

BIOLOGY

Unit 3 – Written examination



2017 Trial Examination

SOLUTIONS

SECTION A

Question 1

Answer: A

Explanation:

The term “fluid mosaic” refers to the fact that all parts of the membrane are highly mobile, and the phospholipid bilayer is interspersed with proteins.

Question 2

Answer: C

Explanation:

Glycoproteins are important in cell-cell communication and the recognition of self and non-self. All other options are incorrect.

Question 3

Answer: C

Explanation:

Cholesterol is positioned between the phospholipid molecules. At low temperatures it prevents them getting too close and therefore maintains the fluidity of the membrane, at high temperatures it ensures that the membrane stays together and so maintains the integrity of the membrane.

Question 4

Answer: D

Explanation:

Only very small or hydrophobic or uncharged particles are able to pass directly through the membrane. Any large, polar molecules (water is polar but it is very small) or ions cannot. D is the only option where all can't pass through the membrane.

Question 5

Answer: A

Explanation:

The nucleus is the site of transcription, which results in the synthesis of mRNA. Synthesis of polypeptides occurs at ribosomes in the cytoplasm and modification of polypeptides occurs in the endoplasmic reticulum. DNA is synthesized by assembling nucleic acids, not amino acids.

Question 6

Answer: C

Explanation:

A common misconception is that proteins are synthesized in the rough endoplasmic reticulum. This process occurs in the ribosomes, the rough endoplasmic reticulum is an intracellular transport system which allows the proteins to be folded and modified.

Question 7

Answer: D

Explanation: Hydrophobic regions are repelled from water and so are often in the centre of the molecule, with hydrophilic areas exposed. All other answers are incorrect: A refers to the primary structure of a protein, not the secondary structure. B refers to the quaternary structure of a protein rather than the tertiary structure. Amino acids join as a result of condensation reactions, not hydrolysis reactions.

Question 8

Answer: B

Explanation:

B is correct as DNA is composed of 2 strands that run in opposite directions, and all three forms of RNA have different folding arrangements. All other answers are incorrect. RNA has the base uracil, DNA has thymine. The ribose sugar in RNA has one more oxygen than DNA, and the amount of thymine in DNA will be double the amount of uracil in a RNA strand, which is single stranded.

Question 9

Answer: C

Explanation:

When a repressor protein is removed from a regulatory gene it will be transcribed and translated to produce a transcription factor that will result in the transcription of the associated structural gene commencing, ultimately resulting in the production of mRNA, which leaves the nucleus and moves to a ribosome. Translation to produce the polypeptide will then occur.

Question 10

Answer: C

Explanation:

A metabolic pathway is controlled by enzymes, and often the product of one reaction is the substrate for the next reaction in the pathway. The other options are incorrect as ATP to ADP + Pi is catabolic and exergonic. The breakdown of glucose does not involve a condensation reaction.

Question 11

Answer: A

Explanation:

Zn^{2+} is an inorganic ion and therefore acts as a cofactor for carbonic anhydrase.

Question 12

Answer: C

Explanation:

ATP synthesis occurs at these stages in respiration and photosynthesis. It does not occur in the light independent reaction of photosynthesis

Question 13

Answer: B

Explanation:

As pellet 2 includes the mitochondria this would contain the proteins associated with the electron transport chain.

Question 14

Answer: D

Explanation:

As cortisone is a steroid hormone it is hydrophobic or lipophilic and can cross the plasma membrane to bind to an intracellular receptor.

Question 15

Answer: B

Explanation:

Auxins are a plant growth regulator. Insulin is the hormone released to reduce blood glucose levels, cytokines are the signalling molecule associated with cells of the immune system and neurotransmitters enable a nerve impulse to cross a synapse.

Question 16

Answer: A

Explanation:

The resting potential is set up when 3 Na⁺ are pumped out of the membrane for every 2K⁺ that are pumped in. This results in a more negative intracellular environment. A is therefore correct.

Question 17

Answer: A

Explanation:

The insulin binds to the protein kinase receptor, which is reception. Transduction occurs when the signal transduction pathway is initiated. The response is the activation of the enzyme. Blood glucose concentration is decreased as a result, not increased.

Question 18

Answer: D

Explanation:

All other options result in apoptosis. Trauma to the cell would result in necrosis.

Question 19

Answer: B

Explanation:

Pathogenic organisms are cellular. Viroids, prions and viruses are not cellular and so cannot be classed as organisms.

Question 20

Answer: B

Explanation:

Stomach acid is a chemical defence. All others are physical defences to prevent pathogen entry.

Question 21

Answer: A

Explanation:

NK cells are part of the innate immune response. They detect any cells with altered MHC markers as a sign of a stressed cell, and release cytokines to cause apoptosis.

Question 22

Answer: D

Explanation:

B plasma cells are lymphocytes, not phagocytes. All others are phagocytic.

Question 23

Answer: A

Explanation:

Humoral immunity involves the activation of immature B cells to undergo clonal expansion to produce B-plasma cells and B-memory cells that release antibodies. Option A includes all cells involved in this response. Cytotoxic T cells are part of the cell-mediated response and phagocytes are part of the innate immune response.

Question 24

Answer: D

Explanation:

The foetus would receive IgG antibodies from its mother across the placenta. This is an example of natural passive immunity as the baby would be unable to produce its own antibodies.

Question 25

Answer: B

Explanation:

In an allergic response, an antigen on a non-pathogenic substance results in the initiation of clonal selection of B cells to produce IgE antibodies. The antibodies bind to the mast cells and cause histamine release if the allergen binds to the antibodies.

SECTION B - Short-answer questions

Question 1 (8 marks)

a.

- Similarity: one of:
 - Both contain phospholipid molecules arranged in a bilayer (1 mark)
 - Phospholipid molecules are arranged with hydrophobic tails in the centre of the bilayer and the hydrophilic heads facing outwards (1 mark)
- Difference:
 - A liposome is composed only of phospholipid molecules whereas a plasma membrane has protein (and cholesterol) molecules throughout (1 mark)

2 marks

b.

- small uncharged molecules are able to move via simple diffusion through the phospholipid bilayer (1 mark)
- ions require a protein channel or protein carrier in order to cross the bilayer either by facilitated diffusion or active transport (1 mark)

2 marks

c.

- Skin cells have carrier proteins in the plasma membrane and so were able to transport the ions via facilitated diffusion (1 mark)
- Liposomes only have a phospholipid bilayer and lack transport proteins. Therefore ions were unable to cross the membrane (1 mark)

2 marks

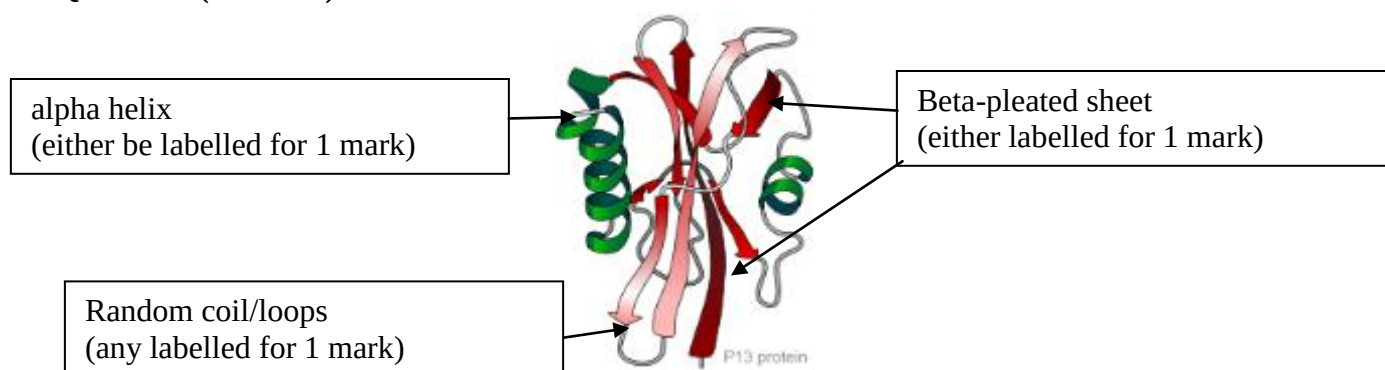
d.

- Movement of water has occurred via osmosis as the extracellular solution is hypertonic (1 mark)
- This was expected because the high concentration of ions outside the liposomes and cells established a concentration gradient for water. Water molecules are small enough to pass between the phospholipid molecules and do not require protein carriers, therefore it has occurred to the same extent in each sample (1 mark)

2 marks

Total 8 marks

Question 2 (11 marks)



a.

All 3 correct for 2 marks

2 correct for 1 mark

0/1 correct award 0 marks

2 marks

- b. The primary structure of protein is the specific sequence of amino acids (1 mark)

1 mark

c.

- Transcription (max 2 marks)
 - RNA polymerase moves along DNA template strand, producing a pre-mRNA molecule that is complementary to the template strand (1 mark)
 - Pre-mRNA undergoes post-transcriptional modifications including removal of introns, splicing of exons and addition of poly-A tail and a methyl cap to produce the mRNA molecule that leaves the nucleus (1 mark)
- Translation (max 2 marks)
 - mRNA binds to a ribosome and is read in groups of 3 bases, called codons (1 mark)
 - a tRNA molecule transfers an amino acid to the ribosome. When the complementary anti-codon binds to the codon the tRNA molecule releases the amino acid. (1 mark)
 - peptide bonds form between the amino acids to produce a polypeptide. (1 mark)

4 marks

d.

mRNA sequence:

AUG - AAU – GGU – UUU – GAG – CAA – CAC (1 mark)

amino acid sequence: Met - Asn – Gly - Phe – Glu – Gln - His (1 mark)

2 marks

e.

- Second codon would change from AAU to UAU (1 mark)
- Resulting in the second amino acid changing from *Asn* to *Tyr* (1 mark)

2 marks

Total 11 marks

Question 3

a.

- Oxygen is produced during photosynthesis (1 mark)
- Oxygen makes the disc rise, therefore faster the discs rise the faster the rate of photosynthesis (1 mark)

2 marks

b.

- The leaf discs under red and blue light will rise faster than those under green light (1 mark)
- Because the leaf discs can absorb red and blue light for use in photosynthesis, but reflect green light (1 mark)

2 marks

- c.** Place the same set up in the dark to ensure that no other factors cause the leaf discs to rise (1 mark)

1 mark

d.

- Light dependent stage (1 mark)
- produces oxygen, ATP and NADPH (1 mark)

2 marks

e.

- Glucose is produced in the light independent stage, using the ATP and NADPH from the light dependent stage to provide the energy for the anabolic reaction (1 mark)
- Under green light the light dependent stage cannot occur, so there will be much less glucose than the red/blue light (1 mark)

2 marks

Total 9 marks

Question 4

a.

- Impulse arrives at the synaptic knob, causing Ca^{2+} channels to open in the membrane and Ca^{2+} ions enter the cell (1 mark)
- Ca^{2+} signals for the vesicles to fuse with the membrane and release neurotransmitter via exocytosis (1 mark)
- Neurotransmitter diffuses across the synaptic cleft and binds to the receptors on the post-synaptic terminal of the next neuron, stimulating the impulse in that neuron (1 mark)

3 marks

b.

- Reception: binding of neurotransmitter to the receptor (1 mark)
- Transduction: opening of Na^+ gated channels (1 mark)
- Response: Na^+ moves into the neuron, resulting in an impulse (1 mark)

3 marks

c.

- Competitive inhibitor (1 mark)
- The chemical in the venom has a similar shape to acetylcholine which enables it to bind to the acetylcholine receptors, preventing the acetylcholine from binding. This means that the post-synaptic neuron cannot receive the signalling molecule and therefore cannot generate or pass on an impulse, resulting in paralysis (1 mark)

2 marks

Total 8 marks

Question 5

a.

- $\text{TNF}\alpha$ binds to receptor on plasma membrane, activating a secondary messenger (1 mark)
- secondary messenger activates apoptosis, resulting in cell death (1 mark)

2 marks

b.

3 from:

- caspases are activated which cleave intracellular proteins (1 mark)
- nucleus shrinks and DNA broken down by endonucleases (1 mark)

- cell shrinks and apoptotic bodies (blebs) form (1 mark)
- apoptotic bodies are engulfed by phagocytes (1 mark)

3 marks

Total 5 marks

Question 6

a.

Any two from:

- goblet cells release mucus to trap pathogens (1 mark)
- Ciliated epithelium cells move trapped pathogens back up the airways (1 mark)
- nose hairs prevent pathogen entry (1 mark)

Answers must be relevant to prevention of pathogen entry to airways

2 marks

b.

- All nucleated body cells have specific MHC1 markers that are specific to the individual (1 mark)
- Any cells without these specific MHC1 markers are recognised as non-self by immune cells (1 mark)

2 marks

c.

Any two from:

- phagocytes are attracted to the area of infection, which engulf the bacteria (1 mark)
- inflammation response is initiated – mast cells release histamine causing vasodilation at the site of infection and increasing the permeability of the walls to aid phagocytes (1 mark)
- Interleukins signal for the hypothalamus to increase body temperature (1 mark)
- complement proteins are activated, which help signal to the phagocytes, and destroy plasma membranes (1 mark)

2 marks

d.

- APC such as macrophages, naïve B-cells or dendritic cells present the antigen to the T-Helper cell in their MHCII markers (1 mark)
- T-Helper cell binds to specific naïve B-cell and secretes cytokines, to cause clonal selection of the B-cell to produce many B-plasma cells and B-memory cells (1 mark)
- The B-plasma cells produce antibodies which travel in the blood to bind with the antigens on the pathogen and aid in its destruction. (1 mark)

3 marks

Total 9 marks