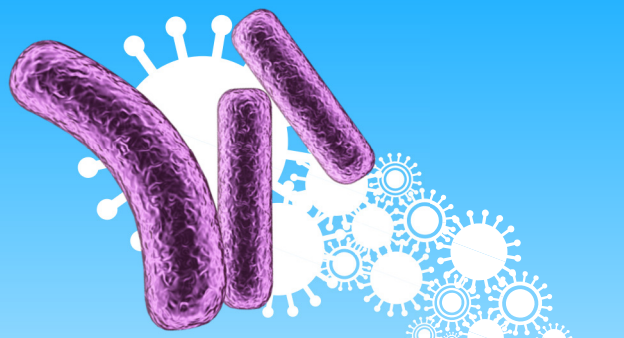
1.2 Useful Microbes

Section 1.2 : Useful Microbes highlights the benefits of some microbes by examining the various ways and means we can utilise them for our benefit.

Through a yogurt making activity, students observe first hand how microbes can be put to good use in the food industry.

The extension activity encourages students to question their experiments by examining a yogurt culture under a microscope and observe the presence of useful bacteria for themselves.



Lactobacillus

LEARNING OUTCOMES

All students:

- Will understand that useful microbes can help keep us healthy
- Will know that most microbes are beneficial to us
- Will know that microbes can be put to good use

More able students:

- Will understand that we need bacterial colonisation to live a healthy life
- Will know that we need to protect our normal microbial flora

NATIONAL CURRICULUM LINKS

Key Stage 3

Science

Working Scientifically
Scientific Attitudes
Experimental Skills and investigations
Analysis and Evaluation
Structure and Function of Living Organisms
Nutrition and digestion
Material cycles and energy
Cellular respiration

Estimated Teaching Time

50 minutes

1.2 Micro-organisms
Useful Microbes

Key Words
Culture
Colonisation
Contamination
Fermentation
Incubate
Natural flora
Pasteurisation
Probiotic

Materials Required

Per student
- ☐ Beaker
- ☐ Cling film/foil
- ☐ Copy of SH 1 and SW 1
- ☐ Dried/Powdered milk
- ☐ Whole milk
- ☐ Live natural yogurt
- ☐ Sterile teaspoon

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

Extension Activity
- ☐ Copy of SW 2
- ☐ Bunsen burner
- ☐ Cover slips
- ☐ Methylene blue
- ☐ Microscope X40 resolution
- ☐ Microscope slides
- ☐ Sterile droppers

Health and Safety

- During cooking students should wear a lab coat or apron and goggles
- Stain slides over a sink

USE TS 1

Background Information

Bacteria are single-celled organisms and although some of these cause illness and disease, others are helpful and beneficial. One of the main ways in which bacteria are beneficial is in the food industry. The natural by-products created during normal microbial growth are used to make many of the food products we take for granted today.

Fermentation causes a chemical change in foodstuffs. It is a process by which the bacteria break down the complex sugars into simple compounds like carbon dioxide and alcohol. Fermentation changes the product from one food to another.

The **acetic acid fermentation** of microbes produces vinegar. **Lactic acid fermentation** produces yogurt and cheese. Some fungi are also used to make the cheese turn blue! The yeast, ***Saccharomyces cerevisiae***, is used to make bread and dough products through fermentation. Wine and beer are also produced in the same manner although alcohol is produced following fermentation when the microbes are grown without air. The chocolate industry also rely on bacteria and fungi. These organisms produce acid through fermentation which eats away at the hard pod and makes it easier to get at the cacao beans.

When the bacteria *Streptococcus thermophilous* or *Lactobacillus bulgaricus* are added to milk they consume the sugars during fermentation, turning it into yogurt. So much acid is produced in fermented milk products that few potentially harmful microbes can survive there.

Lactobacillus bacteria are generally referred to as useful or 'friendly' bacteria. The friendly bacteria that help us digest food have been termed probiotic bacteria, literally meaning 'for life'. It is these bacteria that we find in our yogurts and probiotic drinks.

Advance Preparation

1. Copy SH 1, SW 1 and SW 2 for each student.
2. Purchase a carton of fresh plain yogurt and powdered milk.
3. Boil at least 1teaspoon of yogurt per group to sterilise.

Available Web Resources

- A demonstration film of the activity
- Magnified microbial photographs associated with useful microbes
- SH 1 in MS PowerPoint format
- Magnified images of the yogurt smear

1.2 Micro-organisms
Useful Microbes

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 yogurt, cheese and butter.
2. Remind the class that microbes, 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 yogurt.
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, yogurt and many more foodstuffs. When making yogurt, 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 yogurt. Tell the class that they are going to make their own yogurt and see the fermentation process for themselves.

Main Activity

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 yogurt recipe (SH 1). 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 we 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 yogurt 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 yogurt in step 4 would result in killing the 'yogurt-making' microbes.
    d. Yogurt contains the microbes *Lactobacillus* or *Streptococcus* required to make yogurt. We add the yogurt to the milk mixture so that these microbes will convert the mixture to yogurt 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.

1.2 Micro-organisms
Useful Microbes

Lesson Plan

Main Activity

3. Explain each of the tests to the class
   a. Test 1 - carry out the experiment following the recipe (SH 1) using the yogurt in step 4.
   b. Test 2 - carry out the experiment following the recipe (SH 1) using sterilised (boiled) yogurt in step 4.
   c. Carry out the experiment using the recipe, (SH 1), however at step 7 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 yogurt are useful or 'friendly' bacteria known as probiotics. These bacteria help us by
   a. Defending us against the harmful bacteria that can cause disease
   b. Helping us digest some food types
5. Students should record their observations on the student worksheet (SW 1).

Plenary

Check for understanding by asking students the following questions:

a. What is the process that caused a change in the milk?
   Fermentation is the process by which the milk changed to yogurt. During fermentation microbes consume simple sugars and convert them to acids, gas and alcohol.
b. Why was it important to add some yogurt to the milk mixture?
   The live yogurt contains the bacteria which carry out fermentation.
c. What happens when sterile yogurt is added to the milk, and why?
   No change occurs because the yogurt has been boiled so that all the microbes are killed. Fermentation cannot occur when this sterile yogurt is added to the milk.
d. What changes occurred as the mixture changed from milk to yogurt 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.
e. 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 yogurt.
f. What happens when the experiment goes wrong?
   If the sterile milk turns to yogurt – the milk may not have been boiled properly or the samples may have got contaminated.

Extension Activity

Provide students with a copy of SW 2. Follow the procedure outlined and examine the microbes under a microscope. Students may need to dilute the yogurt with water if the yogurt is particularly thick. You may want students to try this test using yogurt only and yogurt diluted with water.

Remember that the more dilute the yogurt is the farther the bacteria will spread out making them more difficult to find on the slide.

USE TS 3

1.2 Micro-organisms
Useful Microbes

Teacher Answer Sheet

Test 1 – Yogurt

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

Test 2 – Sterile Yogurt

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

How did the mixture change during fermentation?

During test 1 the mixture changed to a thicker creamier texture consistent with yogurt, 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 yogurt when the mixture was incubated at:

20°C *approx 3-5 days* 40°C *overnight*

Conclusions

1. What caused the change from milk to yogurt?
   The microbes added to the milk converted the sugars to lactic acid which caused the milk to thicken into a yogurt.
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 yogurt?
   Bacteria of the genus Lactobacillus and Streptococcus.
5. Why did it take longer to make yogurt 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 yogurt may be contaminated with harmful microbes.

USE TS 4

e-Bug

USEFUL MICROBES

How to Make Yogurt

1. Add two tablespoons of powdered, skimmed milk to 500ml (one pint) of whole milk.

2. 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!

3. Cool to 46-60°C.

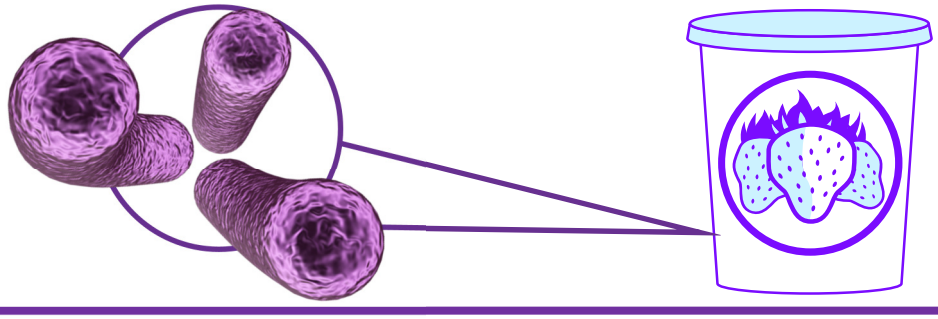
4. Divide the cooled mixture into 2 sterile beakers and label test 1 and test 2.

   Test 1 : add 1-2 teaspoons of live yogurt
   Test 2 : add 1-2 teaspoons of sterile yogurt

5. Stir both mixtures well using a spoon previously sterilised by standing it in boiling water.

6. Cover each container with aluminium foil.

7. Incubate the mixtures at 32-43°C in a hot water bath, for 9-15 hours until desired firmness is reached.



USEFUL MICROBES

Observations

Test 1 – Yogurt

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

Test 2 – Sterile Yogurt

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

How did the mixture change during fermentation?

_____

_____

Test 3

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

20°C _____ 40°C _____

Conclusions

1. What caused the change from milk to yogurt?

   _____

2. What is this process called?

   _____

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

   _____

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

   _____

5. Why did it take longer to make yogurt at 20°C than at 40°C?

   _____

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?

   _____

USE SW 1

USEFUL MICROBES

Procedure

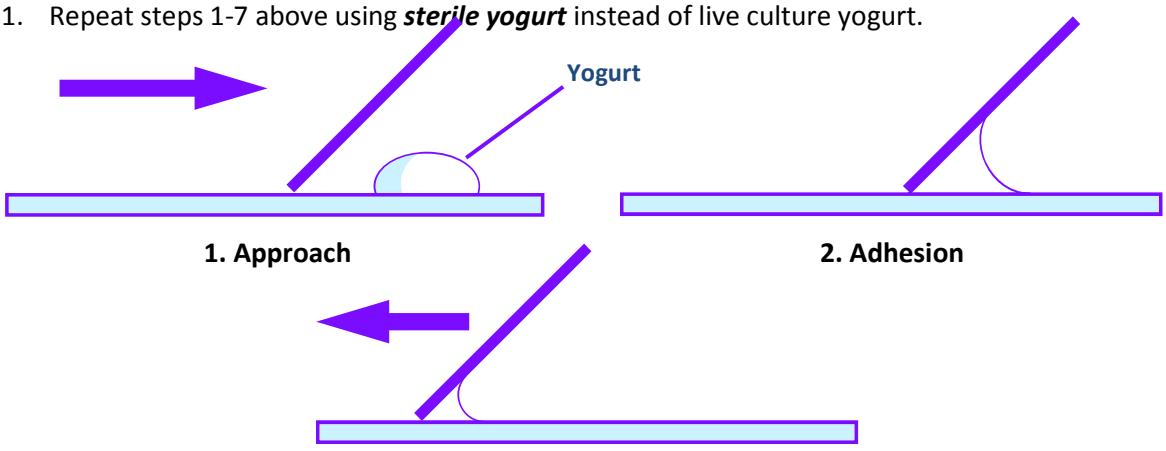
Test 1

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

Test 2

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

How to prepare a smear:



Observations

1. What did you see in the yogurt smear?

   _____
   _____
   _____

2. What did you see in the sterile yogurt smear?

   _____
   _____
   _____

3. What, in your opinion, caused the difference?

   _____
   _____