Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination
Sample 1

Biology

Higher Level

2 hours 30 minutes

300 marks

Examination Number

Date of Birth ☐☐/☐☐/☐☐

For example, 3rd February 2005 is entered as 03 02 05

Centre Stamp

Instructions

There are **seven** questions on this examination paper. Each question carries 50 marks.

Answer **Question 1** and any **five other** questions.

Write your Examination Number and your Day, Month and Year of Birth in the boxes on the front cover.

Write your answers in blue or black pen. You may use pencil for sketches, graphs and diagrams only.

This examination booklet will be scanned and your work will be presented to an examiner on screen. All of your work should be presented in the answer areas, or on the given graphs, or diagrams. Anything that you write outside of the answer areas may not be seen by the examiner.

You are not required to use all the space provided. There is space for extra work at the back of the booklet. If you need to use it, label any extra work clearly with the question number and part.

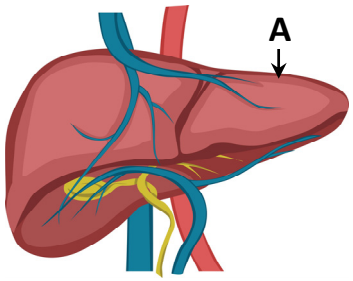
You may lose marks if your solutions do not include relevant supporting work.

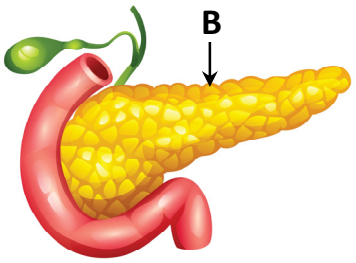
You may lose marks if the appropriate units of measurement are not included, where relevant.

Question 1 is compulsory

Question 1 **50 marks**

(a) **(i)** Identify **each** of the following organs (**A** and **B**) associated with the digestive system.





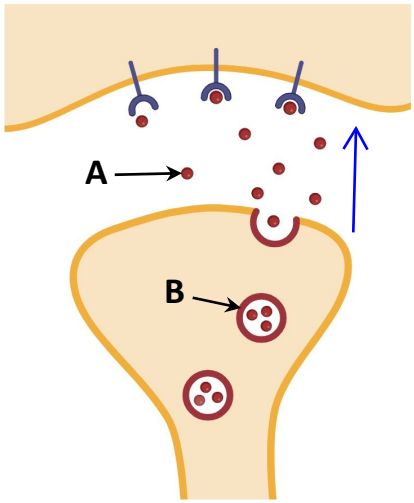
A: Liver	B: Pancreas

(ii) Describe a role organ **A** plays in digestion.

The liver produces bile which emulsifies fats .

(b) The diagram shows a synapse in the nervous system.

(i) Molecule **A** and structure **B** have roles in neurotransmission.
Identify **A and B**.



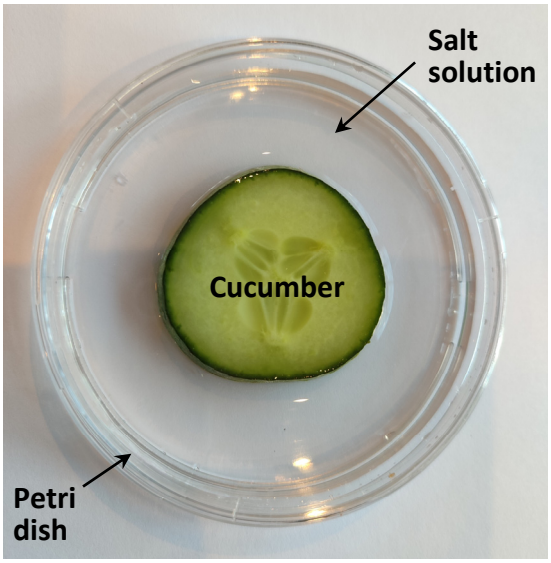
A: Neurotransmitter
B: Vesicle

(ii) **On the diagram on the right**, draw an arrow to show the direction the nerve impulse is transferred.

(iii) What happens to the molecules labelled **A** after the nerve impulse transmission is complete?

The neurotransmitters are inactivated
by enzymes such as cholinesterase and
reabsorbed by the presynaptic neuron to
make new neurotransmitters.

(c) A student carried out an investigation on the movement of water into and out of plant tissue.



During the investigation, pieces of cucumber (each 5 g in mass) were placed into different salt concentrations (M = molarity) and the final masses of each were recorded after 30 minutes. The student collected the following data.
Analyse the data and answer the questions that follow.

Salt concentration (M)	0.0	0.1	0.2	0.3	0.4	0.5
Final mass (g)	5.5	5.3	5.0	4.9	4.7	4.5
Change in mass +/– (g)	+0.5	+0.3	0	– 0.1	– 0.3	– 0.5

Molarity is a measure of concentration

(i) What term describes movement of water across a membrane?

Osmosis

(ii) Name the independent variable in this investigation.

Salt concentration

(iii) What conclusion can the student make from this investigation based on the data collected?

At more dilute concentrations, water entered the cucumber by osmosis, causing the cucumber to increase in mass. Salt solutions that were more concentrated caused the cucumber to lose water by osmosis and decrease in mass. Therre was no change in mass at 0.2 M indicating the cucumber itself has a salt concentration of 0.2 M.

(d) The hormone insulin stimulates the uptake of glucose from the bloodstream into cells, particularly in muscles. Glucagon is another hormone that converts stored glycogen back into glucose when needed. Glucose and glycogen are types of carbohydrate.

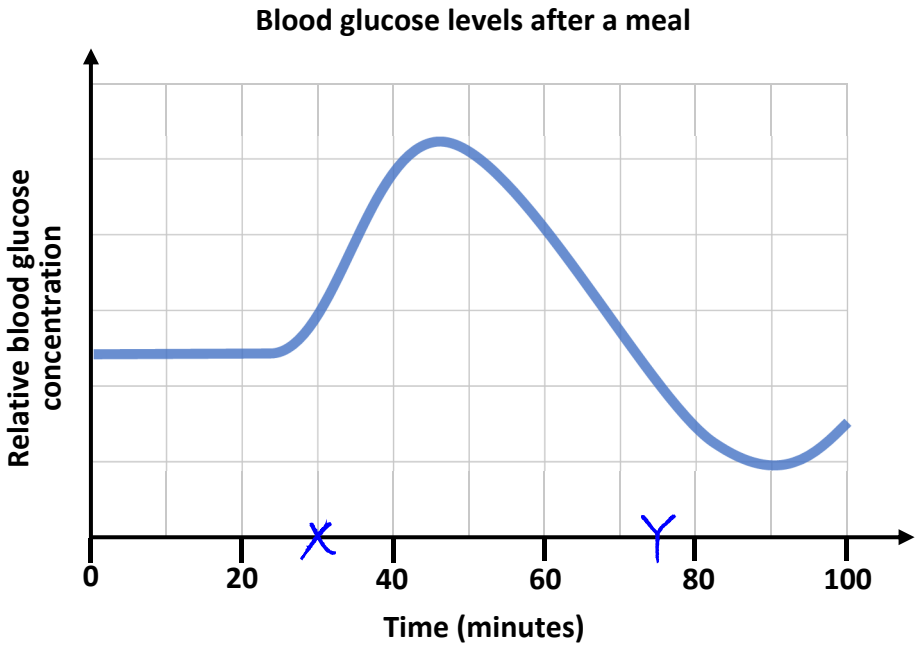
(i) What is the general chemical formula for all carbohydrates?

$C_x(H_2O)_y$

(ii) Explain why glycogen cannot be absorbed into body cells.

Glycogen is a polysaccharide made of many glucose molecules, so it is too
large to pass through the cell membrane into body cells.

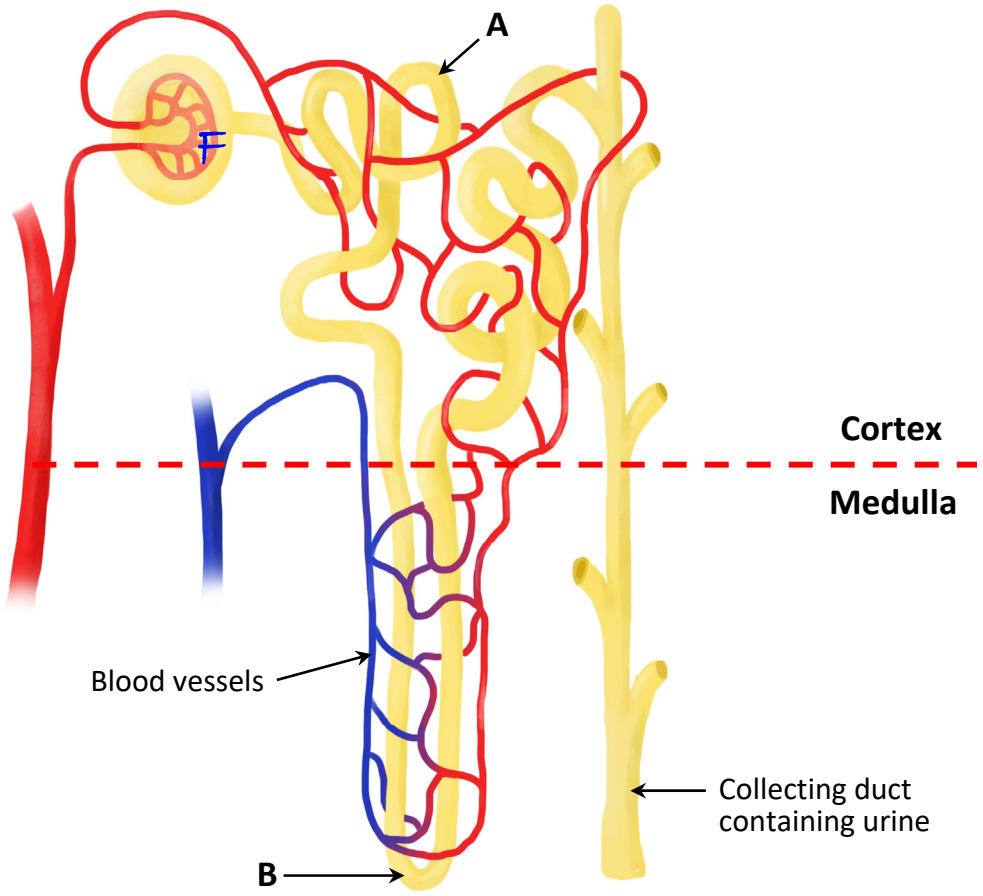
The graph shows a person's relative blood glucose concentration over a period of time.
The person begins eating at the 20 minute mark.
Analyse the data and answer the questions that follow.



(iii) **On the horizontal axis above**, indicate a time with the letter **X**, when the secretion of the hormone insulin is likely to start increasing.

(iv) Low blood glucose concentration is a stimulus for the secretion of glucagon.
On the horizontal axis above, indicate a time with the letter **Y**, when the secretion of the hormone glucagon is likely to start increasing.

(e) The diagram shows a nephron from a human kidney which plays a part in the filtration of blood.



(i) Name the parts of the nephron labelled **A** and **B**.

A: Proximal convoluted tubule
B: Loop of Henle

(ii) Filtration in the kidney occurs under a form of high pressure known as ultrafiltration.
On the diagram above, write the letter **F** to show where this type of filtration occurs.

(iii) Name a constituent of the blood **not** normally present in urine.

PRotein

(iv) The structure labelled **B** has evolved to be longer in certain animal species such as camels and desert rats.
Suggest an advantage this provides to these animals.

Greater time for reabsorption of molecules such as glucose
and water.

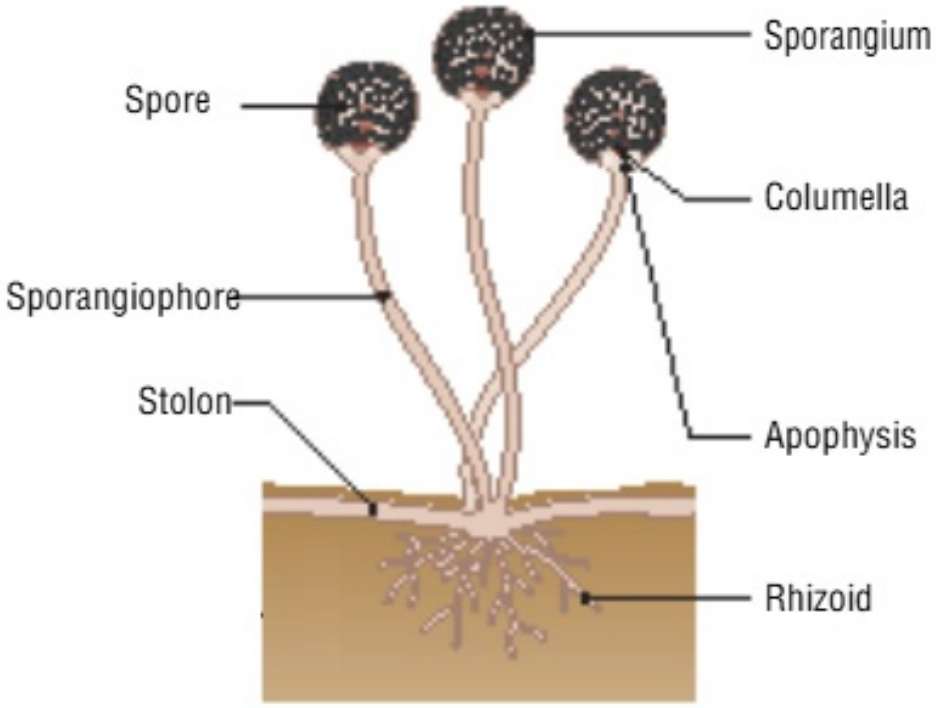
(f) *Rhizopus* is a fungus and can be classified as a decomposer.

(i) What is meant by the term *decomposer*?

A decomposer is an organism that breaks down dead organic matter.

(ii) Draw a labelled diagram of *Rhizopus*.

Labelled diagram:



Answer any five questions from the following questions 2 to 7.
Each question carries 50 marks.

Question 2 **50 marks**

The food and drinks industry use a variety of enzymes and microorganisms to maximise production. Pectinase is an enzyme used to remove the cloudiness in juices such as apple juice by breaking down the pectin found in fruit.

Pectin is a naturally occurring polysaccharide which provides strength to plant tissues. The breakdown of pectin aids the filtration process and increases the overall juice yield.

(a) **(i)** What are enzymes?

Enzymes are biological catalysts

(ii) What is the role of pectin in plant cells?

It provides strength to plant cells .

(iii) Why is pectinase used in juice production?

It removes the cloudiness in juices such as apple juice by breaking
down pectin found in fruit.

(iv) State **two** factors that would affect the rate of activity of enzymes such as pectinase.

Temperature and pH

(v) What part of an enzyme allows them to act on their substrate?

Active site

(b) Microorganisms such as the yeast *Saccharomyces cerevisiae* are used to produce ethanol from fruit juices in a process known as fermentation.

(i) Name **two** conditions that must be present for fermentation to occur, other than the presence of sugars in the fruit juice and microorganisms.

Anaerobic environment and a suitable temperature

(ii) Biologists use a two-part naming system called the binomial system when referring to organisms.
Identify the classification level for **each** part of the binomial name *Saccharomyces cerevisiae*.

Saccharomyces	Genis
cerevisiae	Species

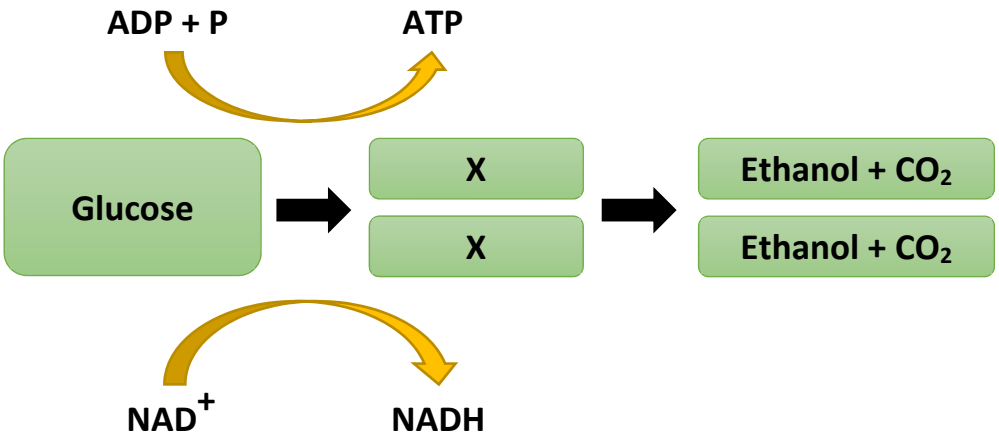
(iii) Apple trees are members of the kingdom *plantae* (plants), whereas yeasts are members of the kingdom *fungi*.

Compare the kingdoms by placing a tick (✓) in the appropriate boxes in the table below.

Note: a characteristic may be present for both kingdoms.

	Kingdoms	
Characteristic	***Plantae***	***Fungi***
Have cell walls made of cellulose	✓	
Heterotrophic		✓
Eukaryotic	✓	
Lacks chloroplasts		✓
Contains chitin		✓

(c) The diagram shows some of the main steps in fermentation in yeast.
Analyse the diagram and answer the questions that follow.



(i) Name the 3-carbon compound formed at **X**.

Pyruvate

(ii) Where in the yeast cell does fermentation occur?

Cytosol

(iii) Describe the role of ATP in cellular reactions.

ATP transfers energy for metabolic reactions in cells

(iv) Name the waste product of fermentation when it occurs in animal cells.

Lactic acid

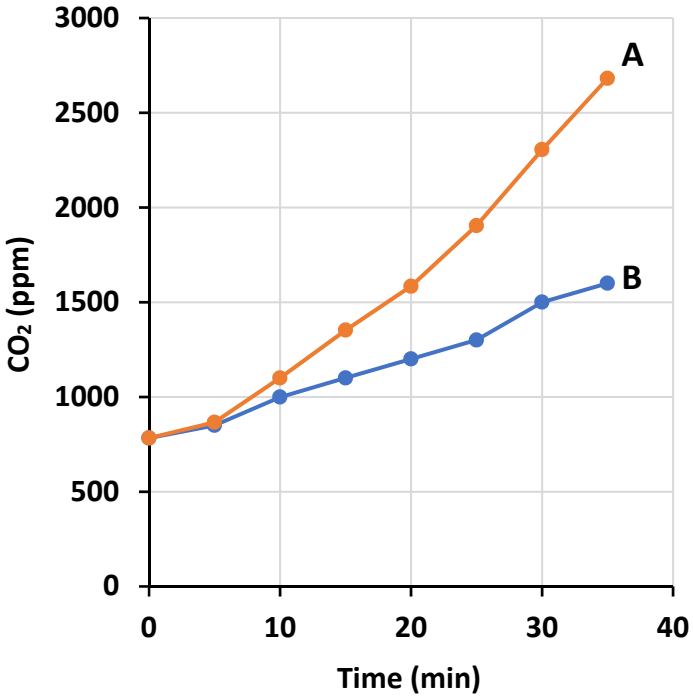
(v) How many carbon atoms does the product you named at part (c) (iv) above contain?

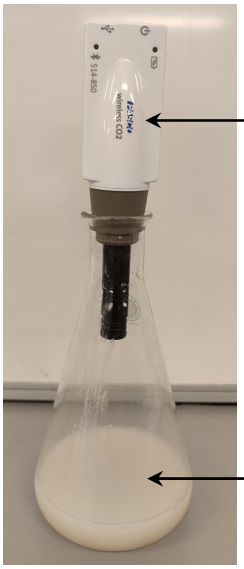
Three

(vi) Suggest an example of animal tissue in which fermentation might occur.

Muscle tissue

(d) A student investigated the effect of different sugars (**A** and **B**) on the rate of fermentation in yeast. The volume of carbon dioxide produced over time was used to measure the rate of fermentation. The yeast and sugar mixture in this investigation was maintained at a temperature of 25 °C. The graph below shows the student's results.
Analyse the graph and answer the questions that follow.





1 ppm = 1 mg/L

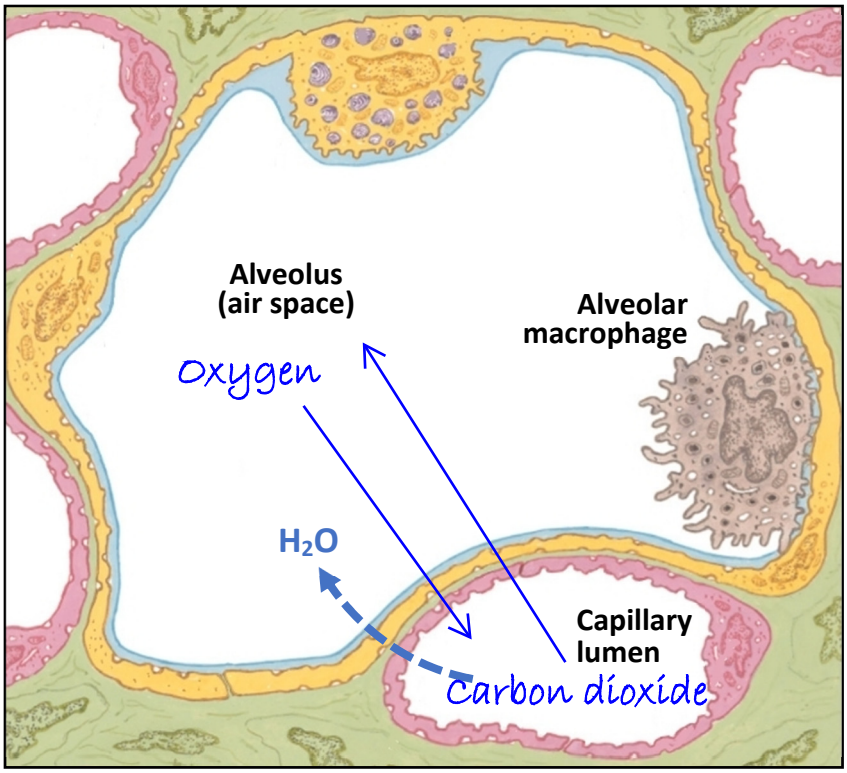
(i) Which line **A** or **B** indicates the results for glucose? Justify your answer.

Line: A
Justify: A indicates the results for glucose as it produces more carbon dioxide quicker. Glucose is a monosaccharide so its conversion to carbon dioxide is quicker than a disaccharide.

(ii) **On the graph above**, draw a line to predict the rate of fermentation of sugar **B** over the course of the investigation if the yeast were maintained at a temperature of 4 °C (placed in the refrigerator).

Question 3 **50 marks**

(a) The diagram shows a transverse section through an alveolus in the lungs.
The arrow shows the overall movement of water vapour during gas exchange.



(i) **On the diagram**, draw labelled arrows to clearly indicate the overall direction in which **each** gas, oxygen (O_2) **and** carbon dioxide (CO_2) move during gas exchange.

(ii) Name the process by which this gas exchange occurs.

Diffusion

(iii) Outline **one** way that alveoli are adapted to carry out efficient gas exchange.

The surface of the alveoli are moist, facilitating rapid diffusion.

(b) **(i)** The alveolar macrophage is an example of a monocyte that has migrated from the bloodstream into the alveolus.
Describe the role monocytes play in the innate immune system.

Monocytes engulf and destroy pathogens and display their antigens on their surface which stimulates the production of antibodies and B lymphocytes.

(ii) Describe **one** other innate immune response in the body.

Hydrochloric acid in the stomach kills pathogens .

(c) Carbon dioxide and oxygen are two common gases carried in the blood between the heart and the lungs in the pulmonary system.

(i) **1.** Describe the **main** way carbon dioxide is transported in the blood.

Carbon dioxide produced by cells dissolves in blood plasma and is transported by the vena cava back to the heart.

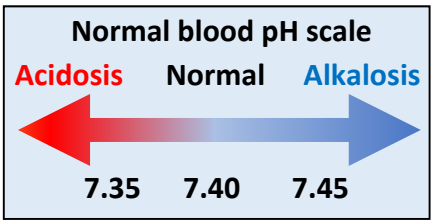
2. Describe the **main** way oxygen is transported in the blood.

Oxygen joins with haemoglobin in red blood cells and is carried by red blood cells and transported by the aorta to the cells of the body

(ii) Compare the relative concentration of **each** gas (carbon dioxide and oxygen) in arterial pulmonary blood **and** venous pulmonary blood by writing the words '**High**' or '**Low**' into the correct boxes.

	Arterial pulmonary blood	**Venous pulmonary blood**
Carbon dioxide	High	Low
Oxygen	Low	High

Increased carbon dioxide in the blood increases its acidity (acidosis). Respiratory acidosis is a condition that results from lower than normal blood pH. The normal pH range of the blood is between 7.35 and 7.45.

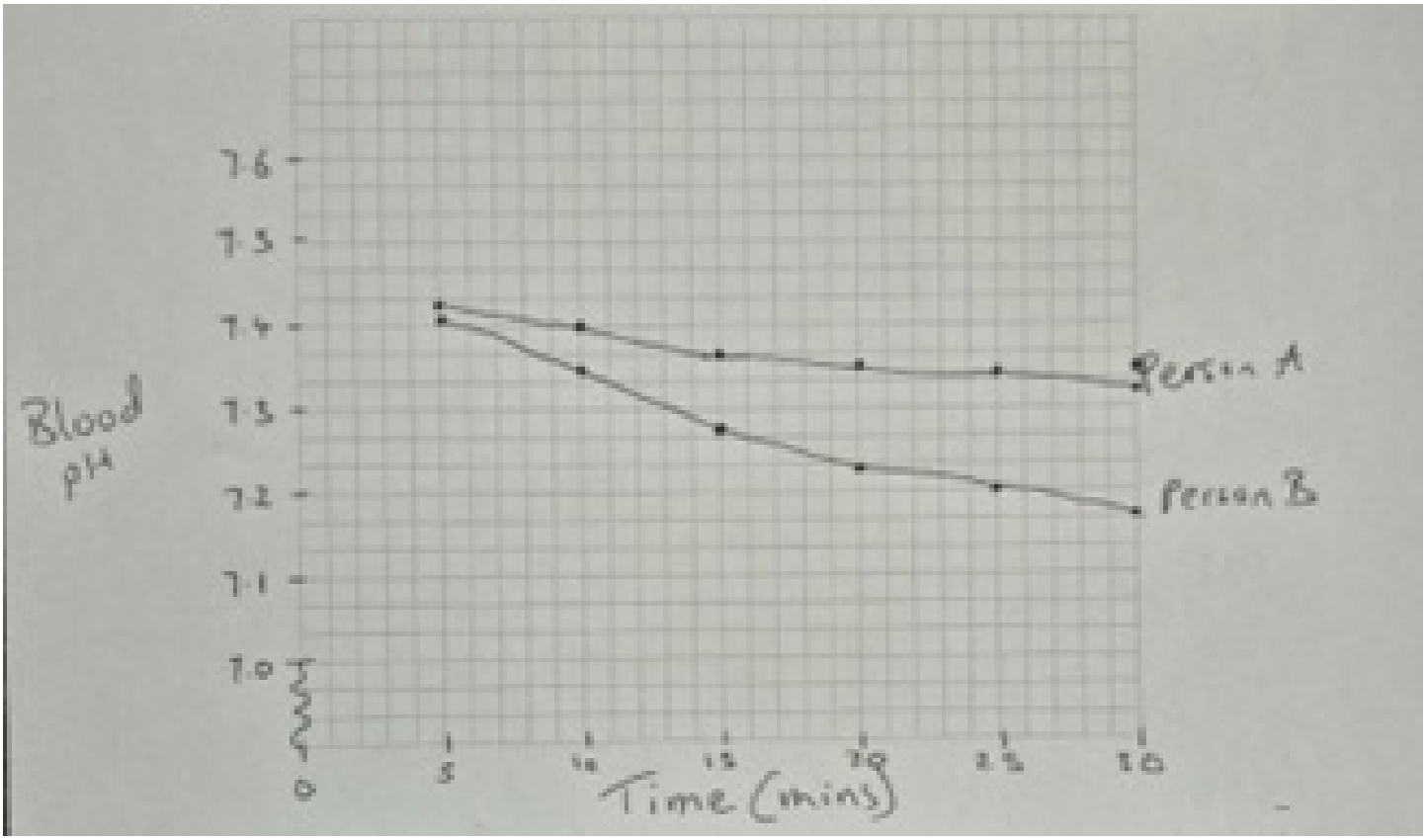


The blood pH of two individuals (**A** and **B**) was measured after resting for 5 minutes. Person **A** had a blood pH of 7.43 and person **B** had a blood pH of 7.42. Their blood pH was then measured at set times during an exercise period. The data from this study is shown in the table.

	Time	5 min	10 min	15 min	20 min	25 min	30 min
Blood pH	**Person A**	7.43	7.40	7.37	7.36	7.35	7.35
	Person B	7.42	7.36	7.27	7.24	7.20	7.17

Adapted from S. Ratel *et al.*, 2002

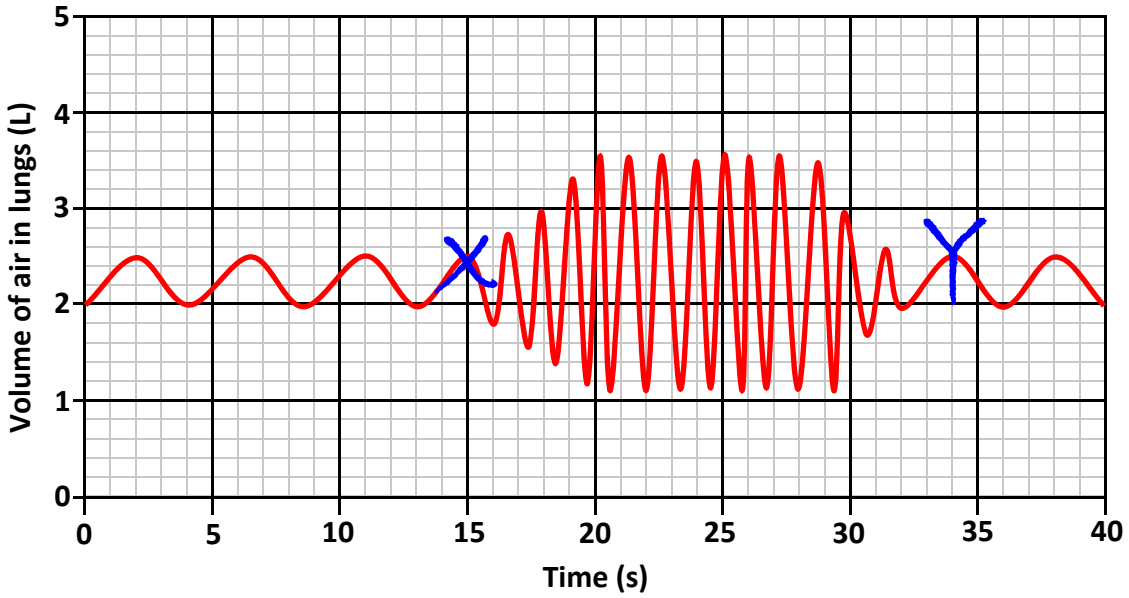
(iii) **On the grid below**, plot a suitable graph to represent all the data in the table above.



(iv) Which person is better adapted at removing carbon dioxide from their bloodstream? Explain your answer.

Person: A
Explain: Person A's blood pH remains closer to neutral after 30 mins
showing that carbond dioxide is being removed from the bloodstream quicker, while person B/s blood pH is more acidic after 30 mins.

(d) As part of their training, athletes often use a spirometer to measure the volume of air inhaled and exhaled during exercise. The graph below shows how the volume of air in the lungs changes for an athlete before, during and after a short period of exercise.



(i) Name the **two** muscles responsible for inhalation **and** indicate whether these muscles are contracting **or** relaxing during this inhalation process.

	Name of muscle	Contracting or relaxing?
1.	Diaphragm	Contracting
2.	Intercostal muscles	Contracting

(ii) Using information from the graph, estimate the volume of air that enters and leaves the lungs of the athlete at rest.

0.5 L

(iii) **On the graph above**, write the letter **X** to show the time at which exercise began **and** the letter **Y** to show the time at which the breathing rate **returned** to the resting rate.

(iv) Analysing information from the graph, describe **two** ways the breathing of the athlete changed during exercise.

Question 4 **50 marks**

(a) Grove snails (*Cepaea nemoralis)* have evolved different colours and patterns on their shells to aid in camouflage.

Brown grove snails are less visible in woodlands while brighter yellow grove snails blend into open grassy areas in summer.

The gene for shell colour has several alleles, such as the dominant allele brown **B**, and a recessive yellow allele **b**.

Banding on the shell is controlled by two alleles: the dominant allele **N**, for a normal, unbanded shell and a recessive allele **n**, for one that is banded.

(i) Explain the underlined terms used in the passage.

Gene: A section of DNA that contains the genetic information
to code for a particular protein.
Alleles: Alternative forms of the same gene
Dominant: The gene which masks the expression of the other gene.

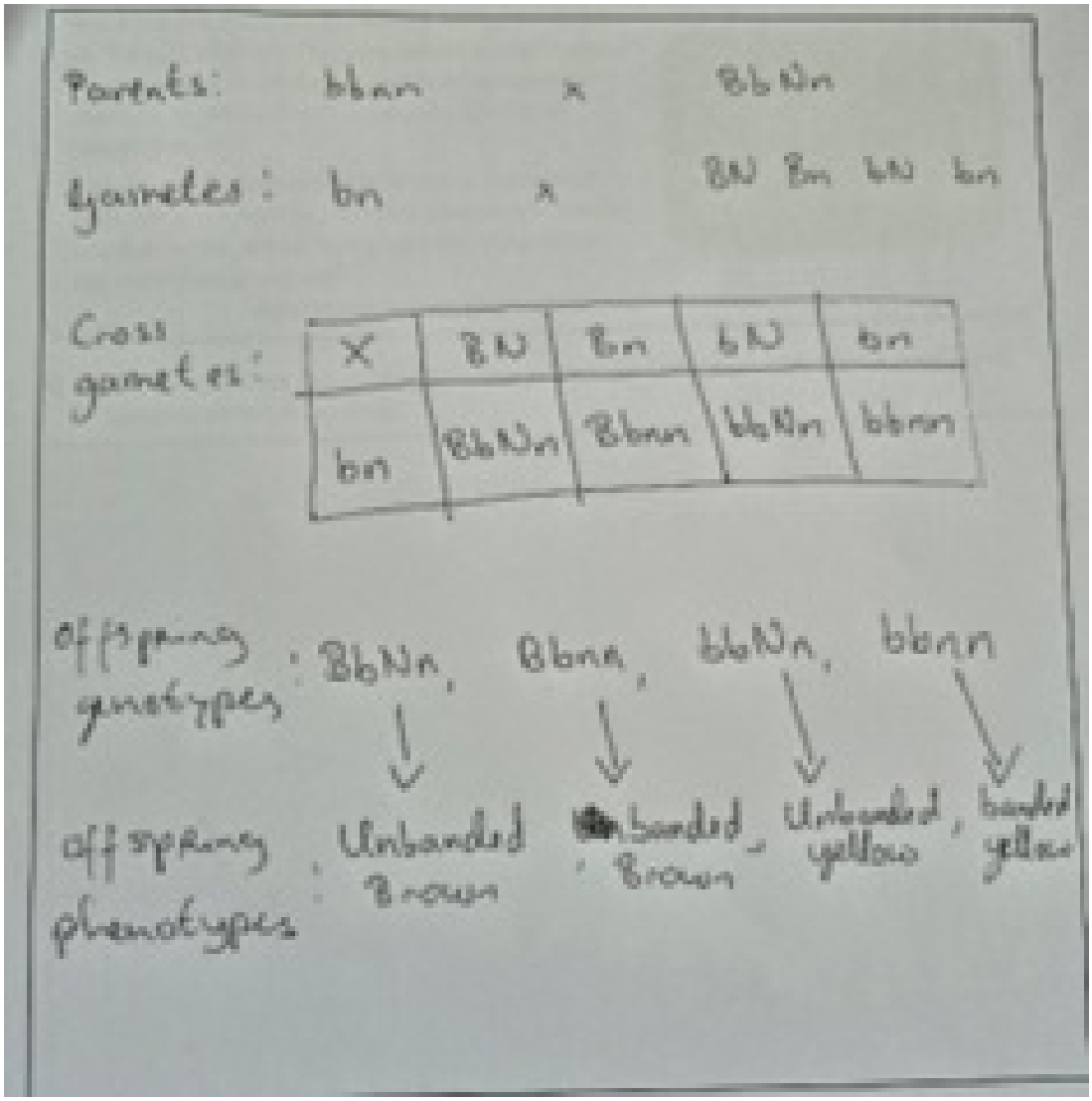
(ii) State the genotype for a snail with a yellow, banded shell **and** state the genotype of the gamete(s) that this snail could produce.

bbnn
Gamete genotype = bn

(iii) State the genotype for a snail with a brown, unbanded shell, heterozygous for both characteristics **and** state the genotype of the gamete(s) that this snail could produce.

BbNn
Gamete genotype = BN, Bn, bN, bn

(iv) A student carried out a cross of the offspring produced between the two snails described in (ii) and (iii). They assumed that the genes are not linked.
Use an appropriate method to determine the genotypes **and** phenotypes of this cross.



(v) Researchers have discovered that the genes controlling colour and banding are linked and are located on the same chromosome.
What is the significance of the genes being located on the same chromosome on the possible offspring of this cross?

There will be less variation, and only two possible phenotypes in the offspring - unbanded brown and unbanded yellow.

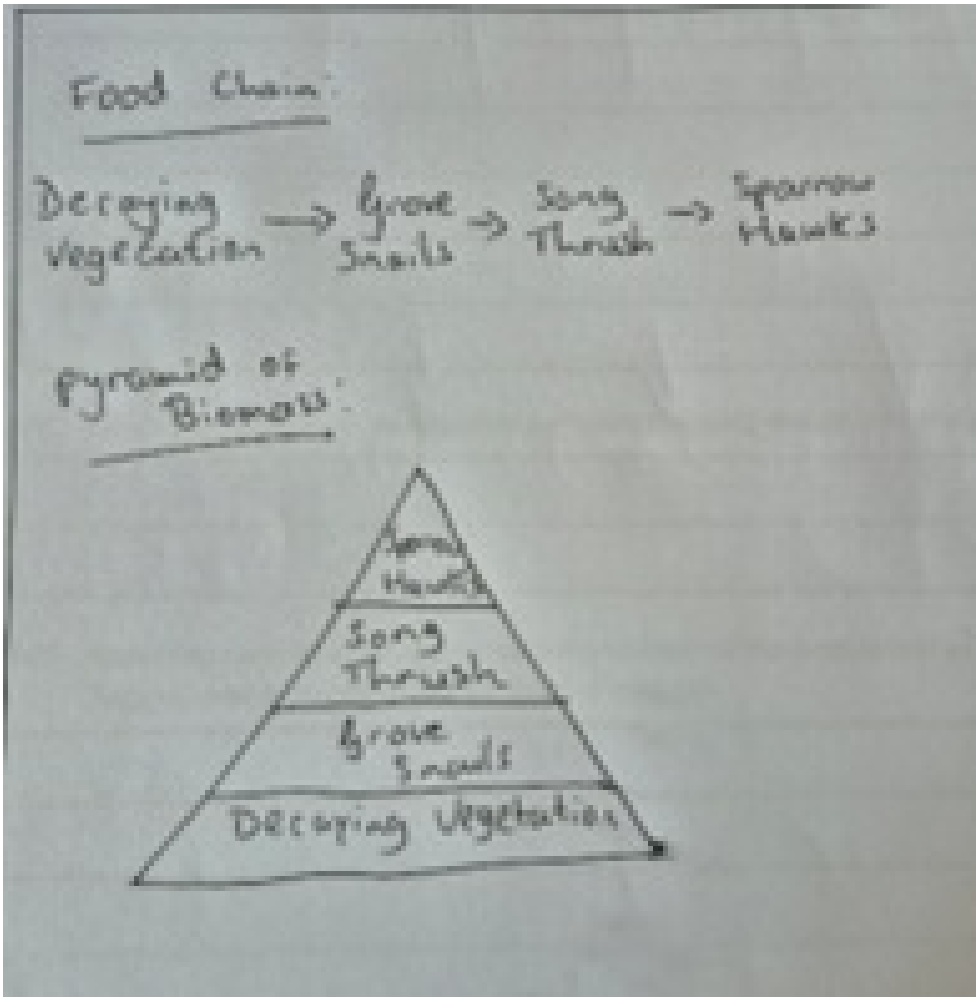
(b) Read the passage below and answer the questions that follow.

Grove snails are a favourite food of the song thrush which breaks open their shells on flat stones to feed on the soft interior. The song thrush is itself hunted by cats and sparrow hawks and uses its speckled plumage to hide in the brown undergrowth of hedgerows.

Grove snails feed mainly on decaying vegetation. They are often host to parasites such as nematodes and flatworms, which along with the song thrush can limit their population.

Adapted from woodlandtrust.org.uk

(i) Using organisms from the article above, model a food chain **and** draw a pyramid of biomass of this food chain.



(ii) The population of song thrushes has declined steeply over the last fifty years. Suggest **one** possible explanation for this decline.

Destruction of habitat

(iii) What ecological change might result if the population of song thrushes continues to decrease?

The population of grove snails will increase.

(iv) Describe **one** adaptation that has evolved in the song thrush which enables it to survive **and** explain how this adaptation benefits the song thrush.

It uses its speckled plumage to hide in the brown undergrowth of
hedgerows to avoid its predators.

(v) State the ecological relationship between the song thrush and the grove snail.

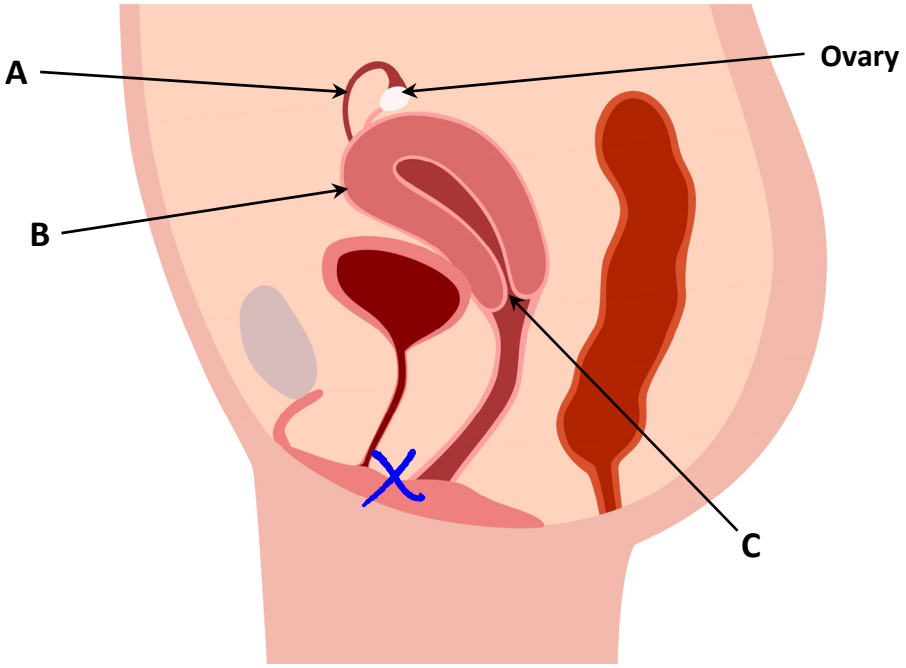
PRedation

(vi) Gardeners sometimes use nematodes to control the population of slugs and snails. Suggest **one** advantage of this form of control.

Biological control does not pollute the water, air or soil.

Question 5 **50 marks**

(a) The diagram shows a side view of the female reproductive system.



(i) Identify **any two** of the parts labelled **A**, **B** and **C**.

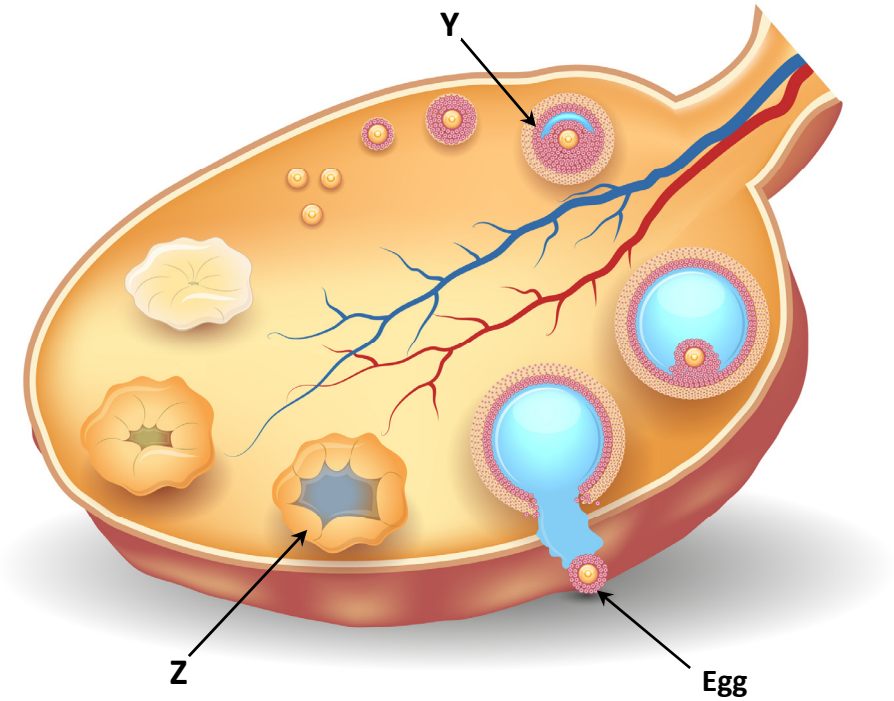
A: Fallopian tube
B: Endometrium
C: Cervix

(ii) **On the diagram above**, mark with the letter **X** the position of the labia.

(iii) State **any one** change that occurs in the human female during puberty.

Maturing and enlargement of breasts

(b) The diagram below shows the events at different stages inside an ovary during a complete menstrual cycle.



(i) Name the type of nuclear division that results in the formation of haploid egg cells.

Meiosis

(ii) Identify the structure labelled **Y**.

Graafian follicle

(iii) Name the hormone that stimulates ovulation of the egg.

Lutenising hormone

(iv) Identify the structure labelled **Z**.

Corpus luteum

(v) Is structure **Z** formed before **or** after ovulation?

After ovulation

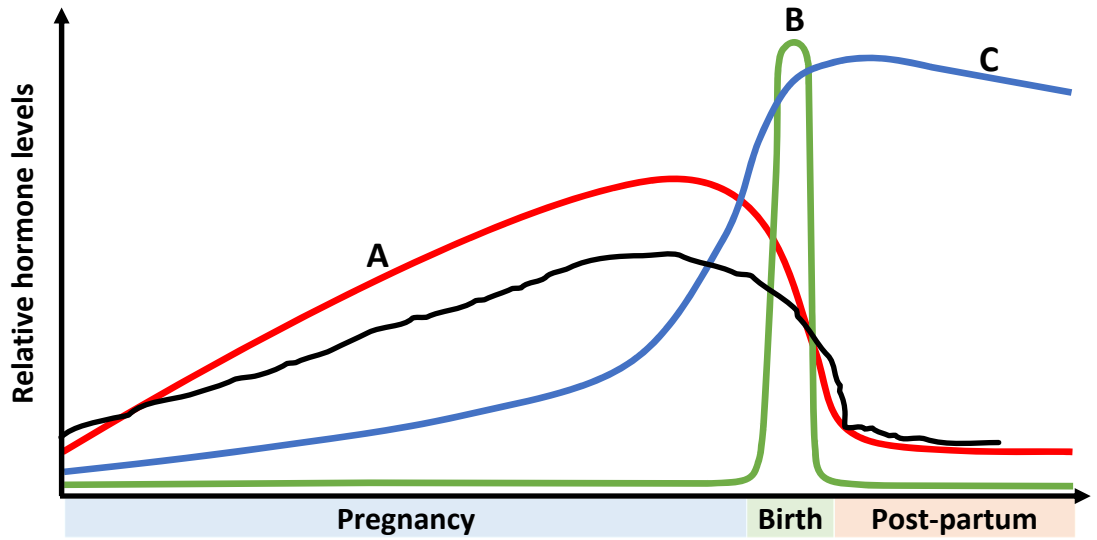
(vi) What happens to structure **Z** at the end of the menstrual cycle, assuming the egg is not fertilised?

It breaks down.

(c) **(i)** When the egg is fertilised, a zygote is formed.
Describe how the zygote develops up until implantation.

The zygote divides by mitosis to form a solid ball of cells called a morula. The morula divides by mitosis to form a blastocyst. The blastocyst embeds itself into the endometrium.

(ii) The graph below shows how the relative levels of the hormones **oxytocin**, **prolactin** and **progesterone** change during pregnancy, birth and post-partum (after the birth).

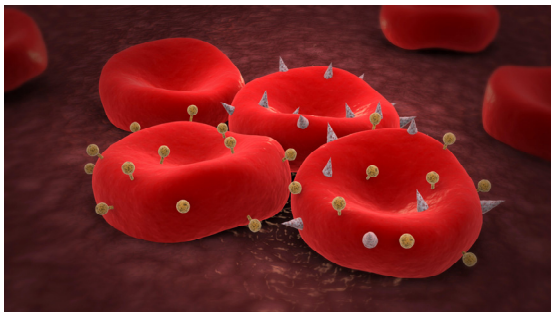


In the table below, match the hormones named above to their effects in the human female **and** match **each** hormone to their correct letter on the graph.

Effect	Hormone	Matching letter
Stimulates breastmilk production	Prolactin	C
Stimulates uterine contractions	Oxytocin	B
Suppresses uterine contractions	Progesterone	A

(iii) Model how the levels of another sex hormone, **oestrogen**, would change throughout pregnancy, birth and the post-partum stage by **either** sketching a line **on the graph above or** describing how the levels would change **in the space below**.

(d) During antenatal screening blood samples may be taken to determine the blood group of the mother.



(i) Name the **two** common blood grouping systems in humans.

1. ABO blood grouping system
2. Rhesus Factor

(ii) Why is knowledge of a person's blood group important?

For blood transfusions, receiving the wrong type of blood can be fatal.

(e) **(i)** Difficulties may occur during the reproduction process due to infertility.
Outline **one** treatment for infertility.

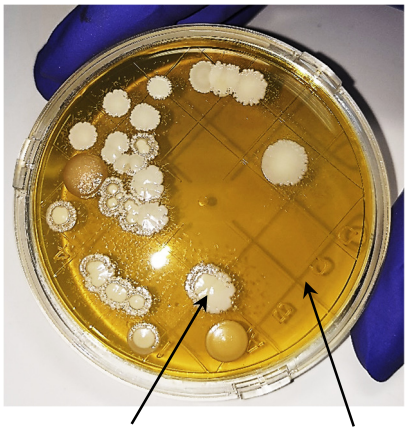
Artificial insermination involves sperm being inserted directly into the
cervix or uterus.

(ii) There are many types of contraception.
Name any **two** types **and** outline how **each** works.

Type: Condom
Outline: Rubber placed over the penis to prevent semen entering the vagina
Type: Contraceptive pill
Outline: Contains hormones which prevent ovulation from occurring

Question 6 **50 marks**

(a) Using aseptic techniques, a student carried out an investigation into the growth of a species of bacteria by inoculating five agar plates, each at a different pH. Inoculation involves the process of introducing bacteria into a nutrient culture, such as agar. All plates were incubated at 30 °C for 48 hours and the average diameters of the bacterial colonies were calculated. The table below shows the student's results.
Analyse the data and answer the questions that follow.



pH level	Average diameter of bacterial colonies (mm)	Observations
4	1	Little growth seen
6	15	Moderate growth
7	20	Largest colonies observed
8	14	Moderate growth
10	6	Small colonies

(i) Name the dependent variable in this investigation.

pH level

(ii) Describe **one** way the student would have maintained aseptic conditions during the investigation.

Wear disposable gloves during the investigation

(iii) Suggest a reason why this species of bacterium shows low growth at pH 4 and pH 10.

The bacterium favours a neutral environment. pH 4 is too acidic and pH 10
is too alkaline.

(iv) It can be difficult to measure the diameter of the colonies when they merge together after a period of time.
Suggest **one** way the student could have overcome this problem.

When inoculating the bacteria, use wide streaks to spread the bacteria out .

(b) Read the article and answer the questions that follow.

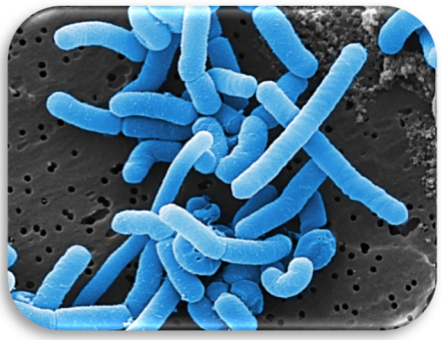
A Human Microbiome

The bacteria naturally present in the vagina form part of the human microbiome, with *Lactobacillus crispatus* as a dominant species in a healthy vagina.

These bacteria maintain an acidic environment that prevents harmful bacteria from growing. Low levels of lactobacilli in the vagina can lead to infections (vaginosis) from other species of harmful bacteria.

Adapted from W.J.Y. Chee *et al.*, 2020.

Lactobacillus crispatus



(i) Explain the term *microbiome*.

Microbiome is all of the microorganisms present in a particular environment

(ii) How does the presence of *Lactobacillus crispatus* in the vagina provide benefit?

They prevent harmful bacteria from growing

(iii) What type of relationship exists between vaginal lactobacilli bacteria and humans?

Mutualistic

(iv) It has been suggested that ingesting capsules containing live *Lactobacillus crispatus* cultures is a treatment for bacterial vaginosis caused by pathogenic bacteria. Is this a testable hypothesis? Justify your answer.

Yes this is a testable hypothesis. A sample of individuals with bacterial can be divided into two equal groups. One group can be given the live cultures, and the other group given a placebo. After one week, they can be tested to check for the presence of bacterial vaginosis.

(c) Read the article and answer the questions that follow.

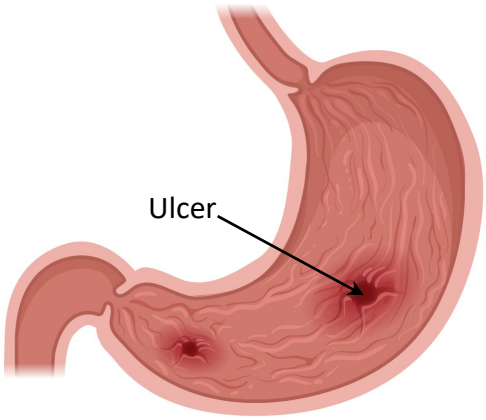
***Helicobacter pylori* and peptic ulcers**

Helicobacter pylori (*H. pylori*) is a species of bacteria that has evolved to survive in the acidic environment of the stomach.

It weakens the mucus lining allowing acid to damage the stomach wall, causing painful disorders such as peptic ulcers.

Long term infection by *H. pylori* can inhibit genes that regulate normal cell division of epithelial cells in the stomach leading to cancer.

Adapted from mayoclinic.org



Stomach

(i) What is the normal pH of the stomach?

pH 2

(ii) State a function of the acid produced in the stomach.

The acid kills bacteria

(iii) *H. pylori* infection can influence gene expression.
What term describes the interaction between environment and gene expression?

Phenotype

(iv) Genetic variations in *H. pylori* can significantly increase its ability to survive in the host.
Describe **two** types of genetic mutations.

1. Point mutations occur due to incorrect base pairing during DNA replication causing a change in the nucleotide sequence

2. Chromosomal mutations occur due to change in a full gene due to deletion, duplication, insertion or substitution

(d) *H. pylori* survives in the acidic stomach environment by producing the enzyme urease. Urease produces ammonia which raises the pH of the stomach. The table below shows a sequence of DNA bases from the CagA gene in *H. pylori* that is responsible for regulating urease production.

(i) Write down the corresponding mRNA code that is generated from this section of DNA.

DNA	**A**	**T**	**A**	**C**	**C**	**A**	**T**	**A**	**G**
mRNA	U	A	U	G	G	U	A	U	C

(ii) Use the information in the translation key below to write down the sequence of amino acids formed when this section of the CagA gene is expressed.

Translation key	
mRNA codon	**Amino acid**
AUC	Isoleucine
GGU	Glycine
UAU	Tyrosine

Amino acid 1:	Tyrosine
Amino acid 2:	Glycine
Amino acid 3:	Isoleucine

(iii) To identify emerging strains of *H. pylori*, researchers use DNA sequencing to map the genome by breaking it into fragments and separating them based on size.
How many fragments are formed from the sequence above during DNA sequencing?

Three fragments

(iv) Describe how these fragments are formed **and** separated.

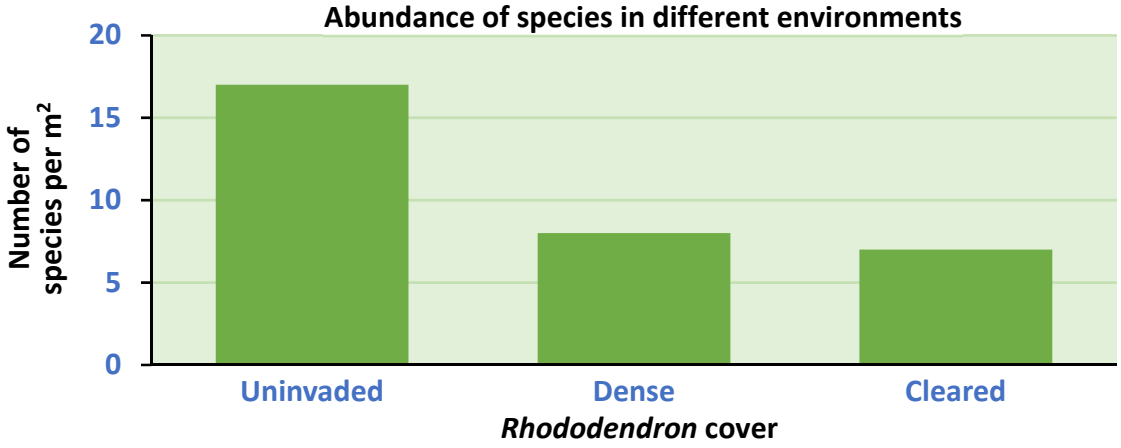
DNA polymerase makes a new copy of the DNA sequence by adding nucleotides until it adds a terminating version such as dideoxy ddA. This is repeated. The fragments are separated based no size by gel electrophoresis from longest to shortest.

Question 7 **50 marks**

(a) The *Rhododendron* is a medium-sized shrub that grows rapidly in woodlands creating shade that inhibits the growth of smaller plants. A group of researchers conducted a study comparing the abundance of species in three different environments.

- Areas without *Rhododendron* (**Uninvaded**)
- Areas with dense *Rhododendron* cover (**Dense**)
- Areas where *Rhododendron* had been previously cleared (**Cleared**)

Adapted from J.E. Maclean *et al.*, 2017



(i) How is the abundance of species affected by dense *Rhododendron* cover?

it decreases

(ii) *Rhododendron* is in competition with the small plants.
Explain the term *competition*.

The struggle between organisms for a resource is short supply

(iii) Suggest a conservation strategy to maintain a high abundance of species in an ecosystem with increasing *Rhododendron* cover.

Introduce native plant species which can outcompete rhododendron

(iv) Suggest why the abundance of species is slow to recover in areas cleared of *Rhododendron*.

Rhododendron prevents sunlight from reaching the ground preventing germination.

(v) Suggest how bias could be avoided when measuring the abundance of species in an area.

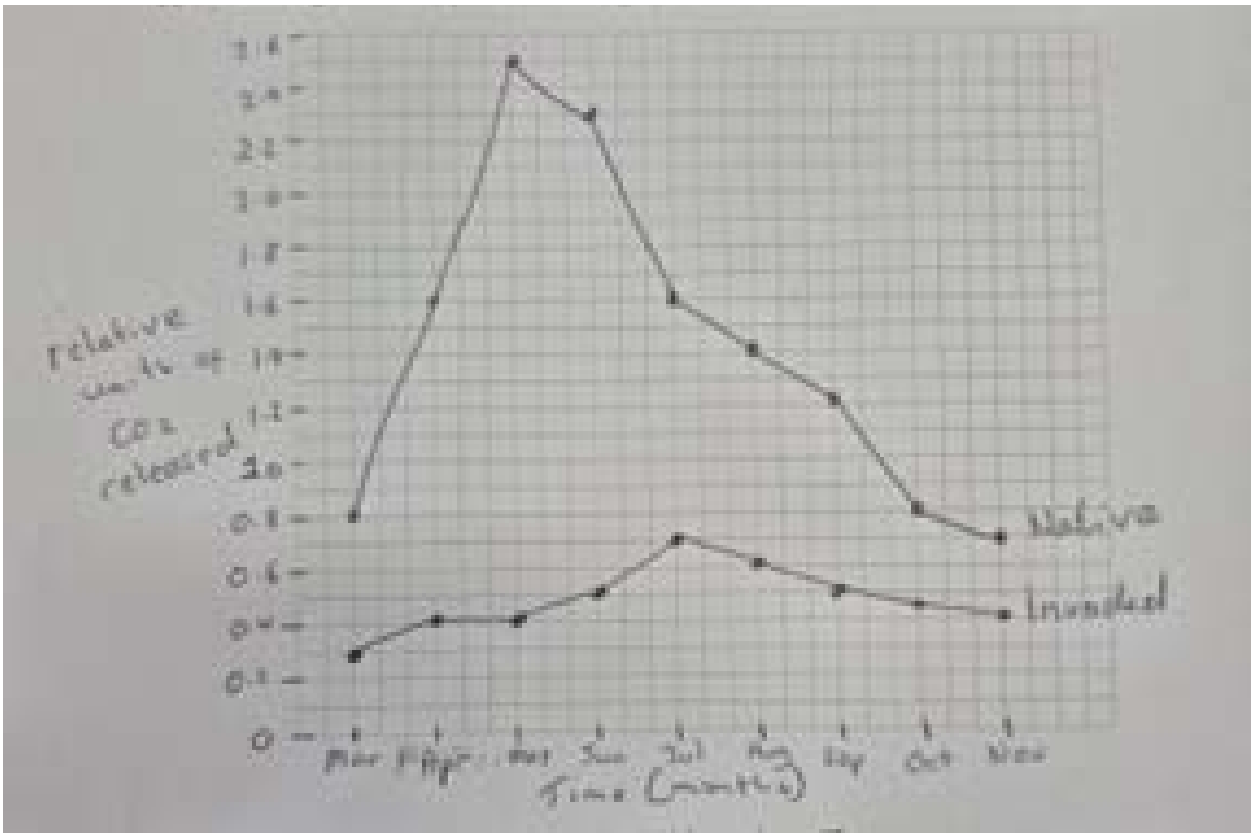
Large sample size

(b) Another group of researchers compared the amount of carbon dioxide (CO_2) released from soil invaded with *Rhododendron* and soil from native woodlands over a nine-month period.

	Time (months)	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Relative units of CO_2 released	**Invaded**	0.3	0.4	0.4	0.5	0.7	0.6	0.5	0.45	0.4
	Native	0.8	1.6	2.5	2.3	1.6	1.4	1.2	0.8	0.7

Adapted from G.L. Jones *et al.*, 2019

(i) **On the grid below**, plot a suitable graph to represent all the data in the table above.



(ii) What is the source of the CO_2 released from the soil?

Decomposers carrying out respiration

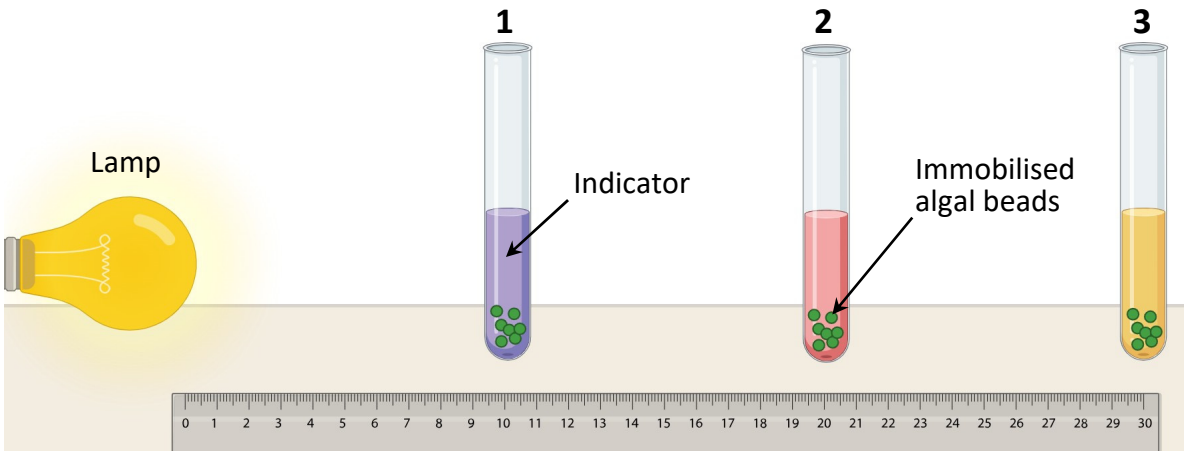
(iii) Suggest a reason for the difference in the levels of CO_2 produced in **each** soil.

The soil invaded with rhododendron would have less decomposers, as rhododendron inhibits other species from growing, and thus less respiration is occurring.

(iv) Name any **other** process that can release carbon to the atmosphere.

Combustion of fossil fuels

(c) A group of students carried out an investigation into the effect of decreasing light intensity on the rate of photosynthesis. Green algal cells were immobilised and placed in hydrogen carbonate indicator, which changes colour in different concentrations of carbon dioxide.



CO_2 level	High	Medium	Low
Colour			

(i) Describe how a named environmental condition could be kept constant during the investigation.

Temperature could be kept constant using a thermostatically controlled water bath

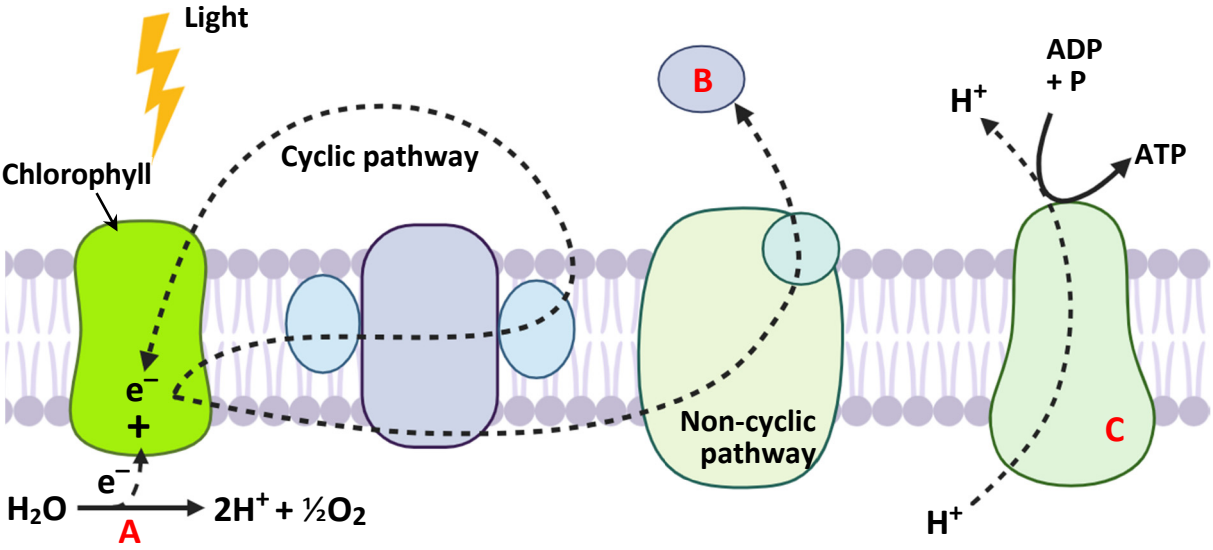
(ii) Use the colour chart above to determine the relative carbon dioxide concentration in each test tube.

Test tube 1: Low
Test tube 2: Medium
Test tube 3: High

(iii) Explain why there are differences in carbon dioxide concentrations between test tubes **1** and **3**.

Test tube 1, closest to the light, has the lowest amount of carbon dioxide as
photosynthesis is occurring in the presence of light and using up the carbon
dioxide Test tube 3, furthest from the light, less carbon dioxide is being used
up in photosynthesis, so carbon dioxide levels remain high.

(d) The diagram represents a section of the thylakoid membrane inside the chloroplast of a leaf cell showing two possible electron pathways during photosynthesis.



(i) What is the purpose of the chlorophyll molecules labelled in the diagram?

Absorption of a photon of light

(ii) Describe how photolysis of water occurs at **A**.

Water is split using sunlight energy due to the attraction from the positively
charged chlorophyll molecule.

(iii) Name the final electron acceptor labelled **B** at the end of the non-cyclic pathway.

NADP+

(iv) Describe the role of molecule **B** in the light-independent reaction.

It provides two electrons and a hydrogen ion for the light-independent stage.

(v) Name the enzyme labelled **C** in the thylakoid membrane that allows protons to flow along a concentration gradient from the thylakoid lumen to the stroma.

ATP synthase

Additional writing space.
Label all work clearly with the question number and part.

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Label all work clearly with the question number and part.

Additional graph paper.
Label all work clearly with the question number and part.

Acknowledgements:

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Texts/data:

Data on page 14:	Adapted from Acid-base balance during repeated cycling sprints….., S. Ratel *et al.*, 2002, Journal of Applied Physiology.
Text on page 18:	Adapted from woodlandtrust.org.uk
Text on page 25:	Adapted from Vaginal microbiota…., W.J.Y. Chee et al., 2020, Microbial Cell Factories.
Text on page 26:	Adapted from mayoclinic.org
Text and data on page 28:	Adapted from Invasion by *Rhododendron ponticum*…., J.E. Maclean *et al*., 2017.
Data on page 29:	Adapted from Reduced soil respiration…., G.L. Jones *et al*., 2019, Soil Biology and Biochemistry.

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Leaving Certificate Examination – Higher Level

Biology

Sample 1

2 hours 30 minutes