### Chapter 21 - Monera (Bacteria)

<table>
<thead>
<tr>
<th>3.1 Diversity of Organisms</th>
<th>Learning Objectives</th>
</tr>
</thead>
</table>
| **3.1.3 Monera (Bacteria)** | 1. Identify the three main types of bacterial cells and examples of each.  
                              | 2. Identify the basic parts (structure) of bacterial cells.  
                              | 3. Discuss the methods of bacterial reproduction.  
                              | 4. Discuss bacterial nutrition and the factors affecting growth, with emphasis on growth curves.  
                              | 5. Explain the term "pathogenic".  
                              | 6. Explain examples of any two beneficial and any two harmful bacteria in terms of economic importance.  
                              | 7. Define and give the role of "antibiotics".  
                              | 8. Discuss the potential abuse of antibiotics in medicine.  
                              | 9. Mention the prokaryotic nature of bacteria.  
                              | 10. Draw and explain the growth curves of micro-organisms.  
                              | 11. Describe batch and continuous flow food processing. |

**Microbiology:** The study of microbiology

**Characteristics**

- Bacteria are prokaryotes (lack nucleus)
- They are unicellular
- Genome consists of DNA & plasmids
- They have no membrane-bound organelles (nucleus, mitochondria or chloroplasts)
- Found free in nature in both terrestrial and aquatic environments (capable of survival at extreme temperature and pH)

**Structure**

**Cell wall:** Made of Peptidoglycan (Sugars & protein)

**Mesosome:** Infolding of membrane (function is respiration)

**Plasmid:** Circular DNA may be present, gives beneficial traits, passes between bacteria

**Flagellum/Capsule:** Enable movement

![Diagram of bacterial cell structure](image)
Types of bacteria

- Round – called coccus
- Rod – called bacillus
- Spiral – called spirillum

Reproduction

Bacteria reproduce asexually by **binary fission**.

Stages:

- DNA replicates and the cell elongates
- The replicated DNA moves apart
- Ingrowths occur in the cell wall.
- The cell splits and two identical cells are formed

Variation & Evolution

- Because bacteria reproduce asexually, there is no variation like in other kingdoms.
- If a single mutation occurs, that is beneficial the bacteria will survive and reproduce passing the mutation on to all future generations.
- Plasmids can also be transferred and replicated to allow bacteria to evolve, this is how they develop antibiotic resistance.

Endospores

- Some bacteria can withstand harsh and unfavourable conditions (eg. Lack of food, water, high temperatures) by producing endospores
- Endospores are formed when bacterial chromosome replicates and one of the new strands become enclosed by a tough walled endospore.
- Endospores can withstand lack of food, water and high temperatures.

Nutrition

**Nutrition** is the way an organism gets its food
Factors affecting growth:

1. **Temperature**
   - Most bacteria grow well at temperatures between 20-30°C
   - Some bacteria can tolerate higher temperatures without their enzymes being denatured.
   - Low temperatures slow down the rate of bacterial growth

2. **Oxygen concentration**
   - *Aerobic bacteria* - require oxygen for respiration e.g. streptococcus
   - *Anaerobic bacteria* - do not require oxygen to respire e.g. clostridium
   - *Facultative anaerobes* - can respire with or without oxygen e.g. E-coli
   - *Obligate anaerobes* - can only respire in the absence of oxygen e.g. tetanus

3. **pH**
   - Bacterial enzymes work best at specific pH values.
   - Most bacteria grow at pH 7

4. **External solute concentration**
   - Bacteria gain or lose water by osmosis
   - If the external solution has higher solute concentration than the bacterial cytoplasm, water will move out of the bacteria.
   - If the external solution has lower solute concentration than the bacterial cytoplasm, water will enter the bacteria.

5. **Pressure**
   - Growth of most bacteria is inhibited by high pressure.

**Economic importance of bacteria**

**Benefits**

- Bacteria such as lactobacillus are used to convert milk into yoghurt, cheese etc.
- Genetically modified bacteria e.g. E-coli are used to make insulin, drugs, vitamins etc.

**Disadvantages**
- Bacteria cause human, plant and animal diseases e.g TB, meningitis, food poisoning etc.
- Bacteria cause food to decay. E.g. Lactobacillus causes milk to sour.

**Antibiotics**

Antibiotics are compounds produced by micro-organisms that stop the growth of, or kill, other micro-organisms without damaging human tissue.

**Note:** Antibiotics do not affect viruses.

- Bacterial strains have emerged that are resistant to almost all known antibiotics. These are said to be multi-resistant. E.g. MRSA

**Abuse of Antibiotics**
- Repeated exposure to antibiotics enables resistant strains of bacteria to evolve. Over time these antibiotic-resistant bacteria reproduce and their population numbers increase. This makes antibiotics less effective.
- Failure to complete treatment of antibiotics allows bacteria to survive and grow.
- The more antibiotics used the more likely it is that bacteria will become resistant.

**Growth curve of Bacteria**

![Growth curve of Bacteria](image)

A- **Lag phase** - bacteria adapt to their environment
B- **Log phase** - bacteria are reproducing at their maximum due to ideal conditions - plenty of food, space & oxygen
C- **Stationary phase** - Increased competition for food, space & oxygen keeps bacteria numbers constant
D- **Decline phase** - bacteria die due to lack of food, space & oxygen and build-up of toxins.
E- **Survival phase** - a small number of bacteria may survive as endospores. These endospores survive until conditions are favourable.
Bioprocessing involves using living things or parts of living things to produce useful products.

- Modern bioprocessing – use bacteria to produce a wide range of food etc. E.g. yoghurts, cheese, vitamins, alcohols
- The use of bacteria/fungi to produce edible forms of protein is called single-cell protein production.

Methods of fermentation:

1. Batch culture
   - A fixed amount of sterile nutrient is added to the bioreactor
   - The micro-organisms go through the lag, log and stationary phases.
   - The nutrients are used up and the product is formed.
   - At the end of the process the bioreactor is cleared out. The product is purified. The bioreactor is then cleaned and sterilised

2. Continuous flow:
   - Nutrients are continuously fed into the bioreactor, at the same time the culture medium is continuously withdrawn.
   - Micro-organisms are maintained at the log stage of growth.
     (all conditions must be kept constant)

Advantages of batch culturing over continuous flow

- Easier to control compared to continuous culture.
- The product may be needed only in small amounts.
- The product may be needed only at particular times (not continuously)
- Large volumes formed allow for losses when the product is purified.