

This website supports substantial areas of the Science Curriculum and the non-statutory framework for PSHE.

Using the site also supports the statutory requirement that 'pupils should be given opportunities to apply and develop their ICT capability through the use of ICT tools to support their learning in all subjects'.

### SCIENCE

This table summarises which sections of the National Curriculum 2000 programme of study in Science (Sc2: Life processes and living things) are addressed in each of the six main sections.

The practical activities also support the following statements relating to Sc1 Investigative skills:

Obtaining and presenting evidence:

- f) use a wide range of equipment and materials appropriately, and manage their working environment to ensure the safety of themselves and others
- j) represent and communicate qualitative and quantitative data using diagrams, tables, charts, graphs and ICT

Considering evidence:

- k) use diagrams, tables, charts and graphs, and identify and explain patterns or relationships in data
- m) use observations, measurements or other data to draw conclusions
- o) use scientific knowledge and understanding to explain and interpret observations, measurements or other data, and conclusions

Section	KS3 pupils should be taught:	KS4 pupils should be taught:
Life	<p>that aerobic respiration involves a reaction in cells between oxygen and food, in which glucose is broken down into carbon dioxide and water</p> <p>to summarise aerobic respiration in a word equation</p> <p>that the reactants and products of respiration are transported throughout the body in the bloodstream</p>	
Cells	<p>that animal and plant cells can form tissues, and tissues can form organs</p> <p>the functions of...the cell membrane, cytoplasm and nucleus in...animal cells</p>	<p>that the nucleus contains chromosomes that carry the genes</p> <p>that the gene is a section of DNA</p> <p>how cells divide by mitosis during growth, and by meiosis to produce gametes</p>
Food	<p>about the need for a balanced diet containing carbohydrates, proteins, fats, minerals, vitamins, fibre and water, and about foods that are sources of these</p> <p>the principles of digestion, including the role of enzymes in breaking down large molecules into smaller ones</p> <p>that the products of digestion are absorbed into the bloodstream and transported throughout the body, and that waste material is egested</p> <p>that food is used as a fuel during respiration to maintain the body's activity and as a raw material for growth and repair</p> <p>that aerobic respiration involves a reaction in cells between oxygen and food, in which glucose is broken down into carbon dioxide and water</p> <p>to summarise aerobic respiration in a word equation</p> <p>that the reactants and products of respiration are transported throughout the body in the bloodstream</p>	
Puberty	<p>about the physical and emotional changes that take place during adolescence</p>	<p>the way in which hormonal control occurs, including the effects of...sex hormones</p>
Sex	<p>that fertilisation in humans...is the fusion of a male and a female cell</p> <p>about the human reproductive system, including the menstrual cycle and fertilisation</p> <p>how the fetus develops in the uterus, including the role of the placenta</p>	
Variation	<p>about environmental and inherited causes of variation</p>	<p>that the nucleus contains chromosomes that carry the genes</p> <p>how variation arises from genetic causes, environmental causes, and a combination of both</p> <p>that sexual reproduction is a source of genetic variation...</p> <p>how sex is determined in humans</p> <p>the mechanism of monohybrid inheritance where there are dominant and recessive alleles</p> <p>about mechanisms by which some diseases are inherited</p> <p>that the gene is a section of DNA</p>



The table below summarises which sections of the Environmental Studies 5-14 National Guidelines for Science in Scotland (Knowledge and understanding: living things and the processes of life) are addressed in each of the six main sections.

Pupils are able to:

Section	Level C	Level D	Level E	Level F
Life	<ul style="list-style-type: none"> <li>● name the life processes common to humans and other animals</li> <li>● identify the main organs of the body</li> <li>● describe the broad functions of the organs of the human body</li> </ul>	<ul style="list-style-type: none"> <li>● describe the role of lungs in breathing</li> </ul>		<ul style="list-style-type: none"> <li>● describe the process of respiration</li> </ul>
Cells			<ul style="list-style-type: none"> <li>● identify and give the functions of the main structures found in plant and animal cells</li> </ul>	<ul style="list-style-type: none"> <li>● describe how different cells are adapted to their functions</li> </ul>
Food		<ul style="list-style-type: none"> <li>● outline the process of digestion</li> </ul>		
Puberty		<ul style="list-style-type: none"> <li>● describe the main changes that occur during puberty</li> </ul>		
Sex		<ul style="list-style-type: none"> <li>● describe the main stages in human reproduction</li> </ul>	<ul style="list-style-type: none"> <li>● identify, name and give the function of the main organs of the human reproduction system</li> </ul>	
Variation			<ul style="list-style-type: none"> <li>● give examples of inherited and environmental causes of variation</li> </ul>	<ul style="list-style-type: none"> <li>● explain the role of chromosomes and genes in inheritance</li> </ul>

**PSHE (Personal, Social and Health Education)**

The site supports the following elements of the KS3 non-statutory framework for Personal, Social and Health education:

**Developing a healthy, safer lifestyle**

2. Pupils should be taught:
  - a) to recognise the physical and emotional changes that take place at puberty and how to manage these changes in a positive way
  - b) how to keep healthy and what influences health
  - c) that good relationships and an appropriate balance between work, leisure and exercise can promote physical and mental health
  - e) in a context of the importance of relationships, about human reproduction, contraception, sexually transmitted infections, HIV and high-risk behaviours including early sexual activity
  - g) to recognise when pressure from others threatens their personal safety and well-being, and to develop effective ways of resisting pressures, including knowing when and where to get help

**Developing good relationships and respecting the differences between people**

3. Pupils should be taught:
  - a) about the effects of all types of stereotyping, prejudice, bullying, racism and discrimination and how to challenge them assertively
  - b) how to empathise with people different from themselves
  - c) about the nature of friendship and how to make and keep friends
  - d) to recognise some of the cultural norms in society, including the range of lifestyles and relationships
  - e) the changing nature of, and pressure on, relationships with friends and family, and when and how to seek help
  - f) about the role and importance of marriage in family relationships
  - g) about the role and feelings of parents and carers and the value of family life
  - j) to resist pressure to do wrong, to recognise when others need help and how to support them
  - k) to communicate confidently with their peers and adults.
  - h) to find information and advice [for example, about the risks of early sexual activity]
  - i) to prepare for change [for example, by anticipating problems caused by changing family relationships and friendships].

# Life

## Breathing to live

This is a practical activity that can be approached as either a class practical or a demonstration using one set of apparatus and a 'volunteer'. It is suitable for use in KS3 as part of a topic on the characteristics of living things or a topic on organ systems.

The main learning objective is that pupils come to an understanding of breathing as a means of providing oxygen for cellular respiration and removing the carbon dioxide which is produced as a waste product of cellular respiration. The key misconception to address here is the notion that breathing is the same thing as respiration. Take every opportunity to reinforce the idea that respiration is a chemical reaction that releases energy, and that it is going on in every living cell.

To get the most from this experiment, ensure that pupils notice two things about the apparatus:

1. The limewater is used as a 'carbon dioxide detector'. Carbon dioxide is an invisible, odourless gas, so we need the limewater to show us it's there. It turns from clear to milky when carbon dioxide reacts with it. The quicker this happens, the more carbon dioxide there is in the air being bubbled through it.
2. The tubes are set up so that exhaled air (breathed out from the lungs) bubbles through the limewater in one tube and inhaled air (breathed in from the room) bubbles through the other. Very able pupils may be able to see why this happens in terms of changes in air pressure, but it is wise not to dwell on this too long as it will confuse most and distract from the point. Just make sure they have noticed which is which!

Before the experiment, ask your pupils to predict what they think will happen. Encourage them to give reasons for their predictions.

All pupils should find that the limewater through which exhaled air is bubbled turns milky after just a few breaths, and understand that this shows they are breathing out carbon dioxide.

Most pupils should go on to notice that, after several more breaths, the limewater through which air is inhaled also begins to turn a bit milky. They should be encouraged to try to explain this observation for themselves; i.e. the air in the room contains a small amount of carbon dioxide.

Some pupils may be able to explain that this carbon dioxide comes from people (and other animals) breathing out. A few may make the link with combustion (burning), which also releases carbon dioxide into the air.

# Life *Continued...*

Some questions for further consideration could include:

- Why bother having lungs? Couldn't cells just get oxygen straight from the air? (Surface area to volume ratio; only tiny organisms can rely on diffusion; body cells aren't in contact with the air.)
- Why doesn't the amount of carbon dioxide in the air keep going up and up from respiration and combustion? (Balance between respiration and photosynthesis, which removes carbon dioxide from the air.)
- How does oxygen get from the lungs to all the cells in the body? (Red blood cells carry it.)
- Are lungs excretory organs? (Technically, yes, as they excrete waste carbon dioxide and water from the body. Many pupils seem to find this idea amusing!)

A simple way to extend the experiment is to demonstrate that exhaled air is moist (as it contains lots of water made by respiring cells). Simply breathing on a mirror works fine (they may have seen mirrors held to the lips of murder victims in TV dramas to see if they are really dead or not!). They will all have noticed how car windows steam up in winter.

A fun question to set as part of homework is to find out what percentage of the air is made up of carbon dioxide. Most are surprised how low this figure is (0.03% is a reasonable figure, although it varies according to how you measure it).

### Taking the ideas further:

Some may well pick up on the fact that the proportion of carbon dioxide in the air is gradually rising and that this may be adding to the 'greenhouse effect'. This could lead into discussion of the balance between photosynthesis (which removes carbon dioxide) and respiration/combustion (which release carbon dioxide) and the suggestion that human activity may be leading to global warming. Details of the greenhouse effect are not expected until KS4. Simply stating that carbon dioxide helps to 'trap heat' from the sun is fine at KS3.

# Cells

## Looking at cells

This is a classic practical that pupils love. There is something inherently interesting about seeing your own cells, and nothing reinforces the idea that our bodies are made up of cells better than seeing them at first hand.

Pupils need to be shown how to set up and use a microscope correctly before doing this experiment. Learning the correct technique for focusing with high power objectives is particularly important. Turning the focusing knob the wrong way can result in cracked slides and damage to expensive lenses.

**Important:** You should double check that this practical is allowed by your LEA. Many banned it on hygiene grounds when HIV first became an issue, although this has been relaxed by many authorities subsequently as the risks have become better understood.

In any event, care should be taken to ensure that pupils only handle their own slides, and that these are immersed in disinfectant immediately after use. Used lolly sticks should be disposed of immediately and hygienically, ideally by being sealed in polythene bags. If you are in any doubt, use commercially available prepared slides of various kinds of cells instead.

Methylene blue stains the nucleus and cell wall. Pupils can try using water as a comparison. Methylene blue also stains fingers, so avoid skin contact.

Wooden toothpicks with rounded ends make a good alternative if lolly sticks are not available, just make sure pupils use the blunt end!

### Drawing tips:

Epithelial cells are an irregular shape with an obvious nucleus. Dark, circular rings are usually trapped air bubbles. Pupils should be encouraged to make large, simple drawings (in pencil) of just a few cells rather than trying to draw everything they can see. You don't need to be an artist, so long as the drawing is big, clear and looks like what's on the slide. Just about anyone can produce a decent drawing with a little care, and praising their efforts can do wonders to boost the confidence of pupils who may not consider themselves to be any good at drawing.

# Food

## Nutrition file

This activity is fairly self-explanatory, and suitable for pupils in KS3 and KS4. The idea is to encourage pupils to appreciate that different foodstuffs contain different components of a balanced diet, and to reinforce work on the five main food groups.

Nutrition labels are a great source of information. Collecting and studying them helps to build research skills, and there are many ways to adapt the activity to suit your particular programme of study. There are a couple of pitfalls to watch out for:

- Over-enthusiastic pupils snipping holes in packages of cereal, rice, pasta, etc. before the contents has been consumed!
- Confusion over units. Best to stick to SI units for energy (i.e. kJ rather than calories or kilocalories). A good opportunity to practise converting between J, kJ and MJ and comparing like with like, eg standardising on 'kJ/100g'.

### ICT opportunity:

An excellent way to incorporate ICT is to pool together class data from nutrition labels into a simple database program. This can then be interrogated in all sorts of ways (rank foods in order of energy per 100g, list foods containing added sugar, etc.) and used to produce graphs for display. With a little thought, the datafile can be set up to allow pupils to assemble portions of various foods and get the computer to calculate the overall nutritional content for the meal.

### Extension idea:

Pupils could plan the provisions for an expedition. This poses extra constraints and can lead to some creative problem solving. For example, backpackers need a balanced diet made up of foods that are light, compact, and non-perishable. The food also has to be cooked using as little fuel as possible, but still be good to eat. A yacht race crew has the same requirements, plus the need to obtain fresh water somehow (carried on board or made from distilled sea water).

### Cross-curricular:

Food provides a great focus for cross-curricular project work. It might be worth checking with the Technology department, who will be covering similar aspects of food technology and diet, to see if there is scope for working together. As well as planning and preparing meals, pupils could devise packaging materials and marketing strategies for food or drinks that they have created themselves.

There is also scope for conducting surveys about, for example, attitudes towards school dinners or conducting a debate on vegetarianism.

# Puberty

## Problem Page

**Aim:** To encourage discussion of issues to do with puberty and adolescence.

This activity is primarily suitable for KS3 pupils. It would fit in well with either a PSHE or Science topic on puberty. It could also be appropriate in English.

To work successfully, the teacher in charge needs to have established a good rapport with the class based on trust and mutual respect. Not an ideal lesson for a cover or supply teacher!

The 'problems' can be downloaded, printed and photocopied (preferably onto card) to provide sufficient cards for the number of groups in the class. It doesn't matter if more than one group get the same card, as their responses will be different and comparing these can help stimulate discussion.

The material is copyright-free, so you can amend it in any way that better suits your circumstances. Before using the cards, pupils could bring in (or be shown) some examples of teenage magazine problem pages to help break the ice and familiarise them with the genre.

Clearly this activity calls for tactful, sensitive handling. If you are not confident to use it, don't. Take particular care over the way that groups are organised, listen out for any unsuitable or hurtful comments and be prepared to intervene if necessary.

It is important to establish some ground rules:

- All opinions are to be listened to politely and respected.
- Nobody will be forced to contribute or deliberately embarrassed.
- Any views expressed, orally or in writing, will be treated in confidence and not used by the teacher outside of the lesson without permission.

Timing is flexible – use your judgement. It is difficult to predict beforehand how the session will go. Try to allow sufficient time for responses to be read out and discussed, and have a fallback activity ready in case things dry up.

A typical KS3 class will contain pupils at widely different stages of knowledge and personal experience of puberty. Bear this in mind and watch out for anyone being made to feel silly or becoming inappropriately boastful. Generally, girls are more likely to be familiar with teenage magazines than boys and may consider themselves to be more mature. This needn't be a problem and could be a useful area for discussion in itself.

During discussion, aim to strike a balance between providing accurate factual information and allowing space for pupils to express themselves freely. If possible, finish the lesson on an affirming note, praising pupils for their contributions. Provide a way for any pupils who have further questions or concerns to get answers from an appropriate adult outside of lesson time. This could be the school nurse, a form tutor, a year head or another trusted teacher. The important thing is that no pupil should find himself or herself with a problem or question that they can't get help with.

# Variation

## Measuring variation

**Aim:** To investigate variation in physical characteristics.

This activity is fairly self-explanatory. It is suitable for use with KS3 or KS4 pupils in Science or possibly Maths.

As with any biometric data collection (measuring physical features), some sensitivity is called for. Pupils who are reluctant to weigh themselves, for instance, should not be made to do so. The activity sheet provides plenty of alternatives. Be especially mindful of any pupils with unusual physical characteristics or disabilities.

Pupils should be reminded that the data they gather is numerical and anonymous – names need not be recorded at all. Each member of the class could be assigned an arbitrary number or letter to identify them for the lesson, to avoid double-counting or missing anyone out. If pupils go on to try measuring other features, check that their ideas are safe and not threatening or embarrassing!

Be prepared to give some guidance with choice of units and number of decimal places / rounding off. A good approach is to ask each group to draw out a table to record their data in and get them to check it with you before they start.

### **ICT opportunity:**

Pooling together class results on a spreadsheet or database can provide a worthwhile extension. Data can then be used to produce frequency distribution graphs or histograms. Pupils should be encouraged to consider the accuracy and plausibility of their data, and to evaluate whether using ICT helped them to analyse their results any better than they could have done otherwise.

In conclusion, it is worth emphasising that variation between individuals is completely normal, and that variation in the sorts of characteristics they have been measuring is the result of a combination of genetic (i.e. inherited) and environmental influences.