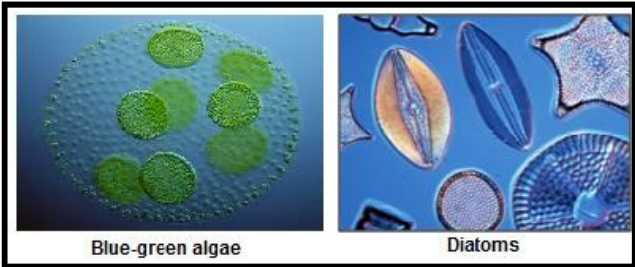



Microorganisms: Friend and Foe

Microorganisms

- Organisms too small to be seen with our naked eyes are called **microorganisms** or **microbes**.
- They can only be seen using a microscope.
- Microorganisms are found in a variety of habitats such as air, soil and water.
- They can live and survive in extreme environments, from ice cold regions to hot springs, from deserts to marshy lands.
- Some microorganisms are useful to us in many ways. They are called **beneficial microbes**. Example: Bacterium *Rhizobium* helps in nitrogen fixation.
- Some microorganisms cause diseases in plants, animals and human beings. They are called **pathogens**. Example: *Anthrax* bacillus causes anthrax in animals.
- Robert Hooke and Anton Van Leeuwenhoek discovered the existence of microbes during the period 1665 - 1683.

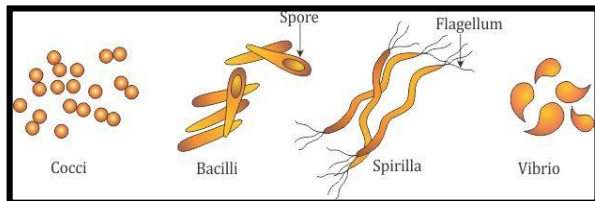
Major Groups of Microorganisms

GROUP	DESCRIPTION
Algae  <p>Blue-green algae Diatoms</p>	<ul style="list-style-type: none"> Found on walls, in fields and in small puddles. May be unicellular or multicellular with a size of $1\ \mu\text{m}$ - $1\ \text{m}$. <i>Oscillatoria</i>, <i>Nostoc</i> and <i>Anabaena</i> are examples of this type of algae. Sexual reproduction occurs by conjugation.
Fungi 	<ul style="list-style-type: none"> Grows on stale bread, chapati, pickles, damp clothes and shoes in monsoon. Respires aerobically or anaerobically. Lives a saprophytic or parasitic life. <i>Mucor</i>, <i>Rhizopus</i> and <i>Aspergillus</i> are examples of fungi.
Protozoa	<ul style="list-style-type: none"> <i>Amoeba</i>, <i>Paramecium</i> and <i>Plasmodium</i> are examples of protozoa. <i>Amoeba</i> has an irregular shape. Locomotion occurs through pseudopodia. <i>Paramecium</i> is slipper shaped.



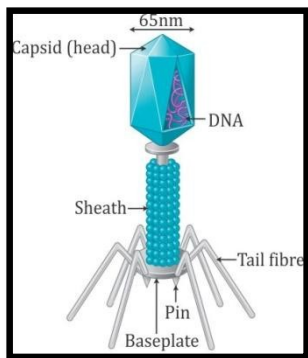
- It has numerous cilia for locomotion.
- *Plasmodium* is a protozoan living a parasitic life. It is responsible for the spread of malaria.

Bacteria



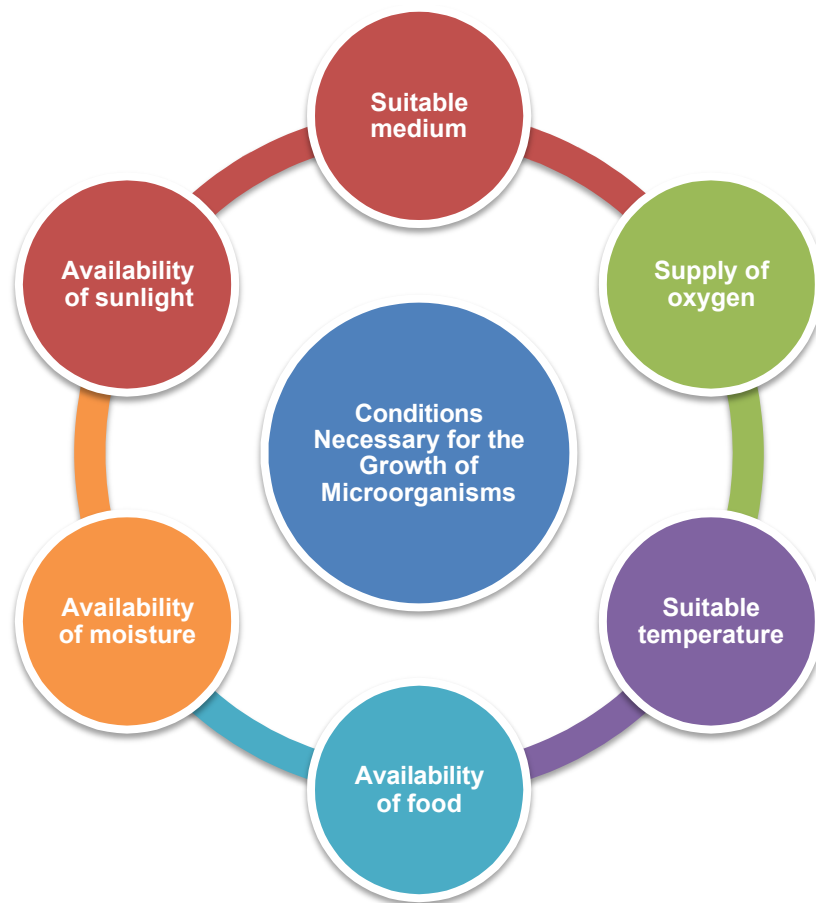
- Found in any kind of environment from deserts to Polar Regions.
- Range in size is from 0.2 to 10 μ .
- Reproduces sexually and asexually.
- Respires aerobically or anaerobically.
- Main types of bacteria according to their shape are Coccus, Bacillus, Vibrio and Spirillum.
- *Rhizobium* and *Lactobacillus* are examples of bacteria.

Virus



- Smallest microorganisms which can grow and develop only inside the host cell.
- In free-living form, viruses are like non-living particles.
- Viruses are classified into three types based on the type of host they infect.
- Examples:
Animal viruses: Foot and Mouth Disease Virus (FMDV)
Plant viruses: Tobacco Mosaic Virus (TMV)
Bacteriophage: Coliphage infecting *Escherichia coli*

Conditions Necessary for the Growth of Microorganisms



Useful Microorganisms

Increasing soil fertility

- Some bacteria and fungi act as decomposers and decompose dead and decaying matter and help in recycling nutrients back to the soil.

Cleaning the environment

- Microorganisms decompose complex organic matter such as waste of vegetables, fruits, plants and animals, and convert them into simpler substances, thereby cleaning the environment.

Retting of fibres

- Some bacteria carry out the process of loosening of fibres of plants by rotting, also called retting.

Tanning of leather

- During tanning, the bacteria attack the skin of animals. The protein structure of the skin undergoes a permanent alteration. This makes them soft and pliable and the skin is converted into leather.

Food industry

- Yeast helps in the commercial production of beer, wine and other alcoholic drinks by fermenting fruit juices, malted grains or molasses.
- Yeast is often used in the baking industry for making breads, pastries and cakes.
- Bacteria find application in the making of curd.
- Algae are a rich source of wholesome and nutritious food.

Production of antibiotics

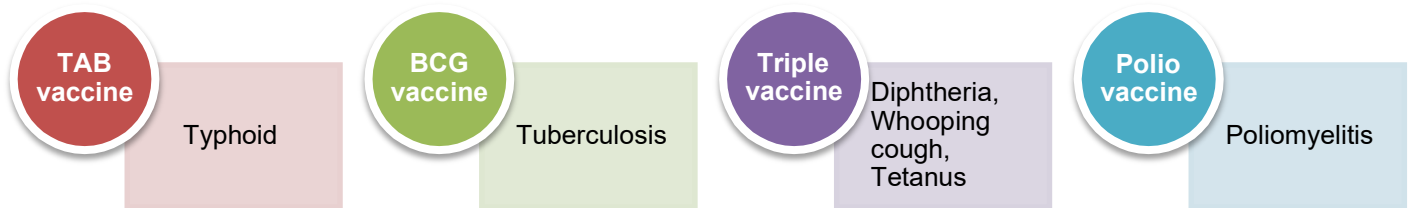
- Antibiotics are manufactured by growing specific microorganisms to treat a wide variety of diseases caused by pathogenic microorganisms.

Production of vaccines

- Vaccines are made on a large scale from microorganisms to protect human beings and other animals from several diseases.

- The first antibiotic penicillin was discovered by Alexander Fleming in 1929.
- Fungus *Penicillium notatum* produces penicillin.

Some Important Vaccines



Harmful Microorganisms

- Pathogens can successfully cause disease due to the following factors:
 - Ability to multiply fast.
 - Ability to destroy tissues of the body of other organisms.
 - Ability to produce toxins which affect certain organs of the host.

Communicable Diseases

- Microbial diseases which can spread from an infected person to a healthy person through air, water, food, physical contact or through vectors are called **communicable diseases**. Examples: Tuberculosis, chickenpox.
- The insects or other animals which transmit disease causing microorganisms to humans without themselves getting infected are called **carriers**. Examples: Housefly, mosquito.

Important discoveries

Alexander Fleming: Discovered penicillin in 1929

Louis Pasteur: Discovered fermentation in 1857

Edward Jenner: Discovered vaccine for smallpox in 1798

Robert Koch: Discovered bacterium *Bacillus anthracis* in 1876

Some of the Common Human Diseases Caused by Microorganisms

Disease	Causative microorganism	Mode of transmission	Preventive measures
Measles	Virus	Air	<ul style="list-style-type: none"> • Dirty, humid or overcrowded habitats should be avoided. • Vaccination should be given at the appropriate age.
Chickenpox	Virus	Air/Contact	
Polio	Virus	Air/Water	
Tuberculosis	Bacteria	Air	
Hepatitis A	Virus	Water	<ul style="list-style-type: none"> • Drink boiled drinking water. • Personal hygiene, cleanliness of the surroundings and consumption of well-cooked, nutritious food. • Vaccination should be given at the appropriate age. • Population of mosquitoes should be reduced or eliminated.
Typhoid	Bacteria	Water	
Cholera	Bacteria	Water/Food	
Amoebiasis	Protozoa	Water/Food/Flies	
Malaria	Protozoa	Mosquito bite	

Common Animal Diseases caused by Microorganisms

Disease	Animal affected	Causative microorganism
Anthrax	Cattle, sheep, elephant	Bacteria
Diphtheria	Guinea pigs, kittens, rabbits	Bacteria
Dysentery	Monkeys	Bacteria
Plague	Rats, squirrels, rabbits, guinea pigs	Bacteria
Tuberculosis	Monkeys, dogs, parrot, cattle	Bacteria
Lung necrosis	Adult cattle	Fungi
Foot and mouth disease	Split hooved animals	Virus
Swine flu	Pigs	Virus

Some Common Plant Diseases Caused by Microorganisms

Disease	Plant affected	Causative microorganism
Angular leaf spot	Cotton	Bacteria
Blight Canker	Paddy	Bacteria
Rust	Wheat	Fungi
Smut	Barley, wheat, oats, sugarcane, forage grasses	Fungi
Ergot	Corn, rye, wheat, bajra, barley	Fungi
Tikka disease	Groundnut	Fungi
Blast	Rice, ragi	Fungi
Late blight disease	Potato, tomato, black pepper, vanilla	Fungi
Sheath blight disease	Paddy	Fungi
Ring spot disease	Sugarcane	Fungi
Red rot disease	Sugarcane	Fungi
Yellow vein mosaic disease	Okra	Virus

Prevention of Communicable Diseases

Mouth and nose should be covered with a handkerchief while sneezing or coughing.

Uncovered roadside foods should not be consumed.

Food should be kept covered to protect it from getting infected by flies.

We should protect ourselves from mosquito bites by using mosquito nets or applying mosquito repellent creams.

Only boiled water must be consumed.

One must avoid sharing towels and combs.

There should not be stagnant water or open garbage dumps in the locality.

Food Poisoning

- Spoilage of food by the action of microorganisms is called **food poisoning**.
- It mostly occurs due to consumption of food spoilt by fungi and bacteria.
- When these organisms come in contact with food, they decompose it and release chemical toxins. This contaminates or spoils food.

Food Preservation

Food preservation is the process of treating and handling food in order to stop or slow down its spoilage while maintaining its nutritional value, texture and flavor.

Advantages of food preservation

- Reduces wastage of food
- Helps to transport food to distant places
- Helps to store food for use in seasons when they are not available

Principles of food preservation

- Keeping out food from the reach of microorganisms
- Removing microorganisms
- Inhibiting the growth of microorganisms
- Killing of microorganisms

Methods of food preservation

- Boiling
- Salting
- Adding sugar
- Dehydration (Drying)
- Irradiation
- Pasteurization
- Refrigeration
- Chemical preservatives

Methods of Food Preservation

Boiling

- Boiling water kills all bacteria. Higher temperatures (110°C) kill spores

Salting

- Biodegradation is prevented under normal conditions

Preservation by sugar

- Reduces the moisture content which inhibits the growth of bacteria

Dehydration (Drying)

- Inhibits growth of microbes

Irradiation

- Radioactive or ultraviolet radiation kills microorganisms

Pasteurisation

- Heating to a temperature of about 60°C for 30 min and then chilling kills bacteria

Refrigeration

- Inhibits growth and multiplication of microbes

Chemical preservatives

- Sodium benzoate increases the concentration of solutes causing plasmolysis and death of bacteria and mould.

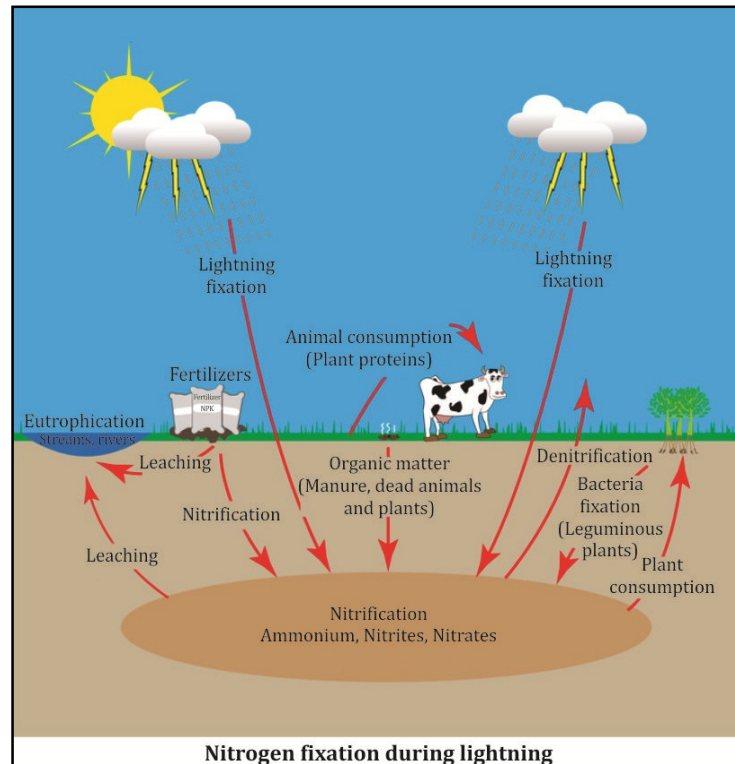
Nitrogen Fixation

- The process of converting nitrogen gas of the atmosphere into compounds of nitrogen which can be used by plants is called **nitrogen fixation**.
- **By nitrogen-fixing bacteria:** Ammonia is converted to nitrates by nitrifying bacteria.
- **By *Rhizobium* bacteria:** *Rhizobia* live in the root nodules of leguminous plants. They convert free nitrogen from the atmosphere into soluble nitrates.
- **By blue-green algae:** They fix nitrogen gas into ammonia, nitrates and nitrites.
- **By lightening:** During lightning, nitrogen and oxygen from the atmosphere combine to form nitrogen oxides which react with rainwater and form dilute nitric acid. Nitric acid reacts with the minerals present in the soil and forms nitrate.

Nitrogen Cycle

- The process of circulation of nitrogen between the atmosphere, soil, plants and animals is called the **nitrogen cycle**.
- Atmospheric nitrogen is fixed by biological nitrogen fixers as well as through physical processes such as lightning.

Nitrogen Fixation during Lightning



Oxides of nitrogen formed during lightening mix with rain water to form nitric acid. Nitric acid when mixes with minerals in the soil for nitrates.

Plants take up these nitrates and convert them into proteins. Animals consume plants.

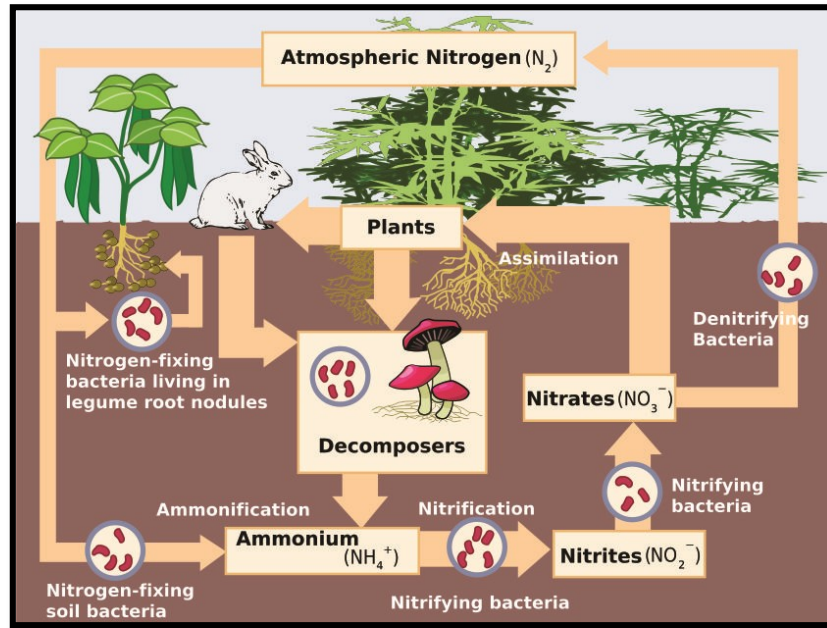
When plants and animals die, nitrogenous compounds present in their bodies are broken down into ammonia by ammonification.

Nitrifying bacteria such as *Nitrosomonas* convert this ammonia into nitrates by nitrification. Nitrates are stored in humus.

Sometimes nitrates are converted into molecular nitrogen by denitrifying bacteria *Pseudomonas*.

Due to constant recycling of nitrogen, the percentage of nitrogen in the atmosphere remains more or less constant.

Biological Nitrogen Fixation



Bacteria such as *Rhizobium* which live in the root nodules of leguminous plants convert free nitrogen into soluble nitrates.

This process makes the soil with nitrogen and increases its fertility.
In return these bacteria get shelter from plants.

Some bacteria such as *Azotobacter* convert inorganic molecular nitrogen into amino acids and proteins.

Nitrogenous wastes from dead plants are converted back into ammonia by bacteria such as *Clostridium spp.*

Then ammonia is converted into nitrites by *Nitrosomonas* bacteria, and then into nitrates by *Nitrobacter*.

Nitrification is followed by denitrification, wherein nitrates are converted into nitrogen gas (N_2) by the action of denitrifying bacteria. The nitrogen gas is then released into the atmosphere.