KEY STAGE 4 - LESSON 2

Micro-organisms: Useful Microbes

The story of insulin helps students learn how microbes can be useful.

Curriculum Links

Science

- Scientific thinking
- Analysis and evaluation
- Experimental skills and strategies,
- Genetic engineering
- Role in biotechnology

Biology

- Cells
- Health and disease
- Development of medicines

PSHE/RSHE

- Health and prevention

English

- Reading
- Writing

Key Words

Fermentation, Genetic modification, Insulin, Microbiome

@ Weblink

e-bug.eu/eng/KS4/lesson/Useful-Microbes

Learning Outcomes

All students will:

- Understand that some microbes can keep us healthy.
- Understand that some microbes can be useful.
- Understand that we need bacterial colonisation to live a healthy life.
- Understand that we need to protect our normal microbial flora.
- Begin to explore scientific research.

Most students:

- Understand that microbes are important in decomposition and nutrient recycling.

Resources Required

Main Activity:
The Story of Insulin

Per student / per group

- [ ] Devices with internet access or biology textbooks

Optional Extension Activity for Upper KS4: Useful Microbes Presentation

Per student / per group

- [ ] Devices with internet access or biology textbooks

Extension Activity: Useful Microbes and their Properties

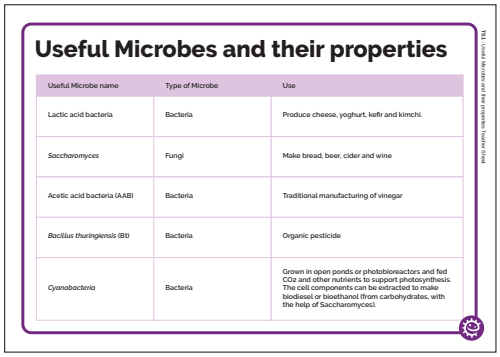
Per student

- [ ] Copy of SW1
- [ ] Devices with internet access

Additional Supporting Materials:

- [ ] TS1 Useful Microbes and Their Properties Sheet

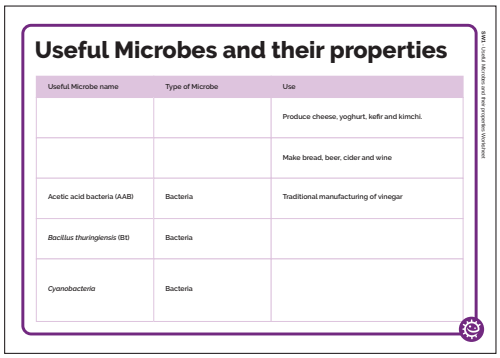
Supporting Materials



Useful Microbes and their properties

Useful Microbe name	Type of Microbe	Use
Lactic acid bacteria	Bacteria	Produce cheese, yoghurt, kefir and kimchi.
Saccharomyces	Fungi	Make bread, beer, cider and wine
Acetic acid bacteria (AAB)	Bacteria	Traditional manufacturing of vinegar
Bacillus thuringiensis (Bt)	Bacteria	Organic pesticide
Cyanobacteria	Bacteria	Grown in open ponds or photobioreactors and fed CO_2 and other nutrients to support photosynthesis. The cell components can be extracted to make biodiesel or bioethanol (from carbohydrates, with the help of Saccharomyces).

TS1 Useful Microbes and Their Properties Teacher Sheet



Useful Microbes and their properties

Useful Microbe name	Type of Microbe	Use
		Produce cheese, yoghurt, kefir and kimchi.
		Make bread, beer, cider and wine
Acetic acid bacteria (AAB)	Bacteria	Traditional manufacturing of vinegar
Bacillus thuringiensis (Bt)	Bacteria	
Cyanobacteria	Bacteria	

SW1 Useful Microbes and Their Properties Worksheet

Lesson Plan

Introduction

1. Begin the lesson by explaining that there are millions of different species of microbes and that most of these are completely harmless to humans; some are actually very good for us. Ask the class if they know of any ways in which we use microbes to our advantage. Examples may include *Penicillium* (fungus) to make antibiotics; some microbes break down dead animals and plant material to make compost; some microbes help us digest foods and some are even used to turn milk into yoghurt, cheese and butter.

2. Remind the class that bacteria and fungi, like us, are alive – they need a food source to grow and multiply. They vary in their food requirements but generally anything we consider food can be used as food by many microbes. Microbes also produce waste products and it is these waste products that can either be beneficial or harmful to humans. Ask students if they have ever seen milk turn sour; although this may be seen as a problem to us, industry uses this process (fermentation) in making yoghurt.

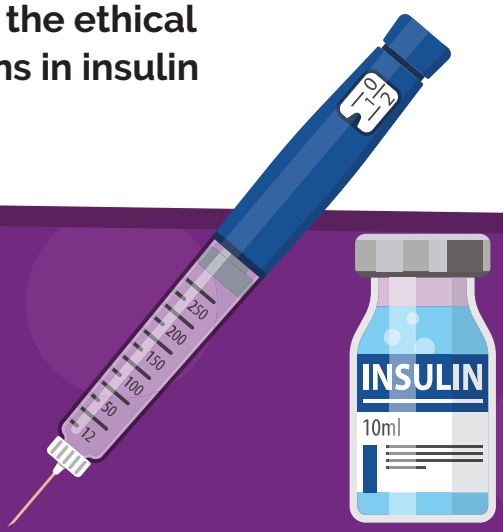
3. Explain that fermentation is a chemical change/process by which bacteria 'eat' sugars and produce acids and gas as waste. We use this process in the food industry to create wine, beer, bread, yoghurt and many more foodstuffs. When making yoghurt, the bacteria added to milk consume the milk sugars, and through fermentation convert these sugars to lactic acid which causes the milk to thicken into a yoghurt.

4. Explain to the class that in this lesson they will be investigating other useful microbes.

Main Activity: The Story of Insulin

1 Conduct research on the history of insulin, what it's used for, how microbes are involved and the ethical considerations in insulin production

2 Share your research with the class



Microbes in industry: The story of insulin (Non-lab activity)

1. Explain to the class: Insulin is a hormone (protein) that is produced in the pancreas and released when we have consumed carbohydrate or sugar. We need some sugar in our blood to feed our cells with energy, but too much can be dangerous. Insulin is the hormone that communicates with our liver, telling it to convert excess sugar into glycogen which is stored in the liver and muscles.
2. People with type 1 diabetes do not produce enough insulin to regulate the levels of sugar in the blood; this can lead to hyperglycemia. An insulin injection after a meal helps people with type 1 diabetes regulate their blood sugar.
3. Ask the class: does anyone know where this insulin comes from? Today much of the insulin we use comes from genetically modified microbes.
4. Tell the students that they will now be conducting research into the production of insulin, encourage them to plan their research and include answers to the following questions.
    a. How was insulin historically made?
    b. How is insulin made using microbes today? Why?
    c. What microbes are involved? Why?
    d. Are there any ethical considerations in this field of science?
5. They may choose to present their research as an essay or a presentation.

Tip 1: Encourage students to explain/ interpret any data they present

Tip 2: Encourage students to check their research plan with you or another teacher before they begin

Optional Extension Activity for Upper KS4: Useful Microbes Presentation

Using the above research criteria, ask students to research and present other useful microbes, for example the fungus *Fusarium*, which produces mycoprotein, a protein-rich food suitable for vegetarians. This activity can be carried out in groups or individually.

Discussion

Start a discussion with students about the importance of maintaining your gut microbiome. This provides the opportunity for students to engage in discussions from a novel area of research.

Explain to the class that living inside of your gut are 300 to 500 different kinds of bacteria. Paired with other tiny organisms like viruses and fungi, they make what's known as the microbiota, or the microbiome. Multiple factors can influence the make-up of the human gut microbiota including diet - one of the main drivers in shaping the gut microbiota across the lifetime. Intestinal bacteria play a crucial role in maintaining the immune system and other regular body processes.

Main message: Gut microbiome can influence many aspects of human health, maintaining a healthy gut microbiome is key.

Some key points to include:

- The microbiota offers many benefits to the host, including strengthening gut integrity or shaping the intestinal epithelium, harvesting energy, protecting against pathogens and regulating host immunity.
- Ongoing area of research: there has been some links to lower gut microbiome biodiversity in people with IBS, eczema and diabetes.
- Gut microbiome has been linked to influencing mood.

Extension Activity

This activity can be conducted in small groups or as an individual task. Making use of classroom devices with internet access and/or textbooks, ask students to research the useful microbes in SW1 and fill in the gaps (see TS1 for answers). There is an empty row for students to select their own useful microbe to research. Once completed, this table can serve as a great way to consolidate information.

Learning Consolidation

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

1. Many microbes are useful, they can help us make food such as bread and yoghurt and can be used in industry due to the proteins or enzymes they produce.

   Answer: True

2. Fermentation happens when bacteria break down the simple sugars into carbon dioxide.

   Answer: False. Fermentation happens when bacteria break down the complex sugars into simple compounds like carbon dioxide, and lactic acid and alcohol.

3. Yoghurt contains bacteria including *Lactobacilli* and *Streptococcus*, meaning eating yoghurt is good for your gut health.

   Answer: True

Useful Microbes and their properties

Useful Microbe name	Type of Microbe	Use
		Produce cheese, yoghurt, kefir and kimchi.
		Make bread, beer, cider and wine
Acetic acid bacteria (AAB)	Bacteria	Traditional manufacturing of vinegar
Bacillus thuringiensis (Bt)	Bacteria	
Cyanobacteria	Bacteria	

Useful Microbes and their properties

Useful Microbe name	Type of Microbe	Use
Lactic acid bacteria	Bacteria	Produce cheese, yoghurt, kefir and kimchi.
Saccharomyces	Fungi	Make bread, beer, cider and wine
Acetic acid bacteria (AAB)	Bacteria	Traditional manufacturing of vinegar
Bacillus thuringiensis (Bt)	Bacteria	Organic pesticide
Cyanobacteria	Bacteria	Grown in open ponds or photobioreactors and fed CO_2 and other nutrients to support photosynthesis. The cell components can be extracted to make biodiesel or bioethanol (from carbohydrates, with the help of Saccharomyces).