KEY STAGE 4 - LESSON 1

Micro-organisms: Introduction to Microbes

Students are introduced to the exciting world of microbes. In this lesson they will learn about bacteria, viruses and fungi, their different shapes and the fact that they are found everywhere.

Curriculum Links

Science
- Scientific thinking
- Analysis and evaluation
- Experimental skills and strategies

Biology
- Cells
- Development of medicines
- Health and disease

PSHE/RSHE
- Health and prevention

English
- Reading
- Writing

Art & design
- Graphic communication

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Key Words

Bacteria, Cell, Fungi, Microbe, Microscope, Pathogen, Virus

Learning Outcomes

All students will:

- Understand that useful bacteria are found in our body.
- Understand that microbes come in different sizes.
- Understand the key differences between the three main types of microbe.

Most students will:

- Understand using a variety of scientific concepts and models, how to develop scientific explanations.

Resources Required

Introduction

Per student

- [ ] Copy of SH1

Main Activity: Microbe Mayhem

Per group

- [ ] Copy of SH2
- [ ] Copy of SH3
- [ ] Copy of SH4
- [ ] Copy of SH5

Extension Activity: Posters

- [ ] Pens/pencils
- [ ] Paper

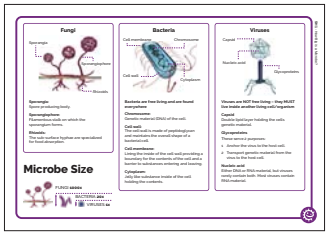
Alternative Main Activity: Peer Education

- [ ] Groups of 3 or 4 students

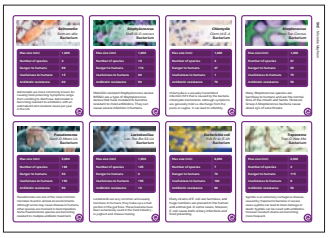
Advance Preparation

Cut out and laminate a set of playing cards (SH2 – SH5) for each group.

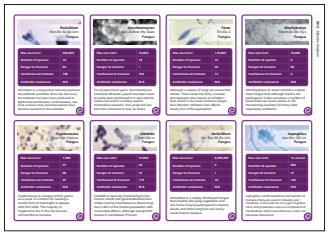
Supporting Materials



SH1 How big is a microbe?

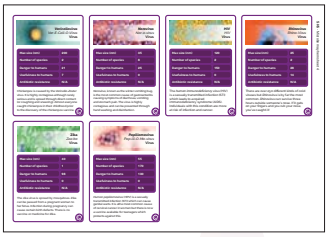


SH2 Microbe Mayhem Sheet 1



SH3 Microbe Mayhem Sheet 2

SH4 Microbe Mayhem Sheet 3



SH5 Microbe Mayhem Sheet 4

Lesson Plan

Introduction

1. Begin the lesson by asking students what they already know about microbes. Most students will already know that microbes can cause illness but may not know that microbes can also be good for us. Ask the class where they would look if they wanted to find microbes. Do they think microbes are important to us?

2. Explain that microbes are the smallest living creatures on Earth and that the word micro-organism literally translates into micro: small and organism: life. Microbes are so small they cannot be seen without the use of a microscope. Antonie van Leeuwenhoek created the first microscope in 1676. He used it to examine various items around his home and termed the living creatures (bacteria) he found on scrapings from his teeth 'animalcules'.

3. Show the class that there are three different types of microbe: bacteria, viruses and fungi. Use SH1 to demonstrate how these three microbes vary in shape and structure.

4. Highlight to the class that microbes can be found EVERYWHERE – floating around in the air we breathe, on the food we eat, in the water we drink and on the surface of and in our bodies. Emphasise that although there are harmful microbes that can make us ill, there are many more useful microbes that we can use.

5. Emphasise that although microbes cause disease, there are also useful microbes. Ask students to identify some benefits of useful microbes. If they cannot, provide examples for them e.g. *Lactobacillus* in yoghurt, probiotic bacteria in our gut which aid digestion and the fungus *Penicillium* which produces the antibiotic Penicillin.

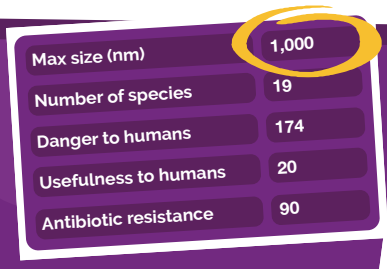
Main Activity: Microbe Mayhem

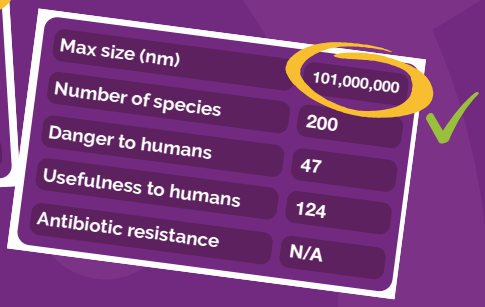
1 Shuffle the cards and deal cards to players

2 Make sure only you can see your cards

3 Take turns to choose which microbe characteristic you would like to battle others with

4 The player with the highest characteristic score wins the round!





Microbe Mayhem

In this activity groups of 3 – 4 students play a card game which helps them remember some of the technical words relating to microbes as well as familiarising students with a variety of microbial names, the differences in size, capability of causing harm and if antibiotic resistance occurs. Microbe size and number of species are correct at the time of resource development; however, as new microbes are continuously being discovered and reclassified, these numbers may be subject to change. The numbers in the other headings used on the cards are only to be used as a guide and are illustrative only. They are not accurate as there is no formulae to create these and they may be subject to change i.e. bacterial species may develop resistance to more antibiotics resulting in them having a higher number in this column and being more dangerous to humans.

Hand out a set of Microbe Mayhem playing cards (SH2 - SH5) to each group and ask each group to appoint a dealer. Let the students know that 'nm' on the playing cards stands for nanometres. There are ten million nanometres in a centimetre.

Game rules

1. The dealer should shuffle the cards well and deal all the cards face down to each player. Each player holds their cards face up so that they can see the top card only.
2. The player to the dealer's left starts by reading out the name of the microbe on the top card and chooses an item to read (e.g. Size 50). In a clockwise direction, the other players then read out the same item. The player with the highest value wins, taking the other players top cards and placing them to the bottom of their pile. The winner then reads out the name of the microbe on their next card and selects the item to compare.

3. If 2 or more players have the same top value then all the cards are placed in the middle and the same player chooses again from the next card. The winner then takes the cards in the middle as well. The person with all the cards at the end is the winner.

Alternative Main Activity: Peer education

Divide the class into groups of 3 – 4 students. Explain to the students that they will be creating a presentation to teach a group of their younger peers about microbes. Allow the students to choose the level at which they want their presentation to be aimed – EY, KS1, KS2 or KS3.

Ask student to design an engaging presentation to teach their younger peers the following:

1. What are microbes?
2. Where are microbes found?
3. Microbial shapes and structures
4. Microbes that are good or bad for humans

Suggest to students that their presentations should include amazing microbe facts, interactive elements or activities and they should make the presentation visually engaging for a younger audience.

Extension Activities

Divide the class into groups of 3 – 4 students. Each group should research and create a poster to reinforce learning on one of the following topics:

1 Choose a specific type of bacterium, virus or fungus e.g. *Salmonella*, *Influenza A* or *Penicillium*. The poster should include:

   a. Structure of that microbe
   b. The different places they can be found
   c. How they affect humans in either a good or bad way
   d. Any specific growth requirements of that group of microbes

OR

2 A timeline poster on the history of microbes. This poster may include:

   a. 1676: van Leeuwenhoek discovers 'animalcules' using homemade microscope
   b. 1796: Jenner discovers smallpox vaccination
   c. 1850: Semmelweis advocated washing hands to stop the spread of disease
   d. 1861: Pasteur publishes germ theory: the concept that germs cause disease
   e. 1892: Ivanovski discovers viruses
   f. 1905: Koch awarded Nobel Prize in Medicine for his work understanding tuberculosis and its causes
   g. 1929: Fleming discovers antibiotics

Learning Consolidation

Check for understanding by asking students if the following statements are true or false.

1. There are two main types of microbes: bacteria and fungi?

   Answer: False, there are three main types: bacteria, viruses and fungi.

2. Bacteria have three main shapes, cocci (balls), bacilli (rods) and spirals.

   Answer: True.

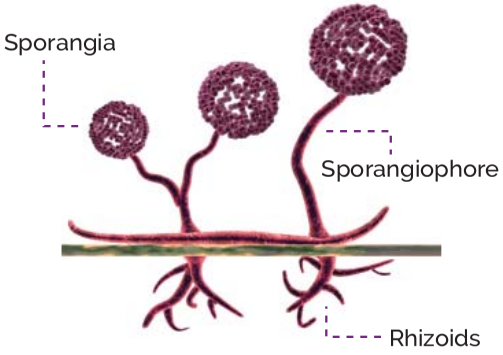
3. Microbes are only in the food we eat.

   Answer: False, there are microbes everywhere, floating around in the air we breathe, on the food we eat, in the water we drink and on the surface of and in our bodies, even inside volcanoes.

4. Microbes can be useful, harmful or both.

   Answer: True.

Fungi

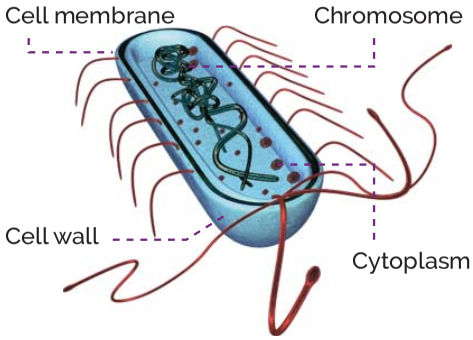


Sporangia:
Spore producing body.

Sporangiophore:
Filamentous stalk on which the sporangium forms.

Rhizoids:
The sub-surface hyphae are specialized for food absorption.

Bacteria



Bacteria are free living and are found everywhere

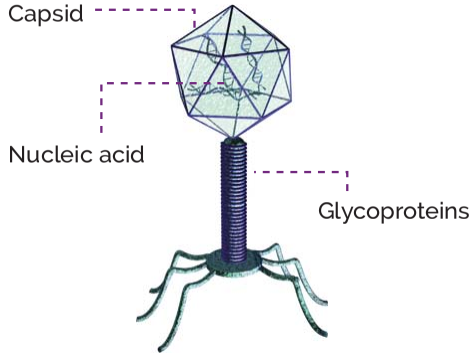
Chromosome:
Genetic material (DNA) of the cell.

Cell wall:
The cell wall is made of peptidoglycan and maintains the overall shape of a bacterial cell.

Cell membrane:
Lining the inside of the cell wall providing a boundary for the contents of the cell and a barrier to substances entering and leaving.

Cytoplasm:
Jelly like substance inside of the cell holding the contents.

Viruses



Viruses are NOT free living – they MUST live inside another living cell/organism

Capsid
Double lipid layer holding the cells genetic material.

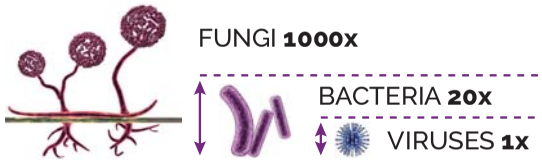
Glycoproteins

These serve 2 purposes:

1. Anchor the virus to the host cell.
2. Transport genetic material from the virus to the host cell.

Nucleic acid
Either DNA or RNA material, but viruses rarely contain both. Most viruses contain RNA material.

Microbe Size



Salmonella
Sam-on-ella
Bacterium

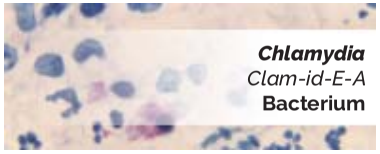
Max size (nm)	1,000
Number of species	3
Danger to humans	89
Usefulness to humans	15
Antibiotic resistance	60

Salmonella are most commonly known for causing food poisoning. Symptoms range from vomiting to diarrhoea. *Salmonella* is becoming resistant to antibiotics with an estimated 6,200 resistant cases per year in the US.

Staphylococcus
Staff-ill-O-coccus
Bacterium

Max size (nm)	1,000
Number of species	19
Danger to humans	174
Usefulness to humans	20
Antibiotic resistance	90

Meticillin resistant *Staphylococcus aureus* (MRSA) are a type of *Staphylococcus aureus* that have mutated to become resistant to most antibiotics. They can cause severe infection in humans.



Chlamydia
Clam-id-E-A
Bacterium

Max size (nm)	1,000
Number of species	3
Danger to humans	37
Usefulness to humans	1
Antibiotic resistance	70

Chlamydia is a sexually transmitted infection (STI) that is caused by the bacteria *Chlamydia trachomatis*. Although symptoms are generally mild i.e. discharge from the penis or vagina, it can lead to infertility.

Streptococcus
Strep-Toe-Coccus
Bacterium

Max size (nm)	1,000
Number of species	21
Danger to humans	50
Usefulness to humans	75
Antibiotic resistance	50

Many *Streptococcus* species are harmless to humans and are the normal flora of the mouth and hands. However, Group A *Streptococcus* bacteria cause about 15% of sore throats.

Pseudomonas
Sued-O-Moan-Us
Bacterium

Max size (nm)	5,000
Number of species	126
Danger to humans	50
Usefulness to humans	150
Antibiotic resistance	90

Pseudomonas are one of the most common microbes found in almost all environments. Although some may cause disease in humans, other species are involved in decomposition. Some *Pseudomonas* species are becoming resistant to multiple antibiotic treatment.

Lactobacillus
Lac-Toe-Ba-Sil-Us
Bacterium

Max size (nm)	1,500
Number of species	125
Danger to humans	0
Usefulness to humans	195
Antibiotic resistance	10

Lactobacilli are very common and usually harmless to humans; they make up a small portion of the gut flora. These bacteria have been extensively used in the food industry - in yoghurt and cheese making.

Escherichia coli
Esh-Er-lc-E-Ah
Bacterium

Max size (nm)	2,000
Number of species	7
Danger to humans	70
Usefulness to humans	184
Antibiotic resistance	80

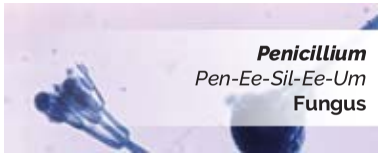
Many strains of *E. coli* are harmless, and huge numbers are present in the human and animal gut. In some cases, however, *E. coli* cause both urinary infections and food poisoning.

Treponema
Trep-O-Nee-Ma
Bacterium

Max size (nm)	2,000
Number of species	3
Danger to humans	115
Usefulness to humans	8
Antibiotic resistance	50

Syphilis is an extremely contagious disease, caused by *Treponema* bacteria. In severe cases syphilis can lead to brain damage or death. Syphilis can be cured with antibiotics however resistant strains are becoming more frequent.

Micro-organisms: Introduction to Microbes



Penicillium
Pen-Ee-Sil-Ee-Um
Fungus

Max size (nm)	332,000
Number of species	16
Danger to humans	64
Usefulness to humans	198
Antibiotic resistance	N/A

Penicillium is a fungus that naturally produces the antibiotic penicillin. Since this discovery, the antibiotic has been mass produced to fight bacterial infections. Unfortunately, due to its overuse many bacterial species have become resistant to this antibiotic.

Saccharomyces
Sac-A-Row-My-Sees
Fungus

Max size (nm)	10,000
Number of species	19
Danger to humans	1
Usefulness to humans	184
Antibiotic resistance	N/A

For at least 6,000 years, *Saccharomyces cerevisiae* (Brewer's yeast) has been used to make beer and bread! It is also used to make wine and it is widely used in biomedical research. One yeast cell can turn into 1,000,000 in only six hours.

Tinea
Tin-Ee-A
Fungus

Max size (nm)	110,000
Number of species	12
Danger to humans	43
Usefulness to humans	14
Antibiotic resistance	N/A

Although a variety of fungi can cause foot rashes, *Tinea* cause the itchy, cracked skin between toes known as Athlete's foot, which is the most common fungal skin infection. Athlete's foot affects nearly 70% of the population.

Stachybotrys
Stack-Ee-Bo-Trys
Fungus

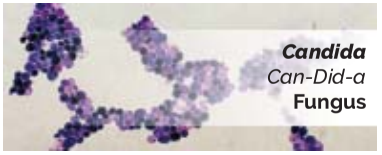
Max size (nm)	72,000
Number of species	2
Danger to humans	83
Usefulness to humans	2
Antibiotic resistance	N/A

Stratchybotrys (or straw mould) is a black toxic fungus that although itself is not pathogenic, it does produce a number of toxins that can cause rashes or life threatening reactions for those with respiratory problems.

Cryptococcus
Cryp-Toe-Coccus
Fungus

Max size (nm)	7,500
Number of species	37
Danger to humans	98
Usefulness to humans	37
Antibiotic resistance	N/A

Cryptococcus is a fungus which grows as a yeast. It is known for causing a severe form of meningitis in people with HIV/AIDS. The majority of *Cryptococci* live in the soil and are not harmful to humans.



Candida
Can-Did-a
Fungus

Max size (nm)	10,000
Number of species	44
Danger to humans	74
Usefulness to humans	175
Antibiotic resistance	N/A

Candida is naturally found living in the human mouth and gastrointestinal tract. Under normal circumstances these fungi live in 80% of the human population with no harmful effects, although overgrowth results in candidiasis (Thrush).

Verticillium
Ver-Tee-Sil-Ee-Um
Fungus

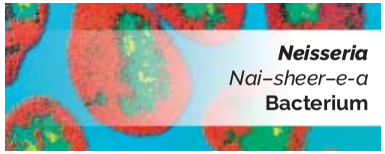
Max size (nm)	8,500,000
Number of species	4
Danger to humans	1
Usefulness to humans	18
Antibiotic resistance	N/A

Verticillium is a widely distributed fungus that inhabits decaying vegetation and soil. Some may be pathogenic to insects, plants, and other fungi but very rarely cause human disease.

Aspergillus
Ass-Per-Gill-Us
Fungus

Max size (nm)	101,000,000
Number of species	200
Danger to humans	47
Usefulness to humans	124
Antibiotic resistance	N/A

Aspergillus is both beneficial and harmful to humans. Many are used in industry and medicine. It accounts for over 99% of global citric acid production and is a component of medications which manufacturers claim can decrease flatulence!



Neisseria
Nai–sheer–e-a
Bacterium

Max size (nm)	800
Number of species	13
Danger to humans	120
Usefulness to humans	0
Antibiotic resistance	20

Neisseria meningitidis is a bacterium that can cause meningitis, a life threatening disease. A vaccine is available to protect against the 4 main types of this bacteria A, C, W and Y.

Mycobacterium
My–co–back–tear–e–um
Bacterium

Max size (nm)	4,000
Number of species	5
Danger to humans	150
Usefulness to humans	0
Antibiotic resistance	100

Tuberculosis (TB) is caused by the bacterium *Mycobacterium tuberculosis* and is one of the top 10 causes of death worldwide. Although treatable with antibiotics, many strains of TB are becoming resistant to multiple antibiotics.

Tobamovirus
Tob-A-Mo-Virus
Virus

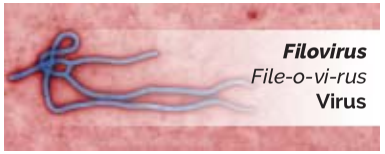
Max size (nm)	18
Number of species	125
Danger to humans	12
Usefulness to humans	34
Antibiotic resistance	N/A

Tobamovirus are a group of viruses that infect plants, the most common being tobacco mosaic virus, which infects tobacco and other plants. This virus has been very useful in scientific research.

Influenza A
In-Flu-En-Za A
Virus

Max size (nm)	90
Number of species	1
Danger to humans	146
Usefulness to humans	12
Antibiotic resistance	N/A

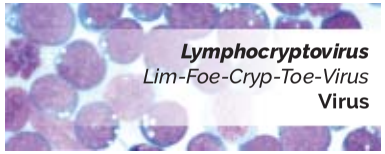
The flu is an infection caused by *Orthomyxoviridae*. Every year 5 – 40% of the population get the flu but most people recover completely in a couple of weeks.



Filovirus
File-o-vi-rus
Virus

Max size (nm)	1,500
Number of species	1
Danger to humans	200
Usefulness to humans	0
Antibiotic resistance	N/A

Filovirus causes a disease more commonly known as Ebola. It is one of the more dangerous viruses known to humans. 25 – 90% of victims died from the disease before the development and approval of a vaccine in 2019.



Lymphocryptovirus
Lim-Foe-Cryp-Toe-Virus
Virus

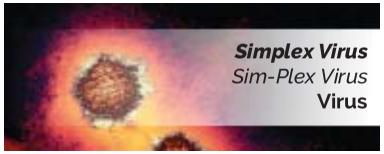
Max size (nm)	110
Number of species	7
Danger to humans	37
Usefulness to humans	2
Antibiotic resistance	N/A

The Epstein-Barr virus, a type of *Lymphocryptovirus*, causes an illness known as the Kissing Disease or Glandular fever. Symptoms include sore throats and extreme tiredness. Transmission requires close contact such as kissing.

Lyssavirus
Lice-A-Virus
Virus

Max size (nm)	180
Number of species	10
Danger to humans	74
Usefulness to humans	5
Antibiotic resistance	N/A

The *Lyssavirus* infect both plants and animals. The most common *Lyssavirus* is the Rabies virus and is usually associated with dogs. Rabies results in over 55,000 deaths worldwide every year but can be prevented by vaccination.



Simplex Virus
Sim-Plex Virus
Virus

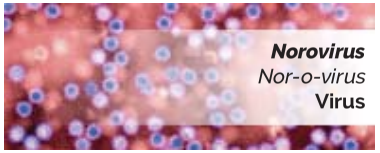
Max size (nm)	200
Number of species	2
Danger to humans	64
Usefulness to humans	2
Antibiotic resistance	N/A

Herpes simplex is one of the oldest known sexually transmitted infections. In many cases, Herpes infections produce no symptoms, but scab-like symptoms do occur in about one third of people infected.

Varicellovirus
Var-E-Cell-O-Virus
Virus

Max size (nm)	200
Number of species	2
Danger to humans	21
Usefulness to humans	7
Antibiotic resistance	N/A

Chickenpox is caused by the *Varicella-Zoster* virus. It is highly contagious although rarely serious and is spread through direct contact (or coughing and sneezing). Almost everyone caught chickenpox in their childhood prior to the discovery of the chickenpox vaccine.



Norovirus
Nor-o-virus
Virus

Max size (nm)	35
Number of species	8
Danger to humans	25
Usefulness to humans	0
Antibiotic resistance	N/A

Norovirus, known as the winter vomiting bug, is the most common cause of gastroenteritis causing symptoms of diarrhoea, vomiting and stomach pain. The virus is highly contagious and can be prevented through hand washing and disinfection.

HIV
HIV
Virus

Max size (nm)	120
Number of species	2
Danger to humans	150
Usefulness to humans	0
Antibiotic resistance	N/A

The *human immunodeficiency virus* (HIV) is a sexually transmitted infection (STI) which leads to acquired immunodeficiency syndrome (AIDS). Individuals with this condition are more at risk of infection and cancer.

Rhinovirus
Rhino-Virus
Virus

Max size (nm)	25
Number of species	2
Danger to humans	28
Usefulness to humans	14
Antibiotic resistance	N/A

There are over 250 different kinds of cold viruses but *Rhinovirus* is by far the most common. *Rhinovirus* can survive three hours outside someone's nose. If it gets on your fingers and you rub your nose, you've caught it!

Zika
Zee-ka
Virus

Max size (nm)	40
Number of species	1
Danger to humans	98
Usefulness to humans	0
Antibiotic resistance	N/A

The zika virus is spread by mosquitoes. Zika can be passed from a pregnant woman to her fetus. Infection during pregnancy can cause certain birth defects. There is no vaccine or medicine for Zika.

Papillomavirus
Pap-ill-O-Ma-virus
Virus

Max size (nm)	55
Number of species	170
Danger to humans	130
Usefulness to humans	0
Antibiotic resistance	N/A

Human papillomavirus (HPV) is a sexually transmitted infection (STI) which can cause genital warts. It is athe most common cause of cervical cancer in women but there is now a vaccine available for teenagers which protects against this.