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YEAR 12 *Trial Exam Paper*

2023

BIOLOGY

Written examination

Worked solutions

This book presents:

- high-level sample answers
- explanatory notes
- mark allocations
- tips.

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SECTION A – Multiple-choice questions

Question	Answer
1	*B*
2	*C*
3	*B*
4	*C*
5	*C*
6	*C*
7	*A*
8	*A*
9	*D*
10	*B*
11	*B*
12	*C*
13	*D*
14	*A*
15	*B*
16	*C*
17	*D*
18	*A*
19	*A*
20	*A*

Question	Answer
21	*D*
22	*D*
23	*A*
24	*B*
25	*D*
26	*B*
27	*B*
28	*C*
29	*B*
30	*B*
31	*D*
32	*C*
33	*B*
34	*C*
35	*A*
36	*A*
37	*A*
38	*D*
39	*D*
40	*A*

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Question 1

Answer: B

Explanatory notes

mRNA and tRNA triplets contain uracil (U) instead of thymine (T). mRNA is made up of codons and tRNA is made up of anticodons.

Question 2

Answer: C

Explanatory notes

Molecule 1 is DNA and Molecule 2 is mRNA. The DNA template molecule is longer than mRNA because DNA includes introns and exons, whereas the introns have been removed from mRNA. However, this question is only asking for a comparison between the triplets. B is wrong because DNA has both adenine and thymine, and mRNA also has adenine. C is correct because the pentose components of the nucleotides are different. D has correct information but does not relate to structural differences between the triplets.

Question 3

Answer: B

Explanatory notes

In this example, two different codons code for serine. This is an example of the degeneracy (or redundancy) of the genetic code.

Question 4

Answer: C

Explanatory notes

The role of gRNA is to direct the Cas9 endonuclease to the target site.

Question 5

Answer: C

Explanatory notes

Glycosylation is an example of a post-translational modification. These occur in the Golgi apparatus.

Question 6

Answer: C

Explanatory notes

Statement 1 is correct because the Golgi body does package proteins into vesicles for exocytosis. Statement 2 is incorrect because vesicles are only found inside cells; they do not coat proteins after they are secreted. Statement 3 is correct because after translation occurs, proteins are packaged into vesicles, which bud off from the endoplasmic reticulum. Statement 4 is incorrect, because secretory vesicles are responsible for the release of proteins by exocytosis rather than the internal transport of the polypeptide post-transcriptionally.

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Question 7

Answer: A

Explanatory notes

The diagram shows the process of translation. mRNA is being read by the ribosome and amino acids are being assembled into a polypeptide chain.

Question 8

Answer: A

Explanatory notes

Off-target effects include both unintended cleavage and mutations at untargeted sites that have a similar, but not identical, sequence to the target site.

Question 9

Answer: D

Explanatory notes

The fact that non-viable embryos were used indicates non-maleficence and the fact that this is a treatment for a genetic disease is an example of beneficence.

Question 10

Answer: B

Explanatory notes

A is incorrect because tryptophan will not be produced as long as the repressor is bound to the operator. B is correct because as long as the repressor protein is in place, RNA polymerase will not be able to bind to the promoter. C is incorrect because the inability to produce tryptophan is not permanent. The repressor will release the operator when more tryptophan is required. D is incorrect because the repressor protein binds to the operator, and it does not interact with mRNA.

Tip

- *Visual prompts, such as in this question, are designed to help you to deduce the correct answer. In this question, the repressor protein is showing as being bound to the operator. Therefore, option D cannot be correct. Understanding the information in the visual prompts can assist you to eliminate incorrect options.*

Question 11

Answer: B

Explanatory notes

The genetically modified soybeans can still synthesise phenylalanine, tyrosine and tryptophan but unmodified plants, such as the weeds, cannot. As a result, the unmodified plants die, resulting in more nutrients being available to the soybeans, resulting in a greater yield.

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Question 12

Answer: C

Explanatory notes

Biodiesel is seen as being more environmentally friendly as well as being more sustainable than petroleum-based diesel.

Question 13

Answer: D

Explanatory notes

A DNA marker solution contains fragments of known size. Fragments of the same size migrate through the gel to the same extent, so the position of the fragments of known size can be compared to the positions of other fragments, which enables their size to be estimated.

Question 14

Answer: A

Explanatory notes

Oxygen gas is a product of the photolysis of water.

Question 15

Answer: B

Explanatory notes

The optimum temperature for C3 plants ranges between 20 °C and 25 °C. The graph shows that the rate of photosynthesis decreases after the optimum point, indicating that enzymes that facilitate photosynthesis, including Rubisco, progressively denature and are completely denatured at approximately 37ºC. In C3 plants as temperature increases, the affinity of Rubisco for CO_2 decreases.

Question 16

Answer: C

Explanatory notes

In C4 plants, the optimum temperature range is 32 °C to 55 °C. C4 plants tolerate higher temperatures with enhanced photosynthesis because of the CO_2 concentrating system that inhibits Rubisco oxygenase. Only graph C shows an optimum temperature consistent with the tolerance range of C4 plants.

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Question 17

Answer: D

Explanatory notes

The carrier molecules NADH and $FADH_2$ are unloaded in the electron transport chain. Oxygen is the terminal acceptor in this process, which will not function in the absence of oxygen. For the Krebs cycle to function, unloaded carrier molecules must be available. Therefore, if the electron transport chain is not functioning because of a lack of oxygen, then the Krebs cycle will not function either, making it dependent on the presence of oxygen.

Question 18

Answer: A

Explanatory notes

The hydrogen removed from isocitrate molecules is picked up by NAD^+ to form NADH.

Question 19

Answer: A

Explanatory notes

Tube 2 shows that the rate of the reaction is highest in the absence of malonic acid. The rate is lowest in tube 1 which contains the lowest amount of succinate. The rate increases in tube 4, which has the same volume of malonic acid as in tube 3 but a higher concentration of succinate. It is reasonable to conclude that the increase in substrate concentration in tube 4 results in a slightly higher rate because there are more successful collisions occurring as the substrate concentration increases.

Question 20

Answer: A

Explanatory notes

Tube 2 is the only tube that does not contain malonic acid and therefore provides a baseline to compare with tubes 3 and 4.

Question 21

Answer: D

Explanatory notes

Caffeine acts as a chemical barrier and the parasites act as a microbiota barrier.

Question 22

Answer: D

Explanatory notes

Lymph vessels are responsible for transporting lymph fluid to the lymph nodes. This fluid is eventually returned to the bloodstream.

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Question 23

Answer: A

Explanatory notes

Lymph nodes close to the site of an infection swell as a result of the proliferation of B and T cells.

Question 24

Answer: B

Explanatory notes

Lymph nodes have large numbers of T and B cells. When the lymph fluid is filtered through the lymph node, the B and T cells are able to recognise the antigens present in the fluid.

Question 25

Answer: D

Explanatory notes

A is incorrect because IgM is usually produced before IgG. B is incorrect because, as the graph shows, both IgM and IgG can be produced at the same time. C is incorrect because IgM only remains in the bloodstream for a short period of time. D is correct because the presence of IgM indicates there is an infection, and IgG is usually produced shortly afterwards.

Question 26

Answer: B

Explanatory notes

The concentration of antibodies increases at point X. This indicates that the person has been re-exposed to the specific antigen. This may or may not have been the result of an infection.

Tip

- *Always look for words that do not allow for any alternatives; for example, never, always, must. In this question the word 'must' means that a pathogen is the only possible source of an antigen. This is not correct because the person may have been given a booster shot.*

Question 27

Answer: B

Explanatory notes

Passive immunity occurs when an individual is provided with antibodies produced by another organism. Antivenin is an antiserum that contains antibodies to specific toxins, such as snake venom.

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Question 28

Answer: C

Explanatory notes

Increasing the permeability enables neutrophils to squeeze into the damaged tissues and engulf any antigenic substances or pathogens.

Question 29

Answer: B

Explanatory notes

Selective breeding is the process by which humans choose specific plants or animals to breed with each other in order to develop a desired trait. In this example, sheep with the finest wool in each generation were chosen to be the parents of the next generation. Repeating the process over many generations results in the production of sheep with very fine wool.

Question 30

Answer: B

Explanatory notes

When a new trait suddenly appears in one member of a population, it is most likely to be the result of a mutation causing a new allele. This is reinforced by the fact that the incidence of this trait increased over 10 generations, indicating that the mutation was passed on.

Tip

- *It is important to read through the information provided very carefully because sometimes, as in this question, one of the options contradicts the information provided and can therefore be eliminated. In this example, the information states that initially only one organism has the trait; therefore, option D must be incorrect.*

Question 31

Answer: D

Explanatory notes

The fossil shows that *Archeopteryx* had features in common with both birds and dinosaurs, so it is classified as a transitional fossil.

Tip

- *This question is another example of the importance of careful reading. Students in a hurry may select option B because the term provided is very similar to that of the correct option.*

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Question 32

Answer: C

Explanatory notes

The age of the fossil would best be determined by using an absolute dating technique. Since the fossil was assumed to be about 147 million years old, potassium to argon dating would be the best choice.

Question 33

Answer: B

Explanatory notes

Genetic drift is the change in allele frequencies in a population due to chance. It is not a term that relates to the movement of people.

Question 34

Answer: C

Explanatory notes

Mitochondrial DNA is inherited down the maternal line and is not subject to recombination.

Question 35

Answer: A

Explanatory notes

Molecular homology refers to similarities between two or more molecules. This includes DNA and amino acid sequencing.

Question 36

Answer: A

Explanatory notes

Isolating the populations limits or even prevents gene flow occurring between the populations.

Question 37

Answer: A

Explanatory notes

Strain D is a new strain of influenza virus that no one would initially have immunity to. The changes to strain A are an example of antigenic drift and the formation of strain D is an example of antigenic shift. Antigenic shift generally has more serious consequences than antigenic drift.

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Question 38

Answer: D

Explanatory notes

Juvenile pandas require a lot of attention and resources. Rejection of the weaker twin increases the chance that the stronger, more biologically fit twin will survive.

Question 39

Answer: D

Explanatory notes

Therapeutic drugs can be attached to monoclonal antibodies, which enables the drugs to be delivered to the cancerous cells. This decreases the dosage required and is more effective than non-targeted therapy.

Tip

- *Be very careful when reading questions because sometimes one word can be the key to answering a question correctly. In this question, it is important to focus on the word 'treatment'. Some of the other options correctly identify the uses or applications of monoclonal antibodies, but they do not relate to treatment of cancers.*

Question 40

Answer: A

Explanatory notes

Modern humans have a comparatively shorter and wider pelvis than other hominins. This is sometimes referred to as 'bowl-shaped'. The shape of the pelvis allows us to bring our knees and feet directly under our centre of gravity; effectively we can balance on one leg when raising the other to take a step.

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SECTION B

Question 1a.

Worked solution

HindIII cuts the DNA so that the fragments produced have sticky ends, whereas SmaI cuts the DNA so that the DNA fragments have blunt ends. Sticky ends enable the insert to anneal into the vector plasmid.

Mark allocation: 2 marks

- 1 mark for stating that HindIII produces DNA with sticky ends compared to the blunt ends caused by the action of SmaI
- 1 mark for providing a specific advantage of using HindIII, such as providing the ability to anneal the insert into the vector plasmid

Tip

- *When a question asks for an advantage, a specific advantage must be identified. In this example, just stating that the endonuclease HindIII produces fragments with sticky ends is not in itself an advantage, and it is only restating the information already provided in the table. The answer has to provide a reason as to why sticky ends are an advantage.*

Question 1b.

Worked solution

DNA ligase

Mark allocation: 1 mark

- 1 mark for stating the answer is DNA ligase

Tip

- *It is important to provide the full name of the enzyme. Just stating 'ligase' is insufficient because there is another enzyme called RNA ligase.*

Question 1c.

Worked solution

There is a restriction site for HindIII located within the resistance gene for tetracycline. HindIII cuts through the resistance gene, preventing it from being expressed. Therefore, none of the bacteria will have tetracycline resistance. As this agar plate contained tetracycline, all of the bacteria were killed by the tetracycline.

Mark allocation: 2 marks

- 1 mark for explaining that HindIII cuts through the gene that confers resistance to tetracycline, preventing it from being expressed

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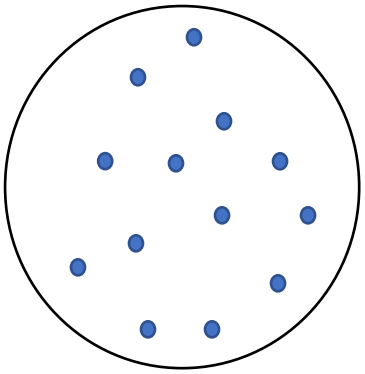
- 1 mark for explaining that the bacteria were all sensitive to tetracycline and therefore would have been killed as a result of exposure to it

Question 1d.

Worked solution

The diagram should show a few discrete colonies as shown below.



Mark allocation: 1 mark

- 1 mark for drawing a diagram showing discrete colonies

Question 1e.

Worked solution

Most bacteria will not have transformed; however, those that did will have resistance to ampicillin. Those few will reproduce, giving rise to colonies.

Mark allocation: 1 mark

- 1 mark for providing a plausible explanation as to why discrete colonies would have been observed on plate 3

Question 1f.

Worked solution

Discrete colonies would have been observed on the plates containing tetracycline and ampicillin. EcoRI does not cut through either of the resistance genes; therefore, all transformed bacteria would have been resistant to both antibiotics.

Mark allocation: 2 marks

- 1 mark for explaining that EcoRI does not cut through either of the genes conferring resistance
- 1 mark for explaining that all transformed bacteria would be resistant to both antibiotics, resulting in the presence of discrete colonies on both plates

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Question 2a.

Worked solution

Cyanide is a non-competitive inhibitor. If it were a competitive inhibitor, it would bind to the active site, blocking the substrate from binding with the active site. Instead, cyanide alters the shape of the active site by binding elsewhere on the enzyme.

Mark allocation: 2 marks

- 1 mark for identifying that cyanide is a non-competitive inhibitor
- 1 mark for explaining why cyanide is a non-competitive inhibitor rather than a competitive inhibitor

Question 2b.

Worked solution

A yield of net 2 ATP is produced in the cytosol (as a result of glycolysis).

Mark allocation: 2 marks

- 1 mark for identifying the cytosol as the location
- 1 mark for stating that net 2 ATP is produced

Question 2c.

Worked solution

Pyruvate is a small molecule, which can cross the membrane of the mitochondria, where it is subsequently converted into acetyl coenzyme A. Carbon dioxide is then produced during the Krebs cycle. Carbon dioxide is not produced in the presence of glucose because the glucose does not cross the membrane, and the Krebs cycle does not occur.

Mark allocation: 2 marks

- 1 mark for providing a plausible explanation for why carbon dioxide is produced when mitochondria are provided with pyruvate, but not when provided with glucose. This could be based on glucose not being able to enter the mitochondria or glucose not being converted into pyruvate inside the mitochondria.
- 1 mark for explaining that carbon dioxide is only produced when the Krebs cycle is functioning

Question 2d.

Worked solution

Carbon dioxide is a product of aerobic cellular respiration. Cyanide is a non-competitive inhibitor of COX. When COX cannot carry out its function, aerobic respiration cannot occur and therefore no carbon dioxide will be produced. Lactic acid is a product of fermentation by animal cells. The cells have access to glucose and therefore are able to produce lactic acid.

Mark allocation: 2 marks

- 1 mark for explaining why the cells cannot produce carbon dioxide in the presence of cyanide
- 1 mark for explaining why the cells can produce lactic acid in the presence of cyanide

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Question 3a.

Worked solution

Plant 1 is soybean and plant 2 is sorghum. Soybeans are a C3 plant, which have a high rate of photosynthesis at low temperatures and a low rate at high temperatures. Sorghum is a C4 plant and is better adapted to warmer conditions, and so will have a low rate of photosynthesis at low temperatures and a higher rate at higher temperatures. The data indicates that the uptake of carbon dioxide for plant 2 is 24.1 mg CO_2 per gram compared to 10.8 mg CO_2 per gram for plant 1.

Mark allocation: 4 marks

- 1 mark for correctly identifying each plant
- 1 mark for explaining how the rate of photosynthesis changes in C3 plants and linking that information to the identification; for example, the rate will be low at high temperatures and higher at low temperatures
- 1 mark for explaining how the rate of photosynthesis changes in C4 plants and linking that information to the identification; for example, the rate will be low at low temperatures and higher at high temperatures. Or for stating that C3 plants have a wider optimal temperature range (which is why most plants are C3)
- 1 mark for including at least one comparative data quote in the answer

Tip

- *When a question asks you to use the data to support an answer, you must actually use the numerical information provided. It is not enough to just refer to the data; for example, stating that carbon dioxide uptake in plant 1 increases and then decreases refers to the data, but is not actually using the data.*

Question 3b.

Worked solution

Rubisco's affinity for carbon dioxide is higher at regular or low temperatures. As a result, the rate of photorespiration in C3 plants is low and the rate of photosynthesis is high. At higher temperatures, bonds holding Rubisco together loosen, which changes the three-dimensional shape of the enzyme, resulting in greater affinity for oxygen. As a result, the rate of photorespiration will increase, and the rate of photosynthesis will decrease.

Mark allocation: 2 marks

- 1 mark for explaining why the rate of photosynthesis in C3 plants is high at low temperatures
- 1 mark for explaining why the rate of photosynthesis in C3 plants decreases as temperature increases

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Tip

- *In addition to the Study Design guide, the VCAA site has also provided a FAQ sheet. This provides detailed information about what you need to understand about a range of subjects, including photosynthesis. It is worthwhile to read this information.*

Question 3c.

Worked solution

Possible answers include:

- decrease in the surface area of the thylakoid membrane
- less ATP is produced in the light-dependent stage
- less NADPH is produced in the light-dependent stage
- absorption of light decreases
- the rate of the light-dependent reactions decreases.

Mark allocation: 2 marks

- 1 mark for each correct response (up to 2 marks)

Tip

- *It is always better to produce a precise or detailed answer rather than a vague answer. Sometimes spending some time teasing out a vague answer can provide you with more precise answers; for example, the point is comparatively vague, but thinking about the outputs of the light-dependent stage could lead you to the second and third points.*

Question 4a.

Worked solution

Reasons may include:

- producing separate inserts decreases the size of the insert, making it easier to incorporate the insert into the plasmids
- the two genes code for different polypeptides, which may later be fused together to form insulin
- any other valid answer.

Mark allocation: 1 mark

- 1 mark for providing a plausible suggestion

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Question 4b.

Worked solution

The original gene contains both introns and exons and the insert only contains exons. The introns are non-coding regions that are removed from the gene before it is inserted into a plasmid.

Mark allocation: 2 marks

- 1 mark for explaining that the insert will be shorter because the introns are removed
- 1 mark for stating that introns need to be removed before insertion

Question 4c.

Worked solution

The unmodified gene contains both introns and exons and therefore will be longer than the modified gene, which contains only exons. The modified gene, being shorter, will travel further through the gel than the larger unmodified gene.

Note: Answers that explain the process of **how** gel electrophoresis can be used (preparing DNA standard ladder of 0 bp to 1600 bp), putting plasmids into wells etc. are also acceptable. This solution focuses more on the results of a gel electrophoresis run, rather than 'how'.

Mark allocation: 2 marks

- 1 mark for explaining that the unmodified gene will be longer than the modified gene
- 1 mark for explaining that the smaller fragment will travel further through the gel (or the converse)

Question 4d.

Worked solution

The gene that codes for the production of the protein β-galactosidase acts as a marker gene (the expression of this gene enables detection of transformed bacteria).

Mark allocation: 1 mark

- 1 mark for providing a correct reason why the gene that codes for the production of the protein β-galactosidase is also included in the modified plasmids

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Question 5a.

Worked solution

The antigen in the vaccine is taken up by macrophages, combined with the class II MHC marker and displayed on the surface of the macrophage. The macrophage may move into the lymphatic system where it presents the antigen to a T helper cell. The T helper cells present the antigen to naïve B cells. The process of clonal expansion occurs, resulting in the production of large numbers of B plasma cells. These secrete antibodies that are specific for the antigen. B memory cells are also produced. These remain in the lymphatic system and are able to recognise the antigen if the person encounters it again in the future.

Mark allocation: 5 marks

- 1 mark for each valid point (up to 5 marks):
  - Stating that the antigen is taken up by a macrophage or other antigen-presenting cell
  - Stating that the antigen is combined with the class II MHC marker and displayed on the surface of the antigen-presenting cell, enabling it to be presented to a T helper cell
  - Stating that the T helper cell presents the antigen to a naïve B cell
  - Stating that large numbers of antibody producing B cells are produced
  - Stating that B memory cells remain in the lymph node and can recognise the antigen in cause of re-exposure

Question 5b.

Worked solution

The advantage of the booster shots is that they enable a faster and stronger immune response. The first dose of the vaccine results in the production of B memory cells, which remain in the lymphatic system in case of re-infection. However, only a small number of these cells are produced. Each subsequent exposure to the antigen increases the number of B memory cells.

Mark allocation: 2 marks

- 1 mark for providing a specific advantage, such as enabling a faster and/or stronger immune response to occur
- 1 mark for explaining that the impact of booster shots is to increase the number of B memory cells in the lymphatic system

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Question 5c.

Worked solution

Natural killer cells can recognise that a cell has been virally affected. They may kill an infected cell directly by secreting perforins, which lyse the cell membrane of the infected cell OR by secreting granzymes, which trigger apoptosis in the infected cell.

OR

Cytotoxic T cells are presented with an antigen by an antigen-presenting cell. They may act directly by secreting perforins, which lyse the cell membrane of the infected cell.

Mark allocation: 2 marks

- 1 mark for identifying an appropriate cell
- 1 mark for an accurate description of the mode of action of the cell

Tip

- *Natural killer and cytotoxic T cells have similar modes of action. However, natural killer cells are not considered to play a role in specific immunity because they do not have antigen-specific receptors. Cytotoxic T cells are specific, and they must be presented with an antigen before they act. It is important to be aware of the difference.*

Question 5d.

Worked solution

The case in 2007 related to a person who contracted polio overseas before entering Australia, rather than being a directly transmitted case where they contracted polio in Australia.

Mark allocation: 1 mark

- 1 mark for a plausible reason that explains why both statements are correct

Question 6a.

Worked solution

It would be expected that the banding pattern of DNA fingerprints from members of the same subspecies would be the same and the banding pattern of each subspecies would be different from each other.

Mark allocation: 1 mark

- 1 mark for stating that the DNA fingerprints would be expected to be different from each other.

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Question 6b.

Worked solution

Eventually this would be an example of allopatric speciation. The river creates a barrier between the two species, preventing gene flow. The separated populations experience different selection pressures. Genetic changes would accumulate in both populations, resulting in the populations having slightly different characteristics. These groups are referred to as subspecies because they are still able to successfully interbreed.

Mark allocation: 5 marks

- 1 mark for identifying allopatric speciation
- 1 mark for stating that the river provides a barrier that prevents gene flow
- 1 mark for stating that the two populations would be subjected to different selection pressures
- 1 mark for stating that genetic changes would accumulate in both populations
- 1 mark for explaining why the populations are subspecies

Question 6c

Worked solution

Possible answers include:

- to prevent inbreeding
- to carry out captive breeding programs
- to facilitate being able to release the chimpanzees back into the correct wild populations
- any other reasonable response.

Mark allocation: 1 mark

- 1 mark for identifying any reasonable reason why zoos would find it useful to know which subspecies captive chimpanzees belong to

Question 7a

Worked solution

The gene for the haemagglutinin would most likely be affected. Haemagglutinin is responsible for enabling the virus to bind to and enter the host cell. If a person has previously been exposed to a specific H antigen, then the virus can be prevented from entering the host cell. However, if there has been a shift in the H antigen, then the altered version may be able to enter the host cell.

Mark allocation: 2 marks

- 1 mark for identifying haemagglutinin
- 1 mark for providing a plausible reason why haemagglutinin is more likely to be affected by genetic drift than neuraminidase

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Question 7b.

Worked solution

Week 21 is approximately 4 weeks before the incidence of cases begins to increase. Having the vaccination then will provide sufficient time for an immune response to occur and memory cells to be produced.

Mark allocation: 1 mark

- 1 mark for an explanation that addresses the time taken for an immune response, including the production of memory cells to occur

Question 7c

Worked solution

This is an example of antigenic shift, resulting in the formation of a new antigen. No one would have any immunity to this antigen, which means that the disease is easily caught and transmitted, ultimately leading to a pandemic.

Mark allocation: 2 marks

- 1 mark for stating that a new antigen is produced
- 1 mark for explaining that people do not have immunity to the new strain, leading to a higher rate of infection and transmission

Question 7d.

Worked solution

People who have been infected cough or sneeze, releasing infectious aerosols into the air. These are then breathed in by other people, who then become infected. This can be prevented by measures such as wearing masks, or coughing or sneezing into a handkerchief. These methods should be effective because they prevent the aerosols being released into the air and therefore minimise exposure.

Mark allocation: 2 marks

- 1 mark for identifying that transmission occurs because of the release of infectious aerosols as a result of coughing or similar
- 1 mark for identifying a method of controlling the transmission of influenza virus by methods such as wearing a mask and for stating that this is designed to prevent the spread of the aerosols

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Question 8a.

Worked solution

The genetic diversity of the populations would be expected to decrease. Reasons for this include an increase in the possibility that individuals in a small population are more likely to breed with close individuals or that there is an increased probability that alleles may be lost because of pure chance.

Mark allocation: 2 marks

- 1 mark for identifying that the genetic diversity of the populations would decrease
- 1 mark for providing a plausible reason for the decrease in genetic diversity, such as by an increase in inbreeding in a small population

Question 8b.

Worked solution

Possible answers include:

- the biological fitness of the population decreases
- the average number of offspring decreases
- the ability of the population to adapt to changing conditions decreases
- there is a loss of advantageous alleles from the gene pool
- any other valid answer.

Mark allocation: 2 marks

- 1 mark for each valid point (up to 2 marks)

Question 8c.

Worked solution

Since the population was initially isolated, gene flow could not occur and the population would have had a comparatively low genetic diversity. The benefit of introducing organisms with desirable traits is an increase in genetic diversity of the population or an increase in the biological fitness of the population as a result of the introduction of alleles for favourable traits.

Mark allocation: 2 marks

- 1 mark for identifying that gene flow into the isolated population can now occur
- 1 mark for identifying a way in which a population would benefit, such as increasing the genetic diversity of the population, increasing the biological fitness of the population, influencing an increase in the size of the population or any other plausible point

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Question 9a.

Worked solution

The hominins from Sima de los Huesos were previously unknown and therefore were not shown on the phylogenetic tree. The human fossil record is open to different interpretations and has to be refined when challenged by new evidence.

Mark allocation: 2 marks

- 1 mark for stating that the Sima de los Huesos hominins were previously unknown OR the phylogenetic tree was modified as the Sima de los Huesos hominins diverged from Denisovans and Neanderthals, not existing before them as *Homo heidelbergensis*
- 1 mark for stating that representations of our understanding of human evolution has to be modified when new evidence is obtained

Question 9b.

Worked solution

The mother of the individual was Denisovan or of Denisovan ancestry.

Mark allocation: 1 mark

- 1 mark for identifying that the mtDNA signifies maternal Denisovan ancestry

Question 9c.

Worked solution

Mitochondrial DNA is inherited down the maternal line and does not provide information about the paternal line.

Mark allocation: 1 mark

- 1 mark for stating that mtDNA does not provide any information about the paternal ancestry of the individual

Question 9d.

Worked solution

Possible answers include:

- interbreeding occurred between the hominins from Sima de los Huesos and Neanderthals
- the hominins from Sima de los Huesos were the result of interbreeding between Denisovans and Neanderthals
- any other plausible response.

Mark allocation: 1 mark

- 1 mark for providing any plausible explanation for the mtDNA and the nuclear DNA results

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Question 9e.

Worked solution

Possible answers include:

- larger brow ridges
- larger, but lower cranium
- more robust (thicker) bones
- larger joints
- broader rib cage
- wider pelvis
- any other valid answer.

Mark allocation: 2 marks

- 1 mark for each valid answer (up to 2 marks)

Question 10a.

Worked solution

The ability to detect sweetness enabled high-calorie foodstuffs to be identified. People with this ability would be able to successfully engage in more/frequent activity due to having more energy. They would tend to survive longer, have more surviving children and have a greater level of biological fitness.

Mark allocation: 2 marks

- 1 mark for providing a statement relating to food detection and/or having the ability to release more energy
- 1 mark for stating that these individuals would be more biologically fit and produce more offspring

Question 10b.

Worked solution

This ability allowed them to assess calorie content with a quick taste before investing a lot of effort in gathering, processing and eating the items. Detecting sweetness helped early humans gather plenty of calories with less effort. Rather than browsing randomly, they could target their efforts, improving their evolutionary success.

Mark allocation: 1 mark

- 1 mark for a description of an advantage as to how an ancestral human would benefit from being able to taste sweet things

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Question 10c.

Worked solution

Many mammals have the *TAS1R1* and *TAS2R2* genes because these organisms break down carbohydrates into sugars, which are then used to release energy through cellular respiration. Carnivores have not retained these genes in a useable form because they depend on proteins instead of carbohydrates. Since these organisms and their ancestors have not been using these genes, they have lost them over time.

Mark allocation: 2 marks

- 1 mark for explaining why mammals have the *TAS1R1* and *TAS2R2* genes
- 1 mark for explaining why carnivores do not need the *TAS1R1* and *TAS2R2* genes

Question 11a.

Worked solution

That different species of bean will secrete different concentrations of urease.

Mark allocation: 1 mark

- 1 mark for producing an appropriate hypothesis based on the information provided

Question 11b.

Worked solution

A staggered start enables the students to have time to set up each group and to record data at the right time. This enables the students to control data collection time because it would be impossible to set up each group at the same time and then record all results at the same time.

Mark allocation: 1 mark

- 1 mark for identifying a specific advantage of using a staggered start, such as by controlling data collection time

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Question 11c.

Worked solution

Control group

OR

Experimental control

This group is used to gain a baseline for comparison. It shows that the beans alone are not the source of the pH change/that urea does not break down without the enzymes contained in the filtrate.

Mark allocation: 2 marks

- 1 mark for identifying that test tube 6 is the control group
- 1 mark for explaining a specific purpose of using distilled water as a control group in this experiment

Tip

- *Be aware of the difference between a generic answer and a specific answer. The purpose of a control group is to gain a baseline for comparison or to isolate the effect of the independent variable. However, that answer would be insufficient in this type of question where you have to specify what the purpose of the control group was for that specific experiment. To ensure that this is a fair test is even more vague and would not be awarded marks.*

Question 11d.

Worked solution

Possible answers include:

- The pH in the test tubes containing filtrate from broad and green beans did not change, indicating that these species of beans do not secrete urease.
- Borlotti beans secreted the highest concentration of urease because the solution turned alkaline after 5 minutes, which was faster than occurred for mung beans and soybeans.
- Both mung beans and soybeans secrete urease as shown by the pH becoming alkaline after 25 and 20 minutes respectively.
- Any other valid point combined with use of the data provided.

Mark allocation: 3 marks

- 1 mark for each valid point made together with data to justify the response, to a maximum of 3 marks

END OF SOLUTIONS BOOK

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