

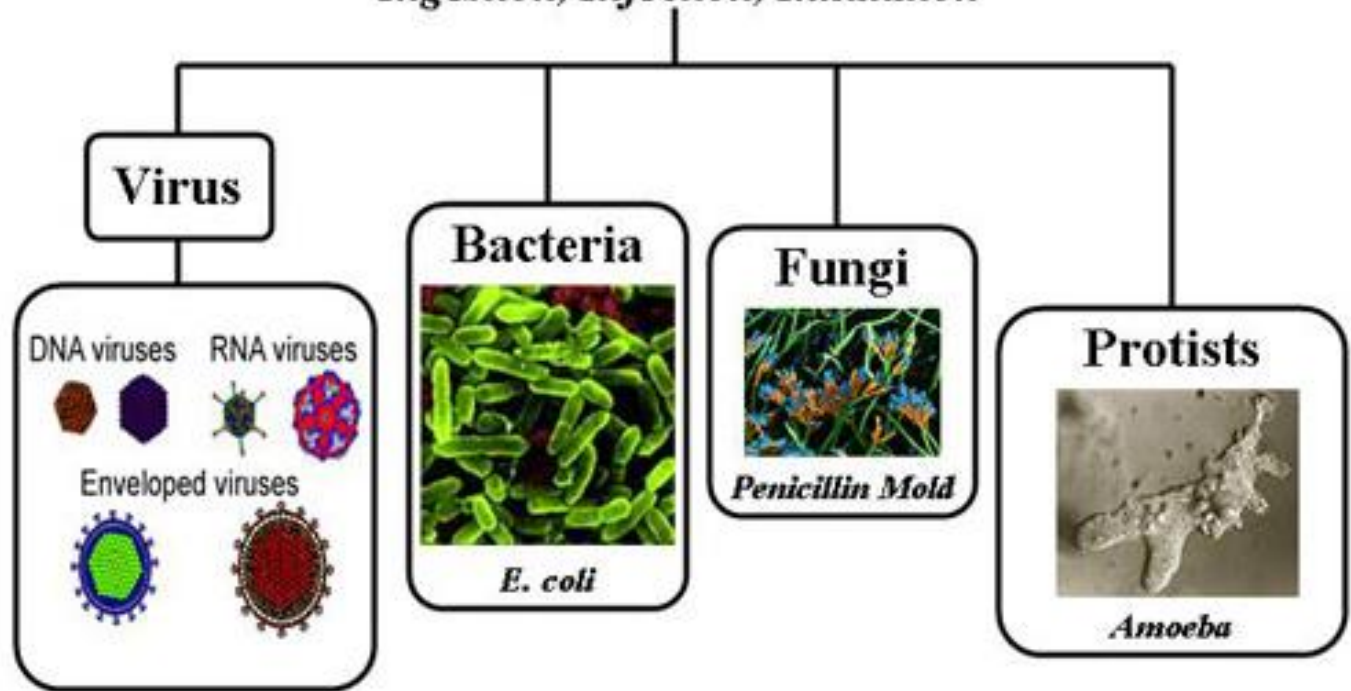
# **Microorganism Classification and properties**

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Faculty Of Medicine

Ragama

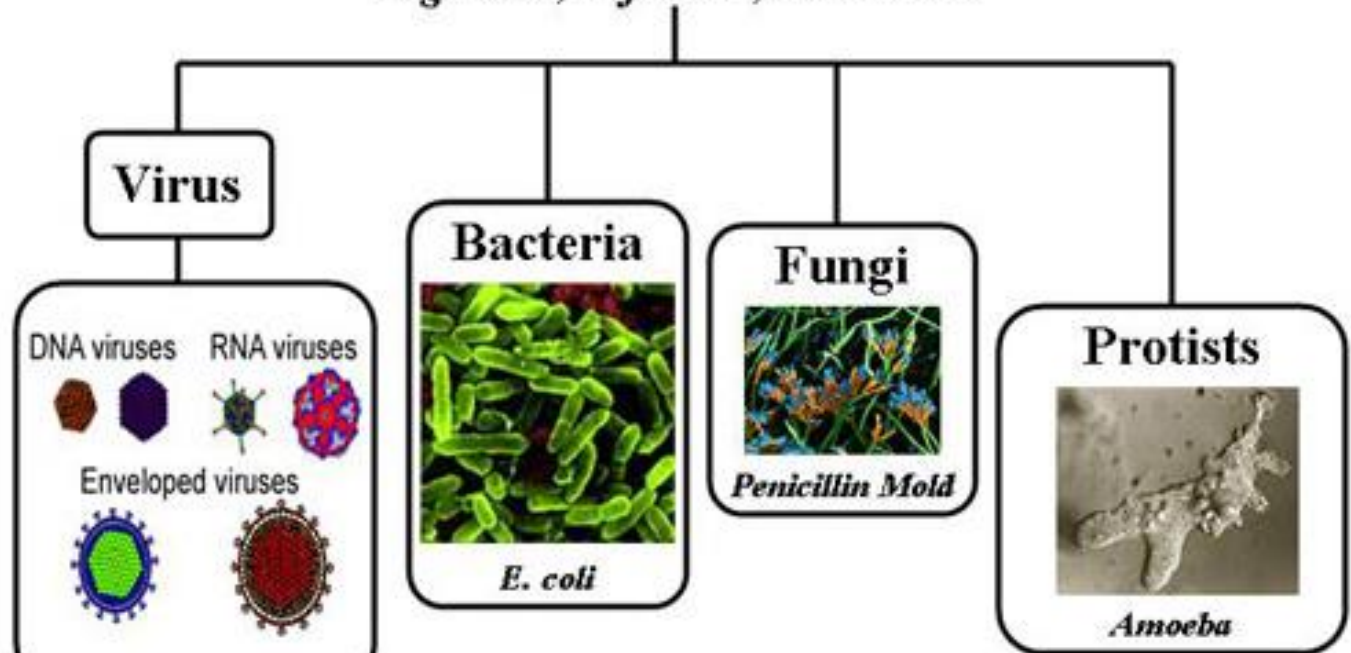
# Microorganisms

*Routes of Exposure:  
Ingestion, Injection, Inhalation*



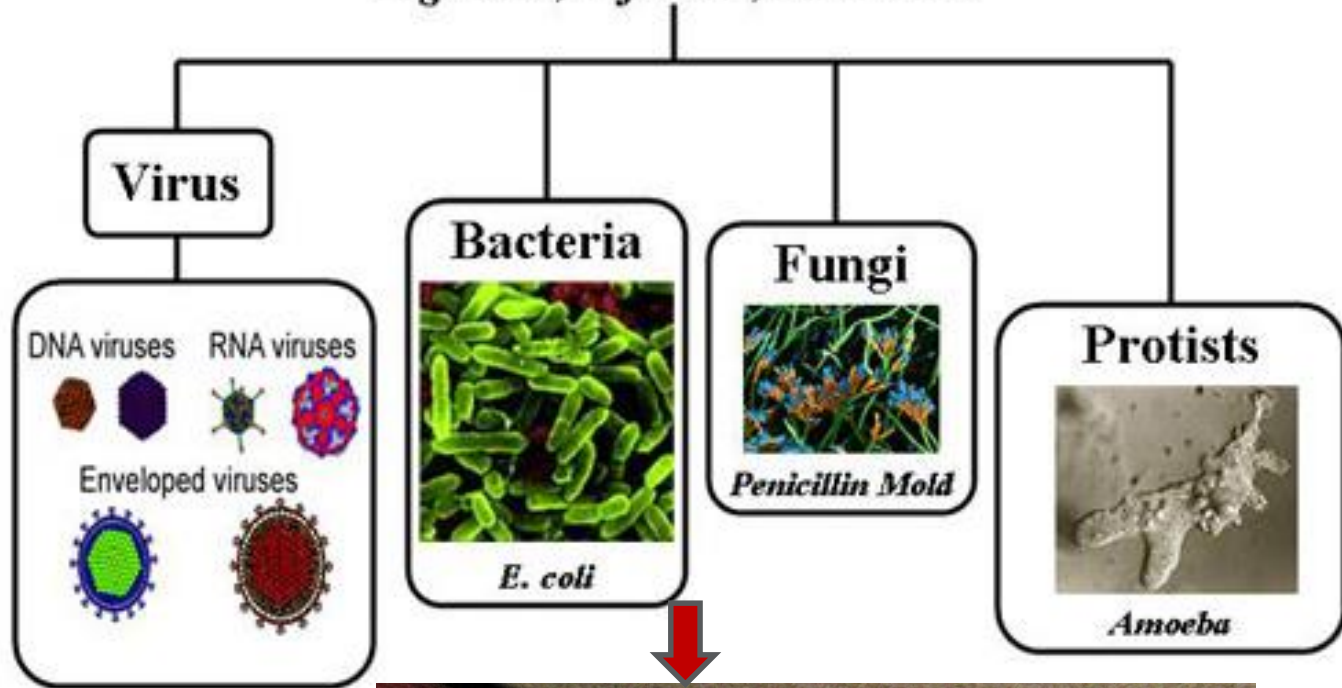
# Microorganisms

*Routes of Exposure:  
Ingestion, Injection, Inhalation*



# Microorganisms

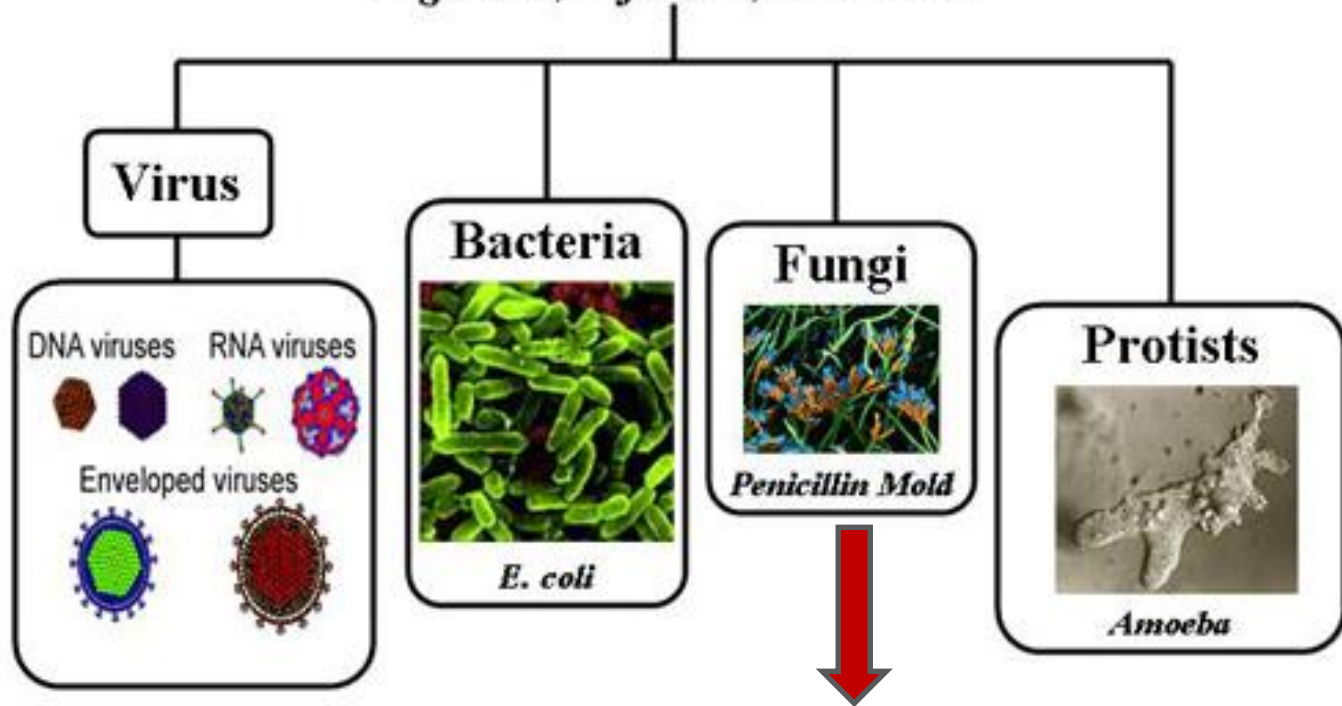
*Routes of Exposure:  
Ingestion, Injection, Inhalation*





# Microorganisms

*Routes of Exposure:  
Ingestion, Injection, Inhalation*



# **INTRODUCTION TO BACTERIOLOGY**

# Contents of the lecture

## **Bacteria**

- ◆ Classification of bacteria
- ◆ Bacterial cell structure
- ◆ Growth of bacteria
- ◆ Bacterial virulence

# Classification / Taxonomy of bacteria

- ◆ Bacteria are classified based on similarities and differences in
  - genetic makeup (**genotype**)
  - physical features (**phenotype**)
  - functional features

- ◆ Involves 3 interrelated categories

Classification / Taxonomy

Nomenclature

Identification



# Taxonomy

(System for organizing, classifying & naming of living things)

## *Consist of*

- Domain
- Kingdom
- Division / Phylum
- Class
- Order
- Family
- Genus
- Species

## Further divisions

- ◆ **Serovarieties (Serovars)**

Serological differences

- ◆ **Biovarieties (Biovars)**

Biochemical test differences

# Nomenclature

- ◆ Naming assignment for each organism

## *Standard rules*

- ◆ Family name capitalized

aceae ending

e.g. *Micrococcaceae*

- ◆ Genus name

capitalized followed by

- ◆ Species name

started with lower case letter

Eg: *Staphylococcus aureus*

◆ Often the genus name is abbreviated using 1<sup>st</sup> letter followed by a period & species letter

eg: *S. aureus*

◆ When 2 genera with same 1<sup>st</sup> letter is described

1<sup>st</sup> two letters / 1<sup>st</sup> syllable is used

eg: *Stahp. aureus*

*Strep. pyogenes*

◆ Species abbreviated as sp.(singular )spp.(pleural)

- ◆ Naming of organisms usually includes only genus and species
- ◆ Both genus and species should be italicized in print & underlined when written

e.g. *Staphylococcus aureus*

Staphylococcus aureus

# **Classification of medically important bacteria**

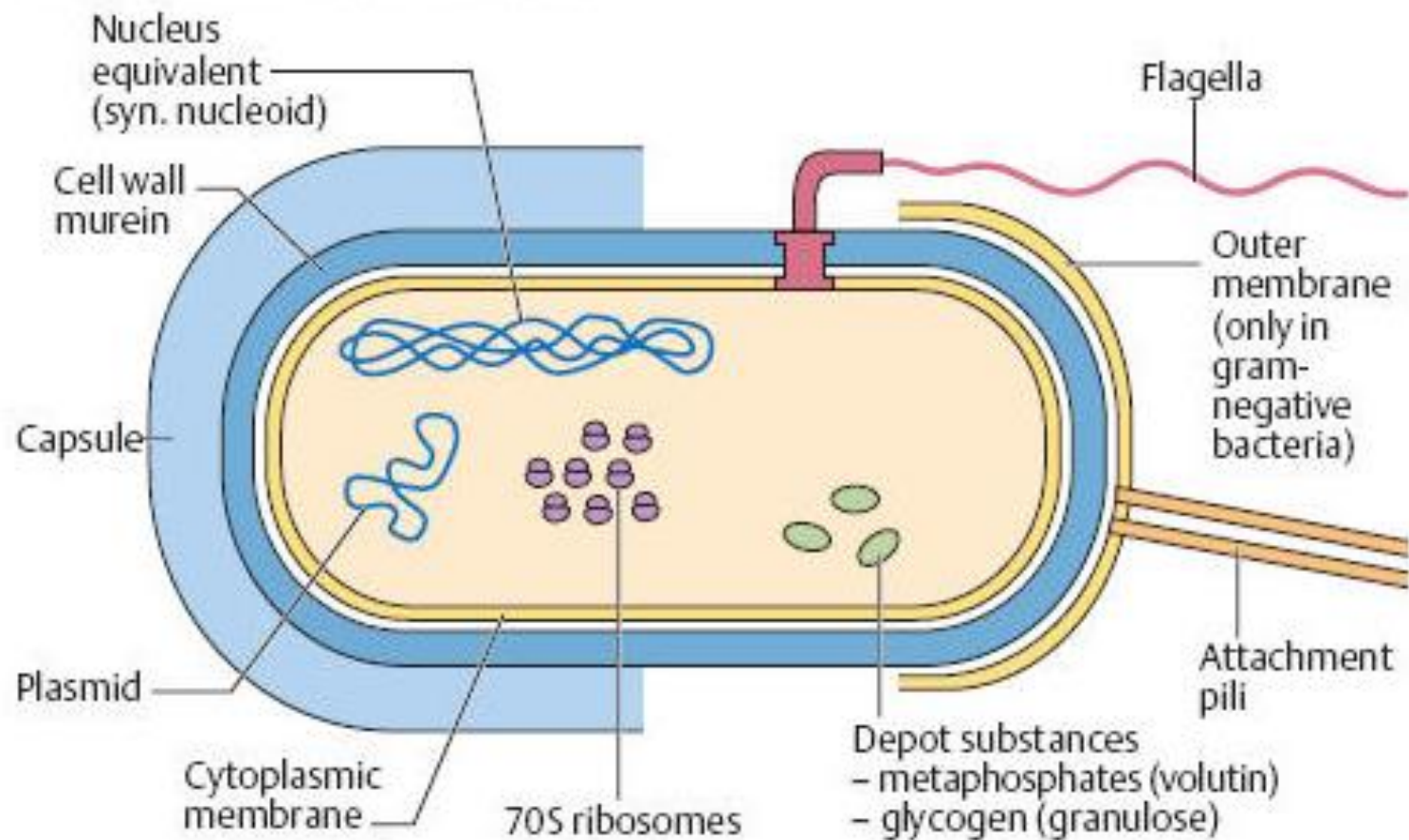
**Table 5-1.** Classification of medically important bacteria.

Characteristics	Genus	Representative Diseases
<b>I. Rigid, thick-walled cells</b>		
A. Free-living (extracellular bacteria)		
1. Gram-positive		
a. Cocci	<i>Streptococcus</i> <i>Staphylococcus</i>	Pneumonia, pharyngitis, cellulitis Abscess of skin and other organs
b. Spore-forming rods		
(1) Aerobic	<i>Bacillus</i>	Anthrax
(2) Anaerobic	<i>Clostridium</i>	Tetanus, gas gangrene, botulism
c. Non-spore-forming rods		
(1) Nonfilamentous	<i>Corynebacterium</i> <i>Listeria</i> <i>Actinomyces</i> <i>Nocardia</i>	Diphtheria Meningitis Actinomycosis Nocardiosis
(2) Filamentous		
2. Gram-negative		
a. Cocci	<i>Neisseria</i>	Gonorrhea, meningitis
b. Rods		
(1) Facultative		
(a) Straight		
(i) Respiratory organisms	<i>Haemophilus</i> <i>Bordetella</i> <i>Legionella</i> <i>Brucella</i> <i>Francisella</i> <i>Pasteurella</i> <i>Yersinia</i>	Meningitis Whooping cough Pneumonia Brucellosis Tularemia Cellulitis Plague
(ii) Zoonotic organisms	<i>Escherichia</i> <i>Enterobacter</i> <i>Serratia</i> <i>Klebsiella</i> <i>Salmonella</i> <i>Shigella</i> <i>Proteus</i>	Urinary tract infection, diarrhea Urinary tract infection Pneumonia Pneumonia, urinary tract infection Enterocolitis, typhoid fever Enterocolitis Urinary tract infection
(iii) Enteric and related organisms	<i>Campylobacter</i> <i>Helicobacter</i> <i>Vibrio</i> <i>Pseudomonas</i> <i>Bacteroides</i> <i>Mycobacterium</i> <i>Rickettsia</i> <i>Chlamydia</i>	Enterocolitis Gastritis, peptic ulcer Cholera Pneumonia, urinary tract infection Peritonitis Tuberculosis, leprosy Rocky Mountain spotted fever, typhus, Q fever Urethritis, trachoma, psittacosis
(b) Curved		
(2) Aerobic		
(3) Anaerobic		
3. Acid-fast		
B. Non-free-living (obligate intracellular parasites)		
<b>II. Flexible, thin-walled cells</b> (spirochetes)		
	<i>Treponema</i> <i>Borrelia</i> <i>Leptospira</i>	Syphilis Lyme disease Leptospirosis
<b>III. Wall-less cells</b>		
	<i>Mycoplasma</i>	Pneumonia



# **Bacterial cell structure**

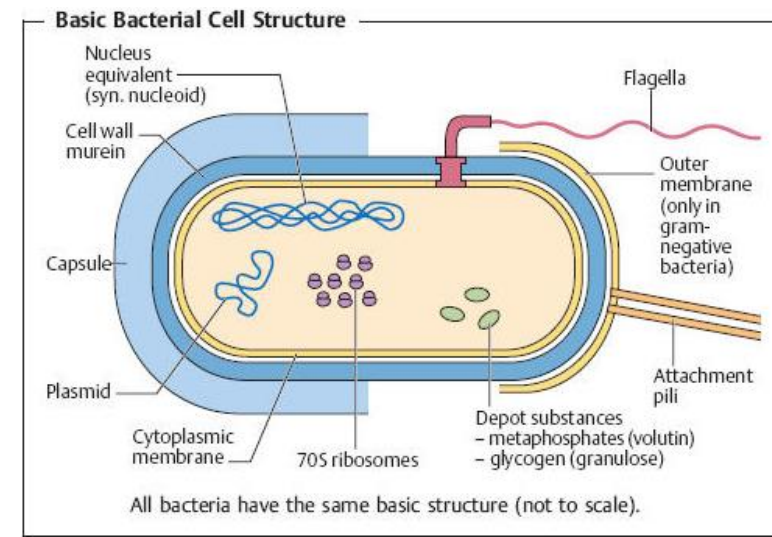
## Basic Bacterial Cell Structure



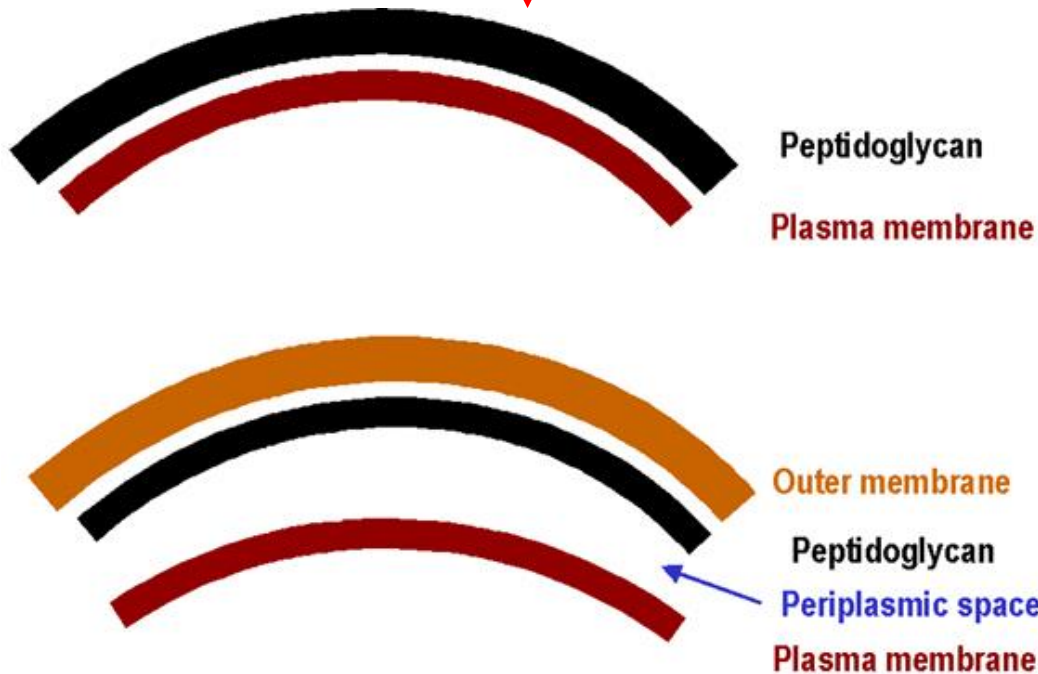
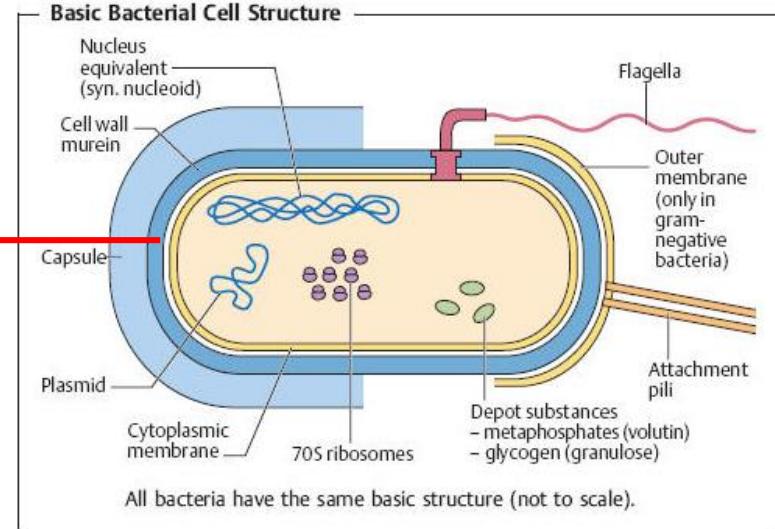
All bacteria have the same basic structure (not to scale).

# Cell wall

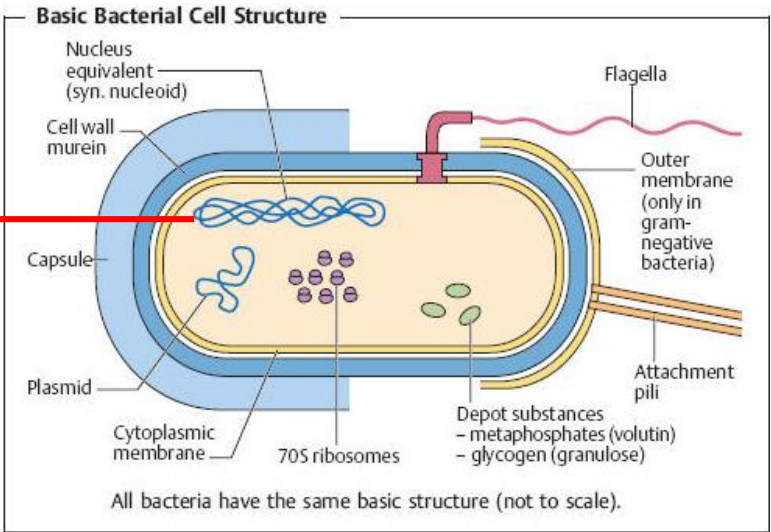
- ◆ Rigid structure
  - ◆ Maintains shape of the cell
  - ◆ Prevent bursting of cell due to high osmotic pressure
  - ◆ Bacteria are classified according to properties of cell wall
  - ◆ Different types of cell walls in bacteria
- Rigid thick walled cells
  - Flexible thin-walled cells (eg. Spirochetes)
  - Wall-less cells (eg. Mycoplasma)



# Structure of the bacterial cell wall



# Structure of the bacterial cell wall



**Peptidoglycan**

**Plasma membrane**

**Gram positive**



**Outer membrane**

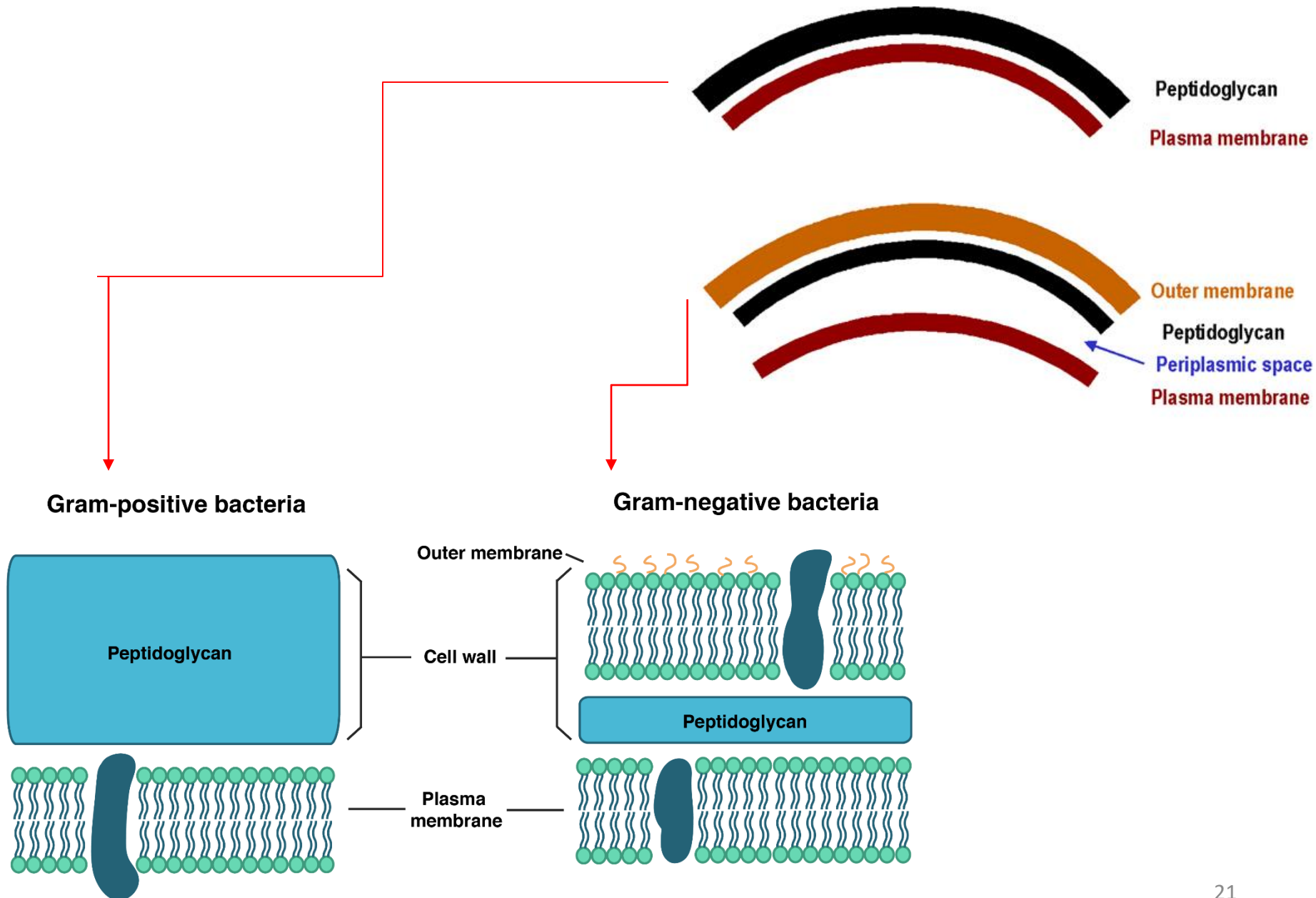
**Peptidoglycan**

**Periplasmic space**

**Plasma membrane**

**Gram negative**

# Structure of the bacterial cell wall



**Rigid thick walled cells are of three types**

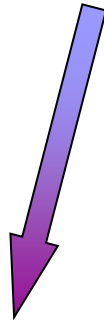
**Gram positive**

**Gram negative**

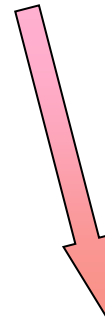
**Acid fast**



# Gram Stain



**Gram Positive**



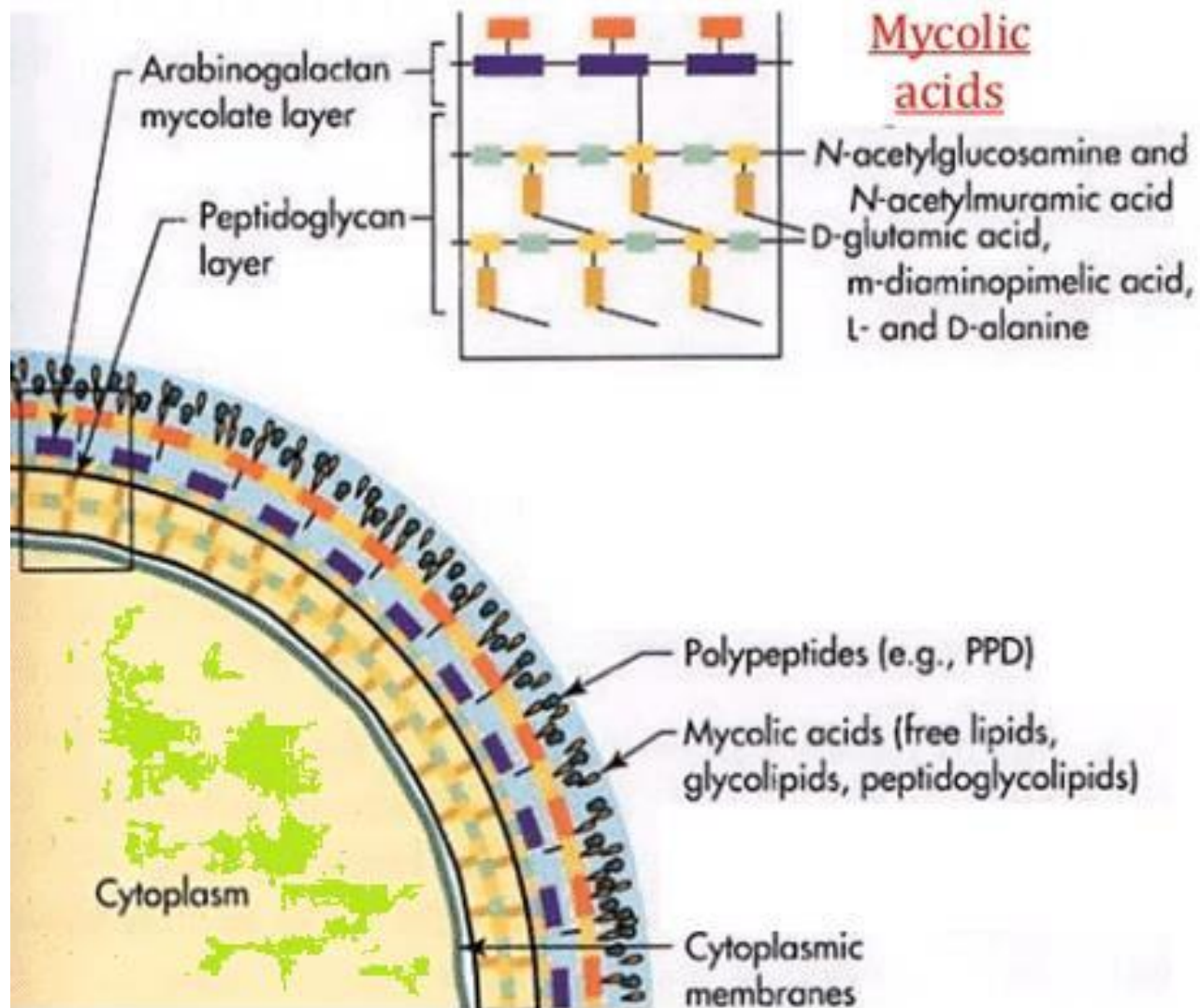
**Gram Negative**

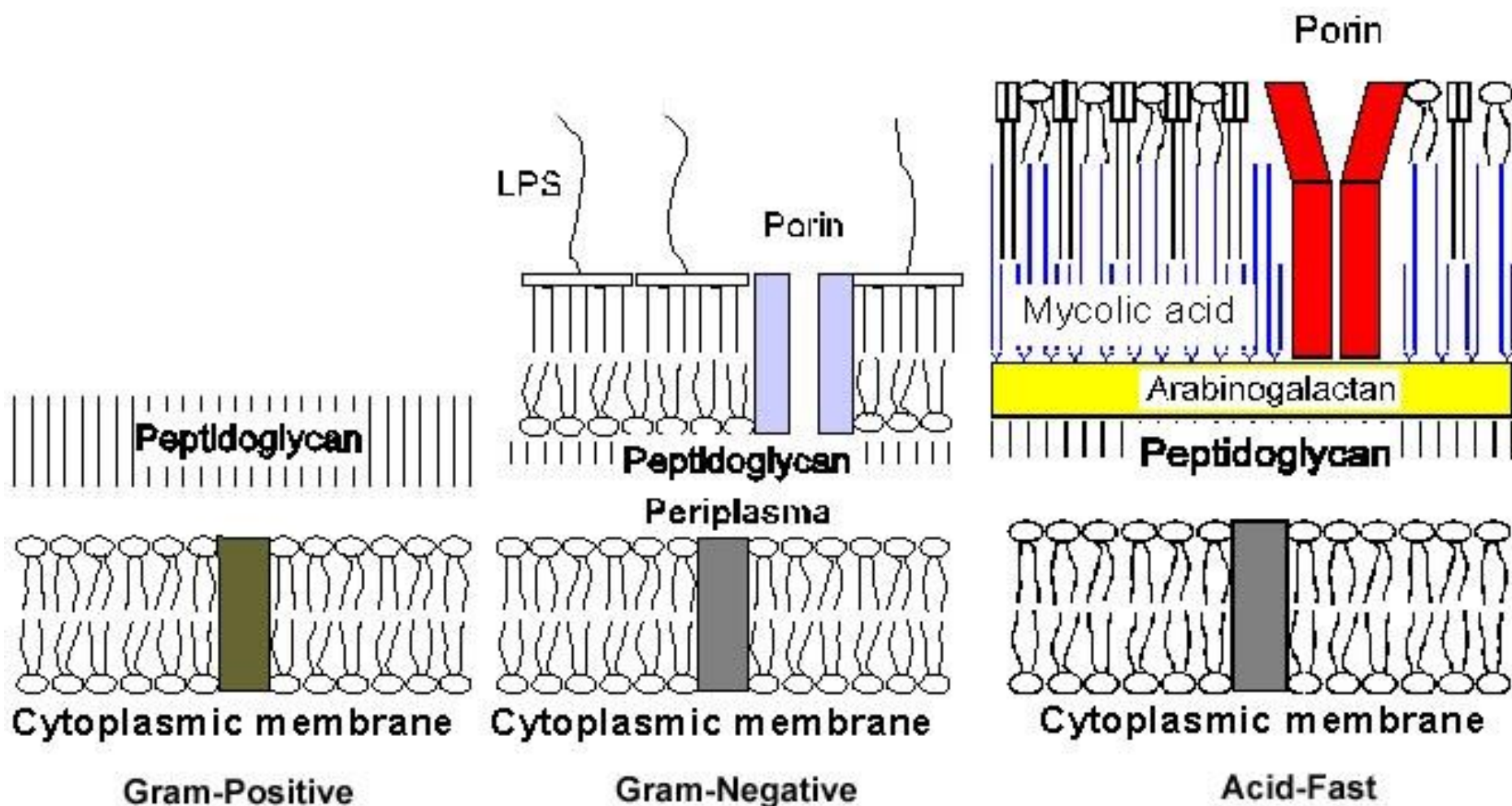
# Acid fast cell wall

- ◆ Certain genera (mycobacteria & nocardia) have Gram positive cell wall
- ◆ Additionally, have waxy layer of glycolipids and fatty acids (mycolic acids)
  - 60% - lipids
  - Hydrophobic

# Acid fast cell wall

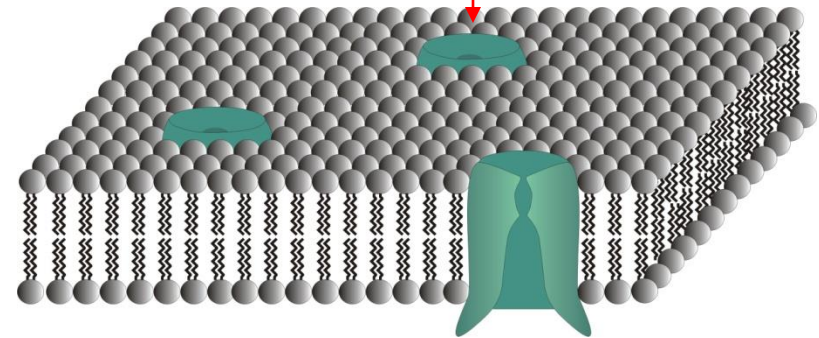
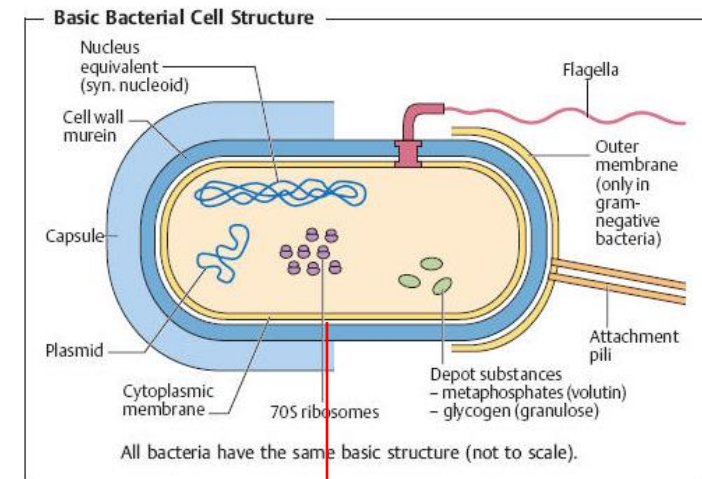
## Lipid-Rich Cell Wall of Mycobacterium





# Cell membrane

- ◆ Phospholipid bilayer with embedded proteins
- ◆ Not contain sterols (except Mycoplasma)

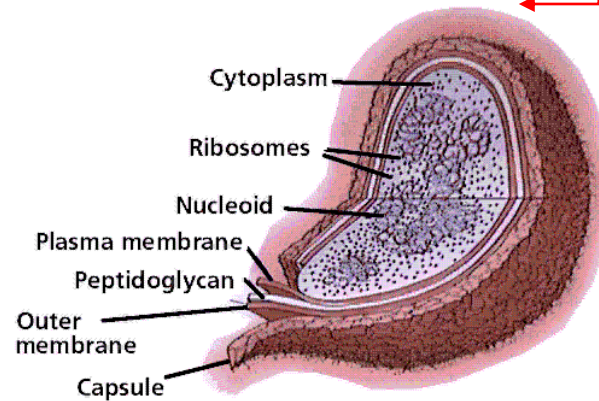
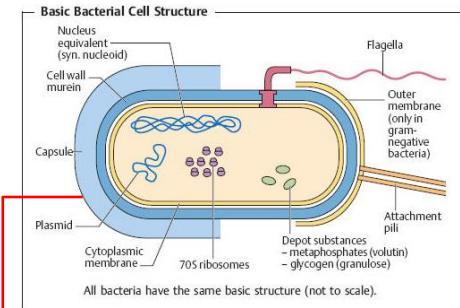


# Cell envelop

- ◆ Consist cell membrane + structures surrounding the cytoplasm (cell wall in bacteria)
- ◆ Some may have capsule & slime layers

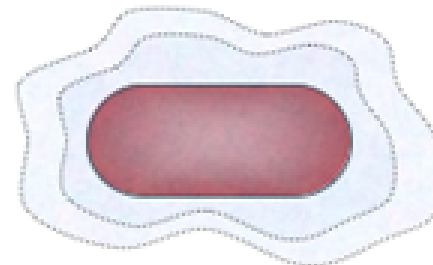
# Capsule

- ◆ Made-up of polysaccharide polymers



# Slime layers

- ◆ Similar to capsule
- ◆ But more diffuse layers surrounding the cell
- ◆ Made-up of polysaccharides

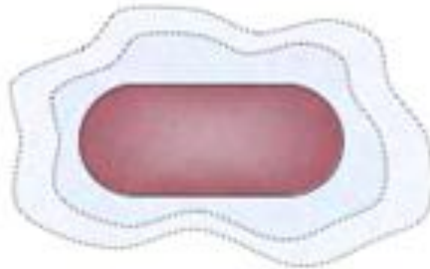


①



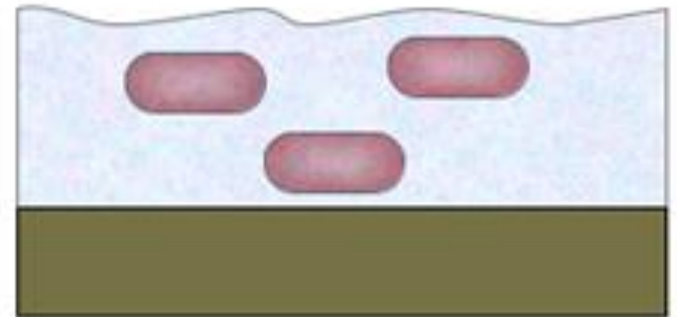
**1. Capsule**

②



**2. Slime layer**

③



**3. Biofilm**



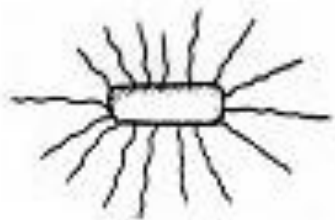
# Cell appendages

## Flagella

- ◆ Helps in motility
- ◆ Exterior protein filaments



- ◆ Types: Polar flagella  
Peritrichous flagella  
Flagella extend from all sides of the bacterium



peritrichous flagella



polar flagella

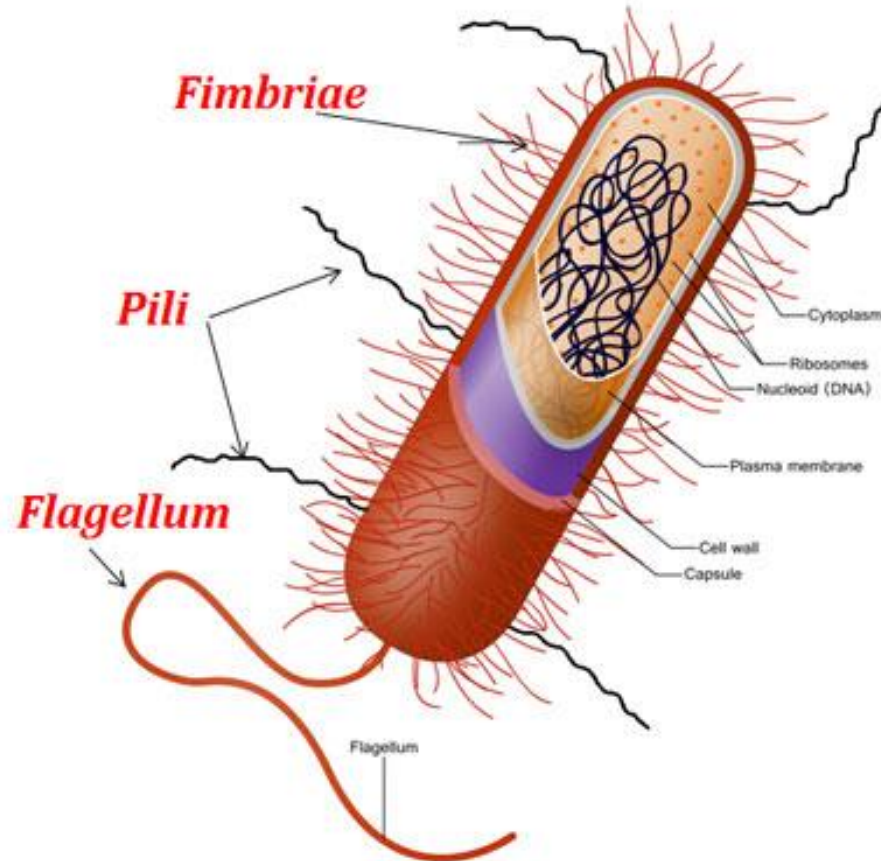


**Pilli -**

Non motile , long , holo protein tubes

**Fimbriae -**

Non flagella, sticky, proteinaceous, hair like appendages that adhere one bacterial cell to another and to environmental surfaces

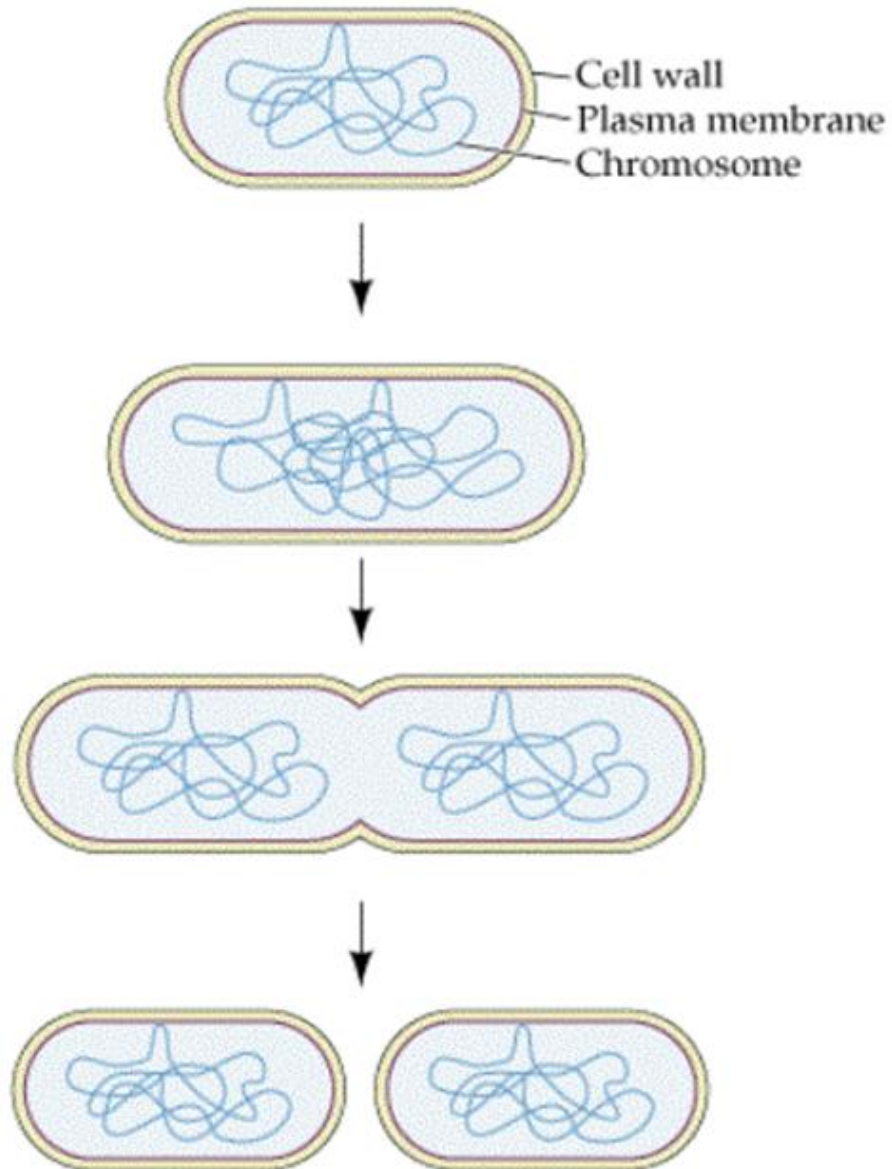


# Microbial growth

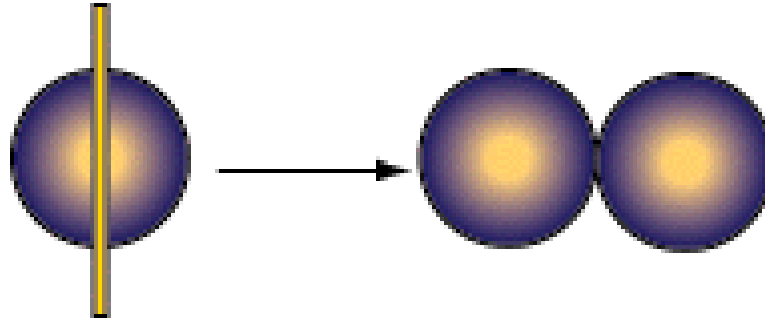
# Microbial Growth

“Because individual cells grow larger only to divide into new individuals, **microbial growth** is defined not in terms of cell size but as the increase in the number of cells, which occurs by binary fission.”

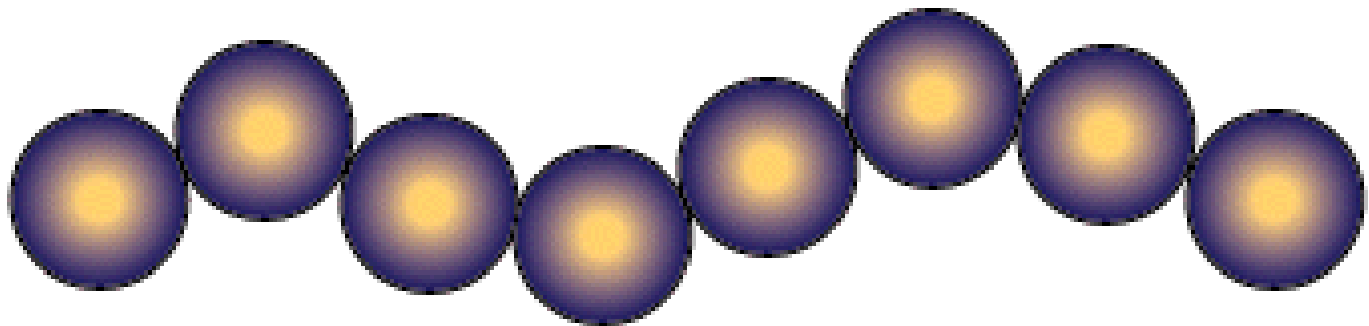
# Binary Fission



# Planes of Division

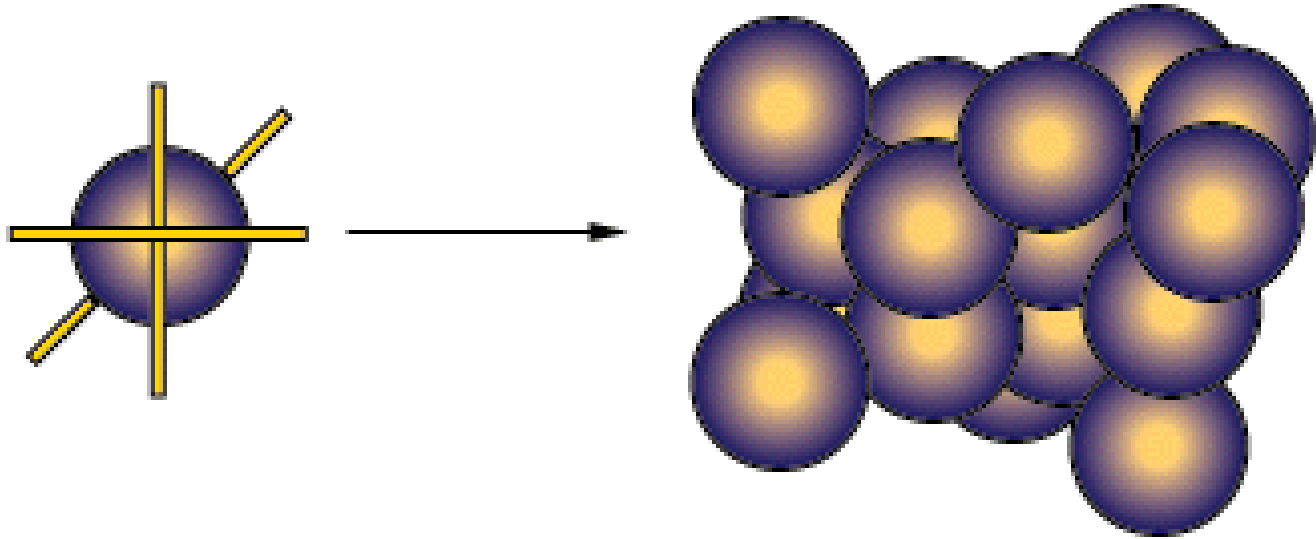


**Diplococcus**



**Streptococcus**

# Planes of Division



**Staphylococcus**



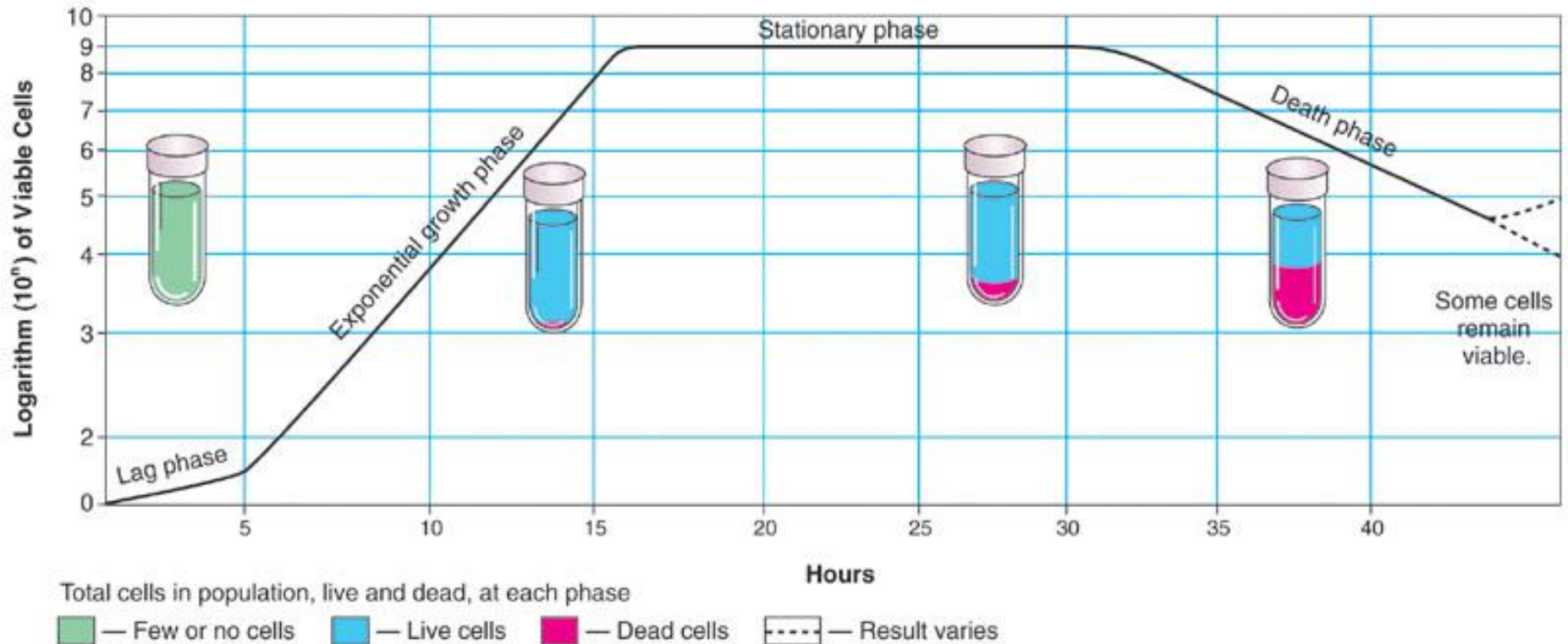
# **Bacterial growth curve**

# Growth curve

1. **Lag phase** – “flat” period of adjustment, enlargement; little growth
2. **Exponential growth phase / logarithmic phase** – a period of maximum growth will continue as long as cells have adequate nutrients & a favorable environment
3. **Stationary phase** – rate of cell growth equals rate of cell death cause by depleted nutrients & O<sub>2</sub>, excretion of organic acids & pollutants
4. **Death phase** – as limiting factors intensify, cells die exponentially in their own wastes

# Growth curve

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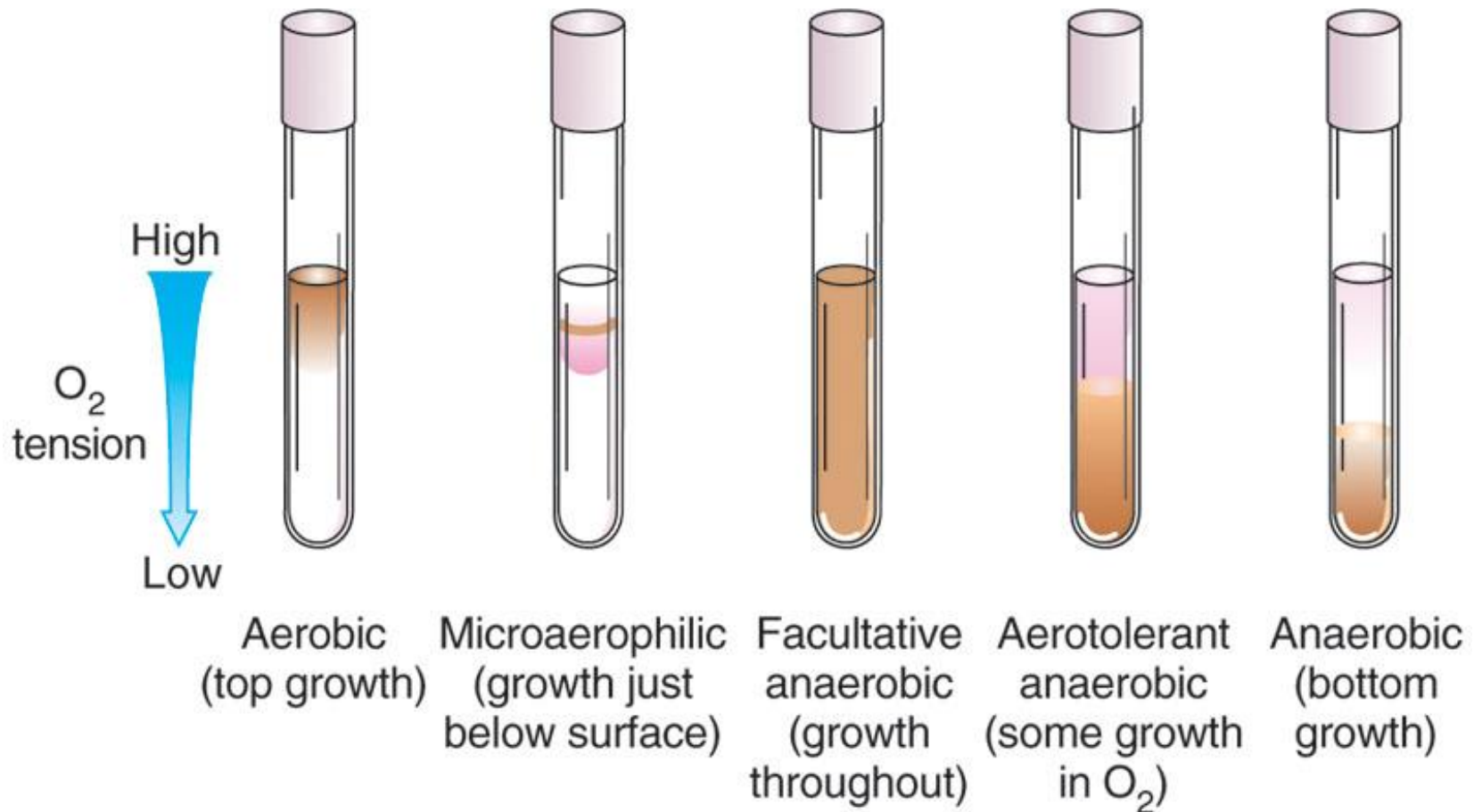
# Environmental Influences on Microbial Growth

- Temperature
- Oxygen requirements
- pH

# Aerobic & Anaerobic growth

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## Demonstration of Oxygen Requirements



# The 5 I's of culturing microbes

1. Inoculation – introduction of a sample into a container of media
2. Incubation – under conditions that allow growth
3. Isolation – separating one species from another
4. Inspection
5. Identification

# **Bacterial virulence**

# Virulence

- ◆ Measure of the extent of disease it has the potential to produce
- ◆ **Virulence factors** are microbial products that determine an organism's capacity to cause disease

## Three major classes:

1. Extracellular products (e.g. toxins)
  2. Surface components (e.g. fimbriae)
  3. Gene regulation factors
- ◆ Virulence factors affect in pathogenicity



# Toxins

Chemical (often protein) agents that damage host tissue

**Endotoxins** - Lipid A portion of LPS

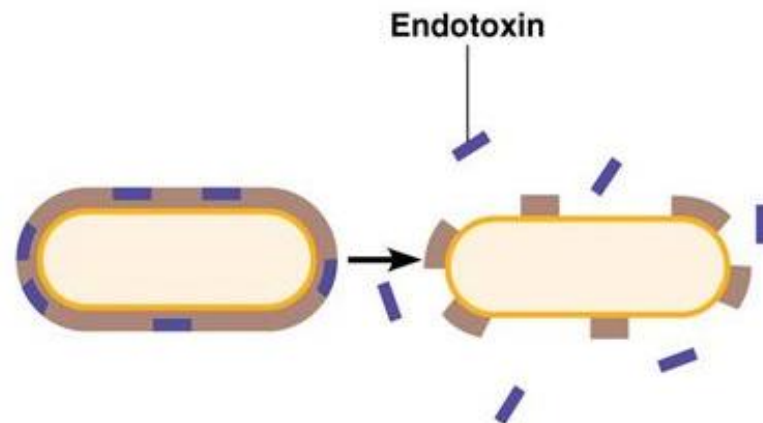
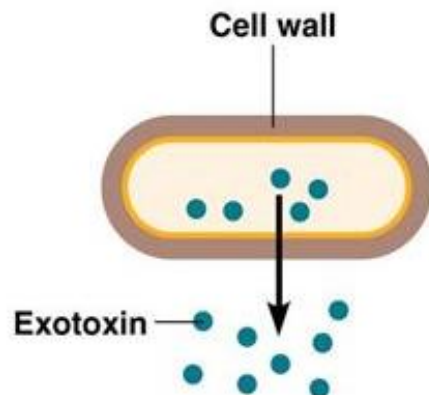
**Exotoxins**

Protein toxins

Typically produced by Gram positives

**Neurotoxins**

**Enterotoxins**



# Classification of medically important bacteria

## Rigid thick walled cells

### Gram positive

Cocci

Bacilli

Spore forming

Non-spore forming

### Gram negative

Cocci

Bacilli

Aerobic

Anaerobic

Facultative anaerobic

**Acid fast** (eg: Mycobacteria)

**Flexible thin-walled cells** (eg: Spirochetes)

**Wall-less cells** (eg: Mycoplasma)

# **Recommended text books (Bacteriology)**



# MEDICAL MICROBIOLOGY

SEVENTEENTH  
EDITION

A GUIDE TO MICROBIAL  
INFECTIONS: PATHOGENESIS,  
IMMUNITY, LABORATORY  
DIAGNOSIS AND CONTROL

EDITED BY

David Greenwood  
Richard Slack  
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