

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

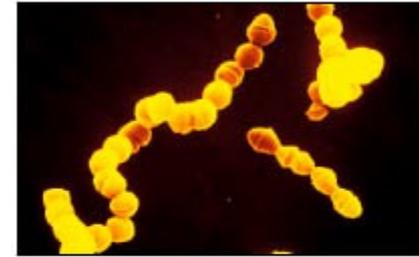
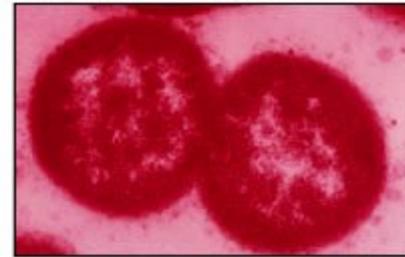
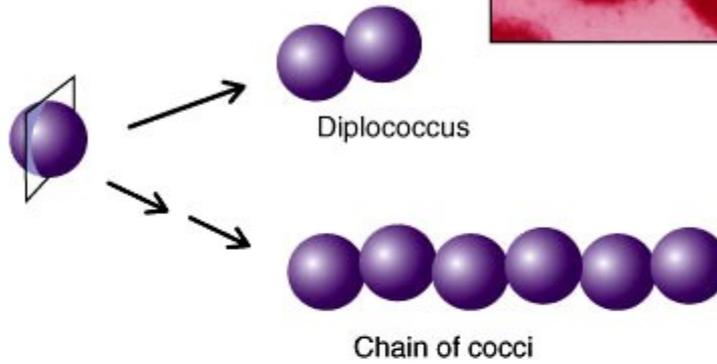
- Bacteria can be classified into **six** major groups on morphological basis.

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)

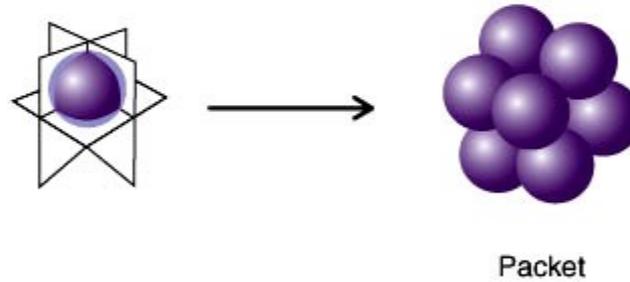
(a) Chains

Cell divides
in one plane



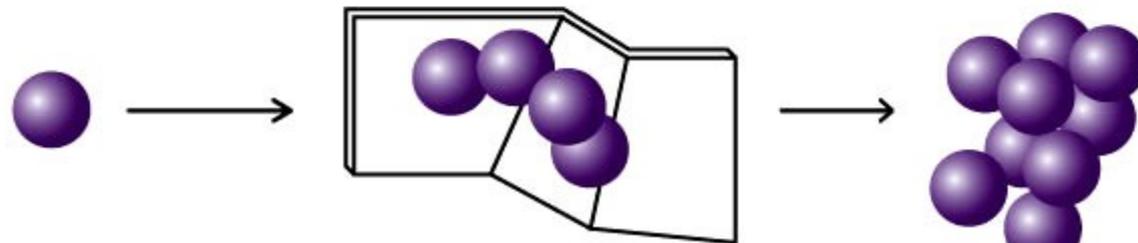
(b) Packets

Cell divides
in two or more planes
perpendicular
to one another



(c) Clusters

Cell divides in several
planes at random



Cocci

coccus



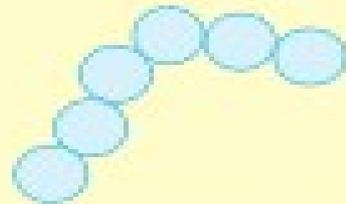
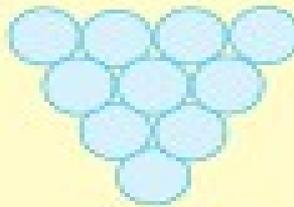
diplococci



diplococci
encapsulated
Peococcus



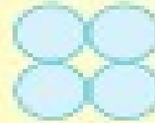
Staphylococci



streptococci



sarcina



tetrad

Bacilli



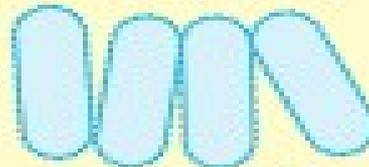
coccobacillus.



bacillus



diplobacilli



palisades.



Streptobacilli

Budding and appendaged bacteria



hypha



stalk

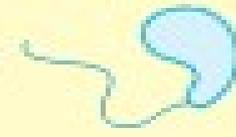
Others



enlarged rod
Fusobacterium



vibrio



Comma's form
Shigella flexneri



Club Rod
Corynebacterium



Helical form
Helicobacter pylori



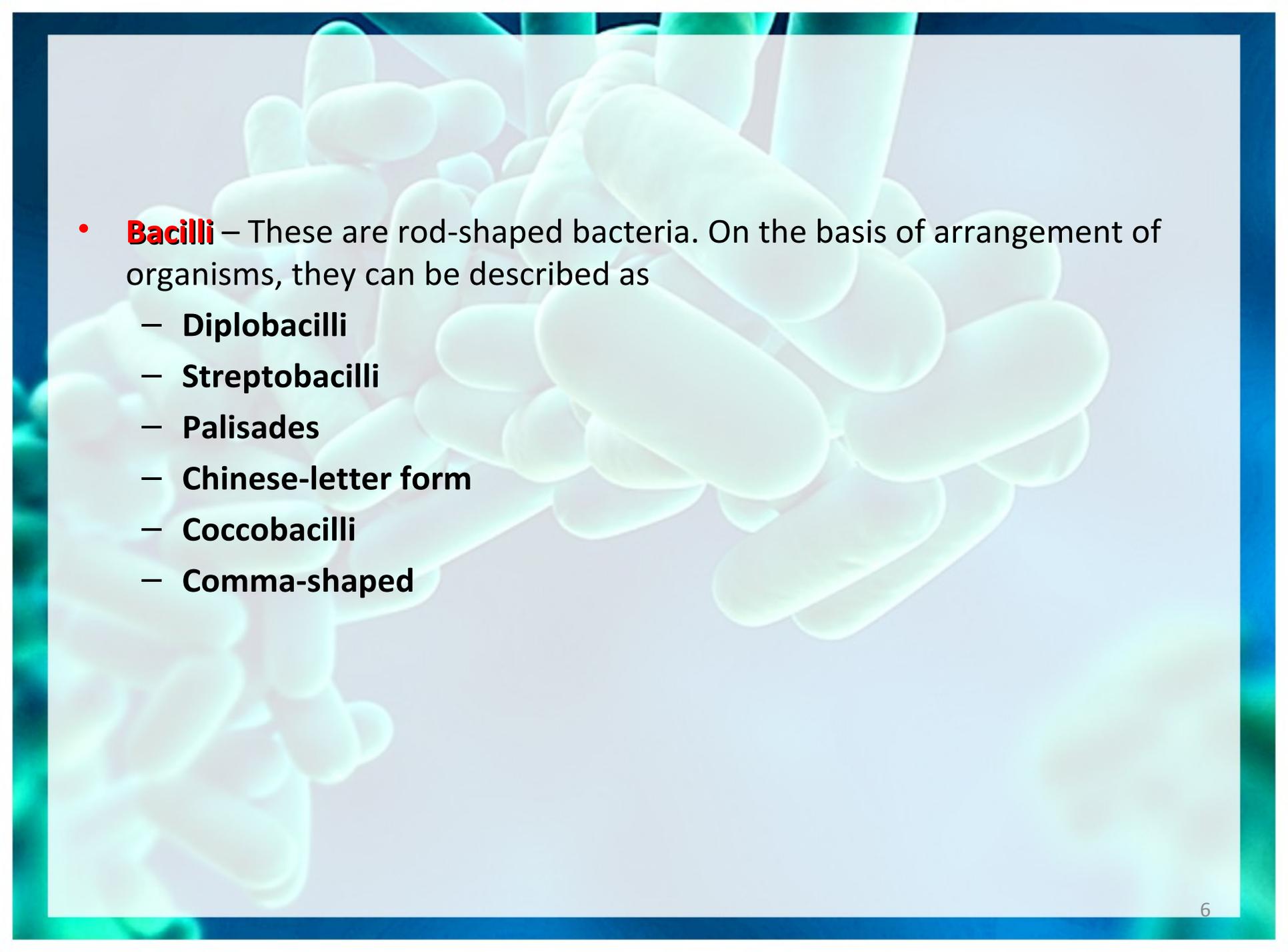
Corkscrew's form
Borrelia burgdorferi



Filamentous



spirochete

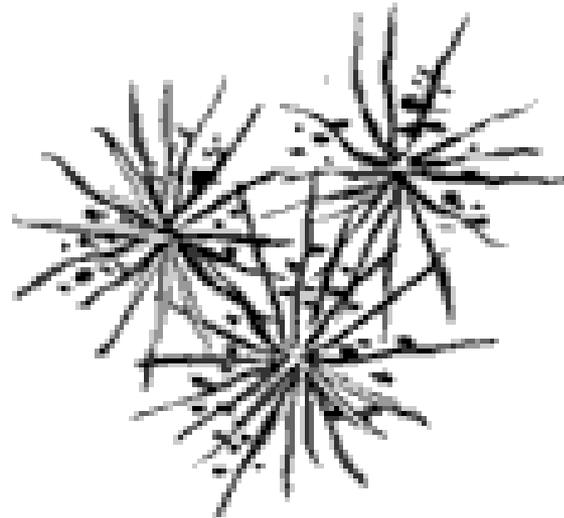
- 
- A microscopic image showing numerous rod-shaped bacteria (bacilli) in various arrangements. Some are in pairs (diplobacilli), some in chains (streptobacilli), and some in a palisade arrangement. The bacteria are light blue and set against a dark blue background.
- **Bacilli** – These are rod-shaped 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.

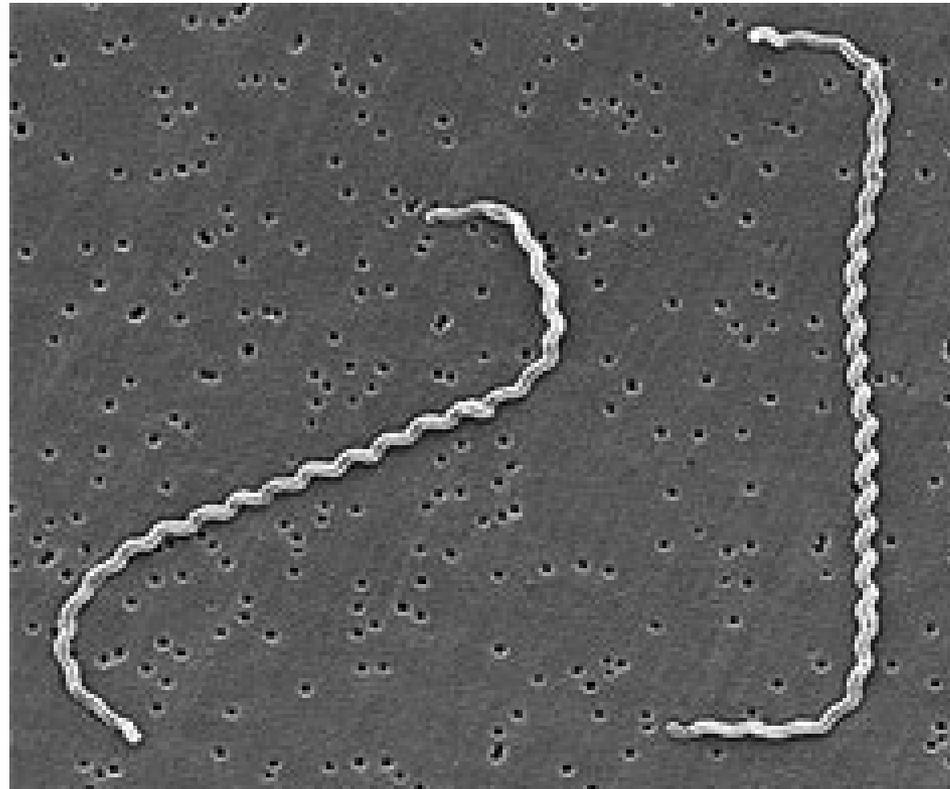
They are termed such because of their resemblance to sun rays when seen in tissue sections.



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** (15-20⁰C) – *Pseudomonas fluorescens*
- **Mesophiles** (20-40⁰C) – *Escherichia coli*, *Salmonella enterica*, *Staphylococcus aureus*
- **Thermophiles** (50-60⁰C)- *Bacillus stearothermophilus*
- **Extremely thermophiles** (as high as 250⁰C)

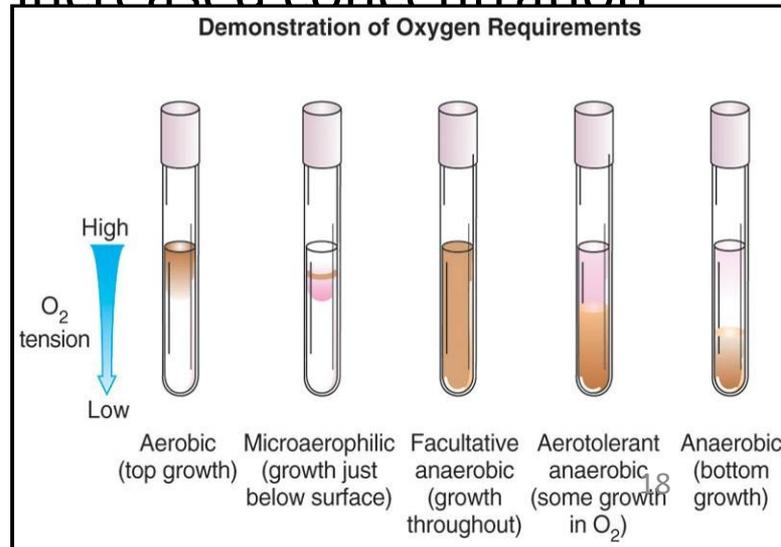


Oxygen dependence

- **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



Thank You