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AS Level Biology A

H020/01 Breadth in biology

Thursday 25 May 2017 – Afternoon

Time allowed: 1 hour 30 minutes

You may use:
- a scientific or graphical calculator
- a ruler (cm/mm)

First name									
Last name									
Centre number						Candidate number				

INSTRUCTIONS
- Use black ink.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **24** pages.

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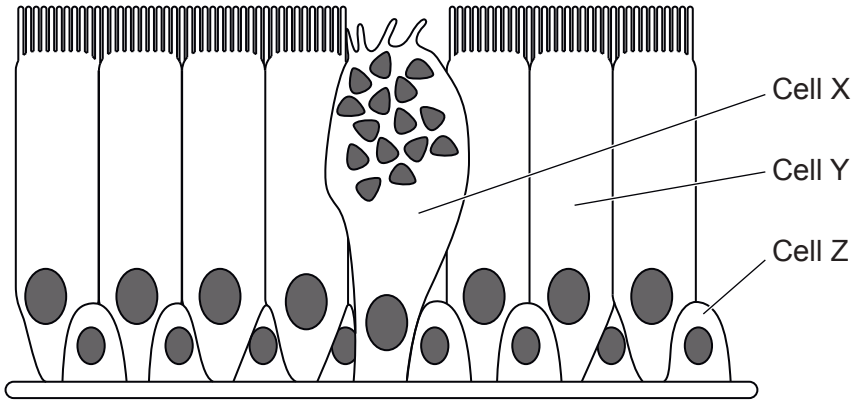
SECTION A

You should spend a maximum of 25 minutes on this section.

Answer **all** the questions.

Write your answer for each question in the box provided.

1 Air moves in and out of human lungs through the trachea, which is lined with cells. The diagram below shows a section containing these cells.



Which of the following statements about tracheal cells is correct?

A Cells X, Y and Z are all columnar epithelial cells.

B Cells X and Y move mucus and trapped bacteria out of the trachea.

C Cell X releases mucus into the trachea.

D Cell Z is a goblet cell.

Your answer ☐ **[1]**

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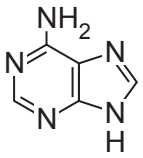
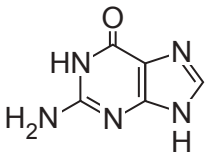
2 DNA is formed from three main groups of molecules: pentose sugars, phosphate groups and nitrogenous bases. The bases can be divided into purines and pyrimidines.

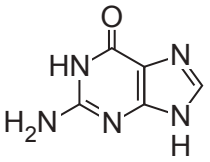
Identify the two purines below.

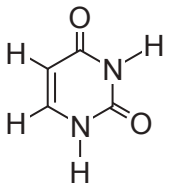
A


adenine

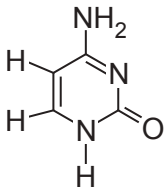

guanine

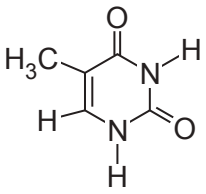
B


guanine

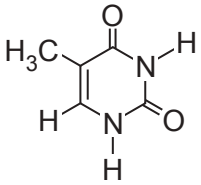

uracil

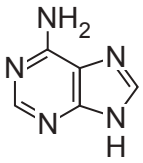
C


cytosine


thymine

D


thymine


adenine

Your answer

[1]

3 Which of the options, **A** to **D**, is a reason why plants require specialised transport tissue?

A to allow osmosis to take place

B because they all have a large surface area to volume ratio

C to carry sucrose to their leaves

D to overcome the limitations of diffusion over large distances

Your answer

[1]

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4 The genetic diversity of a population can be estimated using the following formula:

$$\text{proportion of polymorphic gene loci} = \frac{\text{number of polymorphic gene loci}}{\text{total number of loci}}$$

In 1992 a study estimated the genetic diversity of four isolated populations of lions. They recorded the number of gene variants at a selection of gene loci in each population.

Which of the following populations of lions has the greatest proportion of polymorphic gene loci?

A Asiatic Lion: 73 polymorphic loci out of 1927.

B Transvaal Lion: 1110 polymorphic loci out of 2156.

C Masai Lion: 1030 polymorphic loci out of 2315.

D West African Lion: 1004 polymorphic loci out of 2008.

Your answer ☐ **[1]**

5 Many plants are adapted to the availability of water in their environment; one group of these plants is the xerophytes.

Which one of the following statements correctly describes a xerophyte?

A Smooth cordgrass grows in highly saline marine estuary environments.

B The water lily has aerenchyma tissue to allow the movement of gases to submerged roots.

C The poison tree has leafless branches covered in thorns to reduce water loss.

D Water lobelia completes its entire life cycle submerged in shallow ponds.

Your answer ☐ **[1]**

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6 A standard method can be used to extract DNA from the nuclei of cells in kiwi fruit.

The statements below list some of the steps involved in this method.

Which statement is **not** correct?

A chop the kiwi fruit to break open cell membranes

B add detergent to dissolve nuclear membranes

C add protease to digest histone proteins

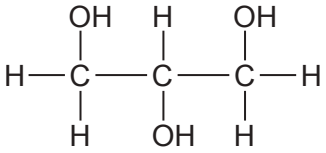
D pour ice cold ethanol onto filtrate to precipitate DNA

Your answer ☐ **[1]**

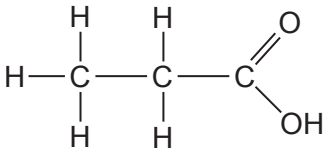
7 Water is known as the universal solvent as it has the ability to dissolve many ionic and covalent compounds due to its polar nature.

Which of the 3-carbon compounds will **not** form hydrogen bonds with water and will therefore **not** dissolve in water?

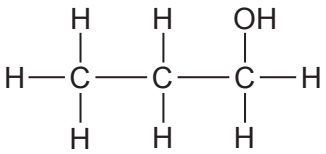
A glycerol



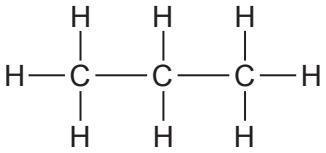
B propanoic acid



C propanol



D propane



Your answer ☐ **[1]**

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8 Which of the options, **A** to **D**, is a correct statement about polysaccharides of glucose?

A Cellulose microfibrils are formed by hydrogen bonding between adjacent chains of α-glucose molecules bonded with 1,4-glycosidic bonds.

B Amylose is a straight chain of α-glucose monomers bound by 1,6-glycosidic bonds to allow for dense packing.

C Glycogen has a high proportion of 1,6-glycosidic bonds to produce a highly branched molecule for rapid release of α-glucose.

D Amylopectin has a mixture of 1,4-glycosidic and 1,6-glycosidic bonds between β-glucose molecules for rapid release of energy.

Your answer ☐ **[1]**

9 Which of the options, **A** to **D**, is a correct statement about tissue fluid?

A Tissue fluid carries carbon dioxide to muscle cells.

B Oncotic pressure in the capillary causes tissue fluid formation from plasma.

C Hydrostatic pressure in the capillary causes tissue fluid formation from plasma.

D Tissue fluid is reabsorbed into the capillary by active transport.

Your answer ☐ **[1]**

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10 A group of students was given a 1% solution of an unknown digestive enzyme.

They were also given three tubes containing an identical mixture of foods.

The students carried out a different biochemical test on each tube before and after adding the unknown enzyme. Their results are shown in the table below.

	Colour before	**Colour after**
Biuret test	purple	purple
Iodine test	blue / black	yellow / orange
Benedict's test	brick red	brick red

Name the type of enzyme the students used.

A protease

B carbohydrase

C lipase

D cellulase

Your answer ☐ **[1]**

11 DNA carries the genetic code which is non-overlapping and degenerate.

Which of the options, **A** to **D**, contains the correct definitions for non-overlapping and degenerate code?

A Each nucleotide is only part of one triplet of bases and the molecule breaks down easily.

B The genes follow straight after each other and the molecule breaks down easily.

C Each nucleotide is only part of one triplet of bases and more than one triplet codes for a specific amino acid.

D The genes follow straight after each other and more than one triplet codes for a specific amino acid.

Your answer ☐ **[1]**

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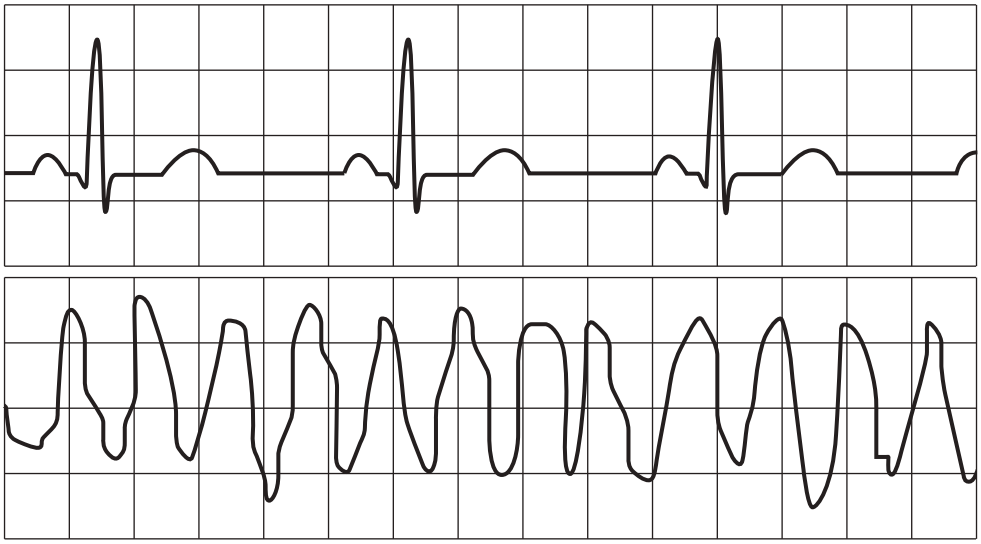
12 In the graph below, the top electrocardiogram (ECG) trace shows normal heart activity and the ECG trace below shows abnormal heart activity.



What is the heart condition represented by the bottom ECG trace?

A fibrillation

B tachycardia

C ectopic heartbeat

D bradycardia

Your answer ☐ **[1]**

13 Tropical rainforests have a very high biodiversity of plant species.

Which of the statements, **A** to **D**, is an economic benefit of high biodiversity?

A High plant biodiversity decreases the animal biodiversity in the rainforest.

B High plant biodiversity increases the organic matter in rainforest soils.

C High plant biodiversity supports drug discovery and development.

D High plant biodiversity protects the ecosystem from environmental changes.

Your answer ☐ **[1]**

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14 Lupus is an autoimmune disease. One symptom is a facial rash, typically in a butterfly shape across the cheeks.

Following a blood test, which of the following would indicate the patient has Lupus?

A the presence of antibodies for the cell surface antigens of connective tissue

B the presence of herpes antibodies

C the presence of high levels of antihistamines

D the absence of B lymphocytes

Your answer ☐ **[1]**

15 Biologists use both phylogeny and classification to understand how different species are related.

Which of the options, **A** to **D**, is a statement about phylogeny?

A There are 21 species of ladybird in the UK that belong to the sub-family Coccinellinae.

B *Homo sapiens* and *Pan bonobo* share a common ancestor.

C The lily family, Liliaceae, consists of fifteen genera.

D The great white shark, *Carcharodon carcharias*, is a member of the class Chondrichthyes.

Your answer ☐ **[1]**

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16 An individual bitten by a rabid dog can be treated by an injection of human rabies antibodies.

Which option, **A** to **D**, describes the type of immunity provided by this treatment?

A natural passive

B natural active

C artificial passive

D artificial active

Your answer [ ] **[1]**

17 A student studied the structure of a blood vessel and found:

- an outer layer of collagen fibres,
- a thick middle layer of smooth muscle and elastic tissue,
- an innermost layer of endothelial cells.

Which of the options, **A** to **D**, identifies the type of blood vessel the student studied?

A artery

B capillary

C venule

D vein

Your answer [ ] **[1]**

18 Which option, **A** to **D**, describes the role of cholesterol in cell surface membranes in the human body?

A Cholesterol binds to phospholipid phosphate heads, increasing the packing of the membrane, therefore reducing the fluidity of the membrane.

B Cholesterol binds to phospholipid fatty-acid tails, reducing the packing of the membrane, therefore increasing the fluidity of the membrane.

C Cholesterol absorbs ATP, preventing active transport across the membrane.

D Cholesterol binds to phospholipid fatty-acid tails, increasing the packing of the membrane, therefore reducing the fluidity of the membrane.

Your answer [ ] **[1]**

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19 What is the correct definition of the term **coenzyme**?

A An inorganic ion that forms the centre of a globular protein.

B A molecule that binds to the enzyme, changing the shape of the active site, preventing an enzyme substrate complex from forming.

C A non-protein organic molecule, not permanently attached to an enzyme, but needed to allow the enzyme to function.

D A metal ion that attaches to the enzyme, changing the shape of the active site, increasing the likelihood of a reaction.

Your answer ☐ **[1]**

20 During DNA replication, DNA polymerase can only work in one direction – from the 3' end to the 5' end. This means that the lagging strand has small gaps left in the backbone. DNA ligase works to seal these gaps.

Which of the options, **A** to **D**, identifies the bond formed?

A hydrogen bond

B phosphodiester bond

C glycosidic bond

D peptide bond

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

21 A student looked at a slide containing onion root tip cells under a light microscope in order to identify cells in different stages of mitosis. Fig. 21 shows a diagram of what they observed.

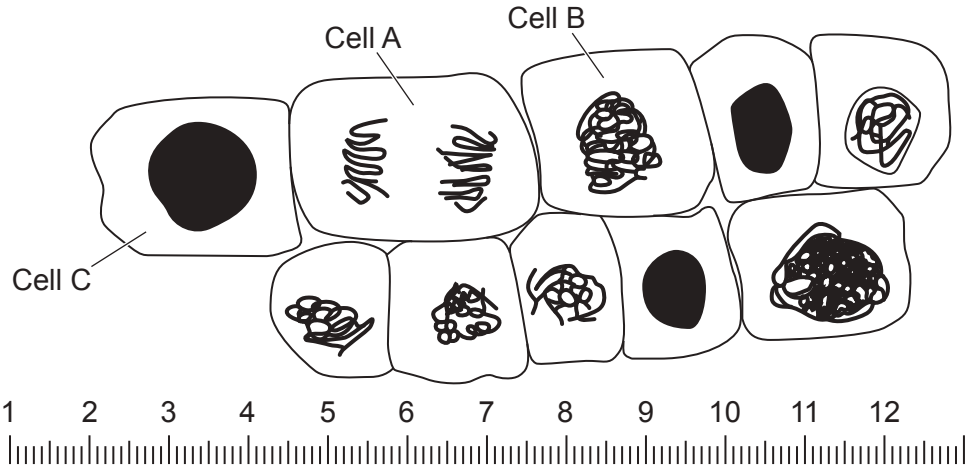

Fig. 21

(a) (i) Explain why onion root tips were used to view cells undergoing mitosis.

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..... **[2]**

(ii) Suggest a stain that the student could have used to highlight the nuclei of these cells.

..... **[1]**

(b) The student used an eyepiece graticule, which is shown in Fig. 21. The student calibrated the graticule before carrying out the root tip squash. He observed that 20 μm measured 2.35 divisions on the graticule.

Calculate the diameter of the nucleus in cell **C** in Fig. 21.

Answer ..... **[2]**

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22 Many multicellular organisms need to be able to convert monosaccharides into polysaccharides and back again.

Mammals convert the monosaccharide glucose into a highly branched polysaccharide called glycogen, which gets stored in liver cells.

(a) Explain why mammals store glycogen instead of glucose.

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..... **[3]**

(b) Humans use the enzyme α-amylase to break down polysaccharides in food for absorption into the blood.

The gene for human α-amylase is found on chromosome 1.

The gene is transcribed in the nucleus and translation occurs on the rough endoplasmic reticulum in cells of the salivary gland.

Describe how the molecule is prepared and secreted by cells of the salivary gland after translation has taken place.

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23 The fluid mosaic model describes plasma membranes of all living organisms.

(a) How does the fluid mosaic model describe the structure of plasma membranes?

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..... **[2]**

(b) Plasma membranes are partially permeable, allowing some molecules to cross the membrane with relative ease.

One molecule that crosses membranes easily is the steroid hormone progesterone which is produced in the ovaries from cholesterol.

(i) Explain why progesterone can move across membranes.

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..... **[2]**

(ii) Name one other molecule that can cross plasma membranes.

..... **[1]**

(c) Potassium ions are unable to move across membranes as they are charged.

(i) State how the structure of the cell surface membrane allows potassium ions to enter or leave a cell.

.....

..... **[1]**

(ii) The process of active transport uses ATP to pump potassium ions through the cell surface membrane against the concentration gradient.

ATP is made up of phosphate groups and two other molecules.

Name the **two** other molecules.

1 .....

2 .....

[2]

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(d) A group of students investigated the effect of temperature on the membranes of beetroot cells.

A colorimeter was used to measure the concentration of purple betalain pigment that leaked out of the cells when they were exposed to different temperatures.

Table 23 shows a summary of the data collected.

Temperature (°C)	Number of readings	Mean absorbance (arbitrary units)	Standard deviation
0	10	0.04	0.01
10	10	0.04	0.02
20	10	0.04	0.02
30	10	0.06	0.02
40	10	0.09	0.03
50	10	0.21	0.06
60	10	0.44	0.18

Table 23

(i) Using the Student's *t*-test formula below, calculate the value of *t* between the data for **50 °C** and **60 °C**.

$$t = \frac{\left|\overline{x}_A - \overline{x}_B\right|}{\sqrt{\frac{S_A^2}{n_A} + \frac{S_B^2}{n_B}}}$$

where: $\overline{x}$ is the mean
S is the standard deviation
n is the number of readings

Answer = ... **[3]**

(ii) The critical value for *t* at the significance level of 5%, with 18 degrees of freedom, is 2.10.

Use the value of *t* that you calculated in part **(i)** to explain whether the null hypothesis should be accepted or rejected.

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..... **[2]**

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(e) The students plotted the data onto a graph, shown in Fig. 23.

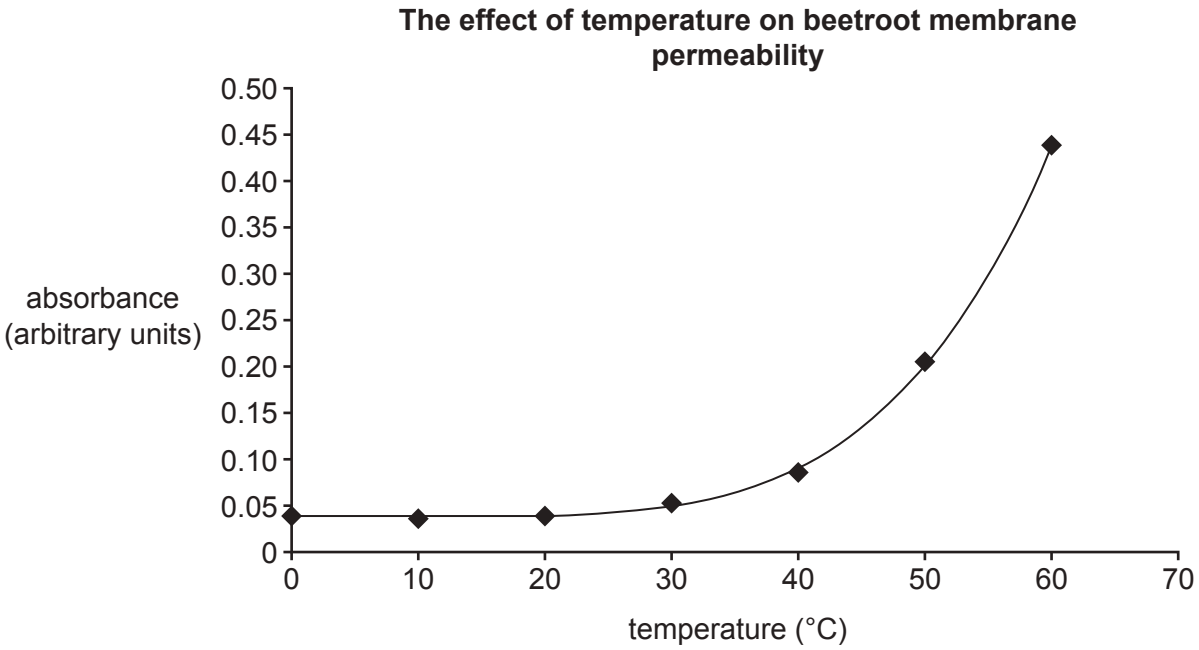

Fig. 23

Describe and explain the pattern of data shown on the graph as temperature increases.

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..... **[3]**

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24 In 1990, Carl Woese suggested a new top level taxon to the current system of classification of living organisms, which he termed a domain. He used his results from studying RNA to organise organisms into three distinct groups.

(a) (i) Name the cell component that appears in organisms of all three domains that Woese suggested.

..... **[1]**

(ii) One of the domains he suggested is called Eukarya.

Name the other **two** domains.

1 .....

2 .....

[2]

(iii) State **two** defining features of all members of the domain Eukarya.

.....

..... **[2]**

(b) Woese carried out a detailed study of RNA molecules in order to draw his conclusions.

Suggest **two** ways in which the scientific community are likely to have validated Woese's research.

.....

..... **[2]**

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25 Semi-conservative replication describes the process by which DNA is replicated in all living organisms.

(a) (i) Explain the meaning of the phrase *semi-conservative replication*.

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..... **[1]**

(ii) DNA ligase is one enzyme involved in the replication of DNA.

State **two** other enzymes involved and describe their functions.

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..... **[4]**

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(b) In 1958, Matthew Meselson and Franklin Stahl carried out an experiment that provided evidence to support the hypothesis of semi-conservative replication of DNA.

Meselson and Stahl grew *E. coli* bacteria in a growth medium that contained only the heavy isotope of nitrogen ^{15}N. They transferred the bacteria to a growth medium that had the light ^{14}N isotope and allowed the bacteria to undergo cell division.

After each division, the DNA from some of the bacteria was extracted from the culture and centrifuged to separate it. Fig. 25 shows the bands of DNA in the centrifuge tubes after a specific number of divisions.

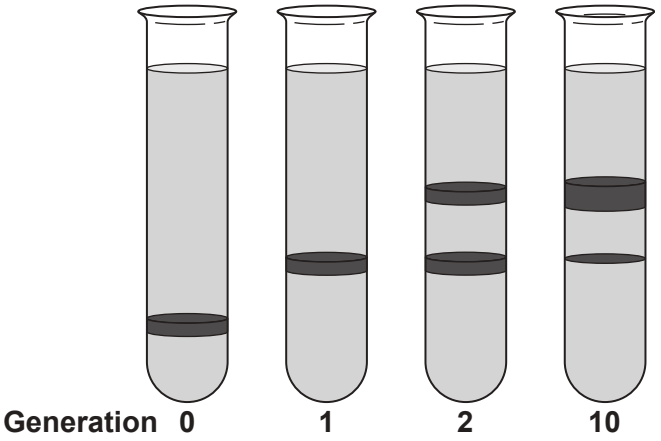

Fig. 25

The tube labelled **Generation 0** in Fig. 25 shows a single band of DNA containing bases that contain only the heavy isotope of nitrogen ^{15}N.

Explain how the results from the other generations provide evidence to support the hypothesis that DNA replication is semi-conservative.

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..... **[2]**

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26 The protease enzyme bromelain can be extracted from pineapples. A student investigated the effect of changing the concentration of the enzyme and measured the time taken to break down the protein gelatine.

(a) State **three** variables that the student would need to control in order to make the results of this investigation **valid**.

1 .....

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2 .....

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3 .....

..... **[3]**

(b) The data from the student's experiment is shown in Table 26.

Concentration of bromelain (%)	Rate of protein digestion (s^{-1})	Standard deviation
0.010	0.0037	0.00014
0.025	0.0090	0.00034
0.050	0.0155	0.00260
0.075	0.0184	0.00371
0.100	0.0198	0.00340

Table 26

(i) Describe how the rate of reaction was calculated.

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..... **[1]**

(ii) Explain what the standard deviation shows in Table 26.

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..... **[2]**

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(c) Fig. 26 shows the results plotted on a graph with the standard deviations as error bars.

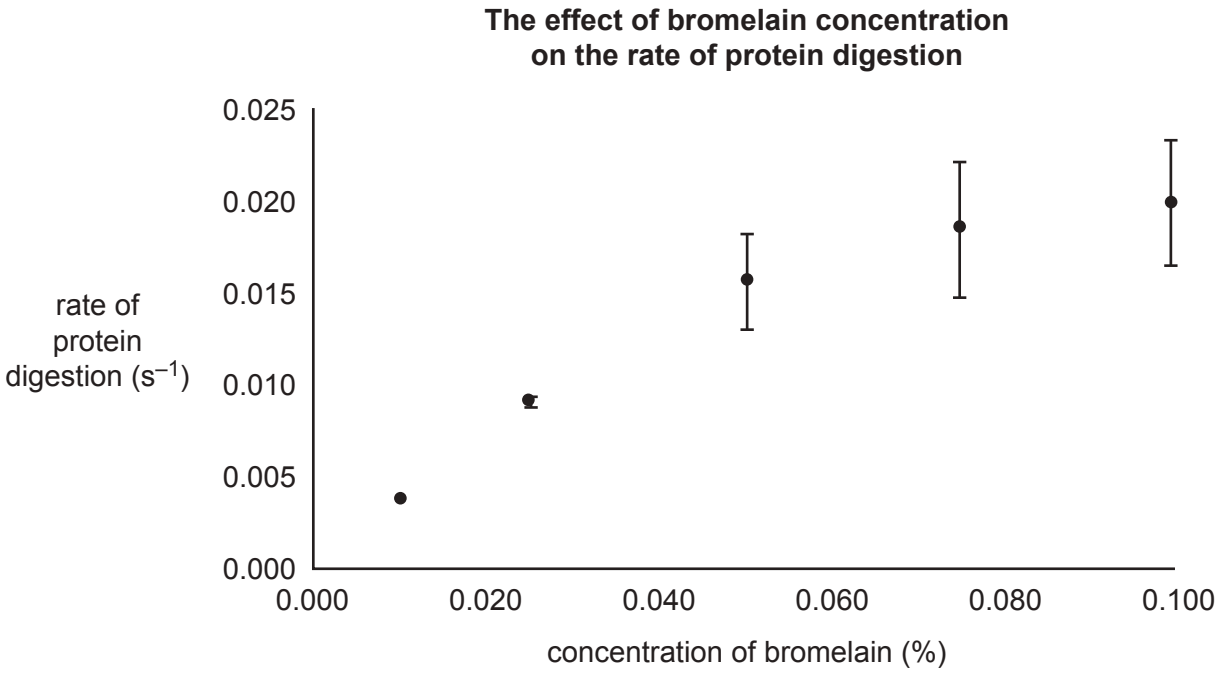

Fig. 26

Explain the pattern shown in the data using Table 26 and Fig. 26.

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..... **[3]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

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