Department of biology

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((MICROBIOLOGY))

Stage (2)

LEC- ((3))

Classification of microbiology

By

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Classification of Living Organisms

Taxonomy - field of science which includes:

1. classification (arrangement)
2. nomenclature (naming)
3. identification (description and characterization) of living organisms

Taxa – taxonomic groups where organisms are placed that share certain common characteristics

Species - basic taxon

- a collection of strains with similar characteristics

- especially similarity in their hereditary material or other

features - like morphology and nutritional requirements

Strain - made up of the descendants of a single colony from a pure culture

Linnaean taxonomy

- is the system most familiar to biologists. It uses the formal taxonomic ranks of kingdom, phylum, class, order, family, genus, and species.

- The lower ranks are approved by a consensus of experts in the scientific community. Of these ranks, the family, genus, and species are the most useful.
- Microorganisms have wide taxonomic distribution and include organisms such as protozoa, algae, fungi, bacteria and virus.

Taxonomy Ranks

- Domain
- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- species

Three domains system

- Molecular phylogenies divide all living organisms into three domains – Bacteria (“true bacteria”), Archaea (means ‘ancient’), and Eukarya (eukaryotes: protists, fungi, plants, animals). These domains represent a level of classification that goes even higher than the kingdoms.
- Organisms were divided into five kingdoms: Monera, Protista, Fungi, Animalia, and Plantae, but the five-kingdom system (proposed by Robert Whittaker in 1969) is no longer accepted by microbiologists. Why?
- This is because not all "prokaryotes" are the same and therefore should not be grouped together in a single kingdom. Furthermore, it is currently argued that the term prokaryote is not meaningful and should be abandoned.

Basis of classification

- Phenotypic classification
  - ❖ Morphological
  - ❖ Anatomical
  - ❖ Staining
  - ❖ Cultural characteristics

- ❖ Nutrition
- ❖ Environmental factors
- ❖ Biochemical reactions
- ❖ Antigenic structure

- Genotypic classification
  - ❖ DNA-DNA hybridization
  - ❖ G+C content

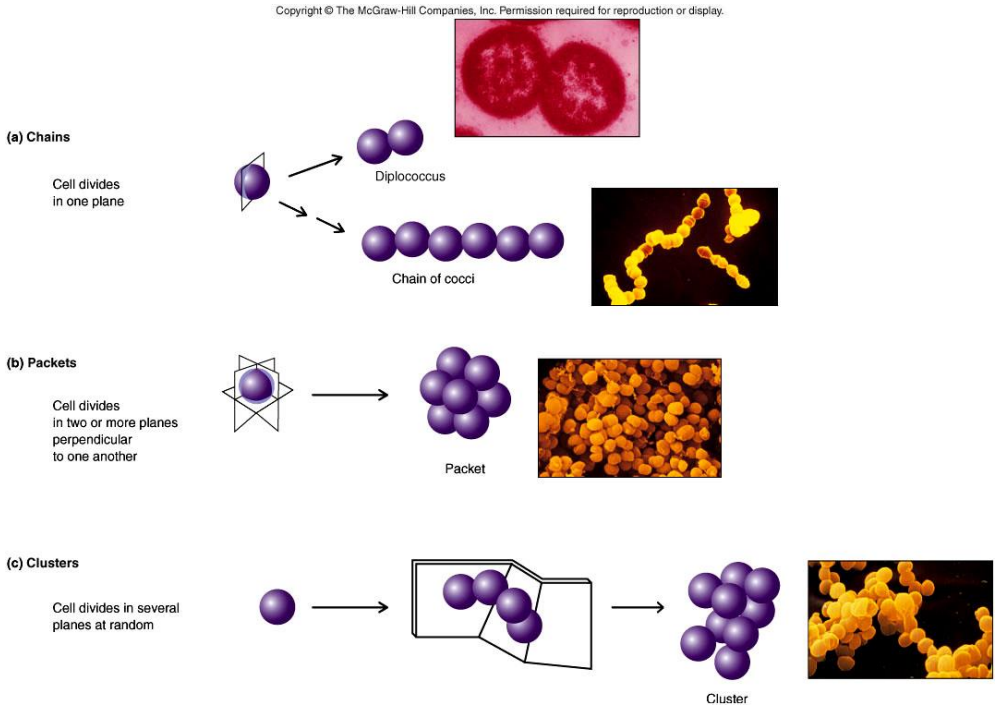
Morphological classification

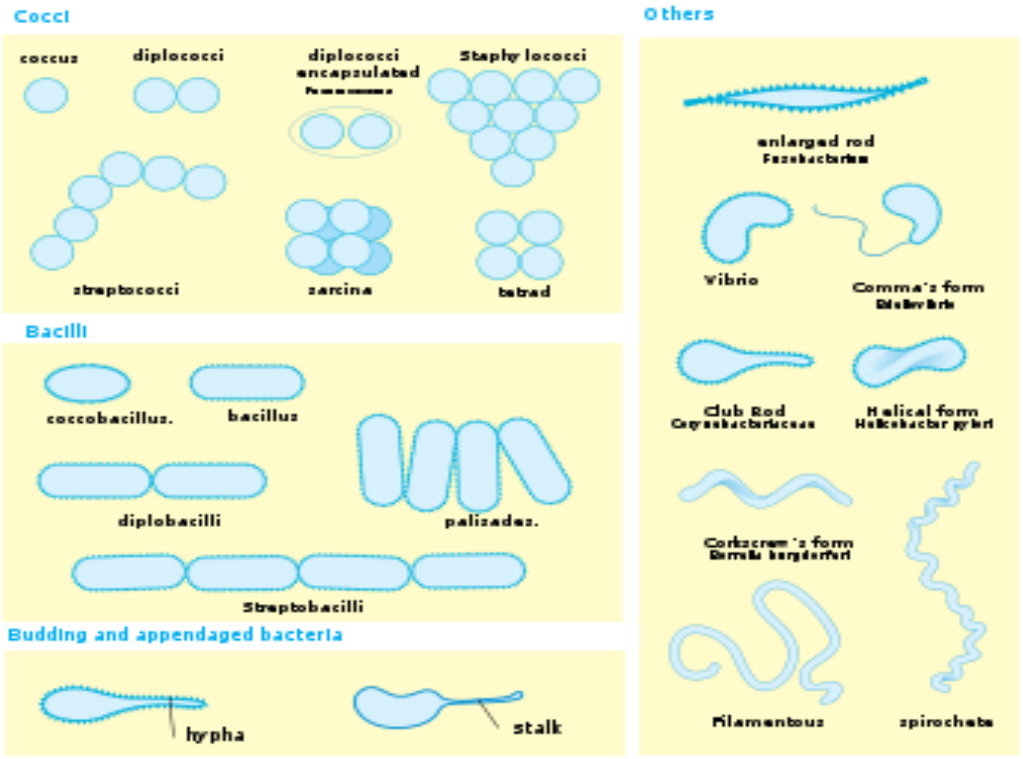
- Bacteria can be classified into **six** major groups on morphological basis.

1. True Bacteria

- **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)



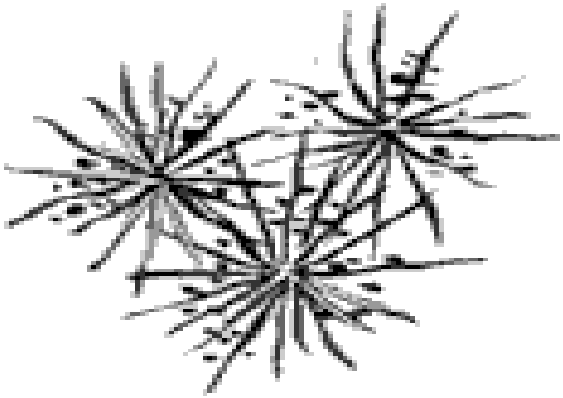


- **Bacilli** – These are rod-shaped bacteria. On the basis of arrangement of organisms, they can be described as
  - **Diplobacilli**
  - **Streptobacilli**
  - **Palisades**
  - **Chinese-letter form**
  - **Coccobacilli**
  - **Comma-shaped**

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

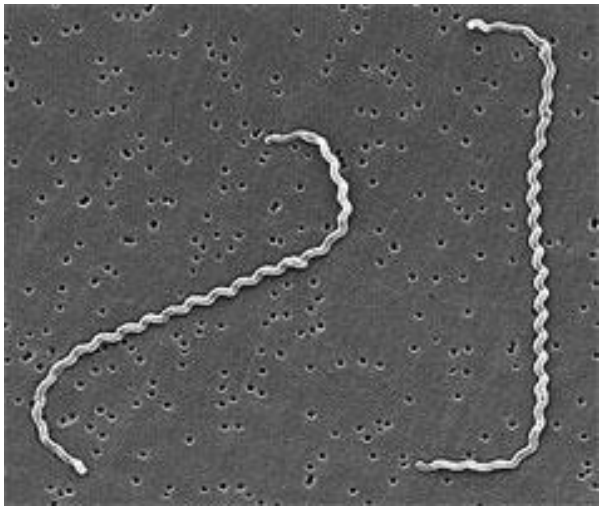
These are rigid organisms like true bacteria but they resemble fungi in that they exhibit branching and tend to form filaments.

They are termed such because of their resemblance to sun rays when seen in tissue sections.



3. Spirochaetes

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



4. 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.

5. 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.

Based on Anatomical features

- Capsule
  - **Capsulate**– *Streptococcus pneumoniae*
  - **Non-capsulate** – Viridans streptococci
- Flagella
  - **Flagellate** –
    - **Monotrichous**
    - **Lophotrichous**
    - **Amphitrichous**
    - **Peritrichous**
  - **Aflagellate** – *Shigella* spp.
- Spore
  - **Spore-forming** – *Bacillus* spp.
  - **Non-sporing** – *Escherichia coli*

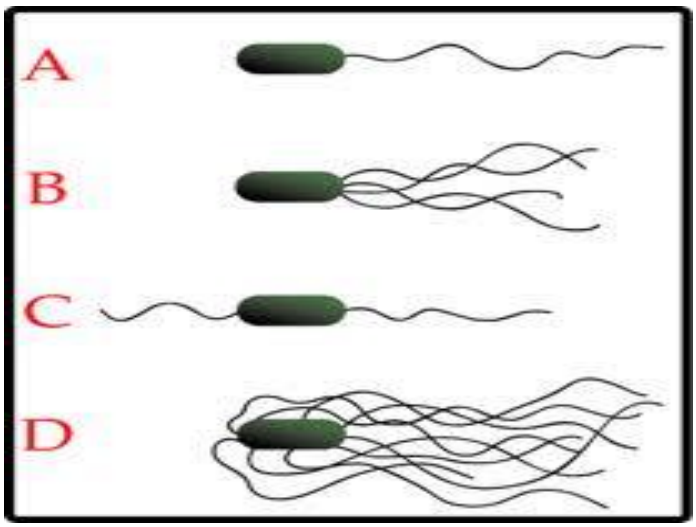
Arrangement of flagella

Monotrichous

Lophotrichous

Amphitrichous

Peritrichous



Based on Staining reaction

- **GRAM'S STAIN**
  - **Gram-positive cocci** – *Staphylococcus aureus*
  - **Gram-negative cocci** – *Neisseria gonorrhoeae*
  - **Gram-positive rods** – *Clostridium* spp.
  - **Gram-negative rods** – *E. coli*
- **ACID FAST STAIN**
  - **Acid-fast bacilli** –*Mycobacterium tuberculosis*
  - **Non-acid-fast bacilli** – *Staphylococcus aureus*

Based on Cultural characteristics

- Extra growth factors requirements
  - **Fastidious** – *Hemophilus influenzae*
  - **Non-fastidious** – *Escherichia coli*
- Hemolysis on Sheep Blood Agar
  - **Alpha-hemolysis** – *Streptococcus pneumoniae*
  - **Beta-hemolysis** – *Streptococcus pyogenes*
- Utilization of carbohydrates
  - **Oxidative** - *Micrococcus*
  - **Fermentative** – *Escherichia coli*
- Growth rate
  - **Rapid growers**– *Vibrio cholerae*
  - **Slow growers** – *Mycobacterium tuberculosis*
- Pigment production
  - **Pigment producer** – *Staphylococcus aureus*
  - **Pigment non-producer** – *Escherichia coli*

Based on Nutrition

- **Autotrophs**
- **Heterotrophs**

Based on environmental factors

- **Temperature**
- **Oxygen dependence**
- **pH**
- **Salt concentration**
- **Atmospheric pressure**

Temperature

- **Psychrophiles** (15-20^{0}C) – *Pseudomonas fluorescens*
- **Mesophiles** (20-40^{0}C) – *Escherichia coli*, *Salmonella enterica*, *Staphylococcus aureus*
- **Thermophiles** (50-60^{0}C)- *Bacillus stearothermophilus*
- **Extremely thermophiles** (as high as 250^{0}C)

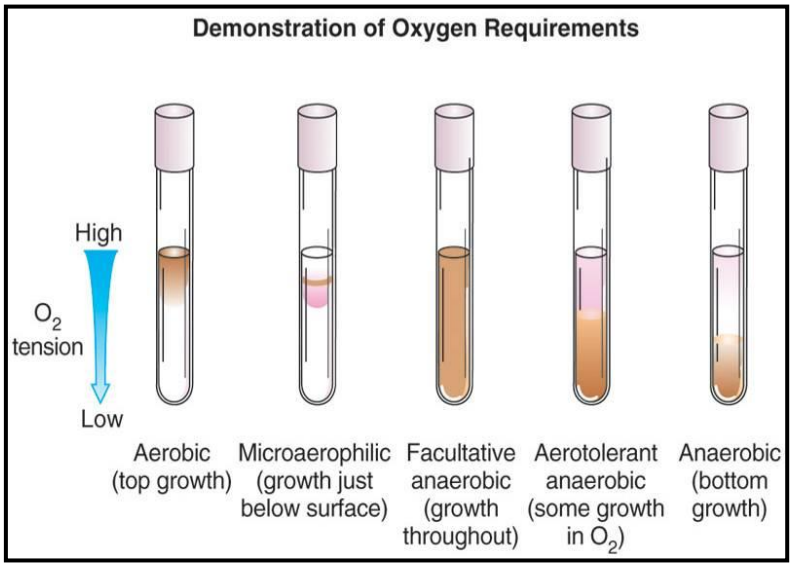
Oxygen dependence

- **Aerobe** (grow in ambient temperature, which contains 21% O_2 and a small amount of CO_2, 0.03%)
- **Obligate aerobes** – Strictly require O_2 for their growth (*Pseudomonas aeruginosa*)
- **Microaerophilic** (grow under reduced O_2, 5-10% and increased CO_2, 8-10%)- *Campylobacter jejuni*, *Helicobacter pylori*
- **Facultative anaerobe** (capable of growing either in presence or absence of O_2)- *E. coli*
- **Obligate anaerobe** – *Clostridium* spp.
- **Capnophilic** (require increased concentration of CO_2, i.e., 5-10%) –

  H. influenzae,

  N. gonorrhoeae

- **Aerotolerant**



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)

Salt concentration

- **Halophiles**
- **Non-halophiles**

Other ways of classification

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