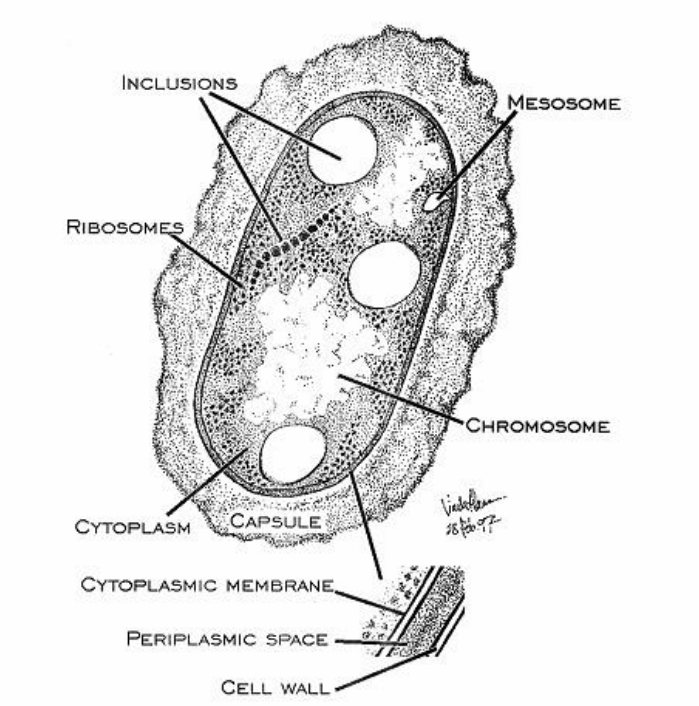
Cell Structure of Bacteria

Prokaryotic structural components consist of macromolecules such as DNA, RNA, proteins, polysaccharides, phospholipids, or some combination thereof. The macromolecules are made up of primary subunits such as nucleotides, amino acids and sugars (Table 1).



A typical bacterial cell

It is the sequence in which the subunits are put together in the macromolecule, called the **primary structure** that determines many of the properties that the macromolecule will have. Thus, the genetic code is determined by specific nucleotide base sequences in chromosomal DNA; the amino acid sequence in a protein determines the properties and function of the protein; and sequence of sugars in bacterial lipopolysaccharides determines unique cell wall properties for pathogens. The primary structure of a macromolecule will drive its function, and differences within the primary structure of biological macromolecules accounts for the immense diversity of life**.**

Table 1. Macromolecules that make up cell material

Macromolecule	Primary Subunits	Where found in cell
Proteins	amino acids	Flagella, pili, cell walls, cytoplasmic membranes, ribosomes, cytoplasm
Polysaccharides	sugars (carbohydrates)	capsules, inclusions (storage), cell walls
Phospholipids	fatty acids	membranes
Nucleic Acids (DNA/RNA)	nucleotides	DNA: nucleoid (chromosome), plasmids rRNA: ribosomes; mRNA, tRNA: cytoplasm

At one time it was thought that bacteria and other prokaryotes were essentially "bags of enzymes" with no inherent cellular architecture. The development of the electron microscope in the 1950s revealed the distinct anatomical features of bacteria and confirmed the suspicion that they lacked a nuclear membrane. Prokaryotes are cells of relatively simple construction, especially if compared to eukaryotes. Whereas eukaryotic cells have a preponderance of organelles with separate cellular functions, prokaryotes carry out all cellular functions as individual units.

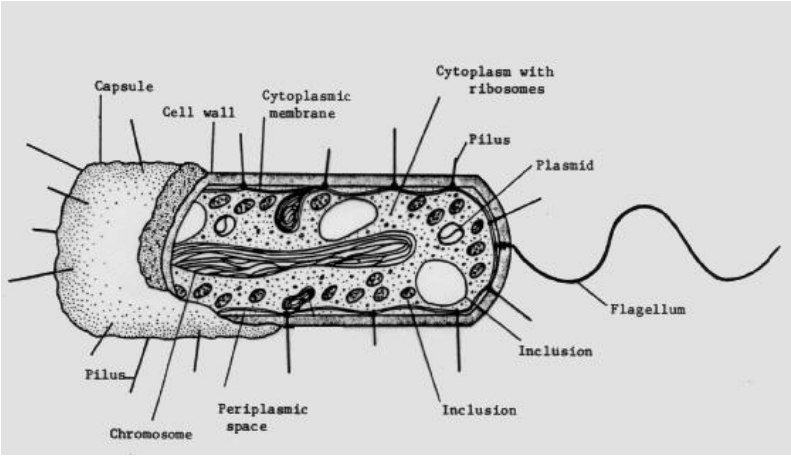


Figure 1. Cutaway drawing of a typical bacterial cell illustrating structural components. .

A prokaryotic cell has five essential structural components: a **nucleoid (DNA)**, **ribosomes**, **cell membrane**, **cell wall**, and some sort of **surface layer**, which may or may not be an inherent part of the wall.

Structurally, there are three architectural regions: **appendages** (attachments to the cell surface) in the form of **flagella** and **pili (or fimbriae)**; a **cell envelope** consisting of a **capsule**, **cell wall** and **plasma membrane**; and a **cytoplasmic region** that contains the cell **chromosome** (**DNA**) and **ribosomes** and various sorts of **inclusions** (Figure 1).

Table 2. Summary of characteristics of typical bacterial cell structures

Structure	Function(s)	Predominant chemical composition
Flagella	Swimming movement	Protein
Pili		
Sex pilus	Stabilizes mating bacteria during DNA transfer by conjugation	Protein
Common pili or fimbriae	Attachment to surfaces; protection against phagotrophic engulfment	Protein
Capsules (includes "slime layers" and glycocalyx)	Attachment to surfaces; protection against phagocytic engulfment, occasionally killing or digestion; reserve of nutrients or protection against desiccation	Usually polysaccharide; occasionally polypeptide
Cell wall		
Gram-positive bacteria	Prevents osmotic lysis of cell protoplast and confers rigidity and shape on cells	Peptidoglycan (murein) complexed with teichoic acids
Gram-negative bacteria	Peptidoglycan prevents osmotic lysis and confers rigidity and shape; outer membrane is permeability barrier; associated LPS and proteins have various functions	Peptidoglycan (murein) surrounded by phospholipid protein-lipopolysaccharide "outer membrane"
Plasma membrane	Permeability barrier; transport of solutes; energy generation; location of numerous enzyme systems	Phospholipid and protein
Ribosomes	Sites of translation (protein synthesis)	RNA and protein
Inclusions	Often reserves of nutrients; additional specialized functions	Highly variable; carbohydrate, lipid, protein or inorganic
Chromosome	Genetic material of cell	DNA
Plasmid	Extrachromosomal genetic material	DNA