Victorian Certificate of Education
2024

Name: _____

Teacher's name: _____

VCE BIOLOGY
Unit 3 Trial Exam

2024
Reading time: 15 minutes
Writing time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	25	25	25
B	4	4	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 book.
- Answer sheet for multiple-choice questions.
- Additional space is available at the end of the book if you need extra space to complete an answer.

Instructions
- Write your student number in the space provided above on this page.
- Check that your name and student number on your answer sheet for multiple-choice questions are correct.
- 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 book.

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

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 book are **not** drawn to scale.

Question 1

DNA, mRNA and tRNA all play important roles in protein synthesis. During the production of a protein, which of the following would occur during translation?

A. the anticodon TAG on a tRNA molecule attached to an amino acid binds to the codon ATG on an mRNA molecule at a ribosome
B. the codon UAC on a tRNA molecule attached to an amino acid binds to the anticodon AUG on an mRNA molecule at the ribosome
C. the anticodon GGA on a tRNA molecule carrying an amino acid binds to the codon CCU on an mRNA molecule at a ribosome
D. the anticodon UAC on an mRNA molecule carrying an amino acid binds to the codon AUG on a tRNA molecule at a ribosome

Question 2

Which of the following statements refers to the degenerate nature of the DNA code?

A. the codons UCU and UCC both code for the amino acid serine
B. DNA is found in all living things
C. the same gene will encode the same protein in different organisms
D. the codon CCG will always code for the amino acid proline, regardless of the organism or species it occurs in

Question 3

The sequence of a particular gene in a DNA strand contains 640 triplet codes. How many codons would the corresponding mRNA strand that leaves the nucleus have?

A. more than 640 codons
B. 640 codons
C. 638 codons
D. fewer than 640 codons

Question 4

Various enzymes, several of which are sourced from bacteria, are used by scientists to manipulate DNA. Which of the following correctly pairs the enzyme type with its application?

A. endonucleases are used to cut DNA in the creation of recombinant plasmids
B. ligase is used to separate DNA strands in electrophoresis
C. polymerase is used to separate DNA segments in preparation for electrophoresis
D. ligase adds free nucleotides to create a complementary DNA strand in PCR testing

Question 5

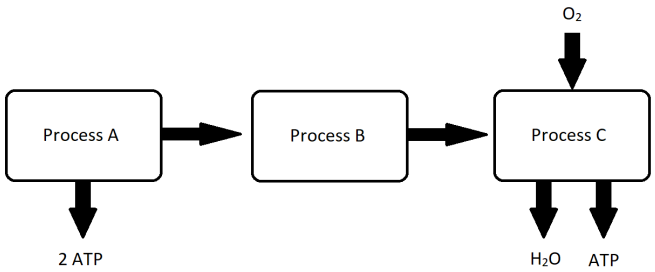
CRISPR-Cas9 offers exciting potential for genetic engineering. What is the role of guide RNA in CRISPR?

A. to signal to Cas1 and Cas2 to extract a protospacer from invading DNA
B. to bind to Cas9 to create a CRISPR-Cas9 complex
C. to cleave foreign DNA at a recognised sequence
D. to add a spacer to the CRISPR array

Use the following information to answer Questions 6 – 8.

Figure 1 shows a sequence of processes that occur in the cells of mammals along with some of their inputs and outputs.

Figure 1.



Question 6

Where in the cell does Process B occur?

A. in the cytoplasm
B. in the stroma of a chloroplast
C. in the mitochondrial matrix
D. on the inner membrane of the mitochondria

Question 7

How would the sequence of processes depicted in *Figure 1* differ in most prokaryotic cells?

A. it would only consist of Process A and the overall net yield of ATP would be higher
B. it would only consist of Processes A and B and the net yield of ATP would be lower
C. it would only consist of Process C, but oxygen would not be an input
D. it would usually only consist of Process A and the overall net yield of ATP would be lower

Question 8

The temperature of the processes in *Figure 1* is gradually increased from 10˚C to 80˚C. How does the overall rate of the process change as the temperature increases?

A. the rate of reaction would increase steadily with temperature
B. the rate of reaction would remain constant
C. the rate of reaction would initially increase with increasing temperature before reducing and eventually ceasing at high temperatures
D. the rate of reaction would initially increase with increasing temperature before then plateauing at high temperatures

Question 9

Co-enzymes play an important role in biochemical processes. Which of the following acts as an electron donor during photosynthesis?

A. NADPH
B. NADH
C. $NADP^+$
D. NAD^+

Question 10

Plants that thrive in hot, dry environments have evolved adaptations to reduce photorespiration. Photorespiration occurs because

A. the affinity for Rubisco to bind to oxygen increases in higher temperatures and from plants opening their stomata.

B. the affinity for Rubisco to bind to oxygen increases in higher temperatures and from plants closing their stomata.

C. the affinity for Rubisco to bind to carbon dioxide increases in higher temperatures and from plants closing their stomata.

D. the affinity for Rubisco to bind to carbon dioxide increases in higher temperatures and from plants opening their stomata.

Use the following information to answer Questions 11 – 13.

Bacterial plasmids are used in genetic engineering to transfer foreign DNA into cells. One application of this technology is the production of human insulin, an important hormone that is responsible for regulating blood glucose levels.

Some people with diabetes are unable to produce insulin and, therefore, must artificially introduce it into their bodies. The insulin protein consists of two polypeptide chains, referred to as the alpha and beta subunits; hence, to produce insulin, two different recombinant plasmids and two different transformed bacteria samples are required, one producing each subunit.

Question 11

From the information above, what can be concluded about the insulin protein?

A. it can only be produced artificially

B. it has a secondary structure due to the two subunits

C. it has a quaternary structure

D. it is a fat-soluble hormone

Question 12

Plasmid vectors that are selected for the production of insulin in bacteria need to contain two antibiotic-resistant genes: amp^R and tet^R. Which of the following correctly identifies the locations of the antibiotic-resistant genes with reference to the restriction sites of the endonucleases that are used in the recombination process?

A. neither gene should contain a recognition site for the same restriction enzyme within their sequence

B. both genes must contain a recognition site within their sequence

C. one gene should contain a recognition site within its sequence for one type of restriction enzyme, while the other gene should contain a recognition site within its sequence for another restriction enzyme; both of these are mixed within the plasmids

D. one gene should contain a recognition site within its sequence, while the other should not contain a recognition site

Question 13

Would the bacteria that successfully take up the recombinant plasmids and begin producing the insulin sub-units be described as transgenic organisms?

A. no, because they have not been inserted into another organism

B. yes, because their genome has been artificially altered

C. yes, because they have incorporated DNA that originates from modified/manipulated recombinant DNA or a separate species

D. no, because they do not contain DNA that would not normally be found in these bacteria

Question 14

Cyanide poisoning occurs because cyanide binds irreversibly to the enzyme cytochrome C oxidase in the mitochondria of cells at the site where its substrate normally binds, halting cellular respiration. Cyanide is, therefore, best described as

A. a competitive inhibitor that binds to the active site of cytochrome C oxidase.
B. a competitive inhibitor that binds to the substrate of cytochrome C oxidase.
C. a non-competitive inhibitor that binds the allosteric site of cytochrome C oxidase.
D. a non-competitive inhibitor that binds to the active site of cytochrome C oxidase.

Use the following information to answer Questions 15 and 16.

Plants may be C3, C4 or CAM plants depending on how they utilise photosynthesis and their environment. Cacti are an example of a CAM plant.

Question 15

What can be concluded about the photosynthesis pathway in cacti?

A. the initial carbon fixation occurs in a different cell from the remainder of the Calvin cycle, separating the processes spatially
B. the initial carbon fixation occurs at night, while the remainder of the Calvin cycle occurs during the day
C. the initial carbon fixation occurs during the day, while the remainder of the Calvin cycle occurs at night
D. the light-dependent reactions are separated over time

Question 16

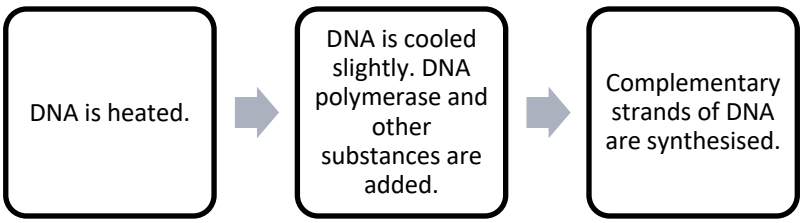
Which of these processes would occur in both cacti and C3 plants?

A. glucose production during the light-independent stage
B. oxygen production in the stroma
C. the energy of sunlight is transformed into chemical energy in the grana
D. the Calvin cycle separated into two different cells

Use the following information to answer Questions 17 and 18.

Figure 2 depicts parts of a process of DNA manipulation.

Figure 2.



Question 17

The process that is shown in *Figure 2* is

A. electrophoresis.
B. CRISPR gene editing.
C. the production of a recombinant plasmid.
D. polymerase chain reaction testing.

Question 18

Which of the following would also need to be added during the second step that is shown?

A. RNA polymerase and free nucleotides
B. primers and free nucleotides
C. guide RNA and primers
D. endonucleases and free nucleotides

Question 19

The *trp* operon, found in species of bacteria such as *E. coli,* contains a series of genes that are involved in the production of the amino acid tryptophan. Regulation occurs through repression and attenuation. During repression,

A. tryptophan binds to a repressor protein.
B. tryptophan binds to the operator.
C. a hairpin loop forms in the leader strand.
D. transcription occurs, but translation does not.

Question 20

The production and secretion of proteins from a cell involves several organelles. The following options describe some of the steps in the protein secretory pathway. Which of these occurs first?

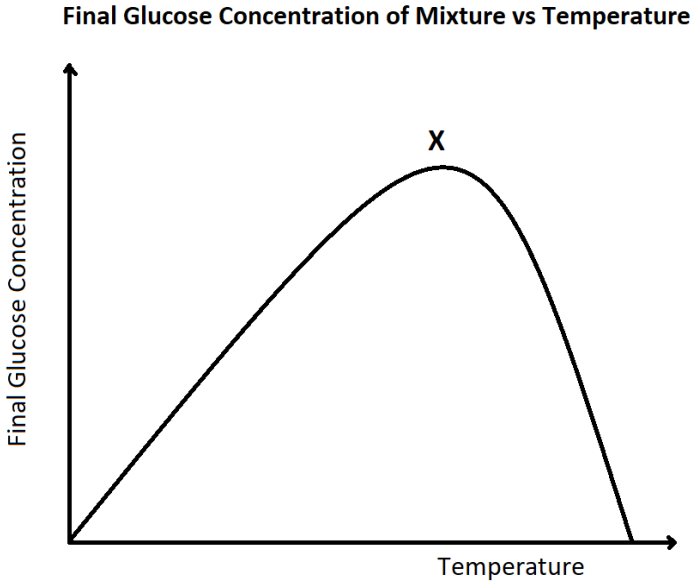
A. amino acids are joined to form a peptide chain in a condensation polymerisation reaction
B. codons align with complementary anticodons at ribosomes
C. the peptide chain is folded into its tertiary structure
D. the protein is packaged into a vesicle at the Golgi apparatus

Use the following information to answer Questions 21 and 22.

An experiment is set up to test the effects of temperature on the activity of the enzyme diastase. Diastase catalyses the breakdown of starch into glucose.

Diastase is mixed with a starch solution and placed in a range of temperatures for 10 minutes. The final concentration of glucose is measured. *Figure 3* illustrates the trend in the results.

Figure 3.



Question 21

What occurs after point X?

A. the bonds that link the amino acids together in diastase are broken
B. the final concentrations of starch reduce with increased temperature
C. the active sites of diastase change shape
D. the rate of reaction increases

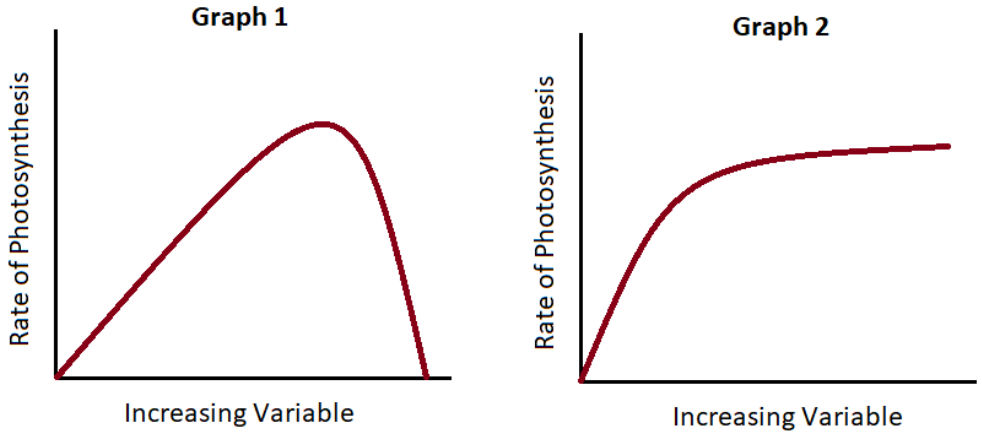
Question 22

Which of the following would be a suitable dependent variable for this experiment?

A. the time for which the enzyme diastase acts on the starch solution
B. the temperature at which the starch-enzyme mixtures were kept
C. the amount of diastase that is added to each solution
D. the final concentration of glucose

Question 23

The following graphs illustrate how two different variables affect the rate of photosynthesis. Which option correctly identifies the independent variables that could be represented in these graphs?



A. graph 1 could represent light availability, while graph 2 could represent temperature
B. graph 1 could represent carbon dioxide concentration, while graph 2 could represent light availability
C. graph 1 could represent temperature, while graph 2 could represent pH
D. graph 1 could represent temperature, while graph 2 could represent carbon dioxide concentration

Question 24

Biofuels, such as ethanol, offer an alternative to conventional fuels as a means to reduce greenhouse gas emissions. What purpose does photosynthesis serve in the production of biofuels?

A. photosynthesis transforms oxygen into water in biofuels, providing energy for an engine to run
B. photosynthesis produces sugar, contributing to plant biomass which is then used to produce ethanol fuel
C. photosynthesis produces energy in a combustion reaction
D. photosynthesis does not play a role in the production and use of biofuels

Question 25

CRISPR-Cas9 technologies offer the potential to genetically engineer crops to improve crop yields; for example, it could improve the efficiency of photosynthesis in a plant by

A. introducing disease-resistant genes into the plant.
B. reducing the affinity of Rubisco to bind to oxygen.
C. increasing the amount of carbon dioxide that is produced during photosynthesis.
D. increasing the concentration of NADH in chloroplasts.

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided.
Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1 (16 marks)

Some VCE Biology students wished to test the effects of temperature on the growth of the grain barley in order to determine the optimum temperature at which it should be grown. Five different temperatures were tested: 10˚C, 20˚C, 30˚C, 40˚C and 50˚C. For each temperature, three barley seeds (Sample 1-3) that were just germinating were prepared and planted. The seedlings all received the same amount of water each day and were all exposed to the same amount, and source, of light. After five days, the final height of each seedling was measured. The following table of results was produced:

Temperature (˚C)	**Height After Five Days** (cm)			
	Sample 1	**Sample 2**	**Sample 3**	**Average**
10	2.3	2.8	2.1	2.4
20	1.5	6.1	5.5	5.8
30	7.9	8.6	9.0	8.5
40	4.1	4.3	4.1	4.2
50	1.3	0.9	0.7	0.97

a. Identify the independent and dependent variables in this experiment and identify one controlled variable that is mentioned in the method. 3 marks

b. Identify a variable that is not listed that would need to be controlled and explain why. 2 marks

c. Describe validity and explain how your answer to Question 1b relates to the validity of the experiment. 2 marks

d. One of the results was omitted as an outlier. 1 mark

Identify which result was most likely to be omitted.

e. Is the data collected qualitative or quantitative? Explain your answer. 2 marks

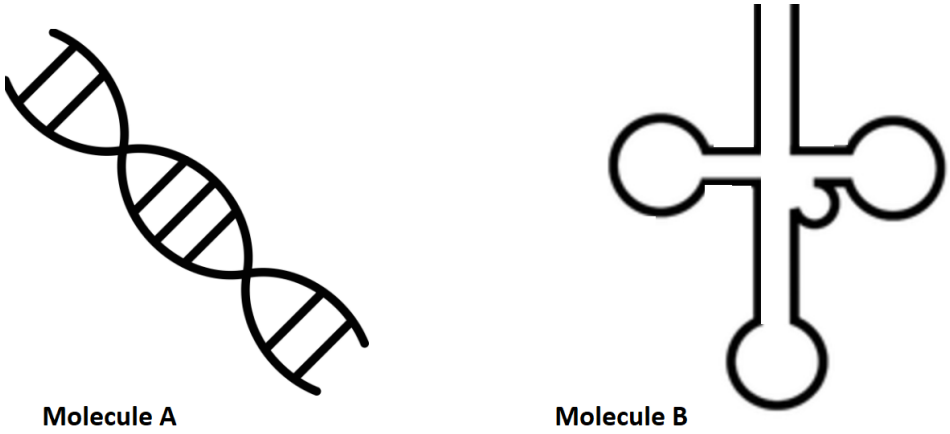
f. The process by which barely produces glucose for energy and growth can be divided into two stages. 3 marks

Name these two stages and identify the inputs, outputs and location of the first stage.

g. Describe the role of Rubisco in the second stage of the process that was referred to in Question 1f and suggest two ways in which Rubisco may be involved in the trend that was seen in the results beyond 30℃. 3 marks

Question 2 (13 marks)

Figure 4.



Molecule A Molecule B

a. Name the two molecules and identify two differences between the monomers of these molecules. 3 marks

b. Describe the role of Molecule B in protein synthesis. 2 marks

c. A particular section of a protein consists of 20 amino acids; however, the gene encoding this protein contains over 100 nucleotides. 2 marks

Explain why this discrepancy exists.

d. Explain what is meant by an organism's proteome and explain why an organism's proteome is larger than its genome. 2 marks

e. The particular protein that is referred to in this question has quaternary structure. 4 marks

Briefly describe each of the hierarchies of protein structure.

Question 3 (12 marks)

A sample of yeast was placed in three airtight containers and a glucose solution was added. The containers were sealed shut. One beaker was kept at 10˚C, one at 40˚C and the third at 80˚C.

The initial percentages of oxygen and ethanol in the sealed containers were recorded. After one hour, the final percentages were recorded. The results of the experiment are shown in the following table.

Temperature (˚C)	**Initial Proportion of Oxygen** (%)	**Final Proportion of Oxygen** (%)	**Initial Proportion of Ethanol** (%)	**Final Proportion of Ethanol** (%)
10	21	19	0	2
40	21	13	0	8
80	21	21	0	0

a. Name the process that occurs in yeast to produce ethanol and identify two other outputs from this process. 2 marks

b. Name the process that consumed oxygen in this experiment. Describe two differences between this process and the process that was identified in Question 3a, that do not relate to oxygen consumption. 3 marks

c. Suggest reasons for the differences in the final proportions of ethanol between the three temperatures. 3 marks

d. The process that was identified in Question 3a is used in the production of biofuels. Briefly describe this process and explain the advantage of biofuels over petrol in terms of greenhouse gas emissions. 2 marks

e. The purpose of the experiment was to determine the optimum temperature at which to use yeast to produce ethanol. To maximise ethanol production, what change should be made to the initial condition of the sealed containers and why should this change be made? 2 marks

Question 4 (9 marks)

DNA profiling can be used to assist in solving criminal cases by placing suspects at, or excluding them from, a crime scene. *Figure 5* shows the results of an electrophoresis run that compared the DNA of suspects at a crime scene.

Figure 5.

a. This particular DNA profile was produced using the short-tandem-repeat (STR) CSF1PO. 3 marks

What are STRs and why are they used in DNA profiling?

b. Describe how the STRs are separated by gel electrophoresis. 2 marks

c. Can any of the suspects be placed at the scene according to these results? Explain your answer. 2 marks

d. Before being separated in an electrophoresis run, the DNA of each sample was amplified using PCR. 2 marks

Outline the roles of DNA polymerase and primers in the process of PCR.

END OF QUESTION AND ANSWER BOOK

Extra space for responses

Clearly number all responses in this space.

VCE Unit 3 BIOLOGY

Written Examination

ANSWER SHEET – 2024

Student name:	

Use a **PENCIL** for **ALL** entries. For each question, shade the box which indicates your answer.

Marks will **NOT** be deducted for incorrect answers.

NO MARK will be given if more than **ONE** answer is completed for any question.

If you make a mistake, **ERASE** the incorrect answer – **DO NOT** cross it out.

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