



## Lec.1

### Medical microbiology

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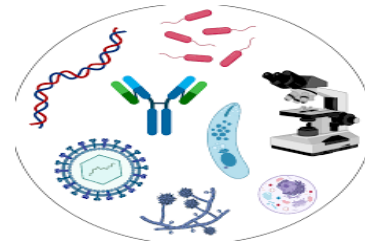
## Introduction to medical microbiology

- **Microbiology:**

is a science of studying micro-organisms that are associated with human disease.

- The importance of microbiology in the world today can be showed by the following list of some of the general areas in which Microbiology is involved:

1. Medicine
2. Environmental science
3. Food and drink production
4. Fundamental research
5. Agriculture
6. Pharmaceutical industry
7. Genetic engineering.



- **Important Figures and dates in Microbiology Science:**

1. Antoni van Leeuwenhoek started out on his pioneering very simple microscope work in 1673.



2. The Italian Francesco Redi (1626–1697) showed in an experiment that the larvae found on meat arose from eggs deposited by flies, and not spontaneously as a result of the decay process.
3. Edward Jenner, during 1796 discovered a method of smallpox vaccination after he noted that dairy workers who contracted cowpox from milking infected cows were resistant to smallpox.
4. Louis Pasteur a French scientist (1822–1895), the most famous figure in the history of microbiology (father of Microbiology), he used his famous swan-necked flasks to proof that contamination with dust lead to spoilage of broth (germ theory) and there is no spontaneous generation. He also used attenuated (weakened) cultures of anthrax and rabies to vaccinate against those diseases and started the first steps in the science of serology. He discovered pasteurization the method of sterilization food mainly dairy products and as preservation method.
5. Joseph Lister is the father of antiseptic surgery, in 1867 he used carbolic acid for the first time to sterilize instruments during surgeries and reduced post-operative infections.
6. The German Robert Koch. In 1876 he discovered (*Mycobacterium tuberculosis* was the causative agent of tuberculosis, which at the time was responsible for around one in every seven human deaths in Europe using simple microscope.
7. Sir Alexander Fleming discovered in 1928 the most common used and the important antibiotic penicillin from the mold *Penicillium notatum*.

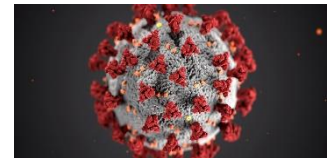


8. Publication of Watson and Crick's structure for DNA in 1953 was an extraordinary achievement that changed the world ever after.
9. Walter Gilbert and Frederick Sanger developed a method for DNA sequencing and that helped in production of recombinant DNA and produce synthetic Insulin in 1979 and first genetic engineered vaccine of Hepatitis B in 1986.

- **There are four classes of organisms that can cause disease:**

1. **Viruses:**

Their size  $< 0.3$  microns in diameter, they are totally dependent on infected cells for replication. They cause intracellular infection.



2. **Bacteria:**

Usually measure about one micron or more, multiply by binary fission, and they can cause intercellular or extracellular infection.



3. **Fungi, these can be of two varieties:**

- a. **Yeasts** are unicellular organisms measuring (2-20) microns.

- b. **Molds** are large multicellular organisms.





**4. Parasites:** these can be of two classes:

**a. Protozoa**, these are unicellular organisms that vary in size, some are very small (about 3 microns) and can cause intercellular infection. Others are large (80 microns) and cause extracellular infection.



**b. Helminthes**, these are multicellular and can reach several meters in lengths.

❖ **Portal of entry**

**Microorganisms that cause disease are said to be pathogenic.**

- Respiratory: via inhalation.
- Alimentary (GIT): by ingestion.
- Genital tract: sexual contact.
- Skin: abrasions, bites...
- Others: Conjunctiva, blood transfusion, injections and organ transplants.
- Congenital infections (vertical transmission) .

❖ **Infection with microorganisms can be:**

**1. Endogenous infection**

When normal patient flora change to pathogenic bacteria because of change of normal habitat, damage of skin and inappropriate antibiotic use.

**2. Exogenous cross-infection**

Mainly through hands of healthcare workers, visitors, patients.



## Classification of Bacteria

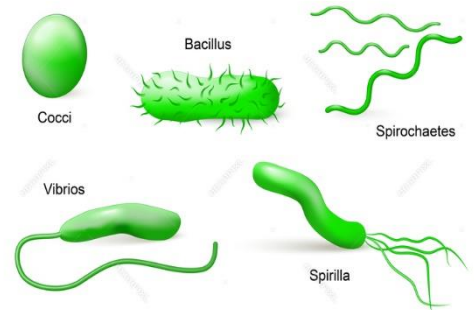
- Bacteria can be classified in many ways. The first classification scheme was published in 1773 and many more have appeared since. Science of microbiology has developed other kind of classification but medically important classification is as follows:

1. Morphological
2. Anatomical
3. Staining
4. Based on pathogenicity
5. Based on relationship of host and organism.
6. Nutrition
7. Environmental factors

### 1- Morphological

Bacteria can be classified according to morphological characteristics like their cell shape, size and structure and their specific arrangement like motility and flagellar arrangement

### SHAPES OF BACTERIA











- Bacteria can be classified into major groups on morphological basis:

**a. True Bacteria**

**1) Cocci** – These are spherical or oval cells. On the basis of arrangement of individual organisms they can be described as :

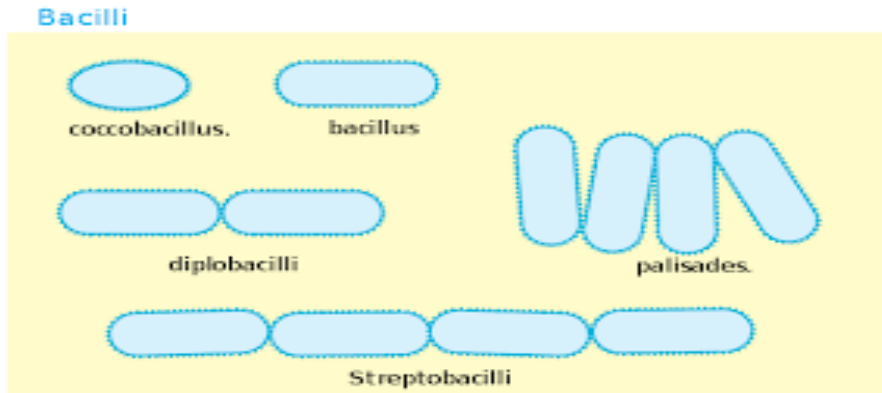
- Monococci (Cocci in singles) – *Monococcus* spp.
- Diplococci (Cocci in pairs) – *Streptococcus pneumoniae*
- Staphylococci (Cocci in grape-like clusters) – *Staphylococcus aureus*
- Streptococci (Cocci in chains) – *Streptococcus pyogenes*
- Tetrad (Cocci in group of four) - *Micrococcus* spp.
- Sarcina (Cocci in group of eight)

	Coccus (single-celled)
	Diplococci (occur in pairs)
	Tetrad (group of four cocci)
	Sarcina (cube-like shape)
	Streptococci (chain-like morphology)
	Staphylococci (grape-like cluster)

**2) Bacilli** – These are rod-shaped bacteria. On the basis of arrangement of organisms, they can be described as

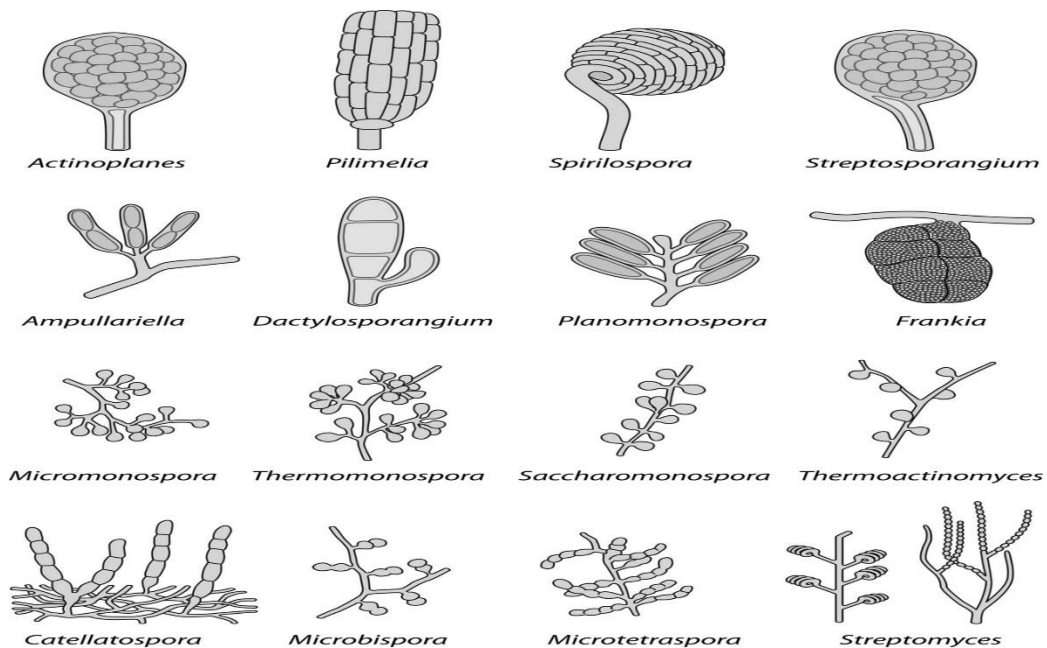
- Diplobacilli
- Streptobacilli
- Palisades

- Chinese-letter form
- Coccobacilli
- Comma-shaped



**b. Actinomycetes** (actin- ray, mykes- fungus)

These are rigid organisms like true bacteria but they resemble fungi in that they exhibit branching and tend to form filaments. They are termed such because of their resemblance to sun rays when seen in tissue sections.







**c. Spirochaetes:** These are relatively longer, slender, non- branched microorganisms of spiral shape having several coils.

**d. Mycoplasmas:** These bacteria lack in rigid cell wall (cell wall lacking) and are highly pleomorphic and of indefinite shape. They occur in round or oval bodies and in interlacing filaments.

**e. Rickettsiae and Chlamydiae :** These are very small, obligate parasites, and at one time were considered closely related to the viruses. Now, these are regarded as bacteria

## 2- Based on anatomical features

a. capsule

- Capsulate– *Streptococcus pneumoniae*
- Non-capsulate – Viridans streptococci

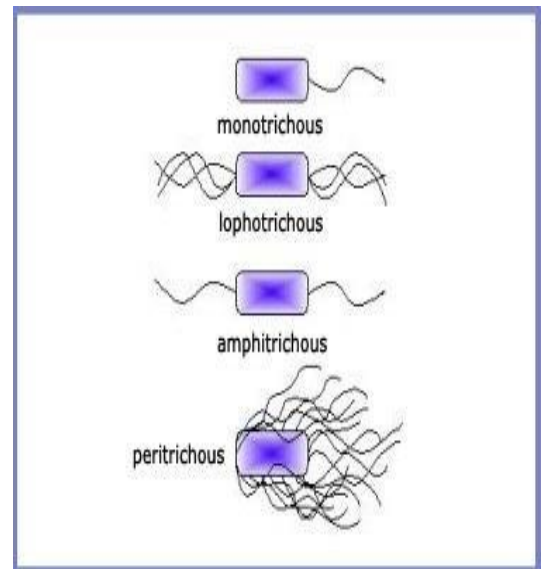
b. Flagella

- Flagellate
  - Monotrichous
  - Lophotrichous
  - Amphitrichous
  - Peritrichous

- Aflagellate -*Shigella* spp.

c. Spore

- Spore-forming – *Bacillus* spp.
- Non-sporing – *Escherichia coli*







### 3- Based on staining reaction

- Gram stain:

- 1) Gram positive: after the gram stain organism which occur violet in color (Gram-positive cocci – *Staphylococcus aureus*) (Gram-positive rods – *Clostridium spp*)
- 2) Gram negative: Which appear pink or red (Gram-negative cocci – *Neisseria gonorrhoeae*) (Gram-negative rods – *E. coli*)

- Acid fast stain:

- 1) Acid fast organism: after the ziehl – neelsen stain it will show pink in color (Acid-fast bacilli – *Mycobacterium tuberculosis*)
- 2) Nonacid fast organism: after this stain organism will appear blue in color (non-acid-fast bacilli – *Staphylococcus aureus*)

### 4- Based on Pathogenicity

- pathogens: the organism which is able to spread disease and can cause disease.
- Non pathogens: which does not cause and disease; e.x: *Lactobacilli*
- Commensals: normally nonpathogenic but sometime they show the disease when immunity impaired

### 5- Based on Relationship of Host and Organism

- saprophytes: free living microbes on dead animals or decaying things that can be found in soil and water and play important role in degradation of organic matter.
- Parasites: that establish themselves and multiply in hosts.



- Commensals: microbes that live in complete live with harmony but they can produce disease when host resistance Is lowered. ex. normal flora organism

## 6- Based on nutrition

- Autotrophs
- Heterotrophs

## 7- Based on Environmental Factors

- A. Temperature
- B. Oxygen dependence
- C. pH
- D. Salt concentration
- E. Atmospheric pressure

### A. Temperature

- Psychrophiles (15-20 °C) – *Pseudomonas fluorescens*
- Mesophiles (20-40 °C) – *Escherichia coli*, *Salmonella enterica*, *Staphylococcus aureus*
- Thermophiles (50-60 °C)- *Bacillus stearothermophilus*
- Extremely thermophiles (as high as 250 °C)

### B. Oxygen dependence

- Aerobe (grow in ambient temperature, which contains 21% O<sub>2</sub> and a small amount of CO<sub>2</sub>, 0.03%)
- Obligate aerobes – Strictly require O<sub>2</sub> for their growth (*Pseudomonas aeruginosa*)



- Microaerophilic (grow under reduced O<sub>2</sub>, 5-10% and increased CO<sub>2</sub>, 8-10%)- *Campylobacter jejuni*,  
*Helicobacter pylori*

### C. PH

- Acidophiles (*Lactobacillus acidophilus*)
- Alkaliphiles (Vibrio)
- Neutralophiles (pH 6-8)
- Majority of the medically important bacteria grow best at neutral or slightly alkaline reaction (pH 7.2-7.6)

### 8- Other ways of classification

- Motile/Non-motile
- Sensitive/Resistant (to particular antibiotic/ chemicals)
- Lactose fermenter/Lactose non-fermenter