

Microbiology

Bacterial cell structure

- ↓
- Unicellular Cells
 - Prokaryotic

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Objectives

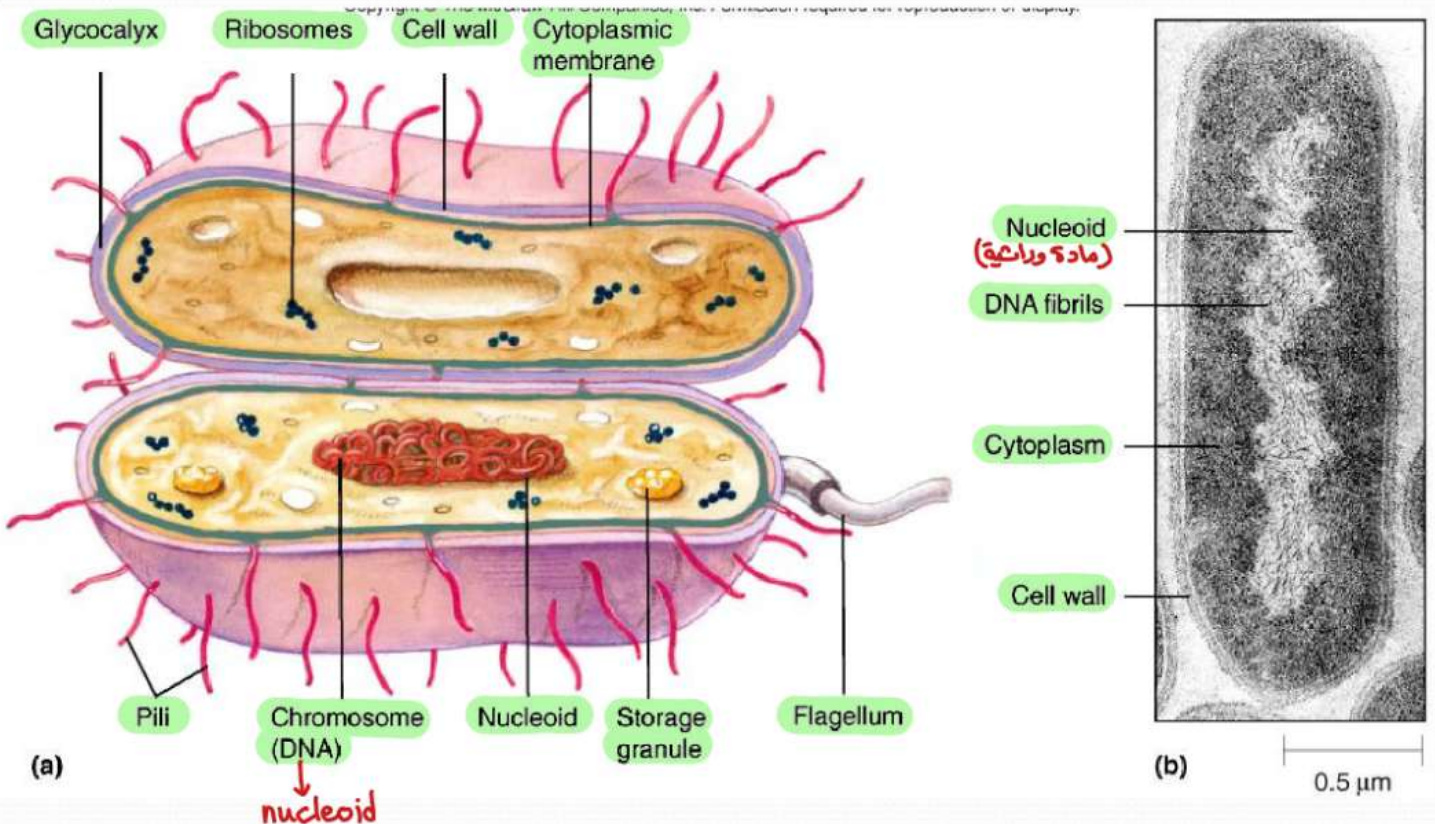
- Understanding Prokaryotic cells structure and function
- Understanding Eukaryotic cells anatomy and function
- Differentiates Prokaryotic from Eukaryotic cells

Introduction

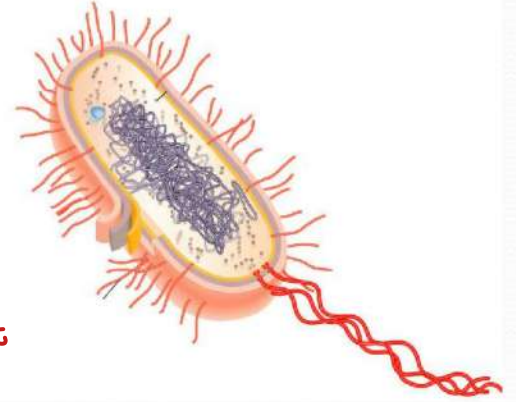
- Prokaryote comes from the Greek words for **pre**nucleus خلية بدائية عنى حقيقة النواة
↓
No nucleus
- Eukaryote comes from the Greek words for **true** nucleus
- Prokaryotic cell is **simpler** than eukaryotic cells **at every level** except the cell envelop which is more complex

the main single most important difference between Prokaryote & Eukaryote could be nucleus & nuclear envelope

Typical Prokaryotic Cell



Cell Wall Functions



- Determines cell shape
 - Bacilli
 - Cocci
 - Spiral
- Prevents osmotic lysis
 - تحلل خلايا البكتيريا
- Part of cell envelope
- In some cases recognized by host immune system

*Cell envelope includes

- Cell wall
- Cell membrane
- other covers

يتعرف الجهاز المناعي على المستنق الخارجي حتى يقتل البكتيريا
 (recognize foreign bodies & microorganisms and kills them)

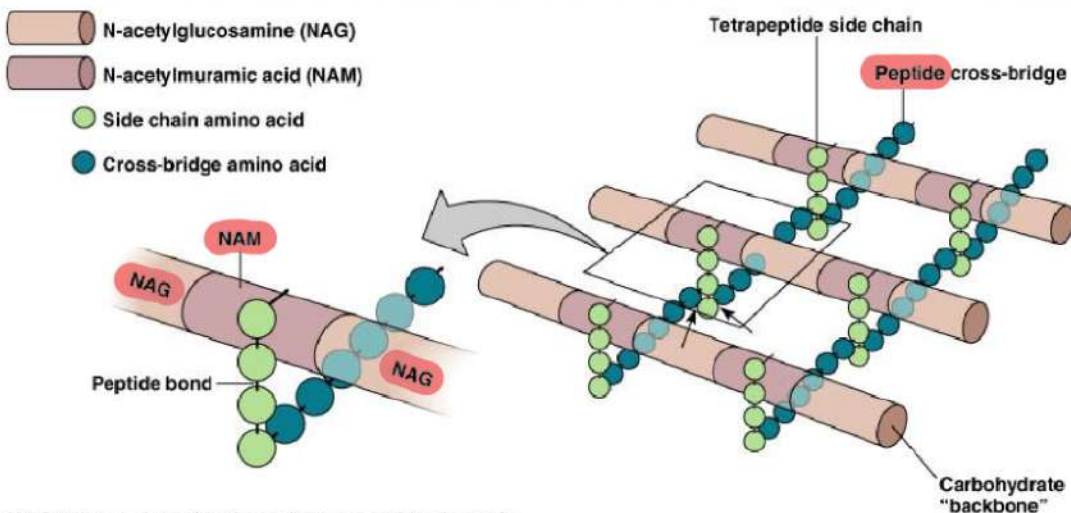
Cell wall structure

* تركيب السطح الخارجي لخلايا البكتيريا
 يختلف عن خلايا الإنسان والحيوان

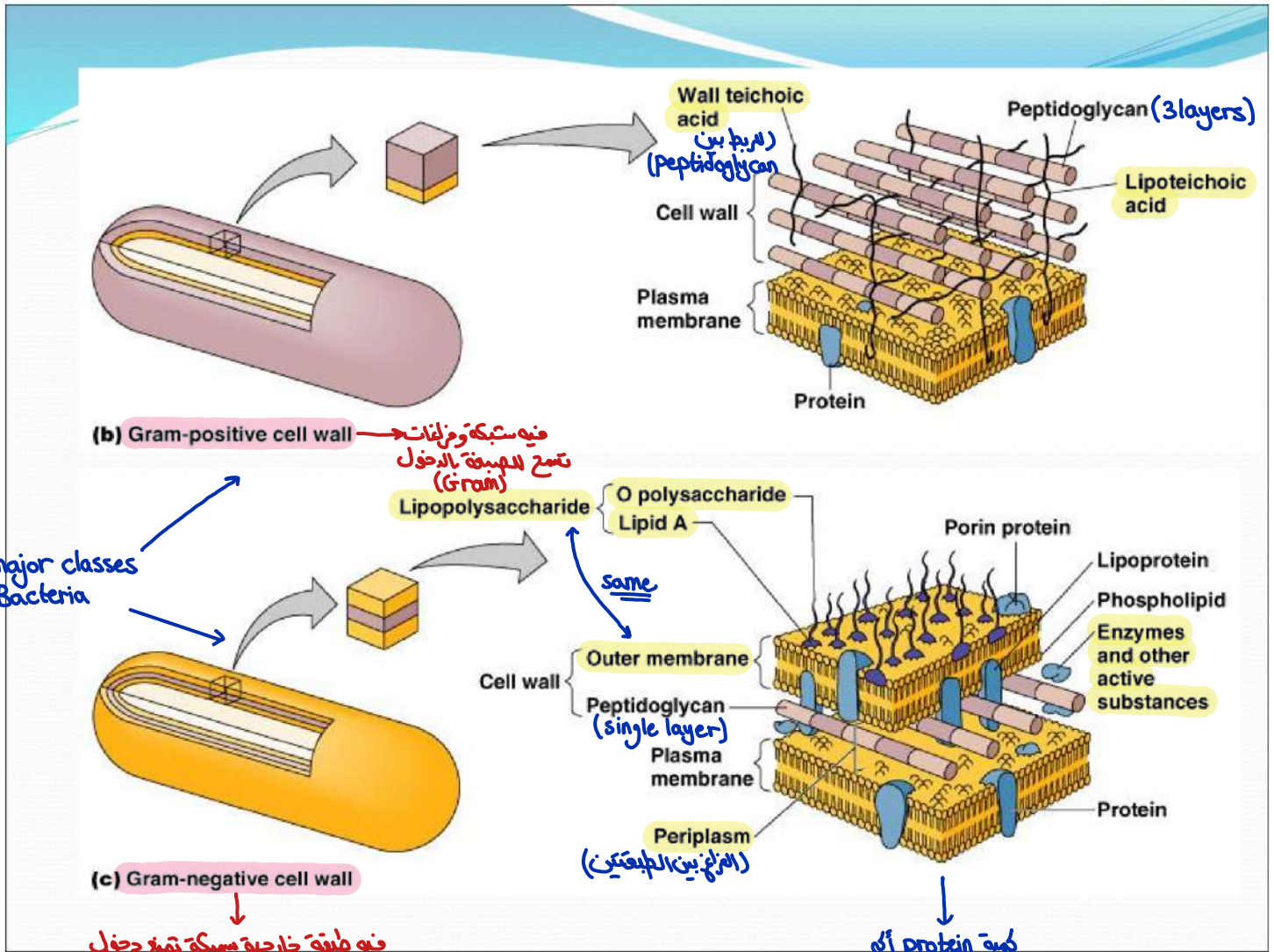
Made of ^{protein} peptidoglycan (in bacteria) ^{glucose (sugar)}

- Polymer of disaccharide
 - N-acetylglucosamine (NAG) & N-acetylmuramic acid (NAM)
- Linked by polypeptides

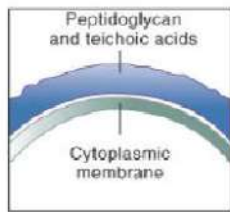
هنا المكونات الرئيسية واحدة
 Gram positive cell wall
 Gram negative



(a) Structure of peptidoglycan in gram-positive bacteria

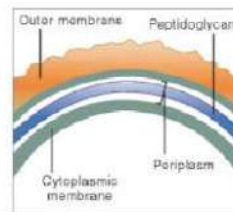


Gram-positive cell walls



Gram-Positive

Gram-negative cell walls



Gram-Negative

- Thick peptidoglycan
- Teichoic acids
- No outer membrane
- No periplasm

- Thin peptidoglycan
- No teichoic acids
- Outer membrane
- Have periplasm

Clinical Importance of Cell Wall

- Differentiate Gram-positive from Gram-negative bacteria (Investigation and diagnosis) by Gram stain
(تعين شكلها الخارجي: ↑ سكر / ↑ protein / peptidoglycan)
- Cell wall provide antigenic variation critical for host immune defense and autoimmune diseases ^{e.g.:} Tonsillitis / Pharyngitis by Streptococcus or Strep throat
- Cell wall is target for antibiotics, Gram-negative cell wall provide resistance for many antibiotics
- Gram negative outer membrane → يمنع ارتباط دخول Antibiotic وبالتالي علاجه أصعب
- Lipopolysaccharide (Lipid A) secretes Endotoxins in Gram negative bacteria

سم ويمكن أن تغزّه لبرا
ويجعل الالتهابات
more toxic
وعلاجها أصعب

* تابع النقطه الثالثه : Structure of cell wall of Strep throat has two proteins :

واحد منهم يشبه بروتينات صمام العقب والبروتين الثاني يشبه البروتينات الموجوده على غلاف joints (المفاصل)

وهن بيحي جهاز المناعه ليه يقطن على البكتريا فيقطن على البروتينات التي تشبهها من التركيب من الجسم وتكرار حدوث التهاب

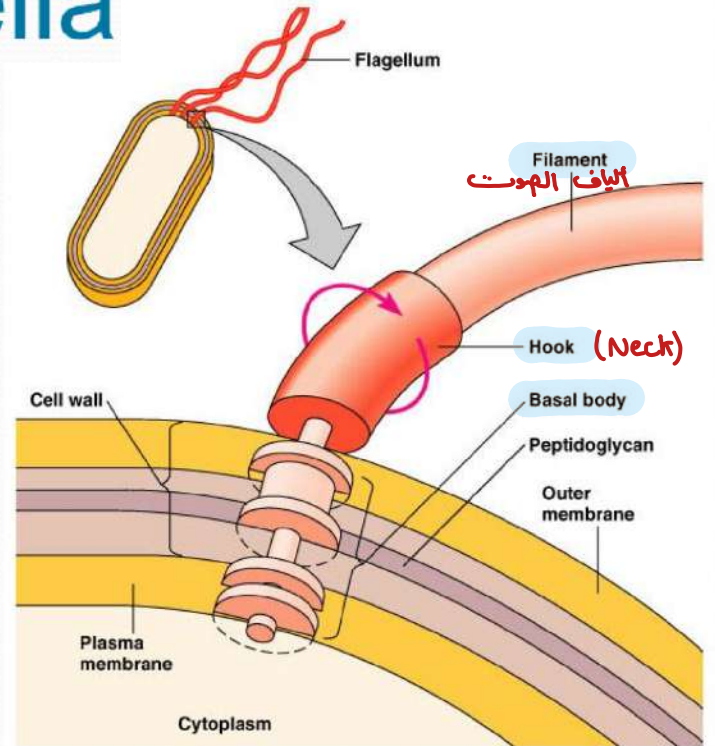
الدورتين بسبب تدمي لعضلات العقب مما يسبب روماتيزم العقب عند الأطفال والعلاج Antibiotic على طول أو ابره

كل شهر حتى ما تكفيه Strep throat بالبره

Bacteria Flagella

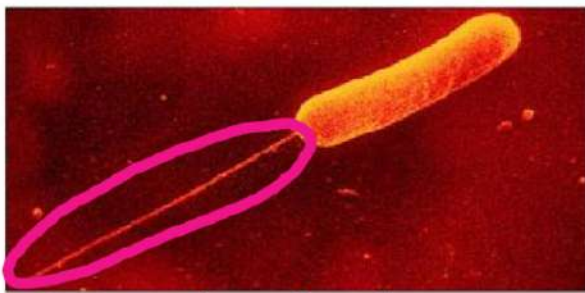
(not all types of Bacteria have Flagella)

- Structure:
 - Outside cell wall
 - Made of chains of flagellin
 - Attached to a protein hook
 - Anchored to the wall and membrane by the basal body
- Function: Motility

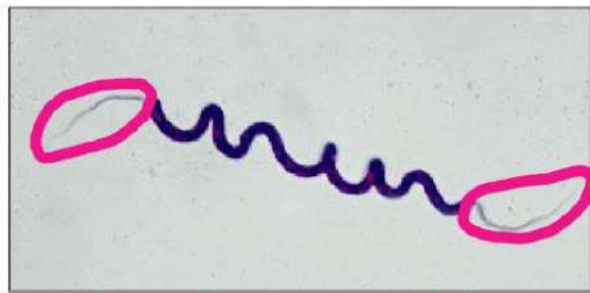


* جهاز المناعة قد يتكيف على البكتيريا من خلال Flagella لأنها تركيب خارجي

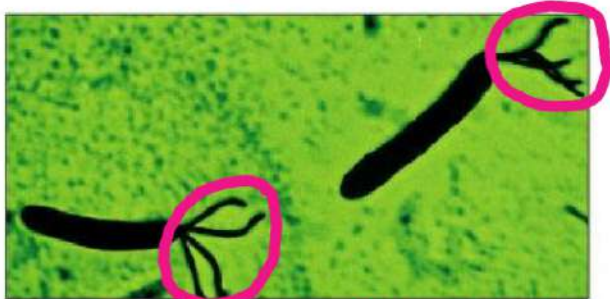
Flagella Arrangement



(a) Monotrichous (single flagella)



(b) Amphitrichous (two flagella not at the same pole)



(c) Lophotrichous (more than 2 flagella but at the same pole)



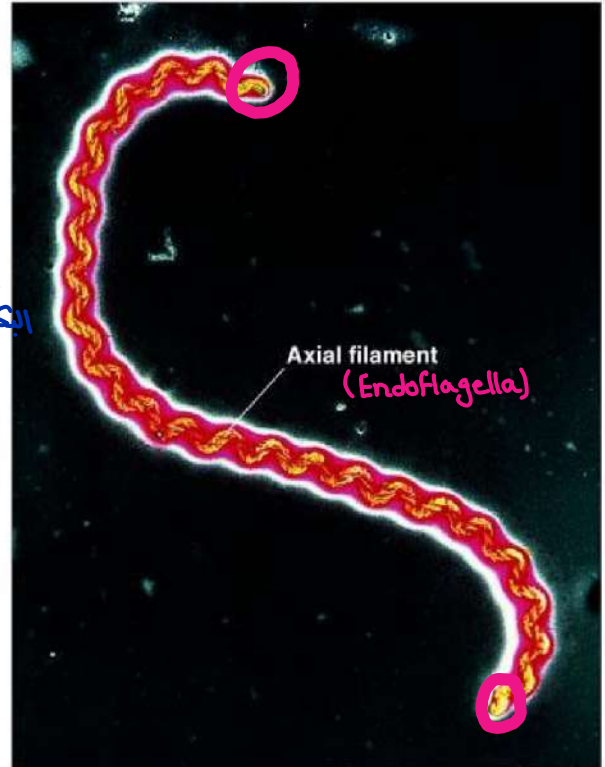
(d) Peritrichous (Flagella is in all around the bacteria)

↓ eg:
Escherichia Coli

Axial Filaments

↓
not outer flagella

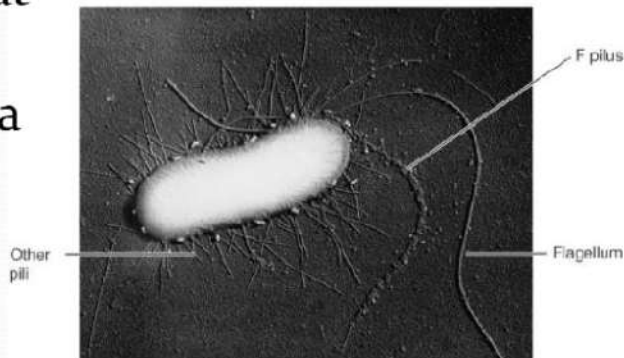
- Endoflagella ⁱⁿ → Spiral Bacteria
- Found only in spirochetes → اسم البكتيريا
- Anchored at one end of a cell
- Rotation causes cell to move
↓
Screw like
مثل البوعني



Pili and Fimbriae → Outer Structures

Filamentous appendages that are shorter, straighter and more numerous than flagella

Found mostly in Gram (-) Bacteria

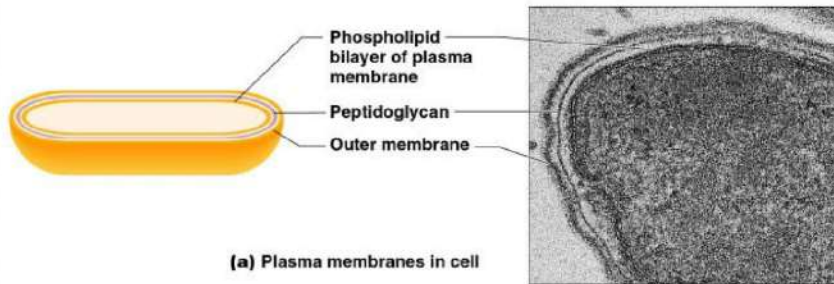
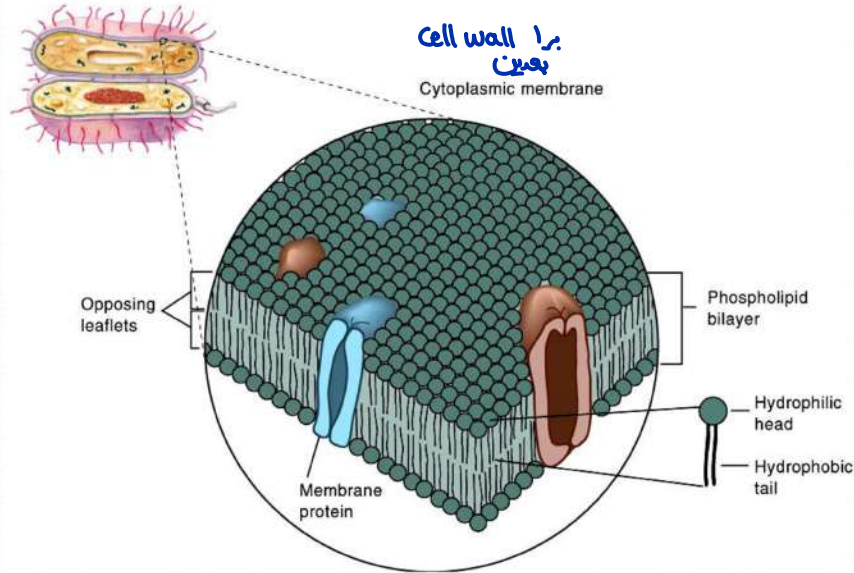


Fimbriae allow attachment while Pili are used to transfer DNA from one cell to another

↓
يمكن البكتيريا تكون حين مقاوم لبعض معين من Antibiotic
به الكرون له لسنوات طويلة ومن ثم تنقله لغيرها عن طريق Pili

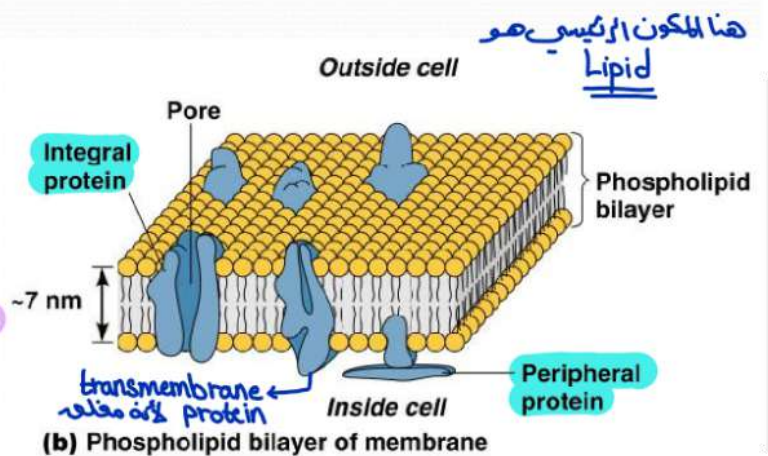
Plasma Membrane

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Structure

- Phospholipid bilayer (two layers)
- Peripheral proteins
- Integral proteins
- Transmembrane proteins



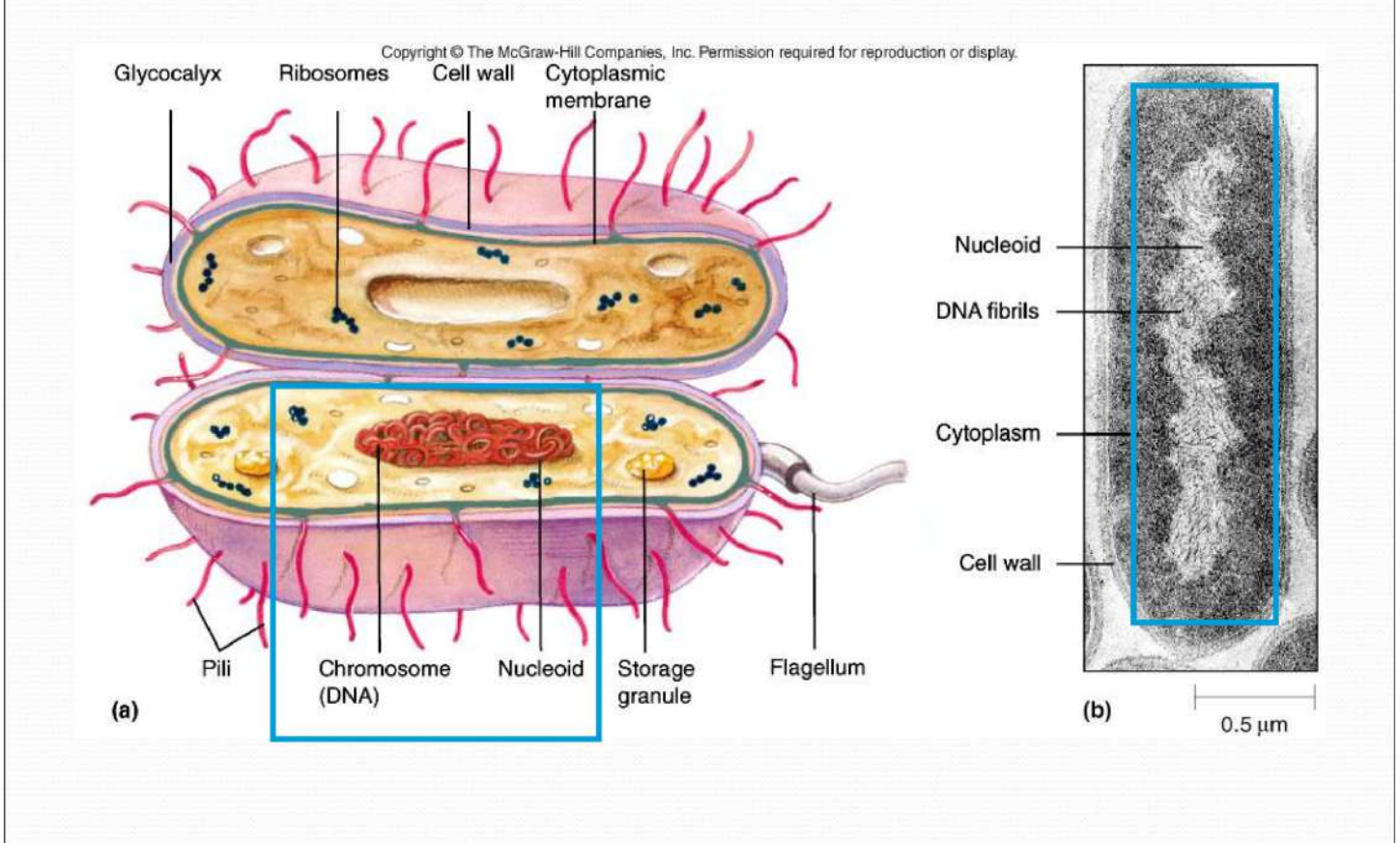
Functions:

- Selective permeability allows passage of some molecules
- Enzymes for ATP production and cell wall synthesis
- Photosynthetic pigments

Movement Across Membranes

- Simple diffusion: Movement of a solute from an area of **high concentration to an area of low concentration** (no energy or carrier (transporter) protein)
↓
will concentration gradient
- Facilitative diffusion: Solute combines with a **transporter protein** in the membrane (with **concentration gradient & no energy expended**)
- Active Transport (**against concentration gradient & energy expended**)

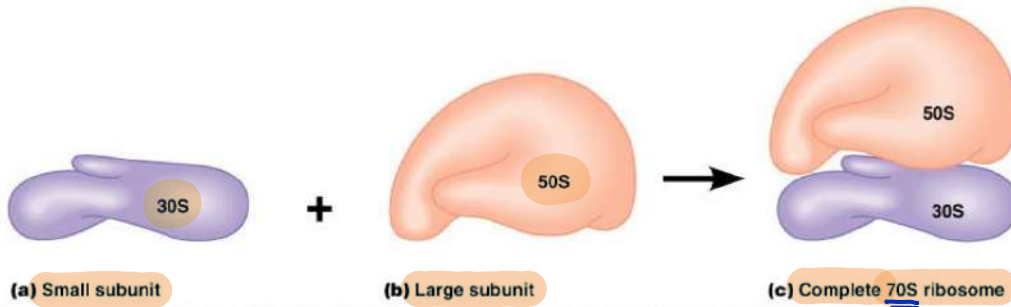
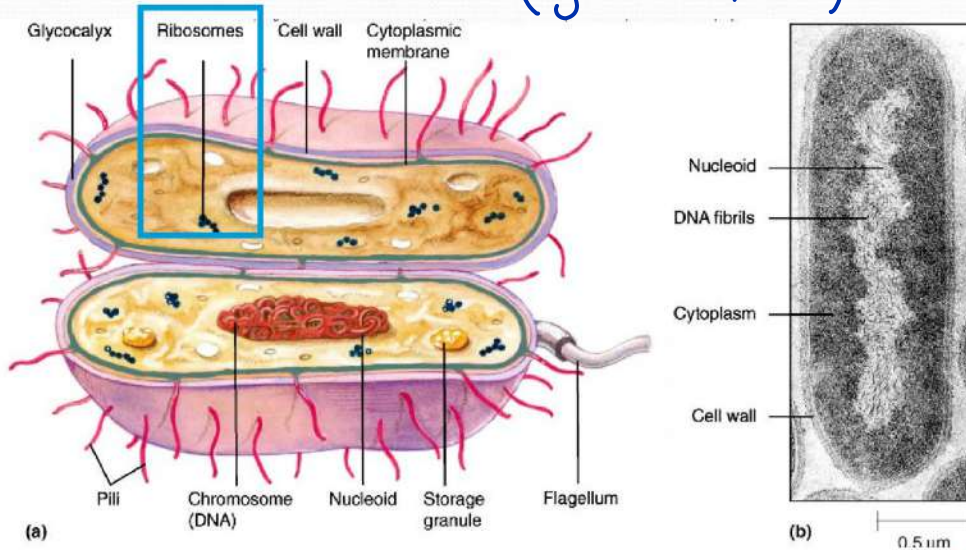
Nuclear Area (Nucleoid) and Plasmid



- Prokaryotic cells have no true Nuclei, DNA is packaged as Nucleoid and some small circular DNA pieces named Plasmid → extrachromosomal
(Nuclear Area/Chromosome)
- The number of Nucleoids and Chromosomes depends on growth condition

Ribosomes: Sites of Translation

(synthesis of Protein)



* Human Ribosome = 40S + 50S = 80S

not size
بل جاذبية (٧٠) حتى
يصل الأوزن مسافة معينة

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Table 3.3 A Summary of Prokaryotic Cell Structures

Structure	Characteristics
Extracellular	
Filamentous appendages	Composed of subunits of proteins that form a helical chain.
Flagella	Provides the most common mechanism of motility.
Pili	Different types of pili have different functions. The common types, often called fimbriae, enable cells to adhere to surfaces. A few types mediate <u>twitching</u> or <u>gliding</u> motility. Sex pili are involved in a mechanism of DNA transfer.
Surface layers	
Glycocalyx	Layer outside the cell wall, usually made of polysaccharide. (مزانج كيمي)
Capsule	Distinct and <u>gelatinous</u> . Enables bacteria to adhere to specific surfaces; allows some organisms to <u>thwart</u> innate defense systems and thus cause disease. (ملاصبي)
Slime layer	Diffuse and irregular. Enables bacteria to <u>adhere</u> to specific surfaces.
Cell wall	
Gram-positive	Peptidoglycan is the molecule common to all bacterial cell walls. Provides rigidity to prevent the cell from lysing.
Gram-negative	Thin layer of peptidoglycan surrounded by an outer membrane. The outer leaflet of the outer membrane is lipopolysaccharide.
Cell Boundary	
Cytoplasmic membrane	Phospholipid bilayer embedded with proteins. A barrier between the cytoplasm and the outside environment. Also functions as a discriminating <u>conduit</u> between the cell and its surroundings. (تواصل)
Intracellular	
DNA	Contains the genetic information of the cell. <u>to transfer them to Ribosome/replication (growth)</u>
Chromosomal	Carries the genetic information that is essential to a cell. Typically a single, circular, double-stranded DNA molecule.
Plasmid	Carries genetic information that may be advantageous to a cell in certain situations.
Endospore	A type of dormant cell that is extraordinarily resistant to damaging conditions including heat, <u>desiccation</u> , ultraviolet light, and toxic chemicals. (الجفاف) (التحمل)
Gas vesicles	Small, rigid structures that provides <u>buoyancy</u> to a cell. (طفو)
Granules	Accumulations of high molecular weight polymers, which are synthesized from a nutrient that a cell has in relative excess.
Ribosomes	Intimately involved in protein synthesis. Two subunits, 30S and 50S, join to form the 70S ribosome, which serves as the structure that facilitates the joining of amino acids.

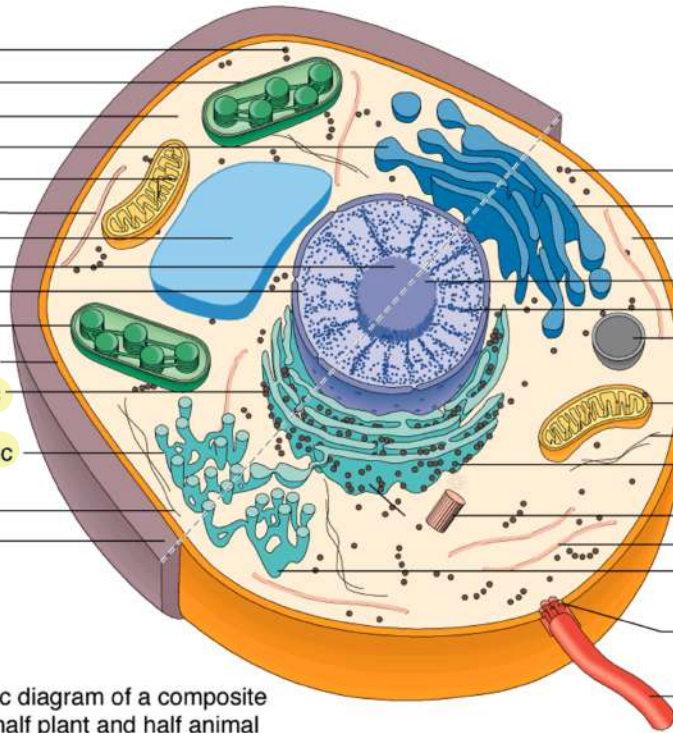
Eukaryotic Cells

PLANT CELL

- Ribosome
- Chloroplast
- Cytoplasm
- Golgi complex
- Mitochondrion
- Microtubule
- Vacuole
- Nucleolus
- Nucleus
- Thylakoid
- Plasma membrane
- Rough endoplasmic reticulum
- Smooth endoplasmic reticulum
- Microfilament
- Cell wall

ANIMAL CELL

- Ribosome
- Golgi complex
- Cytoplasm
- Nucleolus
- Nucleus
- Lysosome
- Plasma membrane
- Mitochondrion
- Microfilament
- Rough endoplasmic reticulum
- Centrioles
- Microtubule
- Smooth endoplasmic reticulum
- Basal body
- Flagellum



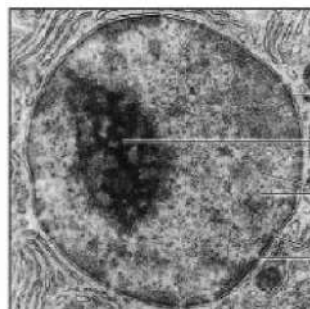
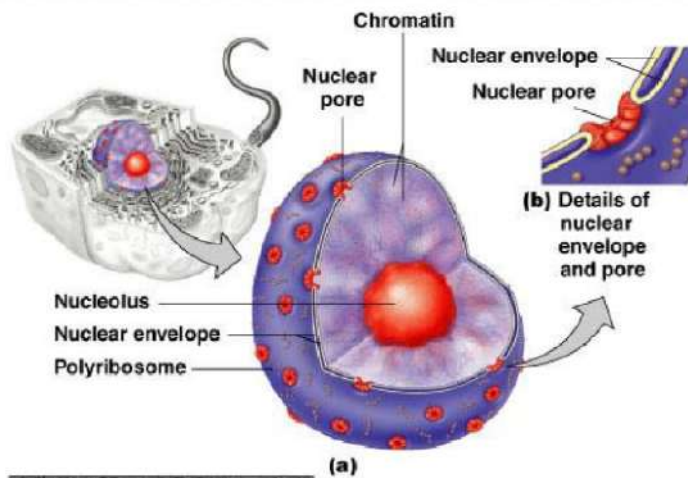
(a) Highly schematic diagram of a composite eukaryotic cell, half plant and half animal

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* Prokaryotic → complex cell wall

* Eukaryotic → complex cytoplasmic structures (organelles)

Nucleus



(c)

Prokaryote

- One circular chromosome, not in a membrane
- No histones
- No organelles
- Peptidoglycan cell walls
- Binary fission

طريقة التكاثر (الانقسام)

Eukaryote

- Paired chromosomes, in nuclear membrane
- Histones
- Organelles
- Polysaccharide cell walls
- Mitotic spindle