MEDICAL BIOLOGY 1ST STAGE / L-6

Structure of eukaryotic cell:

- Cilia & Flagella
-A centrosome
- Inclusions bodies
- The Nucleus

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Cilia & Flagella

- Eukaryotic cilia and flagella are hair-like cellular appendages composed of specialized microtubules and covered by a specialized extension of the cellular membrane. They have found in microorganisms and animals. The function of cilia is **to move a cell or to help transport fluid or materials pass them**. The respiratory tract in humans is lined with cilia that keep inhaled dust and harmful microorganisms from entering the lungs. Cilia are usually shorter and occur together in much greater numbers than flagella.

- In eukaryotic cells, cilia and flagella contain the motor protein **(dynein)** and (**microtubules),** the core of each of the structure is termed the **(axoneme)** and contains two central microtubules that are surrounded by an outer ring of nine doublet microtubules. Dynein molecules are located around the axoneme. A plasma membrane surrounds the entire axoneme complex. it is attached to the cell at a structure termed the basal **body**.

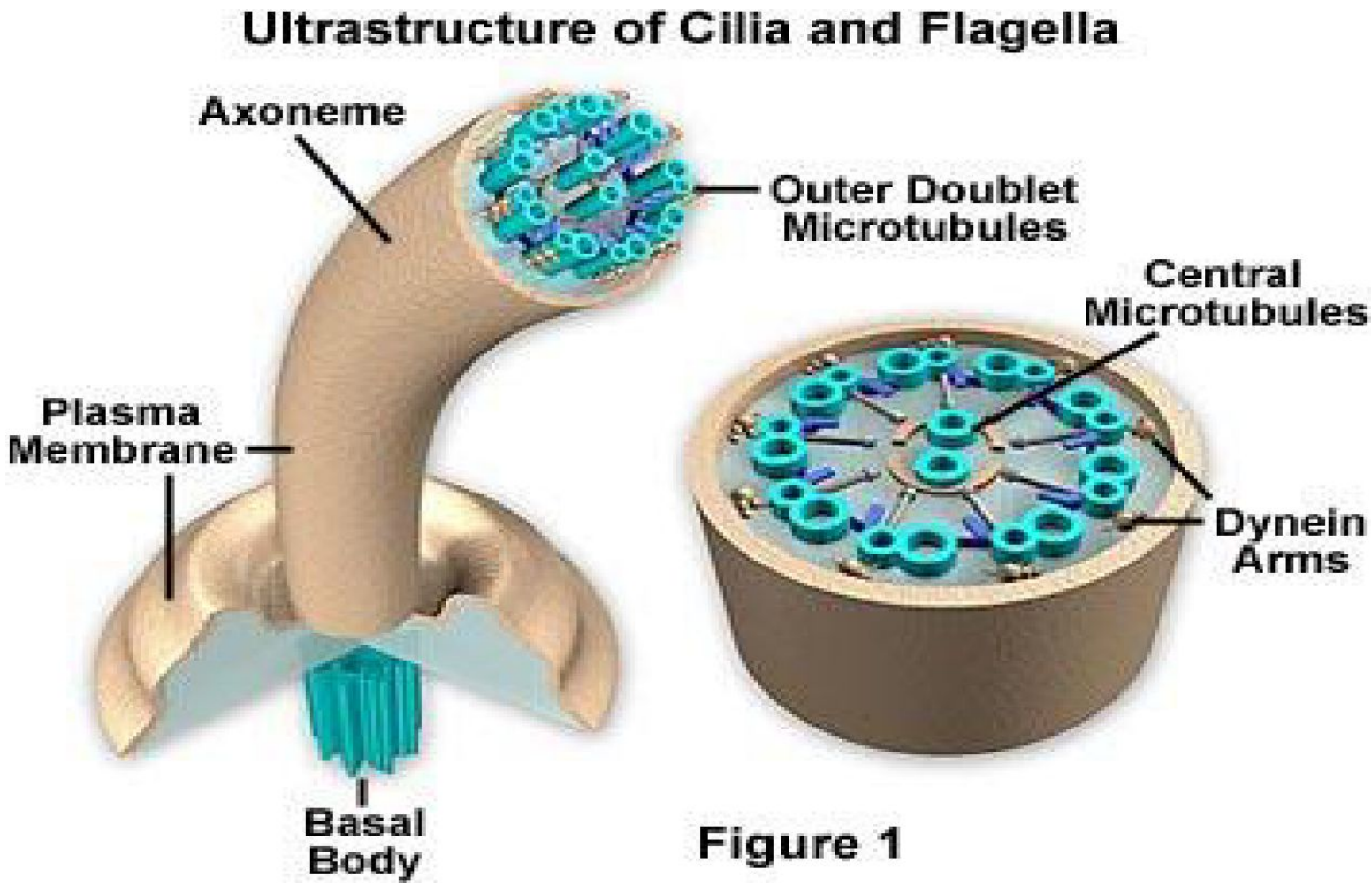
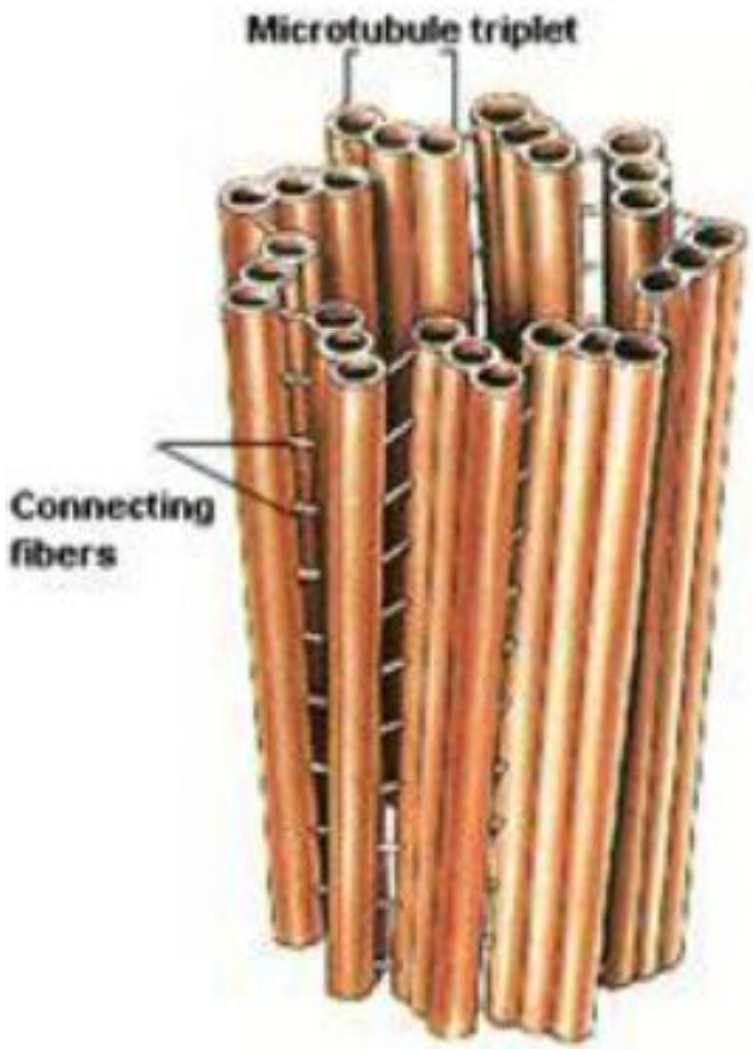

Ultrastructure of Cilia and Flagella
Axoneme
Outer Doublet Microtubules
Central Microtubules
Plasma Membrane
Dynein Arms
Basal Body

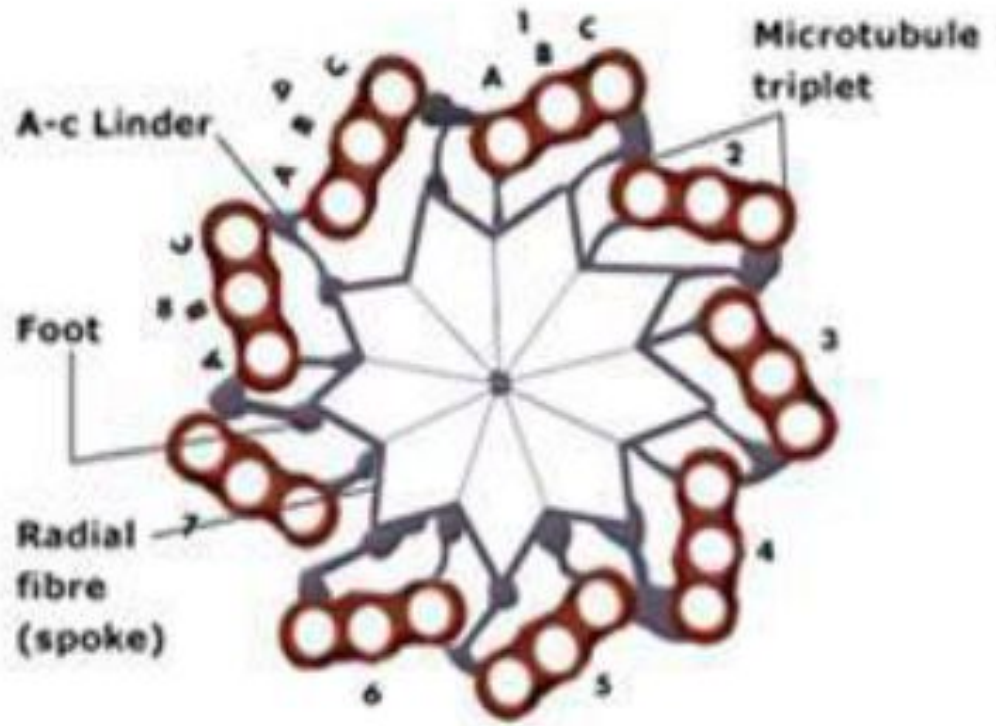
Figure 1

Difference Between Cilia And Flagella	
Flagella	**Cilia**
The number of flagella is comparatively less (usually ranges from **1 to 8**)	The number of cilia is comparatively more (typically ranges in the **thousands**)
Flagella is comparatively **longer** in length	Cilia is usually **shorter** in length
Beating pattern of Flagella involves circular, **wave-like or propeller**-like motion	**Beating** pattern of cilia is very **complicated** – Can move in a wide range of motions
Found in **prokaryotic cells and eukaryotic** cells	Found in **Eukaryotic cells** and **certain microorganisms**
Flagella are of three types: **Bacterial flagella, Archaeal flagella and Eukaryotic flagella**	Cilia are of two types: **Non-motile cilia and Motile** cilia

A centrosome

- **A centrosome** is found close to the nucleus within the cytoplasm of cells. It is duplicated during S phase of the cell cycle. Centrosomes are keys to the division of cells and produce the spindle fibers that are required during metaphase of mitosis. Each centrosome consists of two centrioles that are orientated at right-angles to each other. Each centriole is made of nine bundles of microtubules (three per bundle) arranged in a ring.


Microtubule triplet
Connecting fibers


A-c Linder
Foot
Radial fibre (spoke)
Microtubule triplet

Inclusions bodies

- The inclusion bodies are tiny particles found freely suspended and floating within the cytoplasmic matrix. These cell inclusions are formed with decreasing pH and from the pool of soluble fusion proteins within the cell. They are **the elementary bodies**, formed during **infectious diseases** or within the **virus-infected** cells such as **rabies, herpes**, **measles**, etc.

General Features of Inclusion Bodies

- 1. They are generally **acidophilic.**
- 2. Maybe crystalline **aggregates of virions**.
- 3. Represent **degenerative changes** produced by a viral infection.
- 4. Are made of virus antigens present at the site of **virus synthesis**.
- 5. They are seen as **pink structures** when stained with **gypsum or methylene blue** dye.
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- The different **types** of inclusion bodies are as follows:
- 1. Intranuclear inclusions (herpes virus).
- 2. Intracytoplasmic inclusions (pox virus).
- 3. both (measles)

- Physiological inclusion bodies, Examples of inclusions are **glycogen granules in the liver** .4 **and muscle cells, lipid droplets in fat cells, pigment granules in certain cells of skin and hair, and crystals of various types.**

The Nucleus

- The nucleus is a membrane bound structure found in eukaryotic cells. The nucleus controls and regulates the activates of the cell (e.g., growth and metabolism) and .carries the genes, that contains the cell's hereditary information

- The nucleus is a membrane-enclosed organelle found in eukaryotic cells that .serves as the information processing and administrative center of the cell

- This organelle has two major **functions**: it stores the cell's hereditary material (DNA) and coordinates the cell's activities, which include growth, intermediary .metabolism, protein synthesis, and reproduction (cell division)

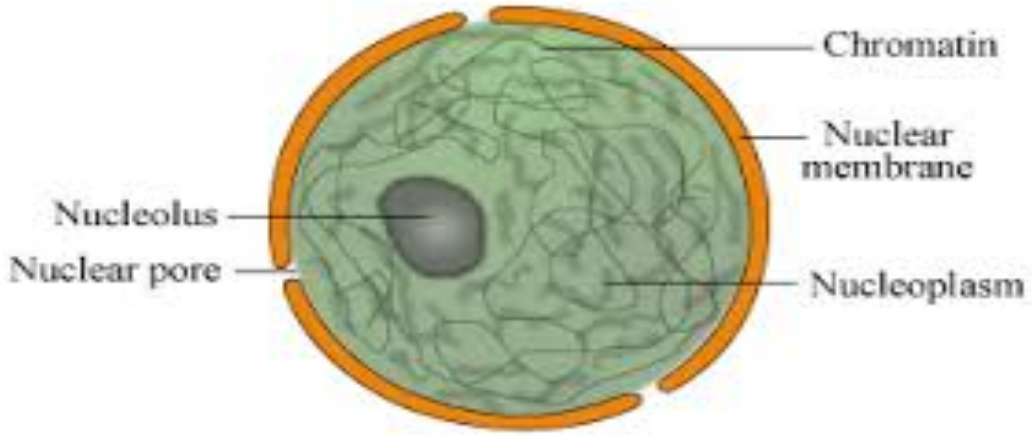
- Its **position** may change from time to time according to the metabolic status of .the cell

- Usually the cells contain **single** nucleus, but few types of cells such as mammalian red blood cells, have **no** nuclei, and few others have **more** than one. The number of nucleus may vary from cell to cell. According number of nuclei present, cells are classified as **mononucleate** (e.g.; smooth muscle cell). **Binucleate** (e.g.; liver cells, .cartilage cells) and **polynucleated** (syncytial cells) (e.g.; osteoclast)

- **The shape** of the nucleus normally related to the shape of the cell, but certain nuclei are almost regular in shape. In a tumor, the presence of nuclei with irregular features (e.g., variable size, atypical chromatin patterns) and the capacity to invade neighboring tissues are the main morphologic characteristic used by pathologists to estimate the malignancy.

- The nucleus is the largest cellular organelle in animal cells. In mammalian cells, the average diameter of the nucleus is approximately 6 (μm), which occupies about 10% of the total cell volume.

The viscous liquid within it is called nucleoplasm or karyolymph,► • and is similar in composition to the cytosol found outside the nucleus. It appears as a dense, roughly spherical or regular organelle. The composition by dry weight of the nucleus is approximately: DNA 9%, RNA 1%, Histone Protein 11%, Residual Protein 14%, and Acidic .Proteins 65%



The Structure of The Nucleus

:The nucleus is composed of four main parts•

the nuclear envelope_→ pore riddled●•

nuclear sap or nucleoplasm__→ fluid interior portion●•

the nucleolus__→ dense cluster of RNA and proteins_ ribosomes●•

the chromatin/ Molecular structure of chromosomes –_→ all DNA•
.+proteins

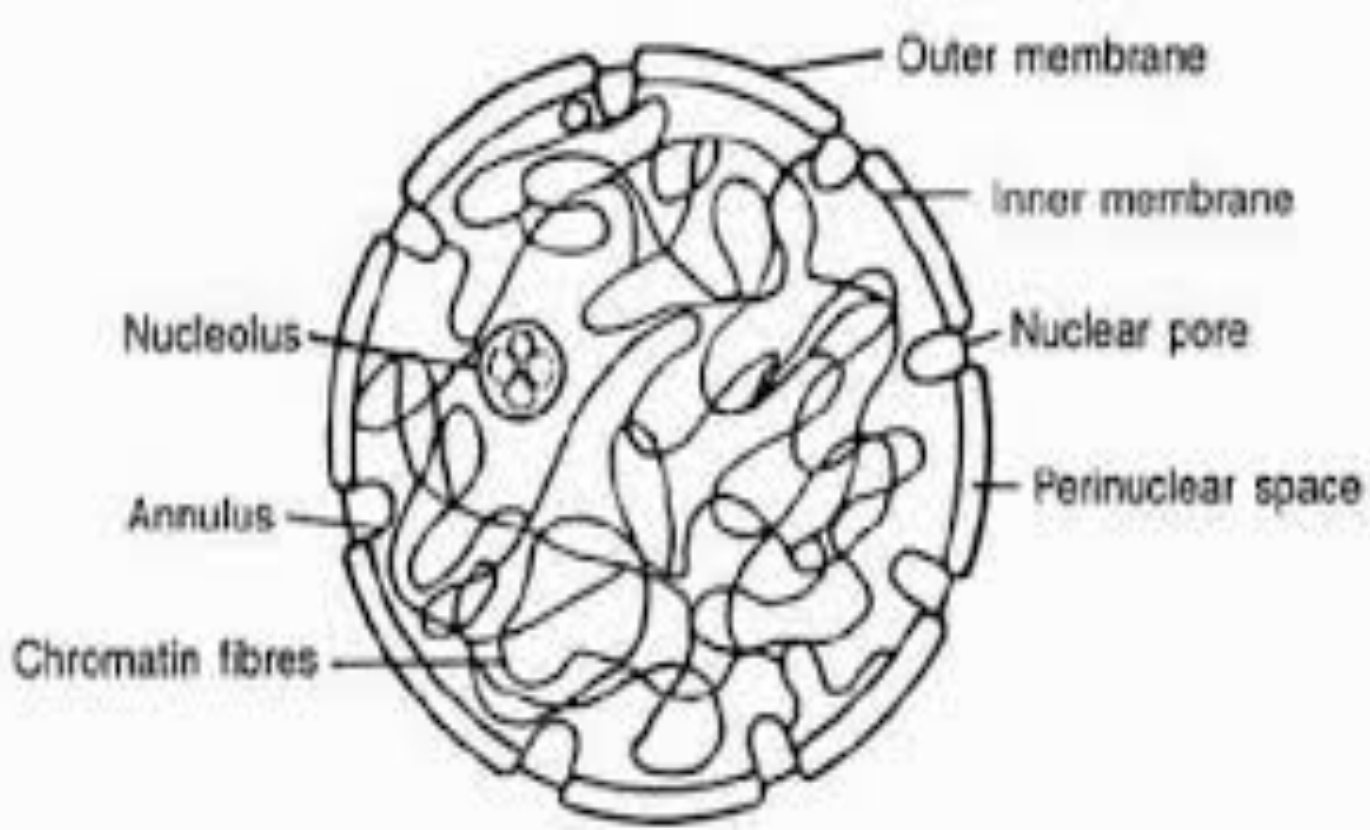


Fig. 2.1. Ultrastructure of Nucleus.

:The nuclear envelope

:The nuclear envelope has a complex structure, consisting of •

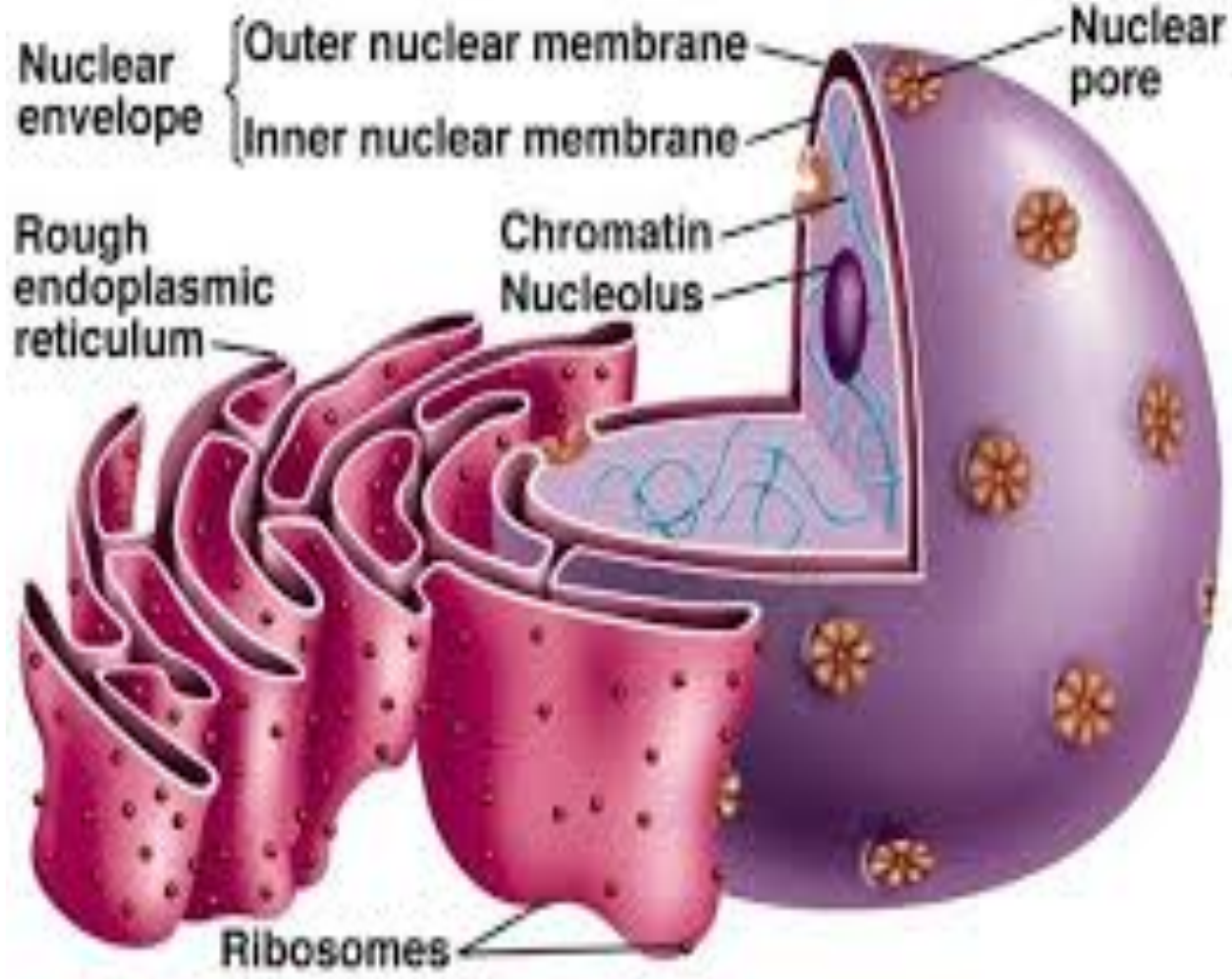
Two nuclear membranes (1) •

Underlying nuclear lamina (2) •

.Nuclear pore complexes (3) •

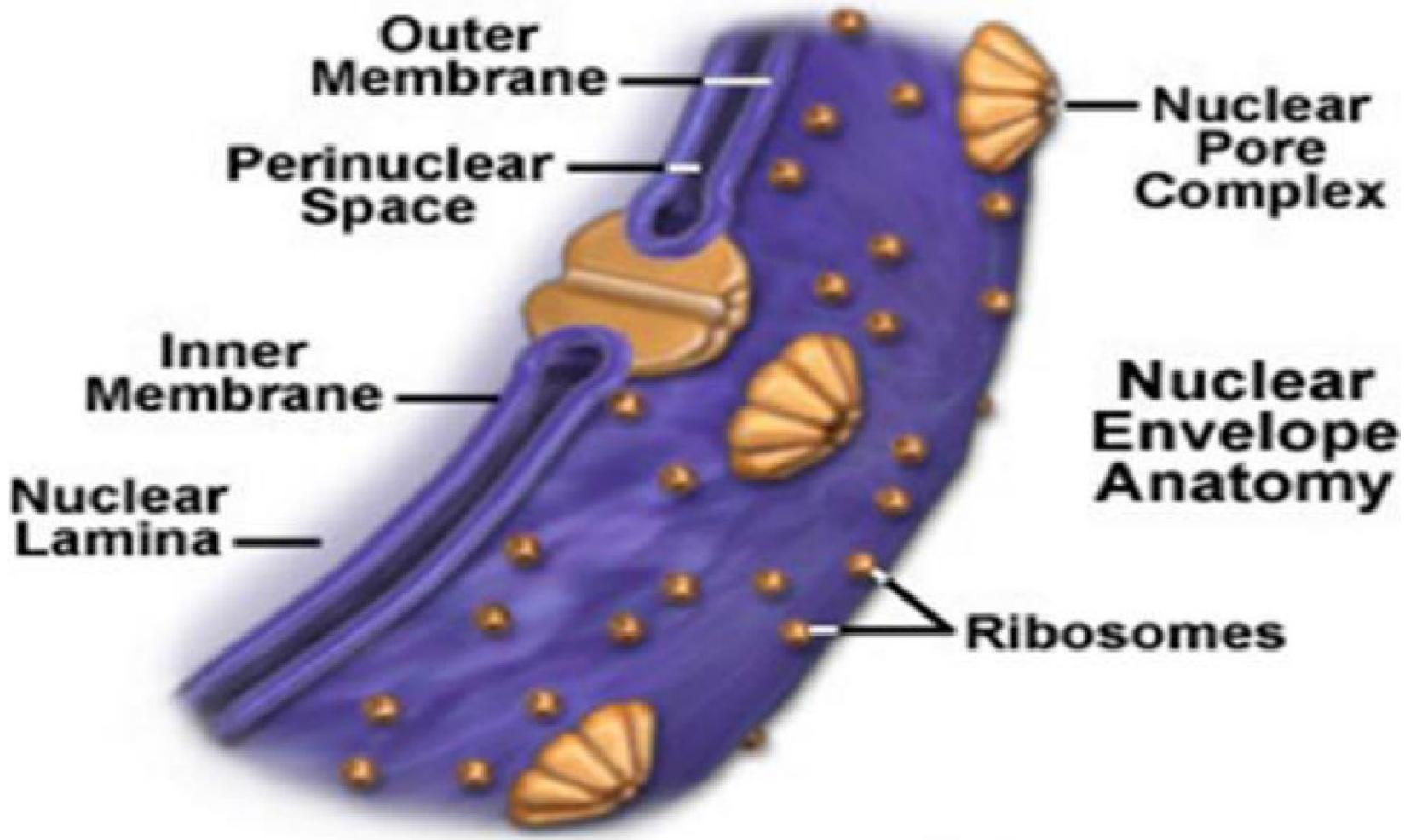
• The nuclear envelope is a double-layered membrane that encloses the content of the nucleus during most of the cell's life cycle. The space between the layers is called perinuclear space and appears to connect with the rough endoplasmic reticulum, where protein synthesis occurs. The inner surface has a protein lining called nuclear lamina, which binds to chromatin and other nuclear components. During mitosis, or cell division, the nuclear envelope disintegrates, but reforms as .the two cells complete their formation

Nuclear Envelope



:Nuclear pores

- The envelope is perforated with tiny holes called nuclear pores. These pores regulate the passage of molecules between the nucleus and the cytoplasm. Detailed structural studies indicate that the nuclear pore complex consists of an assembly of eight spokes arranged around a central channel. The nuclear pores (nuclear pore complex) appear circular in surface view and have a diameter between 10-100nm. The nuclear pore complex is generally permeable for molecules of 5-500 Daltons size. The nucleotides, ions and many other molecules have easy access into the nucleus. But proteins of more than 50 KD cannot diffuse passively; they are transported through ATP dependent (active process) pathway


Outer Membrane
Perinuclear Space
Inner Membrane
Nuclear Lamina
Nuclear Pore Complex
Nuclear Envelope Anatomy
Ribosomes

Nucleoplasm

- Nuclear sap is colorless, transparent, granular, and semi fluid matrix found inside the nucleus called nucleoplasm.
- It consists of mainly the nucleoproteins and other organic and inorganic substances such as nucleic acids, proteins, enzymes and minerals.

:The nucleolus

Through the microscope, the nucleolus looks like a large dark spot • within the nucleus, which manufactures of ribosomes. The number of nucleoli in the nucleus is depended on the species and the number of chromosomes. After a cell division, a nucleolus is formed when chromosomes are brought into nuclear organizing regions. Nucleoli are typically composed of three morphologically distinct regions :which can be visualized by electron microscopy

- **Fibrillar center** (**FC**): it is highly stained inner most region of nucleolus composed of fibrils that occupies 1-2% of the total volume. The RNA genes of nucleolar organizer of chromosomes are located in .this region

- **Dense fibrillar centers** (**DFC**): it surrounds the FC's, composed of densely packed fibrils and occupies a large fraction of the nucleolus .(about 17%). The biogenesis of RNA takes place in this region

- **Granular region** (**GR**): it is the largest and outer most fraction of the total nucleolus volume (about 75%). At this region the processing and .maturation of pre-ribosomal particles occurs

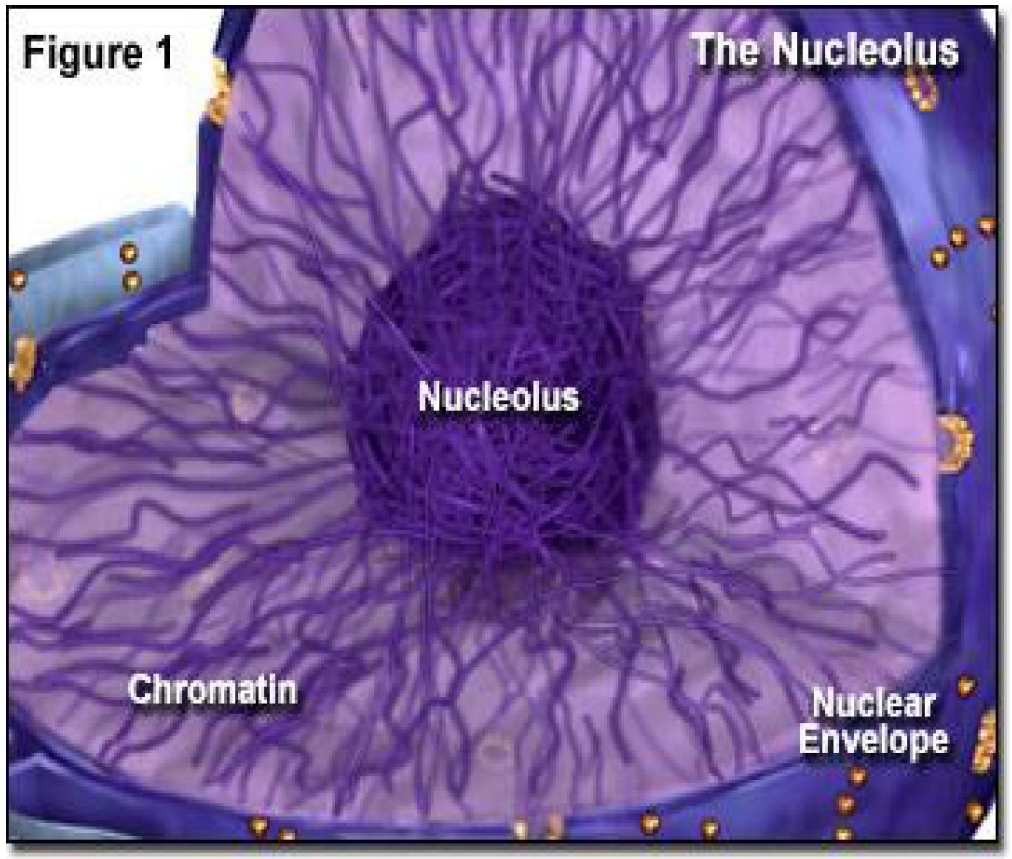
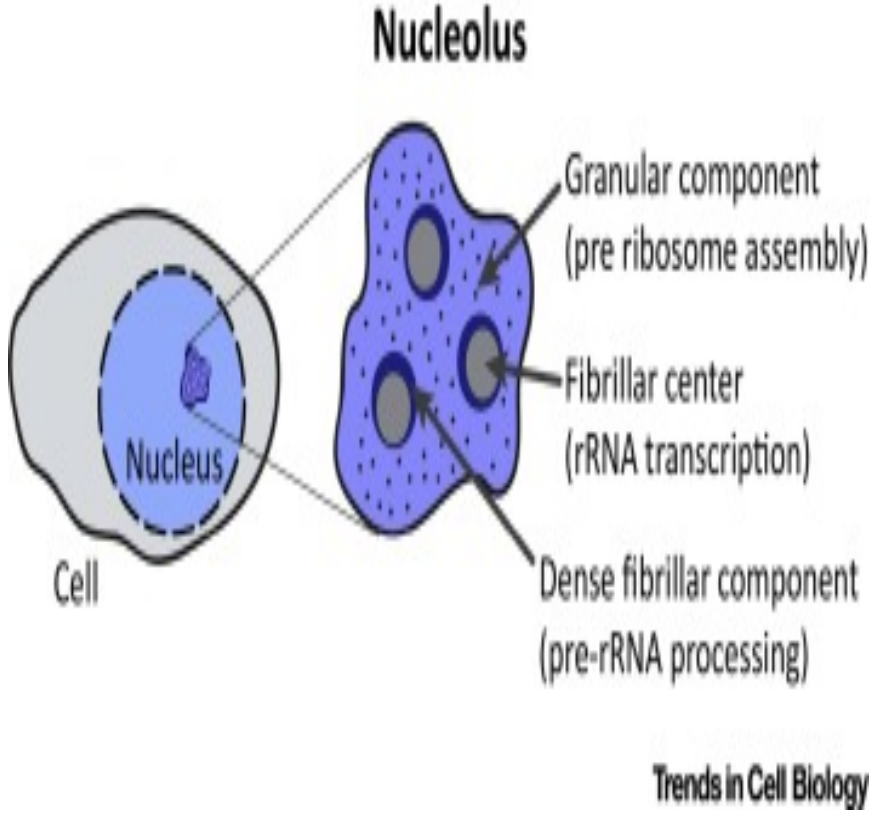


Figure 1
The Nucleolus
Nucleolus
Chromatin
Nuclear Envelope


Nucleolus
Granular component
(pre ribosome assembly)
Fibrillar center
(rRNA transcription)
Dense fibrillar component
(pre-rRNA processing)
Nucleus
Cell
Trends in Cell Biology

:Function of nucleolus•

●Site of transcription •

● Assemblage of ribosomes•

●Synthesis of ribosomes •

Synthesis of RNA•

Chromatin

- Chromatin refers to a mixture of DNA and proteins that form the chromosomes found in the cells of humans and other higher organisms. Many of the proteins — namely, histones — package the massive amount of .DNA in a genome into a highly compact form that can fit in the cell nucleus
- Chromatin fibers are coiled and condensed to form chromosomes.
- Chromatin makes it possible for a number of cell processes to occur including **DNA replication, transcription, DNA repair, genetic .recombination, and cell division**
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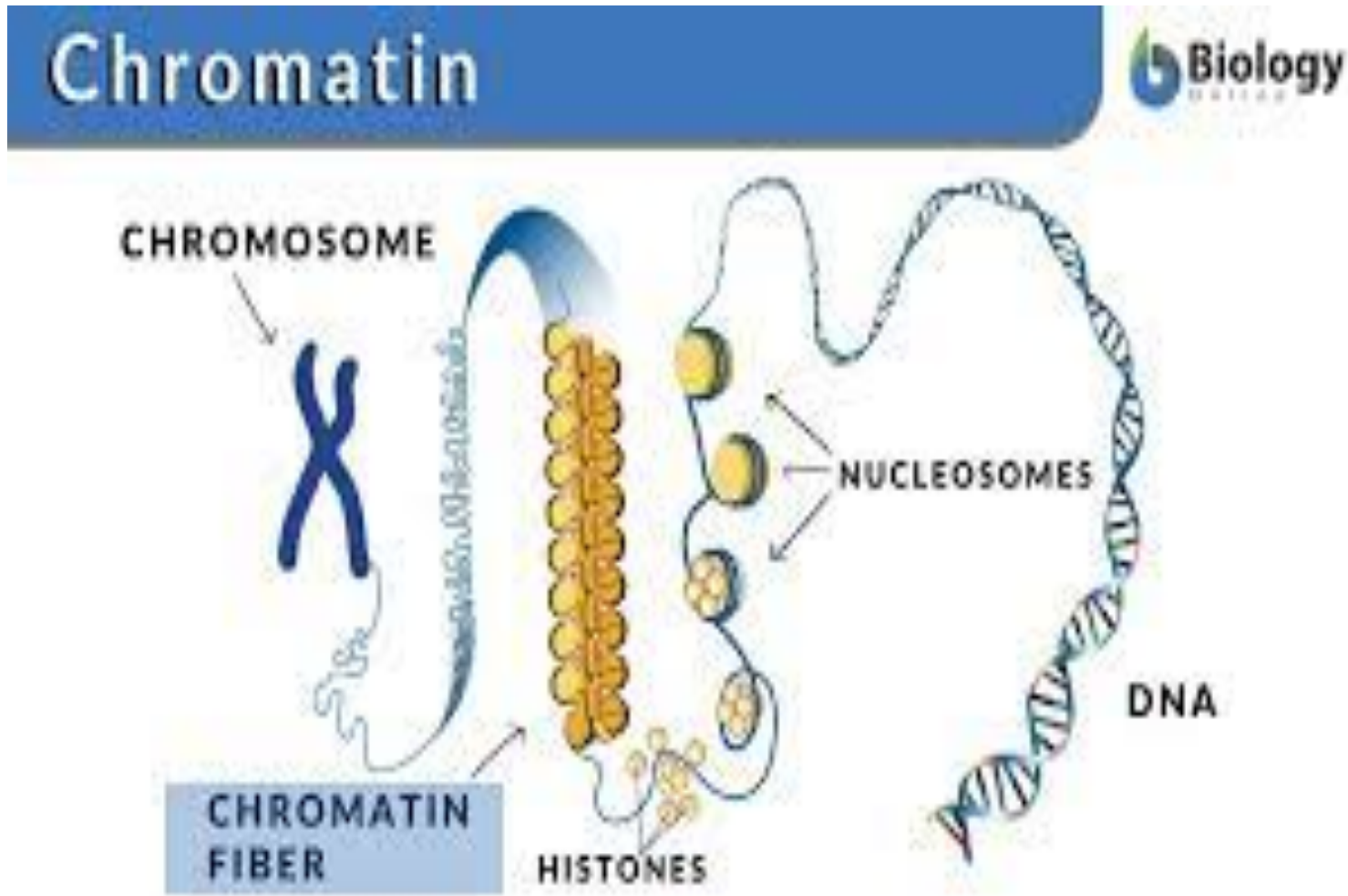
Chromatin
Biology
CHROMOSOME
NUCLEOSOMES
DNA
CHROMATIN FIBER
HISTONES