BIOLOGY

Unit 3 – Written examination

2021 Trial Examination

SOLUTIONS

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

Question 1

Answer: B

Explanation:
NADH is not produced in photosynthesis, as the coenzyme equivalent in photosynthesis is NADPH. The electron transport chain produces the greatest number of ATP molecules, but glycolysis produces the greatest number of NADH molecules. Two NADH molecules are produced in glycolysis, which then transfer energy to the next stage.

Question 2

Answer: B

Explanation:
An infected cell will often release interferons to signal to other cells that it is infected. This may trigger surrounding cells to reduce the permeability of their cell membranes, which would make it more difficult for a virus to enter. Cytokines, not hormones, are the signalling molecules of the immune system, and the infected cell, not the surrounding healthy cells, would release these. Natural killer cells, or cytotoxic T cells are the immune cells that initiate apoptosis in infected cells.

Question 3

Answer: A

Explanation:
Since sodium is moving down its concentration gradient, no energy is required, so it will move into the cell via diffusion. Because sodium ions have an electric charge, they are hydrophilic. This means they will have difficulty passing directly through the plasma membrane as they will be repelled by the fatty acid tails. Therefore, they require a protein channel, and will pass into the cell through facilitated diffusion.

Question 4

Answer: C

Explanation:
The phosphate heads of a phospholipids are polar and hydrophilic, and the fatty-acid tails are non-polar and hydrophobic. Generally, hydrophilic molecules are polar and hydrophobic molecules are non-polar.

Question 5

Answer: D

Explanation:
The light-dependent reactions occur at the thylakoid membranes within the chloroplast, which are arranged into stacks called grana. The light-independent reactions occur in the stroma of the chloroplast. The stomata are the holes in the leaf through which gases can enter and exit the leaf.

Question 6

Answer: D

Explanation:
Hydrophobic signal molecules typically bind to intracellular receptors, as they can pass through the phospholipid bilayer. Hydrophilic signal molecule cannot pass through as they are repelled by the fatty acid tails of the phospholipids. Therefore, they bind to extracellular receptors. Steroid-based signal molecules are hydrophobic.

Question 7

Answer: B

Explanation:
Reactions that build larger molecules from smaller molecules are referred to as anabolic, and typically endergonic (require energy). Reactions that break larger molecules down into smaller molecules are referred to as catabolic and are typically exergonic (release energy).

Question 8

Answer: A

Explanation:
Since ADH is a peptide hormone, it is a protein. The reaction that joins amino acids together is a condensation polymerisation reaction (water is released). The reaction is also endergonic (consumes energy) and anabolic.

Question 9

Answer: C

Explanation:
Anaerobic respiration only involves glycolysis and occurs in the cytosol of the cell. Anaerobic respiration is less efficient than aerobic respiration, as only two molecules of ATP are produced per molecule of glucose.

Question 10

Answer: B

Explanation:
The results for the three trials for the 20 cm distance are the most similar to each other. Therefore, they can be considered the most reliable set of results for this experiment.

Question 11

Answer: D

Explanation:
Lower light intensity reduces the amount of energy available to the light-dependent reactions. The light-dependent reactions release oxygen into the leaves, which is what causes them to float. Answer A is correct, but it does not explain why the leaves float. Lower light intensity reduces the amount of NADPH available to the light-independent reactions since NADPH is produced in the light-dependent reactions.

Question 12

Answer: B

Explanation:
Light intensity is the independent variable. Oxygen production and glucose synthesis are both the results of photosynthesis, so can be considered dependent variables. Temperature can affect rates of photosynthesis, so would need to be controlled for.

Question 13

Answer: D

Explanation:
Codons and anticodons match up during translation. An adenine tail, not a guanine tail, are added to the pre-mRNA molecule. RNA polymerase, not DNA polymerase, moves along the gene. The promoter region of the gene is where RNA polymerase binds to build a molecule of mRNA.

Question 14

Answer: A

Explanation:
When allolactose is present in the cell, it binds to the repressor. This changes the shape of the repressor molecule, causing it to detach from the operator. This allows RNA polymerase to move past the operator and transcribe the lac genes.

Question 15

Answer: D

Explanation:
RNA polymerase is a complex enzyme, and all enzymes are proteins. Polysaccharides, as their name suggests, are made up of sugar monomers (poly = many, saccharide = sugar). Another name for polysaccharides is carbohydrates. Messenger RNA is involved in the production of proteins but is not a protein itself – it is a nucleic acid. Phospholipids form the structure of the cell membrane and contain a phosphate group (the "head") and a lipid tail.

Question 16

Answer: C

Explanation:
The membrane attack complex consists of a ring of proteins that attach to the surface of an extracellular pathogen and create a hole in its cell membrane. This allows water to enter the pathogen via osmosis, causing the cell to swell and lyse (burst).

Question 17

Answer: C

Explanation:
A double helix containing 100 base pairs contains 200 nitrogenous bases. If 30 of those bases are cytosine, then 30 must also be guanine, because cytosine pairs with guanine. Together, these two bases make up 60 of the total 200 bases, meaning the remaining 140 are half adenine, and half thymine. So, the double strand contains 70 thymine bases and 70 adenine bases.

Question 18

Answer: D

Explanation:
This is passive immunity, because the person receiving the antibody treatment does not produce their own antibodies. It is artificial because the antibodies are being deliberately injected into the recipient.

Question 19

Answer: C

Explanation:
The people who were infected with SARS-COV-2 will have developed B memory cells. This gives them long term immunity, because if the memory cells encounter the virus at a later date, they will multiply and differentiate into B plasma cells, which secrete free antibodies. Those who received the antibodies directly do not have any memory cells. Therefore, once the antibodies are used up, they will not be able to produce any more.

Question 20

Answer: C

Explanation:
Antibodies produced in response to SARS-COV-2 target specific viral antigens, opsonising them and marking them for other immune cells to destroy.

SECTION B: SHORT ANSWER QUESTIONS

Question 1

a. The active site is the part of the enzyme to which its substrate binds (1) The shape of the active site is critical as it needs to complement the shape of the substrate (1)

2 marks

b. It is composed of more than one polypeptide chain.

1 mark

c. An error during transcription could result in the wrong amino acid being transcribed (1) Altering the sequence of amino acids could change the 3D shape of the enzyme (1) Therefore, if the sequence is altered, the 3D shape may be changed, also changing the shape of the active site and the substrate may not be able to bind to it and it will not be able to catalyse its reaction (1)

3 marks

d. Initially, as temperature increases, the activity of trypsin increases because the enzyme and its substrate move around more due to the increased kinetic energy and come into contact more frequently (1). Beyond about 45^{o}C, enzyme activity reduces substantially because the enzyme becomes denatured (1)

2 marks

e. Any two of:
- pH
- Enzyme concentration
- Substrate concentration
- Presence of inhibitors

2 marks

2 + 1 + 3 + 2 + 2 = 10 marks

Question 2

a. Any of the following options for each section

	Cells and Descriptions
Humoral Response	B plasma cells (1) – Secrete antibodies that target specific extracellular pathogens, to smother or opsonise the pathogen (1) B memory cells (1) – Contain antibodies that are complementary to the antigens of a particular extracellular pathogen. When these antigens are encountered, memory cells divide and multiply to produce B plasma cells (1) T helper cells (1) – release cytokines to stimulate naïve B cells to multiply and differentiate into B plasma cells and B memory cells, during clonal expansion (1)
Cell-mediated Response	Cytotoxic T cells (1) – Contain T cell receptors that target the antigens of a specific intracellular pathogen. Send death ligands to infected cells to initiate apoptosis (1) T memory cells (1) – Contain receptors that are complementary to the antigens of a particular intracellular pathogen. When these antigens are encountered, memory cells divide and multiply to produce cytotoxic T cells (1) T helper cells (1) – release cytokines to stimulate naïve B cells to multiply and differentiate into B plasma cells and B memory cells, during clonal expansion (1)

Each cell type can only be used once

8 marks

b. Any two of the following:
- The innate immune response responds the same way to each pathogen, while the specific immune response targets a specific pathogen.
- The innate immune response is more rapid than the specific immune response
- The innate immune response is short-lived, while the specific immune response is longer-term, as it produces memory cells
  Or any other suitable comparison

2 marks

8 + 2 = 10 marks

Question 3

a. met-gly-pro-ile-ala-leu-pro-pro

2 marks

b. The fifth amino acid in the peptide chain would be pro instead of ala.

1 mark

c. Point mutation OR missense mutation

1 mark

d. If the amino acid is changed, the chemical bonds / attractions / repulsions between this amino acid and other amino acids may change (1). This would change the way the peptide chain fold and coils, changing its 3D shape (1).

2 marks

e. This is a frameshift mutation (1). In a frameshift mutation, all codons downstream from the mutation are also altered (1). This means that all amino acids of the protein are also altered, changing the protein's structure extensively (1).

3 marks

f. Because multiple codons code for the same amino acid / the DNA code is redundant.

1 mark

2 + 1 + 1 + 2 + 3 + 1 = 10 marks

Question 4

a. Aerobic respiration consumes oxygen (1), and anaerobic respiration produces ethanol (1)

2 marks

b. At lower temperatures, molecules move around less due to less kinetic energy available (1) so the reactants and the enzymes that catalyse the biochemical reaction come into contact less often, so the reactions proceed at a slower rate (1).

2 marks

c. The enzymes that catalyse cellular respiration became denatured at this temperature.

1 mark

d. Any two of:

- The concentration / amount of yeast
- The concentration / amount of glucose
- The age of the yeast
- The pH of the solution

Or any other suitable response

The period of time for the reaction to occur is not a suitable response, as it is stated in the method that all containers were left to react for 90 minutes.

2 marks

e. Aerobic respiration is more efficient than anaerobic respiration (1). Anaerobic respiration is faster than aerobic respiration (1).

2 marks

f. Carbon dioxide levels would increase.

1 mark

2 + 2 + 1 + 2 + 2 + 1 = 10 marks

Question 5

a. Any two of:
- The cell is at the end of its life
- The cell is infected with a virus
- The cell is cancerous
- The cell cycle has been disrupted
- The cell is damaged

Or any other suitable response

2 marks

b. The cell is infected with a virus OR the cell is cancerous OR the cell is displaying abnormal MHC I markers (1). A cytotoxic T cell would initiate this process (1).

2 marks

c. Any three of:
- The mitochondria releases cytochrome c
- Caspases are activated
- Caspases cleave cellular proteins
- Cell organelles are destroyed
- Blebs form

Or any other suitable response

3 marks

d. In the growth of a cancerous tumor, rates of cell growth exceed (1) rates of apoptosis (1).

2 marks

e. Apoptosis is programmed cell death, whereas necrosis is cell death due to damage / trauma.

1 mark

2 + 2 + 3 + 2 + 1 = 10 marks

Question 6

a. **i)** Mast cell

1 mark

ii) IgE antibodies

1 mark

iii) The chemical is histamine (1). Histamine initiates the inflammatory response, causing redness, swelling, dilating blood vessels, a runny nose, itchiness (at least one physical effect should be mentioned in the response (1).

2 marks

b. Upon first exposure to the allergen (eg pollen), the adaptive immune response produces large quantities of IgE antibodies (1). These antibodies attach to mast cells, and the mast cells are now primed (1). Upon second exposure to the allergen, the allergen attaches to the IgE antibodies, forming crosslinks (1). This triggers the mast cells to release histamine, initiating the inflammatory response (1).

4 marks

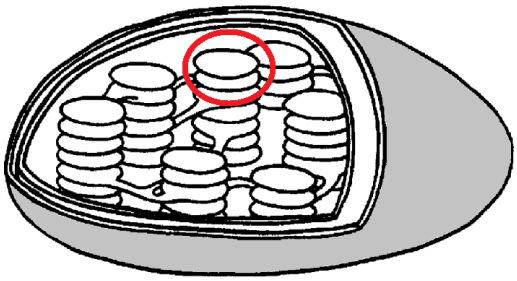
c. The person could take antihistamines (1) as antihistamine counteracts the effects of histamine, so will reduce the symptoms of the allergic response (1).
Or any other suitable response.

2 marks

1 + 1 + 2 + 4 + 2 = 10 marks

Question 7

a. Thylakoid membranes OR grana (1). Any of the grana should be circled (1)



2 marks

b. To produce glucose.

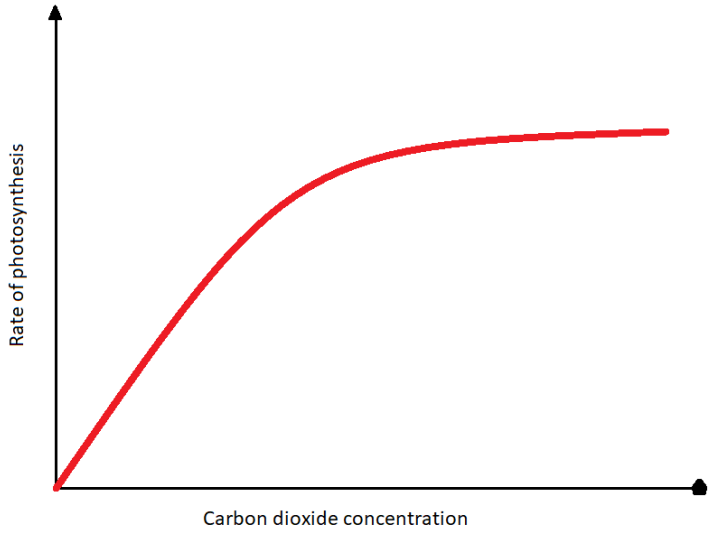
1 mark

c. Either of:

- ATP
- NADPH

1 mark

d. The graph should show an initial increase in photosynthesis rate with carbon dioxide concentration, then should plateau.



1 mark

e. Initially, rates of photosynthesis increase because carbon dioxide is an input into the synthesis of glucose (1). Rates then plateau because although there is more carbon dioxide available, there is not enough energy available from the light-dependent reactions for rates of photosynthesis to continue to increase (1).

2 marks

f. Any of:

- Temperature
- Light availability / intensity
- Water

1 mark

g. Any two of:

- Chloroplasts are of similar size to prokaryotic organisms
- Chloroplasts contain circular DNA, which is independent of nuclear DNA
- Chloroplasts replicate through binary fission
- Small ribosomes
- Chloroplasts have their own membrane

2 marks

2 + 1 + 1 + 1 + 2 + 1 + 2 = 10 marks