OCR
Oxford Cambridge and RSA

Accredited

GCSE (9–1) Biology B (Twenty First Century Science)

H

J257/03 Breadth in biology (Higher Tier)

Sample Question Paper

Date – Morning/Afternoon

Version 2.1

Time allowed: 1 hour 45 minutes

You may use:
- a scientific or graphical calculator
- a ruler

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, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **32** pages.

Answer **all** the questions.

1 Sarah is feeling unwell and feels very tired. Her doctor thinks that she may have Chronic Fatigue Syndrome (CFS).

(a) CFS is difficult to diagnose.

Before diagnosis, doctors rule out a condition called anaemia by carrying out a blood test.
A blood test checks the number of blood cells in Sarah's blood.

(i) What is the role of **red** blood cells?

.....

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

(ii) Extreme tiredness is one symptom of CFS.

The table shows the results of Sarah's blood test.

	Red blood cell (per mm^3)	**White blood cell (per mm^3)**	**Platelets (per mm^3)**
Normal level	3 800 000	8 500	250 000
Sarah	2 700 000	9 000	245 000

Explain how the results in the table show the possible cause of Sarah's tiredness.

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

(iii) The table below shows some information about red blood cells and cheek cells taken from a human.

	Red blood cell	Cheek cell
Surface area (μm^2)	136	7854
Volume (μm^3)	90	65 450
Surface area : volume ratio		0.12 : 1

Calculate the surface area : volume ratio of the red blood cell.

Show your working.

Give your answer to **two** significant figures.

Surface area : volume ratio = ... **[1]**

(iv) Red blood cells have a greater surface area : volume ratio than cheek cells.

Explain how this allows red blood cells to carry out their function.

.....

.....

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

(v) The doctor will check to see if Sarah has an underactive thyroid gland as this could also make her feel tired.

The thyroid gland produces a hormone.

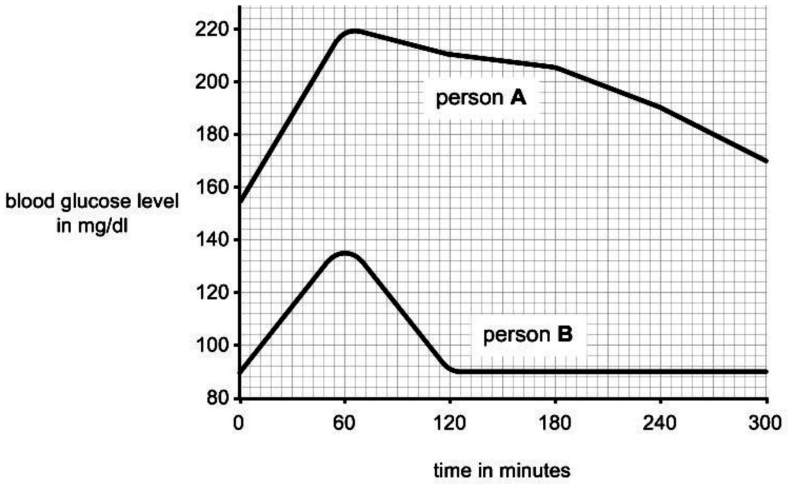
What is the role of a hormone?

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

(b) (i) Insulin is a hormone produced by the pancreas.

The graph shows data from two people who were given a sugary drink.

Their blood sugar level was recorded every 60 minutes.



There are two types of diabetes – type 1 and type 2.

- Person **A** has type 2 diabetes.
- Person **B** does not have diabetes.

Describe how the graph shows this and explain why there is a difference in the blood sugar level.

.....

.....

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

(ii) The statements below apply to type 1 and type 2 diabetes.

Draw **two** lines to link the sentences to **type 1 diabetes.**

	body no longer responds to the insulin produced
	should eat a diet high in complex carbohydrates and exercise
Type 1 diabetes	will need to inject insulin
	pancreas stops producing insulin

[2]

2 Limpets are molluscs that are found on rocky shores.

Limpet

A student wants to find out if there is a different population of limpets on different parts of the shore.

(a) Describe a method that the student could use to find out which parts of the rocky shore have more limpets.

.....

.....

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.....

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

(b) The student counted the number of limpets on three parts of the rocky shore.

The results are shown in the table.

Part of shore	Number of limpets			
	Test A	Test B	Test C	Mean
Low shore (closest to sea)	15	16	17	
Mid shore	45	47	49	
High shore (furthest away from sea)	2	1	8	

(i) The student thinks that one of the results is an outlier.

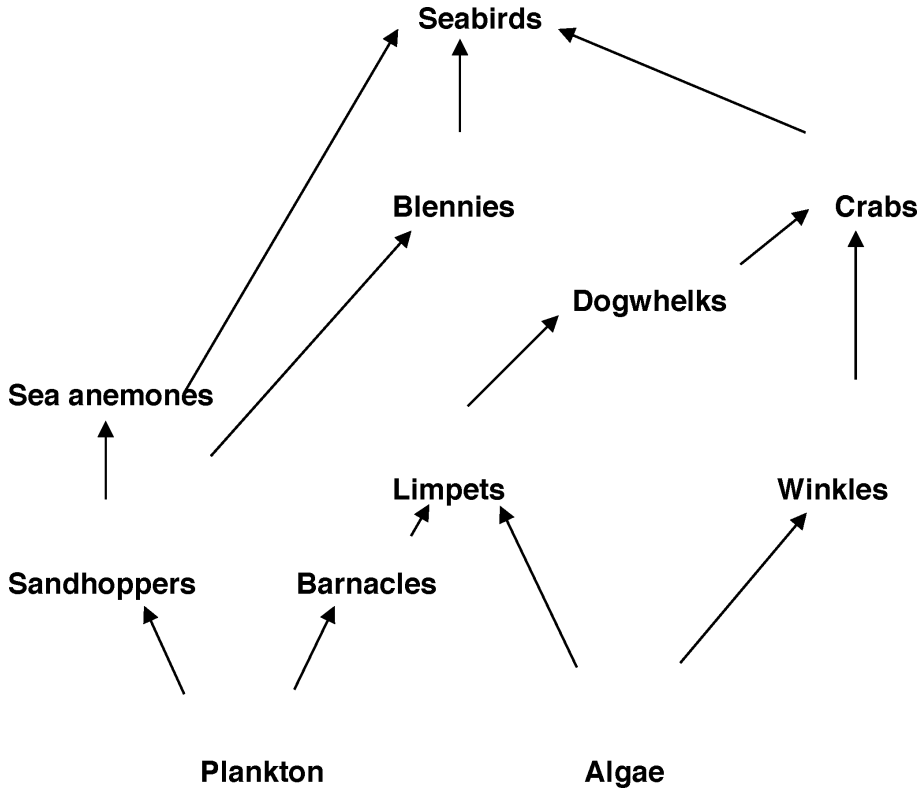
Circle the outlier in the table above. **[1]**

(ii) Calculate the mean number of limpets found on the mid shore.

Show your working.

Number = ... **[2]**

(c) This is a food web for the species that can live on a rocky shore.



Explain the impact of an increase in the number of **dogwhelks** on one species in this food web.

.....

.....

.....

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

(d) In some areas of the UK, dogwhelk numbers are decreasing. This reduces biodiversity.

Give **two** benefits of maintaining biodiversity.

1 .....

.....

2 .....

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

(e) Sea anemones can reproduce asexually.

Give **one** advantage and **one** disadvantage of reproducing asexually.

Advantage .....

.....

Disadvantage .....

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

(f) **(i)** Sea anemones are mainly found in rock pools.

During the summer, the water temperature in a rock pool can increase. This can be dangerous for a sea anemone.

Put a tick (✓) in the box that best explains why this temperature increase is a problem.

Enzyme catalysed reactions will speed up. ☐

Enzyme catalysed reactions will slow down. ☐

Enzymes will be killed. ☐

Enzymes will become denatured. ☐ **[1]**

(ii) When it rains, the concentration of the sea water in a rock pools decreases.

What effect will this change in concentration have on a sea anemone's cells?

Put a tick (✓) in the box next to the correct answer.

Some cells may burst. ☐

Some cells may shrink. ☐

There will be no change to the cells. ☐

Some cells will burst. Other cells will shrink. ☐ **[1]**

3 DNA is a nucleic acid. It is found in all living cells.

(a) Read these statements about DNA.

Put ticks (✓) in the boxes next to the **two** correct statements.

DNA is made from four different nucleotides. ☐

Half the nucleotides have a common sugar. ☐

DNA is made from a copy of RNA. ☐

Half the nucleotides have a phosphate group. ☐

DNA is a polymer. ☐ **[2]**

(b) RNA is another type of nucleic acid. It is involved in protein synthesis.

The table shows the nucleotide sequence in RNA that codes for different amino acids in proteins.

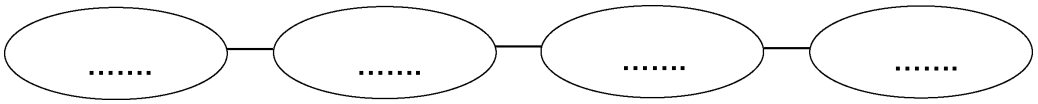
Amino acid	Amino acid abbreviation	Nucleotide sequence
glutamic acid	glu	G A G
leucine	leu	C U G
threonine	thr	A C G
tyrosine	tyr	U A C

Look at the nucleotide sequence in a section of RNA.

G A C U G G A G U A C A C G C C

Write down the sequence of amino acids that this section of RNA codes for.

Use the abbreviation for each amino acid.



[1]

(c) A mutation occurs in the RNA sequence in **(b)**.

The nucleotide sequence that results is:

G A C U G U A G U A C A C G C C

Suggest the effect on the production of a protein.

.....

.....

.....

.....

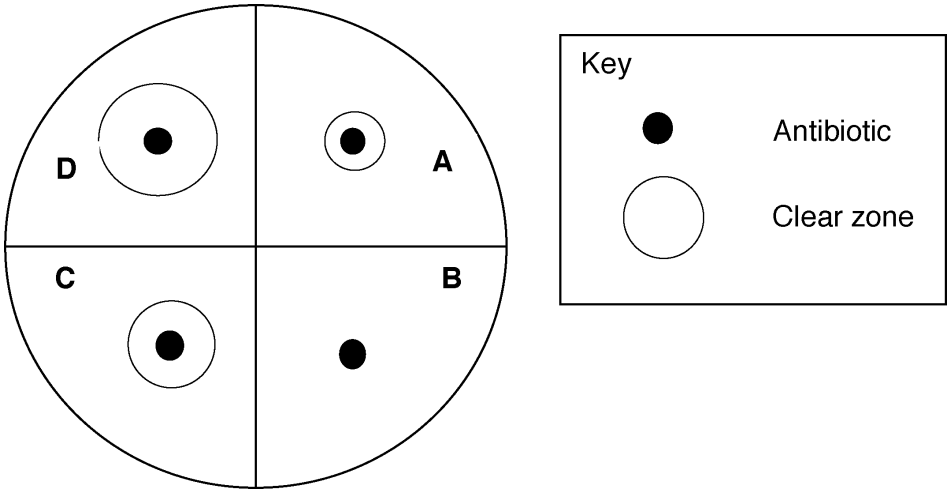
..... **[4]**

4 Jack has a bacterial infection caused by *Streptococcus pneumonia*.

A doctor takes a sample from Jack to work out which antibiotic will kill the bacteria.

The diagram below shows the effectiveness of four different antibiotics when grown on agar jelly.

- The clear zone for each antibiotic is shown on the diagram.
- The clear zone is the area of the bacteria that has been killed by the antibiotic.
- The table shows the areas of the clear zones.



Antibiotic	Clear zone (mm2)
A	50.24
B	0.00
C	94.99
D	

(a) (i) Using the formula πr^2, calculate the clear zone for antibiotic **D**.

Show your working.

- $\pi = 3.14$

Clear zone = ... mm^2 **[2]**

(ii) Jack's doctor must decide which antibiotic to prescribe him.

Use the information provided at the start of this question to decide which of the following conclusions can be made.

Put a tick (✓) in the box next to the correct conclusion.

Antibiotic **A** works best.
Jack should be given antibiotic **A**. ☐

Antibiotic **B** has the least effect.
Jack should not be given antibiotic **B**. ☐

Antibiotic **C** works best.
Jack should be given antibiotic **C**. ☐

All antibiotics worked equally well.
Jack can be given any antibiotic. ☐ **[1]**

(iii) The control for this test could have been a disc which did not contain any antibiotic.

State a reason for using a control in this experiment.

.....

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

(b) Aseptic techniques must be used when culturing organisms.

Give an example of an aseptic technique and explain why it is used.

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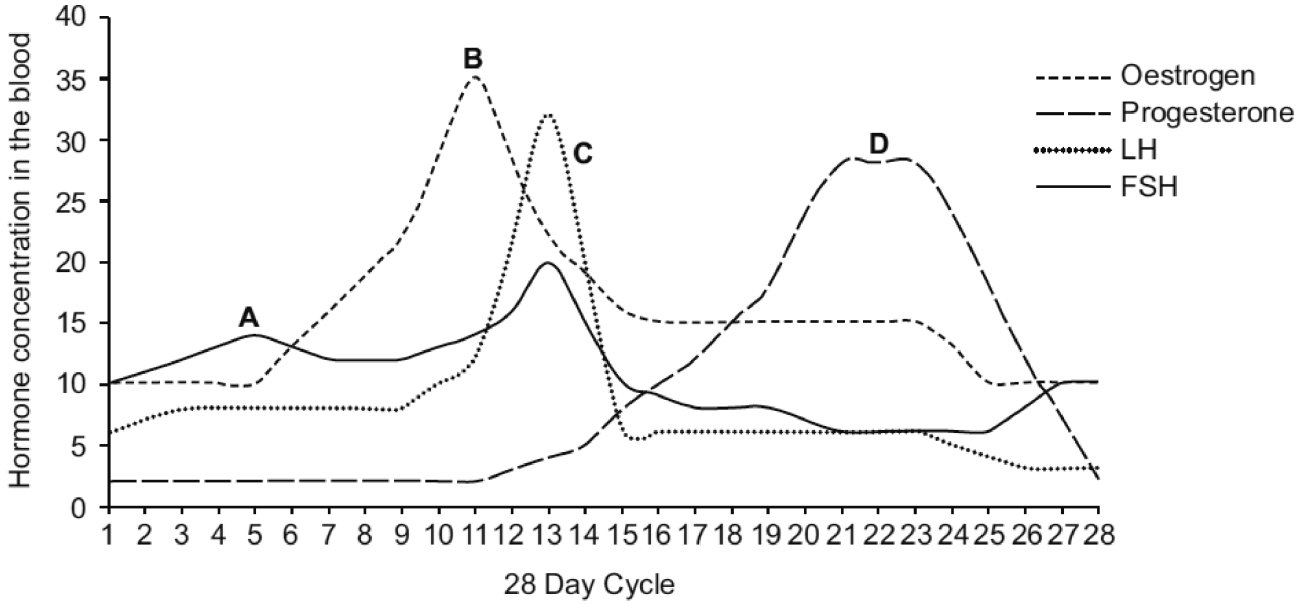
..... **[2]**

5 **(a)** The human menstrual cycle is controlled by hormones.

The diagram shows the concentration of the four hormones involved in the menstrual cycle.



Which letter, **A**, **B**, **C** or **D**, shows when ovulation occurs?

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

(b) Some couples are unable to conceive a child naturally. In-vitro fertilisation (IVF) is a technique that can be used to help these couples.

In IVF, a woman's ovaries are stimulated to produce a greater number of eggs than during a normal menstrual cycle.

Which hormone could be used to achieve this?

Put a tick (✓) in the correct box.

Oestrogen ☐

Progesterone ☐

LH ☐

FSH ☐ **[1]**

(c) To confirm that a female is pregnant, a pregnancy test will be done. This test uses monoclonal antibodies.

(i) Describe how monoclonal antibodies are produced.

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

(ii) Antibodies are proteins.

The statements below describe protein synthesis.

A A copy of the gene is made from messenger RNA.

B The gene that codes for the protein is found in the DNA.

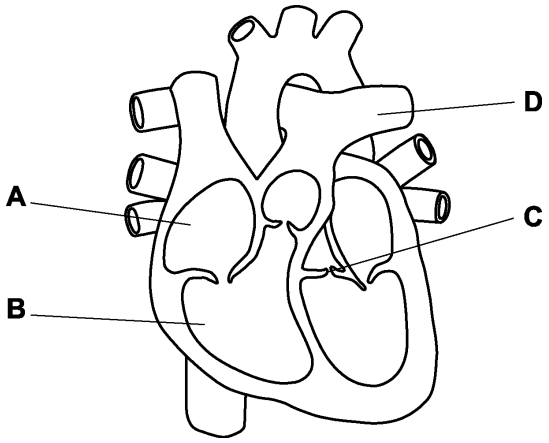
C The mRNA travels to a ribosome in the cytoplasm.

D The ribosome joins the amino acids together in the correct order.

Put the statements in the correct order.

.... **[1]**

6 Look at the diagram of the heart.



(a) (i) Which letter on the diagram, **A**, **B**, **C** or **D**, shows how the backflow of blood is prevented?

Place a tick (✓) in the correct box.

A ☐

B ☐

C ☐

D ☐ **[1]**

(ii) The blood vessels in the circulatory system are adapted to their function.

The table shows features of the three different blood vessels, **X**, **Y** and **Z**.

Vessel	Smooth inner lining	Valves	Muscular tissue	Elastic tissue
X	Yes	Yes	Yes	Yes
Y	Yes	No	Yes	Yes
Z	Yes	No	No	No

Using the table, identify the **type** of blood vessel for **X**, **Y** and **Z**.

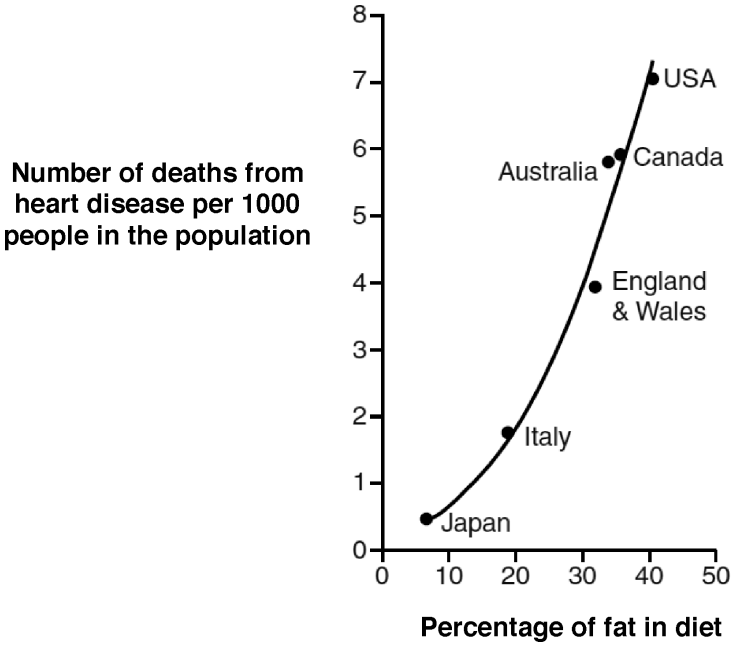
Blood vessel **X** .....

Blood vessel **Y** .....

Blood vessel **Z** ..... **[3]**

(b) A scientist collected information about the percentage of fat in people's diet and the number of deaths from heart disease in various countries.

The information was plotted in the graph below.



(i) What can you conclude about the percentage of fat in the diet and the chance of dying from heart disease?

.....

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

(ii) What **two** lifestyle changes might you suggest to a person to decrease their chance of dying from heart disease?

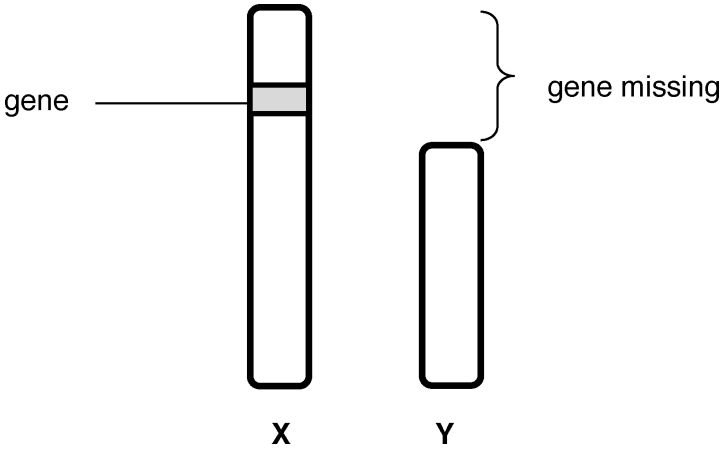
1 .....

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

(c) Some diseases are inherited.

Haemophilia is an example of an inherited disease, caused by a **recessive allele**. The gene for haemophilia is located on the sex chromosomes.

Due to the location of the gene for haemophilia, females inherit two copies of the gene, but males only inherit one. For a male, this is shown on the diagram below.



Males **cannot** be carriers for haemophilia. They either have the disease or they do not.

(i) A female carrier has the genotype X^HX^h and a healthy male has the genotype X^HY.

Complete the Punnet square to show the probability of this couple having a son with haemophilia.

	X^H	X^h
X^H		
Y		

Probability =..... **[2]**

(ii) Which of the following genotypes would a female with haemophilia have?

Put a tick (✓) in the correct box.

X^HX^H ☐

X^HX^h ☐

X^hX^h ☐

X^HX ☐ **[1]**

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TURN OVER FOR THE NEXT QUESTION

7 **(a)** **(i)** Mia has an eye disease that weakens the fibres that hold her cornea in place.

Her cornea has become damaged, causing its shape to change.

What is the role of the cornea and how will damage to the shape affect Mia's sight?

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.....

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

(ii) Scientists are now using stem cells to repair damage to corneas.

What is a stem cell?

.....

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

(iii) Stem cells can be obtained from embryos.

Why are some people against using embryos as a source of stem cells?

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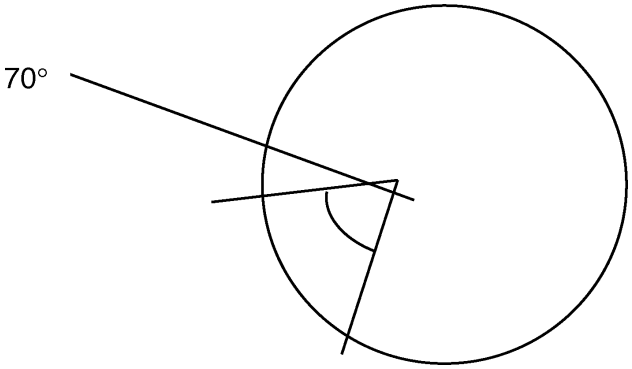
..... **[1]**

(b) New body cells are created as part of the cell cycle.

This is represented in the diagram.



In this example, the whole cell cycle, takes 141 minutes.

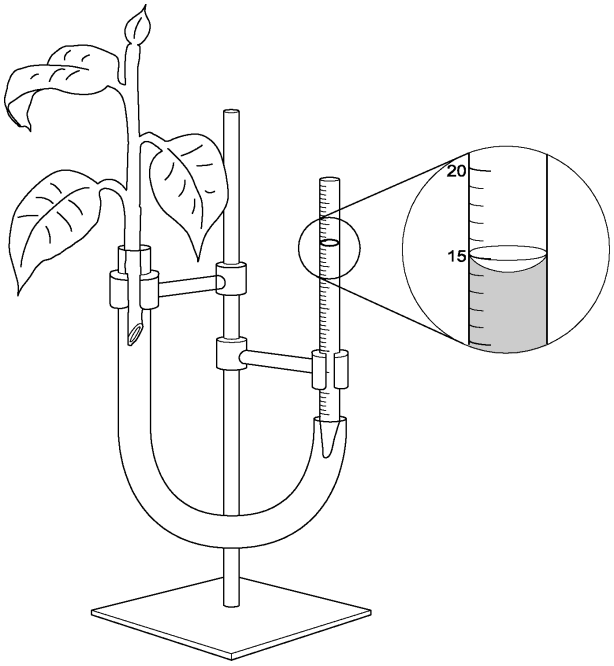
Calculate the time spent in mitosis.

Give your answer to **two** decimal places.

Time spent in mitosis = ... minutes **[2]**

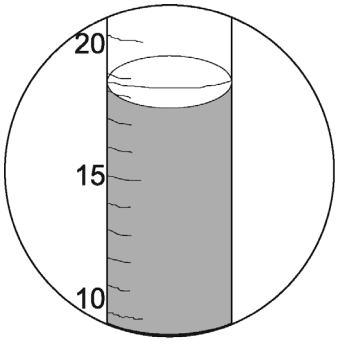
8 A student investigates the effect of temperature on the rate of water uptake by a plant.

(a) She places a plant in the apparatus shown below. The temperature of the room is 35°C.

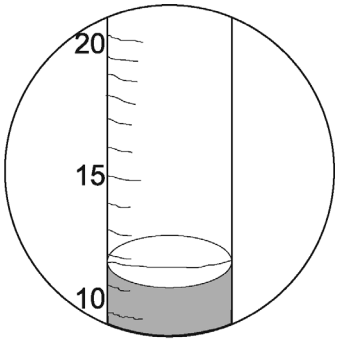


(i) The student measured the distance moved by the water level over a period of 30 minutes.

The diagrams show her results.



Water level before



Water level after

Calculate the rate of water uptake.

Show your working.

Give your answer to **two** significant figures.

Rate of water uptake = ... cm^3/min **[2]**

(ii) How could the student use this apparatus to investigate the rate of water uptake in windy conditions?

Other apparatus is available.

.....

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

(iii) The volume of water taken up may **not** be an accurate measurement of the water lost in transpiration.

Suggest why.

.....

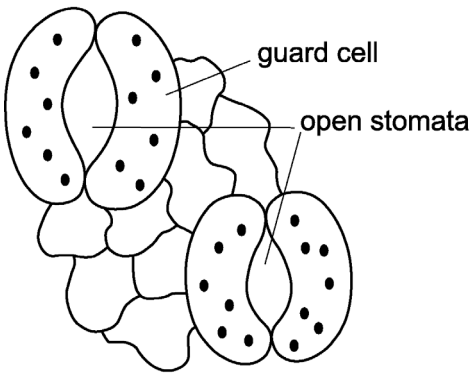
.....

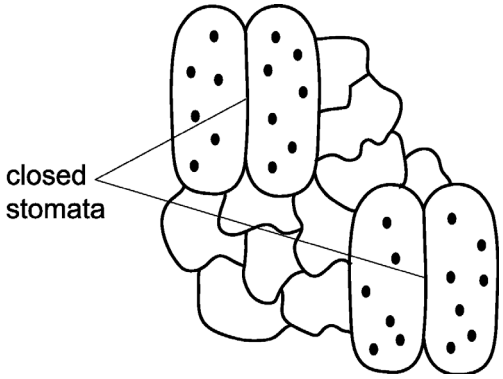
..... **[2]**

(b) Stomata are small holes found mostly on the underside of leaves.

They can open and close. The opening and closing of the stomata is controlled by guard cells.

The diagram shows the stomata and the guard cells.





Potassium ions from neighbouring cells enter the guard cells. This causes the stomata to open.

Explain how this mechanism works.

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.....

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

9 **(a)** In 1991 a type of genetically modified tomato was being developed.

This tomato contained a gene from a fish called an arctic flounder. Arctic flounder live in very cold conditions.

How would the tomato with the arctic flounder gene be useful to modern agriculture?

.....

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

(b) Genetic modification has many wider applications.

Children who lack human growth hormone can be injected with a genetically engineered version so that they grow as normally as possible.

The bacterium *Escherichia coli* is used as part of the genetic engineering process.

Use this information to describe how human growth hormone is made.

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

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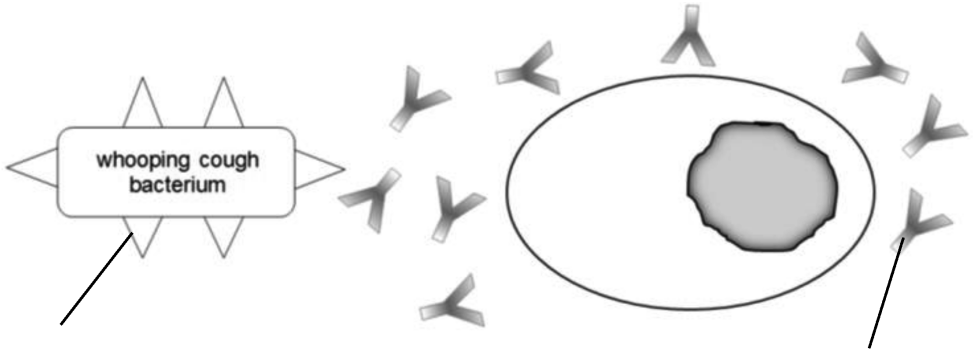
10 **(a)** Whooping cough is a non-communicable bacterial infection.

The diagram below shows the blood of a person infected with whooping cough.

Label the two structures in the diagram.



(i) ……

(ii) ……

[2]

(iii) People can be vaccinated against whooping cough.

There are two types of vaccine:

- Type 1 uses whole bacterial cells
- Type 2 uses parts of bacterial cells.

Some people are concerned about using the Type 1 vaccine with whole bacterial cells.

Suggest why.

.....

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

(b) New medicines, including vaccines, have to be tested before being made widely available.

Preclinical and clinical tests are used to assess the safety and effectiveness of new medicines.

For each test, complete the table by putting a tick (✓), in **one** box to indicate if it assesses **safety**, **effectiveness** or **both**.

For each test, one example has been done for you.

Preclinical tests	Safety	Effectiveness	Both
Cultured human cells			✓
Whole animals			

Clinical tests	Safety	Effectiveness	Both
Healthy volunteers			
Humans with the disease			✓

[2]

11 **(a)** James Watson and Francis Crick are famous for identifying the structure of DNA. They wrote a scientific paper about DNA in 1953.

Before this, scientists had clues about the parts of the DNA molecule. One of these clues was the relative amounts of the bases: A, T, C and G.

Chemical analysis of DNA from a wide variety of cells showed that

Total number of A bases and G bases = Total number of T bases and C bases.

What conclusion could early scientists have made from this analysis?

.....

.....

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

(b) DNA structure is important in the production of proteins. DNA analysis allows scientists to group organisms based on similarities in their DNA.

Complete the sentences below.

A ..... of bases is required to code for an amino acid.

The properties of the protein made depend on the.....of the amino acids.

Grouping organisms according to similarities in their DNA or physical

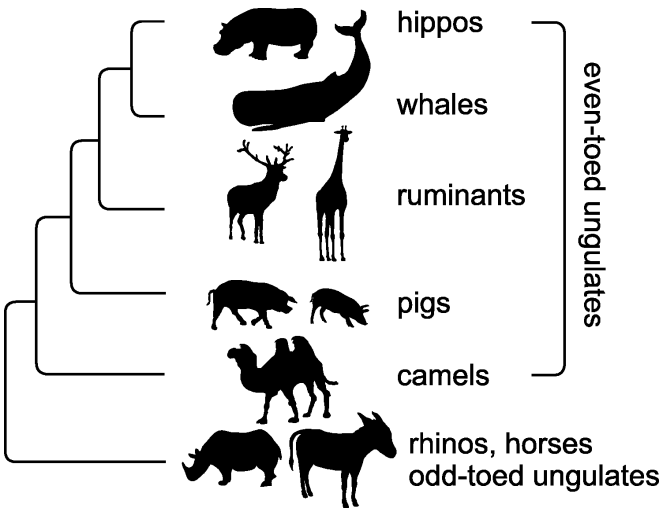
characteristics is called ..... **[3]**

(c) Knowledge of genetics and DNA analysis has allowed scientists to group organisms based on similarities in their DNA.

Scientists can then draw conclusions about the evolutionary relationships between organisms.

An evolutionary tree can be drawn to highlight these relationships.

An example is shown below.



Are hippos more closely related to whales or to pigs?

Justify your answer using evidence from the evolutionary tree in your answer.

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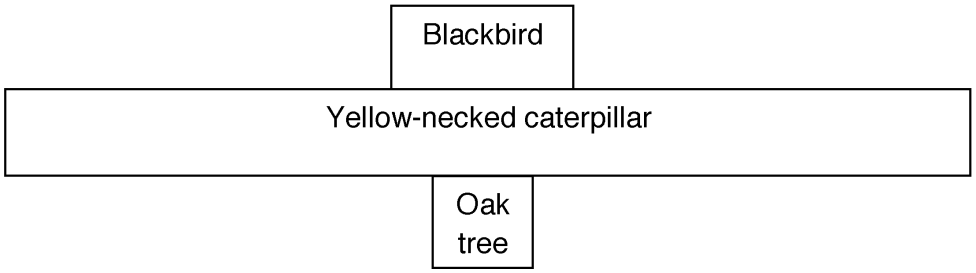
.....

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

12 **(a)** Sundip considers different options for displaying data about the organisms found in a woodland ecosystem.

One option is a pyramid of numbers for the simple food chain, as in the example below.

Oak tree → Yellow-necked caterpillar → Blackbird

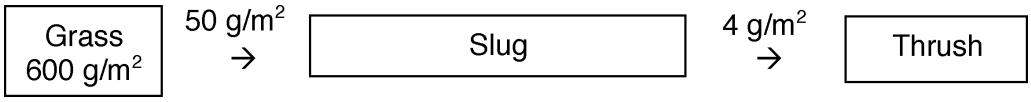


Draw a pyramid of biomass for this food chain in the space below.

[1]

(b) Biomass in an ecosystem can be measured in g/m^2.

Values for a different food chain in the same woodland ecosystem as in **(a)** are shown below.



(i) Calculate the percentage of the biomass from the grass that is passed on to the thrush.

Show your working.

Give your answer to **two** decimal places.

Biomass = ...% **[1]**

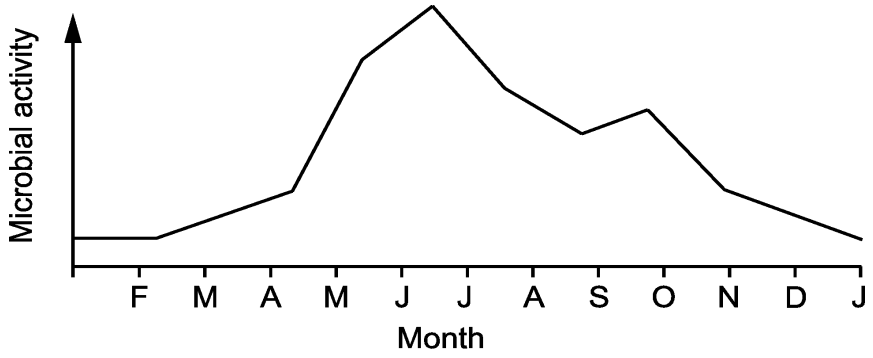
(ii) Give **one** reason why so little biomass from the grass is passed on to the thrush.

.....

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

(c) Decomposers are also an important part of ecosystems.

The graph shows the activity of decomposers in a woodland ecosystem during a year, from January to December.



(i) Describe the pattern of microbial activity shown in the graph above.

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

(ii) Explain the pattern you have described in **(c)(i)**.

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

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