

WEEK NINE

SUBJECT: BIOLOGY

CLASS: SS1

TOPIC: MICRO-ORGANISMS IN AIR AND WATER

Specific Objectives: By the end of the lesson, students should be able to:

1. Define micro-organisms
2. Mention types of micro-organisms with specific examples
3. State the various methods used for identification of micro-organisms
4. Describe an experiment to show that micro-organisms are found in air
5. List various micro-organisms found in air, water and human body
6. Explain an experiment to show that cockroach or housefly are carriers of micro-organisms
7. Explain the growth curve for micro-organisms
8. Mention the beneficial effects of micro-organisms
9. List the harmful effects of micro-organisms
10. Mention various diseases caused by micro-organisms and the various pathogens that cause the diseases

Micro-organisms are those organisms which cannot be seen with our naked eyes. They can only be seen with an aid of microscope. They are also referred to as **germs** or **microbes** and are found everywhere in nature (in air, water and soil; on surfaces of objects; on living and within living organisms). Most micro-organisms are disease-causing agents known as **pathogens** while a lot are also beneficial to us in nature because they bring about decay of organic matter. Many of these organisms are also useful in manufacturing processes.

Types of micro-organisms

1. **Viruses:** These are organisms without cell structure (without nucleus, cytoplasm and cell membrane). They can only be seen under an electron microscope. Examples include poliovirus, small pox virus, Human Immuno -Deficiency Virus (HIV).
2. **Bacteria:** Are unicellular organisms, larger than viruses. The largest is about 12microns (0.001millimetre) long and about 1.5microns in width. They have simple cell structure where nucleus is not enclosed in a membrane e.g *Stapylococcus aureus*, *Vibrio cholerae*
3. **Protozoa:** These are microscopic and unicellular animals found in both marine and fresh water and in damp soil, they are larger than bacteria and have a complex cell wall

structure with a nucleus that is enclosed within a membrane. E.g *Amoeba proteus*, *Paramecium caudatum*, *Plasmodium* species

- 4. Some fungi:** Fungi are non-green simple plants. They adopt mostly the parasitic and saprophytic mode of nutrition. They reproduce by means of **spores**. Examples include: *Mucor*, *Penicillium*, yeast e.g *Candida albicans*
- 5. Some algae:** Algae are also larger than bacteria. They possess chlorophyll and are photosynthetic. Examples include: *Anabaena*, *Spirogyra*, *Volvox*, *Oscillatoria*.

Identification of Micro-organisms

- 1. Use of microscope:** The form and structure of micro-organisms are observed through a microscope. A light microscope is used for most micro-organisms (magnification 1000x); while for studying viruses electron microscope (magnification 1000000x) is used.
- 2. Staining techniques:** Micro-organisms are stained with different types of stains and their reactions observed under the microscope, simple stains include methylene blue and crystal violet. A differential stain known as Gram stain differentiates bacteria into two groups:
 - Gram positive bacteria that picks up the purple colour
 - Gram negative bacteria that shows red colour
- 3. Culture technique:** Culture is the technique used in laboratory to study micro-organisms using special media. The characteristics of colonies formed on various types of culture media are noted. Examples of such culture media include: Nutrient agar, MacConkey agar, Blood agar, Eosin Methylene Blue agar etc.
- 4. Biochemical tests:** These help to determine the activities of micro-organisms and so help to identify those that look very similar. E.g sugar fermentation test to determine organisms that ferment sugars and also produce acid and/or gas.

MICRO-ORGANISMS IN AIR

Micro-organisms, naturally do not grow in air. However, the dust and water droplets in air contain these organisms. Examples of organisms found in the air include:

- Virus e.g common cold virus, measles virus, polio virus, influenza virus, coronavirus etc
- Bacteria e.g *Staphylococcus*, *Streptococcus*, *Bacillus anthracis*, *Mycobacterium tuberculosis* (causes tuberculosis in humans)
- Fungi e.g *Penicillium*, *Rhizopus* (black or bread mould), *Aspergillus*, *Saccharomyces* (yeast).

EXPERIMENT

Aim: To show that micro-organisms are present in air.

Method:

- Get a nutrient agar medium and a sterilized petri-dish. Nutrient agar mixture is a suitable growth medium or culture medium for micro-organisms.
- Pour the nutrient agar into a petri-dish and allowed to solidify and cool
- Open the petri dish and expose to air for 30 minutes.
- Cover the dish and place in the laboratory at room temperature for 4 days.
- Another petri-dish containing agar mixture which was not opened to air is also kept. This acts as a **control**.

Result/observation: The petri-dish that was exposed to air when opened contained some coloured patches. On examination under the microscope, the coloured patches contain bacteria and fungi (*Mucor* and yeast).

No patches will be seen on the petri-dish that was not exposed to air.

Conclusion: Micro-organisms are present in the air.

MICRO-ORGANISMS IN WATER (POND, RIVER, STREAM)

Aquatic environment are rich in both organic and inorganic nutrients and support a wide variety of bacteria, blue green algae, protists and fungi. Examples of groups of organisms found in water include:

a. Natural water micro-organisms

- Bacteria: aquatic species of coccus, *Bacillus*, *Pseudomonas*, *Thiobacillus*, *Vibrio*, *Azotobacter*
- Blue green algae: *Nostoc*, *Anaebena*
- Protists: *Chlamydomonas*, some species of *Euglena*, heterotrophic *Amoeba* and *Paramecium*
- Algae: green algae e.g *Spirogyra* and *Volvox*
- Fungi: e.g mould, mildew

b. Soil and sewage micro-organisms: that find their way into water bodies. E.g nitrogen fixing bacteria, *Streptomyces*, certain fungi, adenoviruses, non-pathogenic bacteria like *Escherichia coli*, *Clostridium welchii*, pathogenic bacteria like *Vibrio cholera* and *Salmonella typhi*

MICRO-ORGANISMS IN OUR BODIES

Micro-organisms begin to colonize human body just after birth. By the time the infant gets to adulthood, numerous bacteria, yeast, protozoa are already established in and on the body. These micro-organisms are known as **normal micro-flora** of the human body. Examples of normal micro-flora and the body parts where they can be found include:

- Mouth e.g *Streptococcus* species, *Staphylococcus* species, *Candida* species
- Skin: *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus pyogenes*
- Intestine: *Lactobacillus*, *Streptococcus faecalis*, *Escherichia coli*, *Clostridium* species
- Urinogenital tract: *Mycobacterium smegmatis*, *Sreptococcus* species

Pathogenic Micro-organisms in the body

Pathogenic micro-organisms are those micro-organisms that establish themselves in our bodies and cause diseases. Example

- *Clostridium tetani* (found in the soil): This enters the body through cuts and wounds
- Influenza virus: Enters through the nose and mouth
- Ringworm fungi: Enters through direct contact

EXPERIMENT

Aim: To show that micro-organisms are present in the dirt under the fingernail.

Method:

- Using a sterilized knife, scrape the dirt under the finger nail into a petri-dish.
- Add five drops of distilled water into the petri-dish and stir properly with a sterilized needle
- Spread the solution on the surface of a nutrient agar mixture in a petri-dish A. In petri-dish B containing nutrient agar mixture, add few drops of distilled water and spread well. This acts as the **control experiment**.
- Cover both petri-dishes A and B and kept at the laboratory at room temperature for 3 days.

Results:

Coloured patches are seen on petri-dish A. A view of a methylene blue stained temporary slide (made from the coloured patches) under the microscope revealed rod and round shaped bacteria. Also fungi such as *Mucor* and *Rhizopus* can also be identified. No coloured patches were observed in petri-dish B.

Conclusion: Micro-organisms are present in dirt under the fingernails.



Figure 1: Experiment to show that micro-organisms are present under the finger nail.

CARRIERS OF MICRO-ORGANISMS

Non-living carriers of micro-organisms: These are non-living agents that carry micro-organisms from one place to another. They are also called **vehicles** which include air, water and food.

Vectors: these are living agents that carry and transmit pathogenic micro-organisms. Examples of vectors that carry microbes are discussed in the table below.

Vector	Parts of the vector that carry microbe	Micro-organisms they carry
Housefly	Leg, mouthparts, wing, hairs	<i>Salmonella typhi</i> <i>Shigella</i> species <i>Vibrio cholera</i> <i>Entamoeba histolytica</i> <i>Escherichia coli</i>
Cockroach	Leg, wing, mouthparts	<i>Pseudomonas</i> species <i>Escherichia coli</i> <i>Proteus</i> species <i>Streptococcus faecalis</i>
Mosquito	Mouthparts, saliva	<i>Plasmodium</i> species, virus
Tsetse fly	Mouthparts, saliva	<i>Trypanosoma</i>

EXPERIMENT

Aim: To show that housefly or cockroach carries micro-organisms

Method:

- Get two petri-dishes, wash and clean them thoroughly.
- Pour a sterilized nutrient agar inside the petri-dishes and allow to solidify.
- Get either cockroach or housefly and put inside one of the petri-dishes
- Allow the insect to walk round the petri-dish
- After sometime open the petri-dish and allow the insect to fly away
- Cover the petri-dish and allow to stay for 1-3 days

Result:

Coloured patches representing colonies of micro-organisms will grow on the particular petri-dish where you added housefly or cockroach while the other petri-dish will remain as before i.e no growth of colonies on it.

Conclusion:

Housefly or cockroach is a carrier of micro-organism.

GROWTH OF MICRO-ORGANISMS

Growth of micro-organisms refers to increase in population size, i.e the number of individuals rather than the cell size. Micro-organisms grow and multiply by binary fission. For example, a bacterium can divide every 20 minutes and this time interval is known as **doubling/generation time**. This generation time depends on environmental factors like availability of food, space,

adequate temperature. If the growth of a bacterium e.g Escherichia coli is plotted against time, the resulting growth curve is shown below:

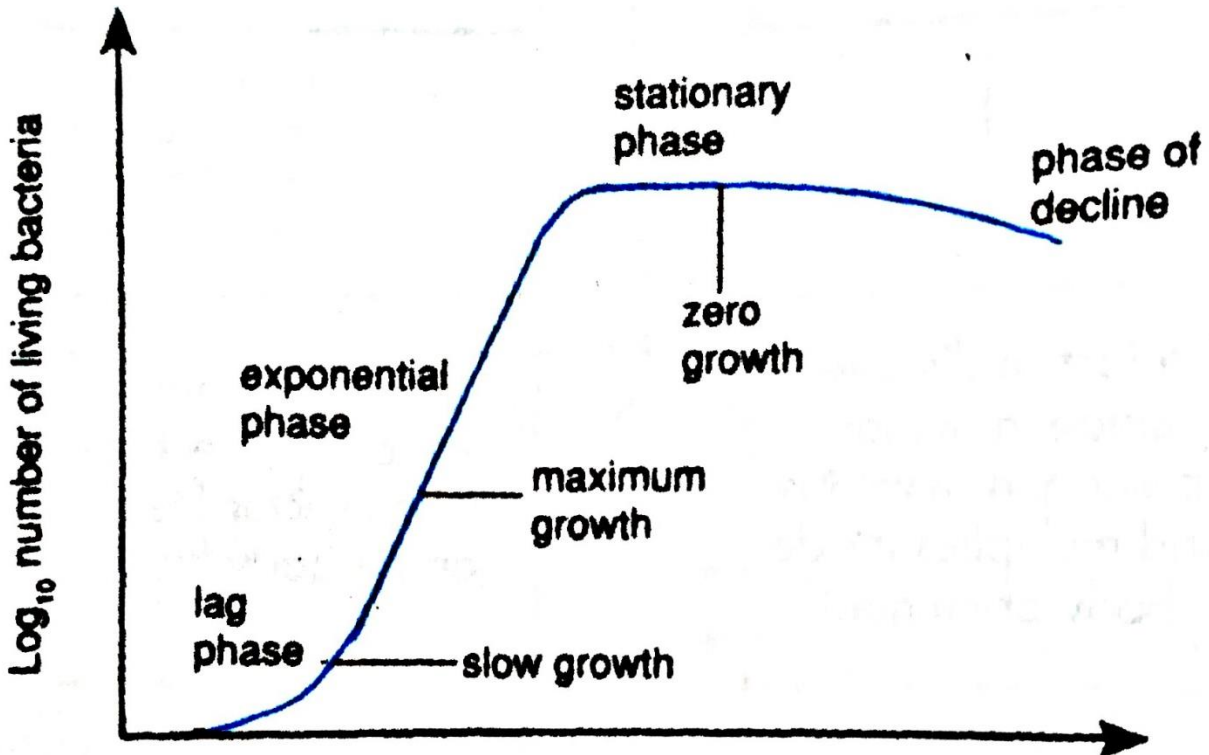


Figure 2: Typical growth curve of a bacterial population

The growth can be observed by inoculating the micro-organism in a liquid culture medium, and the turbidity measured using **spectrophotometer** at regular intervals of time.

The resulting growth curve shows:

Initial slow growth phase(Lag phase): In this phase it takes the organism time to adjust to new environment.

Exponential phase: Growth rate is maximum at this point.

Stationary phase: As a result of increase in population, there arises a competition for food and space and the organism ceases to grow.

Phase of decline: due to increase in toxic wastes and decrease in food, cells stop dividing and dormant cells die; causing a decline in growth rate.

BENEFICIAL EFFECTS OF MICRO-ORGANISMS

Many micro-organisms are beneficial in the following ways:

1. In nature, they function as decomposers and primary producers. Many saprophytic bacteria and fungi convert dead remains of organisms and their wastes into **humus** which improves soil fertility.

2. Useful in sewage disposal: During this process, pathogens are killed as they are out-competed by saprophytic microbes that decompose sewage into harmless inorganic compounds.
3. Used in industry and medicine. For example Bacillus which is used to produce proteases or amylases to dissolve biological stains in detergents. Micro-organisms are also used in the production of antibiotics like penicillin by *Penicillium notatum* and streptomycin by *Streptomyces griseus*.
4. Several micro-organisms are used in food industries for the production of butter, cheese, yoghurt, bread, wine, palm wine etc.

HARMFUL EFFECTS OF MICRO-ORGANISMS

Somemicro-organisms are harmful to humans in two ways:

- By causing food spoilage and
- By causing diseases

These organisms that cause diseases are called **pathogens** and can spread through air, water, food, direct skin contact and animal vectors.

DISEASES CAUSED BY MICRO-ORGANISMS

Some important diseases of humans are discussed in the table below:

Disease	Pathogen	Method of spread	Symptoms
Measles	Paramyxovirus	Air	Sharp cough, headache, rashes, fever
Cholera	<i>Vibrio cholerae</i>	Food and water contaminated with faeces of flies	Vomiting, diarrhoea leading to dehydration
Typhoid fever	<i>Salmonella typhi</i>	Same as cholera	High temperature then bloody diarrhoea
Amoebic dysentery	<i>Entamoeba histolytica</i>	Food and water contaminated with amoebic cyst and faeces	Heavy vomiting, diarrhea, abdominal pains
Malaria	<i>Plasmodium</i> species	Bite of infected <i>Anopheles</i> mosquito	Chills, fever, sweating, headache, loss of appetite, nausea

Tuberculosis	<i>Mycobacterium tuberculosis</i>	Breathing in an infected air or dust, drinking milk from infected cattle	Chronic cough, fever in the afternoon, sweating at night, coughing up blood
Syphilis	<i>Treponema pallidum</i>	Direct contact through sexual intercourse	Thick yellowish discharge, burning sensation during urination
Poliomyelitis	Piconavirus	Contaminated food and water with faeces, droplet infection during coughing and sneezing of polio patient	High fever, headache, nausea, stiffness of limbs, paralysis of the lower extremities and the muscles of the respiratory tract
Trypanosomiasis/ sleeping sickness	<i>Trypanosoma gambiense</i>	Bite of infected tsetse fly	Fever, headache, lymph glands swollen at the neck, semi consciousness, meningitis
Ringworm/ Eczema	Fungi (dermatophytes)	Direct contact	Yellowish patches on the skin, itching
Rabies	Rhabdo virus (an RNA virus)	Breaks in the skin through bites of infected dogs, cats	High fever, headache, sore throat, convulsions

Evaluation

1. Define micro-organisms.
2. Mention 4 types of micro-organisms.
3. Mention 2 methods used for identification of micro-organisms.
4. Mention 2 organisms each that are present in the following environment
 - a. Air
 - b. Water
 - c. Human body
5. Describe an experiment to show that housefly carry micro-organisms.
6. Explain the lag phase and exponential phase of the growth curve of micro-organisms.
7. State 2 beneficial effects of micro-organisms

8. Mention 2 harmful effects of micro-organisms
9. Mention 4 diseases that are caused by micro-organisms.

Assignment

1. Outline two major ways you can grow micro-organisms for study
- 2a) Name the organism that WHO declared pandemic since March 2020
- b) Which group of micro-organisms does the pathogen mentioned above belong to?
- c) Mention the type of illness the pathogen presents
- d) Which part/system of the body is severely affected if somebody is seriously affected by the organism?
- e) Mention two ways the spread of the pathogen can be controlled
3. Micro-organisms are ubiquitous in nature.
- a) Are they all harmful?
- b) Use one sentence to support your answer in (3a) above