

PROKARYOTIC CELLS

- Within the microscopic tapestry of life, prokaryotic cells emerge as exemplars, represented by bacteria, blue-green algae, Mycoplasma, and Pleuro pneumonia-like organisms (PPLO). Characterized by their smaller size and rapid multiplication, prokaryotic cells exhibit a diverse array of shapes and sizes, yet share a fundamental cellular organization.
- **Common Features:** Despite the varied manifestations in shape and function, prokaryotic cells share certain common features. Most notably, they possess a cell wall enveloping the cell membrane, defining the structural boundaries. The cytoplasm, a fluid matrix, fills the cell's interior, while a distinctive absence defines the nucleus, offering a marked contrast with eukaryotic cells. In prokaryotes, the genetic material remains unenclosed by a nuclear membrane, presenting itself as naked genomic DNA, often in the form of a single circular chromosome. Some bacteria supplement this genetic repertoire with small circular DNA, known as plasmids. These plasmids harbor unique genetic information, contributing specific phenotypic traits, such as antibiotic resistance.

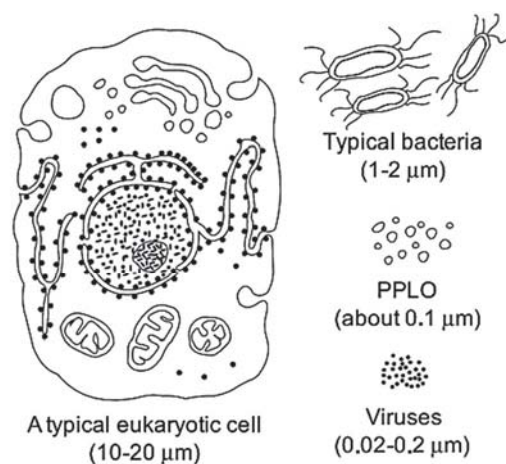


Fig. : Diagram showing comparison of eukaryotic cell with other organisms

- **Genetic Complexity:** The prokaryotic genetic landscape is intricately woven with genomic DNA, constituting the primary chromosome, and plasmid DNA. This genetic setup not only governs the fundamental identity of the organism but also empowers it with adaptability through the acquisition of advantageous traits.
- **Distinctive Traits and Antibiotic Resistance:** Plasmids, acting as carriers of additional genetic information, play a pivotal role in endowing bacteria with distinctive characteristics. One such trait, notably relevant in the contemporary context of medicine, is antibiotic resistance. The presence of plasmid DNA equips bacteria with the ability to withstand the effects of antibiotics, posing challenges in the treatment of bacterial infections.
- **Minimalist Organelle Architecture:** In stark contrast to eukaryotic cells, prokaryotic cells exhibit a minimalist organizational scheme. Organelles, characteristic of eukaryotes, find no counterpart in the prokaryotic realm, with the exception of ribosomes. Ribosomes, integral to protein synthesis, stand as the sole organelles within the prokaryotic cellular framework.

Cell Envelope and its Modifications

- In the microscopic realm of prokaryotic cells, particularly within bacterial cells, a chemical labyrinth unfolds—the cell envelope. This multifaceted structure comprises three tightly bound layers: the outermost glycocalyx, the cell wall, and the plasma membrane.
- **Glycocalyx Dynamics:** The glycocalyx, residing at the forefront, presents a diverse facade across bacterial species. Composed of mucous or polysaccharide macromolecules, it forms a protective coating, facilitating adhesion. This outer layer varies in thickness and chemical composition, manifesting as a loose sheath, aptly termed the slime layer, in some instances. The slime layer serves as a shield, preventing water and nutrient loss. Alternatively, a robust covering known as the capsule may encase the bacterial cell. Both capsule and slime layer, predominantly constituted of polysaccharides, may occasionally harbor proteins. The capsule bestows a distinctive gummy and sticky quality to the cell, offering camouflage against the host's immune system.
- **Structural Sentinel: The Cell Wall:** The cell wall, positioned beneath the glycocalyx, stands as a structural bulwark, determining cell shape and preventing cellular collapse. Rigid in nature, this layer owes its stability to a unique macromolecule—peptidoglycan (murein or mucopeptide). Notably, certain antibiotics, including penicillin, disrupt the cross-linking of peptidoglycan strands, inducing cell lysis.

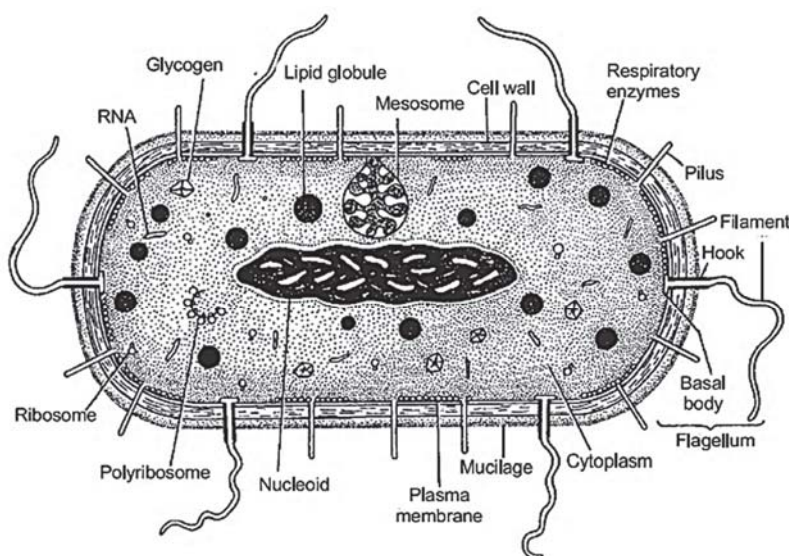


Fig. : Cell structure of bacteria under electron microscope

- **Gram Staining Revelation:** A significant classification tool in the bacterial realm is Gram staining, pioneered by Christian Gram. This technique categorizes bacteria into two groups: Gram-positive and Gram-negative. The ability to take up the Gram stain designates bacteria as Gram-positive, while those unable to do so are deemed Gram-negative. This demarcation holds diagnostic value in microbiology.
- **Selective Gatekeeper: The Plasma Membrane:** The plasma membrane, akin to its eukaryotic counterpart, serves as a selectively permeable interface mediating interactions with the external milieu. An intriguing membranous structure, the mesosome, arises through plasma membrane invagination. These extensions, in the form of vesicles, tubules, and lamellae, contribute to cell wall formation, DNA processes, respiration, and enzymatic content. Mesosomes primarily characterize Gram-positive bacteria.

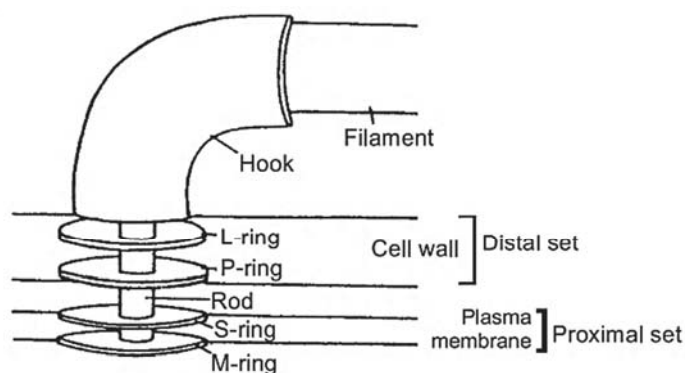


Fig. : A sectional view of a bacterial cell showing the detailed structure of the flagellum and attachment of flagellum to the bacterial cell

- **Motility and Surface Structures:** Bacterial cells exhibit a spectrum of motility, with motile variants featuring thin filamentous extensions known as flagella. Comprising three segments—filaments, hooks, and basal bodies—flagella play a pivotal role in bacterial movement. Beyond flagella, surface structures like pili and fimbriae add complexity. Pili, composed of pilin, facilitate conjugation in Gram-negative bacteria, allowing the transfer of genetic material between cells. Fimbriae, bristle-like fibers, participate in adhesion, attaching bacteria to diverse surfaces, from rocks in streams to host tissues.

Ribosomes and Inclusions Bodies

- Within the intricate landscape of prokaryotic cells, the orchestra of cellular activities unfolds with ribosomes at the forefront, orchestrating protein synthesis. Paired with these dynamic protein factories, inclusion bodies serve as reservoirs of essential materials, each contributing to the cellular symphony.
- **Ribosomal Choreography:** In the realm of prokaryotic cells, ribosomes stand as pivotal actors, intricately associated with the plasma membrane. These molecular machines, measuring approximately 15 nm by 20 nm, manifest as two subunits—50 S and 30 S units. In harmonious collaboration, these subunits converge to form the 70 S prokaryotic ribosomes, the veritable epicenter of protein synthesis. While cytoplasmic ribosomes craft proteins for intracellular use, those tethered to the plasma membrane embark on the production of proteins destined for extracellular journeys. A noteworthy spectacle emerges when multiple ribosomes unite along a single mRNA, birthing a chain known as polyribosomes or polysomes. Within this rhythmic assembly, the ribosomes collectively translate mRNA into the intricate language of proteins.
- **Inclusion Bodies: Custodians of Reserves:** Nestled within the cytoplasm, inclusion bodies materialize as reservoirs for essential components, offering a glimpse into the prokaryotic cell's strategic resource management. Distinguished by their absence of encapsulating membranes, these bodies, whether phosphate granules, cyanophycean granules, or glycogen granules, exist freely within the cytoplasmic expanse. Their unbounded nature underscores their immediate accessibility for cellular processes.
- Adding another layer to this narrative, certain inclusion bodies boast a slender membrane, measuring 2-4 nm in thickness. Encapsulating entities such as poly- β -hydroxybutyrate granules, sulphur granules, and gas vacuoles, this membrane-wrapped ensemble introduces a nuanced dimension to prokaryotic cellular architecture. Gas vacuoles, an intriguing feature found in blue-green algae, purple, and green photosynthetic bacteria, underscore the diversity of strategies employed by prokaryotic cells to navigate their dynamic microcosm.