

Introduction to Zoology

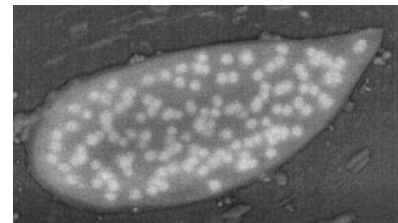
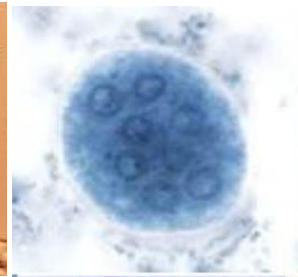
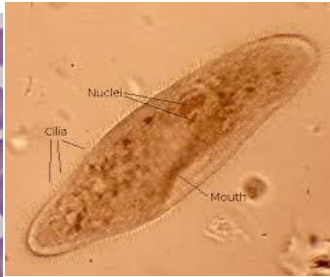
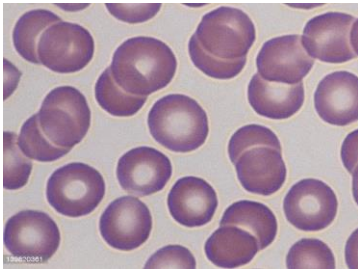
Lecture 4

The cell organelles

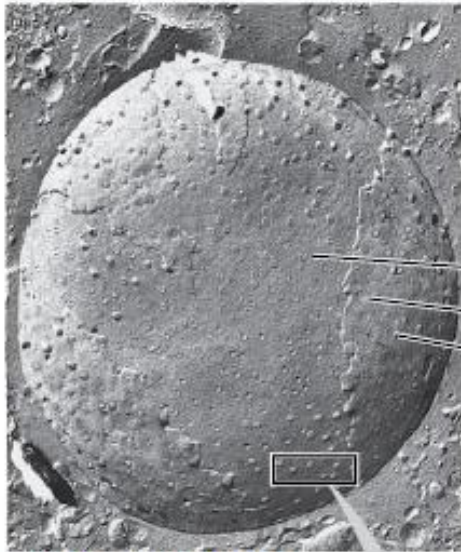
The Nucleus: Command centre

Nucleus (plural, *nuclei*) contains most of the **genes** in the eukaryotic cell (some genes are located in **mitochondria** and **chloroplasts**).

- Most eukaryotic cells have a **single** nucleus.
- Some have **no** nuclei (red blood cells).
- Others have several (**two** in *Paramecium*, **eight** in *Entamoeba coli* cyst, and *Opalina* has about **250** nuclei).
- Nucleus about **5 μm** in diameter.



1 μm



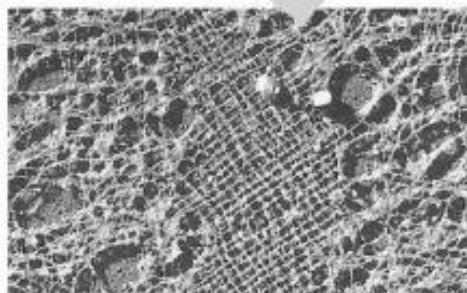
▲ Surface of nuclear envelope

0.25 μm

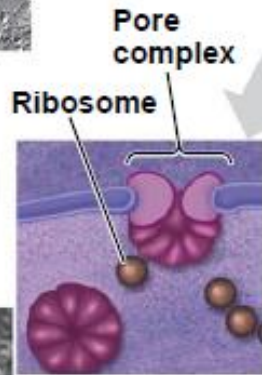


▲ Pore complexes (TEM)

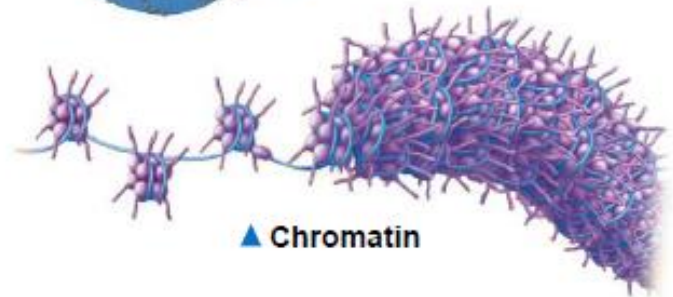
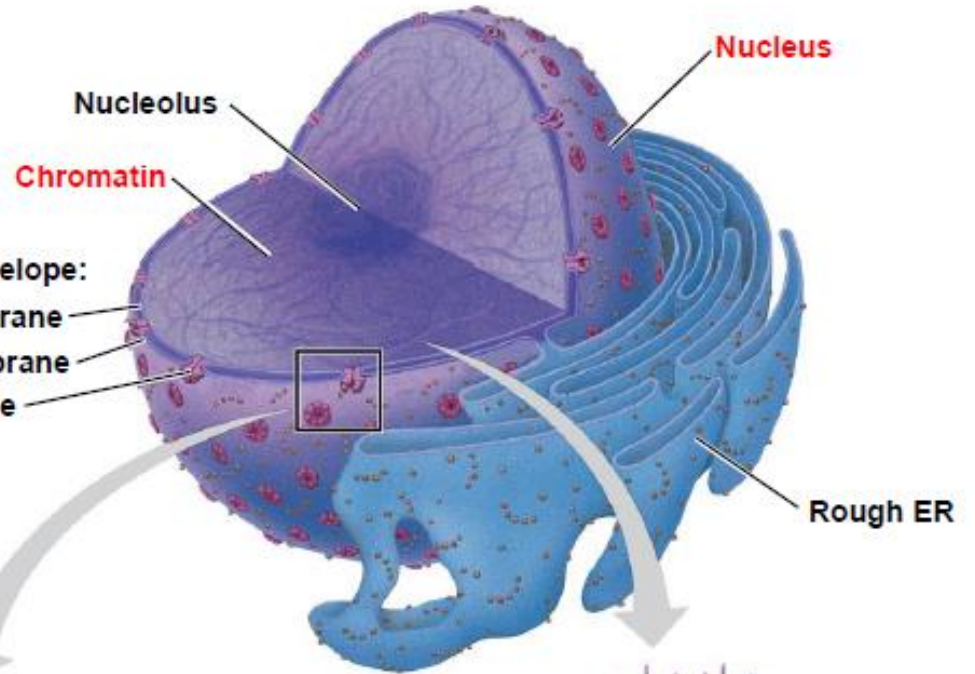
1 μm

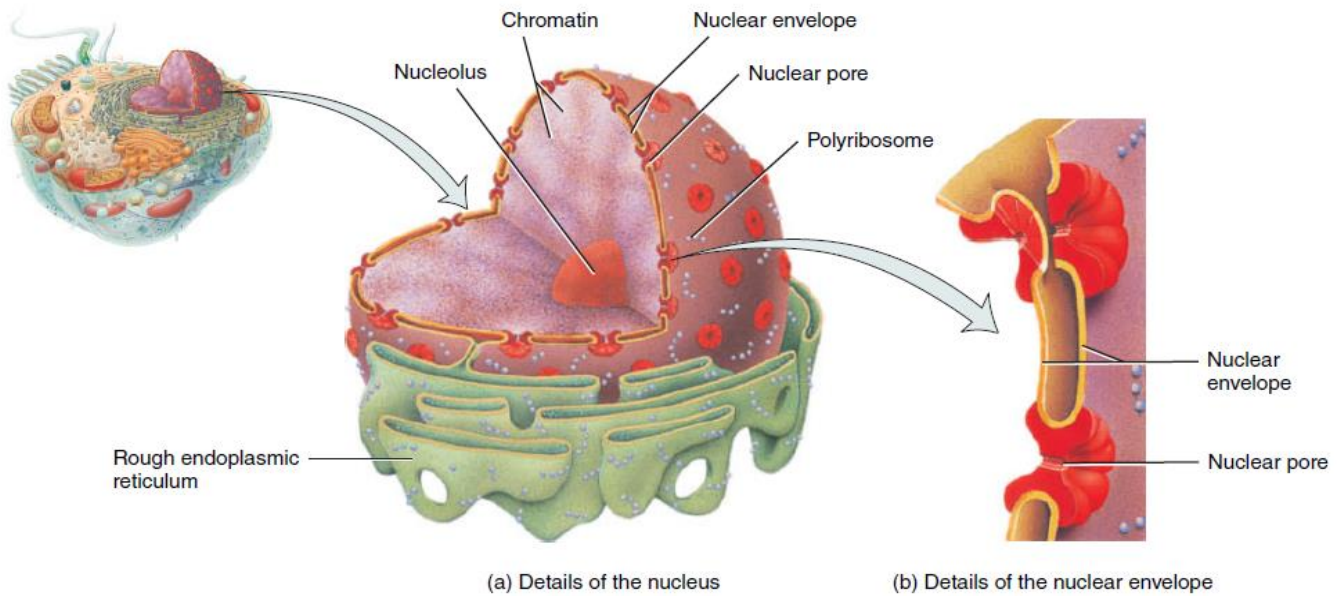


▲ Nuclear lamina (TEM)



▲ Close-up of nuclear envelope

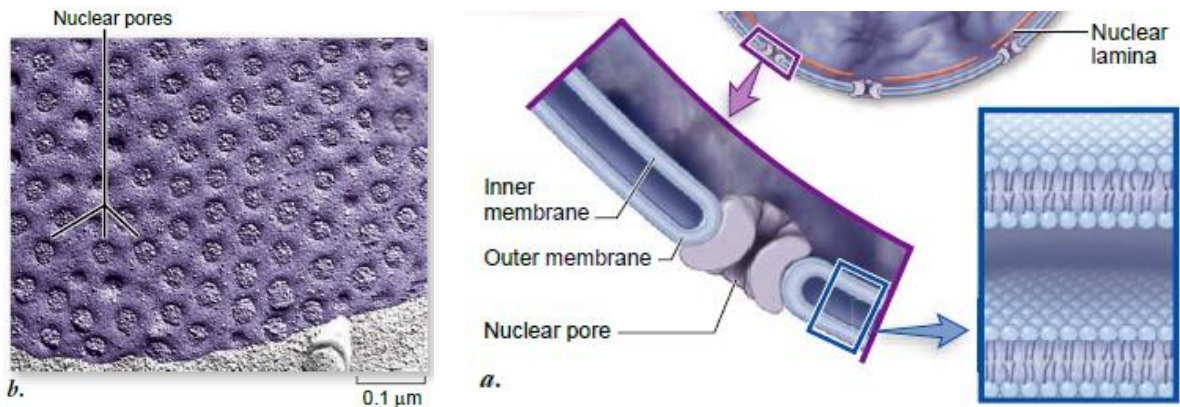


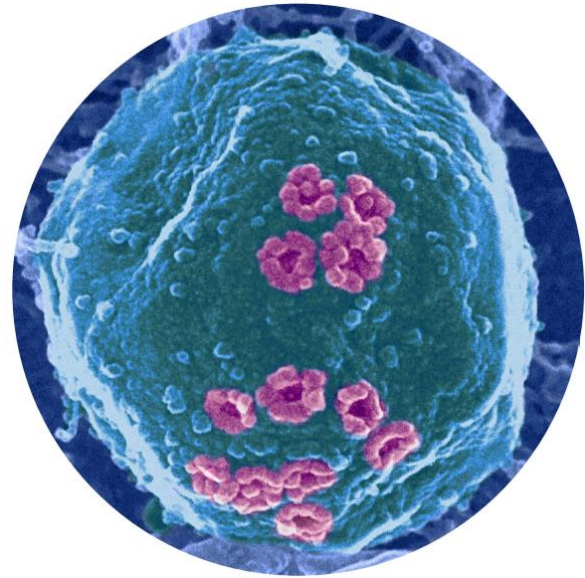
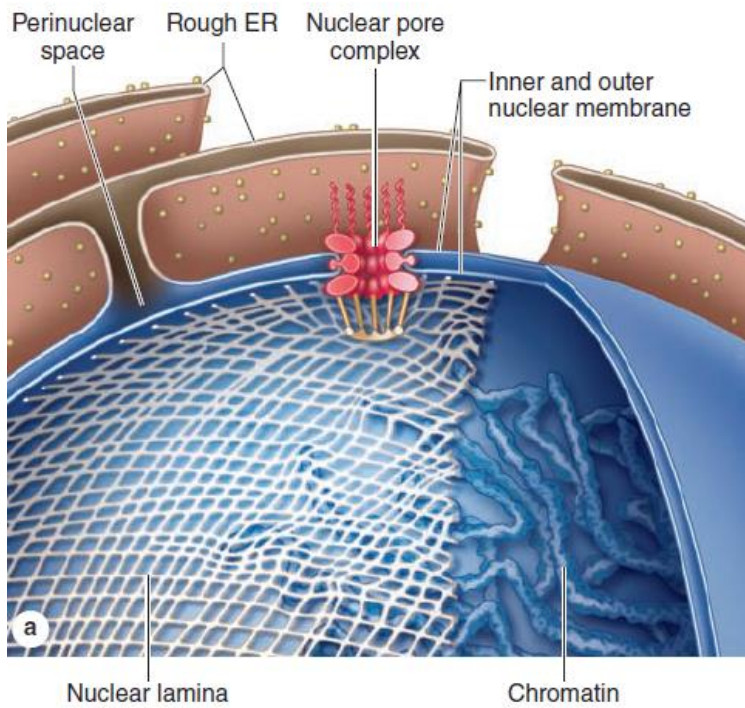


Nuclear envelope

- The **nuclear envelope** surrounds the nucleus, separating its contents from the cytoplasm.
- Nuclear envelope is a **double** membrane made of **lipoprotein** with **20-40 nm** space.
- The envelope is perforated by **pore** structures that are about **100 nm** in diameter.

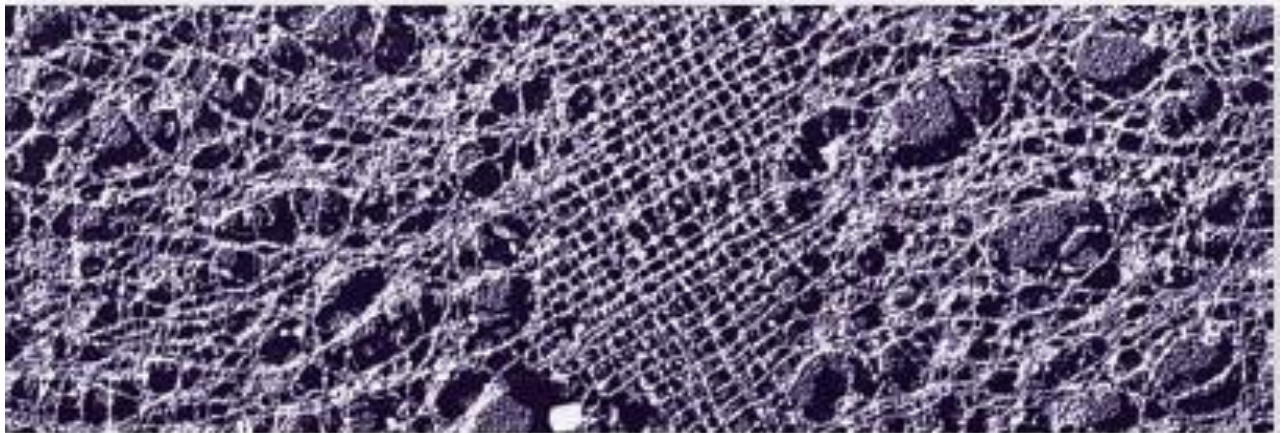
Pore complex (complicated protein structure) lines each pore and plays an important role in the cell by controlling the entry and exit of most proteins, RNAs, and other large complexes of macromolecules.





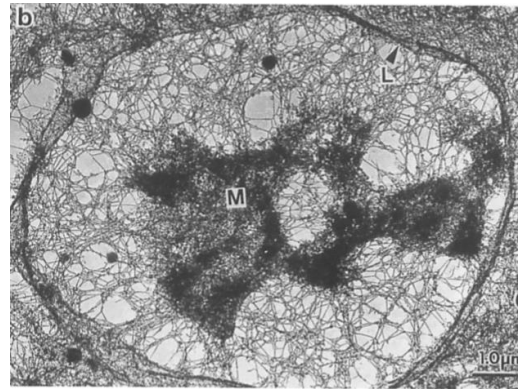
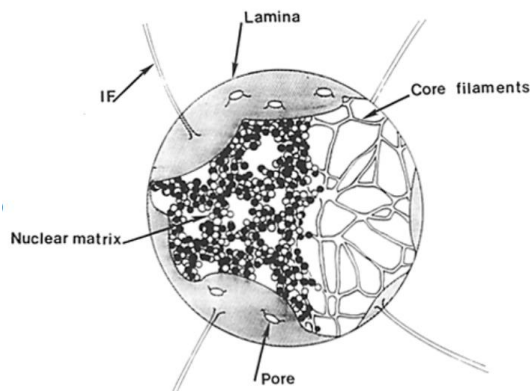
Nuclear lamina

- Nuclear side of the envelope (except at the pores) is lined by a net-like array of protein filaments (**nuclear lamina**) that maintains the shape of the nucleus by mechanically supporting the nuclear envelope.



d. 1 μ m

- **Nuclear matrix** is a framework of fibres extending throughout the nuclear interior.

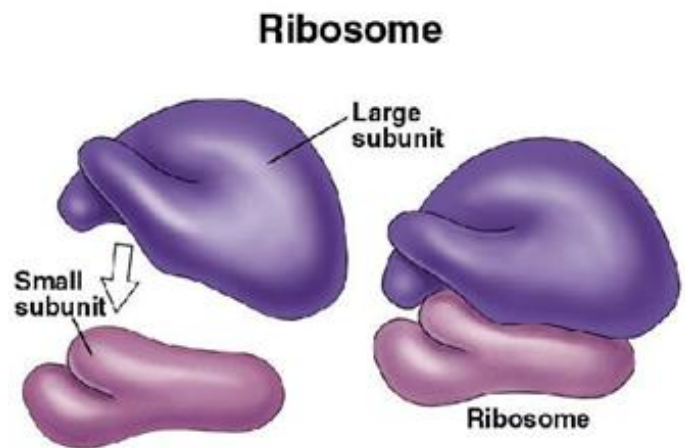


Chromosomes & Nucleolus

- DNA is organised into discrete units called **chromosomes**, which carry genetic information.
- **Nucleolus** (plural, *nucleoli*), a mass of densely stained granules and fibres adjoining part of the **chromatin**.
- Sometimes, there are **two** or **more** nucleoli; the number depends on: (1) the species of animal and (2) the stage in the cell's reproductive cycle.

Ribosomes: Protein factories

- Ribosomes are complexes made of **ribosomal RNA (rRNA)** and **protein**.
- Ribosomes are carried out **protein synthesis**.
- They are composed of **two subunits: large subunit & small subunit**. Each subunit has its own mix of proteins and rRNA.



- Cells that have **high rates** of protein synthesis have a **large number** of ribosomes (pancreatic cells).
- **Two** types of ribosomes: **Free** and **bound**, which are identical in structure and can alternate between.
- Proteins **synthesised** by **free ribosomes** are **used** in the cytoplasm of **cell itself**.
- Proteins **synthesised** by **attached ribosomes end up** in the rough ER and are exported outside cell (**secretion**).

Function of Nucleolus

- Inside nucleolus, **ribosomal RNA** (rRNA) is made by the instruction of DNA.
- Small and large subunits of **ribosome** are made by an assembly of **rRNA** & and **proteins** imported from cytoplasm.
- Nucleolus functions in **regulation** of some cellular processes, such as **cell division**.

Function of Nucleus

- **messenger RNA** (mRNA) is made according to instructions provided by the DNA then it **leaves** the nucleus to cytoplasm via the nuclear pores.
- Ribosomes **translate** the mRNA's genetic message into the primary structure of a specific **polypeptide protein**.

Endoplasmic Reticulum (ER)

- The word **endoplasmic** means “**within the cytoplasm**”, and **reticulum** is Latin for “**little net**”.
- ER is an extensive network of membranes that occupies more than half the total membrane in many eukaryotic cells.

- ER consists of a network of membranous **tubules** and **sacs** called **cisternae** (from the Latin *cisterna*, a **reservoir for a liquid**); inside cisterna has a **space** called **cisternal space**.

Type of ERs

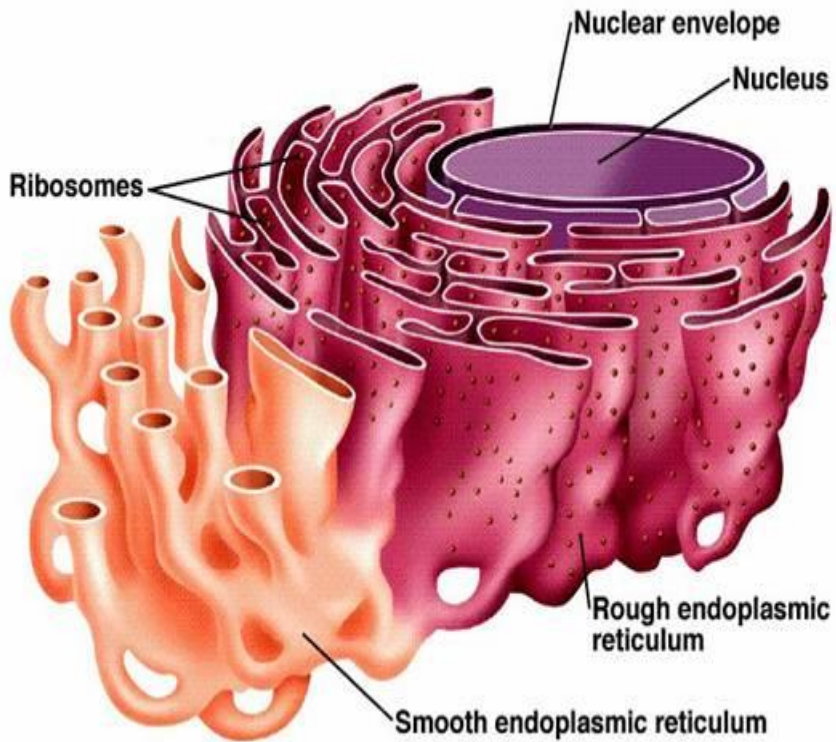
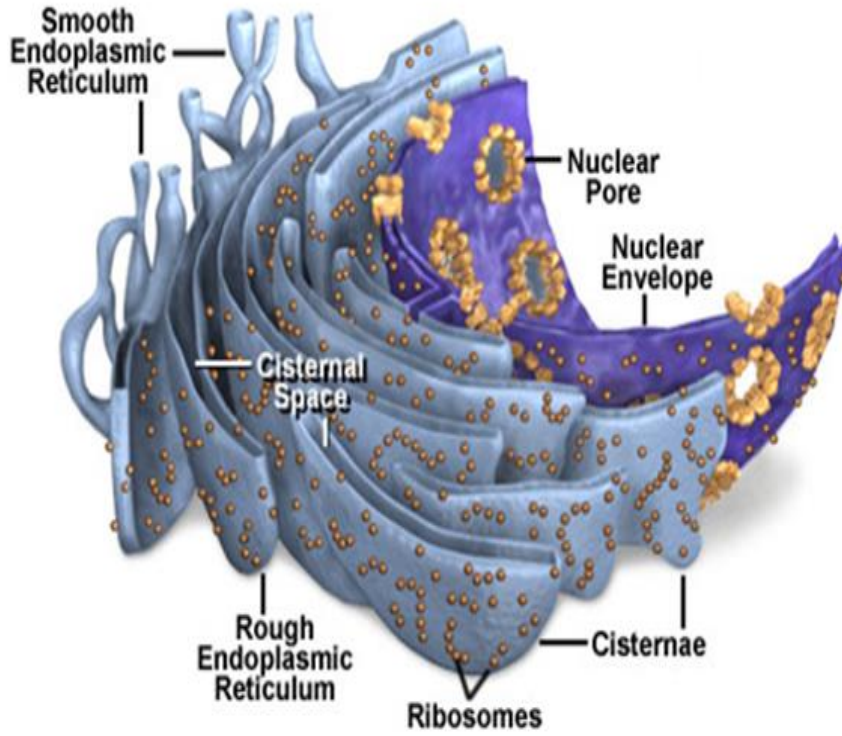
- **Two** types of ER differ in **structure** and **function**:
- **Smooth endoplasmic reticulum** lacks ribosome.
- **Rough endoplasmic reticulum** attached with ribosomes.

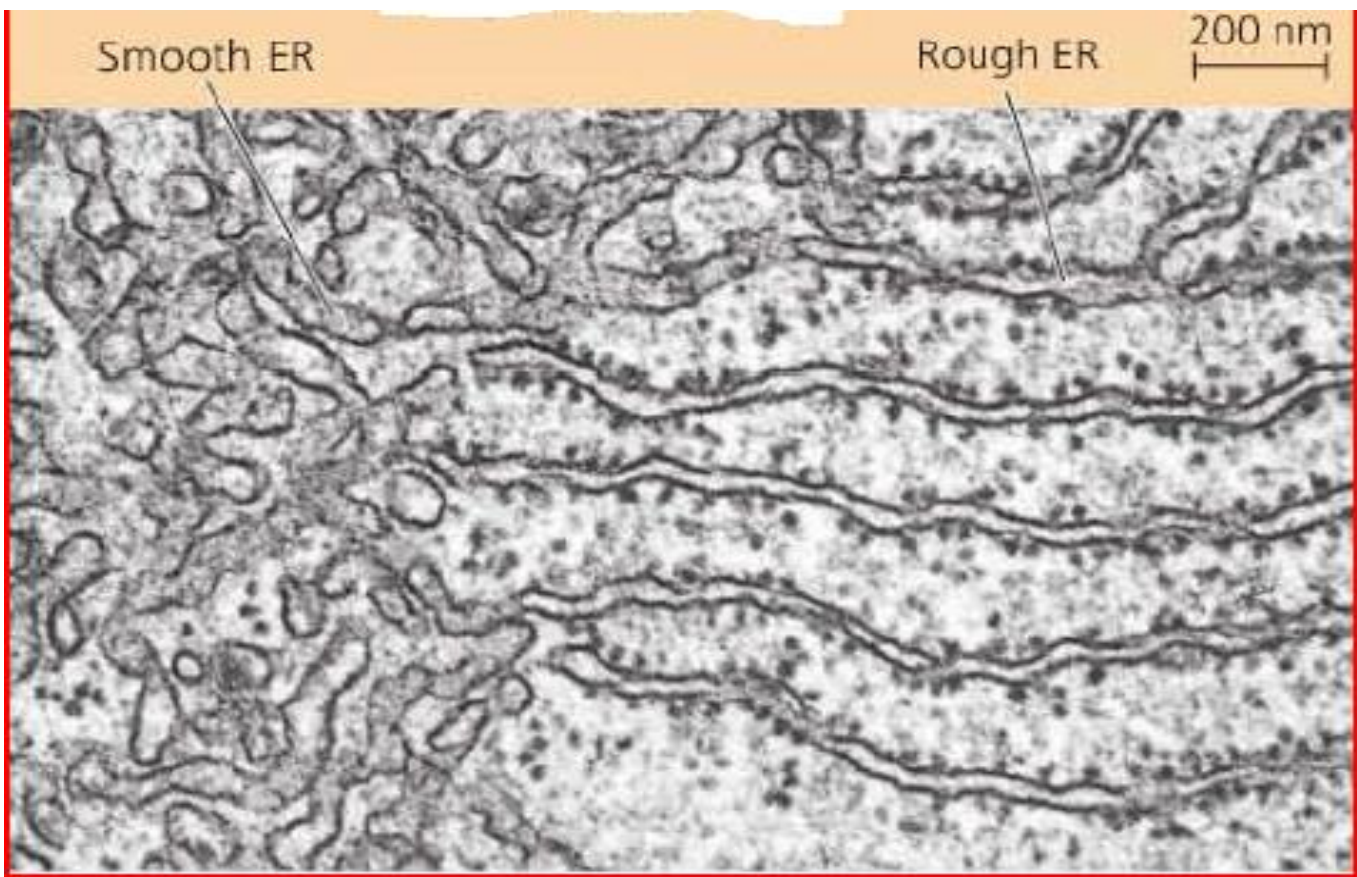
Functions of Smooth Endoplasmic Reticulum

Has different functions depending on cell type:

- (1) Synthesis of **lipids**: **Enzymes** of the smooth ER are important in synthesising **lipids**, including **oils**, **phospholipids**, and **steroids** (sex hormones in testis & ovary, steroid hormones secreted by the adrenal glands).
- (2) Metabolism of **carbohydrates** to **glucose**.
- (3) Detoxification of **drugs** and **poisons**: **Enzymes** of the smooth ER help **detoxify drugs** and **poisons**, especially in **liver cells**.
- (4) Stores **calcium ions** in muscle cells:
 - In muscle cells, smooth ER membrane **pumps calcium ions** from the **cytosol** into the **cisternal space**.
 - When a nerve impulse stimulates a muscle cell, calcium ions **rush back** across the ER membrane into the cytosol and **trigger contraction** of the muscle cell.

Endoplasmic Reticulum





Electron microscope of smooth & rough ER

Definitions:

Nuclear envelope: is a double membrane of lipid bilayer enclosing the nucleus and separating its contents from the cytoplasm. Pore structures perforate the envelope.

Pore complex: A complicated protein structure that lines the nuclear pore and plays an important role in the cell by regulating the entry and exit of most proteins and RNAs, as well as large complexes of macromolecules.

Nuclear lamina: a net-like array of protein filaments that line the nuclear side of the nuclear envelope and maintain the shape of the nucleus by mechanically supporting the nuclear envelope.

Nuclear matrix: a framework of fibers extending throughout the nuclear interior.

Nucleolus: a mass of densely stained granules and fibers adjoining part of the chromatin inside cell nucleus. In the nucleolus, *ribosomal RNA* (rRNA) is assembled with protein imported from the cytoplasm into large and small ribosomal subunits.

Cisternae: a network of membranous tubules and sacs in endoplasmic reticulum.

Cisternal space: a space that separates the internal compartment of the endoplasmic reticulum from the cytosol.