Instructions for teachers for Life Sciences

There are ten sessions of multiple-choice questions here, on the following topics:

To run a session, you need to print ***two documents per pair of students***:

- *student questions,*
- *student feedback.*

Students having to share the questions and feedback sheets is an important part of the set-up, as it should help to encourage discussion.

The questions have been written or selected/modified from resources such as examination papers, to be deliberately challenging and tricky at times, since if the questions are too easy, it often leads to little discussion. Reassure students, where applicable, that questions like this won't be used in their summative assessments. Please emphasise to students that **this activity is not about knowing the answers, but an opportunity to discuss and explore ideas**.

Avoid the temptation to correct students whilst they are discussing. Instead, it is a good idea to allow time following the activity to discuss the most challenging questions as a group.

Always feel free to reach out at:
m.heron@surrey.ac.uk, who prepared this document, or another member of the research team: https://www.surrey.ac.uk/research-projects/educational-dialogue-improving-foundation-year-student-outcomes#team.

Whilst efforts have been made to correct errors and resolve ambiguities, some likely persist – let your discussions explore and uncover them!

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

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

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

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.

Question 5

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

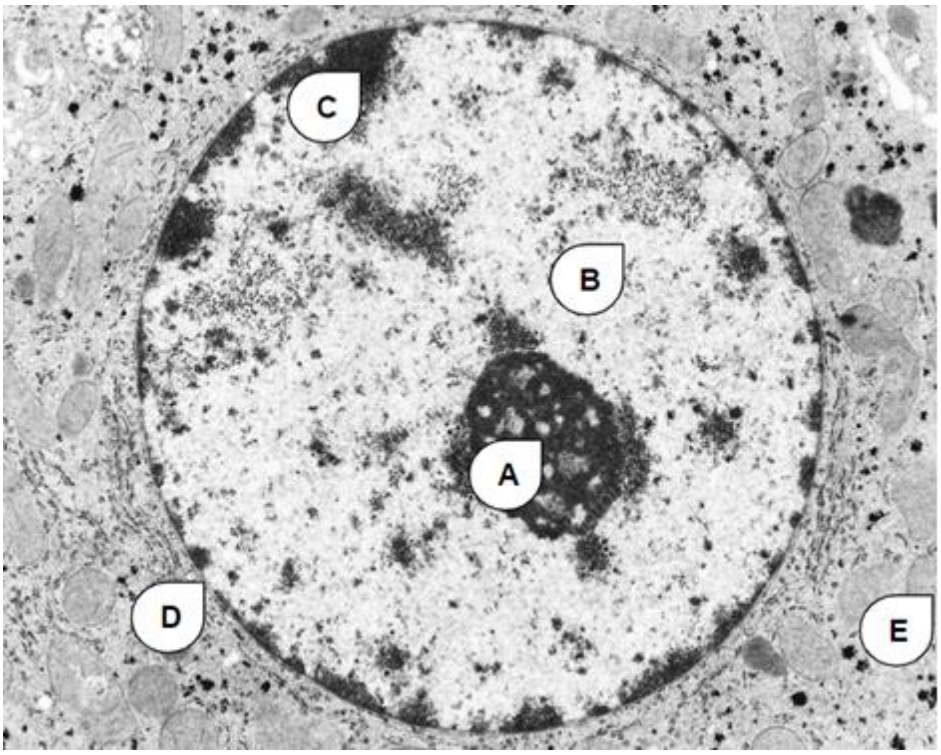
A) 16x ocular lens and 80x objective lens
B) 8x ocular lens and 4x objective lens
C) 4x ocular lens and 20x objective lens
D) 16x ocular lens and 160x objective lens
E) 8x ocular lens and 40x objective lens

Question 6

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

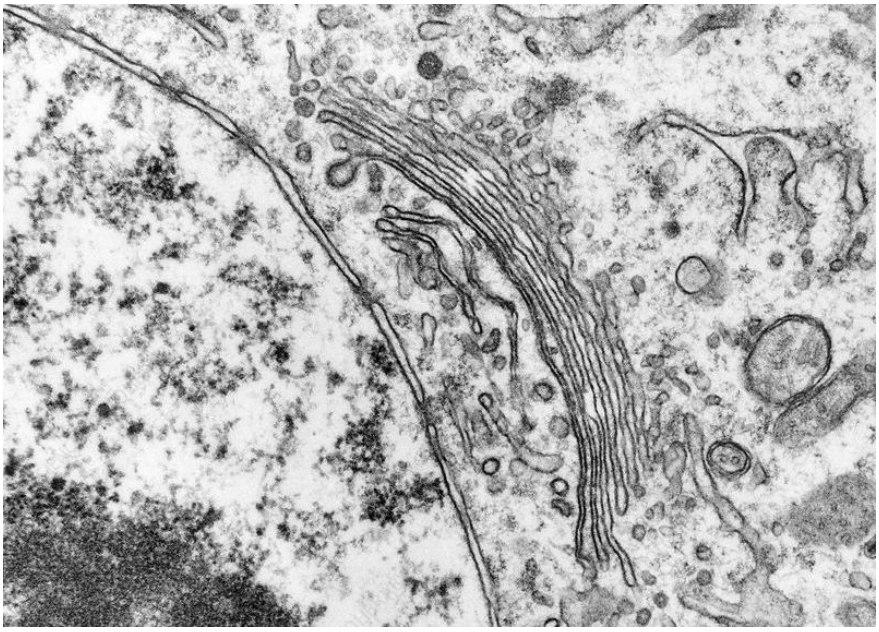
A) You can use a wide variety of staining techniques
B) The equipment is relatively cheap
C) You can visualise transparent objects
D) Your sample can be viewed alive (without fixing)
E) It is quick and easy to prepare samples

Question 7



Which letter indicates heterochromatin on the diagram above?

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

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

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

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.

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.

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.

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.

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.

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.

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.

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.

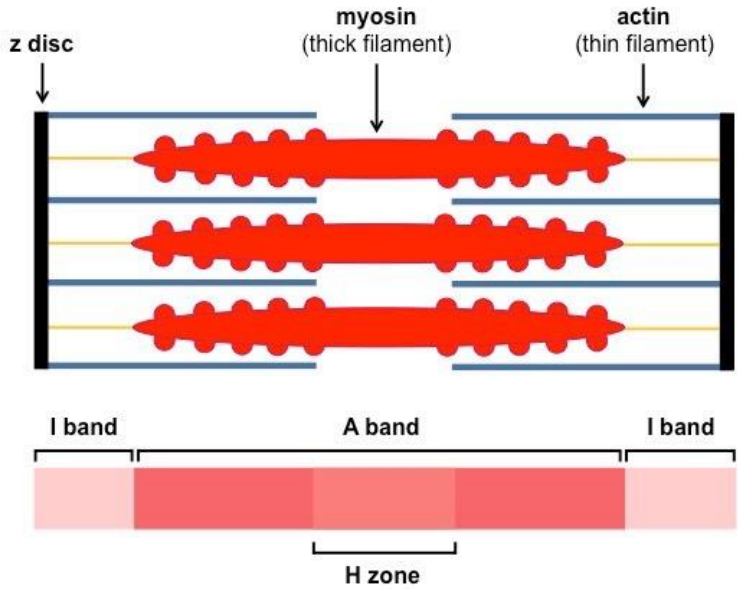
Question 9

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.

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.

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.

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.

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

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

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

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

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

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.

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

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

DNA Structure, transcription & protein synthesis

Question 1

Which of the following will have the highest melting point:

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

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

Question 3

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

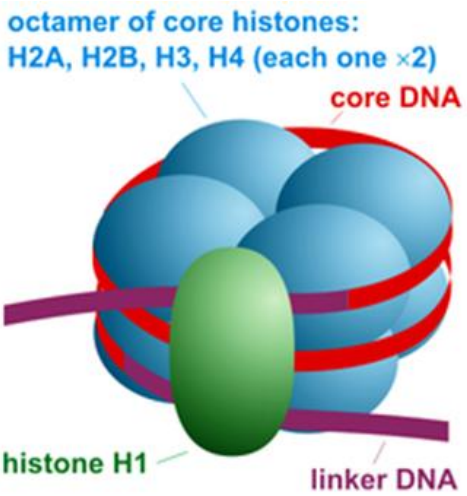
A) Protein catalysing DNA production
B) DNA carrying the code for protein production
C) RNA acting as a template for DNA production
D) Protein acting as a template for RNA production
E) DNA carrying the code for RNA production

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.

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.

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

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

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

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

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

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?

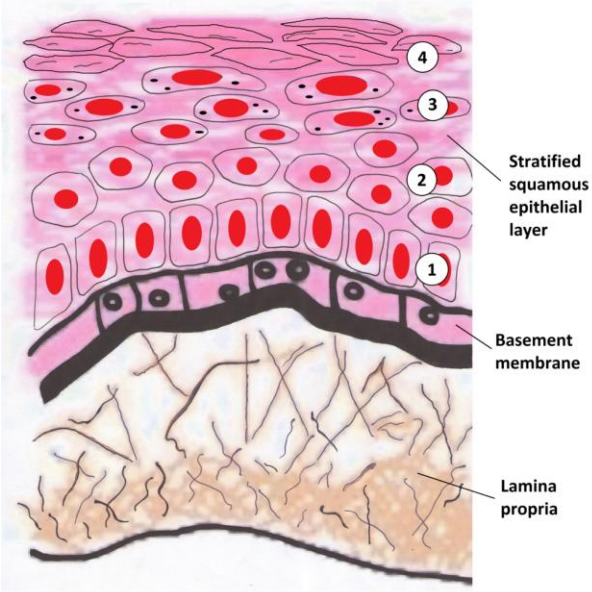
A) All genes in a cell are expressed simultaneously, allowing the cell to perform multiple functions.
B) Differentiation occurs when cells lose their ability to divide and therefore become specialised.
C) Each cell type has a completely different set of DNA, which determines its specialised function.
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.

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.

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

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.

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.

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.

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.

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.

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.

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.

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

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

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

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

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.

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.

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.

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

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

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

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

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

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

Question 4

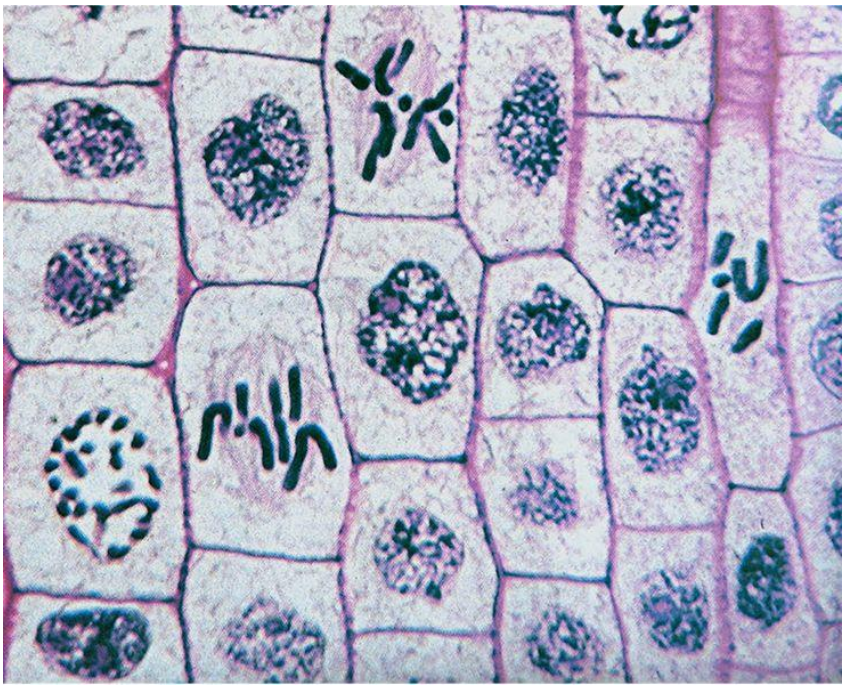
Which of the following takes place during mitosis prophase?

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

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

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

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

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

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

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

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.

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

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

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

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.

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.

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

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

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

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.

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

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.

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.

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.

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

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

Question 7

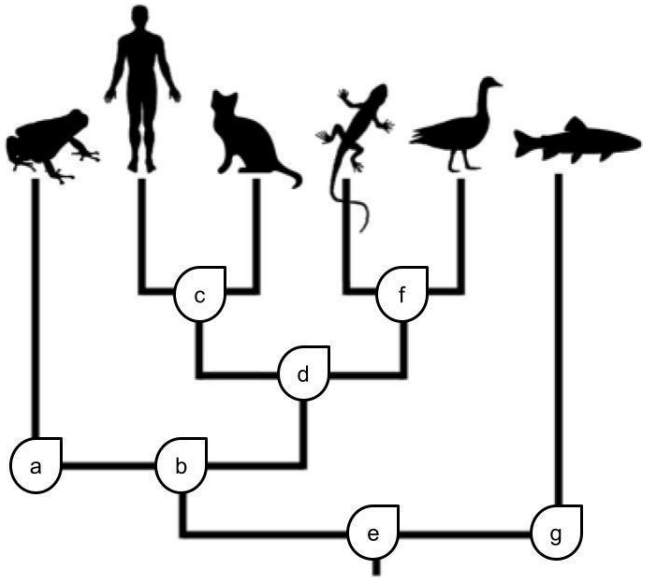
Sticklebacks are fish. Some subspecies live in a series of interconnected lakes in Africa. The sticklebacks in one lake have adapted camouflage to protect against a predator in that specific lake. This same lake is accidentally polluted one year, killing all the sticklebacks in the lake. The alleles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

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

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.

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.

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.

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.

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.

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

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.

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

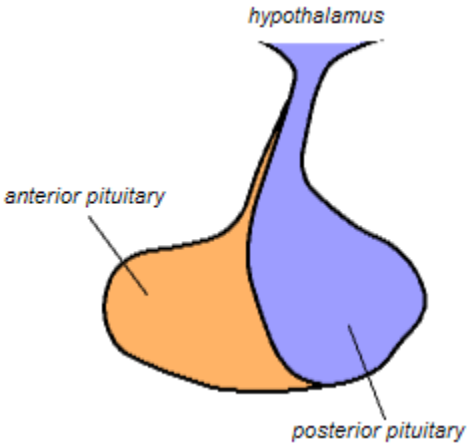
Question 7

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

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.

Question 9

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

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

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