Suggested answers to multiple-choice questions

1. C	**2**. A	**3**. B	**4**. C	**5**. D	**6**. A	**7**. B	**8**. B	**9**. C	**10**. D
11. C	**12**. C	**13**. A	**14**. B	**15**. A	**16**. C	**17**. A	**18**. D	**19**. A	**20**. C
21. C	**22**. A	**23**. D	**24**. B	**25**. A	**26**. B	**27**. D	**28**. C	**29**. B	**30**. B
31. A	**32**. C	**33**. C	**34**. C	**35**. A	**36**. D	**37**. B	**38**. C	**39**. A	**40**. B

Suggested answers to short answer questions

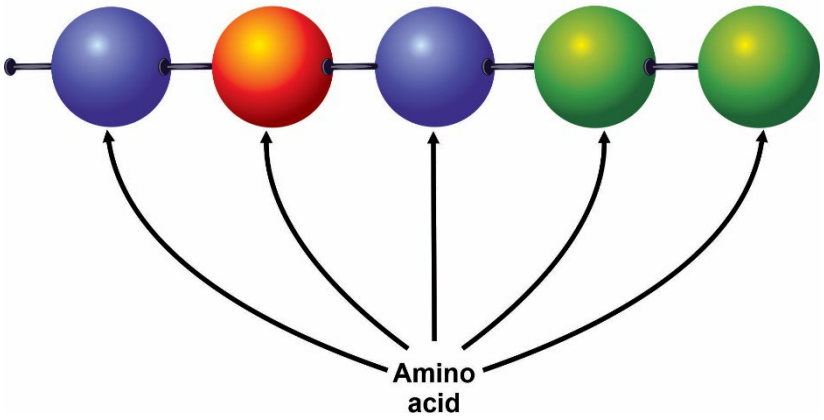
Question 1 (10 marks)

a. DNA nucleotides contain thymine, whereas RNA nucleotides contain uracil **(1 mark)**.

b. Triplet **(1 mark)**.

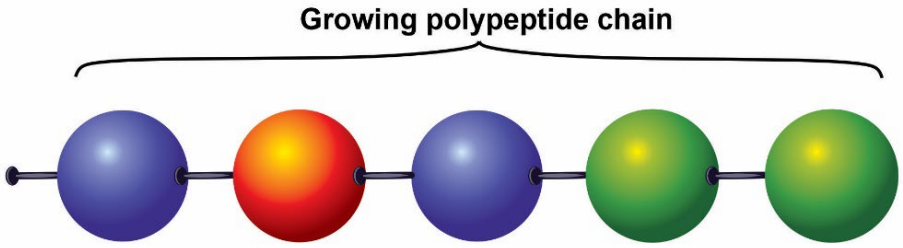
c. **Ser-Tyr-Ser-Asp-Asp (1 mark)**.

d. AGU UAU AGU GAU GAU



(1 mark for any one of the labelled amino acids).

e. **i.**



(1 mark)

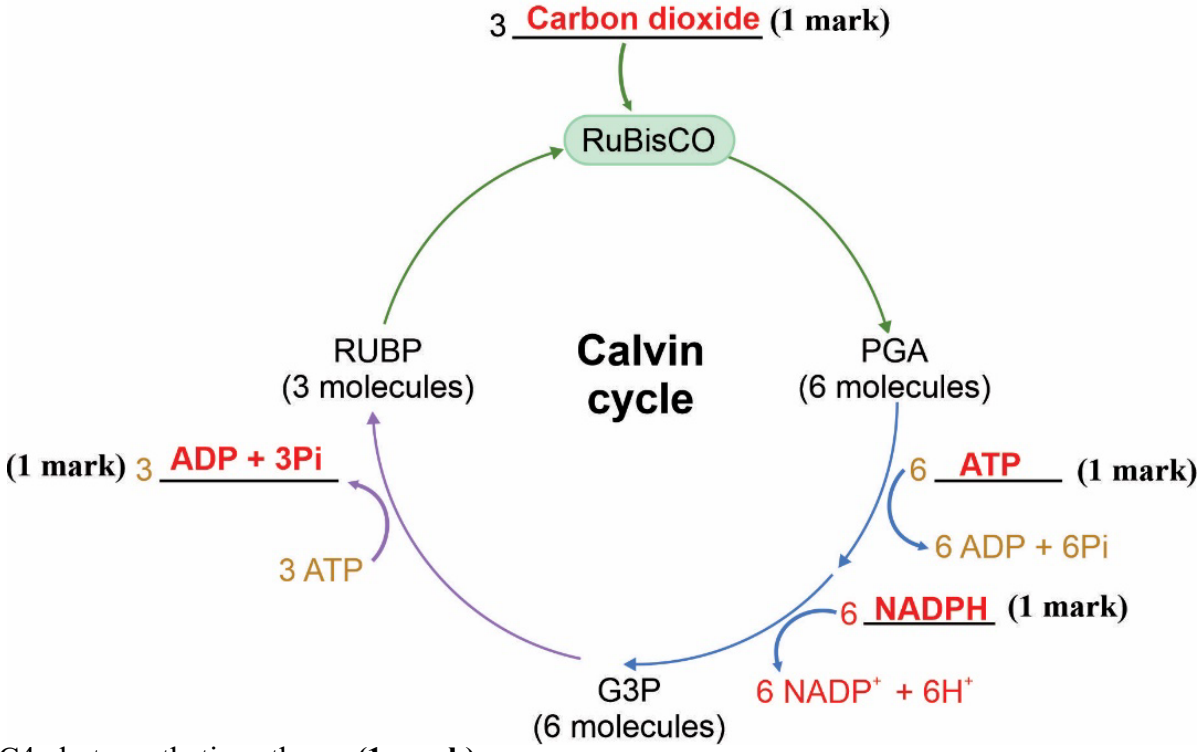
ii. Primary **(1 mark)**.

iii. It shows the linear sequence of amino acids joined by peptide bonds **(1 mark)**.

f. Messenger RNA is read 3 bases at a time at the ribosome **(1 mark)**. The anticodon of transfer RNA molecules attaches to the complementary mRNA codons **(1 mark)** and drops off the specific amino acid required to build the polypeptide **(1 mark)**.

Question 2 (10 marks)

a.



b. C4 photosynthetic pathway **(1 mark)**.

c. The plant separates the process of carbon fixation into two stages and two different locations. Initially, carbon dioxide is fixed in the mesophyll cells using a different enzyme (PEP carboxylase) instead of Rubisco **(1 mark)**. Rubisco enzyme molecules have a high affinity for oxygen as temperature increases **(1 mark)**. The enzyme in the C4 plant does not have a high affinity for oxygen **(1 mark)**.

d. CAM plants open their stomata at night to enable carbon dioxide to diffuse into the plant, which minimises water loss during the day **(1 mark)**. Their stomata are closed during the day which prevents Rubisco molecules from binding to oxygen and it uses the carbon dioxide stored from the night **(1 mark)**.

Question 3 (10 marks)

a. To amplify the DNA fragments of the patient's sample (**1 mark)**.

b. 1. Denaturation: The DNA is heated to 95 degrees Celsius to break the hydrogen bonds and separate the strands **(1 mark)**.
2. Annealing: The DNA is cooled to approximately 55 degrees Celsius, and primers (short strands of DNA) are added to promote replication **(1 mark)**.
3. Extension: The DNA is heated to 72 degrees Celsius and Taq polymerase and free nucleotides are added. Taq polymerase catalyses the joining of the free nucleotides to extend the DNA beyond the primer **(1 mark)**.

c. The standard is a DNA ladder of known DNA fragment sizes **(1 mark)** used to estimate the size of the unknown DNA molecules **(1 mark)**.

d. Patient 2 has Influenza A **(1 mark)**. This is shown through the DNA fragments being the same size as the Influenza A control DNA fragments **(1 mark)**.

e. 170 base pairs **(1 mark)**. The influenza control shows two bands, one that is 70 bp and one that is 100 bp **(1 mark)**. Therefore, the total size of the DNA fragment used for identification is 170 bp.

Question 4 (8 marks)

a. Single guide RNA (sgRNA) contains a complementary sequence to the DNA sequence in the target alpha gliadin gene and acts as a guide molecule **(1 mark)** for Cas9 to cut the double stranded DNA at a specific DNA sequence of the alpha gliadin gene **(1 mark)**. This break in the DNA results in the attempt of the rice plant to repair the DNA, usually resulting in mutations that render the gene non-functional **(1 mark)**.

b. The immune system mistakenly recognises self-cells as non-self and produces antibodies against those cells **(1 mark)**.

c. PAM or protospacer adjacent motif sequence **(1 mark)**.

d. Any of the following or another suitable response:
- Precise **(1 mark)**. CRISPR-Cas9 allows for highly precise targeting of specific DNA sequences **(1 mark)**.
- Increased Safety **(1 mark)**. CRISPR-Cas9 is safer as there is no need to insert foreign DNA into the genome of a cell **(1 mark)**.
- Reduced cost **(1 mark)**. CRISPR-Cas9 experiments cost less as the procedure is simpler than other gene technologies **(1 mark)**

e. CRISPR Cas 9 acts as an adaptive immune defence against viral infection **(1 mark)**.

Question 5 (12 marks)

a. Scientific strategy- sequencing the viral genome and using this information to create a vaccine **(1 mark)**.
Social strategy- effective seizing of illegal pangolin trade **(1 mark)** ***or*** putting sanctions in place which made the illegal pangolin trade more difficult (e.g. lengthy imprisonment as a deterrent) **(1 mark)**.

b. Antigenic shift **(1 mark)**. Antigenic shift occurs when two or more strains of a virus combine to form a new virus **(1 mark)**.

c. It indicates that SARS-CoV-2 virus is likely airborne and able to be inhaled **(1 mark)** as it can bind to the lung ACE-2 receptors **(1 mark)**.
Any **one** of the following for **(1 mark)**:
- mask wearing
- hand washing
- isolating the sick
- covering mouth or nose when sneezing or coughing

d. MHC class I markers or Major Histocompatibility Complex I markers **(1 mark)**.

e. An antigen presenting cell engulfs the virus and presents it on its surface to T helper cells **(1 mark)**. T helper cells activate the specific B cell by secreting cytokines **(1 mark)**. This results in the B cell proliferating and producing plasma cells that secrete antibody specific to the virus and memory B cells **(1 mark)**.
The pangolins died as the adaptive immune response takes time to produce a large enough antibody response to combat the virus **(1 mark)**.

Question 6 (10 marks)

a. **i.** Allopatric speciation **(1 mark)**.

ii. 1. A population of finches exists with phenotypic variation on the mainland **(1 mark)**.
2. The members of this population are separated by a geographical barrier preventing gene flow. Each separated finch population is subjected to different selection pressures on the different islands favouring different phenotypes **(1 mark)**.
3. Over time, differences accumulate in the DNA of the separated finch populations. If the separated finch populations reunite and they cannot produce viable, fertile offspring, they have become two different species **(1 mark)**.

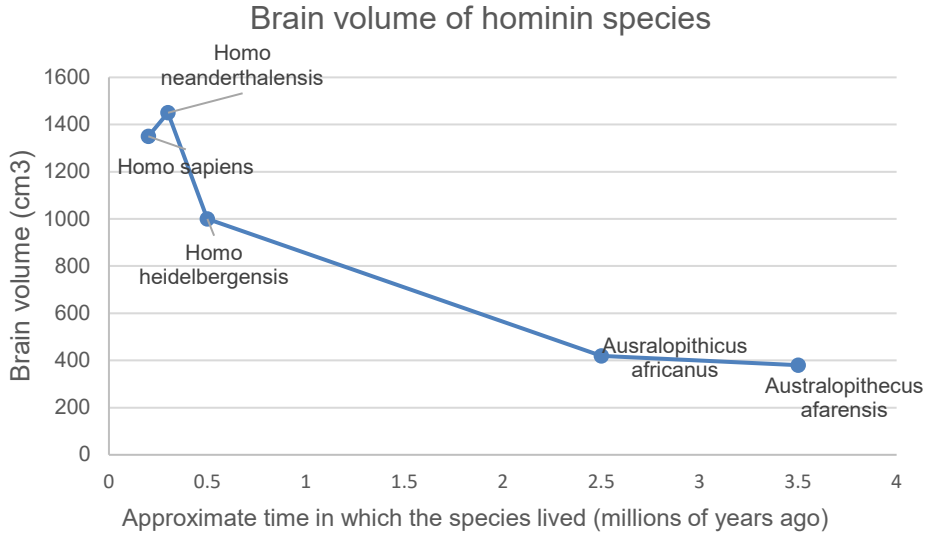
b. As the beak depth of medium ground finches increased, the survival rate also increased, peaking at 40 for a beak depth pf 9.8 mm **(1 mark)**. At beak depths greater than 9.8 mm, survival rates decreased with only 10 finches surviving with beak depths of 10.8 mm **(1 mark)**.

c. Food source **(1 mark)**. The drought would have altered the survival of the plant and animal species on the island **(1 mark)**. The food source now available must have been larger, favouring the survival of birds with a greater beak depth **(1 mark)**.

d. Comparison of DNA sequences **(1 mark)** ***or*** comparison of amino acid sequences **(1 mark)**.

Question 7 (10 marks)

a. Title **(1 mark)**, correctly labelled X and Y axes **(1 mark)**, correct scale **(1 mark)**, and correct plotting and labelling **(1 mark)**.



b. Brain capacity increases over time with the different species of the *Australopithecine* genus having lower brain volumes and the different species of the *Homo* genus having the greater brain volume **(1 mark)**. There is an exception with *Homo Neanderthalensis* having a greater brain volume than *Homo sapiens* by 100 cm^3 **(1 mark)**.

c. Natural selection **(1 mark)**. Variation existed in the brain size of the hominin populations; those with a larger brain had the selective advantage **(1 mark)**. The hominins with the selective advantage survived and reproduced **(1 mark)** and passed the trait of greater brain volume onto their offspring **(1 mark)**.

Question 8 (10 marks)

a. If temperature increases beyond the optimum of 40 ºC then anaerobic cellular respiration in the yeast will decrease, as measured by a decrease in carbon dioxide production in 5-minute intervals **(1 mark)**. (Different variations on answer acceptable)

b. Independent variable: Temperature (ºC) **(1 mark)**.
Dependent variable: Carbon dioxide production (mmol) **(1 mark)**.

c. The optimal temperature for anaerobic respiration in yeast is 40 ºC **(1 mark)**. Temperatures above 40 ºC cause the enzyme molecules involved in anaerobic cellular respiration to denature, changing the tertiary structure of the protein so that the substrate can no longer bind to the enzyme molecule's active sites **(1 mark)**. Temperatures below 40 ºC result in a decrease in the kinetic energy of the enzyme molecules, resulting in fewer collisions between enzyme and substrate molecules **(1 mark)**. The change in temperature above or below 40 ºC results in less carbon dioxide production **(1 mark)**.

d. pH **(1 mark)**.

e. Yes, the data are valid as the experiment measures what it intends to measure, which is rate of anaerobic respiration in yeast at different temperatures **(1 mark)**. ***Or*** there is only one independent variable in the experimental set up.

f. Ethanol production/ alcohol production **(1 mark)**.