

UNIT-I

Classification of bacteria



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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

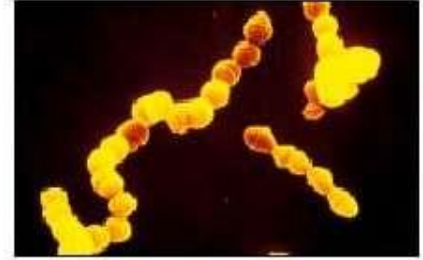
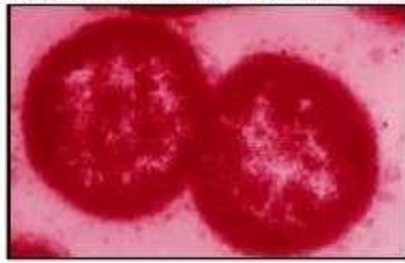
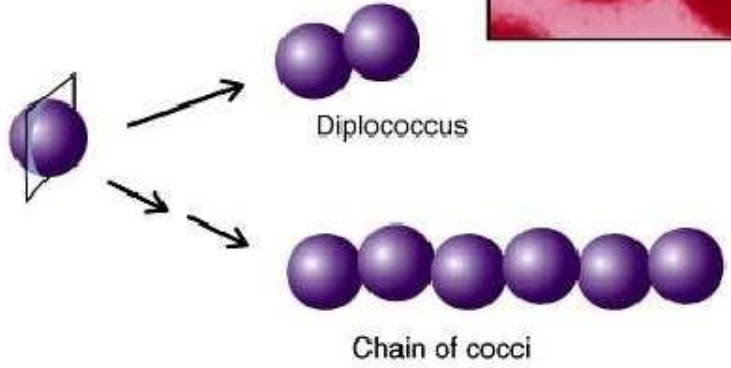
- Bacteria can be classified into **six** major groups on morphological basis.

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)

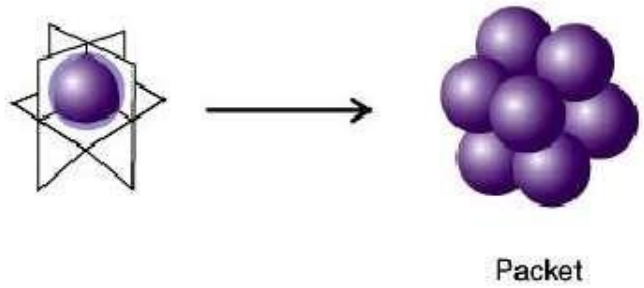
(a) Chains

Cell divides in one plane



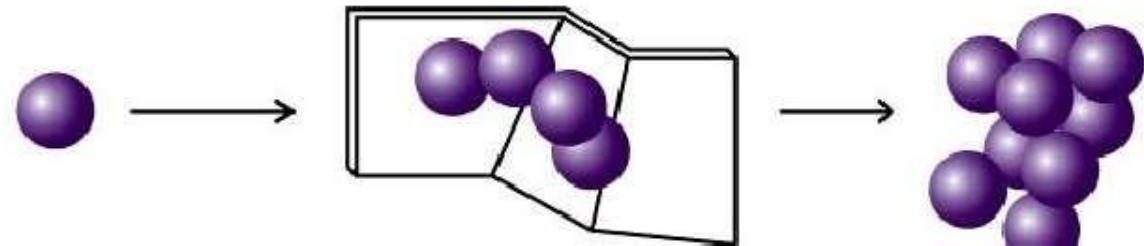
(b) Packets

Cell divides in two or more planes perpendicular to one another



(c) Clusters

Cell divides in several planes at random



Cocci

coccus



diplococci



diplococci
encapsulated

Peptococcus



Staphylococci



streptococci



sarcina

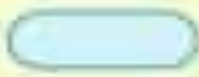


tetrad

Bacilli



coccobacillus.



bacillus



diplobacilli



palisades.



Streptobacilli

Budding and appendaged bacteria



hypha



stalk

Others



enlarged rod
Fusobacterium



Vibrio



Comma's form
Shigella flexneri



Club Rod
Corynebacterium



Helical form
Helicobacter pylori



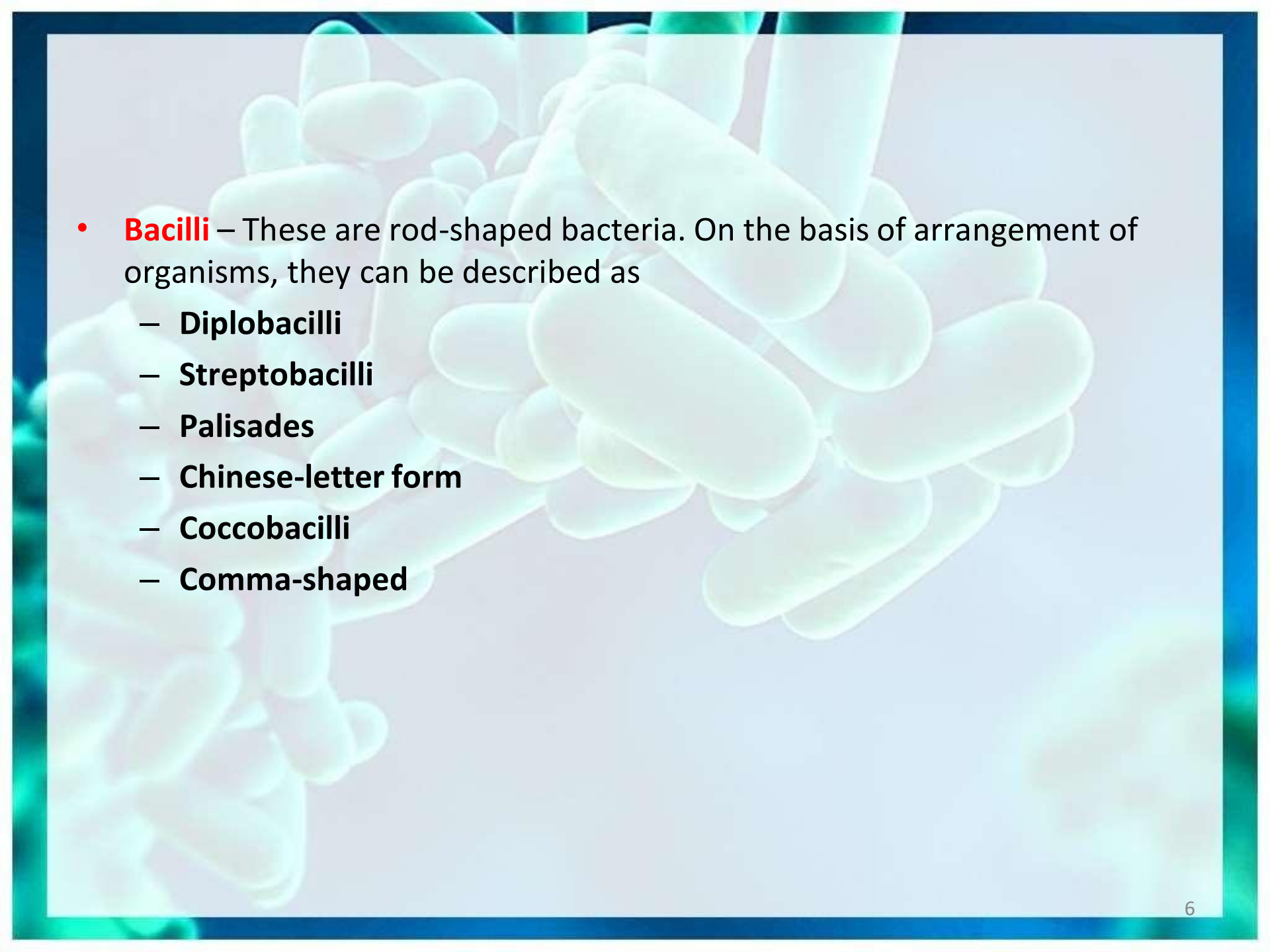
Corkscrew's form
Borrelia burgdorferi



Filamentous



spirochete

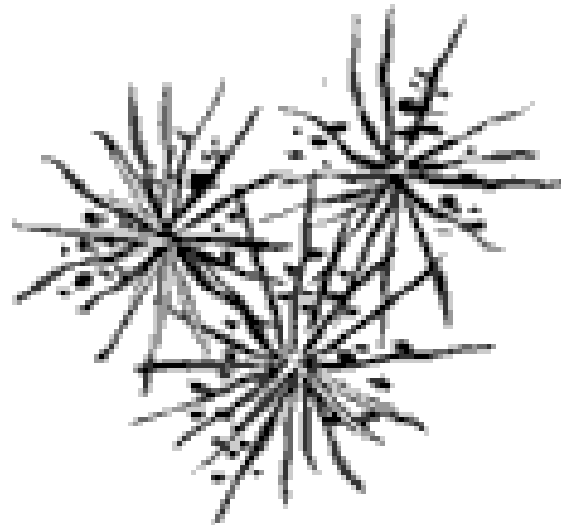
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- A microscopic image showing numerous rod-shaped bacteria (bacilli) in various arrangements. The bacteria are light blue and appear to be in a liquid medium. Some are arranged in pairs (diplobacilli), some in chains (streptobacilli), and some in a palisade arrangement. The background is a light blue gradient.
- **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**

Morphological classification

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.

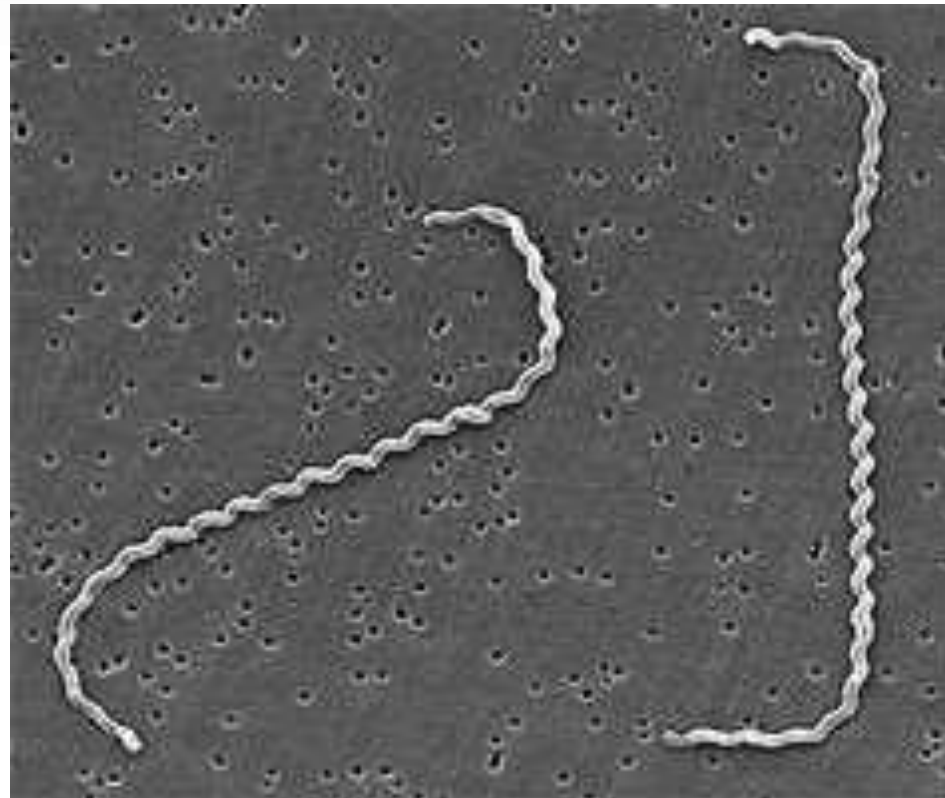
They are termed such because of their resemblance to sun rays when seen in tissue sections.



Morphological classification

3. Spirochaetes

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





Morphological classification

4. Mycoplasmas

These bacteria lack a 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*

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*

Based on Cultural characteristics

- **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°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)

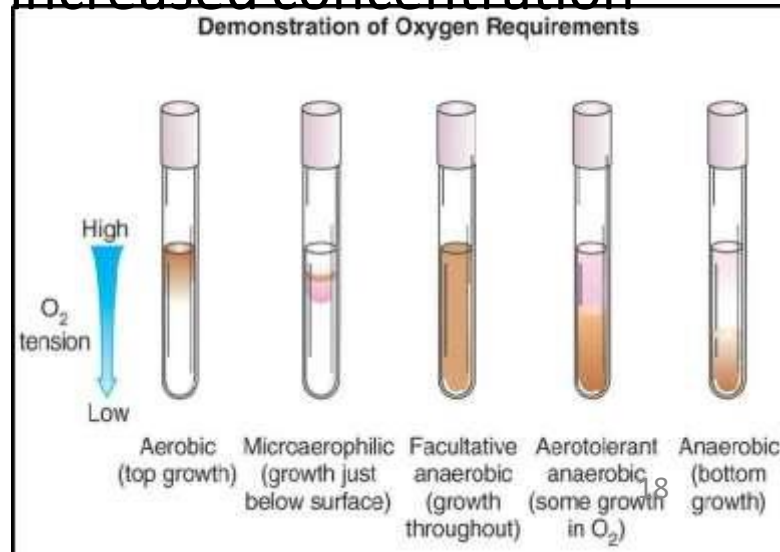


Oxygen dependence

- **Aerobe** (grow in ambient temperature, which contains 21% O₂ and a small amount of CO₂, 0.03%)
- **Obligate aerobes** – Strictly require O₂ for their growth (*Pseudomonas aeruginosa*)
- **Microaerophilic** (grow under reduced O₂, 5-10% and increased CO₂, 8-10%)- *Campylobacter jejuni*, *Helicobacter pylori*

Oxygen dependence

- **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*)
- **Neutrophiles** (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**
- **Bergey's Manual of Determinative Bacteriology**
 - Gram-negative eubacteria that have cell walls
 - Gram-positive eubacteria that have cell walls
 - Cell wall-less eubacteria: Mycoplasma
 - Archaeobacteria

A photograph of a sunset over the ocean. The sun is a large, bright orange circle in the upper right quadrant, partially obscured by the text. The sky is a pale, hazy blue. The ocean is dark blue with white-capped waves. The text 'Thank You' is written in a light blue, cursive font across the middle of the image, with the sun acting as a backdrop for the word 'You'.

Thank You