Molecular Pathology

?What is molecular pathology

Molecular pathology: is the study of diseases at molecular level and includes detection and diagnosis of abnormalities at the level of DNA of the cell.

Functional components of the cell

Cells are the smallest functional unit of the body. They contain structures that are strikingly similar to those needed to maintain total body function.

There are three major components of the eukaryotic cell:

1- Cell (Plasma) membrane.

2-Nucleus.

3-Cytoplasm: The bulk of the cytoplasm is water, in which inorganic and organic chemicals are dissolved. This fluid suspension is called the ***cytosol***.

1. Cell membrane Function

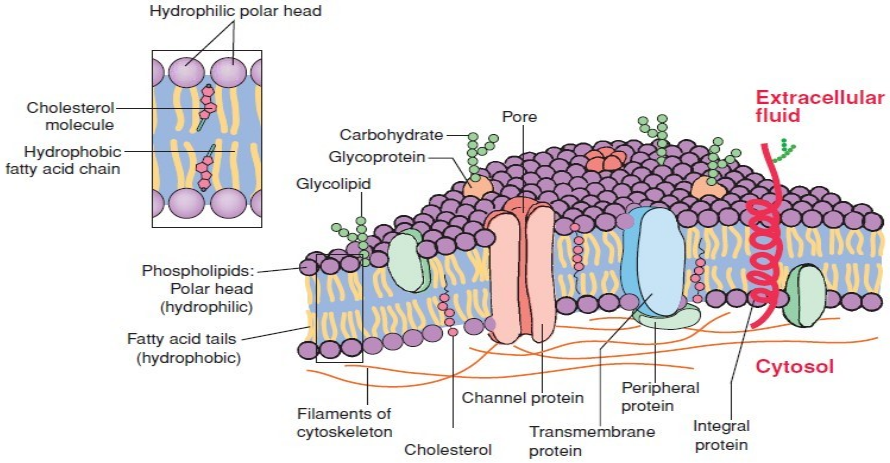
1-The cell membrane encloses the cell.

2-It acts as a semi permeable structure that separates the intracellular and extracellular environments.

3-It controls the transport of materials from the extracellular fluids to the interior of the cell.

4-It maintains the electrical activities that power cell function.

5-It provides receptors for hormones and other biologically active substances.



Diseases associated with Cell Membrane Disorders

•Membrane Structural Defects in human RBC

like: Hereditary Ovalocytosis

•Membrane Permeability Defects in human RBC

Like: Hereditary Xerocytosis

•Also, **Alzheimer's disease** as a disorder of the plasma membrane

2. Nucleus Function:

1- The nucleus can be regarded as the control center for the cell.

2- It contains the deoxyribonucleic acid (DNA) that is essential to the cell because its genes encode the information necessary for the synthesis of proteins that the cell must produce to stay alive. The genes also represent the individual units of inheritance that transmit information from one generation to another.

3- The nucleus also is the site for the synthesis of the three types of ribonucleic acid (messenger RNA, ribosomal RNA, and transfer RNA) that move to the cytoplasm and carry out the actual synthesis of proteins.

Diseases associated with Nucleus Disorders

- Over 200 diseases have been associated with mutations in lamina genes. Most mutations are in lamina and lead to wide variety of phenotypes.
- DNA damage induces sequential responses to either repair the damage, and defects in this critical response leads to wide array of human pathologies that include:
  - like Cancer predisposition
  - like Cell Ageing and Neurodegeneration.

3. The Cytoplasm and Its Organelles

•The cytoplasm surrounds the nucleus. Embedded in the cytoplasm are various membrane-enclosed compartments (endoplasmic reticulum, Golgi apparatus, mitochondria, lysosomes).

a) Ribosome:

• The ribosomes are small particles of nucleoproteins (rRNA and proteins) that are held together by a strand of mRNA to form polyribosomes.

• Free ribosomes are involved in the synthesis of proteins, mainly enzymes that aid in the control of cell function.

Diseases associated with Ribosome Disorders:

• Ribosomopathies compose a collection of disorders in which genetic abnormalities cause impaired ribosome biogenesis and function, resulting in specific clinical phenotypes.

• like: Diamond-Blackfan anemia, a rare congenital bone marrow failure syndrome.

b) Endoplasmic reticulum:

• It functions as a tubular communication system for transporting various substances from one part of the cell to another.
• Its produce proteins are used in the generation of lysosomal enzymes.
• The **rough ER** segregates these proteins from other components of the cytoplasm and modifies their structure for a specific function, as well as the **smooth ER** is the site of lipid, lipoprotein, and steroid hormone synthesis.

Endoplasmic reticulum dysfunction

• Endoplasmic reticulum dysfunction might have an important part to play in a range of neurological disorders:

• like: Cerebral ischaemia

c) Mitochondria

The mitochondria are composed of two membranes: an **outer membrane** that encloses the periphery of the mitochondrion and an **inner membrane** that forms shelflike projections, called cristae. The narrow space between the outer and inner membranes is called the **intermembrane space**, whereas the large space enclosed by the inner membrane is termed the **matrix space**.

Mitochondrial diseases include:

•Mitochondrial diseases are sometimes caused by **mutations in the mitochondrial DNA** that affect mitochondrial function.

• Other mitochondrial diseases are caused by **mutations in genes of the nuclear DNA**, whose gene products are imported into the mitochondria (mitochondrial proteins) as well as acquired mitochondrial conditions.

• like: Mitochondrial myopathy