SOLUTION PATHWAY

NOTE: This task is sold on condition that it is NOT placed on any school network or social media site (such as Facebook, Google Docs, etc.) at any time.

NOT FOR PRIVATE TUTOR USE.

FOR ADJUSTED STUDY DESIGN (2020 ONLY)

Answers to Section A: Multiple choice

Question	Correct Answer	Explanation
1	**D**	tRNA (molecule C) is not needed for transcription, only translation. mRNA is involved in both transcription and translation. The mRNA does bind to both of the other molecules during translation.
2	**A**	DNA can at times be single stranded. When double stranded, it is joined by 'weak' hydrogen bonds. DNA carries a slight negative charge.
3	**C**	The phosphate group is correctly labelled and in the correct position. The molecule is a 'monomer' of RNA, that has an incorrectly labelled 'ribose sugar' and the uracil is joined at the wrong position.
4	**A**	A cell membrane can be described by the fluid mosaic model which has multiple structures that can move laterally.
5	**C**	Photosynthesis (measured by O_2 release) is highest between 400-500nm and 600-700nm, as is the absorption.
6	**B**	The equation represents photosynthesis W = CO_2 and Y = glucose (X = water and Z = oxygen).
7	**D**	2 ATP produced during glycolysis. Kreb's cycle and electron transport cannot occur in the absence of mitochondria.
8	**D**	Cyanide is a poison that is an irreversible inhibitor. The competitive and non-competitive reactions are reversible.

9	**A**	Krebs cycle requires ADP + Pi, Pyruvate, NAD and FAD amongst its inputs, making A correct.
10	**C**	The outputs of anaerobic respiration in animals are Lactate and 2 ATP.
11	**C**	Lipid soluble (steroid) molecules diffuse through the cell membrane to bind to intracellular receptors.
12	**A**	A gall is a physical defence in plants.
13	**C**	Measles has the highest number of secondary infected people. MERS has an R0 value of 0.75. Ebola has a lower value than mumps and COVID19 can spread the same as influenza.
14	**C**	Exposure to influenza would produce different B-memory cells that would not be effective against COVID19. Clean water is useful for washing hands to prevent the spread via hands, but HERD immunity is the most effective as it provides less hosts for the virus to reproduce in.
15	**A**	MS is an autoimmune disorder caused by the misidentification of self-antigens and the production of autoantibodies by B plasma cells in response to this.
16	**B**	The mother received a vaccination which is artificial, triggering an active immune response. The baby would receive maternal antibodies (passive) which is natural.
17	**D**	Point mutations can cause a STOP codon. Frameshift or changes to amino acids/proteins does not always occur. Translocation refers to block mutations.
18	**D**	1 shows the beetles mutating. 2 shows gene flow (no indication that they are new/different species). 3 is genetic drift due to the 'chance event'. 4 is natural selection with the chameleon eating the darker coloured beetles.
19	**C**	The increase in differences due to being separated by a physical barrier could lead to speciation. B is incorrect as the two finches would not mate due to the different mating calls.
20	**B**	Similar selection pressures would result in the similar phenotypes of the frog and toad.
21	**C**	A shortage of food has resulted in the death of many snakes, reducing the diversity of snake populations. Smaller snakes have been selected for when limited food is a selection pressure.

22	**B**	The limbs shown are homologous structures as they have evolved from a shared ancestral origin.
23	**C**	6 is positioned lower in the strata, therefore older than 3, which is in newer layers of strata.
24	**D**	Pharyngeal arches are common to all vertebrate embryos, early on in embryonic development.
25	**B**	If the axe was found in the ash of a volcano that erupted 34,000 years ago, humans must have been there for at least that amount of time.
26	**B**	Humans and chimpanzees each have one amino acid from the sequence, different to the gorilla. As this only shows a section, it cannot be concluded that the human and chimp have an identical protein. The zebra is not classified as a primate.
27	**B**	Molecular homology involves the comparison of amino acid sequences.
28	**C**	Corn has been artificially selected for in farming to look a certain way and to be larger, therefore providing more food.
29	**B**	The flowers discovered contained pollen. It is therefore able to be dated using carbon-14.
30	**A**	Quick burial, free of bacteria and low oxygen levels are required for fossilisation.
31	**B**	Being common and widely distributed within a defined time-period are conditions that make a good index fossil.
32	**A**	Uniform and small teeth are characteristic of modern humans. They also have longer legs and absent brow ridges. Burying the dead is cultural, not structural.
33	**A**	Homo have both types of ilium according to the table. The other examples are contradictory.
34	**C**	As the age of the wasp nests is less than 50,000 years old, carbon would still be present so carbon dating could be used.
35	**C**	Plasmids are not vectors for pathogens. They are present in eukaryotic cells. They are circular molecules of DNA in bacterial cells.
36	**B**	Reverse transcriptase is an enzyme that is used to construct complementary DNA from mRNA.

37	**A**	Effects on other native species can cause an effect on the environment which is consistent with biological implications. The other options relate to social implications where two or more people are affected.
38	**C**	Social implication must affect more than 1 or 2 individuals. The affordability of the product to many farmers is a social implication.
39	**B**	The pigs are transgenic as they contain a gene from another species. They are GM as this change has been engineered.
40	**A**	Pandemic, due to the global spread. Although it is virulent, that does not describe it geographical spread.

Answers to Section B: Short Answer

Question 1 (7 marks)

Sample high level responses:

a. *The material that is taken in is surrounded by part of the cell membrane* (1 mark) *and the formation of a vesicle around the foreign material occurs inside the cell*. (1 mark)
b. *The enzyme is lysozyme* (1 mark*) and its role is to break down foreign material/pathogen*. (1 mark)
c. *Water is an output/produced*. (1 mark) *Energy is required/reaction is endergonic*. (1 mark) *Amino acids are joined together by the formation of peptide bonds/forming the polypeptide*. (1 mark)

Question 2 (7 marks)

Sample high level responses:

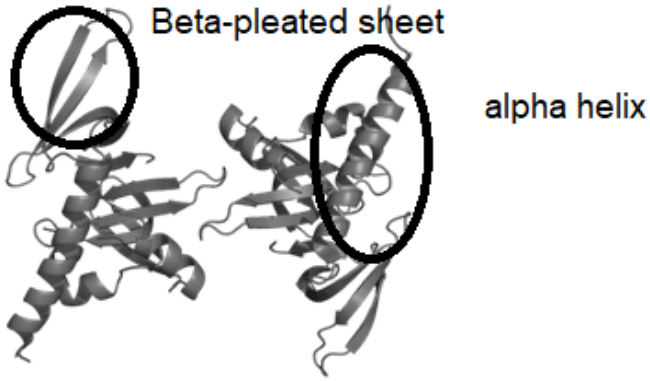
a. *The light-independent stage/Calvin cycle*. (1 mark)
b. *The active site of Rubisco might have a shape complementary to both oxygen and carbon dioxide.* (1 mark) *Therefore, it is able to bind to both molecules.* (1 mark)
c. *Water is needed in the light dependant stage to provide energy/ATP for the Calvin Cycle*. (1 mark) *Less water would be needed if the light independent phase were more efficient and less non-functional molecules were made*. (1 mark)

Question 3 (9 marks)

Sample high level responses:

a. *A pheromone is a signalling molecule that binds to receptors/causes a response in another organism of the same species.* (1 mark)

b.



One label AND name required for 1 mark.

c. *The alpha helix might add flexibility/strength/form part of the binding site to the protein.* (1 mark) *It is important to be able to bind to the receptor* OR *gives the shape for binding to the promotor region*. (1 mark)

d. Three of:

- *The mRNA is read by the ribosome.*
- *The tRNA carries a SPECIFIC amino acid to the ribosome.*
- *The anticodon on tRNA binds to a complementary codon on the mRNA.* AND/OR
- *The amino acid is joined to the polypeptide chain.*

1 mark per correct response.

e. Two of:

- *Exon juggling* (1 mark) *resulting in a different mRNA being formed. OR*
- *Alternative splicing* (1 mark) *resulting in a different mRNA being formed. OR*
- *Post-transcriptional modification* (1 mark) *resulting in the same protein being folded into a different tertiary structure.*

Question 4 (8 marks)

Sample high level responses:

a. *Structural gene codes for a protein that becomes part of the structure or function of the killifish* (1 mark) *and a regulatory gene controls another gene.* (1 mark)

b. *The CBX7 gene produces a protein that could act as a repressor protein for genes that control cell division.* (1 mark) *Such tumour suppressor genes are no longer inhibited, and the cell could divide uncontrollably*. (1 mark)

c. *Only the exons are translated into the protein*. (1 mark) *Intron are spliced out and remain in the nucleus.* (1 mark)

d. *Lactose present: The lactose binds to the repressor protein, causing it to change shape and detach from the operator. This allows for transcription of the structural genes to occur*. (1 mark)
Lactose absent: The repressor protein binds to the operator, blocking RNA polymerase from being able to transcribe the structural genes. (1 mark)

Question 5 (6 marks)

Sample high level responses:

a. *Both supercentenarians and younger people have 40% total T cells, although supercentenarians produce more cytotoxic T cells (32%) than younger people (4%)*. (1 mark)

b. *Cytotoxic T cells kill virus infected cells OR cancerous cells*. (1 mark)
Release perforin to open up a hole OR release toxins into the cell. (1 mark)
This allows more healthy cells to survive/preventing disease. (1 mark)

c. Two of:
- *Only 3 people is a small sample size and therefore may not be measuring a single independent variable*. (1 mark)
- *The cells may have been taken from different locations (e.g. lymph nodes).* (1 mark)
- *The age of the younger controls is not given. They may have underdeveloped immune systems if too young.* (1 mark)
- *B cell numbers would also have a role in protecting the individual, and these results were low.* (1 mark)

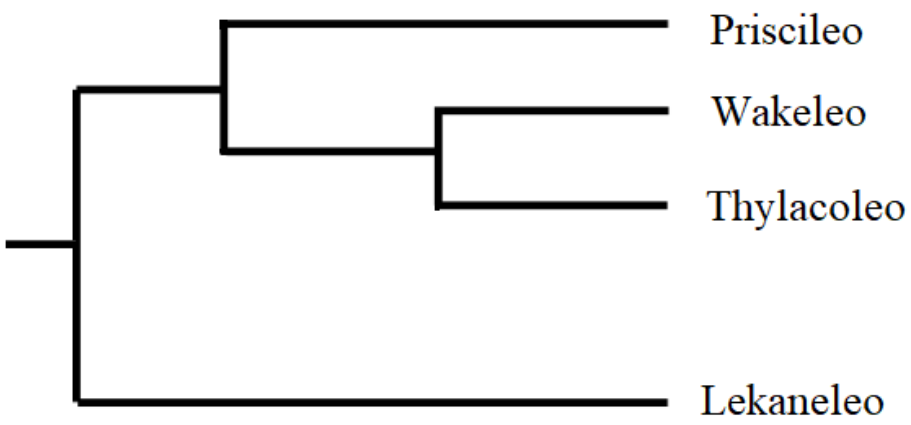
Question 6 (7 marks)

Sample high level responses:

a. *Morphological: both species were the same size* (1 mark) *and both had three pre-molars.* (1 mark)

b. *A common ancestor of the marsupial lions had the oversized pre-molar adaptation.* (1 mark)
Those lions of each species that had it could kill more easily, were successful and reproduced more /selective advantage. (1 mark)
Each species passed on the genes for the oversized tooth and it was inherited through the generations of each species. (1 mark)

c. All correct = 2 marks, 2 correct = 1 mark



Question 7 (9 marks)

Sample high level responses

a. *Kangaroo Island and Green Triangle Forest would have the most differences*. (1 mark) *Mt Lofty Ranges would have the most in common with the other two populations.* (1 mark)
b. *Gene flow is the movement of alleles between populations*. (1 mark) *Kangaroo Island and the other two populations have no gene flow because of the sea separating them*. (1 mark) *Mt Lofty Ranges and Green Triangle Forest are about 200kms apart, also preventing gene flow.* (1 mark)
c. *The bushfires could have killed many Kangaroo Island bandicoots creating a genetic bottleneck.* (1 mark) *Low genetic variation places additional risk on this population.* (1 mark)
d. *Mt Lofty Ranges bandicoots live in a highly urbanised environment and would be at risk of road traffic/domestic dogs.* (1 mark) *These bandicoots live in mountain ranges that may require more rock hopping/strenuous climbing, etc.* (1 mark)

Question 8 (10 marks)

Sample high level responses:

a. *Gene therapy could use a viral vector to deliver a functional factor IX gene to cells*. (1 mark) *Gene expression of the functional gene could result in the production of factor IX.* (1 mark)
b. *A stop codon occurs, and no more amino acids are added to the polypeptide chain*. (1 mark)
c. *The normal factor IX gene would be close to the wells of the gel as it is larger, and the mutated gene would be further down the gel as it is smaller due to the nonsense mutation*. (1 mark)
d. *A tool to deliver genetic material into a cell*. (1 mark)
e. *Graph A shows that participants had a significantly higher rate of bleeding prior to vector infusion and this reduced significantly after treatment.* (1 mark) *Graph B shows that significantly more Factor IX infusions were required prior to vector treatment.* (1 mark)

f.

Restriction enzymes	*Used to cut the target gene AND plasmid (at the same sequence).* (1 mark)
DNA ligase	*Used to join the target gene AND plasmid.* (1 mark)
Polymerase chain reaction	*Produce sufficient quantities of the target gene DNA.* (1 mark)

Question 9 (10 marks)

Sample high level responses:

a. i

Evidence	Justification
H erectus had a larger brain.	*Greater capacity to process tool making/ using information and understanding.*
Artefacts found in H erectus fossil sites/have not been found with P boisei.	*Suggests H erectus used tools as they were found with the fossils, but not found with P boisei.*
H erectus ate meat.	*This supports brain development and the ability to process tool making/using information and understanding.*
H erectus' hand bone structure supports tool use.	*Suggests that they were able to make and use tools.*

1 mark for each corresponding explanation for relevant pieces of evidence for a total of 4 marks.

ii.

Evidence	Justification
P boisei have a powerful hand/arm bone structure.	*Suggests grasping ability which could support tool use.*
P boisei have a weak thumb.	*Suggests that they were able to grip sufficiently to make and use simple tools.*
Other Parathropus species fashioned tools.	*P Boisei may also have been capable of making and using tools if earlier Paranthropus species could.*

1 mark for each corresponding explanation for relevant pieces of evidence for a total of 4 marks.

b. *If tools were discovered with only P boisei fossils in other sites* (1 mark) *and if there were no H erectus fossils found with the discoveries.* (1 mark)

Question 10 (9 marks)

Sample high level responses:

a. *The data being collected is qualitative* (1 mark) *as this is subjective/descriptive. The different colours could be interpreted differently*. (1 mark)
b. *Accuracy refers to the closeness of the experimental results to the true value*. (1 mark) *The most precise distance is 50cm* (1 mark) *as these results were the closest to each other (all pink) compared to the other results that had greater variation.* (1 mark)
c. *That a higher light intensity will increase the rate of photosynthesis*. (1 mark)
d. *Indicator solution AND alginate (without chlorella)*. (1 mark)
e. *As the chlorella undergo respiration, they will produce carbon dioxide*. (1 mark) *This could cause the solution to be more yellow/acidic and cause inaccurate results.* (1 mark)