

BIOLOGY

Written examination



2017 Trial Examination

SOLUTIONS

SECTION A

Question 1

Answer: C

Explanation:

Exocytosis is a form of bulk transport, where large volumes of molecules are packaged into vesicles which fuse with the plasma membrane and release the contents of the vesicle into the extracellular environment.

Question 2

Answer: C

Explanation:

Lysosomes are organelles responsible for breaking down substances in a cell. A phagocytic white blood cell is responsible for engulfing and breaking down pathogens, so would have many lysosomes. Option A (Lysozymes) is the distractor – these are enzymes found in tears

Question 3

Answer: D

Explanation:

Cholesterol is present between the phospholipid molecules in the plasma membrane. At low temperatures, these prevent the phospholipid molecules from getting too close to each other and so maintains the fluidity of the membrane. This is particularly important in the Arctic regions, where the fish would be subjected to very low temperatures.

Question 4

Answer: C

Explanation:

Molecule A is RNA. This can either be mRNA, tRNA or rRNA which each have different functions, so C is correct. All other answers are incorrect.

Question 5

Answer: D

Explanation:

Molecule A is RNA, which carries the genetic code from the nucleus to the ribosome. All other options are incorrect.

Question 6

Answer: A

Explanation:

After transcription, pre-mRNA is produced that contains both introns and exons. The introns are removed before it leaves the nucleus, but spliceosomes (nuclear proteins) can regulate which introns are removed and can shuffle the exons to produce different polypeptides.

Question 7

Answer: C

Explanation:

Each amino acid is coded for by 3 nucleotides, which makes a codon. This means there will be at least 63 nucleotides to make 21 amino acids. However, in order for the polypeptide to be considered complete it must have been released from the ribosome, which requires a stop codon. This means that 66 nucleotides will be needed in total.

Question 8

Answer: A

Explanation:

The light independent stage of photosynthesis requires an input of ATP, it does not produce ATP. All other answers result in the production of ATP.

Question 9

Answer: A

Explanation:

As alkaline phosphatase is found in the body, its optimum temperature will be 37°C. It is found in an alkaline environment, therefore has an optimum pH of 8-10, so will not denature in slightly alkaline conditions.

Question 10

Answer: D

Explanation:

As the poison binds to a regulatory region on cytochrome oxidase, it is a non-competitive inhibitor.

Question 11

Answer: C

Explanation:

The pathway being described is the Calvin Cycle, or the light independent reactions of photosynthesis. These occur in the stroma.

Question 12

Answer: A

Explanation:

The cytokines will only be released if the NK cells bind to the altered MHC1 markers. This is therefore contact-dependent signaling.

Question 13

Answer: B

Explanation:

As the hormone is able to cross the plasma membrane and bind to an intracellular receptor, it must be hydrophobic. It acts as a transcription factor to initiate transcription.

Question 14

Answer: A

Explanation:

A pro-apoptotic intracellular signal is a signal from within the cell that induces apoptosis. The leakage of mitochondrial proteins into the cytoplasm is a signal for apoptosis. B prevents apoptosis from occurring, C is an example of extracellular signaling and D is a mechanism of apoptosis.

Question 15

Answer: B

Explanation:

In a normal cell mutated DNA will be detected and apoptosis will be initiated. In order for a tumour to form, this must be prevented so that the mutant cells can be copied and cause a tumour.

Question 16

Answer: C

Explanation:

The antigen is the specific part of the pathogen that is detected as foreign by the immune cells.

Question 17

Answer: D

Explanation:

Toxins are produced by bacteria, not viruses. All other options are the correct.

Question 18

Answer: D

Explanation:

TSE is caused by the presence of prions in meat. These can pass into the blood stream and come into contact with proteins in the brain, causing these proteins to fold abnormally. Heat has no effect on prions.

Question 19

Answer: A

Explanation:

The innate response refers to the first and second lines of defence. These are non-specific. The adaptive response results in specific antibodies or cytotoxic T cells being produced to act against specific pathogens and is therefore said to be specific. All other options are incorrect.

Question 20

Answer: D

Explanation:

Monoclonal antibodies are produced by clones of a hybrid of a B cell and a tumour cell. They bind to specific antigens on cancer infected cells and can aid in the immune cells destroying the cell, block signals that result in the cancer cell dividing, or transport toxic substances onto the cell.

Question 21

Answer: B

Explanation:

The gene pool is the sum total of all of the alleles present in a population, regardless of whether they are breeding individuals.

Question 22

Answer: C

Explanation:

As the population of tortoises is on a volcano it is likely that a volcanic eruption has reduced the gene pool of this population. This is a chance event and is therefore an example of the bottleneck effect.

Question 23

Answer: B

Explanation:

A selection pressure is an environmental factor that has an effect on the survival of an individual.

Question 24

Answer: C

Explanation:

The change in the population with regard to the increase in the number of rabbits with immunity to the *myxoma* virus has been brought about by a selective agent in the environment favouring particular phenotypes. This is an example of evolution by natural selection.

Question 25

Answer: D

Explanation:

Options A-C all prevent individuals from different species mating and are therefore pre-reproductive isolating mechanisms. Hybrid sterility occurs if the individuals are able to mate, but the offspring are sterile. This is therefore a post-reproductive isolating mechanism.

Question 26

Answer: C

Explanation:

A translocation occurs if a chromosome or segment of a chromosome attaches to another, non-homologous, chromosome.

Question 27

Answer: C

Explanation:

As cartilage is a softer tissue than bone it is less likely to become fossilised, therefore lamprey fossils are very rare.

Question 28

Answer: B

Explanation:

Biogeography is the study of the distribution of past and present organisms across the world.

Question 29

Answer: A

Explanation:

These are vestigial structures, where the ancestral structure remains in an organism, but no longer has a function. This can be used to determine evolutionary relationships.

Question 30

Answer: A

Explanation:

A ratio of 1: 3 carbon-14 to nitrogen-14 suggests that 2 half-lives have occurred (25% of the original C-14 in the sample remains). As each half life is approximately 5500 years, the sample is 11000 years old.

Question 31

Answer: D

Explanation:

The function of the wings is the same in both pterosaurs and birds, however because the structures arose from different ancestral structures it is an example of convergent evolution.

Question 32

Answer: B

Explanation:

All the other methods are molecular methods used to determine evolutionary relationships. Option B involves comparing homologous structures or development of organisms and is therefore not molecular.

Question 33

Answer: C

Explanation:

Pterosaurs diverged before the group classified as dinosaurs, therefore it does not share common features with this group and is not classified as a dinosaur. All the other options are incorrect.

Question 34

Answer: A

Explanation:

From this observation it can be concluded that greater *Bmp4* expression results in a larger beak. Only option A fits this conclusion.

Question 35

Answer: C

Explanation:

Reducing hair across the body prevents insulation around the body and so ensures that heat can be lost efficiently. All other adaptations are adaptations of *Homo erectus*, but are not related to thermoregulation.

Question 36

Answer: A

Explanation:

Dentition size became smaller as the hominins evolved, therefore option A is incorrect. All others are correct.

Question 37

Answer: B

Explanation:

During PCR the DNA is first heated to 95°C to separate the strands (denaturation), then the mixture is cooled to 55°C so that primers can attach (annealing), then heated to 72°C to allow extension. Only option B is correct.

Question 38

Answer: D

Explanation:

The movement of DNA occurs because an electric current passes through the gel. As DNA is negatively charged, it is repelled from the negative electrode and attracted to the positive electrode, which causes it to move through the gel.

Question 39

Answer: A

Explanation:

As the sample shows 3 bands after EcoR1 digestion, it must have been cut in two places and therefore has 2 restriction sites for EcoR1. As the gel shows only 1 band after exposure to BamH1, the DNA was not cut and therefore has no restriction sites for this enzyme. A is therefore correct.

Question 40

Answer: A

Explanation:

A transgenic organism is when a gene from one species is inserted into another. Option A is the only option that describes this.

SECTION B - Short-answer questions

Question 1 (12 marks)

Temperature (°C)	Colour of water after 20mins
20	Light pink
40	Medium pink
60	Dark pink
80	Very Dark purple

a.

- If the temperature increases, then the colour of the water will become darker indicating a more damaged membrane (1 mark)
- This occurs because the phospholipid molecules move further apart and therefore diffusion across the membrane is easier OR high temperatures will cause the membrane to break apart (1 mark)

2 marks

b.

Any 2 from:

- The temperature of the water in the test tubes
- The volume of water in the test tubes
- The samples of beetroot all needed to come from the same beetroot
- The water used all had to come from the same source
- any other reasonable suggestion

2 marks

c. Test-tubes containing beetroot that were not subjected to heat/ kept in cold conditions (1 mark)

1 mark

d.

- qualitative/subjective judge of water colour: use a colorimeter to assess how dark the water is (1 mark)
- difficult to keep water temperature correct: use a water bath (1 mark)
- any other (must include limitation and improvement for 1 mark)

2 marks

e.

- detergent interacts with fatty acid tails of phospholipid molecule (1 mark)
- separates the molecules, breaking apart the membrane (1 mark)

2 marks

f.

- Independent variable: Presence/absence of detergent; Dependant variable: colour of the solution; controlled variables: time in the water, temperature of the water, amount of detergent etc. (1 mark)
- Place test-tubes in a water bath at the same temperature. Place detergent in one set of test-tubes and no detergent in the other set. Add water and beetroot to both sets. Leave for a set period of time and observe the colour of the test-tubes at the end (1 mark)
- Predicted result would be that the test-tubes with the detergent have a darker colour solution than the test-tub without. This is because the detergent breaks down the plasma membrane. (1 mark)

3 marks

Total 12 marks

Question 2 (10 marks)

a. Proteome (1 mark)

1 mark

b. Proteins generally do not act in isolation, so by studying all of the proteins in a cell, it is possible to see the interactions between the proteins. (1 mark)

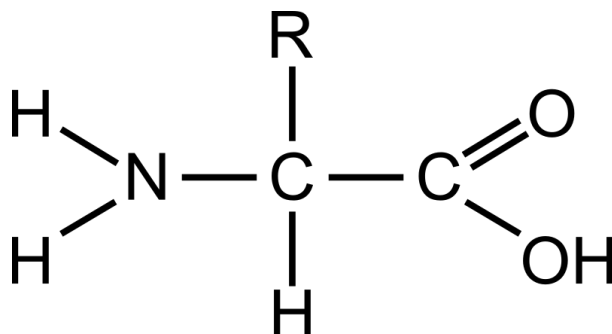
1 mark

c.

- Structural: Collagen/keratin/Fibroin (1 mark)
- Regulatory: any enzyme e.g. amylase, maltase, DNA/RNA polymerase, pepsin, trypsin etc. (1 mark)

2 marks

d.



(1 mark) *Molecular structure of amine and acid groups not necessary*

- R group is different for each amino acid – gives the amino acid different properties (1 mark)
- Interactions/intramolecular bonds form between the R groups, twisting the protein into a specific 3D shape which is the tertiary structure (1 mark)

3 marks

e.

- Frameshift mutation (1 mark)
- Each codon after the mutation will be altered (1 mark)
- This affects all subsequent amino acids, causing a large change to the protein (1 mark)

3 marks

Total 10 marks

Question 3 (7 marks)

- a. Provides sufficient ATP needed for metabolic processes (1 mark)

1 mark

- b. $C_6H_{12}O_6 + 6O_2 (+ 36ADP + 36Pi) \rightarrow 6CO_2 + 6H_2O (+36ATP)$ (1 mark)

1 mark

c.

- Aerobic (or Krebs Cycle and Electron transport chain) and anaerobic respiration (1 mark)
- Any 2 differences, 1 mark for each:
 - Aerobic respiration occurs in the mitochondria, anaerobic respiration occurs in the cytoplasm
 - Aerobic respiration produces 36 ATP, Anaerobic produces 2 ATP
 - Aerobic respiration produces CO₂ and H₂O, anaerobic produces lactic acid

3 marks

d.

- Cellular respiration – NADH and FADH carry H⁺ and e⁻ to the electron transport chain, to provide the energy needed for ATP synthesis. (1 mark)
- Photosynthesis – NADPH carries H⁺ and e⁻ from the electron transport chain in the light dependent stage to produce ATP. (1 mark)

2 marks

Total 7 marks

Question 4 (5 marks)

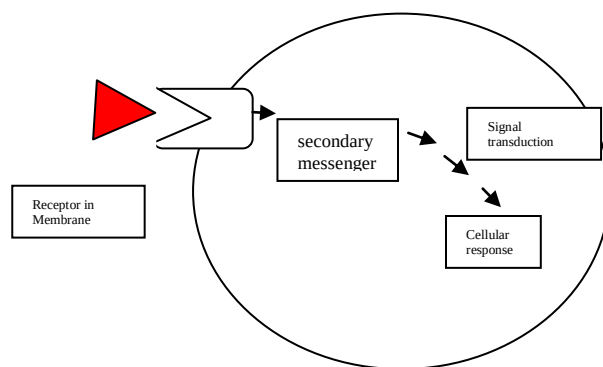
a. Pheromones (1 mark)

1 mark

b. The cells of other animals lack the specific receptors for darcin to bind to. Therefore darcin will have no effect on their cells. (1 mark)

1 mark

c.



- binds to receptor on the external surface of the plasma membrane (1 mark)
- this activates a secondary messenger, which starts signal transduction (1 mark)
- signal transduction occurs to reach target protein and initiate a cellular response (1 mark)

3 marks

Total 5 marks

Question 5 (Total 7 marks)

a.

- non-cellular (1 mark)
- requires a host cell to reproduce (1 mark)

2 marks

b.

- Proteins on virus surface attach to receptors on the host cell (1 mark)
- Viral DNA is injected into the cell and is incorporated into host genome (1 mark)
- Viral DNA is transcribed and translated to make viral proteins, which assemble into viral particles within the cell and eventually leave the cell (1 mark)

3 marks

c.

- Block the receptors on the host cell which the viral proteins bind to (1 mark)
- Prevent the virus from entering the cell (1 mark)

2 marks

Total 7 marks

Question 6 (10 marks)

a. Any two from:

- Specific is slower, non-specific is immediate (1 mark)
- Specific is acquired as a result of exposure to an antigen, non-specific is innate (1 mark)
- Specific targets specific antigens; non-specific is a general response (1 mark)

2 marks

b.

- Humoral - 1 of:
 - B plasma cell – produces antibodies
 - B memory cell – memory to rapidly respond to future infection
 - Naïve-B cell – undergoes clonal selection
 - T-helper cell – binds to naïve B cell and releases cytokines to cause clonal selection
- cell-mediated response – 1 of:
 - Cytotoxic T cells – binds to and destroys body cells infected with a virus

- T-helper cells – bind to naïve cytotoxic T-cell and releases cytokines to cause it to replicate

2 mark

c.

- exposure to weakened form of the toxin caused clonal selection of naïve-B cells (1 mark)
- B memory cells store memory of the toxin (1 mark)
- Exposure to toxin results in rapid cloning of the B-memory cells to produce B-plasma cells which release antibodies to destroy the toxin (1 mark)

3 marks

d. Passive, artificial immunity (1 mark)

1 mark

e.

- B-memory cells can break down over time (1 mark)
- Provides them with the antibodies to help immediately bind to the toxin (1 mark)

2 marks

Total 10 marks

Question 7 (6 marks)

a. Transitional fossil (1 mark)

1 mark

b.

- Features of a dinosaur include teeth and/or scales (1 mark)
- Features of a bird include feathers (1 mark)

2 marks

c. Adaptive radiation (1 mark)

d.

- Mass extinction resulted in many unoccupied niches (1 mark)
- Natural selection enabled different populations to specialise in different niches, resulting in adaptive radiation (1 mark)

2 marks

Total 6 marks

Question 8 (6 marks)

a.

- Different environmental conditions – west coast salamanders lived in coastal environments; east coast salamanders lived in forest environments (1 mark)
- each population has adapted to be camouflaged in its environment (1 mark)

2 mark

b.

- Yes
- Sub species are unable to interbreed (1 mark)

1 mark

c.

Three of:

- Members of the two populations are reproductively isolated from each other. Each population is subject to different environmental conditions
- Natural selection ensures that each population is adapted to suit the environmental conditions that they are exposed to.
- Genetic changes accumulate in the two isolated populations. Eventually the populations become so different that they are no longer able to successfully interbreed.

3 marks

Total 6 marks

Question 9 (7 marks)

a.

- Polymerase Chain Reaction (1 mark)
- A DNA sample is put through many cycles, each of which involves being heated to separate the strands, being cooled to enable primers to bind to the template strands and being heated to enable DNA polymerase to read the template strands and copy them . (1 mark)
- After many cycles, it is the DNA sample has been copied (1 mark)

3 marks

b.

- DNA from each subject is loaded into wells. A charge is applied to the gel and DNA fragments move towards the positive electrode (1 mark)
- Smaller fragments move further, allowing the DNA sample to be separated and analysed (1 mark)

2 marks

c.

- Suspect 2 is the burglar
- The DNA sample has fragments of the same size as those found at the crime scene (1 mark)

1 mark

d.

Either:

- Yes – every individual's DNA has a unique banding pattern so the fact that it matches the sample from the crime scene can only mean that the individual was there (1 mark)

OR

- No – the DNA sample shows that the individual had been present at the crime scene, but there is no way of knowing if they committed the crime (1 mark)

1 mark

Total 7 marks