

Introduction

The **Scientific Eye** programmes seek to trigger the excitement of science by actively provoking viewers into thinking and acting scientifically. Each programme examines a topic relevant to the 11–14 science curricula of England, Wales, Scotland and Northern Ireland, with individual problems or stories being used to illustrate more general scientific ideas. Real-world science, novel experiments and fascinating stories of landmarks in the history of science are brought graphically alive through drama, cartoon and imaginative on-screen investigations, helping pupils to develop their knowledge and understanding of scientific processes and ideas. **Scientific Eye** actively encourages pupils to develop and use the fundamental scientific skills of observing and questioning, coming up with ideas, making and testing predictions, and evaluating and communicating their results and explanations.

An important element of the programmes concerns the nature and interpretation of evidence. As pupils develop their own mental models to explain scientific phenomena, they will behave in much the same way as any scientist: they will have their own ideas, which have to be put to the test. The programmes provide stimuli for such investigations, and they provide additional information and evidence to enable pupils to consider other ideas. By encouraging evaluation of alternative theories, the programmes help pupils to move towards ideas and explanations which have general acceptance and which they find personally satisfactory. They can evaluate the laboratory investigations they see on screen, consider the usefulness or accuracy of the observations being made, and come up with their own ideas and explanations. The programmes also show how scientific ideas continually develop and change, perhaps as a result of new techniques, or through flashes of inspiration!

Study Guide

This Study Guide presents imaginative ways of getting pupils to think and act scientifically, and contains a range of photocopiable activity sheets for each programme. Icons indicate what is expected as pupils rise to the challenges posed by each activity.



use of knowledge and ideas



discussion



researching and gathering information



data handling and interpretation



exploring opinions and values



creative writing and role-play



practical investigation

contents

Programme 1

Movement

The importance of bones and muscles is explored through the activity of several athletes. | 2

Programme 2

Cells

The programme investigates how scientists use their knowledge of cells to grow tissue cultures and save the lives of burn victims. The structure of a range of plant and animal cells is also explored. | 5

Programme 3

Classification

The everyday need to identify and classify plants and animals provides the focus for the programme. Vertebrates are studied at the zoo, and the idea of simple keys is introduced by a lively quiz. | 8

Programme 4

Drugs and Health

Using asthmatics as a case study, the programme offers a scientific look at drugs and how they can be both beneficial and detrimental to health. | 11

Programme 5

Reproduction

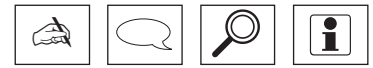
The programme shows fertilisation *in vitro*, follows the development of a foetus and asks why is it rare for more than three babies to survive being born together. | 14

Credits and Useful Addresses | 17

Subtitles

All **Channel 4** series for schools are subtitled on Teletext for the deaf and hearing-impaired.

Movement Overview



Before watching the programme

What are your ideas about:

- ◆ which parts of our body are involved in movement?
- ◆ how strong our bones need to be?
- ◆ how much force our muscles generate?

How might you test your ideas?

After watching the programme

What evidence do you have that supports the following scientific ideas?

- a The body can be thought of as a machine, designed to move in various ways.
- b The bones in our skeleton provide support for our body.
- c Bones are designed to be strong but light.
- d Muscles must work in pairs because they can only pull, and not push.
- e We can measure the size of the forces that our muscles generate.

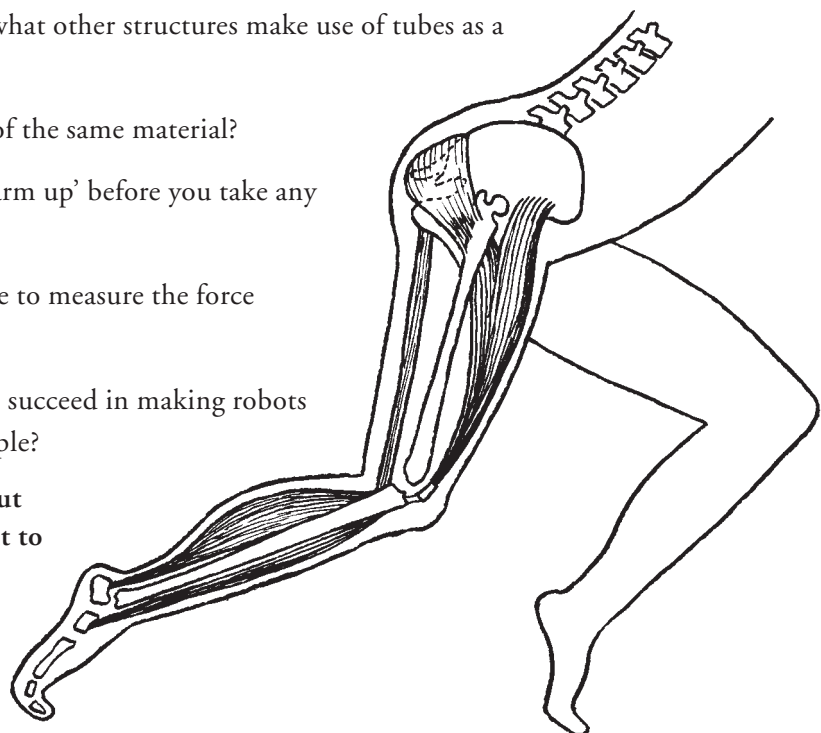
Try to think of more ways to test whether these ideas make sense.

Now try these

Here are more questions about MOVEMENT for you to discuss and investigate.

- 1 Who else might be interested in analysing movement, apart from computer game manufacturers?
- 2 What problems might you have without enough calcium in your diet?
- 3 What types of animal need particularly light bones, and how do you think they achieve this?
- 4 Apart from our skeleton, what other structures make use of tubes as a framework?
- 5 Are all our muscles made of the same material?
- 6 Why is it important to 'warm up' before you take any strenuous exercise?
- 7 Why is it helpful to be able to measure the force of our muscles?
- 8 Do you think humans will succeed in making robots that move exactly like people?

Have you any questions about MOVEMENT that you want to discuss or investigate?



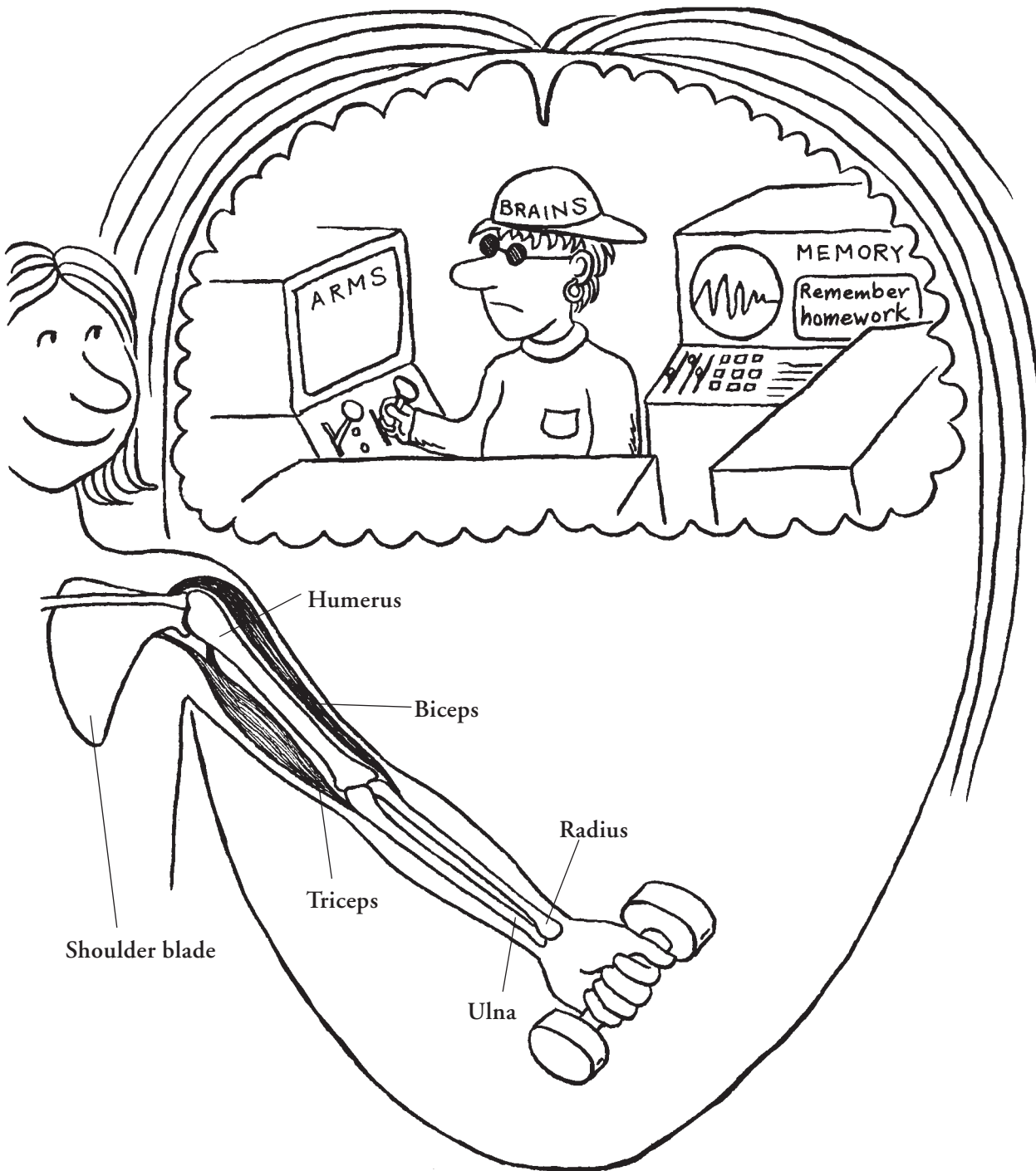
Brain Calling Arm!



Sue is exercising, and wants to lift the weight up to her shoulder. To do this, her brain has to give some instructions to the muscles in her arm.

1 Using the names of bones and muscles on the diagram, write out a complete list of instructions that her brain needs to send so that she can raise the weight and then lower it.

You can use instructions to the muscles such as **contract** and **relax**.



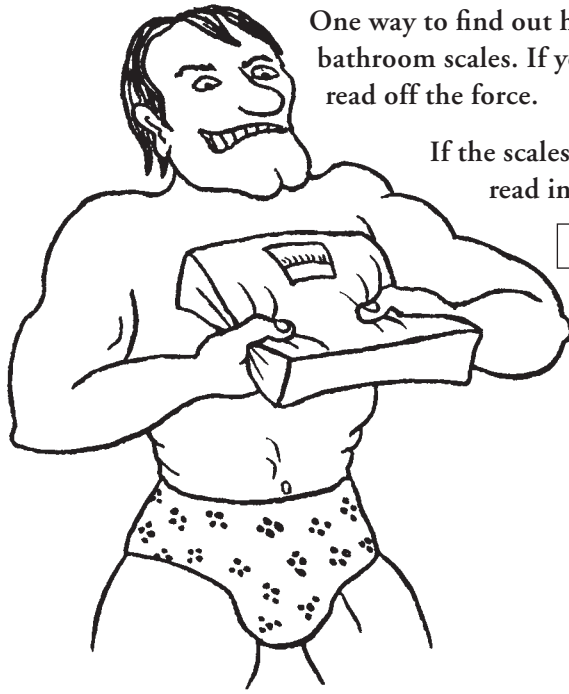
2 Name two of Sue's muscles that are an **antagonistic pair**.

3 How are Sue's muscles attached to her bones?

4 Sue weighs 50kg. If 40% of her body weight is muscle, what weight of muscle does she have?

5 Try and find out what the biggest and smallest muscles are in Sue's body.

Getting to Grips



One way to find out how much force your muscles generate is to use a set of bathroom scales. If you grip the scales at each side and squeeze hard you can read off the force.

If the scales measure in newtons, simply record the force. If they read in kilograms, you will need to convert this to newtons.

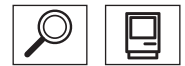
$$10\text{N} = 1\text{kg}$$

- ▶ Try and find out who has the strongest grip in the class.

Here are some things you could investigate:

- ▶ Does the force of a person's grip depend on:
 - a their sex?
 - b their height?
 - c their hand span?

Groaning Bones



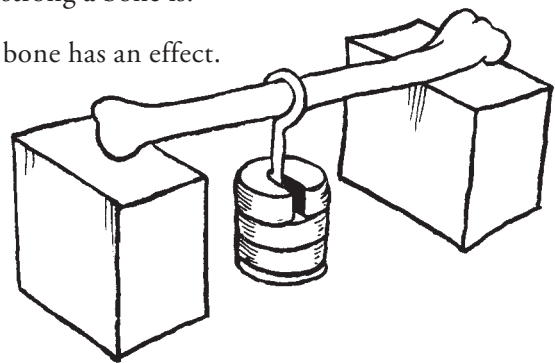
Bones need to be strong to support our weight.

- ▶ Make a list of the things that might affect how strong a bone is.
- ▶ Plan an investigation to see if the length of the bone has an effect.

To model the bone you could use paper straws.

Think about:

- ◆ how many different lengths to use.
- ◆ how you will test the strength of the bone.
- ◆ how you will record your results.
- ▶ Write a report saying what you have done and what you have found out.



Cells Overview

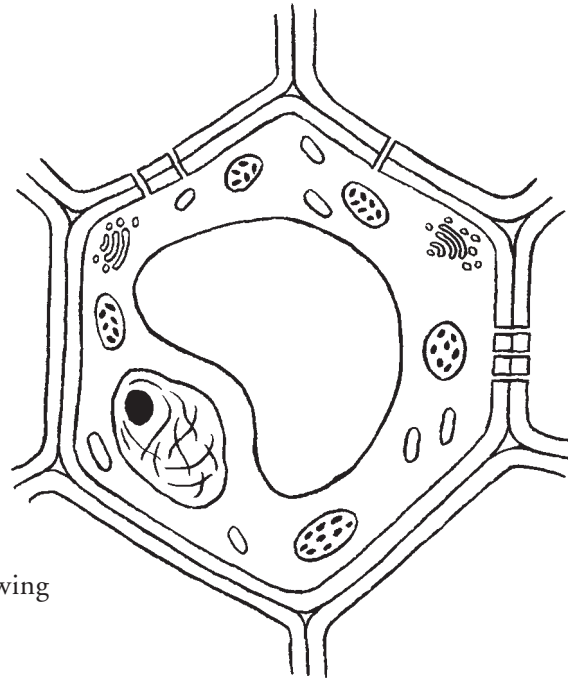


Before watching the programme

What are your ideas about:

- ◆ what cells are?
- ◆ what different kinds of cells look like?
- ◆ what sorts of jobs different cells do?

How might you test your ideas?



After watching the programme

What evidence do you have that supports the following scientific ideas?

- a All living things are made up of cells.
- b Cells can grow and multiply if they have oxygen, water and nutrients.
- c Microscopes let us see that most cells have a nucleus, cytoplasm, and a cell membrane.
- d Different types of cell are designed to do different jobs.
- e Plants have a cell wall made of tough fibres, and chloroplasts to make sugars.

Try to think of more ways to test whether these ideas make sense.

Now try these

Here are more questions about CELLS for you to discuss and investigate.

- 1 What supplies all the cells in your body with oxygen, water and nutrients?
- 2 How are the millions of cells in your body held together so that you don't fall apart?
- 3 If a nucleus is such an important part of a cell, how can a red blood cell manage without one?
- 4 What is the biggest cell?
- 5 Which part of the plant cell allows plants to stand up, even though they don't have bones?
- 6 Explain why leaves on a plant kept in the dark lose their green colour.
- 7 How are egg and sperm cells designed for reproduction?

Have you any questions about CELLS that you want to discuss or investigate?

Sizing Up Cells



Cells are small – but just how small are they?

Here is a way of estimating the size of cells.

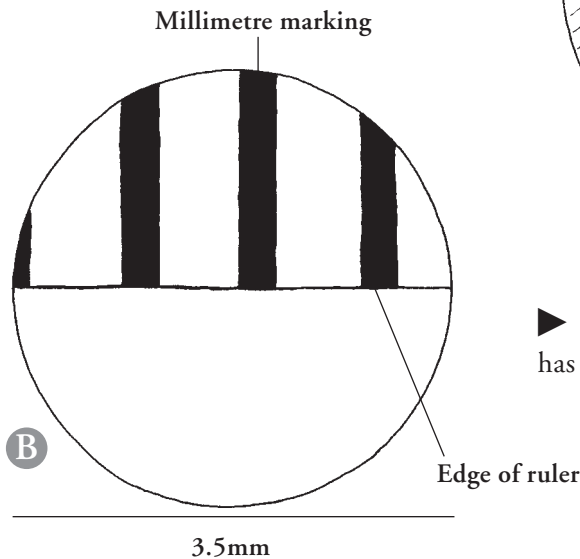
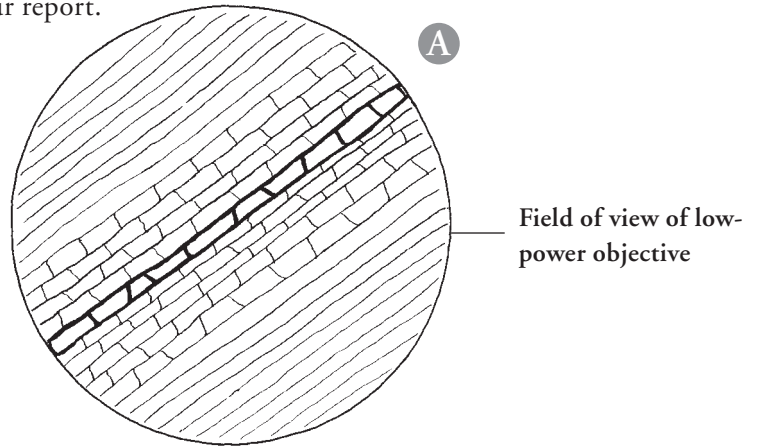
You will need to make a slide from an onion or rhubarb skin.

If you have done this before, read through your report.

If you haven't, ask your teacher what to do.

- ▶ Focus on the slide, using the objective of lowest power.

You should see something like the picture (A).



- ▶ Replace the slide with a clear plastic ruler that has good millimetre markings.

You should be able to focus on a few of the millimetre marks, like in the picture (B).

- ▶ Estimate how many millimetres you can see. This is the **field of view**. Here the field of view is 3.5mm.

Cells are very small, less than a millimetre long. There is a unit smaller than a millimetre, which we can use to measure them. This is called a **micrometre**. One millimetre is made up of 1,000 micrometres.

The field of view in the picture is 3,500 micrometres.

- ▶ Work out the width of your field of view in micrometres.
- ▶ Put the slide back under the low-power objective, and focus on it.

Count how many cells it takes to span the widest part of the field of view from end to end.

In the picture (A) above there are 10.

- ▶ Work out the average length of your cells like this:
 $\text{average cell length} = \text{width of field of view} \div \text{number of cells}$
 In this example, cell length = 3,500 micrometres \div 10 = 350 micrometres.
- ▶ Your result is an estimate. It is not very reliable. How could you make it more reliable?
- ▶ Try this technique with other types of cell.

How many cells would it take to cover your fingertip? How could you work this out?

Model Cells



Making models is a good way of learning how things are put together.

- ▶ Make a model of an animal cell, using some of the junk shown.



Make labels for the **nucleus**, **cell membrane** and **cytoplasm**, and attach them to your model.

- ▶ Make a second model, of a plant cell. What extra features will this model need?

Add to your cell labels for the **cell wall**, **vacuole** and **chloroplasts**.

- ▶ Try designing models of different types of cell, for example a skin cell, a red blood cell, a nerve cell, a root hair cell, a sperm cell or an egg cell.

Write labels for each cell explaining what it does and how it is designed.

- ▶ Make an exhibition of all the models that the class has made.

Super Cell

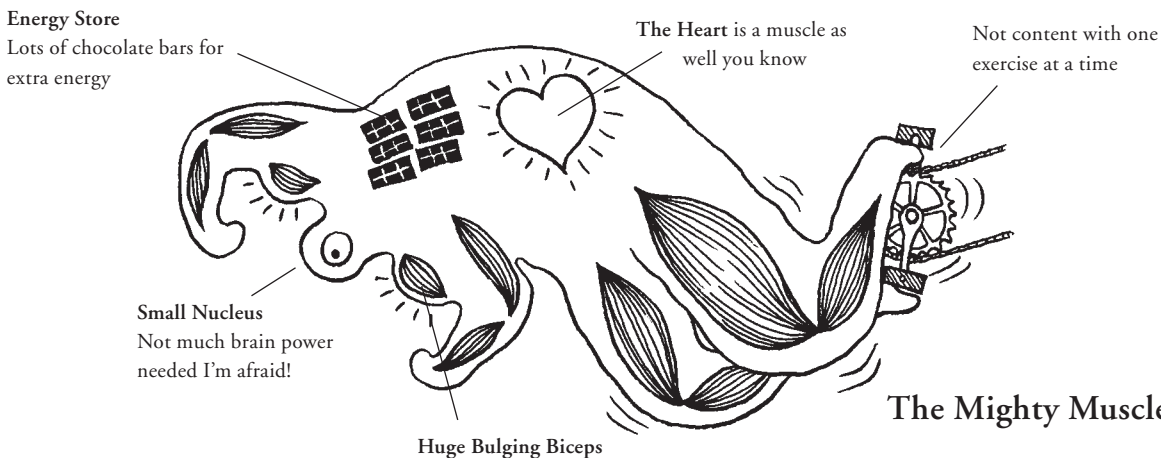


In your body there are hundreds of different kinds of cell, which do different jobs.

- ◆ Nerve cells carry messages and help you to think.
- ◆ Muscle cells allow you to move and lift things, as well as go to the toilet.
- ◆ White blood cells can eat nasty bacteria and make antibodies that stick them together.

- ▶ Choose a cell and design an advert that shows off its wonderful features.

It doesn't have to be very accurate. Here is an example:



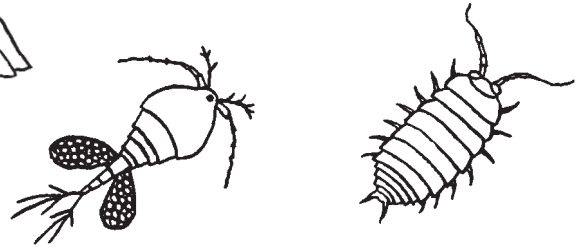
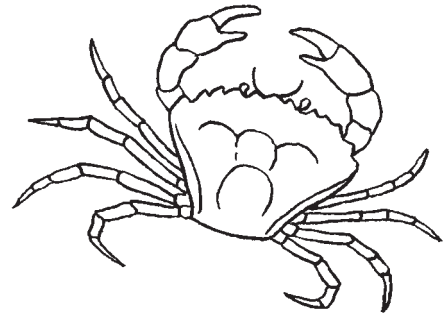
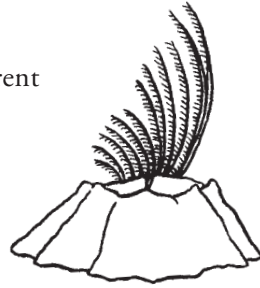
Classification Overview



Before watching the programme

What are your ideas about:

- ◆ what the differences are between plants and animals?
- ◆ what vertebrates are?
- ◆ how we organise different species into groups?



How might you research your ideas?

After watching the programme

What evidence do you have which supports the following scientific ideas?

- a Groups of animals are classified by their different characteristics.
- b The type of skin is a good indication of the type of vertebrate.
- c All vertebrates have a backbone.
- d Some mammals live in water.
- e Humans are in the same group of animals as seals.
- f Reptiles are different from amphibians.
- g Animals breathe in different ways.

Try to think of more ways to explore whether these ideas make sense.

Now try these

Here are more questions about CLASSIFICATION for you to discuss and investigate.

- 1 What are the two main types of invertebrate?
- 2 How are plants divided into groups and subgroups?
- 3 What type of living thing is a mushroom?
- 4 Are all vertebrates warm-blooded?
- 5 Do all plants have leaves and roots?
- 6 How many mammals live in the water? What are their names?
- 7 What is the strangest type of mammal you can find?

Have you any questions about CLASSIFICATION that you want to discuss or investigate?



Missing Link Unearthed

Chinese scientists are claiming to have found a fossil of an entirely new type of animal. The fossil, which is more than three metres long, seems to be part reptile, part bird. It has four limbs: two 'legs' with large claws and two long

jointed 'wings' which could have been covered with feathers.

The rest of the animal, except for its head, was probably covered with scales. The head is smooth and has a long beak-like snout with rows of jagged teeth.

- ▶ What evidence is there that the animal is a reptile? Or a bird?
- ▶ If you were one of the scientists, what else would you need to know before you were sure what it was?
- ▶ Draw a picture of what you think this animal looked like.

Classification Domino Game



This game is designed to help you learn the main characteristics of different living things. The dominoes have a characteristic of a group on one side and a type of animal on the other. Before playing, cut out the dominoes.

How to play

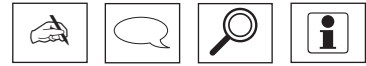
- ◆ In groups of three or four, shuffle and deal out the dominoes face down. Leave any spare dominoes to one side.
- ◆ Take it in turns to place the dominoes on the table, matching the characteristic with the type of animal. If you cannot make a match, you miss a turn.
- ◆ The winner is the person who gets rid of all their dominoes first, or who has the fewest dominoes left at the end.

You can extend the game by making more dominoes of your own. You could also change the rules – for example, deal out only five dominoes each, and pick up one of the spare ones if you cannot play your turn.

have a dry scaly skin	birds	have feathers	crustaceans (e.g. crabs)
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Classification Dominoes

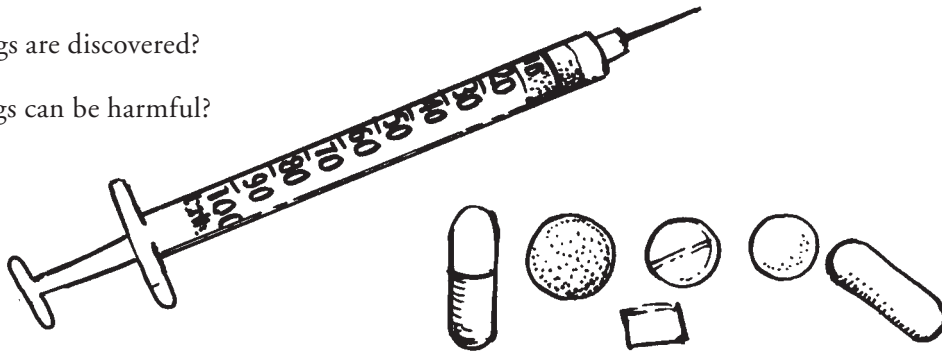
have a backbone	reptiles	have feathers and wings	amphibians	have a hairy skin	fish
lay eggs on land	centipedes and millipedes	have a dry scaly skin	birds	lay eggs with hard shells	amphibians
lay eggs in water	birds	have a smooth moist skin	birds	breathe in water	insects
have many legs	insects	have feathers	crustaceans (e.g. crabs)	have no backbone	amphibians
give birth to live young	fish	breathe through gills	reptiles	have six legs	mammals
have eight legs	vertebrates	breathe in water	invertebrates	have a hard shell and live in water	arachnids (e.g. spiders)
make milk for their young	birds	can sometimes fly	mammals	have beaks	mammals
are cold-blooded	mammals	have a hard outer skin	fish	are warm-blooded	insects



Before watching the programme

What are your ideas about:

- ◆ what different kinds of drug do to your body?
- ◆ how drugs are discovered?
- ◆ why drugs can be harmful?



How might you test your ideas?

After watching the programme

What evidence do you have that supports the following scientific ideas?

- A drug is a chemical that has an effect on your body.
- Some drugs are designed to improve health, but drugs can be harmful.
- Solvents, and nicotine in cigarette smoke, damage your lungs.
- Drugs can change how you feel.
- Many modern drugs have been developed from plant remedies that have been known for a long time.

Try to think of more ways to research whether these ideas make sense.

Now try these

Here are more questions about DRUGS for you to discuss and investigate.

- 1 Which organs of your body can be harmed by alcohol, tobacco and solvents?
- 2 How can one person be affected by chemicals in another person's tobacco?
- 3 How does an inhaler work?
- 4 Why must pregnant women be very careful about drugs that they take?
- 5 Why is it illegal to take some drugs and not others?
- 6 What is an overdose?
- 7 What does addiction mean, and which drugs are addictive?

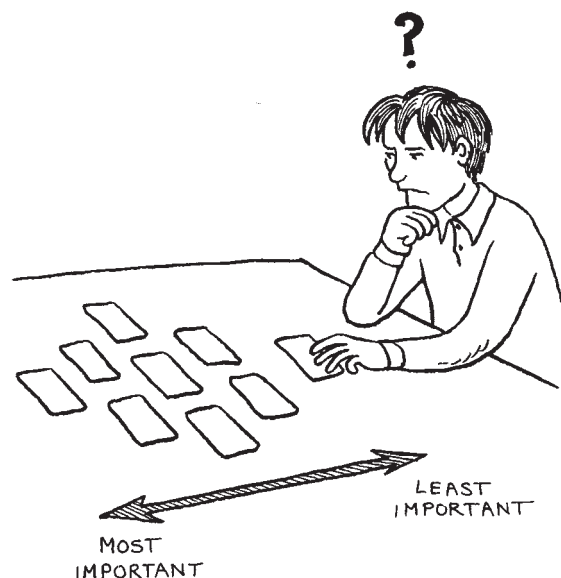
Have you any questions about DRUGS that you want to discuss or investigate?

Why Use Drugs?



The statements below have been used to explain why young people begin to take illegal drugs.

- ▶ Cut out the statements, and read them carefully.
- ▶ Arrange them in a diamond shape, like the person in the picture.
- ▶ Put the most important statement at the top and the least important at the bottom.
- ▶ Discuss your arrangement with a partner, and agree a common arrangement between you.
- ▶ Get together with another pair, and agree an arrangement for your group.



✂

Peer pressure:
My friends take drugs and I want to impress them.

✂

Family problems:
There are lots of arguments at home, so I like to be out with my friends. Taking drugs makes me feel better.

✂

Curiosity:
I want to find out what it feels like.

✂

Fun:
I have a good time. It's a laugh.

✂

Worries:
I'm not doing well at school, and my parents are always on at me. Drugs help me to stop worrying.

✂

Depression:
There's no point to my life. I've got no future.

✂

Availability:
Drugs are easy to get. All my mates can get hold of them.

✂

Illegal:
I like doing things which are against the law and risky.

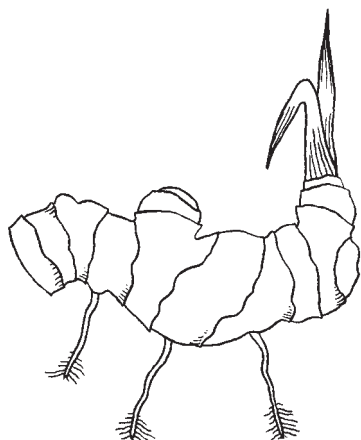
✂

Personality:
I'm just an extrovert. I like to let myself go.

Does it make a difference to the order if you think about different drugs?

Do people have different reasons for smoking, drinking alcohol or taking ecstasy?

Extracting Ginger



Historically, ginger root has been used as a natural remedy for indigestion.

The root can be peeled and chewed to get at the useful substances inside the root cells.

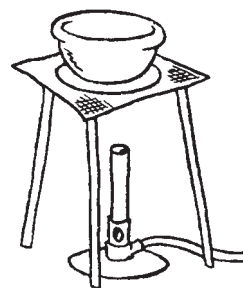
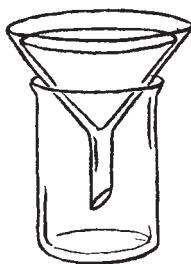
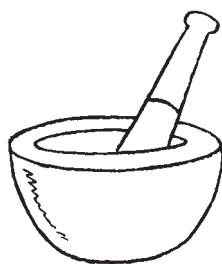
Note: it is quicker and easier to dissolve powdered medicine in water and drink it.

► Plan a method of extracting the useful chemicals from ginger root.

You will need to work out how to:

- ◆ break up the root
- ◆ break open the root cells
- ◆ dissolve out the substances
- ◆ remove the water to leave a solid

You can use normal laboratory equipment. Ask your teacher for extra equipment.



A Breath of Fresh Air

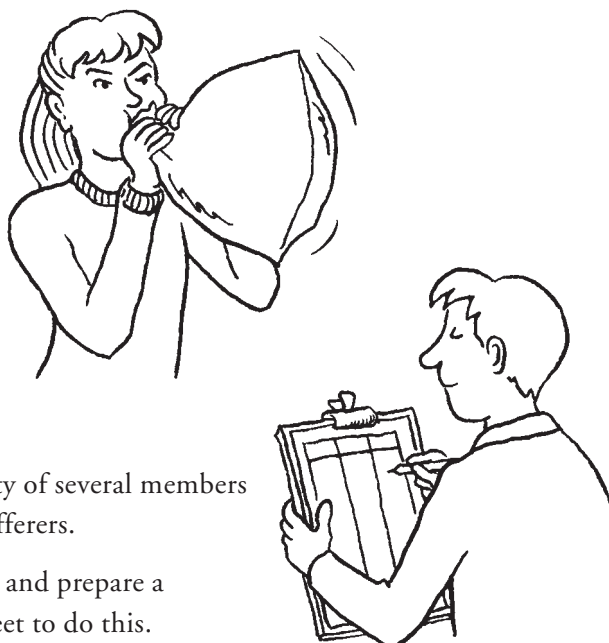


Asthma sufferers have bronchioles that may become narrower than normal. This makes it difficult for them to breathe out completely. A doctor uses a peak flow meter to check how healthy your lungs are. This meter measures how hard you can breathe out.

► Design a simple method to capture and measure the volume of the air you breathe out. Use your method to measure the largest volume of air that you can breathe out. This is your **vital capacity**. Now measure the size of a normal breath. This is your **tidal volume**.

► Measure the tidal volume and vital capacity of several members of your class. Try and include some asthma sufferers.

► Present your results in the form of a table, and prepare a bar chart. You could use a computer spreadsheet to do this.



What, apart from asthma, might affect your vital capacity and tidal volume? Explain any patterns in your results.

Reproduction Overview

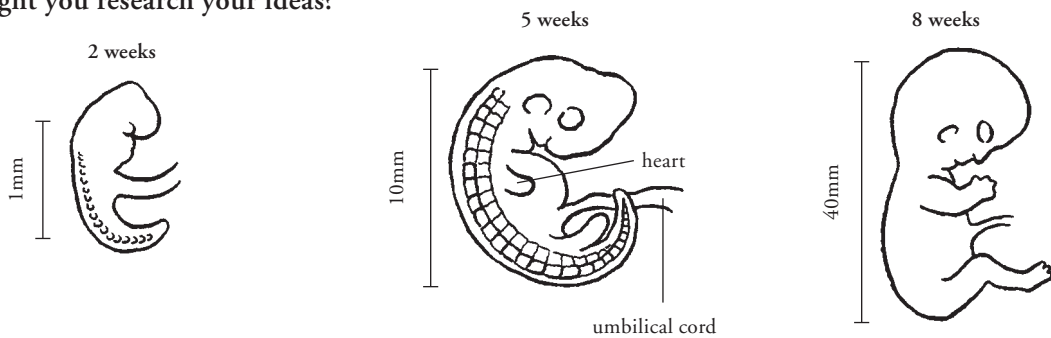


Before watching the programme

What are your ideas about:

- ◆ what changes happen during adolescence?
- ◆ what the differences are between boys and girls, and between men and women?
- ◆ how babies are made?

How might you research your ideas?



After watching the programme

What evidence do you have which supports the following scientific ideas?

- a People develop and go through puberty at different rates.
- b The sex of a baby depends upon the father.
- c Identical twins come from one egg, which divides and separates.
- d Non-identical twins are the result of two eggs being fertilised.
- e Barrier methods of contraception aim to prevent fertilisation.
- f Humans are the only animal that tries to control fertilisation and pregnancy.

Try to think of more ways to research whether these ideas make sense.

Now try these

Here are more questions about REPRODUCTION for you to discuss and investigate.

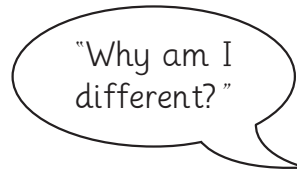
- 1 Why are many sperm cells produced at a time, but usually only one ovum (egg)?
- 2 Why are eggs not produced during pregnancy?
- 3 What are the main functions of the placenta?
- 4 How does the uterus prepare to accept a fertilised egg?
- 5 How are sperm cells specially adapted to do what they have to do?
- 6 How long is the period of pregnancy in:
 - a a cat?
 - b a mouse?
 - c an elephant?
- 7 Is there a relationship between the length of pregnancy and the size of animal?
- 8 What is the strangest type of mammal you can find?

Have you any questions about REPRODUCTION that you want to discuss or investigate?

Growing Pains!



It may seem unfair that during adolescence you go through so many changes and have a lot of worries. All this is perfectly natural. We all pass through puberty as our bodies change from that of a child to that of a young adult capable of reproducing.



► Below are examples of changes that happen either to girls, to boys or to both. Decide which, and circle the correct word. The first one is done for you.

The body starts to change shape	Boy	Girl	Both
Pubic hair starts to grow between the legs and under the arms	Boy	Girl	Both
Bones and muscles grow as the chest and shoulders get bigger	Boy	Girl	Both
Breasts develop and become larger	Boy	Girl	Both
Body hair develops on chest and legs	Boy	Girl	Both
Hips and thighs develop to give a more 'curvy' figure	Boy	Girl	Both
Facial hair develops	Boy	Girl	Both
Sex cells start to be produced	Boy	Girl	Both
The body starts to grow quickly to become the height of an adult	Boy	Girl	Both
The sex organs grow larger	Boy	Girl	Both
Menstruation (having periods) starts	Boy	Girl	Both
The larynx (Adam's apple) appears	Boy	Girl	Both
Sperm starts to be produced	Boy	Girl	Both
Eggs start to be released about every 28 days	Boy	Girl	Both

► Now make a poster of a girl and a boy. Label it with the above statements placed appropriately.

► Write a 'problem page' letter about the worries that boys and girls have during adolescence, and make up suitable replies from the 'agony aunt'.

Sperm Meets Egg



In the boxes below are some of the things that can happen when a male and female have sexual intercourse.

► Cut out the boxes, rearrange them into the correct order, and then draw a flowchart of what happens.

Sperm cells swim up the fallopian tubes

Blood flows to the penis and it becomes erect

The fertilised egg attaches itself to the lining of the uterus

The erect penis enters the vagina

Friction causes sperm to be released (ejaculation)

The vagina becomes moist

The two sexes become emotionally excited

If an egg has been released from the ovary, sperm cells surround the egg and try to break through

The fertilised egg travels down to the uterus

The cells multiply as the foetus develops

Some sperm cells enter the uterus

Only one sperm cell is allowed to enter the egg

The two sex cells join together (fertilisation)

► After drawing the flowchart, make up further statements to continue the process of the developing embryo up to the point of birth. You may have to do some further research.

Credits

Scientific Eye: Life and Living Processes 2 was produced for Channel 4 by Yorkshire Television.

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Study Guide Editors: **Liz Meenan, Phil Gauron**

Useful Drugs Resources and Addresses

4 Learning publishes videos and resource books on drugs education. Contact:

4 Learning
PO Box 100
Warwick CV34 6TZ

SATIS 8–14 publishes stand-alone units putting science in context. Box 3: Number 3 'Asthma' and Number 9 'Medicines from the Rain Forest' are relevant to these programmes. SATIS units are available from:

The Association for Science Education (ASE)
College Lane
Hatfield
Herts AL10 9AA
Telephone: 01707 283001

The National Asthma Campaign has free asthma packs for schools. These are available from:

National Asthma Campaign
Providence House
Providence Place
London N1 2XX

The Global Science Teachers' Network has information on medicines from different countries. Write to:

Development Education Unit
VSO
317 Putney Bridge Road
London SW15 2PN