

Food production: micro-organisms and fish farming

Revision notes · How yeast and Lactobacillus are used to make bread and yoghurt, how fermenters work, and how fish are farmed.

For Pearson Edexcel International GCSE Biology 4BI1 and Science (Double Award) 4SD0. **Biology only** is not in the Double Award and is only examined on Paper 2.

Food production: micro-organisms and fish farming Spec 5.5–5.9B

Yeast and bread making Spec 5.5

Yeast is a single-celled fungus. It is used to make bread because of the way it respires.

When yeast has no oxygen, it respires **anaerobically**. This is also called **fermentation**. It breaks down sugar (glucose) to make ethanol and carbon dioxide, and releases energy.

glucose → ethanol + carbon dioxide

Making bread

1. Flour, water, sugar and yeast are mixed to make a dough. The dough is kneaded.
2. The dough is left in a warm place. The yeast respires the sugar and releases **carbon dioxide**.
3. The bubbles of carbon dioxide are trapped in the dough, so the dough **rises**.
4. The dough is baked. The heat kills the yeast, the gas bubbles expand to make the bread light and full of holes, and the ethanol evaporates.

Exam tip: It is the carbon dioxide that makes the dough rise, not the ethanol. Keep the warm temperature in your answer: it is the optimum range for the yeast enzymes.

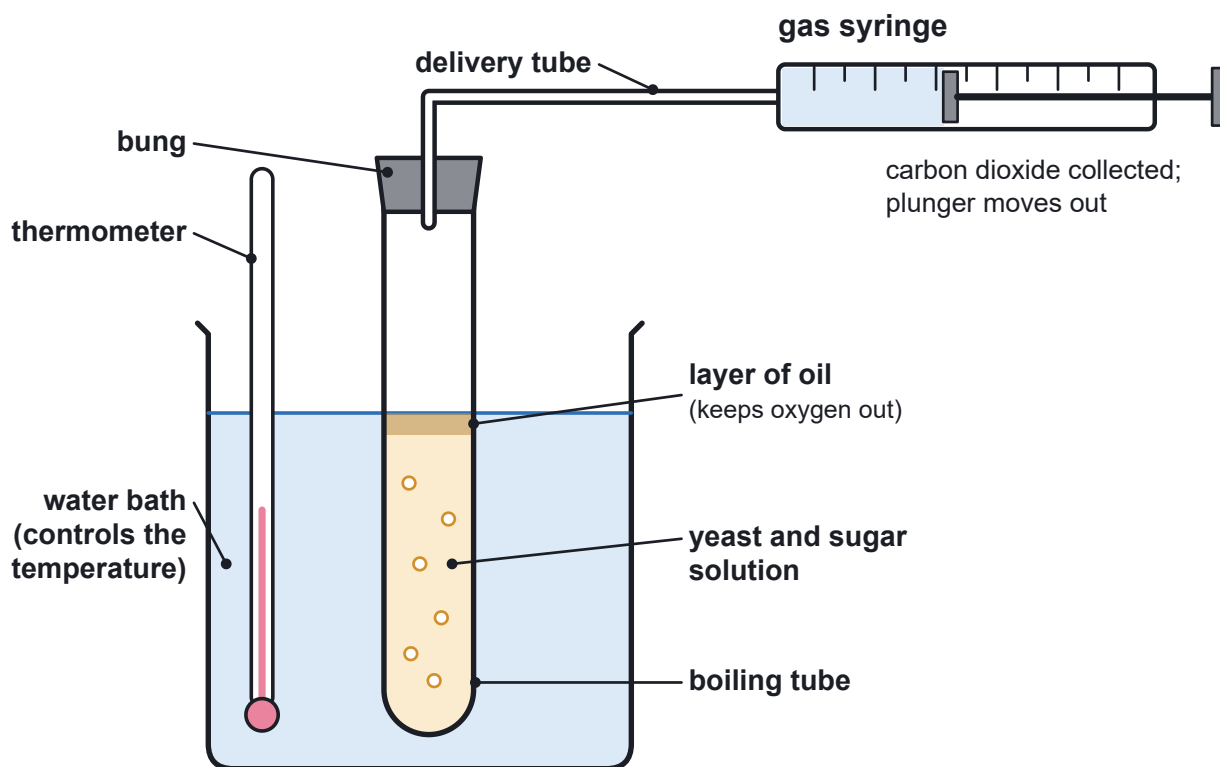
Practical: anaerobic respiration in yeast Spec 5.6

In this practical you investigate how conditions, such as temperature or the type or concentration of sugar, affect the rate of **anaerobic respiration** in yeast. The rate is measured from the **carbon dioxide** produced.

Practical: Investigating the effect of temperature on anaerobic respiration in yeast. The same method can be used with different sugars or sugar concentrations as the independent variable.

1. Boil the sugar solution and let it cool, to remove dissolved oxygen. (It must be cool, or it would kill the yeast.)
2. Mix yeast with the sugar solution in a boiling tube. Add a **layer of oil** on top to stop oxygen getting back in, so the yeast respires anaerobically.
3. Attach a delivery tube to a gas syringe, or run it into water so the bubbles can be counted.
4. Stand the tube in a water bath at the first temperature, for example 20 °C. Leave it to reach that temperature.
5. Measure the volume of gas collected, or count the bubbles, in a set time such as 5 minutes.

6. Repeat at other temperatures, such as 30, 40, 50 and 60 °C, and repeat each temperature to calculate a mean.



The **layer of oil** keeps oxygen out; the volume of gas collected in a set time gives the rate of anaerobic respiration.

Variables	
Type of variable	What it is
Independent	The condition changed, for example temperature
Dependent	The volume of gas collected, or bubbles counted, in a set time
Control	Mass or volume of yeast, volume and concentration of sugar solution, type of sugar, time allowed for each reading, depth of the oil layer

Safety: wear eye protection, take care with hot water, and wash your hands after handling the yeast. Tie back long hair.

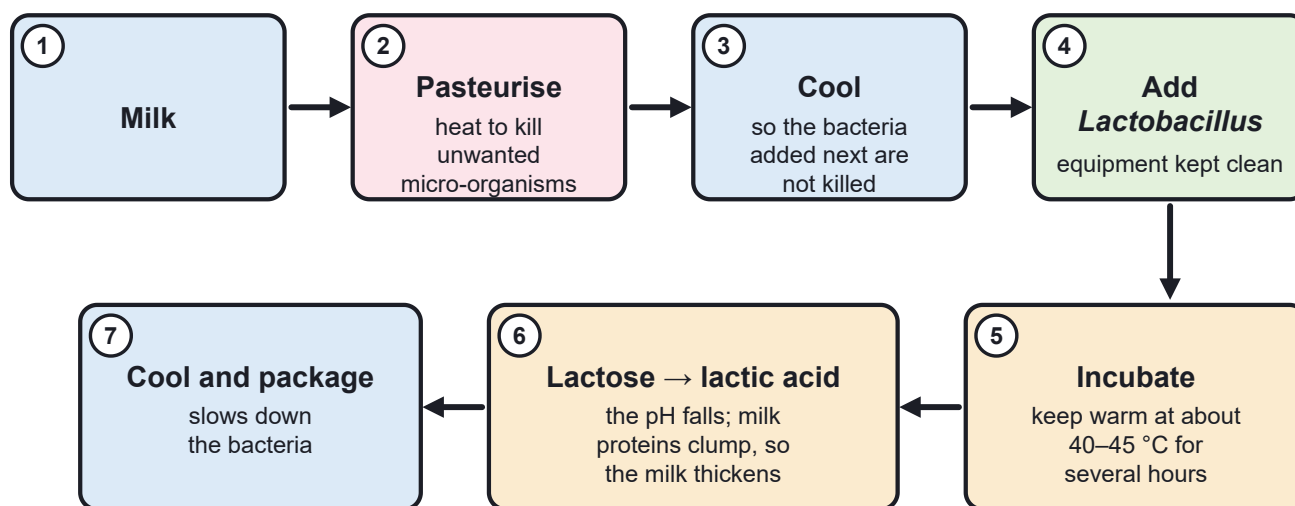
Expected results: the rate is slow at low temperatures. It increases as the temperature rises towards an optimum, usually about 35–40 °C, because the enzymes work faster. Above the optimum the rate falls, because the enzymes are denatured. You can confirm the gas is carbon dioxide by bubbling it through limewater, which turns cloudy.

Exam tip: Name the control variables and say how they are kept the same. Measuring in a fixed time lets you calculate a rate, such as bubbles per minute. A gas syringe is more accurate than counting bubbles, because bubbles can be different sizes.

Bacteria and yoghurt Spec 5.7

Yoghurt is made from milk using the bacterium **Lactobacillus**. The bacteria respire the sugar in milk, called **lactose**, and make **lactic acid**.

1. The milk is heated to a high temperature (**pasteurised**) to kill unwanted micro-organisms. It is then cooled.
2. *Lactobacillus* is added to the milk. The equipment is kept clean so that other bacteria do not get in.
3. The mixture is incubated (kept warm), at about 40–45 °C, for several hours, so the bacteria grow and respire.
4. The bacteria turn lactose into lactic acid. The pH falls, and the acid makes the milk proteins clump together, so the milk thickens and gets a sour taste. The low pH also stops many other micro-organisms growing, so the yoghurt keeps for longer.
5. The yoghurt is cooled to slow down the bacteria, then packaged.

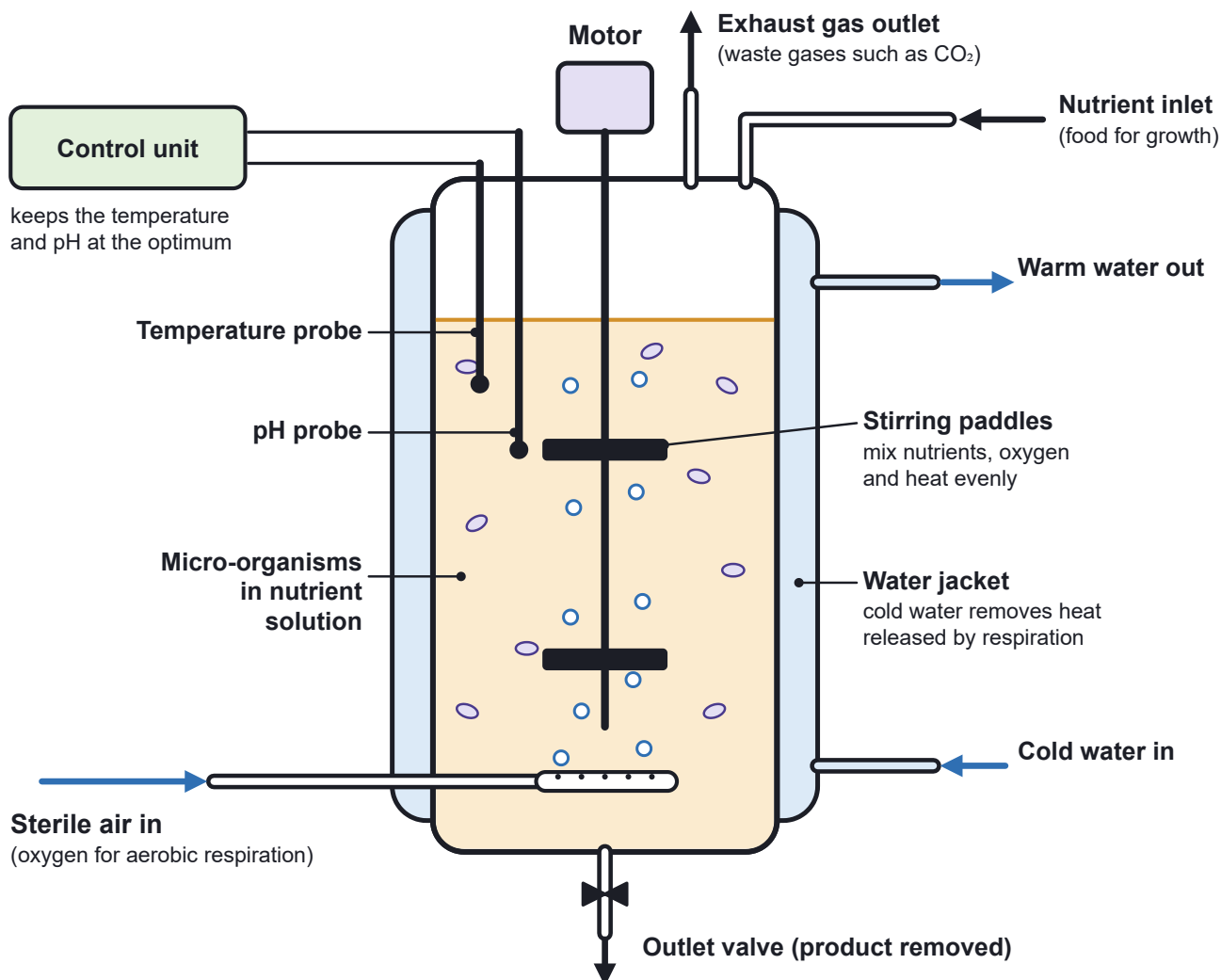


Lactobacillus turns **lactose into lactic acid**, which lowers the pH and thickens the milk.

Common mistake: The acid is made from lactose, not from the milk fat or protein. The acid is what thickens the milk, by making its proteins clump.

Industrial fermenters Spec 5.8

A **fermenter** is a large container in which micro-organisms are grown in large numbers to make a product such as a food, a medicine or an enzyme. The **conditions are controlled** so that the micro-organisms grow and make the product as quickly as possible.



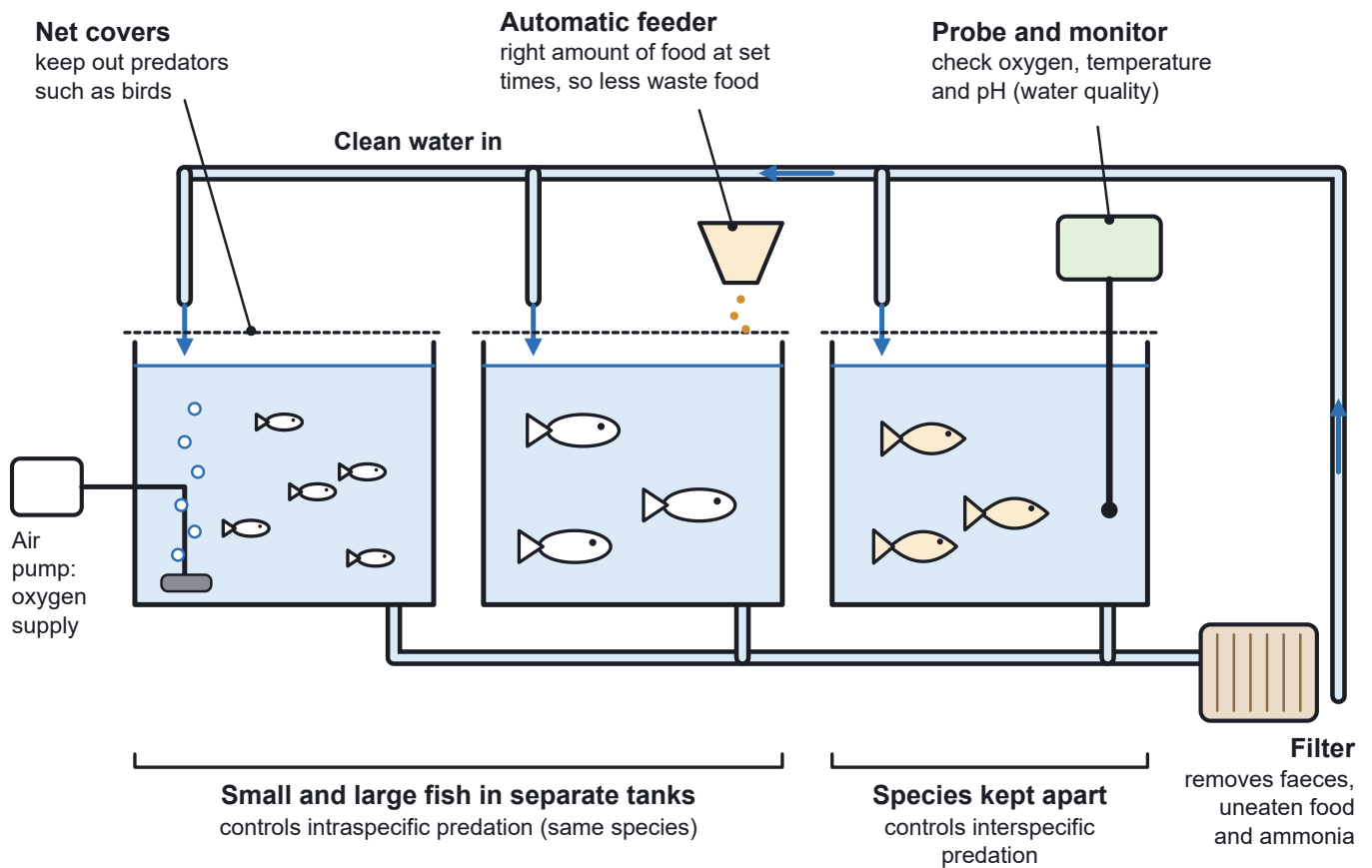
Each part of a fermenter keeps the **conditions at the optimum** for the micro-organisms to grow.

Conditions in a fermenter	
Condition	Why it is needed
Aseptic precautions	The fermenter and nutrients are sterilised, so no other micro-organisms get in. Unwanted microbes would compete for nutrients, spoil the product or cause disease.
Nutrients	A supply of a carbon source such as glucose, plus nitrogen and mineral ions, so the micro-organisms can grow and make the product.
Optimum temperature	Enzymes work fastest at the optimum. Respiration releases heat, so a cooling water jacket keeps the temperature constant. Too hot would denature enzymes.
Optimum pH	Enzymes work best at the optimum pH. A probe monitors pH, and acid or alkali is added to keep it steady.
Oxygenation	Sterile air is bubbled in, so the micro-organisms can respire aerobically, release more energy and grow faster.
Agitation	Stirring paddles mix the contents, so nutrients, oxygen and heat are spread evenly and the micro-organisms are in contact with the nutrients.

Exam tip: For each condition, say what it is and why it is needed. Mark schemes link it to growth: for example, the optimum temperature gives the fastest enzyme activity, so faster growth and more product.

Fish farming Spec 5.9B Biology only

Fish farming raises large numbers of fish, such as salmon, in tanks, ponds or net cages, to provide a source of **protein** for people. The farmer controls conditions so that the fish grow quickly and survive.



Clean water and not overcrowding the tanks (low stocking density) help to control disease.

Fish farmers control **water quality, predation, disease, waste and feeding** so the fish grow quickly.

Methods used in fish farming	
Method	Why it is used
Maintaining water quality (oxygen, temperature, pH and removal of toxic substances)	Fish stay healthy and grow quickly. Low oxygen or toxic ammonia would kill or stunt fish.
Controlling intraspecific predation, by keeping fish of the same size together	Larger fish of the same species eat smaller ones, so grading the fish by size reduces losses.
Controlling interspecific predation, by keeping species separate and keeping out predators such as birds and seals	Other species would eat the fish, so fewer fish survive to be harvested.
Controlling disease, using clean water, vaccines, medicines and low stocking densities	Disease spreads fast in crowded fish, so it would reduce the yield.
Removing waste products, by filtering or exchanging the water	Faeces and uneaten food build up and release toxic substances such as ammonia and cause pollution.
Controlling the quality and frequency of feeding	A balanced diet with the right protein content gives fast growth. Feeding the right amount at set times avoids waste food, which pollutes the water.
Selective breeding	Breeding from fish that grow fastest, resist disease or have good flesh quality produces fish with these features in later generations.

Exam tip: Learn the control points and say what goes wrong without each. Use the terms intraspecific (same species) and interspecific (different species) correctly.

Quick check

1. What gas makes bread dough rise?
2. Write the word equation for anaerobic respiration in yeast.
3. Which bacterium is used to make yoghurt, and what does it make from lactose?
4. Why are aseptic precautions used in a fermenter?
5. **Biology only** Give one way of controlling disease on a fish farm.

Quick check answers

Food production: micro-organisms and fish farming

1. Carbon dioxide, from anaerobic respiration in yeast.
2. Glucose $\rightarrow$ ethanol + carbon dioxide.
3. *Lactobacillus*; it makes lactic acid.
4. To stop unwanted micro-organisms getting in and competing with or spoiling the product.
5. Any one from: clean water, vaccines, medicines, low stocking density.