Neap

Trial Examination 2023

VCE Biology Unit 3

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of booklet

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	25	25	25
B	6	6	50
			Total 75

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers.

Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

No calculator is allowed in this examination.

Materials supplied

Question and answer booklet of 24 pages

Answer sheet for multiple-choice questions

Additional space is available at the end of the booklet if you need extra paper to complete an answer.

Instructions

Write your **name** and your **teacher's name** in the space provided above on this page, and on the answer sheet for multiple-choice questions.

Unless otherwise indicated, diagrams in this booklet are **not** drawn to scale.

All written responses must be in English.

At the end of the examination

Place the answer sheet for multiple-choice questions inside the front cover of this booklet.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2023 VCE Biology Units 3&4 Written Examination.

SECTION A – MULTIPLE-CHOICE QUESTIONS

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** or that **best answers** the question.
A correct answer scores 1; an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.
Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Question 1

The monomers that make up proteins are known as

A. amino acids.
B. nucleotides.
C. R groups.
D. nitrogenous bases.

Question 2

Which molecule(s) are involved in translation?

A. mRNA only
B. tRNA only
C. rRNA only
D. mRNA, tRNA and rRNA

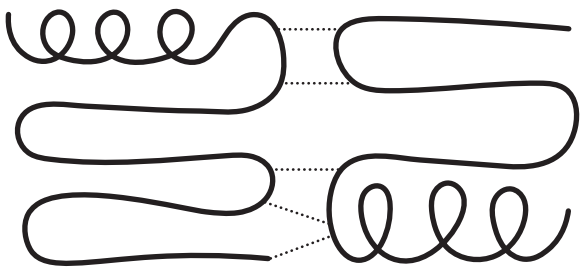
Question 3

Which one of the following correctly compares DNA and RNA?

	DNA	RNA
A.	contains deoxyribose	contains ribose
B.	is a shorter molecule	is a longer molecule
C.	found only in the nucleus in eukaryotes	found in the nucleus and a variety of cytoplasmic locations in eukaryotes
D.	contains four different monomers	contains five different monomers

Question 4

The diagram below shows a functional enzyme.



What is the enzyme's level of arrangement?

A. primary

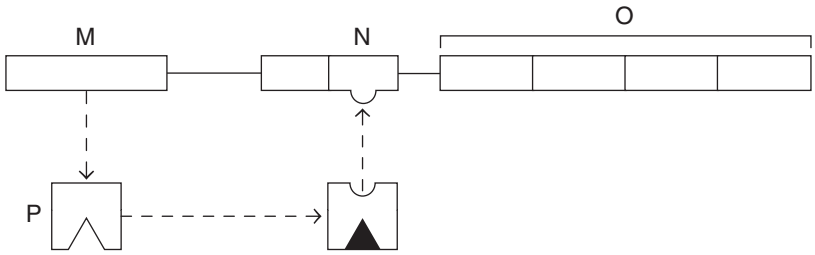
B. secondary

C. tertiary

D. quaternary

Use the following information to answer Questions 5 and 6.

The diagram below shows the process of gene regulation in the *trp* operon. Structures M–P are involved in the process.



Question 5

Which one of the following identifies structures M–P?

	Structure M	Structure N	Structure O	Structure P
A.	regulatory gene	operator	repressor	structural genes
B.	structural genes	promoter	structural genes	repressor
C.	structural genes	promoter	structural genes	operator
D.	regulatory gene	operator	structural genes	repressor

Question 6

When there is a high concentration of tryptophan,

A. structure P will change shape and bind to structure N, which stops gene expression.

B. structure N will change shape to conform with the tryptophan, preventing the RNA polymerase from moving past structure N.

C. structure M will be prevented from producing structure P.

D. structure N will change shape to conform with the tryptophan, preventing structure P from binding to it.

Question 7

Which one of the following is the specific study of the structure of proteins and their interactions within a cell?

A. biotechnology

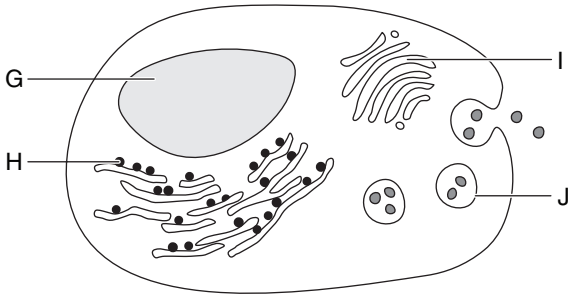
B. proteomics

C. genomics

D. biochemistry

Question 8

The diagram below represents a cell secreting a protein into the extracellular environment. Structures G–J are part of this process.



In which order are structures G–J involved in the secretion of proteins?

A. G, H, I, J

B. J, I, H, G

C. H, J, G, I

D. I, G, J, H

Question 9

One method of biotechnology uses a particular enzyme to break the phosphodiester bonds holding nucleotides together in a single polynucleotide chain.

This enzyme is called

A. ligase.

B. polymerase.

C. endonuclease.

D. reverse transcriptase.

Question 10

Which one of the following statements about polymerase chain reaction (PCR) is correct?

A. The denaturation stage is carried out at 60°C and breaks the hydrogen bonds to form DNA strands that are complementary to the template strand.

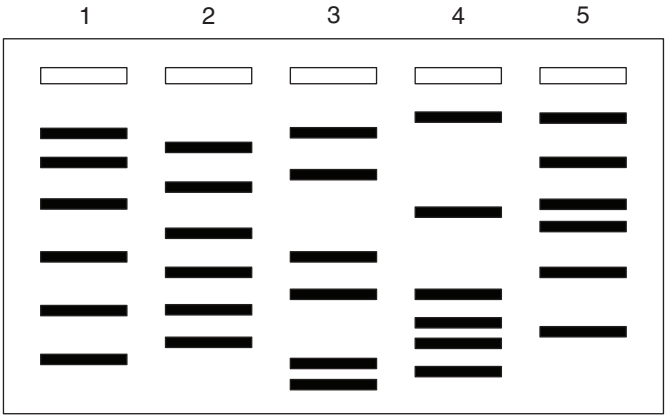
B. The denaturation stage occurs after the extension stage.

C. The annealing stage is carried out at 95°C and enables primers to join with complementary sequences on either side of the target section of DNA.

D. The extension stage is carried out at 72°C and allows the *taq* polymerase to bind to the primers and form DNA strands that are complementary to the template strand.

Use the following information to answer Questions 11 and 12.

Some gene loci vary considerably between individuals. To study this variation, three gene loci were amplified from five individuals to determine who amongst the individuals were most closely related. The gene loci vary in length and nucleotide sequence. Each individual has two copies of each gene locus in their body cells. The gel electrophoresis profiles of individuals 1–5 are illustrated in the diagram below.



Question 11

The smallest DNA fragment in the gel belongs to individual

A. 1

B. 2

C. 3

D. 4

Question 12

Which one of the following conclusions could be drawn from the gel electrophoresis profiles?

A. Individual 5 is more closely related to individual 3 than individual 1.

B. Individual 1 could be a parent of individual 3.

C. Individuals 2 and 4 are the least related individuals.

D. Individuals 1 and 2 could be the parents of individual 4.

Question 13

Scientists are able to produce functional insulin in a bacterium using human DNA. Before being inserted into the bacterium, the human DNA is spliced into plasmids.

This DNA

A. can be formed by isolating mRNA and transcribing it into DNA.

B. is isolated from the nucleus of a human cell and inserted directly into the plasmid.

C. is spliced into a plasmid that has had all of its introns removed.

D. has blunt ends so it will join easily onto the plasmid.

Question 14

A recombinant plasmid with a gene of interest and an ampicillin-resistant gene was copied and inserted into several bacteria, which were then placed in a growth medium at 37°C for 24 hours. This insertion technique was only 10% successful.

Which one of the following methods would give the best chance of selecting the transformed bacteria?

A. growing the bacterium in a normal environment and placing 10% of the colonies in a different medium to continue growing

B. increasing the temperature of the growth medium to 45°C so the ampicillin-resistant bacteria are more likely to survive

C. growing the bacteria in a medium that contains ampicillin so only the transformed bacteria will grow

D. exposing the bacteria to heat shock or electroporation

Use the following information to answer Questions 15 and 16.

The reaction below shows the first step in the Krebs Cycle.

$$\text{acetyl CoA} + \text{oxaloacetate} \xrightarrow{\text{citrate synthase}} \text{citrate}$$

Question 15

The Krebs Cycle occurs in the

A. endoplasmic reticulum.

B. nucleus.

C. mitochondria.

D. Golgi apparatus.

Question 16

The acetyl CoA used in the first step of the Krebs Cycle is produced by glycolysis.

If less acetyl CoA is produced than usual, how is the chemical reaction affected?

A. Less citrate will be produced because there is a lower concentration of oxaloacetate to bind with acetyl CoA.

B. The same amount of citrate will be produced as there are still ample molecules of oxaloacetate available.

C. More citrate will be produced because the active site of citrate synthase is available for more reactions.

D. Less citrate will be produced because there is a lower concentration of acetyl CoA available to bind with oxaloacetate.

Question 17

Which one of the following statements about the lock-and-key model is correct?

A. The active site moulds around the substrate.

B. The shape of the substrate is complementary to the shape of the active site.

C. The enzyme looks for a substrate that it can lock onto.

D. The rate of reaction increases as the temperature the enzyme is exposed to increases.

Question 18

Relenza is an influenza antiviral that is a competitive inhibitor of the reaction between sialic acid and neuraminidase. This inhibition prevents the spread of the influenza virus by containing it in a cell.

Based on this information, it would be reasonable to conclude that

A. increasing the dose of Relenza would block more neuraminidase active sites, reducing the concentration of extracellular influenza virus particles.

B. a low dose of Relenza would be enough to treat influenza because all the neuraminidase active sites would be occupied.

C. competitive inhibition is always more effective than non-competitive inhibition, so Relenza is more effective in smaller doses than non-competitive antivirals.

D. Relenza and neuraminidase have the same three-dimensional shape.

Question 19

Two Biology students, Arun and Chanul, are discussing the effect of coloured lights on photosynthesis. Arun believes that green light increases the rate of photosynthesis because plant leaves are green and absorb the wavelengths of green light. Chanul believes that violet and red light increases the rate of photosynthesis because plant leaves absorb the wavelengths of both violet and red light.

Which student is correct?

A. Arun only

B. Chanul only

C. both Chanul and Arun

D. neither Chanul nor Arun

Question 20

Which one of the following is the location of the light dependent reaction of photosynthesis?

A. the matrix

B. the grana

C. the cytoplasm

D. the stroma

Question 21

Photorespiration is more likely to occur in a leaf when

A. the level of carbon dioxide is higher than the level of oxygen.

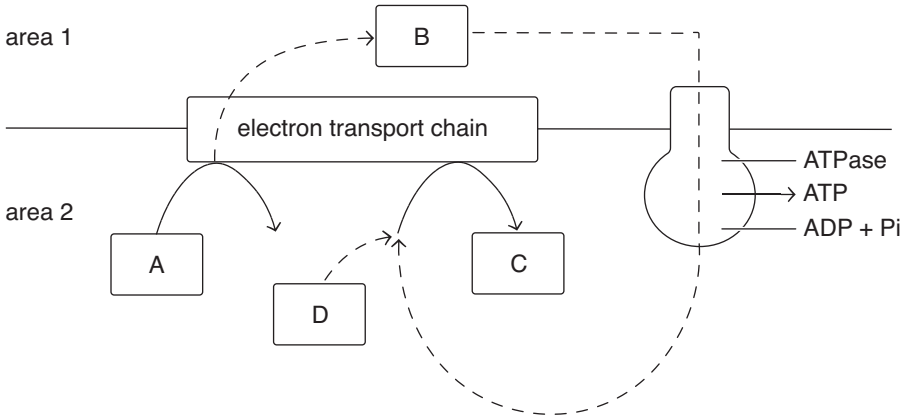
B. the level of oxygen is higher than the level of carbon dioxide.

C. there is a surplus of water and a lack of carbon dioxide.

D. the sun goes down and the stomata close.

Use the following information to answer Questions 22–24.

The diagram below shows a reaction that occurs in most eukaryotic cells. Chemicals A–D are involved in the process.



Question 22

Which one of the following identifies chemicals A–D?

	Chemical A	Chemical B	Chemical C	Chemical D
A.	NADPH	hydrogen	oxygen	water
B.	oxygen	NADH	water	hydrogen
C.	water	carbon dioxide	oxygen	hydrogen
D.	NADH	hydrogen	water	oxygen

Question 23

Which one of the following identifies area 1 and area 2?

	Area 1	Area 2
A.	cytosol	matrix
B.	intermembrane space	matrix
C.	nucleoplasm	cytoplasm
D.	matrix	intermembrane space

Question 24

Identify the ATP yield for the reaction depicted in the diagram.

A. 26 or 28

B. 30 or 32

C. 32 or 34

D. 36 or 38

Question 25

CRISPR-Cas9 technology has been used to improve the efficiency of photosynthesis in crop plants. There are two main methods that successfully change the genome of a plant.

- Method 1 aims to disable an undesired gene in a plant, which may lead to a commercial advantage.
- Method 2 aims to insert a gene into a plant without disrupting other genes.

Which one of the following assumptions could be made about methods 1 and 2?

A. Method 1 is easier than method 2 as it only involves cutting DNA, whereas method 2 involves both cutting and pasting DNA.

B. Method 2 is faster to complete than method 1.

C. Method 1 is easier than method 2 as it involves cutting RNA, which has only one nucleic acid strand, whereas method 2 involves cutting DNA, which has two nucleic acid strands.

D. Methods 1 and 2 are equally viable for future use, but CRISPR-Cas9 technology will never be widely implemented due to the ethical concept of non-maleficence.

END OF SECTION A

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Question 1 (12 marks)

The table below represents a small section of a DNA template sequence that is about to be transcribed.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A	**G**	**T**	**C**	**C**	**G**	**T**	**A**	**G**	**C**	**T**	**G**	**A**	**A**	**T**	**C**	**C**	**G**	**G**	**T**	**T**	**G**

a. Draw a diagram of the DNA molecule that includes the first four nucleotides from the table.

On your diagram, label the:

- phosphate, nitrogenous base and deoxyribose of the DNA molecule
- hydrogen bond(s). 4 marks

b. After transcription, the DNA template sequence is modified and then leaves the nucleus of a eukaryotic cell.

Identify **two** events that occur during the modification of the DNA template sequence. 2 marks

c. Nucleotides 9–15 are removed from the DNA template sequence prior to translation.

i. Determine the nucleotide sequence after this modification. 1 mark

ii. The table below lists codons and their corresponding amino acids.

First base	Second base: U	Second base: C	Second base: A	Second base: G	Third base
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	Stop	Stop	A
	Leu	Ser	Stop	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

Using the information in the table, determine the polypeptide sequence after translation. 1 mark

d. The polypeptide formed from the DNA template sequence is coded for by a single gene; however, there are multiple different polypeptides that can be coded for by this gene.

Identify and explain the process that allows this to occur. 2 marks

e. Describe the role of the following organelles when secreting the polypeptide from the cell.

i. rough endoplasmic reticulum 1 mark

ii. Golgi apparatus 1 mark

Question 2 (8 marks)
The CRISPR-Cas9 complex is a gene-editing technology used in a variety of contexts.

a. Describe the role of the CRISPR-Cas9 complex in a bacterium. 2 marks

b. Describe the function of a spacer in a bacterium. 1 mark

Recent clinical trials have used the CRISPR-Cas9 complex to treat sickle cell anaemia in adults. In the treatment, the bone marrow stem cells of an individual with sickle cell anaemia are extracted and mixed with a CRISPR-Cas9 complex that is designed to disrupt the adult haemoglobin gene. Once the gene is disrupted, the stem cells are placed back into the individual. The cells then differentiate and express foetal haemoglobin, which alleviates the symptoms of sickle cell anaemia.

c. Describe how a CRISPR-Cas9 complex could target and disrupt the adult haemoglobin gene. 3 marks

d. As CRISPR-Cas9 technology becomes increasingly common, questions have been raised about its use in medical treatments for babies. A survey consisting of five questions about the use of CRISPR-Cas9 technology in the treatment of babies is planned to assess the general public's opinion on the topic. The questions are shown in the table below.

Question number	Question
1	Do you think the technology will only be available to the wealthy?
2	Do you think the technology will be used by some in morally unacceptable ways?
3	Do you think the technology will be used before the health effects are fully understood?
4	Do you think the technology will lead to the development of other new medical advances?
5	Do you think the technology will help people live longer and better-quality lives?

Describe the ethical concept of beneficence and identify one question in the survey that refers to beneficence. 2 marks

Question 3 (8 marks)

The term 'genetically modified' refers to organisms that have had a gene or genes transferred from another organism using a series of techniques such as cloning, cutting and splicing DNA segments together, and inserting genes into cells.

The soil-dwelling bacterium *Agrobacterium tumefaciens* naturally transfers part of its DNA into plants. Genetic engineers use it as a vector to genetically modify crop plants such as cotton, corn and canola so that they are disease- and pesticide-resistant.

a. Explain how a gene of interest is spliced into a plasmid. 3 marks

Inserting recombinant plasmids into cells is an inefficient process, meaning that only a small percentage of cells will be transformed by the gene of interest. There are various strategies that can be used to identify transformed cells or tissues.

b. After a recombinant plasmid is inserted into *Agrobacterium tumefaciens*, how are the transformed bacteria selected? 3 marks

c. Once a genetically modified crop plant is developed, biotechnologists conduct a series of evaluations to determine that the gene of interest has been transferred successfully. The gene must be heritable, expressed successfully and not cause any negative effects in the plant. These evaluations are conducted in two stages: an initial controlled greenhouse environment and then a subsequent field environment.

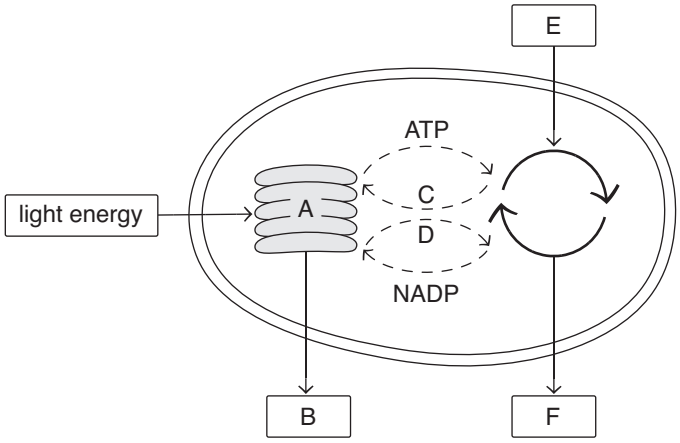
Field evaluations follow strict guidelines that include:

- isolating the genetically modified plants to avoid cross-pollination
- cleaning planting and harvesting machinery carefully
- closely monitoring crop growth
- observing the field for two seasons after the evaluation.

Explain what is meant by a consequences-based ethical approach and identify a situation where this approach has been implemented in the information provided. 2 marks

Question 4 (11 marks)

The diagram below summarises the main steps of photosynthesis in C_3 plants. Labels A–F represent structures or chemicals involved in the process.



a. Complete the table by naming components A–F. 4 marks

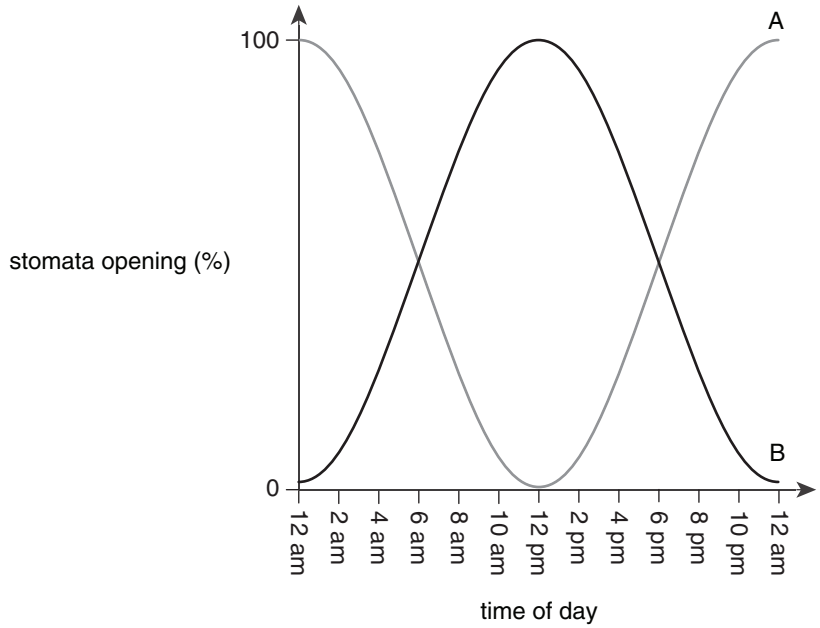
Component	Name
A	
B	
C	
D	
E	
F	

b. What is the function of Rubisco? 1 mark

c. Rubisco can undergo another process called photorespiration.

When is photorespiration most likely to occur? 2 marks

d. Plants have evolved various ways to reduce the rate of photorespiration. The diagram below shows the pattern of stomatal opening for two types of plants, A and B, over 24 hours.



i. The stomatal opening pattern of plant A suggests it is part of a group of plants that have evolved to reduce their rate of photorespiration.

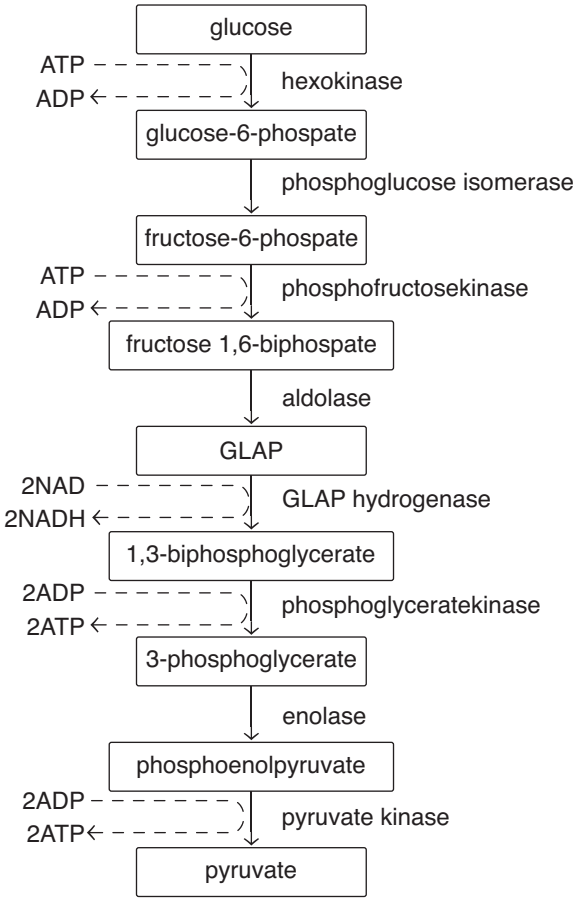
Name the group of plants and state the type of environment in which they are usually found. 2 marks

ii. Explain why a plant closing its stomata during the day would increase the rate of photorespiration. 1 mark

iii. Describe how the group of plants named in **part d.i.** reduce the rate of photorespiration. 1 mark

Question 5 (7 marks)

Glycolysis is a biochemical pathway that occurs in most cells. The steps involved in glycolysis are shown in the diagram below.



a. Using the diagram, state the outputs of glycolysis. 2 marks

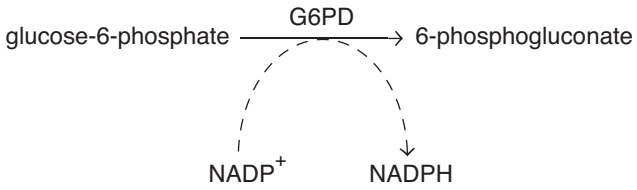
When glucose enters a cell, it is converted into glucose 6-phosphate by hexokinase. Glucose 6-phosphate is a key metabolic substrate because it lies at the intersection of several major metabolic pathways. It can enter glycolysis via phosphoglucose isomerase to provide cellular energy. Glucose 6-phosphate may also be metabolised by glucose 6-phosphate dehydrogenase (G6PD); it will then enter the pentose phosphate pathway (PPP) to increase the oxygen absorption of cells such as red blood cells. Finally, glucose 6-phosphate can be converted into glucose 1-phosphate by phosphoglucomutase, the first step in glycogen synthesis.

b. Identify **one** structural difference between the four enzymes mentioned in the information above and explain the importance of the structural difference. 2 marks

If the PPP is disrupted, it can result in haemolytic episodes and anaemia, which can be severe and, in some cases, fatal. Individuals who cannot synthesise enough G6PD have a condition called favism, which effects about 400 million people worldwide. Diagnostic tests for favism can be either quantitative or qualitative.

c. Describe the difference between a quantitative and qualitative test for a condition such as favism. 1 mark

d. One of the steps in the PPP is shown in the diagram below.



In the process of being diagnosed with favism, an individual is tested to determine the level of NADPH in their blood. A fluorescent spot test can be used to check for the presence of NADPH. An individual who does not have favism will produce a bright fluorescent spot when tested.

Explain why an individual who has favism would produce a different result to an individual who does not have favism. 2 marks

Question 6 (4 marks)

The emerging Australian biofuels industry hopes to use farming waste such as plant stubble for profit within the next decade. Bioethanol is a liquid fuel that is chemically derived from cellulose-rich plant stubble, making it economically attractive. Bioethanol burns much more cleanly than fossil fuels, which reduces pollution, and originates from renewable resources, which is a crucial factor for a sustainable future.

a. Bioethanol is one example of a biofuel.

Identify **one** other example of a biofuel. 1 mark

_____

b. How is bioethanol produced from cellulose-rich plant stubble? 2 marks

_____

_____

_____

_____

c. Explain why biofuels are regarded as renewable energy resources. 1 mark

_____

_____

END OF QUESTION AND ANSWER BOOKLET

Extra space for responses

Clearly number all responses in this space.

Neap

Trial Examination 2023

VCE Biology Unit 3

Written Examination

Multiple-choice Answer Sheet

Student's Name: _____

Teacher's Name: _____

Instructions

Use a **pencil** for **all** entries. If you make a mistake, **erase** the incorrect answer – **do not** cross it out. Marks will **not** be deducted for incorrect answers.
No mark will be given if more than **one** answer is completed for any question.

All answers must be completed like this example: **A** B C D

Use pencil only

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D

14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D
21	A	B	C	D
22	A	B	C	D
23	A	B	C	D
24	A	B	C	D
25	A	B	C	D

