BIOLOGY

Unit 3 – Written examination 1

2012 Trial Examination

SOLUTIONS

SECTION A: Multiple-choice questions (1 mark each)

Question 1

Answer: D

Explanation:
Lipids, Carbohydrates, Proteins and Nucleic Acids all contain both carbon and hydrogen. Proteins and Nucleic acids both contain nitrogen. Sulphur is the only element listed that is unique to proteins.

Question 2

Answer: B

Explanation:
If many beta sheets are packed together (nanoconfined) the strength of the hydrogen bonds between them is maximised increasing the strength and toughness of the spider web.

Question 3

Answer: C

Explanation:
This answer relies upon correctly applying base pairing rules – adenine and thymine, cytosine and guanine.

The correct sequence is: ATCTTTGCGATGCAC

Question 4

Answer: A

Explanation:
For water to diffuse into the cell the external water concentration must be higher than the internal water concentration. This means that the external solute concentration must be lower than the internal solute concentration. Therefore A is the only possible answer.

Question 5

Answer: C

Explanation:
The structure that is indicated is a carbohydrate chain attached to a phospholipid molecule.

Question 6

Answer: D

Explanation:
Since there is an excess of substrate present the reaction rate will increase if additional enzymes are present, eliminating answers A and B. As the optimum temperature for most human enzymes is 37ºC increasing the temperature from 30ºC to 35ºC will increase the reaction rate, and decreasing the temperature to 20ºC would decrease the reaction rate.

Question 7

Answer: B

Explanation:
The amount of enzyme remains constant, therefore the amount of substrate will be limiting. Initially the rate will be rapid, but as substrate concentration increases the point of saturation will be reached and the reaction rate will then become constant.

Question 8

Answer: D

Explanation:
A is incorrect as no ATP will be produced by fermentation. B is incorrect as the ATP yield through aerobic respiration is much higher than that of anaerobic respiration. C is incorrect as there is already sufficient oxygen present for aerobic respiration to occur, and the role of oxygen is to act as final acceptor. D is correct as NADH is the form in which Hydrogen is carried to the electron transport chain, producing high energy electrons, the transport of which provides the energy for phosphorylation of ADP.

Question 9

Answer: D

Explanation:
A is incorrect as glycolysis occurs in the cytosol. B is incorrect as ATP can still be produced by glycolysis. C is incorrect as metabolic water is produced by the electron transport chain, so the production of metabolic water will decrease. D is correct as oxidative phosphorylation occurs in the mitochondria and would be inhibited if the mitochondria are damaged.

Question 10

Answer: C

Explanation:
If insufficient oxygen is present, metabolites are processed through the anaerobic pathway. In animals pyruvate is converted into lactic acid.

Question 11

Answer: A

Explanation:
If the plant wilts, but then recovers the enzymes in the plant cannot have denatured. During the hottest part of the day the stomata close preventing gas exchange. As a result the plant does not take in carbon dioxide and therefore the rate of photosynthesis decreases.

Question 12

Answer: D

Explanation:
NADPH and ATP are both generated by non-cyclic phosphorylation during the light dependent stage of photosynthesis.

Question 13

Answer: D

Explanation:
Carbon fixation occurs during the Calvin cycle (Light independent stage).

Question 14

Answer: B

Explanation:
The question states that all conditions were identical with the exception of the colour of the box; therefore the colour of the box has to be the independent variable.

Question 15

Answer: C

Explanation:
The concentration of carbon dioxide will be the highest in the box where the plant is least able to photosynthesise. Green light will be absorbed by the green box, whilst the wavelengths required for photosynthesis are reflected. The plant in this box will carry out photosynthesise at a reduced rate, so less carbon dioxide will be used.

Question 16

Answer: A

Explanation:
A is the receptor that detects the stimulus; B is the effector which carries out the response, C.

Question 17

Answer: C

Explanation:
The membranes are initially polarised. When the sodium ions move into the axon depolarisation occurs.

Question 18

Answer: C

Explanation:
Positive feedback occurs when the response to a change occurs in the same direction as the change, causing the stimulus to increase rather than return to normal. Contractions during childbirth increase in rate and strength. This is therefore an example of positive feedback.

Question 19

Answer: B

Explanation:
A is incorrect as sensory neurons can also be myelinated. C is incorrect as all neurons have dendrites. D is incorrect as all neurons have terminals. B is correct as the presence of the lateral cell body is unique to sensory neurons.

Question 20

Answer: A

Explanation:
The main advantage of the reflex arc is the ability to carry out rapid, unconscious responses therefore limiting the damage to the body. B is incorrect as two neurons would be connected through a single synapse; C is incorrect as the response is carried out prior to conscious perception of the stimulus. D is incorrect as the spinal cord is the control centre for reflex responses.

Question 21

Answer: B

Explanation:
Initially the cell is damaged (I), calcium then causes enzymes to activate (IV), enzymes catalyse the metabolic pathway which finishes in the conversion of fibrinogen to fibrin (II), fibrin then forms a plug which seals the wound (III)

Question 22

Answer: A

Explanation:
Students may select D as an answer, which is a benefit of using stem cells. However, this question is asking about the benefits of not having to use mouse feeder cells during the production of stem cells.

Question 23

Answer: B

Explanation:
During hypersensitivity reaction allergens bind to antibodies on the surface of mast cells causing them to degranulate and release histamine.

Question 24

Answer: B

Explanation:
This is an example of passive immunity as the person is being supplied with antibodies. As they are injected passive immunity is artificially acquired.

Question 25

Answer: A

Explanation:
The HIV virus targets T helper cells which present antigens to immature B cells, therefore preventing the person from producing antibodies.

SECTION B: Short-answer questions

Question 1

a. Sperm production should increase.

1 mark

AND

Increasing the concentration of GnRH stimulates the man to produce higher concentrations of FSH and LH, which stimulates the production of testosterone, resulting in the production of sperm.

1 mark

b. Neurohormone/s

1 mark

c. GnRH is a peptide hormone.

1 mark

AND

The stomach contains proteases which break proteins down into amino acids. If GnRH were taken orally, it would be broken down by the proteases and therefore would be ineffective.

1 mark

d. Testosterone and GnRH use different methods of signal transduction as testosterone is a lipid soluble steroid, and GnRH is a lipid insoluble protein.

1 mark

AND

Testosterone is a steroid hormone. The receptor for testosterone is located inside the cell. The hormone/receptor complex moves to the nucleus where it alters the activity of genes.

1 mark

AND

GnRH is a peptide hormone. The receptor for GnRH is located on the external surface of the plasma membrane. A peptide hormone binds to the external receptor, triggering a secondary messenger inside the cell which initiates a metabolic cascade.

1 mark

Total 8 marks

Question 2

a. Killer T cells OR T cells for delayed hypersensitivity.

1 mark

AND

Rejection occurs because the transplanted tissue has the incorrect MHC markers identifying the tissue as foreign.

1 mark

b. Cell mediated immunity.

1 mark

AND

Killer T cells produce cytokines which signal the foreign cells to undergo programmed cell death (apoptosis).

1 mark

c. The stem cells are generated using the patient's own corneal cells. They would have the same MHC marker as the patient's cells and would therefore be detected as "self" cells.

1 mark

AND

Therefore there is no need for the patient to take immunosuppressive drugs as there should be no immune response against the stem cells.

1 mark

Total 6 marks

Question 3

a. The presence of the root hairs increases the rate of material transport

1 mark

AND

The rate of material transport is dependent upon the surface area to volume ratio. The presence of the roots hairs substantially increases the surface area to volume ratio.

b. Active transport

1 mark

AND

The mineral ions are moving against the concentration gradient from an area of low mineral ion concentration to an area of high mineral ion concentration.

1 mark

c. Student 2 is correct.

1 mark

AND

The concentration of mineral ions affects the concentration of water. If the internal mineral content is high then the internal water concentration will be low setting up a concentration gradient which enables water to diffuse into the plant cells.

1 mark

d. If the salt concentration surrounding the roots increases then the water concentration surrounding the cell will decrease.

1 mark

AND

Water will diffuse out of the root cells, which will plasmolyse and become flaccid. The plant will lose water, become dehydrated and eventually die.

1 mark

Total 8 marks

Question 4

a. The mitochondrial matrix

(Note: mitochondria is not sufficiently specific)

1 mark

b. 1

1 mark

c. NAD is a hydrogen acceptor responsible for transporting hydrogen to the electron transport chain.

1 mark

d. A person with PDHA is less able to convert pyruvate into Acetyl Coenzyme A.

1 mark

As a result pyruvate will accumulate, ultimately being converted into lactic acid via the anaerobic pathway.

1 mark

e. This suggestion is not plausible.

1 mark

AND

Pyruvate is the substrate for this reaction, since the individual is already unable to convert pyruvate into Acetyl Coenzyme A, it would be counterproductive to supply them with additional pyruvate.

1 mark

Total 7 marks

Question 5

a. Amino acids

1 mark

b. Transcription and Translation

1 mark

c. The students are correct.

1 mark

AND

The electrical component of the impulse depends upon depolarisation and repolarisation occurring in the axon. These events are governed by the movement of sodium and potassium ions moving across the membrane of the axon. Cone venom contains k-conotoxins which block potassium channels and m-conotoxins which block sodium channels.

(Mention of 1 toxin is sufficient to gain this mark).

1 mark

AND

During the chemical component, acetylcholine diffuses across the synapse before binding to post synaptic terminals. Cone venom includes a-conotoxins which block muscle acetylcholine receptors.

1 mark

d. Toxins contained in the venom prevent nervous responses from occurring as well as preventing acetylcholine from reaching muscle tissue.

1 mark

AND

As a result individuals are unable to breathe or move their muscles, leading to death due to envenomation.

1 mark

e. The diagram should have a complementary shape to the shape of the venom molecule. The shape should be similar to the one shown below. Note that only the top section of this shape is important, the lower section not binding to the venom could be any shape.

1 mark
Total 8 marks

Question 6

a. The antigen is recognised as non self. T helper cells present the antigen to immature B cells

1 mark

AND

This leads to clonal selection where large numbers of B plasma cells and small numbers of B memory cells are produced. The plasma cells then secrete antibodies that are specific to the antigen.

1 mark

b. Weakened or less virulent.

1 mark

c. The vaccination was the primary exposure to the antigen resulting in the production of B memory cells.

1 mark

AND

Upon second exposure to the antigen a more rapid secondary response occurred. The antibodies bound to and neutralised the antigen/s and as a result the person did not experience the symptoms.

1 mark

d. Influenza viruses mutate and their antigens change shape by a process called antigenic drift. Antibodies are specific and the antibody for one antigen will not be able to bind to a different antigen.

1 mark

AND

There are many different strains of influenza virus. Antibodies and memory cells are specific to a particular strain of influenza virus and are ineffective against other influenza viruses.

1 mark
Total 7 marks

Question 7

a. Thyroid hormone is responsible for regulating an individual's metabolic rate; if the metabolic rate is decreased less ATP would be produced leading to fatigue.

1 mark

b. Certain self-cells are detected as being foreign. These misidentified cells are then attacked by the immune system.

1 mark

c. There should be a dark spot on the X-ray film.

1 mark

AND

If the person is already sensitised to the allergen they will already be producing specific IgE antibodies which will bind to the allergen on the paper disk. The radioactively labelled anti IgE will bind to the IgE and will be detected by the use of X-ray film.

1 mark

d. A B cell is presented with the allergen and differentiates into plasma and memory cells. The plasma cell produces antibodies specific to the allergen. The antibodies bind to the surface of a mast cell.

1 mark

AND

When the allergen is encountered a second time it binds to the antibodies on the mast cell. As a result the mast cell degranulates releasing histamines.

1 mark

Total 6 marks