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.

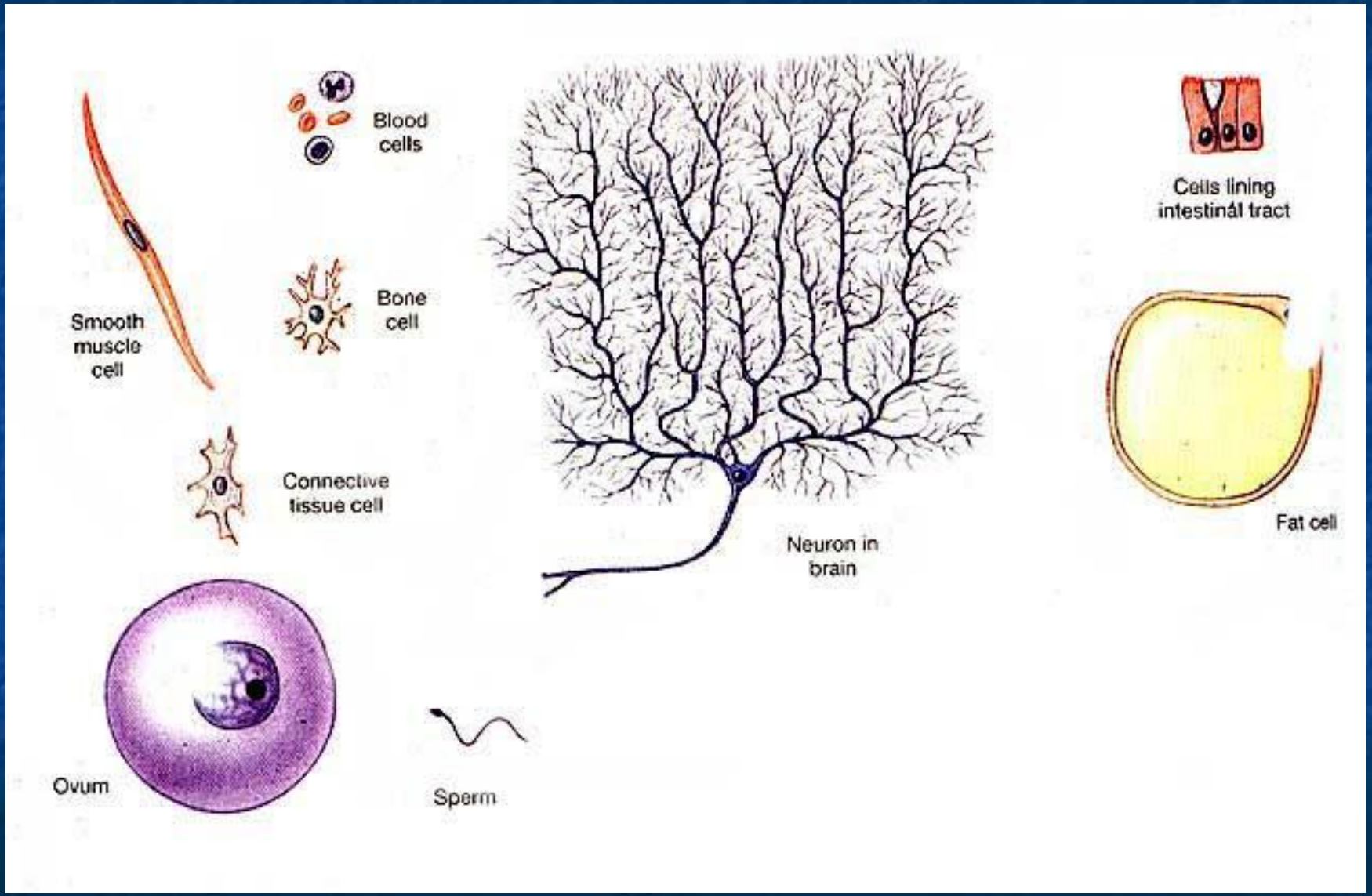
Embryology researches embryonic development (formation) of the body

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

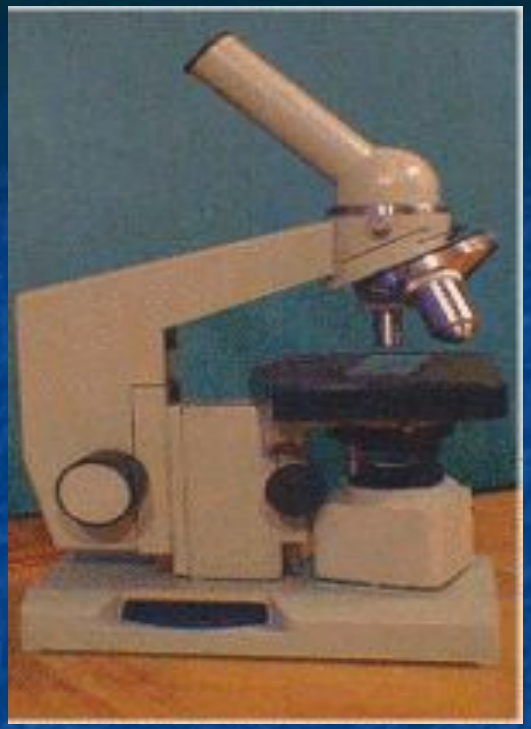


Cells produce matrix

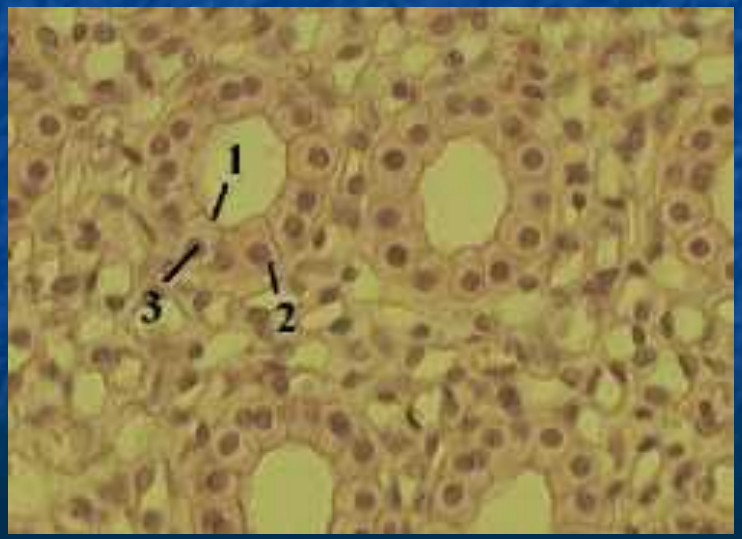
Methods of investigation

Microscopy – basic method

- Light microscope:



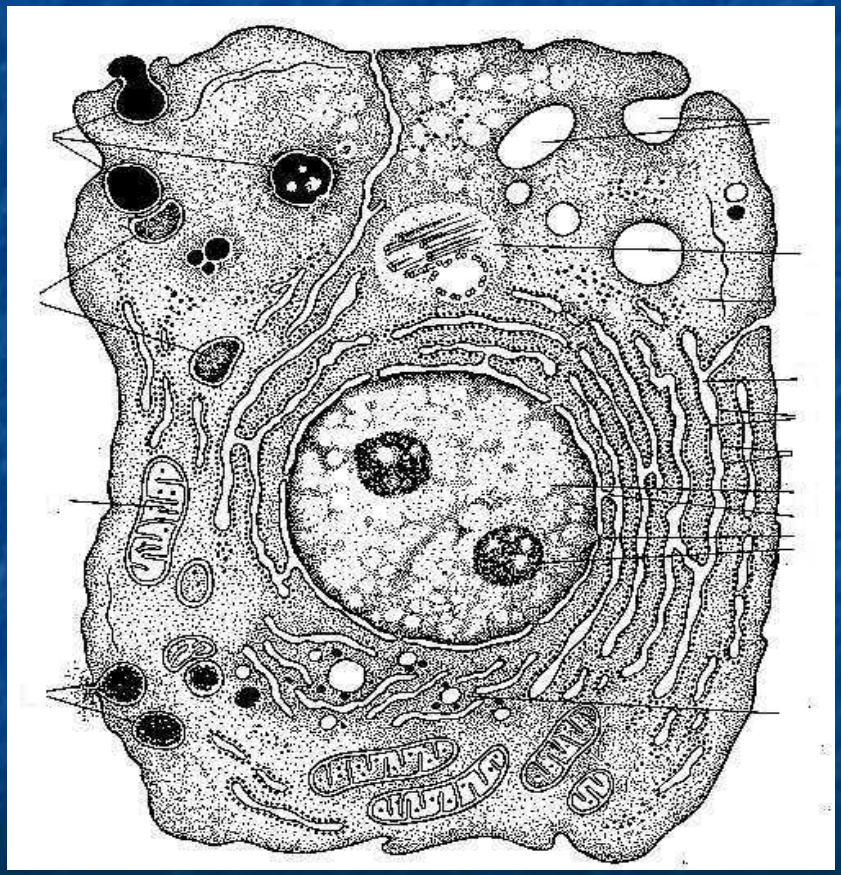
- Histological slide:



Electron microscopy

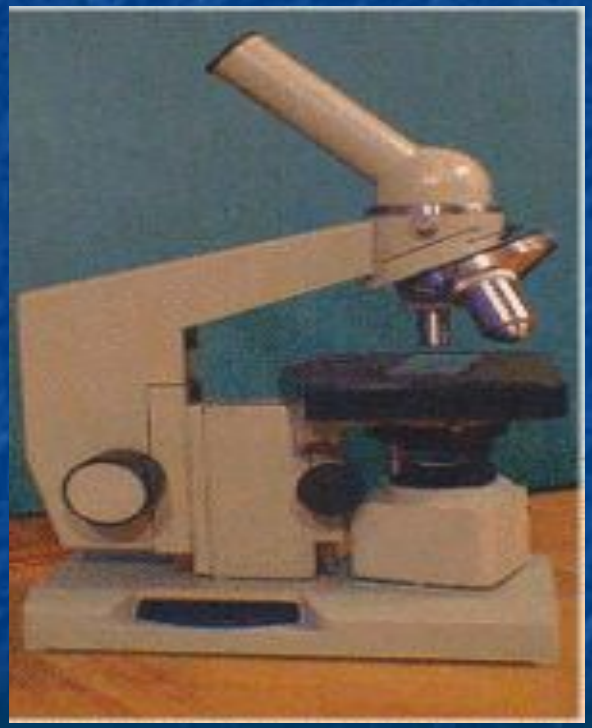
Electron microscopy researches

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



Light and electron microscopy -

are 2 mane methods in histology



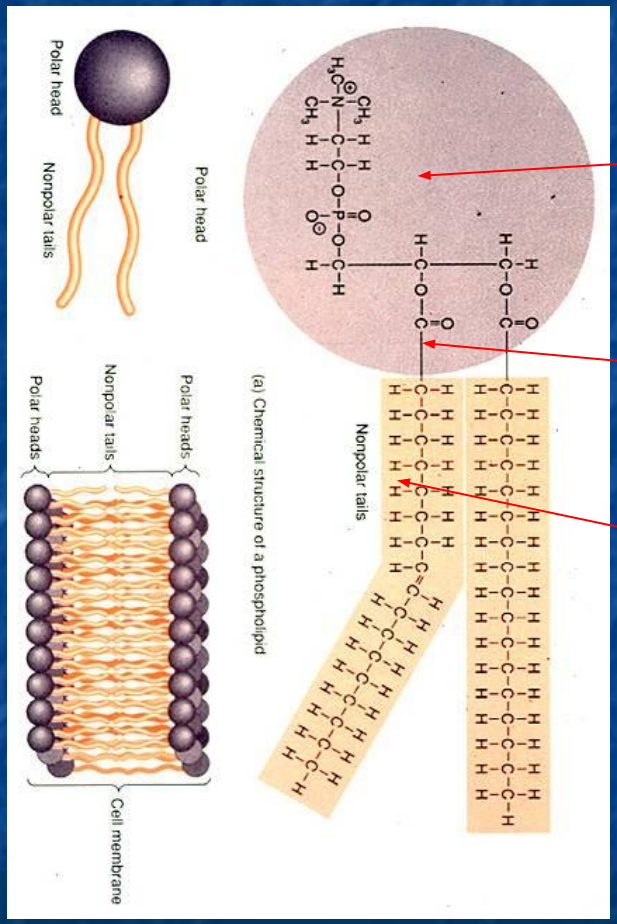
Levels of biological systems

- Biomolecules

- Membranes → Organelles

- CELL

Phospholipids structure :

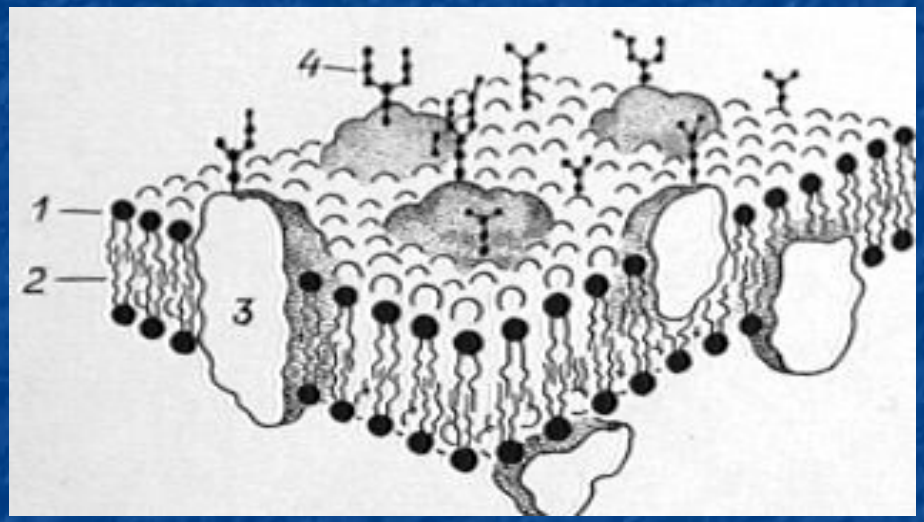


Phosphate group (hydrophilic heads)

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

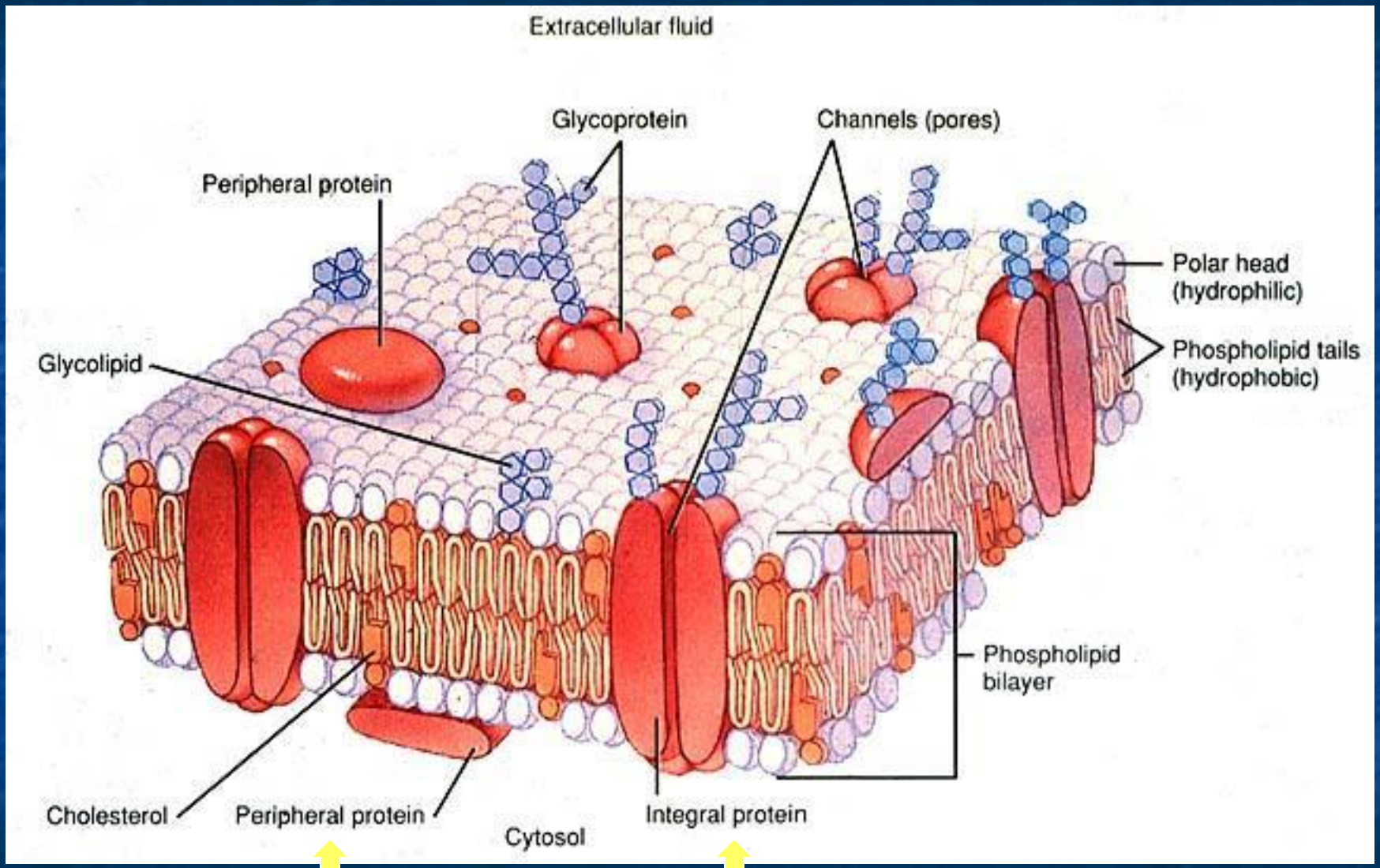
Proteins function:

- 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

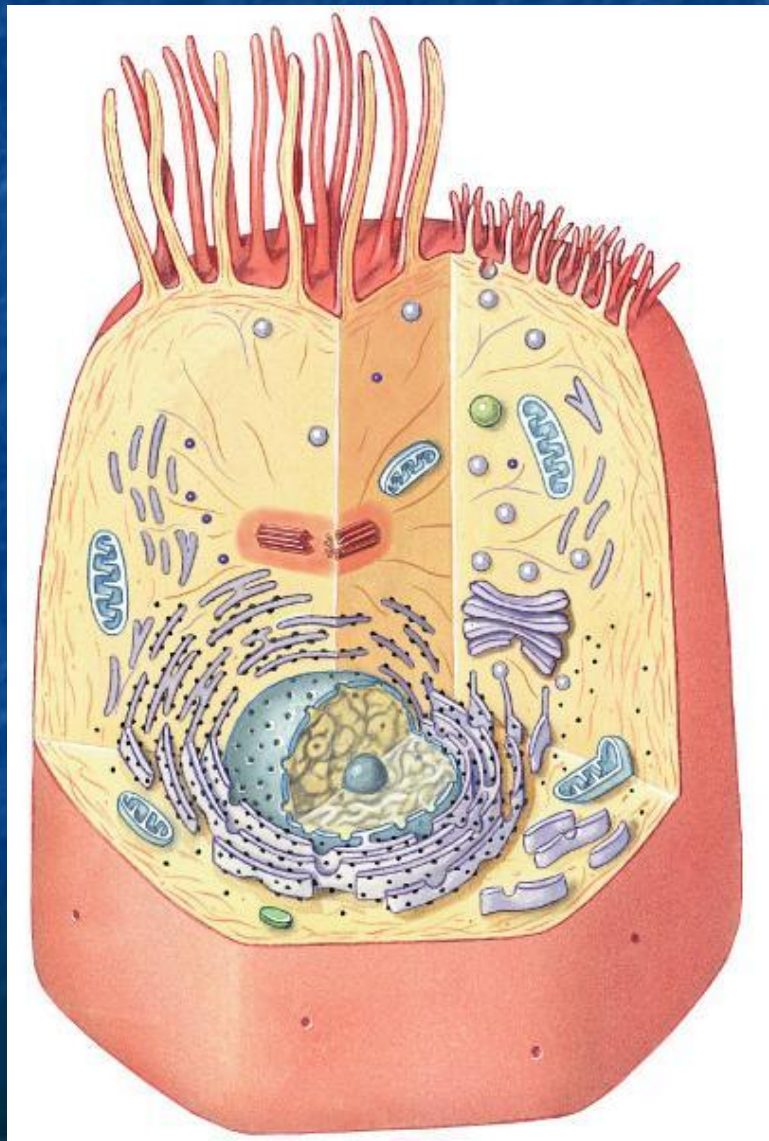


Membranes form:

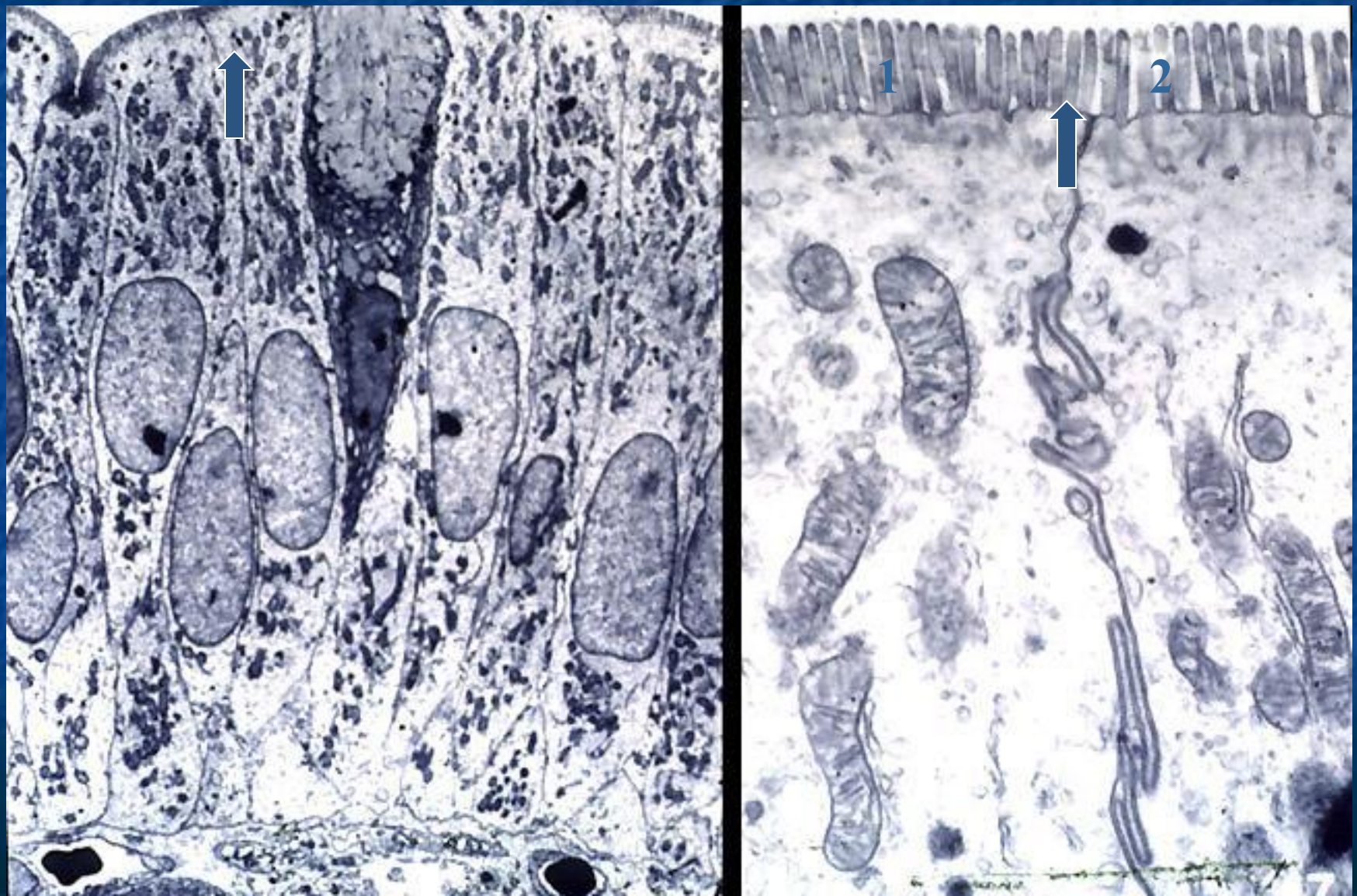
- Outer cell membrane
- Organelles
- Vesicles
- Nuclear envelop

Cell consists of:

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

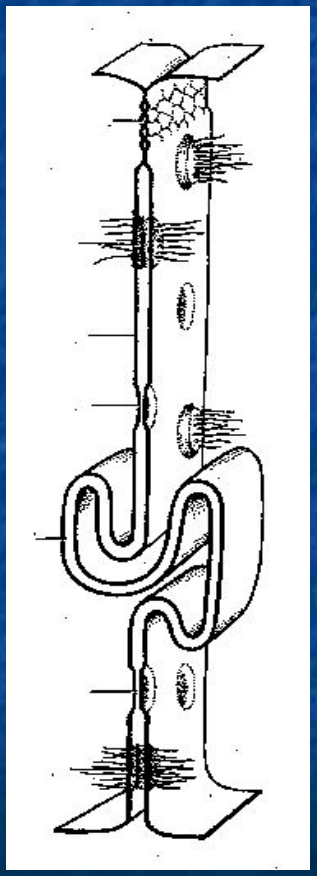


If cells contact, outer cell membrane forms junctions



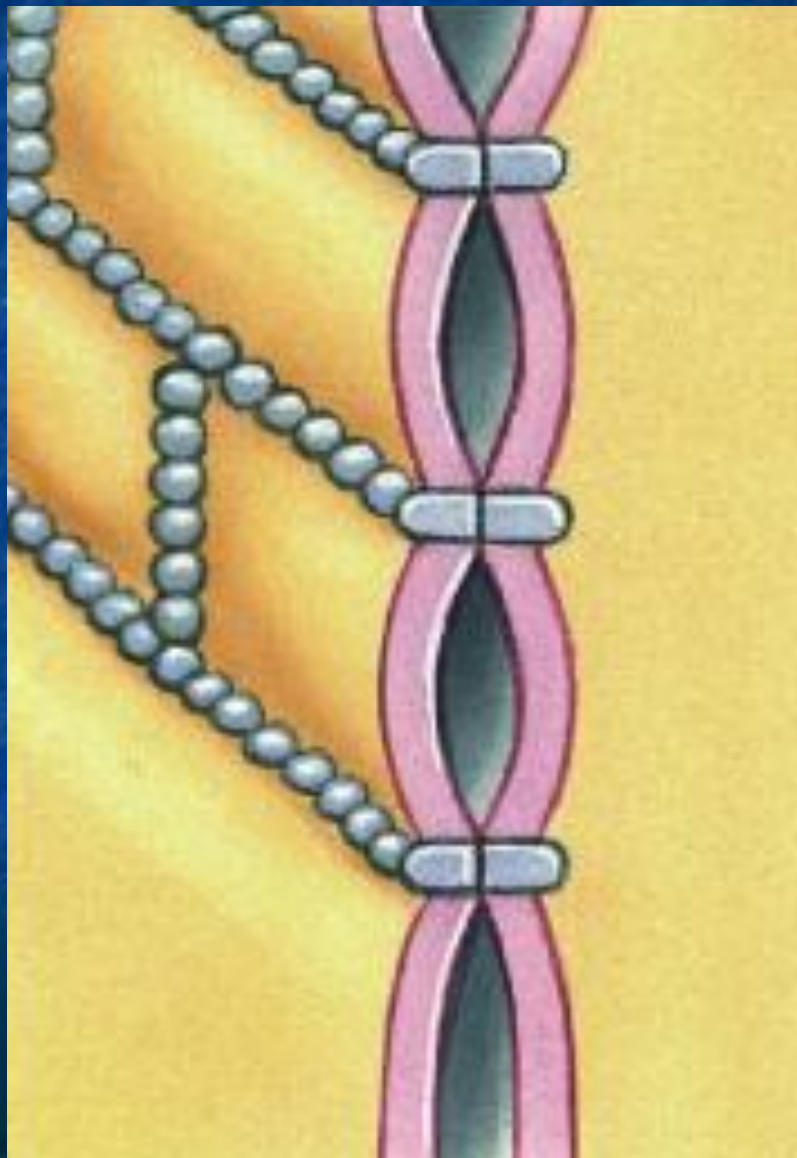
Types of Cell junction

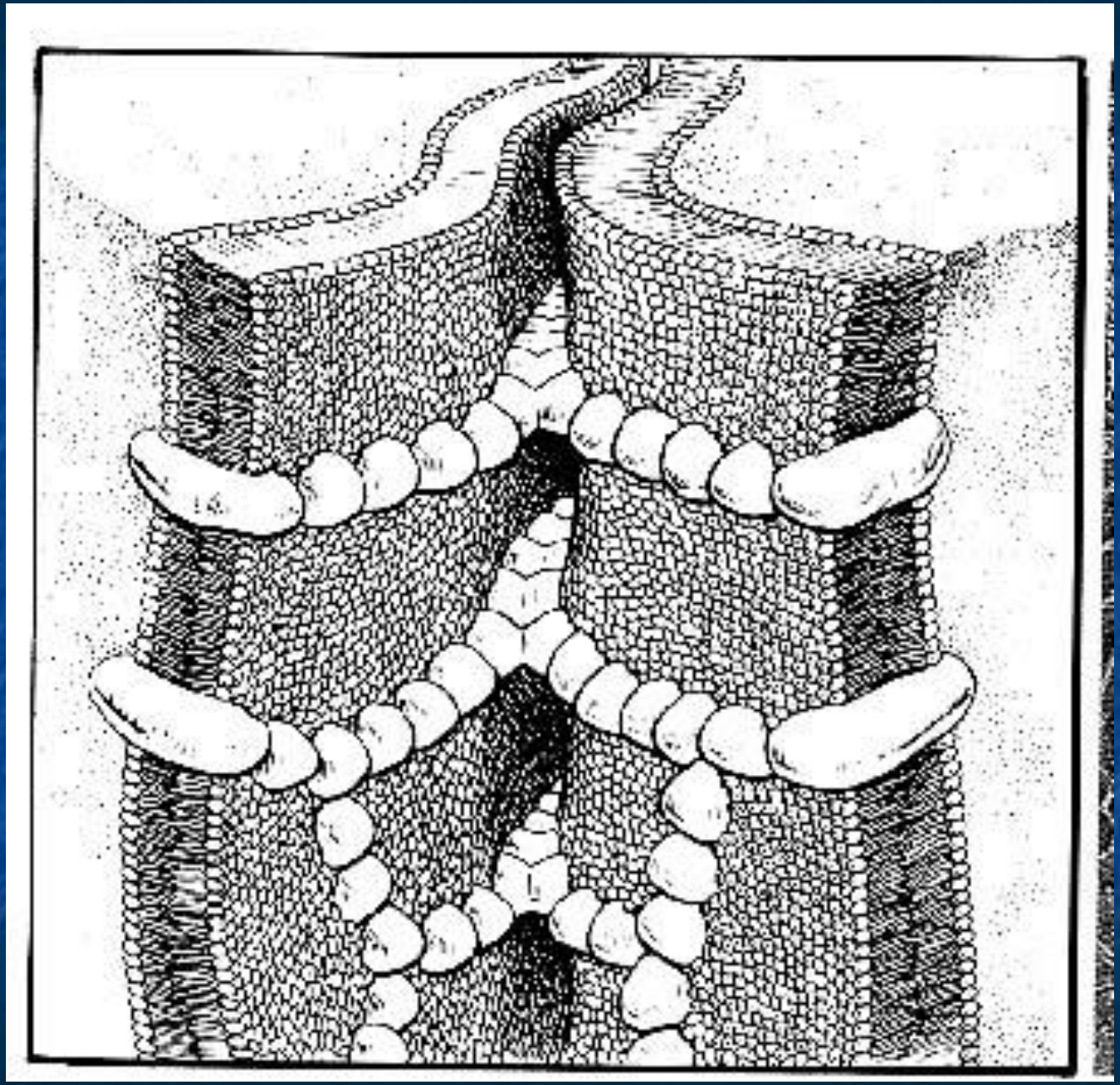
- Tight junction
- Gap junction
- Desmosomes



Tight junction

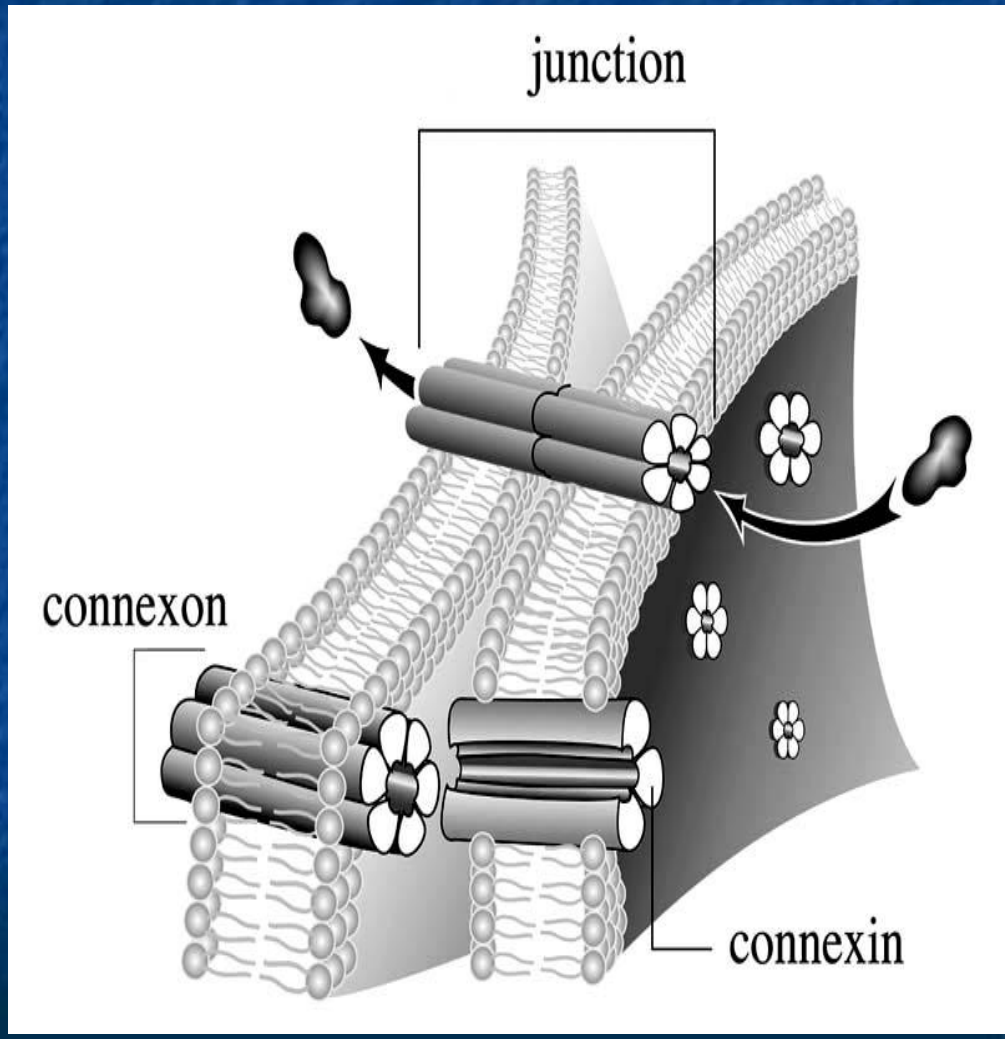
- prevents the movement of molecules into the intercellular spaces
- present between epithelial cells





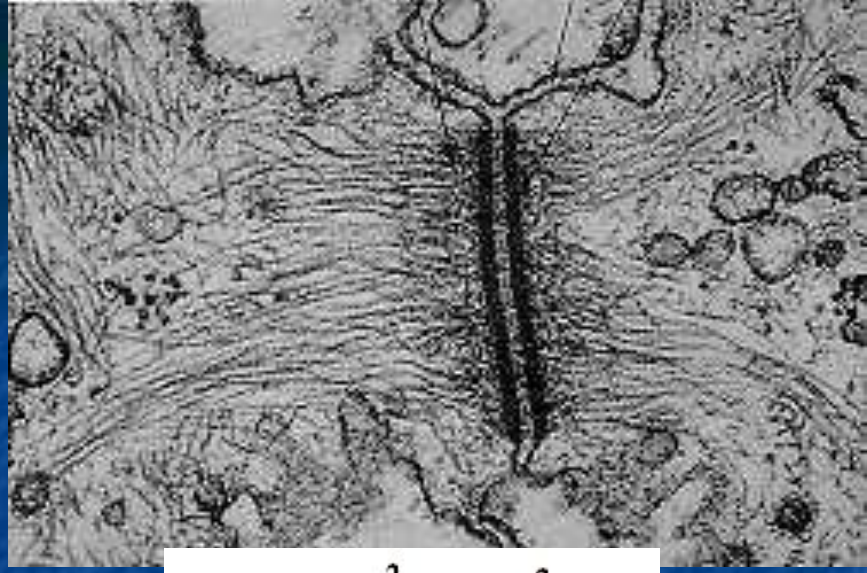
Gap junction

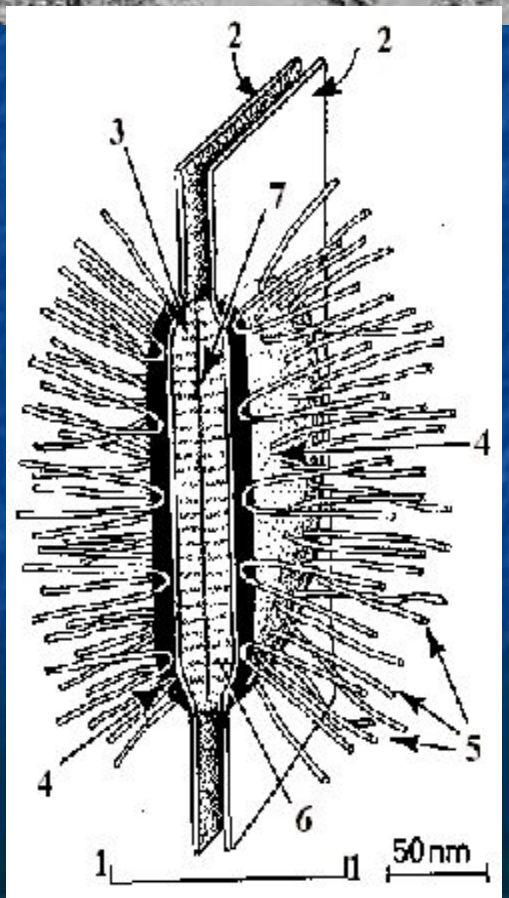
- channels between cells



Desmosomes -

- Provide cell attachment





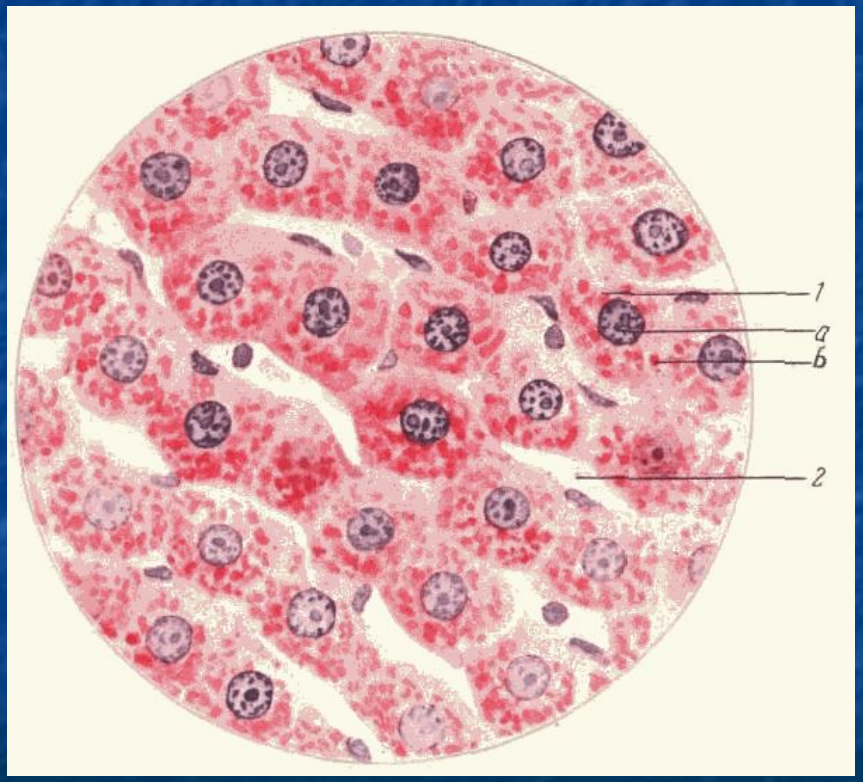
Inside the cell …

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

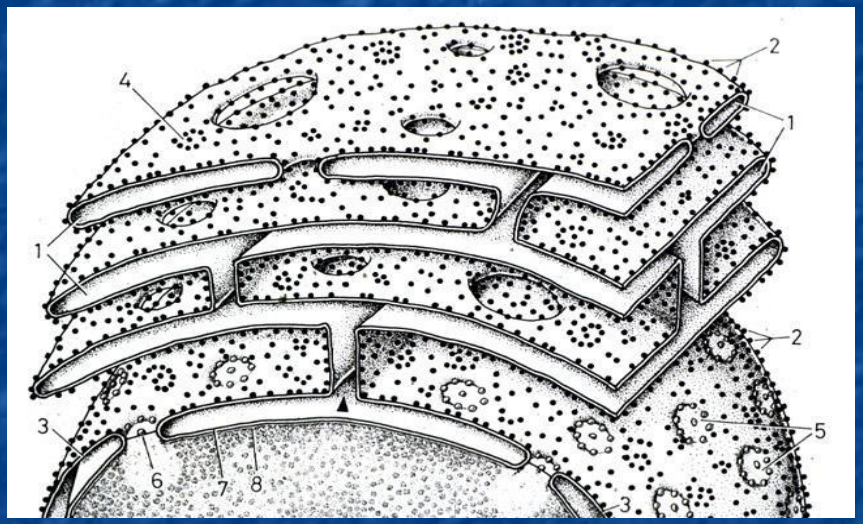
- Special

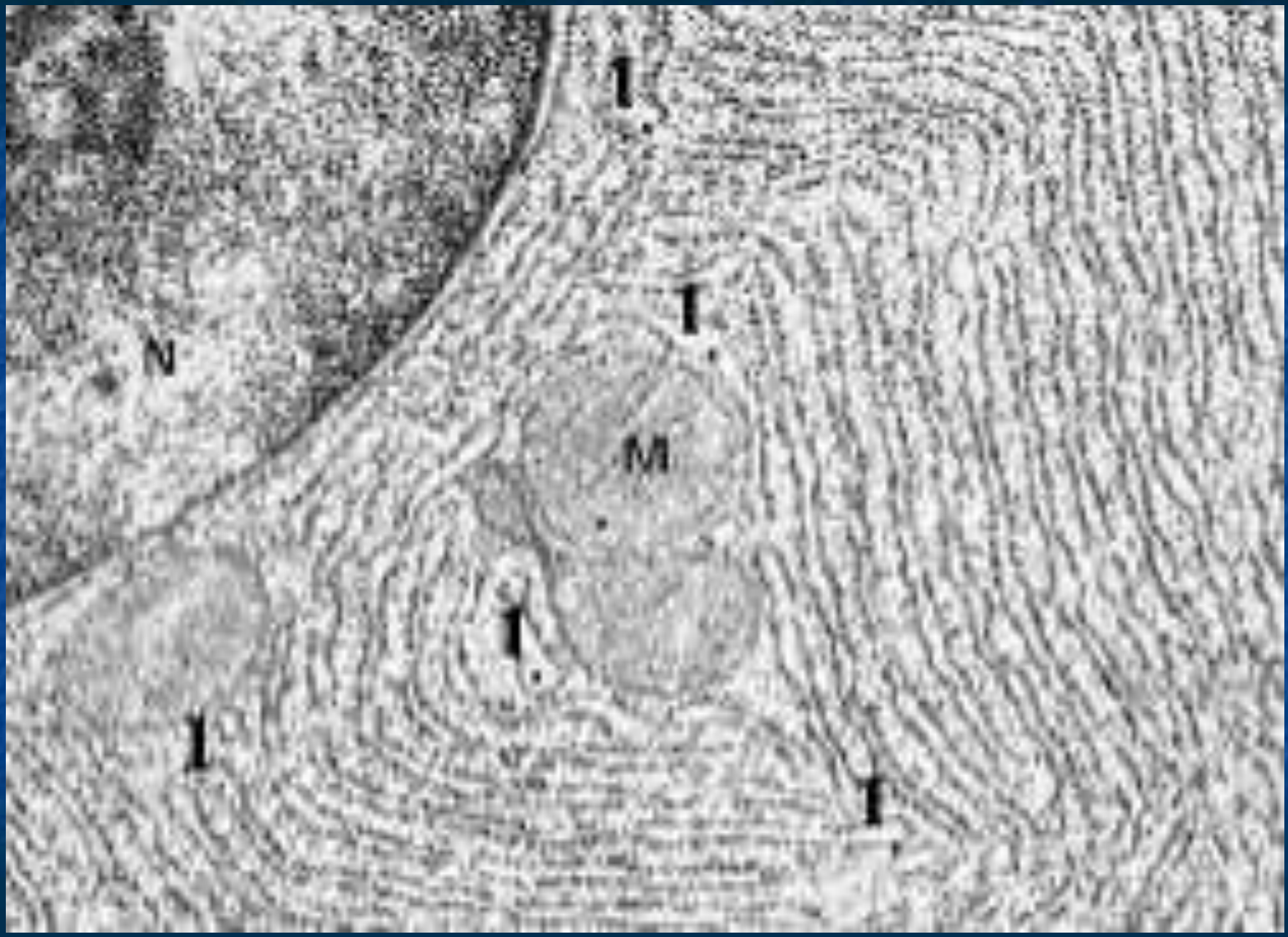
(in specialised cell, perform special function)

- = Myofibril

Rough endoplasmic reticulum

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

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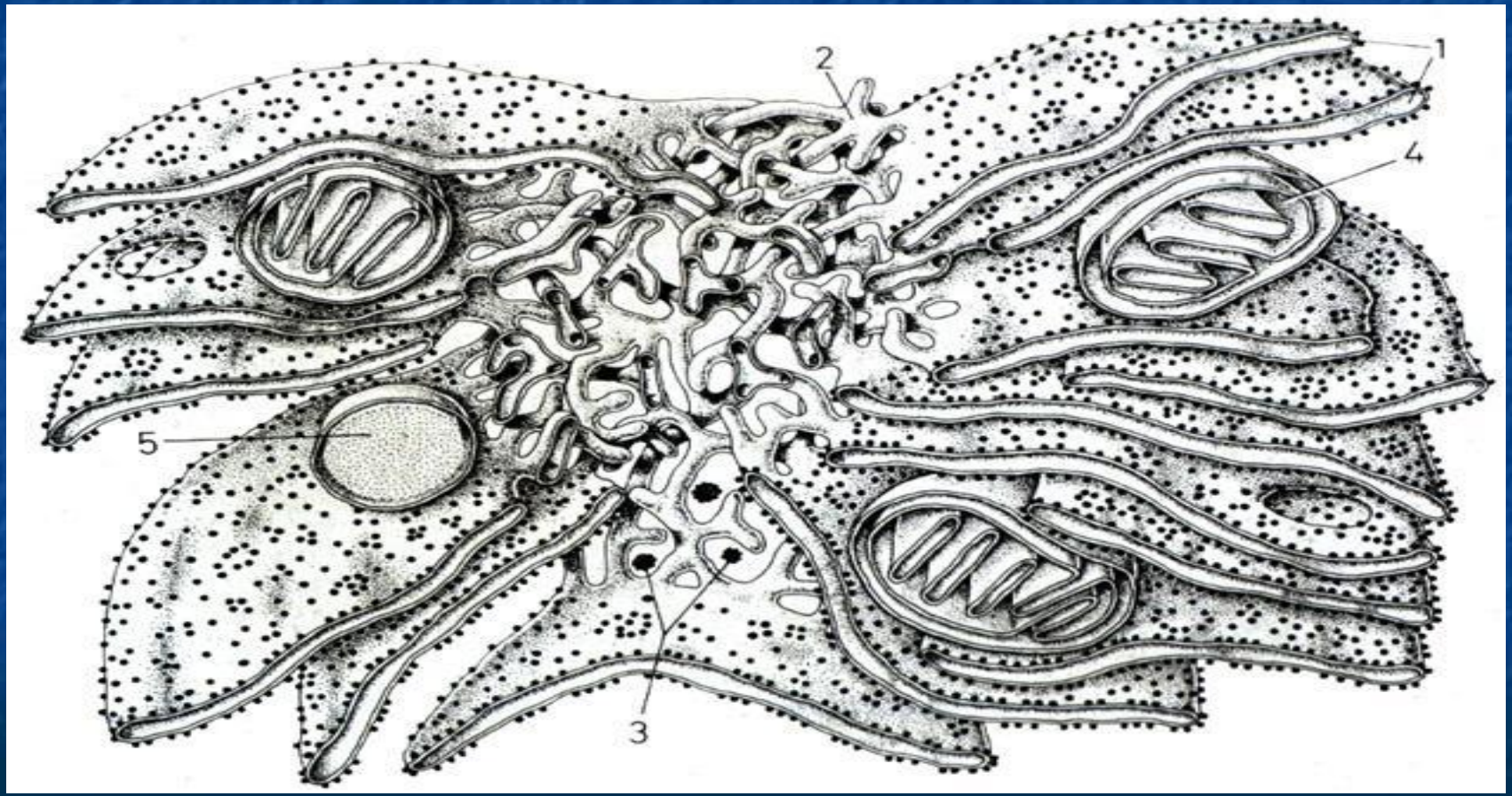
Smooth endoplasmic reticulum, SER



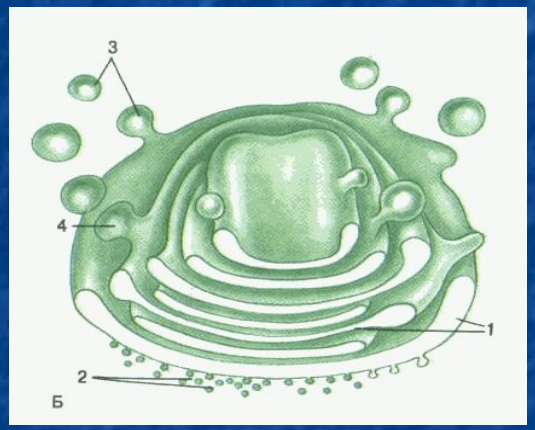
- SER structure: membranes form tubules without ribosomes.

Function:

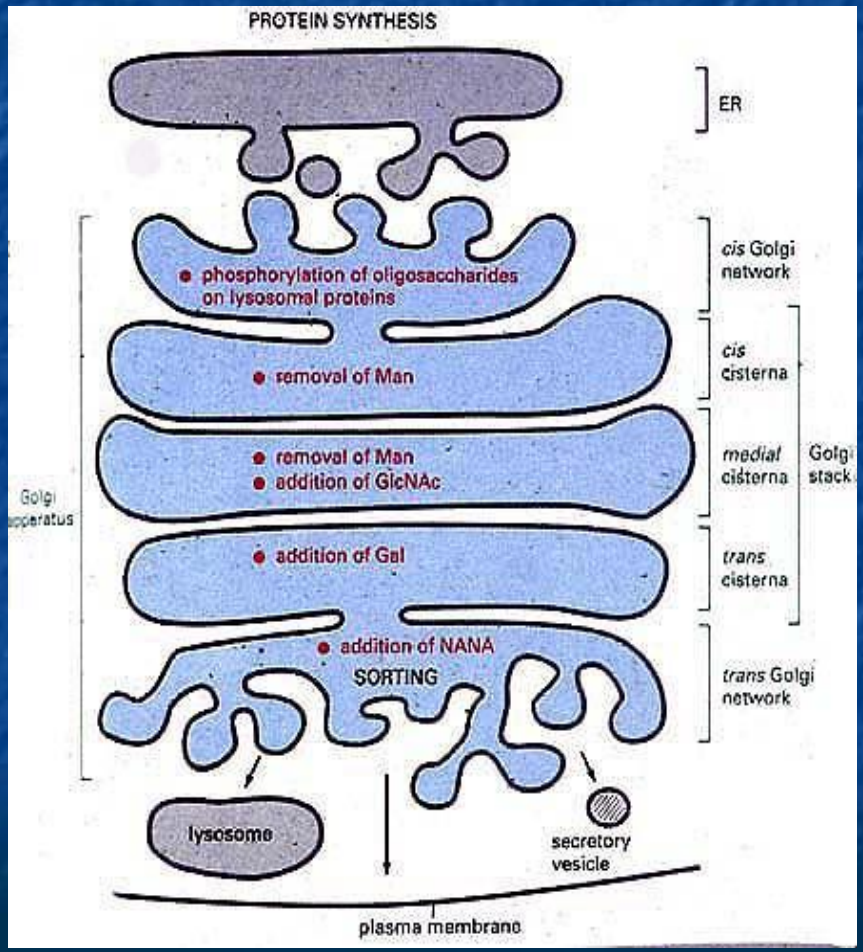
- 1. synthesizis of lipids.
- 2. metabolism of carbohydrates
- 3. drug detoxification (in liver cells).
- 4 storage of Ca-ions (only in muscle cell)

Golgi complex (or apparatus)

- = a pack of sacs.

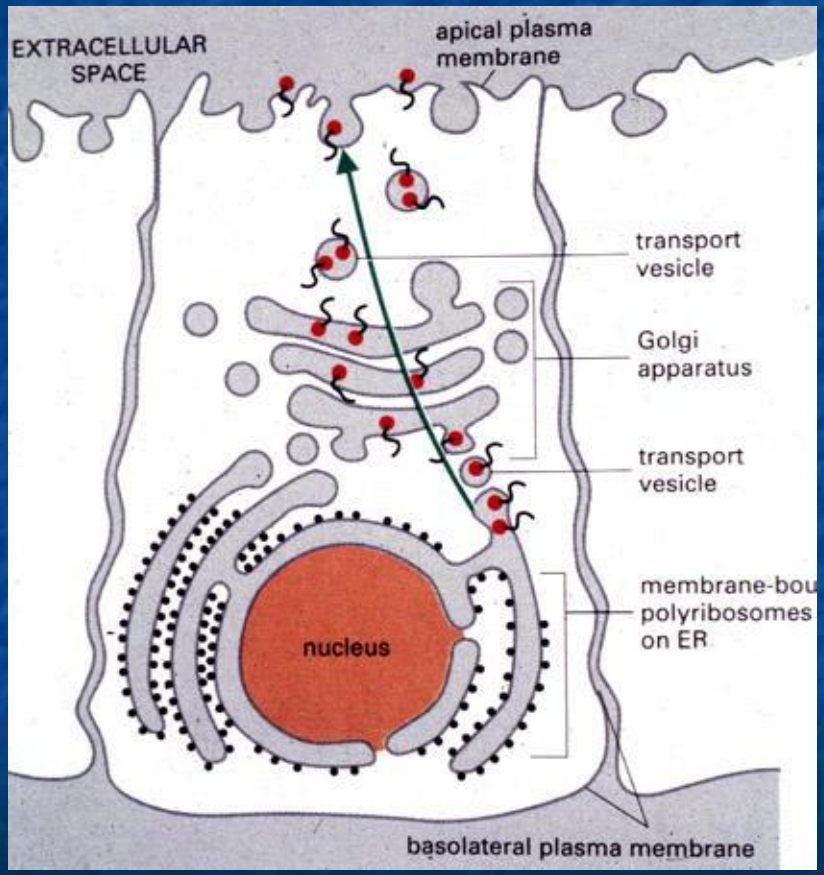


Golgi complex ...



- … is connected with endoplasmic reticulum

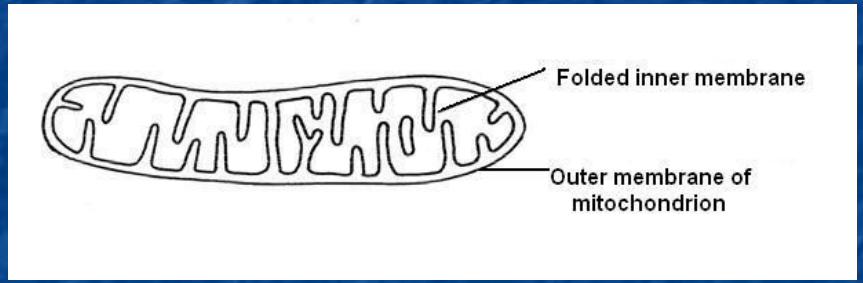
Golgi apparatus functions:



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

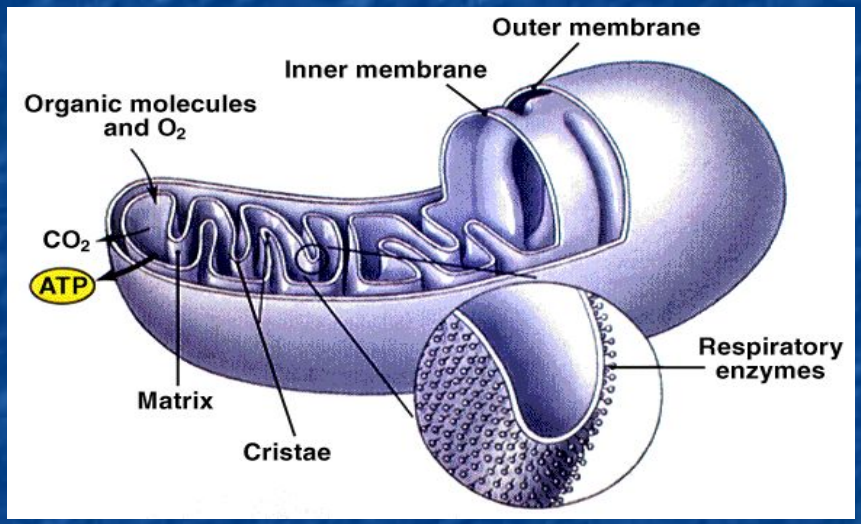
Mitochondrion

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

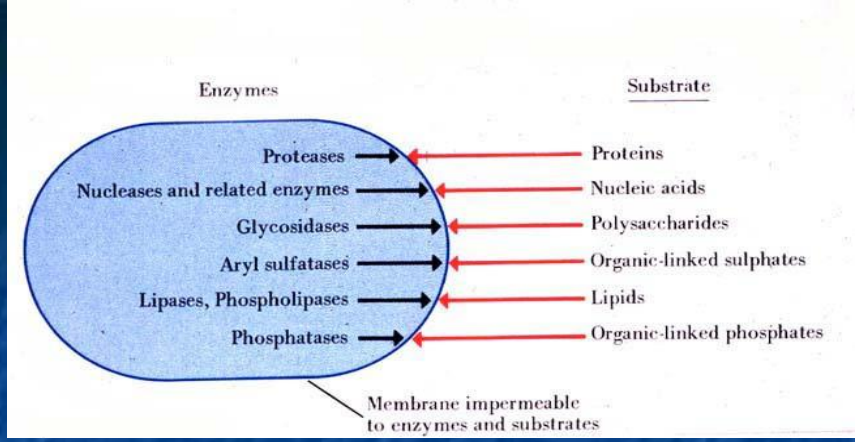


Mitochondrion

- Produce ATP molecules (energy) by Krebs cycle



Lysosome



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

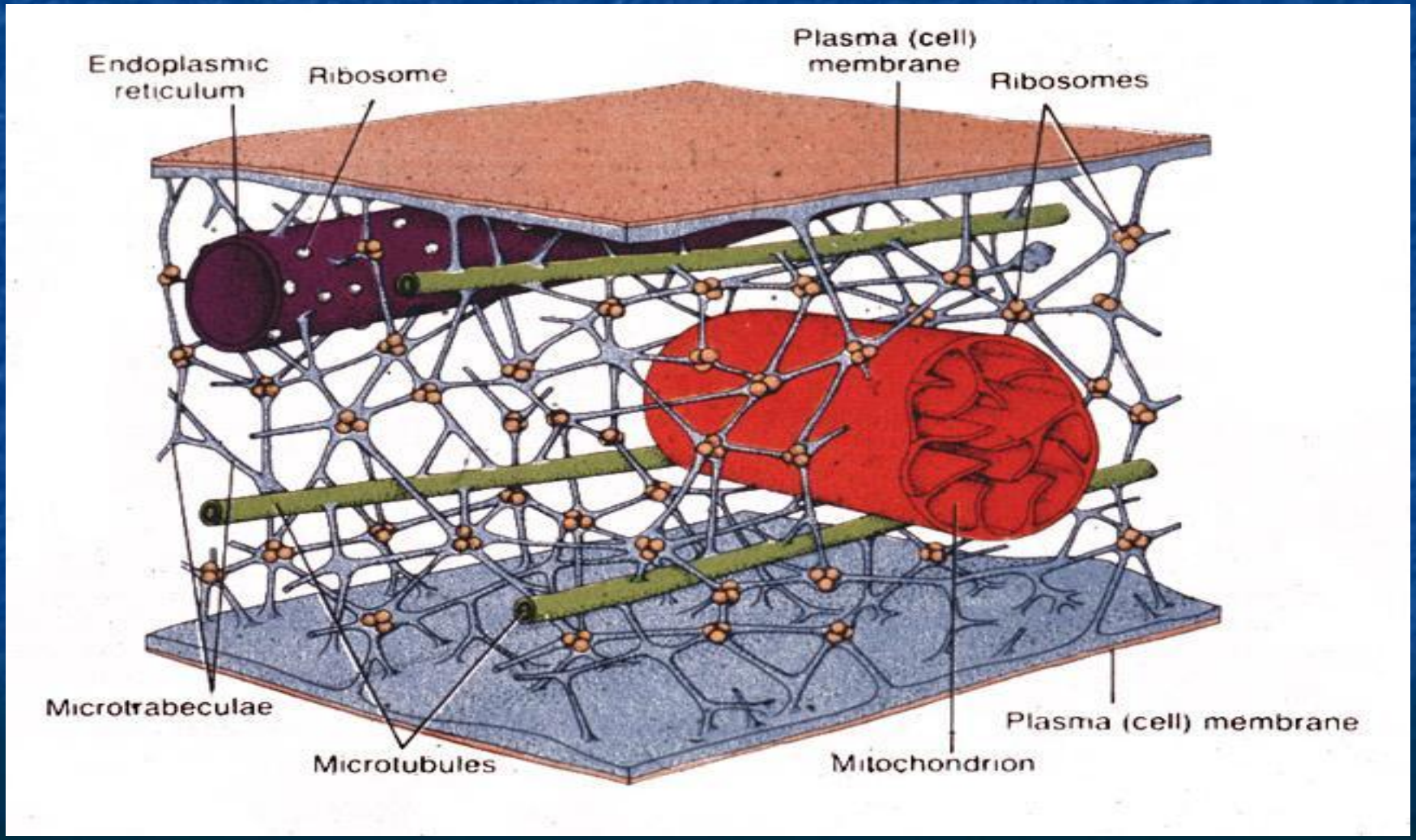
Non-membranous organelles:

- Microfilaments
- Microtubules
- Centrioles (Cell Center)

- **Ribosomes**

Note:

Microfilaments, Microtubules form "Skeleton" of the cell

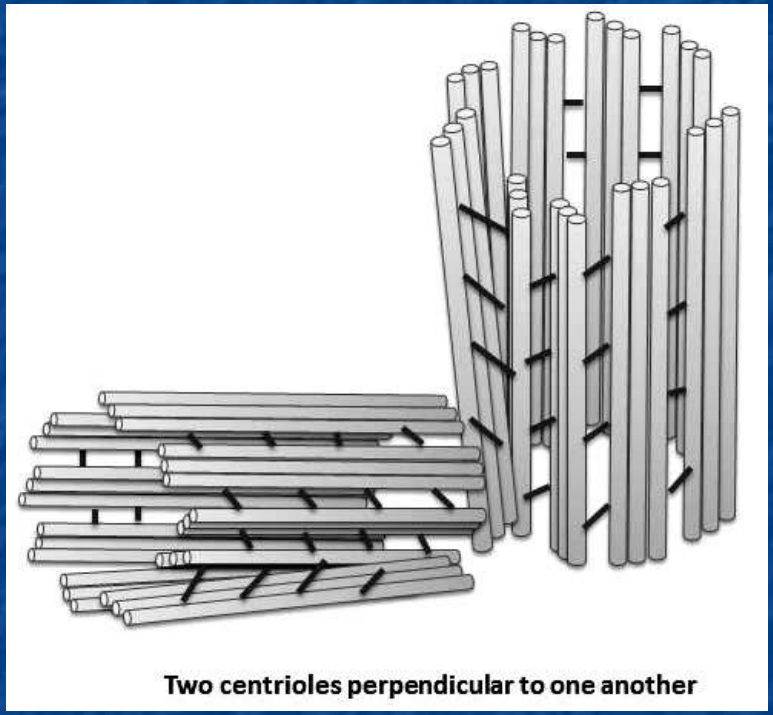


Cell center

Consists of 2 centrioles

Centriole = 9 x 3 = 27 microtubules;

Function - formation of mitotic spindle

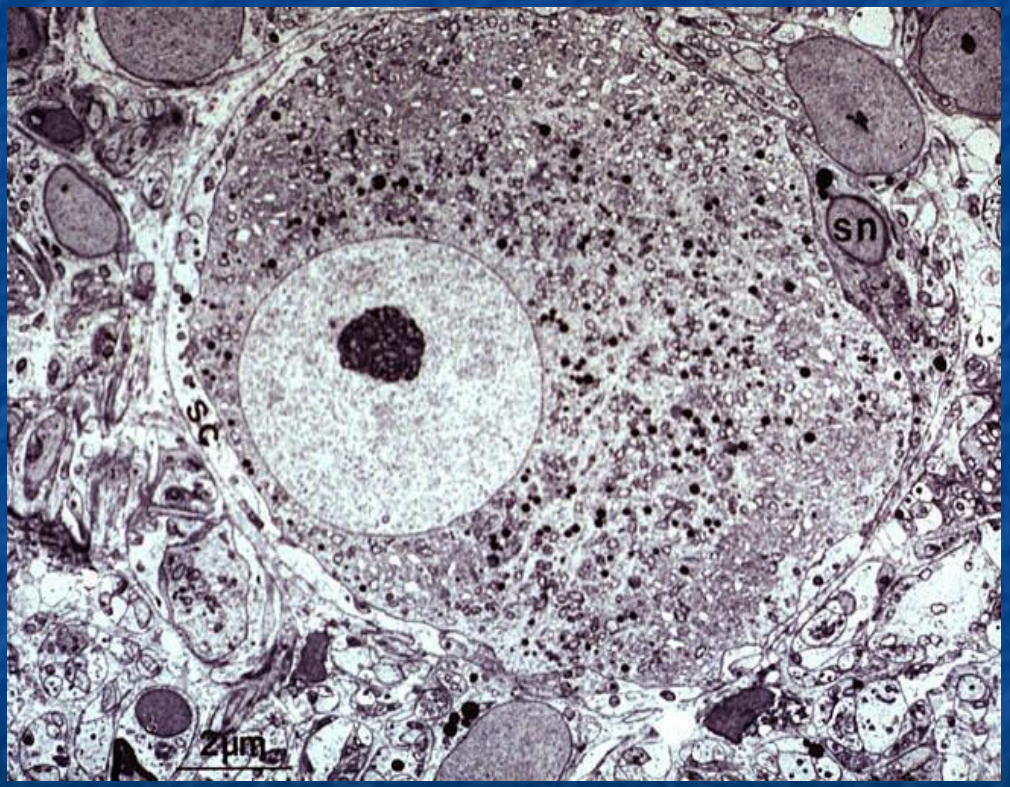


Two centrioles perpendicular to one another

Nucleus

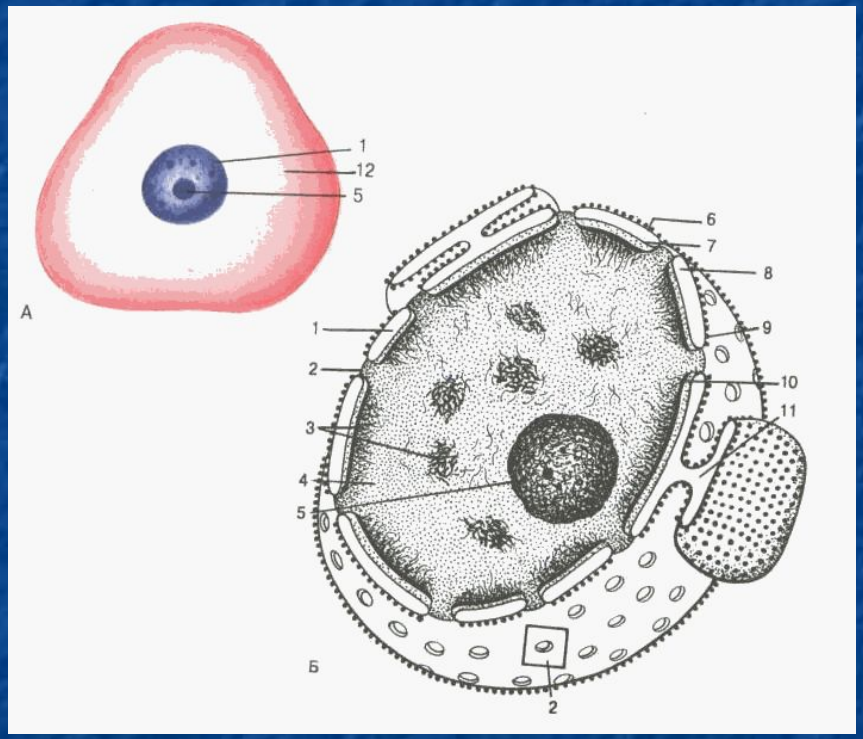
consists of:

- Nucleolemma = nuclear envelope
- Nucleoplasm
- Nucleolus
- Chromatin



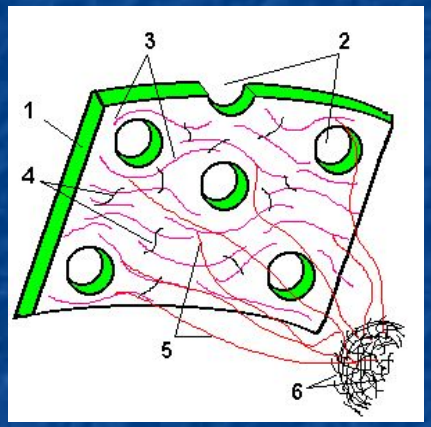
Nuclear envelope

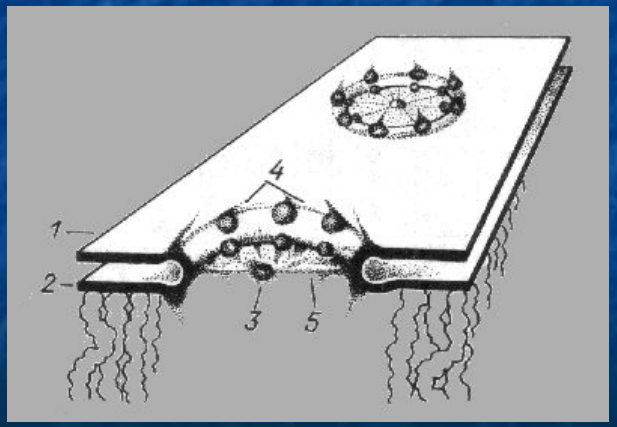
- - Consists of two membranes:
- outer and inner

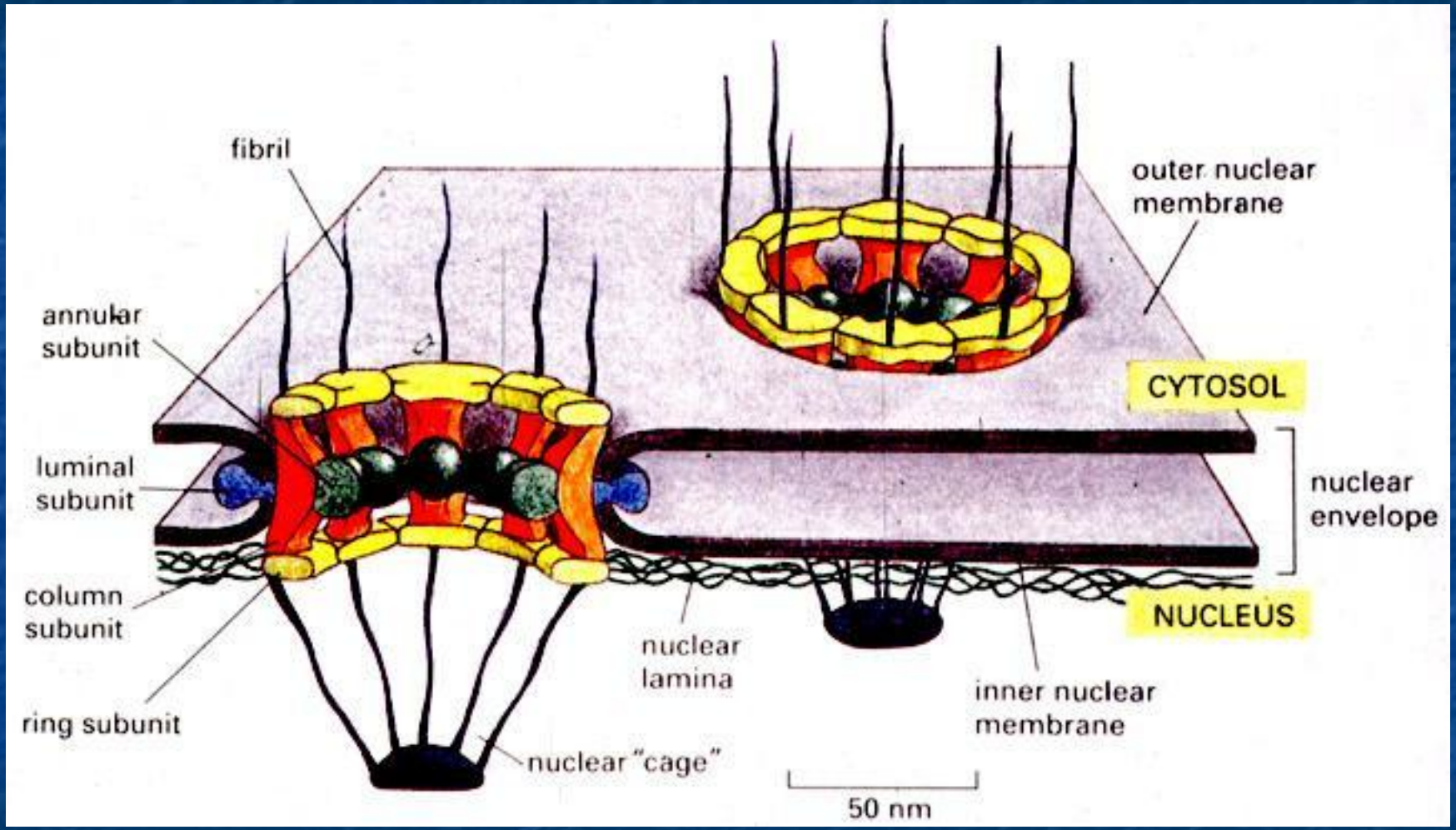


In the nuclear envelope

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



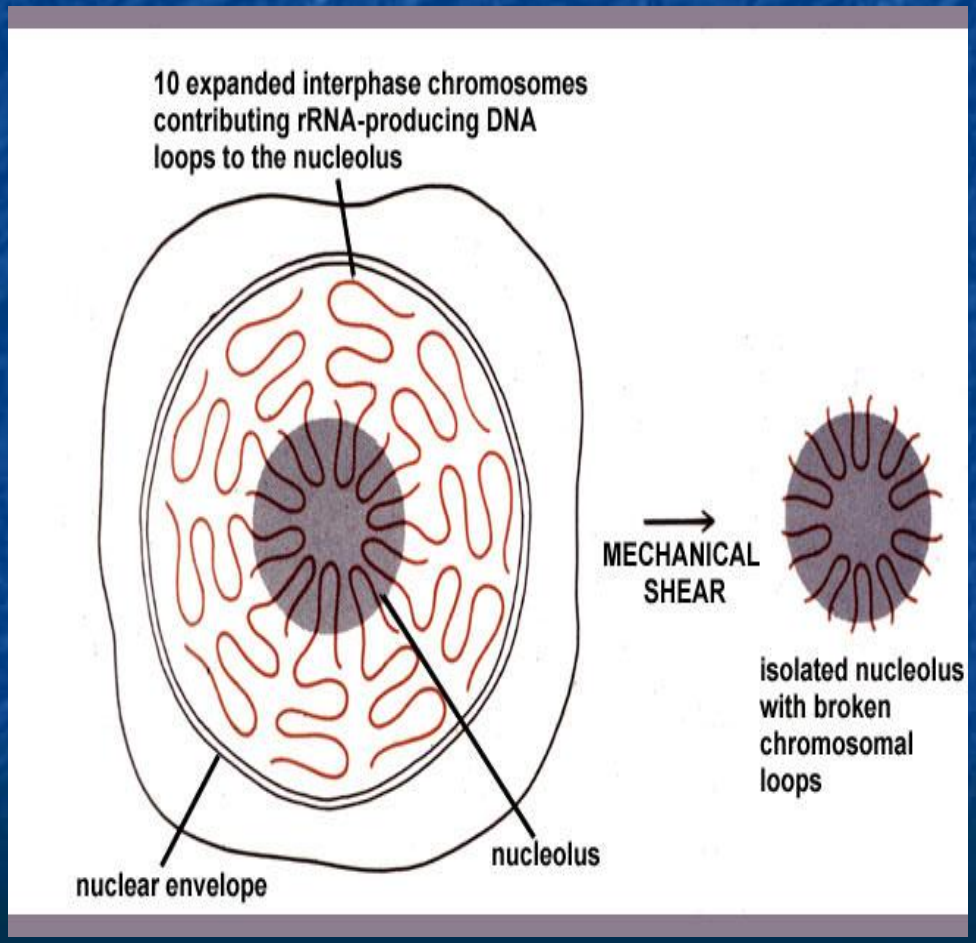




Nuclear pore structure

Nucleolus

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

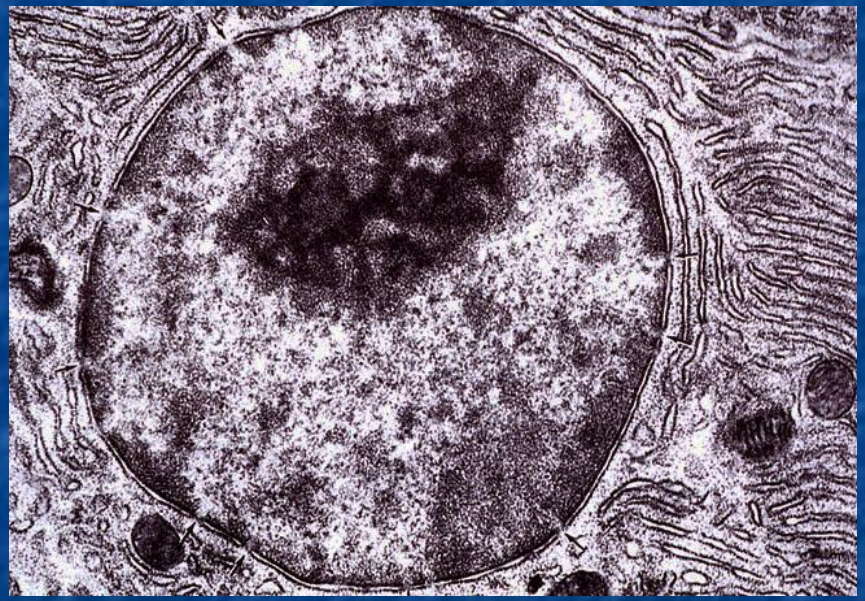


Chromatin

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

Chromatin = DNA in non-dividing cells.

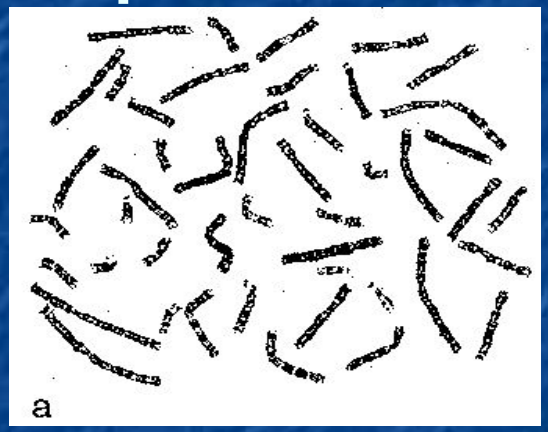
- 2 types:
- 1. *heterochromatin* (non-active) - very tightly packed fibrils .
- 2.*euchromatin* - active – less condensed chromatin fibrils loops

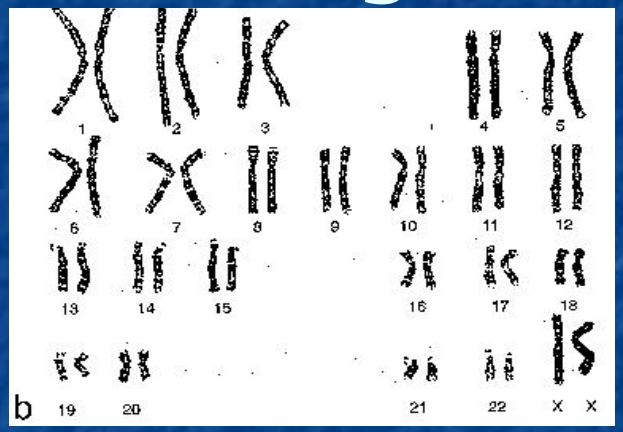


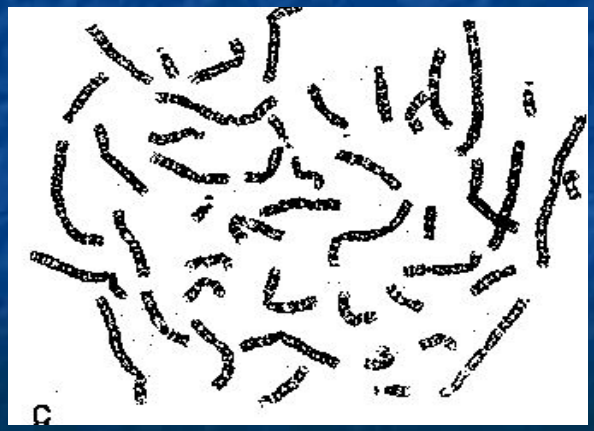
- Euchromatin predominates in metabolically active nuclei,
-
- *Heterochromatin* predominates in metabolically inactive nuclei

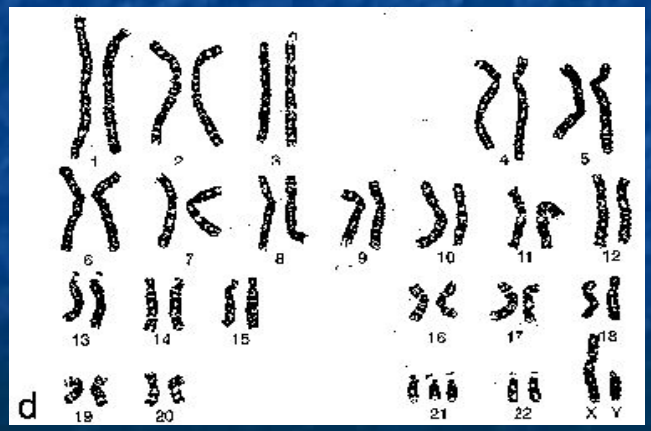
Chromosome

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









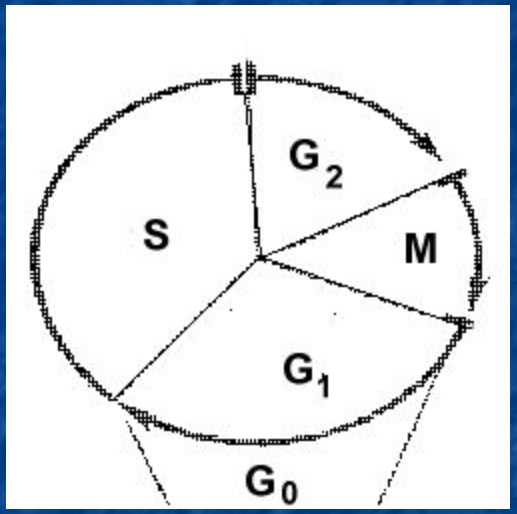
Cell cycle

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

Interphase

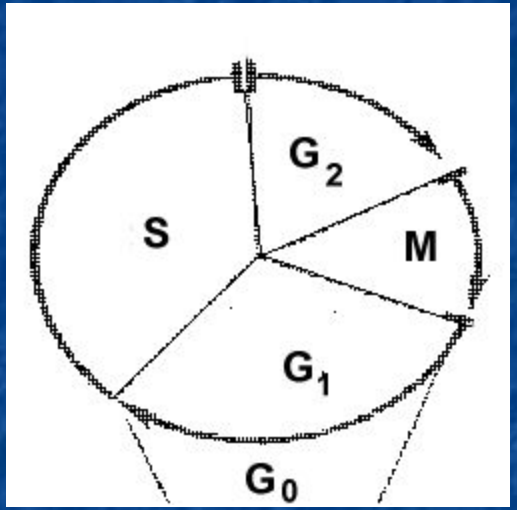
Interphase is a period between two divisions of the cell.

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*

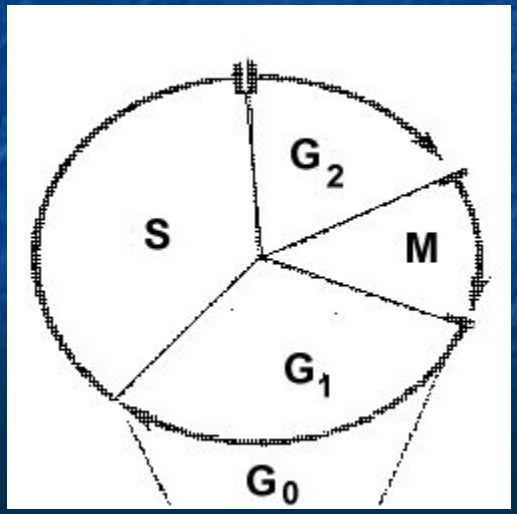
and at the end each chromosome consists of two DNA molecules or two *chromatids*, the chromosome number is *4N*.

G_2 phase

- In this phase synthesis of proteins, which are required for cell division, takes place.
- After phase G_2 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,

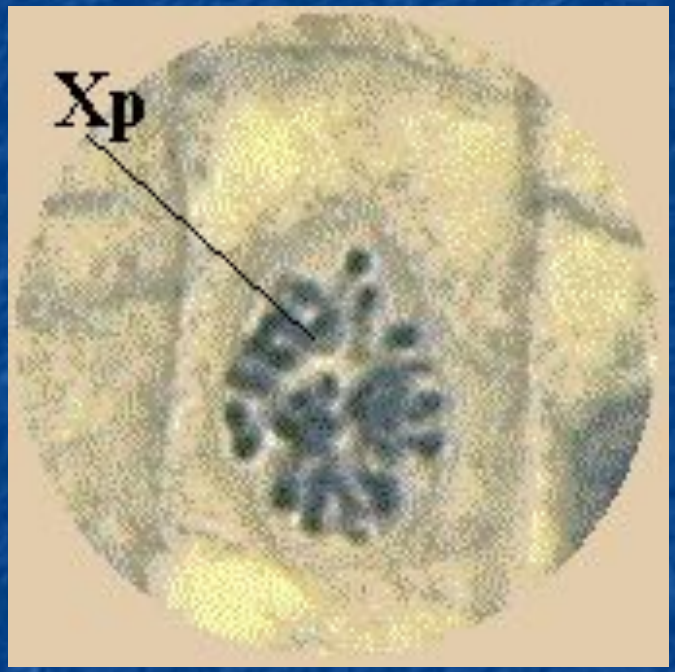
metaphase,

anaphase,

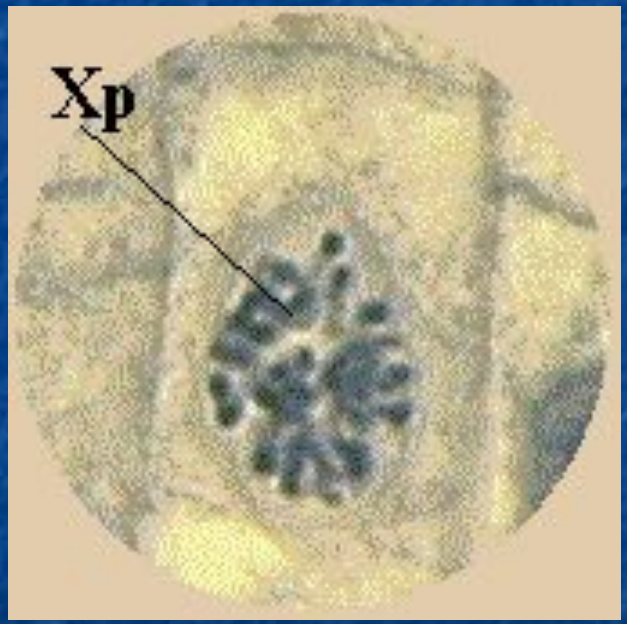
telophase.

Prophase

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

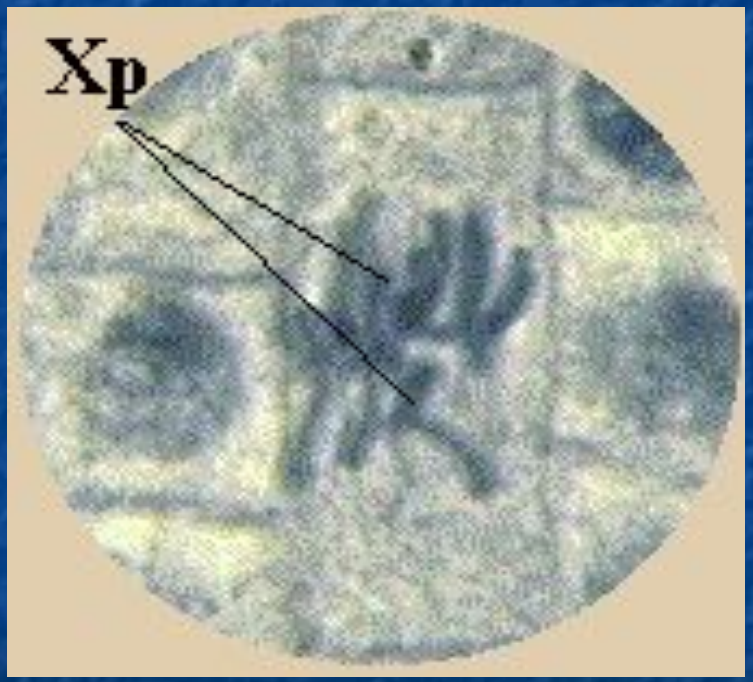


- Two centrioles separate and move to opposite poles of the cell.
- microtubules pass from one centriole to other and form ***a spindle of division***.



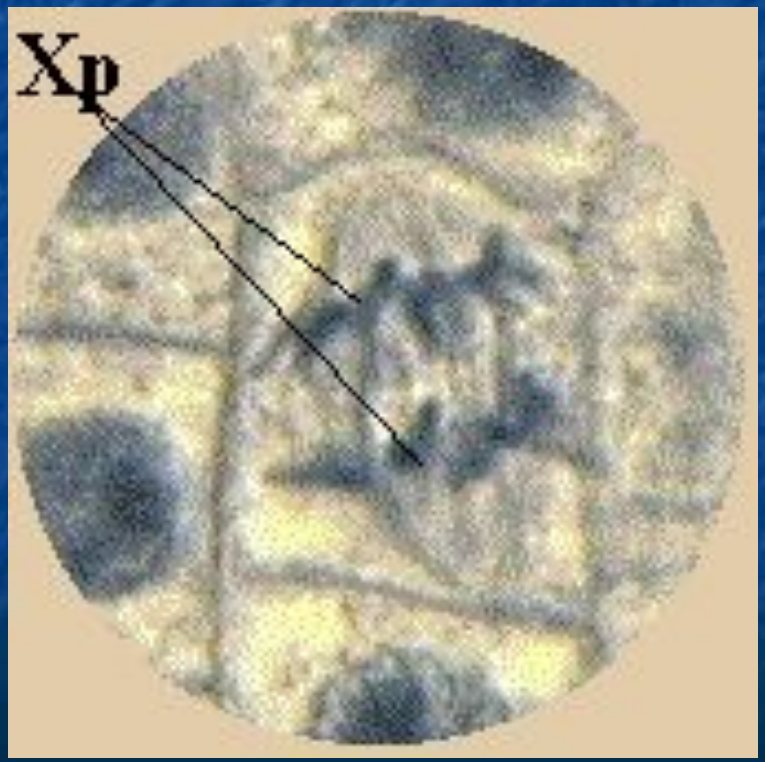
Metaphase

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



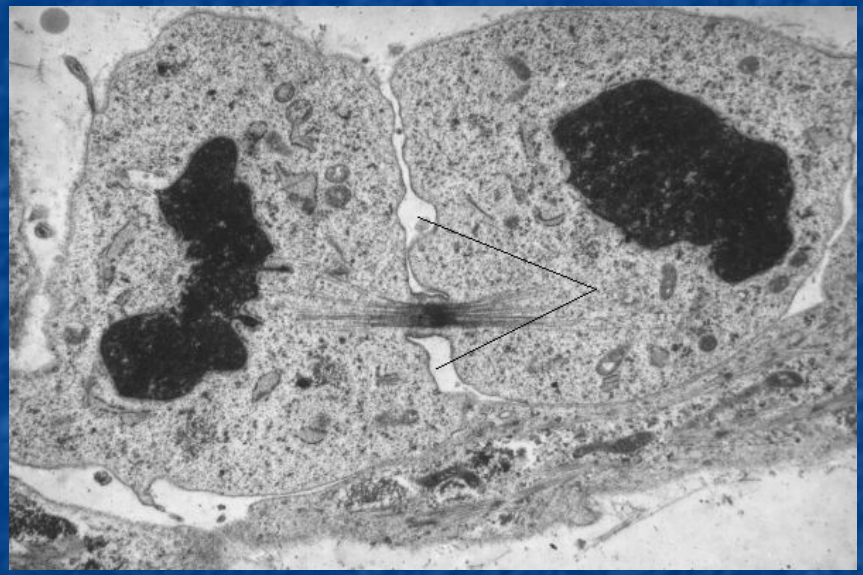
Anaphase

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



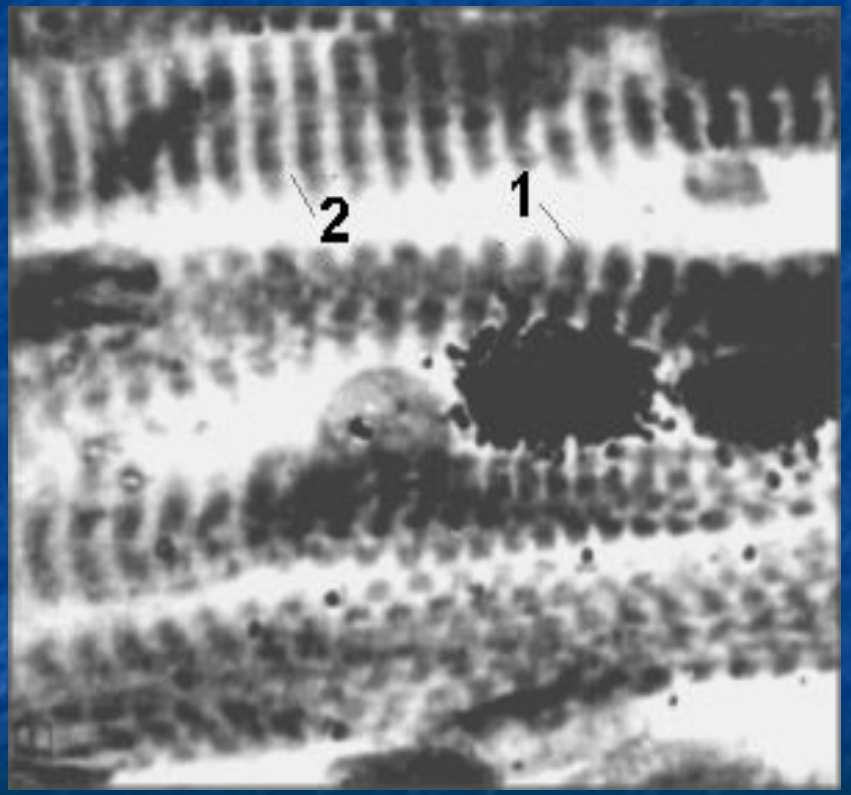
Telophase

- 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