BIOLOGY

Units 3 & 4 Written examination

2024 Trial Examination

SOLUTIONS

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

Question 1

Answer: B

Explanation:

The bonds between nucleotides are phosphodiester, whereas hydrogen bonds join the complementary nitrogenous bases. Peptide bonds join amino acids and disulfide bonds provide support in tertiary protein structures.

Question 2

Answer: C

Explanation:

The regulatory gene is upstream of the operon and produces the repressor protein. When tryptophan is present in the cell, it can bind to the repressor protein, activating it so that it can bind to the operator region.

Question 3

Answer: C

Explanation:

Short tandem repeats are variations in the number of repeating units of 2 to 6 base pairs in DNA sequences in the non-coding regions of a gene.

Question 4

Answer: A

Explanation:

Enzymes are organic as they have a central carbon molecule bonded to a hydrogen. The proteome is all proteins expressed by an organism at a given time. mRNA transfers the genetic code from the nucleus to the cytosol, and co-enzymes transfer protons and electrons.

Question 5

Answer: C

Explanation

Insulin A and B genes must have the introns, not the exons removed. They are then inserted next to the β-galactosidase gene in separate plasmids, in separate bacterium.

Question 6

Answer: D

Explanation

Endonucleases cleave DNA whereas ligases restore phosphodiester bonds in the sugar phosphate backbone.

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Question 7

Answer: B

Explanation

As they have loaded more DNA into the well, the bands would be larger. It will be at the same position as it is only one amplified DNA sequence with the same size so there shouldn't be any other bands.

Question 8

Answer: B

Explanation

Competitive inhibitors bind to the active site of an enzyme. As such, increasing the amount of substrate can increase the rate of reaction as the substrate can 'outcompete' the inhibitor.

Question 9

Answer: A

Explanation

As the graph shows a slow incline with a steep drop off after the peak, the graph represents temperature.

Question 10

Answer: C

Explanation

The peak of an enzyme graph represents the optimum rate of the reaction, where enzyme and substrate interactions are at their greatest.

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Question 11

Answer: A

Explanation

The production of ATP in the light dependent stage of photosynthesis is used to catalyse the production of glucose in the light independent stage of photosynthesis that occurs in the stroma.

Question 12

Answer: D

Explanation

C4 and CAM plants both use PEP carboxylase for initial carbon fixation. CAM plants are adapted to arid regions but can convert to C3 pathways when water becomes available. C4 plants separate carbon fixation by space.

Question 13

Answer: D

Explanation

The unloading of H+ ions by $FADH_2$ and NADH creates a concentration gradient that causes ATP synthase to spin, maintained by oxygen acting as a final acceptor.

Question 14

Answer: C

Explanation

As muscle cells are animal cells, and the lack of oxygen would cause anaerobic respiration to occur. As such, lactic acid would be produced.

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Question 15

Answer: A

Explanation

In glycolysis, 4 ATP molecules are produced. 2 are used, for a net output of 2 ATP.

Question 16

Answer: B

Explanation

A group not having access to the technology will not necessarily cause them harm, and no organism is being devalued in the process. However, as there is not equal access, the ethical concept of justice is being breached.

Question 17

Answer: B

Explanation

Enzymatic hydrolysis breaks down polymers of sugars into monomers so that anaerobic fermentation can occur more efficiently.

Question 18

Answer: A

Explanation

Waxy cuticles are slippery; therefore, water slides off. As fungi grows in moist environments, this provides a way to minimise the chance of the plant providing an optimal environment for fungal growth.

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Question 19

Answer: B

Explanation

Redness and swelling are characteristics of the inflammatory response. When mast cells release histamine, this causes vasodilation and leaky capillaries.

Question 20

Answer: C

Explanation

Macrophages are also referred to as antigen presenting cells, as they present antigenic fragments on MHC-II markers to T-helper cells. This process occurs in the lymph nodes.

Question 21

Answer: C

Explanation

MHC-I markers are found on all nucleated cells. As mature red blood cells do not have a nucleus, they have immunoglobulins, not MHC markers.

Question 22

Answer: B

Explanation

The arrow is pointing to the trough between 2 peaks, where the antibody concentration is still above the x axis. As such, this is the second exposure to the pathogen. If memory cells were depleted the line would be at the x axis as memory cells have attached antibodies.

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Question 23

Answer: B

Explanation

The immunity is passive as no memory cells are being created,

Question 24

Answer: C

Explanation

Creation of a vaccine, herd immunity and antigenic testing of sewerage are all scientific strategies. Implementation of vaccination programs are social strategies.

Question 25

Answer: D

Explanation

Antibodies are made up of two heavy chains and two light chains, therefore they are quaternary structures.

Question 26

Answer: D

Explanation

Memory B cells have membrane bound antibodies whereas plasma cells release antibodies. T cells have receptors, not antibodies bound to their surface.

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Question 27

Answer: A

Explanation

As monoclonal antibodies produced in mice have both self and non-self components, they can be deemed as non-self by the body, and over time, the body may reject them. The chance of monoclonal antibodies mutating to become deviant is minimal.

Question 28

Answer: A

Explanation

As the snow leopard moved from one population and interbred with members of a different population, gene flow has occurred that can increase genetic diversity.

Question 29

Answer: B

Explanation

If the two populations are subject to the same selection pressures, advantageous traits will be the same in both groups. As such, they are not likely to select for different mutations.

Question 30

Answer: B

Explanation

Index fossils are useful for relative dating as they provide a time period to compare fossils to. They are distinctive so do not show characteristics of ancestral and descendent forms characterised by transitional fossils.

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Question 31

Answer: C

Explanation

As pugs are an example of a selectively bred organisms, they are not subject to environmental selection pressures, such as food availability. Rather, humans are the selective pressure.

Question 32

Answer: D

Explanation

Small changes to the surface antigens are caused by antigenic drift, whereas antigenic shift occurs when two strains join together to create a new strain.

Question 33

Answer: C

Explanation

As the change created a new amino acid, this is a missense mutation. It cannot be a nonsense mutation as a stop codon does not code for an amino acid.

Question 34

Answer: D

Explanation

It is widely accepted that Neanderthals and Homo sapiens interbred in Europe. This is supported by the lack of Neanderthal DNA in African populations, and small amounts of Neanderthal DNA in those of European descent.

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Question 35

Answer: A

Explanation

As the amino acid code is degenerate, silent mutations are not observed. Every codon is made of 3 nucleotides; therefore, the chain is shorter, not longer than DNA. All living organisms have amino acids as they are the monomers of proteins.

Question 36

Answer: C

Explanation

A key characteristic that differentiates mammals from primates is the opposable thumb present in primates, that allows for the precision grip.

Question 37

Answer: B

Explanation

Accuracy is how close a value is to the true value, as such, multiple trials are not required. Precision is how close values are to each other, therefore multiple trials are needed. School experiments may be both precise and accurate.

Question 38

Answer: C

Explanation

Despite using the same method and obtaining similar results, the results are reproducible as each group has a different observer.

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Question 39

Answer: C

Explanation

As the students have made the mistake, this is an example of a personal error. The error can not be random as it is explainable.

Question 40

Answer: A

Explanation

Repetition limits the effect of outliers. Calibrating equipment so that it reads closer to the true value also ensures that data is more valid.

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SECTION B Short-answer questions

Question 1 (7 marks)

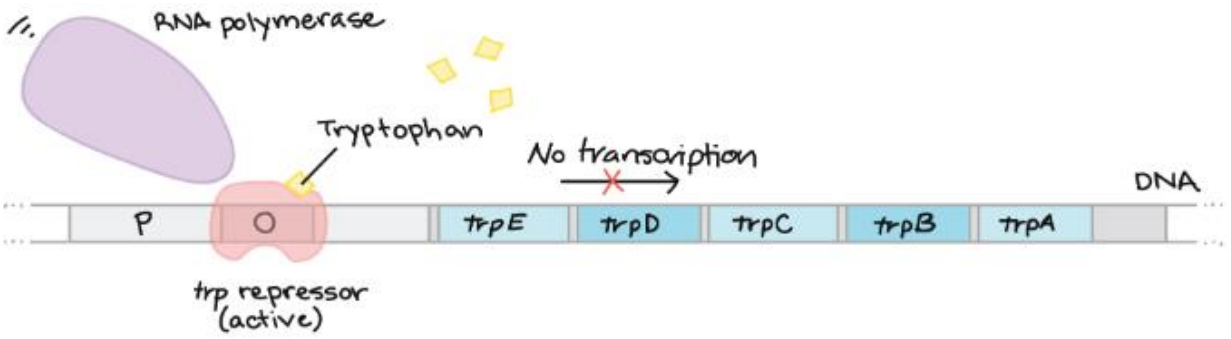
a. A group of structural genes under the control of the one promoter region

1 mark

b. Prokaryotes do not do RNA processing (1) and transcription and translation occur simultaneously (1)

2 marks

c.



1 mark - correct order (promoter, operator, structural genes)
1 mark - trp bound to repressor
1 mark – repressor bound to operator
1 mark – RNA polymerase blocked

4 marks

Question 2 (11 marks)

a. *Answers may vary. A sample response could be:*
Respect (1) as the pigs are being used for insulin and may have poor quality of life (1)

2 marks

b. Two of: cheap; fast; no ethics approval needed; constant supply *or any other suitable response*

2 marks

c. DNA ligase (1) restores phosphodiester bonds in DNA (1)
Endonucleases (1) cut DNA at a specific recognition sequence (1)

4 marks

d. In the presence of X-gal, B-gal causes bacteria to turn blue (1). Inserting the gene for insulin next to the B-gal gene allows for detection of successful transcription of the insulin gene(1). When both the B-gal and insulin gene are inserted successfully, transformed colonies can be identified by the physical characteristic of colour (1)

3 marks

Question 3 (13 marks)

a. C4 as it can minimise photorespiration (1) It is abundant in tropical areas with warm temperatures and high rainfall (1). CAM plants are found in arid regions. (1)

3 marks

b. Pre-treatment – mechanically break the sugar cane into smaller pieces (1). Enzymatic hydrolysis – add enzymes to break down starch polymers into monomers (1). Fermentation – anaerobic environment with yeast to ferment the biomass to produce CO_2 and ethanol (1). Purification – removed any pollutants with a molecular sieve. (1)

4 marks

c. Yes (no mark). When the farmer grows sugar cane, six CO_2 molecules are removed from the environment through photosynthesis (1). During bioethanol production, only two/less CO_2 is produced per glucose molecule (1). Overall, they are removing more CO_2 from the environment than they are adding. (1)
OR
No (no mark) as they use machinery to plough/fertilise/plant their crops (1). During bioethanol production, only two/less CO_2 is produced per glucose molecule (1). Overall, they are removing the same amount/less CO_2 from the environment than they are adding. (1)

3 marks

d. One of:
Justice (1) – consider competing claims (1). Do all farmers have access to the technology? (1)
Integrity (1) – all data must be accurately reported (1). Data from trials must be available publicly (1)
Beneficence (1) – maximise benefits and minimise risk (1). More people/organisms should benefit from the technology with the cost being minimal (1)
Or any other suitable issue, definition, and consideration

3 marks

Question 4 (8 marks)

a. First line of defence (1)

1 mark

b. Histamine (1) released from mast cells (1)

2 marks

c. Bacteria on the glass recognised by antigen presenting cells (1) engulfed, digested and antigenic fragments displayed on MHC-II markers (1) to T-helper cells in the lymph nodes (1). T-helper cells release cytokines to activate naïve B cell (1). B cell rapidly undergoes clonal expansion and differentiates into plasma B and memory B cells, which causes the lymph swelling(1)

5 marks

Question 5 (10 marks)

a. Disinfect common areas (1).

Socially distance so droplets are not ingested by others (1)

Quarantine when unwell to avoid unnecessary contact with people (1)

Or any other suitable response

3 marks

b. Herd immunity/high vaccination rate (1) limited hosts to transmit the pathogen between (1).

2 marks

d. B-cells respond in TB, cytotoxic-T cells in COVID (1)

B-cells target TB directly, T-cells target infected cells (1)

B-cells target TB by mechanisms such as agglutination, T-cells target by triggering apoptosis/cell death (1)

3 marks

d. Eucalyptus oil/caffeine/tea tree oil (1); waxy cuticles/thick bark (1)

Defences such as chitinases are not accepted as they target fungi

2 marks

Question 6 (8 marks)

a. Antibodies are synthesised at the ribosomes (1) and folded at the rough endoplasmic reticulum (1). They travel to the Golgi in a transport vesicle (1) where further modification occurs (1). They are packaged into a secretory vesicle for export from the cell (1)

5 marks

b. Alternative splicing (1). The different combination of exons creates differences in shape due to interactions between amino acids (1)

2 marks

c. As they have two heavy and two light chains joined to form a functional protein (1)

1 mark

Question 7 (6 marks)

a. Allopatric speciation (1)

1 mark

b. Variation existed in the original population, some flies laid eggs in Hawthorn fruits, some laid eggs in apples (1). The flies became reproductively isolated due to the different fruit preference to lay eggs on (1). Different selection pressures acted on each group (fruit to lay eggs in) (1)
Mutations accumulated in each group (1). If bought back together, they could no longer produce viable and fertile offspring (1)

5 marks

Question 8 (9 marks)

a. Comparison of DNA/amino acids/mtDNA (1). More/less differences (1) indicate more or less time apart between populations respectively (1)

3 marks

b.
Yes (no mark). Modern hominins migrated from Asia across land bridges to reach Australia (1). These modern hominins would have had Neanderthal DNA in their genomes as they interbred with Neanderthals (1) previously in Eurasia before migrating to Australia (1).

3 marks

c. Longer legs than arms (1); travel more efficiently (1)
Inward facing femur (1); provide balance and stability (1)
or any other suitable option – legs only, not feet/pelvis

2 marks

e. Fossils are rare as remains are often disturbed/eaten/conditions are not suitable for fossilisation to occur (1) *OR any other suitable response*

1 mark

Question 9 (8 marks)

a. Source of the enzyme (1)

1 mark

b. Temperature/surface area of substrate/initial pH/concentration of substrate/time left for reaction to run
or any other suitable controlled variable

2 marks

c. The control group shows that the IV caused the change, not another factor (1). In this experiment, a conical flask with no enzyme should be used (1)

2 marks

c. *Answers will vary – suggested response:*

Add a competitive inhibitor (1). Compare the initial results (no inhibitor) with the additional trial (inhibitor) (1). If the inhibitor is competitive, the rate of reaction will decrease (1)

3 marks

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