# Internal Structures in Bacteria

# Anatomic Structure of Bacteria

**External Stuructures**

- Cell Wall
- Capsule
- Flagella
- Fimbria (Pilus)

**Internal Structures**

- Cytoplasmic membrane
- Mesosom
- Nucleotide
- Ribosome
- Cytoplasmic granules
- Spore
- Others (plasmids, bacteriophages, pigments, transposons, IS elements)

# Cytoplasmic Membrane

- flexible structures composed of phospholipids and proteins
- observed only by electron microscopy
- structurally similar to the plasma membranes of eukaryotic cells
- bacterial cytoplasmic membranes do not contain sterols.
- The inner and outer faces of cytoplasmic membranes are hydrophilic while the interior is hydrophobic, forming a barrier to most hydrophilic molecules.

# Functions of Cytoplasmic Membrane

- Transfer of small molecules such as water, oxygen, carbon dioxide and some lipid-soluble compounds into the bacterial cells by passive diffusion.
- Active transport of nutrients into the cell
- Elimination of waste metabolites
- The site of electron transport for bacterial respiration, of phosphorylation systems and of enzymes and carrier molecules that function in the biosynthesis of DNA, cell wall polymers and membrane lipids.

# Cytoplasm

- an aqueous fluid containing **nuclear material**, **ribosomes**, **nutrients** and the **enzymes** and **other molecules** involved in synthesis, cell maintenance and metabolism
- enclosed by the cytoplasmic membrane.
- **Storage granules** (composed of starch, glycogen, polyphosphate or other compounds) present under environmental conditions unfavourable for bacterial growth.
- They are identified using particular dyes.

# Ribosomes

- Ribosomes are the structures where all **protein synthesis** takes place
- are composed of **ribonucleoproteins**
- They consist of two subunits, a larger **50S subunit** and a smaller **30S subunit**.
- The **Svedberg (S) unit**: measure of **sedimentation rate**, which is **dependent on both the size and shape of a particle**.

# Ribosomes

- Bacterial RNA is composed of;
  - **Ribosomal ribonucleic acid (rRNA)** is complexed and accounts for about 80% of the RNA of the cell.
  - **Transfer RNA** (tRNA)
  - **messenger RNA** (mRNA) account for the remaining cellular RNA.
- Ribosomes are found in **cytoplasm** or **associated with the inner surface of the cytoplasmic membrane**.
- During active bacterial growth and rapid protein synthesis, individual ribosomes are joined by mRNA into long chains known as **polysomes**.

# Nuclear Material

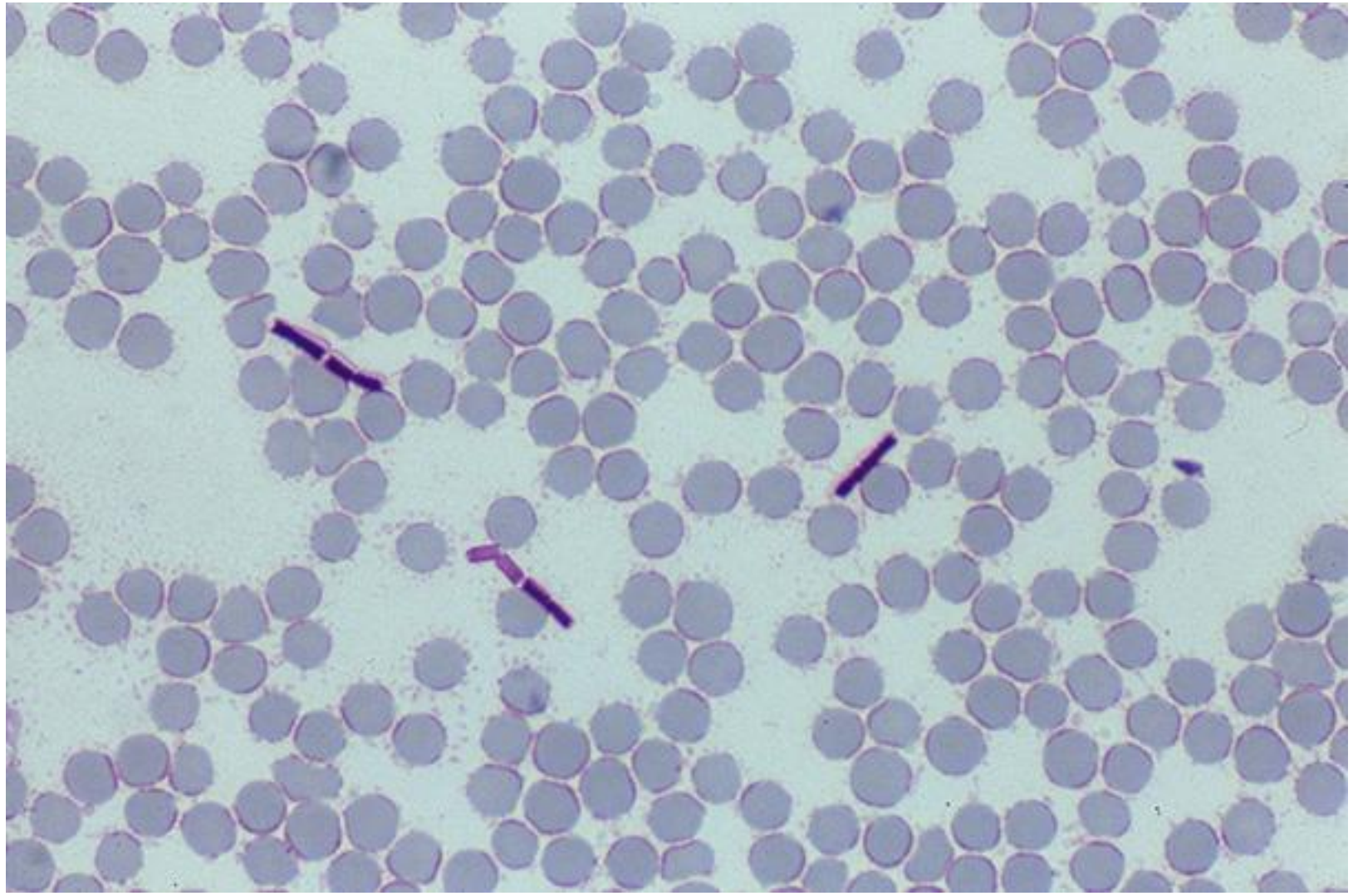
- The bacterial genome is usually composed of a **single haploid circular chromosome** containing **double-stranded DNA**.
- Some bacteria such as ***Burkholderia* spp.*, Vibrio cholerae*** and ***Brucella melitensis*** have two circular chromosomes, and others, including *Borrelia* species, have a linear chromosome.
- Small amounts of **protein** and **RNA** are also associated with nuclear material.
- Genes in the bacterial chromosome encode all the vital functions of the cell.
- Bacterial genomes vary in size depending on the species.
- Bacterial chromosome is extensively **folded** as a dense body, seen by **electron microscopy**.
- Bacteria replicates by **binary fission**, the **DNA helix unwinds** and each **daughter cells** receive **a copy of the original genome**.

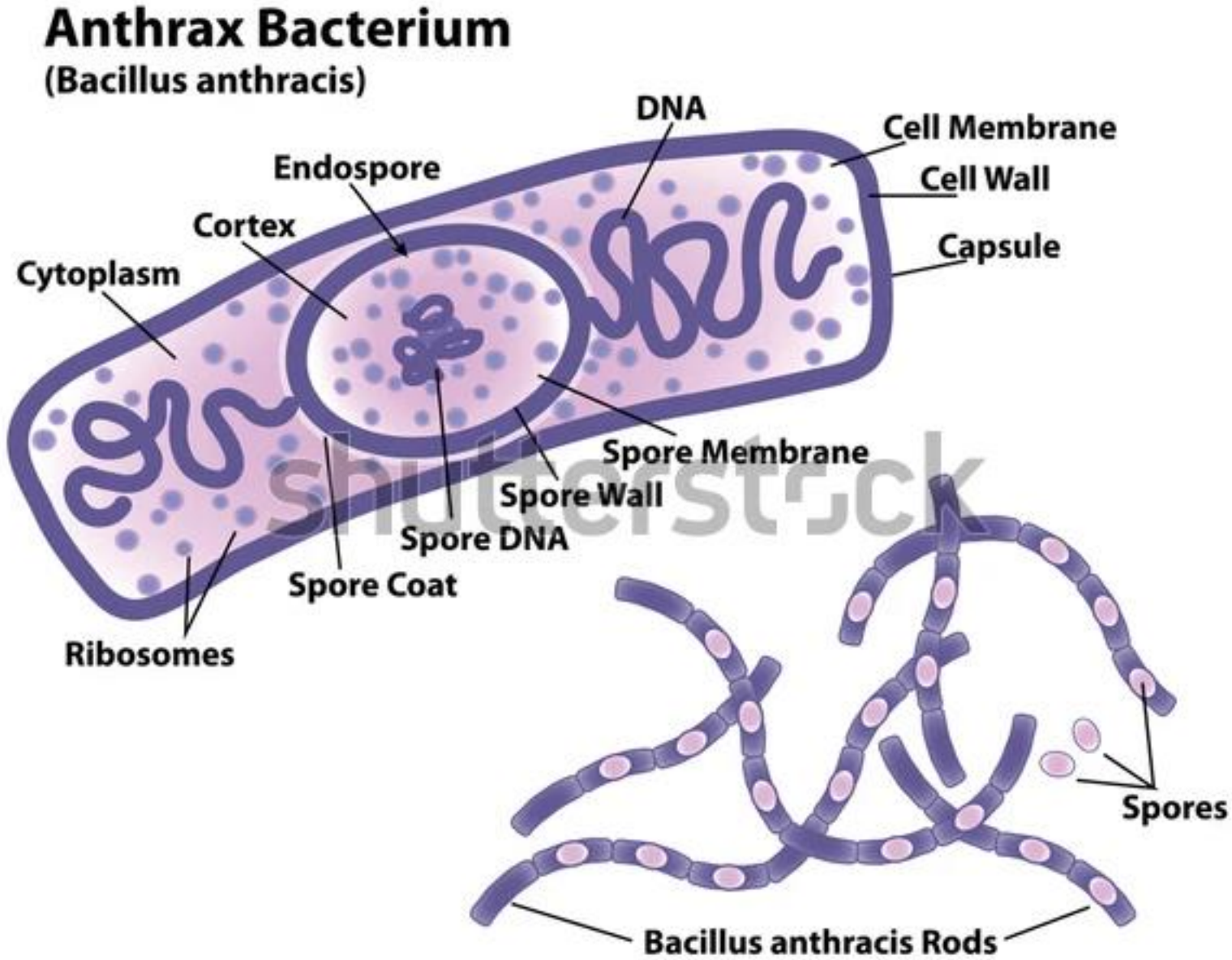
# Plasmids

- Small **extrachromosomal** (separate from the genome) **circular DNA**,
- They are capable of **autonomous replication**,
- Several different plasmids may be present in individual bacterial cells,
- Copies of plasmids can be transferred from cell to cell **during binary fission** or through **conjugation**
- Plasmid DNA may code for characteristics such as **antibiotic resistance** and **exotoxin production**.

# Endospores

- Resistant bodies formed by particular bacteria
- They provide survival during adverse environmental conditions
- Pathogenic bacteria that contain endospore-forming species are ***Bacillus* spp**. and ***Clostridium* spp.**
- They are **produced inside the bacterial cell**, show species **variation in shape, size and position within the mother cell**.
- Because of the resistance and impermeability of the **spore coat**, special staining procedures which employ heat are required to demonstrate endospores.





# Endospores

- Endospores are very resistant structures due to their **layered structure**, their **dehydrated state**, their **negligible metabolic activity**, their high levels of **small acid-soluble proteins** and their high content of **dipicolinic acid**
- **Dipicolinic acid**, which is not found in vegetative cells, occurs in the **core of the spore** in combination with large amounts of **calcium**.
- The high calcium content may explain the extended survival times of endospores in calcium-rich soils. In areas of low soil calcium or in acidic soils, calcium may be leached from spores, shortening their survival times.
- Small acid-soluble proteins bind to the DNA in the core and protect it from damage due to **desiccation**, **dry heat** and **UV radiation**.
- Spores are **thermostable**, they can be destroyed only by moist heat at **121°C for 15 min (autoclave sterilization)**.

# Endospores

- When an endospore is reactivated, germination occurs in three stages, namely **activation**, **initiation** and **outgrowth**.
- Activation may occur in response to factors such as **exposure to heat**, **abrasion of the spore coat** or **environmental acidity**.
- If other environmental conditions i.e. **presence of adequate nutrients are favourable**, **initiation of germination** will occur. In initiation, spore cortex and coats are degraded, water is absorbed, calcium dipicolinate is released.
- Outgrowth is a period of **active biosynthesis** and terminates with division of the **new vegetative cell**.

# References


1. Quinn PJ, Markey BK, Leonard FC, FitzPatrick ES, & Fanning S (2011). Veterinary Microbiology and Microbial Disease. 2nd Ed., Wiley-Blackwell.
2. Tortora GJ, Funke BR, Case CL (2019). Microbiology, An Introduction. 13rd Edition, Pearson Education Inc.
3. McVey DS, Kennedy M, Chengappa MM, Wilkes R (2022). Veterinary Microbiology, 4th Ed., Wiley-Blackwell.