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2024 Trial Examination

STUDENT NUMBER | | | | | | | | | Letter |

BIOLOGY

Unit 3 – Written examination

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

QUESTION & ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	25	25	25
B	5	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 calculator is permitted in this examination.

Materials supplied

- Question and answer book of 17 pages.

Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

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

SECTION A: Multiple-choice questions

Instructions for Section A

Answer all 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

Tryptophan (trp) can only be coded for by UGG. As such, tryptophan is:

A. degenerate

B. ambiguous

C. an exon

D. an intron

Question 2

The monomer of a strand of mRNA contains:

A. a phosphate group, 5 carbon sugar and thymine

B. a phosphate group, ribose sugar and thiamine

C. a phosphorus group, ribose sugar and uracil

D. a phosphate group, ribose sugar and uracil

Question 3

Enzymes are used in DNA manipulation to both cut DNA and join DNA.

The bonds that these enzymes are acting upon are:

A. hydrogen bonds

B. disulphide bonds

C. phosphodiester bonds

D. peptide bonds

SECTION A continued

Question 4

Within the protein secretory pathway:

A. proteins are produced in the smooth endoplasmic reticulum and modified in the rough endoplasmic reticulum

B. proteins are moved between the endoplasmic reticulum and the Golgi via secretory vesicles.

C. secretory vesicles fuse with the plasma membrane for protein export from the cell

D. transport vesicles move proteins from the Golgi to the rough endoplasmic reticulum

Question 5

When attenuation in the trp operon occurs,

A. RNA polymerase is unable to bind to the operator region

B. RNA polymerase quickly transcribes the two trp codons in the leader region

C. the repressor protein binds to the operator region

D. the structural proteins are expressed for use within the cell

Question 6

The proteome is:

A. the complete set of proteins expressed by an organism

B. the complete set of proteins in an organisms' genome

C. the complete set of proteins present in utero

D. the complete set of genes contained within an organism

Question 7

The correct sequence of events in polymerase chain reaction (PCR) is:

A. elongation at 72^{o}C; annealing at 55^{o}C and denaturation at 95^{o}C

B. annealing at 55^{o}C; elongation at 72^{o}C and denaturation at 95^{o}C

C. denaturation at 72^{o}C; annealing at 55^{o}C and elongation at 95^{o}C

D. denaturation at 95^{o}C; annealing at 55^{o}C and elongation at 72^{o}C

SECTION A - continued
TURN OVER

Question 8

CRISPR Cas 9 is a process that allows bacteria to protect themselves from viral infection. The viral DNA is stored in the CRISPR array between:

A. repeats

B. spacers

C. guides

D. PAM sites

Question 9

A tRNA anticodon has the 3-nucleotide sequence of UUA. The corresponding sequence on the coding strand of DNA would be:

A. AAT

B. TTA

C. AAU

D. UUA

Question 10

Within the leader region of the trp operon, there are two adjacent trp codons. These codons help to:

A. regulate the rate of transcription

B. create hairpin loops in the resultant protein

C. create hairpin loops in the pre-mRNA

D. create hairpin loops in the mRNA

Question 11

A non-competitive inhibitor:

A. binds to the allosteric site

B. creates an attenuated protein

C. regulates the rate of transcription by binding to the operator region

D. binds to the active site, with an increase in substrate minimizing the impact of the inhibitor

SECTION A continued

Question 12

The final H+ acceptor in aerobic respiration is:

A. Oxygen

B. FAD+

C. NADP+

D. NAD+

Question 13

A small sample of DNA was extracted from a fossil and PCR was conducted in a laboratory to amplify this. The sample, RNA polymerase, free nucleotides and primers were added to the PCR mixture.

After 30 minutes it was observed that the volume of the DNA in the sample remained unchanged.

The most likely explanation for this is:

A. PCR requires a large sample

B. the incorrect enzyme was added

C. insufficient free nucleotides were added

D. primers are not used in PCR

Question 14

When considering changes in pH and temperature for an enzyme driven reaction, it is fair to state:

A. at a pH above and below the optimum, and a temperature below the optimum, the rate of reaction will be low

B. at an optimum pH and temperature, the amount of substrate will remain unchanged

C. at a pH and temperature above the optimum, the rate of reaction will increase

D. at a pH and temperature below the optimum, the rate of reaction will increase

Question 15

The net total ATP yield in glycolysis is:

A. 2

B. 4

C. 26

D. 30

SECTION A- continued
TURN OVER

Question 16

The optimal temperature for inserting a plasmid into a *E. coli* bacterium via heat shock is:

A. 95^{o}C
B. 55^{o}C
C. 20^{o}C
D. 40^{o}C

Question 17

Post-translational folding of proteins initially occurs:

A. at the smooth endoplasmic reticulum
B. at the rough endoplasmic reticulum
C. within the nucleus
D. at the Golgi complex

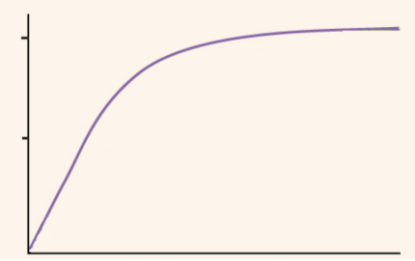
Question 18

The production of bioethanol requires a series of steps, one of which is enzymatic hydrolysis. The purpose of enzymatic hydrolysis is to:

A. produce carbon dioxide
B. directly convert glucose into ethanol
C. break stored sugars into monomers
D. convert monomers of glucose into polysaccharides

Question 19

The axis on the graph below could be:



A. x: temperature; y: rate of reaction
B. x: substrate concentration; y: rate of reaction
C. x: rate of reaction; y: pH
D. x: enzyme concentration; y: substrate concentration

SECTION A continued

Question 20
The Cas9 enzyme acts as molecular scissors, cutting through the double strand of DNA. Cas9 cuts at a precise location by:
A. binding to the target sequence and cutting 2-5 nucleotides upstream
B. recognising a specific palindromic sequence and cutting 2-5 nucleotides downstream
C. binding to the tracer sequence and cutting 2-5 nucleotides downstream
D. binding to the PAM sequence and cutting 2-5 nucleotides upstream

Question 21
RNA processing:
A. removes introns as they are non-coding regions
B. adds a methyl cap to the 3' end and a poly A tail to the 5' end to protect the mRNA molecule from degradation when it leaves the nucleus
C. splices introns together
D. converts mRNA to DNA using reverse transcriptase

The following information relates to questions 22 - 25
A student conducted an experiment to observe the rate of cellular respiration in yeast. Prior to undertaking the experiment, they conducted research and identified that yeast cells have mitochondria, therefore can undergo aerobic respiration.
They added a yeast and sugar solution to a beaker and placed an airtight lid on top. They used an ethanol, carbon dioxide and oxygen probes to measure the changes in the solution over a 30-minute period.

Question 22
After 30 minutes it would be expected that:
A. ethanol levels would decrease
B. carbon dioxide levels would decrease
C. oxygen levels would increase
D. ethanol levels would increase

Question 23
After 30 minutes it would be expected that:
A. aerobic respiration would be occurring
B. anaerobic respiration would have stopped
C. carbon dioxide is being used as an input of aerobic cellular respiration
D. anaerobic respiration would occur

Question 24
The change in carbon dioxide levels would be due to:
A. carbon dioxide being an input in glycolysis
B. carbon dioxide being produced in the Krebs cycle
C. carbon dioxide being an oxygen acceptor in the electron transport chain
D. carbon dioxide being produced in the cristae

Question 25
A controlled variable in the experiment would be:
A. the volume of yeast used
B. the oxygen concentration
C. the number of bubbles produced
D. the amount of product produced

END OF SECTION A

SECTION B - Short-answer questions

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 (6 marks)

In eukaryotes, proteins are produced and may be sent to neighbouring cells. Insulin is one such example. It is produced in beta cells of the pancreas and secreted into the bloodstream.

a. Which organelle in the beta cells is insulin synthesised?

_____

1 mark

b. Outline the process that occurs in the nucleus of the beta cells after transcription that allows the genetic code to leave via nuclear pores.

_____

_____

_____

_____

3 marks

c. In the space below, draw the chemical structure of the monomer of insulin.

2 marks

SECTION B - continued
TURN OVER

Question 2 (6 marks)

The trp operon that occurs in *E. coli*, a bacterium often found in the digestive tract of humans. The *E. coli* are able to obtain the amino acid tryptophan (trp) due to the symbiotic relationship that exists between the bacteria and humans. If the bacteria cannot access the amino acid tryptophan, they can produce it through expressing the structural genes that encode for tryptophan.

a. Briefly describe the relationship between the trp repressor gene, the operator region and the trp structural genes.

_____

_____

_____

_____

2 marks

b. A mutation occurred in the operator region of the trp operon, causing a change in sequence. Outline the potential consequence for the cell.

_____

_____

_____

_____

_____

4 marks

SECTION B - continued

Question 3 (6 marks)

CRISPR Cas9 technology has been used to manipulating genes involved in the ripening process, in tomatoes to extend the shelf life. This modification could potentially reduce food waste and improve the availability of fresh produce.

a. What is the purpose of the PAM sequence in CRISPR Cas9 technology?

_____

_____

_____

_____

2 marks

b. A scientist wanted to use CRISPR technology to modify tomato plants by inserting a gene that would slow ripening. They created a complementary gRNA sequence to the target sequence and added it to a cell with Cas9. They repeated the experiment hundreds of times without success. Propose a reason for this.

_____

_____

_____

2 marks

SECTION B - Question 3- continued
TURN OVER

c. The genetically modified (GM) tomatoes were ready to enter the market and be sold in stores throughout Victoria. Some people protested out the front of markets, accusing the growers of creating Frankenstein foods. The stores argued that the benefit of reduced food wastage was greater than the risk posed by GM foods.

Which ethical approach has the stores' argument been based on? Justify your response

_____

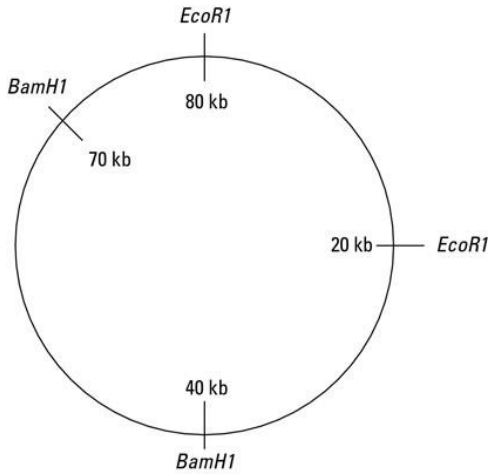
_____

_____

2 marks

Question 4 (6 marks)

A plasmid with recognition sites for EcoR1 and BamH1 is shown below



a. If the plasmid was cut with EcoR1, how many fragments would be produced?

_____

1 mark

b. Both EcoR1 and BamH1 produce sticky ends. What is meant by this term and what is the advantage of these ends?

_____

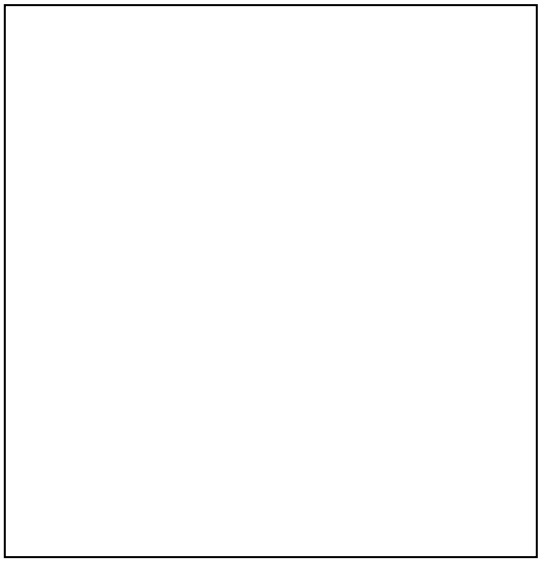
_____

_____

2 marks

SECTION B - Question 4 continued

c. In the space below, show the banding pattern that would appear if the plasmid was cut with both EcoR1 and BamH1. Include the direction that the DNA will move in, and the charge at each end of the well.



3 marks

Question 5 (15 marks)

In dry conditions, plants close stomata to conserve water. When this happens, photorespiration can occur.

a. What is photorespiration and what does it produce?

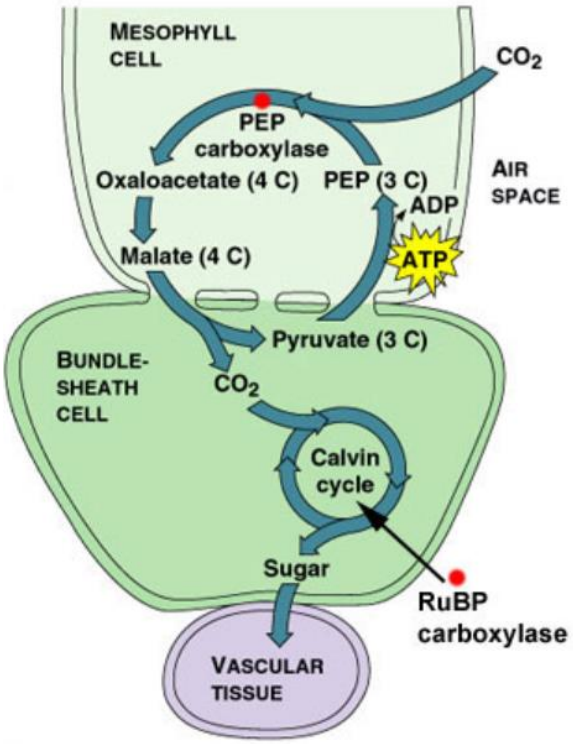
_____

_____

_____

2 marks

The following diagram shows one pathway for the light independent stage of photosynthesis in plants.



b. Using evidence from the diagram, what specific pathway of the light independent stage of photosynthesis is occurring?

_____

_____

_____

_____

3 marks

c. What type of conditions is the pathway above best adapted to?

_____

1 mark

SECTION B – Question 5 - continued

d. (i) Identify 2 co-enzymes required for photosynthesis to occur.

_____

2 marks

(ii) Despite being essential for photosynthesis to occur, provide two pieces of evidence as to why the molecules in part (i) is not considered an enzyme?

_____

_____

_____

_____

2 marks

e. Carbon fixation is required to produce glucose. What is carbon fixation, and how does it differ between C3 plants and plants with photosynthetic adaptations?

_____

_____

_____

_____

_____

_____

5 marks

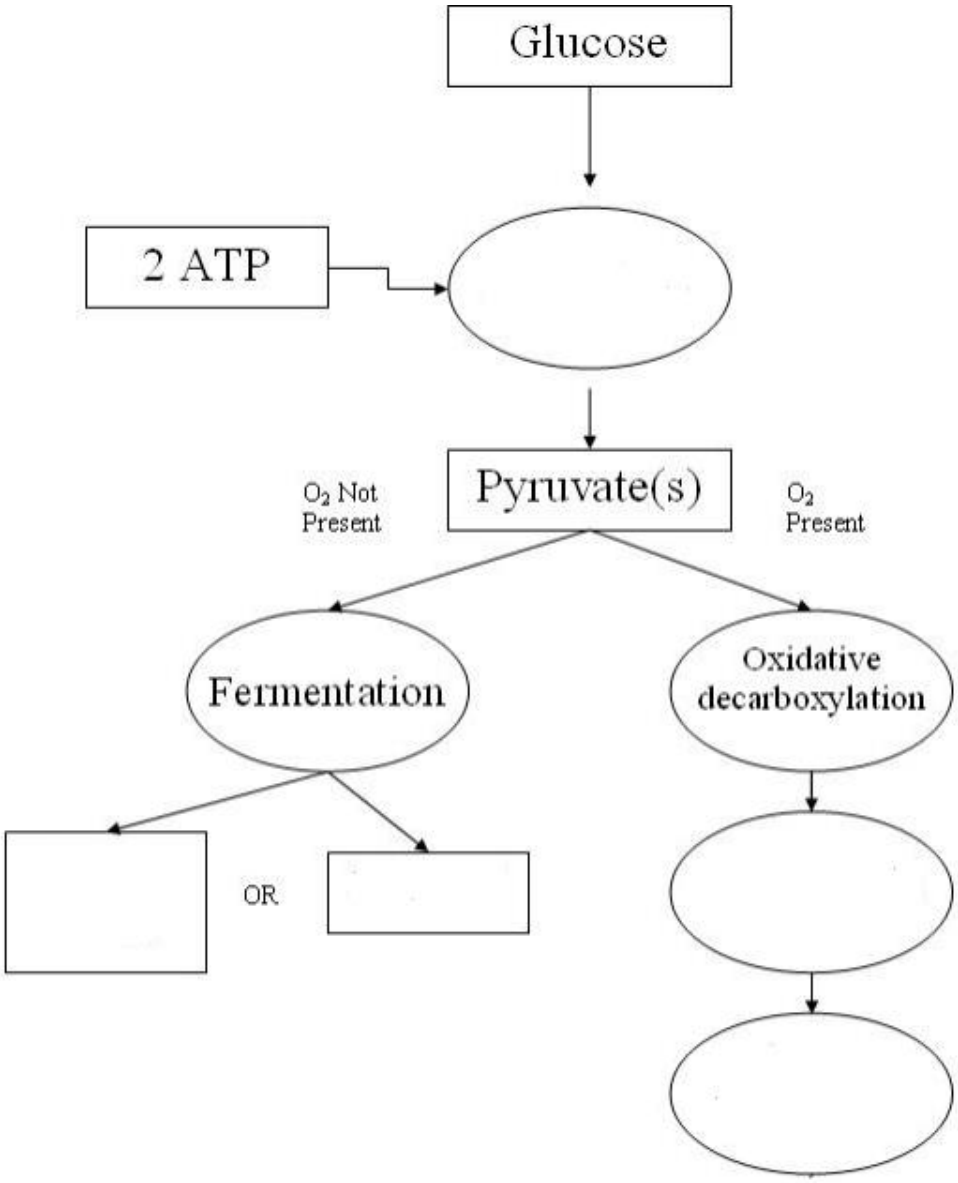
SECTION B –continued

TURN OVER

Question 6 (11 marks)

Cellular respiration is a process that occurs in all organisms, with eukaryotes able to undergo aerobic respiration as well.

a. Fill in the blanks on the flow chart below to complete the stages, inputs and outputs of cellular respiration.



5 marks

SECTION B – Question 6 - continued

b. Oxygen is an input into the final stage of aerobic cellular respiration. Explain the role of oxygen in this stage, and how it can act as a limiting factor.

_____

_____

_____

_____

_____

_____

6 marks

END OF QUESTION AND ANSWER BOOK