

Chapter 21: Using microorganisms

- People use microorganisms in a wide variety of ways.
- Yeast is widely used in the production of beer.
- Yeast produces carbon dioxide as a waste product of respiration.
- Bacteria known as *Lactobacillus* are involved in the production of yoghurt.
- Many useful microorganisms are grown on an industrial scale in fermenters, which provide suitable conditions for them to grow as quickly as possible.

Microorganisms

Most microorganisms are so small that they cannot be seen with the naked eye. They include protozoa, fungi, bacteria and viruses. Many microorganisms are vital as decomposers, some cause diseases, and some are used in the manufacture of useful chemicals and products. Fungi are used as food, to make bread, beer and wine, and to flavour cheeses.

Bacteria are used for many different things, including making yoghurt. They are also used in a genetically modified form to make human proteins such as human insulin.

Viruses can now be used in the process of genetic modification.

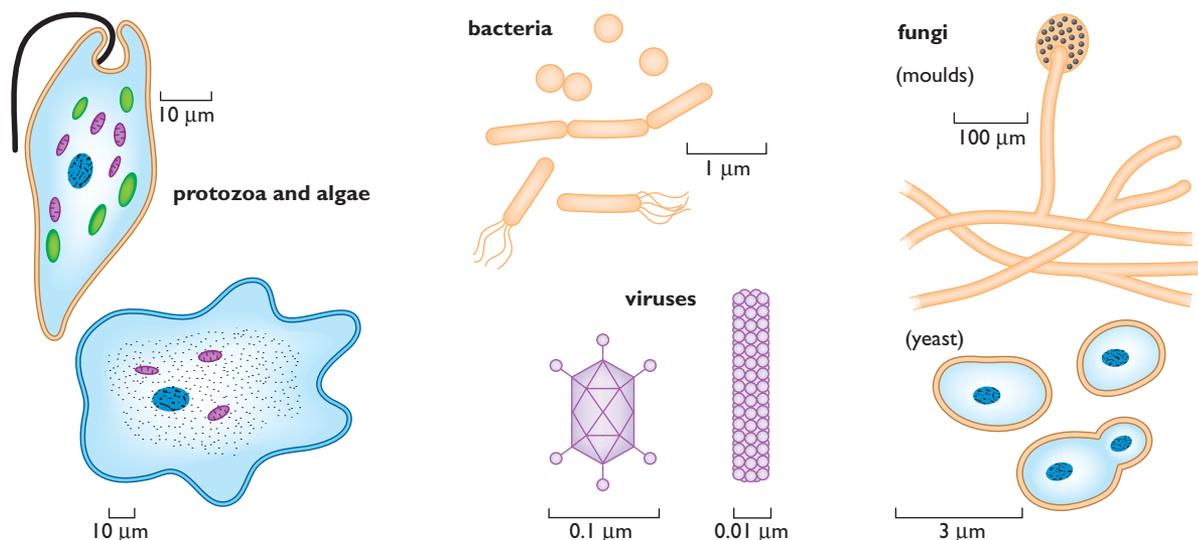
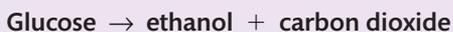


Figure 21.1 Different types of microorganisms

Fermentation and biotechnology

Biotechnology is the use of living organisms to make useful chemicals and products or to perform an industrial task. One of the oldest forms of biotechnology is the use of the **fermentation** reaction in yeast to make beer and other alcoholic drinks. The carbon dioxide produced by yeast is also used to make bread rise. When yeast respire anaerobically it produces ethanol, the chemical which acts as a drug in alcoholic drinks. This is a fermentation reaction.



EXAMINER'S TIP

The reaction of yeast with sugar is just one example of a fermentation reaction, not the only one! Many microorganisms undergo fermentation reactions of different types – this is why they are grown in fermenters.

Beer is made from barley. The process of making beer has not changed much over many years. It can be summarised as shown in the flow diagram.

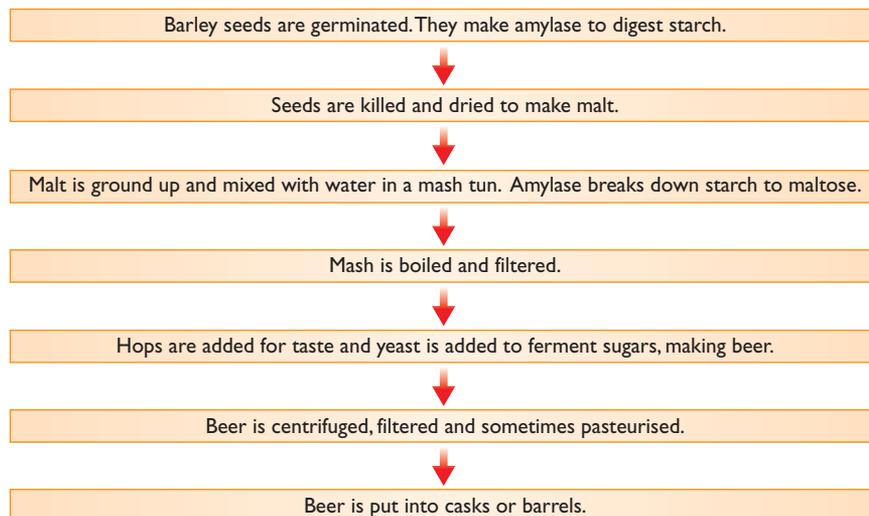


Figure 21.2 Flow diagram to show the production of beer

Other fermentation reactions involve bacteria. The production of yoghurt involves the use of special *Lactobacillus* bacteria, as shown in the flow diagram.

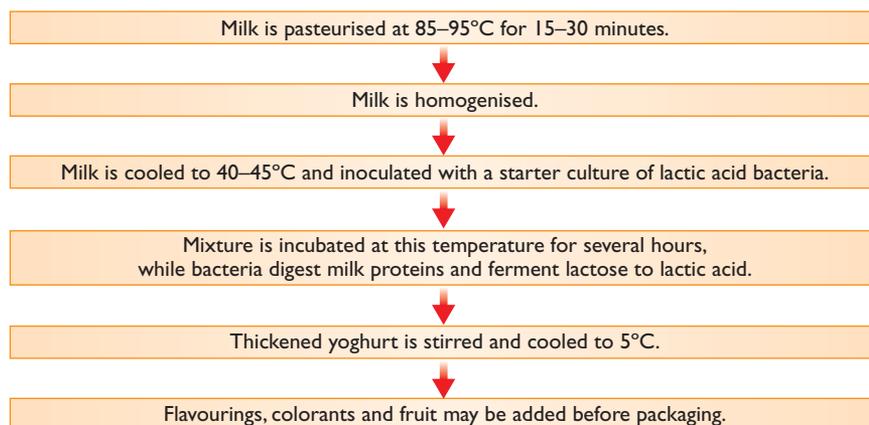


Figure 21.3 Flow diagram to show the production of yoghurt

Modern biotechnology

Microorganisms are now being used to make a huge range of food products and medicines, enzymes and even fuels. Many of these reactions take place in large vessels called fermenters. These are huge containers that hold up to 200 000 dm³ of liquid. They make it possible to control the environmental conditions such as temperature, oxygen and carbon dioxide concentrations, pH and nutrient levels, so that the microorganisms can grow and respire without being limited and can work as efficiently as possible. It is very important that everything in the fermenter is sterile, so that only the microorganisms that are wanted grow in the culture. Penicillin, a widely used antibiotic, is made in an industrial fermenter using *Penicillium* mould.

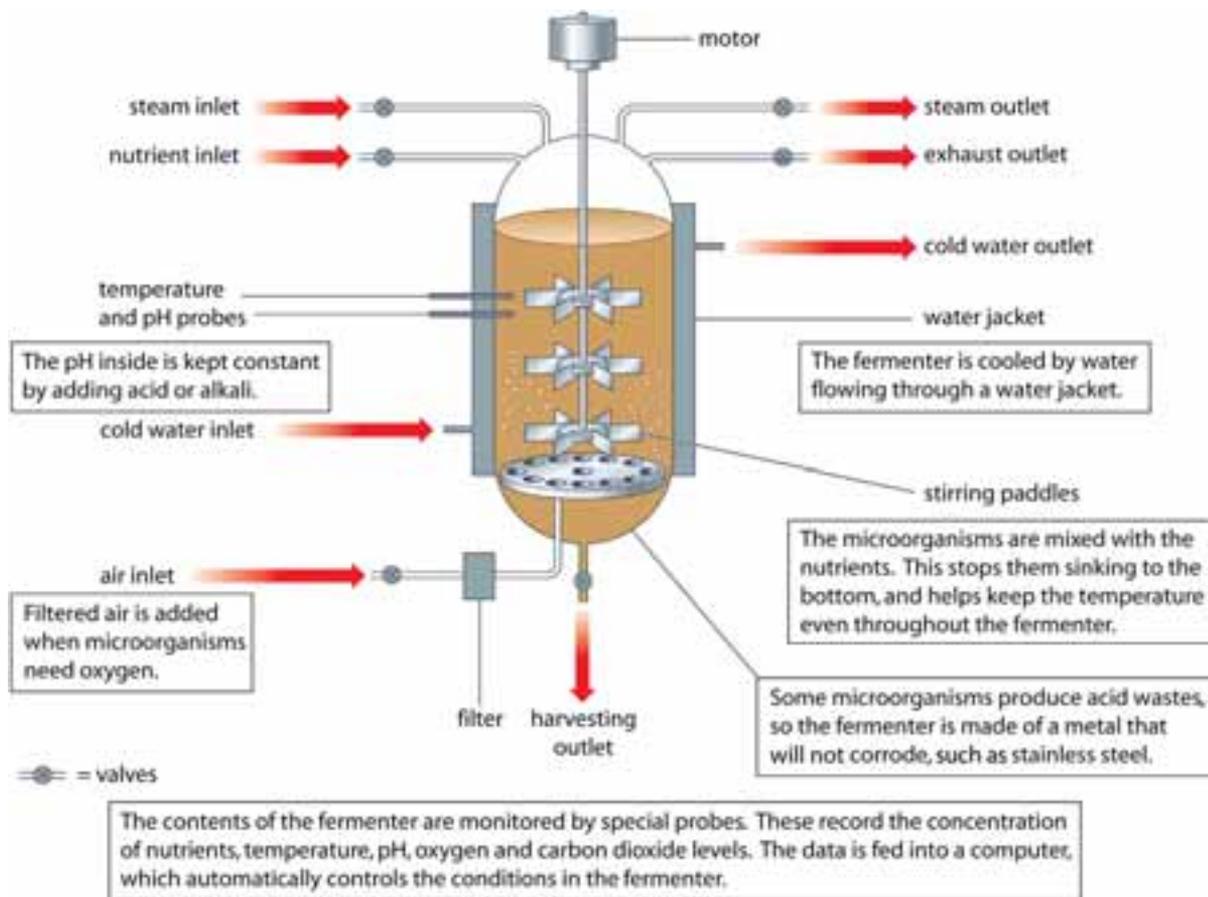


Figure 21.4 A fermenter used to grow microorganisms on an industrial scale

Experimental evidence

You can demonstrate experimentally that anaerobic respiration takes place in yeast and that carbon dioxide is produced during the reaction. A sugar solution is made up with boiled water that contains no air, and yeast is added. A layer of liquid paraffin is poured on top to make sure that no oxygen-containing air gets in. Any gas produced is passed through limewater. This acts as an indicator – it is a clear liquid that turns cloudy when carbon dioxide bubbles through it. You should also be able to smell the ethanol produced by the yeast as it carries out a fermentation reaction. You need a control containing yeast that has been killed by boiling.

Questions

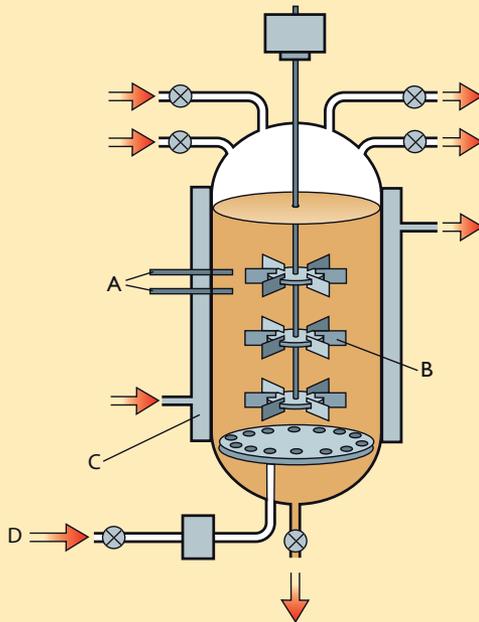
- 1 Copy and complete these sentences. Use the words below to fill in the gaps.

fermentation penicillin microorganisms
biotechnology enzymes

Many of the processes carried out by _____ are known as _____ reactions. They are often used in _____ to produce substances useful to people. These include _____, alcoholic drinks and medicines such as _____.
- 2
 - a) What are the main types of microorganisms?
 - b) Which types of microorganisms are most commonly used by people?
 - c) List as many things made using microorganisms as you can think of.
- 3 Write word equations to show the difference between aerobic and anaerobic respiration in yeast.
- 4
 - a) What is beer?
 - b) Describe the process of making beer, including the role of yeast.

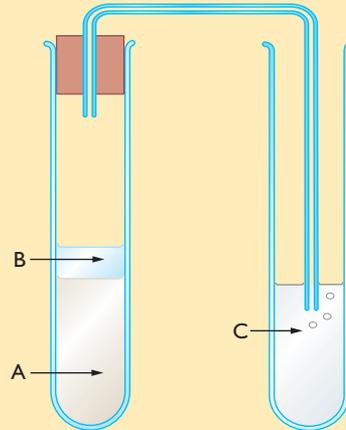
Questions

- 5 a) Explain why temperature control is vital for successful beer and wine making.
- b) Sometimes a small amount of yeast is left in a bottle of wine to make sparkling wine or champagne.
- Explain why the yeast is left in the bottle.
 - What is the gas that makes the bubbles in the drink?
- 6 a) What is the main difference between the production of alcoholic drinks and the production of yoghurt?
- b) Produce a flow diagram to summarise the production of yoghurt from milk *without* referring to page 86.
- 7 a) Give three reasons why microorganisms are so useful in industrial processes.
- b) This diagram shows a fermenter that is used for growing particular bacteria in an industrial process.



- Name the parts labelled A, B, C and D.
- Explain the importance of the parts labelled A, B, C and D in ensuring that the best possible conditions for bacterial growth are maintained.

- 8 Why do the following factors tend to change during the fermentation process?
- Temperature
 - Oxygen
 - pH
- 9 a) Copy this diagram and complete the labelling.



- b) Explain how this apparatus could be used to investigate how temperature affects the respiration rate of yeast.