Unit 3 Biology Practice Exam 2024 – Assessment Guide

Section A

VCAA Key Knowledge	Question	Answer Guide
nucleic acids as information molecules that encode instructions for the synthesis of proteins: the structure of DNA, the three main forms of RNA (mRNA, rRNA and tRNA) and a comparison of their respective nucleotides	**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	*C* *During translation, the anticodons of tRNA molecules, which carry amino acids, match up with the codons of an mRNA molecule at the ribosomes.* *A is incorrect because RNA contains uracil, not thymine. B is incorrect because tRNA molecules contain anticodons and mRNA molecules contain codons. D is incorrect because tRNA, not mRNA, is attached to amino acids.*
the genetic code as a universal triplet code that is degenerate and the steps in gene expression, including transcription, RNA processing in eukaryotic cells and translation by ribosomes	**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	*A* *The degeneracy, or redundancy, of the genetic code refers to the fact that multiple codons code for the same amino acid.* *Options B and C describe the universal nature of the DNA code, while option D describes its unambiguous nature.*

the structure of genes: exons, introns and promoter and operator regions	**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	*D*	*During post-transcriptional modification, introns (non-coding regions of the gene) are spliced out of the pre-mRNA molecule, meaning that the resultant mRNA strand is substantially shorter than the original gene.*

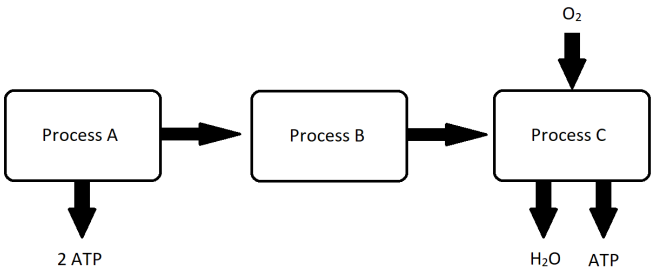
the use of enzymes to manipulate DNA, including polymerase to synthesise DNA, ligase to join DNA and endonucleases to cut DNA	**Question 4** Various enzymes, several of which are sourced from bacteria, are used by scientists to manipulate DNA. Which of the following correctly pairs the enzyme type with 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	*A*	*Endonucleases, or restriction enzymes, cut DNA at a specific sequence; this can be used to cut plasmids to insert a foreign gene.* *Ligase joins DNA fragments together, while polymerase helps to synthesise DNA (for example, in PCR testing).*

the function of CRISPR-Cas9 in bacteria and the application of this function in editing an organism's genome	**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	*B*	*Guide RNA, which can be synthetically produced for genetic engineering applications, has a complementary spacer to the segment of DNA that is to be cut and binds with Cas9 to form a CRISPR-Cas9 complex.* *The PAM sequence signals to Cas1 and Cas2 to extract a protospacer from invading DNA. Cas1 and Cas2 then introduce this protospacer to the CRISPR array, where it becomes a spacer. Cas9 cleaves DNA.*

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.



the main inputs, outputs and locations of glycolysis, Krebs Cycle and electron transport chain including ATP yield the general structure of the biochemical pathways in photosynthesis and cellular respiration from initial reactant to final product

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

C *Process B represents the Krebs cycle of aerobic cellular respiration, which occurs in the mitochondrial matrix.*

the location, inputs and the difference in outputs of anaerobic fermentation in animals and yeasts

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

D *Cellular respiration in prokaryotes is usually anaerobic and only consists of glycolysis (process A). The net yield of ATP in anaerobic respiration is two molecules of ATP per molecule of glucose, which is much lower than the net yield in aerobic respiration.*

the factors that affect the rate of cellular respiration: temperature, glucose availability and oxygen concentration

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

C *Increasing the temperature increases the rate of reaction up to the point at which the enzymes that are controlling the process begin to denature. Beyond this temperature, the rate of reaction reduces rapidly as the enzymes can no longer catalyse their reactions.*

the general role of enzymes and coenzymes in facilitating steps in photosynthesis and cellular respiration
the general structure of the biochemical pathways in photosynthesis and cellular respiration from initial reactant to final product

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^+

A

NADPH acts as an electron donor in photosynthesis, transferring high energy electrons between molecules.

Once NADPH has donated its electrons, it becomes $NADP^+$. NADH plays a similar role in cellular respiration.

the role of Rubisco in photosynthesis, including adaptations of C3, C4 and CAM plants to maximise the efficiency of photosynthesis

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.

B

Photorespiration occurs when Rubisco binds to oxygen instead of carbon dioxide; if oxygen levels are high and carbon dioxide levels are low, then Rubisco is more likely to bind to oxygen. High oxygen levels can occur when plants close their stomata to reduce water loss. Since stomata are the means by which oxygen exits the leaf, this can result in a build-up of oxygen. Hence, at higher temperatures, Rubisco's affinity for oxygen increases.

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.

amino acids as the monomers of a polypeptide chain and the resultant hierarchical levels of structure that give rise to a functional protein

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

C

Insulin contains two polypeptide chains and proteins that consist of two or more polypeptide chains that have a quaternary structure. Like most proteins, insulin is water-soluble rather than fat-soluble.

the use of recombinant plasmids as vectors to transform bacterial cells as demonstrated by the production of human insulin

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

D

To determine which bacteria successfully take up plasmids, they are mixed with the antibiotic that corresponds to the antibiotic-resistant gene that does not contain a restriction site; only those that have taken up plasmids will be resistant. To then determine which of these bacteria have taken up plasmids that contain the foreign DNA, they are mixed with the antibiotic that corresponds to the antibiotic-resistant gene that does contain a restriction site. Only those that have <u>not</u> taken up a recombinant plasmid will be resistant to the second antibiotic.

the use of genetically modified and transgenic organisms in agriculture to increase crop productivity and to provide resistance to disease

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

C *A transgenic organism is a genetically modified organism in which the genetic modification includes the incorporation of DNA that would not normally be found in that species. The genes that are producing the insulin sub-units are from an external organism/source.*

the general factors that impact on enzyme function in relation to photosynthesis and cellular respiration: changes in temperature, pH, concentration, competitive and non-competitive enzyme inhibitors

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.

A *Competitive inhibitors bind to the active site of an enzyme, which is the site to which its substrate normally binds.*

A non-competitive inhibitor binds to another site on the enzyme, called the allosteric site. This causes the enzyme and its active site to change shape, preventing its normal substrate from binding to the active site.

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.

the role of Rubisco in photosynthesis, including adaptations of C3, C4 and CAM plants to maximise the efficiency of photosynthesis

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

B *At night, CAM plants open their stomata to take in CO_2 and fix it into a four-carbon molecule that is stored in the vacuoles of the cell. During the day, the plants do not open their stomata. The four-carbon molecule is transported out of the vacuole and broken down to release CO_2, which is then used to produce glucose.*

inputs, outputs, and locations of the light dependent and light independent stages of photosynthesis in C3 plants (details of biochemical pathway mechanisms are not required)

Question 16

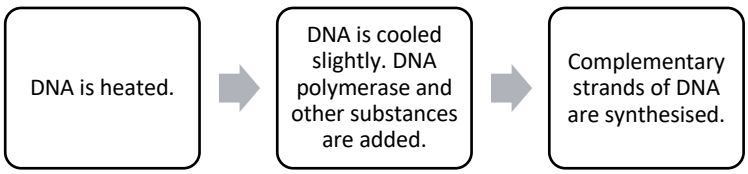
Which of these processes would occur in both cacti and C3 plants?

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

C *Although the light-independent stage differs between C3, C4 and CAM plants, the light-independent stage is the same. In this stage, light energy is transformed into chemical energy, which is then used in the light-independent reactions. This process occurs in the thylakoid membranes of chloroplasts, which are arranged into stacks called grana.*

Use the following information to answer questions 17 and 18.
Figure 2 depicts parts of a process of DNA manipulation.

Figure 2.



amplification of DNA using polymerase chain reaction and the use of gel electrophoresis in sorting DNA fragments, including the interpretation of gel runs for DNA profiling

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.

D *The process shows polymerase chain reaction (PCR) testing, which can be concluded from the addition of DNA polymerase and the synthesis of complementary strands.*

amplification of DNA using polymerase chain reaction and the use of gel electrophoresis in sorting DNA fragments, including the interpretation of gel runs for DNA profiling

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

B *Once the DNA has been heated and separated, it is cooled slightly, and primers and free nucleotides are added. Primers adhere to the single strands of DNA, allowing DNA polymerase to use the free nucleotides to produce a complementary strand.*

the basic elements of gene regulation: prokaryotic trp operon as a simplified example of a regulatory process	**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.	*A*	*Repression occurs when levels of free tryptophan in the cell are high. Tryptophan binds to a repressor protein, which changes the shape of the repressor, allowing it to bind to the operator; this prevents RNA polymerase from transcribing structural genes.*

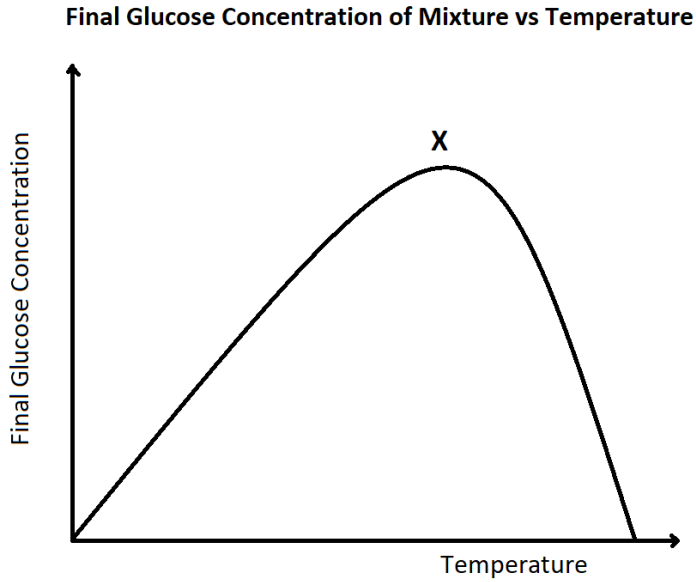
the role of rough endoplasmic reticulum, Golgi apparatus and associated vesicles in the export of proteins from a cell via the protein secretory pathway	**Question 20** The production and secretion of proteins from a cell involves several organelles. The following options describe some of the steps in 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	*B*	*The correct sequence is B --> A --> C --> D.*

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.



proteins as a diverse group of molecules that collectively make an organism's proteome, including enzymes as catalysts in biochemical pathways

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

C *At high temperatures, although the amino acid chain remains intact, the tertiary structure of the enzyme breaks down; this changes the shape of the active site so that the enzyme can no longer catalyse its reaction.*

identify independent, dependent and controlled variables in controlled experiments

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

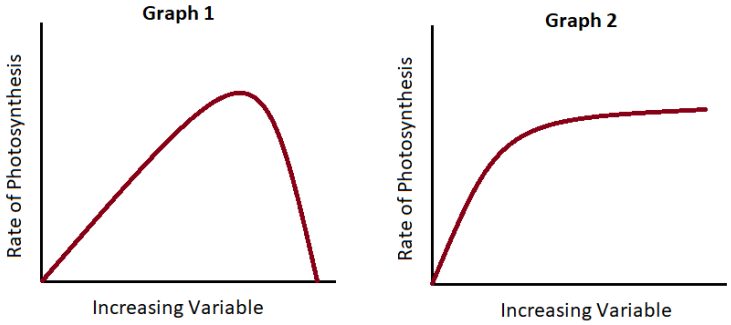
D *The dependent variable is the measured variable in an experiment.*

Options A and C are examples of controlled variables, while option B is the independent variable.

the factors that affect the rate of photosynthesis: light availability, water availability, temperature and carbon dioxide concentration

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

D *Increasing the temperature typically produces a shape similar to graph 1, as once a certain temperature is exceeded, the enzymes that catalyse the processes in photosynthesis denature. Graph 2 could represent carbon dioxide concentration or light availability, as increasing these variables will increase photosynthesis up to the point where another factor becomes limited.*

uses and applications of anaerobic fermentation of biomass for biofuel production

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

B *Photosynthesis is the process by which sugarcane and other plants use to produce biofuels to produce sugar for energy. The sugarcane is then harvested to produce ethanol.*

potential uses and applications of CRISPR-Cas9 technologies to improve photosynthetic efficiencies and crop yields

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.

B *Reducing the affinity of Rubisco would reduce photorespiration, increasing the efficiency of photosynthesis.*

Section B

VCAA Key Knowledge	Question	Answer Guide

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

identify independent, dependent and controlled variables in controlled experiments

Question 1a (3 marks)
Identify the independent and dependent variables in this experiment and identify one controlled variable that is mentioned in the method.

Answer:

- *The independent variable is the temperature at which they are grown.*
- *The dependent variable is the height of the seedlings after five days.*
- *One controlled variable is*
  - *the starting condition of the seedlings (they are all about germinate).*
  - *the amount of water that each seedling receives.*
  - *the amount of light that each seedling receives.*
  - *the source of light that each seedling receives.*

Marking Protocol:
One mark for each of the above points.
N.B. Only one controlled variable is required for a mark.

identify independent, dependent and controlled variables in controlled experiments *the general structure of the biochemical pathways in photosynthesis and cellular respiration from initial reactant to final product*	**Question 1b** (2 marks) Identify a variable that is not listed that would need to be controlled and explain why.	**Answer:** • *The amount of carbon dioxide that each seedling receives must be controlled.* • *This is because carbon dioxide is an input of photosynthesis which affects seedling growth.* OR • *The pH of the soil in which the seedlings are kept must be controlled.* • *This is because pH can affect enzyme function and, thus, affect seedling growth.* OR • *The amount of fertiliser (if any) that each seedling receives must be controlled.* • *This is as fertiliser provides nutrients for seedling growth.* **Marking Protocol:** One mark for each of the above points. Any other reasonable response should be awarded marks.

identify and analyse experimental data qualitatively, handing where appropriate concepts of: accuracy, precision, repeatability, reproducibility and validity of measurements; errors (random and systematic); and certainty in data, including effects of sample size in obtaining reliable data	**Question 1c** (2 marks) Describe validity and explain how your answer to Question 1b relates to the validity of the experiment.	**Answer:** • *Validity refers to how well an experiment measures what it is intended to measure (for an experiment to be valid, only the independent variable should affect the dependent variable).* • *In order for this to occur, all other variables (such as the amount of carbon dioxide as an input / the pH of the soil / the amount of fertiliser) need to be controlled for; otherwise, there may be additional variables that are affecting the growth of the seedlings (the dependent variable).* **Marking Protocol:** One mark for each of the above points.

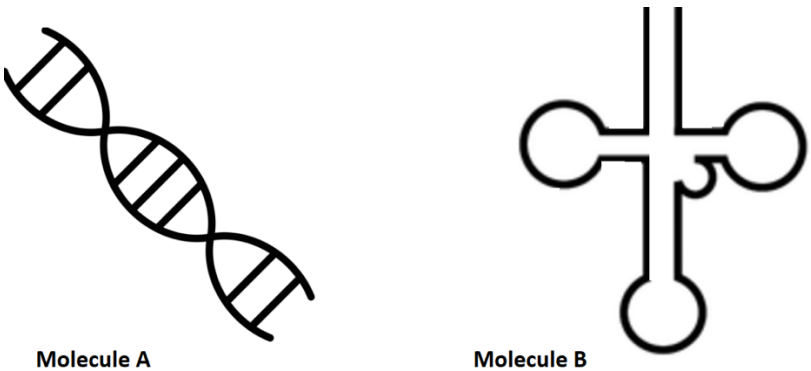
identify outliers, and contradictory or provisional data	**Question 1d** (1 mark) One of the results was omitted as an outlier. Identify which result was most likely to be omitted.	**Answer:** • *Sample 1 at 20˚C.* **Marking Protocol:** One mark for the above point.

process quantitative data using appropriate mathematical relationships and units, including calculations of ratios, percentages, percentage change and mean	**Question 1e** (2 marks) Is the data collected qualitative or quantitative? Explain your answer.	**Answer:** • *The data is quantitative.* • *This is because it is numerical, which is indicative of quantitative data (whereas qualitative data is descriptive).* **Marking Protocol:** One mark for each of the above points.

inputs, outputs and locations of the light dependent and light independent stages of photosynthesis in C3 plants	**Question 1f** (3 marks) The process by which barely produces glucose for energy and growth can be divided into two stages. Name these two stages and identify the inputs, outputs and location of the first stage.	**Answer:** • *The two stages are the light-dependent reactions and the light-independent reactions.* • *The inputs to the light-dependent stage (the first stage) are NADP, ADP, Pi, and water, whereas the outputs are oxygen, ATP and NADPH.* • *The location of the light-dependent reactions is the thylakoid membranes (grana) of the chloroplasts.* **Marking Protocol:** One mark for each of the above points. NB: Light may also be listed as an input but is not required for full marks.

the role of Rubisco in photosynthesis, including adaptations of C3, C4 and CAM plants to maximise the efficiency of photosynthesis	**Question 1g** (3 marks) 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˚C.	**Answer:** • *Rubisco fixes carbon in the light-independent stage of photosynthesis by binding to carbon dioxide.* • *Under high temperatures, Rubisco's affinity to bind to oxygen increases and its affinity for binding to carbon dioxide decreases, reducing the efficiency of photosynthesis; this could contribute to the plants' poor growth under 40˚C and 50˚C.* • *Under high temperatures, plants are also more likely to close their stomata to prevent water loss – this causes oxygen build-up in the leaf, increasing the likelihood that Rubisco will bind to oxygen rather than carbon dioxide. This could reduce the efficiency of photosynthesis and contribute to the plants' poor growth under 40˚C and 50˚C.* **Marking Protocol:** One mark for each of the above points.

Figure 4.



Molecule A **Molecule B**

nucleic acids as information molecules that encode instructions for the synthesis of proteins: the structure of DNA, the three main forms of RNA (mRNA, rRNA and tRNA) and a comparison of their respective nucleotides	**Question 2a** (3 marks) Name the two molecules and identify two differences between the monomers of these molecules.	**Answer:** • *Molecule A is DNA and Molecule B is tRNA.* • *Difference 1: DNA contains thymine, whereas tRNA contains uracil.* • *Difference 2: DNA contains a deoxyribose sugar, whereas tRNA contains a ribose sugar.* **Marking Protocol:** One mark for each of the above points.

the genetic code as a universal triplet code that is degenerate and the steps in gene expression, including transcription, RNA processing in eukaryotic cells and translation by ribosomes	**Question 2b** (2 marks) Describe the role of Molecule B in protein synthesis.	**Answer:** • *During translation, tRNA molecules bring amino acids to ribosomes.* • *At the ribosomes, the codons of mRNA align with the anticodons of tRNA and the amino acids then join together to form a peptide chain.* **Marking Protocol:** One mark for each of the above points.

the structure of genes: exons, introns and promoter and operator regions	**Question 2c** (2 marks) A particular section of a protein consists of 20 amino acids; however, the gene encoding this protein contains over 100 nucleotides. Explain why this discrepancy exists.	**Answer:** • *The original gene – and, therefore, the strand of pre-mRNA – contains introns and exons.* • *The introns get spliced out during post-transcriptional modification, leaving the final mRNA molecule shorter than the original.* **Marking Protocol:** One mark for each of the above points.

the structure of genes: exons, introns and promoter and operator regions *proteins as a diverse group of molecules that collectively make an organism's proteome, including enzymes as catalysts in biochemical pathways*	**Question 2d** (2 marks) Explain what is meant by an organism's proteome and explain why an organism's proteome is larger than its genome.	**Answer:** • *The proteome is the complete set of proteins that a cell or organism is capable of producing.* • *During post-transcriptional modification, alternative splicing can occur, meaning that the exons can be reconnected in various sequences. This means the proteome is larger than the genome, as several combinations are possible.* **Marking Protocol:** One mark for each of the above points.

amino acids as the monomers of a polypeptide chain and the resultant hierarchical levels of structure that give rise to a functional protein	**Question 2e** (4 marks) The particular protein that is referred to in this question has quaternary structure. Briefly describe each of the hierarchies of protein structure.	**Answer:** • *The primary structure is the sequence of amino acids in a peptide chain.* • *The secondary structure is the regular folding of an amino acid chain into an alpha helix or beta-pleated sheet due to hydrogen bonding.* • *The tertiary structure is the irregular, 3D folding of a protein into its unique shape.* • *The quaternary structure is the final shape of a protein that consists of more than one peptide chain.* **Marking Protocol:** One mark for each of the above points.

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

the location, inputs and the difference in outputs of anaerobic fermentation in animals and yeasts

Question 3a (2 marks)
Name the process that occurs in yeast to produce ethanol and identify two other outputs from this process.

Answer:
- *The process is anaerobic respiration (fermentation).*
- *The other outputs are carbon dioxide and (two molecules of) ATP.*

Marking Protocol:
One mark for each of the above points.

the main inputs, outputs and locations of glycolysis, Krebs Cycle and electron transport chain including ATP yield

the location, inputs and the difference in outputs of anaerobic fermentation in animals and yeasts

Question 3b (3 marks)
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.

Answer:
- *The process is aerobic respiration.*

AND any TWO of the following differences:
- *Aerobic respiration produces more molecules of ATP per molecule of glucose compared to anaerobic respiration.*
- *Aerobic respiration consists of glycolysis, the Krebs cycle and the electron transport chain, while anaerobic respiration only consists of glycolysis.*
- *Aerobic respiration requires the organelle mitochondria to be carried out, while anaerobic respiration only occurs in the cytosol.*

Marking Protocol:
One mark for the first point. One mark for any correct difference, to a maximum of two.
NB: Please accept any other correct differences. If students incorrectly answered 3a, teachers can decide whether or not to apply consequential marks to this question.

the factors that affect the rate of cellular respiration: temperature, glucose availability and oxygen concentration

the general factors that impact on enzyme function in relation to photosynthesis and cellular respiration: changes in temperature, pH, concentration, competitive and non-competitive enzyme inhibitors

use reasoning to construct scientific arguments, and to draw and justify conclusions consistent with the evidence and relevant to the question under investigation

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

Answer:

- *In the 10˚C sample, ethanol production was lower because, at low temperatures, the enzymes and substrates that are involved in biochemical reactions move around less (because they have less kinetic energy) and, so, reactions occur at a slower rate due to fewer collisions between the active site of the enzyme and the substrate binding site.*
- *In the 40˚C sample, ethanol production was the highest because this was the closest temperature to the optimal temperature of the enzymes that were catalysing the reactions in anaerobic respiration, leading to the highest amount of collisions between the active site of the enzyme and the substrate binding site.*
- *In the 80˚C sample, there was no ethanol produced because the enzymes that were catalysing the reactions are likely to have denatured due to high temperatures; hence, the changes in the shape of their active site meant that they were unable to bind with the substrate and catalyse the reactions.*

Marking Protocol:
One mark for each of the above points.

uses and applications of anaerobic fermentation of biomass for biofuel production

Question 3d (2 marks)
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.

Answer:

- *Biofuels can be produced through the fermentation of biomass such as sugarcane, which produces ethanol – the ethanol can then be refined into a biofuel and combusted to produce energy.*
- *The overall process releases fewer net greenhouse gas emissions compared to conventional petrol because the process of growing biomass such as sugarcane consumes carbon dioxide.*

Marking Protocol:
One mark for each of the above points.

the main inputs, outputs and locations of glycolysis, Krebs Cycle and electron transport chain including ATP yield (details of biochemical pathway mechanisms are not required)

the location, inputs and the difference in outputs of anaerobic fermentation in animals and yeasts

Question 3e (2 marks)
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?

Answer:

- *The initial oxygen concentration in the containers should be minimised as much as possible.*
- *This is because, if there is oxygen available, the yeast will undergo aerobic rather than anaerobic respiration and aerobic respiration does not produce ethanol.*

Marking Protocol:
One mark for each of the above points.

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.

amplification of DNA using polymerase chain reaction and the use of gel electrophoresis in sorting DNA fragments, including the interpretation of gel runs for DNA profiling

Question 4a (3 marks)

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

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

Answer:

- *STRs are short sections of repeated sequences of DNA that are found in non-coding regions.*
- *The repeated sequences are the same between people, but the number of repeated sequences differ.*
- *They are useful for DNA profiling because the sequences are found in all of the population but, due to differences in their lengths, they can be used to distinguish between individuals.*

Marking Protocol:

One mark for each of the above points.

amplification of DNA using polymerase chain reaction and the use of gel electrophoresis in sorting DNA fragments, including the interpretation of gel runs for DNA profiling

Question 4b (2 marks)

Describe how the STRs are separated by gel electrophoresis.

Answer:

- *DNA is loaded into the wells in the electrophoresis gel at the negative terminal end and a current is applied to the gel; because DNA is negatively charged, it moves towards the positive terminal.*
- *Shorter fragments of DNA will travel further through the gel than longer fragments of DNA, separating the STRs according to size.*

Marking Protocol:

One mark for each of the above points.

amplification of DNA using polymerase chain reaction and the use of gel electrophoresis in sorting DNA fragments, including the interpretation of gel runs for DNA profiling	**Question 4c** (2 marks) Can any of the suspects be placed at the scene according to these results? Explain your answer.	**Answer:** ● *Yes, Suspect 1.* ● *The crime scene contains a STR that matches the victim, but the only individual that contains the other STR that was found at the crime scene was Suspect 1.* **Marking Protocol:** One mark for each of the above points.

the use of enzymes to manipulate DNA, including polymerase to synthesise DNA, ligase to join DNA and endonucleases to cut DNA	**Question 4d** (2 marks) Before being separated in an electrophoresis run, the DNA of each sample was amplified using PCR. Outline the roles of DNA polymerase and primers in the process of PCR.	**Answer:** ● *DNA polymerase synthesises complementary strands of DNA.* ● *Primers anneal to the upstream region of the gene being amplified, initiating the replication process.* **Marking Protocol:** One mark for each of the above points.

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