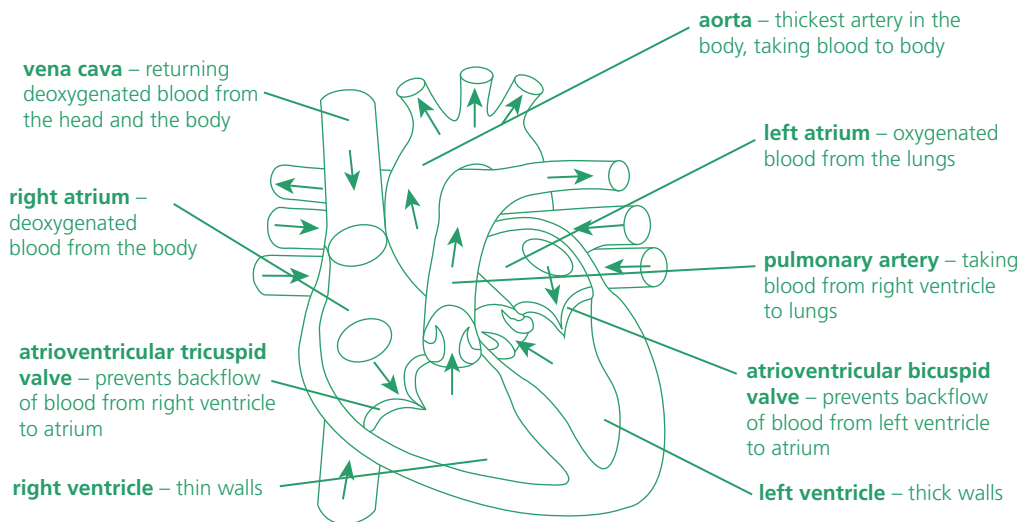


Exercises

2A



2B

- a
 - Aorta – carries (oxygenated) blood from the left ventricle to the body
 - Pulmonary artery – carries (deoxygenated) blood from the right ventricle to the lungs
 - Pulmonary vein – carries (oxygenated) blood from the lungs to the left atrium
 - Left atrium – receives oxygenated blood from the pulmonary vein / from the lungs
 - Right atrium – receives deoxygenated blood from the vena cava / from the body
 - Left ventricle – pumps oxygenated blood to the body / out through the aorta
 - Right ventricle – pumps deoxygenated blood to the lungs / out through the pulmonary artery
 - Bicuspid valve – prevents backflow of blood from the left ventricle into the left atrium
 - Tricuspid valve – prevents backflow of blood from the right ventricle into the right atrium
 - Semilunar valves – prevent backflow of blood from the atria into the veins
 - Vena cava – supplies (deoxygenated) blood from the body to the right atrium
- b Myogenic means the heart tissue can generate its own action potential, even when it is severed from the nervous system.
- c The right ventricle pumps blood to the entire body, whereas the left ventricle pumps blood to the nearby lungs.
- d Sympathetic and parasympathetic nerves.
- e The pacemaker (the sino-atrial node) is in the wall of the right atrium. The cells of the node can spontaneously generate and regulate action potentials.
- f The atrioventricular node is in the wall that separates the two atria, in the right atrium. It transmits the stimulus from the atria to the ventricles.
- g Medulla oblongata in the brain.

2C

- a** Continuous unbroken lines; only four cells drawn, each touching the next cell; double line for cell wall around each cell; cell wall, cytoplasm and nucleus in correct size proportions; cell wall, cytoplasm and nucleus labelled with label lines just touching cell wall and nucleus.
- b** Drawing showing two cells. Drawn with clear (unbroken lines). Showing the membrane pulled away from cell wall, (plasmolysis). Cell membrane, cytoplasm, cell wall and nucleus labelled.
- c** When the plant cells were immersed in iodine solution, the stain diffuses into the cells and stained the cytoplasm and the nucleus. The sugar solution has a lower water potential than the cytoplasm. It causes water to come out of the cells by osmosis. This causes the cell to become plasmolysed. As the cytoplasm shrinks, the cell membrane pulls away from the cell wall.
- d** $\text{percentage cells plasmolysed} = \frac{\text{number of cells plasmolysed}}{\text{total number of cells}} \times 100$
- e** *Any two from:* onion tissue was used because it is easily accessible; the epidermal cells are a single-cell thick; they take up the stain or sugar solution readily.

2D

AB = 20 mm

$$M = \frac{I}{A} = \frac{20}{0.6} = 33.33$$

magnification $M = \times 33.3$

2E

$$M = \frac{I}{A}, \text{ so } A = \frac{I}{M}$$

First convert measured length of line AB in mm to micrometres: Line A–B = 65 mm $\times 1000 = 65\,000\,\mu\text{m}$

$$\text{Therefore, } A = \frac{65\,000}{65\,000} = 1\,\mu\text{m}$$

2F

- a** Answers will vary depending on the specimens used.
- b** Any four of the following rows:

Plant cell	Animal cell
Larger than animal cell	Smaller than plant cell
Contains chloroplasts	No chloroplast
Has a cell wall	No cell wall
Has vacuole	No vacuole
Generally rectangular	Generally round or irregular shape
Has organelles	Has organelles
Has plasma membrane	Has plasma membrane

2G

- a** Mass of sucrose required is 3.75 g.

Dissolve sucrose in water and make up to 250 cm³.

- b** Place beaker on balance and set to zero / press tare.

$$\text{mass} = \text{volume} \times \text{density} \quad \text{or} \quad \text{mass} = 35 \times 1.26 \\ = 44.1 \text{ g}$$

Add glycerol using a syringe / pipette until balance reads the required mass.

- c** 180 g/dm³ will make 1 M solution

We need to make 500 cm³

$$\text{So, } \frac{180}{2} = 90 \text{ g} = 500 \text{ cm}^3 \text{ 1 M}$$

We need to make 0.5 mol dm⁻³ solution, so $\frac{90}{2} = 45 \text{ g}$

Add 45 g glucose to a 500 cm³ beaker, add about 450 cm³ distilled water.

Transfer to a 500 cm³ volumetric flask or measuring cylinder.

Carefully add more distilled water to take it up to the mark.

Transfer to a labelled reagent bottle. Store in a fridge until required.

2H

Using the formula

$$\text{volume of stock solution required} = \frac{\text{required concentration}}{\text{concentration of stock solution}} \times \text{final volume required}$$

For example

$$\frac{0.2}{0.5} \times 10 = 4 \text{ cm}^3$$

Made up to 10 cm³, so need to add 6 cm³ distilled water.

Concentration/mol dm ⁻³	0.1	0.2	0.3	0.4
Volume of stock solution/cm ³	2	4	6	8
Volume of distilled water/cm ³	8	6	4	2

2I

- a** 10 g/100 cm³ = 10% solution

So 20 g/200 cm³ = 10% solution

Weigh 20 g NaCl, add to a 250 cm³ beaker.

Add distilled water to just below 200 cm³ mark.

Transfer to a 200 cm³ volumetric flask or measuring cylinder.

Carefully add more distilled water to take it up to the 200 mark.

Transfer to a labelled reagent bottle. Store in a fridge until required.

b

Concentration/%	1.0	0.1	0.01	0.001
Volume of distilled water/cm ³	9	9	9	9
Volume of stock solution/cm ³	1	1	1	1

- c To ensure that none of the previous dilution(s) / more concentrated solution(s) are carried over.
This will cause the concentration (of the next dilution) to be too large.
Any water present in the pipette will lower the concentration / make the solution more dilute.

2J

- a A table with ruled borders and columns for time / minutes, free and immobilised enzyme.
Times from 0–12 in intervals of 2 and presence or absence of glucose indicated in each row in a clear manner.

Results should show longer time for glucose to appear with immobilised enzyme.

- b i The free enzyme acts faster.
Because glucose appears in the solution sooner.
Accept reverse argument for immobilised enzyme.
- ii Any 2 from:
- Substrate / product does not have to diffuse through alginate when yeast / enzyme is free.
 - Surface area to volume ratio of beads is smaller than free yeast.
 - *Reference to process of immobilising yeast in alginate affecting the yeast in some negative way.*
- c i *Independent* – temperature
Dependent – time for glucose to appear / rate of reaction
- ii Any 3 from:
- Same volume of alginate beads each time.
 - Same concentration / mass of yeast / enzyme each time.
 - Same concentration of sucrose / substrate each time.
 - Test strips left in for the same time.
- Do not accept amount for volume / mass / concentration.*

2K

- a 1 Take 10 g apple and liquidise it in 50 cm³ of distilled water.
2 Filter
3 Label three test tubes as RS, P and F.
4 And add 1 cm³ of the filtrate into each test tube and test for reducing sugars, proteins or fat.

Reducing sugars test

- 1 To 1 cm³ of the filtrate in the test tube labelled RS add 2 cm³ Benedict's reagent (Benedict's reagent should be in excess).
- 2 Place in boiling water bath for 5 minutes (water bath temperature must be 80 °C or above).
- 3 If colour changes from copper sulfate blue to green, yellow or brick red, the test is positive for reducing sugar.

Protein test

- 1 To 1 cm³ of the filtrate in the test tube labelled P add 1 cm³ of biuret reagent; mix well (no heating is required).
- 2 If colour changes from blue to lilac/purple, the test is positive.

Fat test

- 1 To 1 cm³ of the filtrate in the test tube labelled F add 2 cm³ of alcohol. Shake. Add 2 cm³ water. Mix well.
- 2 Stand for a few minutes. If a cloudy emulsion appears at top of the test tube, the result is positive.

b i Reducing sugar test – Benedict's test

Protein test – biuret test

Fat test – emulsion test

- ii 1 Switch on and set water bath to 100 °C.
- 2 Take an equal mass of (5 g) each of leaves, seeds and pods.
- 3 Crush each separately in distilled water.
- 4 Filter
- 5 Prepare 1.0 M glucose solution.
- 6 Prepare 20 cm³ of each of the following glucose dilutions: 0.0 M, 0.2 M, 0.4 M, 0.6 M, 0.8 M, 1.0 M.
- 7 Label test tubes 0, 0.2, 0.4, 0.6, 0.8, 1.0, L (leaves), S (seeds) and P (pods) and arrange in test-tube rack in order.
- 8 Add 2 cm³ Benedict's reagent to each test tube.
- 9 Add 1 cm³ of appropriate glucose solution to each labelled tube. Add 1 cm³ of samples L, S and P to appropriate tube.
- 10 Place the test-tube rack in a boiling water bath for 5 minutes.
- 11 Remove the test-tube rack from the water bath.
- 12 Record the optical density of each sample in a table.
- 13 Plot a graph of glucose concentration against optical density.
- 14 Read off the concentrations of L, S and P from the graph.
- 15 If the reading is within the range, repeat the test with smaller intermediates within the range to get a more precise result.
- 16 If the optical density is outside the range, dilute the samples appropriately and repeat the test, preferably in triplicates.
- 17 Calculate an average of the triplicates, plot a graph of glucose concentration against optical density and read off the concentrations of L, S and P from the graph.

2L

- a A table with ruled lines and borders and columns for absorbance and time with appropriate units in the header.

If absorbance is a decimal, then no units needed, otherwise % should be shown in the header.

Absorbance values recorded every minute to the same number of decimal places.

Absorbance decreases with time.

ANSWERS

b Graph with both axes labelled using the same quantities and units as in the table.

Linear scales on both axes so points cover at least half the grid in both directions.

All points plotted correctly to within $\frac{1}{2}$ small square with points as small crosses or dots in circles.

Smooth curve drawn / lines ruled between points.

c Any 4 from:

- Absorbance decreases with time.
- Graph shows steeper decrease at the start then less steep / starts to level off.
- Substrate gets used up / broken down.
- Enzyme concentration / number of enzymes remain(s) the same.
- Rate of reaction is higher at first / rate of reaction gets slower with time.
- Fewer enzyme-substrate complexes can form with time / fewer active sites occupied with time.

3A

X-axis label: Time/minutes and y-axis label: Glucose concentration/au.

X-axis scale: 5 minutes to 2 cm labelled at least every 2 cm and y-axis scale: 0.1 au to 2 cm labelled at least every 2 cm.

Correct plotting of five points as small crosses or dots in circles.

Smooth curved line through most points or straight lines ruled between points.

3B

X-axis: Species of plant and y-axis: Lipid content/%

Scale on x-axis: even width of bars with space between bars, and scale on y-axis: 10.0% to 2 cm, labelled at least every 2 cm.

Correct plotting of bars.

Labelled bars drawn with thin vertical and horizontal lines.

3C

a-d

Side length of agar cube/mm	Volume of agar cube/mm ³	Surface area of agar cube/mm ²	Surface area to volume ratio	Time taken for whole cube to change colour/s	Rate of diffusion/mm s ⁻¹
3	27	54	2	49	0.031
5	125	150	1.2	117	0.021
7	343	294	0.86	162	0.022
9	729	486	0.67	583	0.0077
11	1331	726	0.55	930	0.0059

(distances from face to centre of cube are: 1.5, 2.5, 3.5, 4.5, 5.5 mm)

1 mark for each correct column.

- e *X*-axis label: Surface area to volume ratio or SA:V (no unit), and *y*-axis label: Rate of diffusion, with mm per second or mm/s or mm s⁻¹.

Linear scales so that points cover at least half the grid in both directions.

All points plotted correctly to within 1 mm.

Line or curve of best fit leaving out the anomalous point (at SA:V of 0.86 if correctly calculated).

- f Results show that as surface area to volume ratio increases the rate of diffusion decreases.

Hydra has a larger surface area to volume ratio than fish.

All cells in *Hydra* can exchange nutrients/wastes/gases with the surroundings by diffusion.

5A

- a The dependent variable is the effect. Its value depends on changes in the independent variable. The dependent variable is the amount of oxygen produced per unit time, and hence, the rate of photosynthesis.
- b Sodium hydrogen carbonate was added to enhance the CO₂ levels in the test tube.
- c Light produces heat, although the beaker of water would absorb some of the heat produced by the lamp, bringing the lamp closer to the plant would have altered the temperature to some degree. Also, some oxygen would be consumed by the plant for respiration.
- d Light is necessary for photosynthesis. At very low light intensity the plant will be respiring but not photosynthesizing. As light intensity increases more photolysis occurs, liberating oxygen, NADP and ATP. The rate of photosynthesis increased proportionally with increasing light intensity up to point, after which, something else becomes the limiting factor (carbon dioxide levels or temperature). This needs to be raised to increase the rate of photosynthesis further.

Also, at a certain point, O₂ begins to compete with CO₂ for RuBisCO, as more O₂ binds to RuBisCO less sugar is made, and the rate plateaus.

6A

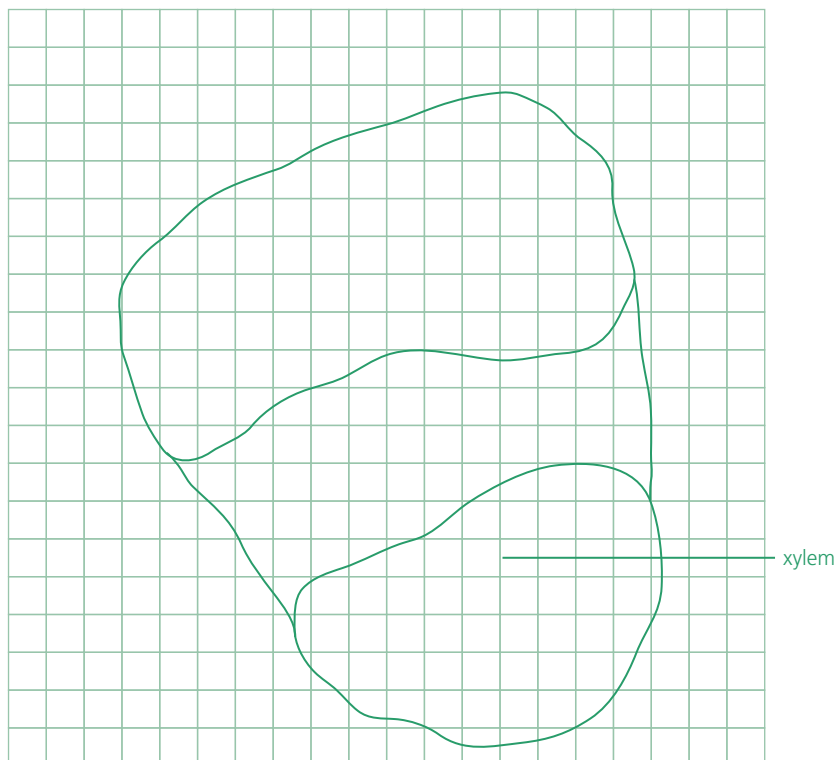
Any 6 from:

- Total number of cases do not take into account the population size of the countries.
- Data to support, e.g. the population of the USA/Brazil, will be much larger than that of Barbados.
- *Idea that* infection may not have started in each country at the same time.
- Not all cases will be identified/some people may not have been tested/some cases are symptomless.
- Not all (identified) cases will have been reported (e.g. early in the pandemic).
- Availability/uptake of vaccine will vary between countries.
- *Idea that* different countries will have implemented different policies to prevent transmission.
- *Idea that* some countries may wish to make their official figures higher/lower, e.g. for political reasons.

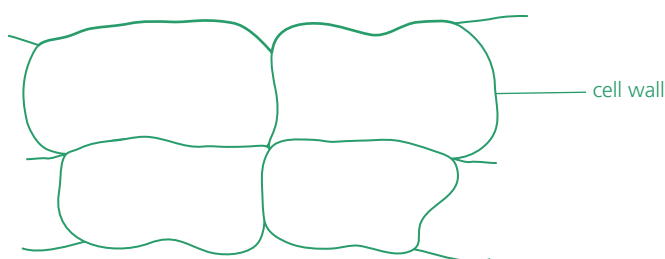
AS Level practice questions

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1 a i



ii



b i If $A = 84 \text{ mm} \times 1000 = 84\,000 \mu\text{m}$, actual length = $\frac{84\,000}{125} = 672 \mu\text{m}$

ii ratio: 275:224

iii habitat: aquatic or water habitat

feature: large air spaces helps plant to float on water

c

Observable differences	
Figure 4.1	Figure 4.2
Epidermis formed of several layers of collenchyma cells	Epidermis formed of single layer of collenchyma cells
No air spaces	Large air spaces around vascular bundle
Many vascular bundles around periphery	Central vascular bundle

2 a Meristematic tissue at the tip of shoot or tip of root.

b 1 Set up a boiling water bath in a 100 cm³ beaker.

2 Cut off about 5 mm from the apical root tip of an onion using a scalpel.

3 Place the root tip in a watch glass. Add a dropper full of aceto-orcein stain and four drops of concentrated hydrochloric acid to help macerate the cells.

4 Place the watch glass on top of the boiling water bath, and turn off the Bunsen burner.

5 Keep the watch glass on top of the water bath for about 3–4 minutes, making sure the stain does not evaporate dry. Add more stain if necessary.

6 Place the root tip on a clean glass slide; add a drop of cold aceto-orcein stain.

7 Without interfering too much with the arrangement of the cells, either break the root tip with a mounted needle or tap it with the back of a glass rod to crush it, and spread it out as thinly as possible.

8 Place a coverslip on top of the macerated tissue and, wrap the slide in several layers of filter paper.

9 Place the slide on a flat surface and squash firmly with your thumb, without allowing the coverslip to slide.

10 Carefully remove the filter paper and warm the slide by quickly passing it through the blue flame of the Bunsen burner. This will intensify the stain. The slide should be warm, but not too hot to touch on the back of your hand.

11 Examine under high power of the microscope.

c Observed in onion root tips because (any three of):

- quick to grow
- easy to obtain
- cheap
- clear tissue, as no chlorophyll to interfere with observations.

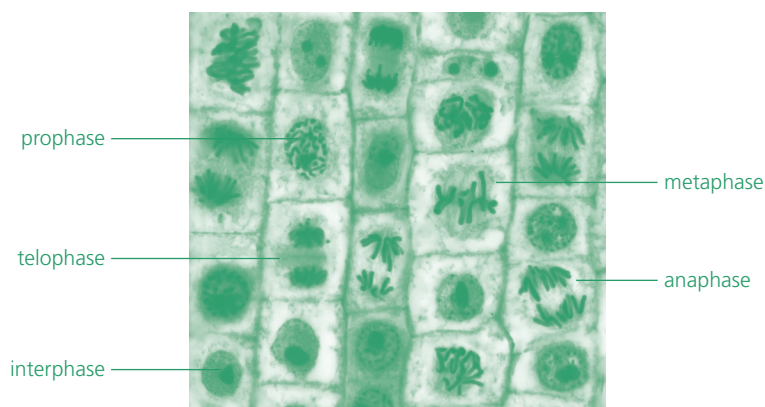
d Scalpel – use with care; can cut.

Using acid – corrosive, can cause burns.

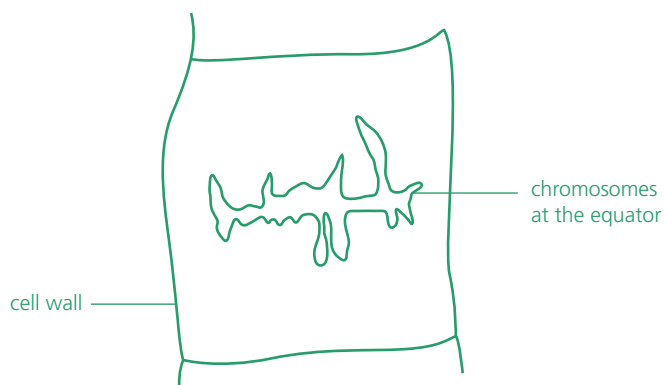
Using Bunsen burner and boiling water bath – danger of getting burnt.

Using stains – may be irritant, or harmful if in contact with skin.

e i



ii



iii MI is usually expressed as a percentage of cells undergoing mitosis.

$$\frac{10}{22} \times 100 = 45.5\%$$

3 a i You have to decide which temperatures you would like to use within the range specified (i.e. 40–80 °C). For example, you could use 40 °C, 50 °C, 60 °C, 70 °C, 80 °C.

ii You must use the letters given for each temperature and decide on the colour to the best of your ability.

iii You are asked to record your data. It would be best to record your data in a table. Think about the number of columns and rows. There should be two columns and six rows. The headings should be Temperature/°C and Time/s. You will lose marks if you forget to write the units in the two columns or do not write the range of temperatures in order. The time recorded must be in seconds. There should be no units in the body of the table.

Temperature/°C	Time/s
40	
50	
60	
70	
80	

- iv** In this investigation the temperature and the change in colour are the major factors.

Judging colour is subjective. It is difficult to judge the colour by eye. What you think is dark purple another student may describe as just purple.

You are not asked how you would overcome this. But if you were asked, one way to overcome this would be to have a colour chart with which to compare the colours, or, better still, if you scaled up the experiment and carried it out in larger volumes in test tubes, you could read the % transmission or % absorption using a colorimeter.

The exact temperature of the mixture would fall as the test tubes are removed from the water bath.

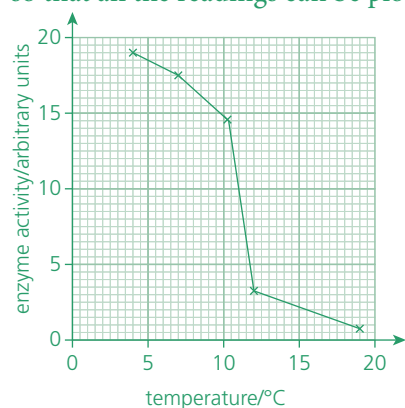
Again, you are not asked how you would overcome this. If you had carried out this investigation in test tubes, you could keep the samples in appropriate water baths.

- v** The optimum temperature for this enzyme is higher than that of humans (37°C).
vi Repeat the experiment at a fixed temperature using a thermostatically-controlled water bath.

You would use a range (at least five) of different enzyme concentrations.

You have to describe how you would make a range of dilutions, either standard dilutions or serial dilutions (pages 33 and 34).

- b i** Make a large graph, with sensible, easy-to-read divisions, for example with two or five increments, so that all the readings can be plotted.



- ii** Enzyme activity decreases with increasing temperature, or as temperature increases the activity decreases.

A Level practice questions

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1 a

	Complete homogenate	Cytosol	Mitochondria	Nuclei
Glucose	✓	✗	✓	✗
Pyruvate	✓	✗	✓	✗

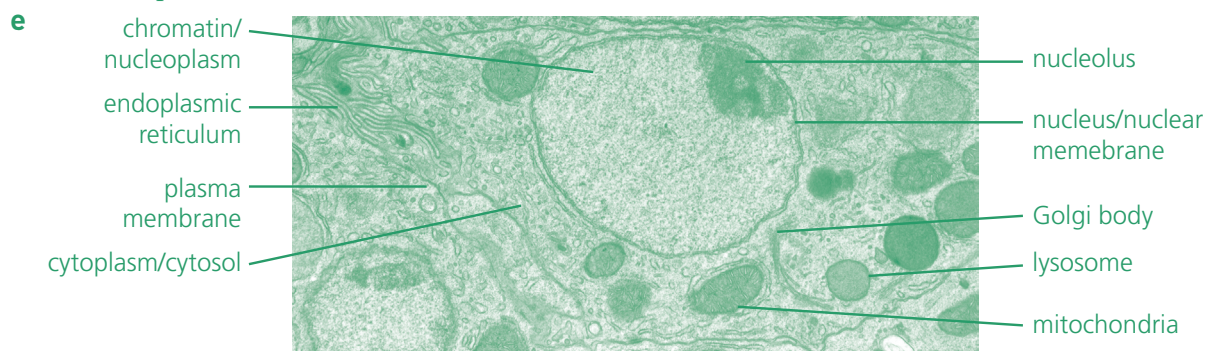
b Link reaction; Krebs cycle

c Using ice-cold buffer solution is necessary to slow enzyme action before the experiment begins.

Buffer maintains the correct pH for enzyme reactions.

Sucrose maintains the water potential of organelles. In distilled water organelles would burst as water would move in by osmosis and rupture them.

d Need to use electron microscope: scanning electron microscope for 3D; transmission electron microscope for internal structure.



2 a i Any 1 from:

- Data is discontinuous / discrete / ordinal / samples are independent.
- Data may not be linear / may be skewed / may not be normally distributed.
- When plotted on a scatter graph there may appear to be a correlation.

ii There is no correlation between the number of prescriptions and the percentage of samples containing antibiotic resistant *E. coli*.

iii Any 2 from:

- ampicillin
- trimethoprim
- quinolone

b *Maximum 2 for description and maximum 2 for explanation.*

Description

- percentage of antibiotic resistant bacteria is higher in males than females
- is high in children / age group 3–15
- decreases in late teens
- only slight changes through middle age / in age range 20s to 70s
- increases in old age
- highest at 100

Explanation

- males may be less likely to use antibiotics correctly / example of mis-use
- antibiotic use is higher in children and elderly than middle age
- children and elderly may encounter antibiotic resistant bacteria in hospitals, etc.
- people in middle age may be given different antibiotics

3 *Any 8 from:*

- Dependent variable identified as the tissue type / tissue A or B.
- Independent variable identified as rate of respiration / time taken for methylene blue to go colourless.
- *Any 2 control variables from:*
 - same mass of each tissue
 - same temperature / maintain at 20°C throughout
 - same reaction volume
 - same volume / concentration of methylene blue
 - same volume of buffer (not same pH as the same buffer was used throughout)
 - *idea of* same procedure for homogenising
 - *do not accept amount in place of mass, volume or concentration*
- Use the same mass of tissue each time.
- Use the same volume of buffer for homogenising each tissue sample.
- Add the same volume of tissue suspension each time.
- Add the same volume of methylene blue each time.
- Keep each test tube at the same temperature / use of thermostatically controlled water bath.
- *Idea of* pre-incubating methylene blue to same temperature as suspension before use.
- Record time taken until blue colour disappears.
- Repeat and calculate mean for each.
- Use of a control water / buffer to replace methylene blue.
- Method for mixing the indicator with the suspension.
- Method to make conditions anaerobic, e.g. layer of oil.
- Low risk procedure where standard lab rules are sufficient.

4 a i 0.09(0)

ii nominal data / categoric data

b i As mother's exposure to radiation increases the number of people (born to them) with cancer increases.

Linear correlation / proportional relationship

People can still develop blood cancer when mothers have no exposure to radiation.

ii Link made between radiation and cell damage or mutation in bone marrow stem cells.

c Any 3 from:

Validity increased by

- Large number of people studied.
- Source of radiation was the same.
- People were from the same area.
- Long time period used.

Validity decreased by

- Type of radiation may not be the same for both groups.
- Methods of measurement changed over time.
- Exposure times of the two groups were different.
- Records lost over time.
- Radiation may not be the only cause of blood cancer / lifestyle factors not considered.

d Any 3 from:

- Same age / method of storage of seeds
- Same variety / type / number of seeds
- Same light intensity / same water availability
- Same temperature / oxygen availability
- Same type of radiation

5 a Any 9 from:

- 1 Record temperature of water, adjust to set temperature if necessary.
- 2 Add known volume of soaked seeds in tube A.
- 3 Add same volume of inert substance/boiled seeds in tube B.
- 4 Make sure the setup is airtight.
- 5 Suitable method to make setup airtight e.g. using Vaseline or molten wax.
- 6 Use syringe to adjust manometer fluid level.
- 7 Leave for suitable length of time (minimum 20 minutes).
- 8 Measure and record distance moved by manometer fluid.
- 9 Repeats and calculate the mean.
- 10 Calculate volume of oxygen taken up per minute.
- 11 Detail of how to calculate volume of oxygen (by multiplying distance moved by fluid in the capillary by $2\pi r$).
- 12 Repeat at different temperatures.
- 13 Record data in a table.
- 14 Make a graph of results.

b Same volume of boiled seeds of the same kind, or glass beads of same volume as germinating seeds.

c Soda lime is used to absorb carbon dioxide produced by the germinating seeds. The manometer fluid will not move in the absence of soda lime, as oxygen used would be replaced by carbon dioxide produced.

d Plot the graph of volume oxygen produced against temperature. Read of the graph the temperature at which maximum volume of oxygen is consumed.

e Respiratory substrate is a biological molecule that can be broken down in respiration to release energy.

f 1

The volumes of oxygen and carbon dioxide are the same. 1 divided by 1 or 6 by 6

g R.Q. of fats is less than 1, as fats require greater amount of oxygen for oxidation, so less carbon dioxide exhaled, and more oxygen inhaled.

h There are **more carbon-hydrogen bonds** in lipids, meaning **more ATP is produced** from them in respiration. This also means **more oxygen is required** to break them down, so has an RQ of less than 1.

- 6 a i Independent variable: distance from the pond; dependent variable: distribution or abundance of different species of plants.
- ii
- 1 Use a (named) method of measuring, e.g. interrupted or continuous line or belt transect or random sampling in a defined area.
 - 2 Use a suitable sampling technique such as placing a stated size quadrat or point frame at regular distance apart or continuous in the line or belt transect. Or generate random samples on calculator or computer and place the quadrat accordingly.
 - 3 Identify or collect samples (to identify later) of all the different species present at each station.
 - 4 Record: abundance as numbers or (ACFOR), present or absent, density or percentage cover, of each species at each station.
 - 5 Ensure not to take samples of endangered species.
 - 6 State precautions taken to ensure accuracy of results, e.g. only count the species touching two sides as in, and be consistent with the procedure.
 - 7 Repeat the procedure at least once.
 - 8 Preferably repeat sampling in different season.
 - 9 State precautions to duplicate the method when repeating the procedure.
 - 10 State precautions taken to ensure safety, e.g. remain with the group, follow instructions from group leader/teacher.
 - 11 State precautions not to damage environment.
 - 12 Wear gloves, protective clothing, masks, especially if allergic to plants or suffer from hay fever or asthma.
 - 13 Be aware of harmful plants and animals such as snakes, spiders, etc.
- b i 317
- ii $(6 \times \Sigma D^2 \Rightarrow) 1902$
 $(n^3 - n \Rightarrow) 990$
 $r_s = (1 - 1.92 \Rightarrow) -0.92$
 $r_s = -0.92$
- iii There is a negative correlation, as the soil water increases the number of species decreases.
- c i The students reached this conclusion because there are 10 pairs of data, (we need to read off column 3), and the r_s value +0.86 is greater than the critical values at 5% and at 1%.
- ii The Spearman's rank correlation only shows there is a relationship. It does not show the cause. The sampling transects may not be representative of the whole area, or some biotic factor (e.g. effect of predation, diseases, human influences) or abiotic factor (e.g. extreme wind, deficiency in nutrients in soil) may be influencing the results.