Unit 8C Microbes and disease

About the unit

In this unit pupils:
- learn that micro-organisms share the characteristics of other living things
- find out about growing micro-organisms to make products, and about the role of micro-organisms in infectious diseases
- learn about the body's defence systems and how immunisation can protect against microbial infections

In scientific enquiry pupils:
- consider how ideas about the transmission of infectious diseases have changed and are continuing to develop
- learn how scientists work together to investigate and reduce the transmission of infectious disease
- learn how to grow micro-organisms healthily and safely
- consider the number of measurements needed for reliable data
- identify and control relevant variables
- investigate the activity of yeast, evaluating proposed approaches

Some of this unit may be undertaken in relation to the school's PSHE programme. Teachers will be aware of the need for sensitivity to pupils and their families who may have or have had, a particular illness or may have reduced resistance to infection.

This unit is expected to take approximately 8 hours.

Where the unit fits in

This unit draws on ideas developed in the key stage 2 programme of study. It builds on unit 6B 'Micro-organisms' in the key stage 2 scheme of work and on unit 8B 'Respiration'.

In unit 9B 'Fit and healthy', pupils have further opportunities to consider the transmission and incidence of infectious diseases.

There are opportunities to link with citizenship and PSHE in this unit in dealing with medical advances, the development of drugs and food safety.

This unit lays the foundation for work in key stage 4 on the body's defences against infection and the uses of micro-organisms in biotechnology.

This unit also relates to unit 9E(i) 'Ensuring quality production (food)' in the design and technology scheme of work, and unit 20 'Twentieth-century medicine' and unit 21 'Scientific discoveries' in the history scheme of work.

Expectations

At the end of this unit

in terms of scientific enquiry

most pupils will: describe how understanding of how some infectious diseases are transmitted has developed as knowledge about micro-organisms has increased; point out trends and patterns in first-hand and secondary data, draw conclusions from these and relate them to scientific knowledge and understanding

some pupils will not have made so much progress and will: describe how some infectious diseases are transmitted, point out some patterns in data and use these to draw conclusions

some pupils will have progressed further and will: describe how scientists' interpretation of evidence has led to new ideas about the transmission of disease and to new drugs

in terms of life processes and living things

most pupils will: classify bacteria, fungi and viruses as micro-organisms, name some of the diseases they can cause and describe how they can be transmitted; describe some of the defences the body has against disease and describe immunisation as a way of improving immunity; recognise that antibiotics are effective against bacteria but not against viruses

some pupils will not have made so much progress and will: name some infectious diseases and describe how they can be transmitted; describe immunisation as a way of protecting against infectious disease

some pupils will have progressed further and will: explain how immunisation can improve immunity and describe how antibiotics may be effective across a wide spectrum or against specific bacteria

Prior learning

It is helpful if pupils:
- know that micro-organisms are living organisms
- have explored the characteristics of micro-organisms and know that they feed, grow and reproduce like other organisms
- know that organisms respire aerobically and produce carbon dioxide during the process
- can name some diseases caused by micro-organisms

Health and safety

Risk assessments are required for any hazardous activity. In this unit pupils:
- plan and carry out an investigation of yeast
- grow lactobacilli and produce yoghurt
- observe the growth of bacteria and the effect of antiseptic and antibiotics

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.

Language for learning

Through the activities in this unit pupils will be able to understand, use and spell correctly:
- words and phrases relating to micro-organisms and diseases, *eg bacteria, viruses, fungi, measles, chickenpox, infection, pathogen, infectious disease*
- words with precise meanings in scientific contexts, *eg immunity, virus, food poisoning*
- words with similar but distinct meanings, *eg vaccination, inoculation and immunisation, antibiotic, anti-microbial*
- words and phrases relating to scientific enquiry, *eg sufficient data, epidemic, reliable data*

Through the activities pupils could:
- listen for a specific purpose, note the main points and consider their relevance
- organise facts/ideas/information in an appropriate sequence

Resources

Resources include:
- secondary sources, *eg simulation software, CD-ROMs*, illustrating the growth of micro-organisms
- datalogging equipment and software to monitor pH
- secondary sources to explore routine immunisation, ideas about side effects, immunisation in other countries
- information on routine immunisation programmes for young children
- resources to cultivate selected strains of micro-organisms
- autoclave or alternative equipment for preparation of materials and safe disposal of microbe-contaminated waste
- stock cultures of suitable micro-organisms
- secondary sources, *eg photographs, advertisements, medicine packaging*, relating to the nature and uses of micro-organisms
- case studies of tracking and dealing with an outbreak of an infectious disease, *eg Ebola, cholera, E. coli*
- data about the incidence of bacterial disease over the last 60 years
- secondary data showing the incidence over the last century of a major childhood disease for which there is now immunisation

Out-of-school learning

Pupils could:
- read leaflets on immunisation available in doctors' surgeries
- follow news stories about outbreaks of diseases such as typhoid, dysentery or cholera after natural disasters
- visit a dairy, creamery, cheese factory, brewery
- read fiction based on epidemics, *eg Siege of Krishnapur, Story of San Michele*
- find out about changes in life expectancy after childbirth since 1900

1	Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
	What are micro-organisms and how do we grow them?			
	• that there are different types of micro-organism • that many micro-organisms are useful, *eg fungi are a source of antibiotics and are used in making food products*	• Use oral questions to establish what pupils know about micro-organisms. • Provide pupils with stimulus material to explore the range of micro-organisms and their uses or occurrence, *eg bread, yoghurt, wine as useful products of micro-organisms, mushrooms and other fungi, large-scale photomicrographs of bacteria and viruses, advertisements for materials which kill household germs, an empty antibiotic bottle*. Provide them with additional secondary sources, *eg video clips, simulation software providing further information about micro-organisms*. Discuss pupils' observations with them and help them construct a table comparing the three kinds of micro-organism.	• identify three types of micro-organism, *eg bacteria, viruses, fungi* • describe the features of each of these three types of micro-organism in terms of, *eg relative size, shape, structure*	• Pupils learn in key stage 2 that there are micro-organisms that cause rotting and disease, and that micro-organisms are used to make foods. However, they may not have used terms such as, 'bacteria', 'virus' or 'fungi'. ⚠ **Safety** – pupils should not be allowed to eat food samples. All cultures should be sealed. Mouldy food should be sealed in plastic bags, containers or Petri dishes to ensure spores are not released

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Learning objectives	Possible teaching activities	Learning outcomes	Points to note
Pupils should learn: • to share ideas and information, carry out the task and then review ideas • to decide what to measure • how to control variables • about the number of measurements needed for data in which they have confidence • that yeast respires like other organisms • to collaborate with other investigative groups to gather reliable data and draw valid conclusions	• Ask pupils what they know about yeast from advertisements they may have seen, *eg yeast respiration causing bread dough to rise*. Discuss with them how they could investigate how increasing the quantity of sugar affects the quantity of carbon dioxide released, *eg by placing a yeast/flour/glucose dough in a measuring cylinder in a warm environment, or by collecting bubbles from a yeast/glucose suspension*. • Help pupils to plan an investigation so that together they obtain sufficient valid and reliable data.	Pupils: • evaluate methods proposed and agree on a common approach • identify variables they need to control • work out how many measurements will be obtained and indicate whether they will have confidence in their results • explain that carbon dioxide is produced during aerobic respiration • collect and store reliable and valid data using the same methodology • identify a trend in the data, *eg the more sugar is added, the greater the volume* • relate results to scientific knowledge and understanding, *eg increase in volume is due to carbon dioxide produced in respiration*	• Pupils may have made bread with or without yeast in key stage 2, and tried keeping yeast and sugar in a warm and in a cold place and testing the gas produced. • The effect of sugar on yeast activity can be observed in a limited period if the yeast is fully active before starting, and the solutions are pre-warmed and quantities of materials, *eg flour, glucose,* are dispensed in advance. Groups of pupils will need to collaborate to obtain a sufficiently wide range of values, including repeat measurements, to draw conclusions. • This relates to work on respiration in unit 8B 'Respiration'. ⚠ **Safety** – school-based training in aseptic techniques for staff may be necessary. All work with micro-organisms should be carried out only after appropriate risk assessments have been consulted – pupils' plans must be checked for health and safety before practical work begins. Ensure that plans do not involve a totally sealed system

3	Learning objectives	Possible teaching activities	Learning outcomes	Points to note
	Pupils should learn:		Pupils:	
	• that bacteria can be grown • that manufacturing processes use micro-organisms to make products • to recognise hazards when working with living materials and to take action to avoid them	• Establish through questioning the outcomes of the yeast investigation, emphasising that carbon dioxide is produced as yeast respires aerobically and grows. Discuss with pupils ways of growing bacteria, using video clips and illustrations to demonstrate growing bacteria on agar plates, *eg in a hospital laboratory*. • Demonstrate how to inoculate a nutrient agar plate, using appropriate aseptic techniques when handling micro-organisms, and help pupils to do this themselves. • Provide pupils with reference material to find out about growing bacteria or fungi to make a product, *eg yoghurt, cheese, Quorn (mycoprotein)*.	• use a procedure to grow micro-organisms • describe a process which involves growing micro-organisms to make a product • recognise hazards when working with living materials and produce information about working safely	• It takes about 24 hours to grow lactobacilli and make a pot of yoghurt, but yoghurt can be cultured in test tubes over a few hours, and changes monitored. Milk thickening, due to protein breakdown and coagulation, can be measured by timing the passage of a fixed volume through a pipette or tap funnel using refrigerated samples. • A visit to a microbiology laboratory, bakery or creamery or a visit from a microbiologist or food scientist would enhance this unit. • Alternative: pupils could make yoghurt using, *eg different types of milk*, and monitor its progress, *eg by recording change in pH (using datalogging equipment) or changes in viscosity*. ⚠ **Safety** – yoghurt made for consumption should not be made in a science lab but in a food technology area
	Can micro-organisms be harmful?			
	• that some micro-organisms can cause disease • that micro-organisms enter the body by a range of mechanisms	• Ask pupils how colds pass from person to person in a class. Use their answers to explain the term 'infectious' and introduce them to viruses as a form of pathogen. • Discuss other infectious diseases and how they are transmitted. Provide pupils with reference sources with which to construct a table of methods of transmission, with examples of diseases and causative agents. • Help pupils to generate a list of ways to avoid infections and then use their ideas to write a leaflet for travellers to a long-haul destination on how to avoid infection by local diseases, *eg water-borne intestinal infections, malaria*.	• recognise that micro-organisms can cause infections, *eg food poisoning, TB, colds, tetanus, malaria, meningitis, athlete's foot* • describe a range of mechanisms by which micro-organisms enter the body, *eg food- and water-borne, droplet/air-borne, vectors, blood-borne passage across the placenta and via breastfeeding* • produce a leaflet giving advice on avoiding infection	• Pupils may have had experiences of having immunisations for trips abroad, which can be drawn on. This should be handled sensitively for pupils whose parents do not agree with immunising children. • Pupils may raise the issue of AIDS during this work. The school sex education, PSHE policy and guidance should be consulted. • Extension: pupils could be asked to find out more about some current public health issues, *eg the increase in tuberculosis, the increased demand for clean water in a UK city, 'blue flag beaches' and the factors affecting the safety of seawater*.

4	Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
	• how a theory can be used to predict behaviour which can be tested by collecting evidence • to listen for a specific purpose, note the main points and consider their relevance • how scientists today tackle the spread of infectious disease	• Ask pupils to find out about an example of people preventing the spread of disease when the role of micro-organisms was not known, *eg the residents of Eyam in Derbyshire restricting the spread of plague, the work of Dr John Snow identifying wells as the source of cholera infections, the work of Finlay on yellow fever*. • Invite groups of pupils to explain what was done and ask others to evaluate how effective approaches would have been in the light of knowledge about micro-organisms. • Establish differences between some of the stories, *eg John Snow's actions were based on evidence about the distribution of cases of cholera, while the actions of others were not based on observed data*. Provide pupils with information about a modern outbreak of a disease, *eg Ebola, cholera, E. coli,* and ask pupils to identify the range of people involved in containing the spread of infection. Help them to present findings, *eg as a poster, flow chart*.	• present information about a method of avoiding infection • relate the methods to knowledge about micro-organisms and evaluate their effects • describe the contributions of different scientists in dealing with an outbreak of disease	• Extension: pupils could be asked to find out about the work of Finlay on yellow fever and how his theories were only accepted once it was known that mosquitoes are carriers of malaria.
	Checking progress			
	• to recall key points, terms and concepts	• Provide pupils with a range of short questions, testing recall of the main types of micro-organism and their uses, the diseases they cause and how infections are transmitted from person to person. Extend for some pupils by asking questions about the ways in which understanding of infectious diseases has depended on our understanding of micro-organisms.	• show by their responses that the main points have been recalled	• Teachers may wish to point out that our understanding of the transmission of infectious diseases is by no means complete, *eg the transmission of BSE*.
	How can we protect ourselves against infectious diseases?			
	• that the body has natural barriers to infection • that the production of antibodies and specialised cells in the blood are part of the defence systems of the body • to listen for a specific purpose, note the main points and consider their relevance	• Explore pupils' ideas of why people are seldom ill despite surroundings rich in potentially harmful micro-organisms by asking them to complete a concept map using a variety of terms, *eg bacteria, virus, hygiene, immunity, vaccination, skin*. • Use pupils' ideas to explain natural barriers to infection, and help pupils to annotate a diagram of the body with natural defence mechanisms. Ask pupils why young children are sometimes less resistant to infections than older children and why breastfeeding can help. • Use video clips, ICT, slides or illustrations to show the action of white blood cells engulfing micro-organisms. Remind pupils about listening for a specific purpose and thinking about the relevance of the points made. Explain that other white blood cells make matching antibodies that identify and hinder specific microbial activity. Use the presence of antibodies in, *eg blood*, to link with the previous activity. Point out that all kinds of micro-organisms can cause disease and that each type of micro-organism needs a different set of antibody-making cells. Ask pupils to write a short passage about how blood cells defend against disease.	• identify natural barriers against infection, *eg dry skin, lysozyme, etc in tears and sweat* • recognise that each type of micro-organism provokes a different set of antibodies • describe how white blood cells defend the body against disease, *eg engulfing micro-organisms, making antibodies* • describe antibody action, *eg marking infecting micro-organisms, entangling micro-organisms* • explain how blood cells defend against disease	• It is not necessary for pupils to learn terms such as 'lymphocyte' or 'phagocyte cell' at this stage. Further work on blood is included in key stage 4. • Pupils sometimes find it hard to distinguish between infectious illnesses and other forms of illness, *eg dietary*. • Teachers will be aware of the need for sensitivity to the circumstances of pupils and their families who may have reduced resistance to infection.

5	Learning objectives Pupils should learn:	Possible teaching activities	Learning outcomes Pupils:	Points to note
	• that not all diseases caused by micro-organisms can easily be treated by drugs • that some medicines contain antibiotics which kill bacteria or prevent their growth • that scientific advances may depend on creative thought and interpretation of evidence	• Using stimulus material such as video clips, discuss with pupils how infections are treated. Identify prevention of transmission and the action of drugs to kill or suppress micro-organisms, or to relieve symptoms. • Remind pupils of how to work safely with micro-organisms and help them to investigate the effect of common household anti-microbial compounds, *eg toothpaste, anti-perspirant, antiseptics, disinfectants, sterilising solutions*, on the growth of bacteria on a nutrient agar plate. Establish that these are not antibiotics but contain agents that can kill bacteria. • Ask pupils about medicines they cannot buy from the chemist but have to obtain on prescription, and ask them why this is so. Use their answers to explain that antibiotics kill particular bacteria and are not effective against all types of bacteria, *eg neomycin sulfate against the bacteria causing middle-ear infection*. • Challenge pupils to explain why: – *people are not prescribed antibiotics when they have a cold or chickenpox* – *some bacteria are resistant to antibiotics* – *people are always told to complete the course of an antibiotic* – *many doctors wish to limit the prescription of antibiotics* • Ask pupils to find out about the initial observation of antibiotic activity by Fleming and the further development by Florey and Chain. Provide them with data about the incidence of diseases that are treatable by antibiotics over the last century and help them to explain trends and patterns.	• show that they can work with micro-organisms safely • describe the effect of household anti-microbial substances on bacterial growth • state that antibiotics are effective against bacteria but ineffective against viral infections • show in their writing that scientific advance may come from creative thought and interpretation of evidence	• Bacteria grown on a slope of nutrient agar containing disinfectant can be used to show the effects of increasing concentration of antiseptic – refer to National Council for Biotechnology Education (NCBE) publications or the Microbiology In Schools Advisory Committee (MISAC). • Extension: pupils could observe the effect of antibiotics directly by adding discs of penicillin or streptomycin to agar plates spread with a variety of bacteria, which will show different sensitivities to the antibiotic used. • Extension: pupils could also be asked to find out about antiviral drugs that are being developed. ⚠ **Safety** – school-based training in aseptic techniques may be necessary. Employer's risk assessments relating to work with culture plates should be followed
	• that immunisation helps to protect against some diseases • that antibodies can pass through the placenta to the fetus and through breast milk to a baby • that vaccines contain material which stimulates body defences	• Ask pupils about which immunisations they have had, *eg polio, DPT (diphtheria/ whooping cough/tetanus), MMR (measles/mumps/rubella), HIB (Haemophilus influenzae B), Heaf tests and TB (tuberculosis),* and why they had them. • Explain what is in a vaccine. Show, by using charts, video clips and simulation software, what happens to antibody levels in the blood as the programme of immunisation proceeds. Challenge pupils to predict what happens in the blood when someone re-encounters the micro-organisms against which they have been immunised. Ask pupils to annotate a graph of antibody changes in the blood after, *eg DPT,* immunisations. Explain that antibodies pass to babies via breast milk and play an important role in protecting newborn babies from disease.	• explain 'immune' as meaning resistant to disease and that immunisation is a way of raising immunity • recall that vaccines contain microbial material, *eg weakened strains, dead micro-organisms, extracts of micro-organisms,* that cannot cause infections • explain that antibodies pass to a baby across the placenta and via breast milk • explain that immunisation protects the body against some diseases because antibodies are made more quickly in response to infection	• It is useful to have a box of information snippets for research, *eg measles immunisation required for entry to US schools, World Health Organization programmes, newspaper clippings about vaccine scares, comparative data on the incidence of measles and ensuing complications in developed and developing countries*.

6	Learning objectives	Possible teaching activities	Learning outcomes	Points to note
	Pupils should learn:		Pupils:	
	• to identify patterns in data from secondary sources and to try to explain them • to organise facts/ideas/ information in an appropriate sequence	• Provide pupils with secondary data on the incidence of a major childhood disease, *eg diphtheria from 1910 to 1955 in a city location*. Ask them to relate patterns to the introduction of immunisation and the start of a free health service. • Ask pupils to find out about programmes of routine immunisations using reference materials, ICT and the internet. Use the information to write a magazine article about the advantages and disadvantages of routine immunisations.	• describe how the incidence of, *eg diphtheria*, varied over the period and relate changes to social changes, *eg the introduction of immunisation* • present a point of view in writing, using statistical evidence and linking points persuasively	• Statistics on disease incidence are available in government reports such as those of the chief medical officer, available from HMSO bookshops. • Some teachers may want to go further and discuss why some immunisations need boosters every few years, *eg against tetanus*, while others, *eg against cholera*, are not very effective. The relationship between the incidence of infectious disease and other factors, *eg diet,* is explored further in unit 9B 'Fit and healthy'.
	Reviewing work			
	• to collate ideas about micro-organisms, diseases and defences against disease • to identify key points about micro-organisms and their relationship to disease	• Ask pupils to produce a concept map of micro-organisms and diseases using the terms in this unit. Using their concept maps they can generate a list of questions to ask each other about micro-organisms. • Ask pupils to go through the work they have done in this unit and pick out five or six key points, and then in groups agree ten amongst themselves. Compare the lists of different groups and agree a summary of key points with the class, in which closely related points are grouped together.	• demonstrate, by their responses, understanding and recall of key points • identify, summarise and group key points	