BHARATHIDASAN UNIVERSITY

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Programme: M.Sc., Biomedical Science

Course Title : Microbiology

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Unit-I

History of Microbiology

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Introduction to Microbiology, History & scope

• Microbiology:

- In the broadest sense, **microbiology** is the study of all organisms that are invisible to the naked eye-that is the study of **microorganisms**.
- Its subjects are viruses, bacteria, many algae and fungi, and protozoa.
- The importance of microbiology and microorganisms can not be overemphasized.
- Microorganisms are necessary for the production of bread, cheese, beer, antibiotics, vaccines, vitamins, enzymes, etc.
- Modern **biotechnology** rests upon a microbiological foundation.

• Microorganisms:

- Microorganisms are everywhere; almost every natural surface is colonized by microbes, from body to ocean. Some microorganisms can live hot springs, and others in frozen sea ice.
- Most microorganisms are harmless to humans; You swallow millions of microbes every day with no ill effects. In fact, we are dependent on microbes to help us digest our food.
- Microbes also keep the biosphere running by carrying out essential functions such as decomposition of dead animals and plants. They make possible the cycles of carbon, oxygen, nitrogen and sulfur that take place in terrestrial and aquatic systems.
- Microorganisms have also harmed humans and disrupted society over the millennia.

- They sometimes cause diseases in man, animals and plants. They are involved in food spoilage.
- Infectious diseases have played major roles in shaping human history (decline of Roman Empire & conquest of the New World.
- The "Great Plague", reduced population of western Europe by 25%.
- Smallpox and other infectious diseases introduced by European explorers to the Americas in 1500's were responsible for decimating Native American populations.
- Until late 1800's, no one had proved that infectious diseases were caused by specific microbes.

• **Discovery of Microorganisms:**

- Invisible creatures were thought to exist long before they were observed.

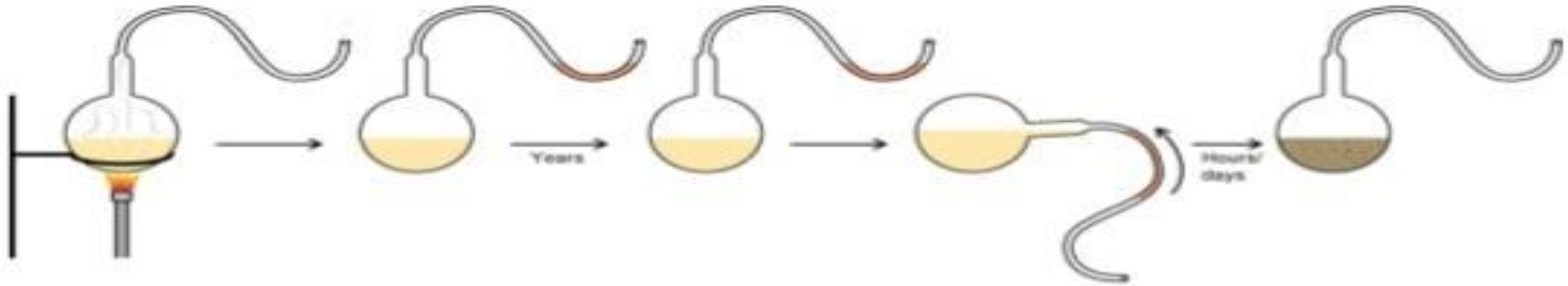
- **Antony van Leewenhoek** (1632 – 1723) who invented the first microscope (50 – 300x), was the first to accurately observe and describe microorganisms.

- **Spontaneous Generation Conflict:**

- From earliest times, people believed that Living organisms could developed from nonliving or decomposing matter.

- The SGT was challenged by Redi, Needham, Spallanzani

- **Louis Pasteur** (1822-1895) settled the conflict once for all; heated the necks of flasks and drew them out .



- **Role of Microorganisms in Disease:**

- **Bassi** – showed that silkworm disease was caused by a fungus.

- **Berkeley** and **Pasteur** showed that Microorganisms caused disease.

- **Joseph Lister** – developed system for sterile surgery

- **Robert Koch** (1843 – 1910) established the relationship between *Bacillus anthracis* and anthrax; also isolated the bacillus that causes tuberculosis.

- **Charles Chamberland** (1851-1908) discovered viruses and their role in disease.

- **Koch's Postulates:**

- Microorganism must be present in every case of the disease but absent from healthy individuals.

- The suspected microorganism must be isolated and grown in pure cultures.

- The disease must result when the isolated microorganism is inoculated into a healthy host.

- The same microorganism must be isolated from the disease host.

- **Isolation of Microorganisms:**

- During Koch's studies, it became necessary to isolate suspected bacterial pathogens.

- He cultured bacteria on the sterile surfaces of cut, boiled potatoes → Not satisfactory.

- Regular liquid medium solidified by adding gelatin → gelatin melted @ T>28∞C.

- Fannie Eilshemius suggested use of agar; 100∞C to melt, 50 ∞C to solidify.

- Richard Petri developed petri dish, a container for solid culture media.

- **Louis Pasteur** (1822 – 1895):

- Developed **vaccines** for Chickenpox, anthrax, rabies

- Demonstrated that all fermentations were due to the activities of specific yeasts and bacteria.

- Developed **Pasteurization** to preserve wine during storage. Important: Foods

- Discovered that **fermentative microorganisms** were **anaerobic** and could live only in absence of oxygen.

• **Other Developments…**

- **Winogradsky** made many contributions to soil microbiology; discovered that soil bacteria could oxidize Fe, S and ammonia to obtain energy.

- Isolated Anaerobic nitrogen-fixing bacteria; studied the decomposition of cellulose.

- Together with **Beijerink**, developed the **enrichment-culture** technique and the use of **selective media**.

- Early 40's, **Microbiology** established closer relationship with **Genetics** and **Biochemistry**; microorganisms are extremely useful experimental subjects.

- e.g. Study of relationship between genes and enzymes; evidence that DNA is the genetic material;

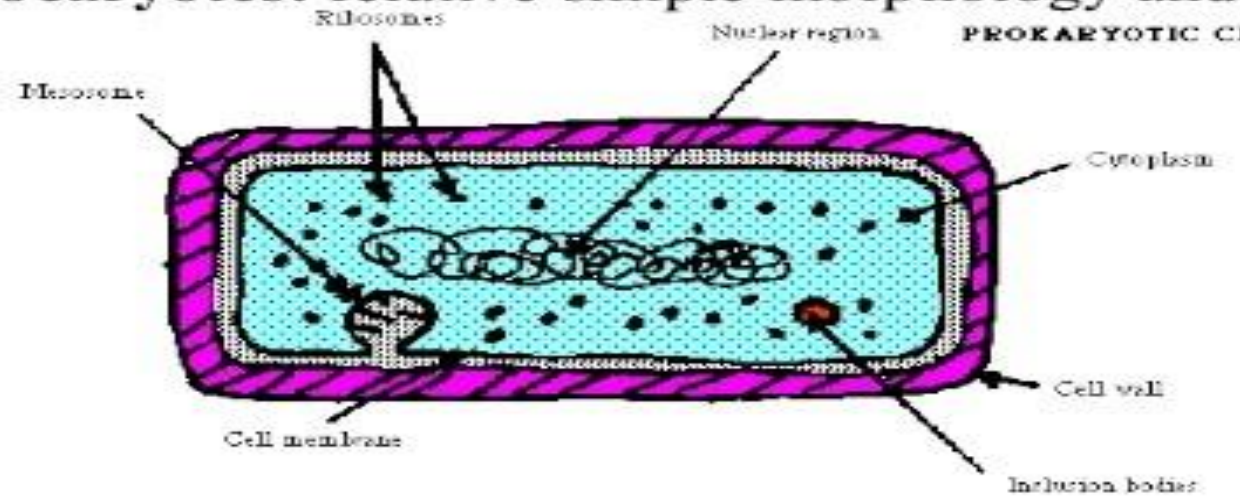
- Recently, **Microbiology** been a major contributor to the rise of **Molecular Biology.**

- Studies on Genetic code; mechanisms of DNA, RNA, and Protein synthesis; regulation of gene expression; control of enzyme activity.

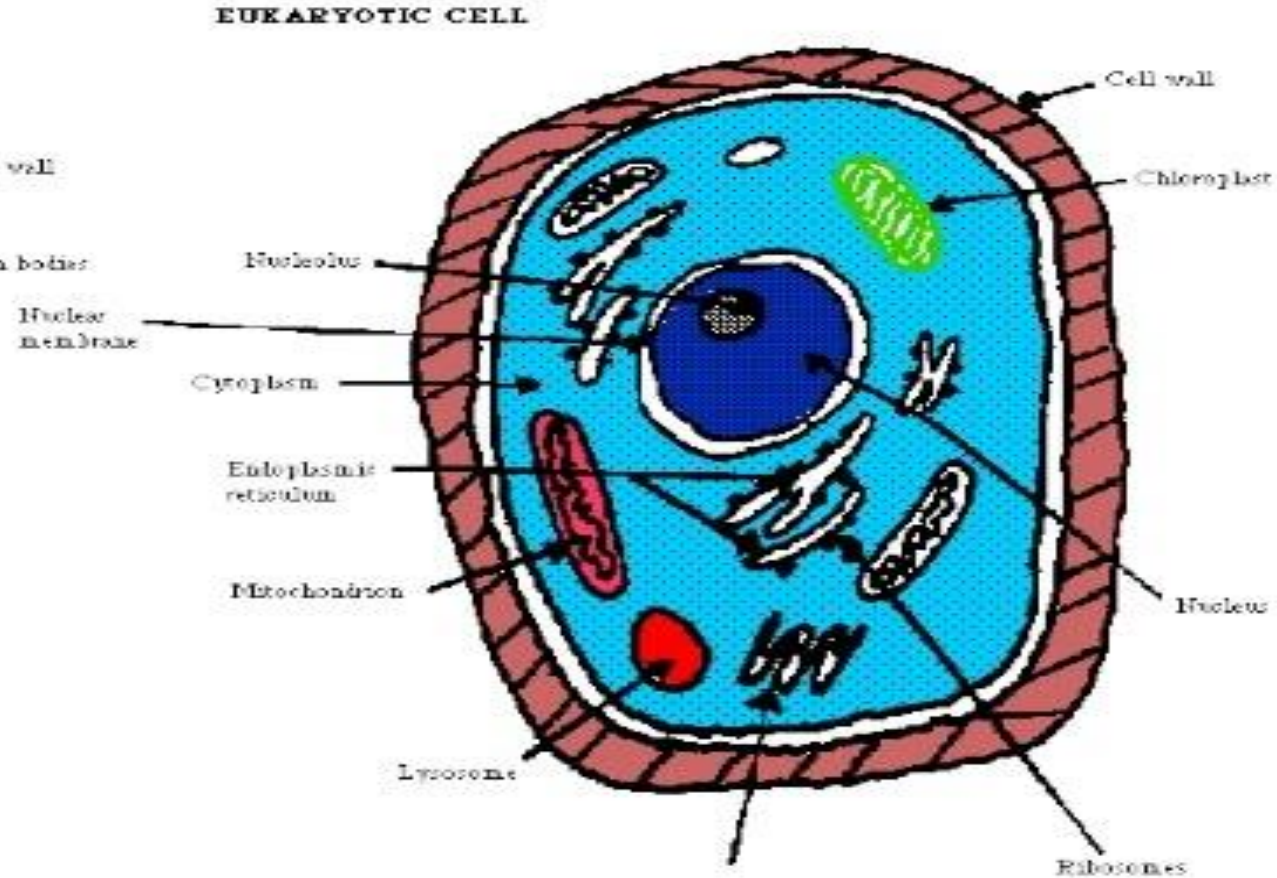
- Development of **Recombinant DNA Technology** and **Genetic Engineering**.

- **Composition of the Microbial World:**

- **Procaryotes:** relative simple morphology and lack true membrane delimited nucleus



- **Eucaryotes:** morphologically complex with a true membrane enclosed nucleus



- Organisms divided into 5 **Kingdoms:**

  - **Monera** – all procaryotes
  - **Protista** – unicellular or colonial eucaryotic cells lacking true tissues; includes algae, protozoa & simpler fungi
  - **Fungi** – eucaryoutic; includes molds, yeasts and mushrooms
  - **Plantae** – multicellular
  - **Animalia** - multicellular

- **Scope of Microbiology:**

- Microbiology has an impact on medicine, agriculture, food science, ecology, genetics, biochemistry, immunology, and many other fields.

- Many microbiologists are primarily interested in the biology of microorganisms, while others focus on specific groups;

- Virologists - viruses

- Bacteriologists - bacteria

- Phycologists – algae

- Mycologist -fungi

- Protozoologists – protozoa

- **Medical Microbiology:** deals with diseases of humans and animals; identify and plan measures to eliminate agents causing infectious diseases.

- **Immunology:** study of the immune system that protects the body from pathogens.

- **Agricultural Microbiology:** impact of microorganisms on agriculture; combat plant diseases that attack important food crops.

- **Food and Dairy Microbiology:** prevent microbial spoilage of food & transmission of food-borne diseases (e.g. salmonellosis); use microorganisms to make food such as cheeses, yogurts, pickles, beer, etc.

- **Industrial Microbiology:** using microorganisms to make products such as antibiotics, vaccines, steroids, alcohols & other solvents, vitamins, amino acids, enzymes, etc.

- **Genetic Engineering:** Engineered microorganisms used to make hormones, antibiotics, vaccines and other products.

- Since **viruses** are **acellular** and possess both living and nonliving characteristics, they are considered neither prokaryotic nor eukaryotic.

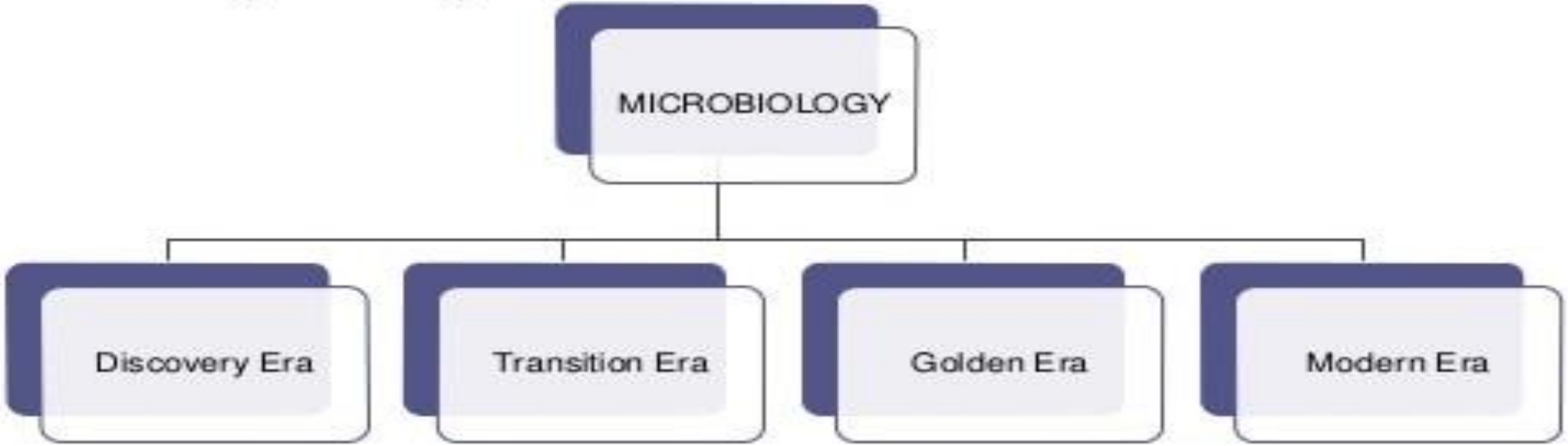
- The principle of biogenesis, which states that all living things come from other living things, seems very reasonable to us today.
- Before the 17th century, however, it was widely thought that living things could also arise from nonliving things in a process called spontaneous generation.

Microbiology is the study of microorganisms / microbes which is visible only with a microscope.

The diverse group of organisms includes algae, archae, bacteria, cyanobacteria, fungi, protozoa, viruses.

Most of the microorganisms are harmless.

99% are good. Eg: Cynobacteria (blue green algae)
1% are bad. Eg: Pathogens



DISCOVERY ERA:

"Spontaneous generation"

Aristotle (384-322) and others believed that living organisms could develop from non-living materials.

In 13th century, Rogen Bacon described that the disease caused by a minute "seed" or "germ".

Antony Van Leeuwenhoek (1632 – 1723)

- Descriptions of Protozoa, basic types of bacteria, yeasts and algae.
- Father of Bacteriology and protozoology.
- In 1676, he observed and described microorganisms such as bacteria and protozoa as "Animalcules".
- The term microbe is used by Sedillot in 1878.

TRANSITION ERA:

Francesco Redi (1626 - 1697)

- He showed that maggots would not arise from decaying meat, when it is covered.

John Needham (1713 – 1781)

- Supporter of the spontaneous generation theory.
- He proposed that tiny organism(animalcules) arose spontaneously on the mutton gravy.
- He covered the flasks with cork as done by Redi, Still the microbes appeared on mutton broth.

Lazzaro spallanzai (1729 – 1799)

- He demonstrated that air carried germs to the culture medium.
- He showed that boiled broth would not give rise to microscopic forms of life.

GOLDEN ERA:

Louis Pasteur

- He is the father of Medical Microbiology.
- He pointed that no growth took place in swan neck shaped tubes because dust and germs had been trapped on the walls of the curved necks but if the necks were broken off so that dust fell directly down into the flask, microbial growth commenced immediately.
- Pasteur in 1897 suggested that mild heating at 62.8°C (145°F) for 30 minutes rather than boiling was enough to destroy the undesirable organisms without ruining the taste of the product, the process was called Pasteurization.

- He invented the processes of pasteurization, fermentation and the development of effective vaccines (rabies and anthrax).
- Pasteur demonstrated diseases of silkworm was due to a protozoan parasite.

Contributions of *Loius pasteur*:

- He coined the term "microbiology", aerobic, anaerobic.
- He disproved the theory of spontaneous germination.
- He demonstrated that anthrax was caused by bacteria and also produced the vaccine for the disease.
- He developed live attenuated vaccine for the disease.

John Tyndall (1820 - 1893)

- He discovered highly resistant bacterial structure, later known as endospore.
- Prolonged boiling or intermittent heating was necessary to kill these spores, to make the infusion completely sterilized, a process known as Tyndallisation.

Lord Joseph Lister (1827-1912)

- He is the father of antiseptic surgery.
- Lister concluded that wound infections too were due to microorganisms.
- He also devised a method to destroy microorganisms in the operation theatre by spraying a fine mist of carbolic acid into the air.

Robert Koch (1893-1910)

- He demonstrated the role of bacteria in causing disease.
- He perfected the technique of isolating bacteria in pure culture.
- Robert Koch used gelatin to prepare solid media but it was not an ideal because

(i) Since gelatin is a protein, it is digested by many bacteria capable of producing a proteolytic exoenzyme gelatinase that hydrolyses the protein to amino acids.

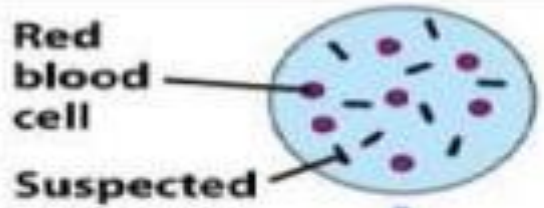
(ii) It melts when the temperature rises above 25°C.

KOCH'S POSTULATES:

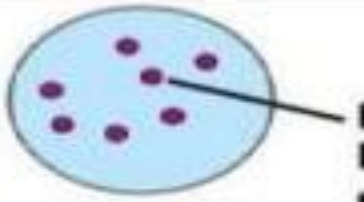
Diseased animal

Healthy animal

1. The suspected pathogenic organism should be present in *all* cases of the disease and absent from healthy animals.



Observe blood/ tissue under the microscope



2. The suspected organism should be grown in pure culture.

Streak agar plate with sample from either diseased or healthy animal

No organisms present

Inoculate healthy animal with cells of suspected pathogen

3. Cells from a pure culture of the suspected organism should cause disease in a healthy animal.

Diseased animal

Remove blood or tissue sample and observe by microscopy

4. The organism should be reisolated and shown to be the same as the original.

Laboratory culture

Pure culture (must be same organism as before)

Fanne Eilshemius Hesse (1850 - 1934)

- One of Koch's assistant first proposed the use of agar in culture media.
- It was not attacked by most bacteria.
- Agar is better than gelatin because of its higher melting pointing (96°c) and solidifying (40 – 45°c)points.

Richard Petri (1887)

- He developed the Petri dish (plate), a container used for solid culture media.

Edward Jenner (1749-1823)

- First to prevent small pox.
- He discovered the technique of vaccination.

Alexander Flemming

- He discovered the penicillin from *penicillium notatum* that destroy several pathogenic bacteria.

Paul Erlich (1920)

- He discovered the treatment of syphilis by using arsenic
- He Studied toxins and antitoxins in quantitative terms & laid foundation of biological standardization.

IMPORTANT DISCOVERIES:

Bacteria:

- Hansen (1874) – Leprosy bacllus
- Neisser (1879) – Gonococcus
- Ogston (1881) – Staphylococcus
- Loeffler (1884) – Diphtheria bacillus
- Roux and Yersin – Diphtheria toxin

Viruses:

- *Beijerinck* (1898) - Coined the term *Virus* for filterable infectious agents.
- *Pasteur* developed Rabies vaccine.
- *GoodPasteur* - Cultivation of viruses on chick embryos.
- *Charles Chamberland*, one of Pasteur's associates constructed a porcelain bacterial filter.
- *Twort and d'Herelle* - Bacteriophages.
- *Edward Jenner* - Vaccination for Smallpox.

MODERN ERA:

Nobel Laureates

Years	Nobel laureates	Contribution
1901	*Von behring*	Dipth antitox
1902	*Ronald Ross*	Malaria
1905	*Robert koch*	Tb
1908	*Metchnikoff*	Phagocytosis
1945	*Flemming*	Penicillin
1962	*Watson, Crick*	Structur DNA
1968	*Holley, Khorana*	Genetic code
1997	*Pruisner*	Prions
2002	*Brenner, Hervitz*	Genetic regulation of organ development &cell death

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THANK YOU