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# BIOLOGY
# Units 3 & 4
# Trial Examination

## SOLUTIONS BOOK

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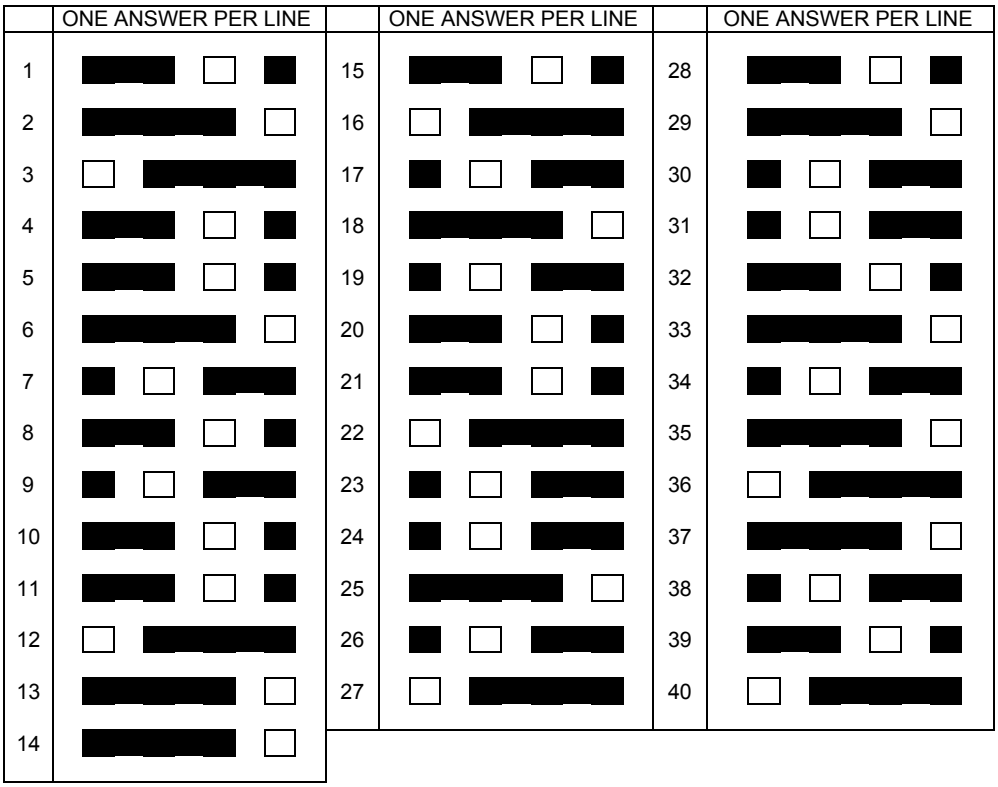
Use this page as an overlay for marking the multiple choice answer sheets. Simply photocopy the page onto an overhead projector sheet. The correct answers are open boxes below. Students should have shaded their answers. Therefore, any open box with shading inside it is correct and scores 1 mark.



***TEACHERS, PLEASE NOTE:***

*In marking the Exam, teachers should keep in mind that the language used in the suggested answers is sometimes more sophisticated than a student would offer, since these answers are written for teachers' information in their correction of the Exam.*

*The answers suggested here might not be the only correct responses possible. Teachers must use their professional judgement in awarding marks for other answers offered. However, in accordance with the VCAA practice, students who give a correct response, and then offer a contradictory incorrect response within the same part of the question, should* ***not*** *be awarded any marks for the correct part of the response. Also in accordance with the VCAA practice, no half marks should be given.*

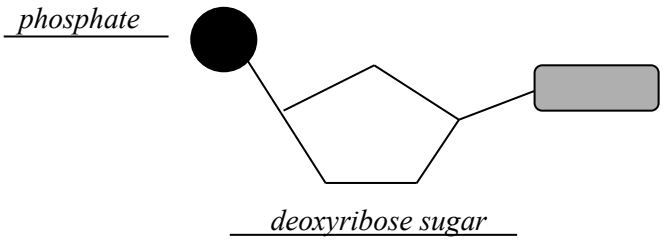
## *SECTION A – MULTIPLE CHOICE QUESTIONS (1 mark each: 40 marks)*

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

## *SECTION B – WRITTEN RESPONSES*

***Question 1***

***a***




***All three labels correct for one mark*** *1 mark*

***b*** *The sugar in RNA is ribose sugar and in DNA is deoxyribose sugar (1)*
*Either: The nitrogenous base uracil can be present in RNA but not in DNA (1)* ***or***
*The nitrogenous base thymine can be present in DNA but not in RNA (1).* *2 marks*

***c***

| Nitrogenous base | T | U | A | G | C |
|---|---|---|---|---|---|
| DNA strand 1 | 23.5 | 0 | 18.5 | 32.7 | 25.3 |
| DNA strand 2 | 18.4 | 0 | 23.6 | 25.6 | 32.4 |
| Primary mRNA | ***0*** | ***23.9*** | 18.6 | 32.2 | 25.3 |

***Both correct for 1 mark*** *1 mark*

***d*** *The template strand is the DNA strand that is copied to form RNA according to base pairing therefore the percentage of adenine in the DNA would approximate to the percentage of its base pair uracil and guanine in DNA and would be approximately the same percentage as guanine (1). This would make strand 2 the template strand (1).* *2 marks*

***Total Question 1: 6 marks***

***Question 2***

***a*** *If the concentration of $NaHCO_3$ is increased then the rate of photosynthesis (as shown by a higher $\frac{1}{ET_{50}}$ value) will increase because the $NaHCO_3$ is needed as a substrate for photosynthesis.* *1 mark*

***b*** *independent variable: the concentration of $NaHCO_3$ (1)*
*dependent variable: time taken for 50% of the leaves to float or $ET_{50}$ (1)* *2 marks*

***c*** *oxygen* *1 mark*

***d*** *Temperature must be kept constant (1). The higher the temperature the faster the rate of photosynthesis due to more kinetic energy available to the molecules (1).*
***Or***
*The light intensity needed to be kept the same (1) as increased light intensity will increase the rate of photosynthesis (1).* *2 marks*

***e*** *Any two of the following for one mark each:*
- *leaf discs were not the same size (1)*
- *leaf discs may be different ages (1)*
- *amount of chlorophyll may differ in the discs (1)*
- *accuracy in preparing $NaHCO_3$ (1)*
- *not all the gas was removed from leaf discs equally (1)* *2 marks*

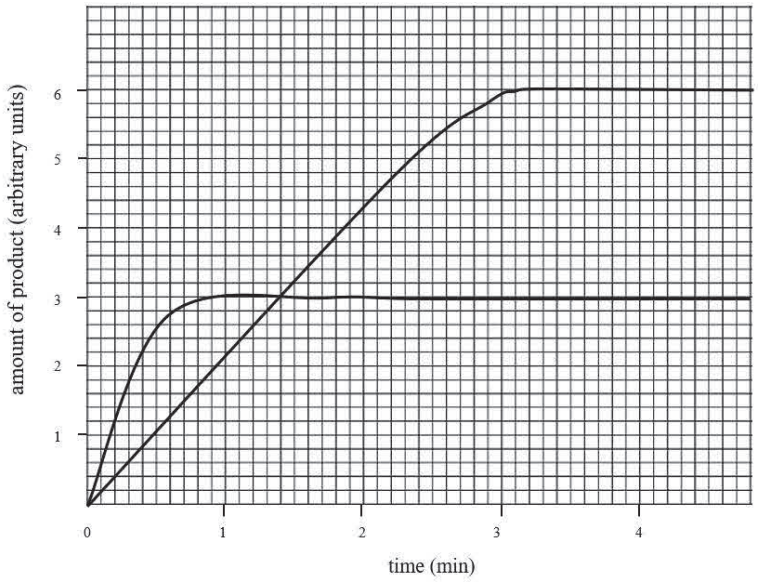
***f*** *Repeating the experiment two or more times or increasing the sample size. The more similar repeated measurements are, the more reliable the results.* *1 mark*

***g*** *The results show that the higher the concentration of $NaHCO_3$ the shorter the time needed for half the discs to rise, the $ET_{50}$, value due to more oxygen produced (1). The higher the rate of oxygen production the higher the rate of photosynthesis (1). Therefore the higher the concentration of $NaHCO_3$ the higher the rate of photosynthesis.* *2 marks*

***Total Question 2: 11 marks***

***Question 3***

***a***




***One mark for showing a slower rate of reaction***
***One mark for showing double the amount of product*** *2 marks*

***b*** *At the lower temperature of 15°C there will be fewer effective collisions between the substrate and the enzyme and therefore a slower rate of reaction (1).*
*The amount of product formed will be double the amount of product formed in the first experiment as the amount of substrate is double (1).* *2 marks*

***Total Question 3: 4 marks***

## *Question 4*

***a*** *hormone* *1 mark*

***b*** *Epinephrine is a hydrophilic molecule as it attaches to its receptor on the cell membrane because it is unable to cross the cell membrane.* *1 mark*

***c*** *second messenger* *1 mark*

***d*** *Second messengers such as cAMP activate cellular enzymes resulting in a cascade of reactions that further amplify the signal.* *1 mark*

***e*** *The response activates the enzyme glycogen phosphorylase that converts stores of glycogen to glucose (1). This means that the muscle has a ready supply of glucose for cellular respiration giving it ATP to readily contract (1).* *2 marks*

***f*** *The receptors in the different tissue cells are the same but the secondary messengers may be different and therefore result in a different response.* *1 mark*

***Total Question 4: 7 marks***

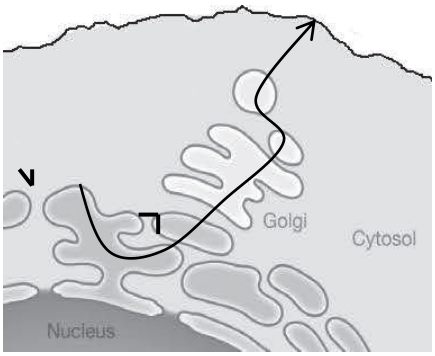
## *Question 5*

***a*** *Any two of the following for one mark each:*
- *the introns are removed and the exons are joined together (1)*
- *a methyl cap is added (1)*
- *a poly A tail is added (1)* *2 marks*

***b*** *The lipid coating helps to protect the mRNA from enzymes or external factors that might attack it (1). The coating, being lipid, enables the particle to cross the lipid membrane and enter the cell (1).* *2 marks*

***c*** *The mRNA moves to the ribosomes on the endoplasmic reticulum and the ribosomes read the mRNA code (1). tRNA anticodons attach to the mRNA codons according to base pairing rules (1). The different amino acids carried by the different tRNAs become attached to each other to form a polypeptide that folds to form the spike protein (1).* *3 marks*

***d***




***line & arrow must be from the endoplasmic reticulum through the golgi to the membrane*** *1 mark*

***e*** *Any one of the following for one mark:*
- *mRNA can be prepared more quickly than attenuated virus vaccines (1).*
- *mRNA vaccines do not use living viruses so there is no danger of any weakened virus mutating to become pathogenic (1).* *1 mark*

***f*** *When a vaccine is given, as well as an immediate response of producing the appropriate antibodies, B and T memory cells are also produced (1). These B or T memory cells are able to be activated in the future should the same infectious agent or pathogen enter the body. Thus long term immunity is established (1).* *2 marks*

***Total Question 5: 11 marks***

***Question 6***

***a*** *G–C complementary nucleotides have three hydrogen bonds compared to two hydrogen bonds for A–T complementary nucleotides. Therefore more G–C bonds means greater temperatures to separate them.* *1 mark*

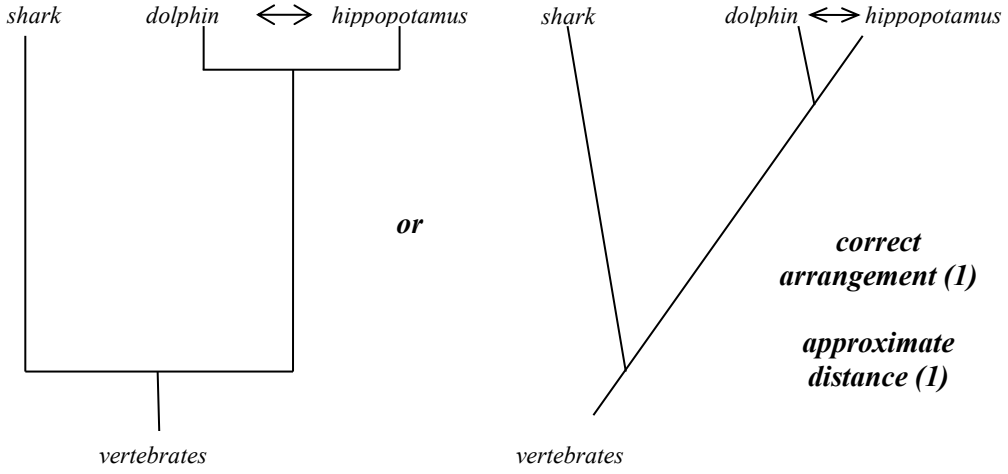
***b*** *DNA is extracted from the cells of the different species and is heated to separate the strands (1). The single stranded DNA from the two species is mixed together and allowed to cool. The DNA from the two species will hybridise according to their complementary bases by forming hydrogen bonds (1). The hybrid DNA is reheated and the temperature at which 50% of the hybrid DNA becomes single stranded is observed ($T_m$) and the higher the temperature the closer the evolutionary relationship (1).* *3 marks*

***c*** *From the graph of hybrid DNA of species 1 and 2 the $T_m$ is about 70°C, whereas the $T_m$ for species 1 and 3 is about 77°C (1). The higher the $T_m$ the more hydrogen bonds have formed between the hybrid DNA due to their increased similarity making species 3 more closely related to species 1 than species 2 is to species 1 (1).* *2 marks*

***Total Question 6: 6 marks***

***Question 7***

***a***




*2 marks*

***b*** *The dolphin and the hippopotamus are the most closely related belonging to the class Mammalia (1). They look completely different due to divergent evolution (1) where selection pressures in their different environments have resulted in adaptive radiation.* *2 marks*

***c*** *The shark and the dolphin look alike because they occupy the same environment and have been subjected to similar selective pressures (1). They do not share a recent common ancestor and this type of evolution is convergent evolution (1).* *2 marks*

***Total Question 7: 6 marks***

***Question 8***

***a*** *Aneuploidy is a chromosome number that differs from the normal number in this case 46 by having more or fewer (1). This usually results in the embryo being incapable of survival in most cases or showing abnormal development (1).* *2 marks*

***b*** *As aneuploidy is the incorrect number of chromosomes it cannot be corrected by a test such as PGT-A, it can only be detected.* *1 mark*

***c*** *No it is not 100% accurate as some mosaic embryos result in live births.* *1 mark*

***d*** *social implication: Any one of the following for one mark:*

- *the extra cost for the test may not result in a live birth (1)*
- *psychological stress for the parents (1)*
- *should the test be paid for by the government? (1)*

*ethical implication: Any one of the following for one mark:*

- *discarding of live mosaic embryos that could result in live births (1)*
- *identification of the parent group that would benefit the most from the extra test (1)* *2 marks*

***Total Question 8: 6 marks***

***Question 9***

***a*** *A master regulatory gene controls the transcription of other genes involved in embryonic development by regulating the amount of gene product those genes produce.* *1 mark*

***b*** *Mutations would have occurred in the BMP4 gene resulting in variations in the amount of gene product (1). Mutations that resulted in high levels of BMP4 would have influenced structural genes that result in biting jaws and mutations that resulted in low levels would have resulted in suction jaws. This would have resulted in a variety of jaw phenotypes (1). Those fish showing appropriate phenotypes for their environment would have been selected for passing that characteristic down to following generations so it became more frequent in the population (1).* *3 marks*

***Total Question 9: 4 marks***

***Question 10***

***a*** *A transcription factor is a protein that helps to activate or repress specific genes by binding to upstream DNA.* *1 mark*

***b*** *The tTAV protein binds to various transcription factors so that cellular genes that are essential for the development of the larvae are not expressed (1). Without these essential genes being expressed the mosquito larvae die before becoming adults (1).* *2 marks*

***c*** *The tetracycline, when present, binds to the tTAV protein and prevents it from binding to the transcription factors enabling them to activate genes that are essential for mosquito development.* *1 mark*

***d*** *As these male mosquitoes contain a modified gene from another living organism (the bacteria E. coli) they are therefore classed as transgenic (1). They are also genetically modified as their DNA has been changed by the insertion of another gene into their genome (1).* *2 marks*

***e*** *Only GM male mosquitoes were released because males do not bite humans or other animals so they cannot spread dengue fever.* *1 mark*

***f*** *The eggs produced from mating with the GM males fail to develop without the presence of tetracycline (1). This will mean a reduction in the size of the mosquito population resulting in fewer mosquitoes carrying the dengue fever virus and hence a reduction in the incidence of dengue fever (1).* *2 marks*

***g*** *Any two of the following for one mark each:*

- *GM mosquitoes may carry or have the ability to carry unknown pathogens (1).*
- *Not enough testing of GM mosquitoes to know long term outcomes (1).*
- *GM mosquitoes may undergo mutations that would make the inserted gene ineffective (1).*
- *Environmental risks are unknown with the introduction of GM mosquitoes (1).*
- *The effect on food chains involving GM mosquitoes (1).* *2 marks*

***Total Question 10: 11 marks***

***Question 11***

***a*** *Each of the different restriction endonucleases cut at specific bases along the double stranded DNA molecule, whereas gRNA/ Cas9 can cut the DNA at any point that the gRNA is designed to match.* *1 mark*

***b*** *gRNA is able to identify a specific location on the host DNA because it its designed so that its bases are complementary to the section of DNA that is being targeted and it will attach there.* *1 mark*

***c*** *In ex vivo gene editing the cells that have been edited can be selected and returned to the patient, whereas in vivo editing will result in only some cells being edited and it is not known how many.* *1 mark*

***d*** *Any one of the following for one mark:*

- *The CRISPR/Cas9 may miss its target and cut another gene with similar sequences to the gene being targeted (1).*
- *The CRISPR/Cas9 could remain in the cells for years after administering it and be triggered later to become active (1).*
- *The CRISPR/Cas9 may not affect the gene or the DNA may be repaired without a change (1).* *1 mark*

***Total Question 11: 4 marks***

***Question 12***

***a*** *Scientists studied the shape of the active site on the neuraminidase enzyme and designed a drug that was complementary to that site.* *1 mark*

***b*** *Administration of this drug leads to the blocking of the active site of the enzyme stopping its function which is to release the virus particle from the cell (1). The virus particles are not able to infect other cells to reproduce and so the symptoms of the infection are reduced (1).* *2 marks*

***c*** *The virus could mutate at the active site of the enzyme neuraminidase preventing Relenza from binding and therefore making it ineffective.* *1 mark*

***Total Question 12: 4 marks***

***Total Section B: 80 marks***

***Total Trial examination: 120 marks***

**END OF SUGGESTED SOLUTIONS**