Rosary School – Marj Elhamam
Unit Six: Chapter 21

Name: _____ Date: ___ / ___ / 2025

Grade: 9 (A, B, C, D) Biology summary notes

Objectives:

6.5 understand the role of yeast in the production of food including bread

6.6 practical: investigate the role of anaerobic respiration by yeast in different conditions

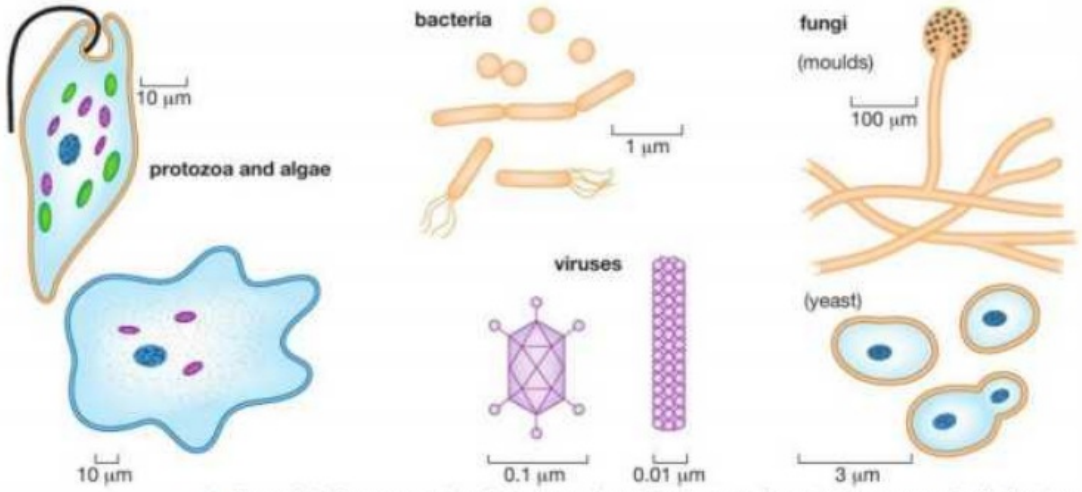
6.7 understand the role of bacteria (Lactobacillus) in the production of yoghurt

6.8 understand the use of an industrial fermenter and explain the need to provide suitable conditions in the fermenter, including aseptic precautions, nutrients, optimum temperature and pH, oxygenation and agitation, for the growth of micro-organisms

Using Microorganisms

Microorganisms have critical roles to play in:

1. recycling the waste products of organisms.
2. recycling the organisms themselves when they die.
3. making useful products, such as food, drink, and medicine.



▲ Figure 21.1 Some examples of microorganisms. They are not drawn to the same scale. Notice the range of size, as shown by the scale bar alongside each organism. One micrometre (1 µm) is a millionth of a metre, or a thousandth of a millimetre.

Fermentation and Biotechnology:

- Fermentation: using anaerobic respiration process of microorganisms to produce useful products.
- Biotechnology: use of microorganisms to make useful products to humans.

1. Yeast in food production (Making bread)

- One example of this is the production of **bread using yeast.**
- Yeast is a single-celled fungus that carry out both **aerobic and anaerobic** respiration.
- Anaerobic respiration in yeast cells is called **fermentation**.

Making bread:

- During bread making yeast is added to bread dough.
- The yeast produces **enzymes** that break down the starch in flour to **sugars** that can be used by the yeast in respiration:
- The yeast begins to respire **aerobically**, producing water and carbon dioxide. The carbon dioxide makes the dough rise.
- When the air runs out, the yeast begins to respire anaerobically making **ethanol** and **carbon dioxide**.

$$\text{Glucose} \longrightarrow \text{ethanol} + \text{carbon dioxide}$$

- The dough is then **baked** in the oven; the gas bubbles expand. This gives the bread a light, cellular texture. Baking also kills the yeast cells and evaporates any ethanol from the fermentation.
- The yeast is killed by the high temperatures used during baking. This ensures there is no further respiration by the yeast.

2.Making Yoghurt (using bacteria):

Yoghurt is made in a process that relies on the presence of a specific type of bacterium lactobacillus (lactic acid bacteria).

First, all equipment is sterilized to kill other, unwanted bacteria and to prevent chemical contamination.

The stages in yoghurt production:

1. Milk is **pasteurized** (heated) at 85-95 ◦C for 15-30 minutes to kill other, unwanted bacteria.
   - Contamination with other bacteria could **slow** production of the yoghurt by competing with the lactobacillus for the lactose in the milk and it could also spoil the taste of the yoghurt.
2. Milk is **homogenized** to disperse the fat globules.

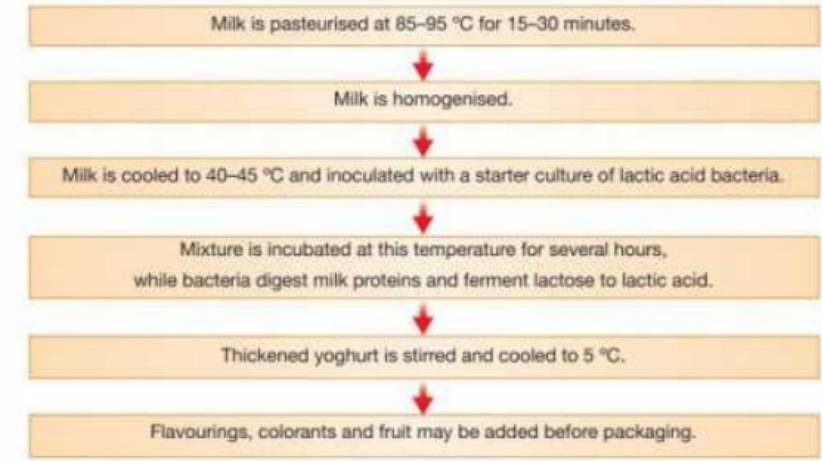
3. The milk is then **cooled** to 40-45 ◦C and inoculated with a starter culture of bacteria (lactobacillus and streptococcus). It is the optimum temperature for growth and activity of the yoghurt bacteria.

4. The mixture is incubated at this temperature for several hours, while the lactobacillus **digests** milk proteins and ferment (digest) lactose to lactic acid. This increased acidity sours and thickens the milk to yoghurt. The mixture coagulates (thickens) as the drop in pH causes the milk proteins to denature and turn into semi-solids.

This lowering of the pH also helps to prevent the growth of other microorganisms that may be harmful. This means the yoghurt can be kept for a longer time.

5. The yoghurt is then stirred and cooled to 5◦ C to halt the action of the lactobacillus bacteria.

6. Flavourings, colorants and fruit may be added before packaging.



▲ Figure 21.6 Flow chart showing the stages in yoghurt production.

3.Making Drinks:

a.Wine:

- Is made by using **yeast** (anaerobic respiration) to ferment sugars in grape juice.
- The alcohol increases in concentration until it kills the yeast cells, at which point fermentation stops.
- To prevent yeast, respire aerobically, the fermenter fitted with air lock, which allows CO_2 to escape but prevents the entry of O_2.

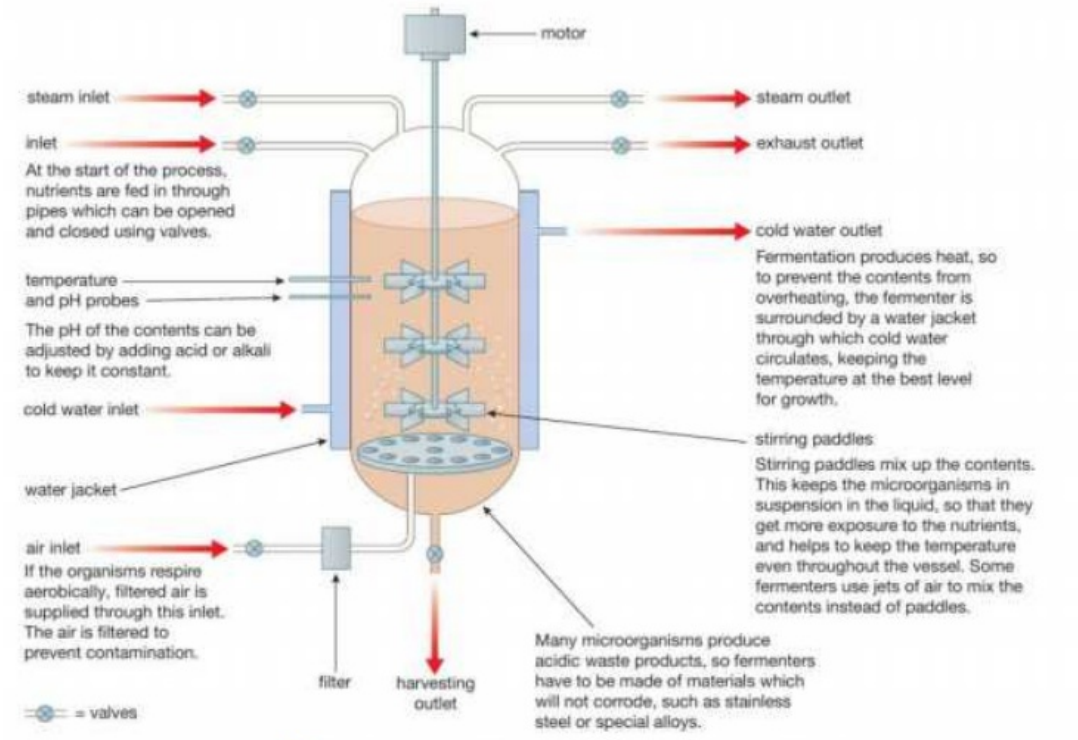
b.Beer:

- Is made from barley. It contains starch rather than sugars.
- When the barley seeds start to germinate they produce the enzyme amylase, which breaks down starch into sugar maltose.
- The maltose from the seeds is fermented by **yeast.**

Industrial fermenters:

-Fermenters are containers used to grow microorganisms in large amounts.

-The advantage of using a fermenter is that conditions can be carefully controlled to produce large quantities of exactly the right type of microorganism.



▲ Figure 21.8 An industrial fermenter. Fermenters like this are used to make many products, such as the antibiotic penicillin.

Controlling conditions in an industrial fermenter table

Condition	Why and how is it controlled?
Aseptic precautions	Fermenter is cleaned by steam to kill microorganisms and prevent chemical contamination, which ensures only the desired microorganisms will grow
Nutrients	Nutrients are needed for use in respiration to release energy for growth and to ensure the microorganisms are able to reproduce
Optimum temperature	Temperature is monitored using probes and maintained using the water jacket to ensure an optimum environment for enzymes to increase enzyme activity (enzymes will denature if the temperature is too high or work too slowly if it is too low)
Optimum pH	pH inside the fermenter is monitored using a probe to check it is at the optimum value for the particular microorganism being grown. The pH can be adjusted, if necessary, using acids or alkalis
Oxygenation	Oxygen is needed for aerobic respiration to take place
Agitation	Stirring paddles ensure that microorganisms, nutrients, oxygen, temperature and pH are evenly distributed throughout the fermenter

Note: If the inside of the fermenter and the new nutrients are not sterile two problems are likely to develop:

1. Unwanted microorganisms may enter and compete with the desired microorganism for nutrients. This can reduce the product yield.
2. The product would become contaminated with waste products.

To avoid this, aseptic precautions are essential. These include **filtering the air** and sterilizing the fermenter using hot steam under high pressure.

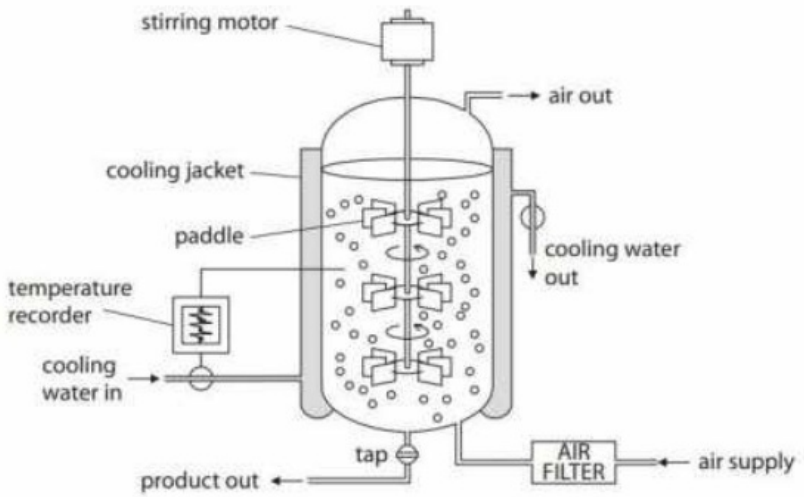
Activity 1:

Study from the book pages 283 + 284

Past papers questions:

Question 1:

The diagram shows a fermenter used to grow microorganisms.



(a) Explain how temperature is controlled in the fermenter.

(2)

temperature recorder / eq;
cooling jacket / cooling water / water in if hot / eq;

(b) Explain why temperature must be controlled in the fermenter.

(2)

respiration produces heat;
enzymes;
denatured / destroyed / eq;
optimum;
best growth / maximum growth / more product / eq;
microorganisms killed / eq;

(c) Explain the purpose of the paddles in the fermenter.

(2)

mixing / distributing oxygen / air; for respiration; mixing / distributing nutrients / microorganisms; for growth; mixing / distributing heat / temperature; for respiration / enzymes;	

(d) Other than temperature, name **one** condition that needs to be controlled in a fermenter and state why it needs to be controlled.

(2)

pH / acidity / alkalinity; enzymes; oxygen; respiration; (other) microorganisms / sterility; competition / contamination / less product / eq;	mark in discrete pairs ignore air

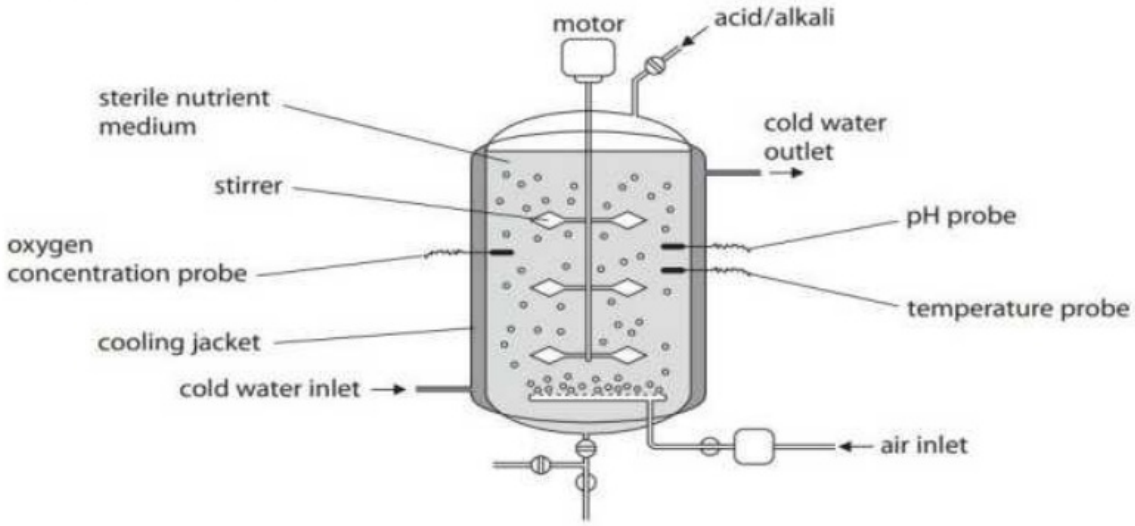
(e) Name a product that could be produced in this type of fermenter.

(1)

insulin / penicillin / antibiotic / *Fusarium* / mycoprotein / any named GM product / eq;	ignore bacteria / fungus / cheese / yoghurt / beer / ethanol / medicine

Question 2:

(d) The diagram shows part of a fermenter used to grow large numbers of genetically modified bacteria.



(i) Suggest how the air inlet helps the genetically modified bacteria to grow.

(2)

(d)	(i)	1. oxygen / aerobic ; 2. respiration;

(ii) If the pH probe stops working the pH in the fermenter becomes more acidic.

Describe and explain how this affects the production of human insulin.

(4)

(ii)	1. less/no insulin / less production; 2. fewer bacteria / kill bacteria / eq; 3. enzymes; 4. (not) optimum pH; 5. denatured / changed active site / destroyed;