

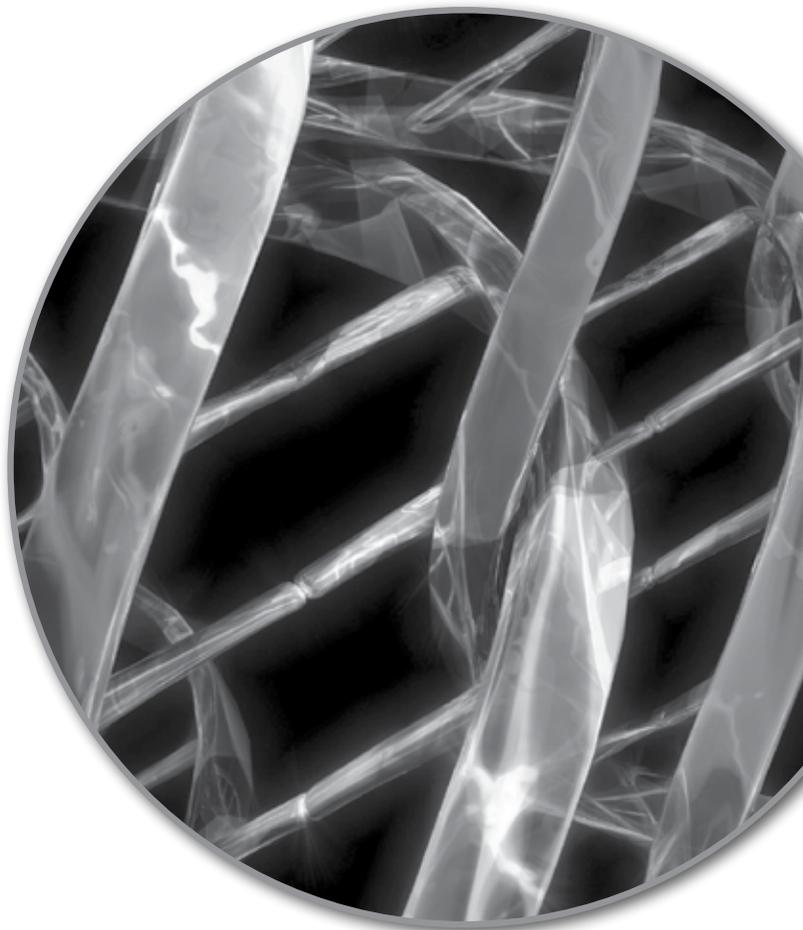
Fundamental **Biology**

for **0 Level**

Teaching Guide

Ron Pickering
Masooda Sultan

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Contents

Introduction 1

Demonstrations

Introduction to cell types..... 2

Osmosis 2

Effect of temperature on enzyme activity 3

Chlorophyll in leaves..... 4

A model of the stoma 4

Surface area and digestion 5

Respiration and transpiration in plants 6

Measuring water loss due to transpiration..... 6

Effect of stress on heart rate 7

Dealing with infection 7

Kidney dialysis 8

Homeostasis 9

The eye..... 9

How antagonistic muscles work 10

Causes of drug addiction 11

CT scan and the lungs..... 11

Cell division through mitosis 12

Parts of a flower 12

A model for genetics 13

Evolution 14

Investigations

Investigating the effect of temperature and pH on enzyme activity 15

Investigating the effect of light intensity on the rate of photosynthesis 16

Investigating the effect of light colour on photosynthesis 18

Investigating the absorption of light by chlorophyll 19

Investigating oxygen production during photosynthesis 20

Investigating plant growth and soil acidity 21

Investigating mineral ions and plant growth .. 22

Investigating the location of phloem in the stem 24

Investigating the effect of physical activity on pulse rate 25

Investigating respiration and heat energy 26

Investigating oxygen consumption during respiration 27

Investigating fitness and lung volume 28

Investigating the effect of temperature on the rate of respiration 30

Investigating the stimulant effect of drugs 31

Investigating keeping cheese fresh without a refrigerator 33

Investigating yogurt production..... 34

Investigating food chains and food webs 35

Investigating the presence of nitrogen-fixing bacteria 36

Investigating air pollution 37

Investigating water pollution 38

Investigating cloning in plants 39

Investigating the conditions necessary for germination 40

Investigating germination with growth curves 41

Investigating continuous and discontinuous variation in human beings 43

Investigating monohybrid crossing in pea plants 44

Practical exercises

Microscopes and how to use them 46

Making microscope slides 48

Looking at cells 49

Measuring cells 50

Osmosis 51

Factors affecting the activity of catalase 52

Chlorophyll and photosynthesis 53

Light, carbon dioxide, and photosynthesis 54

Food tests 55

The role of enzymes in digestion 57

Transpiration in leaves 58

Rate of transpiration 59

Transport tissue in plants 60

Pulse and breathing rates 61

Measuring the energy values of foods 62

Demonstrating respiration 63

Anaerobic respiration 64

Skin and sensitivity 65

Heat loss from a model body..... 66

The function of perspiration 67

Measuring the speed of reflexes 68

Preserving food 69

Decomposition of cellulose by bacteria 70

The effects of soap and pH on bacteria 71

Evolution by natural selection 72



Alternative-to-Practical exercises

Cell structure and organization	73
Plant nutrition.....	76
Animal nutrition	81
Transport in humans	86
Respiration	90
Coordination and response	95
Micro-organisms and biotechnology	100
Development of organisms and continuity of life I	105
Development of organisms and continuity of life II	109
Inheritance	113

Worksheets

Osmosis in potato tissue	118
Enzymes and industry	120
Food, feeding, and health	122
Daily energy requirement.....	125
The action of lipase	126
Transport in plants	128
The beating heart	129
Heart and heart disease	132
Using a spirometer	134
Excretion and homeostasis	136
Keep it cool!	137
Coordination	138
An alcohol problem	139
Tobacco smoke and lung cancer	140
Micro-organisms in biotechnology	142
Growing plants as food for humans	143
Construction of a food web	146
Natural insecticides	148
Reproduction and growth in plants	151
Inheritance I	152
Inheritance II	156
DNA control of protein synthesis	157
Human chromosomes, twins, and triplets ...	159
Animals and plants in biotechnology	162
Animals in medical research—What do you think?.....	164

Assessments

Cell structure.....	169
Observing plant cells in solution	171
Enzymes	173
Investigating photosynthesis in leaves I	176
Investigating photosynthesis in leaves II	179
Nutrition	181
Testing for glucose	183
Transport in plants and animals	186
The circulatory system.....	188
Respiration	190
Excretion	192
Homeostasis	194
Nervous system and hormonal coordination	196
Receptors and senses.....	198
Smoking	200
Bacteria and other micro-organisms	203
Feeding relationships	205
Malaria	207
Recycling of energy, carbon, and nitrogen ...	209
Human impact on the environment	211
Water pollution	213
Asexual reproduction.....	215
Seed growth and germination	217
Human reproduction	219
Variation and inheritance	221

Answers to worksheets 223

Answers to assessments 227

Introduction to Fundamental Biology for O Level Teaching Guide

This Teaching Guide has been written for teachers preparing students for the O Level Biology exam and complements the material presented in the student's book, *Fundamental Biology for Cambridge O Level*.

This Guide contains a number of resources which will enable the teacher to deliver the course more easily and effectively:

Suggested demonstrations The demonstrations suggested in this Guide can be carried out by teachers before explaining a topic. These 20 demonstrations involve presenting material and conducting classroom activities to stimulate students' interest in a new topic. Clear instructions have been provided to guide teachers in conducting the demonstrations effectively.

Suggested investigations The investigations suggested in this Guide can be assigned to students after a certain topic has been discussed in class. These 25 investigations would help students to conduct research and design investigations independently outside the classroom to explore the topics covered in class. The instructions in the Guide offer sufficient flexibility to enable students to devise their own strategy, without prescribing a particular method.

Suggested practical exercises This series of exercises provides guidance for practical work which might be used to support the content in the student's book. Each of the 25 exercises includes a list of materials and apparatus to be used, and step-by-step instructions on the collection of valid data. Materials and apparatus are chosen to be simple and readily available in most centres delivering this subject. Exercises are quantitative wherever possible, and each of them includes appropriate assessment opportunities.

Alternative-to-practical exercises Alternative-to-practical exercises have been included in this Guide to provide practice to students appearing for the ATP exam. Effort has been taken to develop a questioning strategy and style that would enable students to prepare themselves for the final examinations. These 10 exercises cover most of the important topics from the curriculum and can be administered to students at the end of the relevant topics from the student's book rather than towards the end of the course.

Worksheets The worksheets included in this Guide have been developed to facilitate the teacher in providing reinforcement material to students after a topic has been covered in class. All of the 25 worksheets may be assigned either to be completed in class or as homework.

Assessment sheets The 25 assessment sheets provided in this Guide can be used to test students' comprehension after a topic has been completed in class. The assessment questions have been designed to enable students to grasp the questioning style they are likely to come across in their examinations.

Introduction to cell types

This demonstration might be conducted in the classroom to support discussion on cell size and shape.

Aim

To demonstrate that living things are composed of cells and that cells exist in many shapes and sizes

Equipment

- 9 sheets of paper divided into 3 sets with each set containing bark rubbings from three different trees
- overhead projector (OHP) or slide projector
- Transparencies of diagrams of nerve cells, root hair cells, red blood cells, white blood cells, and xylem cells. If a slide projector is to be used, projector slides of the above cells could be used alternatively.

Method of preparing bark rubbings

(To be carried out by the teacher before the class)

- 1 Select three different trees.
- 2 Pin three sheets of paper on the trunk of each tree.
- 3 Rub a brown or green crayon lightly over the paper. Bark rubbings will be produced on the paper with cells of different shapes and sizes outlined depending on the type of tree.

Method of class demonstration

- 1 Divide the class into 3 groups.
- 2 Distribute one set of bark rubbings, consisting of one from each type of tree, to each group.
- 3 Ask each group to compare the shape and size of the cells.
- 4 Take the students to an audio-visual room or draw the curtains over the windows in the classroom. Display the transparencies/slides on a screen using the OHP/slide projector.
- 5 Again ask the students to compare the shape and size of the various cells.

Explanation

Explain that the variations in cell size, shape, and structure are adaptations for performing specialized functions in a given environment or habitat.

Osmosis

This demonstration might be conducted in the classroom to support discussion on osmosis.

Aim

To demonstrate that osmosis involves the movement of water molecules from a region of higher concentration to a region of lower concentration across a semi-permeable membrane.

Equipment

- salted potato crisps or any other salted snacks
- cucumber slices or any other fresh vegetables

Method

- 1 Ask a few students to eat a handful of the salted snacks.
- 2 Ask another group to eat the cucumber slices.
- 3 Ask the students in the two groups whether they feel thirsty. More students who ate the salted snacks will feel thirsty compared with the students who ate cucumber slices.

Explanation

Explain that because the salted snacks have a higher concentration of salt and a lower concentration of water than the cells of the mouth, water moves out of the cells of the mouth. As a result, the mouth becomes dry and the students feel thirsty.

Effect of temperature on enzyme activity

This demonstration might be conducted in the classroom to support discussion on enzyme activity.

Aim

To demonstrate that enzymes become denatured at high temperatures

Equipment

- two test tubes
- 3% hydrogen peroxide solution
- piece of raw potato
- piece of cooked potato

Method

- 1 Fill 1/3 of a test tube with hydrogen peroxide solution.
- 2 Add the piece of raw potato and observe the bubbles given off.
- 3 Fill 1/3 of another test tube with hydrogen peroxide solution.
- 4 Add the piece of cooked potato and ask students to note what they observe.

Explanation

Explain to students that bubbles are given off in the first case because the enzymes in the potato act on the hydrogen peroxide to break it up into oxygen gas and water. Bubbles are not given off in the second case because the high cooking temperature has denatured the enzymes so they cannot act upon the hydrogen peroxide.

Chlorophyll in leaves

This demonstration might be conducted in the classroom to support discussion on the function of chlorophyll during photosynthesis.

Aim

To demonstrate that while chlorophyll is necessary for photosynthesis, several types of chlorophyll are present in leaves

Equipment

- a few spinach leaves
- rubbing alcohol
- glass jar
- filter paper
- bowl
- hot water

Method

- 1 Cut up the spinach leaves into very fine pieces.
- 2 Pour some rubbing alcohol into the glass jar and transfer a small quantity of the leaves into the jar.
- 3 Pour some hot water into the bowl and stand the covered jar in it. Stir the leaves in the alcohol from time to time.
- 4 After about an hour, insert a strip of filter paper into the glass jar so that it dips into the green-coloured liquid.
- 5 As the liquid rises up the filter paper, draw students' attention to the yellow and orange bands that form on the filter paper.

Precaution

Alcohol is flammable.

Explanation

Explain to students that the filter paper acts as a chromatography paper and separates the different types of chlorophyll from the green liquid. Each type of chlorophyll has its own unique properties and absorbs light of different wavelengths.

A model of the stoma

This demonstration might be conducted in the classroom to support discussion on the structure and function of stomata.

Aim

To demonstrate the opening and closing of stomata and the mechanism of guard cells

Equipment

- two empty balloons
- glue
- OHP slides of open and closed stomata

Method

- 1 Place the two empty balloons side by side.
- 2 Apply some glue in the centre of the sides of the balloons that face each other. (Do not stick them together!)
- 3 Inflate the two balloons after the glue has dried.
- 4 Point out to the students that the two balloons inflate except for the region where the glue has been applied because this region has lost its elasticity. The balloons take on a bean-shaped appearance and when placed end-to-end with the glued sides facing each other a space is left in the centre.
- 5 Deflate the balloons. When the balloons are deflated, they lie next to each other leaving no space in the centre.
- 6 Supplement this demonstration by showing OHP slides of open and closed stomata.

Explanation

Explain to students that the inflated balloons represent turgid guard cells that have thickened walls on one side (the areas where glue has been applied) causing a space called a **stoma** to be created. The deflated balloons represent flaccid guard cells resulting in the closing of the stoma.

Surface area and digestion

This demonstration might be conducted in the classroom to support discussion on the importance of surface area in digestion.

Aim

To demonstrate the importance of surface area in digestion

Equipment

- two beakers containing equal volumes of water
- granulated sugar
- sugar cubes
- weighing balance

Method

- 1 Place the two beakers on a table.
- 2 Weigh out equal masses of sugar cubes and granulated sugar.
- 3 Place the sugar cubes in one of the beakers and the granulated sugar in the other.
- 4 Without stirring the water, ask students to observe and note which beaker the sugar dissolves in more rapidly.

Explanation

Explain to students that the granulated sugar has a greater surface area than the sugar cubes. This allows more water molecules and sugar molecules to come into contact and as a result the granulated sugar dissolves more rapidly. During digestion, food particles are broken down to provide a greater surface area for digestive enzymes to act upon.

Respiration and transpiration in plants

This demonstration might be conducted in the classroom to support discussion on respiration and transpiration in plants.

Aim

To demonstrate that water is transpired from the leaves of a plant

Equipment

- a potted plant
- plastic wrap

Method

- 1 Wrap a leaf of the potted plant in plastic wrap and place it near a window.
- 2 Towards the end of the class, ask students to observe the water droplets on the inside of the plastic wrap.

Explanation

Explain to students that the water droplets have formed as a result of condensation of the water vapour given off by the leaf during respiration and transpiration.

Measuring water loss due to transpiration

This demonstration might be conducted in the classroom to support discussion on transpiration in plants.

Aim

To demonstrate how to measure the amount of water transpired using a weighing balance

Equipment

- plant cutting with stem
- tap water
- cooking oil
- weighing balance
- measuring cylinder

Method

- 1 Bring a prepared plant cutting to the classroom. (Make sure it is a leafy one.)
- 2 Fill a measuring cylinder with tap water and place the plant cutting in it. Pour some cooking oil over the water to prevent the water from evaporating.
- 3 Weigh the set-up on the weighing balance and then place it in a sunny area.
- 4 Take readings at regular intervals over the next 2-3 days. Note any changes in the volume of the water and the mass of the set-up.

Explanation

Explain to students that the water in the measuring cylinder has been taken in by the plant, shown by the reduced volume in the cylinder. At the same time, the water taken in by the plant has been lost to the air by transpiration. This results in the reduced mass of the set-up.

Effect of stress on heart rate

This demonstration might be conducted in the classroom to support discussion on the effects of stress on the working of the heart.

Aim

To demonstrate the effect of environmental noise on heart rate

Equipment

- music player
- timer

Method

- 1 Ask students to measure and note their pulse rate or heart rate.
- 2 Play some loud music on the music system for about five minutes and ask students to measure their pulse rate or heart rate.
- 3 Next, play some slow music and ask students to measure their pulse rate or heart rate again.
- 4 Ask students to explain the change in pulse rate or heart rate.

Explanation

Explain to students that heart rate is affected, negatively as well as positively, by environmental factors, e.g. noise. Highlight the importance of developing a healthy environment for maintaining a healthy heart and body.

Dealing with infection

This demonstration might be conducted in the classroom to support discussion on the functions of blood.

Aim

To demonstrate the role of blood components in dealing with infection

Equipment

- overhead projector
- transparencies of lymphocytes, phagocytes, and blood clot formation
- animated computer program on CD showing white blood cells dealing with infections

Method

- 1 In an audio-visual room or a darkened classroom, display the transparencies using an overhead projector and blank wall/whiteboard and describe the stages of blood clot formation.

- Next, describe the structure of phagocytes, B-lymphocytes, and T-lymphocytes using the OHP.
- After a brief explanation, play an educational CD to show the class the role of phagocytes, B-lymphocytes, and T-lymphocytes in dealing with infection in the body. Also explain the process of blood clot formation.

Explanation

Explain to the students that platelets and other clotting factors bring about the conversion of blood fibrinogen into fibrin which forms a mesh of fibres to trap red blood cells that prevents pathogens from infecting the body. Also explain that phagocytes are white blood cells that get rid of pathogens in the blood by engulfing and digesting them whereas B-lymphocytes and T-lymphocytes produce antibodies and attack pathogens directly, respectively.

Kidney dialysis

This demonstration might be conducted in the classroom to support discussion on the principles behind the working of a dialysis machine.

Aim

To demonstrate the process of dialysis in a dialysis machine

Equipment

- visking tubing (or any semi-permeable membrane)
- tubing fluid consisting of water, glucose, and salt
- dialysis fluid (solution of water and glucose)
- beaker ■ food colour ■ glucometer

Method

- Prepare the dialysis fluid in a beaker by dissolving glucose in water.
- Tie one end of the visking tubing.
- Pour half of the dialysis fluid into the visking tubing. Then add a teaspoon of salt and some food colour. This is now the tubing fluid.
- Tie up the visking tubing from the open end and place the tubing inside the beaker containing dialysis fluid for half an hour.
- Note the salty taste of the dialysis fluid in the beaker and the change of colour to red.
- Use a glucometer to test the glucose concentration in both the fluids. It will be the same for both the dialysis and tubing fluids.

Explanation

Explain to the students that the salt and red colour flows across the semi-permeable membrane of the visking tubing into the dialysis fluid. At the same time, water molecules pass across the visking tubing to dilute the sugar molecules in the region of higher concentration, so that the sugar concentration in both the fluids becomes equal. Kidney dialysis machines work in a similar manner by causing harmful urea and salts to flow out of the body of the patient across a semi-permeable membrane into the sterile dialysis fluid.

Homeostasis

This demonstration might be conducted in the classroom to support discussion on homeostasis.

Aim

To demonstrate homeostatic responses to changes in light intensity

Equipment

- torch

Method

- 1 Darken the room and wait until all the students have adjusted to the darkness.
- 2 Call up two students at a time and ask one of them to shine a torch into the eyes of the other student.
- 3 The first student should then observe the changes in the size and shape of the iris and the pupil of the other student.

Explanation

Explain to students that the pupil becomes smaller as the bright light enters the eye to enable the eye to adjust to the change in the surroundings. This illustrates the principle of homeostasis whereby every organism tries to maintain a constant internal environment.

The eye

This demonstration might be conducted in the classroom to support discussion on the structure of the eye.

Aim

To show the structure of the eye

Equipment

- an easy-to-assemble model of the human eye
- an eye of a goat or a cow
- dissection tray
- gloves
- forceps
- scalpel or sharp knife

Method

- 1 Disassemble the model of the eye moving from the outer layers towards the inner layers while identifying each structure by name and function.
- 2 Reassemble the model while asking the students to repeat the name and function of each structure.
- 3 With the help of the knife and forceps, dissect the eye of a goat or a cow.
- 4 Using the forceps, hold up each structure of the eye (cornea, iris, suspensory ligament, lens, etc.) and identify it before the class to reinforce the model.

Precaution

Wear gloves during the dissection to prevent infection.

Explanation

Explain to the students that the eye is an important sense organ composed of various specialized structures that work together to make visual stimuli available to the brain for processing.

How antagonistic muscles work

This demonstration might be conducted in the classroom to support discussion on the function and working of antagonistic muscles.

Aim

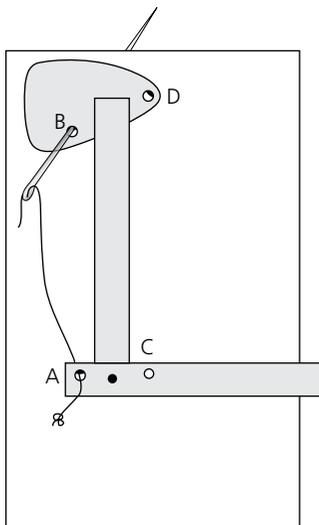
To demonstrate the arrangement and working of the antagonistic muscles at the elbow

Equipment

■ stiff cardboard ■ scissors ■ needle and thread ■ paper fastener

Method

- 1 Draw in the shoulder girdle (scapula) and the humerus, and bore the holes B and D.
- 2 Cut the strip of cardboard to represent the ulna and radius, bore the holes A and C, and use a paper fastener to loosely attach the ulna-radius to the humerus.
- 3 Thread a strand to represent the biceps muscle, and another to represent the triceps muscle.
- 4 Pull on the strands, one at a time. Bring to attention the unique motion of the bones on pulling the triceps.



Explanation

Explain to the students that antagonistic muscles help to move the bones by contracting and extending alternately. This allows vertebrates to move their bodies in useful ways.

Causes of drug addiction

This demonstration might be conducted in the classroom to identify the causes of drug addiction.

Aim

To demonstrate how environmental factors contribute to drug addiction

Equipment

- 7-8 students

Method

- 1 Create a script and assign roles to students for playing out before the class.
- 2 Characters: a poor, jobless young man (Tariq), Tariq's aged father, Tariq's aged mother, Tariq's wife, Tariq's daughter, Tariq's friend, a shopkeeper, a rich young boy, a policeman
- 3 Show Tariq's family in a small house with all the characters complaining to him about their various financial problems.
- 4 Show Tariq becoming frustrated and leaving the house. He comes upon a friend in the street and sits down to share his troubles.
- 5 The friend offers Tariq some heroin which he refuses.
- 6 A rich boy passing by buys a packet of biscuits from a nearby shop and steals the shopkeeper's mobile phone while he is not looking. He then tastes a biscuit and throws away the remaining ones on the street because he does not like them.
- 7 Tariq complains about the theft to a policeman smoking nearby but the policeman feels intimidated by the rich boy and starts beating up Tariq.

Follow-up

After the play, ask the students to comment on whether Tariq would be more likely to accept the heroin the next time his friend offers it. Ask them to explain why. Encourage students to identify and discuss the social and economic issues that lead to drug abuse in society.

CT scan and the lungs

This demonstration might be conducted in the classroom to support discussion on the effects of tobacco smoke on the lungs.

Aim

To demonstrate that damage to the lungs caused by smoking and pollution can lead to various diseases

Equipment

- a collection of CT scans of diseased lungs obtained from a hospital

Method

- 1 Display the CT scan of the lungs of a healthy person in class and describe its parts.
- 2 Display the CT scan of the lungs of a person suffering from bronchitis in class and point to the thickening of the bronchi on the CT scan.

- Next, display the CT scan of the lungs of a person suffering from emphysema and point to the damaged lung structure on the CT scan.
- Next, display the CT scan of the lungs of a person suffering from lung cancer and point to the tumour on the CT scan.

Explanation

Discuss the abnormality in the lungs and explain the causes of lung damage and the health risks of tobacco smoke and pollution.

Cell division through mitosis

This demonstration might be conducted in the classroom to support discussion on mitosis.

Aim

To introduce mitosis for explaining cell division in onion root hair cells

Equipment

- poster showing the stages of mitotic cell division
- projector slides of mitotic cell division
- CD containing a presentation on mitotic cell division

Method

- Use the poster and/or projector slides to explain the process of mitosis. You might not need to identify the various stages of mitotic cell division by name. Instead you might help students to visualize the systematic division of chromosomal and cytoplasmic matter.
- You might also run the CD on cell division for the class if resources allow.

Application

You might ask students to prepare slides of onion root hair cells in the lab and identify the various stages of mitotic cell division demonstrated in class.

Parts of a flower

This demonstration might be conducted in the classroom to support discussion on the structure of an insect-pollinated flower.

Aim

To show the parts of an insect-pollinated flower

Equipment

- any available insect-pollinated flower, e.g. hibiscus, flame of the forest, pansy, etc.
- razor blade
- water
- Petri dish



Method

- 1 Using a razor blade, neatly cut off the first whorl of floral leaves. Identify these as the sepals and state their function.
- 2 Next, identify the brightly coloured petals and point out to the nectar guides.
- 3 Remove the petals with the razor blade.
- 4 Point out to the stamens and identify its parts, i.e. the filament (stalk) and the anther (head).
- 5 Dust out some of the yellow pollen onto a glass slide and cover it with another.
- 6 Expose the nectaries attached to the flower stalk where the petals had been.
- 7 Allow students to touch the nectary and feel the stickiness of the nectar.
- 8 Identify the pistil and its parts, i.e. the stigma, style, and ovary.
- 9 Slit open the ovary with a razor blade to expose the arrangement of ovules.

Explanation

Explain to the students that the flower is the reproductive organ of the plant and consists of a complex system of male and female reproductive organs as well as features that provide protection and encourage pollination.

A model for genetics

This demonstration might be conducted in the classroom to support discussion on inheritance patterns.

Aim

To demonstrate the pattern of trait inheritance in terms of dominant and recessive alleles

Equipment

- two coins
- sticky paper
- marker

Method

- 1 Divide the students into pairs. Each pair should obtain two coins.
- 2 Ask the students to mark one side of the coin **sperm H** and the opposite side **sperm h**, and then label one side of the other coin **ovum H** and the opposite side **ovum h**.
- 3 Ask each pair to spin the 'sperm coin' and the 'ovum coin' at the same time. Look how they fall and enter the result in the appropriate part of the tally column. Repeat at least 50 times, then work out the totals.

Sperm	Ovum	Tally	
H	H		} total =
h	H		
H	h		} total =
h	h		

- 4 Ask students to work out the ratio of dominant to recessive phenotypes. Does it come to about 3:1?

Explanation

Explain to students that **H** and **h** might be alleles of the gene for hair colour. **H** is dominant and if present the hair is dark. If both alleles are **h** the hair is light.

		ova	
		H	h
sperm	H	HH	Hh
	h	hH	hh

Draw the diagram above to show that zygotes with a dominant allele (**HH**, **Hh**, or **hH**) are three times more likely to be produced than zygotes with two recessive alleles (**hh**). In other words, dominant and recessive phenotypes occur in the ratio of 3:1.

This happens because:

- half the sperms carry the **H** allele and half carry the **h** allele
- half the ova carry the **H** allele and half carry the **h** allele
- there is an equal chance that, during fertilization, any sperm may fertilize any ovum, i.e. fertilization is a random process.

Evolution

This demonstration might be conducted in the classroom to support discussion on natural selection and evolution.

Aim

To demonstrate the patterns of evolution in various animal species

Equipment

- models or pictures of the following: a dog and a wolf, a bat and a bird, a dolphin and a shark

Method

- 1 Display each pair of models/pictures one by one.
- 2 Ask students to identify common features between the two species in each pair.
- 3 Ask students to give reasons for some species sharing certain evolutionary features despite being less closely related to one another.

Explanation

Explain to students that although the wolf and the dog are closely related, they possess distinct evolutionary characteristics to adapt to their environments. Similarly, the bat and the bird despite being less closely related to one another than the wolf and the dog, possess a similar evolutionary characteristic because of similar environmental pressures.

Investigating the effect of temperature and pH on enzyme activity

Enzymes are proteins that catalyze a chemical reaction in a living organism. Enzymes work best within an optimum temperature range of 35°C to 45°C but get destroyed (denatured) and become unable to act at a temperature of 60°C. Enzymes work best at specific pH levels, e.g. the enzyme salivary amylase works best at an alkaline pH.

Ask the students to design and carry out an activity to investigate the effect of temperature and pH on enzyme activity.

Get your students started by thinking on the following:

- Which enzyme would be most easily available for this activity?
- What range of temperatures might be feasible for this activity?
- How might the pH of a solution be identified?

Help students to identify the equipment they might need:

- starch solution
- iodine solution
- Benedict's solution
- 3 water baths
- sampling tile
- thermometers
- 3 boiling tubes
- dropper
- sodium hydrogen carbonate solution
- dilute hydrochloric acid

Help the students to plan out their investigation by suggesting the following steps:

Effect of temperature:

- 1 Three water baths might be prepared at temperatures of 37°C, 40°C, and 60°C to observe the effect of varying temperature.
- 2 5 ml starch solution might be used to test enzyme activity in each test tube by placing each test tube in one of the water baths.
- 3 The starch solution might be tested on a sampling tile with the help of Benedict's solution.
- 4 The starch solution might also be tested for reducing sugar with the help of Benedict's solution.
- 5 1 ml saliva might be used as the enzyme source in each of the three test tubes.
- 6 After about half an hour the solution in each test tube might be tested again for reducing sugar with the help of Benedict's solution.

Effect of pH:

- 1 5 ml starch solution might be taken in 3 boiling tubes marked A, B, and C.
- 2 1 ml hydrochloric acid might be added in solution A while 1 ml sodium hydrogen carbonate solution might be added in solution B. Solution C might be left as it is.
- 3 1 ml saliva might be used as the enzyme source in each of the three tubes and the tubes placed in a water bath at 35°C for 15 minutes.
- 4 Benedict's solution might be added to each of the three boiling tubes placed in a boiling water bath for a few minutes to observe the results of the action of salivary amylase on starch at a specific pH level.

Note:

The greatest level of enzymatic activity will be observed at 37°C. At 40°C enzymatic activity will be reduced and will completely stop at 60°C. The students should conclude that enzymatic activity is optimal within a certain temperature range. At higher temperatures, enzymatic activities come to a stop because the enzyme is denatured.

Solution A will show a negative result for reducing sugar because salivary amylase becomes denatured in the presence of hydrochloric acid. Solutions B and C will test positive for reducing sugar. The students should conclude that the optimum pH level for salivary amylase is slightly basic in nature.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of enzymes and the function of salivary amylase
- how the apparatus was set up (including diagrams)
- a log of the activities conducted and the observations recorded in a table
- a conclusion about the effect of temperature and pH on enzymatic activity
- how the students might have performed the investigation better

Investigating the effect of light intensity on the rate of photosynthesis

During photosynthesis plants produce food in the presence of sunlight and release oxygen gas as a by-product. The rate of photosynthesis can be measured on the basis of the volume of oxygen evolved.

Ask the students to design and carry out an activity to investigate the effect of light intensity on the rate of photosynthesis.

Get your students started by thinking on the following:

- Since oxygen is an invisible gas, how can its production during photosynthesis be observed?
- Name a plant that might be suitable for this activity.
- How might the light intensity be manipulated?

Help students to identify the equipment they might need:

- light source
- 4-5 test tubes
- pondweed
- stopwatch

Help the students to plan out their investigation by suggesting the following steps:

- 1 Students might measure the rate of photosynthesis by counting the number of bubbles of oxygen gas released.
- 2 Elodea or any other available water plant might be selected.
- 3 The pondweed might be inserted into a test tube containing water and the number of oxygen gas bubbles given off counted.
- 4 A floodlight or lamp might be selected as a light source.

- 5 Several test tubes might be prepared in a similar way and placed at varying distances from the light source to measure the effect of light intensity on the number of bubbles released.
- 6 Equal volumes of water and equal lengths of pondweed might be selected to keep experimental conditions uniform.

The activity might be carried out in a dark room so that the lamp is the only source of light.

Note:

The number of oxygen bubbles given off will decrease with the increasing distance between the test tube and the light source. The students should reason that since all other variables, i.e. size of plant, volume of water, etc. are uniform the only reason for the difference in the volume of oxygen produced is light intensity. They should conclude that the rate of photosynthesis varies directly with the intensity of light.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of photosynthesis and the factors affecting it
- a description of how the activity was set up (including a diagram)
- a log of the activities conducted and the observations recorded in the form of a table and a graph:

Distance from light source / cm	Number of oxygen bubbles given off per minute
10	
20	
30	
40	
50	

- a conclusion about the relationship between light intensity and the rate of photosynthesis
- how the students might have performed the investigation better

Investigating the effect of light colour on photosynthesis

Plants absorb light during photosynthesis to produce sugar and release oxygen as a by-product. Green plants absorb red and blue light from white light and reflect green light.

Ask the students to design and carry out an activity to investigate the effect of light colour on the rate of photosynthesis.

Get your students started by thinking on the following:

- How can the rate of photosynthesis be measured?
- Why are most plants green?
- How do experimental conditions need to be controlled for this activity?
- What factors need to be varied?

Help students to identify the equipment they might need:

- pondweed (*Elodea*)
- bench lamp
- glass funnel
- test tube
- cellophane paper (red, blue, yellow, and green)
- beaker
- Plasticine or wooden block
- pond water or sodium hydrogen carbonate solution

Help the students to plan out their investigation by suggesting the following steps:

- 1 Sodium hydrogen carbonate solution might be used as a source of carbon dioxide for the pondweed.
- 2 The test tube might be used to collect the oxygen evolved during photosynthesis.
- 3 The bench lamp might be covered with the three cellophane papers alternatively and the number of oxygen bubbles evolved during photosynthesis be monitored over a sufficient time period.

Note:

The greatest number of oxygen bubbles will be observed when the plant is exposed to red and blue light. Fewer bubbles will be observed in yellow light and the least in green light. Students should reason that the number of oxygen bubbles is an indicator of the rate of photosynthesis. They should conclude that photosynthesis takes place fastest in blue and red light and slowest in green light.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- the role of photosynthesis and the factors affecting it
- how the apparatus was set up (including diagrams)
- a log of the activities conducted and the observations recorded
- conclusions about the effect of light colour on the rate of photosynthesis
- how the students might have performed the investigation better

Investigating the absorption of light by chlorophyll

Chlorophyll is the green pigment in plants that absorbs energy from the Sun to combine carbon dioxide and water, producing glucose and oxygen as products. Sunlight can be split up into a spectrum of seven colours each having a different wavelength.

Ask the students to design and carry out an activity to investigate the absorption of light by chlorophyll.

Get your students started by thinking on the following:

- What are the seven colours in the visible spectrum?
- Which instrument might be used to split white light into its component colours?
- How is the spectrum produced by splitting sunlight different from the spectrum produced after the light has been passed through chlorophyll?

Help students to identify the equipment they might need:

- prism
- white paper or screen
- conical flask
- boiling tube
- bench lamp
- alcohol
- water bath
- a few green leaves

Help the students to plan out their investigation by suggesting the following steps:

- 1 The leaves might be inserted into a boiling tube containing alcohol and placed in a hot water bath for 15 minutes.
- 2 The leaves might then be removed and the alcohol containing chlorophyll transferred into a small conical flask.
- 3 A beam of light from the bench lamp might be made to pass through the chlorophyll and then through the prism.
- 4 The spectrum created by the prism might be produced on a screen and then observed.

Note:

Red and blue light will be missing from the spectrum. Students should conclude that red and blue light has been absorbed by chlorophyll for the process of photosynthesis.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- the function of chlorophyll and the composition of light
- how the apparatus was set up (including diagrams)
- a log of the activities conducted and the observations recorded
- conclusions about the absorption of light by chlorophyll for photosynthesis
- how the students might have performed the investigation better

Investigating oxygen production during photosynthesis

Photosynthesis is the process by which starch is manufactured in the leaves for providing energy to carry out the life functions of the plant. This starch is manufactured by trapping sunlight and combining water with carbon dioxide. Carbohydrate and oxygen are produced as a result.

Ask the students to design and carry out an activity to investigate the production of oxygen during photosynthesis.

Get your students started by thinking on the following:

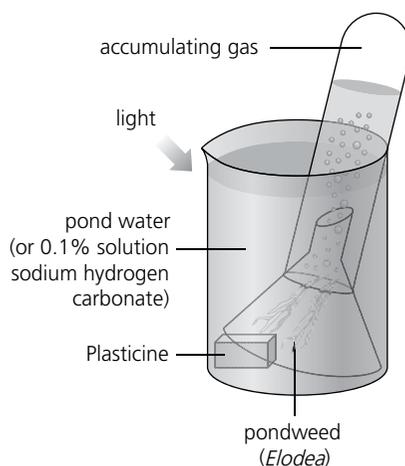
- Why is photosynthesis necessary?
- Why is taking an early morning walk in the park recommended for good health?
- What are some of the properties of oxygen (allows a flame to burn)?

Help students to identify the equipment they might need:

- one-litre beaker
- glass funnel
- bench lamp
- test tube
- Plasticine or wooden block
- spatula
- wooden splint
- Bunsen burner
- pondweed (*Elodea*)
- pond water or sodium hydrogen carbonate solution

Help the students to plan out their investigation by suggesting the following steps:

- 1 Sodium hydrogen carbonate solution might be used as a source of carbon dioxide for the pondweed.
- 2 Sufficient provision might be made for water, carbon dioxide, and sunlight for the pondweed to perform photosynthesis.
- 3 A collection mechanism using the funnel and test tube might be developed for collecting oxygen gas produced as a result of photosynthesis.
- 4 Adequate time (almost a week) might be provided for the gas to collect in the test tube.
- 5 A blown out splint might be used to test for the gas collected in the test tube.



Note:

The splint will light up due to the presence of oxygen in the test tube. The students should conclude that oxygen is evolved during photosynthesis.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of photosynthesis
- how the apparatus was set up (including diagrams)
- a log of the activities conducted and the observations recorded
- conclusions about the gas evolved during photosynthesis
- answers to the following questions:
 - 1 Does the tube contain pure oxygen?
 - 2 Can you devise a control for this experiment?
 - 3 Why must care be taken when lowering the test tube so that air does not enter it?
 - 4 Write an equation to represent the process taking place in the Elodea plant.

Investigating plant growth and soil acidity

Some plants grow better in soils which are slightly acidic ($\text{pH} < 7$) while others prefer slightly alkaline soils. This is because certain plant nutrients are more easily available in acidic soils than in alkaline soils. Plants are known as 'acid lovers' or 'acid haters' depending on the soils they thrive in.

Ask the students to design and carry out an activity to investigate the plants growing in different acid and alkaline soils.

Get your students started by thinking on the following:

- What is pH? How does soil pH affect plant growth?
- What do you know about testing soil pH? What equipment will you need?
- Which plants thrive in acidic soil? Alkaline soil?
- Write down the hypothesis you are going to test for each plant.
- Who might be able to help you find suitable plants?
- How are you going to decide whether a plant is growing well or not?
- How many plants will you need to investigate to test your hypotheses?
- Are there any safety hazards?
- What safety precautions must you take?

Help students to identify the equipment they might need:

- pH meter or indicator
- trowel
- plastic bags
- basin
- garden or area where different plants grow

Help the students to plan out their investigation by suggesting the following steps:

- 1 The students might select 10–15 plants (fruits, vegetables, or herbs) easily available in their surroundings.
- 2 They might hypothesize about the type of soil, i.e. whether acidic or alkaline, each plant might grow in.
- 3 They might test their hypothesis by locating each plant in its habitat and collecting a soil sample with the help of a trowel in a plastic bag.
- 4 Each soil sample might be tested with the help of a pH meter or an indicator to determine whether the soil is acidic or alkaline.
- 5 Students might record whether their hypotheses have been verified or nullified.

Note:

Students might need to be encouraged to identify plants that they can easily locate and obtain soil samples of. Most plants will have a soil pH ranging between 6.5 and 7. Potatoes, tomatoes, peas, onions, and garlic grow in slightly acidic soils. Mustard grows in alkaline soils. The students should conclude that most plants prefer slightly acidic to neutral soils. Very few plants can grow in highly alkaline soils.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of pH and the effect of soil pH on plant growth
- identification of the plants selected for the investigation recorded
- a log of the activities conducted and the observations
- a conclusion about the ideal soil pH range for most plants
- recommendations for how soil pH might be adjusted
- how the students might have performed the investigation better

Investigating mineral ions and plant growth

Plants absorb different mineral ions from the soil. The ions enter the plant roots by diffusion and active transport. Some of the important ions are nitrates, phosphates, potassium, and magnesium ions. Each of these performs important functions in the growth and development of the plant.

Ask the students to design and carry out an activity to investigate the role of mineral ions in plant growth.

Get your students started by thinking on the following:

- Why do plants require minerals?
- Do plants necessarily have to be grown in soil?
- How might you identify healthy growth in a plant?
- Which minerals might be necessary for the healthy growth of plants?
- Which plants might be cultivated easily because of their rapid growth rates?

Help students to identify the equipment they might need:

- tomato seeds
- glass jars
- water
- cotton wool
- nutrients including nitrates, phosphates, potassium, and magnesium ions

Help the students to plan out their investigation by suggesting the following steps:

- 1 Tomatoes might be selected because of their ease of cultivation.
- 2 Tomato seeds might be germinated on soaked cotton wool before being transferred to glass jars.
- 3 Pieces of wire netting might be attached with masking tape to cover the mouth of each glass jar and a germinating seedling transferred to the wire net on each jar.
- 4 Each jar might contain a solution of one of the mineral ions mentioned.
- 5 A control might be set up in the form of a jar containing a solution of all the four mineral ions.
- 6 The level of the solution in each jar should be maintained so that the roots remain dipped into the solution.
- 7 The activity might be carried out for a period of one month.

Note:

This is an established form of hydroponics. The plant in the jar containing phosphate solution will have the best-developed root system of all while the plant dipped into nitrate solution will grow the tallest and have the largest leaves. Similarly, the plant in the jar containing potassium ion solution will have the best-developed flowers and fruits. The plant growing in magnesium ion solution will have the darkest leaves of all. Finally, the plant growing in the control jar will exhibit the best growth in terms of root, leaf, flower, and fruit development.

The students should reason that the different nutrients are responsible for growth and development in specific areas. They should conclude that nutrients are necessary for the healthy overall growth of plants.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of the essential nutrients for plants
- a description of how the investigation was set up (including diagrams)
- a log of the activities conducted and the observations recorded in the form of the table as shown on the next page:

Jars	Root development	Stem development	Leaf development	Flower development	Fruit development
Jar 1 (phosphate solution)					
Jar 2 (nitrate solution)					
Jar 3 (potassium ion solution)					
Jar 4 (magnesium ion solution)					
Jar 5 (control jar)					

- a conclusion about the role played by each nutrient in the growth and development of a plant
- how the students might have performed the investigation better

Investigating the location of phloem in the stem

Xylem and phloem are the conducting tissues of plants. The xylem conducts water from the roots along the stem to different parts of the plant. The phloem transports prepared food from the leaves along the stem to all other parts of the plant.

Ask the students to design and carry out an activity to investigate the location of phloem in the stem of a plant.

Get your students started by thinking on the following:

- What is the function of the phloem tissue?
- What would happen to the plant if the phloem did not perform its function?
- Which plant would be most appropriate for your investigation?
- Would you place the plant in shade during the investigation or in bright light?

Help students to identify the equipment they might need:

- potted plant with thick, erect stem (e.g. rose or any other suitable plant)
- razor blade

Help the students to plan out their investigation by suggesting the following steps:

- 1 Assuming the phloem lies towards the outside in the stem, a blade might be used to carefully debark a 3-inch section of the stem without harming the xylem vessels in the central part of the stem.
- 2 The potted plant might be placed in sunlight and watered carefully everyday for a fortnight.
- 3 The stem might be observed throughout the period.

Note:

The region above the debarked section of the stem will bulge out in all directions while the region below the debarked section will not show a bulge. Since food prepared by the leaves travels down the phloem in the stem up to the debarked section, the students should reason that the accumulation of food above the debarked section due to the absence of phloem has created the bulge. They should conclude that phloem is arranged towards the outside in a dicotyledonous stem.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of xylem and phloem
- how the apparatus was set up (including diagrams)
- a log of the activities conducted and the observations recorded
- conclusions about the arrangement of phloem in the stem
- answers to the following questions:
 - 1 Why does the bulge in the stem appear?
 - 2 What might happen to the plant over the long term?
- how the students might have performed the investigation better

Investigating the effect of physical activity on pulse rate

The pulse rate increases as a result of physical activity because the heart needs to pump blood more often so that more oxygen can be provided to the body cells for respiration. The pulse rate can be measured to determine the effect of physical activity or exercise.

Ask the students to design and carry out an activity to investigate the effect of physical activity on pulse rate.

Get your students started by thinking on the following:

- What are the possible points in the body at which pulse rate can be measured?
- What information does the pulse rate provide?
- When does the pulse rate increase?

Help students to identify the equipment they might need:

- clock or timer

Help the students to plan out their investigation by suggesting the following steps:

- 1 Before the activity, students might measure their pulse count at the temple for 30 seconds.
- 2 Students might then jog in one position for five minutes.
- 3 After a rest of one minute, the pulse rate might be measured again at the temple for about 30 seconds.
- 4 The exercise might be repeated three to four times.

Note:

The pulse rate will increase after physical activity. The students should reason that this is due to the increased blood flow throughout the body to provide oxygen for respiration and energy release. Students might be asked to calculate their fitness index by using the following formula:

fitness index = time of exercise in seconds (X) / mean value for pulse count (Y) x 10

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of pulse rate and the factors affecting it
- a description of how the activity was set up
- a log of the activities conducted and the observations recorded in the form of a table
- a conclusion about the relationship between physical activity and pulse rate
- how the students might have performed the investigation better

Investigating respiration and heat energy

Respiration is the process by which energy is released by the breakdown of food substances within the body. This energy is needed by the body to carry out the various life functions including growth and development. When food is broken down in the presence of oxygen a larger amount of energy is released compared to when oxygen is absent. Along with energy, carbon dioxide and water are released as by-products of respiration.

Ask the students to design and carry out an activity to investigate the production of energy in the form of heat during respiration.

Get your students started by thinking on the following:

- Why do living organisms require energy?
- How is energy stored in food made available for use by the body?
- What are the different forms of energy?
- How can increase or decrease in energy be observed and measured?

Help students to identify the equipment they might need:

- two thermos flasks
- two thermometers
- soaked pea or bean seeds
- beaker
- boiling water
- cotton wool

Help the students to plan out their investigation by suggesting the following steps:

- 1 The soaked seeds might be divided into two equal batches.
- 2 One batch of seeds might be boiled in a beaker of water, cooled, and then placed in a flask.
- 3 The second batch might be placed in another flask.
- 4 The environmental conditions might be controlled by using cotton wool in the flasks.
- 5 Thermometers might be set up in the flasks to monitor the change in temperature.
- 6 The flasks might be inverted so that the seeds are in contact with the bulb of the thermometer.
- 7 The temperature for each flask might be recorded in a table as shown on the next page for a period of seven days:

Day	Temperature / °C	
	Flask 1	Flask 2
1		
2		
3		
4		
5		
6		
7		

Note:

The temperature in the flask containing unboiled seeds will show a steady rise in temperature during the seven-day period. The temperature in the flask containing boiled seeds will show no change for the first five days and then show a rise in temperature. The students should reason that the temperature does not rise at first because boiling the seeds has killed them so that respiration cannot be performed. However, after 5 days decomposition begins which produces a rise in temperature. The living seeds are performing respiration normally so the temperature in the flask rises steadily.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of respiration along with an equation
- how the apparatus was set up (including diagrams)
- a log of the activities conducted and the observations recorded in a table
- a conclusion about the production of energy during respiration
- setting up a control for the investigation
- how the students might have performed the investigation better

Investigating oxygen consumption during respiration

Living organisms respire to provide the body cells with energy for performing various functions. Food substances are oxidized in the presence of oxygen to release stored energy. Since oxygen supports combustion, oxygen consumption can be investigated by testing with a lighted candle.

Ask the students to design and carry out an activity to investigate oxygen consumption in living organisms.

Get your students started by thinking on the following:

- Why do living organisms need energy?
- How do they obtain energy?
- What conditions are necessary for respiration?

Help students to identify the equipment they might need:

- germinating pea seeds
- dead pea seeds
- gas jars with lids
- stopwatch
- cotton
- candle
- combustion spoon

Help the students to plan out their investigation by suggesting the following steps:

- 1 Cotton wool soaked in some water might be placed in both the gas jars.
- 2 Germinating seeds might be placed inside one gas jar (labelled A) and dead seeds in the other (labelled B).
- 3 The gas jars might be sealed and left for about 24 hours.
- 4 A small piece of candle might be lighted and lowered into gas jar A and the gas jar covered. The time taken for the flame to be extinguished should be noted.
- 5 Similarly, a piece of lighted candle might be lowered into gas jar B and the time taken for the flame to die out noted.

Note:

The flame will die out after a few seconds in gas jar B while it will be extinguished immediately in gas jar A. The students should reason that since oxygen supports combustion, it is the lack of oxygen in gas jar A that causes the flame to die out. They should also reason that since the only difference in the two gas jars is that gas jar A contains live seeds, the living seeds have consumed all the oxygen in the gas jar. They should conclude that oxygen is consumed by living organisms to stay alive.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- the function of respiration and the necessary factors to be investigated
- how the activity was set up (including diagrams)
- a log of the activities conducted and the observations recorded
- conclusions about the consumption of oxygen by living organisms
- how the students might have performed the investigation better

Investigating fitness and lung volume

Athletes need to obtain energy quickly. It helps if they can get oxygen to their muscles as it is needed. If not, an oxygen debt builds up, the muscles start respiring anaerobically, and fatigue sets in. When the athlete comes to rest, he or she takes in a large volume of oxygen to compensate for the oxygen debt.

Ask the students to design and carry out an activity to investigate the relationship between lung volume and fitness.

Get your students started by thinking on the following:

- How can you measure lung volume?
- What do you mean by fitness? Is it about power or is it about recovery rate? Can you think of a better definition?
- How many people will you need to test?

- Are there any other factors you should take into account?
- Write down any hypotheses you are going to test.
- Are there any safety hazards or hazards to health?
- What safety precautions must you take?

Help students to identify the equipment they might need:

- basin
- plastic bottle
- plastic tube
- marker
- water
- volunteers

Help the students to plan out their investigation by suggesting the following steps:

- 1 Students might select around ten volunteers from their friends, half of whom are athletic and half of whom are not.
- 2 They might use the displacement of water to test lung volume.
- 3 A plastic bottle might be marked at equal intervals to measure volume.
- 4 The plastic bottle might be completely filled with water and inverted over a basin containing some water so that the mouth of the bottle remains submerged.
- 5 One end of the plastic tube might be dipped into the water basin and turned upwards into the bottle through the mouth.
- 6 Each volunteer might be asked to take in a long breath and then blow into the pipe.
- 7 The volume of water displaced by each volunteer might be measured and recorded.

Note:

As the volunteers blow into the tube, the water level in the bottle decreases because the air displaces the water out of the bottle. Athletic volunteers will be able to displace a lot more water than non-athletic volunteers because of their greater lung capacity. The students should conclude that regular exercise increases lung volume so that a greater volume of oxygen can be taken in for strong physical effort.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of lung volume and anaerobic respiration
- a description of how the activity was set up including a diagram
- a log of the activities conducted and the observations recorded in the form of a table and a graph:

Athletic volunteers	Volume of water displaced / ml	Non-athletic volunteers	Volume of water displaced / ml
1		1	
2		2	
3		3	
4		4	
5		5	

- a conclusion about the relationship between lung volume and fitness
- how the students might have performed the investigation better

Investigating the effect of temperature on the rate of respiration

When animals respire aerobically, they consume oxygen gas (usually from the air) and produce carbon dioxide gas. By monitoring how fast they use oxygen (and produce CO_2) we can measure their respiration rate.

Ask the students to design and carry out an activity to investigate the effect of temperature on the respiration rate of germinating seeds or maggots.

Get your students started by thinking on the following:

- Have you seen any apparatus suitable for measuring respiration rates? If not, try to find a suitable method in your textbook.
- What range of temperatures will you use? How will you control the temperature?
- Which living organisms might be selected for this activity?
- Are there any other factors that you must keep constant?
- What do you predict will happen? Write down any hypotheses you are going to test.

Help students to identify the equipment they might need:

- respirometer
- potassium hydroxide solution
- capillary tube
- germinating seeds or maggots
- thermometer
- coloured liquid
- spring clip
- graduated scale
- Bunsen burner
- rubber stopper

Help the students to plan out their investigation by suggesting the following steps:

- 1 Students might measure the rate of respiration by monitoring the volume of oxygen consumed by living organisms.
- 2 Germinating seeds or maggots might be chosen depending on availability and ease of handling.
- 3 Potassium hydroxide solution might be used to absorb carbon dioxide.
- 4 A coloured liquid might be used to monitor changes in gas volume in the respirometer.
- 5 The temperature might be increased with the help of a Bunsen burner and the effects on oxygen consumption noted.

Note:

Any carbon dioxide produced during respiration will be absorbed by the potassium hydroxide solution. The consumption of oxygen during respiration will reduce the gas volume in the respirometer and the coloured liquid will move backwards in the capillary tube. As temperature is increased the liquid will move back at a faster rate. The students should reason that the movement of the coloured liquid is due to the consumption of oxygen by the germinating seeds or maggots. They should conclude that an increase in temperature increases the rate of respiration which is shown by the rapid movement of the coloured liquid.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of aerobic respiration and the effect of temperature on the rate of respiration
- a description of how the activity was set up (including a diagram)
- a log of the activities conducted and the observations recorded in the form of a table and a graph:

Temperature / °C	Relative oxygen consumption / mm per s
20	
25	
30	
35	
40	

- a conclusion about the relationship between temperature and the rate of respiration
- how the students might have performed the investigation better

Investigating the stimulant effect of drugs

A drug is a chemical that can cause a physiological or psychological change in an individual. Drugs usually affect the nervous system. A drug may be a depressant, e.g. heroin or a stimulant such as caffeine (found in varying degrees in tea, coffee, and cola) and theobromine (found in chocolate).

Ask the students to design and carry out an activity to investigate the physiological effects of stimulants.

Get your students started by thinking on the following:

- Why do people consume tea/coffee/cola? How does it make them feel and behave?
- How are these changes reflected in physiological mechanisms?
- How might these changes be measured and recorded?

Help students to identify the equipment they might need:

- tea or coffee
- chocolate
- cola
- blood pressure monitoring instrument (sphygmomanometer)

Help the students to plan out their investigation by suggesting the following steps:

- 1 Blood pressure might be selected as a suitable physiological mechanism to be investigated.
- 2 Tea, coffee, cola, and chocolate might be selected as stimulants because of their easy availability and social acceptance.
- 3 Students might record their blood pressure at the start of the investigation.
- 4 The blood pressure might then be recorded five minutes after consuming a cup or glass of tea, coffee, cola, or a bar of chocolate.
- 5 The blood pressures might be recorded on a table and then plotted on a graph.

Note:

The activity will produce more fruitful results if students are encouraged to compare the effects on blood pressure of consuming tea/coffee/cola and chocolate. Blood pressure and pulse rate will increase by varying degrees (most by coffee and least by chocolate) with time. The students should reason that the varying quantities of stimulants in the substances produce varying physiological and psychological changes in the body.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of stimulant drugs and their effects on the body
- a description of how the investigation was set up
- an explanation of why specific substances were selected as stimulants
- a comparison of the effects of different stimulants contained in tea, coffee, cola, and chocolate
- a log of the activities conducted and the observations recorded along with a table and a graph:

Minutes	Blood pressure	Coffee	Tea	Cola	Chocolate
2					
4					
6					
8					
10					
12					
14					
16					
18					

- answers to the following questions:
 - 1 By comparing the results of all the substances, which drug do you think is the best stimulant?
 - 2 What other changes were observed in the person taking the stimulant?
 - 3 How long would it take before the blood pressure returned to normal?
- a conclusion about the physiological and psychological effects of stimulants
- how the students might have performed the investigation better

Investigating keeping cheese fresh without a refrigerator

Refrigerators keep food fresh by maintaining a low temperature in the environment which prevents the rapid growth of bacteria. Cheese is produced by the dehydration of yogurt. Salt is usually added. Cheese needs to be stored at low temperatures to preserve it because heat causes it to become rancid.

Ask the students to design and carry out an activity to investigate how to keep cheese fresh without a refrigerator.

Get your students started by thinking on the following:

- How does water remain cool inside an earthen pot?
- Why are earthen water pots placed on a bed of wet sand?

Help students to identify the equipment they might need:

- two clay flowerpots, one small enough to fit inside the other
- bowl containing cheese
- water
- sand
- clay dish
- piece of cloth

Help the students to plan out their investigation by suggesting the following steps:

- 1 A cheese storer might be created by placing the smaller pot within the larger pot and filling the space between them with sand so that the rims of the two pots are at the same level.
- 2 The cheese storer might be placed on a clay dish filled with water. Water might also be poured over the sand inside the storer to dampen it completely. The bowl of cheese might then be placed inside the smaller pot and the storer covered with a wet piece of cloth.
- 3 The water content of the cheese storer might be maintained and the freshness of the cheese monitored over a period of three to four days.

Note:

The cheese storer creates a low temperature environment for the cheese because the water from the sand and the dish is continuously absorbed by the pores of the clay pots and evaporated to the surrounding environment. The wet cloth prevents the cool air from escaping to the environment. Thus, a cool internal environment is maintained. The students should understand the principles involved in the clay cheese storer and describe the cooling mechanism.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of the function and cooling mechanism of refrigerators
- a description of how the investigation was set up (including diagrams of the cheese storer)
- an explanation of why it is cooler inside the flowerpots than it is on the outside
- an explanation of why the dish of water is used in the investigation
- a log of the activities conducted and the observations recorded
- how the students might have performed the investigation better

Investigating yogurt production

Milk undergoes bacterial fermentation to produce a soft solid called yogurt. The soft solid is actually the casein (protein) and lactose (sugar) in milk that separates from the water content of the milk. Bacteria convert the lactose into lactic acid which causes the casein to separate out.

Ask the students to design and carry out an activity to investigate the production of yogurt.

Get your students started by thinking on the following:

- How do bacteria act on milk to convert it into yogurt?
- What is 'live' yogurt?
- How might you confirm whether lactic acid is present in yogurt?

Help students to identify the equipment they might need:

- glass of milk
- one teaspoon 'live' yogurt
- pen
- universal indicator paper

Help the students to plan out their investigation by suggesting the following steps:

- 1 Ordinary milk might be tested for acidity with the help of universal indicator paper. A green colour indicates a neutral solution.
- 2 The milk might be heated to 35°C in a pan and live yogurt (containing *Lactobacillus bulgaricus* or *Streptococcus salivarius*) stirred into it.
- 3 The pan might be covered to prevent the entry of air and placed in a shady place for 24 hours to be converted into yogurt.
- 4 The yogurt might be tested for acidity with the help of universal indicator paper. A yellow colour indicates a weakly acidic pH.
- 5 The acidity of the yogurt might be tested again the next day.

Note:

The yogurt will show increased acidity over time. The students should reason that this is due to the production of acid in the yogurt. They should conclude that the bacteria in the live yogurt act upon the lactose in the milk to convert it into lactic acid which produces yogurt.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of bacteria and their uses, e.g. fermentation
- how the investigation was set up (including diagrams)
- an explanation of why the milk is heated before adding the live yogurt
- a log of the activities conducted and the observations recorded
- a conclusion about the role of bacteria in yogurt production
- how the students might have performed the investigation better

Investigating food chains and food webs

Living organisms are linked to one another in feeding relationships known as food chains and food webs. Green plants prepare their own food and are known as producers. Animals feeding on producers are known as primary consumers while animals feeding on primary consumers are known as secondary consumers. Organisms that feed on secondary consumers are known as tertiary consumers. Energy is transferred along the food chain and food web.

Ask the students to design and carry out an activity to investigate food chains and food webs in their environment.

Get your students started by thinking on the following:

- What is a food chain?
- How are the organisms in a food chain linked to one another?
- How do food chains help to maintain the ecosystem?

Help students to identify the equipment they might need:

- pencil
- notepad

Help the students to plan out their investigation by suggesting the following steps:

- 1 Students might select any accessible habitat such as a tree, field, lake, etc.
- 2 They might observe the organisms in the habitat and identify producers, primary consumers, secondary consumers, and tertiary consumers.
- 3 Students might record their findings in the form of food chains and food webs on a notepad.

Note:

Depending on the habitat students will prepare different food chains and food webs. All the organisms living in a habitat will be included in the food web.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- the role of producers, primary consumers, secondary consumers, and tertiary consumers in a food chain
- how the activity was conducted
- a log of the activities conducted and the observations recorded
- conclusions about the feeding relationships between organisms in a habitat
- how the students might have performed the investigation better

Investigating the presence of nitrogen-fixing bacteria

Leguminous plants, e.g. pea, bean, and clover contain swellings on their roots that contain nitrogen-fixing bacteria. These bacteria convert atmospheric nitrogen into proteins and nitrates that are important compounds necessary for the healthy growth of plants. Plant roots absorb nitrates from the soil through active transport in the root hairs.

Ask the students to design and carry out an activity to investigate the presence of nitrogen-fixing bacteria in the roots of pea plants.

Get your students started by thinking on the following:

- Which leguminous plant might be selected for this activity?
- How might the growth of bacteria in the soil be controlled?
- How might the presence of nitrogen-fixing bacteria in the soil be substituted for?

Help students to identify the equipment they might need:

- four flowerpots
- garden soil
- disinfectant
- nitrates
- soaked bean seeds

Help the students to plan out their investigation by suggesting the following steps:

- 1 The pea plant might be selected because of its ease of cultivation.
- 2 The flowerpots might be filled with garden soil and marked as A, B, C, and D.
- 3 Two of the flowerpots, e.g. C and D might be sprayed with disinfectant.
- 4 Nitrates might be added to a third flowerpot, e.g. B.
- 5 Five pea seeds might be planted in each of the flowerpots and the soil kept moist until the seedlings begin to grow above the soil.
- 6 The seedlings might then be removed and their roots examined.

Note:

The roots of the plant in flowerpot A will have a large number of root nodules indicating the presence of nitrogen-fixing bacteria. The roots in flowerpot B will not have any nodules because the presence of nitrates in the soil makes the presence of nitrogen-fixing bacteria unnecessary. The roots in flowerpots C and D will also not bear nodules because the disinfectant would have killed all the bacteria.

The students should reason that the presence of root nodules indicates the presence of nitrogen-fixing bacteria. They should conclude that the presence of nitrogen-fixing bacteria is necessary for preparing nitrates for absorption by the plant roots.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of the role of nitrates in plant growth and the function of nitrogen-fixing bacteria
- how the apparatus was set up (including diagrams)

- a log of the activities conducted and the observations recorded in a table
- a conclusion about the role of nitrogen-fixing bacteria in plant growth and the conditions necessary for their growth
- how the students might have performed the investigation better

Investigating air pollution

Air pollution is caused by greenhouse gases such as methane and carbon dioxide along with particles from smoke, dust, and other pollutants. These cause serious health consequences when consumed by plants, animals, and human beings.

Ask the students to design and carry out an activity to investigate air pollution in their surroundings.

Get your students started by thinking on the following:

- What is air pollution?
- What are the sources of air pollution?
- How can air pollution be monitored?

Help students to identify the equipment they might need:

- transparent sticky tape
- white chart paper

Help the students to plan out their investigation by suggesting the following steps:

- 1 The students might cut out a strip of transparent sticky tape and fasten it sticky side up to a sheet of chart paper.
- 2 The chart paper might be set up against an outside wall for a day or two.
- 3 The material deposited on the sticky tape might be observed.
- 4 Similar set-ups might be placed at different locations and the results compared.

Note:

Pollutants such as dust and smoke particles, pollen, dirt, and other substances polluting the air will be deposited on the sticky tape. Greater deposits will be formed in areas close to the city centre than in the suburbs. Students should conclude that air pollution is greater in the city centre because of the heavy traffic.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- the causes of air pollution
- how the activity was set up
- a log of the activities conducted and the observations recorded
- conclusions about the prevalence of air pollution in the environment
- how the students might have performed the investigation better

Investigating water pollution

Water becomes polluted when pollutants from pesticides and factory waste flow into rivers. Acid rain is formed when rainwater absorbs acidic gases such as sulfur dioxide and oxides of nitrogen while falling through the air.

Ask the students to design and carry out an activity to investigate water pollution in the form of acid rain.

Get your students started by thinking on the following:

- What is water pollution?
- What is acid rain?
- What are the effects of acid rain?
- How can the acidity of rainwater be measured?

Help students to identify the equipment they might need:

- beaker
- universal pH paper

Help the students to plan out their investigation by suggesting the following steps:

- 1 Rainwater might be collected in a beaker from several different locations.
- 2 The rainwater might be tested for acidity using universal pH paper and comparing the colour change with the reference chart.

Note:

The pH paper will change from blue to red indicating that the rainwater has absorbed acidic gases from the air. Rainwater samples having pH values below 5.7 should be considered acidic because even pure rainwater contains dissolved carbonic acid. Samples collected from the city centre and areas populated by factories will show greater acidity levels than samples collected from suburban areas.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- the causes of water pollution and acid rain
- how the activity was set up
- a log of the activities conducted and the observations recorded
- conclusions about the prevalence of acid rain in the environment
- how the students might have performed the investigation better

Investigating cloning in plants

Cloning is a process by which genetically identical plants are produced. Such plants can be grown from stem cuttings, budding, or grafting. Tubers, (e.g. potatoes), bulbs, (e.g. onions), and rhizomes, (e.g. ginger) are underground stems. As opposed to plants grown from seeds, clones are exactly identical to their parent plants and to one another in their phenotype and genotype. The cell structure of two clones will be completely identical.

Ask the students to design and carry out an activity to investigate the structure of cloned plants.

Get your students started by thinking on the following:

- What is a clone?
- How are plant clones produced?
- How are plant clones different from plants produced from seeds? How are they similar?

Help students to identify the equipment they might need:

- tuberose bulbs
- garden soil
- flowerpots
- staining liquid
- microscope
- slide
- cover slip

Help the students to plan out their investigation by suggesting the following steps:

- 1 Tuberoses grow from bulbs and are cultivated for ornamental value. They might be selected for this activity.
- 2 The bulbs might be obtained from a mature stalk and planted in the soil.
- 3 Simultaneously, seeds from a pea plant might be sown in the soil.
- 4 Once the planted bulb and seeds have grown and flowered, a flower each from the parent plants and the daughter plants might be plucked and their cells observed under a microscope.

Note:

The cell structure of the daughter tuberose flower will be identical to the cell structure of the flower from the parent plant. On the other hand, the cell structure of the daughter pea flower will not be completely identical to the cell structure of the flower from the parent pea plant. The students should reason that the cell structure is identical in the first case because the no mixing of genetic material has taken place. They should conclude that cloning produces an organism that is genetically identical to its parent.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of cloning
- a description of how the investigation was set up (including diagrams)
- an explanation of why the cell structure is identical in both the parent and daughter tuberose flower
- a log of the activities conducted and the observations recorded
- a conclusion about the difference between asexual and sexual reproduction in plants
- how the students might have performed the investigation better

Investigating the conditions necessary for germination

Germination is the process by which an embryo emerges from a seed and begins to grow. The radicle, plumule, and cotyledons can be easily identified. Several factors are necessary for germination to take place. These include the availability of adequate light, moisture, warmth, and air.

Ask the students to design and carry out an activity to investigate the conditions necessary for germination.

Get your students started by thinking on the following:

- What is germination?
- What is an embryo?
- What do living beings need to live and grow?
- Why do plants grow better in sunlight?

Help students to identify the equipment they might need:

- | | |
|---|--------------------------------|
| • four to five test tubes, boiling tubes, or jars | • cotton wool |
| • metal foil or black polythene sheet, marker | • cold boiled water |
| • liquid paraffin or light oil | • small seeds, e.g. mung beans |

Help the students to plan out their investigation by suggesting the following steps:

- 1 Different environmental conditions might be created in the various test tubes, boiling tubes, or jars by varying the availability of air, light, warmth, and water.
- 2 Each container might contain a large number of seeds to increase the chances of germination.
- 3 Cotton wool might be used as a rooting medium for the seeds.
- 4 Water might be boiled to remove oxygen.
- 5 Liquid paraffin or light oil might be used to control the availability of air.
- 6 Warmth might be controlled by placing the seeds in a refrigerator.
- 7 Foil might be used to restrict light.
- 8 At least one set-up should have none of the factors present.
- 9 Results could be compared with those obtained by other students or by using different seeds.

Note:

The maximum number of germinating seeds will be observed in the container in which adequate air, light, warmth, and water were provided. Other containers will show varying results depending on the environmental conditions. The students should determine the relative importance of each factor for germination.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of germination and the conditions necessary for germination

- how the apparatus was set up (including diagrams)
- a log of the activities conducted and the observations recorded including a table as the one below:

Tube	Factors present	Factor absent	Number of seeds germinating	Percentage germination
A	air, light, warmth	water		
B				
C				
D				
E				

- conclusions about the importance of each factor of germination
- answers to the following questions:
 - 1 Would using single seeds, e.g. broad bean seeds affect the reliability of your results?
 - 2 Explain why each of the factors that you have identified is essential for seed germination?
- how the students might have performed the investigation better

Extension

Some seeds will not germinate unless they have passed through the gut of an animal. Use your knowledge of the process of digestion to explain why.

How could you investigate this in the laboratory? Be sure to identify independent, manipulated, and controlled variables in your answer.

Investigating germination with growth curves

Germination is the process by which the embryo emerges from the seed coat and begins to grow. Light, air, moisture, and warmth are needed for a seed to germinate. Germination can be monitored by plotting growth curves. When any organism is weighed as it grows and the results are plotted on a graph the result is a curved shape called a growth curve. The growth curves of two or more organisms can be plotted and compared.

Ask the students to design and carry out an activity to investigate germination with the help of growth curves.

Get your students started by thinking on the following:

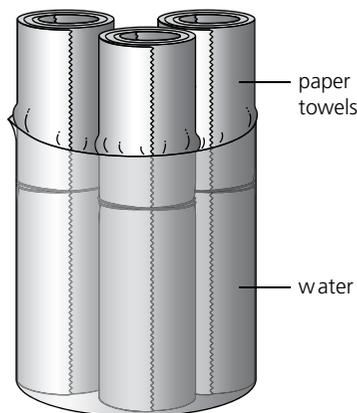
- What are the factors necessary for germination?
- How can growth in an organism be observed?
- What is dry weight?

Help students to identify the equipment they might need:

- pea seeds
- paper towels
- 500 cm³ beakers
- weighing balances
- thermometer
- graph paper

Help the students to plan out their investigation by suggesting the following steps:

- 1 Around 40 peas might be soaked in water for 12 hours and then wrapped in wet paper toweling.
- 2 The wrapped peas might be placed in beakers of water in a warm, dry place.
- 3 Five seedlings might be removed every day and their average weight determined.
- 4 The seeds might then be heated at 100°C until they are completely dry and their average weight determined again.



Note:

The fresh weight will tend to be greater than the dry weight for a sample. The students should reason that the dry weight is less because of water loss due to heating. The graphs will show a rapid increase in weight during the earlier stages of growth. The students should conclude that germination involves rapid increase in weight during early growth.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of germination and growth curves
- how the apparatus was set up (including diagrams)
- a log of the activities conducted and the observations recorded including graphs for plotting wet and dry weight changes
- an explanation of difference between fresh and dry growth curves
- a conclusion about the early stages of growth in plants
- how the students might have performed the investigation better

Investigating continuous and discontinuous variation in human beings

Human beings show continuous and discontinuous variation. Characteristics such as height and weight that have a range of values are examples of continuous variation whereas characteristics like blood group and tongue-rolling ability that have much fewer categories are examples of discontinuous variation.

Ask the students to design and carry out an activity to investigate continuous and discontinuous variation in their classmates.

Get your students started by thinking on the following:

- How do human beings differ from one another?
- Which of these characteristics can be measured?

Help students to identify the equipment they might need:

- measuring tape
- weighing scales
- graph paper

Help the students to plan out their investigation by suggesting the following steps:

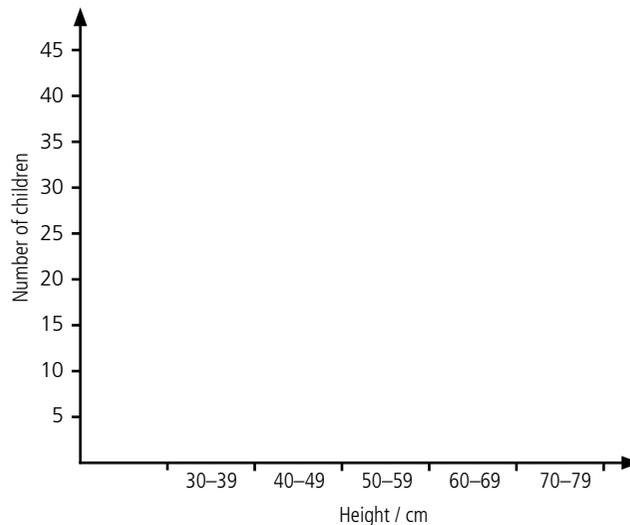
- 1 Students might work in pairs to record variation in the following characteristics: lobed vs unlobed ears, ability to roll tongue, length of the index finger, body weight, height, blood group, etc.
- 2 Students might decide if the variation can best be recorded in the form of a table or a column chart.

Note:

Students should determine that factors like lobed ears, tongue-rolling, and blood group show discontinuous variation and the variation can best be recorded in the form of a table:

Name of student	Ear lobes	Tongue-rolling	Blood group A	Blood group B	Blood group AB	Blood group O

On the other hand, length of the index finger, body weight, and height show continuous variation and the variation can best be shown in the form of a column chart:



Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of variation and the factors affecting it
- a description of how the activity was conducted
- a log of the activities conducted and the observations recorded in the form of a table and a column chart
- a conclusion about the difference between continuous and discontinuous variation
- how the students might have performed the investigation better

Investigating monohybrid crossing in pea plants

Monohybrid crossing is the genetic crossing between two organisms to determine how a single trait is inherited in the subsequent generation. This generation is called the F_1 generation. Usually, the dominant trait is represented in the phenotype in the F_1 generation. If the F_1 generation plants are crossed, the dominant and recessive traits are represented in the ratio 3:1 in the F_2 generation.

Ask the students to design and carry out an activity to investigate the inheritance of height in pea plants through a monohybrid cross.

Get your students started by thinking on the following:

- What are the dominant and recessive traits for plant height in the pea plant?
- What is a monohybrid cross?
- How are genes for a single trait distributed in the F_1 generation? How is this observed in the F_1 generation?
- How might we ensure that cross-fertilization takes place?

Help students to identify the equipment they might need:

- dwarf-sized pea plant
- tall pea plant
- muslin bag
- paintbrush
- pair of forceps

Help the students to plan out their investigation by suggesting the following steps:

- 1 The dwarf and tall variety pea plants might be grown in separate pots.
- 2 When flowers appear on both the plants the anthers might be removed from one plant and the stigma removed from the other by means of a pair of forceps.
- 3 Pollen grains from the flower with the stigma cut off might be picked up and transferred to the flower of the plant with the anthers cut off by means of a paintbrush.
- 4 The female part of the pollinated flower might be covered with a loose-fitting muslin bag and the flower left to develop into fruits.
- 5 The seeds of the fruit might be planted to grow into the F_1 generation and the height of the plants measured.
- 6 The investigation might be extended by crossing F_1 plants to produce the F_2 generation and observing the plant height in this generation.

Note:

This investigation should preferably be carried out over a year long period, preferably in class 10 so that the results are available by the end of the term. All the plants in the F_1 generation will be tall. The students should reason that the tall height is the dominant trait while short height is recessive and suppressed in the F_1 generation. Three-fourths of the plants in the F_2 generation will be tall while one-fourth will be dwarf plants. The students should reason that the recessive trait suppressed in the F_1 generation appears in the phenotype in the F_2 generation. Students should conclude the pattern of inheritance of plant height over two generations by means of a table and a diagram.

Check the students' plans and suggest improvements.

Let the students carry out their investigations.

Ask the students to prepare a write-up on the following:

- the purpose of the investigation
- a brief description of monohybrid crossing and dominant and recessive traits
- a description of how the investigation was set up (including diagrams)
- an explanation of why the pea plant was selected
- an explanation of why plant height was selected to be monitored
- a log of the activities conducted and the observations recorded along with a table showing the results of the crossing in F_1 and F_2 generations
- a conclusion about the pattern of inheritance
- how the students might have performed the investigation better

Microscopes and how to use them

You need:

■ a microscope

■ prepared slides (e.g. insect head, wings, legs, etc.)

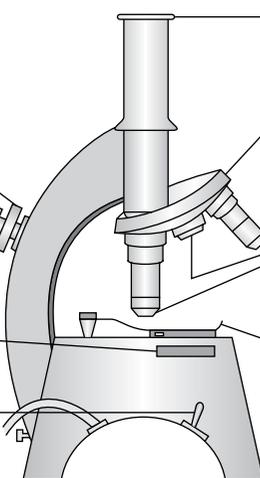
The parts of a microscope (Note that there are many different varieties of microscope; this diagram is intended as a general guide to the structure.)

Coarse focus knob This is used to get the specimen roughly in focus.

Fine focus knob This is used to get the specimen in sharp focus.

Iris adjuster This controls the amount of light reaching the specimen.

Light switch For the bulb used to shine light through the specimen



Eyepiece This is the lens you look through.

Turret This turns round so you can use different objective lenses.

Objective lenses These have different powers of magnification. The longer the lens the greater its power to magnify specimens.

Stage The platform that you put the specimen slides on. Slides are held down by a spring clip.

Using a microscope

- 1 Turn the turret until you have the low power objective lens (the short lens) in line with the eyepiece.
- 2 Clip a slide on the stage so that it is in the centre under the objective lens and look through the eyepiece.
- 3 Adjust the coarse focus until the specimen becomes clear. If necessary adjust the fine focus until the specimen is in sharp focus.
- 4 Move the iris adjuster until the specimen is clearly lit.
- 5 Calculate the magnification by multiplying the power of the eyepiece by the power of the objective lens, e.g. a $\times 5$ eyepiece used with a $\times 15$ objective magnifies 75 times.
- 6 Notice how, when you move the slide, the specimen seems to move in the opposite direction.
- 7 Change to the medium power objective. **Do not use the higher power objective yet.** Focus the microscope and notice that you now see much less of the specimen but at a higher magnification.
- 8 **How to use high power objectives.** If this is done carelessly the lens and a slide can become damaged. With some microscopes, equal damage can be done with smaller lenses too.
 - (a) With your eyes level with the stage, slowly lower the high power objective until it *almost* touches the slide.
 - (b) Look through the eyepiece and focus by moving the lens *away from the slide*, i.e. always focus upwards. This avoids smashing the lens through the slide.

Care of microscopes

When not in use, keep the microscope protected with a plastic cover (and in a box if possible).

Accumulated dust in a microscope can deteriorate image quality. Keep all openings covered with dust caps so that dust does not enter the microscope and settle on inaccessible lenses, mirrors, and prisms.

Use an air blower to blow dust off the stage, base, and body. If necessary wipe it down with a damp cloth, and clean off any smears with ethanol. Take care to clean and wash off the stage if any corrosive substance (even a salt solution) has been used.

Carefully clean the objectives (see detailed description below):

- Remove the condenser top lens and clean it with lens paper and ethanol, if necessary.
- Remove both eyepieces and clean their surfaces with an alcohol swab/lens tissue. Blow any dust or dirt out of the insides with an air blower, if one is available.

An occasional thorough cleaning of immersion objectives is necessary, but try to avoid doing this too often (more than once per month), as cleaning agents can remove the anti-reflection coating of an objective over a period of time.

To clean a lens, remove it from the turret. Fold a piece of lens tissue into quarters, and add a few drops of straight ethanol. Gently wipe the lens in a circular motion (only letting the tissue, not your fingers, come into contact with the lens glass). Always immediately wipe off any excess ethanol with a dry piece of tissue—allowing ethanol to remain on the lens could also affect the anti-reflection coating (and may slowly loosen the cement which holds the lens in position).

Examine the lens carefully by removing the eyepiece, looking through it backwards, to see a magnified image of the lens. The lens surface should appear spotlessly clean. If not, repeat the above procedure. This is also a good way to examine a lens closely for scratches or other imperfections.

Your teacher will be looking for:

- careful use of the apparatus given
- good observation of the point where the image is in sharp focus

Making microscope slides

You need:

- microscopes
- mounted needles
- slides and coverslips
- scissors
- pond or aquarium water
- newspaper with words and pictures
- crystals (salt, sugar, potassium manganate(VII), copper sulfate)
- dropper pipettes

Pond and aquarium water

Water from the bottom of a pond or an aquarium, especially if it contains rotting vegetation, can contain many different protozoa and other microscopic creatures.

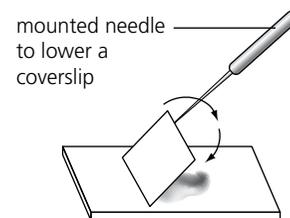
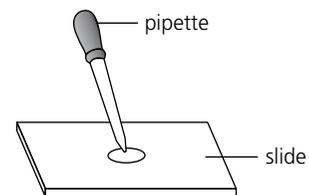
- 1 Use a bulb pipette to place one drop of a pond or aquarium water onto the centre of a glass slide.
- 2 Place a coverslip with one edge resting on the slide near the drop of water. Use a mounted needle to lower it slowly onto the water. If you do this quickly you will trap air bubbles. Use just enough water to spread to the edges of the coverslip and no further. Place the slide on the microscope stage.
- 3 Start with low power magnification and search the slide for interesting objects, then change to medium or high power magnification.
- 4 Make notes and drawings of what you find.

More things to do

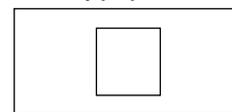
- 1 Put a drop of tap water onto a slide. Remove a hair from your head, place it across the water, and lower a coverslip over it. Study it under medium and high power magnification and make notes and drawings of the root end, the middle, and the upper end of the hair.
- 2 Cut out pieces of newspaper small enough to fit under a coverslip. Mount them in water on slides. What is a newspaper photograph made up of?
- 3 Sprinkle some crystals on a *dry* slide. Study them without a coverslip. Prepare a table and use drawings and words to compare the shape and colour of four different types of crystal.

Your teacher will be looking for:

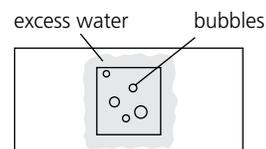
- careful use of the apparatus given
- good observation
- good presentation of results through diagrams



Correctly prepared slide



Badly prepared slide



HAZARD WARNING

Copper sulfate is harmful when swallowed. It may also be irritating to eyes and skin. Potassium manganate(VII) is harmful if swallowed.
AVOID SKIN CONTACT. WEAR EYE PROTECTION.

Looking at cells

You need:

- microscopes
- razors or scalpels
- slides and coverslips
- Petri dishes
- forceps
- onions
- goat liver
- moss plants
- teaspoon or spatula
- methylene blue, glycerol, and iodine stains

Moss leaf cells

- 1 Use forceps to take one leaf off a moss plant. Put the leaf on a slide, add a drop of water, and lower a coverslip onto it.
- 2 Observe it under low, medium, and high power. Identify as many parts as you can.

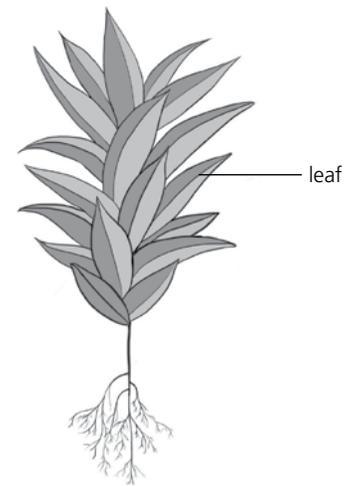
Onion cells

- 1 If you look at half an onion, you will see that it is made up of fleshy leaves. Use a razor to cut a small piece out of one of the leaves. Use forceps to peel skin off the *inner* surface of the leaf. This skin is a thin layer of living cells. Put the skin into a Petri dish containing water. It is important to cut a small piece of skin (less than 5 mm), as a larger piece will keep the curvature of the onion and will not stay flat on a slide.
- 2 Put a drop of iodine stain onto a slide. Put a piece of onion skin into the stain and smooth it out so there are no folds. Lower a coverslip over it, taking care not to trap any bubbles. The bubbles will look like perfectly circular car tyres. Prepare another slide in the same way but water instead of iodine stain.
- 3 Study the stained onion cells under different magnifications, then look at unstained cells. What parts of the cells have become stained? How are onion cells *different from*, and *similar to*, moss leaf cells?

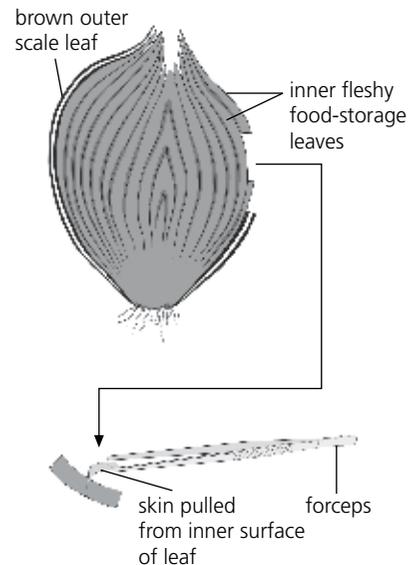
Animal cells

- 1 Cut out and wash thoroughly a 2 cm³ piece of fresh goat liver.
- 2 Scrape the back of a teaspoon or a spatula against the piece of liver and transfer the scraped off material onto a microscope slide.
- 3 Put a few drops of a mixture of methylene blue and glycerol (glycerine) onto the cells.
- 4 After one minute, cover with a coverslip. Dab with filter paper to remove any excess stain.
- 5 Mount the slide and observe it under medium and high power.
- 6 Study the plant and animal cells under the microscope and draw a large well-labelled diagram of the cells.

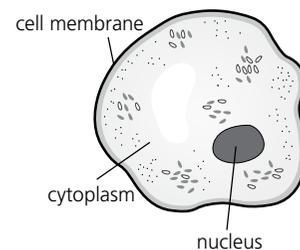
A moss plant



An onion cut in half



An animal liver cell



HAZARD WARNING

Scalpels or razors are sharp—
handle with care.

Measuring cells

You need:

- microscopes
- slides and coverslips
- razor blades
- Petri dishes
- onions and moss plants
- clear plastic rulers
- salt and other crystals
- insect slides (permanent)

Measuring a field of view

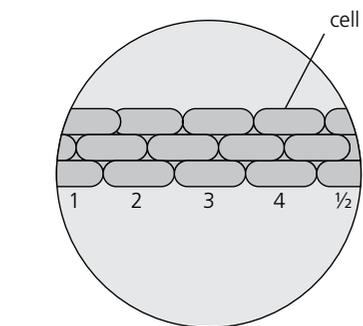
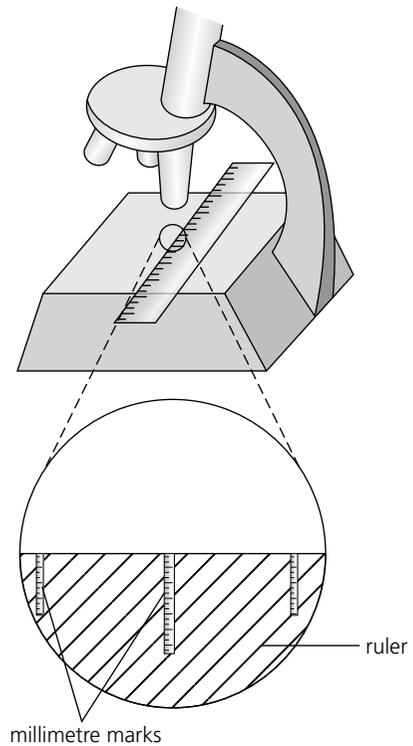
- Place a clear plastic ruler under a microscope and focus on it with low power magnification. How many millimetres wide is the field of view?
- Problem:** Microscopic objects are measured in **micrometres** (one micrometre is written $1\mu\text{m}$). $1\text{mm} = 1000\mu\text{m}$. Convert your field of view into micrometres.

Measuring onion cells

- Prepare a slide of onion cells. Look at the slide under low power magnification. How many cells fit across the field of vision? In the drawing opposite, four and a half cells fill a field of view $2200\mu\text{m}$ wide. What is average length of each cell?
- What is the average length, in micrometres, of onion cells on your slide? Turn the slide around and calculate the average width of the cells.
- You now know the length in micrometres of one onion cell. Use this information, and your onion slide, to calculate the field of vision in micrometres under medium and high power magnification.

More things to do

- Using the technique you have learned, measure:
 - the length and width of a moss leaf cell
 - the width of a human hair
 - the average size of sugar, salt, and other crystals.
- Look at permanent slides of insects and measure various parts, such as the width of scales on the wing of a butterfly, the width of lenses in the compound eye of an insect, the size of the foot of a fly, etc.



Your teacher will be looking for:

- careful use of the apparatus given
- accurate measurements and calculations
- good presentation of results

HAZARD WARNING

Razor blades are sharp—handle with care.

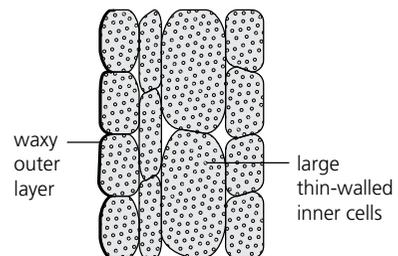
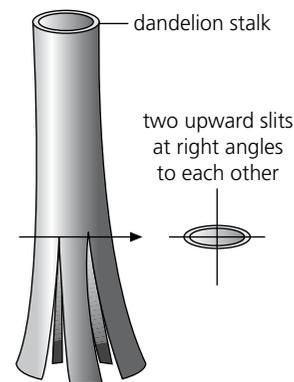
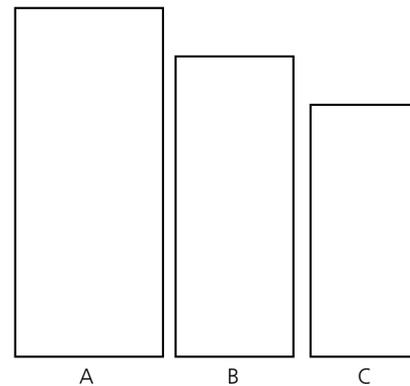
Osmosis

You need:

- potatoes
- Petri dishes
- dandelion/sunflower stems
- test tubes and racks
- scalpels
- sugar
- razor blades
- graph paper, pencil, ruler

Osmosis in potato cells

- 1 Peel a potato and cut out three strips measuring 5 cm x 2 cm x 2 cm.
- 2 Place the strips on graph paper and draw an outline for each.
- 3 Place water in Petri dish A (hypotonic solution), 0.5% sugar solution in Petri dish B (isotonic solution), and saturated sugar solution in Petri dish C (hypertonic solution).
- 4 Place one potato strip in each of the three Petri dishes and leave for 30 minutes.
- 5 Remove the strips from the Petri dishes, rinse with water, and dry.
- 6 Place the strips below their original outlines on the graph paper and draw their new outlines. Label them appropriately.
- 7 Explain what happens to the three strips.
 - (a) Which strip increases in size? What is the name of the process that causes it to happen?
 - (b) Which strip decreases in size? Why?
 - (c) Explain why one of the strips does not show a change in size?
 - (d) Try bending the potato strips. Which strip is the most flexible? Why?



HAZARD WARNING

Razor blades are sharp—handle with care.

Osmosis in dandelion stalks

- 1 Take two test tubes. Half-fill one with water and the other with strong sugar solution.
- 2 Obtain two dandelion stalks. Slit them upwards for about 2.5 cm, then make a second upward slit at right angles to the first to divide the stalk base into four strips (see diagram).
- 3 Put one stalk in water and the other in sugar solution and leave them for 10 minutes.
- 4 Observe and describe what happens.

What happens if you move the stalk in water to the sugar solution and vice versa?

Factors affecting the activity of catalase

Catalase is an enzyme found in many plant and animal tissues. The enzyme has the function of breaking down dangerous peroxide ions. As it does this, oxygen gas is released—because the reaction is rapid the oxygen bubbles form froth on the top of a reacting solution.

You need:

- 3 test tubes in a test tube rack
- hydrogen peroxide (20 volume) solution
- measuring cylinder
- forceps
- dropper pipette
- boiling water bath
- watch glasses
- ruler (with mm scale)
- raw liver, cut into 5 g cubes
- pestle and mortar
- glass rod

Method

- 1 Label the test tubes A, B, and C, and the watch glasses B and C.
- 2 Measure out 5 cm³ of hydrogen peroxide solution into each test tube.
- 3 Place one cube of raw liver into the boiling water bath, and leave for one minute.
- 4 Use the forceps to remove the cube from the water bath, and place it on watch glass B.
- 5 Grind one raw liver cube with the pestle and mortar, and transfer the paste to watch glass C.
- 6 The next step must be carried out quickly and very carefully. Add the remaining raw cube of liver to test tube A, the boiled cube to test tube B, and the raw liver paste to tube C. You should try to add the liver to the test tubes as close to the same time as you possibly can.
- 7 After one minute, measure and record the height of froth in each of the tubes.

Tube	Treatment of liver	Height of froth after one minute / cm
A	Raw cube	
B	Boiled cube	
C	Ground paste	

Explain your results. Use the terms *active site* and *denaturation* in your explanation.

Extension

Write out an equation for the reaction catalyzed by catalase. Try to find out why peroxide ions are so dangerous to cells.

Try the same experiment, using potato cubes instead of liver. Explain any difference between the results for the animal and plant tissues.

Chlorophyll and photosynthesis

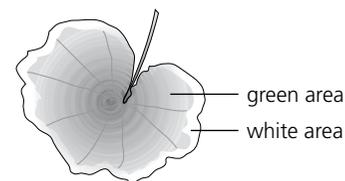
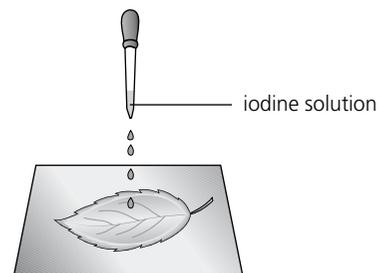
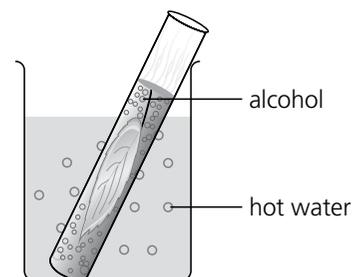
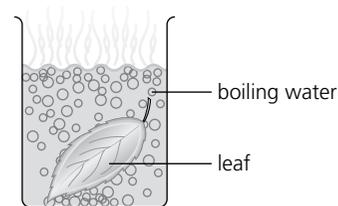
You need:

- plants with normal and variegated leaves (pelargonium, coleus, or geranium)
- iodine solution
- boiling tubes
- tripods and gauzes
- forceps
- beakers
- white tiles
- Bunsen burner
- ethanol (alcohol)

To show that plants need chlorophyll for photosynthesis you need a way of showing that photosynthesis has taken place. Plants change sugar produced by photosynthesis into starch and store it in their leaves. So a leaf with starch has been carrying out photosynthesis.

Testing a leaf for starch: method

- 1 Take a leaf from a non-variegated plant which has been in the light for a few hours. *Put goggles on.* Half-fill a 500 cm³ beaker with water and bring it to boil. Put the leaf in the water for about one minute, then turn the Bunsen burner off.
- 2 Half-fill a boiling tube with ethanol. *This is highly inflammable so do not put it near a naked flame.* Use forceps to take the boiled leaf out of the water and transfer it to the ethanol. Put the tube of ethanol into the beaker of very hot water so that the ethanol does not boil. The ethanol will dissolve out chlorophyll from the leaf as it is a good solvent. This will make test results easier to see.
- 3 Lift the leaf out of the ethanol, dip it into the hot water to soften it, spread it out on a white tile, and cover it with iodine solution. A blue-black colour indicates the presence of starch in the leaf.



A variegated pelargonium leaf

Your teacher will be looking for:

- careful and safe use of the apparatus given
- accurate observations
- good presentation of results
- sensible conclusions that fit your results

HAZARD WARNING

Ethanol is highly flammable.
KEEP AWAY from naked flame.
WEAR EYE PROTECTION.



You are provided with variegated leaves—leaves which have areas with and without chlorophyll. Design an experiment using these leaves to show that chlorophyll is necessary for photosynthesis.

Light, carbon dioxide, and photosynthesis

You need:

- | | |
|--------------------------------------|---------------------|
| ■ potted plants | ■ iodine solution |
| ■ scissors | ■ paper clips |
| ■ ethanol | ■ soda lime |
| ■ white tiles | ■ conical flasks |
| ■ boiling tubes | ■ clamps and stands |
| ■ beakers | ■ cotton wool |
| ■ Bunsen burner, tripods, and gauzes | ■ petroleum gel |
| ■ black paper or polythene | ■ spatulas |

In this exercise, you will try to work out how photosynthesis is affected by differing levels of light and carbon dioxide. The practical method has not been devised for you.

Do plants need light for photosynthesis?

- 1 You could test two plants for starch—one that has been in the dark for 12 hours and one that has been in the light. Can you think of more interesting experiments using the materials provided?
- 2 How could you use strips of black paper or polythene, or even a black-and-white 35 mm photographic negative?
- 3 At which stage will you detach the experimental leaf from the plant?
- 4 Predict what a leaf will look like after the starch test. Make drawings of your results.

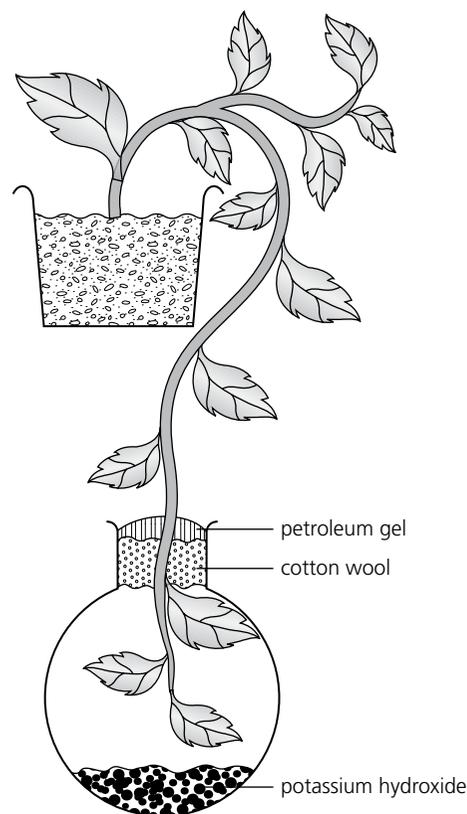
Do plants need carbon dioxide for photosynthesis?

Extension

- You could use the apparatus in the drawing opposite.
- Why must you start with a plant which has been in the dark for 12 hours?
- Why must you test a leaf for starch before setting up the apparatus opposite?
- Find out what the soda lime will do to air in the flask.
- Why is the petroleum gel necessary?
- What control is needed?
- Where will you put the plant and for how long?
- What test is needed to obtain a result?
- How will you present results and conclusions?

Your teacher will be looking for:

- good experimental planning
- careful and safe use of the apparatus given
- good observation and presentation of results
- sensible predictions (hypotheses) and conclusions



HAZARD WARNING

Ethanol is highly flammable. KEEP AWAY from naked flame. Soda lime (sodium hydroxide and calcium hydroxide) is CORROSIVE and can cause severe burns; also dangerous to eyes and skin. AVOID SKIN CONTACT. AVOID CONTACT WITH WATER. WEAR EYE PROTECTION.

Food tests

You need:

- | | | |
|--------------------------------|-----------------------------|---|
| ■ iodine | ■ bulb pipettes | ■ suet |
| ■ Benedict's reagent | ■ sodium hydrogen carbonate | ■ peas and beans |
| ■ Biuret reagent | ■ liquid egg albumen | ■ carrots |
| ■ ethanol | ■ bread | ■ grapes |
| ■ test tubes and racks | ■ potatoes | ■ 4 different fresh fruit juices (e.g. apple, lemon, watermelon, and apricot) or any other suitable fruit juice or glucose solutions of concentration 0.01%, 0.1%, 0.5%, and 1% |
| ■ spotting tiles | ■ cheese | ■ water bath |
| ■ Bunsens, tripods, and gauzes | ■ cooking oil | |
| ■ beakers, 250 cm ³ | ■ glucose | |
| ■ safety goggles | ■ starch powder | |
| ■ glass rods | ■ milk powder | |
| ■ spatulas | ■ peanuts | |

Begin by performing the following tests on known foods to observe a **positive result**. It is recommended that you then repeat each test with sodium bicarbonate to observe a **negative result**. These observations will be helpful when you go on to test foods of unknown composition.

1 Test for starch

- Place a little starch powder in a depression on a spotting tile.
- Add a few drops of iodine.

Positive result: blue/black colour

Negative result: brown colour

2 Test for glucose

- Place equal quantities of a strong glucose solution and Benedict's solution in a test tube (about 2 cm³ of each).
- Lower the test tube into a beaker of boiling water, wait until the test tube contents boil, and leave it for two minutes.

Strong positive result: brick-red precipitate

Medium positive result: yellow-orange precipitate

Weak result: green colour

Negative result: blue colour

Before testing a solid food it must be crushed in warm water to extract any glucose which may be present.

3 Test for proteins

- Dissolve a little milk powder in water in a test tube.

Add a few drops of Biuret reagent.

Positive result: purple colour

Negative result: blue colour

Note that this is a test for soluble proteins. Before testing a solid food it must be crushed in warm water to dissolve any proteins which may be present.

HAZARD WARNING

Iodine and Benedict's reagent are harmful to skin and eyes. AVOID SKIN CONTACT. WEAR EYE PROTECTION.

4 Test for oil and fat

- Place about 1 cm³ of ethanol in a test tube.
- Add a few drops of oil and mix by shaking.
- Add an equal amount of water and shake again.

Positive result: a cloudy emulsion forms

Negative result: liquid remains clear

Food containing solid fats is tested by crushing in ethanol to obtain an alcoholic solution. This is filtered and added to water.

More things to do

Use these tests to analyze the range of foods provided.

Divide each food into four samples and perform one test on each.

Remember to crush solid samples in warm water to extract glucose and protein, and alcohol to extract fats and oils.

Make sure you know the difference between positive and negative results.

Design a results table to show positive and negative results for each test.

List the types of food found in each sample.

From your tests list the types of food present in bread, milk, boiled potato, and cheese.

Would eating these foods give you a balanced diet (i.e. do they contain sufficient carbohydrate, protein, and fat for health)?

What would be the result of basing your diet on these foods alone?

**Tests for deducing glucose concentration**

- Place 5 ml of each fruit juice or glucose solution in separate test tubes.
- Add 1 ml of Benedict's reagent into each test tube.
- Label the 4 test tubes as A, B, C, and D. Place them in a large beaker half-filled with boiling water and leave for 15 minutes.
- Use the colours obtained to deduce the sugar concentration of each solution.

Questions

- 1 Which test tube shows green color? What is the concentration of sugar in this solution?
- 2 What does a blue color with Benedict's reagent prove?
- 3 How might we alter the experiment to determine the concentration of sugar solution between the colours yellow and red?

HAZARD WARNING

Ethanol is highly flammable.
KEEP AWAY from naked flame.
Biuret reagent is harmful to skin
and eyes. AVOID SKIN CONTACT.
WEAR EYE PROTECTION.

The role of enzymes in digestion

You need:

- boiling tubes
- test tubes
- visking tubing
- beakers
- thermometers
- starch solution
- amylase solution
- Benedict's reagent
- iodine solution
- Bunsen burner
- spotting tiles

Method

- 1 Fill half a beaker with water and heat it to 37°C.
- 2 Fill three test tubes with water at 37°C and place them in the beaker.
- 3 Prepare three lengths of visking tubing by tying one end of each and filling them with starch solution, amylase solution, and an equal mixture of starch and amylase solution, respectively.
- 4 Place the three visking tubings in the three test tubes.
- 5 Test the starch solution and amylase solution with Benedict's reagent and iodine solution.
- 6 After 8–10 minutes test the water in the three test tubes with iodine solution and Benedict's reagent. Repeat after 10 minutes and record the observations in a table.

Questions

- 1 Why are Benedict's reagent and iodine solution used in the experiment?
- 2 What substances in the experiment act as digestive enzymes?

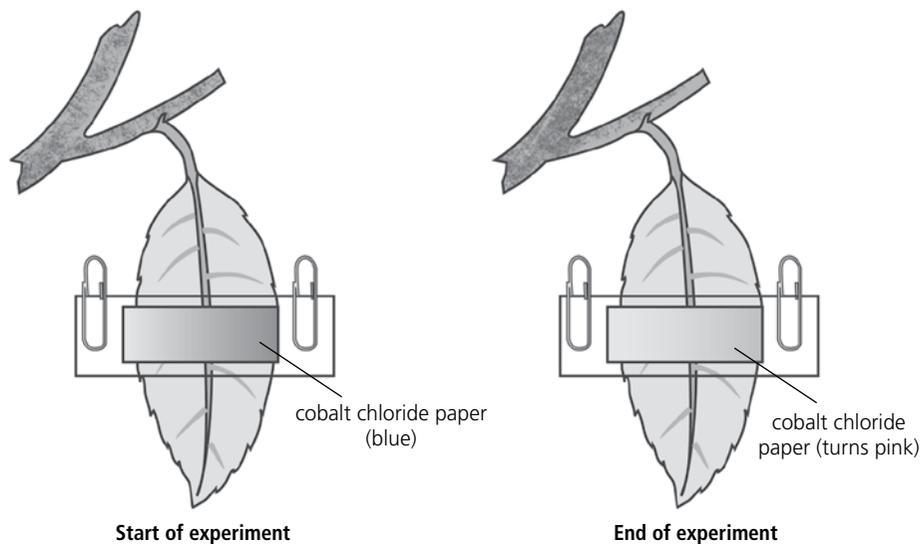
Transpiration in leaves

You need:

- a potted plant
- two glass slides
- two strips of cobalt chloride paper
- rubber band
- a large plastic bag

Method

- 1 Water the soil of the potted plant and then cover the soil with the plastic bag so that no water escapes into the air.
- 2 Wipe the upper and lower surfaces of a green leaf with a clean piece of tissue paper. Sandwich the leaf between the two strips of cobalt chloride paper.
- 3 Place a glass slide to cover each of the strips of cobalt chloride paper and secure the ends of the two glass slides together using a rubber band.
- 4 Place the potted plant in sunlight or near a lighted bench lamp. Cobalt chloride is a chemical which is blue in colour but turns pink when exposed to water.



Questions

- 1 Why was the glass slide used to cover the strips of cobalt chloride paper?
- 2 Did both strips of cobalt chloride paper turn the same shade of pink?
- 3 How would you deduce, from this experiment, which surface of a leaf has a larger number of stomata?

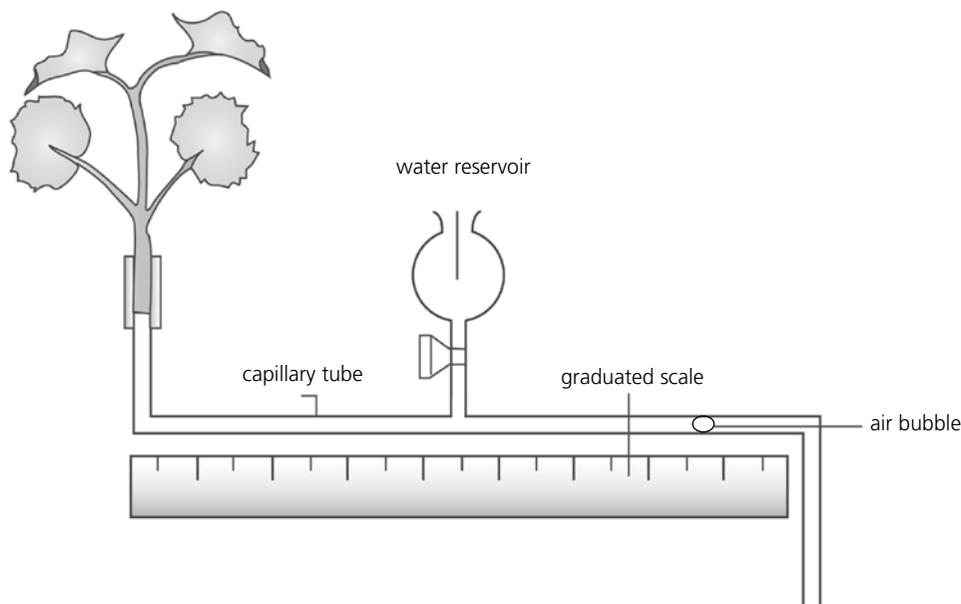
Rate of transpiration

You need:

- potometer
- pipette
- dye
- freshly cut shoots from a green plant containing several leaves
- bench lamp
- ruler
- fan

Method

- 1 Fill the potometer with water until the water falls from the open end of the capillary tube. Close the tap so that no more water enters the potometer while it is filled with water.
- 2 Remove a drop of water from the end of the capillary tube and introduce a drop of dye in its place.
- 3 Insert the green shoot in the wide mouth of the potometer and place a bench lamp near the apparatus.
- 4 As transpiration occurs from the green leaves the drop of dye moves along the capillary tube and the distance it moves can be read from the attached ruler.
- 5 Take readings of the distance travelled by the drop every two minutes. Record the results in a table.
- 6 The experiment can be repeated at different light intensities and with a fan directed towards the leaves to check the rate of transpiration under different weather conditions.



Questions

- 1 Why does the drop of dye move along the capillary tube?
- 2 How does the distance travelled by the dye represent the rate of transpiration?
- 3 Which weather condition is represented by the fan?
- 4 How would you restart the experiment?

Transport tissue in plants

You need:

- microscopes
- slides and coverslips
- razors
- damp sand or cotton
- sunflower, white rose, or any herbaceous dicotyledonous plant along with root, stem, and one or two leaves
- germinated broad beans
- white tiles
- Petri dishes
- paintbrushes
- eosin dye
- jam jar
- blotting paper

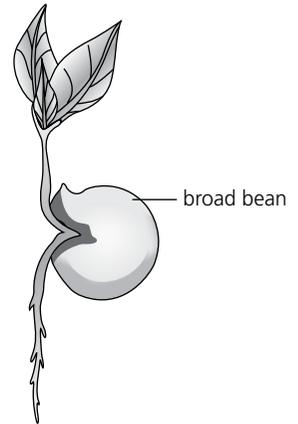
Water-conducting tissue of dicotyledonous green plants

- 1 Obtain a small dicotyledonous plant, preferably white rose or sunflower. Place it in a beaker half-filled with eosin dye and leave it for 24 hours.
- 2 Look carefully at the leaf veins. Observe and describe what has happened. Explain what has happened.
- 3 Lay the plant on a white tile and use a razor to cut thin slices off the root, stem, and leaf. Continue until you have a slice so thin it is almost transparent.
- 4 Use a paintbrush to transfer the slice. Add a drop of water and lower a coverslip over each slide of the root to a microscope slide, the stem to another slide, and the leaf to another.
- 5 Make a drawing of each slide showing which areas have turned red. What are these areas?

Compare root and stem of beans

- 1 Germinate a number of broad bean seeds by trapping them against the sides of a jam jar with a cylinder of blotting paper filled with damp sand or sawdust. Leave them until the root and stem have developed.
- 2 Clamp a bean over a beaker of eosin so that its root is immersed in the dye. Leave it until the dye becomes visible in the leaf veins.
- 3 Cut thin slices of the root and stem, and make drawings to show which areas have become stained red.

What is the difference between the position of xylem in a bean stem and root?



Your teacher will be looking for:

- careful use of the apparatus given
- good observation
- good presentation of results through diagrams

HAZARD WARNING

Razor blades are sharp—
handle with care.

Pulse and breathing rates

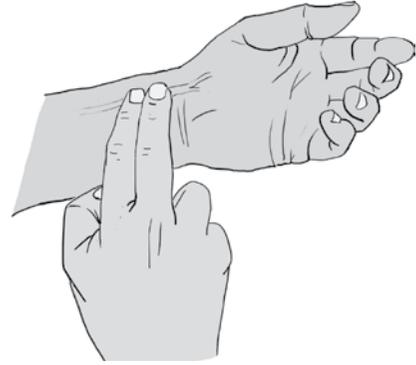
You need:

- clock or watch with a second hand
- bench or step about 30 cm high

A standardized fitness test

(Check with your teacher whether you should do these exercises *before* beginning this activity.)

- 1 Form groups of three. You will take it in turns to do a standardized exercise. (The two members of the group who are not exercising keep time and measure breathing and pulse rates.)
- 2 Before you start, measure and record your resting pulse rate and your resting breathing rate using the methods below:



Pulse rate: Place your fingers as shown in the diagram. Move them until you can feel a pulse. Count the pulses in 30 seconds, then multiply by two to get the pulse rate per minute.

Breathing rate: Count the number of breaths taken in 30 seconds and multiply by two.

- 3 One member performs the exercise while another calls out the time at one minute intervals.
- 4 Face the bench. Step onto it with one foot, then step up with the other foot. Step down with the first foot, then down with the second foot. Practise this so that you can step steadily at about 25 steps per minute.
- 5 When you and the timer are ready, start stepping and keep going at a steady speed for three minutes.
- 6 *Immediately* afterwards, one person measures the pulse rate of the 'exerciser'. At the same time, the other team member measures the exerciser's breathing rate. Keep a record of your results.
- 7 Continue monitoring the pulse rate and breathing rate at one-minute intervals until they return to normal.
- 8 Swap places and repeat steps 2 to 6 until you have all done the test.

Questions

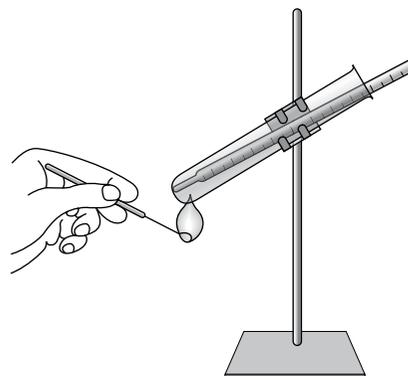
- 1 What are the fastest, slowest, and average *resting* pulse rates for the class?
- 2 What are the fastest, slowest, and average *resting* breathing rates for the class?
- 3 What are the fastest, slowest, and average pulse rates *after exercise* for the class?
- 4 What are the fastest, slowest, and average breathing rates *after exercise* for the class?
- 5 Is the fittest person the one with the lowest pulse rates or the highest?
- 6 How does fitness affect the time taken for the pulse to return to normal?

Measuring the energy values of foods

You need:

- Bunsen burner
- wooden splints
- stands and clamps
- boiling tubes
- mounted needles
- thermometers
- safety goggles
- screen
- measuring cylinder
- foods: shaped pasta, sunflower seeds, bread

- 1 Put 20 cm³ of water into a boiling tube. Fix the tube in a clamp so that it is held at an angle of 45° (see diagram).
- 2 Weigh a piece of shaped pasta very carefully, in grams (if possible to two decimal places), and note the result.
- 3 Fix the pasta onto a mounted needle, taking care that no bits drop off.
- 4 Measure the temperature of the water in the boiling tube and note the result.
- 5 Ignite the pasta in a Bunsen burner flame. *Quickly* place the burning pasta under the boiling tube. The idea is to use as much heat as possible from the burning pasta to heat the water in the tube.
If the pasta goes out, relight it quickly and put it back under the tube.
When the pasta has completely burnt, measure the temperature of the water in the boiling tube again and note the result.
- 6 Before you can go any further you must know:
 - the mass of water in the boiling tube (1 cm³ of water weighs 1 g)
 - the rise in temperature of water in the boiling tube
 - the mass of the pasta



- 7 It takes 4.2 joules of energy to raise the temperature of 1 g of water by 1°C, therefore you can calculate the energy given off by 1 g of pasta as follows:

$$\frac{\text{mass of water} \times \text{rise in temperature} \times 4.2}{\text{mass of the pasta}}$$
 (in grams)
- 8 Compare your result with what is stated on the packaging. Your result will be much lower than the actual energy value of 1 g of pasta. Give as many reasons as you can why this is so. Despite this fact, if you use this method to find out the energy value of other foods, your results can still be compared. Why is this so?
- 9 Use this method to find out the energy values (in joules per gram) of the foods provided. Produce a results table and comment on your findings.
- 10 Design an improved method which will give a more accurate result. (Hint: Is there any way of reducing heat loss to the air?)

Your teacher will be looking for:

- careful use of the apparatus given
- accurate measurements of volume of water, mass of food, and temperature
- accurate recording of results and successful calculations of energies
- critical evaluation of the experiment and sensible suggestions for improving it

HAZARD WARNING

Wear EYE PROTECTION when burning foods. Use a safety screen.

Demonstrating respiration

You need:

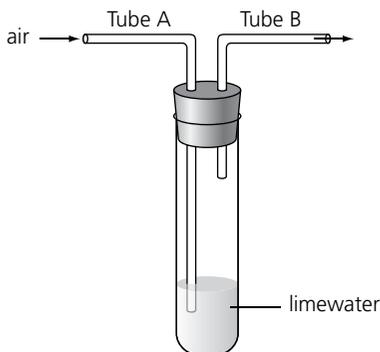
- boiling tube and rubber bung with two holes
- glass tubing
- rubber tubing
- limewater
- four conical flasks and four rubber bungs with two holes each

Compare breathed and unbreathed air

- 1 Prepare the apparatus shown below, on the left. How long does it take for limewater to turn milky when you blow air gently down tube A? Wash out the boiling tube and refill with fresh limewater. How long does it take for limewater to turn milky when you suck air gently through tube B?

Questions

- 1 What turns limewater milky?
- 2 What do your results tell you about the difference between laboratory air and breathed air?
- 3 What exactly do your results prove?

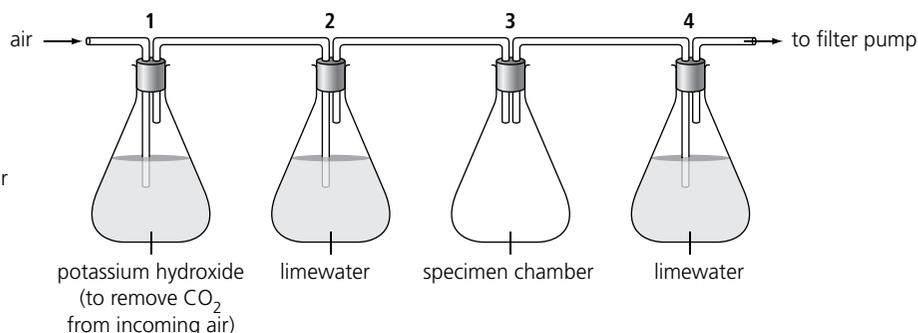


Demonstrate respiration in animals and plants

- 1 Set up the apparatus on the right below. What is the purpose of flask 1? Why is flask 2 necessary? What does the apparatus demonstrate?
- 2 Investigate woodlice, maggots, earthworms, etc. in a small specimen chamber. Use a bell jar to investigate larger animals.

Questions

- 1 How could you use this apparatus to make rough comparisons of respiration rates in, for example, woodlice, and earthworms?
- 2 What things would you need to keep the same?
- 3 How would you set up the apparatus to demonstrate respiration in plants?



Your teacher will be looking for:

- accurate observation
- good presentation of results
- care with live specimens
- sensible conclusions that match your results

HAZARD WARNING

Soda lime is CORROSIVE and can cause severe burns; also dangerous to eyes and skin.
 AVOID SKIN CONTACT.
 AVOID CONTACT WITH WATER.
 WEAR EYE PROTECTION.

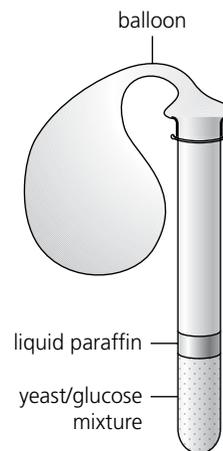
Anaerobic respiration

You need:

- test tubes
- thermometer
- balloons
- measuring cylinder
- limewater
- liquid paraffin
- yeast in cold boiled water
- glucose in cold boiled water
- boiled peas in cold boiled water containing bactericide (e.g. sodium chlorate(I) 10%)

Anaerobic respiration (fermentation) in yeast

- 1 Label three test tubes A, B, and C.
Place 20 cm³ of yeast suspended in cold, boiled water into tube A. (Boiling removes oxygen from water.) Add a few drops of liquid paraffin (to cover the surface of the yeast suspension). Place 20 cm³ of glucose dissolved in cold boiled water into tube B. Add liquid paraffin. Place 10 cm³ of yeast suspended in cold boiled water into tube C, then add 10 cm³ of glucose dissolved in cold boiled water. Mix the two together. Add a few drops of liquid paraffin.
- 2 Place a balloon firmly over the neck of each tube (tie with cotton if necessary). Make sure the balloon is deflated. Put the tubes in a warm place for 24 hours.
- 3 Record what happens to the balloons.
Explain your observations.
Why was cold boiled water used in this experiment?
Why was liquid paraffin added to each tube?
What gas entered the balloon?



Anaerobic respiration in peas

- 1 Fit two thermos flasks with bungs through which a thermometer has been passed. Label the flasks A and B.
- 2 Fill flask A with boiled peas in cold boiled water containing bactericide. Fill flask B with fresh peas in cold boiled water. Note the temperature of each flask.
- 3 Place the bung in each flask, so that air cannot enter and leave them for a week. Note any temperature changes daily.
- 4 Explain any changes which occur in the temperature, and in the peas.
Why was one set of peas boiled?
Why were both sets of peas placed in cold boiled water. Why was bactericide added to flask A?

Your teacher will be looking for:

- careful and skilful use of the apparatus given
- good observation and presentation of results
- sensible conclusions that match your results

HAZARD WARNING

Sodium chlorate(I) solution is corrosive. AVOID SKIN CONTACT.
WEAR EYE PROTECTION.

Skin and sensitivity

You need:

- pair of dividers (a metal hairpin will do)
- mounted needle (pin will do)
- ruler with millimetre scale

Since the skin is in direct contact with the environment, you should not be surprised that it has many sensory cells within it. In this series of experiments you will be able to investigate the distribution and the method of action of some sensory cells in the skin.

Method

Work in pairs throughout these experiments.

Variation in sensitivity in different regions of the skin

- 1 Use a pair of dividers to apply two simultaneous touch stimuli to the outside of your partner's forearm. The points should be exactly 4 cm apart and the subject (blindfolded or looking in the opposite direction) should say when he or she feels them as two separate sensations.
- 2 Now reduce the distance between the points of the dividers and determine the minimum distance by which the stimuli must be separated for the subject to feel both of them (in other words, find the distance at which the two points seem to be causing a single stimulus).
- 3 Repeat the experiment on other parts of the body as listed below. Take great care when working on or near the subject's face. In each case record the distance at which the two stimuli are 'sensed' as one.

Outside of forearm; fingertips; back of hand; palm of hand; lips; shin; back of neck; inside of forearm; sole of foot.

- 4 Record your results in a table.

Calculate the mean values for your class, and present them in the form of a table. Ask every subject to note the minimum distance for 'sensing' a single sensation in each of the mentioned areas. Record these results in a histogram and use it to deduce the most sensitive area of the body. Compare the results with those of other students in the class.

- 5 Now explain your results.

Why are some parts of the skin more sensitive than others? Use a simple diagram to help your explanation

What is the relevance of your results to blind people who read Braille?

Adaptation to stimuli

- 1 With a mounted needle wiggle one of the hairs on your partner's arm or hand until he or she can no longer feel it. How long did it take for the sensory cell at the base of the hair to adapt?
Why is it an advantage to get used to stimuli of this kind?
- 2 Wiggle another hair just long enough for your partner to appreciate the sensation. Now rub the skin vigorously with your finger for 15 seconds, and wiggle the hair again. Can he or she still feel it? Suggest an explanation for what has happened.

Heat loss from a model body

It is possible to represent the body of a human being with a model made up of a boiling tube two-thirds filled with water. If the temperature of the water is raised, and a temperature gradient is established between the tube contents and the surroundings, it is possible to investigate heat loss from the body. To ensure measurable changes, this activity requires that you preheat the contents of the tube to boiling point and construct cooling curves to demonstrate heat loss over a fifteen-minute period.

You need:

- three boiling tubes
- -10°C to $+110^{\circ}\text{C}$ thermometer
- beaker, 1 dm^3
- two retort stands with clamps
- Bunsen burner, tripod, gauze, heat-resistant mat
- test tube holder
- two squares of denim cloth, each large enough to wrap around the boiling tube to give a single layer of material
- two squares of aluminium foil, each a little (1 cm all round) larger than the pieces of denim
- stopwatch
- test tube rack
- wash bottle
- hairdrier

Method

- 1 Assemble the apparatus as described in the introductory paragraph, and construct a cooling curve for the uncovered boiling tube. Now use the apparatus to investigate the statement:
“Denim jeans are adequate for a low level stroll, but wet denim on a windy hillside represents a potentially lethal combination”
- 2 Present your results in a suitable table. Plot a graph of your results.
- 3 Comment on the significance of your results.
- 4 List any major sources of error, and suggest improvements which might be made to the experimental technique.
- 5 Suggest extensions of the activity which you might make, using the same or very similar apparatus.

The function of perspiration

You need:

- thermometers
- cotton wool
- small beakers of water and alcohol

Method

- 1 Wave your hand backwards and forwards in front of you. Does it feel warmer or cooler?
- 2 Swab a little water onto the back of one hand with cotton wool and wave it backwards and forwards again. What does the wet part feel like compared with the dry parts?

Note any feelings to do with temperature sense.

- 3 Dry your hand, then swab a little alcohol onto it with cotton wool. Wave it backwards and forwards again. What does the alcohol-treated part feel like compared with the dry parts?

Note any feelings to do with temperature sense.

Does the alcohol give you a sensation which is different from water?

- 4 What conclusion can you draw at this stage of the experiment?
- 5 Obtain three thermometers. Record the temperature of each. Wrap the bulbs of all three thermometers in a thin layer of cotton wool. Tie it in place with cotton. Leave the thermometers to acclimatize for five minutes, then record the temperature reading of each.
- 6 Take one thermometer (with dry cotton wool) and wave it for one minute, then record the temperature reading. Take another thermometer, dip it into water, wave it for one minute, then record the temperature reading. Take a third thermometer, dip it in alcohol, wave it for one minute, then record the temperature reading.

Questions

- 1 How do the results with a thermometer dipped in water and alcohol compare with those from the thermometer covered with dry cotton wool?
- 2 How do the results of the thermometer experiment help to explain the results from treating skin with water and alcohol?
- 3 Alcohol evaporates more quickly than water. Use this information to explain results from both experiments. What do these results tell you about the function of perspiration?



A chemist has invented a new, harmless liquid that evaporates quickly. She wants to sell it in swabs which people can use to wipe themselves when they feel very hot.

Design an experiment to compare the effectiveness of this invention with a wet cloth.

Your teacher will be looking for:

- careful and safe use of the apparatus given
- accurate observation
- good presentation of results
- sensible conclusions

HAZARD WARNING

Alcohol is highly flammable.
KEEP AWAY from naked flame.
WEAR EYE PROTECTION.

Measuring the speed of reflexes

You need:

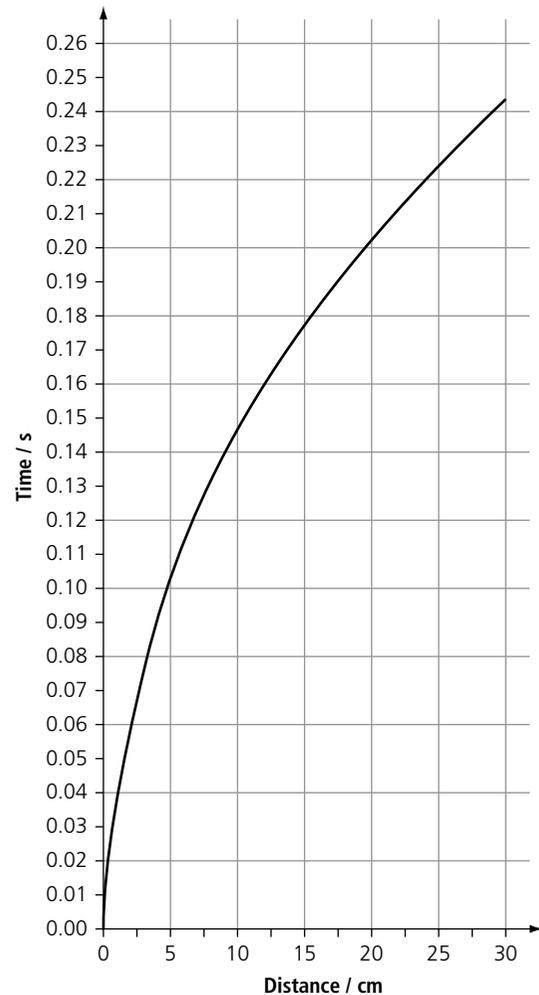
- metric rulers

Measure the speed of your reflexes

- 1 Work in pairs. One student holds a ruler between thumb and forefinger so that the ruler hangs with its zero mark at the bottom. The other waits with the thumb and forefinger of one hand about 2 cm apart and level with the zero mark of the ruler.
- 2 The student holding the ruler says 'ready', then drops the ruler within five seconds without further warning. The other student must catch the ruler between thumb and forefinger.
Note the number of centimetres the ruler has dropped by looking at the position of the thumb and forefinger on the ruler.
- 3 Calculate the average distance over at least ten ruler drops. Use the graph opposite to convert this distance into response time, in seconds. Draw a graph showing the range of results for the whole class.

Questions

- 1 Name all the parts of the nervous system through which impulses travel as you respond to the ruler dropping.
- 2 Your result is the time it takes for impulses to travel from your eyes to your hand. Measure this distance and use it to calculate the speed of nerve impulses, in metres per second.
- 3 Repeat the experiment for each of the other students in class and calculate the speed of nerve impulses for each student.
- 4 State three reasons why some students have a faster speed of response than the others.
- 5 What would happen if a motor nerve was severed in an accident? What would you observe if such a person tried to perform this practical? Explain your answer.



Preserving food

You need:

- seven test tubes
- peas
- distilled water
- dilute salt solution
- concentrated salt solution
- concentrated sugar solution
- vinegar
- cotton wool

Food can be preserved by slowing or discouraging the process of fermentation by micro-organisms like bacteria and fungi. This can be done by depriving the bacteria and fungi of water necessary for survival. Another alternative might be to use substances that are toxic to the micro-organisms.

Method

- 1 Mark the test tubes A to G and place 2-3 peas in each test tube.
- 2 Place test tube A in the refrigerator and test tube B on a shelf.
- 3 Add 5 cm³ distilled water in test tube C, dilute salt solution in test tube D, concentrated salt solution in test tube E, concentrated sugar solution in test tube F, and vinegar in test tube G.
- 4 Plug the top of each test tube with cotton wool and set the test tubes in a dry place.
- 5 Observe the test tubes after 1-2 days. Note in which of the test tubes the peas remain fresh.

Questions

- 1 What clue to freshness does the appearance of the solution provide?
- 2 What type of solution is better at preserving food—dilute or concentrated?
- 3 How do the salt and sugar solutions help to preserve the peas? How does vinegar help to preserve the peas?

Decomposition of cellulose by bacteria

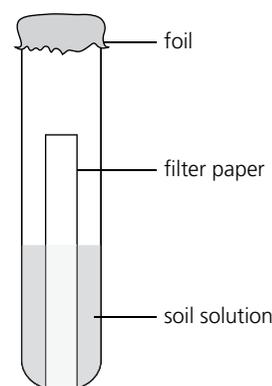
You need:

- tubes/containers of sterile salt solution
- filter paper
- spatula
- soil sample
- marking pen
- distilled water
- metal foil
- measuring cylinders, ruler

Paper is made from crushed and pulped wood—the plant cells have walls made up of cellulose.

Method

- 1 Label the tubes A, B, and C.
- 2 Add soil 1 cm deep in the 10 cm³ cylinder. Add water to make the volume up to 10 cm³. Shake the mixture.
- 3 Add 10 drops of this soil-water mixture to tube A. Try not to drip the mixture onto the filter paper in the tube. Seal with foil.
- 4 Add soil 1 cm deep in the second 10 cm³ measuring cylinder. Transfer the soil to the 100 cm³ cylinder. Add water to make the volume up to 100 cm³. Shake the mixture.
- 5 Using a clean dropper, add 10 drops of this soil-water mixture to tube B. Seal with foil.
- 6 Using a clean dropper, add 10 drops of distilled water to tube C. Seal with foil.
- 7 Keep the test tubes in a warm place for 14 days.
- 8 After 14 days, record the appearance of the filter paper near the air-water junction.
- 9 Shake the tubes. Record what happens to the filter paper.



Tube	Soil added	Appearance of filter paper	Effect of shaking
A	$\frac{1}{10}$		
B	$\frac{1}{100}$		
C	none		

Questions

- 1 If the filter paper falls apart on shaking, what does this show?
- 2 What was the purpose of tube C?
- 3 What is the importance of cellulose decomposition in the recycling of natural materials?

Extension

A yellow or orange stain on the filter paper indicates that cellulose has been digested. Which enzymes would be needed to decompose cellulose?

How could you test that the cellulose had been broken down to its subunits?

Humans build many wooden structures. How can we prevent this decomposition from damaging our buildings?

Animals cannot make cellulose-digesting enzymes. Find out how cattle are able to digest cellulose.

The effects of soap and pH on bacteria

You need:

- Petri dishes of sterile nutrient agar and tubes of nutrient broth
- tubes of nutrient broth
- bacteria culture
- sterile bulb pipettes
- incubator
- warm water, soap, and paper towels

How clean are your hands?

- 1 Label four Petri dishes of sterile nutrient agar A, B, C, and D.
- 2 **Dish A:** Take off the lid for 10 seconds, then replace it and seal the rim with sticky tape.
Dish B: Take off the lid and press the fingers of an *unwashed* hand onto the agar (it must not be broken up by too much pressure). Replace the lid within 10 seconds and seal it.
Dish C: Wash your hands in warm water only (no soap). Dry them with paper towels. Take off the lid and touch the agar as before. Replace the lid within 10 seconds, and seal it.
Dish D: Wash your hands *thoroughly* using warm water and soap. Dry them with paper towels. Take off the lid, touch the agar as before, replace the lid within 10 seconds and seal it.
- 3 Incubate the Petri dishes upside down at 30°C for a week. *Without opening them:*
 - (a) count the number of bacteria colonies in each dish
 - (b) count the number of different colonies in each dish
 - (c) design a results table

What do your results tell you about the cleanliness of washed/unwashed hands and the effectiveness of soap as a cleaning agent?

Investigate the effects of pH on bacterial growth

- 1 Add 8 cm³ of sterile nutrient broth to each of five sterile boiling tubes marked A, B, C, D, and E.
- 2 Add 1 cm³ of 0.1M hydrochloric acid to tube A. Add 1 cm³ of 0.0001M hydrochloric acid to tube B. Add 1 cm³ of distilled water to tube C. Add 1 cm³ of 0.0001M sodium hydroxide to tube D. Add 1 cm³ of 0.1M sodium hydroxide to tube E.
- 3 Inoculate each tube with 1 cm³ of bacterial culture, plug them with cotton wool, and seal with sticky tape.

Incubate the tubes at 25°C to 30°C for 48 hours.

Compare the cloudiness (**turbidity**) of each tube. What do your results tell you about the effect of pH on bacterial growth?

Further work

- a A hospital wants to test a new bactericidal soap for cleaning the hands of surgeons. Design an experiment to compare the new soap with the one they already use.
- b Onions and other vegetables can be preserved in weak acids such as vinegar. Design an experiment to find the strength of vinegar required to preserve vegetables at room temperature for at least one month.

Your teacher will be looking for:

- careful and safe use of the apparatus given
- accurate observation and recording of results
- good presentation of results in tables
- sensible conclusions

HAZARD WARNING

Wash hands thoroughly after touching agar. During incubation, plates SHOULD NOT be completely sealed. After incubation, plates must be completely sealed with tape before observing results.

Evolution by natural selection

You need:

- sheet of white paper
- newspaper
- forceps
- coloured pencils
- clock/watch with second hand
- 30 newspaper circles (made with hole puncher)
- 30 white circles (made with hole puncher)

In this exercise, you will simulate how predators locate prey in different environments. You will analyze how camouflage (colour and pattern) affects an organism's ability to survive in certain environments.

Method

- 1 Work in pairs. Place a sheet of white paper on the table. One student should spread 30 white circles and 30 newspaper circles over the surface while the other student (the 'predator') is not looking.
- 2 The 'predator' will then use forceps to pick up as many of the circles as he or she can in 15 seconds. This corresponds to the predator capturing and eating the prey species.
- 3 This trial should be repeated with white circles on a newspaper background, newspaper circles on a white background, and newspaper circles on a newspaper background.



Record the data in the chart below.

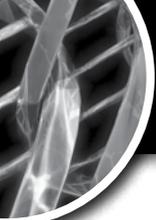
Trial	Background	Starting Population		Number 'eaten'	
		Newspaper	White	White	Newspaper
1	white	30	30		
2	white	30	30		
3	newspaper	30	30		
4	newspaper	30	30		

Questions

- 1 What type of tree surface is represented by the 'newspaper' background?
- 2 Which moth colouration (pale or dark) is the best adaptation for a 'smoke-polluted' background? How do you know?
- 3 Following trial 1, what has happened to the frequency of the allele for 'light' colouration?
- 4 Moths that survive, i.e. are not eaten by predators, can pass on their alleles when they reproduce. How does the simulation model natural selection?

Extension

- Find out the meaning of the term **Industrial Melanism**.
- Hospital managers are very worried about hospital infections. Explain how natural selection might lead to antibiotic-resistant strains of bacteria.
- How do the stripes on a zebra help it to avoid predators? Do the stripes on a tiger have the same effect?



Cell structure and organization

1

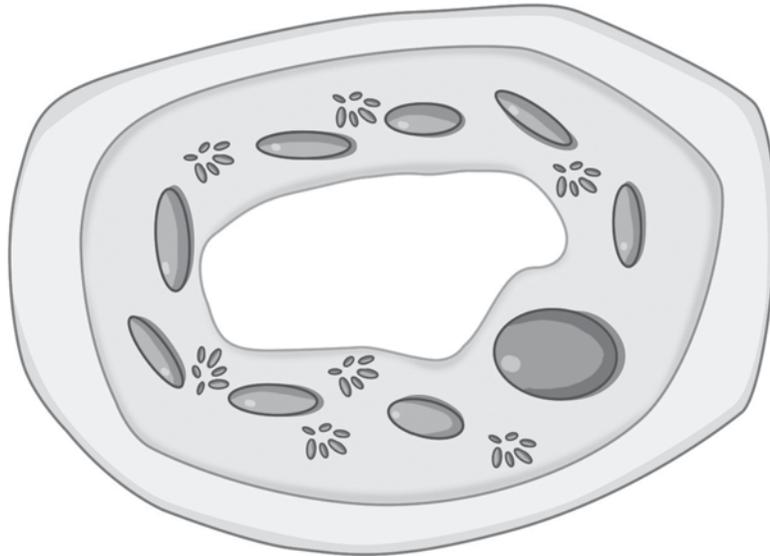


Fig. 1.1

(a)

(i) Mark the following on Fig. 1.1: cell wall, cell membrane, sap vacuole, nucleus, chloroplast.

[5]

(ii) What role do chloroplasts perform during photosynthesis?

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

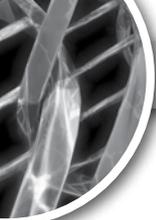
(iii) Which structure enables a plant cell to retain its shape better than an animal cell?

..... [1]

(iv) Name two types of plant tissue.

..... [2]

[Total: 10]



2

(a)

(i) Draw a labelled diagram of an animal cell in the space below:

[5]

(ii) If the diameter across an animal cell measures 0.01 mm, calculate the magnification of your diagram.

.....

.....

..... [4]

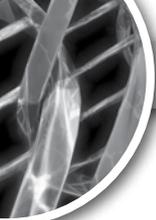
(iii) Compare animal cells with plant cells in Table 2.1:

Table 2.1

Feature / Characteristic	Animal cell	Plant cell
Cell wall		
Vacuole		
Mode of nutrition		
Chloroplasts		
Stored food		

[5]

[Total: 14]



3

(a)

- (i) A student observed red blood cells, muscle cells, and root hair cells under a microscope. List two features for each type of cell that could help him to identify the cells.

.....

.....

..... [6]

- (ii) How are ciliated cells adapted for filtering air entering the lungs?

.....

..... [2]

- (iii) Name two cells that require a large surface area to perform their function.

..... [2]

[Total: 10]

4

(a)

- (i) Use arrows to illustrate how specialized cells combine into complex organ systems.

[4]

- (ii) Why is cell specialization observed in multicellular organisms?

.....

.....

.....

..... [2]

[Total: 6]

Plant nutrition

- 1 A student placed a potted plant in the dark for 24 hours. He then picked a leaf from the plant before placing the plant in the light for 3 hours. He then picked a second leaf from the plant and performed the following steps on both the leaves:
- He placed the leaves in boiling water for 2 minutes.
 - He placed the two leaves in test tubes containing alcohol, which were placed in a beaker containing hot water from under which the Bunsen burner had been removed.
 - He then placed the leaves in cold water.
 - He placed each leaf in a Petri dish and flooded it with iodine solution.

The results are shown in Fig. 1.1:

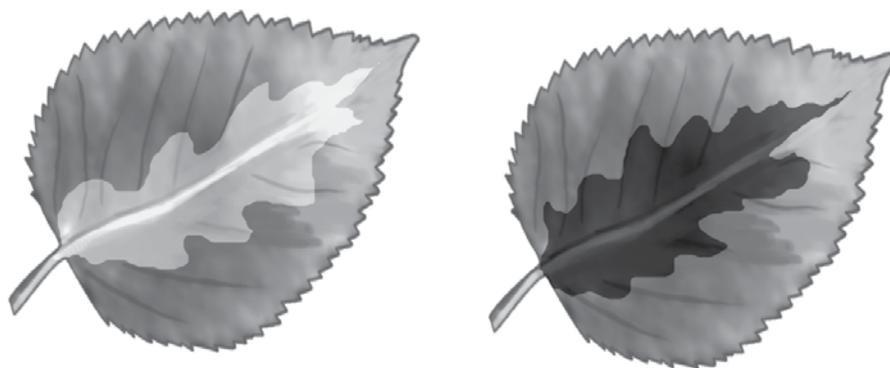


Fig. 1.1

(a)

- (i) Why were the leaves placed in boiling water?

.....
 [1]

- (ii) Why were the leaves placed in hot alcohol?

.....
 [2]

- (iii) Why was the Bunsen burner turned off when the alcohol was placed in the hot water bath?

..... [1]

- (iv) Why did the student use hot alcohol and not boiling alcohol?

..... [1]

- (v) Why do the two leaves in Fig. 1.1 look different?

.....
 [2]

[Total: 7]

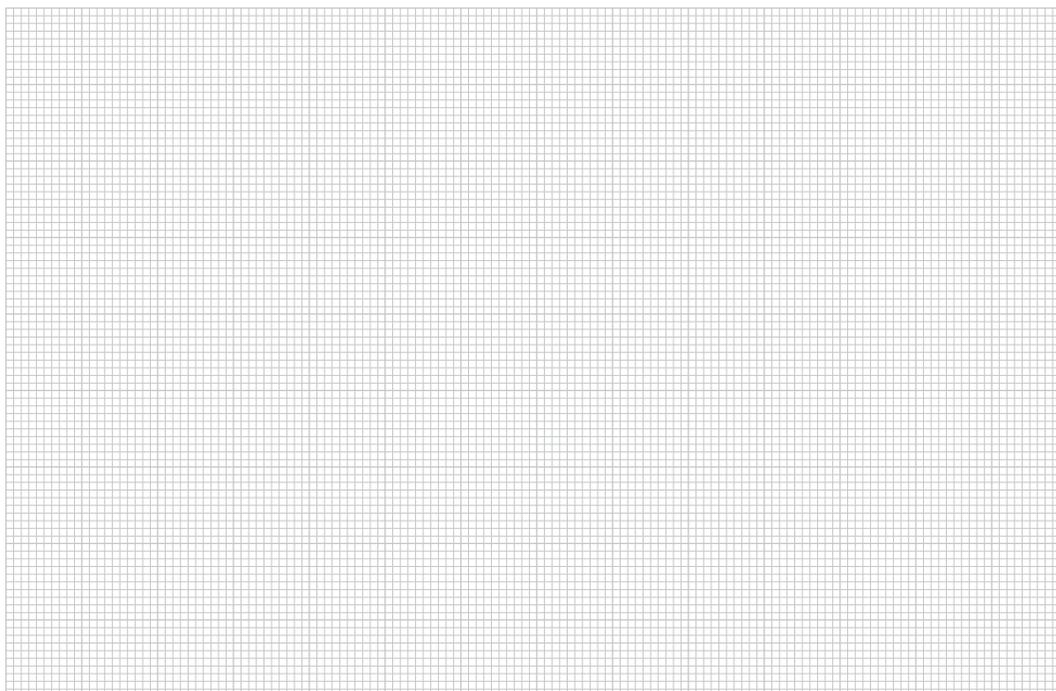
- 2 A student investigated the effect of temperature on the rate of photosynthesis. He placed Elodea plants (pondweed) in a beaker of water. He then added a pinch of sodium hydrogen carbonate powder to the water.
- He placed a 60-watt lamp at a distance of 40 cm from the beaker.
- He placed the beaker in a hot water bath maintained at 25°C and counted the bubbles released every 5 minutes. He repeated the experiment at temperatures of 35°C, 45°C, 55°C, 65°C, and 75°C, and recorded the results in a table. At every temperature, he allowed the experiment to run for five minutes before counting the bubbles. The results are shown in Table 2.1:

Table 2.1

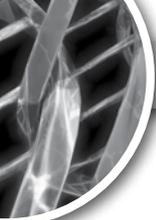
Temperature / °C	Number of bubbles released in five minutes
25	20
35	40
45	43
55	18
65	0
75	0

(a)

- (i) Plot a graph for the data in Table 2.1:



[4]



(ii) Why was sodium hydrogen carbonate added to the water?

..... [1]

(iii) Name the gas released by the pondweed.

..... [1]

(iv) Why was the experiment allowed to run for 5 minutes before recording the results?

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

(v) Why were no bubbles observed at the last 2 readings?

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

(vi) What can you conclude about the relationship between temperature and photosynthesis from this experiment?

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

[Total: 12]

3 Fig. 3.1 shows a stoma along with guard cells:

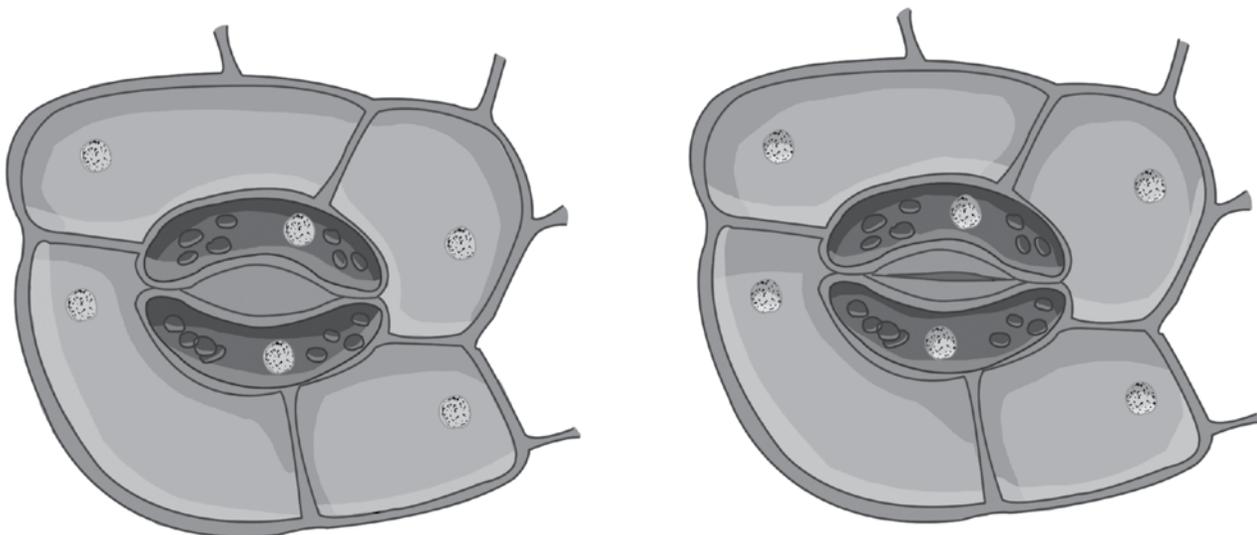
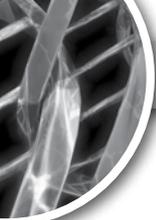


Fig. 3.1



(a)

(i) Draw a large diagram of the stoma and its guard cells in the space below:

[4]

(ii) If Fig. 3.1 is magnified x 1800, calculate the magnification of your diagram with the original size of the stoma.

.....
.....
.....

[4]

(iii) Describe the process by which the guard cells control the opening of the stoma.

.....
.....
.....
.....

[4]

[Total: 12]

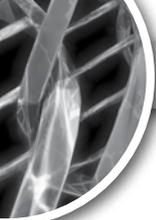
4

(a)

(i) Identify how the following are adapted for photosynthesis: leaf, chloroplast, palisade cell.

.....
.....
.....

[3]



(ii) Write down the word equations for photosynthesis and respiration.

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

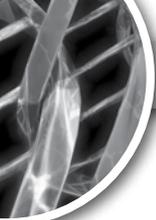
(iii) Name the gas produced during photosynthesis. How can the gas be tested in a laboratory experiment?

..... [1]

(iv) How does the term compensation point describe the relationship between photosynthesis and respiration?

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

[Total: 9]



Animal nutrition

- 1 A student decided to carry out an investigation into the mode of nutrition of sundews. The student collected the glistening drops of secretion from the flower-like leaves of the sundew. He placed them in 2 test tubes marked A and B. In test tube A, he placed a 1 cm³ piece of meat. In test tube B, he first boiled and cooled the secretion, and then placed a 1 cm³ piece of meat in it. After one hour, the meat in test tube A was broken down into small pieces.

(a)

- (i) What conclusion about the nature of the sundew secretion did the student draw from the results of test tube A?

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

- (ii) Why was no change seen in test tube B?

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

- (iii) What does this tell us about the mineral content of the soil on which these plants grow?

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

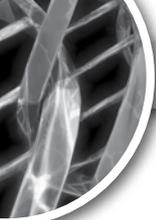
- (iv) How does the sundew produce its carbohydrates?

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

- (v) Name the part of the human body which produces a chemical similar in action to the secretion produced by the sundew.

..... [1]

[Total: 9]



- 2 Tooth decay occurs when the tooth enamel comes into contact with acid. A student decided to carry out an investigation into the source of these acids in the mouth. He obtained some debris from between the teeth of a person two hours after he had had a meal.

He then set up 4 test tubes marked A, B, C, and D, and added equal volumes of water to each tube. He then placed a few drops of methyl-red indicator to each tube. The indicator turns red below pH 7 and yellow at pH 7. Table 2.1 shows the results obtained:

Table 2.1

Test tube	Glucose	Debris	Indicator	Colour
A	✓	✓	✓	Red
B	✓	✗	✓	Yellow
C	✗	✓	✓	Yellow
D	✓	✓	✓	Yellow

(a)

- (i) State three reasons for the results shown in each test tube.

Test tube A

.....

.....

.....

Test tube B

.....

.....

.....

Test tube C

.....

.....

.....

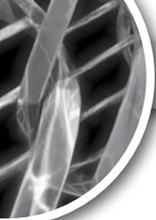
Test tube D

.....

.....

.....

[8]



(ii) What conclusion can be drawn from these results?

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

(iii) With reference to your results in part (i) explain why a good toothpaste:

- has a pH of around 8

.....
.....

- contains a substance that can kill bacteria

.....
.....

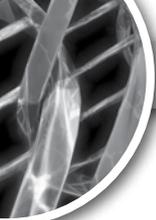
- contains fluoride

.....
..... [6]

(iv) Draw a labelled diagram of a tooth in the space below:

[2]

[Total: 18]



3 Four food tests were carried out on a food sample. The results are shown in Table 3.1:

Table 3.1

Tests	Observations
Iodine test	pale yellow
Benedict's solution	colour change from blue to red
Ethanol test	clear, colourless solution
Biuret test	colour change from blue to purple

(a)

(i) Interpret the observations to state what was present in the food sample.

.....
 [1]

(ii) Describe the method for carrying out the Benedict's test.

.....

 [3]

(iii) What was the reason for the colour change from blue to red in the Benedict's test?

.....
 [2]
 [Total: 6]

4

(a)

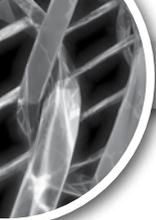
(i) Under a microscope slide, the lining of the intestine is seen to be covered with projections called villi. What function do the villi serve?

..... [1]

(ii) State the functions of the following: stomach, large intestine, liver.

.....

 [3]



(iii) Identify the terms used for the following:

conversion of amino acids of one kind into another

.....

absorption of digested food by the body cells

.....

breakdown of toxins in the liver

..... [3]

[Total: 7]

Transport in humans

1 Fig. 1.1 shows different types of blood cells.

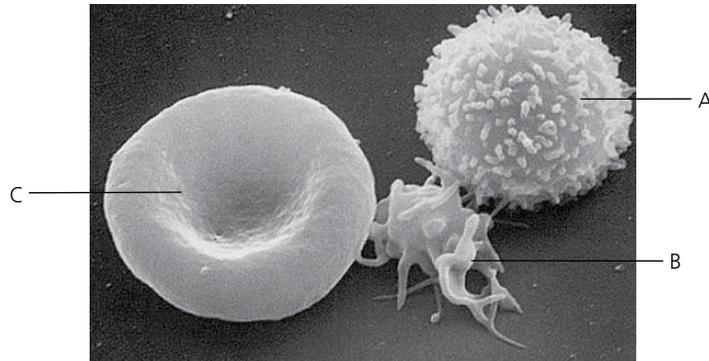


Fig. 1.1

(a) Label the cells marked A, B, and C.

A

B

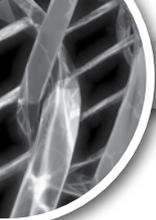
C

[3]

(b)

(i) Draw and label a diagram of cell A in the space below:

[5]



(ii) Calculate the magnification of your drawing from the photograph of cell A given in Fig. 1.1.

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

(c) An athlete training for a race went to a hill station to carry out his training.

(i) State two advantages to the athlete of training at a high altitude.

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

(ii) How long would it take before the athlete's stamina returns to its original level?

..... [1]

[Total: 14]

2 A group of students were investigating blood clotting time. The middle finger of each student was pricked with a fresh lancet and the blood touched onto filter paper every five seconds until finally no further blood smear appeared. The total time for the blood to clot is called the clotting time. The results of the class are presented in Table 2.1 below:

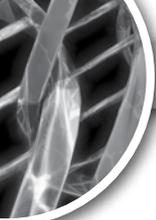
Table 2.1

Number of students	Clotting time / s
4	30
7	22
10	38
2	15
1	45

(a) Draw a bar chart for the data in Table 2.1:



[3]



(b) Present the data in the form of a pie chart in the space below:

[3]

(c) Suggest one reason for the student having a clotting time of 45 seconds.

.....

..... [2]

(d) How is a brief clotting time of importance in preventing infection?

.....

..... [2]

[Total: 10]

3 The pulse rate and blood pressure of two students was checked just before a race. The results are given in Table 3.1 below:

Table 3.1

	Student A	Student B
Pulse rate	110	78
Blood pressure	High	Normal

(a)

(i) Suggest two reasons why the pulse rate of student A is higher than that of student B.

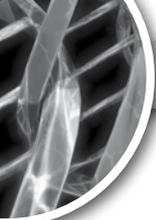
.....

..... [2]

(ii) Suggest two reasons why student A has a higher blood pressure than student B.

.....

..... [2]



(iii) Student B won the race. How would you account for it?

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

[Total: 6]

4

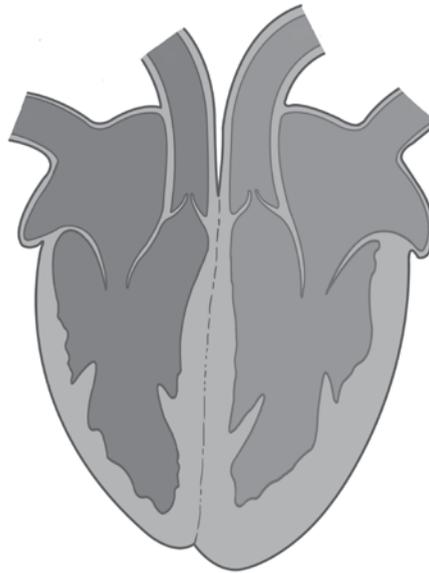


Fig. 4.1

(a)

(i) Label the following in Fig. 4.1: aorta, pulmonary vein, pulmonary arteries, vena cava. [4]

(ii) Identify two structural differences between veins and arteries.

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

(iii) Stressful lifestyles are a major cause of coronary heart disease. Identify two more causes.

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

(iv) What role to valves play in the circulation of blood throughout the body?

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

[Total: 10]

Respiration

- 1 A student carried out an investigation on how the mass of seeds decreases during respiration. The student divided 200 seeds from the same packet into six batches. He placed five batches in agar jelly while batch 6 was weighed and then placed in a drying oven for eight hours to remove any moisture from the seeds. It was then weighed again. One of the other batches was taken after every two days; the agar was carefully washed off, and the seeds were placed in the drying oven for eight hours. The readings were recorded in Table 1.1 below:

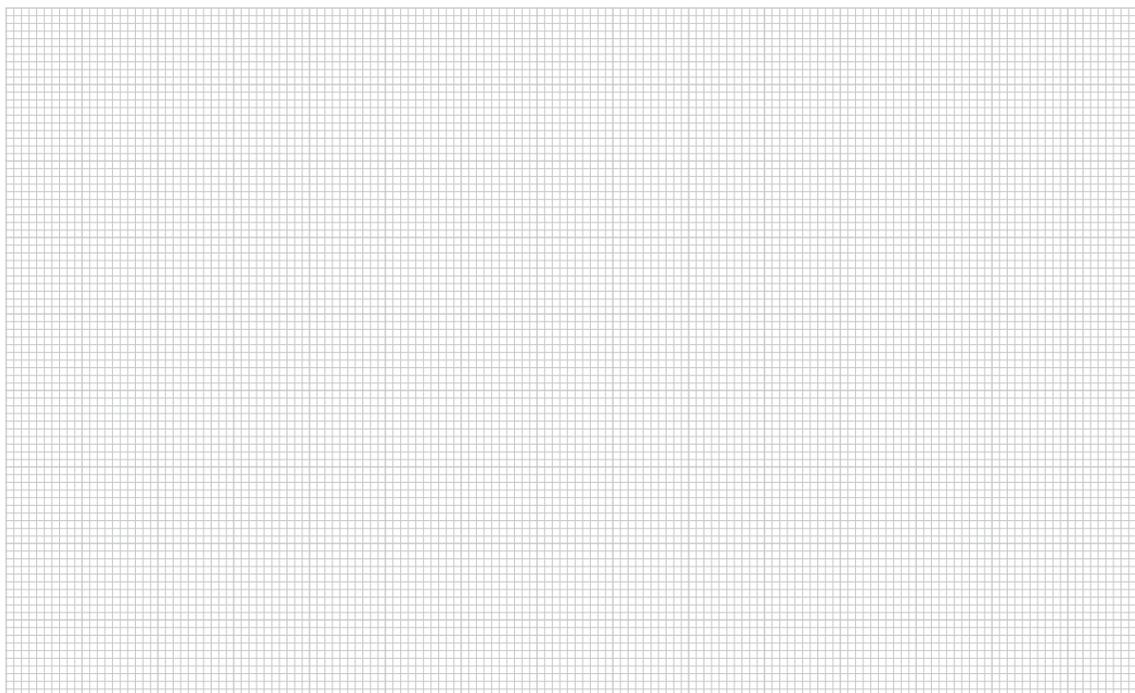
Table 1.1

Batch	Days	Mass / g			% change	Corrected % change
		Initial	Final	Difference		
A	0	16.5	16.2	0.4	2.4	
B	2	16.6	16.1	0.5	3.0	0.6
C	4	15.9	15.0	0.9	5.7	3.3
D	6	15.8	14.7	1.1	7.0	4.6
E	8	16.5	14.8	1.7	10.3	7.9
F	10	16.3	14.5	1.8	11.0	8.6

The percentage change was calculated and the decrease in mass of the first batch of seeds was used to calculate the corrected percentage change.

(a)

- (i) Use the corrected percentage change over time to plot a graph of these results.



[4]

(ii) Why did the first batch of seeds show a decrease in mass?

..... [1]

(iii) Name the process that caused a decrease in the dry mass of the seeds.

..... [1]

(iv) The experiment was carried out in total darkness. Why?

.....
 [2]

[Total: 8]

- 2 Respiration involves the combination of glucose with oxygen to produce carbon dioxide, water, and energy. Three batches of 20 pea seeds each from the same packet were soaked in water for 24 hours and placed between damp sheets of blotting paper for another 24 hours. They were then placed in three thermos flasks as shown in Fig. 2.1. Batch B was dipped in a solution that kills bacteria without harming seeds. Batch C was dipped in formalin which kills both bacteria and seeds.

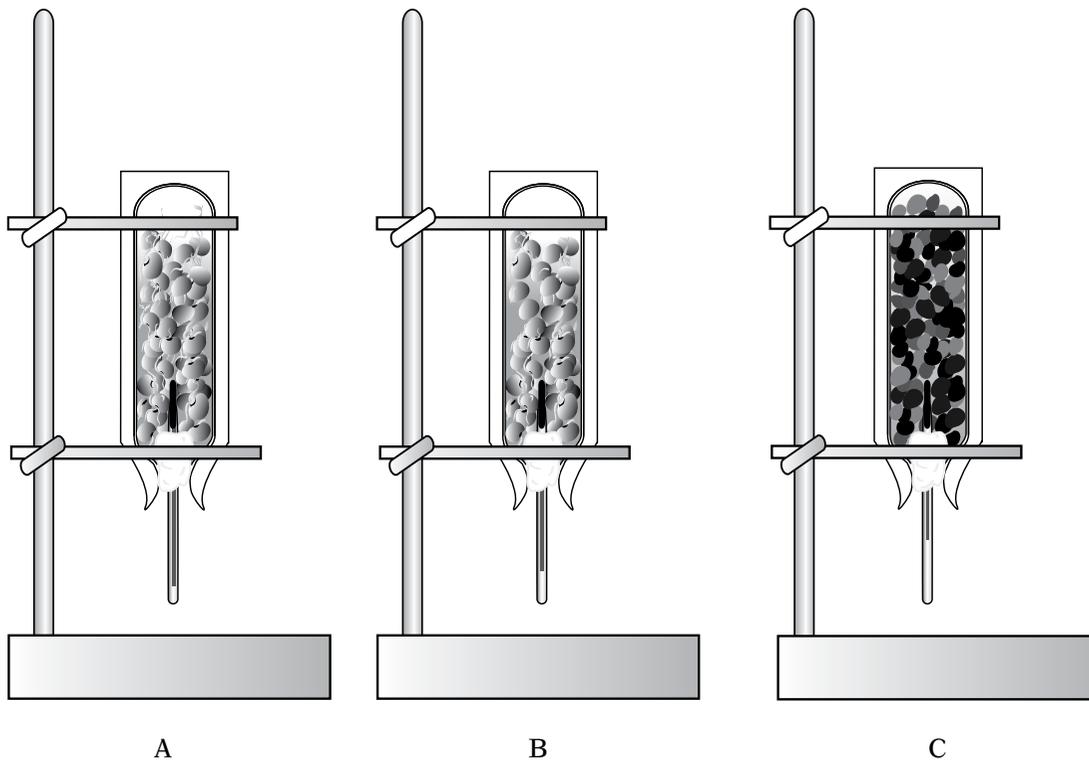
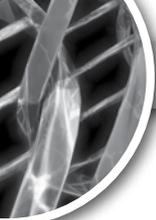


Fig. 2.1

(a)

(i) Which flask acted as the control? Explain your answer.

.....
 [2]



(ii) Why was the rise in temperature of flask A greater than the rise in flask B?

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

(iii) Why did the temperature change in flask A slow down after 30 hours?

..... [1]

(iv) Why were the thermos flasks inverted for this experiment?

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

(v) Why was cotton wool used instead of rubber stoppers to close the mouth of the flasks?

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

[Total: 9]

3 Fig. 3.1 shows sections of lung tissue from a normal lung and from the lung of a person suffering from emphysema:

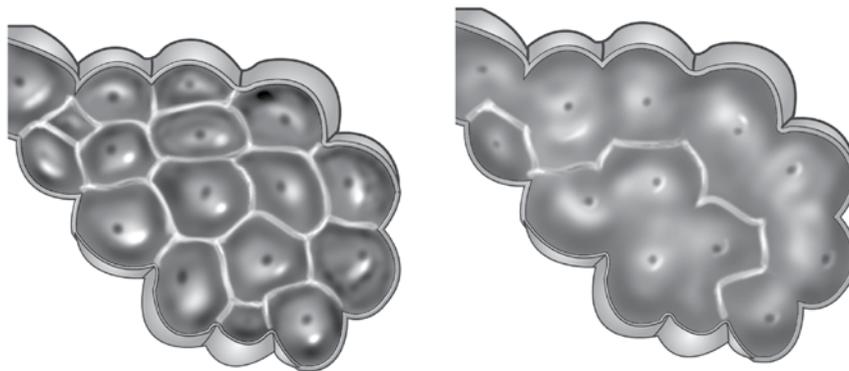
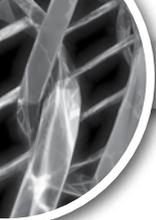


Fig. 3.1



(a)

(i) In the space below, draw a labelled diagram of a complete alveolus from a person suffering from emphysema. Indicate your choice of the alveolus by drawing a base line on Fig. 3.1.

[3]

(ii) Calculate the magnification of your drawing to the size of a normal alveolus. Show your working.

.....
.....
.....
.....

[4]

(iii) How are the alveoli adapted for gas exchange?

.....

[1]

(iv) State two causes of emphysema.

.....

[2]

(v) Explain how emphysema results in a decrease in the surface area of the lungs.

.....
.....

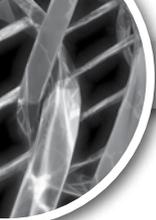
[3]

(vi) Identify two symptoms expected in a person suffering from emphysema.

.....

[2]

[Total: 15]



4

- (a) The composition of inhaled and exhaled air was compared in a laboratory experiment. The findings are presented in Table 4.1 below:

Table 4.1

Component	Inhaled air %	Exhaled air %
oxygen	21	18
carbon dioxide	0.04	3
nitrogen	78	78
water vapour	variable	saturated

- (i) State the difference between gas exchange and respiration.

.....
 [2]

- (ii) Which gas is absorbed by the body?

..... [1]

- (iii) Why does exhaled air contain a higher proportion of water vapour?

.....
 [2]

- (iv) Why does the composition of nitrogen remain unchanged?

..... [1]

- (v) What can you predict about the temperature difference between inhaled air and exhaled air?

.....
 [2]

[Total: 8]

Coordination and response

1

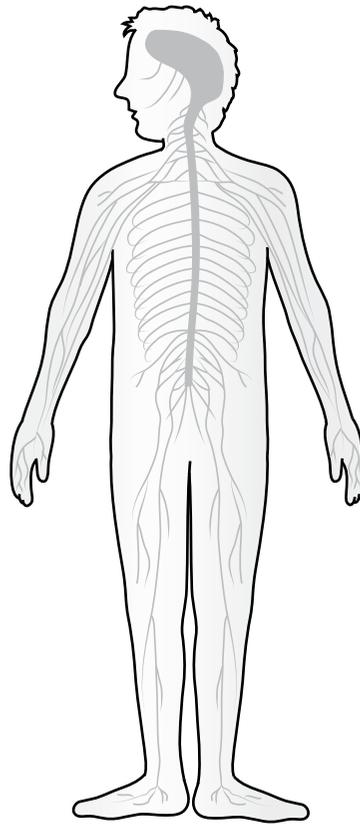


Fig. 1.1

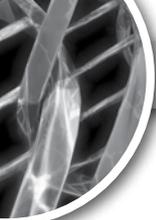
(a)

- (i) Label the central nervous system and the peripheral nervous system on Fig. 1.1. [3]
- (ii) State five differences between the nervous system and the endocrine system in Table 1.1:

Table 1.1

Nervous system	Endocrine system

[5]



(b)

(i) Draw a labelled diagram of a nerve cell in the space given below:

[5]

(ii) State the function of the myelin sheath.

[1]

(iii) Give two examples of reflex action.

[2]

(iv) Identify three functions regulated by the autonomic nervous system.

[3]

[Total: 19]

- 2 Fig. 2.1 shows a frontal view of the human eye:

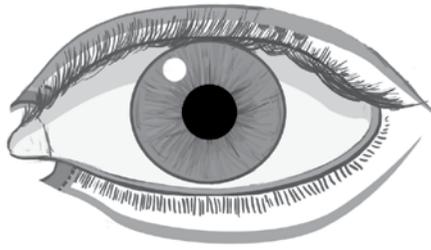


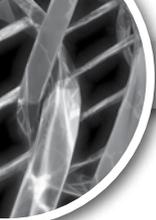
Fig. 2.1

- (a) In the space below, draw a diagram of the human eye showing the pupil and the iris as they would appear when:
- (i) a bright light is shone on the eye

[2]

- (ii) the room is dimly lit

[2]



(b)

(i) Explain how the muscles of the iris act as antagonistic muscles to increase or decrease the size of the pupil.

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

(ii) Explain how the thickness of the lens is altered for focusing on near or distant objects.

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

[Total: 12]

3 Fig. 3.1 shows a section through the human eye:

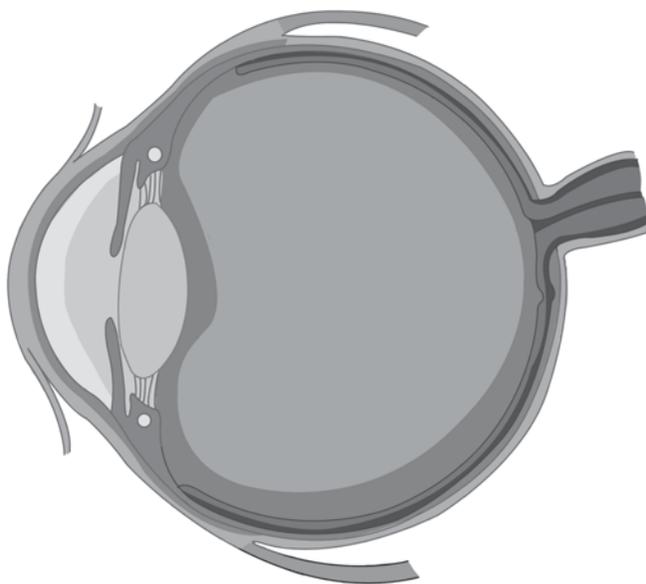
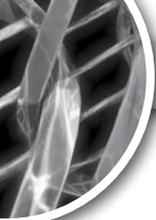


Fig. 3.1



(a) Label the following parts on Fig. 3.1:

- iris
- lens
- pupil
- suspensory ligaments
- fovea
- blind spot

[6]

(b)

(i) Name the two types of cell that enable objects to be seen clearly in daylight and at night.

..... [2]

(ii) Which part of the eye are they located on?

..... [1]

[Total: 9]

Micro-organisms and biotechnology

1

(a)

- (i) Identify the groups (by shape) the bacteria in Fig. 1.1 belong to:

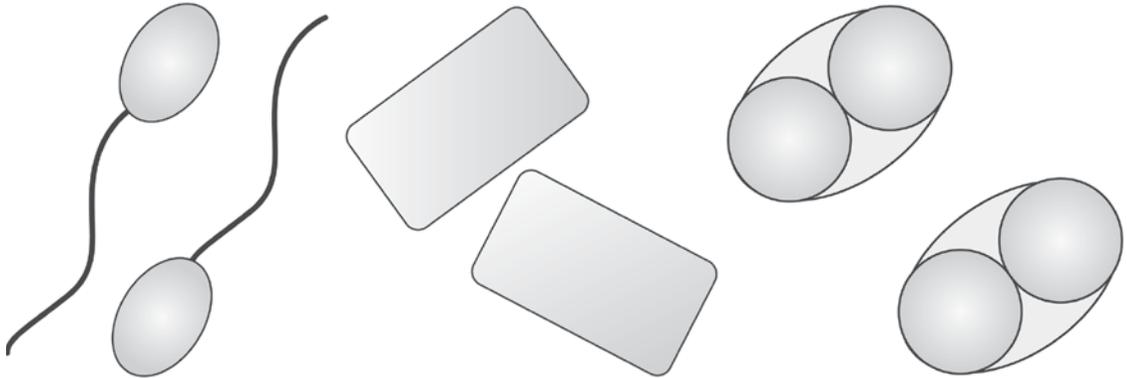


Fig. 1.1

.....

.....

..... [3]

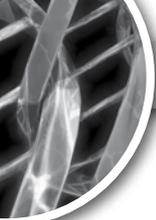
- (ii) State five differences between bacteria and viruses in Table 1.1 below:

Table 1.1

Feature / Characteristic	Bacteria	Virus
Outer covering		
Cell membrane present?		
Cytoplasm present?		
Genetic material?		
Living?		

[5]

[Total: 8]



- 2 Fig. 2.1 shows the structure of a micro-organism. The rounded structures are the spore cases growing on stalks called stolons.

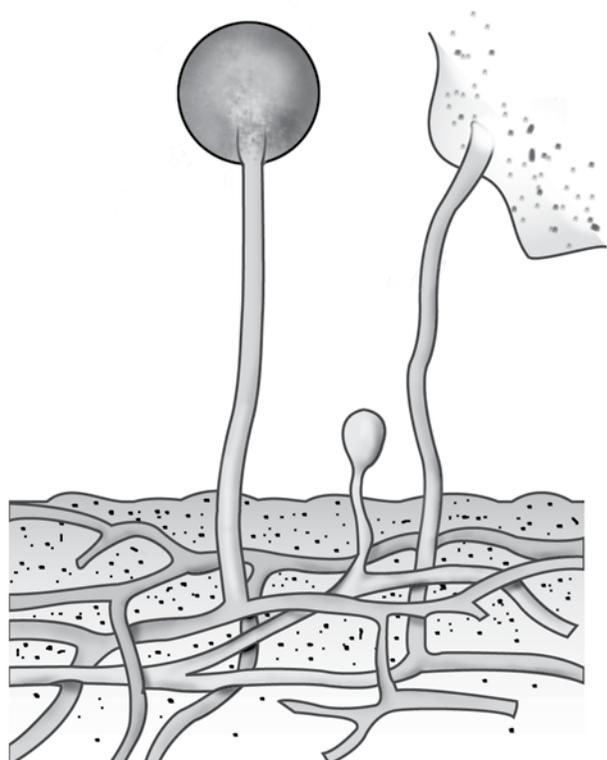


Fig. 2.1

- (a)
- (i) On Fig. 2.1, draw a circle around a stolon and spore cases. Draw a large labelled diagram of your stolon and spore cases in the space given below:

- (ii) Calculate the magnification of your diagram with that of Fig. 2.1. Show your working clearly.

.....

.....

.....

..... [4]

- (b) A student wishes to grow this micro-organism in a fermenter.

- (i) Which process should he use to grow this micro-organism?

..... [1]

- (ii) State three main features which must be present in the fermenter to cultivate this micro-organism.

.....

.....

..... [3]

[Total: 13]

- 3 A student checked the effects of antibiotics on the growth of bacteria.

Bacteria were grown on some agar in a Petri dish. Three drops each of five antibiotics A, B, C, D, and E were placed on the Petri dish and left for 24 hours. The clear area shows the region where the bacteria were killed by the antibiotics.

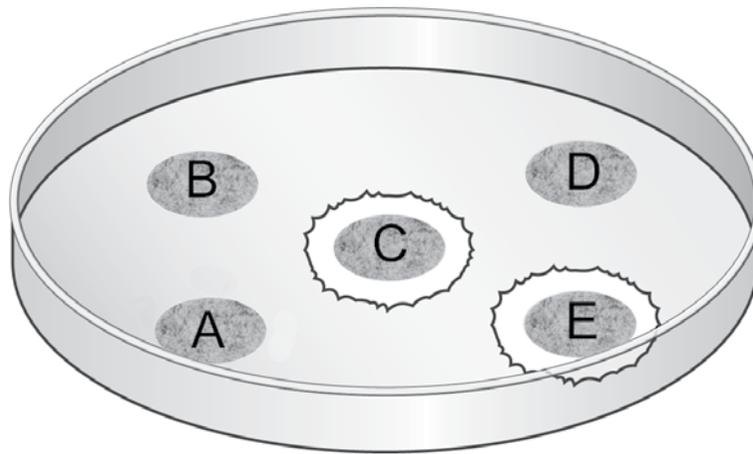
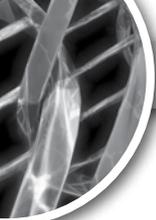


Fig. 3.1



(a)

(i) Which antibiotic is the most effective against the bacteria? Explain your answer.

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

(ii) Which antibiotic is the least effective against the bacteria? Explain your answer.

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

(iii) The student used the effective antibiotic to treat a bacterial infection, but discontinued treatment a few days later. This resulted in a relapse of the infection. He resumed treatment with the antibiotic but found it to be ineffective. Suggest a reason for this change.

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

(iv) Is an antibiotic the same thing as an antiseptic? Explain your answer.

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

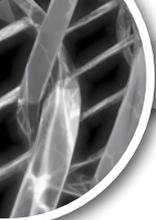
[Total: 11]

4

(a)

(i) A student added some live yogurt to milk at 35°C. He left it covered in a place for six hours. How would the appearance of the milk change?

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



(ii) The student decided to prepare yogurt with the help of bacteria. Which bacteria might he use?

..... [1]

(iii) State three safety precautions that must be followed when using bacteria for food biotechnology.

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

(iv) If yogurt is left exposed in the air for an hour, it turns sour and is changed by a reaction. Name the reaction that occurs in the yogurt to bring about these changes.

..... [1]

[Total: 8]

Development of organisms and continuity of life I

1 Figs. 1.1 and 1.2 show a wind-pollinated flower and an insect-pollinated flower:

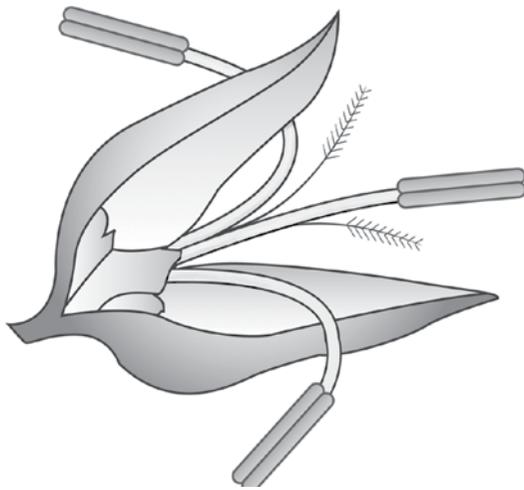


Fig. 1.1

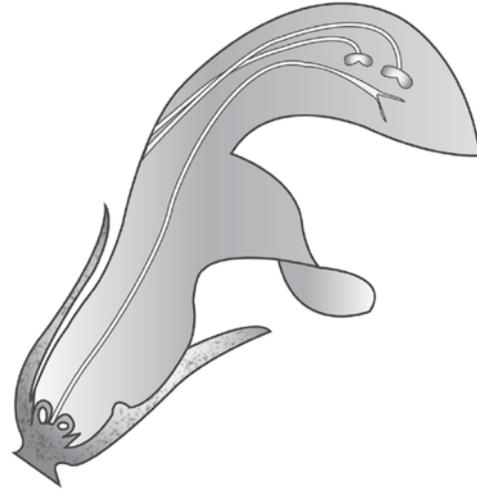


Fig. 1.2

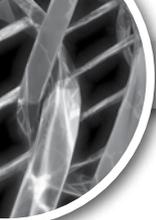
- (a)
- (i) Mark each organ producing male gametes with the letter A. [1]
- (ii) Mark each organ producing female gametes with the letter B. [1]
- (b)
- (i) State 3 visible differences between the male and female parts of each flower.
-
-
- [3]
- (c) The figures below show pollen grains attached to the stigmas of an insect-pollinated flower and a wind-pollinated flower:



Fig. 1.3



Fig. 1.4



Look carefully at the diagrams and state whether the flower in Fig. 1.3 or 1.4 is a wind-pollinated flower. State two reasons for your answer.

.....

..... [3]

(d)

(i) Circle the pollen grains in Fig. 1.3. Draw a diagram of a pollen grain in the space given below:

[4]

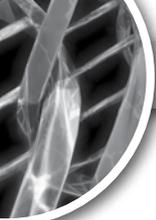
(ii) Calculate the magnification of your diagram with that of the figure. Show your working.

.....

.....

..... [4]

[Total: 16]



2 Fig. 2.1 shows a species of fruit with the seeds being dispersed:



Fig. 2.1

(a)

(i) Label the stalk, sepals, pericarp, and seeds on Fig. 2.1. [4]

(ii) Which type of dispersal is occurring in the fruit?
..... [1]

(iii) Explain the process by which this method of dispersal takes place.
.....
.....
.....
..... [4]

(iv) The fruit uses another method of dispersal. Which of the two methods of dispersal would carry the seeds to a greater distance? Why?
.....
.....
..... [3]



(v) Why is seed dispersal necessary for a plant species?

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

[Total: 14]

3 Fig. 3.1 shows a bean seed in the beginning of germination:

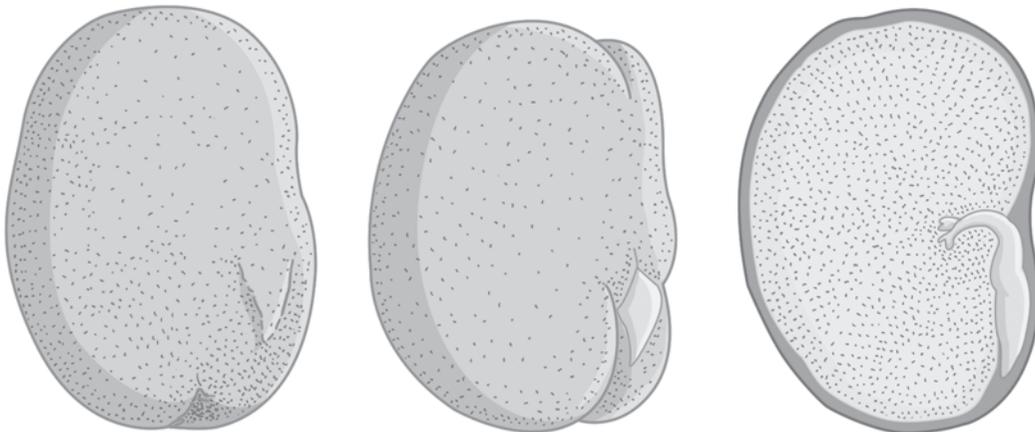


Fig. 3.1

(a)

(i) Label five parts of the seed visible in Fig. 3.1.

[5]

(ii) State two functions of the cotyledons in the seed.

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

(iii) Why must a seed be soaked for 24 hours before it begins to germinate?

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

[Total: 10]

Development of organisms and continuity of life II

1 Fig. 1.1 below shows two insects:

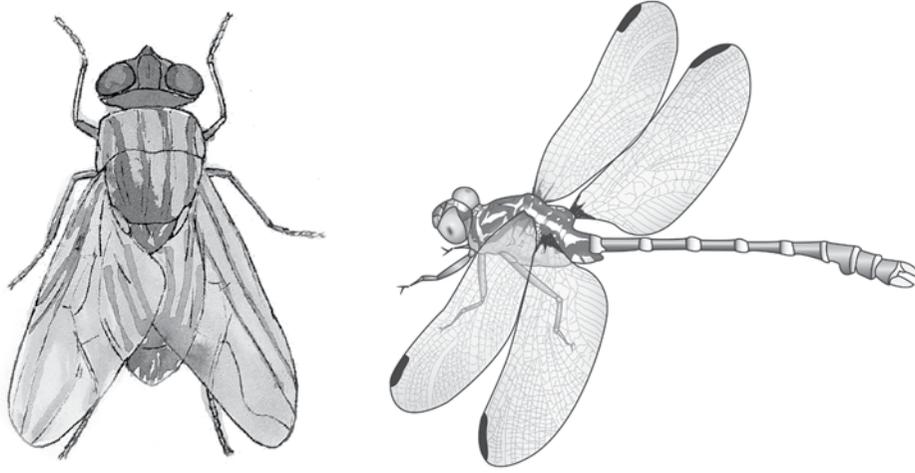


Fig. 1.1

(a)

(i) State three visible differences, besides size, between these two insects.

.....

 [3]

(ii) State four characteristics common to all insects.

.....

 [4]

(iii) Fig. 1.2 shows another species of invertebrate:



Fig. 1.2

State three features present in this organism that insects do not possess.

.....

.....

..... [3]

(iv) State two visible similarities between this organism and an insect.

.....

..... [2]

[Total: 12]

2 Fig. 2.1 shows a honeybee:

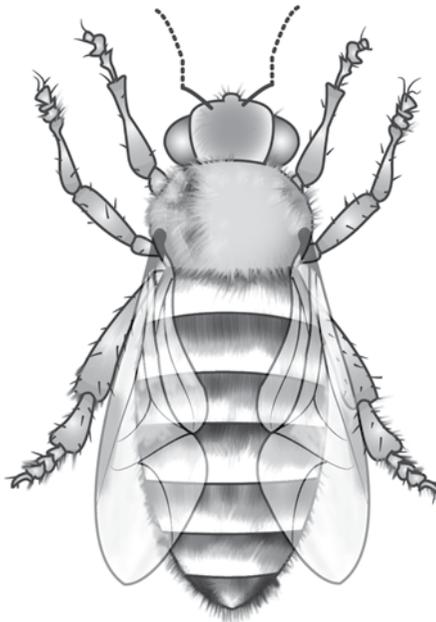
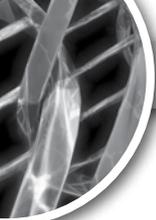


Fig. 2.1



(a)

(i) State three features of this insect that make it well-adapted for collecting pollen.

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

(ii) Name an insect-pollinated flower and identify three ways in which it is adapted for pollination by a honeybee.

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

(b) Fig. 2.2 shows the third leg of a worker bee:

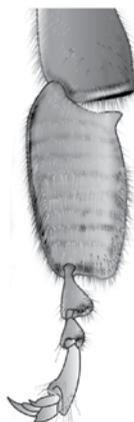
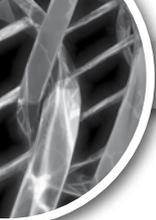


Fig. 2.2

(i) Draw a labelled diagram of the leg of the worker bee.

[4]



(ii) Calculate the magnification if the original diagram is magnified 300 times.

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

(c)

(i) Butterflies are an attractive group of insects that act as agents of pollination. State one disadvantage of butterflies to plants.

..... [1]

[Total: 16]

3 The female Anopheles mosquito is a vector for the disease malaria.

(a)

(i) What is meant by the term vector of disease?

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

(ii) Name another disease that can be transmitted by mosquitoes. [1]

(iii) State four features of the female Anopheles mosquito which make it a suitable vector for malaria.

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

(iv) Why is the male mosquito not a vector of malaria?

..... [1]

(b)

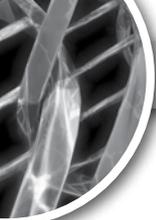
(i) Why do we feel the sting of a mosquito some time after being bitten?

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

(ii) What are the chances of getting malaria after being bitten by a female anopheles mosquito immediately after it has bitten a malarial patient?

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

[Total: 12]



Inheritance

1 Fig. 1.1 shows a maize cob with yellow grains (pale) and purple grains (dark):

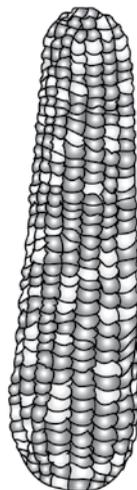


Fig. 1.1

(a)

(i) Count the total number of pale grains and the total number of dark grains visible and record your results.

..... [1]

(ii) Calculate the genetic ratio of pale to dark grains.

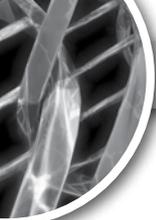
.....
.....
.....
..... [2]

(iii) Which grain, colour—pale, or dark—is recessive? Dominant?

..... [1]

(iv) If a farmer wanted to produce pale and dark grains in the ratio of 1:1, which genotypes would he cross in order to obtain those results?

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



- (v) Suggest the genotypes of the parents that were crossed to produce this cob. Explain your results with a fully-labelled progeny diagram.

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

- (vi) Draw an enlarged diagram of three complete dark grains shown in the cob. Calculate the magnification of your diagram with Fig. 1.1.

.....
.....
..... [7]

[Total: 17]

2 Fig. 2.1 shows the results of some breeding experiments on mice:

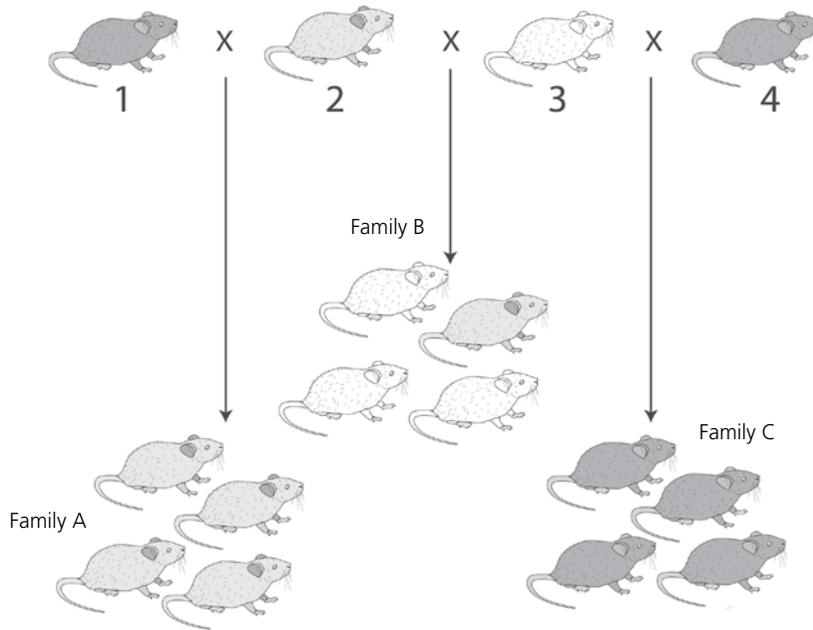


Fig. 2.1

(a)

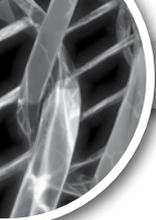
- (i) If mouse 1 and mouse 4 are crossed, what would the possible coat colours of the offspring be? Draw a progeny diagram to explain your answer.

.....

.....

.....

..... [3]



(ii) What can you deduce about the genotype of mouse 2 by looking at families A and B?

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

(iii) Which aspect of family C would confirm whether mouse 3 and mouse 4 are homozygous, dominant, or heterozygous? Explain your answer.

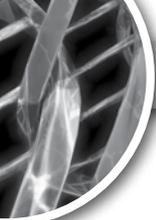
.....
.....
..... [3]
[Total: 8]

3

(a)

(i) A man with blood group A marries a woman with blood group B. State, with the help of genetic diagrams, all possible blood groups of their children.

.....
.....
.....
..... [6]



(b)

(i) What is meant by the term co-dominance?

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

(ii) Why is blood group O called the Universal donor and blood group AB called the Universal acceptor?

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

(c)

(i) Which type of variation—continuous or discontinuous—is affected by the environment? Give an example of this type variation.

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

(ii) Give three points of difference, with suitable reasons, for each type of variation.

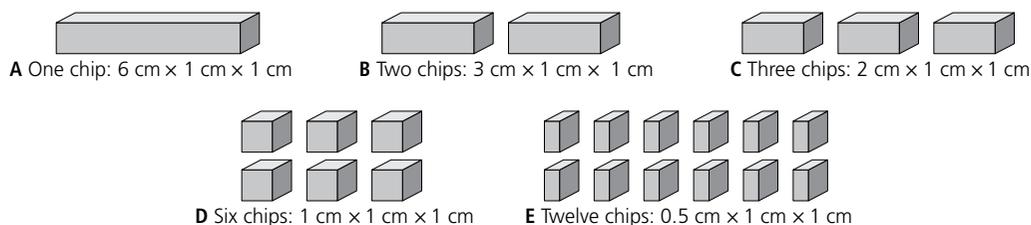
.....
.....
..... [3]

[Total: 15]

Osmosis in potato tissue

1 During an investigation to determine the effect of surface area on the rate of osmosis, potato chips with the same total volume but different surface areas were immersed in distilled water. The chips were first weighed, then immersed for a period of one hour before being removed, blotted dry, and then reweighed. The chips were returned to the water before the process of drying and reweighing was repeated after 24 hours.

The chips were prepared as shown in the diagrams below.



(a) Complete the table below:

Chip type	Surface area / cm ²	Mass / g at time = 0 h	Mass / g at time = 1 h	Mean percentage change in mass after 1 h	Mass / g at time = 24 h	Mean percentage change in mass after 24 h
A		8.4	8.9		9.9	
		8.3	8.9		9.9	
		8.5	8.9		9.8	
B		8.1	9.2		9.9	
		8.4	9.1		10.0	
		8.3	9.3		9.8	
C		8.4	9.5		9.8	
		8.4	9.4		9.8	
		8.4	9.5		10.0	
D		8.3	9.7		9.9	
		8.5	9.7		9.9	
		8.1	9.6		9.8	
E		8.2	9.9		9.7	
		8.2	10.0		9.8	
		8.2	10.0		9.9	

[4]



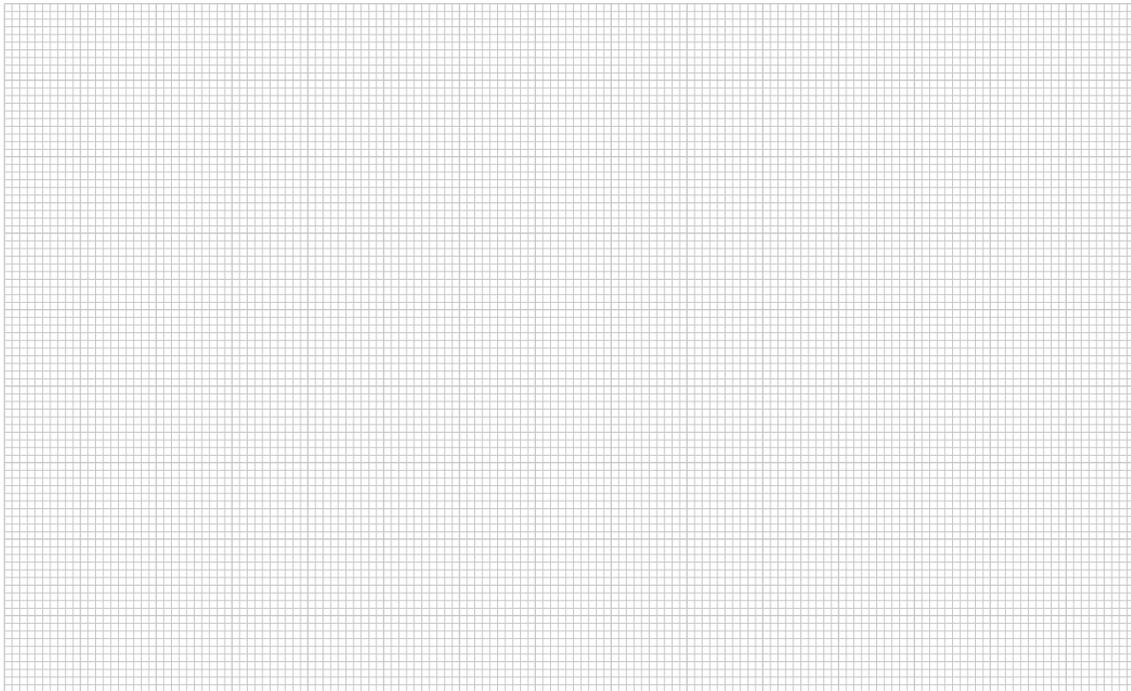
(b) Why were the potato chips dried before they were reweighed?

..... [1]

(c) Suggest **two** variables which should be fixed to make sure that these are valid results.

..... [2]

(d) Present the results in the form of a graph. A grid is provided below. Include a title on your graph.



[4]

(e) What conclusions can you draw from these results?

.....

..... [2]

(f) How can an understanding of osmosis be important in developing methods for the safe storage of food?

.....

..... [2]

[Total: 15]



Enzymes and industry

This exercise looks at how an understanding of the mechanism of enzyme action can be used commercially to carry out some important industrial processes. There are many applications of enzyme technology in industry. Enzyme technology involves collecting purified enzymes, separated from the bodies of the 'whole' organisms which make them. Enzyme technology has several advantages over 'whole-organism' technology.

- 1 **No loss of substrate due to increased biomass.** For example, when whole yeast is used to ferment sugar to alcohol it always 'wastes' some of the sugar by converting it into cell wall material and cytoplasm for its own growth.
- 2 **Elimination of wasteful side reactions.** Whole organisms may convert some of the substrate into irrelevant compounds or even contain enzymes for changing the desired product into something else.
- 3 **Optimum conditions for a particular enzyme may be used.** These conditions may not be the optimum conditions for the whole organism—in some organisms particular enzymes might be working at less than full efficiency.
- 4 **Purification of the product is easier.** This is especially true when using immobilized enzymes.

(a)

(i) What is meant by the term **substrate**?

..... [1]

(ii) Enzymes are very useful because they are **specific**. Use a diagram to explain how the way an enzyme works is responsible for this specificity.

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

(iii) What is meant by **optimum** conditions? Name two conditions that affect how well an enzyme works.

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

Despite these advantages, in some circumstances ‘whole-organism’ technology may still be preferable.

- 1 **We may not want a ‘pure’ product.** The difference between ethanol and an expensive wine lies in the ‘impurities’ in the wine. These include various organic chemicals such as aldehydes, ketones, tannins, and acids, all of which can improve a wine’s taste and flavour.
 - 2 Even if we do want a pure product, **the sequence of reactions** leading to its synthesis may involve so many enzymes in such **a complicated arrangement** that whole-organism technology is the only way the reactions can be made to work.
 - 3 **Purified enzymes are extremely expensive** compared with the organisms which produce them. This difficulty has been tackled from both ends—firstly, by improving the technology of enzyme production and secondly, by making more efficient use of the enzyme once it becomes available.
- (b) Imagine that you are an industrial biochemist, and you want to change over the production of a new wonder-compound called SUPERTECH from an old-fashioned chemical process involving very high temperatures and the use of powerful (and expensive) acids and alkalis to a biological process.

- (i) Give **two** arguments you might use to convince the company's shareholders that a biological process would be less expensive than a chemical method.

.....

 [2]

- (ii) Give **two** arguments that you might use to convince the scientists working for the company that enzyme technology would be better than whole-organism technology for this product.

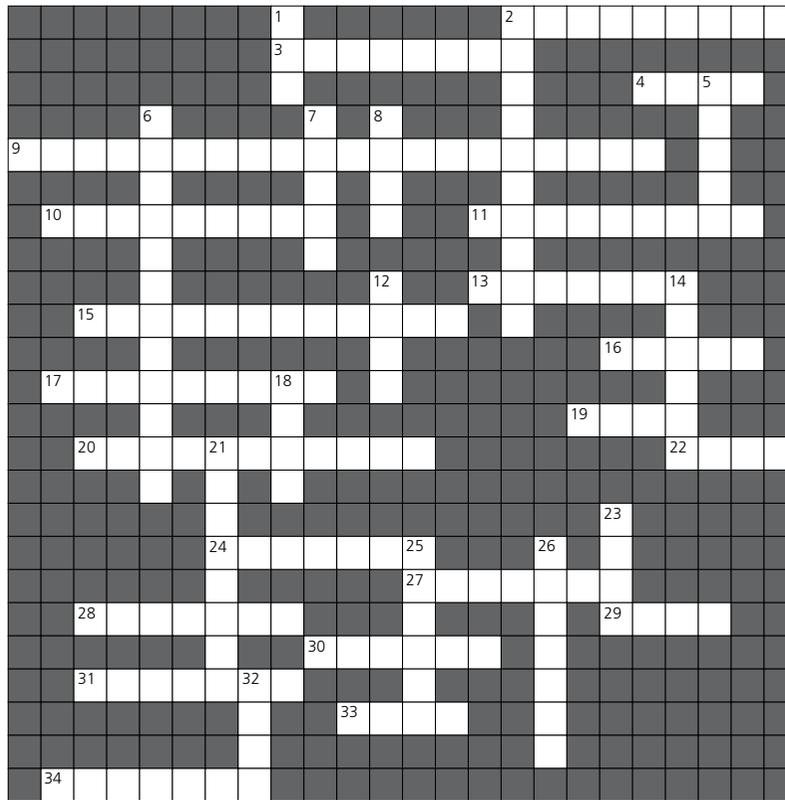
.....

 [2]

[Total: 10]

Food, feeding, and health

Crossword



Across

- 2 this solution is needed to test for glucose
- 3 a sticky material that can block arteries if diet contains too much fat
- 4 the perfect diet for a newborn mammal
- 9 what we eat, and how it should be chosen! (4, 3, 1, 8, 4)
- 10 an animal that feeds only on meat
- 11 an animal that feeds only on vegetation
- 13 a condition caused by a shortage of 32-down
- 15 the main source of 30-across for most of us
- 16 indigestible, but essential for the function of the intestines
- 17 may increase a farmer's yield of our favourite food, but must be washed away before we eat it!
- 19 these flakes are a good source of 16-across
- 20 a lipid linked to problems with circulation

Down

- 1 essential, but too much is present in an obese person
- 2 good source of fibre, protein, and wind! (5, 5)
- 5 an organ responsible for much of the sorting of foodstuffs in an animal
- 6 any disease condition caused by an unbalanced diet
- 7 the reason that there is life on Earth
- 8 too much added to food can cause blood pressure problems
- 12 a protein growing on your head
- 14 a person unable to produce the dark protein pigment called melanin
- 18 fruit of a palm tree
- 21 necessary to prevent heart disease and gaining too much body mass

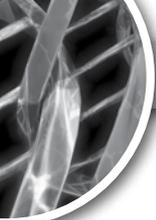


- 22 main constituent of porridge
- 24 a deficiency disease resulting from low vitamin D intake
- 27 mineral that aids development of bones and teeth
- 28 a common problem in the Western world, often the result of a poor energy balance
- 29 what is done to 4-across to remove 1-down
- 30 the capacity for doing work—it must be supplied by our food
- 31 food for the bodybuilder
- 33 a plant source of milk
- 34 needed in small amounts, but essential to make full use of other foods
- 23 can show disease in the absence of vitamin C
- 25 a sailor’s problem, caused by lack of vitamin C
- 26 an important element used in fertilizers
- 32 a mineral required for the production of haemoglobin

[34]

Questions

- 1 How is malnutrition different from starvation?
.....
..... [1]
- 2 How does consumption of fibre and water help to avoid constipation?
.....
..... [1]
- 3 Describe the visible effects of scurvy.
.....
.....
..... [3]
- 4 What is the cause of rickets?
..... [1]



5 Name two food substances that could help a person suffering from rickets.

..... [2]

6 Why is a person suffering from rickets unable to walk?

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

7 How does excessive consumption of fat lead to heart disease?

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

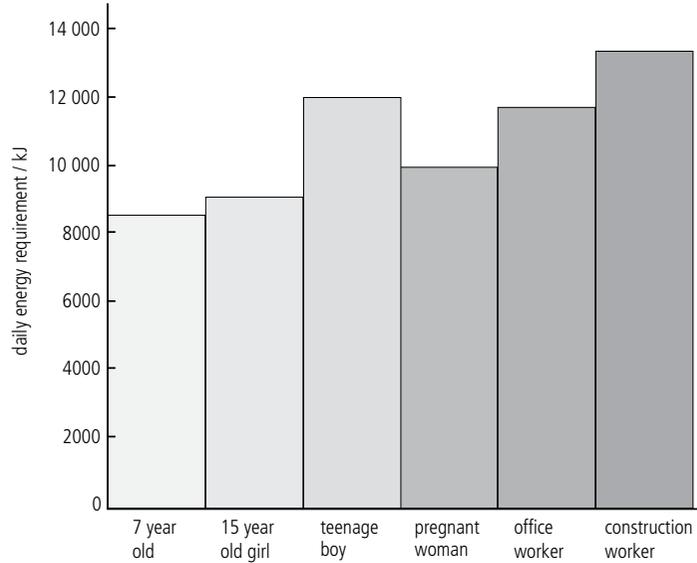
8 Why does a diabetic run a greater risk of suffering from blocked arteries than a person without diabetes?

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

[Total: 45]

Daily energy requirement

Every living organism requires food for growth and to produce energy for metabolic processes. Having a balanced diet means eating the right type of food in the proportions needed to carry out body functions. The daily energy requirement is provided by the action of food with oxygen and enzymes. The graph given below shows the daily energy requirements for different people:



1 Why is the energy requirement for a pregnant woman more than that for a woman doing light work?

..... [2]

2 Why is the energy requirement for a seven year old less than that for a fifteen year old?

.....
 [2]

3 Why does a construction worker have the highest energy requirement?

..... [2]

4 What energy value in kJ per day would be required for a man living in the Arctic region?

..... [2]

5 Suggest how an energy intake lower than the requirement shown in the graph would affect a pregnant woman.

..... [2]

[Total: 10]

The action of lipase

A nutritionist wanted to study the effects of temperature on the action of the enzyme, lipase.

- 1 Write down an equation for the activity of this enzyme.

..... [1]

- 2 Where in the gut does this enzyme have its effect?

..... [1]

- 3 The activity of the enzyme can be measured by checking for a change in pH as the products are formed. The pH change can be followed with an indicator called phenolphthalein which changes from pink to colourless as the pH drops. The scientist set up a series of test tubes in which he tried to replicate the conditions in which the enzyme works. He measured how long it took for an enzyme to catalyze the reaction which causes the pH to fall, at different temperatures.

This table contains the results of his experiment:

Temperature / °C	Time taken for reaction to occur / s	Rate of reaction: 1/time taken / s ⁻¹
20	450	
30	200	
35	75	
40	105	
45	320	
50	420	

- (a) How would he keep the temperature constant for each of the different steps in the experiment?

..... [1]

- (b) Complete the table to show the rate of the reaction at each temperatures. [3]

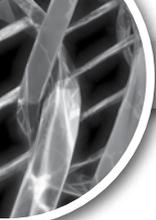
- (c) Plot the results as a line graph. (A grid is provided on the next page.) Join the points with a smooth curve. Make sure that the axes are labelled, and that you provide a title. [4]

- (d) Which is the best temperature for the enzyme-controlled reaction to occur?

..... [1]

- (e) What is human body temperature? Use your graph to predict how long the reaction would take at human body temperature.

..... [2]



(f) Predict how long the reaction would take to occur at 60°C. Explain this result.

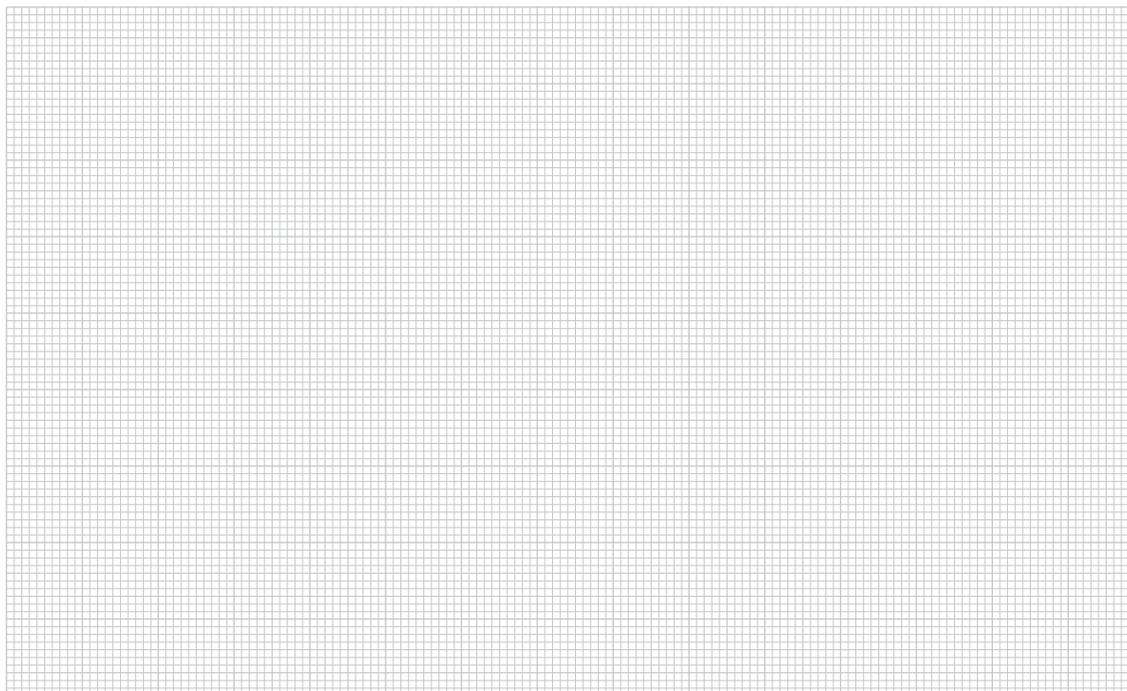
.....
..... [2]

(g) The scientist included a substance called sodium taurocholate in the mixture in each of the test tubes. This substance is a bile salt. Explain why this substance is necessary for this reaction.

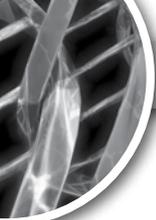
.....
..... [2]

(h) Explain how the nutrition scientist would have made sure that this experiment gave valid results (i.e. was a fair test).

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



[Total: 20]



Transport in plants

The water and mineral nutrients absorbed by the roots of the plant need to be transported to the leaf and growing regions of the plant body. Similarly, prepared food needs to be transported from the leaf to every part of the plant body. A well-developed vascular tissue system performs this function. Specialized cells make up this tissue with each type of cell transporting water and prepared food respectively.

- 1 State why cells of the xylem tissue do not possess cytoplasm or cell walls?

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

- 2 How does the Sun help to set up the transpiration stream within the plant?

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

- 3 Why are stomata located on the upper surface of the leaf in aquatic plants? Within grooves in desert plants?

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

- 4 Where in the transport system in plants can diffusion be observed?

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

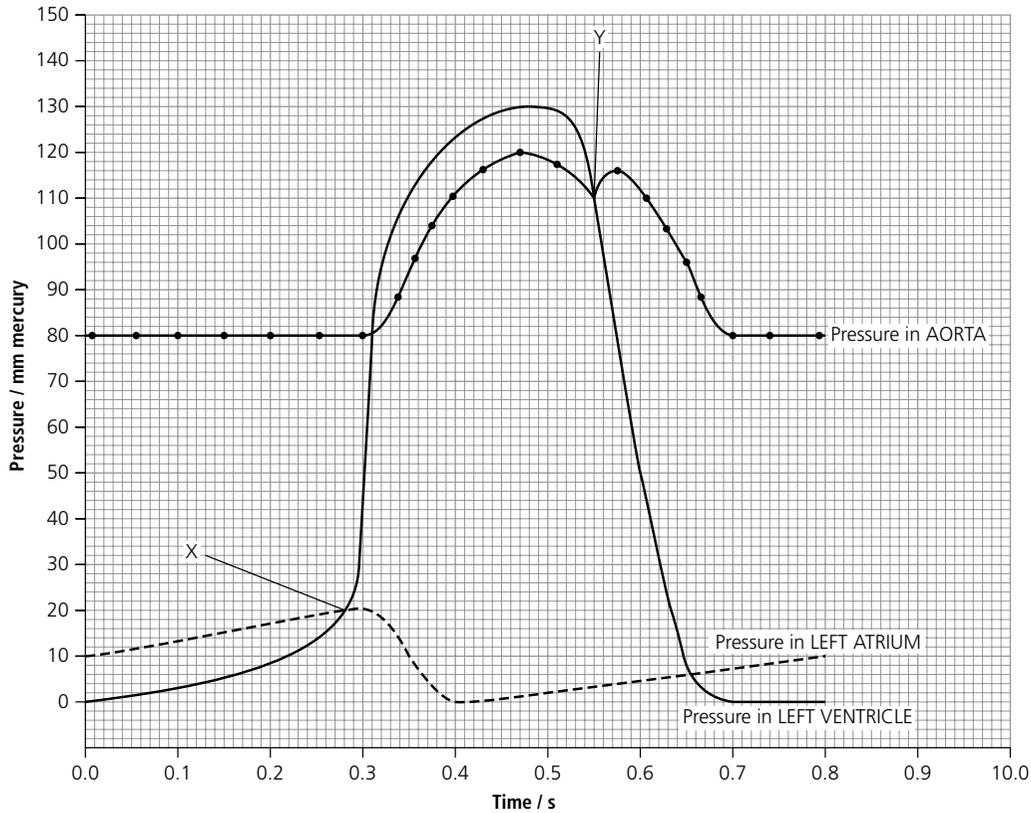
- 5 How do plant roots absorb mineral ions from the soil even against a concentration gradient?

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

[Total: 10]

The beating heart

The graph shows the pressure changes in the left side of the human heart during one complete beat.



1

- (a) Calculate the heart rate (number of beats per minute). Show your working.

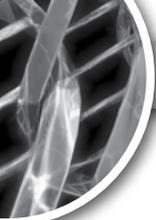
.....
 [2]

- (b) An athlete in a marathon race doubled this heart rate. How long did a single beat take for the marathon runner?

..... [1]

- (c) Apart from a change in heart rate, how else can an athlete increase the amount of blood pumped per minute?

..... [1]



2

- (a) The maximum pressure reached in the *left* ventricle is five times the maximum pressure reached in the *right* ventricle. Calculate the maximum pressure reached in the right ventricle.

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

- (b) How is this difference in pressure between the left and the right ventricle achieved?

..... [1]

- (c) Why does the left side need to beat more powerfully than the right side of the heart?

..... [1]

3

- (a) From your knowledge of how the heart works, suggest which valves close at points X and Y. In each case, explain why the valve closes at that point.

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

- (b) Where else in the circulatory system are valves found?

..... [1]

- (c) What is the purpose of these other valves?

..... [1]

4

- (a) Describe briefly how a blood clot forms.

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



- (b) If a blood clot forms *inside* the circulatory system it might travel around until it causes a blockage. Explain what might happen if this blockage occurs in a coronary artery.

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

5

- (a) If the heart is working poorly, a person might have blue lips. Explain why.

..... [2]

- (b) One treatment for a failing heart is to have a heart transplant. Following the transplant, the heart might be rejected. Why does this happen?

..... [2]

- (c) A transplant patient may be given immunosuppressive drugs. Explain why such a person might be likely to catch simple infections that another person might not suffer from.

..... [2]

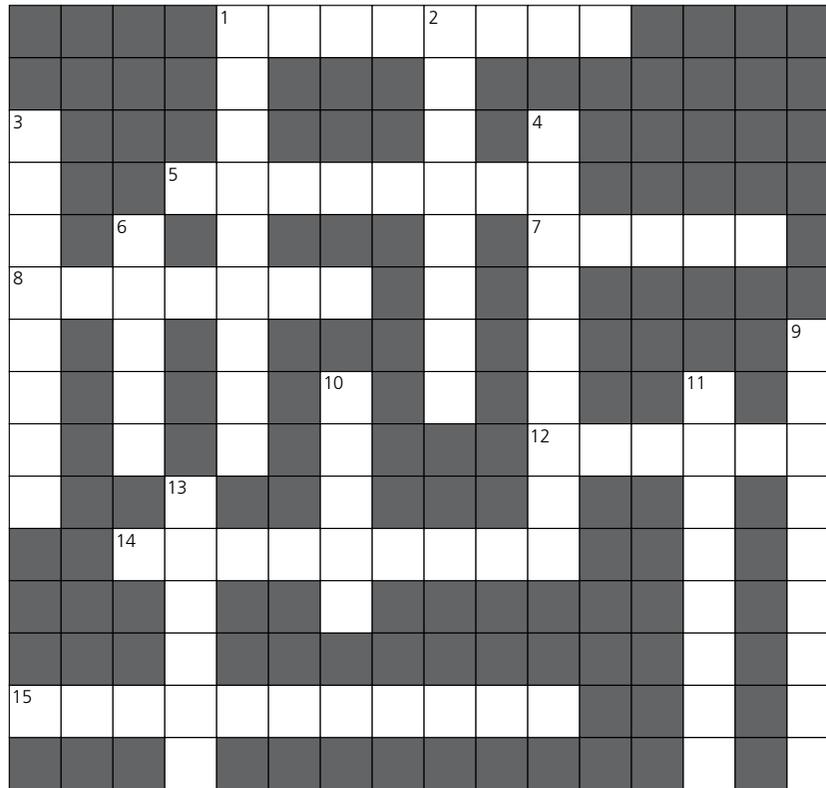
- (d) Doctors know that there is a shortage of hearts for transplant. They suggest that, in future, people might be given the heart of a baboon or other animals. Why might patients believe that this is not an acceptable procedure?

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

[Total: 25]

Heart and heart disease

Crossword



Across

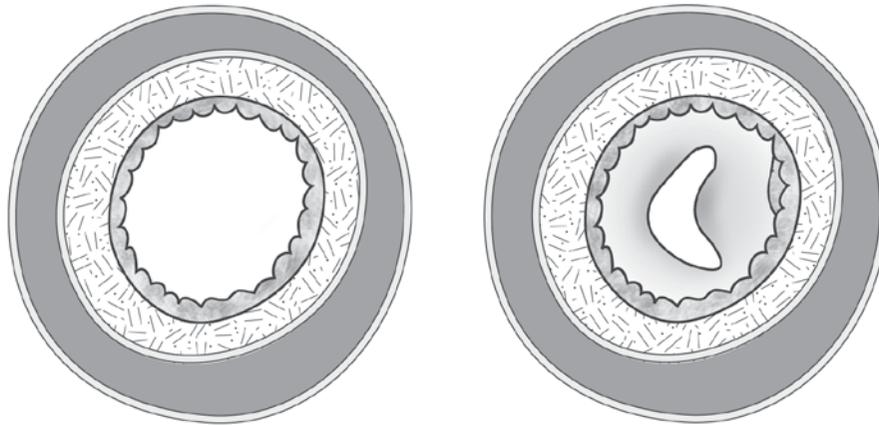
- 1 vein returning deoxygenated blood to the heart
- 5 blockage of arteries by sticky material
- 7 a way of feeling the rate of heartbeat
- 8 a very significant factor in heart and lung disease
- 12 an upper chamber of the heart
- 14 the artery which carries deoxygenated blood
- 15 lipid which is a major cause of circulation problems

Down

- 1 one of the two main pumping chambers of the heart
- 2 artery delivering oxygen and nutrients to the heart muscle
- 3 transport system depending on moving a fluid under pressure
- 4 smallest of blood vessels, where exchange of materials takes place
- 6 the main artery of the body
- 9 valve preventing backflow from arteries to ventricles
- 10 the fluid in the circulatory system
- 11 valve preventing backflow from left ventricle to left atrium
- 13 the heart is made of this type of tissue

[16]

The diagram shows a healthy artery and one blocked with fat deposits:



An alternative method to treating such blockage in the coronary arteries is angioplasty where a stent is passed through the blocked section of the artery forming a free passage for blood flow. The earlier method involved a heart bypass operation.

1 State two disadvantages of treating a blocked artery with bypass surgery.

.....
 [2]

2 What is the advantage of angioplasty?

.....
 [1]

3 State two precautions that a patient must follow throughout life in order to avoid further blockage of arteries.

.....
 [1]

[Total: 20]

Using a spirometer

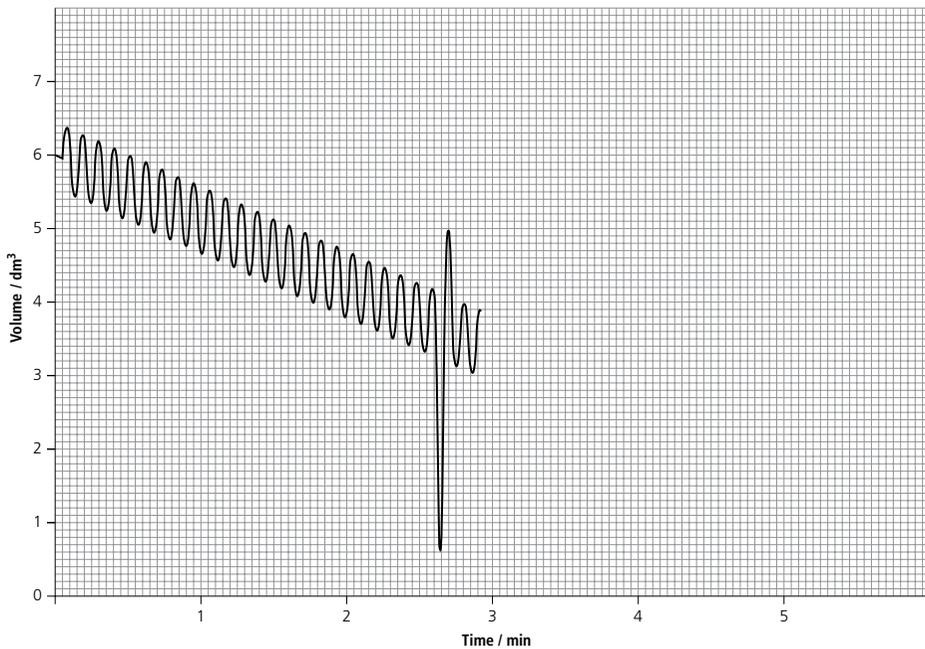
1 Some people believe that the size of the body affects how much oxygen is consumed for metabolism. What information would you need to collect to find out whether or not this is true?

.....
 [2]

2 The apparatus used to measure oxygen consumption is called a spirometer. This instrument will measure oxygen consumption if it is fitted with a carbon dioxide absorber to remove carbon dioxide from exhaled air.

A man was connected to such a piece of apparatus and was asked to breathe normally for 2.5 minutes; then to inhale and exhale as deeply as possible.

The spirogram (spirometer trace) produced is shown in the diagram below:



Use the trace to determine the following:

(a) the tidal volume (volume of air exchanged with one breath) at one minute

.....
 [2]

(b) the vital capacity (the maximum volume of air that can be exchanged)

.....
 [1]

(c) the breathing rate

.....
 [1]

3 As oxygen is used up, the trace slopes downwards. The gradient of the trace allows you to work out the rate of oxygen consumption. Calculate the rate of oxygen consumption. Show all of your working, and choose appropriate units.

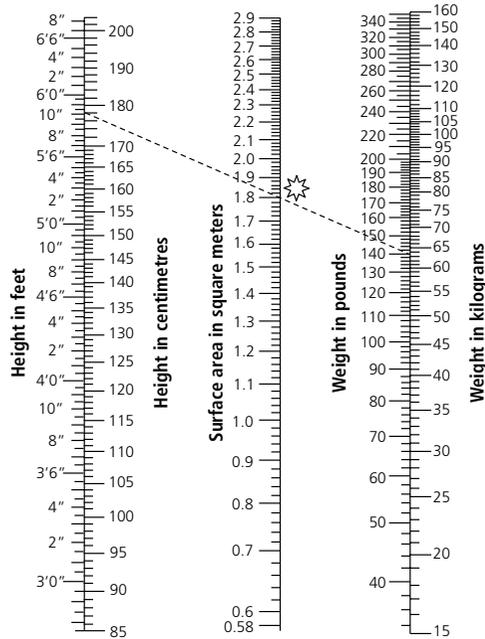
.....

 [2]

4 A nomogram can link several measurable features of an individual. It is used by joining points on different scales, and by observing the point at which the 'joining' line crosses another scale. The man using the spirometer weighed 80 kg and was 182 cm tall. Use the nomogram to work out his surface area.

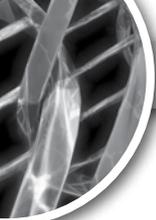
A **nomogram** can be used to calculate **body surface area**.

A ruler should be extended from the height to weight scales—the intersect with scale III gives the body surface area, e.g. the author has a surface area of 1.8 m².



.....
 [2]

[Total: 10]



Excretion and homeostasis

During respiration, glucose is oxidized to release energy. At the same time, carbon dioxide is also released. Similarly, urea is produced when proteins are metabolized. Both urea and carbon dioxide are toxic substances and need to be removed from the body. The excretory system is comprised of specialized organs that work together to remove waste substances from the body.

1 Do excretion and egestion refer to the same process?

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

2 What are the means by which water is lost from the body?

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

3 Why is the membrane used in kidney dialysis a partially permeable one?

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

4 State two ways by which the body maintains a warm temperature in a cold environment.

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

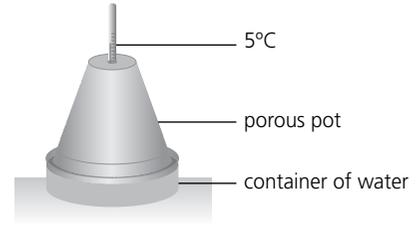
5 What is meant by osmoregulation?

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

[Total: 10]

Keep it cool!

A bottle of milk can be kept cool using this simple method: The bottle of milk is placed in a shallow container of water and is covered with a porous pot. The clay pot soaks up the water. Even in a warm place, the inside of the milk cooler stays at about 5°C.



Sweating is one of the control systems which helps humans to keep cool. Water from the body forms sweat on the surface of the skin. This evaporates and cools us down.

1 Why does the milk cooler stay at 5°C? (Use the words 'water', 'evaporate', 'energy' and 'temperature' in your answer.)

.....
 [2]

2 How are the milk cooler and the body temperature control system similar?

.....
 [1]

3 As humans sweat, why do they not cool down to 5°C like the milk cooler?

.....
 [1]

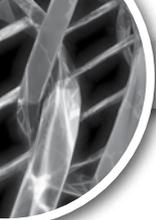
4 When people are ill, it sometimes helps to put a damp flannel on their forehead. How does this help to reduce the body temperature?

.....
 [1]

[Total: 5]

? Cheddar cheese used to be matured in caves where the temperature is a constant 10°C. This is the perfect temperature for maturing cheese. Design an experiment to find out whether the 'milk cooler' could be adapted to give a temperature of 10°C.

Write down the things which should be investigated and the steps that you would take.



Coordination

The nervous system coordinates the functioning of the various organs and systems of the body. Information from these systems is carried along nerve cells to the brain and spinal cord. The signals are processed and appropriate responses are sent to the organs for performing necessary actions.

1 Distinguish between the central nervous system and the peripheral nervous system.

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

2 How do nerve impulses cross a synapse?

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

3 Why is a reflex action a faster response than others?

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

4 Name two functions controlled by the autonomic nervous system.

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

5 How is a conditioned reflex different from other reflex actions, e.g. a knee jerk?

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

[Total: 10]

An alcohol problem

Alcohol is produced by the fermentation of the carbohydrate material in plants. It is a drug that can slow down the reflexes of a person. Hence people having consumed excessive alcohol are not allowed to drive as they pose an accident risk.

A group of students visiting a clinic for alcoholics obtained some information given in the table below:

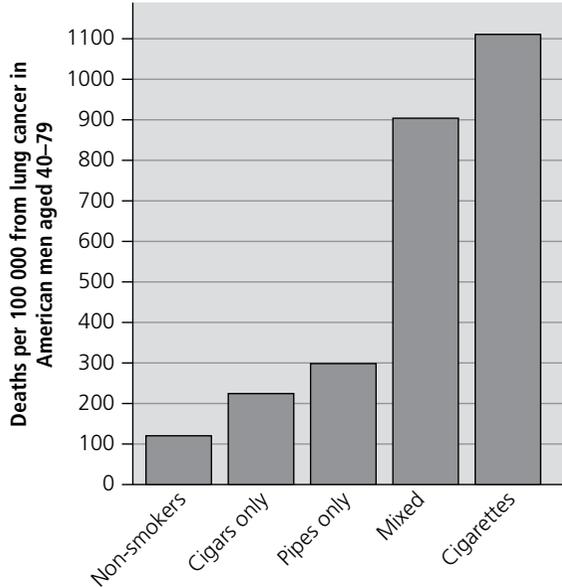
Person	% of alcohol in blood	Period of alcohol consumption
A	0.1	7 years
B	0.4	2 years
C	0.6	6 months
D	0.7	1 month
E	0.01	3 years

- Which person or persons would prove to be an accident risk while driving a car?
..... [1]
- Which person might be suffering from paralysis?
..... [1]
- How many persons might have developed liver malfunctions?
..... [1]
- Which of them might have a migraine problem? Explain your answer.
.....
..... [3]
- Two of the patients were female. How would their alcohol consumption adversely affect their offspring if they were to become pregnant?
..... [2]
- Explain why an alcoholic is not allowed to drive a car.
.....
..... [2]

[Total: 10]

Tobacco smoke and lung cancer

Death by cancer is a common occurrence today. There are many forms of cancer and a large number of substances which bring about this disease. Research on experimental animals has shown that there are more than 70 substances in cigarette smoke which are known to cause lung cancer. The graph given below shows the deaths per 100 000 from lung cancer in American men aged 40–79:



Study the diagram carefully and answer the questions given below:

- 1 Which is the most harmful form of tobacco smoking?
 [1]

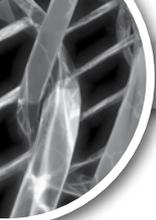
- 2 Tar is a substance that coats the inner surfaces of alveoli. Explain how tar leads to lung cancer.

 [3]

- 3 What is passive smoking?
 [1]

- 4 Why is it more dangerous to be a passive smoker rather than an active smoker?

 [3]



- 5 Suggest why the total number of deaths by smoking a mixture of cigars and pipes is more than the number of deaths caused by smoking cigars only.

.....

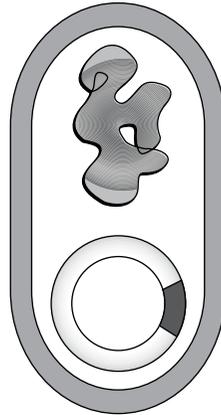
..... [2]

[Total: 10]

Micro-organisms in biotechnology

Bacteria and viruses have become an important source for producing special genes. These genes can then be used in genetic engineering to develop plants and animals with the desired traits, e.g. producing the genes for insulin or producing a gene for increasing the shelf life of tomatoes.

Bacteria contain circular strands of DNA called plasmids. The desired gene is obtained from the cells of a normal person by splicing it from a DNA strand using restriction enzymes. These are then introduced into bacteria by splicing a plasmid, introducing the human gene, and adding a recombinant enzyme. The bacteria are allowed to multiply in a fermenter and this results in a large number of human genes being produced within the bacteria. These are then extracted and used for biotechnology.



- 1 What is the advantage of using genes produced by bacteria instead of injecting insulin from a human or animal source?

.....
 [2]

- 2 Why does tissue rejection not occur when DNA produced by bacteria is transplanted to a human cell?

.....
 [2]

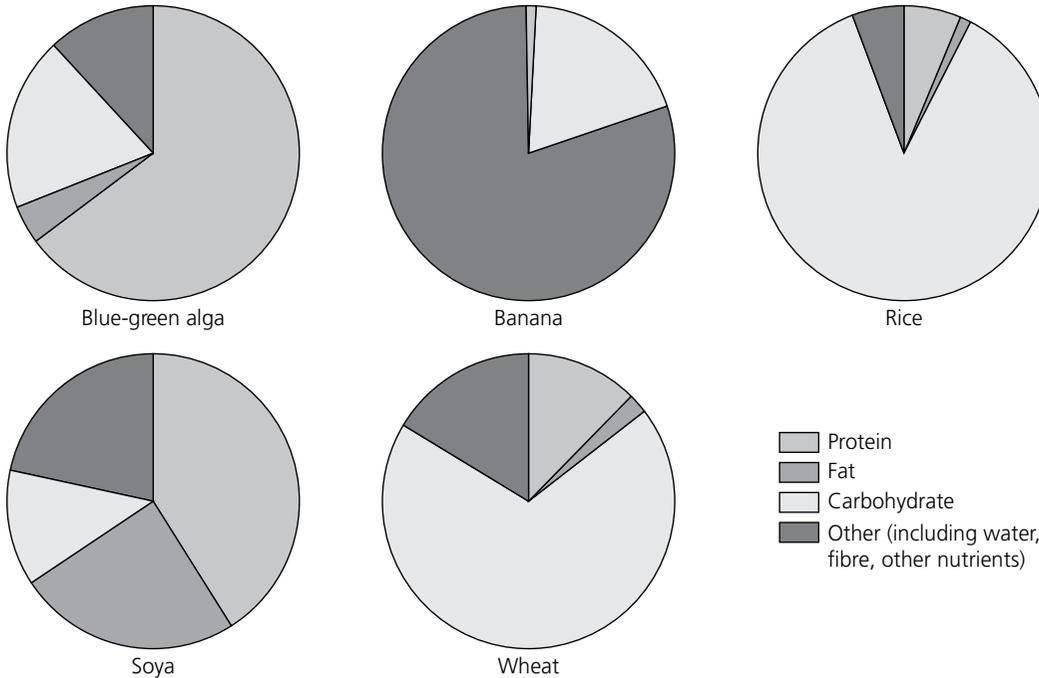
- 3 Name another micro-organism that could be used instead of bacteria to produce human genes.

..... [1]

[Total: 5]

Growing plants as food for humans

Crops are plants grown for humans, or their domestic animals, to eat. Food scientists are interested in the composition of different food crops, and how alternative crop plants might be developed. This diagram shows the composition of five crop plants:



1

(a) The diagram suggests that banana does not contain any fat. Why does this make banana 'healthy' food?

..... [1]

(b) Use the diagram to suggest one other reason why banana would be a 'healthy' food.

..... [2]

2

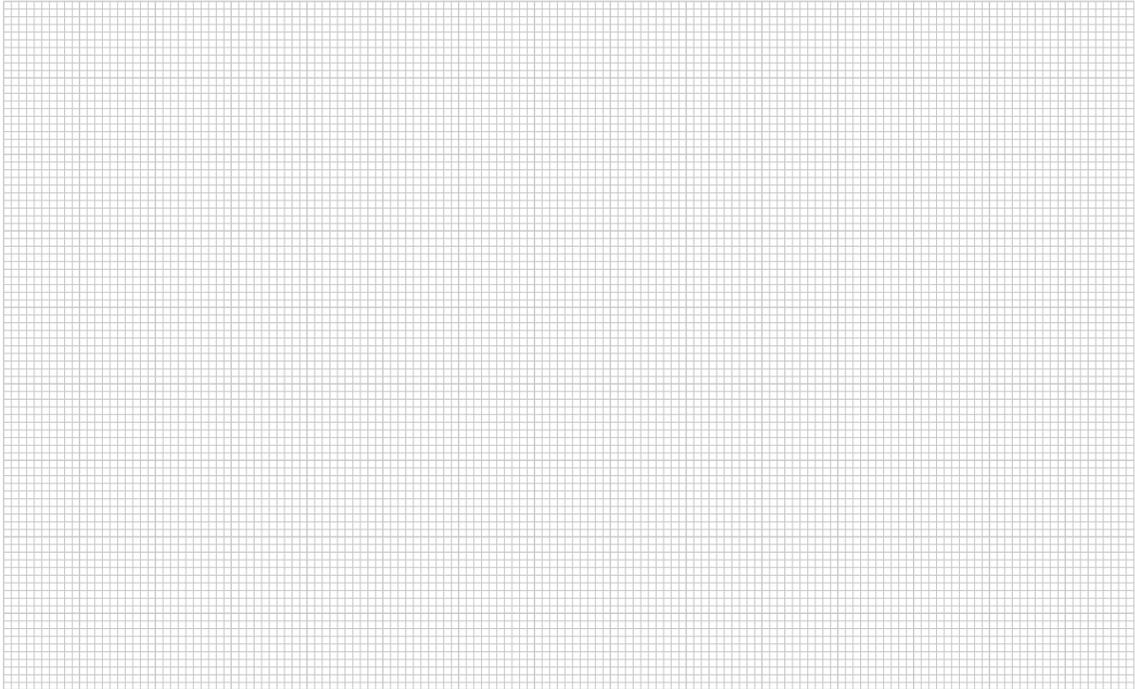
(a) Measure the percentage protein content of the different foods.

Write your answers in this table:

Food type	Banana	Rice	Wheat	Blue-green algae	Soya
Protein content %					

[2]

(b) Present these results in a bar chart. A grid is provided below. Include a title on your chart.



[4]

3 Blue-green algae are simple, single-celled organisms. They can be grown quickly in shallow artificial ponds, in countries that lie close to the equator. They can be collected and dried to form a food that looks like biscuits. This food is called **single-cell protein**.

(a) Which **two** environmental factors affecting the growth of the blue-green algae will be close to optimum values in the countries described above?

..... [2]

(b) Why is it necessary for the ponds to be shallow?

..... [2]

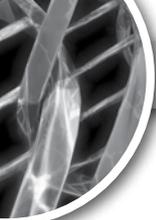
(c) The growers add magnesium and nitrate to the ponds. Why do they do this?

..... [2]

(d) The blue-green algae contain very high levels of protein. Excess protein in our diet cannot be stored. Which human organ might be 'overworked' if we ate large quantities of single-cell protein? Explain your answer:

.....

 [3]



(e) Single-cell protein is often fed to cattle. What advantage would this give to the farmer?

..... [1]

4

(a) When rice is grown and harvested, farmers often prepare it for sale by taking away the brown husk. People who eat a lot of this 'polished' rice sometimes have severe deficiency diseases, and seem unable to efficiently use the carbohydrate present in the rice. Why do you think this is the case?

.....

..... [2]

(b) Suggest one way that genetic engineers have made rice into an even better food.

..... [1]

5 Large areas of rainforest have been cleared to grow more soya for feeding humans and domestic animals. How does this extra production of soya harm the environment?

.....

.....

..... [3]

[Total: 25]

Construction of a food web

Some students made a survey of a pond like the one shown below:



After many visits they put together their results in this list:

Hydra feeds on water fleas.

Diving beetles feed on water fleas and on mayfly larvae.

Pond snails feed on algae and on pondweed.

Pond skaters feed on water fleas and tadpoles.

Perch feed on tadpoles, diving beetles, water fleas, and pond skaters.

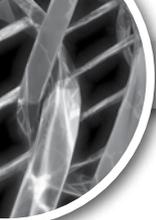
Heron feeds on perch.

Mayfly larvae feed on algae.

Water fleas feed on algae.

Tadpoles feed on algae and on water fleas.

1 Use the information given above to construct a food web for the pond.



2 Who is the top consumer in this food web?

..... [1]

3 How is this animal adapted to its role as a consumer?

..... [3]

4

(a) What happens to the animals and plants that die before they are eaten?

..... [1]

(b) Which type of organism are responsible for this?

.....

..... [3]

5 Select one food chain from your food web. Draw the pyramid of numbers that you would expect for this food chain.

[2]

6 A gardener decided that he did not like the growth of algae in the pond. He added an algicide (a chemical that kills algae) to the pond. Explain how this might lead to:

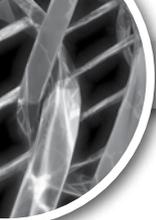
(a) an **increase** in the population of pondweed

..... [1]

(b) a **decrease** in the population of pondweed

..... [1]

[Total: 15]



Natural insecticides

A scientist noticed that some plants were never bothered by insects. He was interested in whether the plants contained their own natural insecticide. He ground up the plants so that he could collect the natural insecticide, which he thought could be dissolved in water. Which technique would he use to separate the dissolved insecticide from the crushed-up remains of the plant.

- 1 Draw a simple diagram to explain how he would do this, and suggest how he would collect the dissolved insecticide from the solution.

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

- 2 He thought that the 'juice' would be able to kill insects, and decided to try to find out whether spraying more pesticide 'juice' would kill more insects. What would his **hypothesis** be and what **prediction** might he make?

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

To carry out this investigation, the scientist and his team of workers made up a number of different concentrations of the natural insecticide and then sprayed the insecticide solutions onto a series of plants. Each plant was of the same species, and each plant had 100 aphids feeding on it. The team kept all of the plants in the same room and then counted how many aphids were left alive after 24 hours.

- 3 What was the **input (independent) variable** in this experiment?

..... [1]

- 4 What was the **outcome (dependent) variable**?

..... [1]

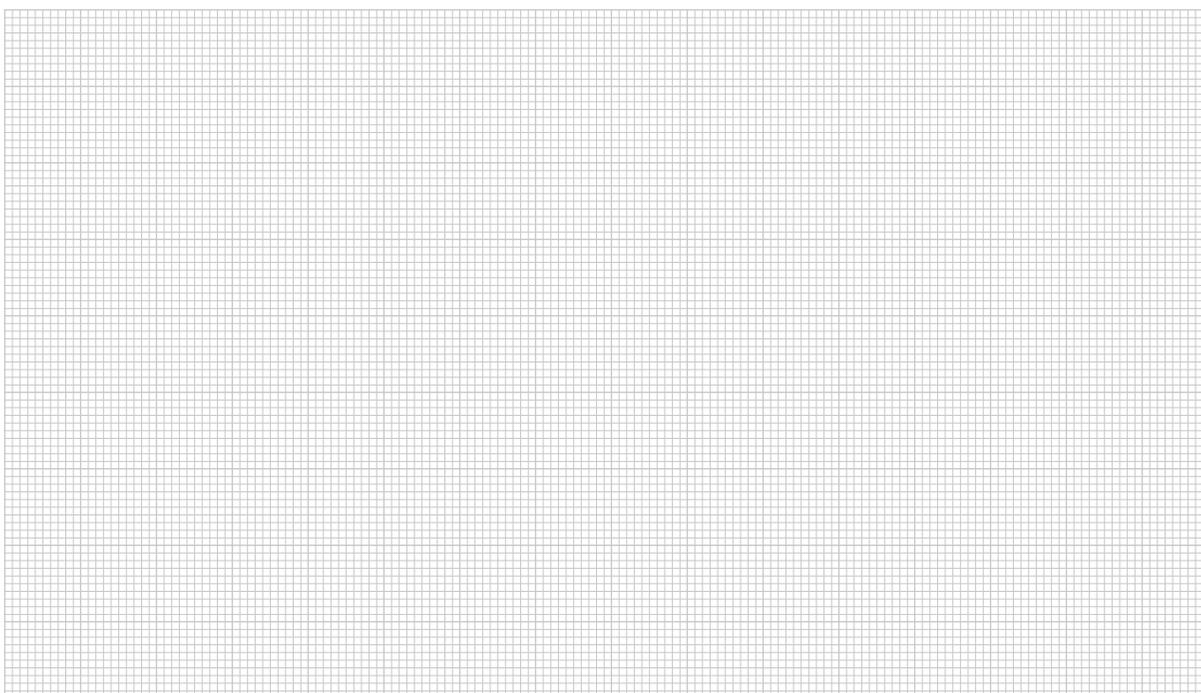
5 Do you think that this was a fair test (i.e. the results were 'valid')? Explain your answer.

.....
 [2]

6 This table shows the results obtained in this experiment:

Concentration of insecticide / ppm	0	5	10	15	20	25	30	40	50	100
Number of aphids alive after 24 hours	99	97	96	95	55	40	25	20	21	20

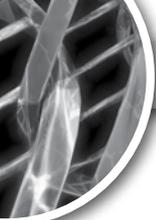
Plot a graph of these results. A grid is provided below. Include a title on your graph.



[6]

7 Use your graph to calculate the concentration of pesticide needed to kill 50% of the aphids.

.....
 [1]



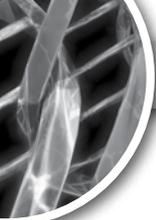
8 Do the results support the prediction that the scientist made? Use the graph to explain the answer that you give.

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

9 Give **two** reasons why scientists should be careful about using new insecticides in the environment.

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

[Total: 20]



Reproduction and growth in plants

Plants reproduce sexually, i.e. they produce male and female gametes in specialized reproductive structures. Since plants do not move around, mechanisms exist to enable male and female gametes to unite. Similar mechanisms have evolved to make it possible for seeds to be dispersed and protected.

1 State any two structural adaptations of wind-pollinated seeds.

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

2 Why is self-pollination a barrier to genetic variation?

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

3 Why do the petals of a flower fall off after fertilization has occurred?

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

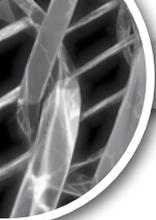
4 State two features of the plum fruit that facilitate dispersal by animals.

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

5 Why does the dry mass of a seed fall during the initial stages of germination and rise during the later stages?

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

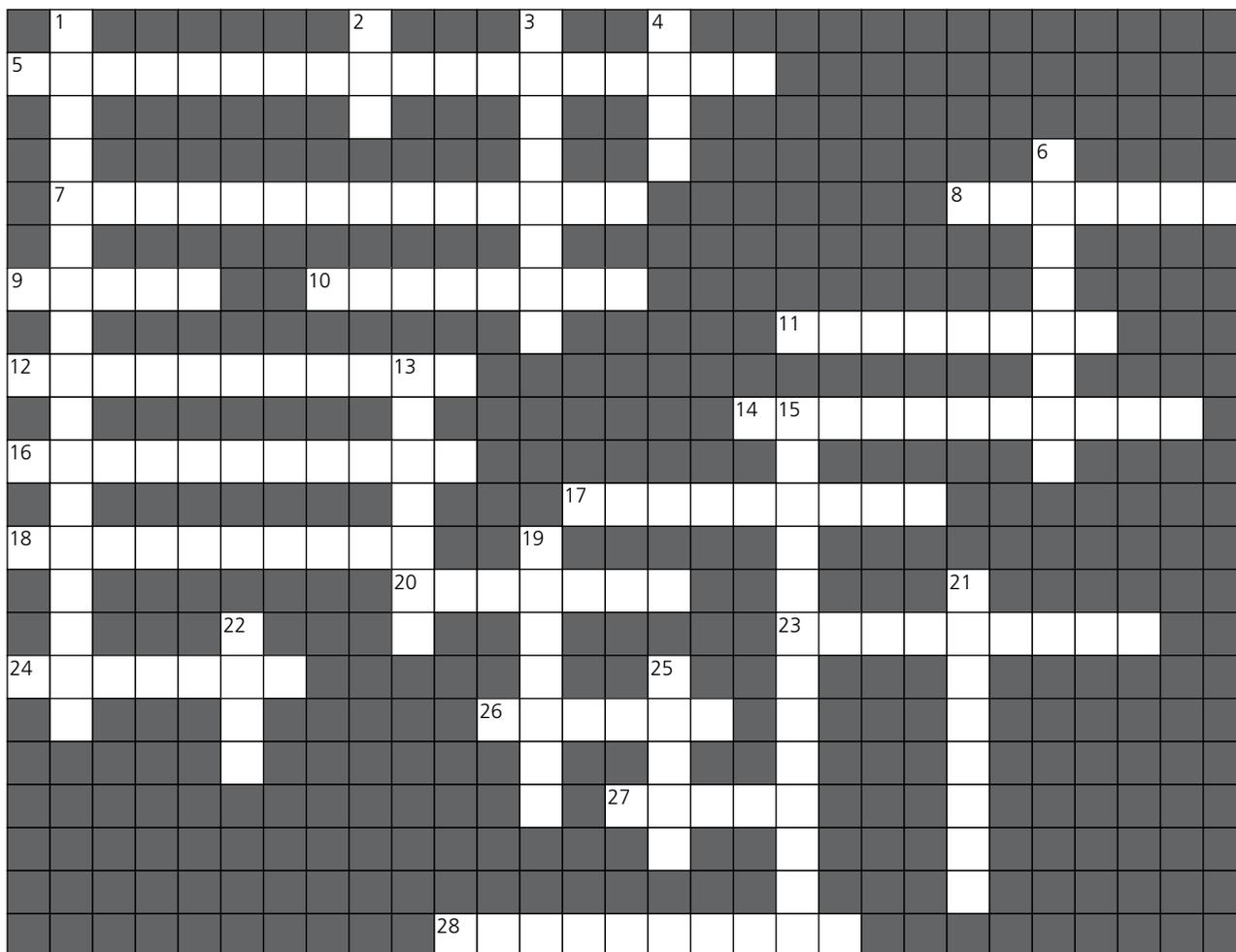
[Total: 10]



Inheritance I

Once scientists began to understand the processes involved in reproduction and inheritance, they began to try to control these processes for the benefit of humans. This exercise tests your recall of some of the key terms used to describe this control.

Crossword



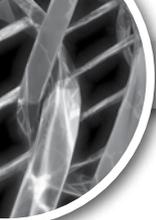
Across

- 5 the techniques involved in changing an organism's genotype (7, 11)
- 7 a disease of the lungs that may be treated by 12-across
- 8 a small circle of DNA in a bacterium
- 9 can be used to carry genes into human lung tissue
- 10 an organism made by combining cells from two different species
- 11 growth chemicals needed to make plants grow well in culture media
- 12 a technique for transferring genes as a means of treating disease
- 14 a disease condition that can be helped by genetically-engineered factor VIII
- 16 with 18-across—the technique of using plant fragments to produce many identical plants
- 17 genetically-modified bacteria are grown in large quantities inside this type of vessel
- 18 see 16-across
- 20 an important engineered protein that is used to treat diabetes
- 23 an enzyme needed to remove the cellulose cell wall from a plant cell
- 24 these biological catalysts are needed to 'cut and stick' pieces of DNA
- 26 the name given to the agent of transferring genes
- 27 a group of genetically identical organisms, produced by mitosis
- 28 a plant cell with the cell wall removed

Down

- 1 a method of 'concentrating' useful characteristics by carefully controlling sexual reproduction
- 2 the hereditary chemical (abbreviation)
- 3 the tip of a plant that can be broken up for use in tissue culture
- 4 a mammalian product that can be used to deliver useful proteins
- 6 microbes that can be engineered to produce useful materials for humans
- 13 a product that is coded for by a gene
- 15 a technique for studying the cells of a developing foetus
- 19 the control centre of the cell
- 21 must be controlled to limit water loss by transplanted 'cloned' plants
- 22 a section of DNA that controls the production of a single protein
- 25 the world's most famous sheep

[28]



The importance of DNA

DNA is the molecule which carries the coded information responsible for all of the characteristics of organisms. The structure of this molecule was not worked out until 1953, and an entire new branch of biology—molecular biology—has developed since that discovery. This exercise will remind you of some of the key features of this molecule.

Crossword

					1										2				
			3			4													
5																			
															6				
7																			
			8							9								10	
		11														12			
								13											
14																			
					15														
16																			
					17														

Across

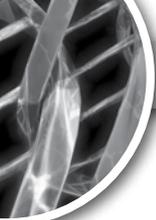
- 1 makes up the backbone of the DNA molecule
- 3 the twisted ladder of DNA (6, 5)
- 5 found in the nucleus and made up of DNA
- 6 a section of DNA that codes for a single protein
- 7 two scientists who suggested the structure of DNA (6, 3, 5)
- 8 another name for a 'feature' of an organism
- 13 control centre of the cell—this is where you would look for DNA
- 14 or DNA for short!
- 15 one of the subunits that makes up DNA
- 16 one of the molecules that make up the rungs of the DNA ladder
- 17 female scientist who helped in understanding the structure of DNA

Down

- 2 a protein found in red blood cells
- 4 a rule that 'links' the two chains of the DNA molecule (4, 7)
- 9 the copying of DNA
- 10 the pigment responsible for skin colour
- 11 type of cell division that produces exact copies
- 12 protein molecule found in hair cells

[17]

[Total: 45]



Inheritance II

- 1 List down the possible genotypes for blood groups A and B.

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

- 2 What is meant by 'fertilization is random'?

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

- 3 What is a homologous pair?

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

- 4 Both parents have straight hair and are heterozygous (Hh). What combinations might possibly take place at fertilization? What might be the ratio of straight hair to curly hair in the F_1 generation?

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

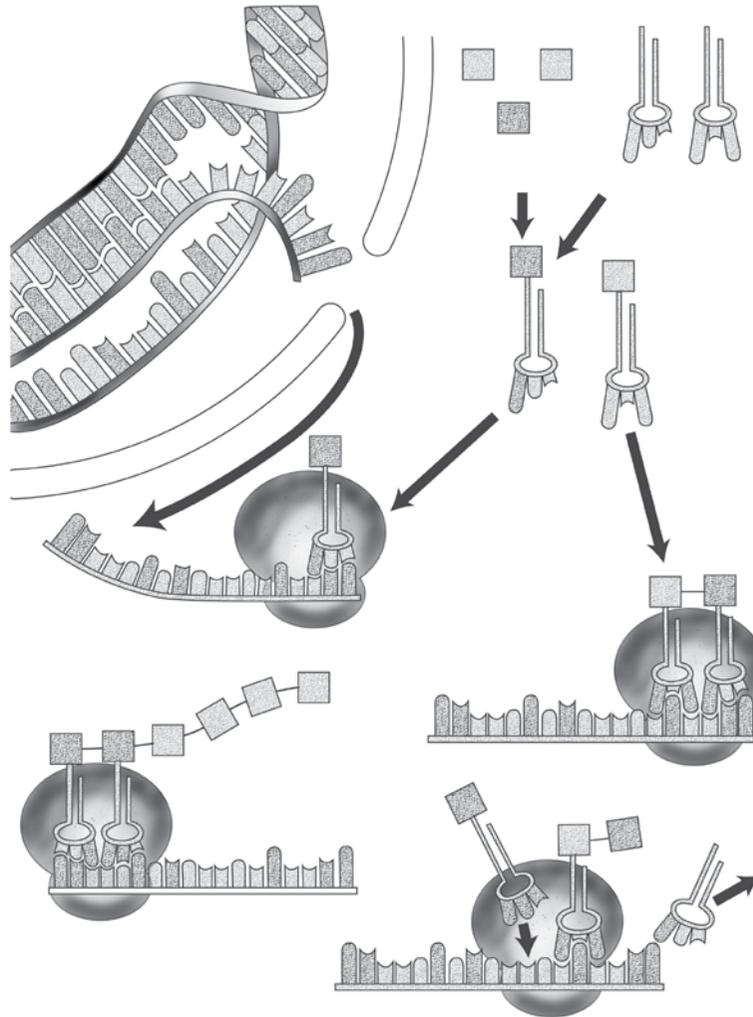
- 5 Name two inherited medical conditions.

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

[Total: 10]

DNA control of protein synthesis

Proteins are synthesized within the ribosomes of a cell. The sequence of amino acids is controlled by RNA molecules present in the cytoplasm. The RNA in turn is controlled by the nucleotide bases which form a DNA strand within the nucleus.



By looking carefully at the diagram and following the arrows, answer the following questions:

- 1 What is the name given to a single strand of DNA coding for a gene?

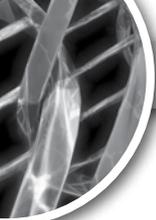
..... [1]

- 2 How does this genetic information pass from the nucleus to the cytoplasm?

..... [1]

- 3 Where does the strand of genetic code attach for protein synthesis?

..... [1]



4 What is the name given to the small RNA molecules within the cytoplasm?

..... [1]

5 How many nucleotide bases are required for capturing an amino acid?

..... [1]

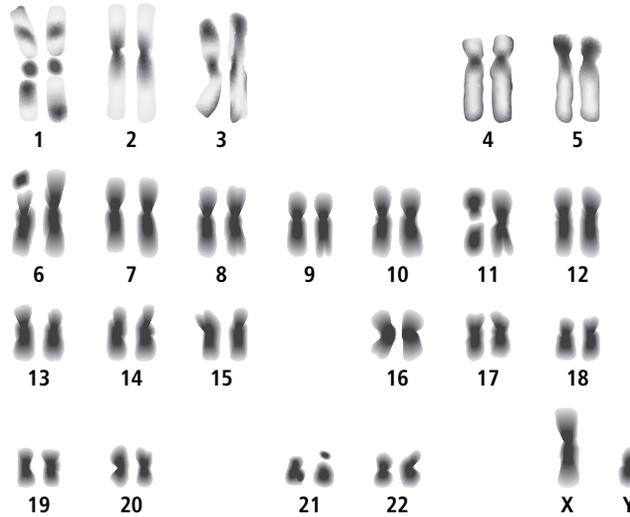
6 The small RNA molecules attach to the genetic strand from the nucleus through their nucleotide bases. During the process of protein synthesis, amino acids link up with each other while separating from the RNA molecules. Describe the steps and explain why this process takes place.

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

[Total: 8]

Human chromosomes, twins, and triplets

It is possible to examine human chromosomes by taking dividing cells from a convenient part of the body, squashing them onto a microscope slide, and staining them. An easy source of cells for this type of study is the lining of the cheek. This image, showing a smear of a human cheek cell, is called a karyotype.



1 How many chromosomes are present?

..... [1]

2 Complete this table:

Type of cell	Number of chromosomes	Number of sex chromosomes
Male liver cell		
Female nerve cell		
Male red blood cell		
Female white blood cell		
Sperm cell		
Egg cell		

[6]

3

(a) What was the sex of the individual who supplied the chromosome smear shown above?

..... [1]

(b) Explain your answer.

.....

..... [1]



4 Draw a simple diagram to explain how identical twins may be produced.

[3]

5 A woman gave birth to triplets and the children were adopted by different parents. They were brought up under very different circumstances, but met up again on their 25th birthday, when a geneticist made some measurements.

	Sally	Jane	Rachel
Body mass (kg)	51	48	59
Height (cm)	160	161	162
Blood group	A	O	O
Shoe size	5	5	5
Does she have cystic fibrosis?	Yes	Yes	Yes
Intelligence quotient	138	128	139

(a) Which of the daughters might be identical twins?

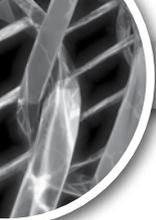
..... [1]

(b) Explain why you have made this choice.

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

(c) Rachel and Jane had very different values for body mass. What reasons could there be for this?

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



6 Cystic fibrosis is an inherited condition caused by a recessive allele (cf). Neither parent had this condition, yet all three daughters did. Use genetic diagrams to explain how this is possible.

[3]

7 Psychologists believe that a measure of intelligence, the intelligence quotient, is partly inherited and partly the result of the learning environment. What evidence from the table of results supports this hypothesis?

.....

..... [2]

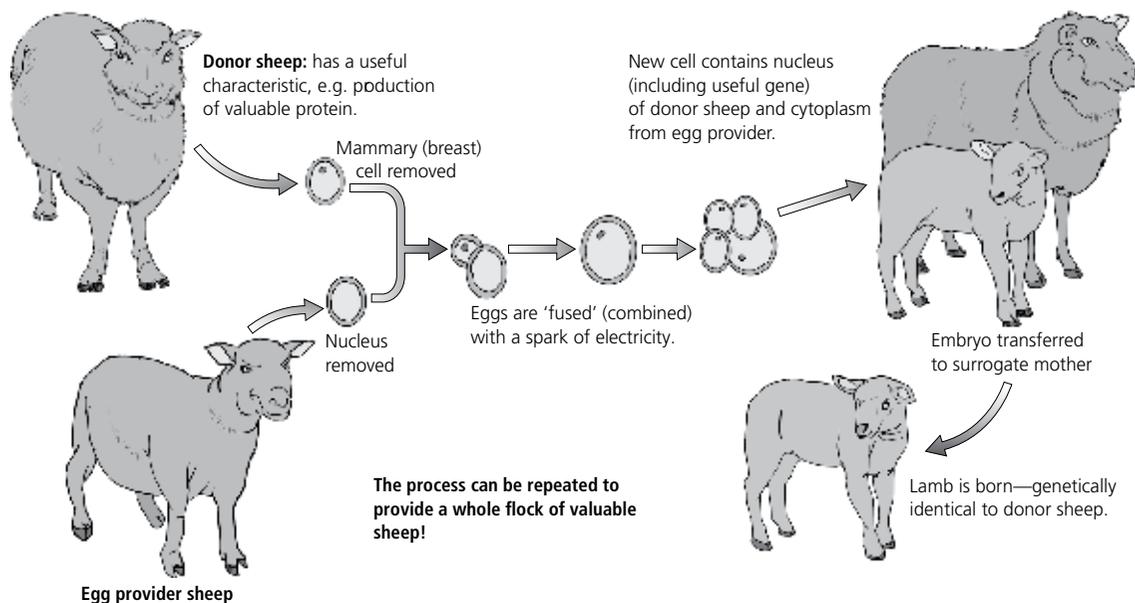
[Total: 20]

Animals and plants in biotechnology

The first successful genetic engineering experiments were conducted as recently as 1973—a gene from one bacterium was transplanted into another one, and was shown to work in the new host. In 1977, somatostatin was the first human protein to be produced by genetically engineered (transgenic) bacteria. Since the 1970s there have been several important examples of transgenic bacteria being used as biochemical factories. For example, insulin (used in the treatment of type I diabetes) and Human Growth Hormone (used in the treatment of hypopituitary dwarfism) have been produced in this way. Not all proteins can be manufactured using transgenic bacteria—some more complex proteins require the addition of carbohydrate side branches in order to work properly. The addition of these sugar residues can only be accomplished in plant and animal (eukaryote) cells, so that the development of transgenic eukaryotes has been of great importance.

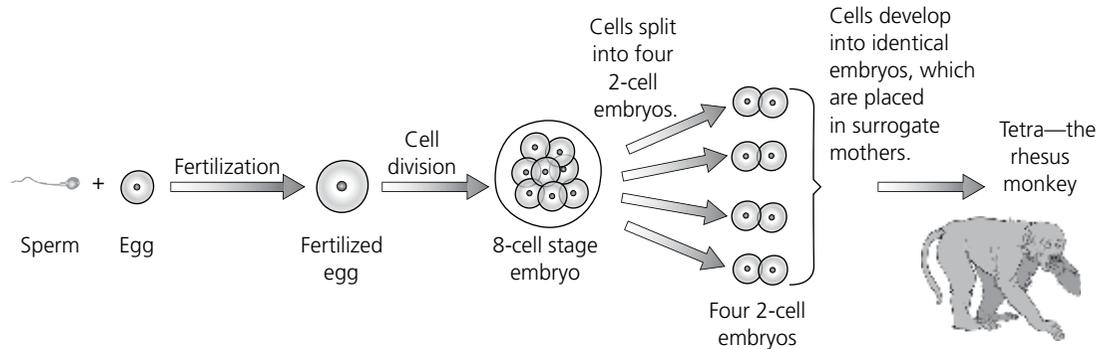
- 1 The following paragraphs list some of the milestones in the use of animal and plant cells in biotechnology. Rearrange them into the correct chronological order (i.e. the sequence in which the discoveries and announcements were made). Present your rearranged sequence in the form of a table. [8]

- (a) In 1992, Calgene (a bioengineering company in the USA) produces the 'Flavr-Savr' tomato which has been genetically engineered to have a longer shelf life.



- (b) Tracy, the transgenic sheep, was born in 1995. Tracy had mammary glands which could produce alpha-1-antitrypsin, a protein important in the development of the body's defence systems.
- (c) A genetically modified tobacco was produced—this was the world's first transgenic plant. In this same year, 1981, courts in the USA decided that GMOs (genetically modified organisms) could be patented. The first patent issued for a vertebrate was in 1988—for a mouse carrying an oncogene that made it susceptible to cancer.
- (d) The first transgenic mice were produced in 1983. In 1988, Rudolf Jaenisch and his colleagues transferred the gene for a human hereditary disease into a mouse, suggesting that this might lead to an improvement in disease treatment.
- (e) Dolly, the first mammal to be cloned from an adult cell, was produced in 1996.

- (f) In 1989, it was announced that transgenic plants had been produced carrying genes coding for antibodies against human diseases.
- (g) The UK government recommended, in 2000, that research into tissue cloning for therapeutic use should be permitted.
- (h) The first ever chimera was produced in 1984—this was a ‘shoat’, a hybrid between a sheep and a goat.
- (i) The first attempt at human gene therapy took place in 1990. A girl was transfused with white blood cells genetically engineered to produce an essential protein that her own immune system could not manufacture.
- (j) In 1998, the first cloning of stem cells took place—this paved the way for the culture of replacement organs and tissues.
- (k) Polly, the first transgenic sheep to be cloned, was developed in 1997.
- (l) Scientists in Oregon, USA, announce Tetra, a rhesus monkey. Tetra is the first cloned primate and, because of this, the scientists suggest that she will be of great value in testing medicines for human use.



- 2 Look carefully at the table you have produced. Highlight those announcements/discoveries that you feel directly affect the management of disease in humans. Use a different colour to highlight those announcements/discoveries that depend on government legislation. [6]
- 3 Look again at your table. Draw a simple graph to illustrate how the pace of research into transgenic organisms has accelerated over the past twenty years. You would be able to use this image in a presentation to your teaching group about the significance of molecular biology. [6]

[Total: 20]

Animals in medical research—What do you think?

Animal testing (also known as vivisection) brings about strong responses from many people, both for and against the procedures. The role of animal experimentation in medical research is controversial, but the British Medical Association states firmly that animal experimentation is necessary to develop a better understanding of diseases and how to treat them. There are many misunderstandings of the procedures, of the treatment of the animals used, and of the controls under which the experiments are carried out. For example, many people believe that cats and dogs are carelessly used and discarded—in fact research in the UK uses about 5000 dogs and 300 cats each *year*, whereas about 1000 pets are put down every *week* after being abandoned by their owners.

The '3R's': working towards a reduction in the need for animal testing and good laboratory practice whenever animal testing is necessary.

REPLACE the use of animals whenever possible.

REDUCE the number of animals needed to a minimum.

REFINE the tests so that there is the least possible distress to the animals.



Pet animals are stolen for research.

Pet animals have an unknown genetic history, and so are not suitable for animal research.

Animal testing is not useful, and many products are withdrawn because of their side effects.

Only about 4% of drugs and medicines are withdrawn from use because of side effects which were not detected during animal and human tests.

Huge numbers of animals are killed for medical research.

There is the equivalent of 2.5 mice and half a rat used for each person in the UK during their whole lifetime.

Monkeys and apes are our nearest relatives, and many of them are experimented on for medical research.

Less than 0.2% of all animal experiments are carried out on non-human primates.

- 1 Give **two** concerns from those listed on the previous page which animal welfare supporters would have about animal research.

.....
 [2]

- 2 For these two concerns, suggest how scientists would try to answer these concerns.

.....
 [2]

- 3 What are the rules that reduce the risk of mistreatment of animals in research establishments?

.....

 [4]

- 4 One use of animals is in the investigation of diet. Case study 1 examines the use of a group of animals in an investigation into the **benefits of milk**.

Case study 1

In one experiment, a group of fifteen baby rats were divided into five groups of three. The five groups were fed on a diet of pure egg protein, glucose, starch, lard, and water. In addition, each group received a supplement of milk. The animals were allowed to grow for fifteen days and then they were weighed. The results of this experiment are shown below.

Amount of additional milk (cm ³)	Mass of animal at fifteen days: three values ()	Mean (average) mass of animals ()
5	45, 48, 42	
10	50, 53, 50	
15	53, 52, 54	
20	56, 57, 58	
25	60, 59, 64	

- (a) Calculate the mean mass of each of the groups, and write your answers into the table.

Add the correct units for mass. (Think carefully!) [2]

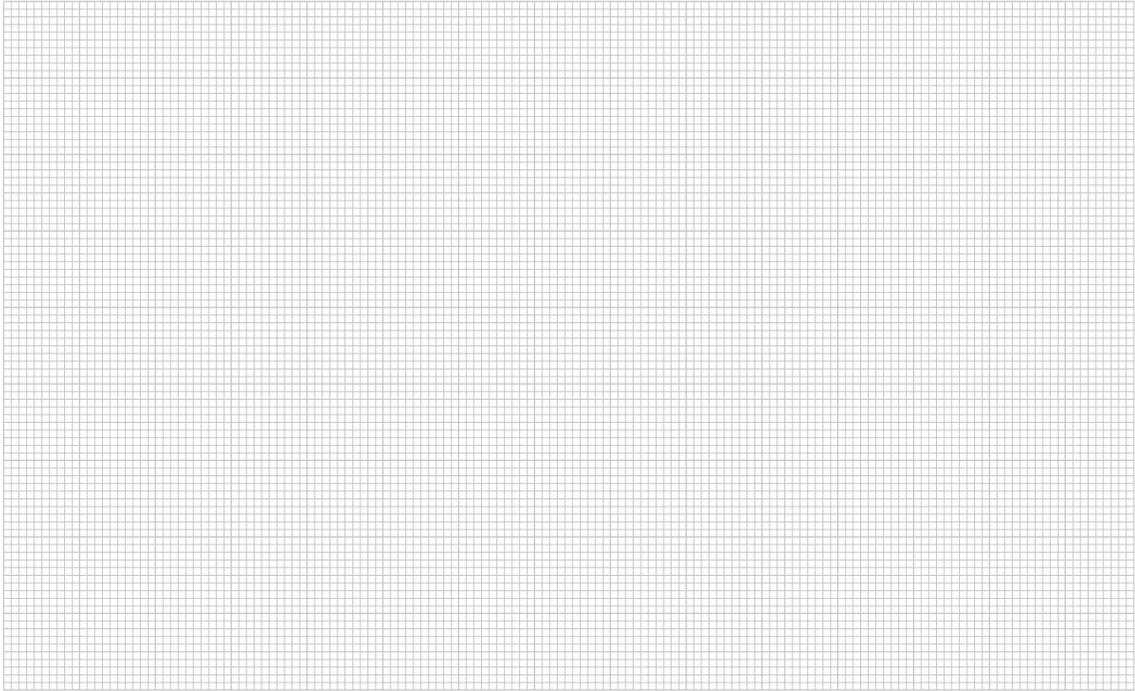
- (b) What is the input (**independent**) variable for this experiment?

..... [1]

- (c) What is the outcome (**dependent**) variable?

..... [1]

- (d) Plot the results as a line graph on the grid provided below. Include a title for your graph.



- (e) Suggest three **control** variables for this experiment.

[4]

..... [3]

- (f) What is present in the milk that might explain these results?

..... [2]

Case study 2

The first clinical trial of an anti-retroviral medicine, AZT, took place in 1986.

Chimpanzees are primates (just as humans are). They can be infected with HIV, but do not develop symptoms of AIDS because they have an immune system which is extremely effective against HIV. This observation was crucial to the development of the ELISA test for HIV. In this test a diluted sample of blood serum is tested with HIV antigens: this test detects the presence of HIV antibodies in the blood. This is now the standard screening test for the presence of the virus in human sufferers, and allows both diagnosis of infection and the screening of blood donations.

The Asian Macaque originates from Asia rather than Africa and so has not developed immunity to HIV. A Macaque that is infected with HIV develops AIDS-like symptoms very quickly.

Anti-retroviral drugs are not usually tested for **efficacy** (how well they work) on primates, but generally only for **safety**.



- 1 Give two reasons why scientists support research on primates.

.....
 [2]

- 2 Give two reasons why a non-scientist might believe it is not appropriate to carry out research on primates.

.....
 [2]

- 3 Find out two features of the chimpanzee that identify it as a primate.

.....
 [2]

- 4 Which type of cell is infected by the AIDS virus?

..... [1]



5 List three ways by which AIDS might be transferred from one person to another.

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

6 State three precautions that must be taken in order to avoid AIDS.

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

7 A person might be HIV-positive while still not suffering from AIDS. Explain the statement briefly.

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

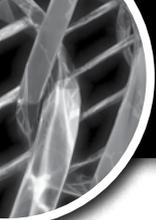
8 Why has a vaccine not been prepared against AIDS yet?

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

9 A person suffering from AIDS dies of minor infections. Explain the statement.

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

[Total: 40]



Cell structure

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 The animal cell does not contain ...
- (a) a cell membrane
 - (b) a nucleus
 - (c) a large sap vacuole
 - (d) cytoplasm
- [1]

- 2 Plant cells contain stored food in the form of ...
- (a) cell sap
 - (b) starch
 - (c) glycogen
 - (d) glucose
- [1]

- 3 An example of connective tissue is ...
- (a) blood
 - (b) hair
 - (c) muscle
 - (d) neurone
- [1]

- 4 Cells with a similar structure and function together form a/an ...
- (a) cell structure
 - (b) tissue
 - (c) organ
 - (d) organism
- [1]

- 5 State three structural adaptations of red blood cells.
-
- [3]



6

(a) Identify the following as cell, tissue, organ, and organ system:

(i) stomach [1]

(ii) epithelium [1]

(iii) digestive system [1]

(b) A cell measures 10 mm on a photomicrograph magnified 1500 times. What is the actual size of the cell?

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

7

(a) Describe how the animal cell and plant cell are adapted to enable the organisms to perform their life functions.

.....
.....
.....
.....
.....
..... [6]

(b) Identify three features animal and plant cells share in common.

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

(c) Name three types of plant tissue.

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

[Total: 25]

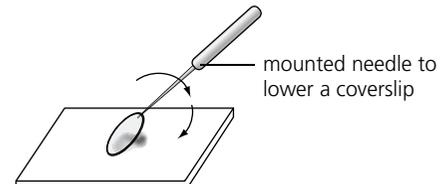
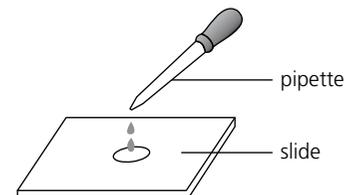
Observing plant cells in solution

You need:

- microscope
- dropping pipette
- strong sugar solution
- slides and coverslips
- test tube and rack
- stick of rhubarb, red onion or a species with a red epidermis
- mounting needle
- scalpel

Method

- 1 In this experiment you will observe the behavior of plant cells in different liquids.
- 2 Prepare a thin strip of cells from the outer skin of the rhubarb or onion. If you snap the stick of rhubarb, you may see the thin, outer 'skin' of cells. If you are using onion you might see a thin membrane around one of the thicker layers. This can be peeled off.
- 3 Put drops of distilled water on one slide and strong sugar solution on another. (Label them so you know which is which!)
- 4 Put a piece of rhubarb or onion skin on each slide and then gently lower coverslips over them. If your slides have too many air bubbles in them, start again.
- 5 Observe the cells under low, medium, and then high power.
- 6 Describe and draw any changes you observe in the cells. Do this for the cells in water and those in sugar solution.
- 7 Explain your observations using scientific knowledge.
- 8 Remove the coverslip from the cells in sugar solution. Wash the strip of cells and then make a new slide by mounting them in water.
- 9 Observe what happens and record your results.



Your teacher will be looking for:

- using apparatus and equipment
- observing carefully and accurately
- presenting results in a table
- drawing and explaining conclusions

HAZARD WARNING

Scalpels are sharp—handle with care.

Teacher/technician notes

Skills

This experiment can be used to assess a student's ability in the following:

- using apparatus (microscope)
- observing accurately
- presenting results as diagrams
- drawing conclusions

Previous lessons

Students should be familiar with the use of microscopes including making observations under high power magnification.

Students should know about the structure of plant cells and osmosis.

Apparatus and equipment

- access to a microscope
- microscope slides and coverslips
- stick of rhubarb (or piece of red onion or a similar species with a red epidermis)
- test tubes and rack
- dropping pipette
- strong sugar solution

This experiment works better if cells from the outer skin of rhubarb are used since these are easier to see without staining. However, some teachers may wish to use onion.

Procedure

Students will prepare slides of rhubarb or onion cells in water and in sugar solution. They will observe and draw these under high power magnification.

Students will be asked to use their scientific knowledge to explain their results.

Cue sheets

No cue sheets are provided for this assessment task.

Criteria

Using apparatus and equipment

- (a) Correct use of microscope [2]
 (b) Good preparation of slides [2]

Making observations and measurements

- (a) Cells in water are well-observed. [2]
 (b) Cells in sugar solution are well-observed. [2]

Presenting data

- (a) Clear, accurate diagram of cells in water. [2]
 (b) Clear, accurate diagram of cells in sugar solution [2]

Drawing and explaining conclusions

- (a) Relates observations to movement of solute (water) [1]
 (b) Explains observations in terms of osmosis [2]

[Total: 15]

Background information

There is no background information sheet for this assessment.

Enzymes

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 Osmosis is ...
- (a) the movement of molecules into a larger space
 - (b) the movement of molecules from a region of lower concentration to a region of higher concentration
 - (c) the diffusion of water molecules from a region of higher concentration to a region of lower concentration across a semi-permeable membrane
 - (d) the movement of glucose molecules across a semi-permeable membrane [1]

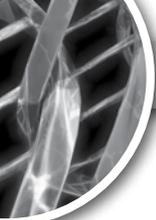
- 2 The process by which movement of molecules takes place against a concentration gradient is called ...
- (a) diffusion
 - (b) active transport
 - (c) osmosis
 - (d) plasmolysis [1]

- 3 At higher temperatures enzymes ...
- (a) work faster
 - (b) damage the cell
 - (c) become denatured
 - (d) perform a reverse reaction [1]

- 4 The enzyme amylase is found in ...
- (a) saliva
 - (b) stomach
 - (c) lungs
 - (d) blood [1]

- 5
- (a) How does the structure of the lungs facilitate diffusion of gases?
-
- [2]

- (b) Describe how a water potential gradient is formed.
-
-



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

6

(a) What role do enzymes play in metabolism?

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

(b) State two factors that affect enzyme activity.

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

(c) Suggest an ideal range for the factors identified above for optimum enzyme activity.

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

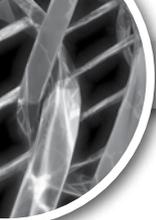
(d) Name an intracellular enzyme and an extracellular enzyme.

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

7

(a) How is a hypothesis different from a conclusion?

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



(b) What is the purpose of a control experiment?

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

(c) Identify the dependent and independent variables in an experiment designed to test the factors affecting the activity of amylase.

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

{Total: 25}

Investigating photosynthesis in leaves I

Teacher/technician notes

Skills

This experiment can be used to assess a student's ability in the following:

- using apparatus and equipment safely
- observing accurately
- presenting results in a table
- drawing conclusions

Previous lessons

Students should have studied photosynthesis. They should also be familiar with the test for starch.

Apparatus and equipment

Each group should have the following:

- access to a plant kept in the dark
- access to a plant kept in the light
- access to a variegated plant

Each student should have the following:

- scissors or scalpel
- forceps
- Bunsen burner, tripod, gauze, heat resistant mat, safety goggles
- boiling tubes, beaker
- white tile, dropping pipette
- ethanol
- iodine solution

Ideally, all the plants should be of the same species. Therefore, it is suggested that variegated and non-variegated geraniums are used. If this is not possible, coleus or variegated tradescantia leaves may be used.

One of the non-variegated plants and the variegated plant should be kept in the light. The other plant should be kept in a dark place for about 24 hours before the assessment takes place.

Safety: Teachers will need to ensure that students do not use ethanol near naked flames. This is also stressed in the student's instructions.

Procedure

Students will carry out a test for starch on the leaves provided. Students will be asked to present their results, and to explain them using scientific knowledge.

Cue sheets

No cue sheets are provided for this assessment task.

Criteria

Using apparatus and equipment

- (a) methodical preparation of leaf specimens [2]
- (b) *safe* heating of leaves in ethanol [1]
- (c) successful application of starch test [2]

Making observations

- (a) all results clearly and logically presented [2]

Drawing conclusions

- (a) correct relationship between light and photosynthesis [1]
- (b) correct relationship between leaf colour and photosynthesis [1]
- (c) leaf colour linked to chlorophyll [1]

[Total: 10]

Background information

There is no background information sheet for this assessment.

Student's instructions

You need:

- | | | |
|--|--------------------------------|--------------------|
| ■ plant with normal leaves kept in light | ■ scissors or scalpel | ■ forceps |
| ■ plant with normal leaves kept in dark | ■ boiling tube | ■ ethanol |
| ■ plant with variegated leaves | ■ beaker | ■ white tile |
| | ■ Bunsen burner, tripod, gauze | ■ iodine solution |
| | ■ heat-resistant mat | ■ dropping pipette |

- Most plants produce their food by *photosynthesis*. One of the products of photosynthesis is sugar. Leaves change this into starch so that it can be stored. If we can detect starch in a leaf we can conclude that photosynthesis has been taking place.
- In this experiment you will test various leaves for starch. You will then use your results to draw some conclusions about photosynthesis.
- Collect one leaf from each of the plants provided. Make a note of the conditions in which each plant was kept. (Do not get the leaves mixed up!)
- Cut pieces from each leaf for testing. For the variegated leaf, cut one piece from the green part and one from the 'white' part. The pieces should be large enough to test but small enough to fit in the boiling tube. So that you can identify them, cut the different leaves into different shapes. For example:



normal



kept in dark



variegated (green part)



variegated (white part)
- Put on your safety goggles.** Light your Bunsen burner and turn it to a yellow flame. Heat a beaker of water until it is boiling. Dip each piece of leaf in the boiling water for about 30 seconds to kill it.
- SAFETY—TURN YOUR BUNSEN BURNER OFF.**
Leave your beaker of hot water on the tripod.
- Put all the pieces of leaf into a boiling tube. Add ethanol to the tube so that all the pieces are covered (about half full only). Put the boiling tube into your beaker of hot water. The ethanol will boil and remove much of the leaf colour. This will take about three minutes.
- Lift the leaf pieces out of the ethanol using forceps. Put them on a white tile. Cover each one with iodine solution. Write down what happens. (Remember that a blue-black colour means that starch is present.)
- What conclusions can you draw from your results? Explain your conclusions using your knowledge of photosynthesis.

This experiment will test your skills in:

- using apparatus and equipment
- observing accurately
- presenting results clearly
- drawing conclusions

HAZARD WARNING

Ethanol is highly flammable. KEEP AWAY from naked flame. Iodine is harmful to skin and eyes. AVOID SKIN CONTACT. WEAR EYE PROTECTION.



1 State three other factors, besides chlorophyll, which can affect photosynthesis.
..... [3]

2 How would you prove that light is essential for photosynthesis?
.....
..... [3]

3 How would you set up a control to prove that light is essential for photosynthesis?
.....
..... [2]

4 Design an experiment giving all practical details to prove that carbon dioxide is important for photosynthesis.
.....
.....
.....
..... [5]

5 What is meant by carbon dioxide saturation point?
.....
..... [2]

6 What is meant by light compensation point and at what time of the day would it occur?
.....
..... [2]

7 How can the temperature, carbon dioxide concentration, and oxygen concentration be maintained within a jungle jar?
.....
..... [3]

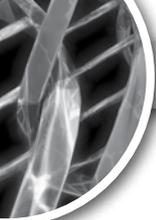
[Total: 20]

Investigating photosynthesis in leaves II

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 During photosynthesis, chlorophyll acts as a ...
- (a) pigment
 - (b) catalyst
 - (c) light source
 - (d) food source
- [1]
- 2 The rate of photosynthesis can be measured by measuring ...
- (a) the volume of carbon dioxide absorbed
 - (b) the size of the leaves
 - (c) the number of hours of sunlight
 - (d) humidity
- [1]
- 3 Chloroplasts are present in the ...
- (a) epidermis
 - (b) mesophyll
 - (c) xylem
 - (d) palisade cells
- [1]
- 4 Identify an essential mineral for plant growth.
- (a) nitrogen
 - (b) calcium
 - (c) sodium
 - (d) iron
- [1]
- 5 Draw a labelled diagram of the cross-section of a leaf in the space below:

[5]



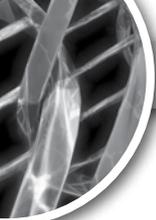
6 State three environmental conditions necessary for photosynthesis.

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

7 Describe an environmental problem caused by the use of fertilizers.

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

[Total: 15]



Nutrition

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 Carbohydrates provide ...
- (a) energy
 - (b) building material
 - (c) fibre
 - (d) hormones
- [1]

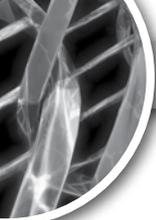
- 2 Proteins are found in ...
- (a) potatoes
 - (b) meat
 - (c) vegetables
 - (d) peanuts
- [1]

- 3 Iron deficiency in the body leads to ...
- (a) scurvy
 - (b) heart disease
 - (c) diabetes
 - (d) anaemia
- [1]

- 4 Which of these is a major problem in the developed world?
- (a) obesity
 - (b) rickets
 - (c) malaria
 - (d) marasmus
- [1]

- 5 Fibre cannot be digested by humans. Why is it still important to include it in a balanced diet?
-
-
- [3]

- 6 What is the difference between mechanical digestion and chemical digestion?
-
-
- [3]



7 Describe how dental decay occurs in human beings.

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

8

(a) Name four enzymes that participate in the process of digestion.

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

(b) State two functions of the liver.

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

[Total: 20]

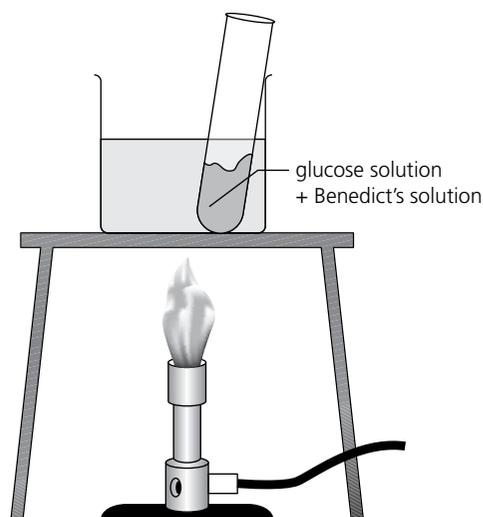
Testing for glucose

Student's instructions

You need:

- Bunsen burner, heat resistant mat, tripod, gauze
- Benedict's solution
- glucose solution of unknown strength
- beaker, five test tubes, rack
- safety goggles
- four glucose solutions of known strength
- dropping pipette

- 1 In this experiment you will be testing solutions for glucose using Benedict's solution. It is known that the result of this test depends on the strength of the glucose solution.
- 2 In each of four test tubes, add about 2 cm³ glucose solution of known strength. Label the test tubes so you know which is which!
- 3 Set up a water bath, as shown in the diagram, in which to heat your solutions. *Put on your safety goggles.* Light the Bunsen burner and heat the water until it is nearly boiling ('simmering').
- 4 Add a few drops of Benedict's solution to the weakest of your glucose solutions. Lower the test tube into the hot water. As you do so, start timing.
- 5 The colour of the solution will change because glucose is present. Time how long it takes the solution to change colour. Write down your result. Also write down the final colour of the solution. (Make sure it has finished changing!)
- 6 Record your results in a table. If you need help, ask for Cue Sheet 1.
- 7 Repeat the Benedict's test for each of the glucose solutions in turn. Record your results.



- 8 When you have tested all four known solutions, write down any conclusions which you can draw from your results.
- 9 Finally, collect about 2 cm³ of glucose solution of 'unknown strength' in a test tube. Carry out Benedict's test on this solution. Write down the time taken for it to change colour and describe the final colour.
- 10 Using your result, estimate the strength of the unknown solution. Write down your answer.
- 11 Explain how you arrived at your answer.

This experiment will test your skills in:

- using apparatus safely
- measuring times accurately
- presenting results in a table
- drawing conclusions
- explaining conclusions

HAZARD WARNING

Benedict's is harmful to skin and eyes. AVOID SKIN CONTACT.
WEAR EYE PROTECTION.

Cue sheet 1: setting out the results

Solution	Strength / gram per litre	Time for change / s	Final colour
A			
B			
C			
D			
E			

Teacher/technician notes

Skills

This experiment can be used to assess a student's ability in:

- using apparatus and equipment safely
- observing and measuring accurately
- presenting results in a table
- handling data
- drawing conclusions

Previous lessons

Students should be familiar with food tests.

Apparatus and equipment

- Bunsen burner, heat resistant mat, tripod, gauze, safety goggles
- beaker
- five test tubes and rack
- bulb pipette
- Benedict's solution
- access to four glucose solutions of known strength and one of unknown strength

The teacher should prepare five glucose solutions of different strengths from weak to very strong to give a wide range of reactions with Benedict's solution.

The three weakest and the strongest should be labelled with their strengths in grams per litre. The remaining solution should be labelled 'unknown strength'.

Procedure

Students will carry out the test for glucose on the four known solutions. They will note the time taken to observe a change and the final colour of the solution.

From their results they will draw conclusions about the relationship between test results and solution strength. They will then use their findings to test the unknown solution and hence, estimate its strength.

Note the use of the cue sheet and deduct marks where necessary.

Cue sheets

A cue sheet for this experiment gives a sample table for reading.

Criteria

Using apparatus and equipment

- (a) Safe use of apparatus [1]

Making observations and measurements

- (a) Time for changes accurately measured
(b) Colours of final solutions well-observed [2]

Presenting and handling data

- (a) All readings and observations for known solutions clearly and logically presented in a table [2]
(b) Reading and observations clearly presented for unknown solution [2]

Drawing conclusions

- (a) Relationship between time for changes and solution strength clearly stated [1]
(b) Relationship between colour and solution strength clearly stated [1]
(c) Strength of unknown solution correctly placed [1]

{Total: 10}

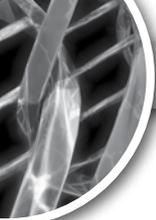
Background information

There is no background information sheet for this assessment.

Transport in plants and animals

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 Water absorbed by the roots is transported through the stem by means of ...
- (a) phloem tissue
 - (b) xylem tissue
 - (c) mesophyll tissue
 - (d) parenchyma [1]
- 2 Transpiration is ...
- (a) movement of water from root to leaves
 - (b) movement of prepared food from leaves to the root
 - (c) water loss from the leaf surface
 - (d) evaporation of water from the soil surface [1]
- 3 Blood cells are formed in the ...
- (a) liver
 - (b) kidneys
 - (c) bone marrow
 - (d) veins [1]
- 4 Which of these play an important role in blood clotting?
- (a) platelets
 - (b) white blood cells
 - (c) plasma
 - (d) red blood cells [1]
- 5 Compare red blood cells and white blood cells on the basis of:
- (a) structure
..... [1]
 - (b) function
..... [1]
 - (c) proportion in blood
..... [1]



6 Describe the process of blood clot formation.

.....
.....
.....
.....
.....
.....
.....
.....

[7]

7

(a) Why does transpiration occur from the lower surface of the leaf?

.....
.....

[1]

(b) Describe how a transpiration stream is created.

.....
.....
.....
.....

[4]

8

(a) How do white blood cells protect the body against disease?

.....
.....
.....
.....

[4]

(b) What is meant by the term immunity?

.....
.....

[2]

{Total: 25}

The circulatory system

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 Which artery carries deoxygenated blood?
- (a) renal artery
 - (b) pulmonary artery
 - (c) hepatic artery
 - (d) aorta
- [1]

- 2 The two upper chambers of the heart are called ...
- (a) atria
 - (b) ventricles
 - (c) arteries
 - (d) valves
- [1]

- 3 Coronary arteries supply blood to the ...
- (a) lungs
 - (b) liver
 - (c) heart
 - (d) kidneys
- [1]

- 4 Blood pressure increases when ...
- (a) the arteries become wider
 - (b) the valves do not function normally
 - (c) the pulse rate increases
 - (d) the ventricles contract with greater force
- [1]

- 5
- (a) Define double circulation.
-
- [2]

- (b) Why are arteries thicker than veins?
-
- [2]



6

(a) Describe how substances are transported across the capillary walls to the cells of tissue.

.....
.....
.....
.....
..... [5]

(b) State the function of the tricuspid and bicuspid valves in the heart.

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

(c) Describe how an artificial pacemaker works.

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

7

(a) State three causes of coronary heart disease.

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

(b) Suggest two ways in which regular exercise might help to strengthen the circulatory system.

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

{Total: 25}

Respiration

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 The release of energy during respiration occurs in the ...
- (a) alveoli
 - (b) blood
 - (c) cells of the body
 - (d) mouth
- [1]

- 2 During the process of breathing the following change takes place:

	Diaphragm	External intercostal muscles	
(a)	flattens	contract	
(b)	flattens	relax	
(c)	relaxes	relax	
(d)	relaxes	contract	[1]

- 3 Energy is released through respiration in the ...

- (a) red blood cells
 - (b) mitochondria
 - (c) cell cytoplasm
 - (d) lungs
- [1]

- 4 A cramp may occur when muscle cells respire anaerobically. This is due to an accumulation in the muscles of ...

- (a) alcohol
 - (b) carbon dioxide
 - (c) water
 - (d) lactic acid
- [1]

- 5 State three important features of a respiratory surface.

.....

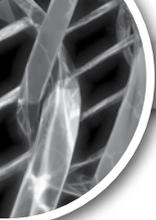
..... [3]

6

- (a) What is the advantage of the following to the respiratory system of a mammal?

- (i) c-shaped rings of cartilage

..... [1]



(ii) cilia in the bronchi

..... [1]

(iii) goblet cells

..... [1]

(b) Cigarette smoke leads to overproduction of mucus. How can this prove to be an obstacle to breathing?

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

7

(a) Name the parts of the respiratory system through which a molecule of oxygen passes during its journey from the air to the blood.

.....
..... [6]

(b) How are inspiration and expiration related to pressure change in the lungs?

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

(c) Why is a film of moisture inside an alveolus necessary for gaseous exchange?

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

{Total: 25}

Excretion

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 Which of these is not a toxic by-product of metabolism?
- (a) carbon dioxide
 - (b) energy
 - (c) urea
 - (d) salts
- [1]

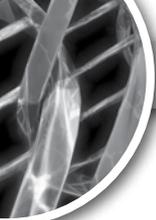
- 2 The functional unit of the kidney is the ...
- (a) nephron
 - (b) tubule
 - (c) capsule
 - (d) neurone
- [1]

- 3 Osmoregulation is ...
- (a) the maintenance of water balance in the body
 - (b) the maintenance of salts in the body
 - (c) the maintenance of body temperature
 - (d) the maintenance of hormone levels in the body
- [1]

- 4 Which of these carries blood to the kidneys?
- (a) hepatic artery
 - (b) hepatic vein
 - (c) renal artery
 - (d) renal vein
- [1]

- 5 State why urea is harmful.
-
- [1]

- 6 (a) State the functions of the following:
- (i) ureter
- [1]



(ii) bladder

..... [1]

(iii) urethra

..... [1]

(b) Suggest two ways to minimize the chances of tissue rejection during kidney transplants.

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

7 Describe how a dialysis machine works.

.....
.....
.....
.....
.....
.....
..... [5]

{Total: 15}

Homeostasis

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 The liver acts as a/an ...
- (a) blood producer
 - (b) glycogen store
 - (c) respiratory organ
 - (d) insulin producer
- [1]

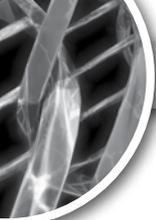
- 2 The body responds to overheating by ...
- (a) expanding the adipose tissue layer of the skin
 - (b) vasoconstriction
 - (c) vasodilation
 - (d) shivering
- [1]

- 3 Excess amino acids which reach the liver are ...
- (a) converted into urine
 - (b) converted into glucose
 - (c) filtered out and returned to the bloodstream
 - (d) deaminated
- [1]

- 4 Insulin ...
- (a) converts glucose into starch
 - (b) converts glucose into glycogen
 - (c) combines glucose with oxygen during respiration
 - (d) aids in glucose absorption by body cells
- [1]

- 5
- (a) Define homeostasis.
-
- [2]

- (b) What is meant by negative feedback?
-
- [2]



6

(a) What causes insulin to be released into the bloodstream?

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

(b) State four ways in which insulin is able to control the glucose level in the blood.

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

(c) State three symptoms of diabetes mellitus.

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

(d) What is meant by the term diet-controlled diabetes?

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

7

(a) State five responses of the human body to overcooling in order to return the body temperature to normal.

.....
.....
.....
.....
..... [5]

(b) How does sweat production help to lower the body temperature?

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

{Total: 25}

Nervous system and hormonal coordination

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 Blood pressure is controlled by the ...
- (a) cerebellum
 - (b) cerebrum
 - (c) medulla
 - (d) hypothalamus
- [1]

- 2 A sensory neurone ...
- (a) transmits responses to the muscles
 - (b) transmits stimuli within the brain
 - (c) transmits stimuli to the brain or spinal cord
 - (d) none of the above
- [1]

- 3 A pain tablet can relieve pain by ...
- (a) increasing the frequency of vibrations at the synapse
 - (b) decreasing the frequency of vibrations at the synapse
 - (c) increasing the production of synaptic fluid
 - (d) diverting the impulse through the spine
- [1]

- 4 When a person blushes his face turns red. This is due to adrenaline production which ...
- (a) causes vasoconstriction of capillaries near the skin
 - (b) causes excess production of blood cells
 - (c) causes pigments to collect under the skin
 - (d) causes vasodilation of the capillaries near the skin
- [1]

- 5
- (a) Define a synapse.
-
- [2]

- (b) Describe the process by which an impulse can cross a synapse.
-
-
- [3]



(c) Why is the presence of a synapse important for neurotransmission?

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

6

(a) How is a reflex action different from a voluntary action?

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

(b) Why is a reflex action faster than a voluntary action?

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

(c) List, in correct sequence, the route taken by a nerve impulse from the time an ant bites a child's finger to the time the child pulls his hand away.

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

7

(a) List three visible effects of adrenaline production when a person becomes frightened.

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

(b) How does the excitement before a race prepare an athlete for winning it?

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

(c) How is a hormone different from an enzyme?

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

{Total: 25}

Receptors and senses

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 Which of these is not a sense organ?
- (a) nose
 - (b) lung
 - (c) eye
 - (d) skin
- [1]

- 2 A receptor acts as a transducer. This means ...
- (a) it creates a stimulus
 - (b) it carries a stimulus to the brain
 - (c) it protects the sense organ
 - (d) it converts one form of energy into another
- [1]

- 3 The ear contains ...
- (a) mechanoreceptors
 - (b) chemoreceptors
 - (c) photoreceptors
 - (d) ciliary muscle
- [1]

- 4 The vitreous humour helps to ...
- (a) protect the eye
 - (b) change the shape of the lens
 - (c) maintain the shape of the eye
 - (d) focus light on the retina
- [1]

- 5
- (a) Identify the receptors in the eye.
- [2]

- (b) How do the cells in the eye receive nourishment?
- [2]



6

(a) What is the function of the ciliary muscle?

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

(b) Describe how the lens adjusts to near and distant objects.

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

7 Suggest two ways in which eye strain can be reduced.

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

[Total: 15]

Smoking

Teacher/technician notes

Skills

This assessment can be used to assess a student's ability in the following:

- making detailed observations
- recording data
- interpreting data from graphs and tables
- constructing a graph from data

Previous lessons

Teachers may find this a useful exercise to include in a discussion on health education. Students should be familiar with the structure and workings of lungs. They should know how to construct a bar graph from data.

Apparatus and materials

The smoking machine illustrated below should be set up as a working demonstration so that it is clearly visible to all students. This may be done in a fume cupboard. Smoke inhalation should be avoided.

Each student should have:

- graph and lined paper
- an instruction sheet

Procedure

Students should watch at least three cigarettes being smoked in the demonstration. They should be encouraged to make detailed observations of what happens in each part of the apparatus.

Written notes of these observations can be made during, or shortly after, the demonstration. Students then complete the second part of the instruction sheet.

Criteria

Making detailed observations

- | | |
|--|-----|
| (a) colour and density of smoke in 'U' tube | [1] |
| (b) colour change of cotton wool | [1] |
| (c) colour and density of smoke in first flask | [1] |
| (d) colour of water in first flask | [1] |
| (e) color and density of smoke in second flask | [1] |
| (f) colour of water in second flask | [1] |

Interpreting observations

- | | |
|--|-----|
| (a) Tar deposits could form in the lungs. | [1] |
| (b) Chemicals from smoke will dissolve in moisture in the lungs. | [1] |

Answers to questions in part B—interpretation of bar graph

- | |
|--|
| (a) 11 in 100 000 |
| (b) 110 in 100 000 |
| (c) ten times more likely |
| (d) two times and two-and-a-half times more likely |

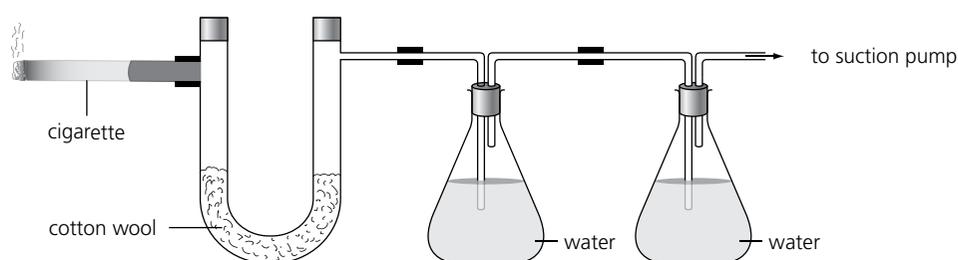
Answer to question 3—construct graph from data

- | |
|-------------------------|
| (i) title |
| (ii) axes labelled |
| (iii) plotting accurate |
| (iv) neatness |

Answer to question 4—interpreting bar graph

The more cigarettes you smoke, the greater the risk of dying from cancer.

Diagram of smoking machine

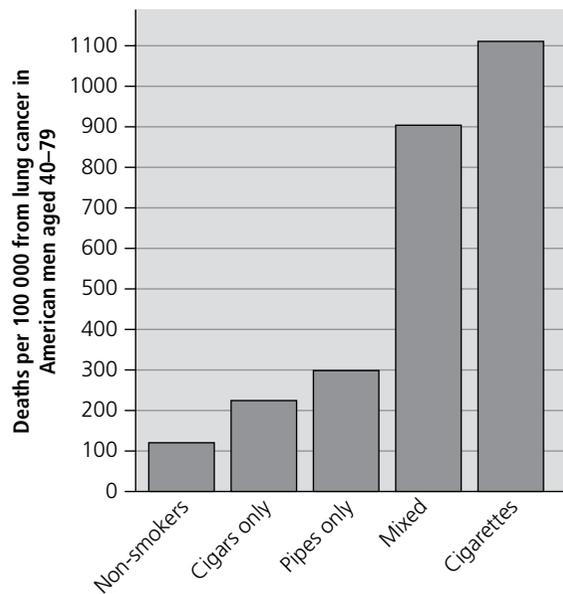


Student's instructions—part A

- 1 Make detailed observations of the smoking machine demonstration provided.
- 2 You will be assessed on your ability to:
 - describe what happens to the smoke in each part of the apparatus
 - describe all the effects which smoke has on parts of the apparatus
 - describe what you think might happen inside a smoker's lungs while a cigarette is being smoked.

Student's instructions—part B

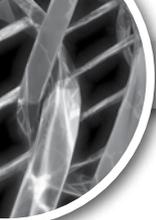
- 1 Study the graph below.
- 2 You will be assessed on your ability to interpret the graph by answering the questions that follow as fully as possible.



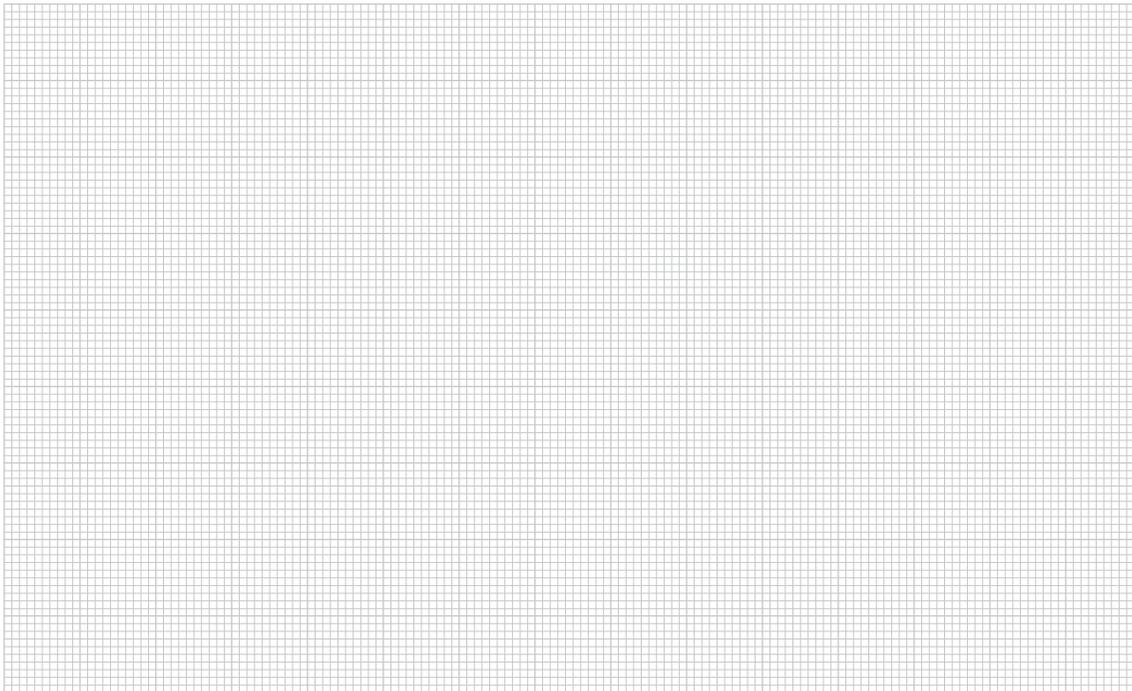
- (a) What is the risk of dying of lung cancer if you are a non-smoker?
..... [2]
- (b) What is the risk of dying of lung cancer if you smoke cigarettes?
..... [2]
- (c) How many times more likely are you to die of lung cancer if you smoke?
..... [2]
- (d) What health risks are involved with smoking pipes and cigars?
..... [2]

3 Study the table below:

Number of cigarettes per day	Deaths from lung cancer
none	12 per 100 000
1 to 14	96 per 100 000
15 to 24	156 per 100 000
more than 25	300 per 100 000



Plot this information as a bar graph. You will be assessed on your ability to present the information clearly and effectively.



[2]

4 What does this graph tell you about health risks from smoking cigarettes?

..... [2]

[Total: 20]

Bacteria and other micro-organisms

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 Which of these statements is not true for bacteria?
- (a) Bacteria exist in several shapes.
 - (b) Bacteria possess cell walls.
 - (c) Bacteria possess nuclei.
 - (d) Bacteria are larger than viruses. [1]

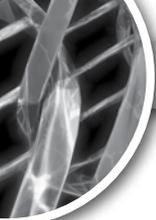
- 2 Fungi reproduce by means of ...
- (a) spores
 - (b) seeds
 - (c) binary fission
 - (d) sexual reproduction [1]

- 3 Bacteria and fungi help in the preparation of certain foods by a process known as ...
- (a) decomposition
 - (b) fermentation
 - (c) recycling
 - (d) metabolism [1]

- 4 Which of these micro-organisms is useful in baking?
- (a) viruses
 - (b) bacteria
 - (c) fungi
 - (d) amoebae [1]

- 5 State three applications of enzymes in industry.
-
-
- [3]

- 6 State two advantages of batch culture and two disadvantages of continuous culture.
-
-



7

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

(a) State one difference between an antibiotic and an antiseptic.

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

(b) State what is meant by antibiotic resistance.

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

8 Describe the process by which single-cell protein is manufactured.

.....
.....
.....
.....
.....
..... [6]

9

(a) What is the role of scavengers in decomposition?

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

(b) State three differences between viruses and bacteria.

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

[Total: 25]

Feeding relationships

For questions 1 to 4, choose the correct answer by circling the letter.

1 Which of the following is a producer?

- (a) mushroom
- (b) grass
- (c) rat
- (d) sunlight

[1]

2 Select the correct food chain.

- (a) grass → rabbit → fox → vulture
- (b) fox → rabbit → vulture → grass
- (c) grass → vulture → rabbit → fox
- (d) rabbit → fox → grass → vulture

[1]

3 The primary source of energy is ...

- (a) rain
- (b) soil
- (c) the Sun
- (d) plants

[1]

4 Algae are aquatic plants. Which of these is a primary consumer of algae?

- (a) crabs
- (b) coral
- (c) fish
- (d) water fleas

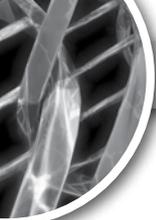
[1]

5 Identify two decomposers in a food chain.

.....
 [3]

6 Explain how energy is lost at each trophic level in a food chain.

.....



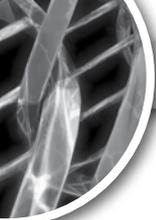
Name:

.....
.....
.....
..... [6]

7 Why is fishing prohibited during certain months of the year?

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

{Total: 15}



Malaria

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 The vector for spreading the malaria parasite is the ...
- (a) male Anopheles mosquito
 - (b) female Aedes mosquito
 - (c) male Culex mosquito
 - (d) female Anopheles mosquito
- [1]

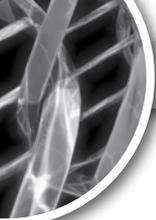
- 2 The life cycle of the mosquito from the egg to the pupa stage occurs in ...
- (a) rubbish heaps
 - (b) rivers
 - (c) stagnant water
 - (d) human blood
- [1]

- 3 Pouring oil on stagnant water helps to control mosquitoes because the oil ...
- (a) blocks the breathing tubes of the larvae
 - (b) makes the pupae sink to the mud below
 - (c) prevents the entry of fresh oxygen into the water
 - (d) kills the mosquito eggs
- [1]

- 4 Malaria can be fatal. However, people in Africa do not die of malaria because they develop ...
- (a) immunity to the parasite
 - (b) partial sickle-cell anemia
 - (c) liver infections
 - (d) antibodies against malaria
- [1]

- 5 Why is the introduction of shrimps in lakes and ponds an advantage in controlling mosquito populations?
-
- [2]

- 6 State four reasons why the female Anopheles mosquito is a suitable vector for the spread of malaria.
-
-



Name:

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

7 What causes the shivering and high temperature characteristic of malaria?

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

8 How does cutting down trees help to control the spread of malaria?

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

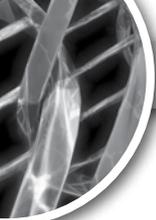
[Total: 15]

Recycling of energy, carbon, and nitrogen

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 The concentration of carbon dioxide in the air is ...
- (a) 3%
 - (b) 0.3%
 - (c) 0.03%
 - (d) 0.003%
- [1]
- 2 Carbon dioxide is added to the environment by ...
- (a) respiration and combustion
 - (b) respiration and photosynthesis
 - (c) combustion and photosynthesis
 - (d) photosynthesis and decomposition
- [1]
- 3 Nitrogen-fixing bacteria convert ...
- (a) nitrates into nitrogen
 - (b) nitrogen into nitrites
 - (c) nitrates into nitrites
 - (d) nitrogen into nitrates
- [1]
- 4 Which of these is a primary constituent of glucose?
- (a) magnesium
 - (b) potassium
 - (c) nitrogen
 - (d) carbon
- [1]
- 5 Draw a labelled diagram of the carbon cycle in the space below:

[5]



6 State the difference between a pyramid of biomass and a pyramid of energy.

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

7 Differentiate between nitrogen fixation and nitrification.

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

8 How do photosynthesis and respiration affect the balance between oxygen and carbon dioxide in the atmosphere?

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

[Total: 15]

Human impact on the environment

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 Which of the following are known as greenhouse gases?
- (a) chlorine and methane
 - (b) methane and carbon dioxide
 - (c) sulfur dioxide and methane
 - (d) carbon dioxide and ozone
- [1]

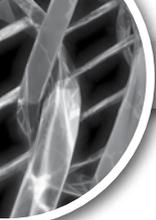
- 2 Which of these can be recycled?
- (a) paper
 - (b) glass
 - (c) aluminium
 - (d) all of the above
- [1]

- 3 Leaching occurs when ...
- (a) algae grow and cover the surface of the water
 - (b) nutrients in fertilizers wash into rivers
 - (c) fertilizers start polluting the soil
 - (d) industrial waste flows into rivers
- [1]

- 4 Acid rain is formed by oxides of ...
- (a) sulfur
 - (b) carbon
 - (c) ozone
 - (d) oxygen
- [1]

- 5 (a) What is meant by global warming?
-
- [2]

- (b) State one possible advantage of global warming.
-
- [1]



(c) Suggest three steps that can be taken to control global warming.

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

6

(a) Describe how ethanol is produced.

.....
.....
.....
.....
..... [6]

(b) Identify two disadvantages of using ethanol as a fuel.

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

(c) What environmental conditions could ensure ideal production of biogas?

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

7 List any four methods applied at a sewage treatment plant.

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

[Total: 25]

Water pollution

For questions 1 to 4, choose the correct answer by circling the letter.

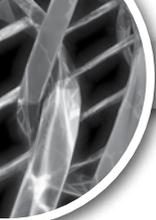
- 1 When water from a river is used to cool a thermal power station, the temperature of the water rises by 10°C. This results in ...
- (a) the fish getting overheated in the water
 - (b) growth of bacteria
 - (c) a faster rate of photosynthesis in aquatic plants
 - (d) a decrease in the oxygen concentration of the water
- [1]

- 2 Sewage dumped into rivers causes eutrophication due to the presence of ...
- (a) nitrates and phosphates
 - (b) nitrates and chlorides
 - (c) bacteria and nitrates
 - (d) carbonates and sulfates
- [1]

- 3 River water containing dissolved nitrates is harmful if used to prepare milk for a baby because it may cause ...
- (a) blindness
 - (b) stomach cramps
 - (c) blood poisoning
 - (d) stunted growth
- [1]

- 4 When acid pollutants fall as acid rain and flow into rivers, they cause death of aquatic life. This is because the acid rain ...
- (a) makes the water too acidic for life
 - (b) dissolves aluminum ions from clays which encrust the gills of fish
 - (c) causes nitrogen depletion in the river
 - (d) reacts with chemical effluents
- [1]

- 5
- (a) What is meant by the term residual pesticide?
-
-
- [2]



(b) A farmer sprayed DDT over a pond to kill mosquito larvae. How would this cause the DDT to enter a food chain two years later?

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

6

(a) What is meant by the term algal bloom?

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

(b) How does water leaching from a farm cause algal bloom?

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

7 How does acid rain affect aquatic plants?

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

[Total: 15]

Asexual reproduction

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 The process of reproducing plants from any part of the plant body other than the seed is called ...
- (a) sexual reproduction
 - (b) germination
 - (c) cloning
 - (d) cell division
- [1]

- 2 The onion bulb is an underground stem which reproduces by ...
- (a) terminal buds
 - (b) roots
 - (c) fleshy leaves
 - (d) axillary buds
- [1]

- 3 The penicillin fungus produces rows of sporangia that burst to release ...
- (a) seeds
 - (b) pollen grains
 - (c) spores
 - (d) fruits
- [1]

- 4 The method of artificial cloning in which a section of a plant or a tree is tied onto a scion with an intact root system is called ...
- (a) budding
 - (b) grafting
 - (c) marcottage
 - (d) tissue culture
- [1]

- 5 A fruit tree, such as a mango or an apple tree, can be grown from seeds as well as cloning methods. State three advantages of growing a tree by means of a cloning technique rather than from seeds.

.....

.....

..... [3]



6 From the perspective of a farmer, state two advantages and one disadvantage of cloning a named fruit or flower.

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

7 Describe budding in yeast.

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

8

(a) Single-cell proteins are actually fungi grown in fermenters using the continuous process as a means of food material. Describe how such a fermenter works in the continuous process.

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

(b) How is this fermenter different from that used in the batch process?

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

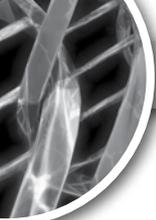
[Total: 20]

Seed growth and germination

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 The outermost covering of the seed is called the ...
- (a) cotyledon
 - (b) testa
 - (c) tegument
 - (d) pericarp
- [1]
- 2 The part of the seed which develops into the root system is called the ...
- (a) plumule
 - (b) embryo
 - (c) radicle
 - (d) micropyle
- [1]
- 3 In hypogeal germination ...
- (a) the cotyledons remain below the soil
 - (b) the cotyledons grow above the soil
 - (c) the cotyledons turn green in colour
 - (d) the cotyledons wither up and fall off
- [1]
- 4 The food stored in the cotyledons of a bean seed is converted into soluble form by the action of ...
- (a) water
 - (b) hormones
 - (c) enzymes
 - (d) oxygen
- [1]
- 5 Draw a labelled diagram showing the internal structure of a bean seed in the space below:

[5]



6 State three essential conditions for seed germination.

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

7 Which parts of a flower form the following parts of a fruit?

(a) pericarp

..... [1]

(b) seed

..... [1]

(c) testa

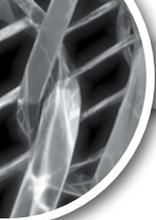
..... [1]

{Total: 15}

Human reproduction

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 The testes in males are present inside a scrotum which extends outside the body. This is advantageous to sperm production because ...
- (a) other hormones cannot affect the function of the testes
 - (b) the temperature is lower outside the body than inside it
 - (c) blood pressure cannot stop sperm production
 - (d) more semen is produced by the testes [1]
- 2 The ovum moves along the oviduct ...
- (a) by the movement of cilia inside the oviduct
 - (b) by the flow of fluids through the oviduct
 - (c) by the increase in blood pressure inside the capillaries of the oviduct
 - (d) by the movement of urine along the oviduct [1]
- 3 Ovulation is stimulated by the release of ...
- (a) FSH and LH
 - (b) insulin
 - (c) adrenaline
 - (d) oestrogen [1]
- 4 The microvilli of the placenta absorb food materials from the mother's blood space. This ensures that ...
- (a) food materials enter the placenta but waste materials do not
 - (b) the mother's blood never comes into contact with the blood of the foetus
 - (c) more blood passes through the blood space than through a blood vessel
 - (d) the mother's blood absorbs shocks that might damage the foetus [1]
- 5 Differentiate between the sperm and ovum with respect to the following:
- (a) numbers
..... [1]
 - (b) mobility
..... [1]
 - (c) shape
..... [1]



6 State three functions of the placenta which make it a life support system for the foetus.

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

7

(a) Where in the female reproductive system does fertilization take place?

..... [1]

(b) Describe the process of fertilization and zygote formation in humans.

.....
.....
.....
..... [5]

8 Compare the advantages of breast milk with those of bottled milk.

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

9

(a) What is the infertile period of the menstrual cycle?

..... [2]

(b) With respect to oestrogen and progesterone formation, describe the menstrual cycle in females.

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

[Total: 25]

Variation and inheritance

For questions 1 to 4, choose the correct answer by circling the letter.

- 1 During meiosis the number of chromosomes in the cells is ...
- (a) halved
 - (b) doubled
 - (c) unchanged
 - (d) quadrupled
- [1]

- 2 Which of these is a sex-linked characteristic?
- (a) sickle-cell anaemia
 - (b) haemophilia
 - (c) albinism
 - (d) height
- [1]

- 3 A transgenic organism is ...
- (a) a clone
 - (b) an endangered species
 - (c) produced from two different species
 - (d) an organism with a genetic disease
- [1]

- 4 Which of these terms describes the observed characteristics of an organism?
- (a) phenotype
 - (b) genotype
 - (c) species
 - (d) trait
- [1]

- 5 Differentiate between discontinuous and continuous variation.
-
-
- [3]

- 6
- (a) State three possible causes of mutations.
-
-
- [3]



(b) Explain the term survival of the fittest.

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

7

(a) Describe how genetic engineers produce insulin with the help of bacteria.

.....
.....
.....
.....
.....
.....
..... [7]

(b) Explain how an individual might not exhibit haemophilia but be a carrier of the disease.

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

(c) What is meant by embryo splitting?

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

[Total: 25]

Osmosis in potato tissue

(1) (a) Surface area for chip types A to E: 26 cm², 28 cm², 30 cm², 36 cm², 48 cm²; mean percentage change in mass after 1 h: A = 7.2%, B = 10.8%, C = 12.7%, D = 16.5%, E = 21.5%; mean percentage change in mass after 24 h: A = 17.5%, B = 19.7%, C = 17.4%, D = 18.9%, E = 19.5% (b) to avoid any change in mass due to water on the surface of the chips (c) temperature of the water; osmotic potential of the water (f) It can help us to select a solution that will allow water to leave the food and preserve it.

Enzymes and industry

(4) (a) (i) The term substrate is used to describe the molecules that take part in a reaction catalyzed by enzymes. (ii) See page 18 of *Fundamental Biology*. (iii) Optimum conditions refer to the environmental conditions in which an enzyme can function best. Two such environmental conditions are temperature and pH. (b) (i) The biological process would not involve the expensive use of electricity; the use of chemicals will be reduced which will bring down expenses (ii) Compared to whole-organism technology, enzyme technology will result in fewer unwanted by-products. Enzyme technology will also be faster and less expensive than whole-organism technology.

Food, feeding, and health

Crossword

Across: 2. benedicts 3. atheroma 4. milk 9. food and a balanced diet 10. carnivore 11. herbivore 13. anaemia 15. carbohydrate 16. fibre 17. pesticide 19. corn 20. cholesterol 22. oats 24. rickets 27. calcium 28. obesity 29. skim 30. energy 31. protein 33. soya 34. vitamin **Down:** 1. fat 2. baked beans 5. liver 6. malnutrition 7. water 8. salt 12. hair 14. albino 18. date 21. exercise 23. gums 25. scurvy 26. nitrogen 32. iron

Questions

(1) Malnutrition involves the consumption of foods in the wrong proportions whereas starvation involves food deprivation. (2) Fibre helps the food to move along the gut whereas water helps to prevent dehydration in the body. (3) rough skin, gum disease, loose teeth, etc. (4) Rickets is caused by a deficiency of vitamin D which results in soft bones that become deformed and fracture easily. (5) eggs, fish oil, etc. (6) Rickets causes the bones to become soft and deformed. In extreme cases, this renders the person unable to walk. (7) Excessive consumption of fat causes cholesterol to deposit as plaque in the arteries. This blocks the flow of blood and may lead to heart disease. (8) Diabetes causes an increase in the cholesterol level. This could deposit on the arteries and cause heart disease. Additionally, people with diabetes tend to be lethargic and exercise less. This also leads to high levels of cholesterol.

Daily energy requirement

(1) A pregnant woman needs more energy to provide nourishment to the developing foetus. (2) A fifteen year old needs more energy for the growth and development taking place during adolescence. (3) A construction worker needs the greatest amount of energy to perform heavy work and operate large machines. (4) Answers may vary from 11 500 to 27 000 kJ per day. (5) The health of the pregnant woman and the development of the foetus would suffer because of lower energy intake than required.

The action of lipase

(1) fats $\xrightarrow{\text{lipase}}$ fatty acids + glycerol (2) duodenum/small intestine (3) (a) by adding hot and cold water to keep temperature of the water bath constant (b) Rate of reaction: 0.002, 0.005, 0.013, 0.01, 0.003, 0.002 (d) 35°C (e) 37°C (f) The reaction will take much longer or it will not take place at all. This is because the lipase enzyme becomes denatured at higher temperatures. (g) Sodium taurocholate is necessary for the reaction because it helps to emulsify fats which makes it easier for digestive enzymes to act upon them. (h) The nutrition scientist could have set up a control experiment by keeping the temperature constant.

Transport in plants

(1) The cells of the xylem tissue do not possess cytoplasm or cell walls to form a hollow tube along which water and nutrients can travel up along the stem. (2) The Sun evaporates water from the leaves which sets up a water potential gradient within the plant. This causes water to be taken in from neighbouring cells so that water is pulled up along the xylem vessels. (3) The upper surface of the leaf of an aquatic plant is exposed to the atmosphere. The presence of stomata on the upper surface helps in exchange of gases. The stomata are located within grooves

in desert plants to avoid excessive transpiration and dehydration of the plant. **(4)** Diffusion can be observed in the root where water molecules and nutrients diffuse into the root hair cells. **(5)** Plant roots can absorb mineral ions from the soil against a concentration gradient by active transport. This requires expenditure of energy made available by respiration.

The beating heart

(1) **(a)** duration of cardiac cycle = 0.8 seconds; heart rate = $60/0.8 = 75$ beats per minute **(b)** 0.4 seconds **(c)** by increasing stroke volume **(2)** **(a)** 26 mm mercury **(b)** because of a thicker wall **(c)** to pump oxygenated blood through the aorta to various parts of the body **(3)** **(a)** At X: tricuspid valve closes to prevent blood from flowing back into the right atrium when the right ventricle contracts; At Y: bicuspid valve closes to prevent blood from flowing back into the left atrium when the left ventricle contracts **(b)** in the veins **(c)** to ensure blood flow in one direction **(4)** **(a)** When the blood capillaries get torn and are exposed to the air, the platelets are stimulated to release enzymes. These enzymes act on an inactive blood protein called fibrinogen and convert it into another protein called fibrin. The fibrin forms a mesh of threads around the platelets. Red blood cells get trapped in the mesh and a blood clot is formed. **(b)** It might create a barrier to blood flow resulting in a heart attack. **(5)** **(a)** The blue lips are an indication of a lack of oxygen in the blood which might be due to a poorly functioning heart. **(b)** The transplanted heart might be attacked by the receiver's immune system as a foreign body because it might not recognize the antigens in the donated heart tissue. **(c)** Immunosuppressive drugs cause the immune system to stop functioning. These drugs do not act selectively so the immune system becomes unable to deal with infections of all kinds while it allows the transplanted heart to function normally. **(d)** Answers may vary.

Heart and heart disease

Crossword

Across: 1. vena cava 5. atheroma 7. pulse 8. smoking 12. atrium 14. pulmonary 15. cholesterol **Down:** 1. ventricle 2. coronary 3. diastole 6. aorta 9. semilunar 10. blood 11. bicuspid 13. muscle

(1) possibility of infection, stroke, or death during surgery; longer recovery period **(2)** less risky because surgery is not involved; shorter recovery period **(3)** avoid active and passive smoking; remain involved in regular exercise

Using a spirometer

(1) volume of air inhaled; composition of air exhaled **(2)** **(a)** 0.8 dm^3 **(b)** 4.5 dm^3 **(c)** 18 bpm
(3) change in volume/change in time = $6.0 - 5.6 / (9/20) = 0.4 / 0.45 = 0.89 \text{ dm}^3 \text{ per min}$ **(4)** 2.02 m^2

Excretion and homeostasis

(1) Excretion refers to the removal of the waste products of metabolism from the body. Egestion refers to the process by which undigested food is removed from the body. **(2)** exhalation, sweating, urination, defecation, bleeding, etc. **(3)** The membrane used in kidney dialysis is partially permeable to allow urea to diffuse across it but to prevent blood cells and large protein molecules diffusing out of the blood. **(4)** narrowing blood vessels (vasoconstriction), shivering, contracting hair erector muscles, etc. **(5)** Osmoregulation is the process by which the body regulates water potential in the body. This helps to maintain a balance between solute and water concentration in the body.

Keep it cool!

(1) The water from the clay pot evaporates carrying with it heat energy from the pot. This helps to bring down the temperature inside the clay pot and the milk stays cooler. **(2)** The sweat glands below the skin produce sweat which rises up to the skin. When the sweat evaporates from the skin surface it carries with it heat energy from the body to bring down the body temperature. The milk cooler also uses the principle of evaporation in a similar way. **(3)** Human beings are warm-blooded and maintain a constant internal temperature through homeostasis. **(4)** The water in the damp flannel absorbs heat energy from the body and helps to bring down the fever.

Coordination

(1) The central nervous system consists of the brain and the spinal cord. It helps to coordinate responses to stimuli. The peripheral nervous system consists of sensory and motor nerves. These help to carry electrical impulses to and from the central nervous system. **(2)** Nerve impulses cross a synapse when chemicals called neurotransmitters are released from the end plate of a neurone into the synapse and diffuse across the gap to the dendrite of another neurone. **(3)** A reflex action is a faster response than other voluntary actions because it does not involve conscious

information processing by the brain. The electrical signals travel along a shorter path across the spinal cord. **(4)** digestion, heart rate, etc. **(5)** A conditioned reflex is a learned response to a certain stimulus. The stimulus might not be naturally related to the response. A reflex action is an automatic response to a stimulus and does not involve behaviour learning.

An alcohol problem

(1) B and C **(2)** D **(3)** two (B and C) **(4)** A and B. They are suffering from withdrawal symptoms due to alcohol consumption over an extended period of time leading to headaches and migraines. **(5)** It would result in their babies having low body mass. It might also cause dehydration in the brains of the babies leading to mental retardation. It might also result in miscarriages. **(6)** Alcohol blocks the motor pathways and so slows down responses and distorts coordination, making a driver unable to respond to traffic problems in time resulting in accidents.

Tobacco smoke and lung cancer

(1) cigarette smoking **(2)** Tar can lead to lung cancer by the action of toxins contained in the tar on the lung cells. This damages the lung cells and leads to lung cancer. Tar also collects in the cilia preventing them from moving mucus, germs, and dirt particles away from the lungs. **(3)** Passive smoking occurs when individuals are exposed to tobacco smoke from other smokers in their surroundings. Passive smokers involuntarily take in the smoke into their lungs when they inhale. **(4)** It is more dangerous to be a passive smoker rather than an active smoker because passive smokers take in more smoke than active smokers. Active smokers exhale most of the smoke which is inhaled by passive smokers. **(5)** Smoking both cigars and pipes might lead to reactions in the body that cause greater damage to the lungs than smoking cigars or pipes alone.

Micro-organisms in biotechnology

(1) Insulin from an animal source is slightly different from humans and could create moral issues. Insulin from humans can cause reactions in other humans. Insulin produced by bacteria is inexpensive, can be produced in large numbers, and does not cause any tissue rejection. **(2)** DNA produced by bacteria does not have a protein tag which can be rejected by blood and so tissue rejection does not occur. **(3)** virus

Growing plants as food for humans

(1) **(a)** High levels of fat can lead to high levels of cholesterol, obesity, and coronary heart disease. **(b)** Banana contains high levels of fibre and water which aids digestion. **(2)** **(a)** banana 0.8%; rice 6.9%; wheat 12.5%; blue-green algae 65%; soya 40.2% **(3)** **(a)** light; temperature **(b)** so that sunlight can reach them **(c)** the magnesium and nitrate are nutrients and encourage the growth of blue-green algae **(d)** The liver might be overworked because it would have to deaminate the excess amino acids. **(e)** A small amount of micro-organisms can produce a large amount of single-cell protein containing higher levels of protein than ordinary cattle feed. **(4)** **(a)** Polishing strips off nutrients from the rice which leads to deficiency diseases in some individuals. Carbohydrates in polished rice are absorbed immediately and increase glucose levels in the blood which the body cannot use. **(b)** by developing varieties that contain higher levels of nutrients **(5)** The deforestation results in loss of trees that could produce oxygen and remove carbon dioxide from the environment. Flooding might become more destructive. The soil might become stripped of nutrients.

Construction of a food web

(2) heron **(3)** camouflaged body; long, pointed beak for stabbing prey; etc. **(4)** **(a)** They are decomposed. **(b)** decomposers like bacteria and fungi **(6)** **(a)** more oxygen for the pondweed to flourish **(b)** increased predation by pond snails

Natural insecticides

(2) Hypothesis: An increase in the pesticide juice sprayed leads to an increase in the number of insects killed. Prediction: Spraying more pesticide will kill more insects. **(3)** amount of pesticide **(4)** number of insects killed **(5)** The experiment was not a fair test because the experimenter had not set up a control experiment. **(7)** about 22 ppm **(8)** The results support the prediction because the curve slopes downward showing an inverse relationship between the pesticide concentration and number of aphids alive. However, the curve flattens out at 50 ppm. **(9)** The insects might develop resistance to the new insecticides. The new insecticide could have adverse health effects on wildlife and humans.

Reproduction and growth in plants

(1) flat surface, wings, etc. (2) Self-pollination does not encourage genetic variation because the pollen fertilizes the ovule of the same flower. There is no introduction of new genetic material but the genes of the parent plant are transferred to the next generation. (3) The role of the petals is to protect the ovary and to attract insects to bring about pollination. Once the flower has been pollinated and the egg cell fertilized, the petals can serve no other purpose. As a result, they fall off. (4) sweet, fleshy mesocarp; hard testa resistant to digestive juices; etc. (5) The dry mass falls during the initial stages of germination because stored food is being used up to provide energy for germination. It rises during the later stages because the seedling begins preparing food by photosynthesis.

Inheritance I

Across: 5. genetic engineering 7. cystic fibrosis 8. plasmid 9. virus 10. chimaera 11. hormones 12. gene therapy 14. haemophilia 16. propagation 17. fermenter 18. vegetative 20. insulin 23. cellulose 24. enzymes 26. vector 27. clone 28. protoplast **Down:** 1. selective breeding 2. DNA 3. meristem 4. milk 6. bacteria 13. protein 15. amniocentesis 19. nucleus 21. humidity 22. gene 25. Dolly

Across: 1. sugar phosphate 3. double helix 5. chromosome 6. gene 7. Watson and Crick 8. characteristic 13. nucleus 14. deoxyribonucleic acid 15. nucleotide 16. base 17. Franklin **Down:** 2. haemoglobin 4. base pairing 9. replication 10. melanin 11. meiosis 12. keratin

Inheritance II

(1) A: I^AI^A, I^AI^O; B: I^BI^B, I^BI^O (2) Fertilization is described as random because in sexual reproduction, every male gamete has an equal chance of fusing with any female gamete. (3) A homologous pair consists of two chromosomes that carry the same set of genes. They may carry different alleles of the same gene. (4) Possible combinations: HH, Hh, Hh, hh. The ratio of straight hair to curly hair in the F₁ generation will be 3:1. (5) albinism; sickle-cell anaemia

DNA control of protein synthesis

(1) template (2) through m-RNA that enter the cytoplasm through pores in the nuclear membrane (3) to the ribosome in the cytoplasm (4) t-RNA (5) 3

Human chromosomes, twins, and triplets

(1) 46 3 (a) Male (b) The individual has sex chromosomes X and Y. (5) (a) Jane and Rachel (b) same blood group (c) Body mass is influenced by environmental factors. It is likely that Rachel and Jane were exposed to different environmental conditions such as food, exercise, etc. (7) Jane and Rachel are identical twins and have almost the same height, the same blood group and shoe size, and have cystic fibrosis. However, Rachel has a higher intelligence quotient than Jane. This supports the hypothesis the intelligence quotient depends on both genetic and environmental factors.

Animals and plants in biotechnology

(1) The correct sequence is c, d, h, f, i, a, b, e, k, j, l, g.

Animal in medical research—what do you think?

(1) animal cruelty; all possible side effects cannot be observed in animals (2) greatest care is taken to avoid unnecessary pain to animals; scientists try to ensure maximum safety of products for humans by testing them on animals to which there is no equally beneficial argument at present (3) replace, reduce, refine **Case Study I** (4) (a) 45 g, 51 g, 53 g, 57 g, 61 g (b) amount of milk (c) mass of animal (e) quantity of glucose; amount of exercise; living space (f) protein, fat **Case Study II** (1) genetically related to humans; the research might even help to discover cures for diseases common in primates (2) does not reveal every possible side effect on humans; causes pain and suffering to the animal (3) a large brain; bipeds (4) T-lymphocytes (5) through transfusion of HIV infected blood; through transfer of sexual fluid; sharing hypodermic needles among drug addicts (6) using disposable syringes; using a condom; having one sexual partner (7) The HIV positive person might be carrying the virus and be a carrier for the disease but might have developed natural immunity to the virus. (8) Virus mutate each time they reproduce. Since AIDS is caused by a virus, a vaccine prepared against it would only be effective against one strain of the virus and not on all forms of the virus (9) A person suffering from AIDS dies of minor infections because the AIDS virus damages the immune system and renders the body vulnerable to minor infections.

Cell structure

(1) c (2) b (3) a (4) b (5) nucleus absent, flexible, depression to increase surface area (6) (a) (i) organ (ii) tissue (iii) organ system (b) 0.0067 mm (7) (a) The animal cell contains dense cytoplasm to help retain its shape. It contains glycogen as stored food. Small vacuoles help in intracellular digestion. The plant cell has a cellulose cell wall to maintain its shape. It contains chloroplasts to aid in photosynthesis. A large sap vacuole helps to hold water for turgor pressure. (b) cell membrane, cytoplasm, nucleus (c) epidermis, mesophyll, parenchyma

Enzymes

(1) c (2) b (3) c (4) a (5) (a) The lining of the walls of the lungs is thin enough to allow oxygen molecules to diffuse into the blood. At the same time, carbon dioxide molecules can diffuse from the bloodstream into the lungs across the cells. (b) A water potential gradient exists between two solutions with different water concentration or potential. A higher water potential exists in a solution that contains a large number of water molecules. A lower water potential exists in a solution with a smaller number of water molecules. Water molecules move down the water potential gradient from the solution having higher water potential to the solution with a lower water potential. (6) (a) Enzymes act as biological catalysts and help to speed up metabolism. Intracellular enzymes help in intracellular metabolism such as catabolic and anabolic reactions. Extracellular enzymes like lipase aid in digestion. (b) temperature, pH (c) temperature: 25°C to 37°C, pH: 2.0 for pepsin, 7.5 for amylase (d) catalase (intracellular), lipase (extracellular) (7) (a) A hypothesis is a likely explanation of certain observations. It has not been tested or verified. A conclusion is an explanation that is based on data and inferences from experiment. It is more valid than a hypothesis. (b) The purpose of a control experiment is to ensure that only the input variable is responsible for the variation in results of the experiment. The input variable for the control is kept unchanged throughout the experiment. (c) independent variables: temperature, pH, volume of starch; dependent variable: maltose produced

Investigating photosynthesis in leaves I

(1) carbon dioxide concentration, light, temperature (2) An experiment would be designed by exposing a plant to varying light conditions. Other factors like type of plant, carbon dioxide concentration, water, and temperature would be kept constant. The leaves would then be tested for starch. (3) A control would be set up by placing an identical potted plant in bright sunlight and maintaining the same environmental conditions as the original set-up. (4) Answers will vary. (5) Carbon dioxide saturation point is the point at which the leaf cannot process any more carbon dioxide for photosynthesis. At this point the rate of photosynthesis becomes constant provided other factors such as light and temperature do not change. (6) Light compensation point is the point where the amount of glucose manufactured by photosynthesis is equal to the amount of glucose used up in by respiration. It would occur early in the morning or late in the evening when there is little light to accelerate photosynthesis. (7) A few earthworms can be introduced into the jungle jar. The carbon dioxide they release by respiration would balance the requirement of plants for photosynthesis and the oxygen released by them would be used for respiration. The heat released during respiration by the earthworms would increase temperature which would remain constant because overheating would be avoided due to transpiration from the leaves.

Investigating photosynthesis in leaves II

(1) b (2) a (3) d (4) a (5) See diagram on page 30 of *Fundamental Biology*. (6) water, light, carbon dioxide (7) The use of fertilizers can cause an environmental problem called eutrophication when fertilizers run off into rivers and streams. The fertilizers stimulate growth of algae that consume oxygen from the water, leaving little for fish and other animals to survive. When the algae die, they are decomposed by bacteria that further deplete oxygen.

Nutrition

(1) a (2) b (3) d (4) a (5) Fibre is an important part of a balanced diet because it helps to move the food along the intestine. It also helps to prevent constipation, bowel cancer, and overeating. (6) Mechanical digestion involves the breaking down of food into smaller pieces so that they can be acted upon by digestive enzymes. Teeth and muscular movements bring about mechanical digestion. Chemical digestion involves the action of enzymes on food to break it down to substances that can be absorbed into the bloodstream. (7) Bacteria feed upon sugars present in food particles stuck between teeth and convert them into acids. The acids erode calcium from the enamel which begins tooth decay. A cavity is formed that allows bacteria to penetrate into the dentine and eventually reach the dental pulp to form an abscess. (8) (a) amylase, pepsin, lipase, maltase, etc. (b) The liver stores glucose after converting

it into glycogen; manufactures bile; converts amino acids and removes excess amino acids by deamination; breaks down toxins, etc.

Transport in plants and animals

(1) b (2) c (3) c (4) a (5) (a) Red blood cells: small, flexible, no nucleus, greater surface area; White blood cells: irregular shaped nucleus, sensitive cell surface membrane (b) Red blood cells: oxygen transport; White blood cells: combating infection (c) Red blood cells: 40% of total blood volume; White blood cells: 1% of total blood volume (6) When the blood capillaries get torn and are exposed to the air, the platelets are stimulated to release enzymes. These enzymes act on an inactive blood protein called fibrinogen and convert it into another protein called fibrin. The fibrin forms a mesh of threads around the platelets. Red blood cells get trapped in the mesh and a blood clot is formed. (7) (a) because of the presence of stomata on the lower side (b) A transpiration stream is created when transpiration through the stomata lowers the water potential in the leaf cells. This causes water from neighbouring tissues to enter the leaf cells. In this way a transpiration pull is created that causes water to be pulled up along the stem through the xylem cells. This causes water to be taken in down the water potential gradient by the roots through osmosis. (8) (a) two types of white blood cells that protect the body against disease are phagocytes and lymphocytes. Phagocytes recognize pathogens by their antigens and destroy them by engulfing and digesting them. Lymphocytes produce proteins called antibodies in response to particular antigens. The antibodies destroy the antigens and help to protect the body. (b) Immunity refers to the condition when lymphocytes are able to remember particular antigens after the body has been infected by them earlier. As a result, they are able to produce the required antibodies and destroy the pathogens when they infect the body again.

The circulatory system

(1) b (2) a (3) c (4) d (5) (a) Double circulation refers to the movement of the blood through the heart twice—once when deoxygenated blood enters the heart and is pumped to the lungs, again when oxygenated blood is pumped to various parts of the body. (b) Arteries are thicker than veins because blood is pumped through them at a higher pressure. (6) (a) The capillaries are extremely narrow and only one cell thick. A vast network of capillaries surrounds the cells of tissue. Useful substances such as oxygen and nutrients passing through the capillaries diffuse across the capillary walls and form tissue fluid. The nutrients are then absorbed by the tissue cells. Similarly, waste substances from the tissue cells diffuse into the tissue fluid and are taken up by capillaries. (b) The tricuspid valve closes to prevent blood flowing back from the right ventricle into the right atrium when the heart contracts. The blood then enters the pulmonary arteries. The bicuspid valve closes to prevent blood flowing back from the left ventricle into the left atrium. The blood then enters the aorta. (c) An artificial pacemaker consists of an electronic timing device powered by batteries placed in the upper chest. It sends out periodic electrical charges that help the heart to beat at a normal rate. It also makes adjustments for changes in breathing and body temperature. Without an artificial pacemaker the heart would beat at a much lower rate. (7) (a) poor diet, smoking, lack of exercise (b) by increasing the size of the heart; by keeping artery walls flexible

Respiration

(1) c (2) a (3) b (4) d (5) large surface area, moisture, blood capillaries, etc. (6) (a) (i) prevent the trachea from collapsing while inhaling air (ii) help to move mucus and trapped particles away from the lung (iii) produce mucus to trap dust particles and microorganisms (b) Excessive mucus production blocks the trachea and prevents air from entering the lungs. (7) (a) nasal passage, trachea, bronchus, bronchiole, alveolus, capillary (b) Inspiration takes place when the pressure in the lungs is less than the external pressure due to an increase in lung volume. This causes air to enter the lungs. Expiration takes place when lung volume decreases and the lung pressure becomes greater than the external pressure. This causes air to move out of the lungs. (c) The film of moisture allows oxygen to be dissolved in it and later diffused into the capillaries. Similarly, it helps carbon dioxide to be moved into the alveoli by dissolving it.

Excretion

(1) b (2) a (3) a (4) c (5) Urea is harmful because it can denature enzymes. (6) (a) (i) carries urine from the kidney to the bladder (ii) stores urine before it can be excreted (iii) transports urine from the bladder (b) Blood groups of donor and recipient could be matched; tissue types could be matched (7) See page 117 of *Fundamental Biology*.

Homeostasis

(1) b (2) c (3) d (4) d (5) (a) Homeostasis is the process by which the internal environment of the body is kept constant by keeping the tissue fluid around the cells under constant conditions. (b) Negative feedback refers to the use of information about a change to initiate a response for cancelling out the change, e.g. an increase in body temperature brings about sweating to cool down the body. (6) (a) An increase in glucose concentration in the

blood following digestion causes insulin to be released into the bloodstream so that the glucose may be absorbed by the cells. **(b)** stimulates the liver to convert glucose into glycogen; stimulates the liver to convert glucose into fats; stimulates the liver to restrict the conversion of fats and glycogen into glucose; links to glucose and helps to transport it from the blood into the cells by active transport **(c)** excessive thirst, sweet-smelling breath, high overflow of glucose into urine **(d)** Diet-controlled diabetes refers to a form of diabetes in which the condition can be controlled by limiting fat and sugar intake in the diet. Injection of insulin is not required. **(7) (a)** shivering, reduced sweat production, vasoconstriction, increased respiration, contraction of hair erector muscles, etc. **(b)** Sweat is produced by sweat glands in the skin. When the sweat evaporates from the skin surface, heat energy is lost and the body temperature is lowered.

Nervous system and hormonal coordination

(1) c (2) c (3) b (4) a (5) (a) A synapse is a tiny gap between the end of one neurone and a subsequent nerve cell across which neurotransmitters carrying signals diffuse to travel to a muscle cell or a gland cell. **(b)** See page 125 of *Fundamental Biology*. **(c)** It helps to screen out weaker impulses which would interfere with the concentration level of an individual. Only very strong impulses can cross the synapse. **(6) (a)** In a reflex action the stimulus travels along a reflex arc through the spinal cord instead of travelling to the brain. This makes the reflex action a rapid, automatic response compared to other voluntary actions that involve conscious thinking. **(b)** A reflex action is faster than a voluntary action because it is an automatic response generated by the stimulus travelling along a shorter path called the reflex arc. The brain is not involved in initiating the action. **(c)** receptor, sensory neurone, relay neurone, motor neurone, effector **(7) (a)** dilated pupils, skin growing pale, rapid breathing **(b)** The excitement before a race triggers the release of adrenaline hormone. This brings about changes such as increased heart rate, diverting of blood towards muscles, and conversion of glycogen into glucose to release energy for the race. **(c)** Enzymes are produced by living cells whereas hormones are produced by glands. Enzymes act as catalysts for metabolic functions whereas hormones may have longer-term effects. Enzymes act on specific substrate molecules whereas hormones are released into the bloodstream and affect only target organs.

Receptors and senses

(1) b (2) d (3) a (4) c (5) (a) rods, cones **(b)** through the blood vessels in the choroid **(6) (a)** The ciliary muscle relaxes to make the lens thinner and allow distant objects to be viewed. It contracts to make the lens thicker and allow close objects to be viewed clearly. **(b)** See page 135 of *Fundamental Biology*. **(7)** taking regular breaks from working at the computer; working in adequate lighting; etc.

Bacteria and other micro-organisms

(1) c (2) a (3) b (4) c (5) pharmaceuticals, biological washing powders, food production **(6)** Batch culture: vessels can be used for other purposes; limited wastage if the batch becomes contaminated. Continuous culture: greater wastage upon contamination; possible blockage of pipes because of continuous production **(7) (a)** An antibiotic helps to treat a bacterial infection. An antiseptic helps to prevent infection by killing germs. Antibiotics are administered internally whereas antiseptics are applied externally. **(b)** Antibiotic resistance refers to the tendency of certain antibiotics to become less effective in dealing with bacteria over long periods. This happens because the bacteria evolve into becoming resistant against a specific antibiotic when they have been subjected to it for long. **(8)** See page 159 of *Fundamental Biology*. **(9) (a)** Scavengers help in the decomposition of dead plants and animals by breaking them up into smaller pieces and eating some of it. The remaining pieces can then be acted upon by decomposers. **(b)** Viruses: protein coat, no cell membrane, genetic material in the form of RNA or DNA; Bacteria: cell wall instead of protein coat, cell membrane present, genetic material in the form of DNA

Feeding relationships

(1) b (2) a (3) c (4) d (5) mushrooms, worms, etc. **(6)** See page 97 of *Fundamental Biology*. **(7)** to protect the fish population during the breeding season

Malaria

(1) d (2) c (3) c (4) a (5) The introduction of shrimps is helpful in controlling mosquito populations because the shrimps feed on mosquito larvae. **(6)** It feeds on blood and so can transmit the parasite. It has wings and can fly to transmit the parasite from one person to another. Its stomach wall and salivary glands do not harm the parasite and allow it to pass through part of its life cycle. The female Anopheles mosquito injects some saliva into its victim before sucking blood which enables parasites to be transferred from the salivary glands of the mosquito into the blood of the victim. **(7)** The parasite develops and multiplies inside the red blood cells by feeding on haemoglobin. The toxins released by the breakdown of haemoglobin cause the shivering and fever.

(8) The male mosquitoes feed on plant juices and hide under tree cover. Destroying the habitat would mean that fertilization of the eggs would not occur and the eggs would not hatch.

Recycling of energy, carbon, and nitrogen

(1) c (2) a (3) d (4) d (5) See diagram on page 173 of *Fundamental Biology*. (6) A pyramid of biomass represents the biomass or mass of the individuals present in a habitat at a particular point in time. On the other hand, a pyramid of energy represents the amount of energy flowing in an ecosystem over a period of time. This helps to overcome the problem of varying rates of population growth in different species. (7) Nitrogen fixation is the conversion of atmospheric nitrogen into nitrates in the presence of oxygen so that they may be used by plants. Nitrification is the conversion of ammonium ions into nitrates in the presence of oxygen. (8) Photosynthesis consumes carbon dioxide and adds oxygen to the atmosphere whereas respiration consumes oxygen and adds carbon dioxide to the atmosphere. These processes take place at varying rates with the rate of photosynthesis being controlled by light. When there is less light during early morning and in the evening the rate of photosynthesis is lowered and more carbon dioxide is added to the atmosphere. During the day the rate of photosynthesis is increased and so more oxygen is added to the atmosphere.

Human impact on the environment

(1) b (2) d (3) b (4) a (5) (a) Global warming refers to the increase in average temperatures on the Earth caused by the greenhouse effect. (b) increased photosynthesis and food production (c) reduce fossil fuel consumption; control deforestation; plant more trees (6) (a) See page 203 of *Fundamental Biology*. (b) less land for growing food crops; increase in food crop prices (c) temperatures between 20°C to 30°C; low oxygen levels; location below ground level (7) screening, aerobic digestion, anaerobic digestion, sedimentation

Water pollution

(1) d (2) a (3) c (4) b (5) (a) A residual pesticide is a pesticide that requires a sufficient amount of time after they are applied to become effective. The length of the duration varies for different pesticides. (b) The mosquito larvae may be eaten by consumers such as tadpoles who in turn might be eaten by larger consumers such as snakes when they develop into frogs. (6) (a) Algal bloom refers to a dramatic growth in the population of algae in an aquatic ecosystem. Algal bloom can be seen as a film of algae on the surface of the water. It happens when there is an increase in the concentration of oxygen or nutrients in the water. (b) Water leaching from a farm may contain nitrates and phosphates from fertilizers. When these nutrients flow into a pond or a stream they help the algae to thrive and flourish. (7) When acid rain flows into streams and rivers it causes the water to become acidic. Several aquatic plants become unable to grow or reproduce because of the increased acidity because the soil cannot neutralize the acids in the water.

Asexual reproduction

(1) c (2) d (3) c (4) b (5) reduces the risk of seeds not germinating; cuts down maturation time needed to develop fruits; fruits of a consistent quality can be produced (6) Fruit: banana; Advantages: It is economical because it reduces the maturation time of the fruit; desired qualities of taste and size can be maintained; Disadvantage: The entire plantation could be destroyed because the cloned plants may lack resistance to a common virus that could infect all the plants, e.g. the bushy top virus destroyed the banana plantations in Karachi during the 1990s. (7) Budding is the mode of reproduction in yeast. Small outgrowths called buds appear on the surface which increase in size and finally separate out and grow individually. (8) (a) The temperature is kept at the optimum level and the liquid contains glucose and mineral salts, e.g. ammonium phosphate. Sterile air is bubbled through so that the fungus can respire aerobically. A stirrer is not used as it would break up the strands of hyphae of the fungus. (b) A stirrer is absent in the fermenter used in the continuous process, while it is present in the batch process. In the continuous process the fungus is removed at intervals leaving some of it behind to continue the process but in the batch process the fungus is removed entirely and the fermenter sterilized before growing a fresh batch of the fungus.

Seed growth and germination

(1) b (2) c (3) a (4) c (5) See diagram on page 222 of *Fundamental Biology*. (6) water, oxygen, suitable temperature (7) (a) ovary wall (b) ovule (c) integument

Human reproduction

(1) b (2) a (3) a (4) b (5) (a) Only one ovum is sufficient for fertilization whereas millions of sperm cells are necessary to provide a good chance of fertilization (b) Sperm cells travel with the help of a tail whereas ova are moved by the action of cilia lining the oviducts. (c) The sperm is shaped like a tadpole while the ovum is spherical. (6) exchange of food, oxygen, and waste substances between mother and foetus; protection from mother's immune system; protection against changes in mother's blood pressure; secretion of hormones for maintaining uterus lining (7) (a) in the oviduct (b) See page 226 of *Fundamental Biology*. (8) Advantages of breast milk: contains all required nutrients that can be digested by the infant, contains antibodies, requires no preparation, encourages social bonding between mother and infant; Advantages of bottled milk: exact quantity can be measured, mother need not be present (9) (a) the time period before ovulation (days 1-12); the time period when hormonal levels fall and the uterine lining is peeling off (days 18-28) (b) See page 230 of *Fundamental Biology*.

Variation and inheritance

(1) a (2) b (3) c (4) a (5) Discontinuous variation is observed in characteristics that an organism either possesses or not. Such characteristics are influenced by genetic factors and cannot be measured, i.e. they are qualitative. Continuous variation is observed in characteristics that are possessed by different organisms in varying degrees. They can be measured and are the result of genetic and environmental factors. (6) (a) incorrect pairing of bases; uneven distribution of chromosomes; damage to the DNA (b) Survival of the fittest is used to explain the survival in the struggle for existence of individuals better suited to their environment over others who are ill-equipped. This includes the possession of adaptations that prevent being preyed upon, for example. (7) (a) See page 272 of *Fundamental Biology*. (b) See page 262 of *Fundamental Biology*. (c) Embryo splitting is a special type of cloning method in which an embryo is split into smaller groups of cells or individual cells in the early stages of development. Each of these separate cells develops into a new embryo.

