

## Unit 9B Fit and healthy

### About the unit

In this unit pupils learn:

- how the human respiratory, digestive and circulatory systems interact to maintain activity
- about the functions of the skeleton
- about ways in which diet, exercise, smoking and drugs affect health

In scientific enquiry pupils:

- find out how scientists linked diseases to a lack of specific nutrients
- consider how the work of different scientists has contributed to a medical advance
- work collaboratively to collect sufficient valid and reliable data to form conclusions
- evaluate conflicting evidence
- investigate reaction time, considering how factors which cannot be controlled can be taken into account

Teachers should make sure that work on tobacco, alcohol and drugs and eating disorders in this unit is consistent with their school's PSHE programme. Teachers will be aware of the need for sensitivity to the circumstances of individual pupils and their families.

This unit is expected to take approximately 8.5 hours.

### Where the unit fits in

The unit builds on unit 7A 'Cells', unit 7B 'Reproduction', unit 8A 'Food and digestion', unit 8B 'Respiration', unit 8C 'Microbes and disease' and unit 9A 'Inheritance and selection'.

Careful planning of the work in this unit alongside the school's drugs policy and the PSHE programme will be required, particularly when pupils are introduced to the effects of smoking, alcohol and drugs, etc.

This unit provides opportunities to revisit and revise work on nutrition and human respiration and the function of the circulatory system. With some pupils, teachers may wish to concentrate on some of the new topics, extending activities, and with others to spend more time on revision of previous work.

This unit relates to unit 20 'Twentieth-century medicine' in the history scheme of work and to unit 9A(i) 'Selecting materials (food)' on special diets in the design and technology scheme of work.

### Expectations

#### At the end of this unit

##### in terms of scientific enquiry

**most pupils will:** select and make effective use of secondary sources of information about health, indicating how strongly evidence supports or does not support a conclusion; plan how to carry out appropriately an investigation using human subjects

**some pupils will not have made so much progress and will:** select information from secondary sources about health; use data obtained to draw a conclusion; investigate a question using human subjects safely and appropriately

**some pupils will have progressed further and will:** synthesise information about health and identify limitations in the data assembled; explain some methods adopted to carry out an investigation on human subjects safely and appropriately

##### in terms of life processes and living things

**most pupils will:** describe how the body uses the energy in food, representing respiration by a word equation; describe some effects of diet, smoking, alcohol and other drugs and of exercise on some organ systems; explain how different body systems work together in a healthy individual

**some pupils will not have made so much progress and will:** describe some effects of diet, smoking, alcohol and other drugs and of exercise on the body and on a developing fetus

**some pupils will have progressed further and will:** describe how cells in the respiratory system are adapted for their purpose and how they may be damaged by smoking and other forms of air pollution; represent respiration by a symbol equation

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## Prior learning

It is helpful if pupils can:

- describe a balanced diet and know this is required for healthy growth
- name the gases exchanged in the alveoli of the lungs
- know that developing fetuses obtain materials from the mother's blood supply through the placenta
- name some inherited characteristics

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## Health and safety

Risk assessments are required for any hazardous activity. In this unit pupils:

- carry out fitness-related activities
- plan and carry out their own investigation into the effect of caffeine on reaction time

Model risk assessments used by most employers for normal science activities can be found in the publications listed in the *Teacher's guide*. Teachers need to follow these as indicated in the guidance notes for the activities, and consider what modifications are needed for individual classroom situations.

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## Language for learning

Through the activities in this unit pupils will be able to understand, use and spell correctly:

- names of vitamins and minerals
- specialised words, *eg cilia, emphysema*
- words with different meanings in scientific and everyday contexts, *eg addiction, fit*
- words and phrases relating to scientific enquiry, *eg trial*

Through the activities pupils could:

- discuss and evaluate evidence to arrive at a considered viewpoint
- follow a demonstration and make notes which are then used in another task

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## Resources

Resources include:

- secondary sources providing data about effects of smoking, effects of alcohol on reaction time, heart disease
- normal and decaffeinated cola
- leaflets, articles, etc about fitness regimes
- secondary sources providing data about illnesses caused by dietary deficiencies and about sports-related injuries
- information about replacement hip/knee joints
- secondary sources illustrating how joints work
- secondary sources illustrating how energy from food is used
- slides showing smokers' and non-smokers' lungs
- a variety of sources of information about health and disease over the last 100 years


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## Out-of-school learning

Pupils could:

- read publicly available leaflets on smoking, drugs and diet
- find out about the strategies available to people wishing to give up smoking
- talk to people who have managed to give up smoking and those who haven't
- read articles in newspapers and magazines about fitness and exercise regimes, sports injuries and their cure
- read fictional and non-fictional accounts of life in other cultures or of life 50–100 years ago

### What do we mean by fit?

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| <ul style="list-style-type: none"> <li>• to relate fitness to the systems of the human body</li> <li>• that 'fitness' is different for different individuals</li> </ul>                              | <ul style="list-style-type: none"> <li>• Ask pupils what they understand by the term 'fit' and how they might go about finding out if they are fit. Discuss how fitness means different things to different people, relating this back to work in unit 8C 'Microbes and disease'. Ask what a fitness programme might deal with, <i>eg exercise, diet, smoking, alcohol</i>, and establish that these relate to the functioning of the human respiratory, digestive and circulatory systems and skeleton and joints.</li> <li>• Ask pupils to carry out simple activities to measure aspects of fitness, <i>eg running on the spot, or steps, for 30 seconds and monitoring the return of pulse and breathing rates to resting level using datalogging equipment; fat callipers on upper arm; pressing a set of bathroom scales with arms raised to measure muscle strength.</i></li> </ul> | <ul style="list-style-type: none"> <li>• identify aspects of fitness and describe how fitness might differ in different individuals</li> <li>• describe ways in which fitness relates to some of the body systems</li> </ul> | <ul style="list-style-type: none"> <li>• Teachers will be aware of the need to be sensitive to the circumstances of individual pupils and their families, and the need to encourage pupils to be sensitive to differences between them.</li> <li>• Pupils could be asked to provide their own examples of advice on fitness from newspaper/magazine articles, fitness and leisure centres, etc. Some examples that consider the fitness of disabled athletes would be useful, <i>eg information provided by <a href="http://www.kidshealth.org">www.kidshealth.org</a></i></li> </ul> <p> <b>Safety</b> – the needs of pupils with specific medical conditions, and those excused from PE, should be considered when deciding if they should take part. Suitable shoes should be worn, and benches/steps should be held firm. Over-competitiveness should be avoided</p> |
| <ul style="list-style-type: none"> <li>• that the utilisation of energy by the body depends on several body systems</li> <li>• to represent the process of respiration by a word equation</li> </ul> | <ul style="list-style-type: none"> <li>• Use secondary sources, <i>eg video clips, slides, ICT simulations</i>, to remind pupils how energy from food is utilised, <i>eg in leg muscles</i>, and how this depends on the digestive, respiratory and circulatory systems. Ask pupils to make a summary, <i>eg by listing key points or annotating diagram(s) of the processes involved</i>, prompting them, as appropriate, with key words and phrases. Remind pupils of the word equation for respiration.</li> </ul>  | <ul style="list-style-type: none"> <li>• describe the processes by which the energy in food is utilised in muscle</li> <li>• describe the chemical reaction through which energy is utilised</li> </ul>                      | <ul style="list-style-type: none"> <li>• This activity is designed to enable teachers to find out about pupils' knowledge and understanding of human body systems. Teachers will need to bear this in mind in later work.</li> <li>• It may be helpful to use an analogy of a machine, <i>eg a car</i>, to illustrate how all systems need to function well and interact if the machine is to function properly.</li> </ul>   |

### What helps the respiratory system to function?

- that the lungs, diaphragm, rib cage and associated muscles of the rib cage are essential for breathing
- that reducing the chest volume expels air from the lungs
- Review pupils' understanding of what happens when they breathe and help them to construct a concept map of breathing, *eg oxygen, carbon dioxide, asthma, bronchi, lungs, moisture evaporating from the lungs.*
- Ask pupils to feel changes in the chest as they breathe by placing their hands on their ribs and taking a few deep breaths in and out. Ask questions, *eg*
  - What happened to the chest wall when they breathed in?*
  - What happened when they breathed out?*
  - Which required more effort?*
- Ask pupils how breathing can vary, *eg when asleep, blowing out candles, playing the trumpet.* Discuss how they could measure the volume breathed and which factors might affect lung volume, *eg swimming, playing a brass instrument, body size, asthma.*
- Use secondary sources, *eg models, video clips, software simulations*, to illustrate how air is drawn into and expelled from the lungs, and help pupils to label simple diagrams.
- explain that increasing the chest's capacity draws air in, and that reducing the volume of the chest pushes air out
- A pair of bellows or a bell-jar model can be used to illustrate air drawn in and pushed out, but it is not necessary to discuss pressure changes at this stage.
- There is an opportunity to look at the technology of life-support systems used when people are unable to breathe for themselves or when undergoing an operation.

### What is the effect of smoking on the lungs and other body systems?

- to make notes during a demonstration and to use these in another task
- that smoking is implicated in a range of illnesses
- that carbon particles, carbon monoxide, heat, nicotine and tar cause specific damage
- that ciliated epithelial cells in the airways are specialised for moving fluid
- how evidence about the effects of smoking has gradually been collected
- Using a variety of resources, *eg video clips, slides, illustrations, demonstrations*, discuss with pupils the specific effects of smoke components, *eg carbon monoxide, nicotine, tar*, on the organs of the respiratory system, on cardiovascular function and on developing babies, and of heat effects on ciliated epithelial cells. Remind pupils how to make notes during a demonstration and use these to annotate a diagram.
- Challenge pupils to give reasons why people find it difficult to give up smoking.
- Provide pupils with secondary data, *eg death rate from specific illnesses correlated with smoking habits, incidence of chest conditions in smoking and non-smoking households, number of working days lost through smoking-related illnesses, smoking habit and likelihood of miscarriage or stillbirth.* Give prompts, *eg*
  - Why was smoking acceptable 30 years ago, but is less so now?*
  - What is the health warning?*
  - What is passive smoking?*
  - Why can't people under 16 buy cigarettes?*
- Ask pupils to use what they have found out to produce either a leaflet for younger pupils or a leaflet for adults explaining why smoking is harmful. Help pupils select information to be emphasised in each leaflet.
- listen actively, demonstrating understanding and use of scientific terminology
- describe the effects of cigarette smoke on tissues of the lungs and gaseous exchange
- explain that damage to air sacs reduces surface area for gas exchange
- explain the harmful effects of smoke components, *eg nicotine is addictive and narrows blood vessels, affecting blood pressure while accelerating the heart; tar causes lung cancer; carbon monoxide replaces oxygen in the blood*
- describe how ideas about smoking have changed as evidence has accumulated
- This builds on unit 8B 'Respiration' and provides an opportunity to revisit lung function, cell structure and the transport of material in the blood.
- Pupils are likely to have learnt about some of the effects of substances, such as tobacco, that change our physical or mental state in unit 5A 'Keeping healthy' in the key stage 2 scheme of work. They will also have considered the effect of smoking on the developing fetus in unit 7B 'Reproduction'.
- Extension: pupils could find out how cells in the respiratory tract are adapted for their functions.
- As an alternative, pupils could use a 'smoking machine' to collect tar.



**Safety** – 'smoking machines' should be used in a fume cupboard. Staff should wear gloves when cleaning the apparatus to protect from carcinogenic tar

Pupils should learn:

### Why is diet important?


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| <ul style="list-style-type: none"> <li>• that a balanced diet requires nutrients, including vitamins, in the correct quantities</li> <li>• that deficiencies in specific nutrients lead to specific diseases</li> <li>• how evidence about specific nutrient deficiencies is used</li> </ul> | <ul style="list-style-type: none"> <li>• Remind pupils of work they did in unit 7A 'Cells' on the way in which cells are arranged into tissues, and ask them to list a variety of body tissues. Point out that the food we eat has to provide the components for growth and repair of all tissues as well as energy for activity.</li> <li>• Use quick oral questions to review pupils' knowledge of the components of a balanced diet (covered in unit 8A 'Food and digestion'). Discuss the effect of the shortage of a particular dietary component and some of the overall consequences, <i>eg children succumb more easily to waterborne infections and measles, developmental delay, effects of low-energy foods in the diet, lack of calcium in bones and teeth.</i></li> <li>• Provide pupils with secondary sources, including ICT, to identify the consequences of specific nutrient deficiencies. Consider investigations into the effects of specific nutrient deficiencies, <i>eg the work of Magendie and Gowland Hopkins, the role of folic acid in development, the recognition of kwashiorkor (protein deficiency).</i></li> <li>• Ask pupils about other ways in which a diet may be unhealthy and talk about ways in which overeating can affect health and lifestyle. Help pupils make a summary of the nutrients needed for a healthy diet and some of the consequences of an inadequate or inappropriate diet.</li> </ul> | <ul style="list-style-type: none"> <li>• describe the effects of deficiencies in diet, <i>eg of calcium, iron, protein</i></li> <li>• describe some effects of an unhealthy diet, <i>eg obesity, rickets, scurvy</i></li> <li>• describe evidence linking nutrition and health, and how evidence has been used</li> </ul> | <ul style="list-style-type: none"> <li>• Teachers will be aware of the need for sensitivity when discussing diet. Anorexia is a multi-faceted disorder with no agreed specific cause or therapy or treatment. Teachers need to ensure that their work is consistent with the school's PSHE programme.</li> <li>• The World Health Organization (WHO) produces maps drawn according to energy intake of population and other factors.</li> <li>• Extension: pupils could be asked to find out about foods rich in trace elements, <i>eg zinc</i>, and why such elements are needed in the diet, <i>eg using the British Nutrition Foundation's website, <a href="http://www.nutrition.org.uk">www.nutrition.org.uk</a></i></li> </ul> |
| <ul style="list-style-type: none"> <li>• to make notes during a demonstration and to use them in another task</li> <li>• to estimate how precise measurements need to be</li> <li>• to identify trends in quantitative data</li> </ul>   | <ul style="list-style-type: none"> <li>• Demonstrate how to measure vitamin C content using DCPIP, encouraging pupils to make notes.</li> <li>• Ask them to compare the vitamin C content of a selection of fruit juices and squash, <i>eg fresh fruit, carton juice, carton opened for several days, squash</i>, using DCPIP, and to write a report on their findings.</li> </ul>  | <ul style="list-style-type: none"> <li>• learn how to make very precise measurements</li> <li>• recognise that vitamin C content declines with storage and processing</li> </ul>  | <ul style="list-style-type: none"> <li>• Extension: this could be extended into a full investigation of the effects of storage on the vitamin content of juice.</li> </ul>   |

### How does alcohol affect the body?

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| <ul style="list-style-type: none"> <li>• that alcohol alters behaviour</li> <li>• that excessive use of alcohol can damage the liver and developing fetus</li> <li>• how to locate information within a text and to identify key points</li> </ul> | <ul style="list-style-type: none"> <li>• Explore pupils' ideas about alcohol and its effects through written answers to a quick quiz.</li> <li>• Prompt the pupils to explain what is meant by a driver being 'over the limit'. Discuss with pupils the reasons for control and advice on alcohol consumption, <i>eg a limit for driving, recommended weekly consumption, minimum age of 18 for purchase of alcohol</i>. Help pupils to use secondary sources, <i>eg testing results, ICT simulations, video clips</i>, to explore the effects on reaction time and driving skills.</li> <li>• Provide pupils with secondary sources to help them annotate a diagram showing the specific effects of alcohol on body organs and the developing fetus.</li> <li>• Pupils go back to the quiz they completed earlier to amend their answers.</li> </ul> | <ul style="list-style-type: none"> <li>• describe the effects of alcohol on behaviour, <i>eg reaction time, reduction of inhibition</i></li> <li>• describe the effects of alcohol on the liver, diet and developing fetus</li> <li>• show in their annotations that they have identified the key points</li> </ul> | <ul style="list-style-type: none"> <li>• Teachers will be aware of the need to be sensitive to the circumstances of individual pupils and their families.</li> <li>• There are several alcohol education packages available containing resource material, such as effects on reaction time, information about units and alcohol content of drinks. Some include quizzes.</li> </ul> |
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Pupils should learn:

### What else can we do to maintain fitness?

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| <ul style="list-style-type: none"> <li>• how diet, smoking, alcohol and exercise can affect fitness and health</li> </ul>   | <ul style="list-style-type: none"> <li>• Remind pupils of the comparison of the human body to a properly working machine and ask them what else must be kept in good order if they are to remain fit. Establish that a healthy heart is essential to circulate blood. Ask pupils to use secondary sources of information to find out how diet, smoking, alcohol and exercise can affect the heart and about circulatory problems, <i>eg arteriosclerosis, high blood pressure</i>, which can be made worse by an unhealthy lifestyle. Help pupils to make a list of lifestyle changes that could reduce the chance of heart problems.</li> </ul>   | <ul style="list-style-type: none"> <li>• describe how diet and lack of exercise can worsen heart and circulation conditions</li> <li>• describe diets and forms of exercise that can lead to improvements in heart and circulation conditions</li> </ul>                     | <ul style="list-style-type: none"> <li>• Teachers will be aware of the need to be sensitive to the circumstances of individual pupils and their families.</li> <li>• Extension: pupils could dissect a heart from a butcher's shop to investigate the position and distribution of coronary arteries.</li> </ul> <p> <b>Safety</b> – hands should be washed after handling animal material and benches wiped with disinfectant</p> |
| <ul style="list-style-type: none"> <li>• how simple joints function</li> <li>• that inappropriate exercise or too much exercise can be harmful to muscles and weak or damaged joints</li> <li>• that scientists work together to develop and apply ideas</li> </ul> | <ul style="list-style-type: none"> <li>• Ask pupils about sports-related injuries and how some of these occur, and ask them to suggest how some might have been avoided. Discuss with pupils what happens if they participate in an unfamiliar amount or form of exercise. Show pupils secondary sources, <i>eg photographs, diagrams, video clips, software simulations</i>, that show the structure and functioning of joints and muscle systems and discuss with them some of the problems that can occur. Ask pupils how these problems may be dealt with, if possible showing a replacement joint, and what kinds of exercise might reduce damage.</li> <li>• Provide pupils with a case study, <i>eg of a treatment for a sports injury, a hip replacement</i>, and ask them to identify the different scientists who will have been involved, <i>eg in developing new materials, new techniques, in trialling, in carrying out treatment</i>, and to present their findings, <i>eg as a flow chart or diagram</i>.</li> </ul> | <ul style="list-style-type: none"> <li>• describe how a joint, <i>eg hip, knee</i>, functions</li> <li>• identify how injury or wear and tear can impair the functioning of a joint</li> <li>• describe the role of different scientists in a medical development</li> </ul> | <ul style="list-style-type: none"> <li>• Pupils can use newspaper/magazine articles and the internet as sources of information about sports injuries. A physiotherapist could be invited to talk about accident and sports injuries.</li> <li>• It is not necessary to go into detail about the different types of joints.</li> <li>• Work on how bones, muscles and joints operate as levers is included in unit 9L 'Pressure and moments'.</li> </ul>   |

### What effects do drugs have?

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| <ul style="list-style-type: none"> <li>• that a drug is any substance that changes the way the body or mind works</li> </ul> | <ul style="list-style-type: none"> <li>• Explore pupils' perceptions of drugs by providing a list of well-known substances, <i>eg paracetamol, cannabis, tobacco, penicillin, ecstasy, calamine, branded antiseptic</i>. Ask the pupils to divide the list into drugs and other substances, then categorise the drugs into different groups. Ask the pupils to explain the criteria or reasons for their categories.</li> <li>• Explain what a drug is and the distinction between different categories of drug.</li> <li>• Discuss with pupils their perceptions of the dangers of drugs, <i>eg widely used, side effects, addictive, likely to cause death</i>. Use secondary sources to investigate the accuracy of their perceptions of recreational drugs. Help pupils present their findings as a 'fundamental facts' chart for use by year 9 pupils in other classes or for later year 9 groups.</li> </ul> | <ul style="list-style-type: none"> <li>• categorise drugs into over-the-counter and prescription drugs, <i>eg penicillin, paracetamol</i>, recreational drugs, <i>eg caffeine, alcohol, nicotine</i>, and illegal (unless prescribed) drugs, <i>eg amphetamines, cannabis</i></li> <li>• recognise that there is some overlap between different categories of drug</li> <li>• recognise that prescription drugs can have side effects and are potentially dangerous</li> <li>• explain addiction and identify addictive drugs</li> </ul> | <ul style="list-style-type: none"> <li>• Teachers will be aware of the need to be sensitive to the circumstances of individual pupils and their families.</li> <li>• Liaise with PSHE teachers to ensure the same materials are not being used.</li> <li>• Many outside agencies, <i>eg drugs education units</i>, can visit schools to provide discussion material and factual information.</li> </ul> |
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**Learning objectives**

Pupils should learn:

- that drugs alter the way the body works physically or mentally
- to recognise the need for informed consent in experiments involving people
- how to deal with factors that cannot be controlled
- how to work collaboratively to obtain sufficient valid data to draw conclusions

**Possible teaching activities**

- Using suitable stimulus material, establish that caffeine is consumed widely, *eg in tea, cola, coffee*, and that it is considered to be a stimulant which makes people more alert. Ask pupils to suggest how to investigate whether this is so.
- Demonstrate a technique for measuring reaction time, *eg catching a dropped ruler, using datalogging equipment*. Discuss with pupils how they could deal with caffeine sensitivity in certain individuals, how long caffeine takes to work, the placebo effect and the use of double-blind trials and the problem of sample size.
- Ask pupils to drink measures of caffeinated or decaffeinated cola, record the effect on reaction time and present a report on their findings.

**Learning outcomes**

Pupils:

- identify caffeine as a stimulant
- recognise that drugs can change the mental activity of a body
- recognise that there are ethical issues involved in scientific research, *eg not subjecting people to harmful experiences*
- recognise that researchers must guard against influencing results, *eg by not knowing which subjects have the drug*
- consider evidence and reasons and reach conclusions when presenting ideas

**Points to note**

- This activity would be enhanced by a visit from a scientist involved in the development and trialling of a new drug. (See unit 9H 'Using chemistry'.)
- Coffee would be cheaper to use, but most pupils prefer drinking cola to coffee. This work will also require a discussion of likely inaccuracies and uncontrollable variables, as well as different pupils' immunity or lack of measurable response to the caffeine.
- Pupils unable or unprepared to take part could plan and suggest results, followed by taking part as 'referees' or checking results, etc.
- Extension: pupils could be asked to find out how double-blind trials are used in the trialling of new drugs.



**Safety** – any pupil who claims caffeine sensitivity must not participate. Pupils' plans must be checked for health and safety before practical work begins. If pupils drink cola in the laboratory, strict hygiene must be observed, *eg disposable cups*. Do not use laboratory measuring cylinders

### Are we healthier than our great-grandparents were?

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| <ul style="list-style-type: none"> <li>• to ask different sorts of questions to extend thinking and refine ideas</li> <li>• to identify what information is needed, then use different sources</li> <li>• to evaluate conflicting evidence to arrive at a considered viewpoint</li> </ul> | <ul style="list-style-type: none"> <li>• Ask pupils to consider the question and to suggest how it could be turned into further questions that could be investigated and the sources of information that might be used. Agree, with the class, questions that individuals or groups could investigate and the sources of data each might use. Discuss, <i>eg as a debate</i>, the evidence for and against the idea that we are healthier than our great-grandparents were, helping pupils to identify the key points and to evaluate the strength of conflicting evidence.</li> </ul> | <ul style="list-style-type: none"> <li>• produce supplementary questions relating to different aspects of an original question</li> <li>• assemble evidence to answer the question</li> <li>• decide whether the evidence supports or does not support the idea, and give reasons for their decision</li> </ul> | <ul style="list-style-type: none"> <li>• In unit 8C 'Microbes and disease' pupils considered infectious diseases, and in this unit they have considered influences of lifestyle on health. They may need to be reminded that there are many other types of illness and that the cause of many of these is not yet known.</li> </ul> |
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**Reviewing work**

- to relate fitness and health to scientific knowledge and understanding
- Help pupils to summarise the key points identified in earlier activities and to turn these into a series of recommendations for remaining fit and healthy. Ask pupils to provide the scientific knowledge on which each recommendation is based.
- identify factors that can affect fitness and health, relating these to scientific knowledge and understanding