

Department of  
**Histology, Cytology and  
Embryology**

**Lecture 1. Introduction.**  
**Essential Cytology**

**Histology** studies the organization of the **tissues** and **organs** of the body.

**Cytology** studies the structure and functions of the **cell**.

**Embryology** researches embryonic development (formation) of the body

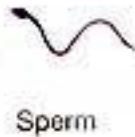
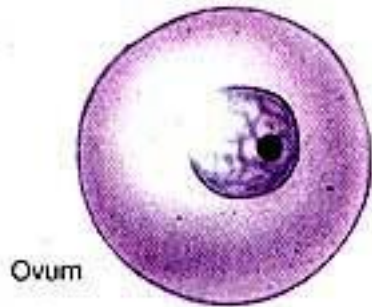
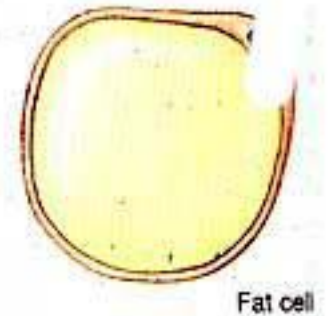
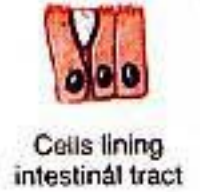
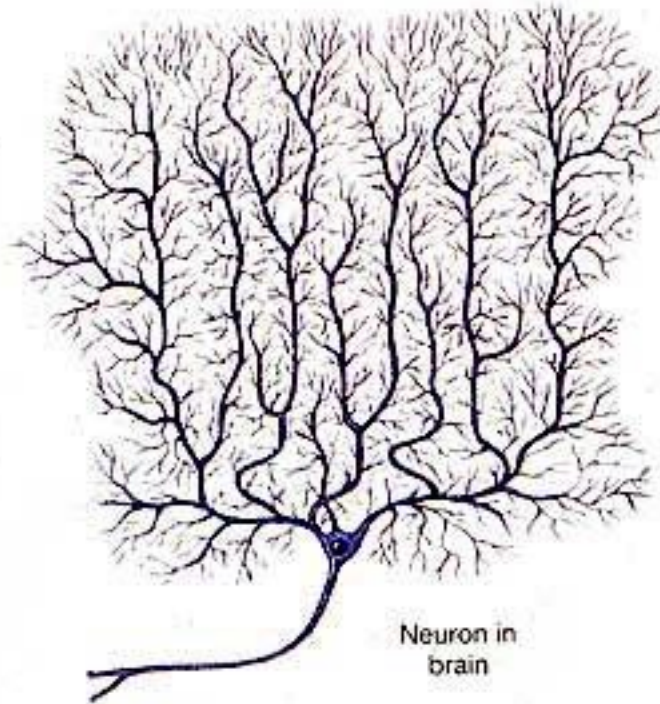
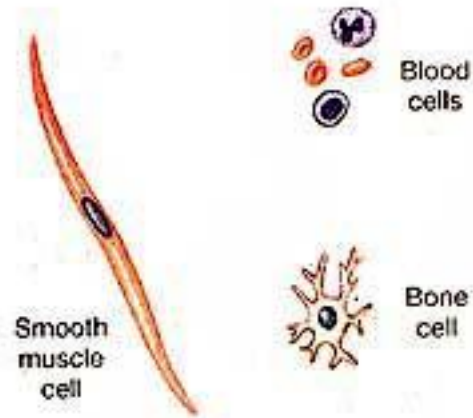
# Cytology

# Note:

- 1. The cell is the smallest structural and functional unit of the body
- 2. Cells form tissues.
- 3. Tissues form organs and systems



# Types of cells in human body



# Cells produce matrix

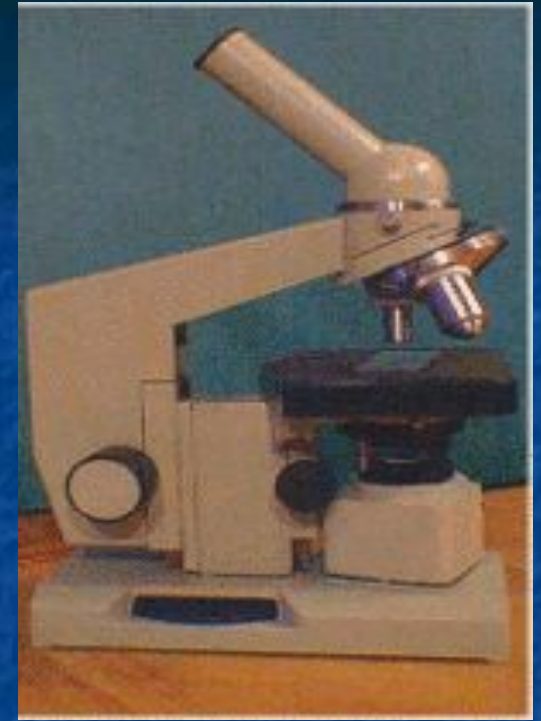


# Methods of investigation

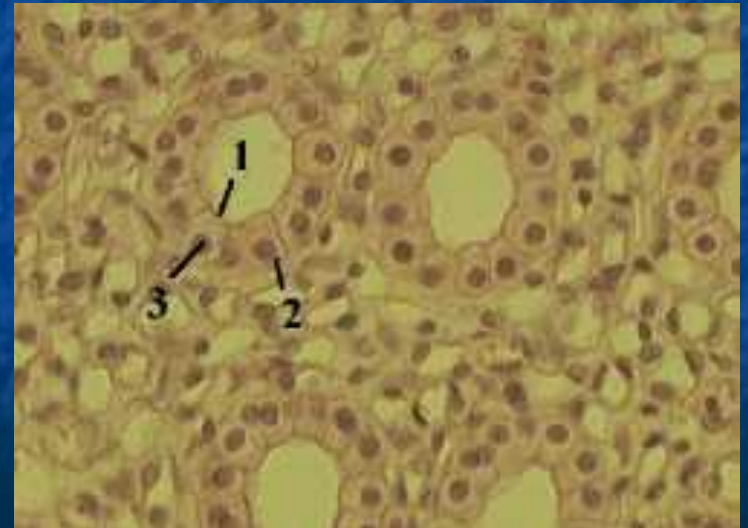


# Microscopy – basic method

- Light microscope:



- Histological slide:



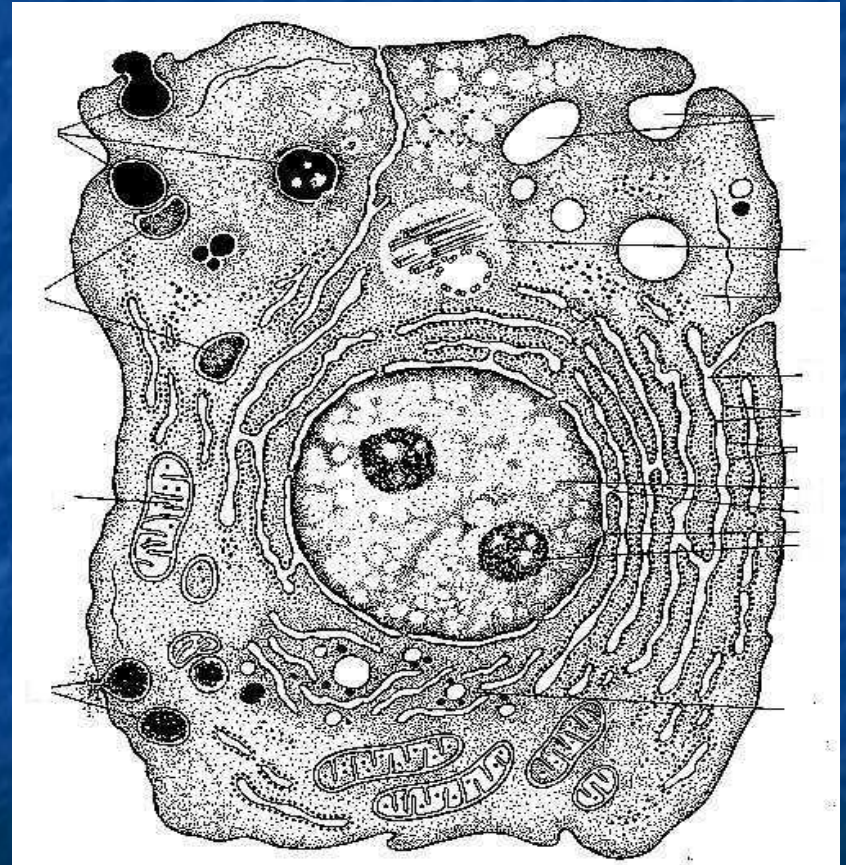


# Electron microscopy



# Electron microscopy researches

- *Ultra*structure of cells (organelles) and organisation of intercellular matrix





# Light and electron microscopy - are 2 main methods in histology





# *Levels of biological systems*

- Biomolecules



- Membranes



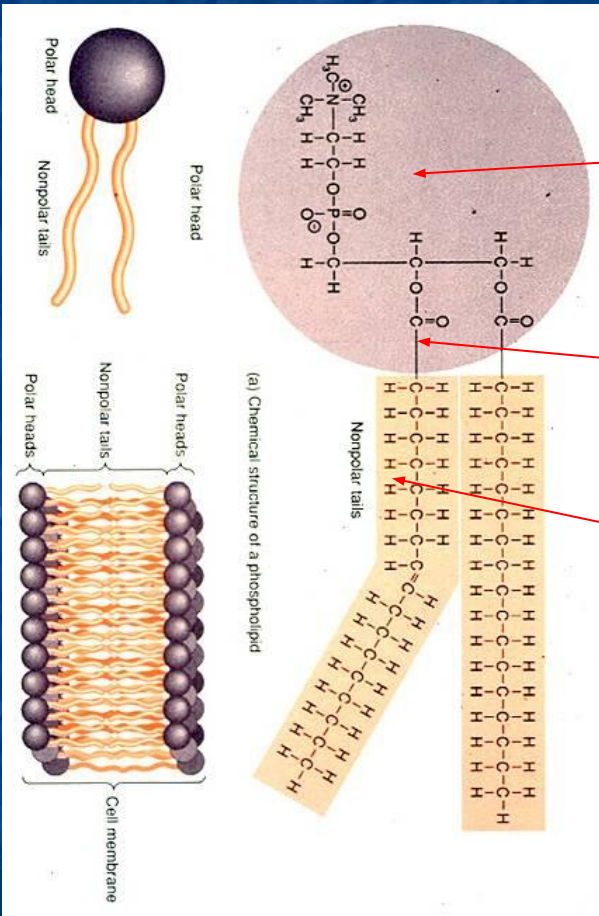
Organelles



CELL

-

# Phospholipids structure :

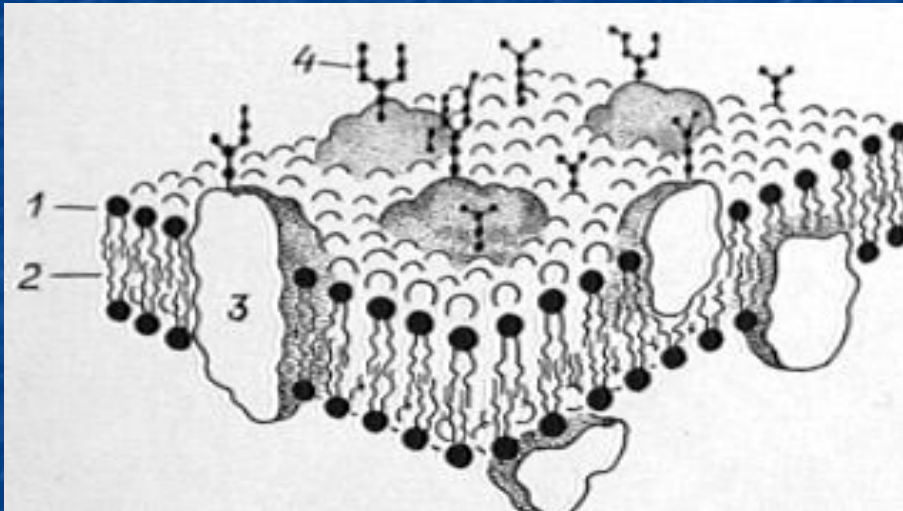


Phosphate group (hydrophilic heads)

Glycerol

Fatty acids (hydrophobic tails)

# Membrane contents:



- A. Phospholipids: (1 – hydrophilic head, 2 – hydrophobic tails)
- B. (3 ) – proteins
- C. (4 ) – carbohydrates (only **outer cell membrane**)



# Lipids

may be:

- Phospholipids – triglycerides (polar)
- Cholesterol (non-polar)

# Proteins

may constitute close to 50% of  
membrane content

# Proteins

## function:

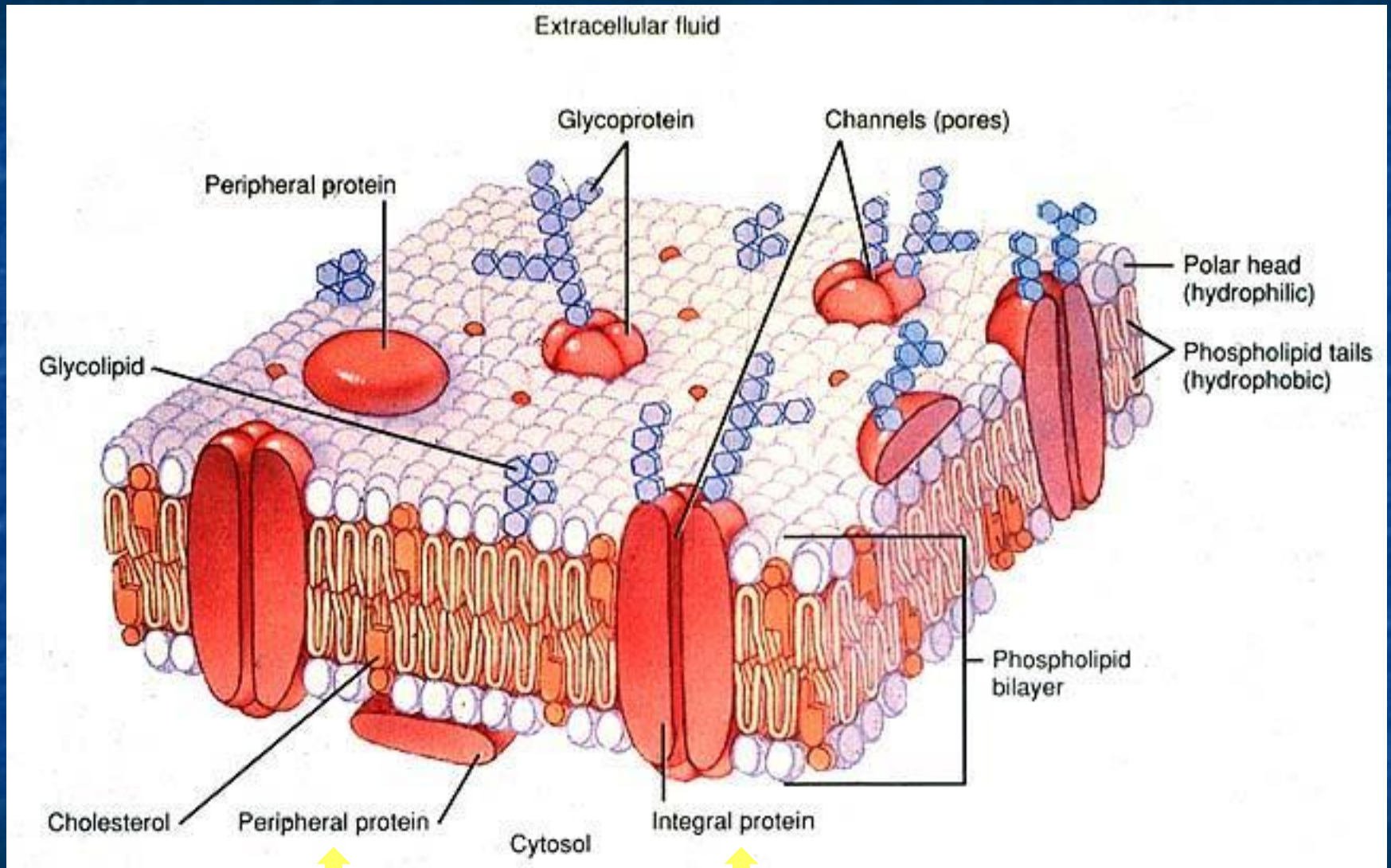
- 1- channels,
- 2- pumps,
- 3- receptors,
- 4- enzymes,
- 5- integrative,
- 6- structural



# Carbohydrates

- Present in the outer cell membrane
- Form Receptors

# Outer cell membrane – cytolemma or plasmalemma



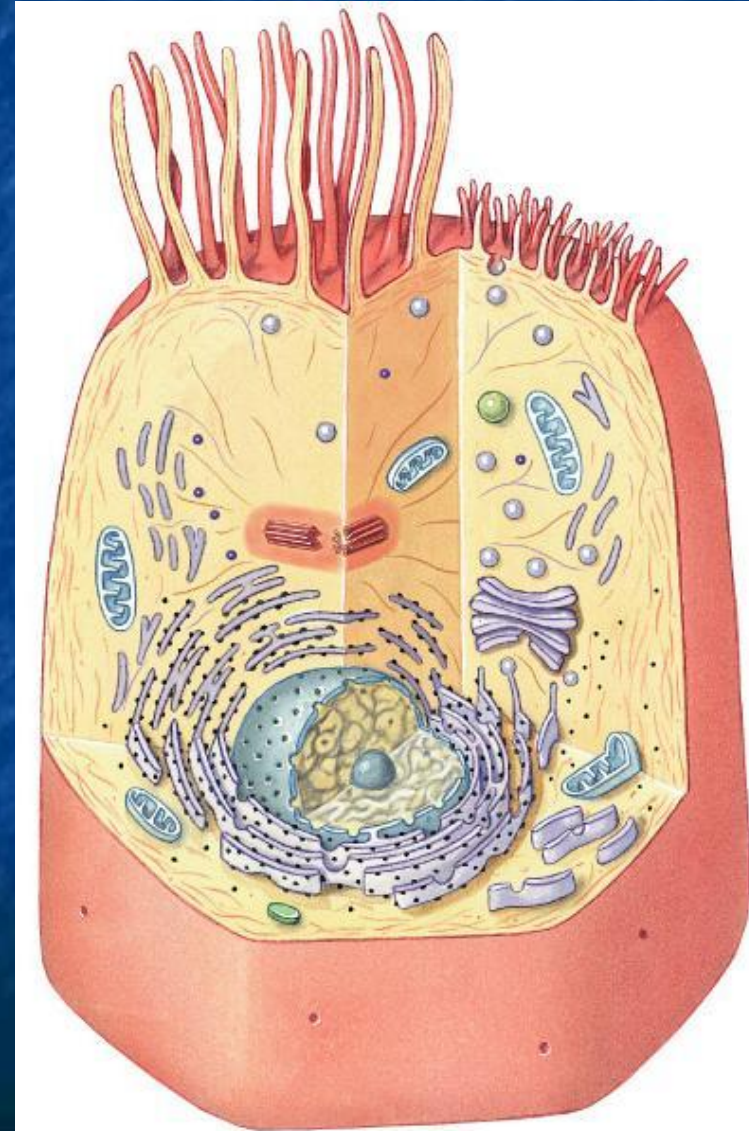
# Membranes form:

- Outer cell membrane
- Organelles
- Vesicles
- Nuclear envelop



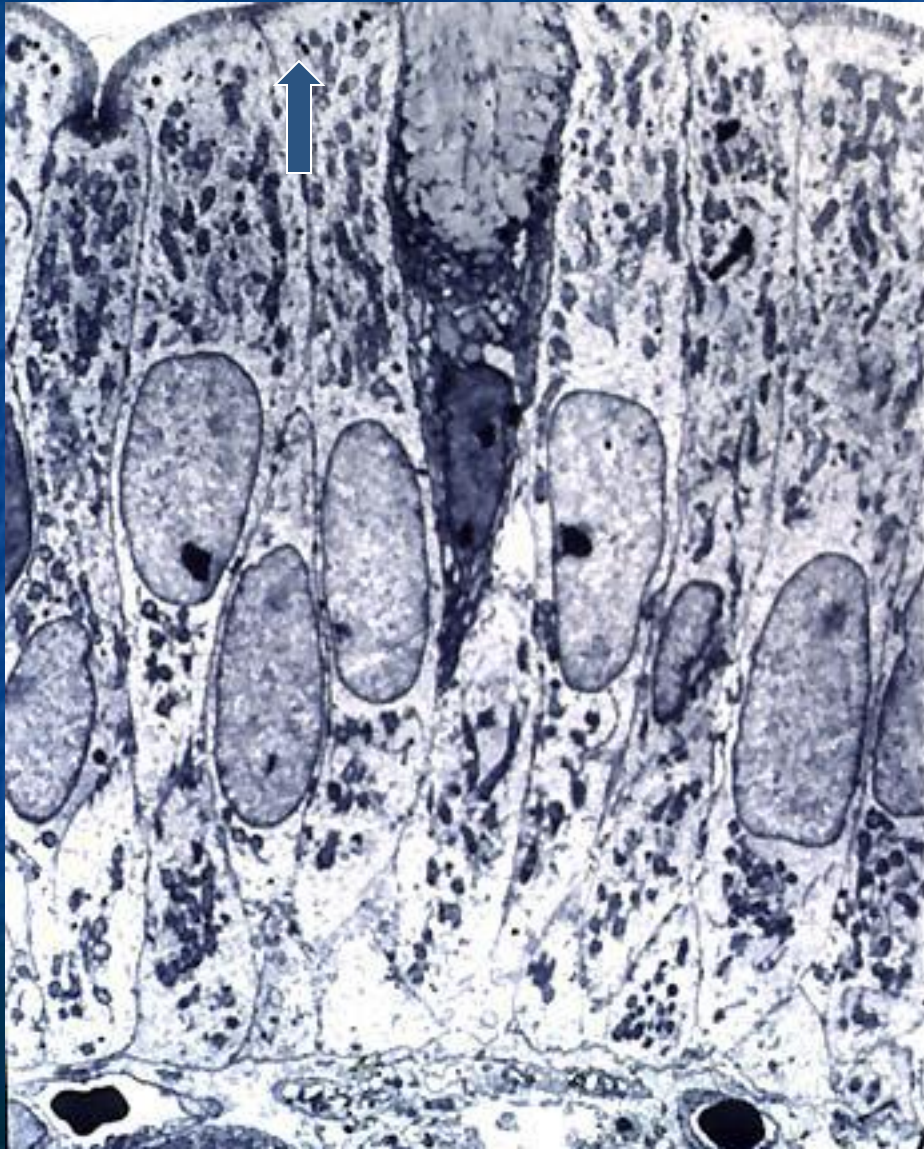
# Cell consists of:

- - Outer cell membrane,
- - Cytoplasm and
- - Nucleus



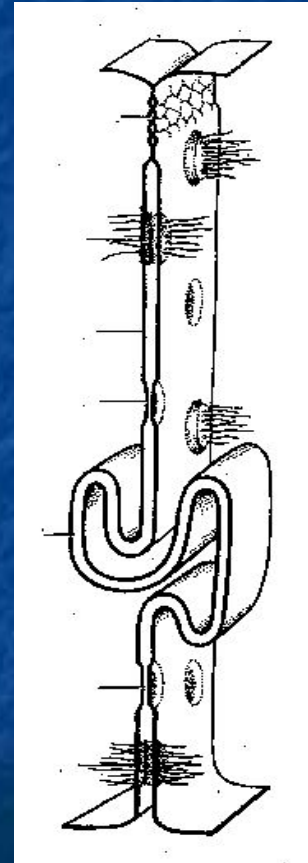


If cells contact, outer cell membrane  
forms junctions



# Types of Cell junction

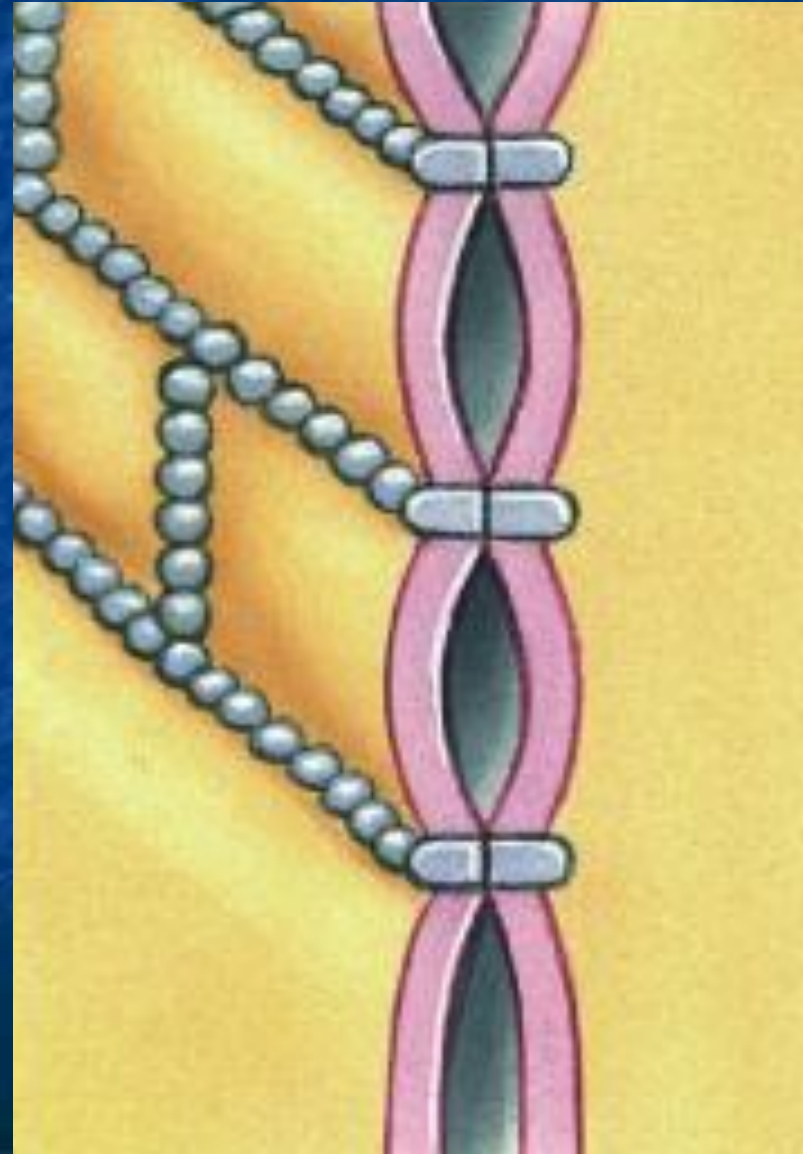
- Tight junction
- Gap junction
- Desmosomes

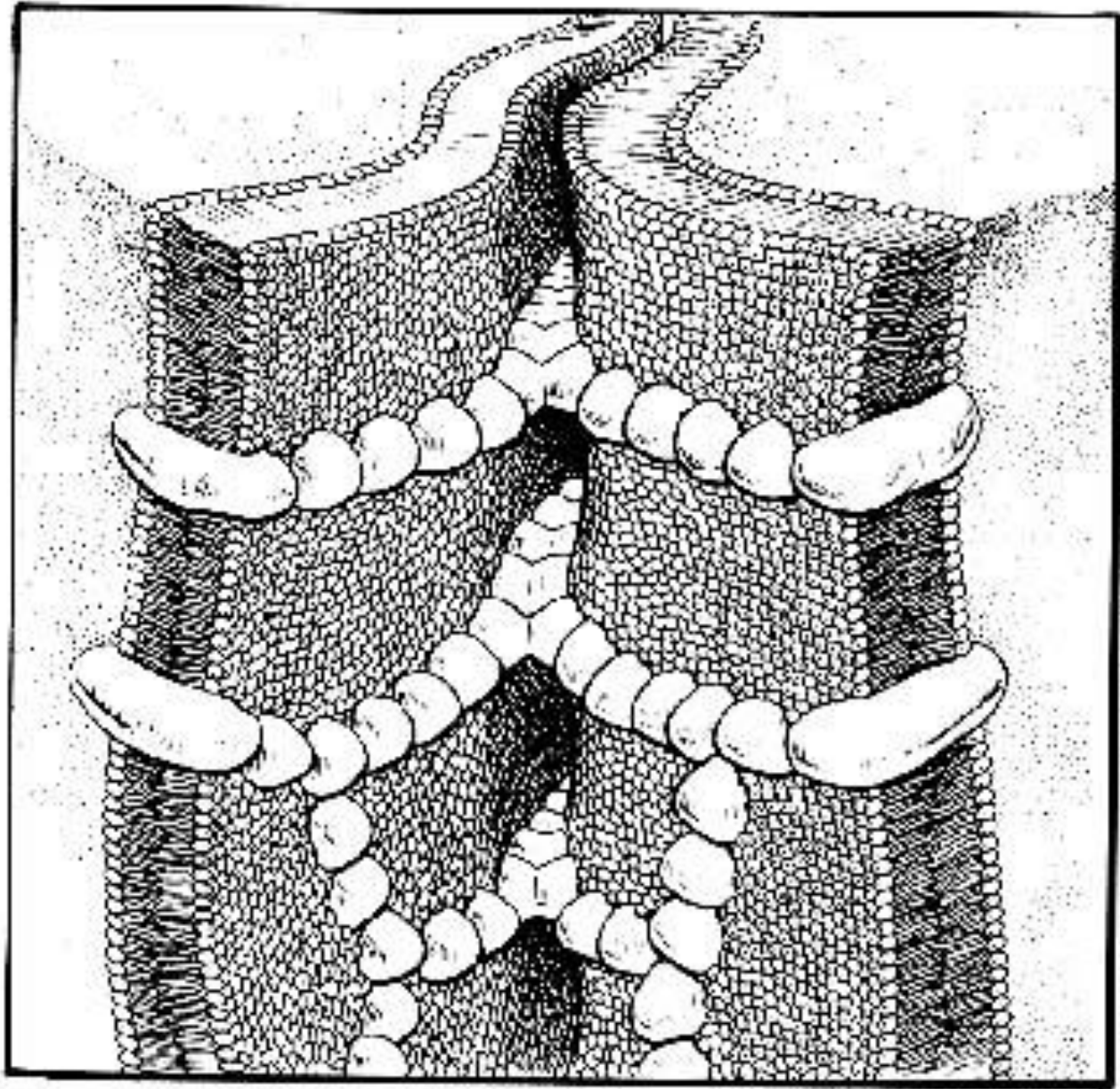




# Tight junction

- prevents the movement of molecules into the intercellular spaces
- present between epithelial cells

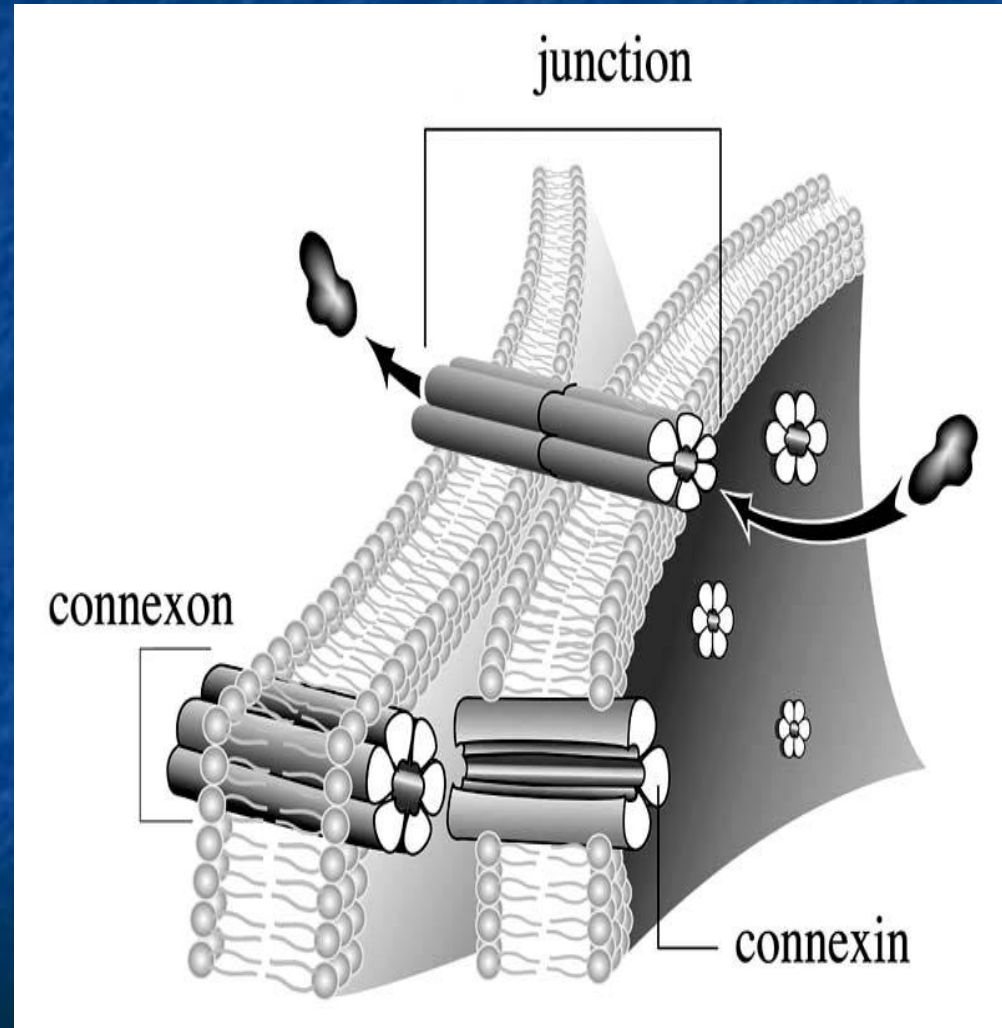






# Gap junction

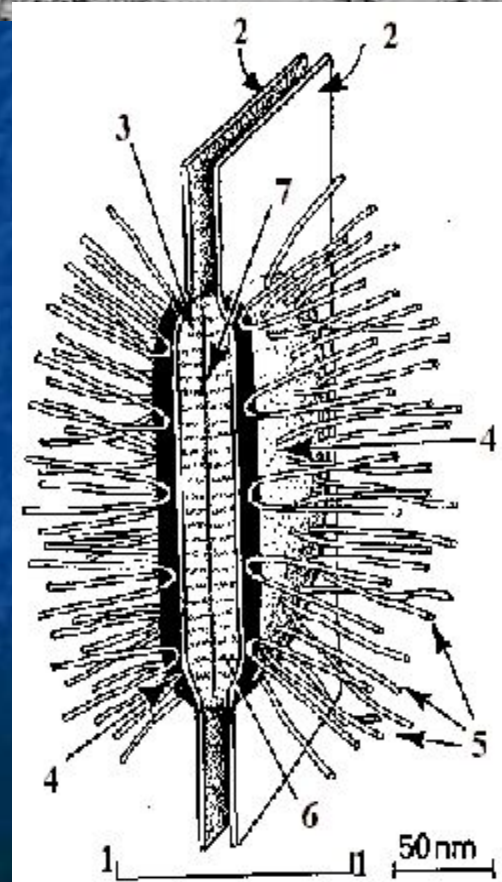
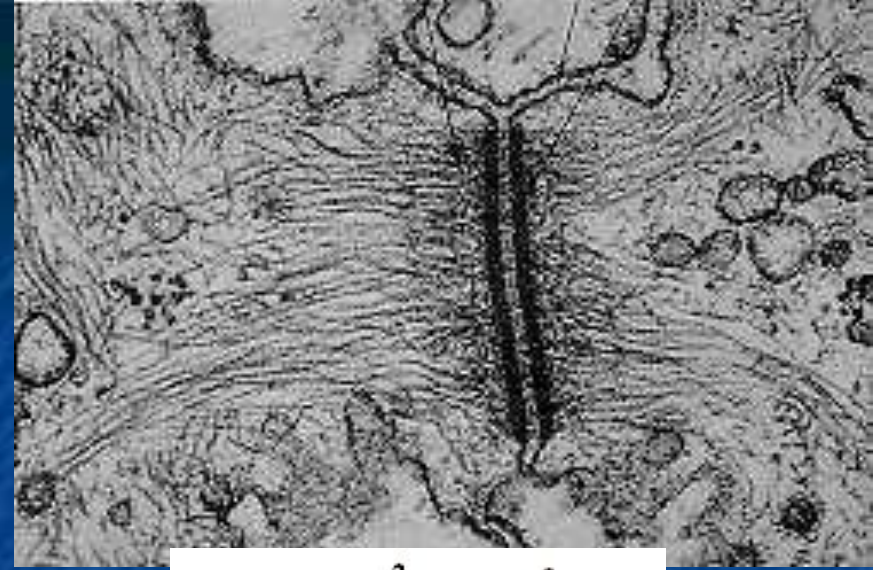
- channels between cells





# Desmosomes -

- Provide cell attachment



# Inside the cell ...

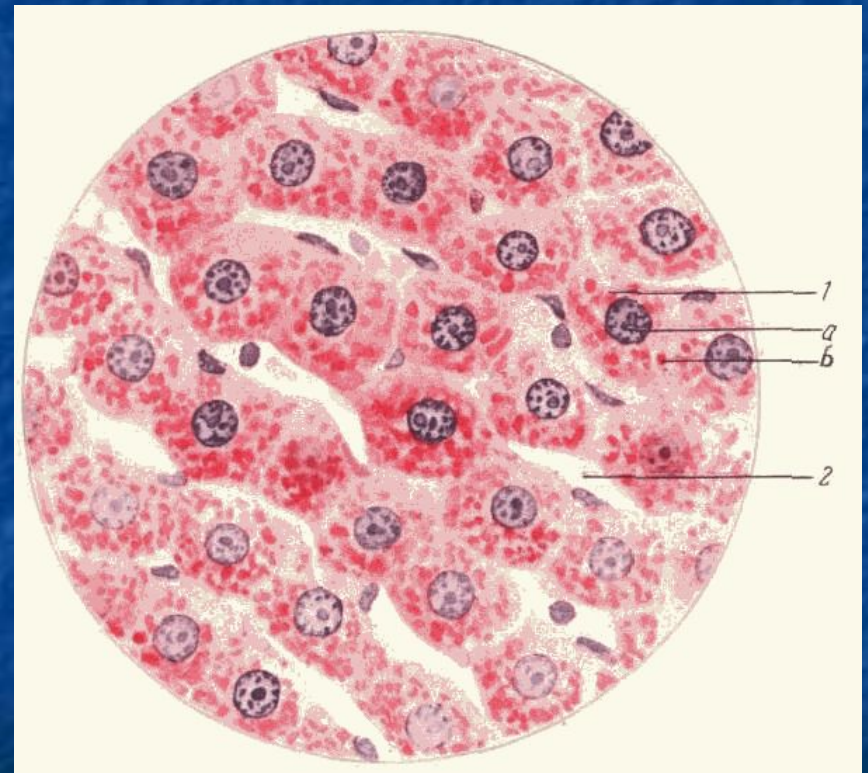
Cytoplasm consists of:

- Matrix (hialoplasm, cytozol)
- Organelles
- Inclusions



# Inclusions -

- granules with secretions, pigment granules, lipid and **glycogen** droplets





# Organelles:

(classification by structure)

- Membranous

- Non-membranous

# Organelles:

(classification by function)

- General

(present in every cell,  
perform general  
function)

- Ex.: Mitochondrion

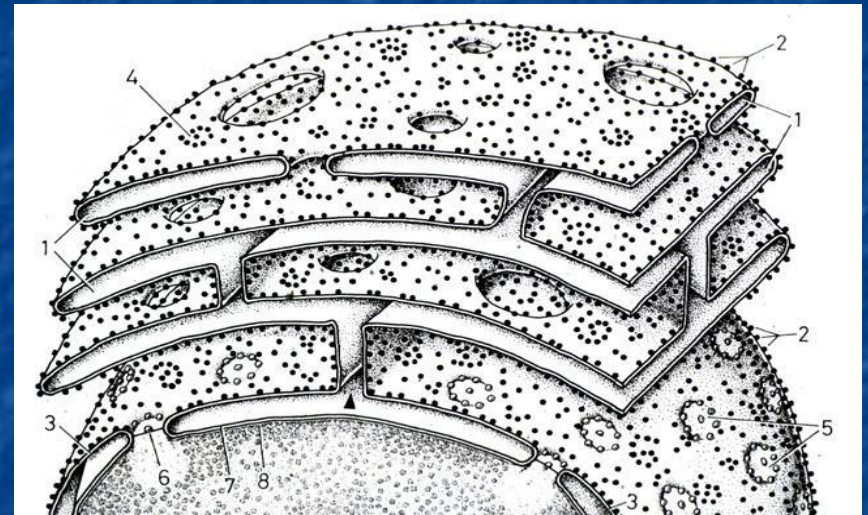
- Special

(in specialised cell,  
perform special  
function)

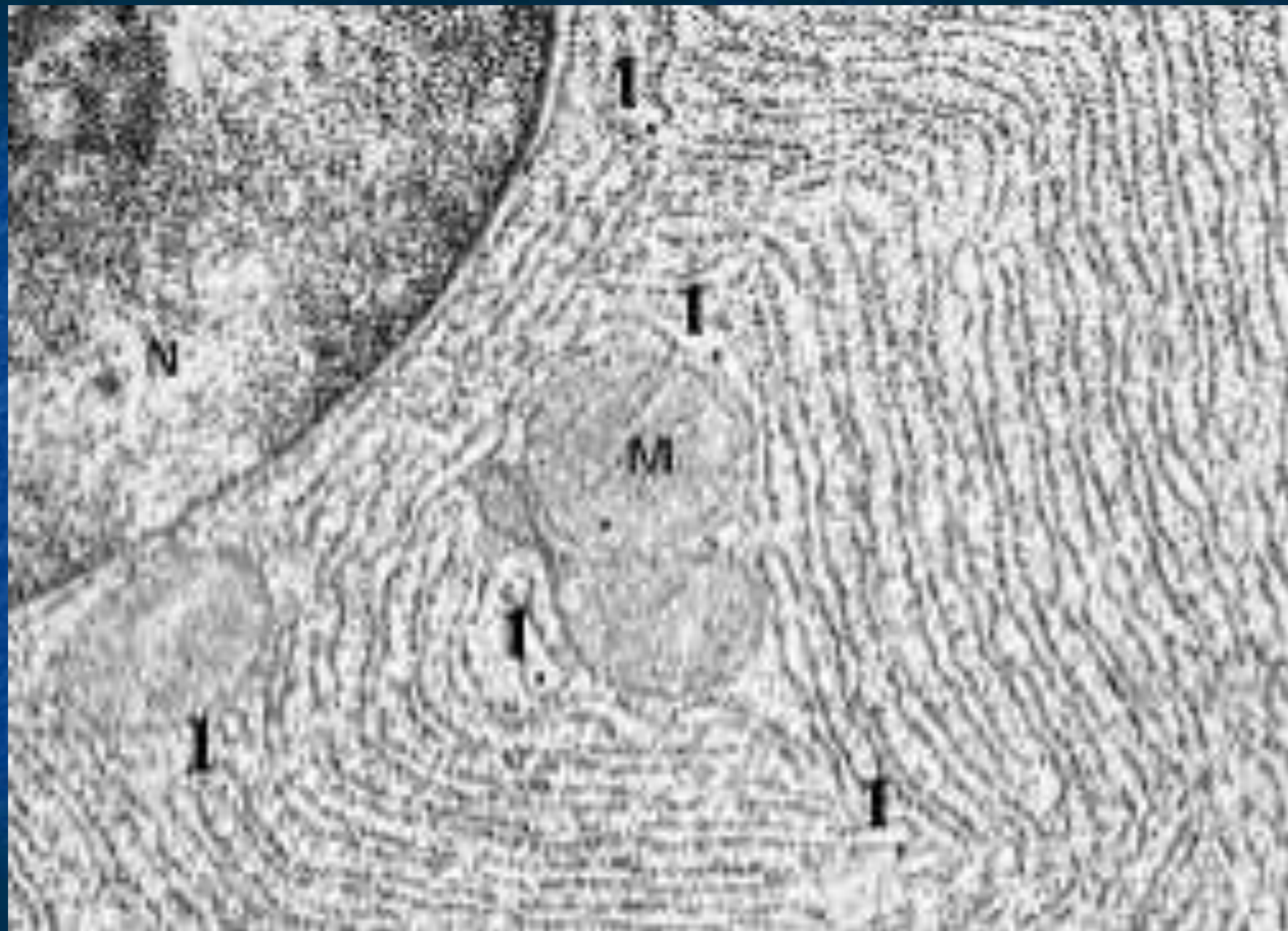
- = Myofibril

# Rough endoplasmic reticulum

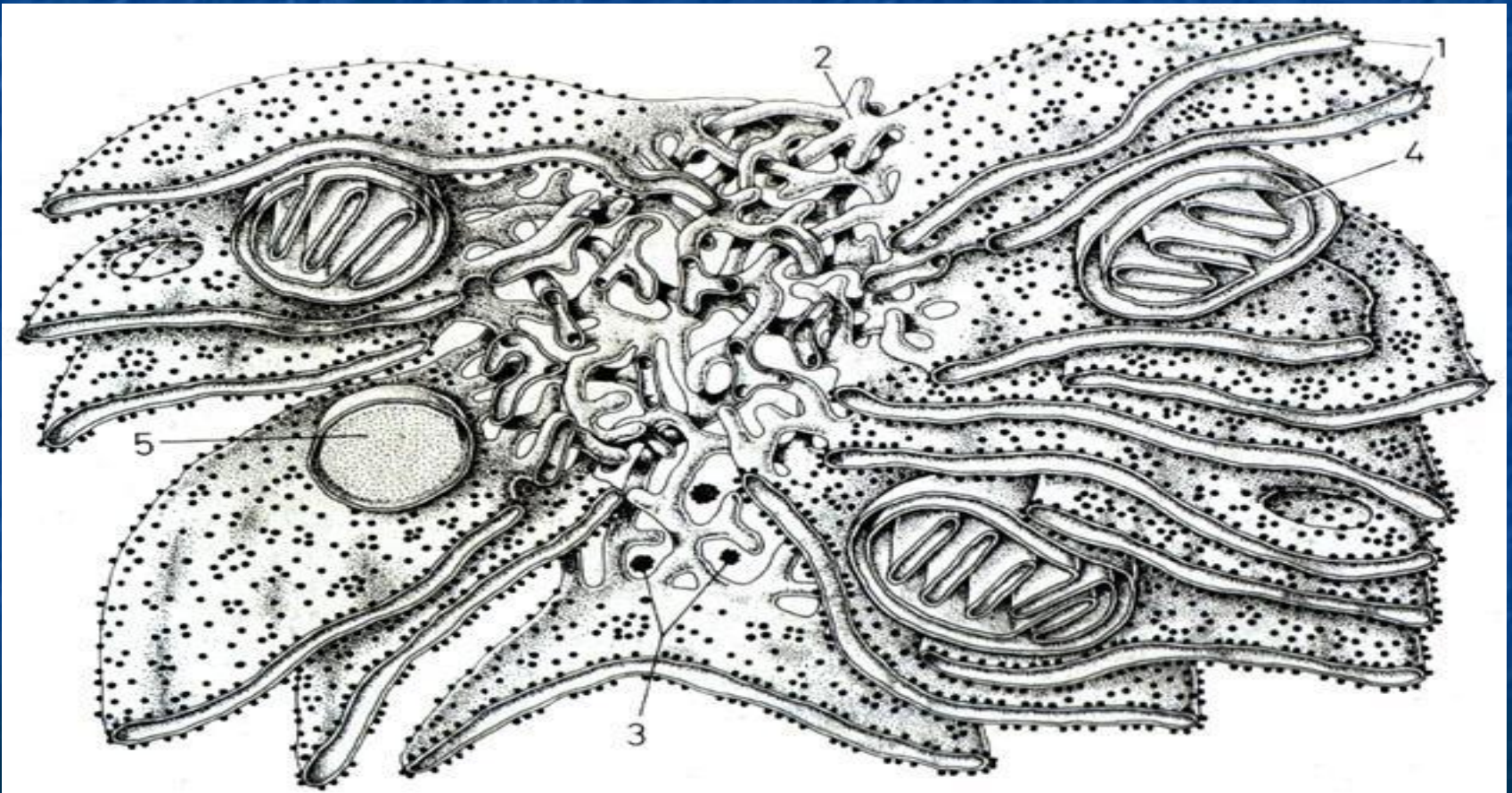
- Membranes form a network of sac-like structures called ***cisternae*** .
- Ribosomes lie on the outer surface.
- Function - synthesis of proteins







# Smooth endoplasmic reticulum, SER





- SER structure: membranes form tubules without ribosomes.

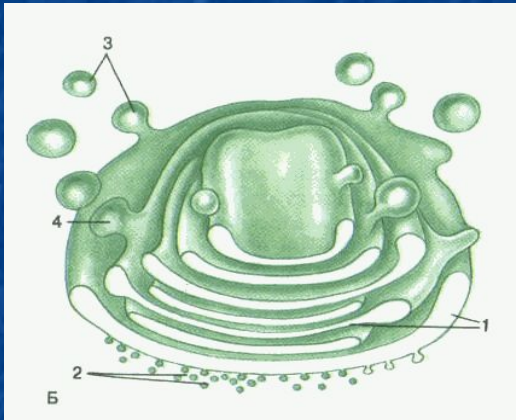
Function:

- 1. synthesizis of lipids.
- 2. metabolism of carbohydrates
- 3. drug detoxification (in liver cells).
- 4 storage of Ca-ions (only in muscle cell)

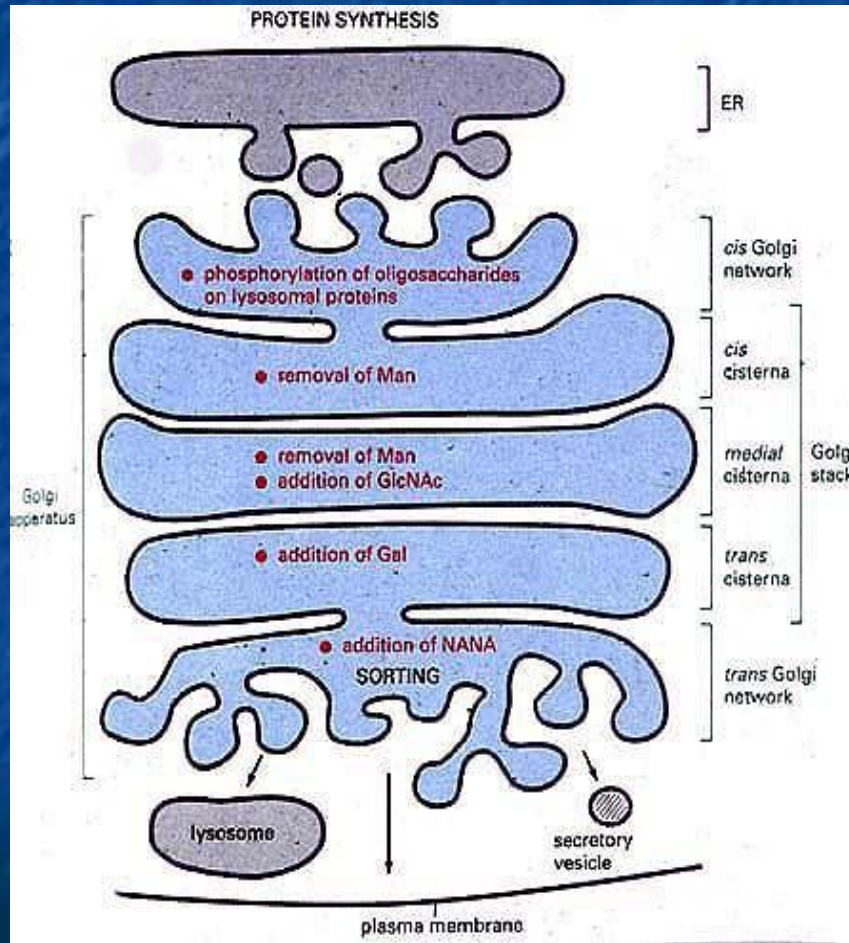


# Golgi complex (or apparatus)

- = a pack of sacs.



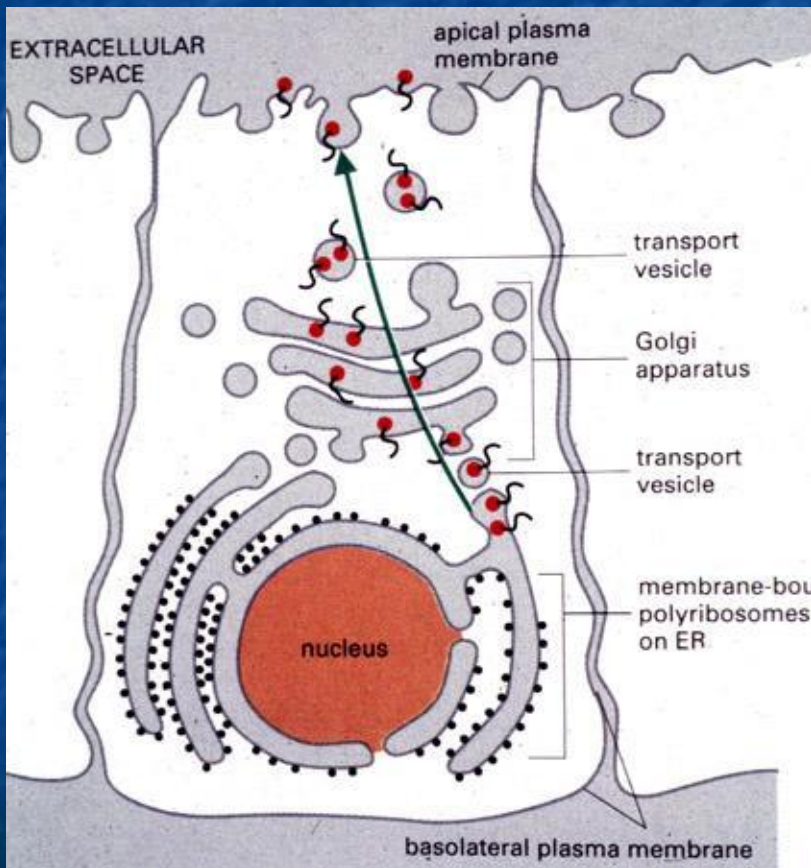
# Golgi complex ...



- ... is connected with endoplasmic reticulum



# Golgi apparatus functions:

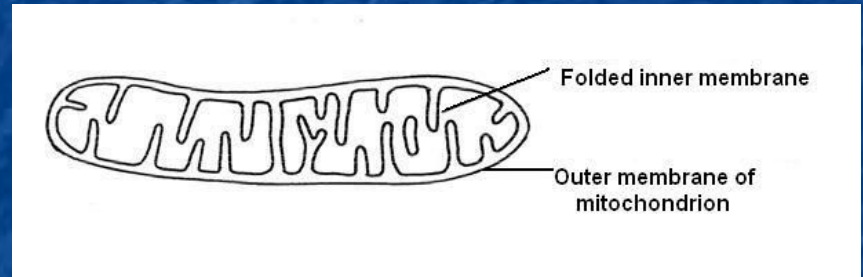


1. formation of compound molecules – glycoproteins, lipoproteins.
2. production of lysosomes and secretory vesicles.



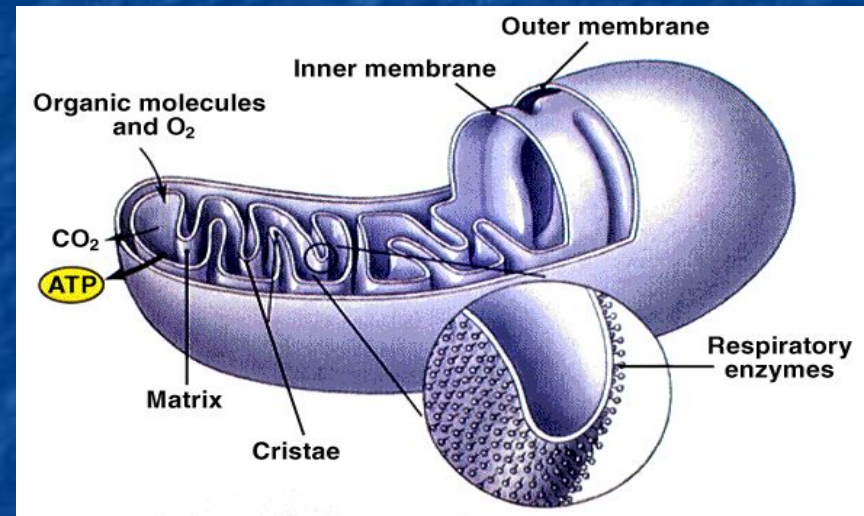
# Mitochondrion

- Structure :
- Contains **outer** and **inner** membranes
- --Folds of inner membrane – *cristae*
- --- Inside lie **matryx**

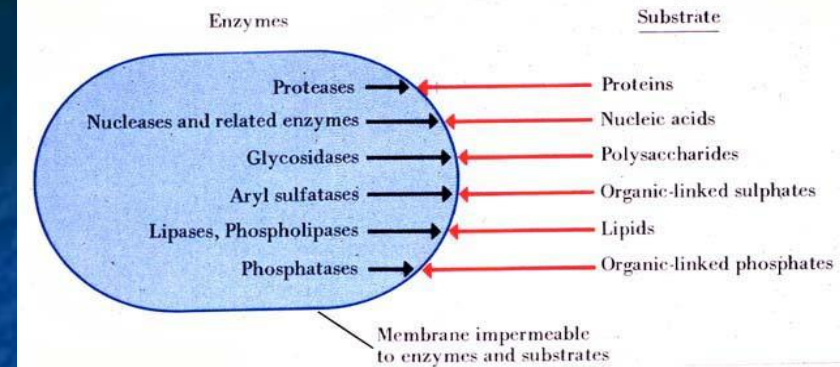


# Mitochondrion

- Produce ATP molecules (**energy**) by Krebs cycle



# Lysosome



- Lysosomes are round vesicles that contain enzymes
- These enzymes break down waste materials and cellular debris and digest the materials within phagosomes.

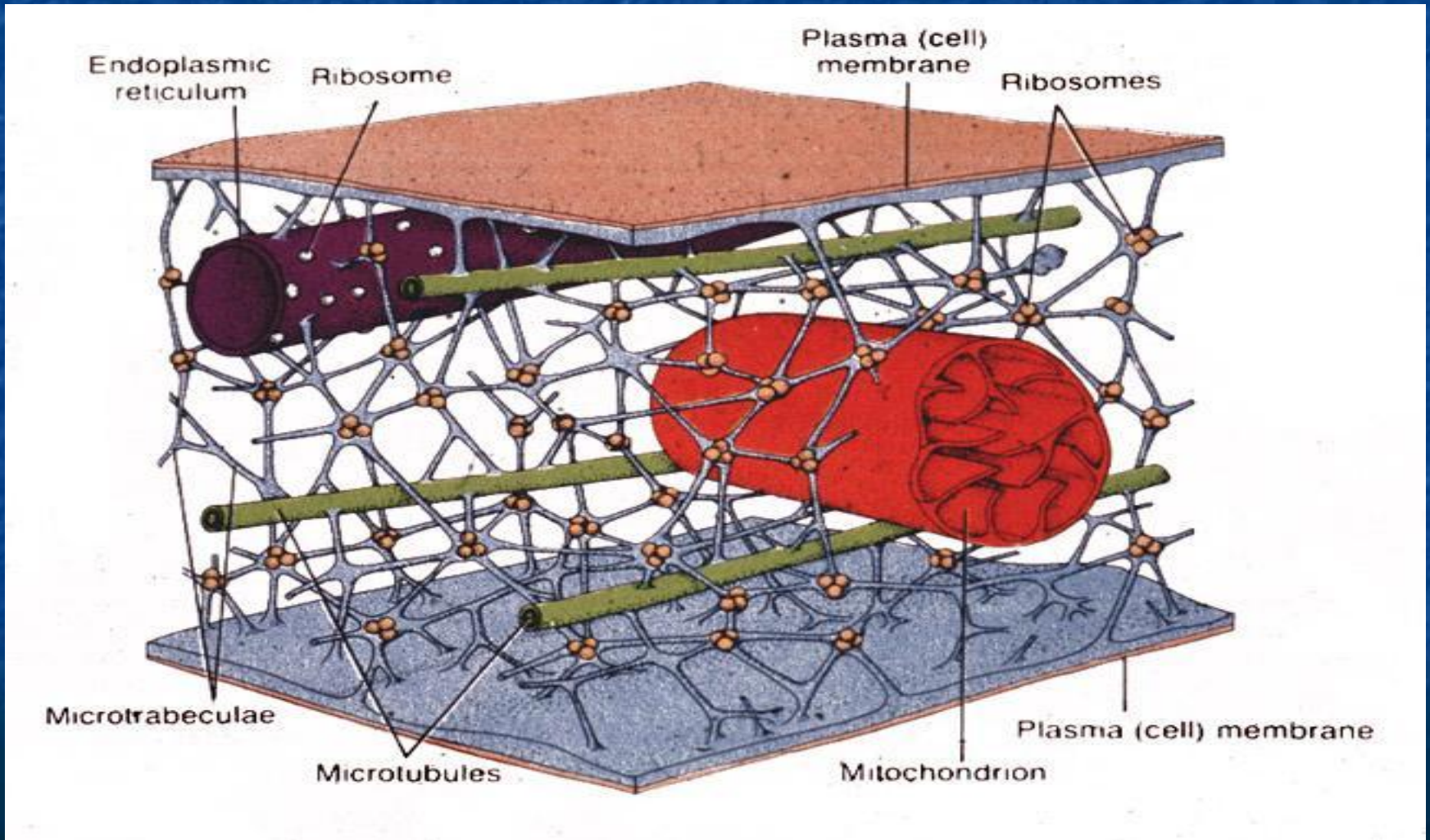


# Non-membranous organelles:

- Microfilaments
- Microtubules
- Centrioles (Cell Center)
  
- **Ribosomes**

Note:

# Microfilaments, Microtubules form "Skeleton" of the cell

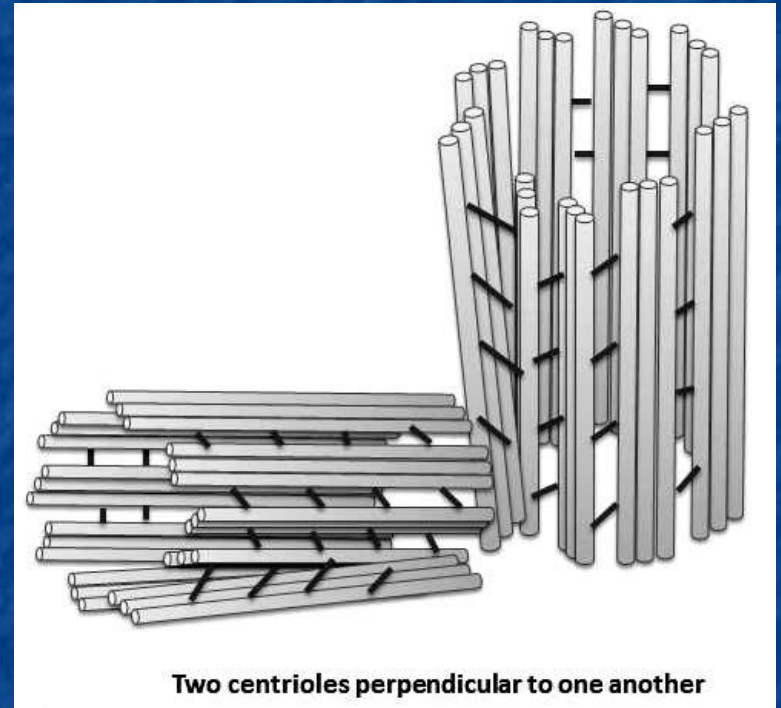


# Cell center

Consists of 2 centrioles

Centriole =  $9 \times 3 = 27$   
microtubules;

**Function - formation  
of mitotic spindle**

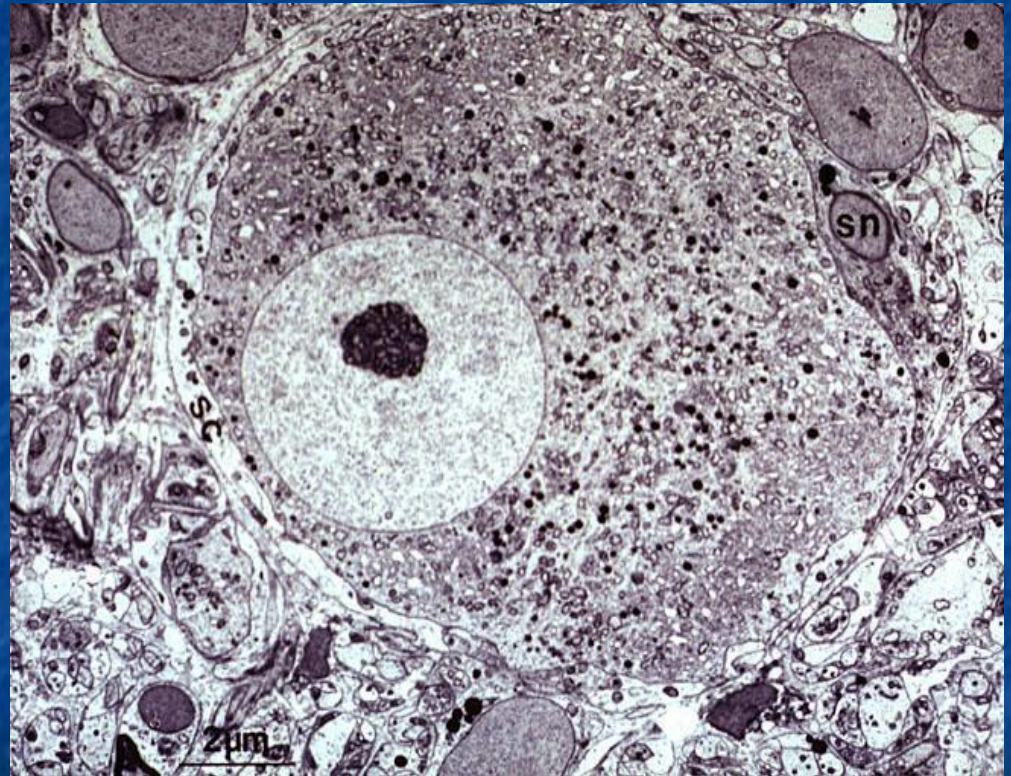




# Nucleus

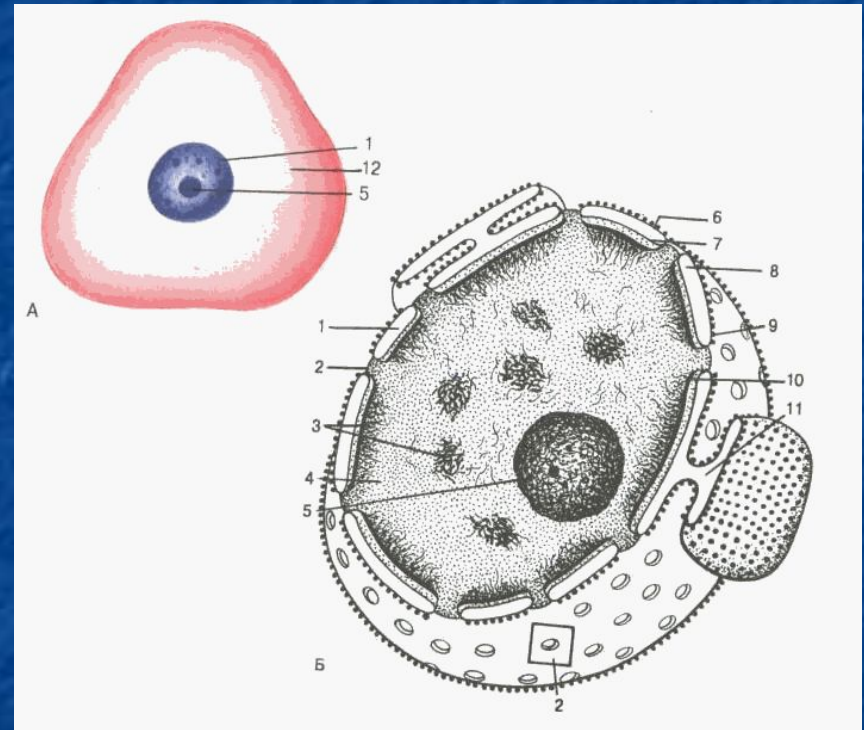
consists of:

- Nucleolemma = nuclear envelope
- Nucleoplasm
- Nucleolus
- Chromatin



# Nuclear envelope

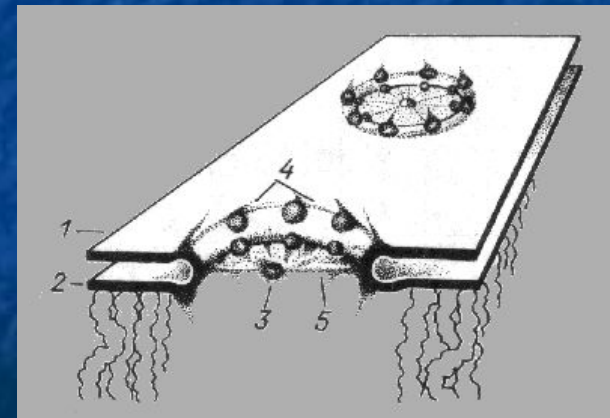
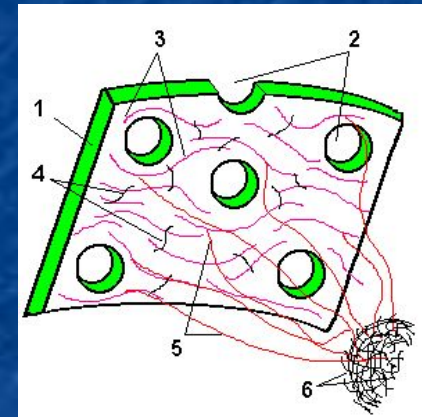
- - Consists of two membranes:
- outer and inner



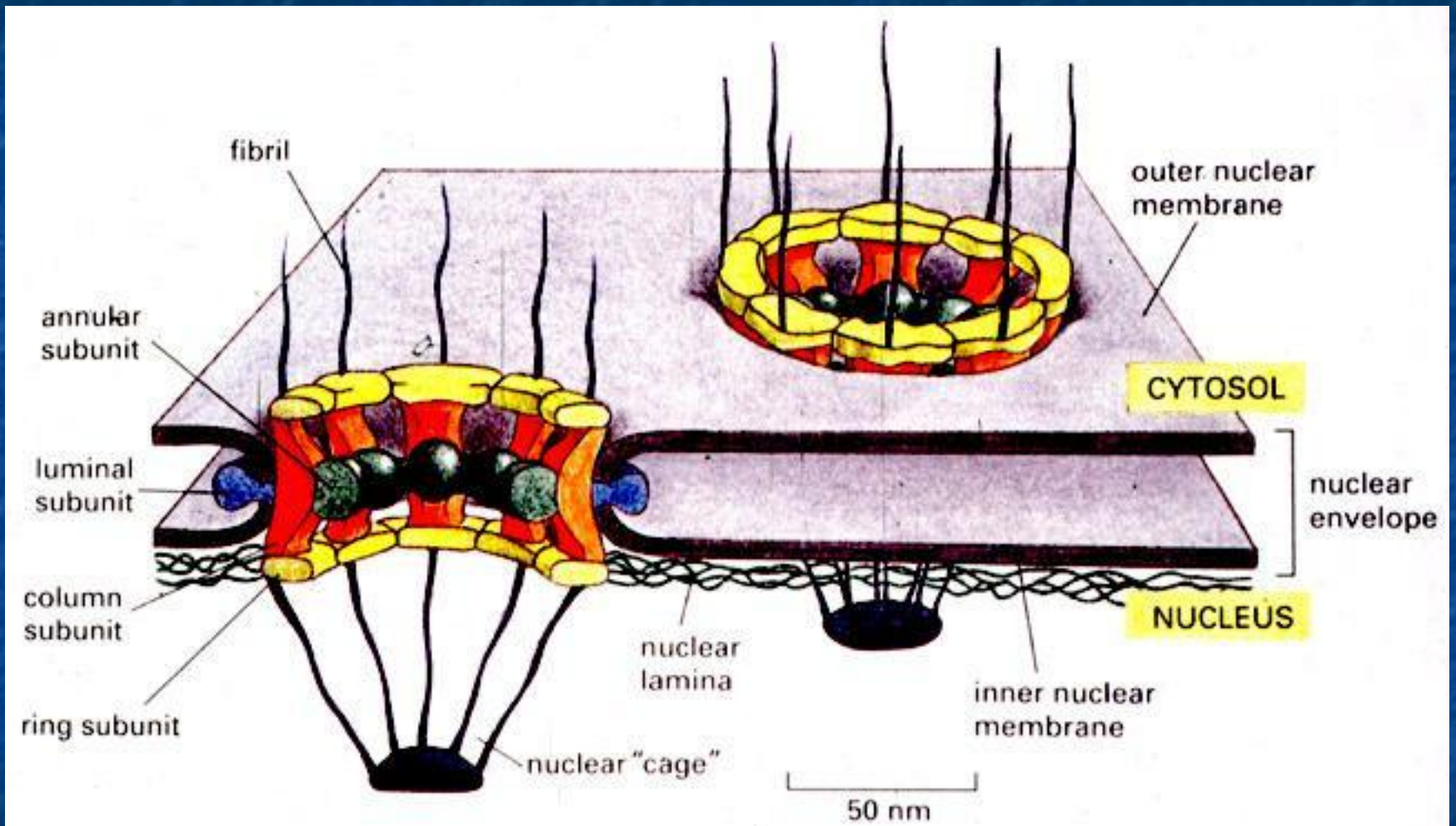


# In the nuclear envelope

- there are gaps, called *nuclear pores*, provide
- transport from nucleus into cytoplasm



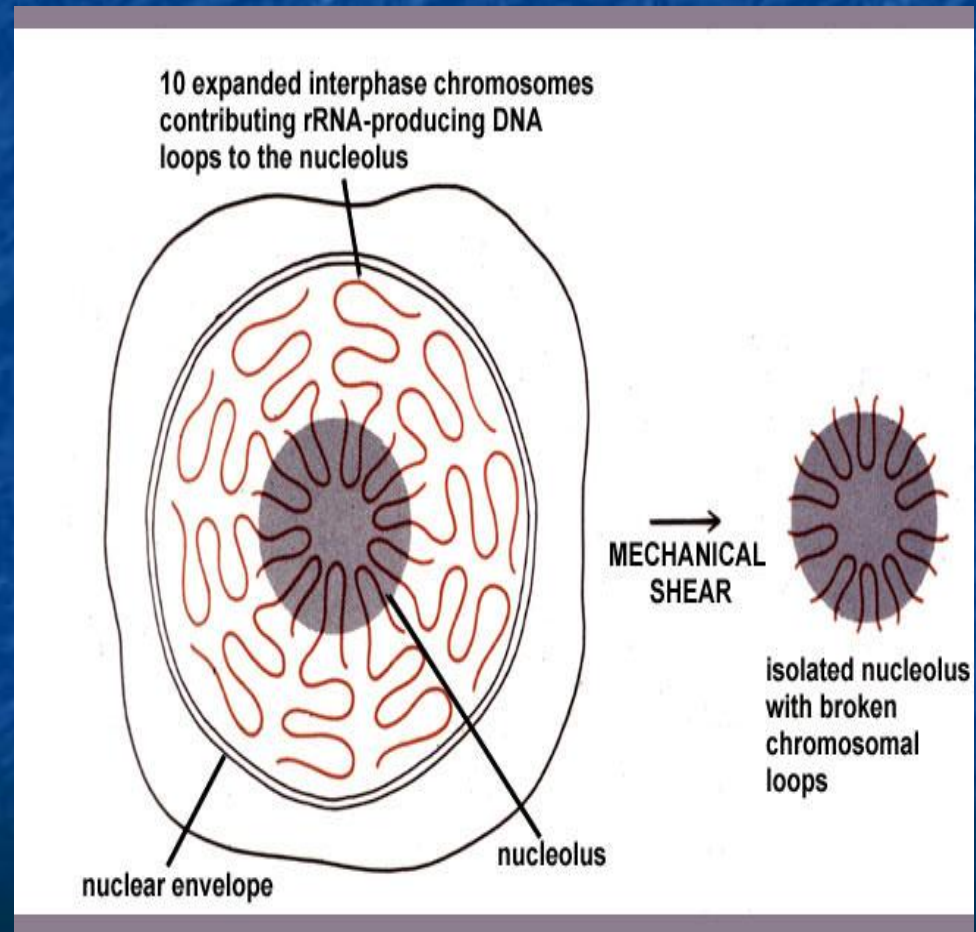




Nuclear pore structure

# Nucleolus

- Nucleolus is the site of active synthesis of ribosomal RNA and formation of ribosomes.



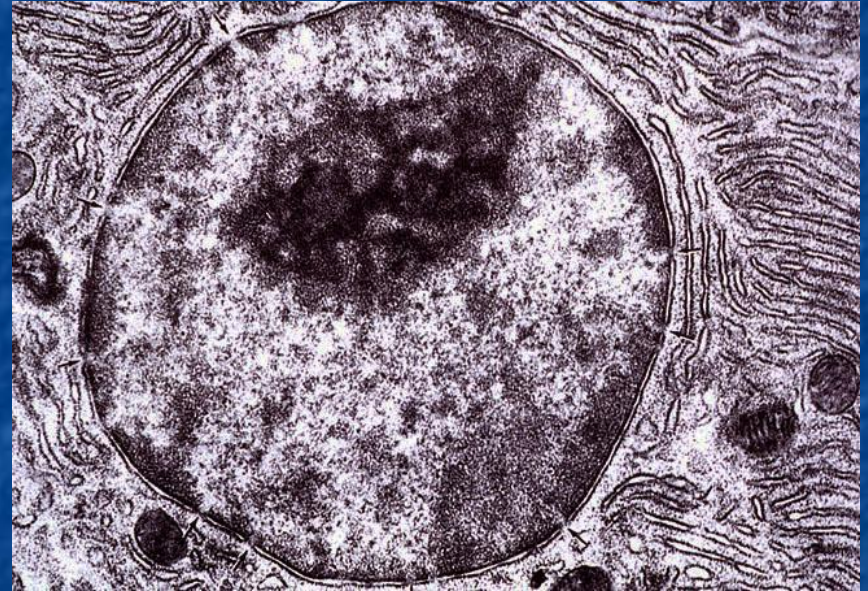
# Chromatin

- is the combination of DNA and proteins that make up the contents of the nucleus of a cell.



# Chromatin = DNA in non-dividing cells.

- 2 types:
- 1. *heterochromatin* (non-active) - very tightly packed fibrils .
- 2. *euchromatin* - active – less condensed chromatin fibrils loops

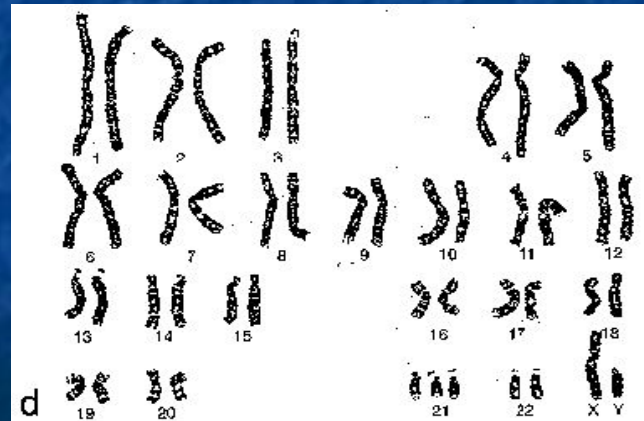
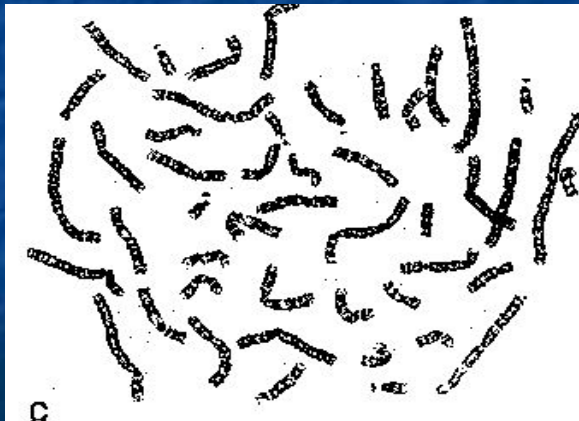
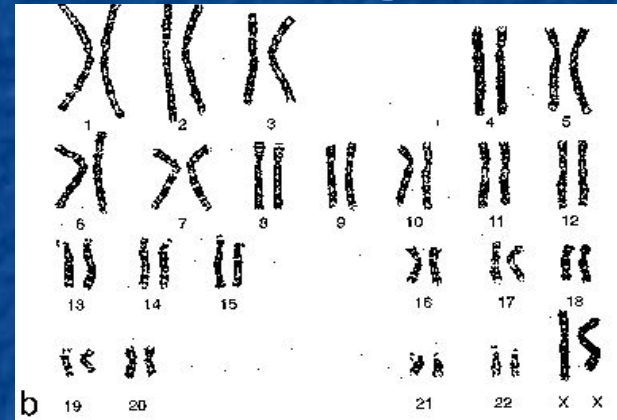
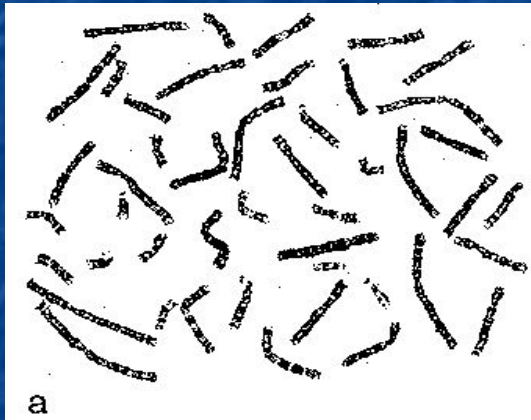


- Euchromatin predominates in metabolically active nuclei,
- 
- *Heterochromatin* predominates in metabolically inactive nuclei



# Chromosome

- is an organized structure of DNA and protein found in dividing cells.





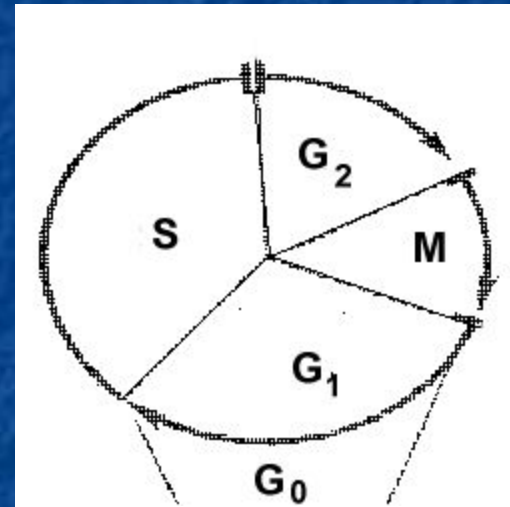
# *Cell cycle*

- The life of a somatic cell is a cyclic process
- It is called ***cell cycle***
- It consists of two periods: ***interphase*** and ***mitosis.***

# *Interphase*

*Interphase* is a period between two divisions of the cell.

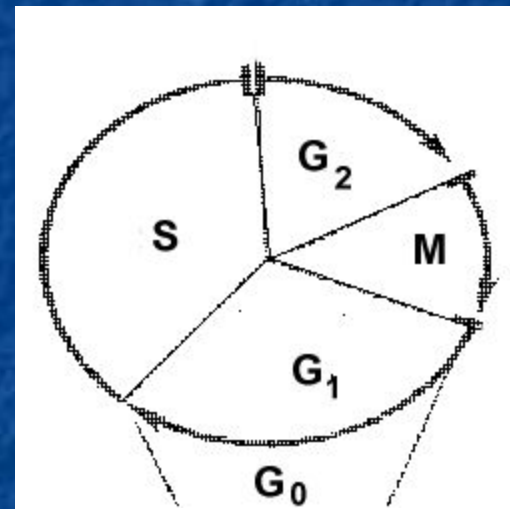
*Consists of 3 phases -*  
 $G_1$ ,  $S$ ,  $G_2$





# In $G_1$ phase:

- cell grows,  
performs its  
routine functions.



# S- phase (S- synthesis)

- DNA molecules are duplicated

NOTE: At the beginning of this phase the chromosome number is  $2N$

and at the end each chromosome consists of two DNA molecules or two *chromatids*, the chromosome number is  $4N$ .

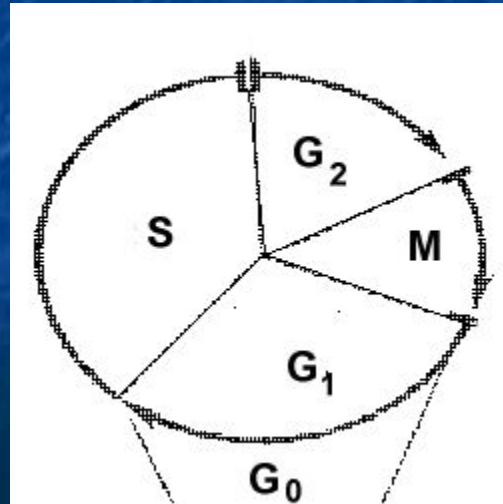
# G<sub>2</sub> phase

- In this phase synthesis of proteins, which are required for cell division, takes place.
- After phase G<sub>2</sub> **mitosis** always begins



# $G_0$ phase

- cell can leave the cycle and enter to so-called  $G_0$  phase (outside the cycle). They are reserve or *stem cell*.



# Mitosis

is the process of somatic cells  
division.

Mitosis consists of four phase:

*prophase,*

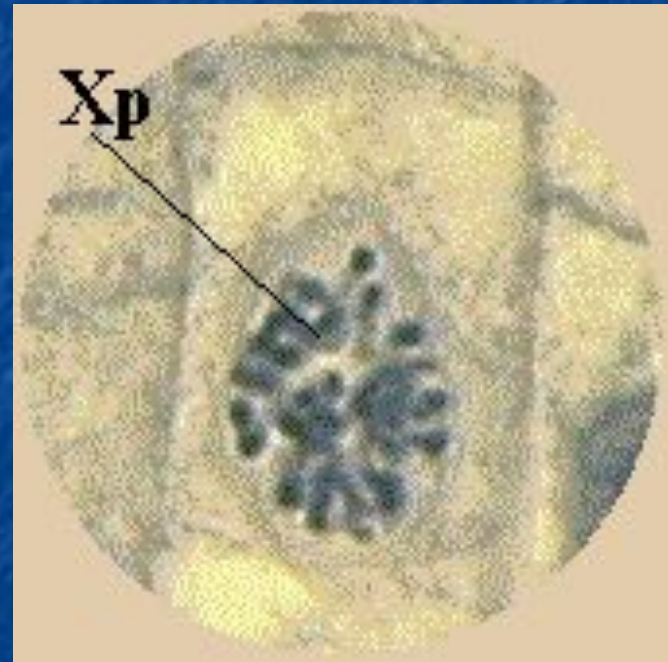
*metaphase,*

*anaphase,*

*telophase.*

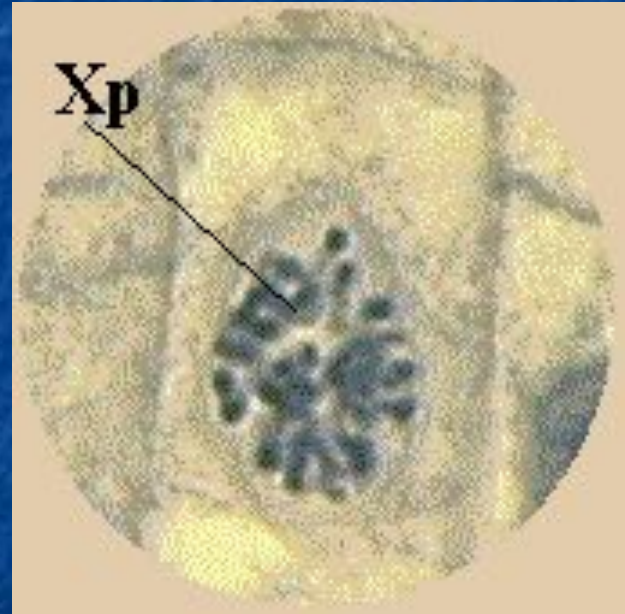
# *Prophase*

- Chromosomes become *recognisable*.
- the nuclear membrane breaks down and the **nucleoli disappear**



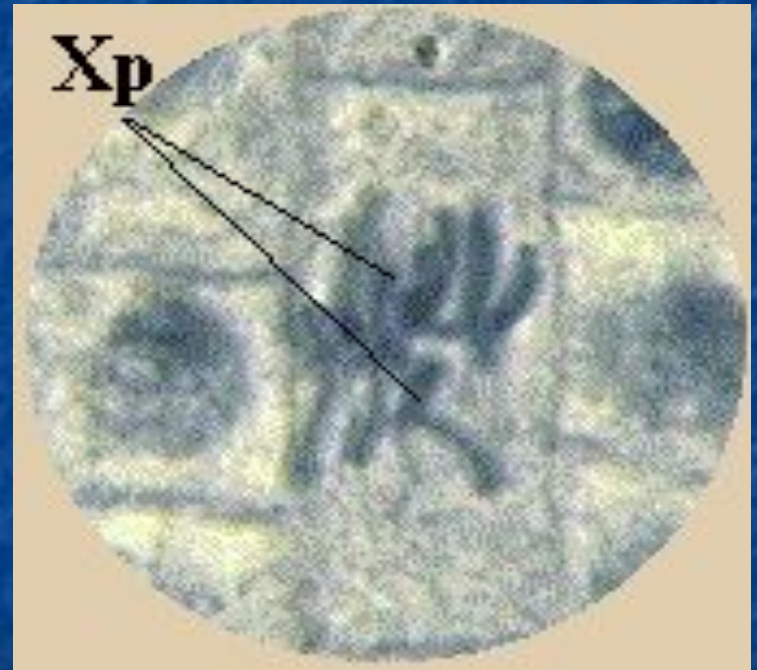


- Two centrioles separate and move to opposite poles of the cell.
- microtubules pass from one centriole to other and form *a spindle of division.*



# *Metaphase*

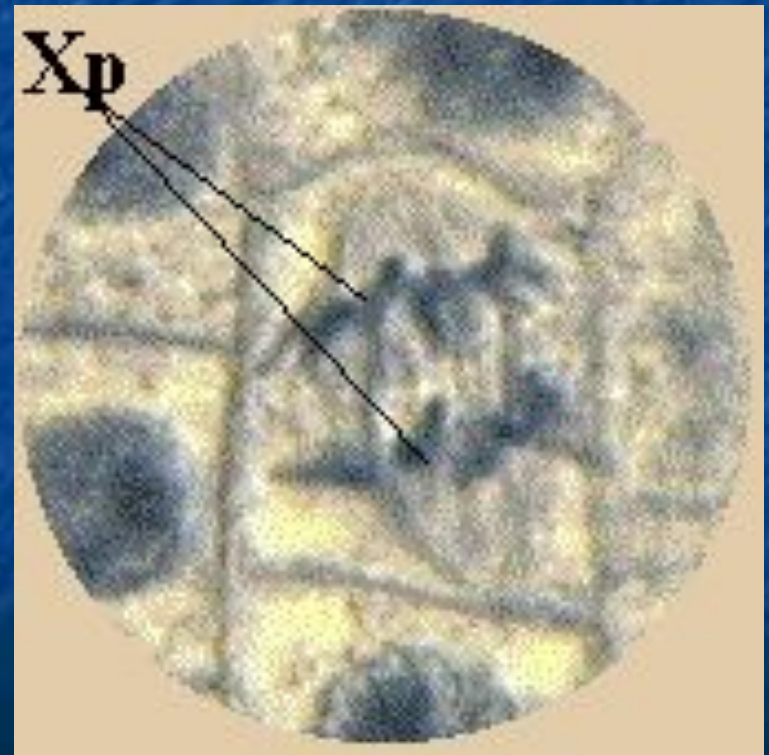
- - chromosomes move to a position midway between the two centrioles (the equator of the cell) and form the equatorial plate





# *Anaphase*

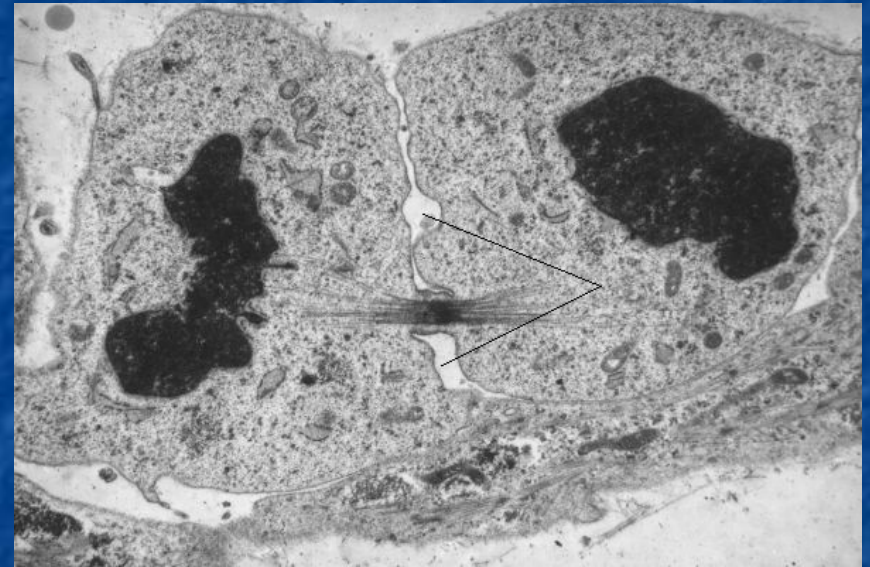
- - the chromatids separate and move to opposite poles of the cell
- At the end of anaphase chromatids are called chromosomes.





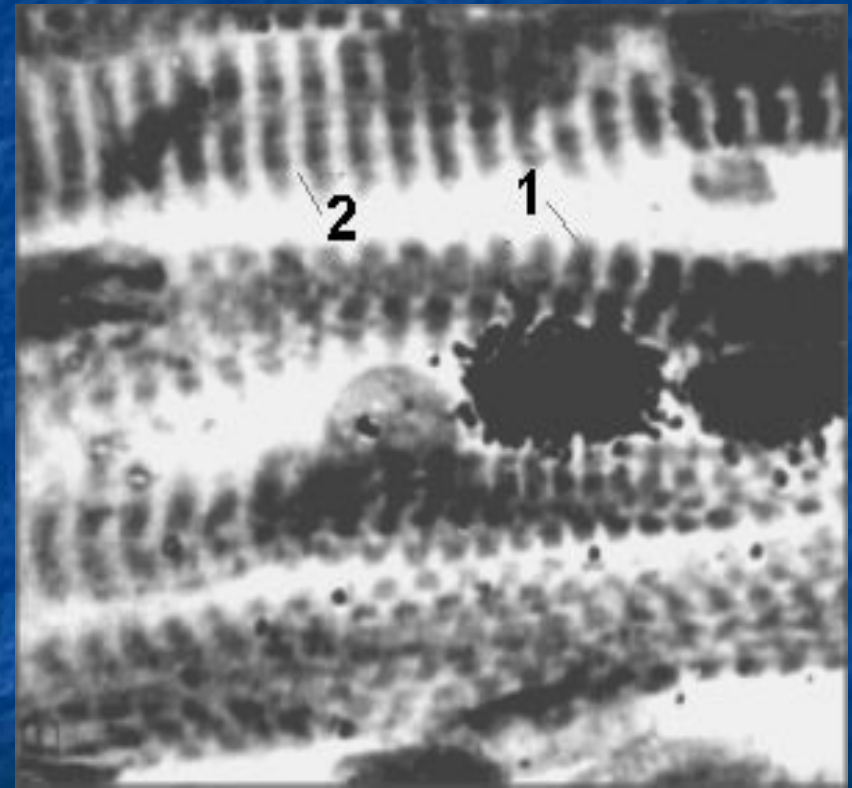
# *Telophase*

- two daughter nuclei are formed
- chromosomes become indistinct.
- Nucleoli reappear.



# Another methods:

- Polarized microscopy  
(*property of tissues:  
can rotate the angle  
of the plan of  
polarized light*)
- Faso-contrast  
microscopy



# Gap junction

- Consists of six connexin proteins, interacting to form a cylinder with a pore in the centre - connexon.
- This protrudes across the cell membrane, and when two adjacent cell connexons interact, they form the gap junction

