

**END OF QUESTION AND ANSWER BOOK****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.**

Below are sample answers. Please consider the merit of alternative responses.

**SECTION A: Multiple Choice Answers**

<b>Question</b>	<b>Correct Answer</b>	<b>Explanation</b>
<b>1</b>	<b>C</b>	The amine, carboxyl and central carbon are all the same between the different amino acids. The R group is the variable region that causes the differences between the 20 amino acids.
<b>2</b>	<b>B</b>	Glutamine has a role as a neurotransmitter as indicated by the text stating it 'is a signalling molecule in the nervous system'. The other options require the glutamine to be turned into a protein, which was not the reaction shown.
<b>3</b>	<b>D</b>	A chromosome would be the longest, Pre-mRNA, next final mRNA (after introns spliced out), Lastly the transfer RNA is the smallest.
<b>4</b>	<b>B</b>	The functional role of these proteins is that they are transport proteins. The carrier proteins don't have a fixed structure. They are comprised of protein (not lipids), and are involved in the passive movement of molecules.
<b>5</b>	<b>A</b>	Facilitated diffusion, as with all types of diffusion, occurs without the use of energy. The other processes require ATP to be used.
<b>6</b>	<b>D</b>	Introns splicing occurs after transcription. Options A and B occur during translation. Enzymes can fold the polypeptide to determine the

		final shape of the protein – the only option that occurs after translation has concluded.
<b>7</b>	<b>A</b>	Adenine pairs with uracil. It can't be thymine as it is DNA not RNA. Cytosine and guanine pair with each other and are not correct answers.
<b>8</b>	<b>B</b>	Water is an output. Energy (ATP) is required. Co-enzyme A is required for Krebs cycle. The products are what can be produced.
<b>9</b>	<b>D</b>	Cytokines are a type of signalling molecule. Hormones could be endocrine or paracrine. Neurotransmitters are released by nerve cells and a variety of animals are capable of releasing pheromones (although insects certainly do, they are not the 'only' organisms).
<b>10</b>	<b>A</b>	The diagram indicates the order of amino acids. The polypeptide has not formed any bonds to form any higher level structure.
<b>11</b>	<b>D</b>	Light, carbon dioxide concentration and correct temperature are all required for an optimal photosynthesis rate. Glucose is the final product of photosynthesis.
<b>12</b>	<b>C</b>	NADP is the carrier molecule not NAD. ATP is produced in the light-dependent stage to be used by the light-independent stage to produce glucose.
<b>13</b>	<b>C</b>	EPSPS is an enzyme that catalyses the conversion of shikimate-3-phosphagte into the aromatic amino acid products.
<b>14</b>	<b>A</b>	The original substrate is sugar, which would have been formed through photosynthesis which involves a condensation reaction.
<b>15</b>	<b>C</b>	Glycolysis occurs in the cytosol. Krebs occurs in the matrix of the mitochondria. Fermentation also occurs in the cytosol.
<b>16</b>	<b>A</b>	Auxin accumulates on the shaded side of the plant to cause elongation and therefore growth towards the light source.
<b>17</b>	<b>C</b>	The mast cells can't produce antibodies. They need to package histamine into vesicles for degranulation and therefore require large number of Golgi apparatus. The release of histamine can increase inflammation.

<b>18</b>	<b>B</b>	Monoclonal antibodies can deliver a drug or radioactive isotope to a target cancer cell to kill it. They can't prevent cancer from starting, and cytotoxic T-cells kill virus infected cells and can induce apoptosis.
<b>19</b>	<b>C</b>	Natural as it does not require any human intervention using technology to occur, and passive as no B memory cells are produced.
<b>20</b>	<b>B</b>	The disease would likely be multiple sclerosis where the body's immune system attacks the myelin on its own nerve cells.
<b>21</b>	<b>B</b>	Biogeography is the study of the geographical distribution of species
<b>22</b>	<b>D</b>	Domestic dog breeds as shown in the image are a result of artificial selection, not natural selection. Allopatric speciation or a population bottleneck has not occurred
<b>23</b>	<b>D</b>	Mutations have contributed to the variation, which humans have then selected for. Human manipulation, not selection pressures, has been the contributing factor to the variation seen in domestic dog breeds.
<b>24</b>	<b>C</b>	This is the only possible mRNA sequence that could code for the given amino acid sequence.
<b>25</b>	<b>A</b>	<p>A deletion would result in a frameshift mutation, changing the amino acid sequence downstream of the change, i.e. from the 3<sup>rd</sup> amino acid. The answer cannot be B because the change to amino acid is before the 7<sup>th</sup> nucleotide. A change to the first nucleotide in any codon resulting in -arg- will not result in a STOP codon, therefore C is not possible. D could only occur if it was a silent mutation, as there has been no change to the amino acid sequence.</p> <p>The new code becomes</p> <p>New code: UGC AGU GGG GUC AGG CU  Amino Acids: Cys - Ser - Gly - Val - Arg -</p>
<b>26</b>	<b>A</b>	A change to either of the cysteine codons to substitute an A as the 3 <sup>rd</sup> base will result in UGA and code for a STOP codon, which is a nonsense mutation.

<b>27</b>	<b>D</b>	A decrease in the population size would reduce the gene pool. Gene flow and migration would most likely increase the genetic diversity. The question refers to the populations of cheetahs in Africa, therefore not the founder effect.
<b>28</b>	<b>B</b>	Poaching by humans was the most likely cause of the reduced population size of cheetahs in Africa.
<b>29</b>	<b>B</b>	Cockroaches and termites share the most recent common ancestor compared to the other options as they have diverged most recently.

<b>30</b>	<b>A</b>	DNA-DNA hybridisation measures the relatedness between species by heating and combing their DNA samples and, measuring the temperature of separation of the hybrid DNA.
<b>31</b>	<b>C</b>	BMP4 is a protein produced that controls cartilage development in cichlids. BMP4 is the product of the BMP4 gene, therefore, A and B are incorrect.
<b>32</b>	<b>B</b>	The placement of <i>Homo</i> species on the evolutionary tree is challenged by and interpreted differently by scientists. New fossils/evidence are reasons for this.
<b>33</b>	<b>D</b>	Endonucleases (restriction enzymes) are specific and recognise specific sequences in DNA.
<b>34</b>	<b>D</b>	Plasmids can act as a vector to transport DNA into a cell.
<b>35</b>	<b>C</b>	The EcoR1 cutting site occurs within the gene for tetracycline resistance, cutting at this site will reduce tetracycline resistance.
<b>36</b>	<b>D</b>	The question refers to testing of newborn babies. Families can make lifestyle changes such as diet of the baby as it gets older, to assist in management of genetic disorders.
<b>37</b>	<b>C</b>	Rational drug design involves the development of a drug that is complementary in shape to part of a pathogen so as to prevent it from causing disease.
<b>38</b>	<b>A</b>	Influenza is a virus and is shown to affect a large number of countries, therefore it is a pandemic.

<b>39</b>	<b>C</b>	Golden rice has been genetically modified to incorporate a gene from two other species, making it both GM and transgenic.
<b>40</b>	<b>A</b>	Poorer farmers who may not be able to afford the golden rice seeds may be adversely affected by their inability to access this crop. The other responses are biological or ethical considerations.

**SECTION B: Short Answer****Question 1** (4 marks)

a. 1 mark for each two correctly labelled answers

- *Process Y: exocytosis*
- *Process Z: Signal transduction*
- *Structure A: Vesicle (containing proteins)*
- *Structure B: Golgi Apparatus or Golgi complex.*

b. *The signalling molecule through activating **secondary messenger molecules** (1 mark) is able to cause the **response** within the cell of exocytosis of the proteins (1 mark).*

**Question 2** (11 marks)

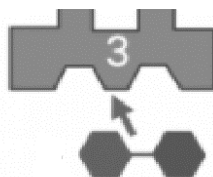
a.

Name	DNA, RNA or Protein	Function
1. <i>LacI OR regulatory Gene</i>	<i>DNA</i>	<i>Contains the DNA coded instruction for making the repressor protein</i>
2. <i>Messenger RNA</i>	<i>RNA</i>	<i>Carries the coded instruction to the ribosome to be turned into a protein</i>
3. <i>Repressor Protein</i>	<i>Protein</i>	<i>To control the expression of the Lac Operon structural genes.</i>

1 mark for each 3 correct responses.

(9 correct = 3 marks, 6-8 correct = 2 marks, 3-5 correct = 1 mark, 0-2 correct = 0 marks)

b. *Example shape or other acceptable shape that can bind to the repressor protein (1 mark).*



c. 1 mark each for any two of the following

- *Lactose is present*
- *RNA polymerase is present*
- *DNA Helicase is present*

- d. *Lactose/Allolactose would bind to the repressor protein (1 mark). This would cause the repressor protein to change shape and detach from the operator/no longer bind to the operator (1 mark).*
- e. 1 mark each for any three of the following
- *Messenger RNA is read by the ribosome*
  - *tRNA picks up a specific amino acid and carries it to the ribosome*
  - *Anticodon on tRNA binds to a complementary codon on mRNA*
  - *Amino acids are joined in a condensation reaction.*

### Question 3 (6 marks)

- a. *At 180°C the Tma DNA polymerase would denature and undergo a permanent change in shape, reducing the rate of reaction (1 mark). At 0°C the Tma DNA polymerase would not change shape, but move slower resulting in fewer enzyme-substrate collisions, reducing the rate of reaction (1mark).*

b.

Inputs	Outputs
<i>Glucose</i> $C_6H_{12}O_6$ <i>ADP+Pi</i>	<i>Carbon dioxide</i> / $CO_2$ <i>Alcohol/ethanol</i> / $C_2H_5OH$ <i>ATP</i>

1 mark per two correct responses.

- c. 1 mark for each correct piece of evidence, must be compared to bacteria.

*E.g. Mitochondria are a similar size/have a similar membrane structure/divide in a fission like process/have their own ribosomes/have their own DNA, LIKE bacteria.*

### Question 4 (11 marks)

- a. *Proteins (1 mark).*
- b. *Alternative splicing or Exon juggling (1 mark) PLUS one mark for any correct descriptive option*  
*E.g.*
- *where the exons can be rearranged in different orders / or not included;*
  - *poly A tail placed in different position;*
  - *other suitable definition of alternative splicing.*

c. I mark each for correctly showing the following four

- I. Correct exons in labelled membrane bound (no introns)
- II. Correct exon arrangement in labelled bloodstream antibody
- III. 5' Cap labelled
- IV. Poly A tail.

Please note: Exons can be drawn juggled in different orders.



- d. The bloodstream antibody would be hydrophilic (1 mark) as it needs to travel around in the bloodstream to find target antigens (1 mark).
- e. Naïve B cells would produce membrane bound antibodies (1 mark) as they need to have them attached to their membrane surface for clonal selection (1 mark).

### Question 5 (9 marks)

- a. Interferon will increase the resistance of surrounding cells to RSV viral infection (1 mark).
- b. When the majority of a population are vaccinated/immune, there are less hosts for viral replication (1 mark), reducing the risk of spreading RSV to vulnerable newborn babies who are at greater risk (1 mark).
- c. 1 mark each for any two of the following OR any two suitable examples
  - Washing hands often with soap.
  - Avoiding contact with sick people.
  - Staying home during outbreaks.
  - Avoiding touching face with unwashed hands.
  - Limiting time at childcare.
- d. The viral load increases, and then decreases as CD4<sup>+</sup> T cells increase in days 1-8 (1 mark).  
The viral load is reduced and the number of CD4<sup>+</sup> T cells reduces from days 8 to 40 (1 mark).



e. 1 mark each for any two of the following

- *Caspases are activated*
- *Cytoskeleton is cleaved*
- *Cell shrinks*
- *Blebbing*
- *Cell breaks into apoptotic bodies and phagocytes are signalled*

**Question 6** (8 marks)

a. 1 mark each for any two of the following

- *Food spoilage AND if living bacteria are present in food eg milk pasteurisation.*
- *Bacterial infections AND detect if pathogenic bacteria are still alive and able to cause disease.*
- *Any other acceptable answer, but must reference the ability of the bacteria to be alive.*

b. *That Ethidium monoazide has a complementary shape to the DNA*(1 mark). *It also must be hydrophobic/lipophilic as it can cross the nuclear membrane* (1 mark).

c. 1 mark each for any two of the following

- *separate double stranded DNA BY HEATING TO 94 DEG*
- *Bind primers (cool to 55 DEG)*
- *polymerase joins in complementary nucleotides, 5' to 3' direction*

d.

DNA Sample	Fragments of DNA present at end of PCR
Living E.coli sample of single-stranded DNA	16
Dead E.coli sample of double-stranded DNA	None
Living E.coli sample of single-stranded DNA	16
Dead E.coli sample of double-stranded DNA	32

1 mark for each 2 correct answers.

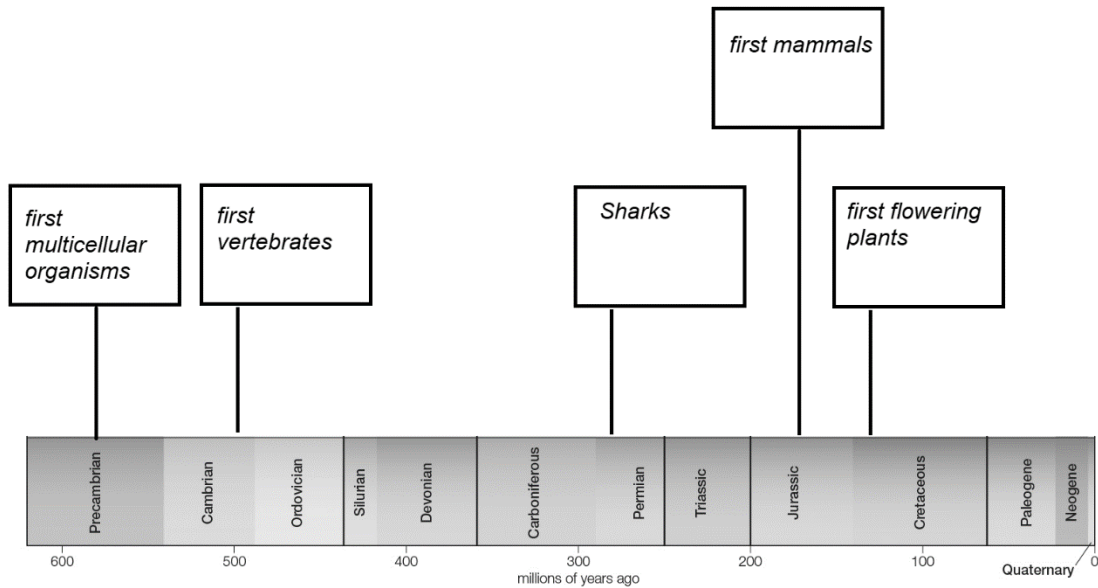
**Question 7** (8 marks)

**a.** 1 mark each for any two of the following:

- *Cartilage doesn't fossilise as readily as bones/teeth.*
- *The action of the water disturbs the remains.*
- *Unlikely to be rapidly buried.*
- *Presence of scavengers.*

**b.** *Potassium argon dating, AND the remains are millions of years old (1 mark) AND carbon dating could not be used as no carbon would be present (1 mark).*

c.



1 mark for 3 correctly placed groups, 2 marks for 4-5 correctly placed groups.

- d. *This is an example of convergent evolution AND the organisms do not share a recent common ancestor (1 mark).*  
*The similarities have occurred as a result of similar selection pressures (1 mark).*

**Question 8 (4 marks)**

- a. *Molecular homology (1 mark).*
- b. 1 mark each for any three plausible suggestions.

*E.g. Variation existed within the penguin population with the oxygen carrying ability due to the haemoglobin molecule (1 mark). Selection pressures favoured the penguins that were able to dive for longer, as they were able to feed more successfully (1 mark). Over time, penguins that were able to dive for longer due to the haemoglobin molecule survived, reproduced, and passed on more of these alleles to the next generations (1 mark).*

**Question 9** (5 marks)

- a. *Species Z is a primate, as it shares the least/only 2 bands with Species A* (1 mark).  
*Species Y is a hominin as it share the most/4 bands with species A* (1 mark).  
*Species X is a hominoid as it shares less bands than Y but more than X/3 bands with species A* (1 mark).
- b. 1 mark each for any two of the following

*The skull of species A would have*

- *less prominent brow ridge.*
- *less protruding jaw.*
- *larger brain case.*
- *more U shaped/parabolic jaw.*
- *less prominent zygomatic arches.*
- *teeth more similar in size.*

**Question 10** (3 marks)

Cultural evolution	Biological evolution
<i>Tattoos</i>	<i>Fine motor skills/precision grip to manipulate tools to create tattoos.</i>
<i>Presence of tools such as daggers and an axe.</i>	<i>Larger brain capacity allowed for the use of tools.</i>
<i>Modified metal items with heat.</i>	<i>Larger brain/braincase allowed the controlled use of heat/fire to construct tools.</i>
<i>Backpack, shoes, clothing.</i>	<i>Larger brain/Fine motor skills/precision grip to manipulate tools to create clothing.</i>
<i>Bone needle/medical kit</i>	<i>Larger brain to learn/comprehend medicine.</i>
<i>Use of animal items to create tools, clothing.</i>	<i>Larger brain/Fine motor skills/precision grip to manipulate tools to create clothing.</i>

1 mark for each example of cultural evolution and relevant explanation of biological evolution.

Note: explanations of biological evolution can be used to explain various example of cultural evolution. Each explanation must be suitably different from the others.

**Question 11** (11 marks)

a. 1 mark for each of the correct results listed below.

- *Elodea must be present to form bubbles.*
- *Higher bicarbonate means more bubbles.*
- *No bicarbonate produces a low number of bubbles.*
- *Number of bubbles relates to amount of photosynthesis.*

b. *Oxygen* (1 mark).

c. *Qualitative is a descriptive measure* (1 mark).

AND

1 mark for any one of the following

- *pH could be measured by determining colour.*
  - *Size of bubbles.*
  - *Change in colour of the elodea.*
  - *Any other suitable answer*
- d. *Random errors like differences in plant tissues OR Differences in measuring the bicarbonate/water/length of elodea* (1 mark). *A random error could reduce the precision of the results OR could cause repeated results to be different to each other (decreasing precision)* (1 mark).
- e. 1 mark each for any two of the following:
- *Lab coat/Goggles/Gloves*
  - *Correct disposal of biological matter.*
  - *Guards for scalpels*