BIOLOGY

Unit 3 – Written examination

2022 Trial Examination

SOLUTIONS

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

Question 1

Answer: B

Explanation:

Uracil is found in RNA and a methyl cap and poly A tail are added to mRNA during post-transcriptional modification. Anticodons are present on tRNA. DNA contains a deoxyribose sugar.

Question 2

Answer: B

Explanation:

The genetic code is considered redundant as more than one codon can code for a single amino acid. If all organisms had the same nucleotide sequence, all organisms would be identical and so option A is incorrect.

Question 3

Answer: D

Explanation:

Exons are the coding region of mRNA and are expressed, whereas introns are the non-coding regions that are spliced out in the nucleus prior to the mRNA leaving. Codons are sequences of 3 nucleotides on an mRNA molecule that code for an amino acid.

Question 4

Answer: C

Explanation:

The tertiary structure is 3-dimensional, which determines a proteins function as it can create features such as active sites. Not all proteins are quaternary structures therefore D is not a correct response.

Question 5

Answer: C

Explanation:

In an operon, the RNA polymerase binds to the promotor region to initiate transcription. Repressor proteins bind to the operator region to regulate gene expression.

Question 6

Answer: D

Explanation:

The active site of an enzyme is complementary to the substrate, enabling it to bind. The product is the result of the reaction.

Question 7

Answer: B

Explanation:

Transport of proteins within a cell occurs from the endoplasmic reticulum. Transport outside of the cell occurs from the Golgi.

Question 8

Answer: C

Explanation:

DNA ligase restores the phosphodiester bonds between nucleotides. Polymerase catalyses the addition of free nucleotides, and ATP synthase catalyses the production of ATP.

Question 9

Answer: B

Explanation:

CRISPR-Cas9 can cut at any sequence of DNA, whereas restriction enzymes can only cut at a specific palindrome sequence.

Question 10

Answer: C

Explanation:

Increasing the current and having less porous gel increases the rate of movement of DNA fragments. DNA has a negative charge and is attracted to the positive electrode. It is assumed that the smaller fragments move faster than the larger fragments.

Question 11

Answer: D

Explanation:

When bacteria are transformed, a gene for antibiotic resistance is added and the bacteria is cultured on a plate containing the antibiotic to identify which bacteria have successfully been transformed.

Question 12

Answer: A

Explanation:

As every living organism contains the same 4 nitrogenous bases for DNA, any organism can receive DNA from a different species and the same segment of DNA will code for the same protein in any organism

Question 13

Answer: B

Explanation:

Photosynthesis uses carbon dioxide, and cellular respiration produces carbon dioxide. When these processes are occurring at equal rates, the net output of carbon dioxide is zero.

Question 14

Answer: C

Explanation:

NADPH is a co-enzyme in photosynthesis. ADP + Pi is the unloaded form of ATP.

Question 15

Answer: B

Explanation:

As the inhibitor has bound to a site other than the active site (allosteric), the inhibition is non-competitive as the substrate and inhibitor are not competing for the same region of the enzyme.

Question 16

Answer: D

Explanation:

Water is split in the light dependent stage of photosynthesis releasing oxygen and producing ATP, with carbon dioxide entering in the light independent stage of photosynthesis.

Question 17

Answer: A

Explanation:

Carbon dioxide accumulates in the bundle sheath cells so that stomata do not have to open in the heat of the day for photosynthesis to continue to occur.

Question 18

Answer: C

Explanation:

As CAM plants are found in dry, arid environments, they have sunken stomata to reduce the concentration gradient of water between the inside of the plant and the external environment.

Question 19

Answer: C

Explanation:

Four ATP are produced in glycolysis. A net of 2 ATP is produced, with 2 also being used to break the glucose molecule.

Question 20

Answer: C

Explanation:

Carbon dioxide is produced as well as ethanol in the anaerobic pathway in plants. This gas creates the bubbles and pop in wine.

Question 21

Answer: D

Explanation:

Glycolysis occurs in the absence of oxygen in the cytosol. When oxygen becomes available, aerobic respiration occurs however anaerobic occurs in the interim to sustain the metabolic needs of the organism.

Question 22

Answer: B

Explanation:

As oxygen is an input for aerobic respiration, and carbon dioxide is an output, when aerobic respiration is occurring oxygen levels will decrease and carbon dioxide levels will increase. B is the best answer since CO2 levels will still change during anaerobic respiration

Question 23

Answer: C

Explanation:

Carbon dioxide is an input into the light independent stage of photosynthesis. If oxygen has not bound to Rubisco, more carbon dioxide is able to bind – increasing the rate of photosynthesis.

Question 24

Answer: A

Explanation:

First generation biofuel comes directly from the natural source of the crop, whereas second generation biofuel comes from non-food crops, such as sawdust.

Question 25

Answer: D

Explanation:

Carbon dioxide is a by-product of fermentation, and if there is not sufficient plant material to absorb the carbon dioxide, this would be released to the atmosphere. Access to any new technology creates implications for equity and contamination of fuel sources may also occur.

SECTION B: Short-answer questions

Question 1 (14 marks)

a. The subunits of a nucleotide of DNA are a phosphate group (1), deoxyribose sugar (1) and a nitrogenous base (A, C, T, G) (1).

3 marks

b. Hydrogen bonds are weak and phosphodiester bonds are strong (1). Hydrogen bonds need to be able to separate for protein synthesis to occur (1), whereas the backbone of the DNA needs to maintain the structural integrity (1).

3 marks

c. Sample DNA is isolated from the organism of interest and the bacterial plasmid (1) and cut with the same restriction enzyme (1) creating sticky ends (1). (1). Ligase is added to restore phosphodiester bonds of the backbone (1) and the plasmid is given a shock to reinsert into the bacteria to be grown on an agar plate (1). Because DNA is universal the gene of interest will code for same protein in bacteria(1)

6 marks

d. The production of insulin in the bacteria (1) would identify which have been transformed, compared to the bacteria that do not produce insulin – and therefore have not been transformed (1). OR antibiotic resistance gene added to plasmid (1) transformed bacteria would not die when exposed to antibiotic on agar plate (1)

2 marks

Question 2 (9 marks)

a. Rough ER transports protein to Golgi (1) Golgi sorts and packages proteins into vesicles (1) The protein is bound in a vesicle a and then buds off the Golgi (1). The vesicle fuses with the membrane (1) and the contents are released (1). Any of the 4 points above.

4 marks

b. Introns are removed as they are non-coding (1). A methyl cap is added to prevent enzyme attack from occurring (1) with the poly A tail making the mRNA more stable (1).

3 marks

c. pre-mRNA and tRNA are both involved in protein synthesis (or both have uracil, ribose or are single stranded) (1). mRNA contains a copy of the DNA code whereas tRNA brings over the amino acids to create the protein (1).

2 marks

Question 3 (10 marks)

a. NADP (1) carries hydrogen ions from the grana to the stroma (1) or ATP (1) provides the energy for the synthesis of the glucose molecule (1).

2 marks

b. An enzyme catalyses a reaction but does not change (1) whereas FAD is converted to $FADH_2$ (1).

2 marks

c. At lower temperatures, there is low kinetic energy and therefore less likelihood of contact between enzyme and substrate, so the rate of reaction is slow (1). At optimum temperatures reactions occur at their greatest rate (1). At high temperatures, enzymes denature, and the rate of reaction slows (1).

3 marks

d. A limiting factor results in less product produced (1) as an input such as CO2 is limited (1) whereas a competitive inhibition prevents a substrate from binding to the enzyme's active site (1).

Question 4 (10 marks)

a.

Step	Key Events
Pre-treatment	Surface area of biomass increased by grinding substrate (1)
Enzymatic hydrolysis	Enzymes added to break the bonds between monomers (1)
Fermentation	Oxygen removed to allow fermentation to occur (1)
Distillation and purification	Water is removed to create a usable biofuel (1)

4 marks

b. i) Increasing temperature to a set point below the optimum (1) increases the rate of reaction due to an increase in kinetic energy and thus an increase in likelihood of substrate(s) and enzyme contact (1).

ii) Substrate availability is a limiting factor, as when there is a high amount of substrate, enzymes' active sites can become saturated and the reaction occurs at the maximum rate (1). A low amount of substrate decreases the rate of reaction (1).

When oxygen is available, organisms undergo aerobic respiration (1). Removing oxygen allows for fermentation to occur (1).

6 marks

Question 5 (7 marks)

a. The tubes without elodea act as a control group, demonstrating that the presence of elodea creates the changes in carbon dioxide level (1).

1 mark

b. Photosynthesis decreases the carbon dioxide level as carbon dioxide is an input for photosynthesis (1), therefore the pH would increase and become more alkaline (1). Cellular respiration increases carbon dioxide levels as carbon dioxide is an output of cellular respiration (1), therefore the pH would decrease and become more acidic (1).

4 marks

c. Using a pH meter (1), as indicator colour is qualitative data and therefore subjective (1).

2 marks