SCIENCE TEACHERS ASSOCIATION VICTORIA 2023

TRIAL EXAMINATION

QUESTION AND ANSWER BOOK

Total writing time:
1 hours 30 minutes

BIOLOGY
UNIT 3

Student name	

Student ID									**Letter**	

Structure of book

Section	Number of questions	Number of marks
A	25	25
B	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 white out liquid/tape.
- No calculators are allowed in this examination.

Materials supplied

- Question and answer book of 17 pages, with a detachable answer sheet for multiple-choice questions inside the front cover.

Instructions

- Detach the answer sheet for multiple-choice questions during reading time.
- Write your name and student ID in the space provided above on this page and on the answer sheet for multiple-choice questions.
- Unless otherwise indicated, the diagrams in this book are not drawn to scale.
- All written responses should be in English.

At the end of the examination

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

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STAV
2023

BIOLOGY
Unit 3 Trial Examination
MULTIPLE CHOICE ANSWER SHEET

STUDENT NAME:	

INSTRUCTIONS: **USE PENCIL ONLY**

- Write your name in the space provided above.
- Use a **PENCIL** for **ALL** entries.
- If you make a mistake, **ERASE** it – **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.
- Mark your answer by **SHADING** the letter of your choice.

	ONE ANSWER PER LINE		ONE ANSWER PER LINE
1	A B C D	14	A B C D
2	A B C D	15	A B C D
3	A B C D	16	A B C D
4	A B C D	17	A B C D
5	A B C D	18	A B C D
6	A B C D	19	A B C D
7	A B C D	20	A B C D
8	A B C D	21	A B C D
9	A B C D	22	A B C D
10	A B C D	23	A B C D
11	A B C D	24	A B C D
12	A B C D	25	A B C D
13	A B C D		

SECTION A – Multiple choice questions

Specific instructions for Section A

This section consists of 25 questions. You should attempt **all** questions.

Each question has four possible correct answers. Only **one** answer for each question is correct. Select the answer that you believe is correct and indicate your choice on the Multiple-Choice Answer Sheet by shading the letter that corresponds with your choice of the correct answer.

If you wish to change an answer, erase it and shade your new choice of letter.

Each question is worth **one** mark. **No** mark will be given if more than one answer is completed for any question. Marks will **not** be deducted for incorrect answers.

Question 1

Messenger RNA (mRNA) is found in the

A. nucleus only.

B. ribosome.

C. cytosol and nucleus.

D. endoplasmic reticulum.

Question 2

The monomers of tRNA are composed of

A. an amine group and a carboxyl group.

B. a ribose sugar, nitrogenous base and phosphate group.

C. a ribose sugar, nitrogenous base and phosphorus group.

D. a promoter and operator region.

Question 3

The *Trp* operon regulates production of tryptophan, an amino acid, in bacterial cells. When bacteria are unable to source tryptophan from the environment, they can produce it to enable protein synthesis to occur. The production of tryptophan can cease when

A. the activated repressor protein binds to the operator region.

B. RNA polymerase binds to the operator region.

C. the operator region is unoccupied.

D. no tryptophan is bound to the repressor protein.

Question 4

Amino acids have a constant region and a variable region. How many variable regions are possible?

A. 16

B. 20

C. 61

D. 64

Question 5

A strand of nucleic acid was analysed and found to contain one less oxygen group than another type of nucleic acid. The strand is

A. mRNA.

B. tRNA.

C. rRNA.

D. DNA.

Question 6

Insulin is composed of 2 chains, an A chain and a B chain. The 2 chains must be bonded together for insulin to be functional.

Source: http://www.chm.bris.ac.uk/motm/insulin/insulinh.htm

What level of protein hierarchy is insulin?

A. primary

B. secondary

C. tertiary

D. quaternary

Question 7

Transport vesicles

A. move proteins from the Golgi bodies to the rough endoplasmic reticulum.

B. move proteins from the rough endoplasmic reticulum to the Golgi bodies.

C. move proteins from the Golgi bodies to the plasma membrane for endocytosis.

D. bud off the nuclear membrane and travel to the ribosomes for protein synthesis to occur.

Question 8

The amino acid code is described as degenerate, with the exception of

First Base	Second Base U	Second Base C	Second Base A	Second Base G	Third Base
U	Phenylalanine (Phe/F)	Serine (Ser/S)	Tyrosine (Tyr/Y)	Cysteine (Cys/C)	U
	Phenylalanine (Phe/F)	Serine (Ser/S)	Tyrosine (Tyr/Y)	Cysteine (Cys/C)	C
	Leucine (Leu/L)	Serine (Ser/S)	STOP	STOP	A
	Leucine (Leu/L)	Serine (Ser/S)	STOP	Tryptophan (Trp/W)	G
C	Leucine (Leu/L)	Proline (Pro/P)	Histidine (His/H)	Arginine (Arg/R)	U
	Leucine (Leu/L)	Proline (Pro/P)	Histidine (His/H)	Arginine (Arg/R)	C
	Leucine (Leu/L)	Proline (Pro/P)	Glutamine (Gln/Q)	Arginine (Arg/R)	A
	Leucine (Leu/L)	Proline (Pro/P)	Glutamine (Gln/Q)	Arginine (Arg/R)	G
A	Isoleucine (Ile/I)	Threonine (Thr/T)	Asparagine (Asn/N)	Serine (Ser/S)	U
	Isoleucine (Ile/I)	Threonine (Thr/T)	Asparagine (Asn/N)	Serine (Ser/S)	C
	Isoleucine (Ile/I)	Threonine (Thr/T)	Lysine (Lys/K)	Arginine (Arg/R)	A
	Methionine (Met/M)	Threonine (Thr/T)	Lysine (Lys/K)	Arginine (Arg/R)	G
G	Valine (Val/V)	Alanine (Ala/A)	Aspartic acid (Asp/D)	Glycine (Gly/G)	U
	Valine (Val/V)	Alanine (Ala/A)	Aspartic acid (Asp/D)	Glycine (Gly/G)	C
	Valine (Val/V)	Alanine (Ala/A)	Glutamic acid (Glu/E)	Glycine (Gly/G)	A
	Valine (Val/V)	Alanine (Ala/A)	Glutamic acid (Glu/E)	Glycine (Gly/G)	G

A. Thr.

B. Met and Trp.

C. Arg.

D. No amino acids.

Question 9

When creating a recombinant plasmid of insulin, the insulin gene is inserted before the end of the β-galactosidase gene. This is so the insulin gene

A. is able to digest lactose as well.

B. has a promoter region for RNA polymerase to bind to.

C. has a complementary sequence where it can be effectively inserted.

D. can disrupt the β-galactosidase gene to allow for detection of successful transformation.

Question 10

The creation of a recombinant plasmid of insulin requires inserting the gene for insulin, obtained from a mammal, and inserting it into a bacterium to allow for transcription and translation of the protein to occur. The plasmid is

A. genetically modified and transgenic.

B. genetically modified but not transgenic.

C. artificial.

D. resistant to all disease.

Question 11

Gel electrophoresis is used primarily to

A. amplify small samples of DNA.

B. insert a gene of interest at a specific recognition site.

C. separate DNA fragments based on their molecular size.

D. transform bacteria using heat shock.

Question 12

When cut with restriction enzymes, DNA can produce either sticky or blunt ends. Sticky ends are characterised by an overhang and allow for complementary base pairing to occur to join fragments of DNA. The enzyme that is added to restore the backbone of the DNA is

A. DNA ligase.

B. DNA helicase.

C. DNA polymerase.

D. endonuclease.

Question 13

Cas9 is an endonuclease used in CRISPR Cas9 gene editing technology. Scientists can use Cas9 to cut at specific DNA sequences. Cas9 does not cut the guide RNA as

A. it only cuts upstream from the PAM sequence.

B. it only cuts downstream from the PAM sequence.

C. it does not recognise RNA nucleotides.

D. it only cuts viral genomes.

Question 14

Polymerase chain reaction (PCR) is used in medical diagnostics for detecting infectious diseases, such as SARS Cov-19, and for the diagnosis of genetic disorders. What occurs in PCR when the temperature is lowered to 55°C?

A. The double stranded DNA separates.

B. Taq polymerase catalyses the addition of free nucleotides.

C. The DNA strand denatures.

D. The primers anneal to the 3’ end of the DNA strands.

Question 15

A plasmid is digested with EcoRI and when run through an electrophoresis gel, four bands are observed. How many recognition sites did the plasmid have?

A. 3

B. 4

C. 5

D. 6

Question 16

The purpose of guide RNA in CRISPR Cas9 is to

A. provide a binding site for the Cas9 enzyme.

B. direct the Cas9 to the target sequence.

C. provide the genetic code for the Cas9 enzyme.

D. allow a complementary sequence of the viral DNA to be inserted into the bacterial genome.

Question 17

Tyrosinase is an enzyme that catalyses the conversion of the amino acid tyrosine into melanin pigments which determine the colour of a dog's fur. Tyrosinase converts tyrosine into melanin by adding oxygen to it which creates a series of intermediate products that are eventually polymerised into melanin. The specific type and amount of melanin produced depends on the genetic makeup of the individual dog.

A competitive inhibitor is bound to tyrosinase. It would be expected that

A. the dog would produce more melanin.

B. the dog would produce less melanin.

C. the rate of melanin production by the dog would remain unchanged.

D. tyrosine levels in the cell would decrease.

Question 18

When comparing C4 and CAM plants, it is true to state that

A. both C4 and CAM plants undergo carbon fixation in the bundle sheath cells.

B. both C4 and CAM plants use PEP carboxylase as the initial enzyme in carbon fixation.

C. photorespiration is higher in C4 and CAM plants when compared to C3 plants.

D. C4 plants are found in areas where there is low rainfall compared to CAM plants that are found in tropical regions.

Question 19

Enzymatic hydrolysis is a key step in the production of bioethanol. It involves breaking down the complex sugars in the biomass into simpler sugars, such as glucose. This step in the production of bioethanol is important as

A. simple sugars are an input into glycolysis.

B. complex sugars are unable to enter the intermembrane space of the mitochondria.

C. mechanical digestion increases the surface area available for fermentation to occur.

D. it slows the rate of bioethanol production, allowing the reaction to be more easily controlled.

Question 20

During aerobic cellular respiration, NADH and $FADH_2$ become unloaded in the intermembrane space of the mitochondria. The purpose of this is

A. to allow the unloaded coenzymes to return to the cytosol .

B. to create a concentration gradient, causing the H^+ ions to move through ATP synthase.

C. to donate protons to enable pyruvate to be converted into acetyl CoA.

D. to be an oxygen acceptor, producing water than can be used for cellular processes.

Question 21

In C3 plants

A. water is split in the light independent stage on the thylakoid membranes, with NADP becoming loaded to form NADPH.

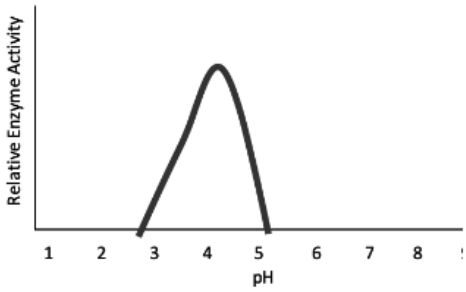
B. carbon dioxide is fixed in the bundle sheath cells, with water being released as a waste product.

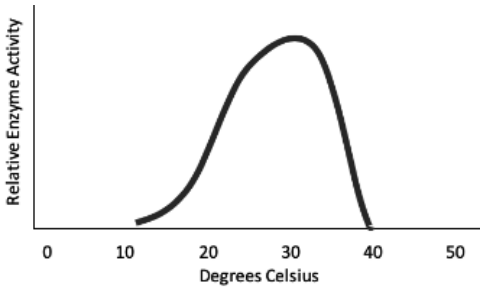
C. NADPH and ATP are produced in the light dependent stage in the grana.

D. NADPH and $FADH_2$ are unloaded in the stroma, to combine with CO_2 to produce glucose.

Question 22

The graphs below show the activity of an enzyme in varying pH levels and temperatures.





From the graphs it is reasonable to conclude that

A. at a temperature of 10 degrees Celsius, the enzyme has denatured.

B. the enzyme has an optimal pH of 4 and temperature of 40 degrees Celsius.

C. the enzyme exists within an alkaline environment.

D. the optimal temperature for the enzyme is 25 degrees Celsius.

Question 23

Whist completing an experiment at school, a student realised halfway through that they had added too much enzyme to a solution, despite being told at the start of the lesson to be careful as they needed to ensure that there was enough enzyme left for the other Biology class.

What type of error has the student made?

A. systematic

B. random

C. justified

D. personal

Question 24

To measure the rate of respiration, students decided to design an experiment that used cockroaches sourced from a local pet store. They intended to alter the levels of carbon dioxide and measure the time that it took for each cockroach to die at a given concentration. Their teacher did not permit them to do the experiment, as they said that it was unethical. Which ethical concept did they breach?

A. respect

B. integrity

C. duty based

D. justice

Question 25

A student investigated the effect of light intensity and carbon dioxide concentration on the rate of photosynthesis. They set up a light on a retort stand and measured the rate of photosynthesis with the light at different heights. They also changed the concentration of sodium bicarbonate to identify the effect of varying carbon dioxide concentration. The experiment was not reliable as

A. it does not state how the data was collected.

B. the expected value was not identified; therefore, they are unable to determine the accuracy of their data.

C. there are two independent variables.

D. it arranges objects into discrete sets.

END OF SECTION A

SECTION B

Specific instructions for Section B

This section consists of **6** questions. There are **50** marks in total for this section.
Write your responses in the spaces provided. You should attempt **all** questions. Please write your responses in **blue** or **black ink.**

Question 1

Cells must convert the code found within genes into a functional protein product. For eukaryotes, this process occurs within the cell.

Below is a simplified overview of what is occurring within the nucleus.

a Account for the difference in the length of the strands.

_____

_____

(2 marks)

b The second strand is not ready to leave the nucleus. State the modifications that need to occur to this strand **and** explain their importance.

_____

_____

_____

_____

_____

(3 marks)

c Protein synthesis occurs in both prokaryotes and eukaryotes. Describe **two** differences that occur in protein synthesis for these types of cells.

_____

_____

_____

_____

_____

(2 marks)

d mRNA is a nucleic acid that is found within the cytosol of all cells. Name the other two RNA molecules **and** describe their role within the cell.

_____

_____

_____

_____

_____

_____

(4 marks)

Total 11 marks

Question 2

Amino acids are the building blocks of proteins and are essential to cell survival. Some can be made by the cell but many are obtained from the diet.

a In the space below, draw a monomer of a protein, and identify the part that varies between each monomer.

(2 marks)

b Protein synthesis needs to be regulated to ensure that cells conserve resources. The *Trp* operon is a regulatory process in prokaryotes that, by default, is always switched off. Explain how this can occur.

_____

_____

_____

_____

_____

(2 marks)

One protein product produced in prokaryotes are endonucleases. These enzymes can cleave DNA at specific recognition sequences.

c Describe how endonucleases are used in the creation of a recombinant plasmid of insulin **and** the role of an additional enzyme required in this process.

_____

_____

_____

_____

_____

_____

(3 marks)

Total 7 marks

Question 3

Sugarcane is a tall tropical grass that is primarily grown for its sugar-rich stalk. It is one of the world's largest crops and a major source of sugar. It is native to Southeast Asia and is commonly grown in the tropical regions of Queensland, as shown by the shaded areas on the map below.

Source: https://www.bundysugar.com.au/education/where.html

a Sugarcane undergoes carbon fixation in the bundle sheath cells. What type of plant is sugarcane?

_____

(1 mark)

b Identify the enzyme responsible for the initial carbon fixation that occurs in the sugarcane **and** the initial enzyme used for carbon fixation that occurs in most types of plants.

_____

_____

(1 mark)

CRISPR technology can be used to increase crop production in plants. In the sugarcane plant, the genome has been altered to increase the biomass – an input in the production of biofuels.

c Outline the process by which scientists could insert a gene to increase biomass production in the sugarcane plant.

_____

_____

_____

_____

_____

_____

(5 marks)

When editing a genome, ethical considerations need to be evaluated. Whilst the increase in biomass of the sugarcane may be beneficial for the production of additional biomass, the increased food source could see an increase in pest species such as cane grubs.

d With reference to **two** ethical concepts, describe considerations that the scientists should evaluate prior to genetically modifying the crop.

_____

_____

_____

_____

_____

_____

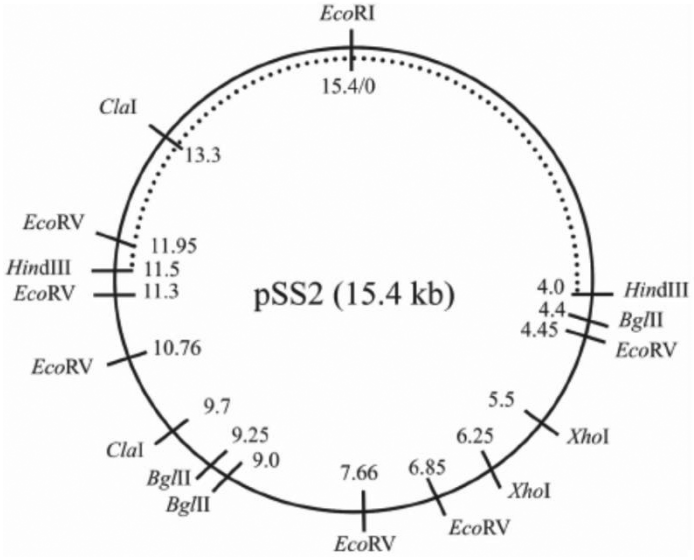
(4 marks)

Total 11 marks

Question 4

Tetracycline is an antibiotic commonly used in the creation of recombinant plasmids. It is inserted into a plasmid to be transformed, allowing scientists to determine whether the plasmid has taken up the gene of interest. If the bacteria are able to grow on a medium containing the antibiotic, the transformation has been successful.

The image below shows the different recognition sites of a range of endonucleases in a tetracycline resistant plasmid.



Source: Balassiano, Ilana & Bastos, Maria do Carmo & Madureira, Danielle & Silva, Iris & Freitas-Almeida, Angela & Oliveira, Selma. (2007).

a Define the term endonuclease.

_____

_____

(1 mark)

b The plasmid is digested with EcoRV and HindIII. How many fragments would be produced as a result?

_____

(1 mark)

c When using endonucleases, such as EcoRI to digest a sample of DNA for gel electrophoresis, is it preferable to create sticky or blunt ends? Explain your answer.

_____

_____

_____

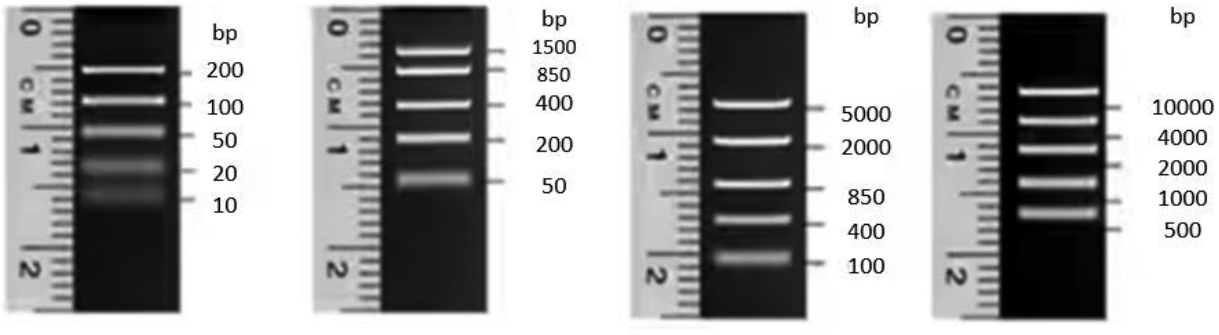
_____

(2 marks)

A standard ladder is usually included when running an electrophoresis gel to enable scientists to estimate the size of the DNA fragments.

Four standard ladders are shown below:

A **B** **C** **D**



d Which ladder would be most appropriate if the plasmid shown on the previous page was digested with XhoI and EcoRI? Use data to support your response.

_____

_____

_____

_____

(2 marks)

e Describe how the viscosity of the gel will affect the resultant gel electrophoresis sample obtained from digesting the plasmid with XhoI.

_____

_____

_____

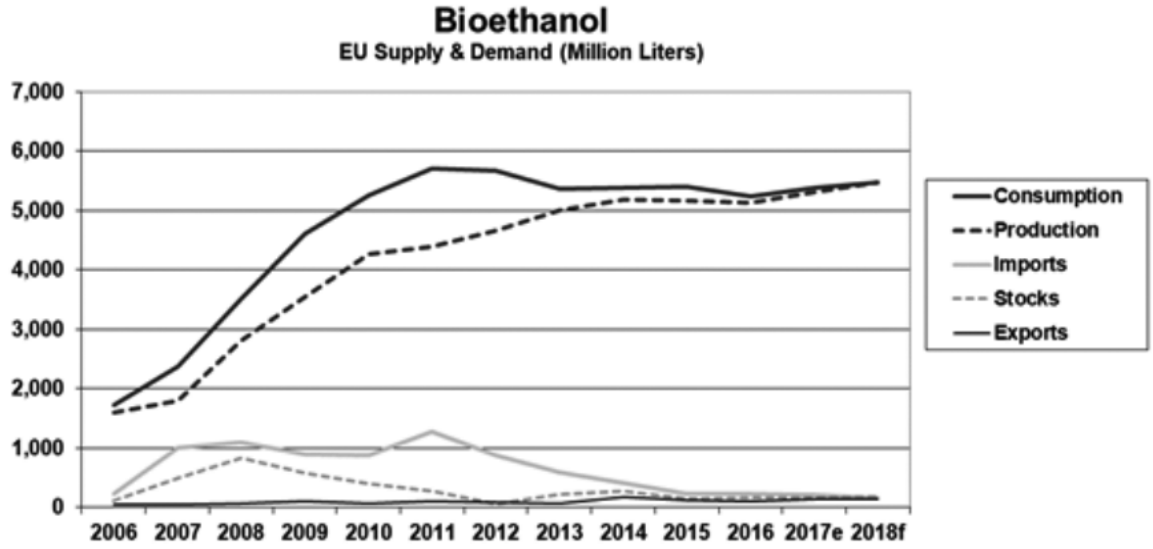
_____

(2 marks)

Total 8 marks

Question 5

The use of biofuels, including bioethanol and biodiesel has increased in consumption and production in the last 15 years, as shown in the graph below.



Source: https://www.eubia.org/cms/wiki-biomass/biofuels/bioethanol/

Bioethanol fuel is generally produced by fermentation of sugar. The main sources of sugar required to produce ethanol come from crops with large amounts of stored energy. These crops are grown specifically for energy use and include corn, maize and wheat crops, waste straw, willow and trees, sawdust, reed canary grass, cord grasses, Jerusalem artichoke, miscanthus and sorghum plants.

There is a move in the field of bioethanol to focus on using lignocellulosic or woody materials as a feedstock. These include short rotation energy crops (for example willow, poplar, miscanthus and eucalyptus), agricultural residues (for example straw and sugar cane bagasse), forest residues, waste woods, and municipal solid wastes. About 2 – 4 dry tons of woody or grassy material is required for the production of 1 ton of ethanol. With a total sugar content of 60 – 70% (40% glucose as cellulose and 25% xylose as hemicellulose), wheat straw can produce around 230 kg of ethanol per ton of dry material.

a There are several reasons for shifting to ethanol production from lignocellulosic biomass. Why is lignocellulosic biomass not suitable for the production of biodiesel?

_____

_____

_____

(2 marks)

b The information above makes reference to both first generation and second generation biofuels. Compare these two initial sources of energy by stating one difference between them.

_____

_____

(1 mark)

c Name and discuss one ethical concept that should be considered with the production of bioethanol from biomass.

_____

_____

_____

_____

(2 marks)

Total 5 marks

Question 6

Yeast is a unicellular fungus that is widely used in food and beverage production, such as baking and brewing. Yeast can undergo both aerobic and anaerobic respiration to produce energy.

During anaerobic respiration, yeast converts glucose into ethanol and carbon dioxide, releasing some ATP in the process. The process is controlled by a series of enzymatic reactions that take place within the cytoplasm of the yeast cell. The first step in anaerobic respiration is the breakdown of glucose into pyruvate via the process of glycolysis. The pyruvate is then converted into ethanol and carbon dioxide.

The rate of anaerobic respiration in yeast can be affected by various environmental factors, including temperature, pH, and the availability of nutrients.

A student completed an experiment where they exposed the yeast to various levels of pH. They then placed the yeast in a solution with glucose and sealed the container. Using a carbon dioxide probe, they measured the amount of carbon dioxide in the container for a period of 5 minutes.

a If the optimal pH for anerobic respiration in yeast is 4, describe the predicted rate of carbon dioxide production in the yeast exposed to the pH of 8.

_____

_____

_____

(2 marks)

b Suggest a limitation in the experiment and how this could be improved.

_____

_____

_____

(2 marks)

The student used a control solution but left it on a windowsill at lunchtime. The sun was shining directly on it and it was a 35°C day. She put the solution in the fridge when she returned after lunch to bring it back down to room temperature.

c Explain what the control would consist of **and** what you expect will happen to the results.

_____

_____

_____

_____

_____

_____

4 marks

Total 8 marks

END OF TRIAL EXAMINATION