

Major : Medicine & Dentistry

Lecture : *Microbiology* # 3

Lecturer : Dr. Hussein Al Qasim



TAQAROB



Price

0.5JD

مدير الأكاديمية

سعد ابو حرب / محمود ابو عيد

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WhatsApp
0786262562



* The ability of biomolecules to interact non-covalently w each other → supramolecular system

* Biological membranes:

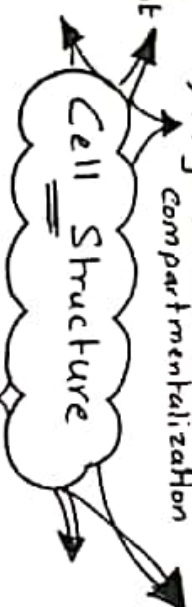
- Key supramolecular systems
- act as spatial barriers
- Control substance passage
- Selective permeability
- play pivotal role in
 - separating biological processes from other processes from each outside environment

→ Non-membranous organelles:

- * Ribosomes:
 - made of RNA & protein
 - polypeptide synthesis
 - 80S = 60S + 40S
 - arrange into polysomes
- * Cellular Filaments:
 - specialized proteins polymerize in cell
 - Form Complex Filamentous structure
 - three main types
 - Microtubules = made of protein tubulin
 - Micro Filaments = made of actin or myosin
 - Intermediate Filaments = made of proteins such as vimentin or keratin

* The cell:

- The smallest unit of living matter
- The most basic level displaying all characteristics of life
- can be divided into
 - a] Prokaryotic: nucleic material is found free within the cell
 - b] Eukaryotic:
 - genetic material is separated by nuclear membrane
 - larger & show more compartmentalization



* Lysosomes: vesicles housing digestive E.

* Peroxisomes: vesicles housing oxidative E.

* Mitochondria: house many enzymatic pathways

→ house portions of cellular respiration pathway

→ has double membrane structure

→ contain DNA

→ origin = bacteria living within eukaryotic cell

* Plastids: contain photosynthetic pigments

→ such as chloroplast

→ Chloroplasts: house C₃ pathway

→ double m. struct. contain DNA

→ origin = bacteria

* Structure of eukaryotic cell:

1] Outer boundary

a] Cell wall → Fungi (chitin) → plant (cellulose)

b] Plasma membrane made of lipid bilayer backbone functional protein

2] Protoplasm

a] Cytoplasm → cytoplasmic (cytosol) matrix

→ divided into organelles: membranous or non-membranous

→ membranous organelles enclosed by membranes similar in basic structure to cell membrane

• include ER: rough & smooth

* Golgi apparatus → stacked flattened sacs

→ ER → protein maturation → packaging → storage

* Endosomes → vesicles formed by endocytosis

→ Endocytosis → phagocytosis

→ receptor-mediated endocytosis → pinocytosis

→ storage

→ secretion

* Cellular Filaments arrange into

- Cytoskeleton:
 - Intracellular mesh-like structure
 - composed of microtubules, microfilaments & intermediate filaments
 - has static & dynamic fxn
- Centrioles:
 - special microtubular arrangement
 - guide movement of chromosomes during division

2] Glycocalyx

- slimy layer on surface of some bacteria
- classified into

I Slime layers

- not highly organized attached to bacterial surface
- not firmly attached to formation of biofilms
- contribute to formation of biofilms
- biofilms render bacteria more resistant to
 - Antibiotics
 - Desiccation
 - Environmental factors

II Capsule

- more organized
- may contribute to virulence
- may have species-unique structure
- usually seen using negative stains

→ Flagella & cilia

- hair-like projections
- extend from cell surface
- cause movement
- made of microtubules (complex)
- Flagella
 - longer
 - fewer
- Cilia
 - shorter
 - more numerous
 - coordinated motion



→ According to cell wall, bacteria is classified into

- Gram +ve
 - Thicker cell wall
 - Teichoic acid
 - Lipoteichoic acid
- Gram -ve
 - Thin cell wall
 - lying b/w cell m. & outer m.
- Outer membrane
 - Phospholipids
 - bilayer of lipopolysaccharides (LPS)
- outside cell wall of gram -ve bacteria

3] Nucleus:

- Controlling & integrating cellular fxns
- made of:
 - * Nuclear membrane: contains pores
 - * Nucleoplasm: base material
 - histones & chromatin
 - * Chromatin:
 - Linear DNA & proteins → non-histone
 - organizes into chromosomes
 - Genes along chromatin encode for gene products (proteins or RNA)
 - * nucleolus: rRNA production

* Structure of Prokaryotic cell:

- Generally made up of
 - 1 Interior Core (same as protoplasm)
 - 2 Cell envelope (same as outer boundary)
 - 3 Cell membrane: similar to eukaryotic cell wall
 - 4 Cell wall
- Bacterial cell wall
 - more complex than eukaryotic
 - main constituent = peptidoglycan
 - peptidoglycan =
 - N-acetyl glucosamine
 - N-acetyl muramic acid
 - cross-linking peptide

External appendages

→ Bacterial flagellar arrangement

II Pili (Fimbriae)

I Flagella

- long hair-like projections
- used for movement
- made of flagellin protein
- simpler structure than eukaryotic
- threads twisted around each other in a rope-like fashion

* Peritrichous: many flagella around all sides of cell

* Monotrichous: single flagella

* Amphitrichous: two flagella, one on each opposite pole of cell

* Lophotrichous: bundle of many flagella on one side of cell

→ shorter than flagella

→ made of pilin protein

→ in Gram -ve bacteria

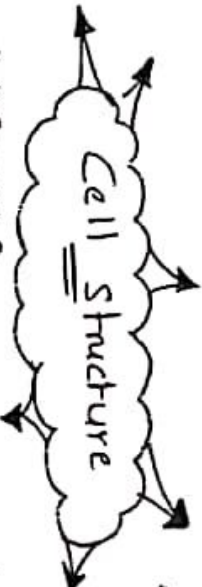
→ functions

- surface attachment
- contribute to virulence

→ Sex pili

- specialized type
- transfer genetic material (plasmids) b/w cells (conjugation)

- longer than normal pili
- hollow in the center



Overview of reproduction:

→ on the level of organism

- 1 Asexual: single organism is the sole parent gives rise to offspring
- 2 Sexual: two parents give rise to offspring

→ on the level of the cell

- 1 Eukaryotic cell
 - mitosis
 - parent cell gives two daughter cells
 - daughter cells carry same number of chromosomes as parent cell
- 2 Metosis
 - diploid parent cell gives rise to four haploid daughter cells

* Spores:

- specialized structures for survival
- produced by some bacteria once exposed to adverse conditions
- have thick outer layers
- contain dipicolinic acid
- produced by a process = sporulation
- enter dormant, metabolically inactive state & live w/o nutrition for long time
- reactivation to vegetative state occurs when outside to growth more accommodating to kill in the most difficult to kill in sterilization
- can cause hospital epidemics
- used as biological warfare (Bioterrorism)

* The interior core

1 cytosol = not as differentiated as eukaryotic

→ contains

a) Ribosomes → 70S = 50S + 30S

b) plasmids

- small, extrachromosomal
- segment of circular dsDNA
- may contain functional genes
- imp. for antibiotic resistance

2 Nucleoid

- bacterial chromosome embedded in cytosol, containing circular DNA
- not separated from rest of the cell by a membrane

- ② Prokaryotic cells
- reproduce through Binary Fission
 - parent cell divides into two daughter cells
 - generation time: time needed for binary fission to occur
- * unicellular organism's life cycle would be very simple, while multicellular organism would have a more complicated cycle

* Sequence of Taxa

- 1] Kingdom
 - 2] Phylum (Division)
 - 3] Class
 - 4] Order
 - 5] Family
 - 6] Genus
 - 7] Species
- ↓
- Cell wall
- Present → Plants
→ Algae
→ Fungi
→ Most bacteria
- Absent → Animals
→ Protozoa
→ Mycoplasma

* Taxonomy :

- Classification of living organisms
- Divided into three fields
- ① Classification → arranging organisms into taxa (groups)
- ② Nomenclature → assigning specific name to each taxon
- ③ Identification → determining to which taxon a specific organism belongs



* Whittaker's Five Kingdom of Classification (Phenetic)

1. Animalia
 2. Plantae
 3. Fungi
 4. Protista
 5. Monera → the only prokaryotic kingdom in system
- * Woese's three-domain system (Phylogenetic)
- | | |
|-------------|-----------------------|
| 1. Bacteria |] Prokaryotic domains |
| 2. Archaea | |
| 3. Eukarya | |

* Systems of Classification

- ① Phenetic → grouping organisms according to shared phenotypic feature (shape & appearance)
 - ② Phylogenetic
- grouping organisms according to genetic relatedness
 - by studying rRNA in small ribosomal subunit of the organism
 - the more similarity in nucleotide sequence of SS, rRNA of two organisms → i.e. closer to each other in phylogenetic tree
 - Ribosomes are used because they are found in all organisms & have nucleic acid in them
 - The more modern system could overlap w/ phenetic
 - The SSU, rRNA are divided into (based on sedimentation coefficient)
 - ① 16S SSU, rRNA → prokaryotes
 - ② 18S SSU, rRNA → eukaryotes
 - Important way of diagnosis when culture fails (pt. took antibiotics)
 - NO can't be grown in culture
 - NO needs long time to grow
 - Scanning for 18S SSU, rRNA is common in fungal infections