STUDY MATERIAL

VIVEKANANDA COLLEGE THAKURPUKUR

NAAC ACCREDITED GRADE—'A'

Subject: Microbiology
Topic: The Morphology of Bacteria

Name of the Teacher: **Dr. Dibyendu Raj**

Introduction

- Living organisms classified under 3 kingdoms:

1.Plant
2.Animal
3.Protista

- Under Protista - Microorganisms are classified as

i.PROKARYOTES (Bacteria & Blue-green algae)
ii.EUKARYOTES (Fungi, Protozoa, slime molds & other algae)

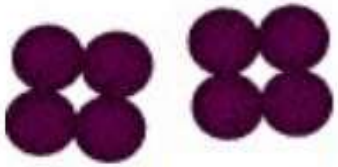
Shape of Bacteria

- Cocci – spherical/ oval shaped major groups
- Bacilli – rod shaped
- Vibrios – comma shaped
- Spirilla – rigid spiral forms
- Spirochetes – flexible spiral forms
- Actinomycetes – branching filamentous bacteria
- Mycoplasmas – lack cell wall

Arrangement of bacteria: Cocci

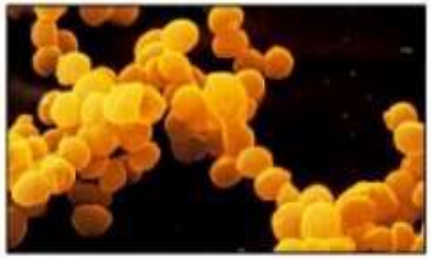
Cocci in pair – Diplococcus

Coccus



Tetrad – groups of four

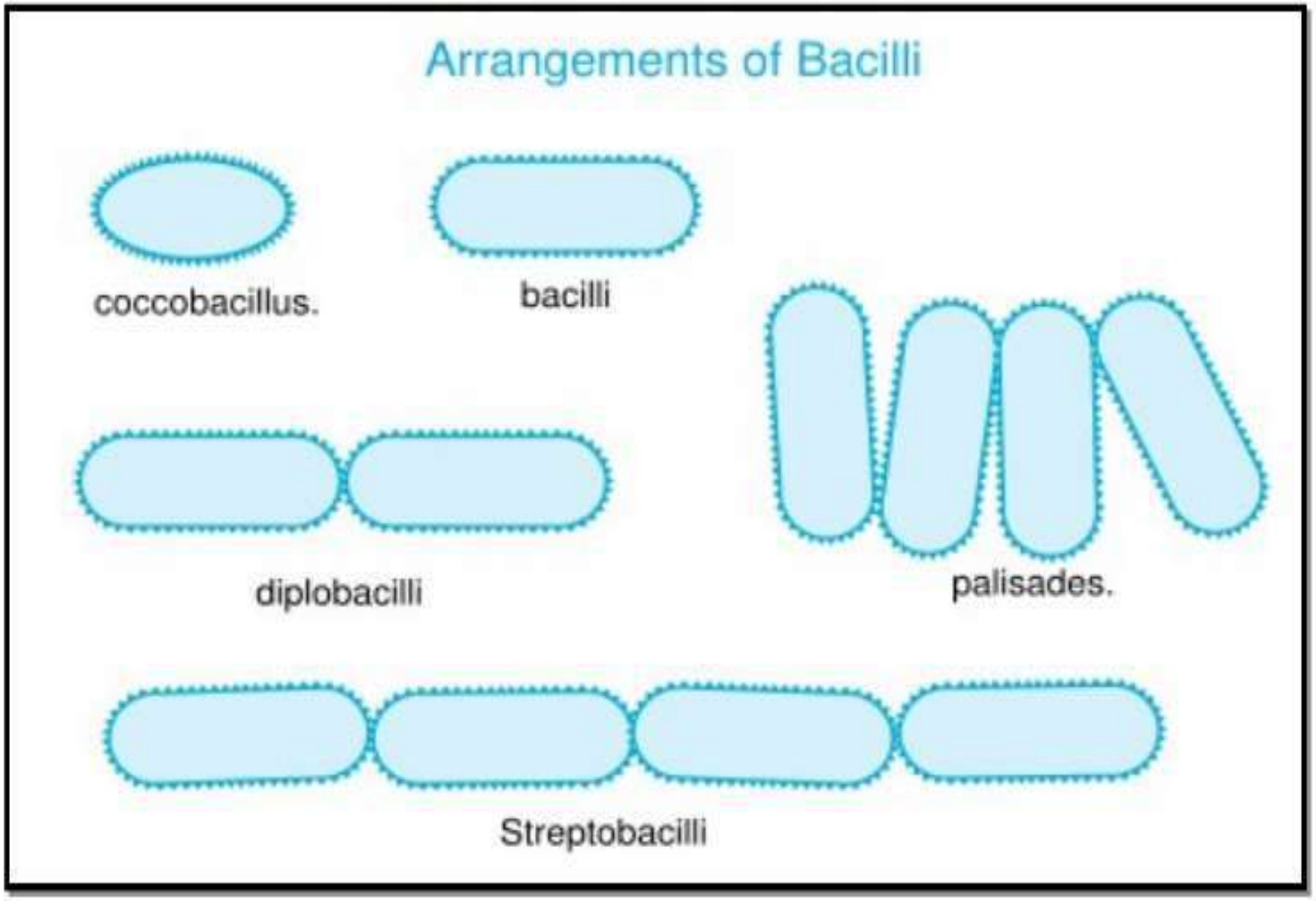
Cocci in chain - Streptococci



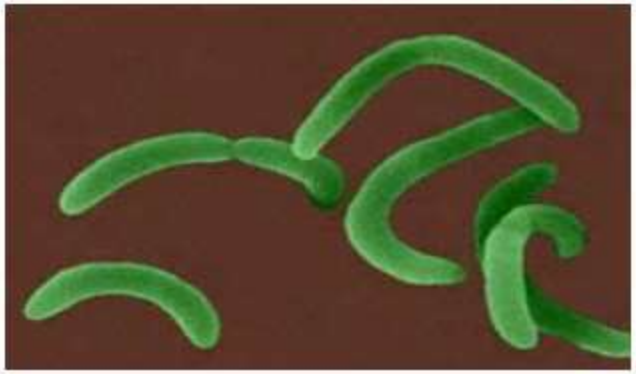
Cocci in cluster - Staphylococci

Sarcina – groups of eight

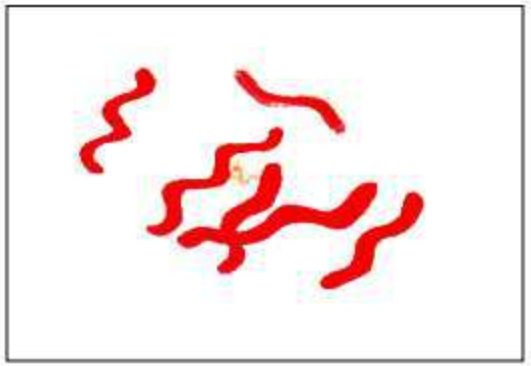
Arrangement of bacteria: Bacilli



Other shapes of bacteria



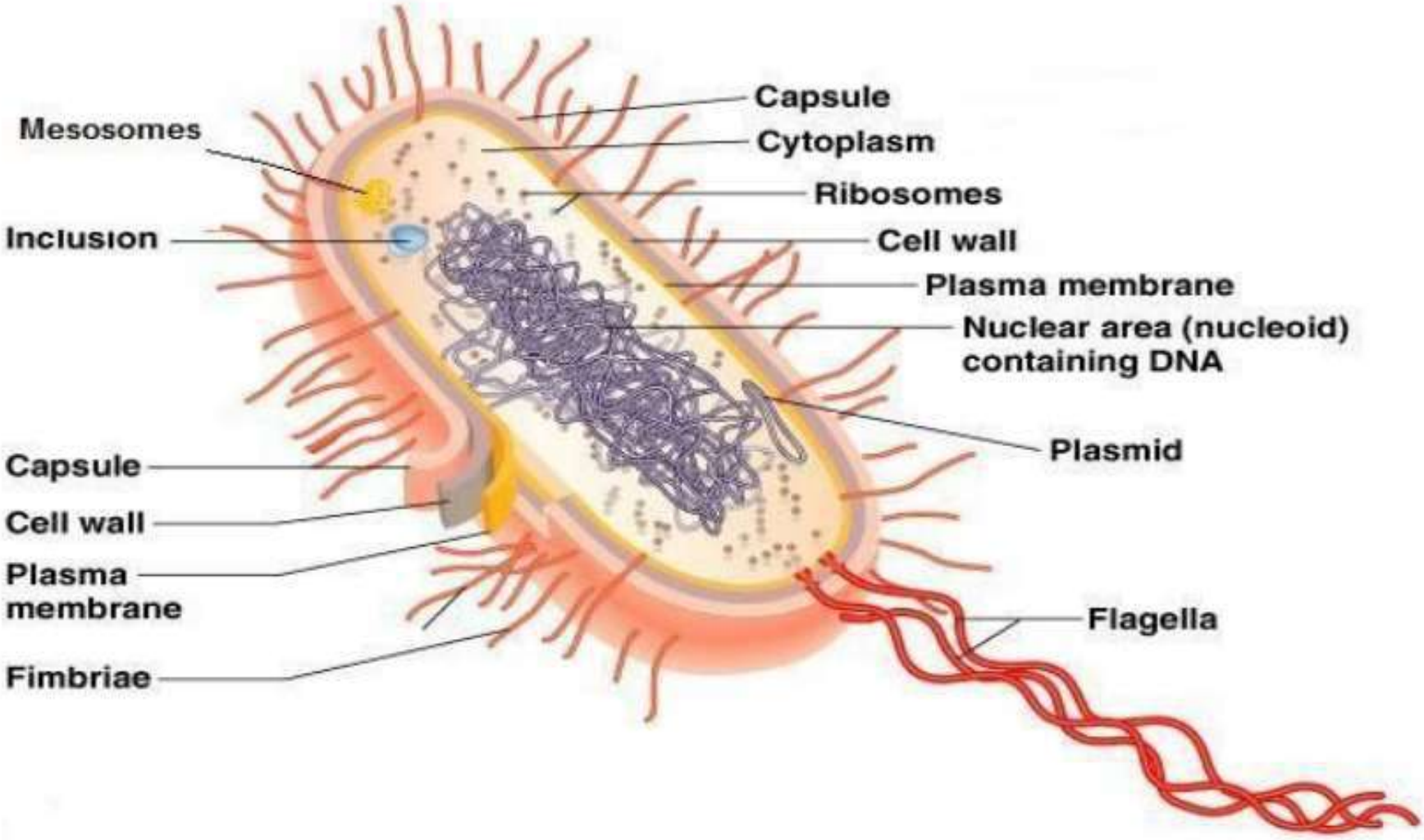
Comma shaped



Spirilla

Spirochetes

Anatomy of a Bacterial Cell



Anatomy of A Bacterial Cell

• Outer layer – two components:

1. Rigid cell wall
2. Cytoplasmic (Cell/ Plasma) membrane – present beneath cell wall

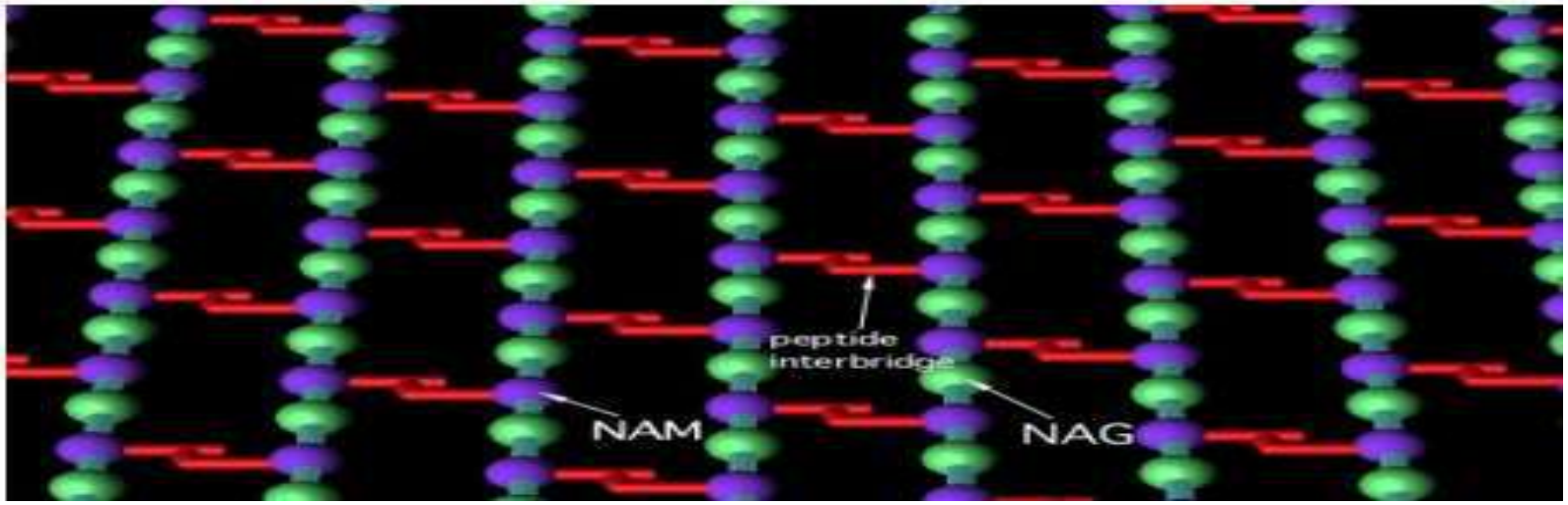
• Cytoplasm – cytoplasmic inclusions, ribosomes, mesosomes and nucleus

• Additional structures – plasmid, slime layer, capsule, flagella, fimbriae (pili), spores

CELL WALL

- Outermost layer, encloses cytoplasm

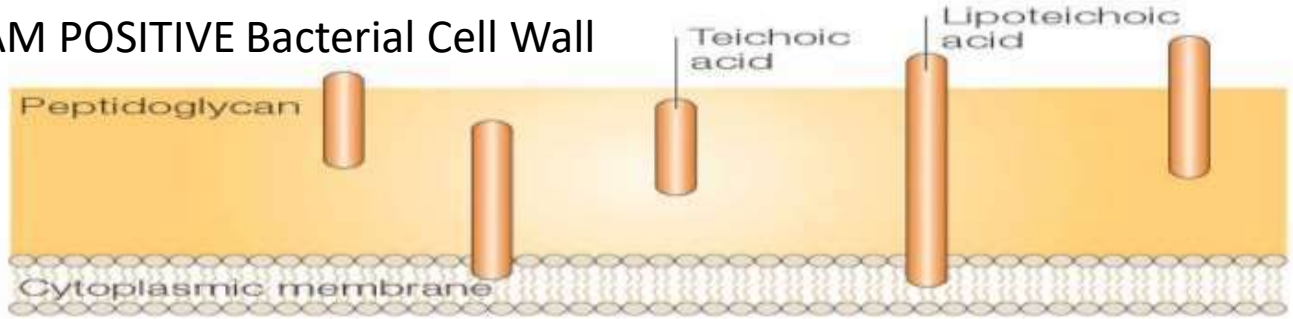
1. Confers shape and rigidity
2. 10 - 25 nm thickness
3. Composed of complex polysaccharides (peptidoglycan/ mucopeptide) - formed by N-acetyl glucosamine (NAG) & N-acetyl muramic acid (NAM) alternating in chains, held by peptide chains.



Cell wall

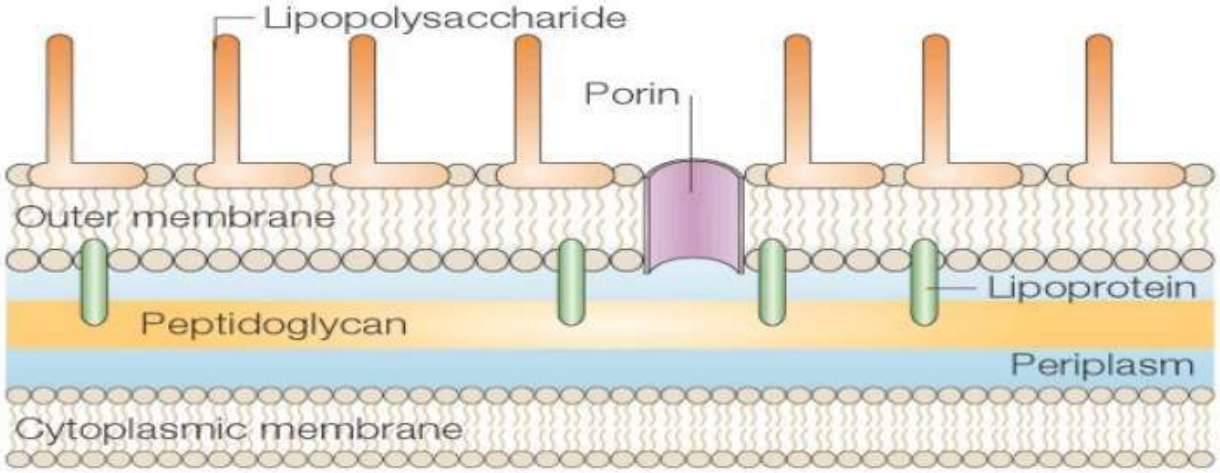
4. Carries bacterial antigens – important in virulence & immunity
5. Chemical nature of the cell wall helps to divide bacteria into two broad groups – Gram positive & Gram negative
6. Gram +ve bacteria have simpler chemical nature than Gram –ve bacteria.
7. Several antibiotics may interfere with cell wall synthesis e.g. Penicillin, Cephalosporins

GRAM POSITIVE Bacterial Cell Wall

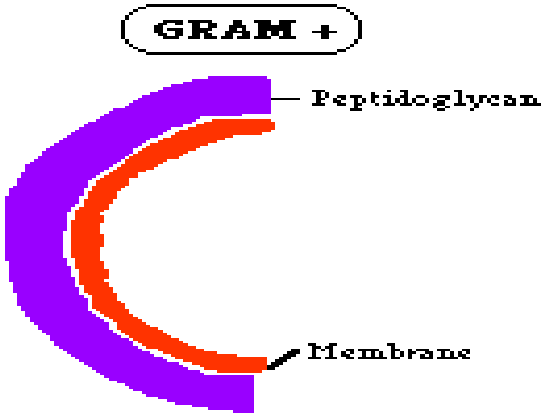


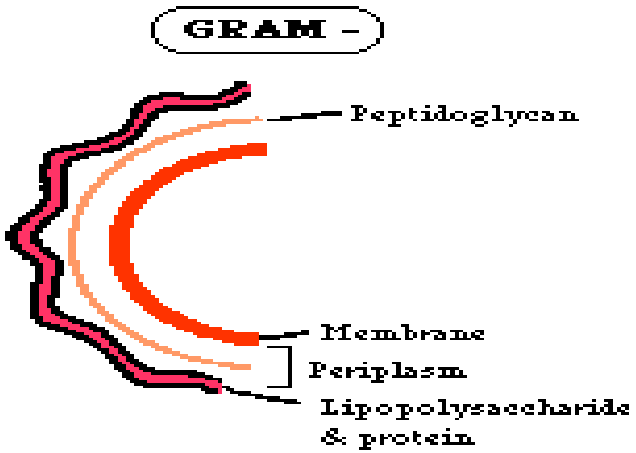
The Gram-positive cell wall is composed of a thick, multilayered **peptidoglycan** sheath outside of the cytoplasmic membrane. **Teichoic acids** are linked to and embedded in the peptidoglycan, and **lipoteichoic acids** extend into the cytoplasmic membrane

GRAM NEGATIVE Bacterial Cell Wall



The Gram-negative cell wall is composed of an outer membrane linked to thin, mainly **single-layered peptidoglycan** by **lipoproteins**. The peptidoglycan is located within the **periplasmic space** that is created between the outer and inner membranes. The outer membrane includes **porins**, which allow the passage of small hydrophilic molecules across the membrane, and **lipopolysaccharide molecules** that extend into extracellular space.





Difference between Cell Wall of Gram Positive and Gram Negative Bacteria

Property of bacteria	Gram Positive	Gram Negative
Thickness of wall	20-80 nm	10 nm
Number of layers in wall	1	2
Peptidoglycan content	>50%	10-20%
Teichoic acid in wall	+	-
Lipid & lipoprotein content	0-3%	58%
Protein content	0%	9%
Lipopolysaccharide	0	13%
Sensitive to penicillin	Yes	Less sensitive
Digested by lysozyme	Yes	Weakly

Cytoplasmic (Plasma) membrane:

• Thin layer 5-10 nm, separates cell wall from cytoplasm

• Acts as a semipermeable membrane: controls the inflow and outflow of metabolites

• Composed of lipoproteins with small amounts of carbohydrates

Other Cytoplasmic Components:

• Ribosomes – protein synthesis

• **Mesosomes** –

1. Multilaminated structures formed as invaginations of plasma membrane
2. Principal sites of respiratory enzymes
3. Coordinate nuclear & cytoplasmic division during binary fission
4. More prominent in Gram +ve bacteria

• **Intracytoplasmic inclusions** – reserve of energy & phosphate for cell metabolism e.g. Metachromatic granules in diphtheria bacilli Nucleus

• No nucleolus

• No nuclear membrane

• Genome –

• single, circular double stranded DNA.

• Haploid

• Divides by binary fission Additional Organelles

1. Plasmid – • Extranuclear genetic elements consisting of DNA

• Transmitted to daughter cells during binary fission

• May be transferred from one bacterium to another

• Not essential for life of the cell

• Confer certain properties e.g. drug resistance, toxicity

2. Capsule & Slime layer –

• Viscous layer secreted around the cell wall.

• Polysaccharide / polypeptide in nature

a) Capsule – sharply defined structure, antigenic in nature

• Protects bacteria from lytic enzymes

• Inhibits phagocytosis

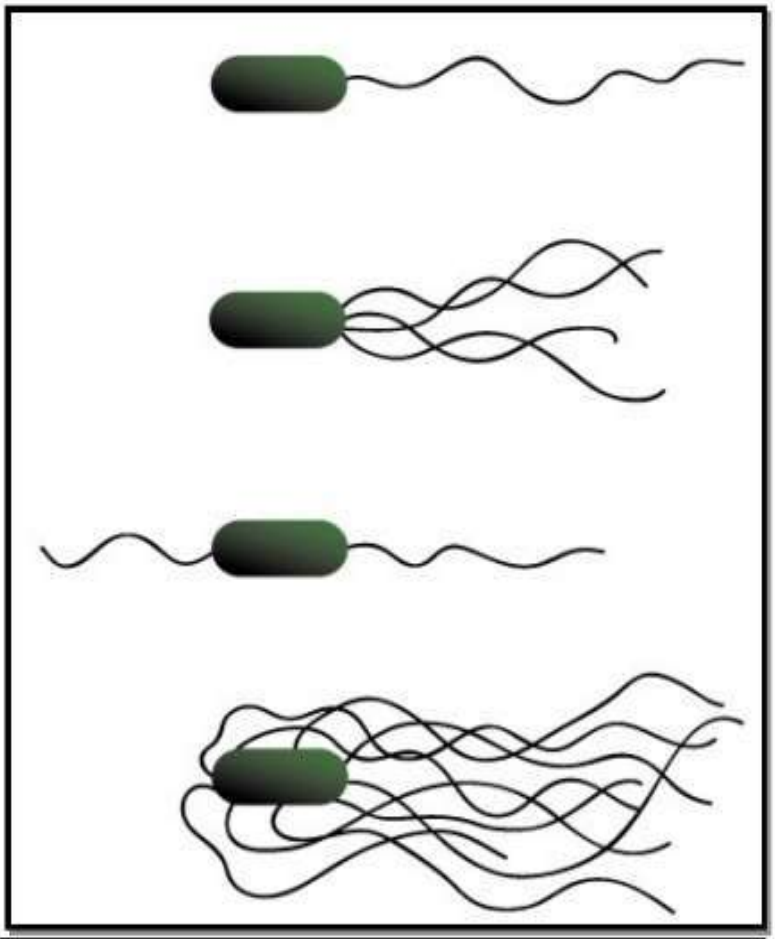
• Stained by negative staining using India Ink

• Can be demonstrated by Quellung reaction (capsule swelling reaction)

a) Slime layer – loose undemarcated secretion

3. Flagella – Long (3 to 12 µm), filamentous surface appendages Organs of locomotion Chemically, composed of proteins called flagellins The number and distribution of flagella on the bacterial surface are characteristic for a given species - hence are useful in identifying and classifying bacteria Flagella may serve as antigenic determinants (e.g. the H antigens of Gram-negative enteric bacteria) Presence shown by motility e.g. hanging drop preparation

Types of flagellar arrangement

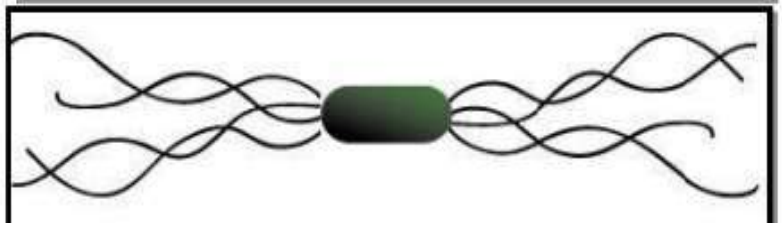


Polar/ Monotrichous – single flagellum at one pole

Lophotrichous – tuft of flagella at one pole

Amphitrichous – flagella at both poles

Peritrichous – flagella all over



Amphilophotrichous – tuft of flagella at both ends

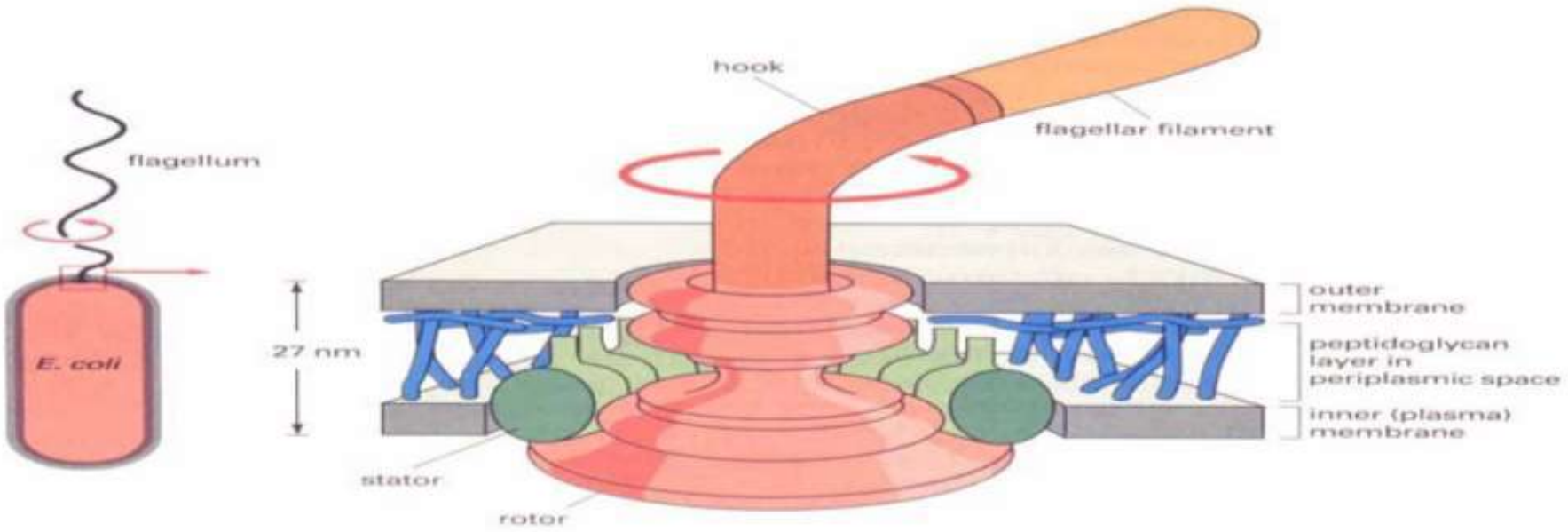
➢• Long unbranched sinuous filaments present on motile bacteria

➢ • Made of 3 parts

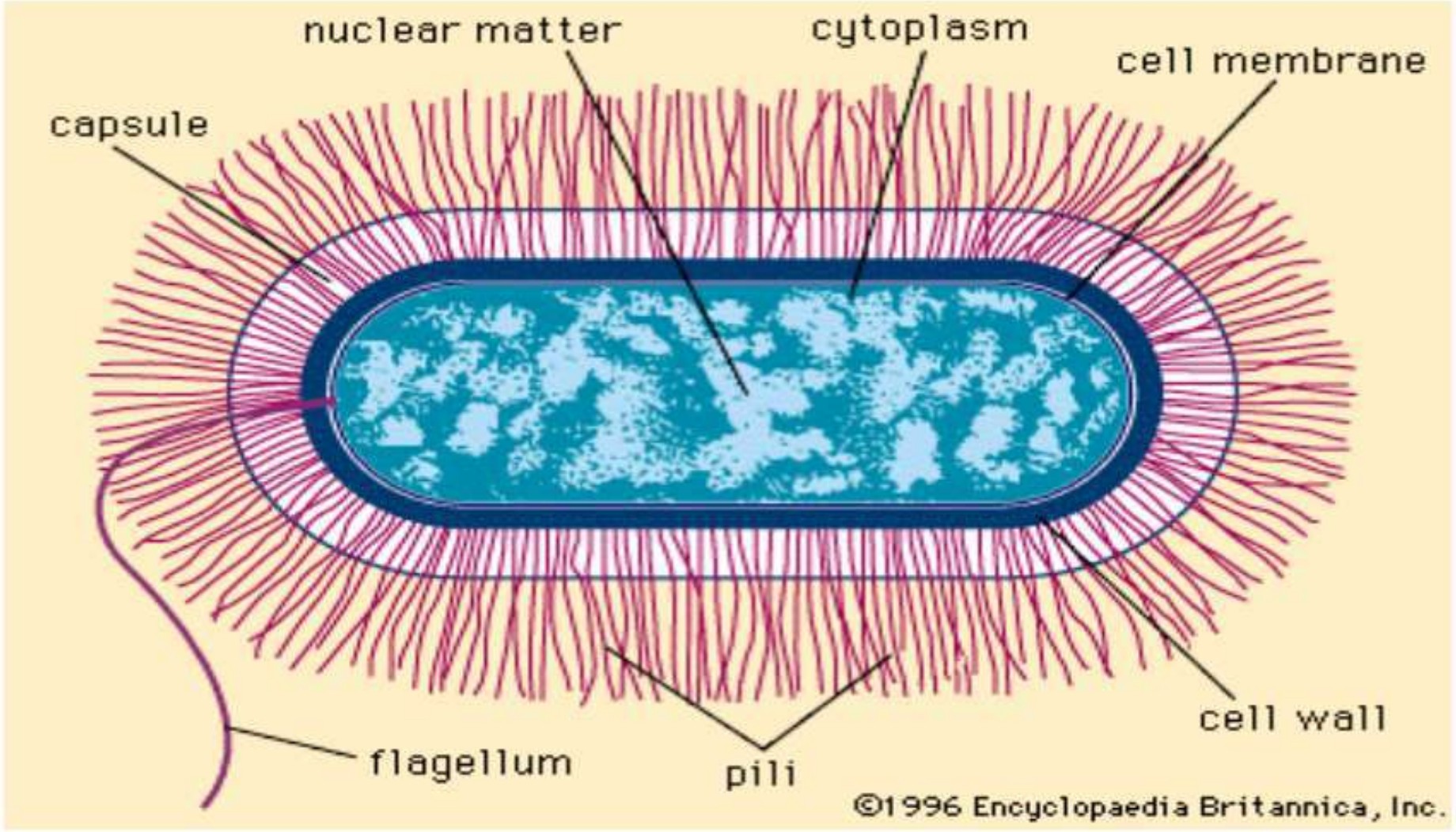
➢ • Filament, hook, and basal body

➢ • Filament is external and hook basal body complex embedded in the cell envelope

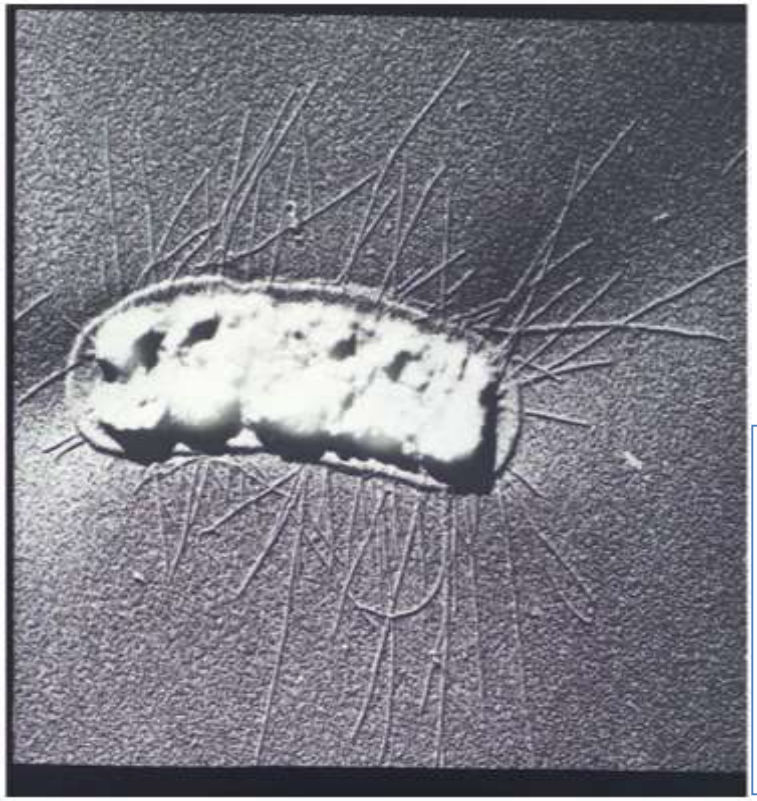
➢• Hook and basal body are antigenically different



Flagella and fimbriae (Pili)



Fimbriae / Pili



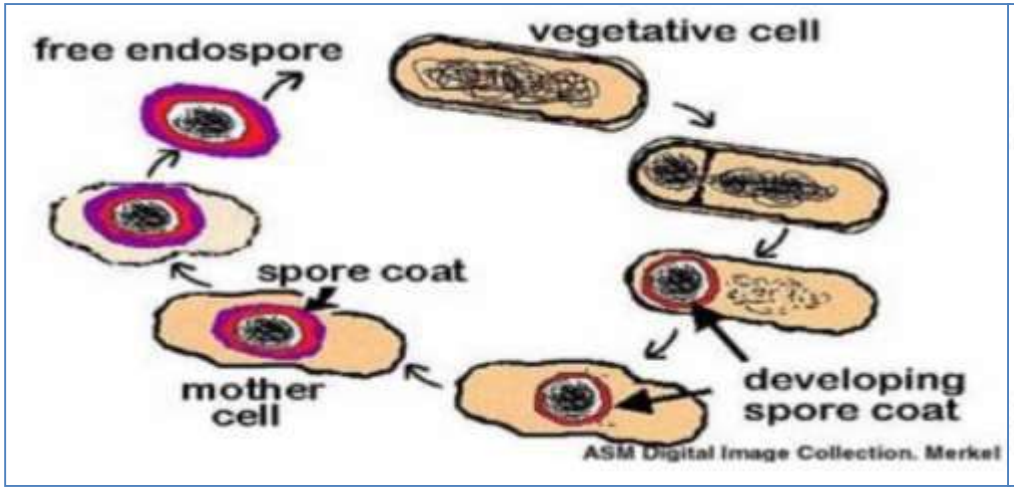
- Fine hair like appendages
- Shorter and thinner than flagella projecting from cell membrane
- Present on both motile and non motile bacteria
- Made up of pilin
- 8 morphological types known
- Classified as common or sex pili
- Confer adhesive property to the cell
- Disappear following subcultures

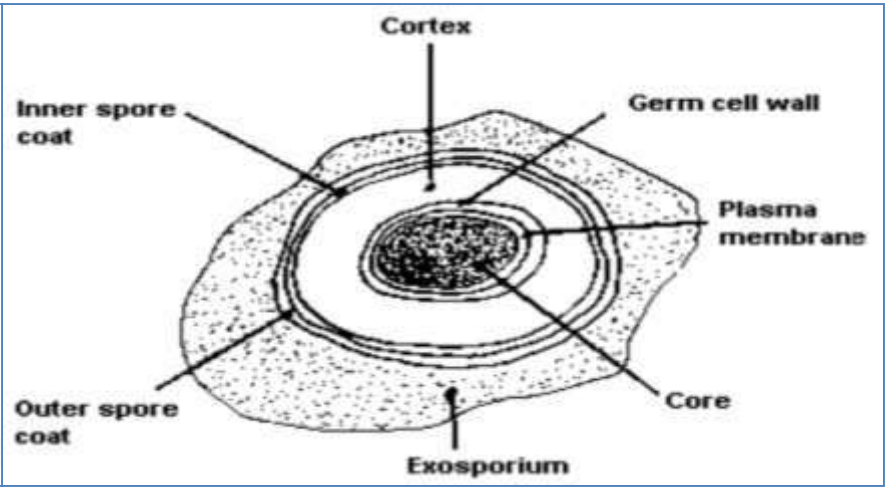
- Agglutinate red blood cells of guinea pigs, horses and pigs strongly
- Human and sheep cells weakly
- Detected by hemagglutination
- Antigenically similar and may cause cross reaction in serological tests

Fig: Google image

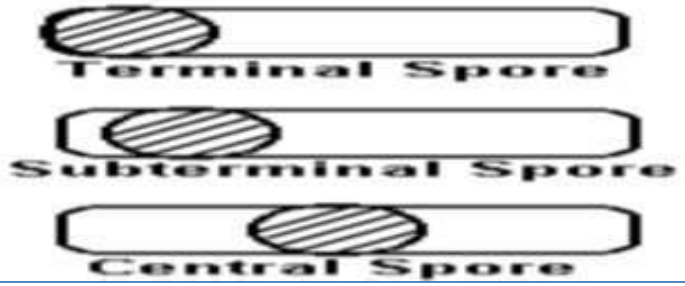
Spores

- Highly resistant resting stages
- Endospores – formed inside cell
  - Due to deletion of exogenous nutrients / unfavourable environment
  - Young spores are seen attached to parent cell
- Appear as unstained area in gram stain
  - Special spore stain can be used





- Spores may bulging or non bulging



Shape & position of bacterial spore