Evolution & heredity

Question 1

Rank the following in evidence from best to worst. What is good evidence that DNA is the heritable material inside cells?

1. Cells with no DNA are not able to multiply and form daughter cells.
2. RNA does not live long enough to pass to daughter cells.
3. Direct injection of DNA into cells leads to changes in cells that can be passed down to daughter cells.
4. Introduction of damage to DNA can lead to faulty cells.

a. 3, 2, 1, 4

b. 3, 1, 4, 2

c. 1, 3, 4, 2

d. 4, 1, 2, 3

e. 1, 4, 3, 2

A. 3, 2, 1, 4

Feedback: This answer is incorrect. While the direct injection of DNA leading to heritable changes (option 3) is strong evidence, ranking RNA's short lifespan (option 2) above cells without DNA being unable to multiply (option 1) and DNA damage leading to faulty cells (option 4) is less accurate. RNA's instability supports DNA as the hereditary material but is weaker evidence than the inability to reproduce without DNA or the direct consequences of DNA manipulation.

B. 3, 1, 4, 2

Feedback: This answer is correct. Direct injection of DNA causing heritable changes (option 3) provides the strongest evidence. The inability of cells without DNA to multiply (option 1) and DNA damage causing faulty cells (option 4) also strongly support DNA as the heritable material. The lifespan of RNA (option 2) is the weakest evidence, making this ranking logical.

C. 1, 3, 4, 2

Feedback: This answer is partially correct. Ranking cells' inability to multiply without DNA (option 1) high makes sense, but direct injection of DNA (option 3) provides more direct evidence of DNA's role in heredity. The evidence from RNA's lifespan (option 2) should be ranked last, as it provides indirect support. Try again!

D. 4, 1, 2, 3

Feedback: This answer is incorrect. While DNA damage leading to faulty cells (option 4) is

important, it is not as strong as direct manipulation of DNA causing heritable changes (option 3). Ranking RNA's lifespan (option 2) above direct evidence from DNA manipulation is a significant error, as the latter provides more direct and compelling evidence for DNA as the hereditary material.

E. 1, 4, 3, 2
Feedback: This answer is partially correct but not optimal. The inability of cells without DNA to multiply (option 1) and DNA damage causing faulty cells (option 4) are strong evidence but not stronger than direct manipulation of DNA (option 3). Ranking RNA's lifespan (option 2) last is appropriate, but option 3 should be ranked higher for more direct evidence of DNA's role in heredity. Try again!

Question 2
Henry says that "DNA is a good store of information because it can be passed down with the same effect in each generation." Which of the following is the most important and valid criticism of Henry's statement?

a. DNA is not a good store of information, because it takes minutes to copy.
b. DNA code is not passed down identically between each generation.
c. DNA is a reliable store of information, but it does not have the same effect in each generation.
d. DNA can be transferred horizontally as well as down generations.
e. DNA has been selected as heritable material because it can be packaged small, not because it can be passed down between generations.

A. DNA is not a good store of information, because it takes minutes to copy.
Feedback: This answer is incorrect. The time it takes to copy DNA is not a valid criticism of its ability to store information or be passed down with the same effect across generations. The speed of DNA replication is not a factor that undermines its role as a reliable store of genetic information.

B. DNA is not passed down identically between each generation.
Feedback: This answer is somewhat correct. Whilst it is true that DNA code is not passed down identically (due to mutations or recombination events), in most instances the changes between generations to individual letters in genes are so few that we can effectively ignore them. Also, the mechanism of DNA heredity does not alter between generations. There is a more important criticism. Try again!

C. DNA is a reliable store of information, but it does not have the same effect in each generation.
Feedback: This answer is correct and addresses the key flaw in Henry's statement. While DNA is a reliable store of information, its expression can vary between generations due to

environmental influences, epigenetic changes, and genetic recombination. This can result in different effects in each generation, challenging Henry's assertion.

D. DNA can be transferred horizontally as well as down generations.
Feedback: This statement is true, but is of questionable relevance to Henry's statement. While horizontal gene transfer does occur, especially in bacteria, it is not the primary process by which genetic information is passed down through generations in most organisms. This statement does not directly address the validity of DNA as a reliable store of information across generations.

E. DNA has been selected as heritable material because it can be packaged small, not because it can be passed down between generations.
Feedback: This answer is incorrect. The ability of DNA to be passed down through generations is one of the key reasons it serves as heritable material. Its compact packaging is an advantage, but it is not the primary reason for DNA's selection as genetic material. This criticism does not effectively challenge Henry's statement.

Question 3

Which of the following is the best definition of a gene?

a. A discrete stretch of DNA on a chromosome.
b. A trait that can be seen and passed down through the generations.
c. A stretch of DNA that has been identified.
d. A heritable trait passed down to offspring as DNA.
e. The triplet code used to make a protein.

A. A discrete stretch of DNA on a chromosome.
Feedback: This answer is partially correct. While a gene is indeed a specific stretch of DNA on a chromosome, this definition is incomplete because it doesn't mention the function of a gene, which involves encoding a functional product, typically a protein or RNA. More importantly, not all stretches of DNA contain genes!

B. A trait that can be seen and passed down through the generations.
Feedback: This answer is incorrect. A gene is not the trait itself, but rather the DNA sequence that encodes the trait. The trait is the manifestation of the expression of one or more genes, but the gene itself is the underlying genetic material.

C. A stretch of DNA that has been identified.
Feedback: This answer is incorrect. While a gene is a stretch of DNA, not all identified DNA stretches are genes. Genes specifically encode functional products (such as proteins or RNA), so the definition should include this aspect of functionality.

D. A heritable trait passed down to offspring as DNA.
Feedback: This answer is correct. It is the DNA sequence that encodes for a trait, allowing for its passing down through generations.

E. The triplet code used to make a protein.
Feedback: This answer is incorrect. The triplet code (or codons) refers to the genetic code within a gene that specifies amino acids in a protein, but this definition doesn't fully capture what a gene is. A gene includes not just the coding sequence but also regulatory regions that control its expression.

Question 4

When sorting organisms into evolutionary groups, why are questions referring to traits like **limb number or whether the organism is warm/cold blooded** more suitable than questions about traits like **hair colour or ear size**.

a. The former are unambiguous.
b. The former are major evolutionary changes.
c. The former are easy to identify.
d. The former are more specific.
e. The former can affect an organisms chance of survival.

A. The former are unambiguous.
Feedback: This answer is incorrect. While traits like limb number or being warm/cold-blooded might seem less ambiguous than traits like hair color, the key reason for using these traits in evolutionary classification is not about ambiguity. It's more about their significance in evolutionary history and phylogenetic relationships.

B. The former are major evolutionary changes.
Feedback: This answer is correct. Traits like limb number or whether an organism is warm/cold-blooded represent significant evolutionary adaptations that are more useful for determining evolutionary relationships and grouping organisms. These traits often reflect deep evolutionary divergences, making them more suitable for classification.

C. The former are easy to identify.
Feedback: This answer is incorrect. Although traits like limb number might be easier to identify than hair color in some cases, ease of identification is not the main reason why these traits are preferred in evolutionary grouping. The focus is on the evolutionary significance of the traits, not just their visibility.

D. The former are more specific.
Feedback: This answer is incorrect. While traits like limb number or thermoregulation are important, "specificity" is not the most relevant factor here. In fact, traits like hair color or ear size could be considered more specific in some contexts, but they do not have the same evolutionary significance as the broader physiological or anatomical traits.

E. The former can affect an organism's chance of survival.
Feedback: This answer is partially correct but not the best explanation. While it's true that traits like limb number or thermoregulation can affect an organism's survival, the primary reason these traits are used for classification is their role in significant evolutionary developments that help scientists understand phylogenetic relationships. The focus is on the evolutionary history, not just survival advantages.

Question 5

Who is the Most Recent Common Ancestor of a person and their first cousin?

a. Their Mother
b. Their great-grandmother
c. Their Aunt
d. Their grandmother
e. Their Sister

A. Their Mother
Feedback: This answer is incorrect. The Most Recent Common Ancestor is the most recent individual to whom they are both directly related. Try drawing a family tree to see who the most recent person is who they are both related to.

B. Their great-grandmother
Feedback: This answer is incorrect. The Most Recent Common Ancestor is the most recent individual to whom they are both directly related. Try drawing a family tree to see who the most recent person is who they are both related to.

C. Their Aunt
Feedback: This answer is incorrect. The Most Recent Common Ancestor is the most recent individual to whom they are both directly related. Try drawing a family tree to see who the most recent person is who they are both related to.

D. Their Grandmother
Feedback: This answer is correct. The most recent common ancestor of a person and their first cousin is their grandmother (or grandfather). This is because the cousins share the same grandparents, with their respective parents being siblings.

E. Their Sister
Feedback: This answer is incorrect. The Most Recent Common Ancestor is the most recent individual to whom they are both directly related. Try drawing a family tree to see who the most recent person is who they are both related to.

Question 6

Which order correctly describes how natural selection occurs?

1. Adaptations which conferred more fitness in the previous generation accumulate in subsequent generations.
2. A selection pressure causes some individuals to be more fit than others within a population.
3. Variation between individuals in a population is introduced.
4. Poorly adapted individuals die and/or fail to pass on their genes to the next generation.

a. 2, 3, 4, 1
b. 3, 2, 4, 1
c. 3, 2, 1, 4
d. 2, 3, 1, 4
e. 2, 1, 3, 4

A. 2, 3, 4, 1
Feedback: This answer is incorrect. You have figured-out how selection pressures eventually lead to evolutionary change, but what comes first?

B. 3, 2, 4, 1
Feedback: This answer is correct. Variation between individuals must come before selection pressures can act on these differences. It is the act of selection for and against individuals that leads to adaptations eventually accumulating in subsequent generations. Well done!

C. 3, 2, 1, 4
Feedback: This answer is incorrect. Reconsider what must occur before you get adaptations accumulating in subsequent generations.

D. 2, 3, 1, 4
Feedback: This answer is incorrect. What must be in place before selection pressures can act? Also, reconsider what must occur before you get adaptations accumulating in subsequent generations.

E. 2, 1, 3, 4
Feedback: This answer is incorrect. Biological variation must be in place before selection pressures can act.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 7

Sticklebacks are fish. Some subspecies live in a series of interconnected lakes in Africa. The sticklebacks in one lake have adapted camouflage to protect against a predator in that specific lake. This same lake is accidentally polluted one year, killing all the sticklebacks in the lake. The alleles that confer camouflage are lost.

What type of evolution has been caused by the pollution?

a. Evolution by natural selection
b. Evolution by acquiring characteristics (Lamarckian)
c. Evolution by gene flow
d. Evolution by genetic drift
e. The founder effect

A. Evolution by natural selection
Feedback: This answer is incorrect. While natural selection is involved in the adaptation of sticklebacks to their environment, the scenario described involves the loss of alleles due to pollution, not a selective process where advantageous traits increase in frequency. What type of evolution is more randomly acting?

B. Evolution by acquiring characteristics (Lamarckian)
Feedback: This answer is incorrect. Lamarckian evolution refers to the idea that organisms acquire traits during their lifetime and pass these traits to their offspring. The loss of camouflage alleles due to pollution does not fit this model, as it involves a loss of genetic variation rather than the acquisition of new characteristics.

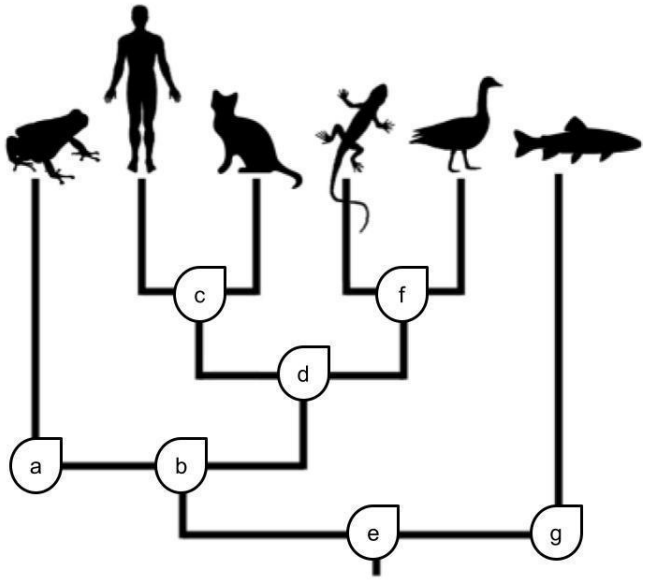
C. Evolution by gene flow
Feedback: This answer is incorrect. Gene flow involves the transfer of genetic material between populations through migration or interbreeding. In the scenario provided, gene flow is not a factor, as the loss of camouflage alleles is due to pollution rather than changes in gene flow between populations.

D. Evolution by genetic drift
Feedback: This answer is correct. Genetic drift is the random change in allele frequencies in a population, especially in small populations, due to chance events. The pollution event that led to the death of all sticklebacks in the lake and the loss of the camouflage alleles is an example of genetic drift.

E. The founder effect
Feedback: This answer is incorrect. The founder effect occurs when a new population is established by a small number of individuals from a larger population, potentially leading to different allele frequencies. The scenario describes a loss of alleles due to pollution rather than the establishment of a new population, so the founder effect does not apply.

Question 8

Which of the statements about the phylogenetic tree below is most correct?



a. The MRCA of geese and cats is **b**
b. Humans are more closely related to lizards than to geese
c. Frogs are a suitable outgroup when comparing the tetrapods
d. Limbs evolved before **b**
e. **d** was a tetrapod

A. The MRCA of geese and cats is b
Feedback: This is incorrect. The most recent common ancestor (MRCA) of geese and cats is d, seen where the lineage of cats and geese first meet.

B. Humans are more closely related to lizards than to geese
Feedback: Although lizards and humans appear closer, they have similar genetic distance, according to the tree, because they both branch from f. Lizards and geese are equally related to humans. You must study the tree to understand relatedness.

C. Frogs are a suitable outgroup when comparing the tetrapods
Feedback: This is wrong because frogs have four limbs tetra-pod = four-limb. An outgroup is a group that lies outside the group being considered. The fish would be the outgroup here.

D. Limbs evolved before b
Feedback: Based on the tree, this statement is almost certainly true (and is actually true). The limbs of frogs, geese, and humans are all functionally related, having the same evolutionary origin, which the tree implies.

E. d was a tetrapod
Feedback: This is somewhat likely to be correct, but is not the most correct. There is one answer that has to be correct. Remarkably, although geese are bipedal, they have evolved from a tetrapod.

Question 9

Which of the following statements best describes the difference between horizontal and vertical gene transfer?

a. **Horizontal gene transfer** occurs within a single organism's genome, while **vertical gene transfer** occurs between organisms of the same species.
b. **Horizontal gene transfer** involves the transfer of genetic material between unrelated organisms, while **vertical gene transfer** involves the transmission of genetic material from parent to offspring.
c. **Horizontal gene transfer** is the process by which genetic material is transferred through sexual reproduction, while **vertical gene transfer** occurs through asexual reproduction.
d. **Horizontal gene transfer** only occurs in prokaryotes, while **vertical gene transfer** only occurs in eukaryotes.

A) Horizontal gene transfer occurs within a single organism's genome, while vertical gene transfer occurs between organisms of the same species.
Feedback: This answer is incorrect. Horizontal gene transfer refers to the transfer of genetic material between unrelated organisms, not within a single organism's genome. Vertical gene transfer, on the other hand, involves the transmission of genetic material from parent to offspring within the same species.

B) Horizontal gene transfer involves the transfer of genetic material between unrelated organisms, while vertical gene transfer involves the transmission of genetic material from parent to offspring.
Feedback: Correct! Horizontal gene transfer occurs between unrelated organisms, often across species, and is a key mechanism for acquiring new traits. Vertical gene transfer is the process by which genetic material is passed down from parents to offspring.

C) Horizontal gene transfer is the process by which genetic material is transferred through sexual reproduction, while vertical gene transfer occurs through asexual reproduction.
Feedback: This answer is incorrect. Horizontal gene transfer does not involve sexual reproduction; it refers to the transfer of genetic material between different organisms, often unrelated. Vertical gene transfer involves the transmission of genetic material from parent to offspring, regardless of whether reproduction is sexual or asexual.

D) Horizontal gene transfer only occurs in prokaryotes, while vertical gene transfer only occurs in eukaryotes.

Feedback: This answer is incorrect. Horizontal gene transfer can occur in both prokaryotes and eukaryotes. Vertical gene transfer, the passing of genetic material from parent to offspring, also occurs in both prokaryotes and eukaryotes.

Question 10

Which of the following best explains the process of speciation?

A) Speciation occurs when individuals within a population adapt to their environment, resulting in new traits that enhance outgroup survival.

C) Speciation occurs when mutations within a population lead to hindered interbreeding.

B) Speciation occurs when a population becomes isolated, leading to the development of groups that can no longer interbreed.

D) Speciation occurs when two different species hybridise, producing offspring that are unique.

A) Speciation occurs when individuals within a population adapt to their environment, resulting in new traits that enhance outgroup survival.
Feedback: This answer is incorrect. While adaptation to the environment can lead to new traits within a population, speciation specifically refers to the formation of new species, typically due to reproductive isolation. The concept of "outgroup survival" is unrelated to the process of speciation.

B) Speciation occurs when mutations within a population lead to hindered interbreeding.
Feedback: This answer is incorrect. While mutations can play a role in the process of speciation, speciation is not simply about mutations hindering interbreeding. It typically involves the isolation of populations (geographical, behavioral, or other forms of isolation) that eventually leads to the emergence of distinct species.

C) Speciation occurs when a population becomes isolated, leading to the development of groups that can no longer interbreed.
Feedback: Correct! This answer accurately describes the process of speciation. When a population becomes geographically or reproductively isolated, the groups may evolve independently over time, eventually becoming distinct species that can no longer interbreed.

D) Speciation occurs when two different species hybridize, producing offspring that are unique.
Feedback: This answer is incorrect. While hybridization between species can occasionally lead to unique offspring, this is not the typical process of speciation. Speciation usually occurs due to the isolation and independent evolution of populations, not through hybridization between different species.

Homeostasis & Hormones

Question 1

Homeostasis ensures the stability of the internal environment despite external changes. Which of the following scenarios best illustrates the general principles of homeostasis?

a. A system where a deviation from a set point triggers responses that amplify the deviation until equilibrium is reached.
b. A system where equilibrium is maintained by passively adapting to external environmental changes without internal regulation.
c. A system where internal conditions fluctuate randomly in response to external changes, eventually stabilizing.
d. A system where the same response is triggered regardless of the direction of deviation from the set point.
e. A system where a deviation from a set point activates mechanisms to restore the set point, reducing the deviation.

A. Incorrect. Amplifying deviations describes positive feedback, which is not the primary mechanism of homeostasis. Homeostasis relies on negative feedback to counteract deviations and maintain stability.

B. Incorrect. Homeostasis involves active regulation through feedback mechanisms, not passive adaptation. Passive systems cannot maintain stability in fluctuating environments.

C. Incorrect. Homeostasis is about controlled responses to maintain stability, not random fluctuations. Stability arises from precise regulation, not chance.

D. Incorrect. Effective homeostasis requires responses tailored to the nature of the deviation. For example, heating mechanisms activate when the body is too cold, and cooling mechanisms activate when it is too hot.

E. Correct. This describes the fundamental principle of negative feedback, which is central to homeostasis. The system detects changes and acts to restore the internal environment to its set point.

These multiple choice questions are designed to stimulate discussion, not test knowledge!

Question 2

Which of the following best describes the role of negative feedback in maintaining homeostasis?

a. Negative feedback amplifies changes to restore equilibrium.
b. Negative feedback counteracts deviations from a set point to maintain a stable internal environment.
c. Negative feedback suppresses the activity of all effectors, preventing any physiological response.
d. Negative feedback involves the activation of effectors to enhance the original stimulus.
e. Negative feedback operates only in response to external environmental changes, not internal fluctuations.

A. Negative feedback amplifies changes to restore equilibrium.

- Feedback: Incorrect. Negative feedback reduces or counteracts changes, not amplifies them. Amplification of changes is a characteristic of positive feedback, not negative feedback.

B. Negative feedback counteracts deviations from a set point to maintain a stable internal environment.

- Feedback: Correct. This is the fundamental principle of negative feedback, which acts to restore homeostasis by opposing deviations from the body's set points.

C. Negative feedback suppresses the activity of all effectors, preventing any physiological response.

- Feedback: Incorrect. Negative feedback activates specific effectors as needed to counteract changes and restore balance. Suppressing all effectors would disrupt homeostasis rather than maintain it.

D. Negative feedback involves the activation of effectors to enhance the original stimulus.

- Feedback: Incorrect. Enhancing the original stimulus is a characteristic of positive feedback, such as during childbirth (oxytocin release). Negative feedback works to reverse the stimulus.

E. Negative feedback operates only in response to external environmental changes, not internal fluctuations.

- Feedback: Incorrect. Negative feedback responds to both internal and external changes, such as regulating body temperature (external) or blood glucose levels (internal).

Question 3

Positive feedback amplifies changes in a biological system, leading to an enhanced response until a specific outcome is achieved. Which of the following is an example of a positive feedback mechanism?

a. After eating a meal, the body releases insulin to lower blood glucose levels.
b. During blood clot formation, activated platelets release chemicals that recruit additional platelets to the injury site, forming a plug.
c. When the body overheats, sweating occurs to cool it down and maintain a stable temperature.
d. High levels of estrogen suppress the secretion of follicle-stimulating hormone (FSH) to regulate reproductive cycles.
e. The release of cortisol inhibits further secretion of adrenocorticotropic hormone (ACTH) by the pituitary gland to prevent excess cortisol production.

A) Incorrect. This describes a negative feedback mechanism where insulin lowers blood glucose to restore balance, preventing further rise in blood sugar.

B) Correct. This is a positive feedback mechanism where activated platelets enhance their own recruitment to amplify the clotting process until the injury is sealed.

C) Incorrect. Sweating to cool down the body is an example of negative feedback, as the response (sweating) counteracts the initial stimulus (overheating).

D) Incorrect. The suppression of FSH by high estrogen is an example of negative feedback, maintaining hormonal balance rather than amplifying a process.

E) Incorrect. The inhibition of ACTH by cortisol is another example of negative feedback, preventing overproduction of cortisol in the body.

Question 4

A friend explains Le Chatillier's principle to you as follows, what is the biggest error in their explanation?

"Le Chatelier's principle states that if a system at equilibrium is disturbed by changing conditions such as concentration, pressure, or temperature, the system will shift in the direction that counteracts the change to restore equilibrium. For example, if you increase the concentration of a reactant in a reaction, the system will shift toward the reactant side to decrease the concentration of that reactant. In terms of pressure, if you increase the pressure in a system involving gases, the equilibrium will shift toward the side with fewer gas molecules to reduce the pressure. Finally, adding a catalyst increases the rate of the

reaction and speeds up both the forward and reverse reactions without changing the equilibrium position."

a. Homeostasis doesn't just concern gasses; it affects all equilibria.
b. Homeostasis doesn't affect solutions the same as gasses, so the concentrations example confuses understanding of Le Chatelier's principle.
c. If you increase the concentration of a reactant, the system shifts away from the reactant side, not towards.
d. If you increase pressure in a system, whether the system acts to reduce or increase gas molecules depends on the equation in question.
e. The explanation of catalysts is irrelevant to the explanation of Le Chatillier's principle

a. The explanation correctly addresses equilibria involving gases, solutions, and other systems. Thus, this does not pinpoint a flaw in the explanation. Additionally, the term "homeostasis" renders this option less relevant, as the discussion is about chemical equilibrium and not biological regulation.

b. The explanation about concentration is valid and does not cause confusion. Additionally, the term "homeostasis" renders this option less relevant, as the discussion is about chemical equilibrium and not biological regulation.

c. This is the **correct answer**. The explanation contains an error: if the concentration of a reactant is increased, the system shifts **away** from the reactant side (toward the product side) to counteract the increase in reactant concentration. The friend's explanation incorrectly states that the system shifts toward the reactant side.

d. The explanation correctly states that increasing pressure will shift equilibrium toward the side with fewer gas molecules. This answer does not highlight a flaw in the explanation. Try again!

e. This explanation is somewhat true but does not address an error. The explanation includes a correct description of how catalysts work, but mentioning catalysts is not directly relevant to Le Chatelier's principle. This inclusion is a minor digression, however, not a major error in the explanation.

Question 5

When an animal experiences dehydration, which of the following best demonstrates the application of Le Chatelier's principle to maintain homeostasis?

a. Increased reabsorption of water in the kidneys leads to a concentrated urine output, reducing water loss.

b. Decreased secretion of antidiuretic hormone (ADH) minimizes water reabsorption, conserving energy.
c. Elevated blood osmolarity decreases the release of ADH to prevent further changes.
d. Excessive thirst causes the body to increase respiratory water loss to compensate.
e. Blood plasma becomes more dilute to counteract rising osmolarity, restoring balance.

A. Increased reabsorption of water in the kidneys leads to a concentrated urine output, reducing water loss.

- **Feedback:** Correct. This is a biological application of Le Chatelier's principle. The increase in blood osmolarity due to dehydration shifts the "equilibrium" of water distribution, prompting mechanisms like ADH release to reabsorb water and restore balance.

B. Decreased secretion of antidiuretic hormone (ADH) minimizes water reabsorption, conserving energy.

- **Feedback:** Incorrect. In dehydration, ADH secretion increases, not decreases, to enhance water reabsorption and reduce further loss. A decrease in ADH would worsen dehydration.

C. Elevated blood osmolarity decreases the release of ADH to prevent further changes.

- **Feedback:** Incorrect. Elevated osmolarity stimulates ADH release to restore balance by conserving water, not decreasing its secretion.

D. Excessive thirst causes the body to increase respiratory water loss to compensate.

- **Feedback:** Incorrect. While thirst is triggered by dehydration, respiratory water loss increases water loss rather than conserving it. This does not align with the principle of counteracting the disturbance.

E. Blood plasma becomes more dilute to counteract rising osmolarity, restoring balance.

- **Feedback:** Incorrect. Blood plasma does not automatically dilute itself. Instead, mechanisms like water reabsorption in the kidneys or increased water intake work to decrease osmolarity.

Question 6

Which of the following is the most false similarity between hormonal and nervous communication.

a. Both occur quickly
b. Both involve diffusible signalling molecules
c. Both typically involve specialised tissues
d. Both are used in the brain

e. Both can elicit strong physiological responses

a. Both occur quickly

- **Feedback**: This is the **correct answer** as the **most false similarity.** Nervous communication occurs very quickly (milliseconds), whereas hormonal communication is generally slower, taking seconds to minutes or even longer to produce an effect. The assertion that both occur quickly is inaccurate, making this the most false similarity.

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b. Both involve diffusible signalling molecules

- **Feedback**: This statement is true and not the most false similarity. Hormonal communication involves hormones (diffusible molecules) traveling through the bloodstream, and some forms of nervous communication (e.g., neurotransmission) involve diffusible molecules like neurotransmitters across synapses.

---

c. Both typically involve specialised tissues

- **Feedback**: This is true and not the most false similarity. Nervous communication involves specialised tissues like neurons and synapses, while hormonal communication involves endocrine glands, which are also specialised tissues. This is a valid similarity.

---

d. Both are used in the brain

- **Feedback**: This statement is true and not the most false similarity. Hormones like oxytocin and neurotransmitters are both integral to brain function, so this similarity is accurate.

---

e. Both can elicit strong physiological responses

- **Feedback**: This is true and not the most false similarity. Both hormonal and nervous communication can induce significant physiological responses, such as fight-or-flight reactions (mediated by adrenaline and neural activation) or reflexes.

Question 7

The bicep and tricep work as an antagonistic pair of muscles to help control the position of the hand. In terms of temperature control, which of the following would be the antagonistic action to shivering?

a. Increasing basal metabolic rate
b. Piloerection (formation of goosebumps)
c. Peripheral vasoconstriction
d. Release of insulin from the Islets of Langerhans
e. Taking a coat off

a. Increasing basal metabolic rate

- **Feedback**: This is **not an antagonistic action to shivering**. Both shivering and an increased basal metabolic rate work to **generate heat** and raise body temperature. Therefore, they are complementary, not antagonistic.

---

b. Piloerection (formation of goosebumps)

- **Feedback**: This is also **not an antagonistic action to shivering**. Piloerection is a response to cold that traps heat by causing hair to stand up. Like shivering, it works to retain or generate heat, making it complementary rather than antagonistic.

---

c. Peripheral vasoconstriction

- **Feedback**: This is **not antagonistic to shivering**. Peripheral vasoconstriction reduces heat loss by narrowing blood vessels near the skin, aiding in temperature retention. This complements shivering as part of a heat-conservation strategy.

---

d. Release of insulin from the Islets of Langerhans

- **Feedback**: This is irrelevant to shivering and temperature control. Insulin release regulates blood glucose levels, not thermoregulation. It does not oppose or relate to the function of shivering, making this a poor choice.

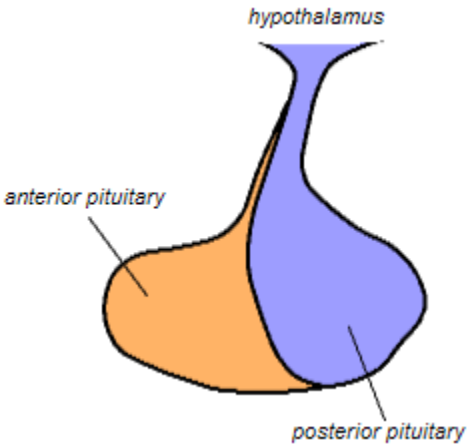
---

e. Taking a coat off

- **Feedback**: This is the **correct answer** as the **antagonistic action to shivering.** Shivering generates heat to warm the body, while taking a coat off would lead to greater heat loss, counteracting the body's effort to retain warmth. This makes it a true antagonistic action.

Question 8

Study the diagram shown. Which is the most false statement about the pituitary?



a. The pituitary is formed from the fusion of two distinct tissues.
b. The posterior pituitary is directly connected to the hypothalamus by nerves, and so is part of the brain.
c. The anterior pituitary is shown on the left as drawn, but is on the anatomical right hand side.
d. The anterior and posterior pituitaries produce structurally and functionally different hormones to each other.
e. Tumors of the pituitary can lead to a wide range of disorders.

a. The pituitary is formed from the fusion of two distinct tissues.
Feedback: True. The pituitary gland develops from two distinct embryological origins: the anterior pituitary (adenohypophysis) arises from oral ectoderm (Rathke's pouch), while the posterior pituitary (neurohypophysis) is derived from neural ectoderm. This statement is accurate and not false.

b. The posterior pituitary is directly connected to the hypothalamus by nerves, and so is part of the brain.
Feedback: True. The posterior pituitary is an extension of the hypothalamus and connected to it by nerve fibers. It is indeed considered part of the brain, as it stores and releases neurohormones like oxytocin and vasopressin that are synthesized in the hypothalamus. This statement is correct and not false.

c. The anterior pituitary is shown on the left as drawn, but is on the anatomical right-hand side.
Feedback: This is the most false statement. The word 'anterior' means front and posterior means 'rear'. This diagram is showing a view from the side, not front or back. Thus, this statement is incorrect. It is true -however- that drawings of anatomical structures often adhere to the convention of left-right orientation from the perspective of the subject being observed.

d. The anterior and posterior pituitaries produce structurally and functionally different hormones to each other.
Feedback: True. The anterior pituitary produces hormones such as ACTH, GH, TSH, LH, FSH, and prolactin, which are synthesized by its own cells. The posterior pituitary, in contrast, stores and releases hormones like oxytocin and vasopressin that are synthesized in the hypothalamus. This statement is accurate and not false.

e. Tumors of the pituitary can lead to a wide range of disorders.
Feedback: True. Pituitary tumors can result in overproduction or underproduction of hormones, causing conditions such as acromegaly, Cushing's disease, or hypopituitarism. Tumors may also compress nearby structures, leading to symptoms such as vision problems. This statement is correct and not false.

Question 9

Which of the following endocrine organs is NOT associated with steroid production?

a. Liver
b. Thyroid
c. Ovaries
d. Testes
e. Adrenals

a. Liver
Feedback: The liver is not primarily an endocrine organ associated with steroid hormone production. It does play a role in metabolizing steroid hormones, however. This is a reasonable choice but not the best answer.

b. Thyroid
Feedback: Correct! The thyroid gland primarily produces thyroid hormones (T3 and T4), which are derived from the amino acid tyrosine, not steroids. It is not involved in steroid production, making this the correct answer.

c. Ovaries
Feedback: Incorrect. The ovaries are endocrine organs that produce steroid hormones, including estrogens and progesterone, as part of their role in the female reproductive system.

d. Testes
Feedback: Incorrect. The testes are involved in steroid production, primarily synthesizing testosterone, a key male sex hormone.

e. Adrenals
Feedback: Incorrect. The adrenal glands are major endocrine organs associated with steroid production, including glucocorticoids (e.g., cortisol), mineralocorticoids (e.g., aldosterone), and adrenal androgens.

Question 10

Which of the following is NOT a common misconception about diabetes?

a. There are two types of diabetes, type I and type II.
b. People with diabetes require insulin injections to manage their condition.
c. Type I diabetes is primarily caused by genetic predisposition.
d. The vast majority of diabetes sufferers' conditions can be reversed.
e. Diabetes sufferers should avoid fruit

a. There are two types of diabetes, type I and type II.
Feedback: Incorrect. This is a misconception because diabetes is not limited to just two types. While type I and type II are the most common, there are other forms, such as gestational diabetes and maturity-onset diabetes of the young (MODY). This makes the statement a common misconception.

b. People with diabetes require insulin injections to manage their condition.
Feedback: Incorrect. This is a common misconception. While most people with type I diabetes require insulin injections, many individuals with type II diabetes can manage their condition through lifestyle changes, oral medications, and sometimes insulin.

c. Type I diabetes is primarily caused by genetic predisposition.
Feedback: Incorrect. While genetic predisposition plays a role, type I diabetes is primarily an autoimmune disorder where the immune system attacks insulin-producing cells in the pancreas. Environmental factors -such as childhood infections- also contribute, making this statement a misconception.

d. The vast majority of diabetes sufferers' conditions can be reversed.
Feedback: This is true, so it is *not* a common misconception. Well done! The vast majority of diabetes sufferers have type II diabetes mellitus, and this condition can usually be at least somewhat reversed through lifestyle changes and medication. Even type I diabetes mellitus sufferers can often dramatically improve their condition through careful medication and lifestyle adaptations.

e. Diabetes sufferers should avoid fruit.
Feedback: Incorrect. This is a common misconception. People with diabetes do not need to avoid fruit entirely. While they should monitor their carbohydrate intake, many fruits are nutritious and can be included in a balanced diet when consumed in appropriate portions.