

# BIOLOGY

## Units 3 & 4 – Written examination



## 2022 Trial Examination

### *SOLUTIONS*

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

**Question 1**

*Answer:* B

*Explanation:*

As the nucleic acid only contains exons, RNA is the correct response as post transcriptional modification has occurred. C is incorrect as amino acids are not found in the nucleus. D is incorrect as glucose is a product of photosynthesis, produced in the chloroplast.

**Question 2**

*Answer:* C

*Explanation:*

NADPH is loaded, as hydrogen ions have bonded to NADP<sup>+</sup>. It is used in photosynthesis to transfer protons from the grana (light dependent reaction) to the stroma (light independent reaction).

**Question 3**

*Answer:* D

*Explanation:*

Initially, PCR starts with 2 strands. Each cycle doubles the number of strands. After 5 cycles there would be 64 strands.

**Question 4**

*Answer:* B

*Explanation:*

In an operon, the repressor protein binds to the operator region, and regulatory genes are produced upstream from the promoter and operator region. RNA polymerase binds to the promoter region to initiate transcription.

**Question 5**

*Answer: C*

*Explanation:*

Post transcriptional modification involves the addition of a methyl cap to the 5' ends and a poly A tail to the 3' end. Introns are removed and exons are spliced together. Therefore, C is the only correct response.

**Question 6**

*Answer: B*

*Explanation:*

The y axis would be the rate of reaction, as this is the dependent variable. The x axis would be temperature as the graph shows an increase in rate of reaction, followed by a steep decline following the peak. If this was a pH graph, the shape would be symmetrical.

**Question 7**

*Answer: A*

*Explanation:*

C3 plants are inefficient compared to C4 and CAM plants as they only undergo carbon fixation once, whereas C4 and CAM plants undergo carbon fixation twice to minimise water loss.

**Question 8**

*Answer: C*

*Explanation:*

This is a human error as poor technique created the error. Systematic errors are due to poorly calibrated equipment, whereas random errors have an unexplained source.

**Question 9**

*Answer:* B

*Explanation:*

Antigen presenting cells have MHC II markers, where they display antigenic fragments to T helper cells to stimulate the specific immune response.

**Question 10**

*Answer:* B

*Explanation:*

Plasma cells release free antibodies, whereas memory cells have attached antibodies. As the antibodies are composed of protein, extensive rough endoplasmic reticulum is required.

**Question 11**

*Answer:* B

*Explanation:*

As the mitochondria were heated to 80°C, enzymes within the mitochondria required for aerobic respiration would be denatured. Because of this, the rate of reaction would decrease

**Question 12**

*Answer:* C

*Explanation:*

Oxygen acts as a competitive inhibitor for photosynthesis, binding to the active site and preventing carbon dioxide from bonding. Carbon dioxide is required for the light independent stage of photosynthesis.

**Question 13**

*Answer:* D

*Explanation:*

Quantitative data is numerical, whereas qualitative data is descriptive or subjective. As colour is descriptive, it is classified as qualitative data.

**Question 14**

*Answer:* C

*Explanation:*

Viral infected cells, not bacteria, release interferon. T helper cells stimulate the third line of defence and are not innate. Complement proteins are activated for the second line of defence. Natural killer cells target deviant cells not bacteria.

**Question 15**

*Answer:* C

*Explanation:*

During the first exposure to an allergen, IgE antibodies are produced and they bind to mast cells.

**Question 16**

*Answer:* A

*Explanation:*

On the second exposure to an allergen, crosslinking of the IgE antibodies bound to the mast cells occurs, causing the mast cells to degranulate – releasing histamine.

**Question 17**

*Answer: C*

*Explanation:*

Homologous structures are ones that common ancestors share, whereas analogous structures are ones that due to similar selection pressures, appear to look the same. Structures that no longer serve a functional purpose are vestigial.

**Question 18**

*Answer: C*

*Explanation:*

As Ross river virus is spread via mosquitoes, removing mosquitoes from an area is a suitable way to minimise the spread, such as by using insect repellent.

**Question 19**

*Answer: C*

*Explanation:*

As the mutation occurs in the intron, and this is the non-coding region of the protein, any mutation would have no effect.

**Question 20**

*Answer: D*

*Explanation:*

Characteristics of primates include stereoscopic vision, opposable thumbs and 5 digits on each hand. Some primates have tails however no hominoids have tails.

**Question 21**

*Answer:* D

*Explanation:*

The higher the melting temperature, the more related that 2 species are. Species B had a higher melting temperature with species A compared to species C, therefore B is more related to A than C.

**Question 22**

*Answer:* B

*Explanation:*

Precise data is that which has values with the lowest range. Ben had a range of 2 seconds, compared to Cahil with a range of 12 seconds.

**Question 23**

*Answer:* B

*Explanation:*

Ben had the most accurate data, as his values were the closest to the expected value of 55 seconds.

**Question 24**

*Answer:* A

*Explanation:*

As enzyme speeds up the rate of reaction, adding more lipase will provide more active sites for substrate to bind to, speeding up the rate of reaction.

**Question 25**

*Answer:* C

*Explanation:*

In PCR, the strands must be denatured first. Following this, primers anneal and then the strands are elongated.

**Question 26**

*Answer:* B

*Explanation:*

The Out of Africa hypothesis proposes that *Homo sapiens* began in Africa before migrating across the Earth. This is supported by the greatest amount of mutations in mtDNA, as more time has passed for mutations to accumulate.

**Question 27**

*Answer:* B

*Explanation:*

Due to cancerous cells dividing uncontrollably, the regular cell checkpoints do not occur. This can cause surface antigens to change, therefore monoclonal antibodies created to target cancer cells may no longer be complementary to the cancerous cells.

**Question 28**

*Answer:* D

*Explanation:*

As the population of frogs from the zoo originate from one breeding pair, they would have less genetic diversity as a population in the wild that could have multiple parents contributing alleles to the population. Less genetic diversity causes a population to be at greater risk of extinction, as if conditions change, there are less individuals that are likely to be able to survive.



**Question 29**

*Answer:* C

*Explanation:*

As the frogs are inflicted with a fungal disease, antibiotics would be ineffective as they treat bacteria. Antimicrobial sprays are broad spectrum, treating a range of pathogens, hence would be the most effective form of treatment.

**Question 30**

*Answer:* D

*Explanation:*

To prevent transcription of structural genes in the trp operon, the repressor protein binds to the operator region. This prevents RNA polymerase from moving along the DNA strand to create a complementary mRNA molecule.

**Question 31**

*Answer:* B

*Explanation:*

Based on the law of superposition, layers closer to the surface are younger than those below. As the mineral layer is above the fossil, and this has been dated at 30,000 years old, the fossil must be older than 30,000 years old.

**Question 32**

*Answer:* B

*Explanation:*

As the fossil is less than 50,000 years, Carbon dating is effective as it has a half life of 5760 years.

**Question 33**

*Answer: C*

*Explanation:*

An organism that has altered its DNA is referred to as genetically modified. When DNA from another species has been inserted, it is known as transgenic. As the organism has had its genome altered, and inserted foreign DNA, it is both transgenic and genetically modified.

**Question 34**

*Answer: C*

*Explanation:*

Like all blood cells, both B and T cells are produced in the bone marrow. B cells remain and mature in the bone marrow whereas T cells mature in the thymus. Both B and T cells are part of the adaptive, not innate immune response.

**Question 35**

*Answer: A*

*Explanation:*

Leaky capillaries are a characteristic of inflammation. Additionally, vasodilation and an increase in temperature are often associated with inflammation. Swollen lymph nodes generally occur when the specific response has been activated.

**Question 36**

*Answer: D*

*Explanation:*

Hominins are classified as members of the genus *Homo* and their bipedal ancestors.

**Question 37**

*Answer:* A

*Explanation:*

Speciation that occurs in the same location is referred to as sympatric speciation. Allopatric speciation requires a geographical barrier, whereas natural selection is the change in allele frequencies within a population. The founder effect is when a population unrepresentative of the original population colonises a new area.

**Question 38**

*Answer:* B

*Explanation:*

As the darker moths could more easily camouflage with the change in building colour, they now had a selective advantage. The variation existed in the population, so it is not an example of a novel phenotype.

**Question 39**

*Answer:* D

*Explanation:*

Herd immunity limits the spread of pathogens within a population as there are less available hosts in which to replicate and spread. This protects the very old and very young who may not be able to be vaccinated.

**Question 40**

*Answer:* B

*Explanation:*

Phenol acid is a chemical defence used by plants. Sap and resin both trap microbes so are considered physical barriers, with the waxy cuticle providing the initial physical barrier.

**SECTION B: Short-answer**

**Question 1** (15 marks)

**a.** Proteins or polypeptide

1 mark

**b.** From top to bottom – antigen binding site, variable region, constant region

1 mark

**c.** 3 of the following for 1 mark each:

DNA is unwound.

RNA polymerase catalyses the addition of free nucleotides complementary to the template strand of DNA.

Uracil replaces thymine.

Introns are removed and exons are spliced together.

A methyl cap is added to the 5' end, and a poly A tail is added to the 3' end.

3 marks

**d.** Quaternary (1).

The antibody is composed of 4 (or more than 1) separate polypeptide chains (1).

(Two) heavy chains, and (2) light chains (1) OR chains are held together with disulphide bonds

(1).

3 marks

**e.** Foreign pathogen is engulfed by an antigen presenting cell (1).

Fragments are presented to a Helper T cell (1).

Helper T cell find the naïve B cell with the complementary antibody, and release cytokines (1).

Clonal expansion occurs with the B cell differentiating into plasma cells that produce and secrete antibodies(1).

4 marks

**f.** Antigenic variation (1). The shuffling of the nucleotides that code for the variable regions creates different combinations (1). These combinations code for varying protein structures (1).

3 marks

**Question 2** (6 marks)

**a.** Ribosomal RNA is found in the ribosome whereas DNA is found in the nucleus.

1 mark

**b. Only one example is needed for each. Two correct responses must be given for the differences to attain one mark.**

	rRNA	DNA

<b>Difference</b>	Ribose sugar Single stranded Uracil	Deoxyribose sugar Double stranded Thymine
<b>Similarity</b>	Pentose sugar Both composed of nucleotides	

2 marks

**c. One of:**

In prokaryotes, DNA is circular whereas in eukaryotes DNA is linear.

In prokaryotes, DNA is found in the cytosol, and in eukaryotes it is found in the nucleus.

1 mark

**d.** As 10% of the cell is guanine, 10% must also be cytosine due to complementary base pairing (1). The remaining nucleotides would be 40% adenine and 40% thymine (1).

2 marks

**Question 3 (7 marks)**

**a.** The DNA would be heated to 98°C to separate the strands (1). The sample would be cooled to 55°C to allow primers to anneal (1). The sample would be heated to 72°C to allow Taq polymerase to catalyse the addition of free nucleotides (1).

3 marks

**b.** As the bones and teeth are hard, they take longer to decompose.

1 mark

**c.** Comparing amino acid sequences (or DNA nucleotides) (1). The more amino acids in common, the more related two species are (1) as there has been less time to accumulate differences (1).

3 marks

**Question 4 (14 marks)**

**a.** As temperature increases, the rate of reaction increases, as evident by the increased oxygen production (1). Above the optimum value, enzymes denature and the rate of reaction decreases, as evident by the decreased oxygen production (1). The peak in photosynthetic rate correlates to the optimum temperature (1).

3 marks

**b (i).** C4 plants have an optimum temperature of about 36°C (1); compared to C3 plants that have an optimum temperature of about 28°C (1), and CAM plants that have an optimum temperature of 15°C (1). Students need to give a precise value, with allowance of plus or minus one degree.

3 marks

(ii). Following the peak of the graph, enzymes such as Rubisco denature (1). The change in active site means that substrate can no longer bind (1).

2 marks

c. C<sub>4</sub> plants are well adapted to hot and dry areas (1), whereas CAM plants are also adapted to hot and dry conditions, with the lower optimum temperature (5°C) due to most of the photosynthesis occurring in the cooler night temperatures (1). C<sub>3</sub> plants are adapted to most environments (1).

3 marks

d.

Stage of Photosynthesis	Location	Inputs	Outputs
Light Dependent	Grana	One of: Water ADP + Pi NADP <sup>+</sup>	Oxygen
Light independent	Stroma	One of: Carbon dioxide NADPH ATP	One of: water Glucose NADP ADP + Pi

5 correct – 3 marks

3-4 correct – 2 marks

2 correct – 1 mark

3 marks

**Question 5** (15 marks)

a. A virus contains nucleic acid enveloped in protein/protein coat.

1 mark

b. Antigen presenting cell engulfs the virus and presents fragments on the cell surface to Thelper cell (1). Th cell travels to the lymph node and finds T cell with complementary markers (1). Thelper cell releases cytokines causing clonal expansion (1). T cell differentiates into memory T cell and cytotoxic T cells (1).

4 marks

c. An innate response is the release of interferon (1) to allow neighbouring cells to undergo apoptosis/become less permeable (1).

2 marks

d. Wearing appropriate PPE when close to infected individuals (1).

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Sanitising all surfaces/areas where an infected individual may be (1).

Isolating and quarantining affected individuals (1).

Don't share equipment or spaces (1)

Any reasonable response accepted.

3 marks

**e.** Inside the areas of the bats' home range, virus is transmitted between bats and humans or human to human (1). In areas outside of the bats' home range, the virus is transmitted from infected monkeys (1). As such, the virus is zoonotic (1).

3 marks

**f.** Add sample to be tested and primary antibody, specific for the antigen (1).

Add enzyme linked secondary antibody that is specific for the primary antibody, and enzyme substrate, specific for the enzyme-linked secondary antibody (1).

Check for any colour change. If colour change occurs, the sample has shown agglutination due to the presence of antibodies (1).

3 marks

### Question 6 (8 marks)

**a.** Humans are the selective pressure (1), as they are removing elephants with tusks from the population, increasing the frequency of tuskless elephants (1).

2 marks

**b.** Over time, the tusk allele may be lost to the population (1), with all elephants having no tusks, decreasing genetic diversity (1).

2 marks

**c.** Variation existed in the elephant population, some with tusks and some without (1).

Those elephants without tusks had a selective advantage (1), as they were able to survive and reproduce (1).

Over time, the allele for elephant tusks became more prevalent in the population (1).

4 marks

### Question 7 (15 marks)

**a.** The positive control demonstrates that the antigen and antibody are binding so antigen is present(1). The negative control demonstrates that another factor is not causing the binding of the antigen and antibody/ shows the expected result when antigen is absent(1).

2 marks

**b.** One mark each for up to 2 of the following: same amount of sample blood; same temperature; same amount of time *or any other suitable controlled variable*. Concentration of antigens not suitable as this is altered.

2 marks

**c.** Patient A does not have HIV as no agglutination has occurred (1).

Patient B may have HIV as agglutination occurred at the higher antigen concentrations (1).

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Patient C has HIV as agglutination occurred at all dilution factors (1).

3 marks

**d.** As patient B's blood did not agglutinate in the very dilute solution, they may not have HIV (1). Further testing should be conducted to confirm their diagnosis (1).

2 marks

**e.** Only 3 dilution factors were tested (1). Expanding the range may provide greater certainty in the results (1).

2 marks

**f.** Ethical: people may choose not to be tested (1) as they do not want their employer to know their HIV status (1).

Social: the cost of mandatory testing would be high (1), diverting funds from other resources such as schools and hospitals (1).

*Any suitable ethical issue that has a moral right/wrong. A social issue must affect society not just the individual.*

4 marks