mandatory activities

mandatory activity 1

see page 54

IDENTIFY AND USE VARIOUS APPARATUS FOR COLLECTION METHODS USED IN AN ECOLOGICAL STUDY

Study a minimum of ten organisms, to include five fauna (animals) and five flora (plants), and note the range of variation of each particular species, e.g. height, mass, etc.

A. Collecting plants

Plants cannot move around and hide, so they are easier for you to find. Get to identify and know which plant is which by studying the leaf shape and the flower.

B. Collecting animals

Because animals move about, and many are **nocturnal**, you must actively search for them and catch them humanely.

1. Direct search

Lift up stones, look among leaves or in bark crevices or in the air above you. Use a knife or trowel if it helps.

2. Beating tray

This can be a white linen sheet or sheet of A2 paper. It is held under a section of a bush or a tree, which is then shaken or hit with a stick. Any animals on the leaves will fall onto the sheet, where they can be collected by hand or with a pooter.

3. Pooter

This is a jar with two plastic tubes inserted. You **suck** up small animals into the jar. (Your fingers would squash them.)

4. Tullgren funnel

This is used to extract small animals from a sample of soil or leaf litter. The sample is placed on a coarse sieve over a funnel and left for 24 hours. The light and heat from the bulb drives the animals downwards, into a beaker for collection.

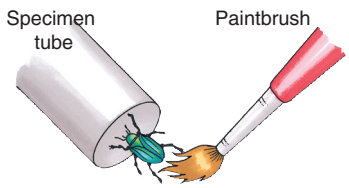

Fig. 1 Collecting by direct search

Fig. 2 Beating tray

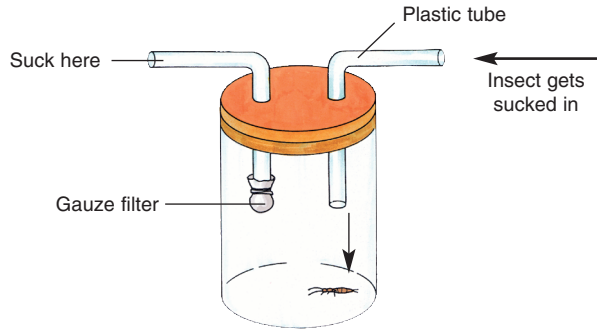

Fig. 3 Pooter

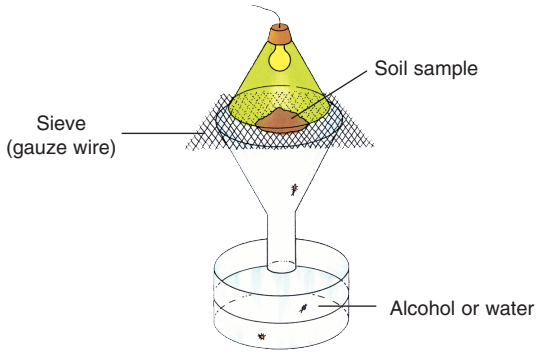

Fig. 4 Tullgren funnel

5. Pitfall trap

This trap collects nocturnal and walking animals. A jam-jar or beaker is sunk into the ground with its rim level with the soil. The animals fall in and can't climb out.

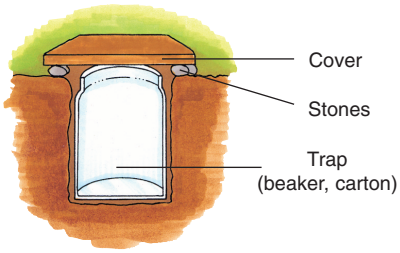

Fig. 5 Pitfall trap

6. Cryptozoic trap

An upturned flower pot stuffed with crumpled paper is left on the ground in the habitat. Animals, such as woodlice, centipedes and slugs, use the trap for shelter where they stay hidden during the day.

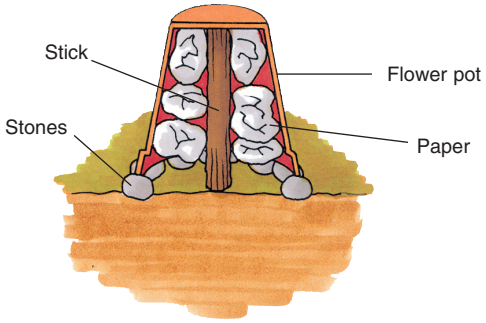

Fig. 6 Cryptozoic trap

7. Mammal traps

A Longworth trap is a metal box with an entrance tunnel and a trapdoor, which closes firmly behind the animal when it enters. The trap should be set and examined at least once a day. Record the types of mammal caught and release them as soon as possible.

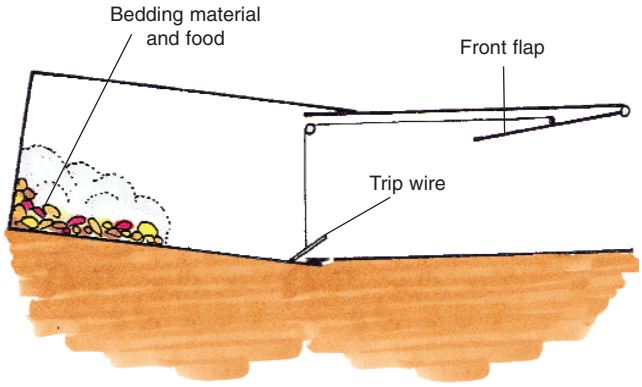

Fig. 7 Mammal trap

8. Nets

These collect flying or swimming animals. Nets with short handles catch flying insects. A stronger **sweep net** can be dragged along grass or through bushes, dislodging insects, which fall into the net. A plankton net collects microscopic water animals and plants.

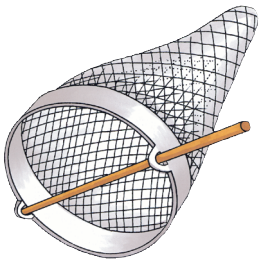

Fig. 8 Net

mandatory activity 2

see page 54

USE SIMPLE KEYS TO IDENTIFY ANY FIVE FAUNA AND ANY FIVE FLORA

There is such a diversity of living organisms that we need to organise them into manageable groups. This is known as **classification**. There is no one 'correct' scheme of classification – different ones suit different purposes.

Natural classification

During the eighteenth century, the Swedish botanist Carl Linnaeus devised a scheme where organisms are grouped together according to their basic **similarities** – i.e. if they look the same or are built to the same body plan. Nowadays, similarities in biochemistry and DNA of organisms are used too.

Artificial classification – Keys

Artificial classification is based on **differences**, rather than similarities. Organisms with a particular feature are selected from the main group and placed in a subgroup. Each selection is based on a single characteristic and groups may contain many unrelated organisms.

How to use a key

In the key below, start with Item 1. If a shell is present you then read Item 2, and decide whether the shell is coiled or not. If there is no shell present, then Item 3 is read instead.

1. Shell present – go to 2
Shell absent – go to 3
2. Shell coiled = WINKLE
Shell not coiled = LIMPET
3. Fins present = FISH
Fins absent go to 4
4. Tentacles present = SEA ANEMONE
Tentacles absent = STARFISH

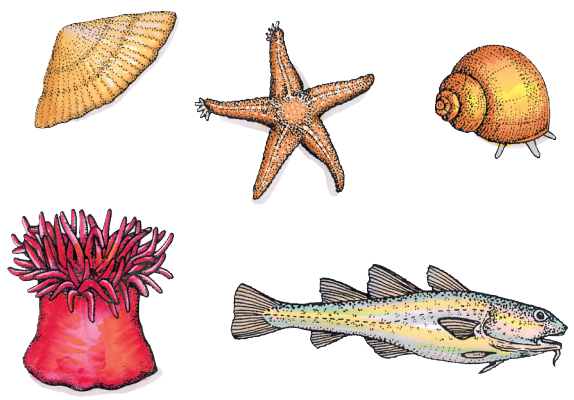

Fig. 1 Using a key to identify organisms

Using a key, you should be able to identify five animals and five plants from the selected ecosystem. Identify their mode of nutrition and reproduction, and draw the flower of the plants. (Algae are classified as 'plants' for this section.)

mandatory activity 3

see page 54

CONDUCT A QUANTITATIVE STUDY OF A SAMPLE AREA OF A SELECTED ECOSYSTEM (ESTIMATING NUMBERS)

Here you **count** the number of each plant or animal present. Since you cannot possibly measure every single one, you take small **samples** in different parts of the habitat and count them, and using those numbers you make a guess at the total number in the whole area.

The four **sampling techniques** used are:
direct count, **quadrats**, **transects** and **capture-recapture** method.

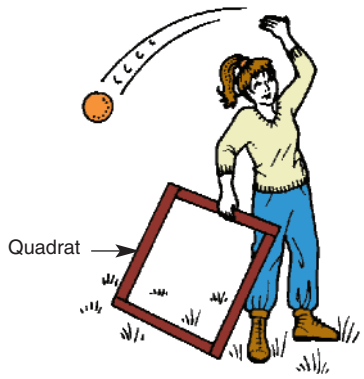

Fig. 1 Random sampling with a quadrat

Direct count

Count the total number of organisms in the habitat. This direct counting is suitable for large trees or animals such as deer.

Quadrats

A quadrat is a square frame, of metal or wood, either 50 cm x 50 cm or 1 m x 1 m. To ensure your sample is **random**, throw a ball or pen over your shoulder – place the quadrat wherever it lands. The quadrat can be used to measure **frequency** or **percentage cover**.

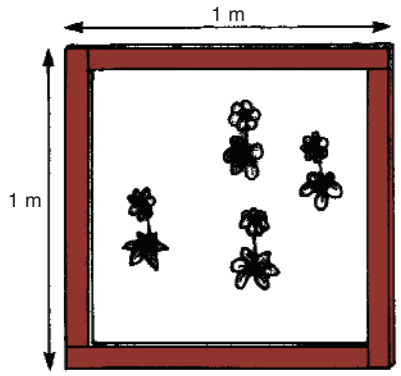

Fig. 2 Quadrat

Frequency

Frequency = How often you would expect to find the organism within the habitat

Record if a species is present (✔) or absent (–) in the quadrat. Repeat this 9 more times in other parts of the habitat and add up the total percentage. Frequency = Total × 10

For example:

	QUADRAT NO. FREQUENCY										
NAME OF PLANT	1	2	3	4	5	6	7	8	9	10	TOTAL (%)
Clover	✓	✓	–	✓	–	✓	✓	–	✓	✓	7 (70%)
Moss	✓	✓	–	–	–	–	–	–	–	–	2 (20%)
Grass	–	✓	✓	✓	✓	✓	✓	✓	✓	–	8 (80%)
Dandelion	–	✓	–	✓	✓	–	✓	–	–	✓	5 (50%)

Percentage Cover (using a grid quadrat)

% Cover = The amount of ground that the plant is covering.

This is used when each individual plant cannot be seen clearly, e.g. in grassland. You estimate the ground covered as a percentage of the **total area** of the **quadrat**.

A **grid** is a quadrat that has been subdivided into (100) smaller squares.

1. Count the number of squares that contain the plant or animal. If a square is half-filled or more, count this as one. The total is the percentage cover.

   OR

   Insert a knitting needle or pen into the grid where the strings meet and count how many times an individual plant touches ('hits') the organism being studied. The number of 'hits' is the % cover.

2. Repeat this in nine other places and calculate the average.

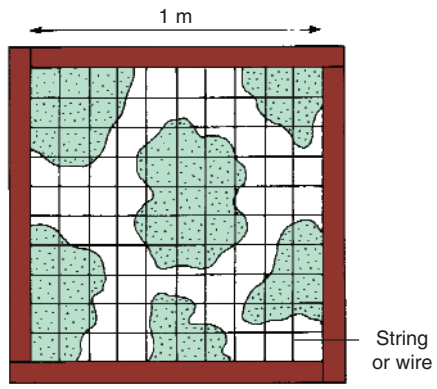

Fig. 3 Grid quadrat

Transects

Environmental gradients – Sometimes you notice a **gradual** change in vegetation from one part of an ecosystem to another, e.g. at the edge of a pond where the water gives way to the land, or along a seashore from the high tide mark to the low tide mark.

Such a change can be studied by making a transect where you try to relate the change in vegetation to environmental factors. You decide where the transect should be placed and so it is not a random sampling.

A. Profile transect

If the height of the ground changes greatly along the transect, construct a profile transect to show how the ground level rises or falls.

For example, on a rocky seashore, the height of the shore above the sea affects the length of time any point is covered by the tide. This greatly influences the species that can survive there. The distribution of species is related to the vertical height on the shore.

1. Using metre sticks, a spirit level and a measuring tape, take readings along a 10 m straight line, measuring the rise (or fall) in the ground for each metre.
2. Transfer the measurements to graph paper.

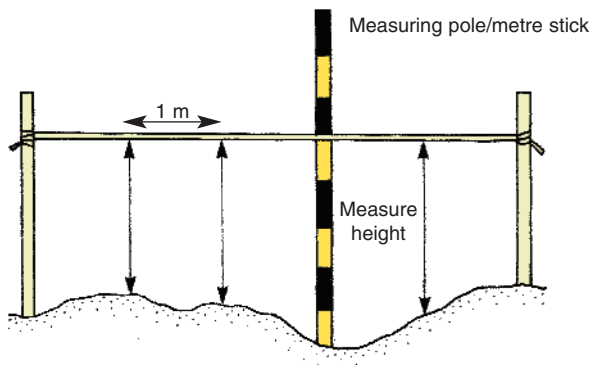

Fig. 4 Profile transect

B. Belt transect

This consists of two ropes parallel to each other, say 1 m apart. It is a more time-consuming and detailed method than a profile transect, but gives greater information about the ecosystem.

1. Place a quadrat between the two lines and sample the plants and animals inside (measure % cover and frequency).
2. Repeat at 1 m intervals along the transect.
3. At the same time, measure the environmental factors at each quadrat and try to correlate (match) any observed changes in the abundance of different species with environmental differences.

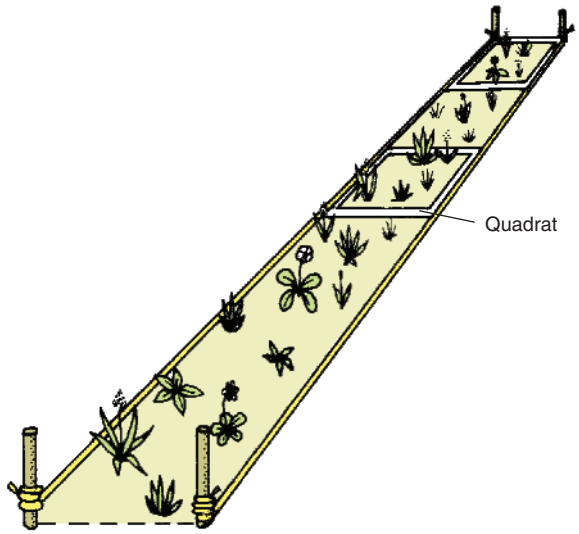

Fig. 5 Belt transect

Capture-recapture method

Capture-recapture is used to estimate the size of an animal population in the habitat.

1. Collect some members of a species and count them (= C_1). Mark them with paint (for example), then release them back in the same area.
2. Collect more in a few days and count them (= C_2). Some of them will be marked (= M_2), hopefully!
3. Calculate the total numbers using the equation:

$$\text{Total number} = \frac{C_1 \times C_2}{M_2}$$

Note: You must make sure that the marking does not make the animal more visible to **predators**.

Example

Fifty snails were caught (C_1 = 50) and marked with paint under their shells.

Two days later 40 more snails were collected (C_2 = 40). Sixteen of these were marked (M_2 = 16).

$$\text{Total number of snails} = \frac{50 \times 40}{16} = 125$$

This method assumes that:

- Animals mix and spread evenly throughout the habitat.
- Animals do not move far from the area under study.
- The marked animals are given enough time to mix with the rest of the population before recapture.

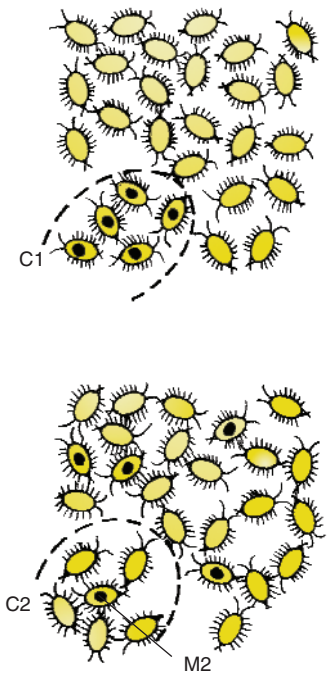

Fig. 6 Capture–recapture method

mandatory activity 4

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INVESTIGATE ANY THREE ABIOTIC FACTORS

Abiotic factors, such as soil and climatic conditions, are important in determining what organisms can grow and reproduce in an ecosystem and how they adapt to surviving in those conditions.

It is important, therefore, that any ecological study must include measuring the variations in environmental conditions at different times (day/night and season) and in different parts of the ecosystem.

MEASURING THE ABIOTIC FACTORS (CHOOSE ANY THREE)

1. Slope

- Measure the slope using profile mapping method
- Compass (N, S, E, W) and weather vane – take regular readings to find the prevailing wind direction. **Slope** influences run-off and the accumulation of nutrients, soil and organic matter. The **aspect** is the direction the habitat faces and the prevailing wind direction.

2. pH

- Universal Indicator (pH) paper or a pH meter.

1. For soil, weigh a moist sample and mix it with twice its weight of distilled water.
2. Allow the sample to settle for a few minutes and then:
   (a) Dip in the pH paper and read the pH off the colour chart.

   or

   (b) Put the electrode of the pH meter carefully at the liquid-soil junction and wait for the reading to stabilise before you record it.

3. Temperature – the **daily and seasonal** temperature variations

- Thermometer – glass, digital or soil type.
- Maximum-minimum thermometer

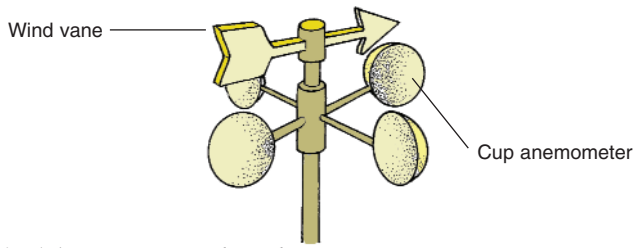


Fig. 1 Anemometer and weather vane

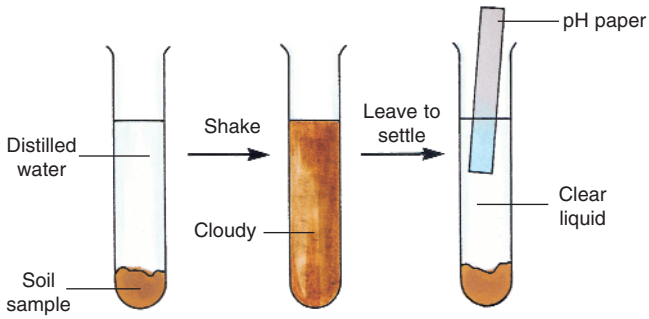


Fig. 2 Measuring the pH of a soil sample

Fig. 3 Maximum-minimum thermometer

4. Light intensity

- **Light meter** (photographic)

1. Read the light intensity at each of five sites in random order, within five minutes.
2. Half an hour later, repeat the samplings in a different order and average the results.

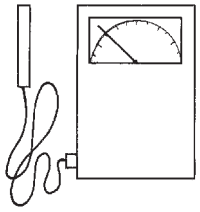


Fig. 4 Light meter

5. Air current

- Cup **anemometer**

1. Take a **wind speed** measurement at the same height at each site, within as short a time as possible.
2. Repeat this at intervals. Find the average.

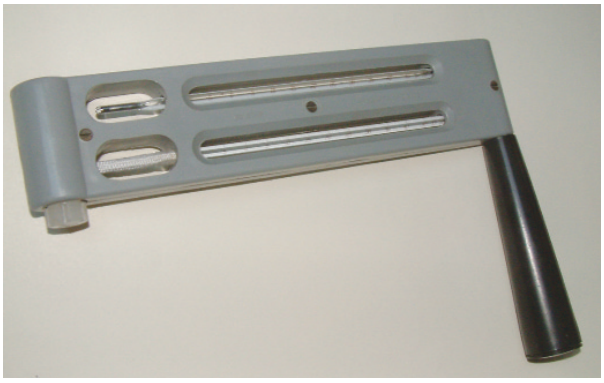


Fig. 5 Hygrometer

6. Humidity

- **Hygrometer** – read the temperature on a wet and dry bulb thermometer. The % humidity is read off a conversion scale supplied with the hygrometer.

7. % Air in soil

Note: You will need two identical tin cans. Make holes in the bottom of one (Can 1).

1. Push Can 1, open end first, fully into the soil.
2. Dig around it and remove the can full of soil, cutting it level with the top of the can.
3. Fill a large water trough with water up to a fixed mark (A). With Can 2, remove a canful of water and, using a measuring cylinder, find its volume (= the volume of the soil in Can 1).
4. Empty the soil from Can 1 into the trough. Stir to allow air bubbles to escape. The water level rises, but not quite up to mark A.
5. Now add water to the trough, from a measuring cylinder, until it is up to mark A again.
6. The volume of water added = the volume of air that escaped from the soil.

% air = volume air / volume soil x 100.

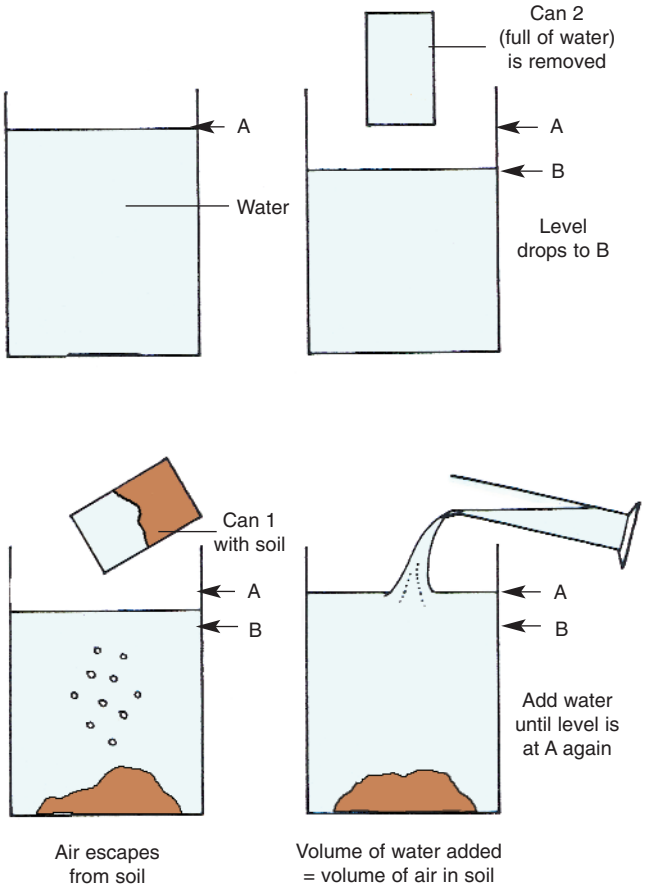


Fig. 6 Finding the % air in a soil sample

8. % Water in soil

1. Collect labelled samples of fresh soil in polythene bags.
2. In the laboratory, transfer each sample to a weighed evaporating dish.
3. Weigh again, and calculate the weight of the soil.
4. Place in an oven at 105°C for 48 hours – the water will evaporate.
5. Reweigh and calculate the weight of the dried soil.
6. The loss in weight (fresh weight – dried weight) is the mass of water lost from the sample.

% water = mass water / mass fresh soil x 100

9. % Humus in soil

1. Weigh a crucible and half-fill with a **dry** soil sample.
2. Reweigh and calculate the weight of just the dry soil.
3. Heat the crucible very strongly over a Bunsen flame. This will burn off the humus. Turn the soil over from time to time with a spatula.
4. After 15 minutes, weigh the crucible and soil.
5. Heat again for another 15 minutes and then reweigh.
6. Repeat this until two readings (weights) are the same – in other words, all the humus has been removed.
7. The loss of weight (dried weight – burnt weight) is the mass of humus burned off.

% humus = mass humus / mass dry soil x 100

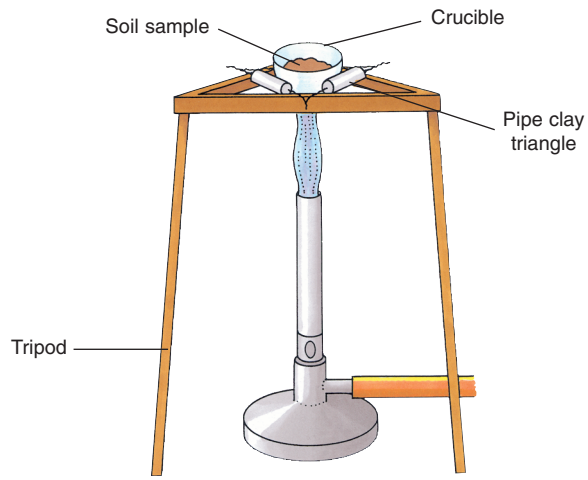


Fig. 7 Finding the % humus in a soil sample

10. Mineral content

Minerals are the soluble salts in **soil or water**.

1. For soil, place a sample in a beaker and add distilled water to it.
2. Shake the mixture well and filter.
3. Transfer some of the filtrate into an evaporating dish.
4. Place this in an oven at 100°C and evaporate the water. There will be a residue of mineral salts – these are normally absorbed by the root hairs of plants.
5. The individual levels of soil nitrogen, phosphorus, potassium and calcium are measured most easily with a soil test kit (available from gardening shops).

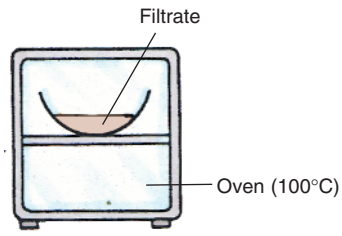


Fig. 8 Finding % mineral content in a soil sample

11. Water current

Time the movement of a floating object over, say, 20 m. The object should be weighted so that it is mainly under the surface, e.g. use a specimen tube partly filled with water, or an orange.

12. Salinity (salt concentration)

A conductivity meter measures the ability of a solution to conduct electricity. The more salt ions it contains, the better a solution conducts.

1. For soil, take a sample, add twice that amount of water, mix and put the probe into the paste.
2. Use the same dilution for all your samples to compare readings.

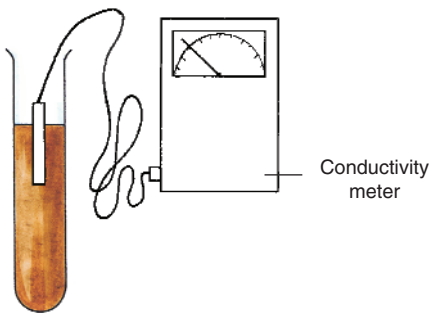


Fig. 9 Measuring the salinity of a soil sample

13. Degree of exposure

Record the exposure of intertidal organisms to air and wave action in the different zones on a rocky shore (splash zone, upper shore, mid-shore and lower shore organisms).

14. Oxygen concentration

- An oxygen meter is a probe connected to a digital meter.

The oxygen content of water determines the number of aerobes that it can sustain. Larger organisms like fish need a good supply of oxygen.

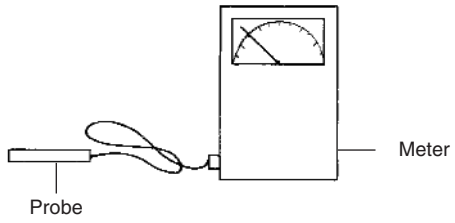


Fig. 10 Measuring the oxygen concentration of a soil sample

RESULTS AND ANALYSIS

Results

- The information you gather in your field studies can be **displayed** in folders, on wall charts or on computer – maps, diagrams, photographs, tables, graphs, histograms.
- Note the role of each selected organism in **energy transfer** – construct food chains, a food web and a pyramid of numbers, from the information obtained in the study.
- **Present** your results as a Report or a Portfolio.
- **Assess** your results by identifying possible **sources of error** when using the different measuring techniques.
  1. **Human Error** – may be due to incorrect or inaccurate readings, incorrect experimental technique or misinterpretation of results.
     Equipment error – may be due to inaccurate settings on electronic balances, light meters, etc. All these can be minimised by care and attention to detail, and teamwork to double-check each group's work.
  2. **Habitat in a state of change** – Weather conditions and time of day/year could affect the distribution of organisms present. This can be minimised by repeat studies on a number of occasions over the year.
  3. **Accidental discovery** – some animals may only be present on rare occasions and some quadrat sampling may give biased results due to change. Again, these effects can be minimised by repeating the activity as many times as possible and by comparing your results with those of other groups.
  4. **Limitations of sample size** – if only a few samples are taken, in quadrats or animal collection, then a distorted result may be produced. Minimise this by always taking as large a sampling as time will allow.

Analysis

What conclusions can you draw from your results and your activity? When interpreting results, take care to identify possible ambiguities and errors. Can you apply and relate your knowledge, understanding and skills to other ecosystems?

mandatory activity 5

see page 76

BE FAMILIAR WITH AND USE THE LIGHT MICROSCOPE

1. Turn the smallest (**low power**) lens into line with the barrel.
2. Using the coarse focus knob (large wheel), **lower** the lens down towards the **stage**, as far as it will go.
3. Place the **slide** on the stage so the **specimen** is over the hole (with the light shining through).
4. Look down the eyepiece lens and turn the **big** wheel – after 1/4 turn you should see the sample **in focus** (clear, without any blur).
5. If you're not sure if it is focused fully, then keep turning the wheel until the image goes fuzzy again and then turn the wheel back.
6. To **magnify** the image more, turn the next size lens (**medium power**) into position – feel it click into place.
7. It should be almost in focus. Turn the **fine focus** knob (small wheel) to focus it properly.
8. Before using the biggest lens (high power), place a **cover slip** over the sample, at an angle of 45° and allow it to slowly drop down – this avoids getting air bubbles trapped in the sample.
9. Turn the **biggest** lens into position and focus with the **small** wheel.
10. When finished, turn the smallest lens back in place, remove the slide and then lower the barrel.

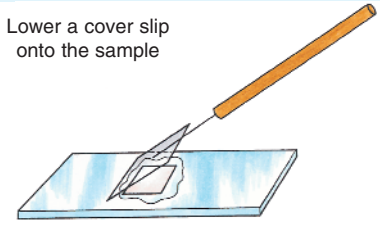


Fig. 1 Positioning a cover slip

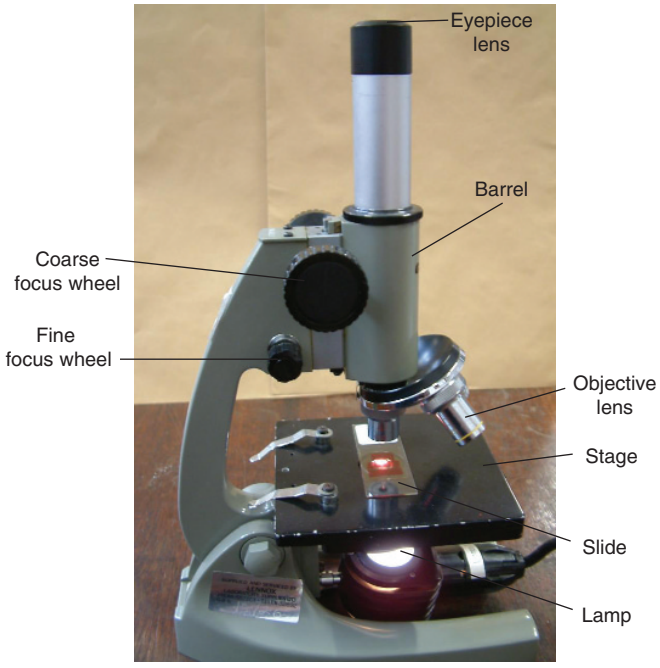


Fig. 1 The light microscope

mandatory activity 6

see page 76

PREPARE AND EXAMINE ONE PLANT CELL, UNSTAINED AND STAINED, USING THE LIGHT MICROSCOPE (X100, X400)

Materials

- Microscope, glass slides, coverslips, stain solution (iodine, methylene blue), onion.

Method

1. Get a clean, dry microscope slide and coverslip.
2. Place a drop of water on the centre of the slide.
3. Cut a small square of onion and peel off a thin layer with a tweezers. Place the sample in the water on the slide.
4. Examine the sample under low and medium power.
5. If the sample is a good one and you are happy with it, stain it and place a cover slip on it at a 45° angle and allow it to slowly drop down.
6. Examine again under low, then medium and then high power.
7. Make drawings of what you see, a few cells at each magnification.

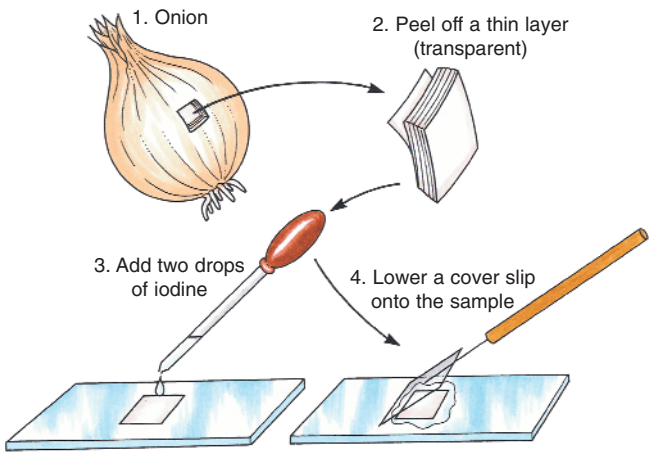


Fig. 1 How to prepare onion cells for viewing under a microscope

Fig. 2 Onion cells as viewed under a light microscope. The cell walls, shown as dark lines, are interlocked together

mandatory activity 7

see page 76

PREPARE AND EXAMINE ONE ANIMAL CELL, UNSTAINED AND STAINED, USING THE LIGHT MICROSCOPE (X100, X400)

(e.g. cheek cells)

Materials

- Microscope, glass slides, coverslips, stain solution (iodine, methylene blue), cotton buds, cheek cells.

Method

1. Get a clean, dry microscope slide and coverslip.
2. Place a drop of water on the centre of the slide.
3. Using a clean cotton bud, rub it against the inside of your mouth and then dip it into the water on the slide. Try not to trap any air-bubbles, as they will look like big black tyres.
4. Examine the sample under low and medium power.
5. If the sample is a good one and you are happy with it, stain it and place a cover slip on it at a 45° angle and allow it to slowly drop down.
6. Examine again under low, then medium and then high power.
7. Make drawings of what you see, a few cells at each magnification.

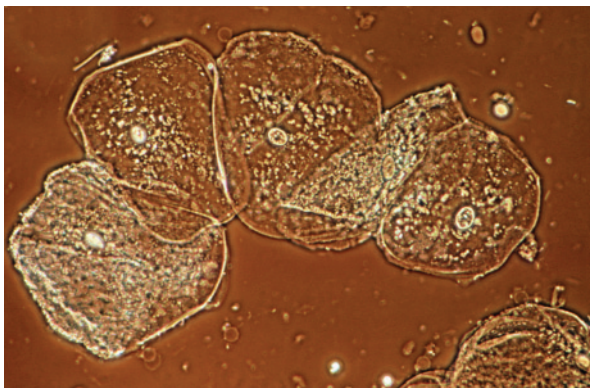


Fig. 1 Human cheek cells as seen through a light microscope. The bright spot inside each cell is the nucleus

mandatory activity 8

see page 224

PREPARE AND EXAMINE MICROSCOPICALLY THE TRANSVERSE SECTION OF A DICOTYLEDONOUS STEM (X100, X400)

Materials

- Stem of sunflower, or other suitable plant
- Pith or carrot
- Single-edged razor blade
- Paintbrush
- Dish of water
- Microscope and slides

Method

1. Thin sections of the stem are cut by a single horizontal movement of a sharp razor blade, **away** from your fingers and body.
2. Cut smoothly and rapidly, constantly wetting the blade and the surface of the stem with water. As the sections gather on the surface of the blade, transfer them to a dish of water using a paintbrush.
3. Thick material can be cut freehand. Less rigid material can be supported in a slit cut into a carrot or pith, in which case the support and the sample are cut through together.
4. Select a good sample from the dish and place it in a drop of water on a clean microscope slide.
5. Examine the slide under low power. Make an outline drawing of the stem (No need to draw individual cells.)
6. Select an area of the stem that includes vascular tissue and examine again under medium and then high power. (Remember to use a cover slip.)
7. Stains can be used to make the tissues easier to see. Place a section in the stain and leave for five minutes.
   (a) Toluidine blue – xylem tissue stains green-turquoise; dermal and ground tissue stain purple.
   (b) Aniline sulfate – xylem stains yellow.
8. Draw labelled diagrams to show the three tissue types: dermal, ground and vascular (one or two cells of each is sufficient).

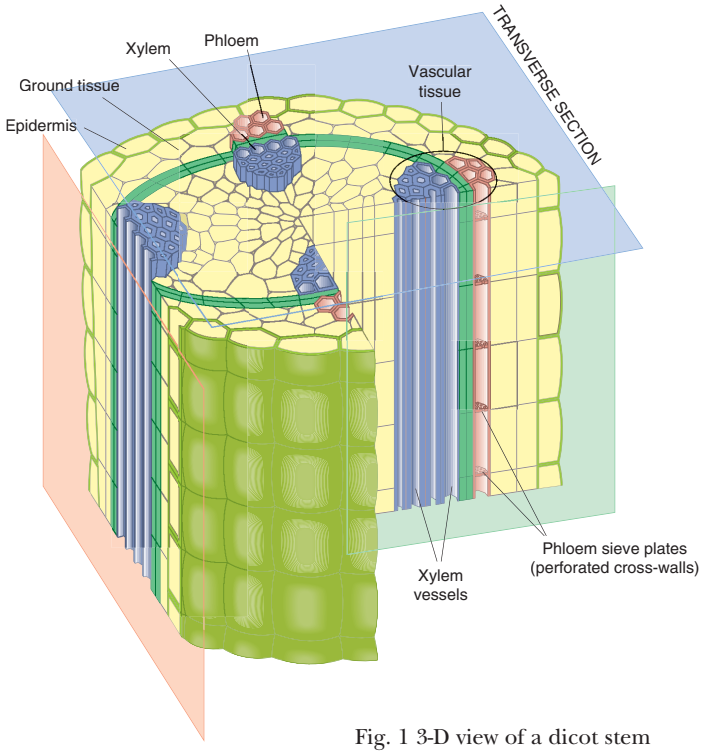


Fig. 1 3-D view of a dicot stem

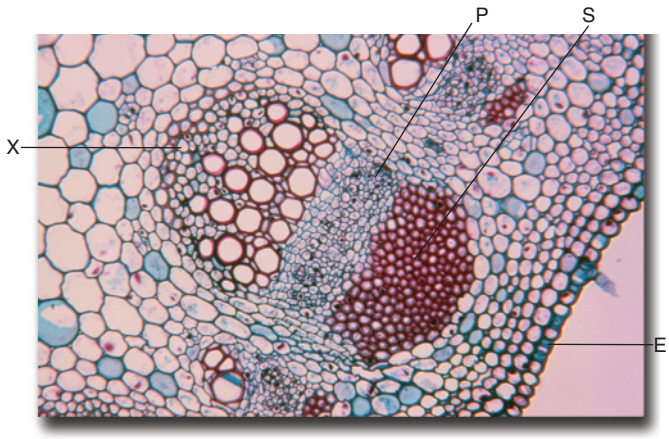


Fig. 2 Vascular bundle showing support cells (S), phloem (P) and xylem (X) cells. E = epidermis

mandatory activity 9

see page 266

DISSECT, DISPLAY AND IDENTIFY THE HEART OF AN OX OR SHEEP

1. Examine the outside of the heart first.
   (a) The front of the heart is more rounded and has thick-walled arteries.
   (b) Try and identify the parts labelled in the diagram.
2. Using a tube, run water into:
   (a) The superior vena cava. (**Note**: Clamp the inferior vena cava). The water comes out the pulmonary artery. Why?
   (b) The pulmonary vein. The water comes out the aorta. Why?

Left side of heart

1. Cut through the side wall of the left ventricle (see dotted line in the diagram).
2. At the top left, note the semi-lunar valves to the aorta. In the centre, note the bicuspid valve attached to the wall by cords and muscles. The valve may be dissected to show its two flaps.
3. Run water into the aorta. Note how the semi-lunar valves block the flow.
4. Continue cutting up through the left atrium and aorta – this exposes the semi-lunar valves. (Note also the coronary artery opening in the wall of the aorta just above these valves.)

Right side of heart

5. Cut through the side wall of the right ventricle. At the top right, note the semi-lunar valves to the pulmonary artery. In the centre note the tricuspid valve, attached to the wall by cords and muscles. The valve may be dissected to show its three half-moon shaped flaps.
6. Continue cutting up through the right atrium and pulmonary artery – this exposes the semi-lunar valves.
7. Identify the septum (middle wall) between the atria. You may notice a small oval depression in the wall, which is the remains of the foramen ovale (a hole that connected the two atria in the embryo). Why was there a hole here once?
8. Note the difference in sizes of the four chambers and the thickness of their walls. Which is the largest chamber and why? Which has the thickest wall and why?

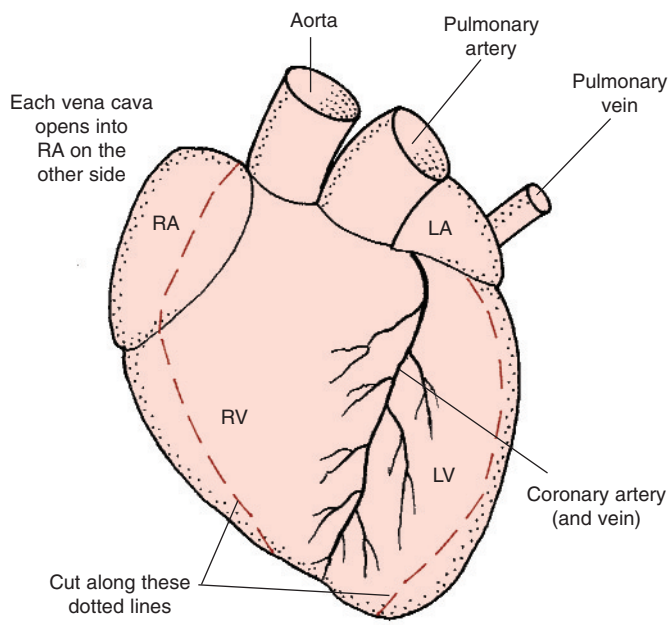


Fig. 1 Dissection of the heart (front view)

mandatory activity 10

see page 21

CONDUCT A QUALITATIVE TEST FOR:

A. STARCH,
B. REDUCING SUGAR,
C. PROTEIN
D. LIPID

Controls

Use water instead of the food under test.

Safety notice

Take care as you use the different chemicals as many are caustic (will burn) or stain. Also, boiling water is used to heat some of the chemicals.

A. TEST FOR STARCH

Chemicals

- Iodine solution

Method

To 4 cm^3 (1/4 of a test tube) starch solution, add two drops of **iodine** solution. Shake carefully to mix.

Result

A **blue-black** colour indicates the presence of starch.

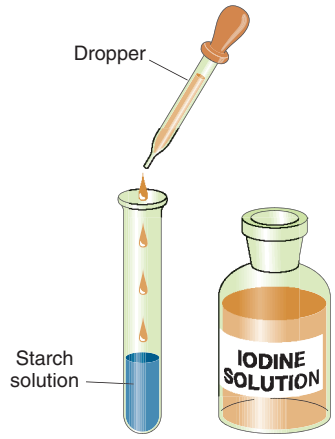


Fig. 1 Starch test

B. TEST FOR REDUCING SUGAR

All monosaccharide sugars and certain disaccharides will change copper sulfate (bluestone) to red copper oxide when heated. Such sugars are known as **reducing sugars**.

Chemicals

- Fehling's or Benedict's reagent

Method

To 4 cm^3 (1/4 of a test tube) glucose solution in a test tube, add 4 cm^3 of the reagent. Shake carefully and boil by heating the test tube in a water bath.

Result

A yellow or brick-red colour indicates the presence of a reducing sugar.

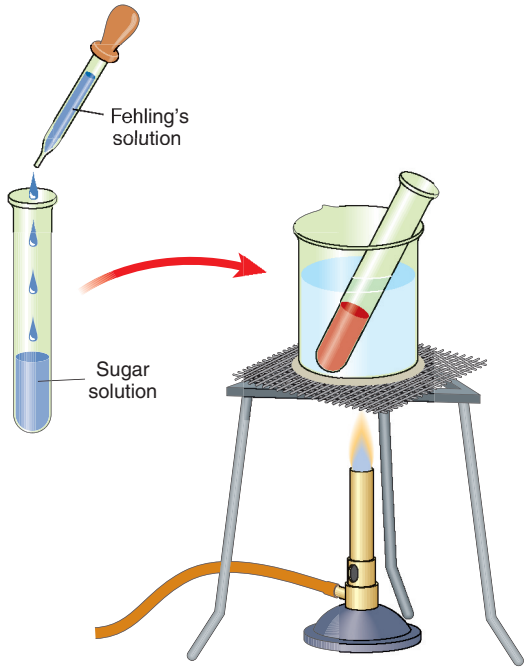


Fig. 2 Sugar test

C. TEST FOR PROTEIN

Chemicals

- 10% sodium hydroxide solution, 0.5% copper sulfate solution (Biuret Test)

Safety precautions

Excess copper sulfate will produce negative results – use small amounts.

1. Sodium hydroxide is **caustic**. Wash affected area immediately if it comes into contact with the skin.

Method

1. To 4 cm^3 egg white (or milk), add 4 cm^3 sodium hydroxide solution. Shake the tube carefully to mix.
2. Add copper sulfate solution a drop at a time, shaking the tube continuously (and carefully). Do not add more than 10 drops.

Results

A **purple/mauve** colour shows the presence of protein.

Fig. 3 Protein test

D. TEST FOR LIPID

BROWN PAPER TEST

Method

Rub some cooking oil against a piece of brown paper.

Result

A **translucent** (clear) spot appears and remains even when the paper dries – this shows the presence of lipid.

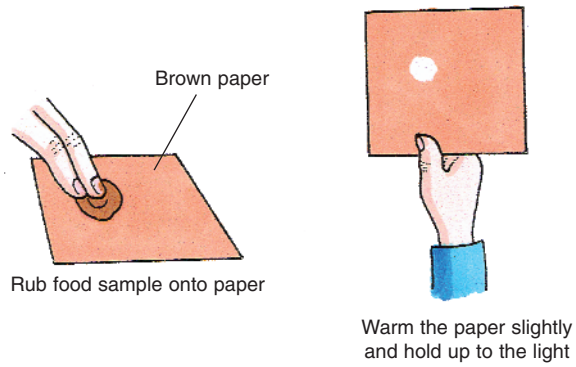


Fig. 4 Brown paper test

mandatory activity 11

see page 105

INVESTIGATE THE EFFECT OF pH ON THE RATE OF ENZYME ACTION

Note: Buffer solutions do not change their pH, despite the addition of small amounts of acid or base.

Chemicals

- Solutions of:
  2% starch
  1% amylase
- Iodine
- Buffer (pH 4, 7 and 9)
- Fehling's (or Benedict's) solution

$$\text{Starch} \xrightarrow{\text{Amylase}} \text{Glucose}$$

Method

1. Set up three water baths at 37°C.
2. Into each of three test tubes, put 5 ml starch solution, and 3 drops iodine – each solution turns blue-black.
3. Into each of three more test tubes put 2 ml amylase solution.
4. Place a pair of test tubes (one starch, one amylase) in each water bath. To each amylase tube, add 5ml of **one** of the buffer solutions (4, 7 or 9). Leave for 5 minutes.
5. Pour the amylase into the starch tube. Gently shake each tube to mix the contents.
6. Replace the tube in the water bath, and measure the time taken for the solution to go colourless (short time => fast rate) – the blue colour should fade as the amylase changes the starch into sugar.
7. To test for sugar at the end, add 1 ml Fehling's solution to the tube and boil in a water bath (100°C) for 5 minutes – a brick-red colour indicates sugar is now present.

Controls

(a) Test the original starch solution for sugar – it should give a negative result.

(b) Repeat the whole experiment **without** the amylase – this is to rule out the possibility that the pH conditions caused the change from blue-black to colourless.

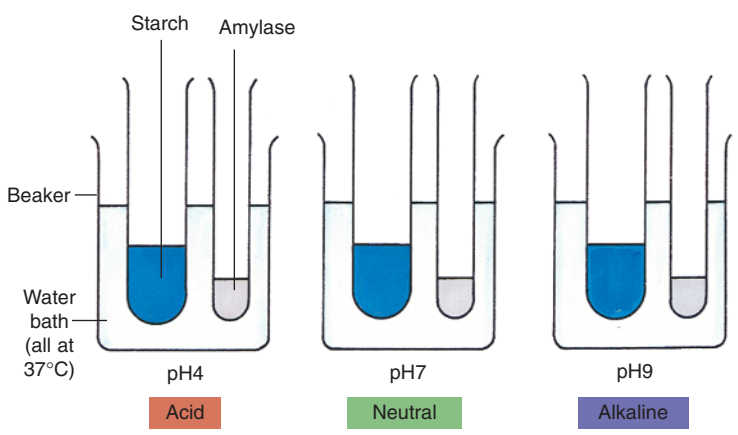


Fig. 1 To find how pH affects the action of amylase

mandatory activity 12a

see page 105

INVESTIGATE THE EFFECT OF TEMPERATURE ON THE RATE OF ENZYME ACTION

$$\text{Starch} \xrightarrow{\text{Amylase}} \text{Glucose}$$

Chemicals

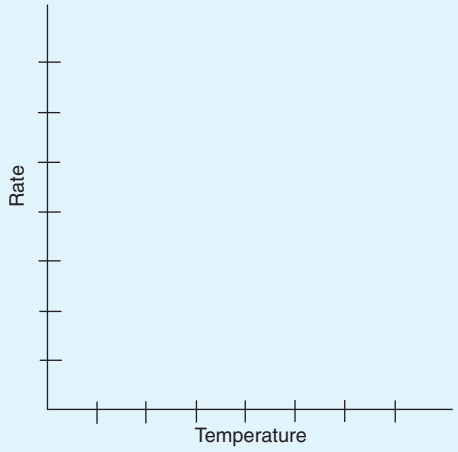
- Solutions of:
  2% starch
  1% amylase
- Iodine
- Fehling's (or Benedict's) solution

Method

1. Set up five **water baths** at different temperatures (as shown) – use ice or warmed water.
2. Into each of 5 test tubes, put 5 ml starch solution and 3 drops of iodine – each turns blue-black.
3. Into each of 5 more test tubes, put 2 ml of amylase solution.
4. Place a pair of tubes (one starch, one amylase) in each water bath and leave for 5 minutes.
5. Pour the amylase into the starch-iodine tube. Gently shake each tube to mix the contents.
6. Replace the tube in the water bath, and measure the time (in minutes) taken for the solution to go colourless (short time => fast rate) – the blue colour should fade as the amylase changes the starch into sugar.
7. Plot a graph to show the results over the range of temperatures.
8. To test for sugar at the end, add 1 ml Fehling's solution to the tube and boil in a water bath (100°C) for 5 minutes – a brick-red colour indicates sugar is now present.

Measure the rate as $\frac{100}{\text{Time (mins)}}$

Temperature	0°	15°	25°	35°	65°
Rate					



Controls

(a) Test the original starch solution for sugar – it should give a negative result.
(b) Boil some amylase solution and repeat the whole experiment – no change should occur, as boiling damages the enzyme by changing its shape.

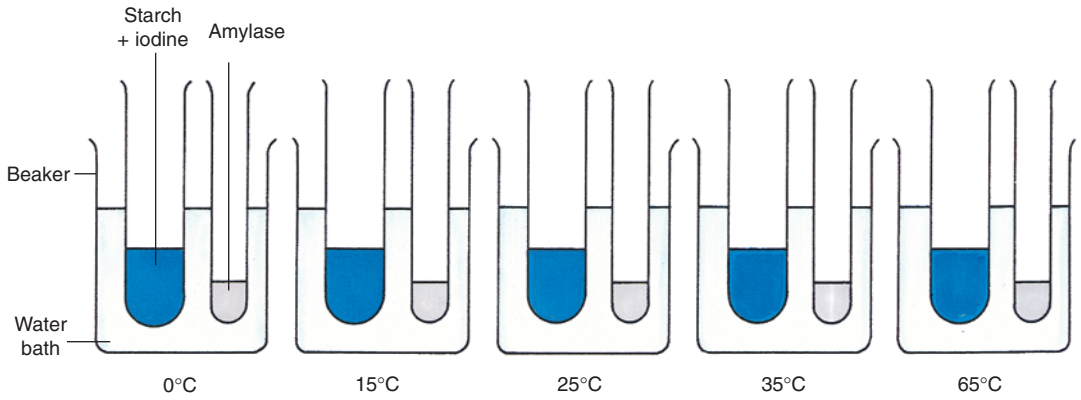


Fig. 1 To find how temperature affects the action of amylase

mandatory activity 12b

see page 107

Higher Level Only

INVESTIGATE THE EFFECT OF HEAT DENATURATION ON THE ACTIVITY OF AN ENZYME

$$\text{Starch} \xrightarrow{\text{Amylase}} \text{Glucose}$$

Chemicals

- Solutions of:
  2% starch
  1% amylase
- Iodine
- Fehling's (or Benedict's) solution

Method

1. Into each of 2 test tubes, put 5 ml starch solution and 3 drops iodine – each turns blue-black.
2. Into each of 2 more test tubes, put 2 ml of amylase solution. Boil one of these tubes for 5 minutes, to denature the enzyme.
3. Place all four tubes in a water bath (30°C) for 5 minutes.
4. Pour one of the starch solutions into the unboiled amylase tube. Pour the second starch solution into the boiled amylase tube. Gently shake each tube to mix the contents.
5. Replace the tubes in the water bath for 15 more minutes.
6. In the unboiled amylase tube, the blue colour should fade as starch is converted to sugar.
7. Test for sugar by adding 1 ml Fehling's solution and heating in a water bath (100°C) – a brick-red colour indicates sugar is now present.
8. The boiled amylase should not cause the blue colour to fade – the heat damaged the enzyme by changing its shape (it denatured it).

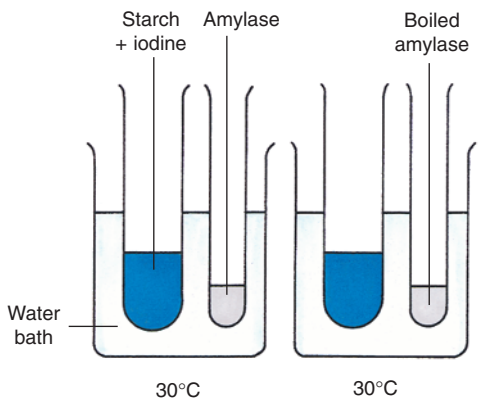


Fig. 1 To find how boiling affects the action of amylase

HIGHER LEVEL

mandatory activity 13

see page 123

A OR B

INVESTIGATE THE INFLUENCE OF:

A. LIGHT INTENSITY ON THE RATE OF PHOTOSYNTHESIS

Materials

- 10% sodium hydrogen carbonate solution ($NaHCO_3$) – also called sodium bicarbonate or bread soda. This chemical releases carbon dioxide into the water.
- Canadian pondweed (Elodea)
- Lamp (40 W bulb), beakers and test tubes.

A. Light intensity

- The **rate** can be found by measuring the amount of oxygen gas released from the plant. This is done by **counting** the number of **bubbles** released in one minute.
- Alter the light intensity by changing the **distance** of the lamp from the plant.

Method

1. Fill a beaker with tap water and add 5 cm^3 bicarbonate solution.
2. Collect a few pieces of pondweed, 5–10 cm long, and cut the ends with a razor blade mid-way between two nodes (where leaves are attached to the stem).
3. Place the shoots upside down in the beaker, with the lamp about 15 cm away. When bubbles appear from the stems, select a shoot that is bubbling rapidly and regularly.
4. Transfer the shoot to a new beaker of water and add about 5 cm^3 bicarbonate solution.
5. In a slightly darkened room, position the lamp 5 cm from the plant. Allow the plant 5 minutes to adjust before beginning the count.
6. Count the number of bubbles released in one minute.
7. Repeat twice more. Calculate the average.
8. Now move the lamp 10 cm away from the plant and count the bubbles per minute.
9. Take readings with the lamp at distances of 5 cm, 10 cm, 15 cm, 30 cm, 45 cm, 60 cm and 75 cm from the plant.

Result

Calculate the light intensity as $1000/d^2$ for each distance used (where d = the distance between the light and the plant). Copy the following table into your answer book and fill in your results.

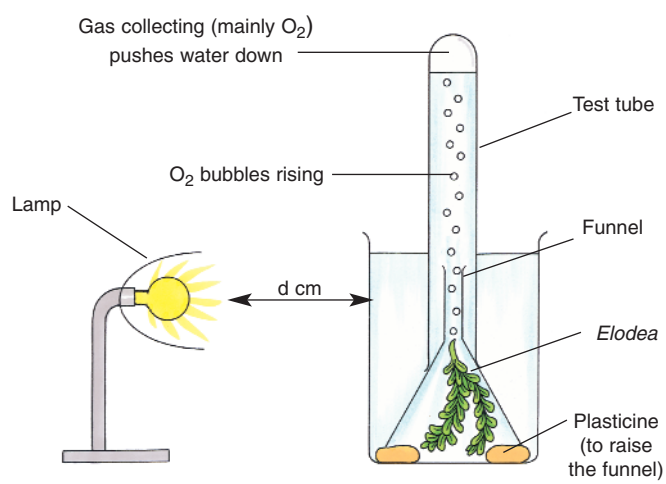


Fig. 1 To measure the rate of photosynthesis

d (Lamp distance)	d^2	$1000/d^2$ (Light intensity)	No. bubbles per minute
75 cm			
60 cm			
45 cm			
30 cm			
15 cm			
10 cm			
5 cm			

Plot the results as a line graph where:
- The X-axis shows the light intensity.
- The Y-axis shows the number of bubbles produced per minute (which is taken as the rate of photosynthesis).

OR

B. CARBON DIOXIDE CONCENTRATION ON THE RATE OF PHOTOSYNTHESIS

B. CO_2 concentration

- The **rate** can be found by measuring the amount of oxygen gas released from the plant. This is done by **counting** the number of **bubbles** released in one minute.
- Alter the CO_2 concentration by changing the amount of bicarbonate added to the water.

Method

1. Fill a beaker with tap water.
2. Collect a few pieces of pondweed, 5–10 cm long, and cut the ends with a razor blade mid-way between two nodes (where leaves are attached to the stem).
3. Place the shoots upside down in the beaker, with the lamp about 15 cm away. When bubbles appear from the stems, select a shoot that is bubbling rapidly and regularly.
4. Transfer the shoot to a new beaker of water.
5. Position the lamp 15 cm from the beaker and do not move it during the course of the experiment.
6. Allow the plant 5 minutes to adjust before beginning the count.
7. Count the number of bubbles released in one minute.
8. Repeat twice more. Calculate the average.
9. Now add 5 cm^3 bicarbonate solution to the beaker.
10. After 5 minutes, count the number of bubbles released in one minute. Repeat twice more and get the average.
11. Add a further 5 cm^3 of bicarbonate and repeat the counting.

Result

Plot the results as a line graph, where:
- The X-axis shows the volume of bicarbonate added (which reflects increasing CO_2 concentration).
- The Y-axis shows the number of bubbles produced per minute (which is taken as the rate of photosynthesis).

mandatory activity 14

see page 116

DEMONSTRATE OSMOSIS

Materials

- Strong sugar solution
- Two 20 cm strips of Visking tubing
- Two (250 ml) beakers

Method

1. Half-fill two beakers with water and label them A and B.
2. Dip the strips of Visking tubing into the water to soften them.
3. Tie a knot in one end of each piece of tubing.
4. Half-fill one tube with water, tie a knot to close the end, dry the outside and weigh it. Then place it into Beaker A.
5. Half-fill the other tube with the strong sugar solution, tie a knot to close the end, dry the outside and weigh it. Then place it into Beaker B.
6. Leave the beakers for an hour.
7. Remove each tube, dry the outside and re-weigh. Also, note any change in appearance.

Result

Tube A (the control) is unchanged.
Tube B becomes stretched, turgid and heavier due to water moving into it from the beaker by osmosis.

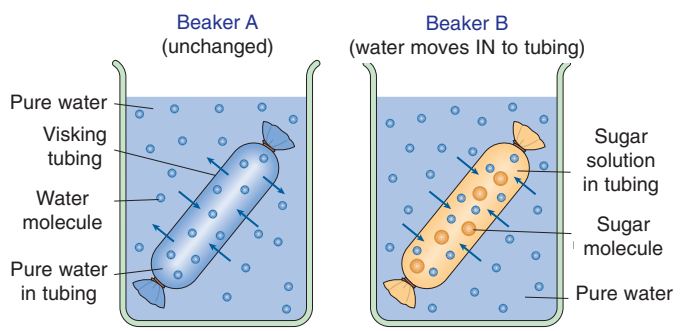


Fig. 1 Visking tubing placed in pure water

mandatory activity 15

see page 267 & 299

INVESTIGATE THE EFFECT OF EXERCISE ON:

A. BREATHING RATE
OR
B. PULSE (HEART RATE) OF A HUMAN

A. Breathing rate

1. Using a stopwatch, measure the person's breathing rate for one minute, at rest (e.g. sitting).
2. Take three readings and get the average – this is your resting breathing rate.
3. Let the person exercise strenuously for five minutes.
4. Measure their rate per minute, until it returns to normal.
5. Graph your results.
   Note: A Data Logging system may be used, if available. A respiration belt is attached around the chest and linked to a pressure sensor that records the breathing rate and level.

Fig. 1 Strenuous exercise for five minutes will increase your rate of breathing (as well as your heart rate)

B. Pulse

1. Find your pulse at your wrist, neck or temple.
2. Sit down and count your pulse for 30 seconds. Double the number to find the beats per minute. Take three separate counts and calculate the average – this is your resting pulse.
3. Jog or do step-ups for three minutes. Sit down and immediately count your pulse for 30 seconds. Wait 30 seconds. Then count again for 30 seconds. Keep counting like this until you are back to the resting pulse.
4. Plot a graph of the readings.
   Note: A Data Logging system may be used, if available. A clip is attached to your ear and a heart rate sensor detects the pulse.

Fig. 2 Use your index and middle finger to feel a pulse

mandatory activity 16

see page 131

PREPARE AND SHOW THE PRODUCTION OF ALCOHOL BY YEAST

By trapping yeast cells in a sodium alginate gel (immobilising them), you can stop them from mixing in with, and contaminating, the alcohol.

Chemicals

- 0.4 g sodium alginate
- Distilled (soft) water
- 2 g yeast
- 1.4 g calcium chloride
- 10% glucose solution
- 10% potassium iodide solution
- 15% sodium hypochlorite solution
  – with some added sodium hydroxide.

Safety notice

Sodium hypochlorite and sodium hydroxide are both corrosive, so handle with care.

Apparatus

Beakers
Dropper (or syringe)
Electronic balance
Pestle and mortar
Conical flasks (500 ml)
Fermentation lock (air trap)

Method

1. First you have to make some **alginate beads** with the **yeast** inside.
   (a) Add 0.4 g sodium alginate to 10 ml distilled water.
   (b) Mix 2 g yeast into 10 ml warm distilled water and leave for 5 minutes.
   (c) Grind 1.4 g calcium chloride using a pestle and mortar, and add it to 100 ml water in a 250 ml beaker.
   (d) Mix the alginate solution and the yeast suspension and draw the mixture into a syringe or dropper.
   (e) Hold the syringe 10 cm above the calcium chloride solution and release the mixture, drop by drop, into the solution. Beads containing the yeast will form.
   (f) Leave the beads for about 20 minutes in order to harden.

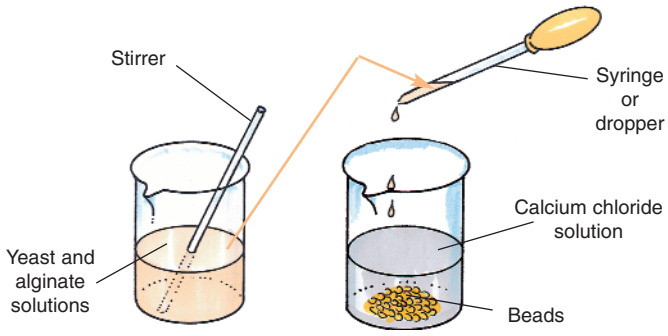


Fig. 1 Making resin beads with yeast inside

Fig. 2 Filtering and washing the beads

2. Second you have to make a **glucose solution**.
   (a) Add 25 g glucose to 250 ml water in a flask and boil for 10 minutes to drive out the air (to give anaerobic conditions).
   (b) Plug the neck loosely with cotton wool and allow the solution to cool (to about 30°C).
3. Filter the beads of yeast and wash them with distilled water.
4. Open the flask and add the beads to the glucose solution.
   Half-fill a fermentation lock with water and attach to the neck of the flask.
5. Place the flask in a water bath at 30°C for 24 hours.
6. Next day, filter (sieve) the contents to remove the beads.
7. Test the solution for alcohol:
   (a) Put 3 ml of the solution in a test tube and add 3 ml potassium iodide solution and 5 ml sodium hypochlorite solution.
   (b) Warm gently for 5 minutes in a water bath at 60°C.
   (c) Allow to cool – formation of solid yellow crystals indicates alcohol.

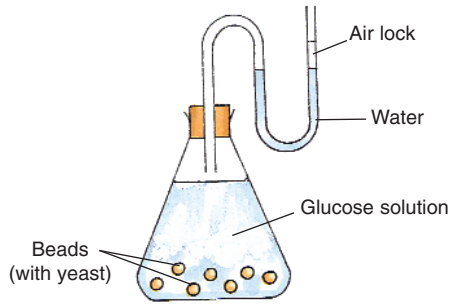


Fig. 3 Yeast producing alcohol under anaerbic conditions

Control:

Repeat the whole procedure but leave out the yeast beads at Step 4.

mandatory activity 17

see page 106

PREPARE ONE ENZYME IMMOBILISATION AND EXAMINE ITS APPLICATION

CHANGING SUCROSE INTO SIMPLE SUGARS USING THE ENZYME INVERTASE, FOUND IN YEAST CELLS

Sucrose (table sugar) forms crystals more easily than simple sugars like glucose. This can cause sweet foods, like ice cream, to go hard and lumpy. So, manufacturers use invertase to break the sucrose down into simple sugar molecules, glucose and fructose. The formation of glucose can be tested with Fehling's solution. Remember that sucrose does not give a positive result with Fehling's solution.

$$\text{Sucrose} \xrightarrow{\text{Invertase}} \text{Glucose + Fructose}$$

Chemicals

- 0.4 g sodium alginate
- Distilled (soft) water
- 2 g yeast
- 1.4 g calcium chloride
- 2% sucrose solution
- Fehling's (or Benedict's) solution

Apparatus

Beakers
Dropper (or syringe)
Electronic balance
Pestle and mortar

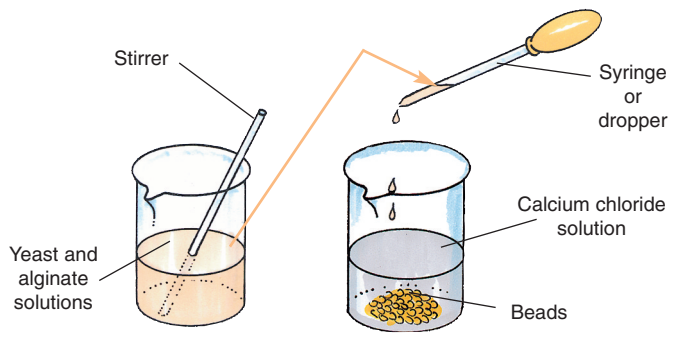


Fig. 1 Making resin beads with yeast inside

Method

1. First you have to make some **alginate beads** with the yeast (enzyme) inside.
   (a) Add 0.4 g sodium alginate to 10 ml distilled water – tap water is OK, once it is not hard water.
   (b) Mix 2 g yeast into 10 ml warm distilled water and leave for 5 minutes.
   (c) Grind 1.4 g calcium chloride using a pestle and mortar; add it to 100 ml water in a 250 ml beaker.
   (d) Mix the alginate solution and the yeast suspension and draw the mixture into a syringe or dropper.
   (e) Hold the syringe 10 cm above the calcium chloride solution and release the mixture, drop by drop, into the solution. Beads containing the yeast (+enzyme) will form.
   Leave the beads for about 20 minutes in order to harden.

2. Filter the beads and wash them with distilled water.
3. Fill a burette (or dropping funnel) with the beads, leaving a space at the top. Make sure that the tap of the burette is closed.
4. Pour the sucrose solution into the burette and leave for 15 minutes.
5. Open the tap and run out the solution into a clean beaker. Test the solution by heating with Fehling's solution – a change to a brick-red colour shows glucose is now present.

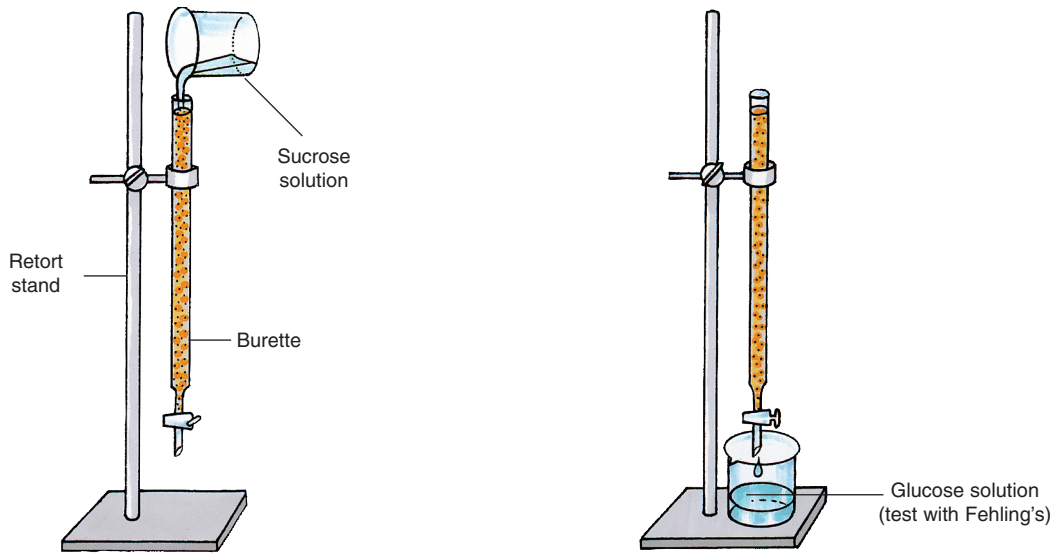


Fig. 2 Filling a burette with yeast beads, and then with sucrose

mandatory activity 18

see page 140

ISOLATE DNA FROM A PLANT TISSUE

One way to purify DNA is to get rid of everything from the cell except the DNA, i.e cell wall, cell membrane, mitochondria, nuclear membrane, etc.

For this you will need something: to **mash** the cells (blender); to destroy **membranes** (detergent dissolves them); to remove **proteins** and **carbohydrates** (salt causes them to clump together); to separate **insoluble** cell material from soluble DNA (filtration); and to **extract** the DNA (alcohol precipitates it).

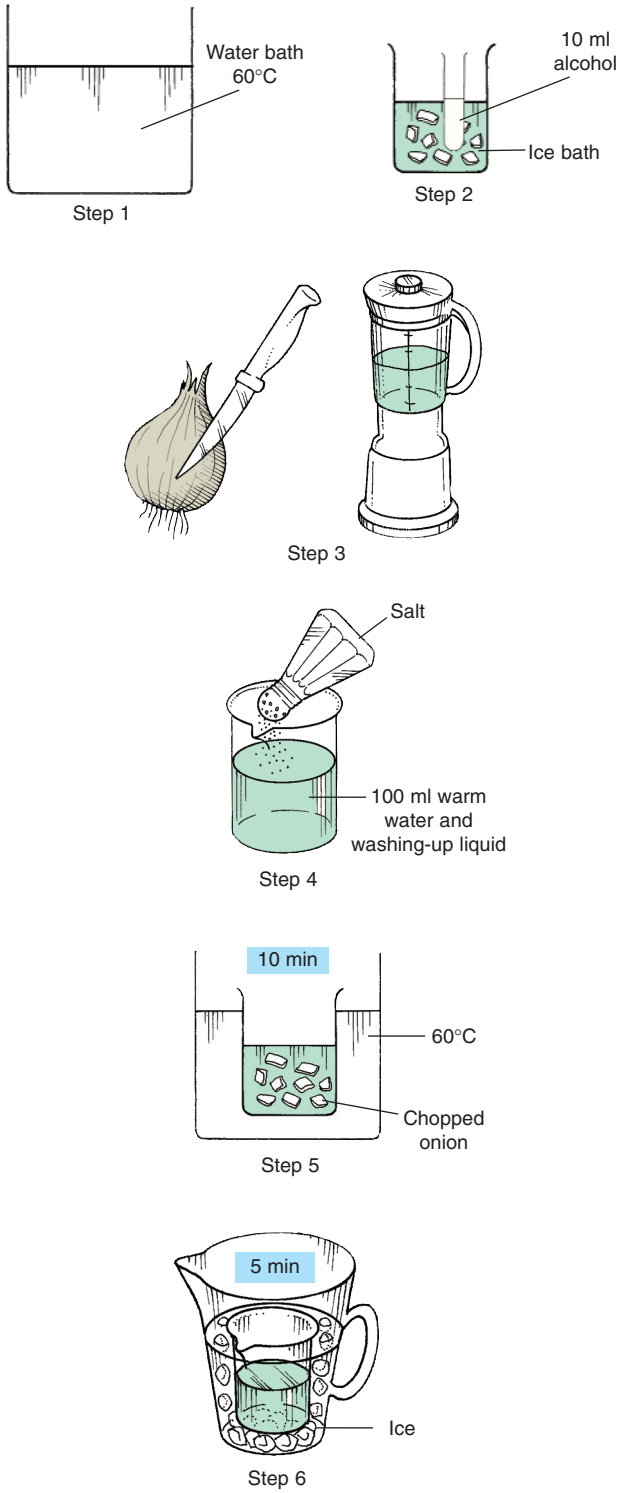
Three main steps: **D**etergent
e**N**zyme
Alcohol.

Materials

- Water bath at 60°C
- Ice in a jug
- 2 test tubes
- 10 ml ethanol (alcohol) or methylated spirits – kept in freezer overnight
- 5 g onion, kiwi, or wheat germ
- Food blender
- 3 large (250 ml) beakers
- 2 g table salt
- 10 ml detergent (washing-up liquid/shampoo)
- 100 ml warm water (60°C)
- Spatula
- Coffee filter paper
- 2–3 drops protease enzyme
- Wire loop or glass rod

Method

1. Set up a warm **water bath** at 60°C, and an ice water bath at 0°C.
2. Pour the cold **alcohol** into a test tube (10 ml = 1/3 full) and place it in the **ice bath**.
3. Coarsely **chop** the onion with a food **blender** (2 seconds!) to about the size of spaghetti and put it into a large beaker. (The blending breaks open the cell walls, so that the detergent and salt can get in.)
4. In a second beaker, add the **salt** to the **washing-up liquid** and make up to 100 ml with warm water. Dissolve the salt by stirring slowly to avoid foaming. **Pour** this solution onto the chopped **onion**
(The detergent breaks down the cell membrane and the salt causes carbohydrates and proteins to precipitate out (stick together and fall out) of the solution.)



5. Stand the beaker in the **water bath** at 60°C for 10 minutes. During this time, **press** the chopped onion mixture against the side of the beaker with the back of a spatula. (Heat speeds up the process by softening the phospholipids in the cell and nuclear membranes; it damages the enzymes that might digest the DNA, but beyond 10 minutes the heat will begin to break down the DNA itself.)

6. **Cool** the mixture in the **ice water bath** for 5 minutes. During this time, **press** the mixture against the side of the beaker with the back of the spatula. (Cooling slows the breakdown of DNA.)

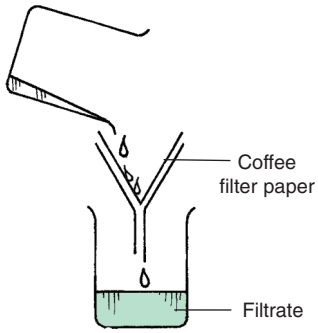
7. Pour the mixture through a coffee **filter** paper over a large beaker – try to keep the foam from getting into the filtrate. (Filtering separates the cell material from the DNA, which is now in the filtrate.)

8. Pour 10 ml **filtrate** into a test tube (10 ml = 1/3 full). Add 2–3 drops **protease** enzyme and stir gently. (The protease digests the protein that surrounds and supports the DNA.)

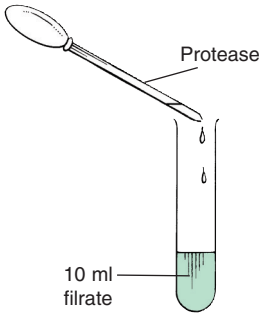
9. Take the test tube of cold alcohol from the ice bath and slowly **pour** the **alcohol** down the inside of the tube with the filtrate, to create an **alcohol layer** on top. Let the solution sit for 2–3 minutes without disturbing it. Do **not** shake the test tube.

10. Soon you will see **white thin strands** of DNA rising up from the cell extract into the upper layer – it has the appearance of white mucus. (The protein and lipids stay in the bottom layer. DNA is not soluble in cold alcohol and so it comes out of solution (precipitates) into the upper layer.)

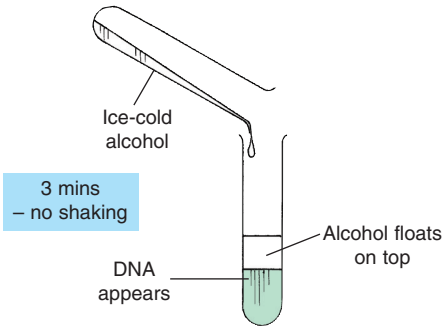
11. Using a wire **loop**, scoop out the DNA. It can be **dried** gently with a hair drier.



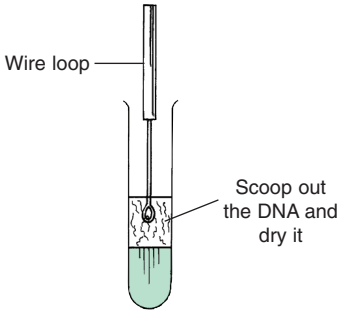
Step 7



Step 8



Steps 9 and 10



Step 11

mandatory activity 19

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INVESTIGATE THE EFFECT OF IAA GROWTH REGULATOR ON PLANT TISSUE

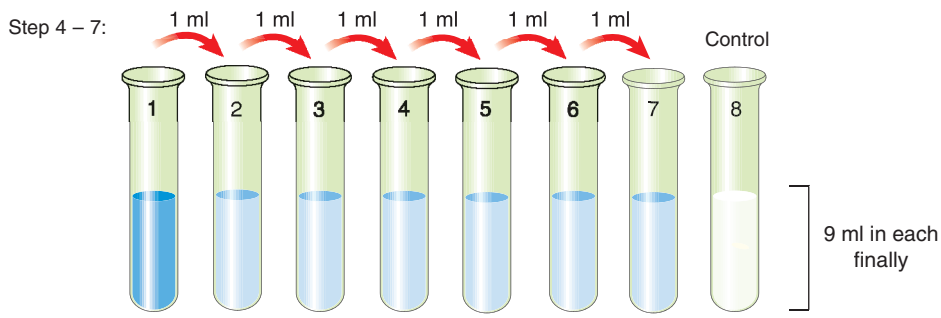
Materials

- IAA solution, 0.01% w/v = 100 parts per million (ppm)
- Distilled water
- 8 small (20 ml) bottles
- 8 (1 ml) droppers
- 2 (10 ml) syringes
- Seeds (radish or other small variety)
- 8 Petri dishes
- 8 circular acetate grids (graph paper)
- Filter paper
- Cotton wool
- Disposable gloves
- Tape
- Incubator (25°C)

Method

A. Preparing different concentrations of IAA

1. Label the 8 Petri dishes, droppers and bottles 1, 2, 3 . . . 8
2. Using a syringe, add 10 ml IAA solution to Bottle 1.
3. Using another syringe, add 9 ml distilled water to each of the bottles numbered 2 to 8.
4. Using Dropper 1, remove 1 ml IAA solution from Bottle 1 and add it to Bottle 2. Place the cap on Bottle 2 and mix.
5. Using Dropper 2, remove 1 ml IAA solution from Bottle 2 and add it to Bottle 3. Mix.
6. Using a different dropper each time, repeat this procedure up to Bottle 7.
7. After mixing Bottle 7, remove 1 ml so that each bottle now contains 9 ml of solution.
8. Leave Bottle 8 as it is, with just 9 ml distilled water – it will act as the **control**.

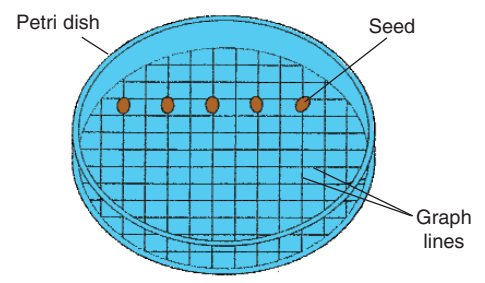


Step 2 & 3: At the start add these to the test tubes

IAA	10 ml	–	–	–	–	–	–	–
Water	–	9 ml	9 ml	9 ml	9 ml	9 ml	9 ml	9 ml
IAA conc (ppm)	10^2	10^1	10^0	10^{-1}	10^{-2}	10^{-3}	10^{-4}	0
=	100	10	1	0·1	0·01	0·001	0·0001	0

Fig. 1 Serial dilution – preparing IAA solutions of different concentrations

B. Growing seeds in different IAA concentrations



1. Inside the base of each dish:
   (a) Fit a circular acetate grid
   (b) Place six radish seeds across the middle on a grid line
   (c) Cover the seeds with filter paper
   (d) Add 2 ml of each Bottle 1 to 8 to its matching dish
   (e) Place some cotton wool on top of the filter paper
   (f) Pour the remaining 7 ml of each solution onto the cotton wool.
2. Put the lid on each dish and keep it closed with tape on either side.
3. Place in the incubator for 2 to 3 days – stand the dishes vertically on their edge so that the roots grow down and the shoots grow up.
4. Using the acetate grids, measure the length of the shoots and roots of the seedlings in each dish.
5. Calculate the average length of the shoots and roots for each dish.
6. Estimate the % stimulation (or inhibition) of root and shoot growth in each dish using the formula:

$$\% \text{ stimulation} = \frac{(\text{Average length} - \text{Average length of control})}{\text{Average length of control}} \times 100$$

Positive answer => Stimulation Negative answer => Inhibition

7. Draw a graph of % stimulation and inhibition of root and shoot growth against IAA concentration. Put IAA concentration on the horizontal axis.
8. Compare your results with other groups. Calculate a class average.

Results – Shoots

Conc of IAA (ppm)	Length of shoot (mm) Seed						Total length (mm)	Average length (mm)	% Stimulation or inhibition
	1	2	3	4	5	6			
100									
10									
1									
0.1									
0.01									
0.001									
0.0001									
control									

Results – Roots

Conc of IAA (ppm)	Length of root (mm) Seed						Total length (mm)	Average length (mm)	% Stimulation or inhibition
	1	2	3	4	5	6			
100									
10									
1									
0.1									
0.01									
0.001									
0.0001									
control									

mandatory activity 20

see page 251

INVESTIGATE THE EFFECT OF WATER, OXYGEN AND TEMPERATURE ON GERMINATION

Background information

Germinate seeds by providing one group with water, air and heat – this is the **control**. Treat the other seeds in a similar way, except leave out one of the factors each time, e.g. don't add water to one group, take the oxygen out of the air for another, and place another group in very cold conditions.

Materials

- Seeds (e.g. cress, mustard)
- Conical flasks
- Cotton wool and thread
- Strong sodium hydroxide solution
- Pyrogallic acid crystals.
  Caution: Alkaline pyrogallol is caustic and can burn your skin.

Method

1. Add 3 ml sodium hydroxide to a test tube and then drop in a few crystals of pyrogallic acid – a solution called alkaline pyrogallol is formed. This absorbs oxygen from the air in the flask and turns dark brown in colour.
2. Roll some cotton wool in the seeds, tie the bundles with thread and set up the flasks as shown.
3. After four days, examine each test tube and record your observations.
4. From the results obtained, list the conditions necessary for the germination of seeds.

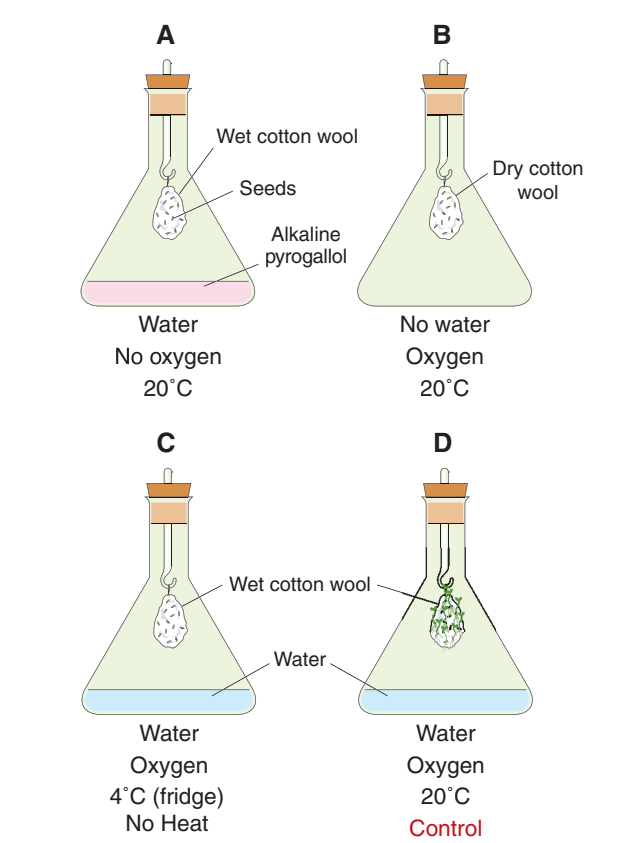


Fig. 1 To investigate the effect of water, oxygen and temperature on germination

mandatory activity 21

see page 251

INVESTIGATE DIGESTIVE ACTIVITY DURING GERMINATION, USING STARCH AGAR OR SKIMMED MILK PLATES

Background information

When a seed germinates, digestive enzymes are released by the embryo. These enzymes digest the food (starches, proteins and fats) stored in the cotyledon (or endosperm), changing them to a soluble form for absorption by the embryo for its growth.

Place cut seeds on agar that contains starch. The embryo releases amylase into the agar, which digests the starch. Later, adding iodine to the plate will show up the areas where starch has been digested.

(If skimmed milk plates are used, trypsin from the embryo will digest protein in the milk, which can be tested for by using the Biuret test.)

Materials

- Broad bean seeds, soaked in water for two days
- Starch/agar Petri dishes
- Iodine solution
- Disinfectant solution (1 hypochlorite : 4 water)
- Sterilised water
- Disposable gloves

Method

1. Swab the laboratory bench with disinfectant.
2. Take 2 seeds and treat them as follows:
   (a) Sterilise by soaking them in disinfectant for five minutes
   (b) Separate each seed lengthways into its two halves (cotyledons) – leave the embryo attached to one half.
   (c) Rinse using sterilised water
   (d) Using a sterile forceps, place the four halves in a dish, with the inside part of the cotyledon against the agar.
3. Incubate the dish at 20°C for 48 hours.
4. Remove the seeds from the plates and treat them as follows:
   (a) Flood the plates with iodine solution and leave for two minutes.
   (b) Pour off the iodine solution.
   (c) Record the diameter (in mm) of any clear region in the agar beneath or around each seed half.
   (d) Note any differences between the half with the embryo still attached and the other half without.
5. As a **control**, repeat the experiment with 2 seeds that are first **boiled** for five minutes. In this case any enzymes should be denatured and so no digestion should occur.

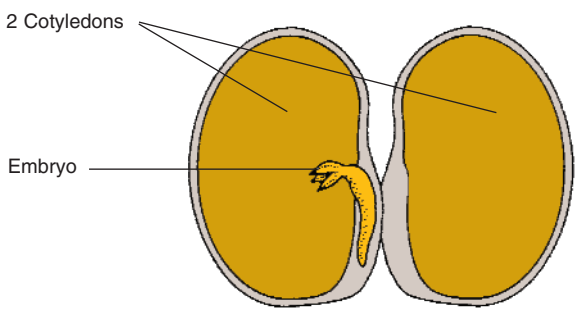


Fig. 1 Dicot seed opened up

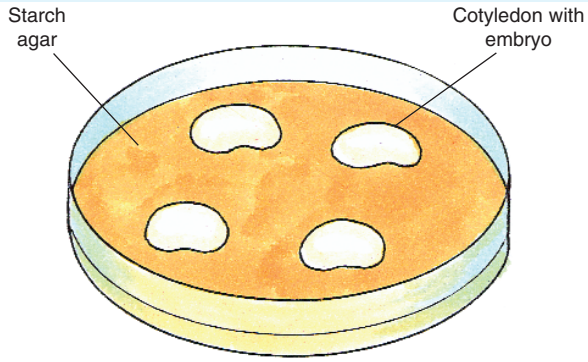


Fig. 2

mandatory activity 22

see page 196

INVESTIGATE THE GROWTH OF LEAF YEAST, USING AGAR PLATES AND CONTROLS

Background information

Leaf yeasts can be used to indicate air quality and pollution. These fungi are widespread on the surface of the leaves of deciduous trees (e.g. oak, ash and sycamore). They do not harm the leaf but feed on sugars leaking from the leaves. Living in this exposed position, they are vulnerable to poisoning from pollutants in the air. We can culture these yeasts and use their numbers to indicate air quality. Leaves in clean air will have more yeast growing on them than leaves in polluted air. (This is best done in September.)

Materials

- Nutrient agar (malt extract 2 g, agar 15 g, water 1 L)
- 4 Petri dishes, with nutrient agar
- 4 ash leaves
- Cork borer (5 mm diameter)
- Petroleum jelly (e.g. Vaseline)
- Disinfectant (1 hypochlorite : 4 water)

Method

1. Select an ash tree (in September) and collect four leaves from the base of long shoots. These leaves will have been on the tree since early summer. Each leaf will have 7 to 17 leaflets. You should carry out the activity on the day the leaves are collected.
2. Wipe down all laboratory surfaces, instruments and your hands with disinfectant.
3. Using the cork borer, cut 7 discs from a leaf, and lay them out, with the lower surfaces pointing upwards. Sterilise the borer after use.
4. Take Plate 1 and place it upside down on the bench, i.e. with the agar in the top half. Lift the base and place it down next to the lid. Do not turn the plate over or touch the agar, as you will contaminate it.
5. Put 7 small blobs of jelly in a circle on the inside of the lid. Using a sterile tweezers, stick each of the leaf discs by its upper smooth surface to each of the blobs of jelly by pressing the disc down gently. Lift up the base of the dish and replace it down in the lid.
6. Repeat Steps 3–5 for two other leaves (sets of 7 discs) using Plates 2 and 3.

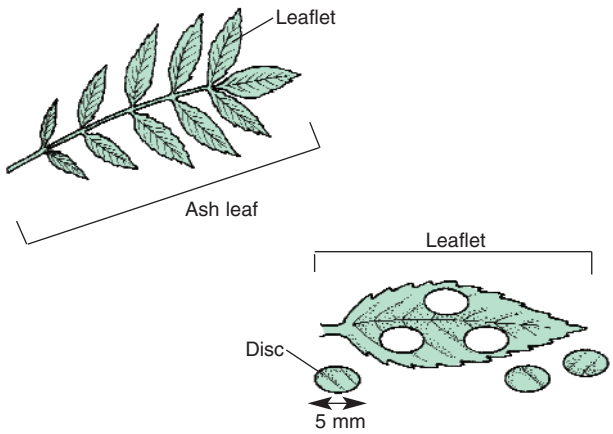


Fig. 1 Cutting ash leaf discs

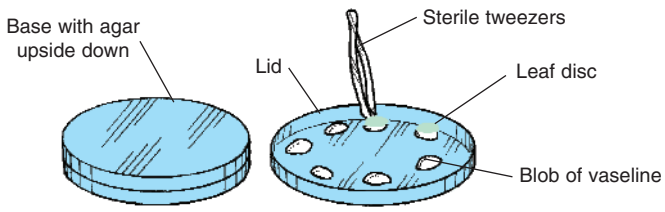


Fig. 2 Sticking each leaf disc to vaseline

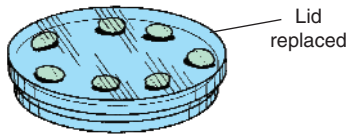


Fig. 3 Replace the lid and leave for 24 hours

7. As a **control**, wash one of the leaves with disinfectant, prior to cutting the discs, in order to remove all microorganisms. Place these discs on Plate 4.
8. Now invert the four Petri dishes so that the leaves are uppermost and above the agar. Any yeasts will fall off the leaf onto the agar and grow. Place the dishes in an incubator at 20°C, for 24 hours.
9. After 24 hours, turn all the dishes so that the agar is uppermost and no more yeasts can fall from the leaves onto the agar. Leave the plates for a further 3 days.
10. Pink glistening yeast colonies should now be visible on the agar. There may also be white glistening colonies (these are bacteria/yeasts), and fluffy white/grey colonies (these are fungi).
11. Count the number of pink colonies under each disc and record the results for all four plates.

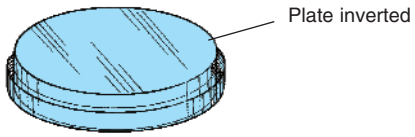


Fig. 4 Turn upside down and leave for three days

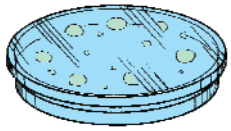


Fig. 5 Examine the plates after three days

Results

Tree location: _____

PLATE NO.	NUMBER OF PINK YEAST COLONIES IN EACH PETRI DISH LEAF DISC NUMBER							TOTAL
	1	2	3	4	5	6	7	
1								
2								
3								
4 (Control)								

} Average per plate =

Interpretation of results

Average count per plate

0–20 = Poor quality air

21–50 = Moderate quality air

> 50 = Good quality air

glossary

Red highlighted term = definition required in syllabus

A

abiotic environment The non-living, physical environment.

abiotic factors Features of an organism's habitat due to the non-living, physical environment.

ABO blood typing Use of two surface proteins (antigen A, B) on red blood cells to classify a person's blood.

abortion Expulsion of an embryo or foetus before it is capable of surviving.

abscisic acid Plant hormone that promotes bud and seed dormancy, and responses to stress.

abscission The seasonal fall of leaves or other plant parts, such as fruits or flowers (in our winter).

absorption (1) The taking in of nutrients through the wall of the digestive tract and into the blood or lymph. (2) The taking in of water and mineral salts by the roots of plants.

accommodation Ability of the eye (lens) to change its shape (focal length) to see clearly.

acetyl coenzyme A (acetyl CoA) A key intermediate compound in metabolism, especially aerobic respiration.

acetylcholine A common neurotransmitter, especially from motor neurons.

acid A substance that releases hydrogen ions when dissolved in water; has a pH less than 7.

acid rain Contains sulfur oxides and nitrogen oxides in solution (pH less than 5 generally).

acquired immune deficiency syndrome (AIDS) Disease caused by the human immunodeficiency virus (HIV).

acrosome A cap-like structure covering the head of a sperm cell; contains enzymes to enter the egg.

activation energy The energy required to start a chemical reaction.

active site Specific region of an enzyme (generally near the surface) that accepts a substrate and catalyses a chemical reaction.

active transport Movement of substances across a cell membrane against a concentration gradient, using energy from respiration.

adaptations Ways an organism is specialised, in its body structure or behaviour, to survive and reproduce.

adenine A nitrogenous purine base; a component of nucleic acids (DNA, RNA) and ATP.

adenosine diphosphate (ADP) Made from ATP when the last phosphate group is removed and energy is released.

adenosine triphosphate (ATP) An organic compound containing adenine, ribose, and three phosphate groups; of prime importance for energy transfer in cells.

ADH (Antidiuretic hormone) Controls water reabsorption by the kidney; secreted by the pituitary.

adhesion Force that sticks molecules of different substances to each other, e.g. water and xylem tube wall.

adipose tissue Fat store; found under the dermis of the skin (acts as insulation).

ADP (Adenosine diphosphate) Formed when ATP splits up to release energy.

adrenal gland Endocrine (hormone) gland, sitting like a cap on each kidney; makes adrenaline.

adrenaline The 'fight or flight' hormone; prepares the body for emergencies; raises blood levels of sugar and fatty acids; increases heart rate and the force of contraction.

adventitious root A root that arises in an unusual position on a plant, such as from a stem or leaf.

aerobe Organism that grows or metabolises only in the presence of oxygen. Compare with anaerobe.

aerobic respiration Getting energy with the use of oxygen.

aerobic respiration equation
Glucose + oxygen = carbon dioxide + water + energy.

agar Mucilage got from seaweeds; forms a gel with water; can grow bacteria on it if nutrients added.

agglutination Antibodies in the blood attach to foreign cells and cause them to clump together.

AIDS **A**cquired **i**mmune **d**eficiency **s**yndrome; caused by HIV; destroys white blood (helper T) cells.

aim What you are trying to find out in a scientific investigation.

albino Person who cannot form the pigment melanin; results in white hair and skin, and pink irises.

algae Group of photosynthetic protista that are important producers in aquatic ecosystems.

algal bloom Rapid growth of pondweed in lakes and rivers, which form a mat on the water surface, blocking out the light for other plants.

alleles Different forms of the same gene; found at a given gene locus on homologous chromosomes.

allergy Hypersensitivity to some substance in the environment, e.g. hay fever, skin rash, asthma, etc.

alveolus (pl. alveoli) Air sac of the lung through which gas exchange with the blood takes place.

Alzheimer's disease Progressive brain disease leading to premature memory loss and lowered brain functioning.

amino acid An organic compound containing C, H, O and N; there are 20 different types, and they are the basic building blocks of proteins (polypeptide chains).

ammonification The conversion of nitrogen-containing compounds to ammonia (NH_3) by certain bacteria in the soil; part of the nitrogen cycle.

amniocentesis Sampling of the amniotic fluid surrounding a foetus in order to obtain information about its development and genetic make-up.

amnion A membrane that forms a fluid-filled sac for the protection of the developing embryo.

amoeba A unicellular protista that moves by means of pseudopodia.

amylase Starch-digesting enzyme; converts starch to maltose (a disaccharide).

anabolic steroids Synthetic male hormones; increase muscle, strength, endurance, and aggressiveness.

anabolism Anabolic reaction pathway; metabolism that involves the building up of big complex molecules from simpler ones.

anaemia Deficiency of haemoglobin or red blood cells; symptoms include pale skin and tiredness.
anaerobe Organism that grows or metabolises only in the absence of oxygen. Compare with aerobe.
anaerobic respiration Glucose —> Lactic acid (bacteria and muscle) *or* Glucose —> Alcohol + CO_2 (yeast).
analysis Study of the interconnections between the results of experiments and possible factors influencing them.
anaphase Stage of mitosis, in which the chromosomes move to opposite poles of the cell.
anemometer Instrument used to measure wind speed; cups spin around in the wind.
angiosperm A flowering plant; produces seeds enclosed in fruits; includes monocots and dicots.
annual plant A plant that completes its entire life cycle in one year or less. See perennial and biennial.
anterior Toward the head end of an animal. Compare with posterior.
anther The part of the stamen in flowers that produces pollen grains.
antibiotic Product of certain microorganisms that kills other bacteria and fungi, to reduce competition.
antibody Protein made by certain white cells, that attach to antigens (foreign chemicals) and mark them for destruction by other defence cells.
anticodon Sequence of three nucleotides in tRNA that is complementary to, and can base-pair with, the three nucleotide codon on an mRNA molecule.
antidiuretic hormone (ADH) Controls water reabsorption by the kidney; secreted by the pituitary.
antigen Any chemical that white blood cells recognise as foreign and that triggers antibodies to be made against it = **anti**body **gen**erator; most antigens are proteins at the surface of pathogens or tumour cells.
anus The final end and outlet of the digestive tract.
aorta Largest artery of the body; arises from the left ventricle and branches to bring blood to all parts of the body (except the lungs).
apical bud A bud at the tip of a stem. Compare with lateral bud.
apical dominance Hormones from the apical bud inhibit growth of side buds lower down the stem.
apical meristem Area of cell division at the tip of a shoot or root; increases the length of the plant body.
Apophysis Broad tip of the sporangiophore in *Rhizopus*; it supports the columella and sporangium.
appendicular skeleton Bones of the limbs (arms and legs), hips, and shoulders; compare with axial skeleton.
arteriole A very small artery. Vasoconstriction and vasodilation of arterioles help regulate blood pressure.
artery A thick-walled blood vessel with a pulse; carries oxygenated blood away from the heart.
artificial insemination (AI) The impregnation of a female by artificially introducing sperm from a male.
artificial selection Selection by humans of traits that are desirable in plants or animals, and breeding only those individuals that possess the desired traits.
aseptic Free from disease-causing microorganisms.
asexual reproduction Any reproduction not involving gametes; offspring arise from a single parent and inherit the genes of that parent only (they are clones).
aspect Direction a habitat faces and the prevailing wind direction; use compass and weather vane
assimilation The use the body makes of the food it takes in; our liver controls much of this process.
association neuron Carries impulses from one nerve cell to another; found in the CNS. See interneuron.
atherosclerosis Progressive disease in which fat deposits build up in the inner lining of arteries, leading eventually to reduced blood flow and heart disease.
atoms Smallest part of an element that can exist.
ATP (Adenosine triphosphate) A nucleotide of adenine, ribose, and three phosphate groups that acts as an energy carrier; a small 'packet' of readily available energy for cell metabolism.
atrioventricular (AV) node Mass of specialised heart tissue that receives an impulse from the sinoatrial node (pacemaker) and conducts it to the ventricles.
atrioventricular (AV) valve A valve in the heart between each atrium and its ventricle, that prevents backflow of blood, e.g. tricuspid valve and bicuspid (mitral) valve.
atrium (pl. atria) The top chamber of the heart that receives blood from the veins.
autoimmune disease A disease in which the body produces antibodies against its own cells or tissues.
autosome A chromosome other than the sex (X and Y) chromosomes.
autotroph A producer; an organism that makes its own food from simple chemicals and a supply of energy.
auxin Plant hormone controlling growth and development, e.g. stem elongation, fruit development.
axial skeleton The skull, backbone, ribs, and breastbone (sternum); compare with appendicular skeleton.
axon The long extension of the neuron that transmits nerve impulses away from the cell body.

B

B lymphocyte (B cell) White blood cell that produces antibodies.
bacillus (pl. bacilli) Rod-shaped bacterium.
bacteria Unicellular, prokaryotic microorganisms; most are decomposers, some parasites, others autotrophs.
bacteriophage Virus that can infect a bacterium. Also called a phage.
bark The outermost covering over woody stems and roots; barrier against disease and water loss.
base pair (complementary) Two nucleotide bases, located on adjacent strands of DNA, that are hydrogen-bonded to each other – Adenine with Thymine, Cytosine with Guanine.
base pH greater than 7; neutralises acids; substance that accepts hydrogen ions when dissolved in water.
base sequence The order of nucleotide bases in a strand of DNA or RNA.
batch cultivation Microorganisms are allowed go through most of the growth phases up to a specific point. Then the fermenter is emptied and the product extracted, filtered and purified.
beating tray White linen sheet held under a bush, to collect animals that fall when the leaves are beaten.
belt transect Two ropes parallel to each other, 1 metre apart; place a quadrat between them and sample the plants and animals inside (measure % cover and frequency). Repeat at intervals along the transect.
Benedict's solution Test for reducing sugar; add to sugar and heat —-> brick-red colour produced.

beriberi Dietary deficiency disease, caused by lack of vitamin B1(thiamine) – weakened heart muscle, nerve breakdown and digestive tract disorders.
bicuspid valve Between the left atrium and left ventricle of the heart; prevents backflow; (= mitral valve).
biennial plant A plant that takes two years to complete its life cycle – flowers in the second year.
bile The fluid secreted by the liver; emulsifies fats; also a route for excretion from the liver.
binary fission Division of a cell into two equal pieces; a type of asexual reproduction, e.g. in bacteria, amoeba.
biological diversity The number and variety of living organisms.
biology The study of life (living organisms).
biomass Weight of living material; combined weight of all organisms at a given trophic level in an ecosystem.
biome A large, distinct terrestrial region characterised by a similar climate, soil, plants, and animals, regardless of where it occurs on Earth, e.g. tropical rain forest, grasslands, tundra, etc.
biomolecule Biological molecule, often consisting of thousands of atoms, and most with a backbone of carbon atoms (organic molecules). The 4 major types of biomolecule are carbohydrates, lipids, proteins and vitamins.
bioprocessing The use of organisms or their enzymes to produce commercial products, using a large container known as a fermenter (bioreactor).
biosphere That part of the earth's land, air and water where life can survive and reproduce.
biotechnology The use of organisms to produce products for medicine or industry.
biotic factors Features of an organism's environment arising from the activities of other living organisms.
birth control Parents deciding the number of children to have in their family, through contraception.
biuret test Food test for protein; sodium hydroxide + copper sulfate + protein —-> purple colour.
bladder Organ that receives urine from the ureters and temporarily stores it.
blade The thin, flat part of a leaf.
blastocyst Hollow ball of cells produced by division of a fertilised egg; implants in the womb.
blood Fluid that transports nutrients and other materials through the body; contains red cells, white cells, and platelets floating in a liquid called plasma.
blood pressure The force exerted by blood against the inner walls of the blood vessels.
bone Main support tissue in vertebrates, produced by osteocytes (bone cells); composed of hard inorganic calcium salts embedded in a flexible organic protein framework.
Bowman's capsule Cup-shaped part of a nephron (in the kidneys) that surrounds the glomerulus and receives water and solutes being filtered from the blood.
brain Control centre of the nervous system; it receives sensory information and issues coordinated commands for response by muscles and glands.
brain stem The midbrain and medulla that connect the cerebrum to the spinal cord; contains the centres controlling blood pressure, heart and breathing rates.
bronchiole Tiny air duct in the lung that branches from a bronchus; divides to form air sacs (alveoli).
bronchus (pl. bronchi) One of the branches of the trachea and its immediate branches within the lung.
bud An undeveloped shoot that can grow into flowers, stem or leaves; enclosed in bud scales.
bud scale A modified leaf that covers and protects a dormant bud.
bud scale scar Scar on a twig left when a bud scale falls off once growth resumes after winter.
budding Asexual reproduction in yeast; the nucleus is copied and, along with a small part of the parent cell, separates from the rest and develops into a new individual.
buffer solution Keeps the pH steady, despite the addition of some acid or base to the solution.
bulb Swollen leaf-bases, on a short, vertical stem, e.g. onion, daffodil; an organ of vegetative reproduction.

C

calcium Element needed for bone, blood clotting, cement for plant cells, etc.
callus Undifferentiated tissue formed on a tissue or organ in plant tissue culture.
Calorie A measure of the energy content of food; 4.2 kilojoules (kJ).
cambium Meristematic plant tissue that can divide to produce a wider stem or root (for support).
cancer A group of disorders in which certain cells lose normal regulation over both the rate of mitosis and the number of divisions they undergo. This results in the uncontrolled multiplication of abnormal cells.
capillaries Microscopic blood vessels that allow exchange of materials between tissues and blood.
capillary action Ability of water to rise in small diameter tubes; due to its cohesive and adhesive properties.
capsid Protein coat surrounding the nucleic acid of a virus.
capsule Gelatine coat that surrounds some bacteria.
capture-recapture method Estimates the size of an animal population in a habitat. Collect (C_1), mark, release, and collect again (C_2). The total number = $C_1 \times C_2 / M_2$, where M_2 = marked animals in C_2.
carbohydrate Compound containing carbon, hydrogen, and oxygen, in the ratio 1:2:1, e.g. sugars, starch, glycogen and cellulose; used as building materials and for energy.
carbon cycle The movement of carbon from the atmosphere (as CO_2), through organisms (in photosynthesis and respiration), and then back to the atmosphere.
carcinogen Substance or agent (e.g. ultraviolet radiation) that could possibly be a cause of cancer.
cardiac cycle The sequence of muscle contraction (systole) and relaxation (diastole) for one heartbeat.
cardiac muscle Heart muscle; generates its own impulse for contraction and never tires.
cardiovascular disease Disease of the heart or blood vessels; leading cause of death in industrial societies.
carnivore Animal that feeds on other animals; a flesh eater; a type of heterotroph.
carotenoids Yellow to orange plant pigments; assist in photosynthesis, e.g. carotenes, xanthophylls.
carpals wrist bones (8)
carpel Female reproductive part of a flower; consists of stigma, style and ovary.

carrying capacity Maximum population that a particular habitat can support and sustain (long-term).
cartilage (gristle) Flexible tissue that covers the tips of bones, to reduce friction and ease movement at joints.
catabolism Metabolism that involves the splitting up of big complex molecules into simpler ones; important in releasing chemical energy stored by the cell. Compare with anabolism.
catalase Enzyme that breaks down poisonous hydrogen peroxide (H_2O_2) to oxygen and water.
catalyst Substance that speeds up a chemical reaction without being used up. Enzymes are biological catalysts.
cDNA (complementary DNA) DNA copied from RNA, using the enzyme reverse transcriptase.
cell Basic structural and functional unit of life; living material bounded by a membrane.
cell continuity The ability of cells to divide and survive from one generation to the next.
cell cycle Time period from the formation of a cell by mitosis to the point when that cell itself divides; consists of interphase, mitosis, and cytokinesis.
cell division Production of new daughter cells from one parent cell; mitosis or meiosis.
cell membrane Surrounds the cell contents and controls all materials entering or leaving the cell; composed of a double layer of phospholipids, with proteins embedded in the layers; selectively permeable.
cell plate Middle wall that forms during cytokinesis in plants, producing two daughter cells.
cell theory The theory that the cell is the basic unit of life, of which all living things are composed, and that all cells are derived from pre-existing cells.
cell therapy Use of stem cells grown in the lab to repair damaged tissues (Parkinson's, burns or accidents).
cell wall Structure outside the plasma membrane of certain cells; may contain cellulose (plants), chitin (fungi), polysaccharide with protein or fat (bacteria), or other material (e.g. lignin in plants).
cellular respiration Breakdown of sugar to release energy for cell metabolism. See respiration.
cellulose Main constituent of plant cell walls; polysaccharide of many glucose molecules linked together.
central nervous system (CNS) Brain and spinal cord. Compare with peripheral nervous system (PNS).
centriole Rod-like structure in cell that produces spindle fibres during mitosis and meiosis.
centromere Specialised region of a chromosome to which the spindle fibres attach during cell division.
cerebellum Back part of the brain, concerned with coordination of movements, muscle tone and balance.
cerebral cortex Outer 3 mm layer of the cerebrum, composed of grey matter (nerve cell bodies).
cerebrospinal fluid (CSF) Bathes and protects the brain and spinal cord; see meninges.
cerebrum Main part of the brain, covering much of the rest; the centre for learning, voluntary movement, and interpretation of sensation; divided in two (cerebral hemispheres).
CFCs (chlorofluorocarbons) Odourless, invisible compounds that are contributing to the thinning of the ozone layer above the Earth's surface; found in fridges and aerosols.
characteristics of life Properties shown by living organisms; breathing, feeding, etc.
chemosynthetic Autotrophic bacteria that dismantle sulfur or nitrogen compounds, to release energy for their metabolism. In this way, they cause the recycling of nitrogen and other nutrients in ecosystems.
chemotropism The growth response of plants to chemicals, e.g. pollen grains grow downwards in response to chemicals released by the ovule.
chitin Tough, strong chemical that forms the exoskeleton of insects and the cell walls of fungi.
chlorophyll Green pigment that absorbs light for photosynthesis.
chloroplast Organelle that contains chlorophyll; site of reactions of photosynthesis.
cholesterol Made from animal fats in our diet, we use it to manufacture bile salts, steroid hormones, cell membranes. Excess in the blood sticks to our arteries, reducing blood flow to the heart and brain.
chorion Membrane that forms an outer cover around the embryo; forms part of the placenta.
chromatids, sister A chromosome and its identical copy, still attached at the centromere, during mitosis.
chromatin The DNA, protein, and RNA that makes up chromosomes.
chromosome number Each species has a characteristic number of chromosomes in each cell of its body.
chromosomes Thread-like structures in the nucleus, composed of DNA and protein.
cilia (sing. cilium) Short hairs that project from the surface of some cells and are used for sensing or creating movement of liquids, e.g. in lungs and oviduct.
circulatory system Moves blood through the body; for internal transport.
classification system Method of organising and retrieving information about organisms.
clavicle Collar bone
clay soil Small particle size, small air spaces, poor aeration and drainage; high nutrient content; heavy and difficult to dig.
climate Average weather conditions that occur in an ecosystem over a period of years.
climatic factors Features of an organism's environment arising from local weather conditions.
clone Group of genetically identical organisms, produced by asexual reproduction.
coccus (pl. cocci) A bacterium with a spherical (round) shape.
cochlea Snail-like structure of the inner ear that contains receptor cells that sense sound vibrations.
co-dominance Condition in which each allele is expressed in a heterozygote, also called incomplete dominance.
codon Sequence of three bases (triplet) of mRNA that is a genetic code for a particular amino acid, or a start or stop instruction, in the assembly of proteins.
co-enzyme Chemical that assists an enzyme by transferring electrons and hydrogen atoms to or from it.
cohesion Force that sticks molecules of the same substance to each other, e.g. water molecules.
coleoptile Protective sheath that encloses the young leaves and stem in grasses.
collagen Main protein in connective tissues (cartilage, bone, etc.).
collecting duct Tube that receives filtrate from several nephrons (in the kidney) and conducts it to the pelvis and ureter.

colon Portion of the large intestine between the caecum and rectum; reabsorbs water from food.
columella Balloon-shaped bulge at the tip of the sporangiophore in *Rhizopus* which helps nourish the spores as they develop within the sporangium.
commensalism Type of symbiosis in which one organism benefits and the other one is neither harmed nor helped. Compare with mutualism and parasitism.
communication Important in scientific work; writing a **report** (a 'paper'), recording all the significant detail, so that others may repeat the work.
community Interdependent association of different species (populations) living together in a habitat.
compact bone Dense, hard bone tissue, found mainly near the surfaces of a bone.
companion cell Specialised ground tissue in plants that controls the activity of phloem sieve tubes.
comparative anatomy Study of comparable body parts of different groups of organisms.
competition Interaction between members of a community that struggle for the same resource that is in short supply in an ecosystem (such as food, living space, etc.).
competition, contest An active confrontation between two organisms, which allows one to win the resource.
competition, scramble All the individuals in a population 'share' the limited resource, so that each tries to acquire as much of the resource as possible.
complementary base pairs Two nucleotide bases, located on adjacent strands of DNA, that are hydrogen-bonded to each other – Adenine with Thymine, Cytosine with Guanine.
compound Substance formed by combining two or more elements together chemically.
concentration gradient Difference in the concentration of a substance from one place to another.
conception Fertilisation followed by implantation; pregnancy.
conclusion What the result of an experiment tells you about your hypothesis: it either confirms it or not.
cone (a) Light receptor cell in the retina of the eye; responsible for colour vision; work in bright light.
(b) reproductive part of conifers that bears seeds.
conifer Cone-producing plant; gymnosperm; woody trees and shrubs with needle-like leaves.
connective tissue Cells scattered and embedded through a matrix (non-living material) e.g. bone, tendons.
conservation The wise management of existing resources; doing things to limit the impact of humans on the environment, and to maintain an ecological balance.
consumer Organism that obtains its energy and nutrients by feeding on the tissues of other organisms.
contest competition An active confrontation between two organisms, which allows one to win the resource.
continuity of life All living things are composed of cells, and these cells are derived from pre-existing cells;
continuous cultivation Growth of microorganisms in a fermenter (bioreactor) where the used medium and products are continuously removed and fresh raw materials added.
contraception Any method used to prevent pregnancy.
control experiment Differs in just one way from the main experiment: if there is a difference in results, it is due to the difference in this variable.
control group In a scientific experiment, a group in which the experimental variable is kept constant; it is used to show up possible side effects in a test involving an experimental group.
convoluted tubule Twisted tubes in the nephron that selectively reabsorb materials filtered from the blood.
corm Short, swollen underground stem specialised for food storage and asexual reproduction, e.g., crocus.
cornea Front, curved, transparent part of the sclera (outer layer of the eye); helps in focusing the light.
corpus luteum (yellow body) Temporary endocrine tissue in the ovary that develops from the Graafian follicle after ovulation; lives for 2 weeks and secretes progesterone.
cortex, the outer part of an organ in animals (compare with medulla).
cotyledon The seed leaf of a plant embryo; may contain food for the seedling during germination.
crenated Term used to describe the shrivelled appearance of an animal cell, such as a red blood cell, that has lost water due to osmosis. Compare with plasmolysis.
cristae (sing. crista) Finger-like inward projections of the inner membrane of a mitochondrion.
cross-pollination Where pollen reaches the stigma of a flower on a different plant (of the same species).
cuticle Transparent, waxy covering over the epidermis of leaves and stems; reduces water loss.
cyanobacteria Prokaryotic microorganisms that have chlorophyll and carry out photosynthesis.
cyclic phosphorylation In photosynthesis, a series of reactions where ATP is formed, but O_2 and NADPH are not produced.
cystic fibrosis Genetic disease due to a recessive allele; abnormally thick mucus produced in the lungs and digestive system.
cytochrome enzymes Proteins embedded in membranes of chloroplasts and mitochondria; transfer electrons or atoms from one substrate to another, so that ATP can be generated.
cytokinesis Stage of cell cycle in which the cytoplasm divides to form two daughter cells.
cytokinin Plant hormone involved in growth and development, e.g. cell division and delay of senescence (ageing).
cytoplasm Cell contents with the exception of the nucleus.
cytosine Nitrogenous pyrimidine base that is a component of nucleic acids (DNA and RNA).
cytoskeleton Internal network of protein fibres in a cell; support the cell and control movement in the cell.
cytosol Cytoplasm excluding organelles.

D

dark stage Photosynthesis reactions that take place in the stroma and are independent of light; involves the combination of CO_2 with hydrogens to form glucose.
data logging Use of electronic measuring devices in experiments.
deamination Breakdown of excess amino acids to carbohydrate and urea; takes place in the liver.
death (decline) phase Stage in the growth of populations when they begin dying faster than they are replaced.
deciduous Plants that shed leaves (or other structures) at regular intervals, e.g. autumn.
decomposer Saprophyte; consumer that gets its energy and carbon by breaking down the remains or wastes of other organisms and helps recycle nutrients back to producers.

defence, general Natural immunity, e.g. skin, white cells.
defence, specific Immunity using antiobiotics.
deficiency diseases Caused by a lack of certain nutrients in the diet.
deforestation Permanent removal of forest without adequate replanting.
demographics Human population statistics (such as density and distribution).
denature To alter the physical properties and 3-D structure of a protein (enzyme), nucleic acid, or other large molecule by treating it with excess heat, strong acids or bases.
dendrite Short branch of a neuron that receives nerve impulses and conducts them toward the cell body (nucleus).
denitrification Conversion of nitrate (NO_3) to nitrogen gas (N_2) by certain bacteria (denitrifying bacteria) in the soil; part of the nitrogen cycle.
dental formula The arrangement of teeth on one side of the mouth: 2/2, 1/1, 2/2, 3/3.
dentition Type, size and number of an animal's teeth.
deoxyribonucleic acid *See* DNA
deoxyribose 5-carbon sugar in DNA.
dermal tissue Covers and protects the surfaces of a plant; the epidermis.
dermis Layer of dense connective tissue beneath the epidermis of the skin; contains adipose tissue.
detritivores Detritus feeders.
detritus Dead, decaying matter from decomposing organisms.
detritus feeder Organism that consumes fragments of dead organisms (e.g. earthworm or crab).
detritus food chain Energy flows mainly from plants through detritus feeders and decomposers.
developed country Industrialised country with a low fertility rate, low infant mortality rate, and high per capita income, e.g. US, Japan, and European countries.
developing country Not highly industrialised, a high fertility rate, high infant mortality rate, and low per capita income, e.g. India, Kenya.
development Changes that lead to specialised tissues and organs.
diabetes mellitus Disorder caused by insulin deficiency; results in lack of control over blood sugar levels.
dialysis Diffusion of solutes across a selectively permeable membrane; machine used when the kidneys fail.
diaphragm (1) Arched, muscular floor of the thorax (chest cavity); contracts and flattens during inspiration, expanding the chest cavity; (2) contraceptive device; stops sperm from entering the uterus.
diastole Phase of the cardiac cycle in which the heart is relaxed. Compare with systole.
diatom Unicellular alga; an important component of plankton in both marine and fresh waters.
dicot A dicotyledon; a flowering plant whose seeds have embryos with two cotyledons (seed leaves).
diet, balanced Contains the correct type of nutrient, in the correct proportions, to meet the needs of a particular person.
differentiation The way cells becomes specialised in structure, and function, so forming tissues.
diffusion The movement of particles from a region where they are concentrated to a region where they are less concentrated (down a concentration gradient or slope). It is a passive process, i.e. no energy is needed.
digestion Physical and chemical breakdown of large, insoluble food into smaller, soluble molecules.
digits The fingers or toes of our skeleton.
dihybrid cross Genetic cross involving alleles of two different genes (loci). Compare with monohybrid cross.
diploid number (2n) Twice the basic set of chromosomes; gives matching pairs (homologous chromosomes).
direct count Counting the total number of organisms in the habitat, e.g. large trees or animals such as deer.
direct search Looking for animals in a habitat by lifting up stones, looking among leaves, etc.
disaccharide Sugar produced by linking two monosaccharides, e.g. glucose + glucose = maltose
disease Sickness or unhealthy condition in some part of the body.
diversity, biological The number and variety of living organisms.
DNA (deoxyribonucleic acid); double-stranded nucleic acid; contains genetic information coded in the specific sequences of its nucleotides.
DNA fingerprint Specific set of bands of DNA fragments that gives each individual a unique identity.
DNA library Collection of DNA fragments that have been inserted into plasmids.
DNA profiling Cutting up a person's chromosomes (DNA) into fragments, a series of bands, like a bar code, which are unique to that person.
DNA replication Copying of the DNA in a nucleus for distribution to daughter nuclei.
DNA sequencing Working out the order of nucleotides in a section of DNA.
dominance Where one trait hides or masks the effect of another (called the recessive).
dominant allele An allele that produces its effect (phenotype), whether it is present once or twice.
dopamine Neurotransmitter released at synapses, at the ends of nerve cells.
dormancy Time of inactivity during which metabolic activities and growth are greatly reduced, e.g. in seeds.
dorsal The back of an animal. Compare with ventral.
double fertilisation Process in the flowering plant life cycle in which there are two fertilisations – one produces a zygote that develops into an embryo, while the second produces an endosperm (food store).
duodenum First 30 cm of the small intestine into which the contents of the stomach (chyme) first enter; bile from the liver and juice from the pancreas are added to the food here.

E

ecological pyramid Graph representing the relative energy value at each trophic level in a food chain.
ecology Study of how living things interact with each other and with their environment.
ecosystem A community of organisms interacting with each other and their environment; involves a flow of energy and a cycling of materials, e.g. a lake, woodland, seashore.
edaphic factors Features of an organism's environment due to the physical, chemical and biological properties of the soil.
effector Muscle (or gland) that responds to signals from the brain.
egestion Release of undigested and unabsorbed food from the body (elimination).

egg Mature female gamete; an ovum.
electron microscope Produces high resolution, highly magnified images; uses an electron beam (not light).
electron transport system Organised series of enzymes involved in chemical reactions, during which hydrogens (or their electrons) are passed along from one molecule to another, with the release of energy in the form of ATP.
element A substance that cannot be broken down into simpler substances by chemical means, e.g. C, H, O.
Elodea canadensis Pondweed; water plant used in photosynthesis experiments; releases oxygen bubbles.
embryo (1) Young organism before it emerges from the egg, seed, or body of its mother; (2) Developing human until the end of the second month, after which it is called a foetus.
embryo sac 8-celled structure in the ovule of a flower, containing the egg and two polar nuclei (these develop into the embryo and food store following fertilisation).
emigration Type of migration in which individuals leave a population and so decrease its size.
emulsification Suspension of droplets of fat (coated with bile salts); formed in the small intestine.
endocrine gland Secretes hormones directly into the blood or tissue fluid instead of into ducts.
endometrium Lining of the womb (uterus); builds up each month in preparation for pregnancy.
endoparasite Lives inside the body of another organism (its host) and does it harm, e.g. tapeworm, virus.
endoskeleton Having a bony (or cartilage) structure inside the body that provides support.
endosperm The triploid (3n) food storage tissue that feeds the embryo when the seed germinates.
endospore Resting cell formed by certain bacteria; highly resistant to heat, radiation and disinfectants.
endothelium Tissue that lines the cavities of the heart, blood and lymph vessels.
energy Ability to do work (to move something); expressed in kilojoules (kJ) or kilocalories.
energy flow Passage of energy in a one-way direction through an ecosystem.
environment Surroundings of an organism, both the living and non-living factors.
enzyme Organic catalyst that speeds up a chemical reaction, without getting used up in the process; usually a protein; lowers the activation energy required for the reaction.
enzymes, immobilised Enzymes stuck to resin beads or embedded in jelly; the enzyme is more stable in this stationary form, and may be reused many times.
epidermis Outer layer of cells covering the body of plants and animals; for protection.
epididymis Coiled tube that stores sperm from the testis, and carries them to the vas deferens.
epiglottis Flap-like structure at the top of the trachea, that prevents food entering the windpipe.
epithelium Animal tissue that covers body surfaces, lines internal cavities and tubes, and forms glands.
erythrocyte Red blood cell.
essential amino acids Amino acids that cannot be made by the organism, and so must be eaten in food.
ethanol 'alcohol'; waste product of anaerobic respiration in yeast and plant cells.
ethene Plant hormone involved in growth and development, such as leaf fall and fruit ripening.
ethics Set of moral principles or values (accepted ideas of 'right and wrong').
eukaryote Organism whose cells possess nuclei and other organelles. Compare with prokaryote.
eustachian tube Links the middle ear cavity and the throat; keeps air pressure equal on each side of the eardrum.
eutrophication Rapid increase in the concentrations of dissolved nutrients of an aquatic ecosystem.
evaporation rate How fast water vapour is lost from a plant; shows the drying effect the air has on the plant.
evolution Gradual change, over a long period of time, in the characteristics of a species, so that a new species is formed.
excretion Removing waste products of metabolism.
excretory system Removes metabolic wastes from an animal, e.g. lungs, kidneys, liver, skin.
exocrine gland Secretes products through ducts (tubes), e.g. salivary gland.
exoskeleton An external skeleton, e.g. shell of snails or outer covering of insects, spiders, etc.
experiment Procedure that tests a hypothesis; carried out under controlled conditions.
expiration Breathing out; expelling air from the lungs to the outside.
exponential (log) growth Pattern of growth in which the population size expands by ever increasing amounts.
extinction Elimination of a species; occurs when the last individual member of a species dies.

F

F_1 generation (first filial generation) First generation of offspring from a cross between parents from two different true-breeding lines; results in a hybrid.
F_2 generation (second filial generation) The offspring of the F_1 generation.
facultative anaerobe Organism capable of carrying out aerobic respiration, but able to switch to fermentation when oxygen is unavailable, e.g. yeast. Compare with obligate anaerobe.
FAD/$FADH_2$ = Flavin adenine dinucleotide; coenzyme that transfers electrons (and hydrogen) in cellular metabolism, including cellular respiration.
faeces Dung of an animal; the undigested food after it is eliminated from the body.
fallopian tube Oviduct; where fertilisation takes place in the female.
family planning Parents controlling the frequency and number of children they have in their family.
fat Lipid that is solid at room temperature.
fat test Rub the food sample on brown paper and dry it – a translucent stain indicates fat (lipid).
fatty acid Molecule with a backbone of up to thirty-six carbon atoms; found in lipids.
feedback control System in which the build-up of the product of a reaction then affects its rate of production.
feedback, negative Control mechanism by which the release of a substance changes a condition or activity, which then results in a drop in the release of the substance.
Fehling's solution Test for reducing sugar; add to sugar and heat —> brick-red colour produced.

fermentation (1) Anaerobic respiration. Pyruvate (from glycolysis) is converted into alcohol (ethanol) and CO_2.
(2) chemical changes in organic substances produced by the action of enzymes.
fertilisation Uniting of sperm and egg (haploid gametes), which results in a diploid zygote.
fertiliser Chemicals (natural and synthetic) added to soil which release nutrients to increase plant growth.
fertility (soil) The amount of nutrients in soil that will allow good plant growth.
fibre (1) Plant cell walls, which are made of cellulose; helps peristalsis in the digestive system. (2) In animals, an elongated cell such as a muscle or nerve cell.
fibrous root System in plants that has many roots that are similar in length and thickness.
filament Thin stalk of a stamen in flowering plants; it bears an anther at its tip.
fittest, survival of the Measure of the ability of an organism to compete successfully and leave many offspring.
flagellum Long, whip-like structure extending from a cell and used in moving about, e.g. in bacteria.
flower Reproductive part of angiosperms.
foetus Unborn human offspring from the third month of pregnancy to birth.
folic acid Coenzyme in nucleic acid synthesis; helps make red blood cells; needed for embryo growth.
follicle (1) Small sac of cells in the ovary that contains a maturing egg; (2) pocket in the skin from which a hair grows.
follicle-stimulating hormone (FSH) Secreted by the pituitary gland; stimulates follicle development in the ovaries of females and sperm production in the testes of males.
food chain Series of organisms through which energy flows in an ecosystem; a straight-line sequence of who eats who in an ecosystem.
food preservation, osmosis Using salt or sugar causes water to be drawn out of bacteria by osmosis, thus preventing the food from spoiling.
food web Complex interconnection of all the food chains in an ecosystem.
fossil fuel Coal, petroleum or natural gas; formed from the remains of organisms that existed millions of years ago; a non-renewable source of energy.
fossil Dead remains (or evidence) of an organism, often preserved in rock.
fovea (yellow spot) Area of sharpest vision in the retina; cone cells are concentrated here.
frequency, % How often you would expect to find an organism in a habitat.
fruit Mature, ripened ovary of a flower; contains seeds and is an adaptation for dispersal of the seeds.
FSH Follicle-stimulating hormone; triggers egg or sperm production.
fungus (pl. fungi) Heterotroph, with chitinous cell walls and a body in the form of branched, thread-like hyphae. Most are decomposers; some are parasitic. One of the five kingdoms of organisms.

G

gall bladder Small sac attached to the liver that stores bile.
gamete Haploid sex cell (egg or sperm); it must unite with another if it is to develop any further.
ganglion (pl. ganglia) Mass of cell bodies of neurons located outside the central nervous system.
gastric Relating to the stomach.
gel electrophoresis Method of separating DNA fragments, on the basis of size and charge, as it migrates through a jelly material in an electrical field.
gene Segment of DNA (chromosome) that controls a certain trait; produces a specific protein.
gene expression The way characteristics result from the interaction of genes with the environment.
gene pharming The use of transgenic farm animals to produce pharmaceuticals.
gene therapy The introduction of normal genes into a person's cells to correct a disease or genetic disorder.
genetic code The nucleotide triplets in DNA that code for a specific sequence of amino acids in proteins.
genetic disorder Inherited condition that results in mild to severe medical problems.
genetic engineering The process by which the genetic make-up of an organism is manipulated or changed.
genetic fingerprinting The DNA of individuals is compared on the basis of the different patterns of DNA fragments (bands) generated when their DNA is cut with the same restriction enzyme. *See* DNA profiling.
genetic recombination New combination of alleles in offspring – results from gene mutation, changes in chromosome structure or number, or recombinant DNA technology.
genetics The study of inheritance (the way in which parents pass on their characteristics to their offspring).
genome All the genetic material in a cell or organism.
genotype The set of genes an individual possesses; in crosses, represented by letters, e.g. Tt or BB.
genus Classification category made up of related species.
geotropism Response of a plant to gravity; shoots grow away (negative ~); roots grow towards (positive~).
germination Growth of the embryo, using the food store inside the seed. Needs H_2O, O_2 and heat.
gibberellin Plant hormone involved in growth and development, e.g. stem growth, flowering, germination.
gills (1) Respiratory organs of aquatic animals, (2) Spore-producing structures under the caps of mushrooms.
gland Body structure specialised for secretion (production and release of some chemical).
global warming Long-term increase in Earth's average temperature.
glomerulus Net of blood capillaries inside Bowman's capsule in a nephron; filtration occurs here.
glucagon Pancreatic hormone that stimulates cells to convert glycogen (and amino acids) to glucose.
glucose A very common 6-carbon sugar; used in respiration to supply energy.
glycerol A 3-carbon alcohol; a component of fats and phospholipids.
glycogen Highly branched polysaccharide (similar to starch) – main storage carbohydrate of animals.
glycolysis First stage of cellular respiration; conversion of glucose into pyruvate.
goitre Enlargement of the thyroid gland; symptoms include swollen neck and reduced metabolic rate.

Graafian follicle Fluid-filled vesicle in the ovary that contains the egg; after ovulation, it develops into the corpus luteum, which produces progesterone.
graft rejection Immune response directed against a transplanted tissue or organ.
granum (pl. grana) Stack of membranes (discs) within a chloroplast; covered in chlorophyll.
grazing food web Network of food chains in which energy flows from plants to herbivores, then carnivores.
greenhouse effect Global warming of Earth's atmosphere, produced by greenhouse gases.
greenhouse gases Trace gases in the atmosphere that allow the sun's energy to penetrate to the Earth's surface but do not allow as much of it to escape as heat, e.g. CO_2, methane.
grey matter Nerve tissue in the brain and spinal cord that contains cell bodies, dendrites and unmyelinated axons. Compare with white matter.
grid Quadrat which has been subdivided into (100) smaller squares.
ground tissue Makes up the bulk of the plant body and is involved in photosynthesis, support and storage.
growth Increase in the number, size or volume of cells.
growth regulator Plant hormones; chemicals that control the development of the plant.
guanine Nitrogenous purine base that is a component of nucleic acids (DNA, RNA).
guard cell One of a pair of epidermal plant cells that adjust their shape to form a stoma for gas exchange.
gymnosperm Plant in which the seeds are produced in cones; mainly conifers (spruce, pine).

H

habitat Type of place (natural environment) where an organism lives.
haemoglobin Red, iron-containing protein pigment of red blood cells; transports oxygen.
haemophilia Hereditary disease in which blood does not clot properly; due to an X-linked recessive gene.
haploid number (n) Basic set of chromosomes found in a gamete (sperm or egg).
Haversian canals Channels extending through the matrix of bone; contain blood vessels and nerves.
heart attack When heart muscle receives insufficient oxygen along the coronary arteries and cells die.
hedgerow Narrow, straight strips of woodland ecosystem, originally intended as fences and land boundaries.
helper T cell T lymphocyte that assists B lymphocytes to replicate in response to an antigen.
hepatic Relating to the liver
hepatic portal vein Carries blood rich in absorbed food from the intestine to the liver. A portal system carries blood from one organ to another without going through the heart – it begins and ends in capillaries.
herbivore Animal that feeds on plants; a primary consumer.
heredity Study of how traits (characteristics) are passed on from one generation to the next.
heterotroph A consumer; lives on other organisms or decaying matter; obtains its energy and nourishment from organic molecules made by other organisms.
heterozygote Individual having a pair of unlike alleles for a particular trait (gene locus), e.g. Tt.
HIV (human immunodeficiency virus) Retrovirus that causes AIDS (acquired immune deficiency syndrome).
homeostasis Maintenance of a constant internal environment within the body; keeping blood and tissue fluid within ranges suitable for cell activities.
homologous chromosomes Pairs of chromosomes that possess the same genes, in the same positions (loci).
homozygous Individual having a pair of identical alleles for a particular trait (gene locus), e.g. TT or tt.
hormones Chemical messenger molecule, produced in specialised glands (endocrine), transported in the blood to a target organ where it affects some aspect of metabolism.
host Organism a parasite lives on and does harm to.
human genome project Worldwide research project to sequence the estimated 3 billion nucleotides present in the DNA of human chromosomes.
humidity Amount of water vapour in the air; fully saturated is 100% humidity.
humus Decomposing organic matter in soil; gives soil a dark brown or black colour,
hybrid A heterozygote, e.g. Bb; offspring of two genetically unlike parents.
hydrogen bond Weak attractive force between a hydrogen atom with a partial positive charge and an atom (usually oxygen or nitrogen) with a partial negative charge.
hydrogen peroxide (H_2O_2) Colourless, corrosive liquid that slowly decomposes to water and oxygen.
hydrotropism The growth response of plant roots to water – they will grow towards it.
hygrometer Instrument that measures the relative humidity of the air; consists of a wet and a dry bulb thermometer.
hypha Thread-like filament, composing the body of a fungus.
hypothalamus Part of the brain that regulates the pituitary gland, emotional responses, body temperature, water balance, and appetite; located below the thalamus.
hypothesis Possible explanation of some occurrence; can be tested by experiment.

I

identifying Finding the name of an organism, generally by using a key.
immigration Migration in which individuals enter a population and so increase the population size.
immobilisation A method of attaching enzymes to certain materials, so they can still catalyse a reaction but be easily separated from the products.
immune response Production of lymphocytes or antibodies in response to foreign invaders (antigens).
immunisation Ways of using antibodies against specific diseases; includes vaccination.
immunity Resistance to disease; by natural methods (white cells, skin, etc.) or induced (antibodies).
implantation Embedding of a blastocyst into the endometrium of the uterus; starts pregnancy.
impulse Electrical message that is carried along a neuron.
inheritance The way in which parents pass on their characteristics to their offspring.
incinerator Factory or furnace that burns (waste) material to get rid of it.

incomplete dominance Condition in which each allele in the heterozygote produces an effect, e.g. red x white —> pink; also called **co-dominance**

incubation Growing of the microorganisms in a warm environment.

Independent Assortment, Law of Mendel's 2nd law states that, when the alleles of two different genes separate during gamete formation, the distribution of one pair of alleles is independent of the distribution of the other pair.

induced fit mechanism The way a substrate more or less fits into the active site of an enzyme molecule.

induced immunity This is immunity due to antibodies, produced by lymphocytes (white blood cells).

infection Invasion and growth of a pathogen in host tissues. Disease may follow if defences cannot be mobilised fast enough.

ingestion Taking food (or other material) into the body; eating and drinking.

inheritance Transmission of traits controlled by genes from parents to offspring.

inhibitor Substance that slows down the action of an enzyme, by blocking its active site.

inoculation (1) Addition of cells or microorganisms to a nutrient medium, so they can then grow; (2) Injection of a mildly infective or dead pathogen into an animal which causes slight infection but produces immunity (= vaccination).

insemination Release of sperm into the vagina, during intercourse.

inspiration Breathing in; inhaling; drawing air into the lungs.

insulin Hormone secreted by the pancreas; stimulates cells to take up glucose; lowers blood glucose levels.

integument Outer layer of ovule, covering the nucellus and embryo sac; forms the seed coat after fertilisation.

interferon Protein produced by animal cells when attacked by a virus; prevents viral replication.

interleukins Proteins produced by white blood cells that regulate the immune response.

interneuron Nerve cell that carries impulses from one nerve cell to another; found in the CNS (brain and spinal cord); part of a reflex arc.

interphase Stage of the cell cycle in between successive mitotic divisions; 'resting' stage, though replication of DNA (chromosomes) takes place just prior to prophase.

intertidal zone Marine (sea) shoreline area between the high tide mark and the low tide mark.

invertebrate Animal without a backbone (vertebral column); make up about 95% of animal species.

in vitro Occurring outside a living organism (technically means 'in glass').

in vivo Occurring in a living organism.

iodine Orange-brown solution that turns blue-black when added to starch.

ion Atom or group of atoms bearing electrical charge(s), either positive or negative.

iris Coloured part of the eye; controls the amount of light entering the eye. Hole in iris = pupil.

iron Element needed for the manufacture of haemoglobin and the cytochrome enzymes.

islets of Langerhans Endocrine portion of the pancreas that secretes glucagon and insulin.

J

Jenner, Edward Devised the first vaccination, using cowpox to immunise against smallpox.

joint Junction where 2 bones meet.

joule Unit of energy. *See* kilojoule (kJ).

K

karyotype Chromosomal makeup of a person; got by photographing the chromosomes and arranging the homologous pairs according to size, centromere position and pattern of bands.

keratin Tough, waterproof protein found in skin, nails, feathers, hair and horns.

key Arrangement of important characteristics of plant and animal groups as an aid to their identification.

kidney Organ important in excretion of metabolic wastes and in osmoregulation.

killer T cell T lymphocyte that destroys cancer cells and infected body cells on contact.

kilocalorie Unit of energy = 1000 calories = 4.2 kilojoules; amount of heat needed to raise the temperature of 1 kg water by 1°C.

kilojoule Measure of the energy content of food; the amount of energy needed to raise the temperature of 240 ml water by 1°C

kingdom Broad classification category made up of related groups of organisms; 1. Prokaryotae (Monera) – bacteria; 2. Protista (Protoctista) – protozoa (Amoeba), algae; 3. Fungi – yeasts and mushrooms; 4. Plants; 5. Animals.

Krebs cycle Series of chemical reactions in the mitochondrion (during aerobic respiration), in which pyruvate is dismantled into carbon dioxide and water, with the release of energy in the form of ATP.

L

lactation Production or release of milk from the breasts; stimulated by the hormone prolactin.

lacteal Branch of the lymphatic system, in a villus of the intestines; absorbs fat.

lactic acid (**lactate**) A 3-carbon organic acid; produced during anaerobic respiration in bacteria and muscle.

lag phase Slow increase in the growth of a population as it settles into a new habitat (= exponential phase).

landfill Use of old quarries and gravel pits for the dumping and disposal of wastes.

large intestine Last part of the digestive tract – caecum, colon, rectum and anus; it reabsorbs water.

larva Immature form in the life cycle of some animals (especially insects); generally not like the parent.

larynx The voicebox (vocal cords) at the top of the windpipe; in males the 'Adam's apple'.

lateral bud A bud in the axil of a leaf (in the angle between the stem and the leaf); can grow into a side stem.

Law of Independent Assortment Mendel's 2nd law states that, when the alleles of two different genes separate during gamete formation, the distribution of one pair of alleles is independent of the distribution of the other pair.

Law of Segregation Mendel's 1st law states that when gametes form, the two alleles of a gene separate, one going into each gamete.

leaching Removal of nutrients from soil as water percolates through it and carries them away.
legume Member of the pea family, e.g. pea, bean, peanut, clover; often have mutualistic bacteria in their roots, in nodules, which can fix nitrogen gas (convert it to usable nitrates).
lens Oval, transparent part of the eye; focuses light rays on the retina.
lenticels Openings on woody stems where the bark cells are loosely packed; allow the exchange of gases.
LH Luteinising hormone; secreted by the pituitary; stimulates ovulation and the formation of the corpus luteum in the ovaries; stimulates testosterone production in the testes of males.
lichen A compound organism composed of an alga and a fungus; a mutualistic relationship.
life Property shown by organisms that can grow and reproduce; it results from the interaction of organisation, nutrition, excretion, response and reproduction.
ligament A connective tissue that connects bones to each other at joints, or holds other organs in place.
light dependent reactions In photosynthesis; light energy absorbed by chlorophyll is used to synthesise ATP and usually NADPH.
light intensity Measure of the amount of light a plant is receiving for photosynthesis.
lignin substance that strengthens and waterproofs cell walls; especially in xylem.
limiting factor Any essential resource that limits population growth when it is in short supply.
linkage group the set of genes on the same chromosome, linked together and inherited together in successive generations.
lipase Fat-digesting enzyme; secreted by the pancreas and ileum, it breaks fats into fatty acids and glycerol.
lipid Organic compound, insoluble in water, but soluble in alcohol; fats and oils; serves as energy storage and an important component of cell membranes.
liver Large, complex organ that has many metabolic functions.
loam soil Mixture of 50% sand, 30% clay and 20% humus; blends the best properties of sandy and clay soils.
locus Particular location of a gene in a chromosome.
Longworth trap Metal box with bait, which is used to catch mammals.
loop of Henle U-shaped loop of a nephron (of the kidney) that reabsorbs water and solutes.
lost energy heat energy released in respiration, which cannot be used by organisms for metabolism.
lung Respiratory organ that functions in gas exchange; (oxygen in, carbon dioxide out).
luteinising hormone (LH) stimulates ovulation, formation of the corpus luteum and testosterone production.
lymph Colourless (tissue) fluid that has drained from the blood into the vessels of the lymphatic system.
lymph node Swelling along lymph vessels; lymphocytes inside filter out germs before they reach the blood.
lymph vessel Tube that drains excess tissue fluid, transports fats and has lymphocytes for defence.
lymphocyte White blood cell responsible for immune responses; some produce antibodies, others eat germs.
lysis Damage to a cell membrane or wall, that allows the cytoplasm to leak out and leads to cell death.

M

macronutrient Essential element that is required in fairly large amounts for normal (plant) growth.
macroparasites Large, visible parasites: invertebrates (flatworms, fleas, ticks), fungi and plants (mistletoe).
macrophage Large phagocytic white blood cell; ingests and digests bacteria and other foreign invaders.
magnesium Element needed for bones and teeth, energy exchanges in cells and chlorophyll in plants
malignant Cancer cells that spread to disrupt other tissues.
mammal Vertebrate that feeds its young on milk, has hair and sweat glands and a constant body temperature; the young generally develop in a womb prior to their birth.
marrow, red Site of blood cell formation in the spongy tissue towards the ends of many bones.
marrow, yellow Site of fat storage in the spongy tissue towards the centre of many bones.
matrix (1) Non-living material secreted by and surrounding connective tissue cells, e.g. bone. (2) The innermost area of a mitochondrion.
medulla oblongata Back part of the brain; controls vital tasks, such as breathing and heart rate.
meiosis Division of a diploid (2n) nucleus to produce four haploid (n) daughter nuclei, each containing half the chromosome number of the original parent cell. Produces gametes in animals and spores in plants.
membrane Outer boundary of cells and organelles, made of phospholipid and protein; semipermeable – controls movement of materials through it.
memory cell Lymphocyte that organises a rapid immune response when a particular antigen invades the body a second time.
Mendel's 1st law – Law of Segregation Alleles occur in pairs in organisms, and during gamete formation, the two separate (segregate), with only one going into each gamete.
Mendel's 2nd law – Law of Independent Assortment When the alleles of two different genes separate during gamete formation, the distribution of one pair of alleles is independent of the distribution of the other pair.
meninges Three membranes that cover and protect (with fluid) the brain and spinal cord; infection of these is called meningitis.
menopause Time when a woman's menstrual cycle ceases; occurs between 45 and 55 years of age.
menstrual cycle Events that produce and release an egg and prepare the endometrium (womb) to receive it should it be fertilised; the complete cycle takes about 28 days in humans.
menstruation Monthly discharge of blood and tissue from the endometrium (lining) of the womb.
meristem Growth region in a plant; localised area of cell division (mitosis).
messenger RNA (mRNA) Specifies the amino acid sequence of a protein; transcribed from DNA.
metabolic pathway Orderly sequence of enzyme-controlled reactions in a cell.
metabolism Set of all enzyme-controlled, chemical reactions taking place within a cell or organism, the energy being supplied by respiration.
metacarpals Bones of the hand (palm), one per digit.
metaphase Stage of mitosis, when sister chromatids line up on the equator (middle) of the cell.

metatarsals Bones of the foot (sole), one per digit.
method Describes the steps necessary to carry out an experiment.
micrograph Microscope photograph; picture taken by attaching a camera to the eyepiece lens.
micrometre (μm) = 1/1000 mm.
micronutrient Essential element that is required in trace amounts for normal plant growth.
microorganism Organism, usually single-celled, that is far too small to be seen without a microscope, e.g. bacterium.
micropyle Gap through the integuments in the ovule; pollen tube enters here; in seed, water enters here.
microscope Instrument that magnifies small objects, by using two convex lenses held in a tube.
microvilli Minute projections of the plasma membrane that increase the surface area of the cell; found mainly in cells concerned with absorption or secretion, e.g. those lining the intestine or the kidney tubules.
middle lamella Layer of calcium pectate (pectin) that cements the walls of adjacent plant cells together.
migration Movement of an organism (individual or population) from one place to another.
minerals Inorganic nutrients ingested in the form of salts dissolved in food and water, e.g. calcium, iodine.
mitochondrion Cylinder-like organelle involved in aerobic respiration.
mitosis Division of a cell nucleus to form two daughter nuclei, each containing identical chromosomes to the parent nucleus; four phases – prophase, metaphase, anaphase, and telophase.
mitral (bicuspid) valve Between the left atrium and left ventricle of the heart.
molar Tooth with a platform having cusps (surface bumps) that help crush, grind and shear food.
molecule Two or more elements combined together chemically; smallest piece of a compound that can exist.
Monera Bacteria – one of the 5 kingdoms.
monocot Monocotyledon; a flowering plant with seeds having one cotyledon (seed leaf), e.g. grasses.
monocyte White blood cell that 'eats' germs (macrophage).
monohybrid cross Genetic cross involving one gene – one pair of alleles of a single gene locus.
monomer Molecule that can be linked to many other similar ones to form a large molecule called a polymer.
monosaccharide Simple carbohydrate, with only one sugar monomer, e.g. glucose.
motor neuron Carries impulses away from the central nervous system to effectors (glands, muscles).
movement Characteristic of life; organisms can move about or move part of their body.
mRNA (messenger RNA) Specifies the amino acid sequence of a protein; transcribed from DNA.
mucus Sticky secretion of protein and carbohydrate; lubricates body parts and traps particles of dirt.
multicellular Organism with many cells, specialised and arranged into tissues, organs and organ systems.
multiple alleles Three or more different forms of the same gene (alleles) in a population, e.g. blood types.
muscle Tissue having cells that can contract under stimulation.
mutagen Agent capable of causing mutations in organisms – UV radiation, certain chemicals and x-rays.
mutation Any change in the structure, arrangement or quantity of DNA, which is then inherited.
mutualism Symbiotic relationship in which both partners benefit from the association.
mycelium (pl. mycelia) Network of tiny, branching filaments (hyphae) – the food-absorbing part of fungi.
mycorrhiza Form of mutualism between the hyphae of a fungus and young roots of many plants, that aid in the plant's absorption of essential minerals from the soil.
myelin sheath White, fatty, insulating layer on most sensory and motor neurons – it speeds up the impulse; made from the cell membranes of Schwann cells, wrapped around the axon.

N

n (haploid); chromosome number of a gamete; a set of chromosomes consisting of one copy of each type.
NAD (**Nicotinamide adenine dinucleotide**); Coenzyme that transfers electrons (and hydrogen), in catabolic pathways, including cellular respiration.
NADP (Nicotinamide adenine dinucleotide phosphate); Coenzyme that transfers electrons (hydrogens), in anabolic pathways, including photosynthesis.
natural killer cell (NK cell) Large lymphocyte that functions in both non-specific and specific defence; releases digestive enzymes that target tumour cells and cells infected with viruses and other pathogens.
natural selection Mechanism of evolution proposed by Charles Darwin: the tendency of organisms that possess favourable adaptations to survive and become the parents of the next generation.
nectary Gland in flowers that secretes nectar, a sugary chemical to attract animals to help pollination.
negative feedback system Homeostatic mechanism in which a change in some condition triggers a response that counteracts, or reverses, the changed condition, e.g. how we maintain our body temperature.
nephron Microscopic working unit of the kidney; filters blood and selectively reabsorbs materials.
nerve Collection of neurons; a bundle of axons (or dendrites) of sensory and motor neurons.
nerve impulse Electrical message that is carried by a neuron.
nervous system Communication system, based on electrical impulses. Senses, processes and responds.
neuron Nerve cell; specialised cell that can carry electrical messages (impulses) around the body.
neurotransmitter Chemical released across a synapse, to carry a signal from one neuron to another.
niche Role of an organism in a habitat; all the activities and relationships in which an organism engages, to secure and use the resources necessary to survive and reproduce.
night blindness Dietary deficiency disease, due to lack of Vitamin A; hard to see in dim light.
nitrification Formation of nitrates in soil by (nitrifying) bacteria, as they decompose dead matter.
nitrogen cycle Circulation of nitrogen and nitrogen compounds between the air, soil and organisms.
nitrogen fixation Conversion of atmospheric nitrogen gas (N_2) to nitrates by certain bacteria – in root nodules of legumes and in the soil.
nodule Swellings on the roots of plants, such as legumes, in which symbiotic nitrogen-fixing bacteria live.

non-cyclic phosphorylation Series of reactions in photosynthesis, that results in the formation of ATP, NADPH, and O_2.
non-living Opposite of living; cannot grow or reproduce; not the same as dead (which implies once alive).
nucellus Ground tissue in the ovule; provides food to the embryo sac.
nuclear membrane Double membrane that surrounds a cell nucleus, perforated by pores.
nucleic acid Long chain molecule composed of four different kinds of nucleotides, e.g. DNA, RNA.
nucleolus Site of rRNA production in the cell nucleus; formed from regions of several chromosomes.
nucleotide Molecule composed of a phosphate group (PO_4), a 5-carbon sugar (ribose or deoxyribose) and a nitrogen-containing base (A, T, C, G or U); the basic unit of ATP, NAD, NADP and nucleic acids.
nucleus Organelle in eukaryotes that contains the DNA (chromosomes) and is the control centre of the cell.
nutrient agar Seaweed (jelly) extract with added nutrients; used as a solid substrate to grow microorganism on.
nutrient Chemical substance in food that is used for making materials and/or as an energy source.
nutrient recycling Involves molecules of a nutrient being transferred from the environment to organisms, then back to the environment, which acts as a huge reservoir for them.
nutrition The way organisms get their food (nutrients) for growth and metabolism.

O

obligate anaerobe Organism that grows only in the absence of oxygen. Compare with facultative anaerobe.
observation Noticing some event or situation and asking the question, why?
oesophagus Tube that carries food from the throat to the stomach, by peristalsis.
oestrogen Female sex hormone, produced by the ovary; helps eggs mature, builds up the womb lining during the menstrual cycle and pregnancy, and helps maintain secondary sexual traits.
omnivore Animal that eats a variety of plant and animal materials, e.g. humans.
organ Collection of tissues having a definite form and structure, which performs a specific function.
organ system An organised group of tissues and organs that work together to perform a specialised set of functions.
organelle Structure within a cell, specialised to do a certain job, and separated from the cytoplasm by a membrane, e.g. mitochondrion, chloroplast, nucleus.
organic compound Composed of a backbone of carbon atoms.
organisation A structured plan which improves efficiency and increases the chances of survival.
organism Any living thing composed of one or more cells.
osmoregulation Control of the concentration of body fluids so that they do not become too dilute or too concentrated; control of the amount of water in an organism.
osmosis Diffusion of water molecules across a semipermeable membrane, from an area of high concentration of water molecules to an area of low concentration of water molecules.
osteoblast Bone-producing cell.
osteoclast Bone-digesting cell
osteocyte Mature bone cell; an osteoblast that has become embedded within the bone matrix.
osteoporosis 'Porous bones'; the bones become fragile as they lose calcium; problem in women especially.
ovary (1) In animals, the organ that produces eggs and sex hormones; (2) In flowering plants, the swollen base of the carpel that contains ovules; it develops into a fruit after fertilisation.
oviduct (Fallopian tube) Tube through which eggs travel from an ovary to the uterus; fertilisation takes place here.
ovulation Release of an egg from an ovary, midway through a menstrual cycle.
ovule Part inside the ovary (of a flower) that, after fertilisation, develops into the seed.
ovum (pl. ova) Egg; a mature female gamete.
oxygen debt The oxygen needed to metabolise (remove) the lactic acid produced during strenuous exercise.
oxyhaemoglobin Haemoglobin that has combined with oxygen.
oxytocin Hormone that stimulates contraction of the pregnant uterus (causing birth) and the ducts of mammary glands to release milk; released by the pituitary gland.
ozone Blue gas, O_3, a relative of oxygen; found in the upper atmosphere, the ozone layer absorbs most of the harmful UV radiation coming from the sun, so protecting the DNA of organisms from damage.
ozone depletion The thinning of the ozone layer in the stratosphere.

P

P_1 x P_2 (parental generation) Members of two different true breeding lines that are crossed to produce the F_1 generation.
pacemaker Specialised cardiac muscle where each heartbeat begins; found in the wall of the right atrium; also called the sinoatrial (SA) node.
paleoanthropology Study of human evolution.
pancreas Gland located under the stomach; produces pancreatic juice (digestive enzymes) and secretes hormones (insulin and glucagon); it is an exocrine and an endocrine gland.
parasite Organism that feeds on or in another living organism and does it harm.
parasitism Symbiotic relationship in which one member (the parasite) benefits and the other (the host) is adversely affected. Compare with commensalism and mutualism.
parathyroid glands Small, pea-sized glands sitting on top of the thyroid gland; regulate Ca and P levels.
Parkinson's disease Slow progressive disabling condition, marked by tremor and increasing stiffness of muscles; results from degeneration of nerve cells at the base of the brain.
passive immunity Temporary immunity provided by getting ready-made antibodies from another organism.
passive transport Diffusion of a solute through a cell membrane, down its concentration gradient – it does not require energy.
patella Knee cap
pathogen Organism, usually a microorganism, capable of producing disease.
PCR Polymerase chain reaction; method of producing millions of copies of a tiny DNA fragment.
pectoral girdle The two shoulder blades (and collar bones).

pelvic girdle The hip bones, fused to the base of the spine (sacrum), so that force is transmitted to the spine, which is the central support of the whole body.
penis Male sexual organ of copulation (intercourse) in mammals.
pepsin Enzyme produced in the stomach that digests proteins into shorter lengths (peptides).
peptide bond Carbon-to-nitrogen bond that links amino acids together in peptides and proteins.
peptide Compound consisting of a chain of amino acids; a polypeptide is a longer chain.
percentage cover Amount of ground area that a plant is covering.
perennation Ability of a plant to survive winter, as an underground food store.
perennial Flowering plant that lives for more than two growing seasons.
period menstruation; monthly loss of the endometrium (womb lining).
peripheral nervous system (**PNS**) Nerves and receptors that lie outside the CNS (spinal cord and brain).
peristalsis Waves of contraction and relaxation of muscles in the wall of the oesophagus and digestive system.
pesticides Chemicals used to kill insects and microorganisms that cause disease.
petal Coloured part of a flower; advertising to attract animals to assist in pollination.
petiole Part of a leaf that attaches it to a stem.
pH Measure of the hydrogen ion concentration of a solution. Neutral is 7; acidic is less than 7, and basic is greater than 7.
phage Bacteriophage; a virus that attacks bacteria.
phagocyte White blood cell that 'eats' foreign cells – just like amoeba eats its food, e.g. monocytes.
phagocytosis Engulfing (taking in) of food particles or foreign cells by means of pseudopod formation.
phalanges 2 or 3 bones articulating in a row, as in our fingers and toes.
pharming The use of transgenic farm animals to produce pharmaceuticals.
pharynx Throat region.
phenotype Physical expression of a gene; arises from the interactions between genes and the environment.
phloem Food-transporting tissue in vascular plants; made of sieve tube elements and companion cells.
phospholipid Main structural material of cellular membranes.
phosphorylation Generation of ATP, from light or respiration; stores energy as chemical bonds.
photophosphorylation Production of ATP in photosynthesis, using light energy.
photosynthesis Manufacture of sugar in a plant, using sunlight energy.
photosynthesis equation

$$6H_2O + 6CO_2 \xrightarrow[\text{chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6O_2$$

phototropism Change in the direction and rate of plant growth in response to a light from one direction.
phytoplankton Community of microscopic green plants in water, that are the base of most aquatic food webs.
pilus (pl. pili) Hair-like structure on the surface of many bacteria. Functions in attachment to surfaces.
pitfall trap Jar sunk into the ground, with its rim level with the soil; insects fall in and can't climb out.
pituitary gland Endocrine gland located below the hypothalamus; 'the master gland', it secretes several hormones that control other glands and influence a wide range of metabolic processes.
placenta Organ through which materials are exchanged between child and mother in the uterus; formed from tissues of the embryo and womb lining; later on called the 'afterbirth'.
plankton Free-floating, mainly microscopic organisms, living in freshwater and saltwater habitats.
plant Organism which contains chlorophyll, can photosynthesise and has well-developed roots and shoots.
Plantae Kingdom of plants.
plantlet Small, immature plant (in tissue culture or on leaf edges).
plasma cell Specialised B lymphocyte; produces antibodies.
plasma Liquid part of blood. Composed of water and dissolved substances; transports cells and nutrients.
plasmid Small, circular molecule of extra DNA in many bacteria, that carries only a few genes.
plasmolysis Shrinkage of the cytoplasm of a plant cell, due to loss of water by osmosis.
platelet Blood cell that releases chemicals necessary for clot formation.
pleural membrane Lines the chest cavity and surrounds each lung, reducing friction during breathing.
plumule Part of a seed's embryo that will develop into the shoot.
polar nuclei Two haploid nuclei in the embryo sac of flowering plants, that will unite with a sperm nucleus from a pollen grain, to produce the triploid (3n) endosperm or food store.
pollen grain Two-celled structure, made in the anther and carried to the stigma of a carpel, where it germinates, producing a pollen tube and 2 male gametes (sperm) for fertilisation.
pollen tube Forms when a pollen grain germinates; grows through carpel tissues; carries sperm to the ovule.
pollination Transfer of pollen grains from the anther to the stigma of a carpel.
pollination, cross Where pollen reaches the stigma of a flower on a different plant (of the same species).
pollination, self Where pollen is transferred to a stigma of the same flower, or another flower on the same plant.
pollutants Substances that build up to levels that have harmful effects on our health, activities or survival.
pollution Contamination of an environment, especially with man-made wastes.
polymer Large molecule built up from repeating subunits of the same type (monomers), e.g. protein.
polymerase chain reaction *See* PCR.
polypeptide chain Compound consisting of many amino acids linked by peptide bonds, e.g. proteins.
polysaccharide Chain of many sugar units linked together, e.g. starch, glycogen, cellulose.
pondweed *(Elodea canadensis)* Water plant used in photosynthesis experiments; releases oxygen bubbles.
pooter Jar with two tubes; used to suck up and collect small animals.
population Individuals of the same species occupying the same area at the same time.
population density Number of individuals of a species per m^2 or km^2 of area.

population dynamics The study of changes that occur in a population and the factors that cause these changes.
population ecology Branch of biology that deals with the numbers of a particular species that are found in an area and how and why those numbers change (or remain fixed) over time.
portal system Part of the circulatory system that begins and ends in capillaries, e.g. the hepatic portal vein.
posterior Toward the tail-end of an animal. Compare with anterior.
postsynaptic neuron Transmits an impulse away from a synapse.
predation Relationship in which one organism (the predator) kills and eats another organism (the prey).
predator Animal that feeds on other living organisms (its prey), but does not live in or on them.
predator-prey cycles Manner in which both predator and prey numbers keep each other in check.
prediction Statement about what you can expect to find in nature if a theory or hypothesis is true.
presynaptic neuron Transmits an impulse to a synapse.
prey Animal that a predator hunts and eats.
primary consumer Herbivore; a consumer that eats producers.
primary growth An increase in the length of a plant that occurs at the tips of the shoots and roots.
primary response The response of the immune system to first exposure to an invader (antigen).
prion Infectious agent that consists only of protein; linked to diseases such as BSE and vCJD.
producer Organism that uses light (or chemical) energy to make its own food from simple chemicals in its environment.
product Substance formed by a chemical reaction, e.g. enzymes act on substrates and form products.
profile transect Graph which shows how the ground level rises or falls in an ecosystem.
progesterone Hormone secreted by the corpus luteum and placenta; prepares the womb for pregnancy.
prokaryote Single-celled organism, that does not have a nucleus or other organelles, e.g. a bacterium.
prophase First stage of mitosis; the chromosomes condense and become visible as distinct structures, the nuclear membrane breaks down, and spindle fibres form.
prostate gland Produces seminal fluid to nourish sperm; lies beneath the bladder in males.
protein Large, complex organic compound composed of amino acids linked together (polypeptide).
protein test Food test; add protein, potassium hydroxide and copper sulfate solutions —> purple colour.
Protista (Protoctista) Diverse group of eukaryotes, mainly single-celled or simple multicellular; mostly aquatic; includes protozoa (amoeba), algae (seaweeds).
pseudopodium (pl. pseudopodia) Temporary extension of an amoeba, used for feeding and movement.
pulmonary circulation Blood vessels leading to and from the lungs. Compare with systemic circulation.
pulse Alternate expansion and recoil of an artery, due to the pumping effect of the heart.
Punnett square Grid structure that shows the occurrence of all possible offspring of a genetic cross.
purine Nucleotide base with a double ring structure, e.g. adenine and guanine.
pyramid of energy Ecological pyramid that shows the energy flow through each trophic level of an ecosystem.
pyramid of numbers A bar diagram indicating the relative numbers of organisms at each successive trophic level in a food chain.
pyrimidine Nucleotide base with a single ring structure, e.g. cytosine, thymine and uracil.
pyruvate (pyruvic acid) 3-carbon organic acid; glycolysis splits glucose into two pyruvate molecules.

Q

quadrat Square frame of metal or wood (1 m x 1 m), used to mark off an area in ecology for study.
qualitative data Observations without measurements; listing the type of plants and animals in ecological fieldwork.
quantitative data Observations based on measurement; Counting or estimating the number of plants and animals in ecological fieldwork.

R

radicle Part of a seed's embryo that will develop into the root.
reabsorption Taking back of substances previously released from the body, e.g. food, from the filtrate, in the nephron; water, from enzyme solutions, in the large intestine.
receptacle Top end of a flower stalk where the flower parts are attached.
receptor Specialised cell (or nerve ending) that can detect a stimulus, e.g. light, sound, etc.
recessive allele Only produces its phenotype when present twice; it is not expressed in the heterozygote.
recombinant DNA technology Ways in which DNA (genes) from different organisms are combined together, and the new recombinant molecules increased in quantity.
recycling Movement and re-use of elements (atoms) between the biotic and abiotic parts of an ecosystem.
red blood cell (RBC) Round, doughnut-like cell that contains haemoglobin and transports oxygen.
reflex action Involuntary, automatic response to a stimulus; not under conscious control by the brain.
reflex pathway Receptor —> sensory neuron —> interneuron —> motor neuron —> muscle or gland —> action.
renal Relating to the kidney.
replication Making of an exact copy of a DNA molecule.
report Written account of an experiment; four headings – aim, method, results, conclusions.
reproduction Making of more individuals of the same species – asexual and sexual.
resolution (resolving power) Ability of a microscope to show fine detail; the minimum distance between two points at which they can be seen as separate images.
resources Food, energy and materials that organisms need to survive in a habitat.
respiration (1) Cellular respiration is the breaking down of food (sugar, fat) to release chemical energy for metabolism. (2) External respiration refers to gas exchange through the lungs.
respiration, equation : $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
responsiveness How an organism detects what is happening around it and takes action to allow it survive.
restriction enzyme Produced by bacteria to break down foreign DNA; splits DNA at specific base sequences; used in recombinant DNA technology (genetic engineering).

results Record of what happened in an experiment; include observations, measurements and graphs.
retina Innermost layer of the eye, which contains the light-sensitive rod and cone cells.
reverse transcriptase Enzyme in viruses that uses viral RNA as a template to make DNA in a host cell.
Rhesus factor The D-antigen on red blood cells, first identified in *Rhesus* monkeys. People with the antigen are called Rhesus positive (Rh^+), those lacking it are Rhesus negative (Rh^-).
rhizoid Root-like absorptive structure of some fungi and non-vascular plants (algae, mosses).
rhizome Horizontal underground stem; method of vegetative reproduction and perennation.
rhodopsin Light-sensitive pigment in the rod cells of the retina; made with vitamin A.
ribonucleic acid *See* RNA
ribosomal RNA (rRNA) Combined with proteins to form ribosomes (on which proteins are assembled).
ribosome Structure in all cells, at which amino acids are linked together to form proteins.
rickets Dietary deficiency disease, due to lack of Vitamin D; symptoms – soft bones, leading to bow-legs.
RNA (Ribonucleic acid) Family of single-stranded nucleic acids that function mainly in protein synthesis.
rod Light receptor cell in the retina of the eye; sensitive to very dim light (our black and white vision).
root cap Covering of cells over the root tip that protects the delicate growing tissue directly behind it.
root hair Extension, or outgrowth, of a root epidermal cell; increase the surface area for absorption.
root Plant part that absorbs water and nutrients, helps anchor the plant, and often stores food.
root pressure Pressure in root xylem due to water moving from the soil into the roots by osmosis.
roughage (fibre) Plant cell walls, which are made of cellulose; helps peristalsis in the digestive system.

S

salinity Concentration of dissolved salts (e.g. sodium chloride) in a body of water, especially the sea.
salivary glands Produce saliva and release it into the mouth – for digestion and taste.
salt Ionic compound, most commonly sodium chloride (NaCl).
salt marsh Wetland dominated by grasses in which the salinity fluctuates between that of sea water and fresh water; usually located in estuaries.
sandy soil Large particle size, large air spaces, good aeration and drainage; low mineral content – easily washed downwards (leached) away from roots; light and easy to dig.
saprophyte Heterotroph (consumer) that feeds on dead organic matter and so causes its decay, e.g. fungi.
saturated fat Animal fat and butter; tends to raise the level of cholesterol in the blood, with increase risk of heart attack or stroke.
scapula Shoulder blade
Schwann cell Wraps itself around an axon of a neuron and forms a myelin sheath (for insulation).
scientific method Ordered and logical approach to a problem, involving a series of steps – observation, hypothesis, prediction, experiment, result, conclusion.
scramble competition All the individuals in a population 'share' the limited resource, so that each tries to acquire as much of the resource as possible.
scrotum External sac of skin in males that contains the testes.
scurvy Dietary deficiency disease, due to lack of Vitamin C; symptoms – bleeding from gums, teeth loosen.
secondary consumer Carnivore; an organism that eats primary consumers (herbivores).
secondary response Rapid production of antibodies induced by a second exposure to an antigen; more rapid and prolonged than the first owing to the swift participation of memory cells (type of white blood cell).
secondary sexual trait Associated with maleness or femaleness but with no direct role in reproduction, e.g. hair in males, breasts in females.
secretion Production and release of a chemical from a gland or cell.
seed Mature ovule in conifers and flowering plants; an embryo, together with its food store.
Segregation, Law of Mendel's 1st law states that when gametes form, the two alleles of a gene separate, one going into each gamete.
selectively permeable Semipermeable; membrane that allows some substances to cross it while stopping others.
self-pollination Where pollen is transferred to a stigma of the same flower, or another flower on the same plant.
semen Sperm plus seminal fluid; released from the penis during intercourse.
semicircular canals Fluid-filled tubes in the inner ear that control our sense of balance (equilibrium).
semilunar valves Lie between the ventricles of the heart and the arteries that carry blood away from them.
seminal vesicles Glandular sacs that secrete seminal fluid.
semipermeable Membrane that allows small particles through it but blocks larger ones; selectively permeable.
sensory neuron Carries an impulse from a receptor to the CNS (brain and spinal cord).
sepals Outermost parts of a flower, usually leaf-like in appearance; protect the flower as a bud.
septum Cross-wall or partition, e.g. the middle wall of the heart.
sex chromosome One of two types of chromosome (X or Y), the combinations of which control gender.
sex linkage Refers to the carrying of certain genes on the sex chromosomes; the connection between gender and certain non-sexual traits.
sex-linked trait Controlled by a gene carried on an X-chromosome; also called X-linked.
sexual reproduction Production of offspring by way of meiosis, gamete formation and fertilisation.
shoot system The above-ground part of a plant (the stem, leaves and flowers).
sieve tube elements Phloem cells that transport sugar in flowering plants; join end to end to form phloem tissue.
sinoatrial (SA) node Pacemaker
sister chromatid One of two identical, copied chromosomes that are attached at their centromere region until separated at mitosis or meiosis; each ends up as a chromosome in a different daughter nucleus.
skeletal muscle Voluntary (striped) muscle, that causes movement of the bones; under conscious control.

small intestine The 15 m, thin part of the digestive tract; where digestion is completed and nutrients are absorbed.
smallpox Serious virus disease that causes fever and skin rash, and was often fatal in previous centuries.
smog Polluted, grey-coloured air; smoke+fog; occurs in industrialised cities with cold, wet winters.
smooth muscle Involuntary muscle (not under conscious control); found mainly in sheets surrounding hollow organs, such as the intestine and blood vessels.
soil erosion Wearing away or removal of soil from the land; occurs naturally from rain and runoff.
soil Mixture of mineral particles and decomposing organic material, along with air and water in the spaces.
solute Substance that dissolves in a solvent, forming a solution.
solution Mixture of a solid dissolved in a liquid.
solvent Substance capable of dissolving other substances, e.g. water, alcohol.
species Group of organisms that can interbreed and produce fertile offspring; they have similar structural and functional characteristics.
sperm Mature male gamete.
sphincter muscle Circular muscle which contracts to close an opening, e.g. pyloric sphincter at the exit of the stomach (with the small intestine).
spinal cord Collection of nerves running through the vertebrae of the spine and protected by them.
spindle fibres Thin protein strands that move the chromosomes to the poles during cell division.
spleen Abdominal organ located just below the diaphragm; a large lymph gland; filters the blood.
sporangium (pl. sporangia) Case containing spores (asexual reproductive cells); found in plants and fungi.
spore Asexual reproductive cell.
stamen Male part of flower; consists of a filament and anther (which produces pollen).
starch Polysaccharide composed of many glucose subunits; a store of energy in plants.
starch test Food test: starch + iodine —-> blue-black colour
stationary phase Stage in the growth of a population when its numbers remain at a particular level.
stem cell Animal cell that remains unspecialised, but produces cells that develop into different tissues.
sterile Free from any microorganism.
sterilisation (1) Procedure to prevent a person having children – vasectomy (males) and tubal ligation (females). (2) Killing microorganisms by using heat, radiation or chemicals.
sterility The lack of sufficient sperm in seminal fluid to bring about fertilisation.
stigma Sticky or hairy surface tissue at the top of the carpel, where pollen grains land during pollination.
stimulus Any change in the environment of an organism, e.g. light that stimulates a sensory receptor.
stolon (1) Above-ground, horizontal stem with buds that develop into separate plants. (2) Horizontal hypha in *Rhizopus* that spreads the colony across the substrate.
stoma (pl. stomata) Gap between two guard cells in the epidermis of stems and leaves; allows gas exchange.
stomach Muscular bag that stores and mixes food, and digests proteins; produces gastric juice.
stroma Fluid region of the chloroplast; site of the dark reactions of photosynthesis.
style Neck of a carpel, connecting the stigma to the ovary in flowers.
substrate (1) Substance on which an enzyme acts; (2) medium (food) on which microorganisms feed.
sugar, reducing (test) Food test: sugar + Fehling's solution (+heat) —-> Brick-red colour.
sulfur dioxide Gas released when fossil fuels are burned; dissolves in rain to form strong acid.
suppressor cell T lymphocyte that slows down and turns off the immune response.
surface tension Attraction that the molecules at the surface of a liquid have for each other.
survival phase Stage in bacterial growth cycle when they form an endospore, which can resist unfavourable conditions.
sustainable development Meets the needs of the present generation and allows future ones do the same.
symbiosis Close relationship between two organisms of different species in which at least one of them benefits. See commensalism, mutualism, and parasitism.
synapse The region where two neurons (or a neuron and a muscle/gland) come into close proximity.
synaptic cleft The gap between the two neurons.
synaptic knobs Ends of axon terminals; they secrete neurotransmitters to bridge the synapse.
systemic circulation Flow of oxygen-rich blood from the heart to the rest of the body and back again.
systole Part of the cardiac cycle when the heart is contracting. Compare with diastole.

T

taproot system One main root with smaller roots branching off it. Compare with fibrous root system.
target tissue A tissue that is affected by a hormone.
tarsals Ankle bones (7)
taxonomy Science of naming, describing, and classifying organisms.
telophase Final stage of mitosis, when chromosomes arrive at the poles and two daughter nuclei form.
tendon Connective tissue that joins a muscle to a bone.
tendril Leaf or stem that is modified for holding or attaching onto objects.
test cross Genetic cross that may reveal whether an individual is homozygous dominant or heterozygous.
testis Male reproductive organ in which sperm and testosterone are produced; situated in the scrotum.
testosterone Principal male sex hormone; produced by the testes; stimulates sperm production and is responsible for primary and secondary sex characteristics in the male.
theory Widely accepted idea, supported by a large body of observations and experiments.
thigmotropism Plant growth in response to contact with a solid object, e.g. a vine curling around a support.
thylakoid disc Interconnected system of flattened, sac-like membranes inside the chloroplast; they contain chlorophyll and the electron transport chain; a collection of discs = a granum.
thymine Pyrimidine base found in DNA; forms a complementary base pair with adenine.

thymus gland Endocrine gland that functions as part of the lymphatic system; important in our ability to make immune responses; T lymphocytes multiply, differentiate and mature in its tissues.
thyroid gland Endocrine gland, in front of the trachea; releases thyroxine to regulate the rate of metabolism.
thyroxine Hormone of the thyroid gland; controls overall metabolic rate, growth and development.
tissue culture Taking of cells from an organism and growing them on a nutrient medium (food) under sterile conditions, in order to study their development and differentiation and how to influence it.
tissue fluid Bathes the tissues of the body, allowing exchange of materials between the blood and cells.
tissue Group of closely associated, similar cells that work together to carry out a specific function.
T lymphocyte White blood cell that matures in the thymus and produces chemicals to fight infected cells.
topography Physical features of a region – altitude, slope, aspect.
toxin Poison; metabolic product of one species that can harm or kill individuals of a different species.
trace element Element required by an organism, but in very small amounts.
trachea The windpipe.
tracheid Type of xylem cell, with holes in its end and side walls to allow movement of water.
transcription Process of transferring the DNA code into a new form (mRNA).
transect Strip of habitat under study; observe changes in biotic and abiotic factors along the strip.
transfer RNA (tRNA) RNA molecules that bind to specific amino acids and serve as carrier molecules in protein synthesis. The tRNA anticodons bind to complementary mRNA codons.
transgenic organism Plant or animal that has incorporated foreign DNA into its chromosomes.
translation The process of assembling proteins at the ribosomes. Stage of protein synthesis when the sequence of information in mRNA becomes converted to a sequence of particular amino acids, so producing a polypeptide chain (protein).
translocation Transport of sucrose (sugar) and other nutrients through the phloem tissue of a plant.
translucent spot Clear spot on paper in food test for fat; light passes through but you cannot see through it.
transmission Conduction of a nerve impulse along a neuron or from one neuron to another.
transpiration Loss of water vapour by evaporation from the leaves and stem of a plant.
triplet code Sequences of three nucleotides (codons) in mRNA that specify the order of amino acids in a polypeptide chain.
trophic level Step in a food chain at which an organism obtains its food; producers belong to the first trophic level, herbivores to the second trophic level, and so on.
tropism Growth response of plants to a stimulus coming from one direction.
true breeding Where the offspring of each generation are just like the parents in the traits being studied; all are homozygous for the traits.
tuber Swollen underground stem or root, adapted for food storage, e.g. potato.
tumour Mass of tissue that grows in an uncontrolled manner and at an abnormally high rate.
turgid Describes a plant cell in which the cell wall is rigid, due to the cytoplasm pushing out against it as it fills with water.
turgor State of a plant cell in which the cell wall is rigid, due to the cytoplasm pushing out against it as it fills with water by osmosis.
turgor pressure Internal fluid pressure applied to a cell wall when water moves into the cell by osmosis; this rigidity of the cell gives support, to herbaceous (non-woody) plants. *See* plasmolysis and wilting.

U

ultrastructure Fine detail of a cell, generally only visible using an electron microscope.
uracil Nitrogenous pyrimidine base found in RNA; like thymine, it can base-pair with adenine.
urban environment Habitats around or in towns and cities.
urea Principal nitrogenous excretory product of mammals; produced in the liver from excess amino acids, and excreted by the kidneys.
ureter Tube that carries urine from the kidney to the bladder.
urethra Tube that carries urine from the bladder to the outside of the body.
urinary system Consists of kidneys, bladder, and associated ducts; adjusts the composition of blood.
urine Fluid formed in kidneys; consists of wastes (e.g. urea), excess water, and solutes.
uterus The womb; hollow, muscular organ in which the child develops during pregnancy.

V

vaccine Weakened or killed antigen of a particular disease that stimulates the body to make antibodies.
vacuole Fluid-filled organelle in plant cells (mainly), that stores amino acids, sugars, ions and toxic wastes.
vagina Elastic, muscular tube; receives sperm during sexual intercourse and serves as the birth canal.
variable Condition in an experiment that changes over time.
variable, dependent Effect or outcome you are measuring in an experiment, e.g. no. bubbles per minute.
variable, independent Condition that is changed systematically in an experiment, e.g. distance of plant from light.
variation Changes in the genotype (or phenotype) of an organism; arise through mutations, sexual reproduction and meiosis.
vas deferens Sperm duct that connects the epididymis of the testes to the urethra (of the penis).
vascular bundle Collections of transport tubes (xylem and phloem) in the stems of plants.
vascular plant Has xylem and phloem, and well-developed roots, stems, and leaves.
vasoconstriction Narrowing of the diameter of blood vessels.
vasodilation Expansion of the diameter of blood vessels.
vector (1) Agent that transfers genes from one organism to another, e.g. virus, bacterial plasmid; (2) Agent that transfers a parasite from one host to another, e.g. flea, mosquito.
vegetative propagation Asexual reproduction in plants, using part of the parent plant to produce a new individual.

vein (1) Blood vessel that carries blood from tissues back to the heart; (2) Strand of vascular tissue in a leaf.
ventral Front surface; toward the lowermost surface or belly of an animal. Compare with dorsal.
ventricle Bottom chamber of the heart from which blood is pumped; receives blood from an atrium.
venule Small blood vessel that receives blood from capillaries and delivers it to a vein.
vertebra (pl. vertebrae) Individual bones of the spine (vertebral column).
vertebrate Animal with a backbone, e.g. fishes, amphibians, reptiles, birds and mammals.
vesicle Small round membrane-bound compartment within the cytoplasm.
vessel element Xylem cell in plants; has no cytoplasm or nucleus or end walls (and so forms a long hollow tube which can transport water); has walls reinforced with lignin; wood = many of these cells.
vestigial Evolutionary remnant of a formerly functional structure, e.g. our appendix.
villus (pl. villi) Small finger-like projection from the surface of a membrane, e.g. villi of the small intestine; increase the surface area for absorption of food.
virulent Able to cause disease in a host.
virus Non-living, infectious agent that consists of nucleic acid (DNA or RNA) enclosed in a protein coat; it can only replicate in a host cell.
visking tubing Cellophane material that is selectively permeable, like a cell membrane.
vitamins Organic compounds required in relatively small amounts for normal biochemical functioning.
vocal cord Thickened, muscular fold of the larynx that helps produce sound waves for speech.

W

waste disposal Removing the waste we produce in our homes and industries.
weathering Chemical or physical process that helps form soil from rock.
white blood cell Defends the body against attacks by pathogens, e.g. lymphocytes and monocytes.
white matter Neurons (axons) covered in white, fatty myelin sheaths; found in the CNS; specialise in rapid transmission of impulses. *See* grey matter.

X

X chromosome One of the two sex chromosomes; XX = female, XY = male.
X-linked trait Controlled by a gene carried on a X-chromosome; also called sex-linked.
xylem Vascular tissue that transports water and dissolved minerals in plants.

Y

Y chromosome One of the two sex chromosomes; has genes that control maleness; is smaller than the X chromosome and is missing some of its gene loci, e.g. for blood clotting, colour vision.
yeast Unicellular fungus; reproduces asexually by budding; used in brewing and bread making.
yellow marrow Fatty tissue in the cavities of mature bones.

Z

zero population growth Point at which the birth rate equals the death rate.
zooplankton Non-photosynthetic organisms present in plankton. Compare with phytoplankton.
zygote Fertilised egg; diploid cell; formed by the fusion of a sperm with an egg in sexual reproduction.

index

* = Higher Level
Bold = Mandatory Activity