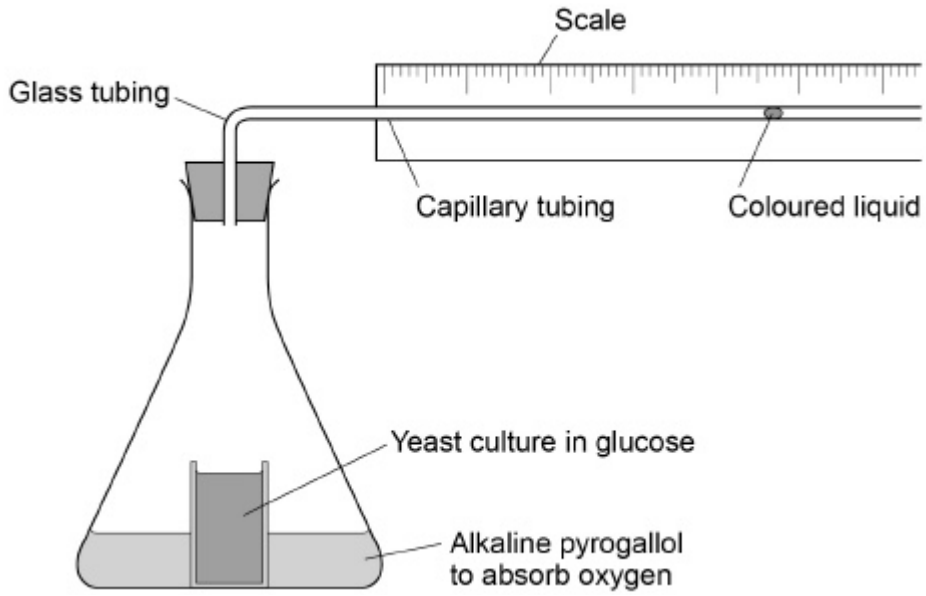
Q1.

Yeast cells can respire aerobically or anaerobically. A student used the apparatus shown in **Figure 1** to measure the rate of respiration in yeast.

She:

- positioned the flask in a water bath so that the yeast culture reached a constant temperature
- then left the apparatus for one hour before starting her investigation.

Figure 1



(a) Suggest **one** reason why it was important that the student left the apparatus for one hour after the yeast culture reached a constant temperature.

_____

_____

(1)

(b) During her investigation, the coloured liquid moved to the right.

Explain why it moved to the right.

_____

_____

_____

_____

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_____

_____

(2)

(c) The student found that the coloured liquid moved 1.5 cm in 24 hours. The diameter of the lumen (hole) of the capillary tubing was 1 mm.

The volume of a capillary tubing is given by $\pi r^2 l$, where π is 3.14 and l = length.

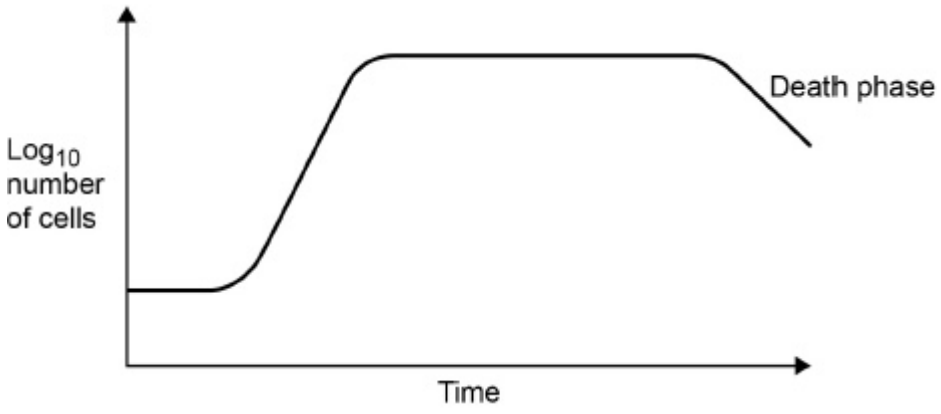
Calculate the volume of gas produced in $cm^3\ hour^{-1}$.
Show your working.

Answer = _____ $cm^3\ hour^{-1}$

(2)

Figure 2 shows a typical population growth curve for yeast under laboratory conditions.

Figure 2



(d) Explain why a log scale is used to record the number of cells.

_____

_____

_____

(1)

(e) Many yeast cells die during the death phase.

Suggest **one** reason why.

_____

_____

_____

_____

(1)

(f) The following equation can be used to make predictions of the growth in the population of yeast cells under ideal laboratory conditions.

$$\mathbf{X_t = X_0 \, e^{rt}}$$

X_t = the population after a certain time
X_0 = the population at the start
e = 2.72 (base of natural logarithm)
r = growth rate
t = time period in hours over which r applies

A population of 2000 yeast cells was left for 10 hours.
The value for the growth rate was 0.5

Assuming no yeast cells died, calculate the predicted size of the population after 10 hours. Show your working.

Answer = _____

(2)
(Total 9 marks)

Q2.

Scientists investigated treatment of a human bladder infection caused by a species of bacterium. This species of bacterium is often resistant to the antibiotics currently used for treatment.

They investigated the use of a new antibiotic to treat the bladder infection. The new antibiotic inhibits the bacterial ATP synthase enzyme.

(a) Place a tick (✓) in the appropriate box next to the equation which represents the reaction catalysed by ATP synthase.

$ATP \longrightarrow ADP + P_i + H_2O$ ☐

$ATP + H_2O \longrightarrow ADP + P_i$ ☐

$ADP + P_i \longrightarrow ATP + H_2O$ ☐

$ADP + P_i + H_2O \longrightarrow ATP$ ☐

(1)

(b) The new antibiotic is safe to use in humans because it does **not** inhibit the ATP synthase found in human cells.

Suggest why human ATP synthase is not inhibited and bacterial synthase is inhibited.

_____

_____

_____

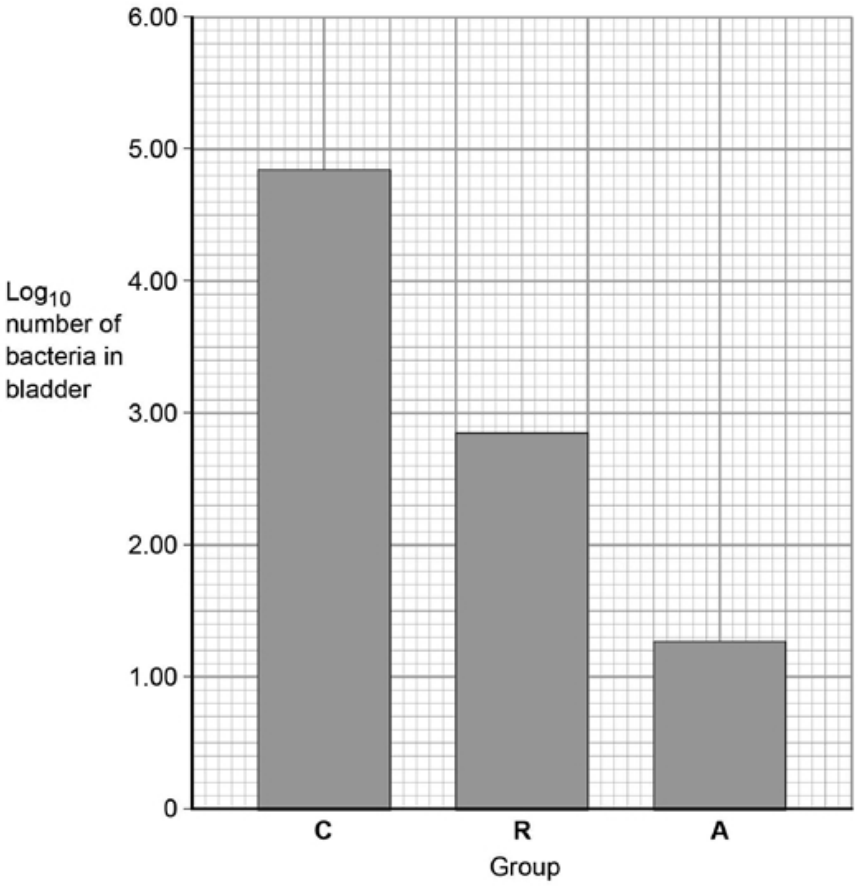
(1)

(c) The scientists tested the new antibiotic on mice with the same bladder infection. They divided these mice into three groups, **C**, **R** and **A**.

- Group **C** was the control (untreated).
- Group **R** was treated with an antibiotic currently used against this bladder infection.
- Group **A** was treated with the new antibiotic.

They removed samples from the bladder of these mice after treatment and estimated the total number of bacteria in the bladder.

Their results are shown in the graph.



The antibiotics were given to the mice at a dose of 25 mg kg^{-1} per day.

Calculate how much antibiotic would be given to a 30 g mouse each day.

Show your working.

Answer = _____ mg

(2)

(d) Calculate the percentage difference in actual numbers of bacteria in group **A** compared with group **R**. The actual number of bacteria can be calculated from the $\log_{10}$ value by using the 10^x function on a calculator.

Show your working.

Answer = _____ %

(2)

(e) The scientists suggested that people newly diagnosed with this bladder infection should be treated with both the current antibiotic and the new antibiotic.

Explain why the scientists made this suggestion.

Use information from the graph in part (c) and your knowledge of evolution of antibiotic resistance in bacteria in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

(3)
(Total 9 marks)

Q3.

In mammals, in the early stages of pregnancy, a developing embryo exchanges substances with its mother via cells in the lining of the uterus. At this stage, there is a high concentration of glycogen in cells lining the uterus.

(a) Describe the structure of glycogen.

_____

_____

_____

_____

_____

_____

_____

_____

(2)

(b) During early pregnancy, the glycogen in the cells lining the uterus is an important energy source for the embryo.

Suggest how glycogen acts as a source of energy.

Do **not** include transport across membranes in your answer.

_____

_____

_____

_____

_____

(2)

(c) Suggest and explain **two** ways the cell-surface membranes of the cells lining the uterus may be adapted to allow rapid transport of nutrients.

1. _____

_____

_____

2. _____

_____

_____

(2)

(d) In humans, after the gametes join at fertilisation, every cell of the developing embryo undergoes mitotic divisions before the embryo attaches to the uterus lining.

- The first cell division takes 24 hours.
- The subsequent divisions each take 8 hours.

After 3 days, the embryo has a total volume of 4.2×10^{-3} mm^3.

What is the mean volume of each cell after 3 days? Express your answer in standard form.

Show your working.

Answer = _____ mm^3

(2)

(Total 8 marks)

Q4.

Arbuscular mycorrhiza fungi (AMF) are fungi which grow on, and into, the roots of plants. AMF can increase the uptake of inorganic ions such as phosphate.

(a) Suggest **one** way in which an increase in the uptake of phosphate could increase plant growth.

_____

_____

(1)

(b) Suggest **one** way in which AMF may benefit from their association with plants.

_____

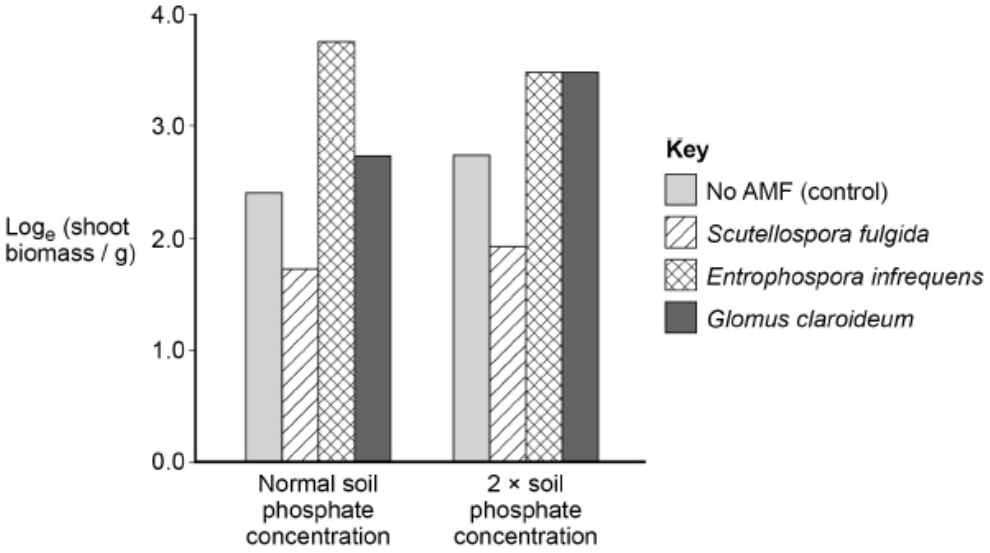
_____

(1)

(c) Scientists investigated the effects of different AMF species on the productivity of the plant community of a prairie grassland ecosystem when growing in/on soil containing different phosphate concentrations.

The scientists set up identical plots of prairie grassland soil containing seeds of the plant species found in the ecosystem. The scientists added different AMF species and different concentrations of phosphate to particular plots. Control plots without AMF species were also set up. After 20 weeks the scientists determined the shoot biomass for each plot.

The results the scientists obtained are shown in the graph.



Explain why an increase in shoot biomass can be taken as a measurement of **net** primary productivity.

_____

_____

_____

(2)

(d) Using the data from the graph in part (c), evaluate the effect on plant productivity of adding AMF species and adding phosphate to the soil.

_____

_____

_____

_____

_____

_____

_____

(4)

(e) Using the e^x button on your calculator, determine the rate of shoot biomass production in grams per day for the control plot in soil with normal phosphate concentration.

Answer = _____ g day^{-1}

(2)

(Total 10 marks)

Q5.

A group of students carried out an investigation to find the water potential of potato tissue.

The students were each given a potato and 50 cm^3 of a 1.0 mol dm^{-3} solution of sucrose.

- They used the 1.0 mol dm^{-3} solution of sucrose to make a series of different concentrations.
- They cut and weighed discs of potato tissue and left them in the sucrose solutions for a set time.
- They then removed the discs of potato tissue and reweighed them.

The table below shows how one student presented his processed results.

Concentration of sucrose solution / mol dm^{-3}	Percentage change in mass of potato tissue
0.15	+4.7
0.20	+4.1
0.25	+3.0
0.30	+1.9
0.35	−0.9
0.40	−3.8

(a) Explain why the data in the table above are described as **processed** results.

_____

_____

(1)

(b) Describe how you would use a 1.0 mol dm^{-3} solution of sucrose to produce 30 cm^3 of a 0.15 mol dm^{-3} solution of sucrose.

_____

_____

_____

_____

(2)

(c) Explain the change in mass of potato tissue in the 0.40 mol dm^{-3} solution of sucrose.

_____

_____

_____

_____

(2)

(d) Describe how you would use the student's results in the table above to find the water potential of the potato tissue.

_____

_____

_____

_____

_____

_____

(3)
(Total 8 marks)

Mark schemes

Q1.

(a) (So the) oxygen is used/absorbed/respired;

1

(b) 1. Anaerobic respiration produces carbon dioxide;

2. Increase in pressure/volume (of gas);

Reference to either volume or pressure required for the mark

2

(c) 1. Correct answer in range of
4.9×10^{-4} to 4.91×10^{-4} = **2 marks**;;

Accept any equivalent mathematical representation of this answer

2. Incorrect answer buts shows division by 24 = **1 mark**
OR
Incorrect answer but shows a number from 1175 to 1178 (ignore position of decimal point, standard form and any numbers that follow) = **1 mark**;
OR
Incorrect answer but show the number 49 (ignore position of decimal point, standard form and any numbers after 49) = **1 mark**;

2

(d) Large range/difference/increase in numbers;

Accept reference to exponential (increase)
Ignore if the answer only refers to numbers being high
Ignore to 'fit on the scale'

1

(e) Decrease/no glucose/substrate
OR
Increase in ethanol/carbon dioxide/acidity;

*Accept decrease/no oxygen as **Figure 2** is not linked to **Figure 1**.*
Accept competition for glucose/oxygen.
Accept any named sugar
Accept decrease in pH
Accept increase in toxins
Ignore food/nutrients

1

(f) 1. Correct answer of 298000 or 297766 or 297765.59 or 296826 = **2 marks**;;

Accept: any equivalent answer with appropriate rounding
e.g. 2.98×10^5,
29.78×10^4 *etc.*

2. Incorrect answer but working shows 2000×2.72 = **1 mark**;
OR
Incorrect answer but working shows $2.72^{0.5 \times 10}$ / 2.72^5 / $e^{0.5 \times 10}$ / = **1 mark**

2

[9]

Q2.

(a)

$ATP \longrightarrow ADP + P_i + H_2O$	
$ATP + H_2O \longrightarrow ADP + P_i$	
$ADP + P_i \longrightarrow ATP + H_2O$	✓
$ADP + P_i + H_2O \longrightarrow ATP$	

1

(b) 1. Human ATP synthase has a different <u>tertiary</u> structure to bacterial ATP synthase
OR
Human ATP synthase has a different <u>shape active site</u> to bacterial ATP synthase
OR
Antibiotic cannot enter human cells/mitochondria
OR
Antibiotic not <u>complementary</u> (to human ATP synthase);

1

(c) 0.75;
One mark for showing 30 g = 0.03 kg;
One mark for showing 0.025 <u>mg g^{-1}</u>

2

(d) Answer in range 97.0 – 97.8%;
OR
Answer in range 3288 – 4368%;

2. *1 mark for correct log_{10} readings from graph converted to actual numbers*

(16.98 – 19.50 ***and*** *660.7 – 758.6)*

2

(e) 1. (From the graph in part c) New / old antibiotic does not kill all bacteria;
OR
(From the graph in part c) Some bacteria are resistant to the new / old antibiotic;
2. Resistant bacteria will reproduce to produce (more) resistant bacteria;
3. (Use of both) one antibiotic will kill bacteria resistant to the other antibiotic;
OR
Unlikely that bacteria are resistant to both the new and the old antibiotic;
OR
Use of both antibiotics (likely to) kill all / most bacteria;

*Accept use of '**A**' for 'new antibiotic' and '**R**' for 'old antibiotic'.*

1. *Must relate to the bacteria that are still present – 'some bacteria are killed' or 'the bacteria number is reduced ' is insufficient.*
2. *Accept 'resistant bacteria reproduce to pass on resistance gene / allele'*
3. *'Use of both antibiotics will be more effective' is insufficient.*

3

[9]

Q3.

(a) 1. Polysaccharide of α-glucose;
OR
polymer of α-glucose;
2. (Joined by) glycosidic bonds
OR
Branched structure;

2

(b) 1. Hydrolysed (to glucose);
2. Glucose used in respiration;
1. Ignore 'Broken down'
2. 'Energy produced' disqualifies mp2

2

(c) 1. Membrane folded **so** increased / large surface area;
OR
Membrane has increased / large surface area **for** (fast) diffusion / facilitated diffusion / active transport / co-transport;
2. Large number of protein channels / carriers (in membrane) **for** facilitated diffusion;
3. Large number of protein carriers (in membrane) **for** active transport;
4. Large number of protein (channels / carriers in membrane) **for** co-transport;
1. Accept 'microvilli to increase surface area'
1. Reject reference to villi.
Note feature and function required for each marking point and reference to large / many / more.
List rule applies.

2 max

(d) 3.3×10^{-5} **OR** 3.28×10^{-5} **OR** 3.281×10^{-5};
1 mark for
Evidence of 128 (cells)
Correct numerical calculation but not in standard form gains 1 mark (0.00003281 **OR** 0.0000328 **OR** 0.000033);
Accept any number of significant figures as long as rounding correct (3.28125×10^{-5} scores 2 marks)

2

[8]

Q4.

(a) Used to produce named phosphate compound in cells;
e.g. ATP / ADP / phospholipids / DNA / RNA / RuBP / TP /GP etc.

1

(b) Example of a carbon-containing biological compound e.g. carbohydrate / amino acid / vitamin;

Accept: sugars / organic (compounds).

Ignore: products of photosynthesis.

Ignore: starch.

1

(c) 1. Represents dry mass / mass of carbon;
2. Represents gross production minus respiratory losses;

2. Accept: NPP = GPP –R.

2. Accept: Chemical energy minus respiratory losses.

1 and 2. Chemical energy store minus respiratory losses = 2 marks.

2

(d) 1. For the control an increase in phosphate increases (plant) growth;
2. For *Entrophospora* an increase in phosphate reduces (plant) growth;
3. *Scutellospora* reduces (plant) growth (compared to control);
4. *Entrophospora* and *Glomus* increases (plant) growth (compared to control);
5. No SD / statistical test to determine significance;
6. Only 20 weeks of growth;
7. Underground / root growth not known;

5. Accept: no error bars.

7. Accept: only shows shoot growth.

4 max

(e) 1. Answer in range 0.07 to 0.09 = **2 marks**;
2. Answer in range 9.97 to 12.2
OR
Shows division by 140 or 20 × 7 = 1 mark;

2

[10]

Q5.

(a) Calculations made (from raw data) / raw data would have recorded initial and final masses.

1

(b) Add 4.5 cm^3 of (1.0 mol dm^{-3}) solution to 25.5 cm^3 (distilled) water.

If incorrect, allow 1 mark for solution to water in a proportion of 0.15:0.85

2

(c) 1. Water potential of solution is less than / more negative than that of potato tissue;

Allow Ψ as equivalent to water potential

2. Tissue loses water by osmosis.

2

(d) 1. Plot a graph with concentration on the *x*-axis and percentage change in mass on the *y*-axis;
2. Find concentration where curve crosses the *x*-axis / where percentage change is zero;
3. Use (another) resource to find water potential of sucrose concentration (where curve crosses *x*-axis).

3

[8]