



Micro-organisms: Useful Microbes

Students learn that microbes can be useful, experimenting with *Lactobacillus* and *Streptococcus* to make their own yoghurt.

Curriculum Links

Science

- Working scientifically
- Scientific attitudes
- Experimental skills and investigations

Biology

- Structure and function of living organisms
- Cells and organisation
- Nutrition and digestion

Material cycles and energy

- Cellular respiration

PSHE/RSHE

- Health and prevention

English

- Reading
- Writing

Key Words

Culture, Contamination,
Fermentation, Pasteurise,

Learning Outcomes

All students will:

- Understand that some microbes can be put to good use.
- Understand that we need bacterial colonisation to live a healthy life.

Most students will:

- Understand that we need to protect our normal microbial flora.

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[e-bug.eu/eng/KS3/lesson/
Useful-Microbes](http://e-bug.eu/eng/KS3/lesson/Useful-Microbes)

Resources Required

Main Activity: Yoghurt Experiment

Per student

- ☐ Copy of SH1 and SW1
- ☐ Sterile Beaker
- ☐ Cling film/foil
- ☐ Dried/Powdered milk
- ☐ Whole milk
- ☐ Live natural yoghurt
- ☐ Sterile teaspoon

Per group

- ☐ Hot plate
- ☐ Water bath set at 20°C
- ☐ Water bath set at 40°C

Extension Activity: Microscopic Yoghurt

Per class/group

- ☐ Copy of SW2
- ☐ Bunsen burner
- ☐ Cover slips
- ☐ Methylene blue microscope
- ☐ X40 resolution microscope slides
- ☐ Sterile droppers
- ☐ Yoghurt

Extensions activity: Poster

Per student

- ☐ Paper
- ☐ Pens/pencils

Advance Preparation

1. Copy of TS1 teacher answer sheet.
2. Purchase a carton of fresh plain yoghurt and powdered milk.
3. Boil at least 1 teaspoon of yoghurt per group to sterilise.

Health and Safety

Yoghurt experiment: During cooking students should wear an apron and goggles.

Microscopic Yoghurt: Stain the slides over a sink.

For safe microbiological practices in the classroom consult CLEAPPS www.cleapps.org.uk



Supporting Materials

TS1 - Microscopic Yoghurt Answer sheet

Yoghurt Experiment

Observation answer sheet

Test 1 – Yoghurt

	Before Incubation	After incubation
What was the consistency of the mixture?	<i>Runny liquid</i>	<i>Thick and creamy</i>
What did the mixture smell like?	<i>Like milk</i>	<i>Like rotting food</i>
What was the colour of the mixture?	<i>White</i>	<i>Cream / white</i>

Test 2 – Sterile Yoghurt

	Before Incubation	After incubation

TS1 - Microscopic Yoghurt Answer sheet

Yoghurt Experiment

Conclusions answer sheet

- What caused the change from milk to yoghurt?
The microbes added to the milk converted the sugars to lactic acid which caused the milk to thicken into a yoghurt.
- What is this process called?
Lactic acid fermentation.
- Explain the difference in results in test 1 and test 2.
Everything in test 2 was sterile; therefore there were no microbes present to carry out lactic acid fermentation.

TS1 Microscopic Yoghurt Teacher Sheets

SH1 - How to Make Yoghurt [Instructions]

How to Make Yoghurt Experiment

- Add two tablespoons of powdered, skimmed milk to 500ml (one pint) of whole milk.
- Bring the mixture to a boil over medium heat for 30 seconds, stirring constantly to kill any unwanted bacteria present. Take care it does not overflow!
- Cool to 46-60°C.

SH1 How to Make Yoghurt Instructions

SW1 - Yoghurt Experiment: Observation sheet

Yoghurt Experiment Observations

Use the boxes to fill in the observations from your experiment and check these with your teacher

Test 1 – Yoghurt

	Before Incubation	After incubation
What was the consistency of the mixture?		
What did the mixture smell like?		
What was the colour of the mixture?		

SW1 - Yoghurt Experiment: Conclusions

Yoghurt Experiment Conclusions

Answer the questions below using the conclusions from your experiment and discuss these with your teacher

- What caused the change from milk to yoghurt?
- What is this process called?
- Explain the difference in results in test 1 and test 2.

SW1 Yoghurt Experiment: Observation Sheet

SW2 - Microscopic Yoghurt: Observation sheet

Microscopic Yoghurt Procedure

Test 1

- Place a small drop of yoghurt onto one side of a glass microscope slide.
- Taking a second clean slide, streak the yoghurt across the length of the slide creating a thin smear.
- Leave the slide to air dry and then pass once through a Bunsen flame in order to heat fix the smear.
- Cover the smear with a few drops of Methylene Blue and leave for 2 minutes.
- Wash off any excess stain by running under a slow running tap.
- Cover smear with a cover slip and examine the slide under a high powered microscope.
- Record your observations below.

Test 2

- Repeat steps 1-7 above using sterile yoghurt instead of live culture yoghurt.

SW2 Microscopic Yoghurt: Observation Sheet

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 useful to 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. Tell the class that they are going to make their own yoghurt and see the fermentation process for themselves.

Main Activity: Yoghurt Experiment

- 1 Add 2 tablespoons of powdered milk to a pint of whole milk
- 2 Stir the mixture while heating
- 3 Cool mixture down
- 4 Divide mixture into 2 labelled sterile beakers and add live yoghurt to one and sterile yoghurt to the other
- 5 Heat and stir mixtures
- 6 Cover top of container and wait at least 9 hours



Yoghurt Experiment

1. This activity consists of 3 different tests and can be done as an entire class or in groups.
2. Supply the class or groups with the yoghurt recipe (SH1). It is important to go through each step of the recipe with the class, having a group discussion as to why each of the steps are carried out.
 - a. Powdered milk helps to thicken the mixture.
 - b. Boiling the milk helps eliminate any unwanted microbes, later you will be incubating the mixture at a temperature favourable for microbial growth. Other unwanted organisms may interfere with the fermentation process, or if found in yoghurt, may cause food poisoning.

NOTE 1 if boiling the milk is not an option in the classroom it is possible to use UHT or sterile milk.

- c. Not cooling the mixture before adding the yoghurt in step 4 would result in

killing the 'yoghurt-making' microbes.

- d. Yoghurt contains the microbes *Lactobacillus* or *Streptococcus* required to make yoghurt. We add the yoghurt to the milk mixture so that these microbes will convert the mixture to yoghurt through fermentation.
- e. Stirring the mixture helps to evenly distribute the *Lactobacillus* through the mixture. It is important to use a sterile spoon to prevent contaminating the mixture with unwanted microbes such as moulds.
- f. Again sterilised containers with lids help prevent contamination with unwanted microbes which may disrupt the fermentation process.
- g. 32°C - 43°C is the ideal growth temperature range for *Lactobacilli* or *Streptococcus*. The mixture can be left at room temperature, but it will take up to 5 days longer for the

microbes to multiply and produce the lactic acid required.

NOTE 2 This activity can be carried out using smaller quantities of milk if required.

3. Explain each of the tests to the class:

- Test 1 - carry out the experiment following the recipe (SH1) using the yoghurt in step four.
- Test 2 - carry out the experiment following the recipe (SH1) using sterilised (boiled) yoghurt in step four.
- Test 3 - Carry out the experiment using the recipe (SH1), however, at step six incubate half the samples at the recommended temperature and the other half at 20°C or in the fridge.

4. Highlight that the *Lactobacillus* bacteria found in yoghurt are useful or 'friendly' bacteria known as probiotics. These bacteria help us by

- Defending us against the harmful bacteria that can cause disease.
- Helping us digest some food types.

5. Students should record their observations on the student worksheet (SW1). Answers are available on TS1.

Students will learn that not all microbes are harmful and that they can be put to good use, for example, to make yoghurt.

Discussion

What is the process that caused a change in the milk?
Fermentation is the process by which the milk changed to yoghurt. During fermentation microbes consume simple sugars and convert them to acids, gas and alcohol.

Check for understanding by asking students the following questions:

What changes occurred as the mixture changed from milk to yoghurt and why did these changes occur? The lactic acid produced by the bacteria caused the milk to sour resulting in a thickening and slight colour change.

Why was it important to add some yoghurt to the milk mixture?
The live yoghurt contains the bacteria which carry out fermentation.

Why was it important to keep the mixture warm overnight? Bacteria prefer to grow at approximately 37°C, temperatures outside this range will either kill microbes or reduce the rate at which they multiply. It is important for the bacteria to grow and multiply quickly in order to produce enough lactic acid to cause the milk to change to yoghurt.

What happens when the experiment goes wrong?
If the sterile milk turns to yoghurt – the milk may not have been boiled properly or the samples may have got contaminated.

What happens when sterile yoghurt is added to the milk, and why? No change occurs because the yoghurt has been boiled so that all the microbes are killed. Fermentation cannot occur when this sterile yoghurt is added to the milk.

Extension Activities

Microscopic Yoghurt

1. Provide students with a copy of SW2. Follow the procedure outlined and examine the microbes under a microscope. Students may need to dilute the yoghurt with water if the yoghurt is particularly thick. You may want students to try this test using yoghurt only and yoghurt diluted with water.
2. Remember that the more dilute the yoghurt is the further the bacteria will spread out making them more difficult to find on the slide. Students should be able to see bacteria under the microscope from the yoghurt made with live culture.

Poster Design

Divide the class into groups of 3 or 4 students. Ask each group to create a poster. Choose a type of food that utilises microbes during production e.g. yoghurt, bread, beer, soy sauce, kombucha, salami, cheese, chocolate. Ask students to include

1. Type and name of the microbe used.
2. History of when this food was first produced.
3. How this food is produced?
4. Are there associated health benefits?

Class visit

As a fun alternative to the classroom experiment, students could visit a food room to observe fermentation in the making of ginger beer, bread, kombucha or even kimchi. This will support student understanding by providing further examples of how microbes can be useful.

Learning Consolidation

To consolidate learning you may wish to encourage students to present their poster to the class or consider creating a display in your classroom or on a common notice board.

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

1. Many microbes are useful and help us make foods like yoghurt or bread.
Answer: True
2. Fermentation happens when microbes digest sugars, this is the process by which milk changed to yoghurt.
Answer: True
3. Yoghurt contains bacteria including Lactobacilli and Streptococcus, meaning eating yoghurt is good for your gut health.
Answer: True



Yoghurt Experiment

Observation answer sheet

Test 1 – Yoghurt

	Before Incubation	After incubation
What was the consistency of the mixture?	<i>Runny liquid</i>	<i>Thick and creamy</i>
What did the mixture smell like?	<i>Like milk</i>	<i>Like rotting food</i>
What was the colour of the mixture?	<i>White</i>	<i>Cream / white</i>

Test 2 – Sterile Yoghurt

	Before Incubation	After incubation
What was the consistency of the mixture?	<i>Runny liquid</i>	<i>Runny liquid (no change)</i>
What did the mixture smell like?	<i>Like milk</i>	<i>Like milk (no change)</i>
What was the colour of the mixture?	<i>White</i>	<i>White (no change)</i>

How did the mixture change during fermentation?

During test 1 the mixture changed to a thicker creamier texture consistent with yoghurt, this was due to the lactic acid fermentation of the microbes present. No change was observed in the second test due to the lack of microbes present

Test 3

How long did it take to make the yoghurt when the mixture was incubated at:

20°C - approx 3-5 days

40°C - overnight





Yoghurt Experiment

Conclusions answer sheet

- 1 What caused the change from milk to yoghurt?

The microbes added to the milk converted the sugars to lactic acid which caused the milk to thicken into a yoghurt.

- 2 What is this process called?

Lactic acid fermentation.

- 3 Explain the difference in results in test 1 and test 2.

Everything in test 2 was sterile; therefore there were no microbes present to carry out lactic acid fermentation.

- 4 What is the type and name of microbes which can be used to make yoghurt?

Bacteria of the genus Lactobacillus and Streptococcus.

- 5 Why did it take longer to make yoghurt at 20°C than at 40°C?

Bacteria prefer to grow at body temperature i.e. approx 37°C, at 20°C it takes the bacteria longer to multiply therefore they are slower to produce the lactic acid.

- 6 A sterile spoon is used to stir the mixture (step 5) before incubating, what do you think might happen if a dirty spoon was used?

The resulting yoghurt may be contaminated with harmful microbes.

