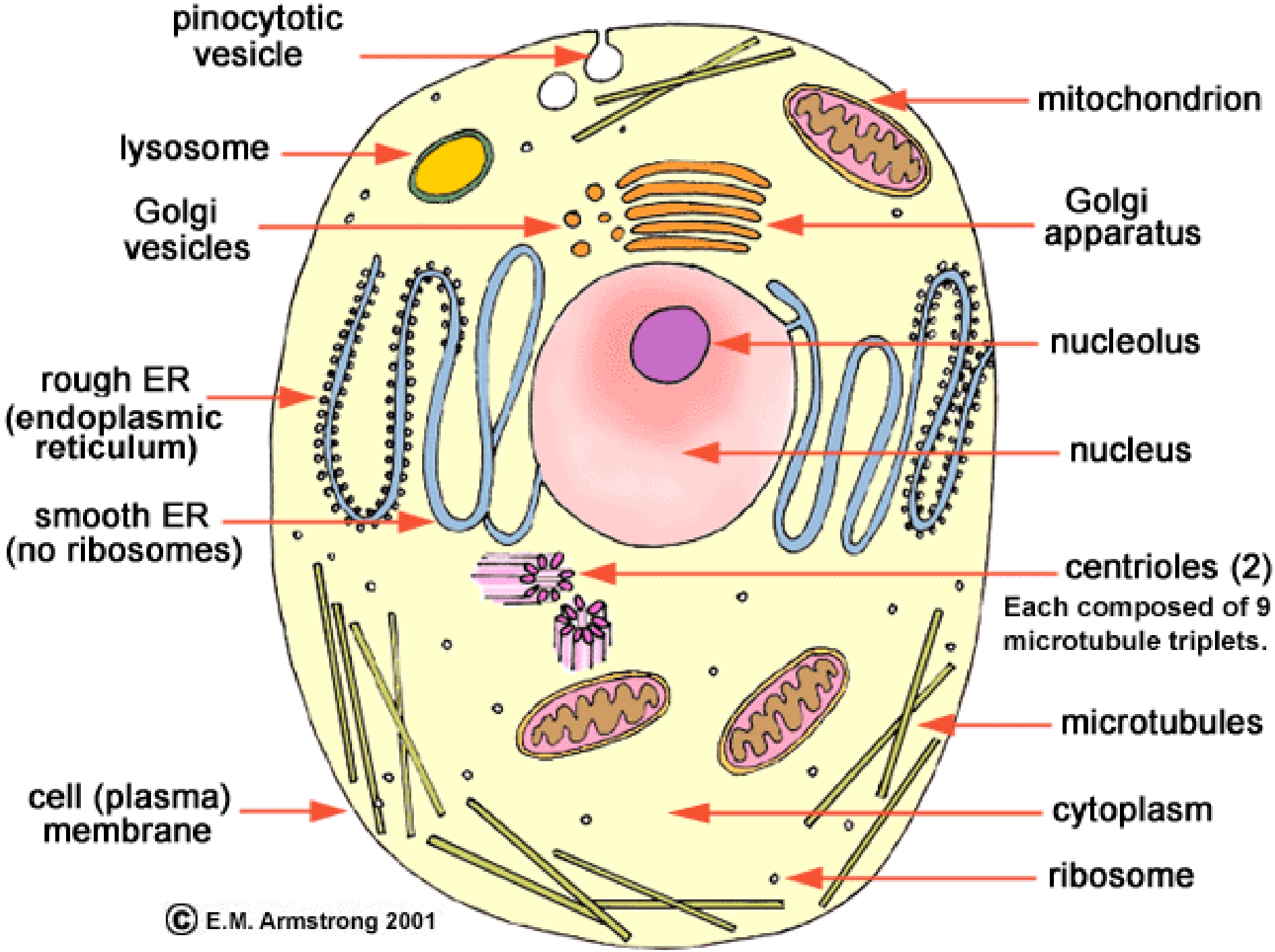

بسم الله الرحمن الرحيم
قالوا سبحانك لا علم لنا إلا ما
علمتنا إنك أنت العليم الحكيم
صدق الله العظيم
البقرة (٣٢)

Cytology

د. علا اسماعيل مجاهد
مدرس الهستولوجيا
كلية الطب البشرى
جامعة بني سويف

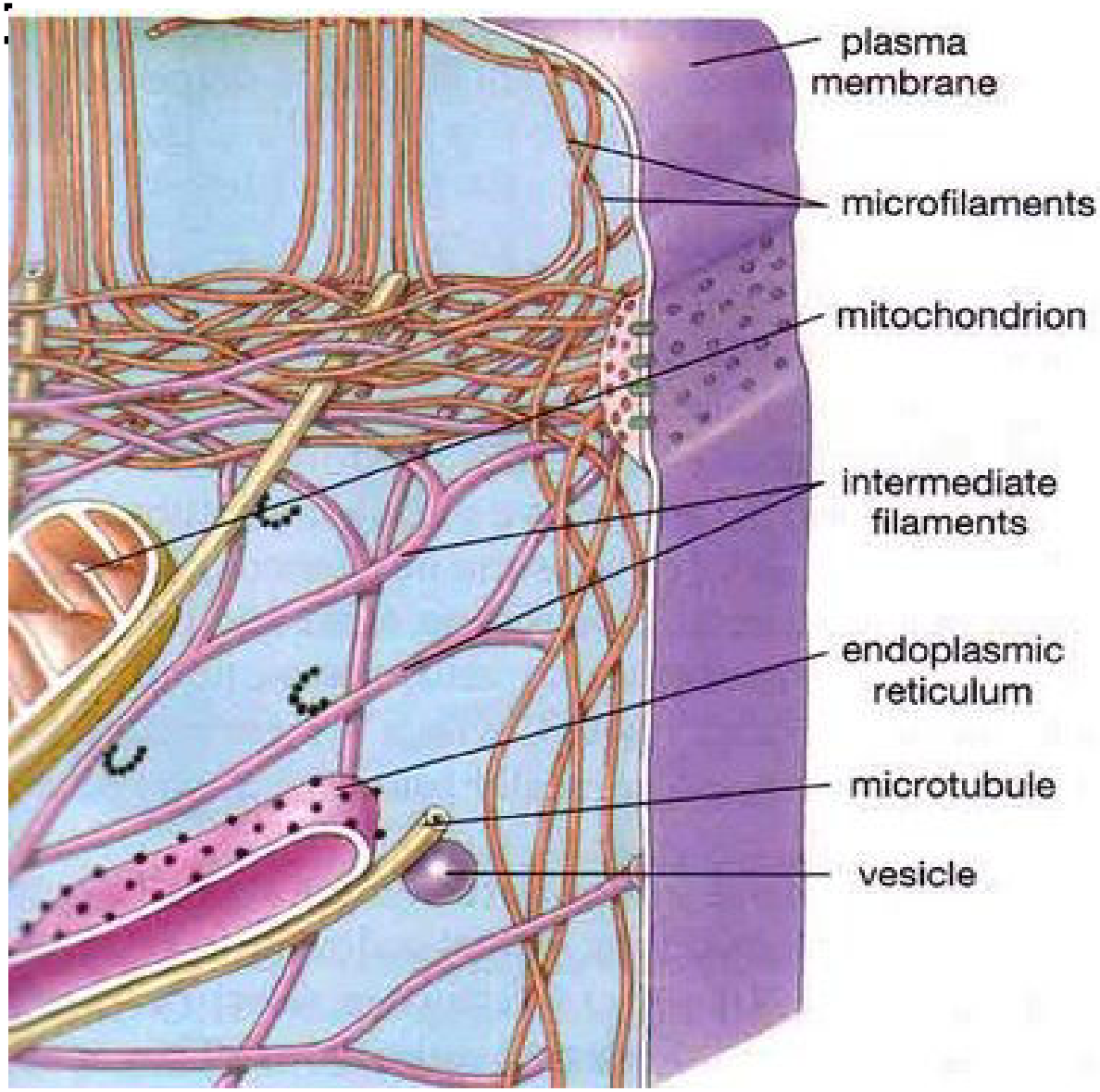

pinocytotic vesicle
lysosome
Golgi vesicles
rough ER (endoplasmic reticulum)
smooth ER (no ribosomes)
cell (plasma) membrane
mitochondrion
Golgi apparatus
nucleolus
nucleus
centrioles (2)
Each composed of 9 microtubule triplets.
microtubules
cytoplasm
ribosome
© E.M. Armstrong 2001

2- Cytoskeleton

Network includes:

1. Microtubules

2. Filaments



a) Microtubules

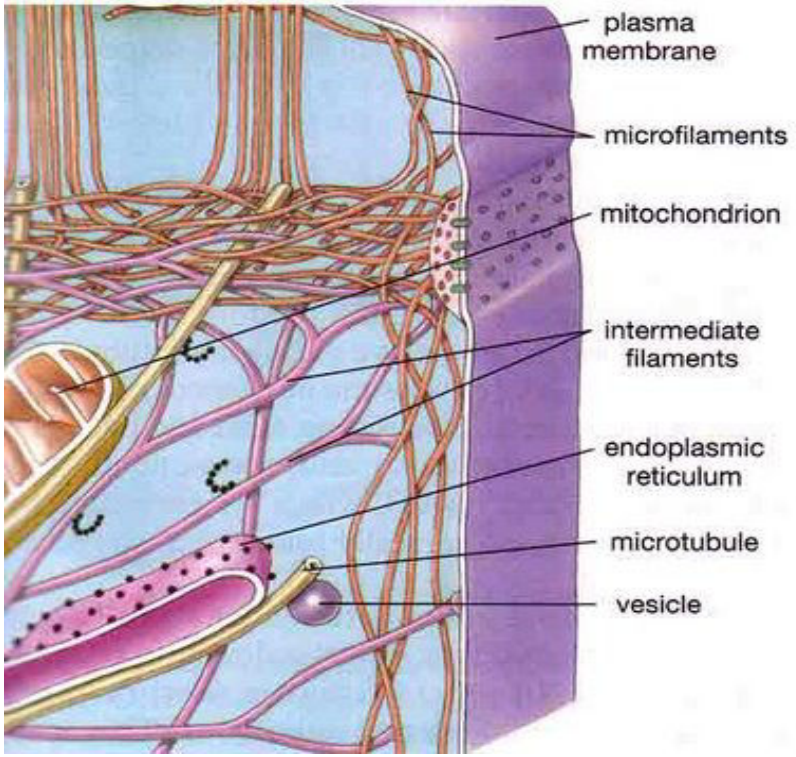
Definition: Straight hollow tubules

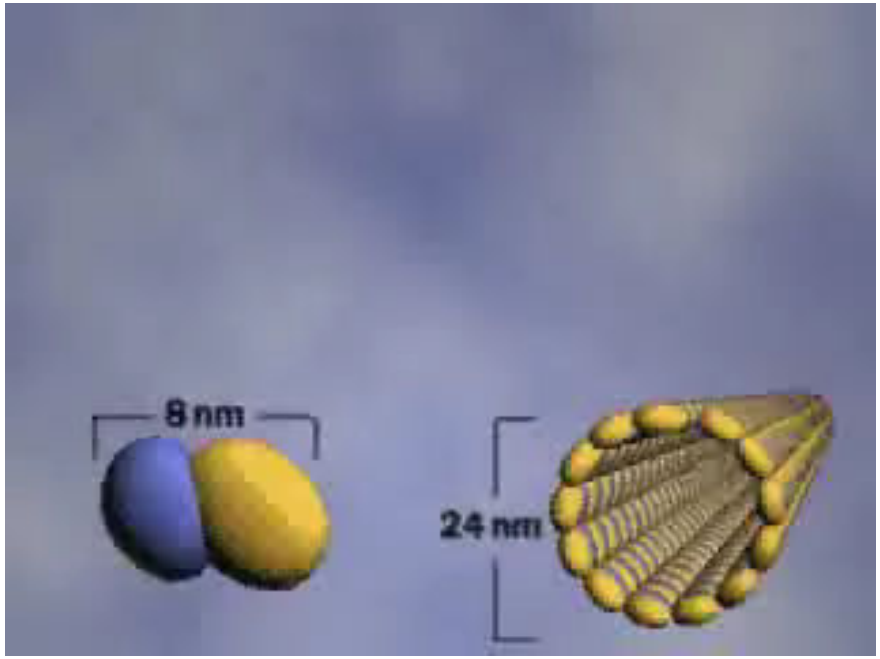
LM: not seen

EM: long cylindrical tubes

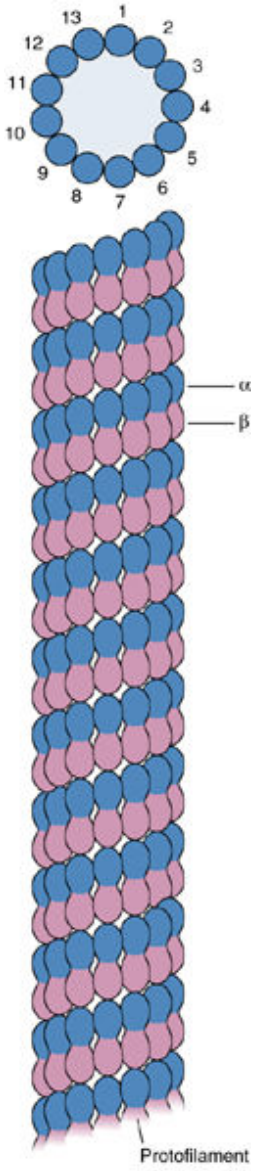
Molecular: subunits of protein (called tubulin)

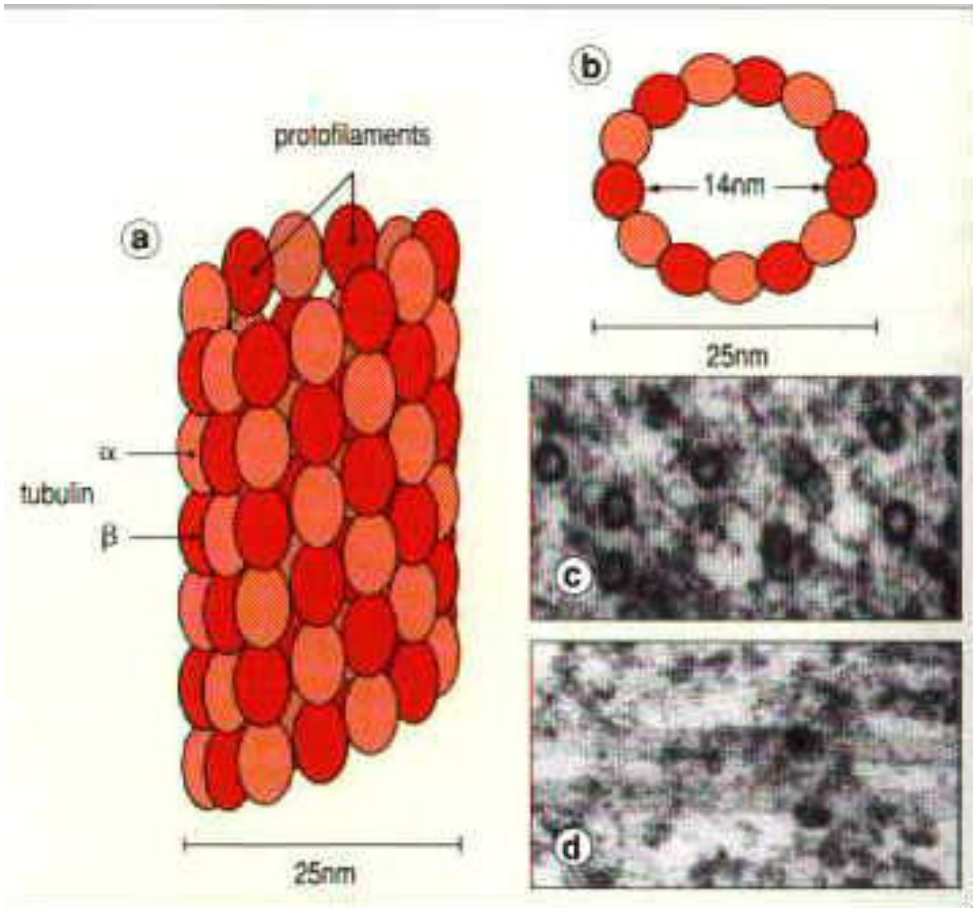
Dynamic

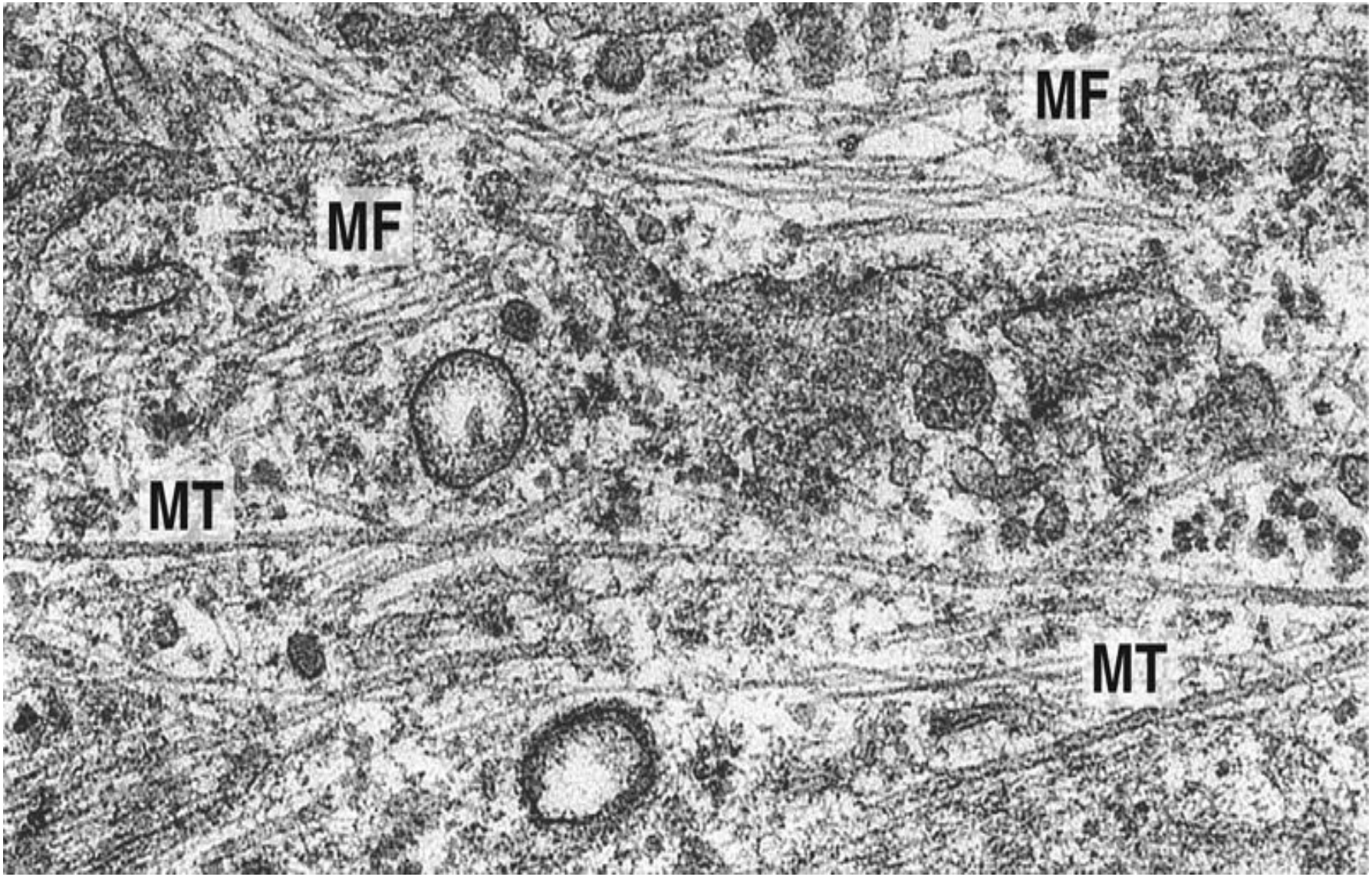




Microtubules

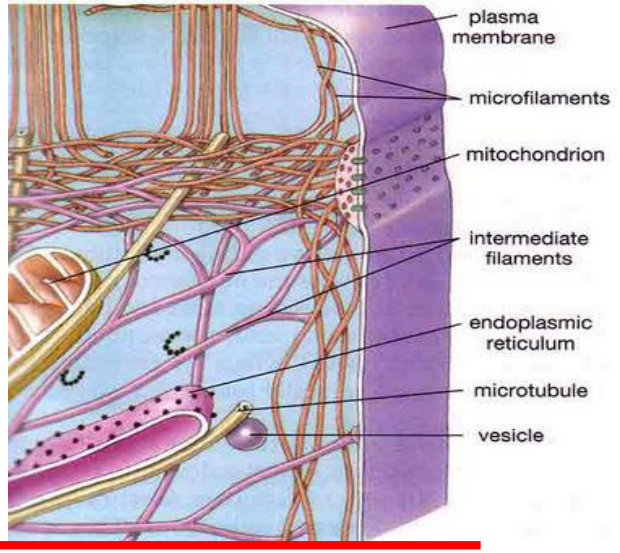




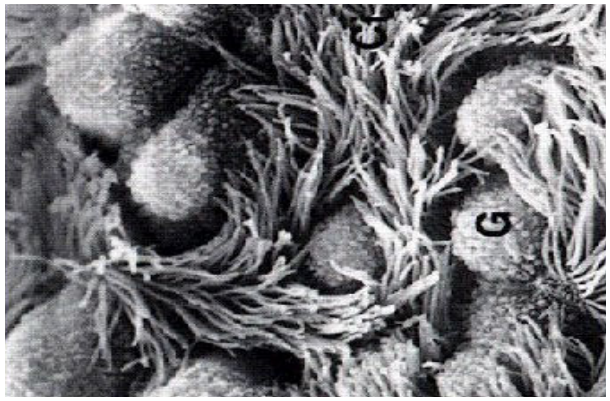

MF
MF
MT
MT

Functions:

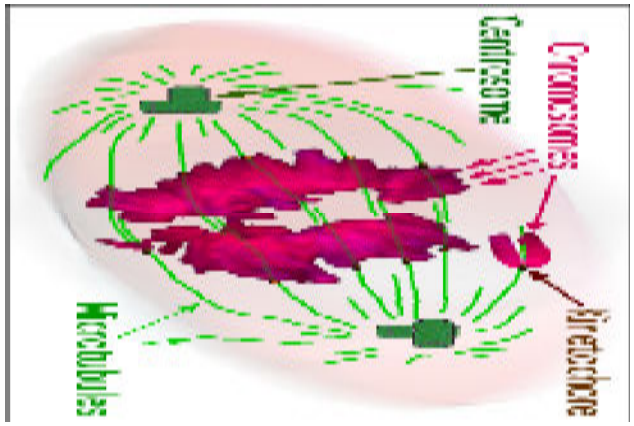
1. Form the **skeleton** of the cell
2. Preserve cell **shape**
3. Help intracellular **transport**



4. Form cilia .

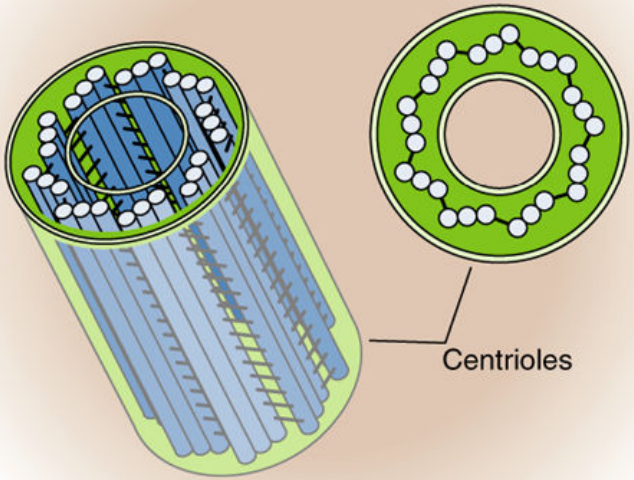


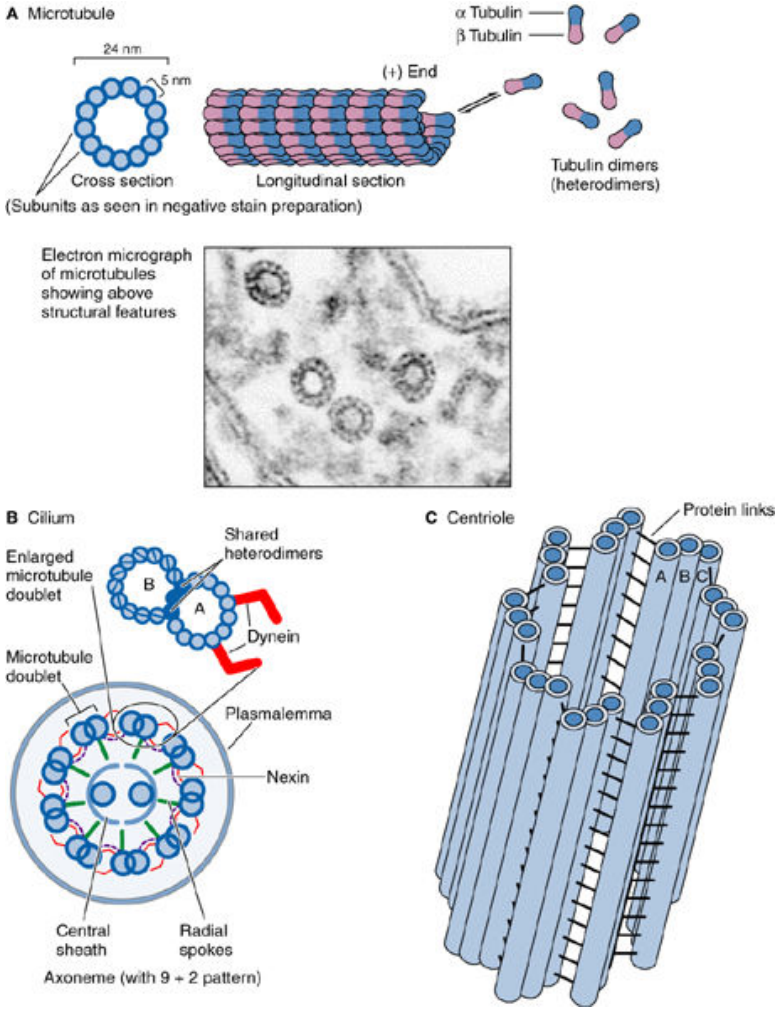
5- forming mitotic spindle

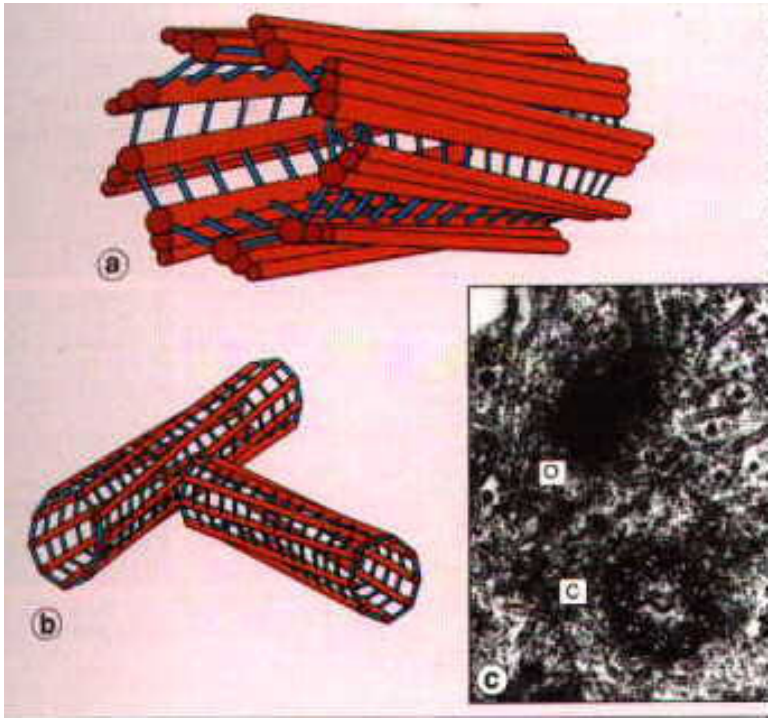


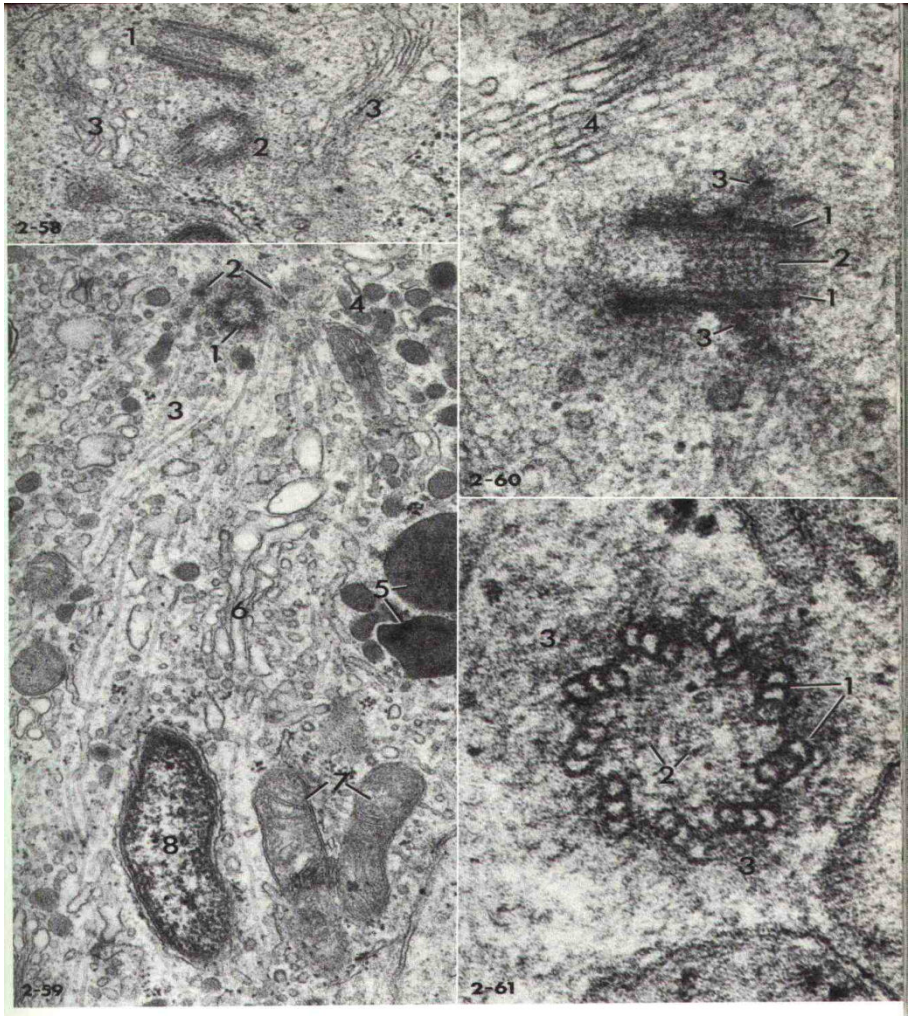
6. Form flagella as in sperms

Centriole


Centrioles


A Microtubule
α Tubulin
β Tubulin
24 nm
5 nm
(+) End
Cross section
Longitudinal section
Tubulin dimers
(heterodimers)
(Subunits as seen in negative stain preparation)
Electron micrograph
of microtubules
showing above
structural features
B Cilium
Shared
heterodimers
Enlarged
microtubule
doublet
B
A
Dynein
Microtubule
doublet
Plasmalemma
Nexin
Central
sheath
Radial
spokes
Axoneme (with 9 + 2 pattern)
C Centriole
Protein links
A B C


a
b
c
o
c


1
3
2
3
2-58
4
3
1
2
1
3
2-60
2
1
4
3
5
6
8
7
2-59
3
1
2
3
2-61

Cilium

Def. motile hair like over cell surface

LM: acidophilic striations

Origin ; centrioles

EM :1. Basal body: 27 microtubules in 9 tribletes

2. Shaft (Axoneme):

20 microtubules in 9 bundles

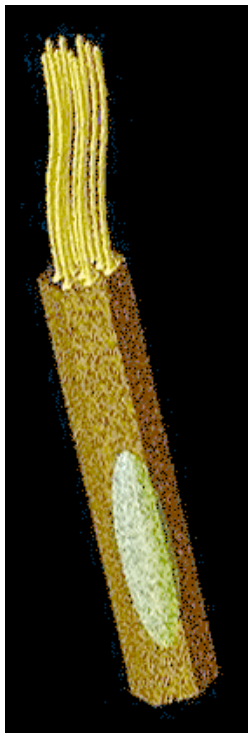
of doublets + 2 singlets

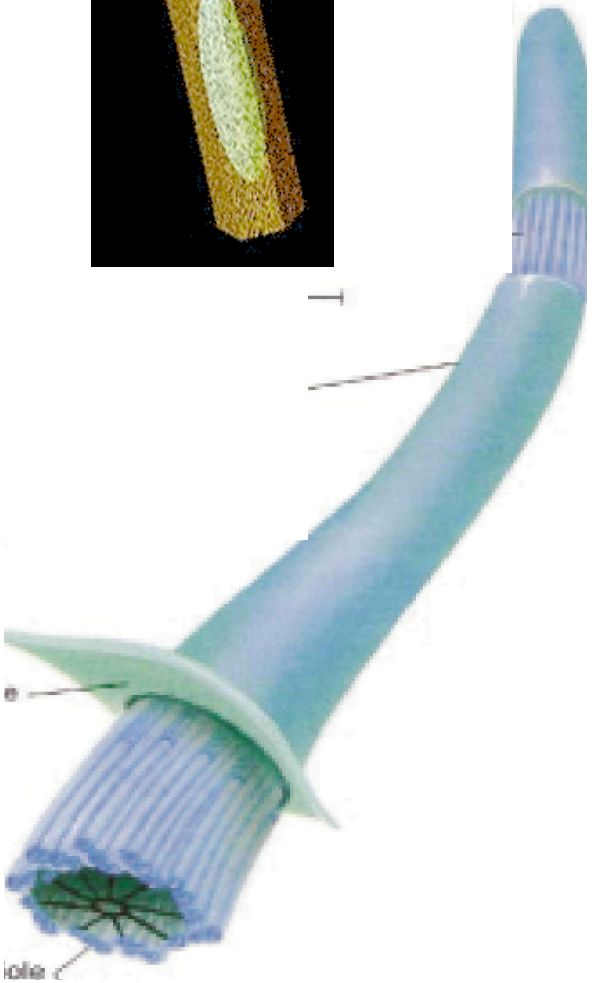
3. Rootlets: At lower end, fix basal body and shaft. (9 microtubules)

Function:Move secretions and particles in Res. & female genital system

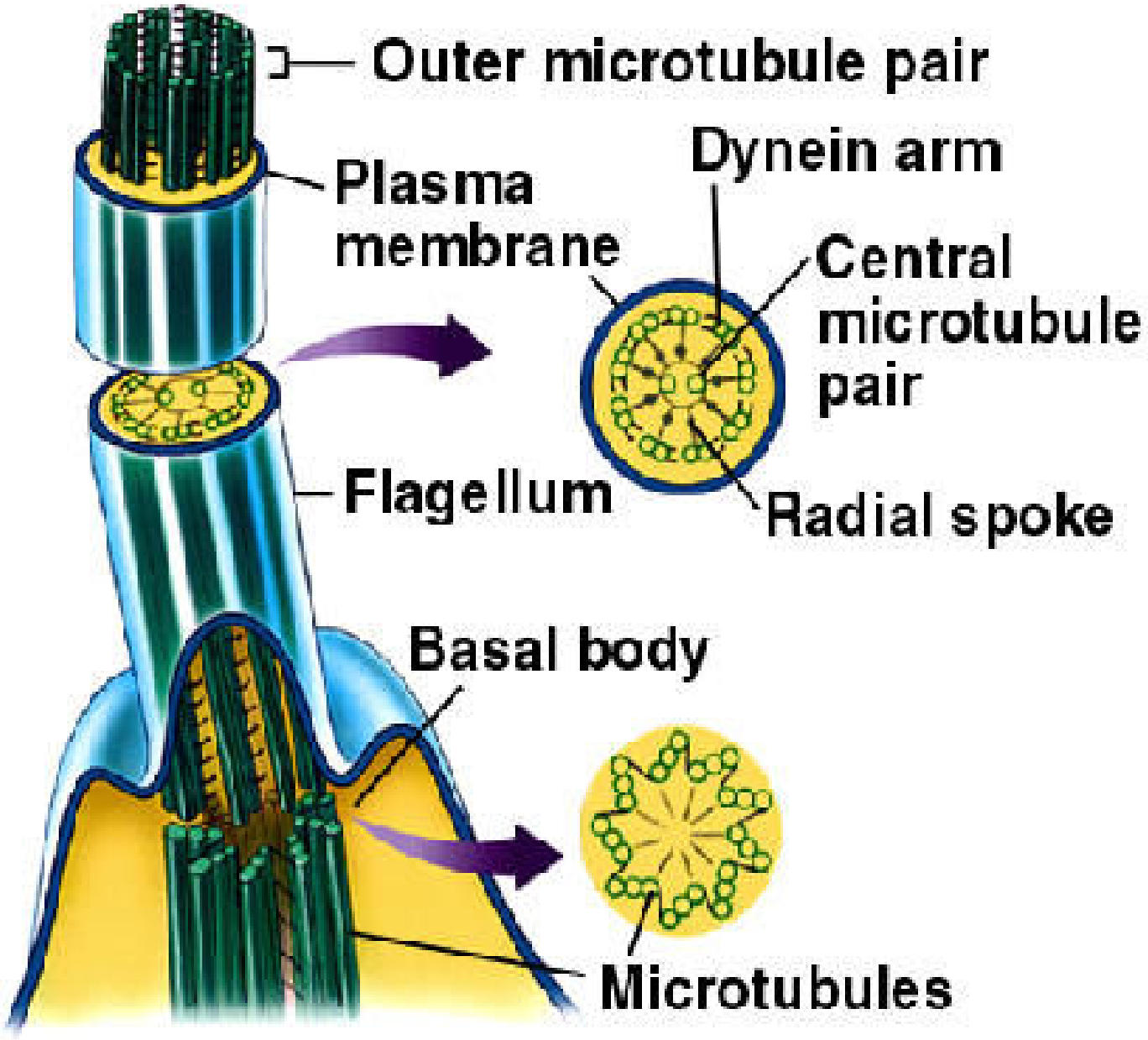
Act as receptores (rods &cones)

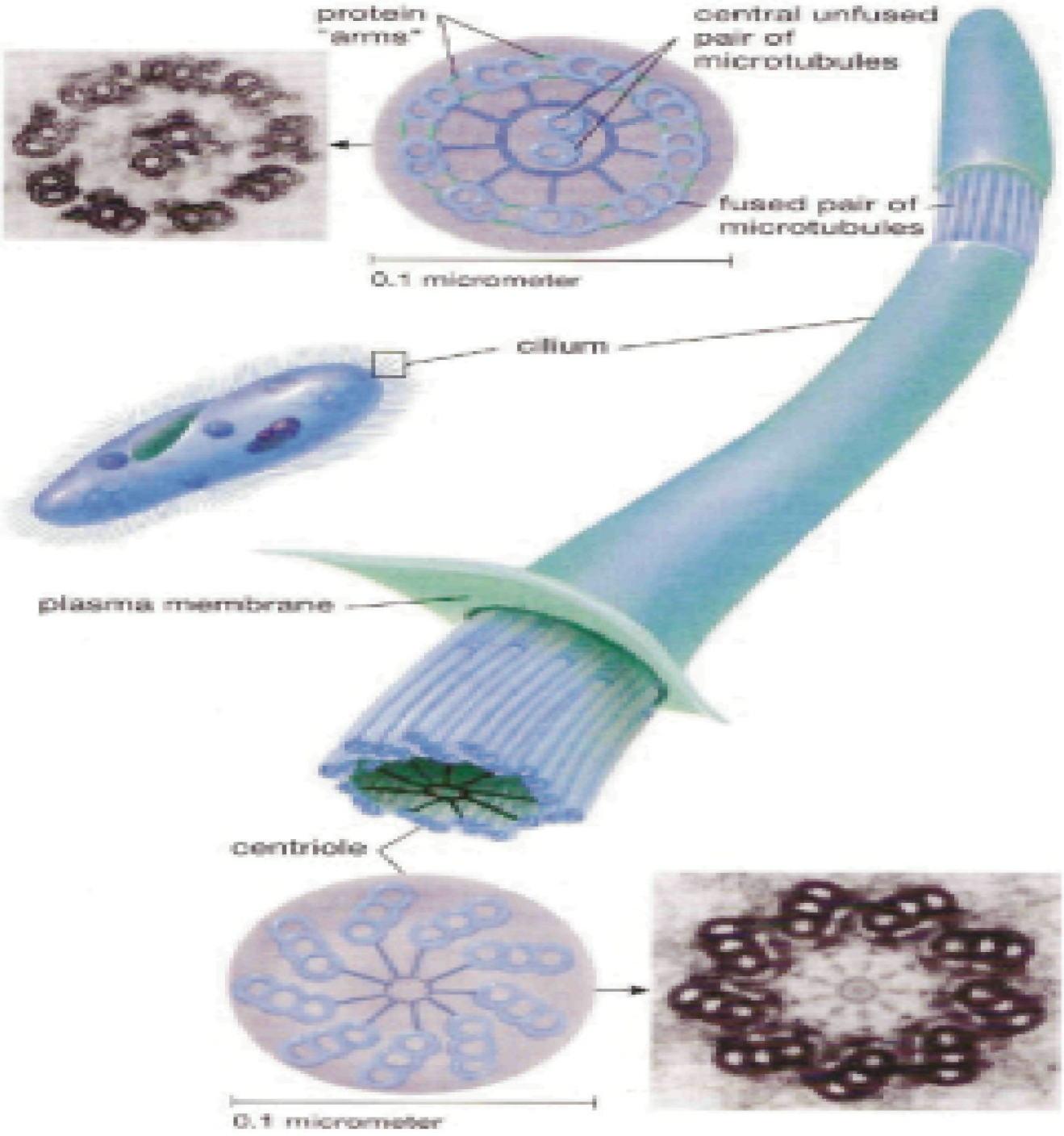
Flagellum as long cilium (tail of sperm)

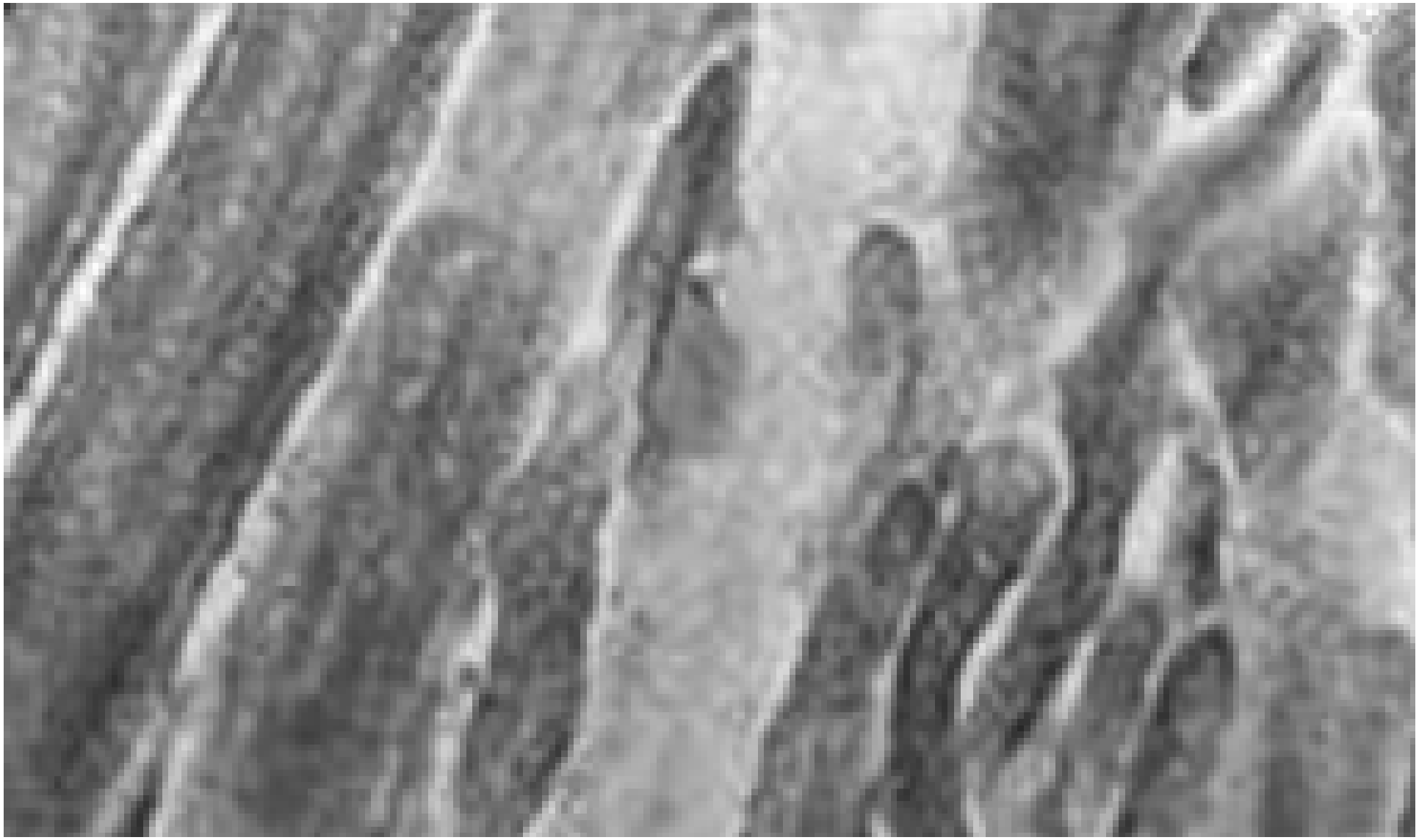




Eukaryotic Flagellum



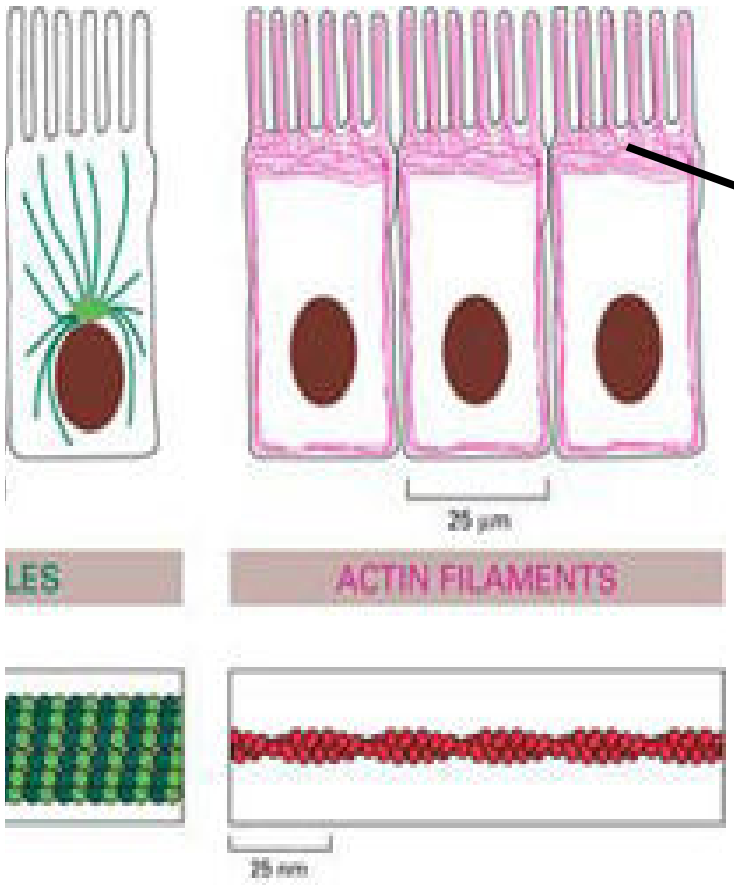

protein "arms"
central unfused pair of microtubules
fused pair of microtubules
0.1 micrometer
cilium
plasma membrane
centriole
0.1 micrometer

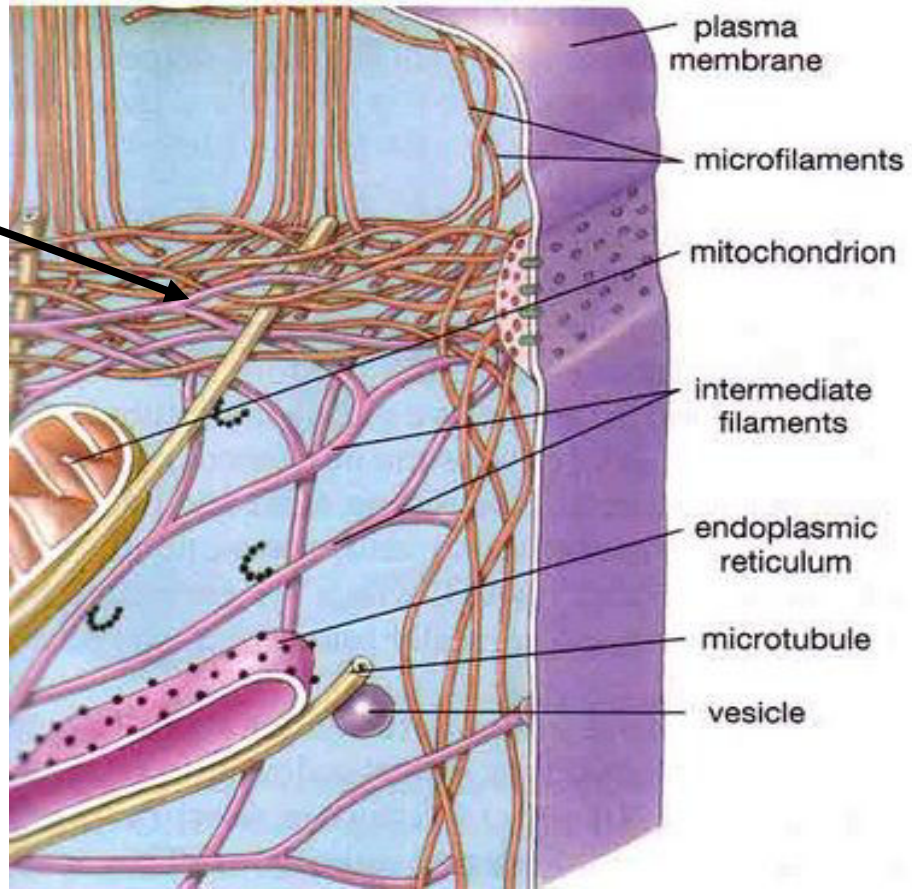


b) Filaments

Fine strands of proteins

Responsible for elasticity and contractility of cytoplasm





Types: According to size:

1- Thin filaments: microfilaments = Actin

2- Intermediate filaments:

3- Thick filaments: Myosin

Thin filaments: microfilaments = Actin filaments

5 nm , made protein actin formed of globular actin (G-actin polymerize forming long chains F- actin

Actin filaments: form **mesh beneath the cell membrane (cell cortex) they held by filamin**

Also can separate &reform in different orientation alter the shape of the cell

Microfilaments

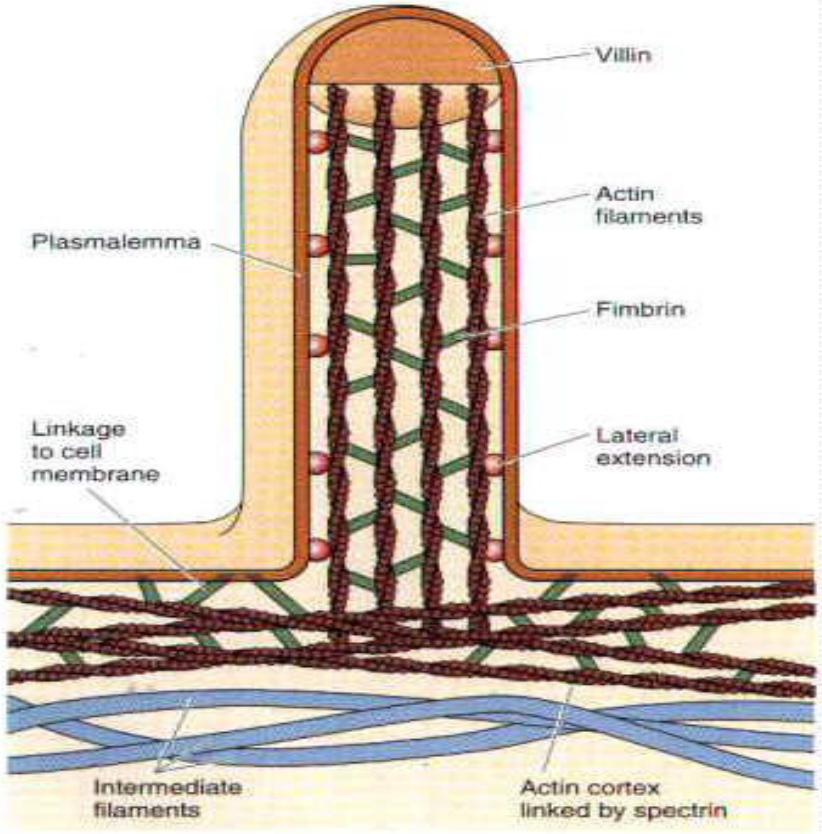


Figure 5–8. Schematic diagram of the structure of a microvillus.

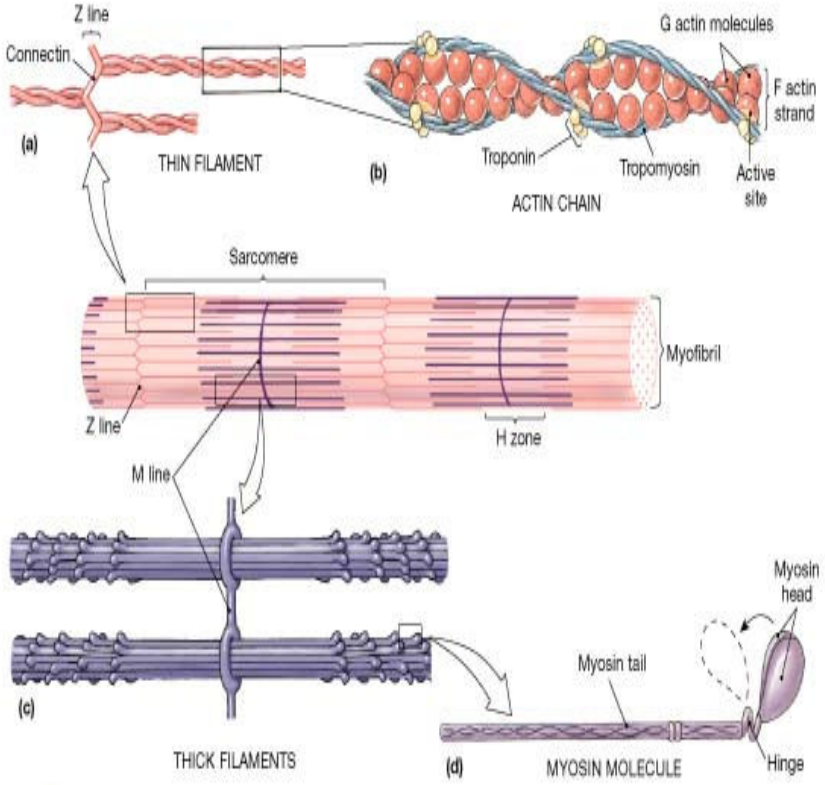


FIGURE 10-5 Thick and Thin Filaments. **(a)** Gross structure of a thin filament, showing the attachment at the Z line. **(b)** The organization of G actin subunits in an F actin strand and the position of the troponin–tropomyosin complex. **(c)** Structure of a thick filament, showing the orientation of the myosin molecules along the thick filaments. **(d)** Structure of a myosin molecule.

Intermediate filaments

- **Keratin : Epithelium**
- **Vimentin : Fibroblasts**
- **Desmin : Muscles**
- **Neurofilaments**
- **Glial filaments**

NB: Essential for diagnosis of highly undifferentiated malignant tumours

Sites & Functions:

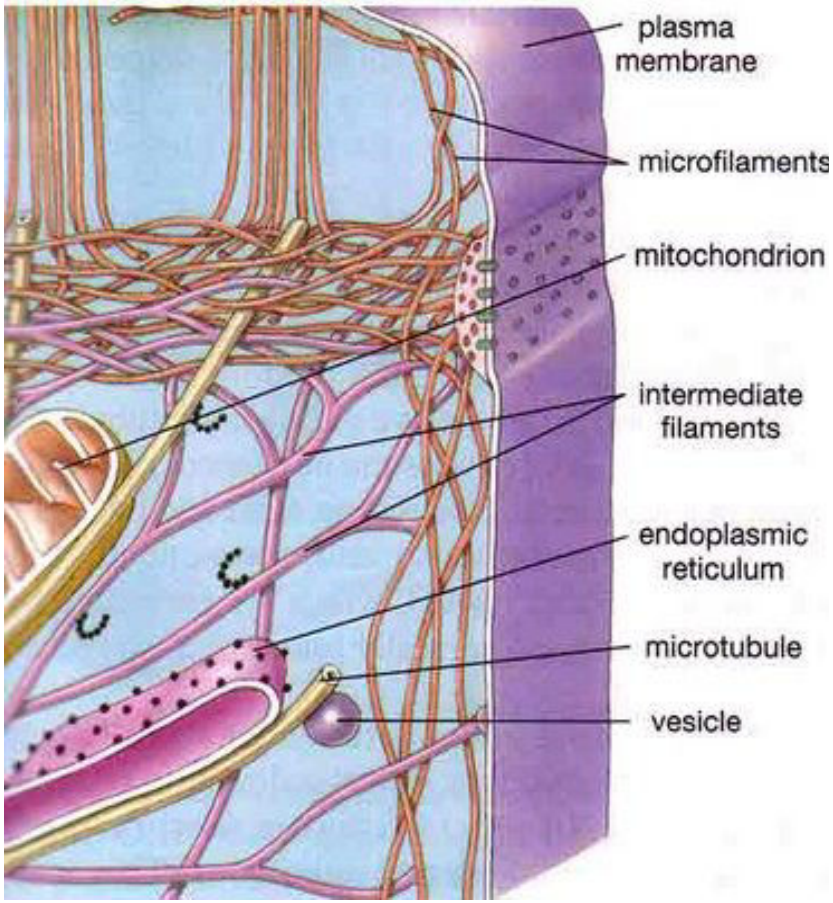
1. Form dense mesh beneath the cell membrane (cell cortex) to strengthen the cell

Help seperation of dividing cells (deepening in cleavage furrow)

Initiate cell membrane mobility ,Changes in cell shape (Amoeboid movements

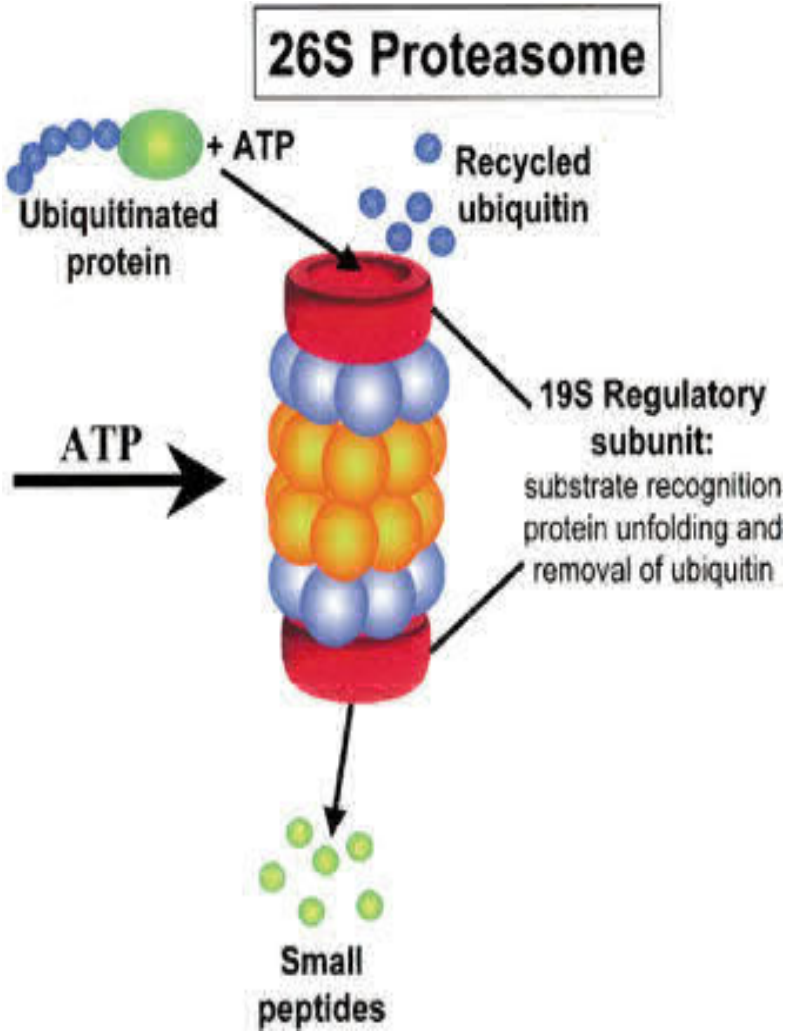
2. In microvilli microfilaments form their core to keep their shape.

3- In skeletal muscles, interact with myosin filaments for contraction



Definition of Proteasome: non membrounus organells , A protein degradation "machine" within the cell that can degrade unneeded or damaged proteins, by proteolysis, into short polypeptides and amino acids.
Digest protein as individual molicules.
Deal with proteins attached to **ubiquitin**
It is composed of one **barrel shaped core** and two terminal **regulatory particles that contains ATPase and recognizees** proteins attached to **ubiquitin**

Function: removal excess enzymes & unneeded or damaged proteins (incorrectly folded) or proteins encoded by virus.



Cytoplasm contains

Organelles

Living structures

Essential

In all nucleated cells

Permanent

Have vital functions

Active

Inclusions

Non living

Not essential

Not in all cells

Temporary

Stored material or waste Inert

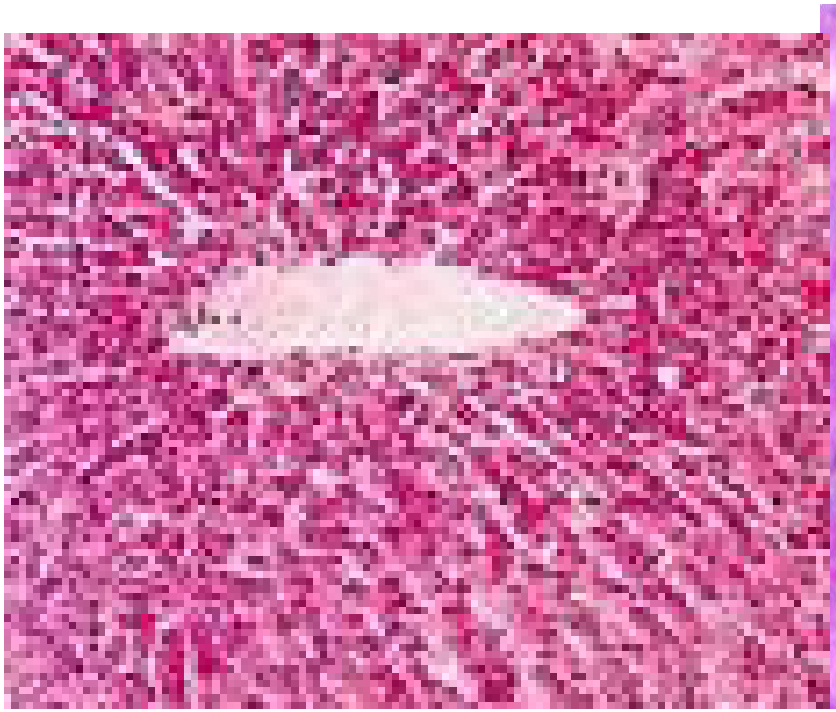
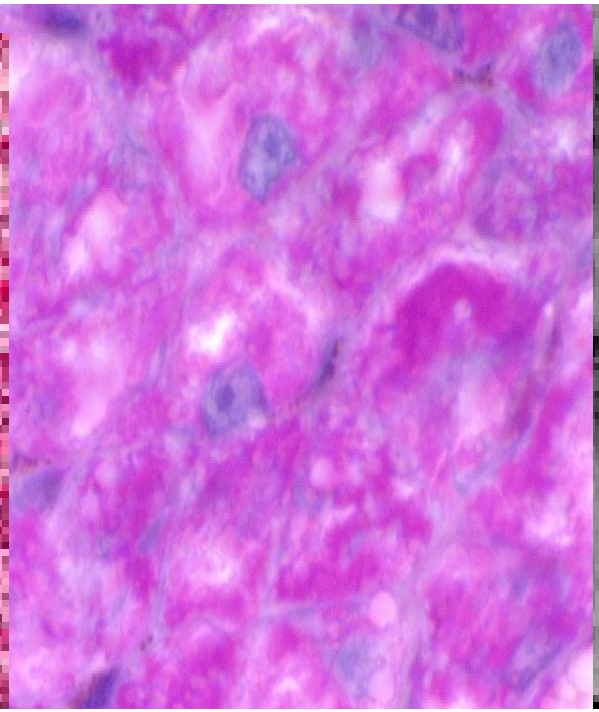
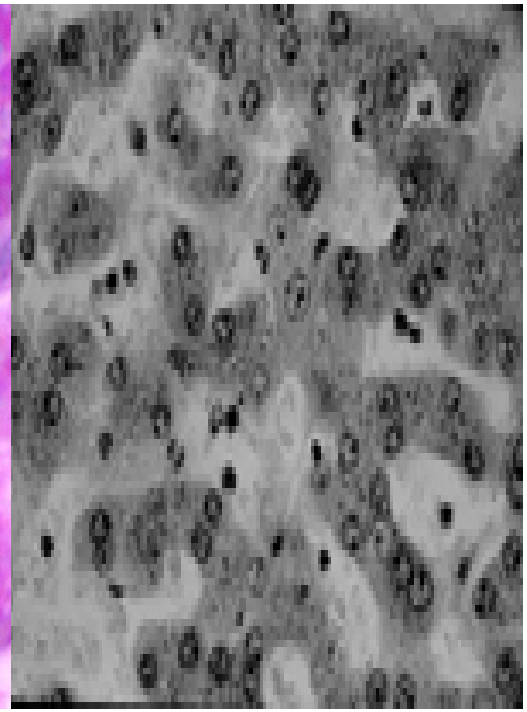
Cytoplasmic Inclusions

- Nonliving, temporary, nonessential, inert

A.Stored Food

1.Carbohydrates

- **Site** glycogen granules in liver & muscle
- **LM** By H&E vacuoles, Best s carmine red, PAS magenta red
- **EM** single=alpha clusters or rosettes=beta at sER

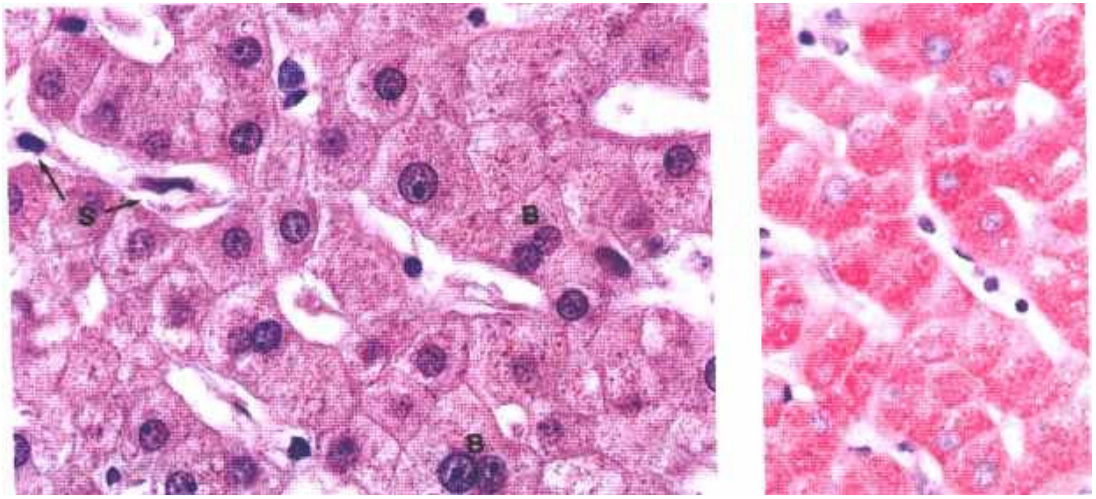
Stored food

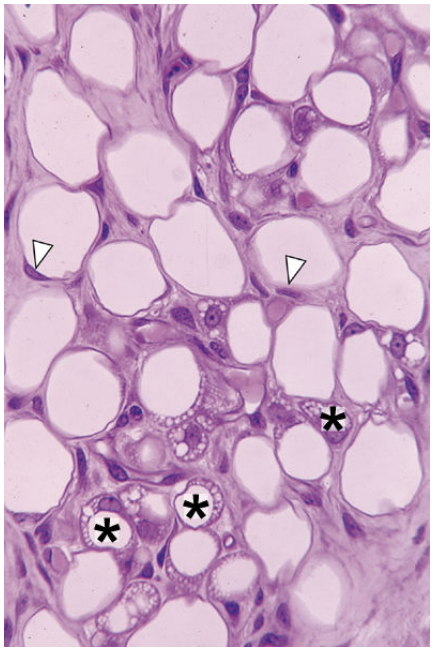
Types	Site	H&E	Special stain
Glycogen	Liver and muscle	Vacuoles	Best Carmine (red) PAS (magenta)
Fats	Fat cells	Vacuoles	Sudan III (orange)

Inclusions

- **Stored food :**

CHO **Fat**





Pigments

Types	Site	Roles
A)Endogenous	**Produced in cell**	**Functional**
1. Hemoglobin	RBCs	Carries gases
2. Melanin	Skin	Protect from UV Give it color
3. Lipofuscin	Nerve and cardiac muscle cells	Accumulate with age
B)Exogenous	**Taken from outside**	
Carotene	With food as carrots	
Tattoo	Dyes Injected under skin	
Dust	In lung	

Pigments

- **Pigments**

Melanin

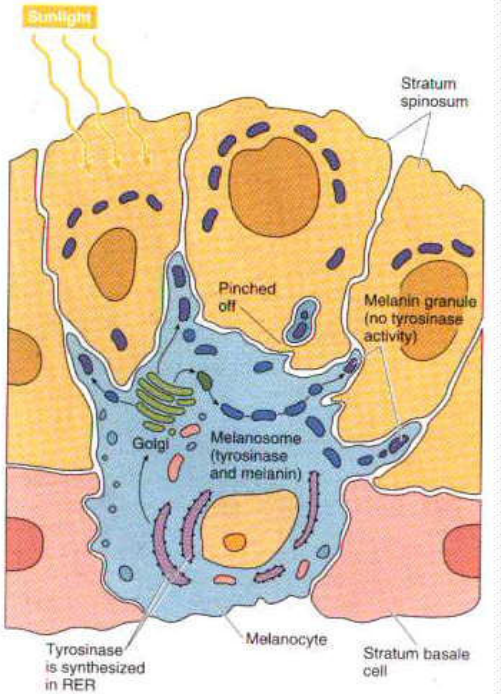
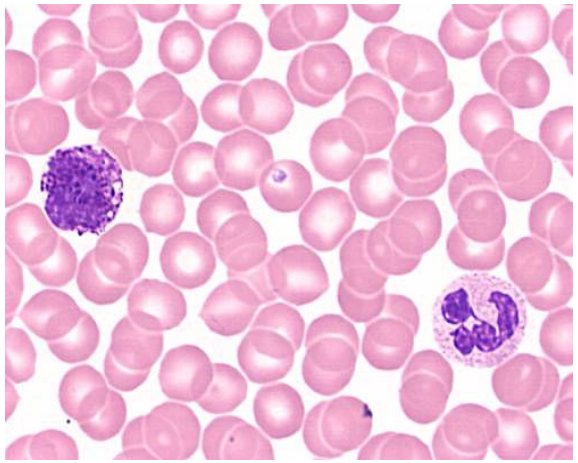


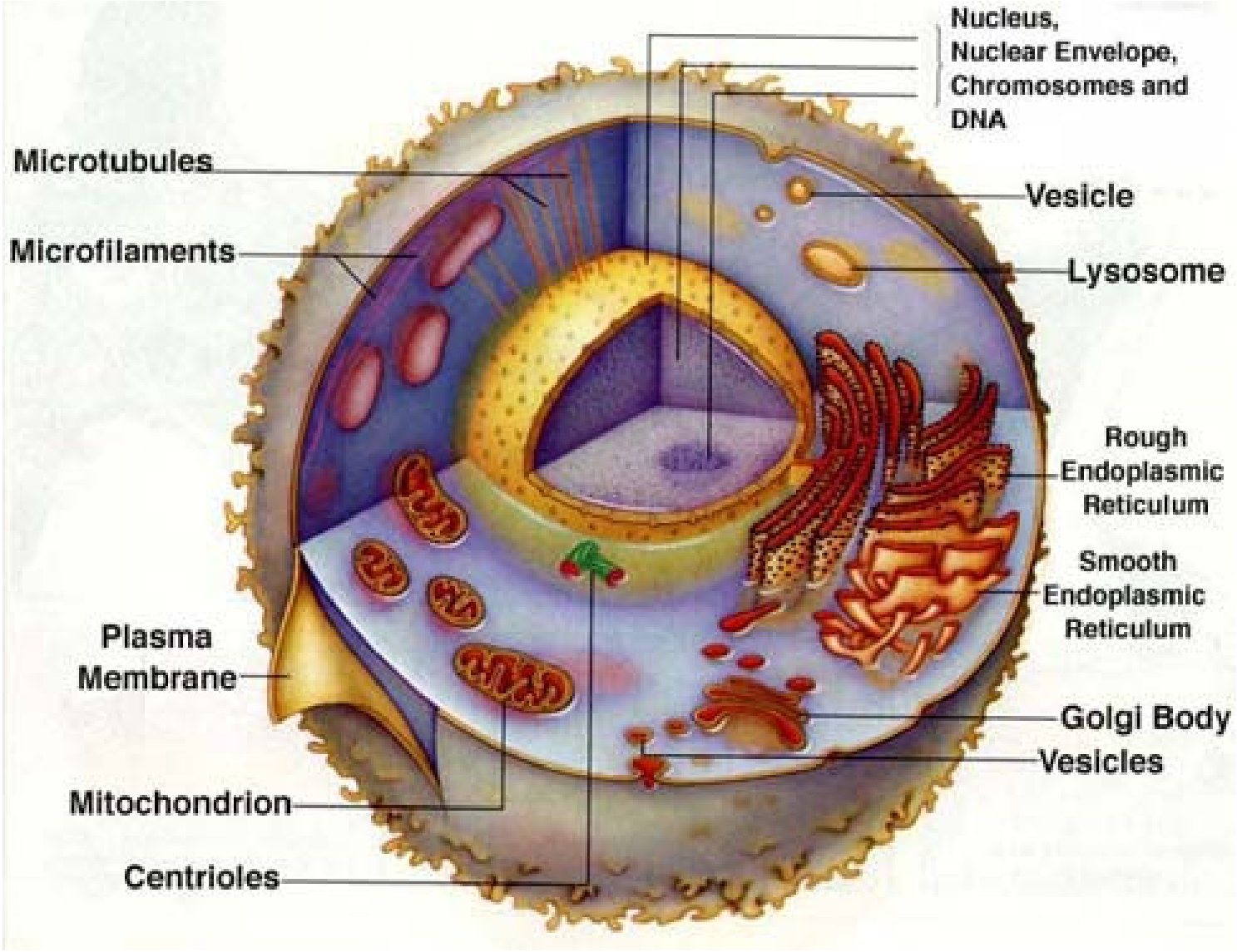
Figure 14–6. Diagram of melanocytes and their function.

Hb



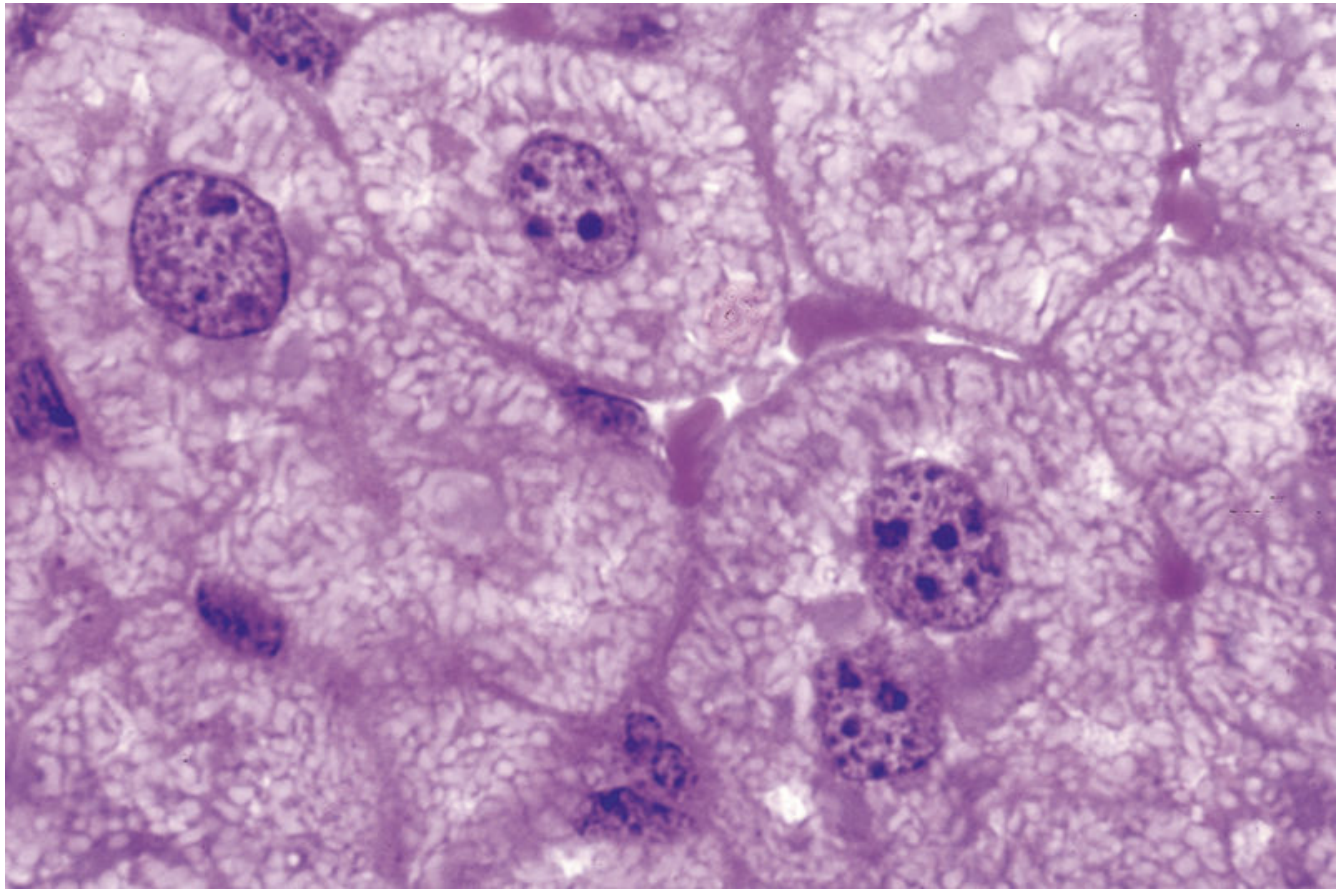
Lipofuscin

Nucleus


Nucleus,
Nuclear Envelope,
Chromosomes and
DNA
Microtubules
Microfilaments
Vesicle
Lysosome
Rough
Endoplasmic
Reticulum
Smooth
Endoplasmic
Reticulum
Plasma
Membrane
Golgi Body
Vesicles
Mitochondrion
Centrioles

The Nucleus

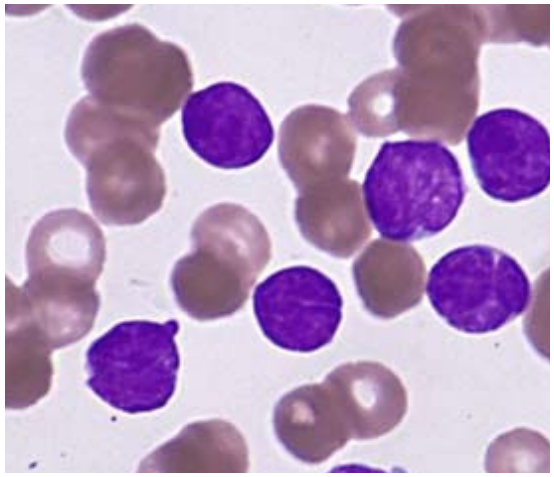
- Definition
- Number
- Position
- Shape
- L/M



Nucleus

General

Largest component of the cell



Site

In all cells

Except: RBCs and platelets

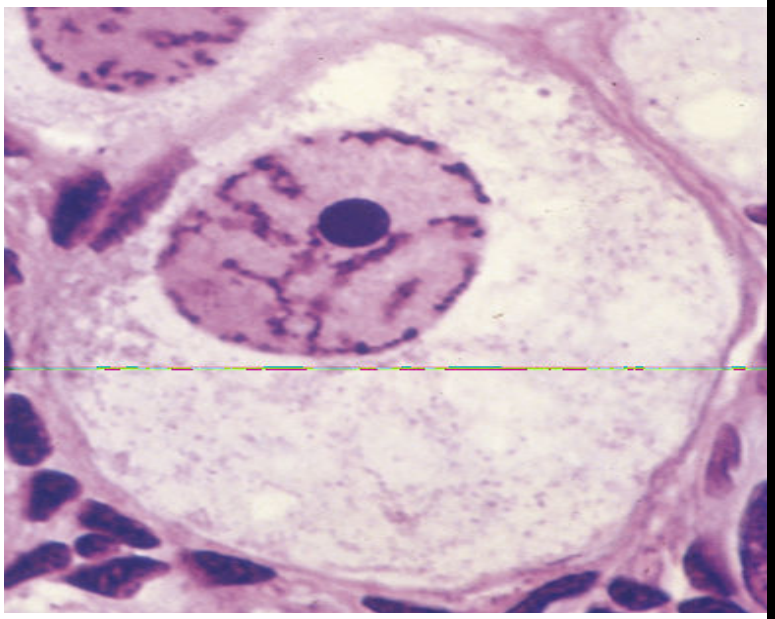
Number:

Mononucleated:	Most cells
Binucleated:	Liver cells
Multinucleated:	Skeletal muscles

LM: Basophilic due to its content of DNA & RNA.

According to cell activity it may appear:

A. Lightly stained

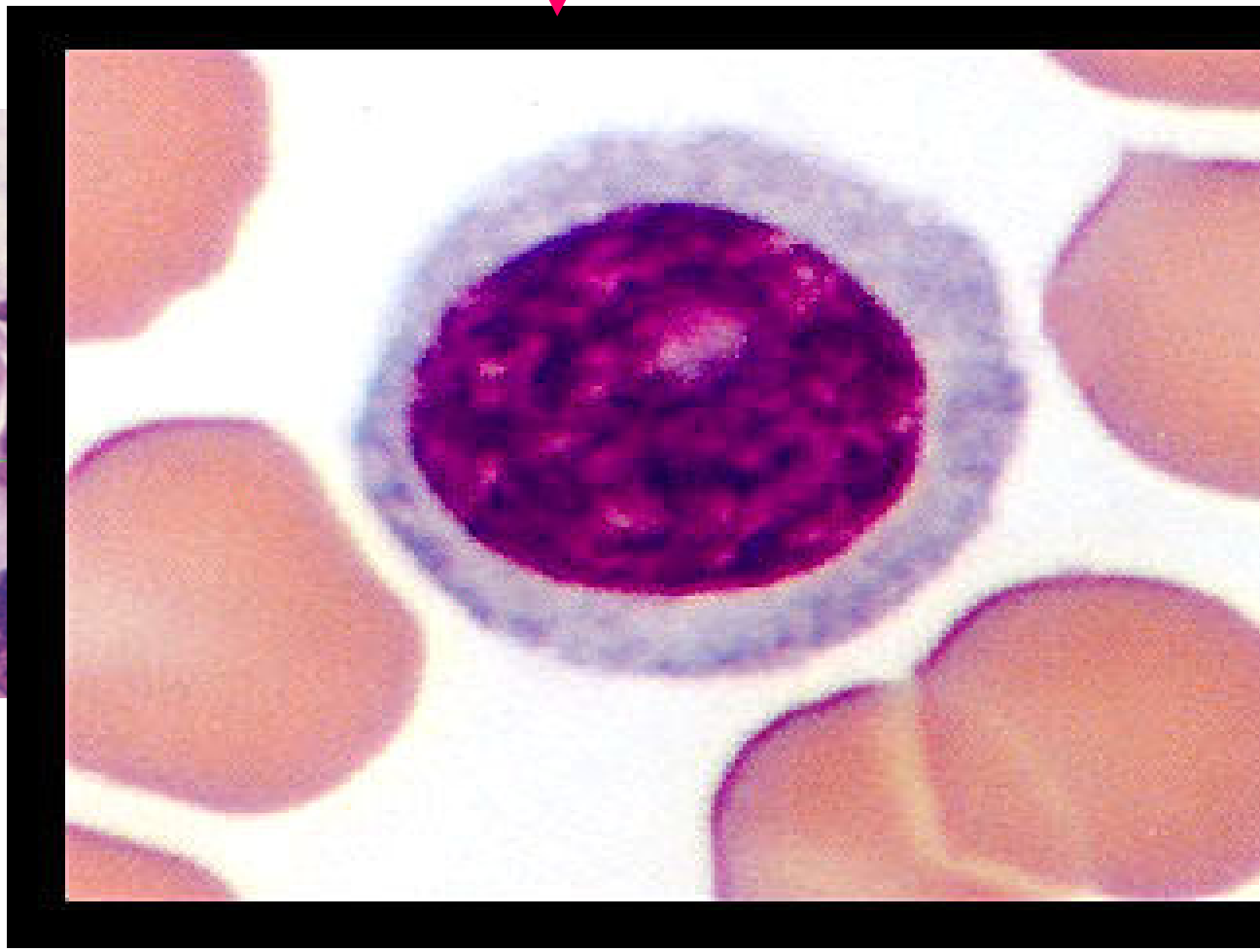


Open face nucleus

(Vesicular)

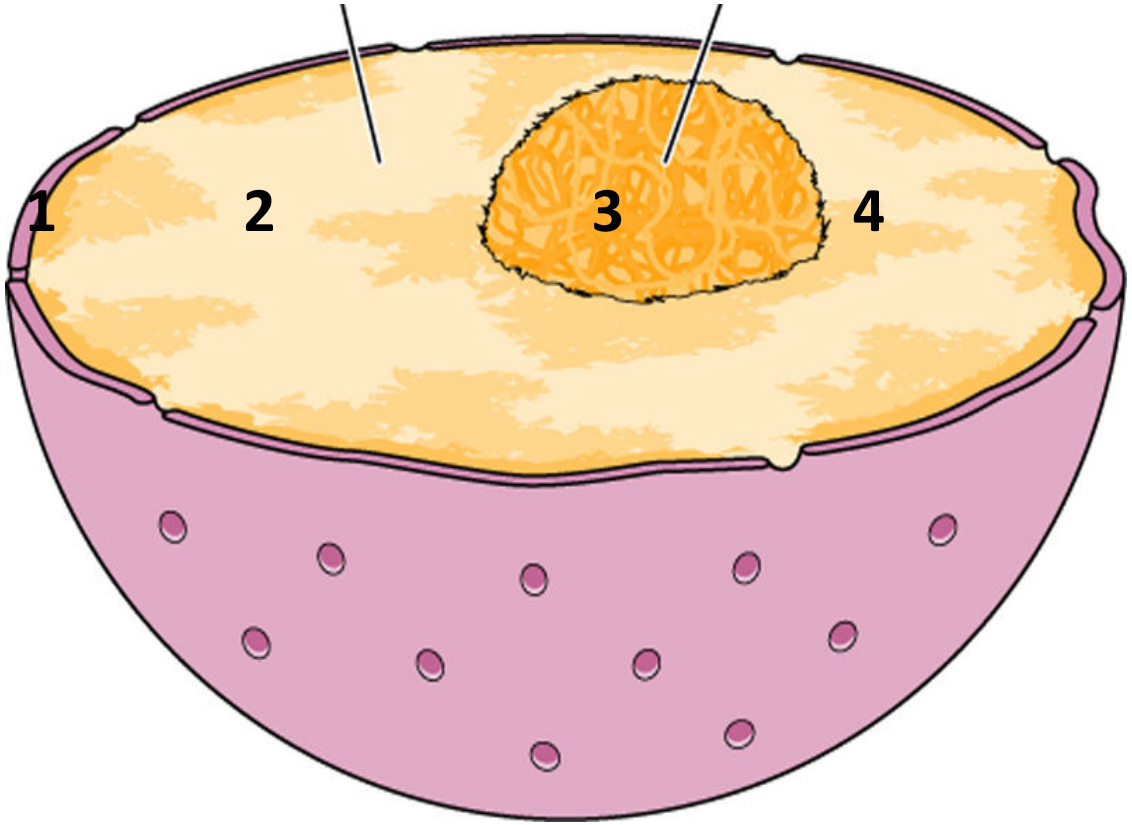
Extended chromatin

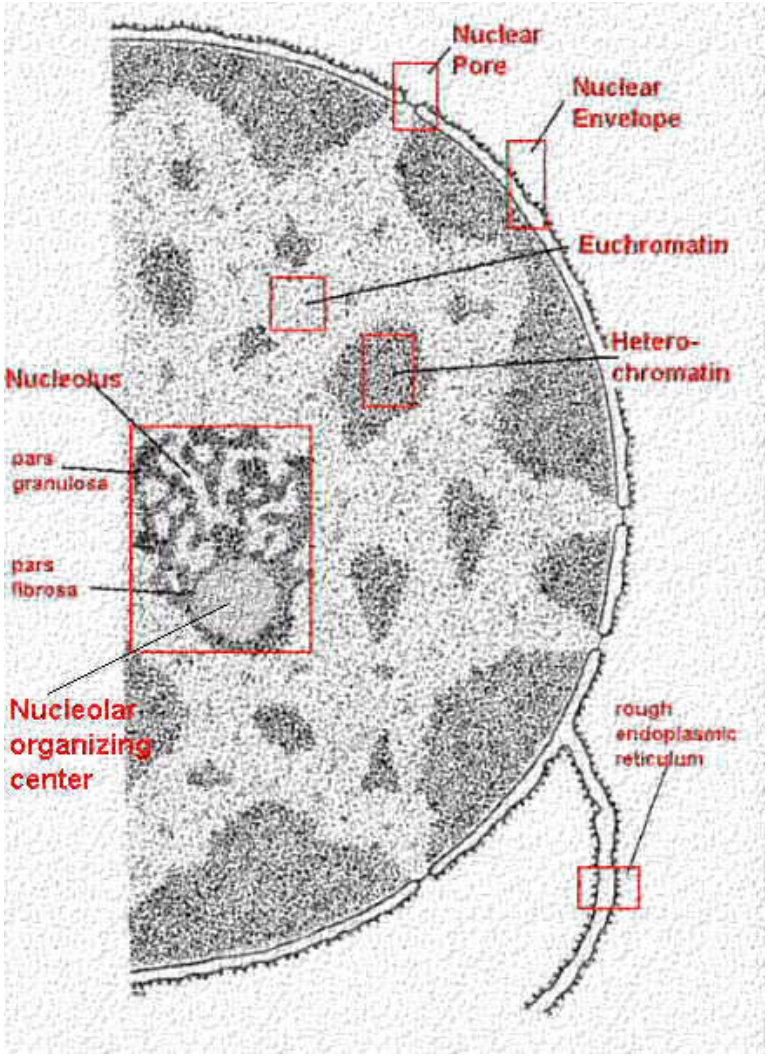
Prominent nucleolus

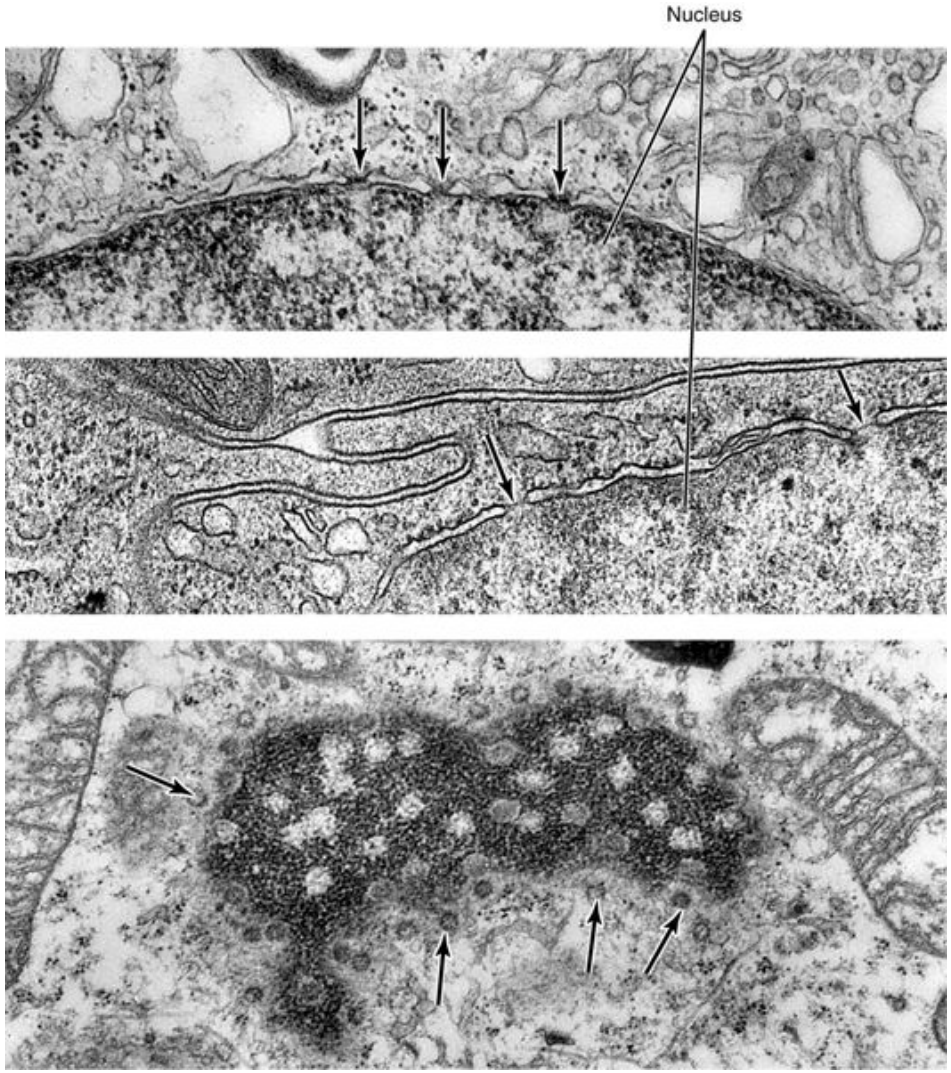


Structure of the nucleus

1. Nuclear membrane
   - Outer
   - Inner
2. Nuclear sap
3. Nucleolus
4. Chromatin
   - Euchromatin
   - Heterochromatin




Nuclear Pore
Nuclear Envelope
Euchromatin
Hetero-chromatin
Nucleolus
pars granulosa
pars fibrosa
Nucleolar organizing center
rough endoplasmic reticulum


Nucleus

EM of nuclear membrane: 2 unit membranes

Inner membrane

fibrillar

Chromatin on

inner side

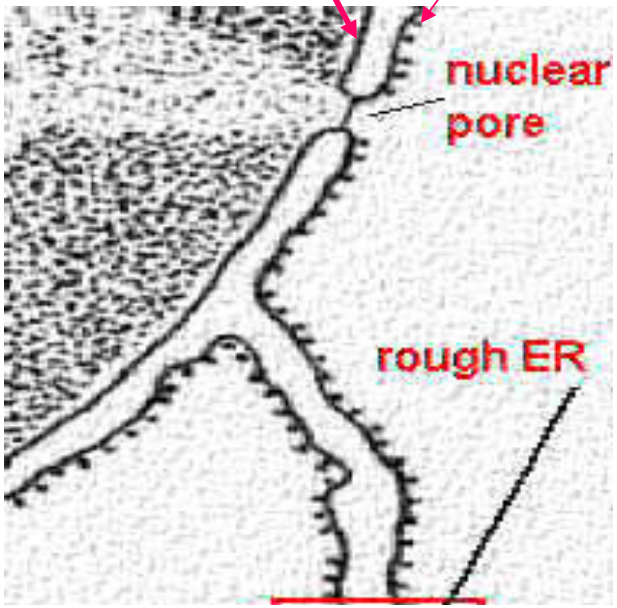
Outer membrane

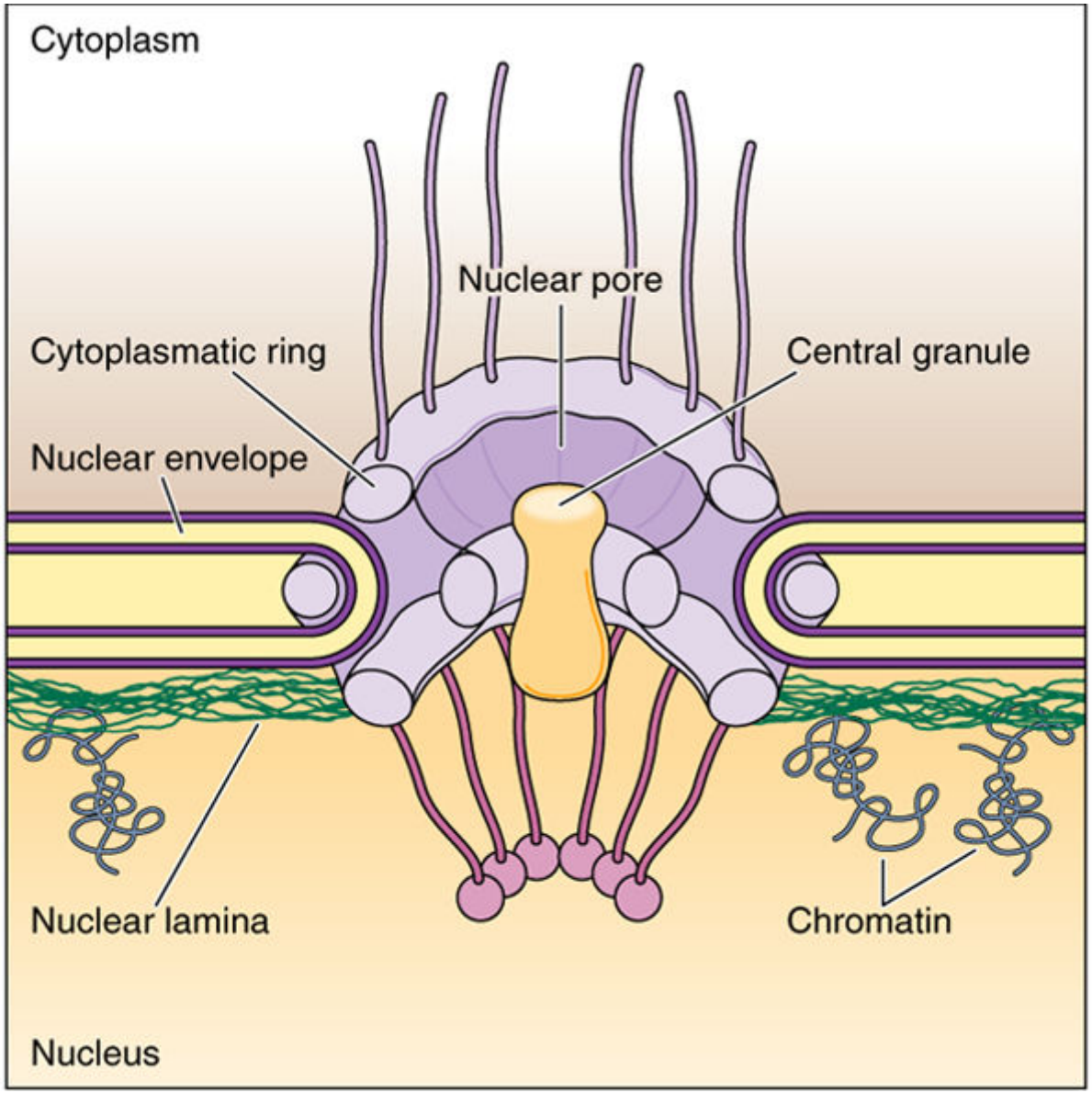
Granular

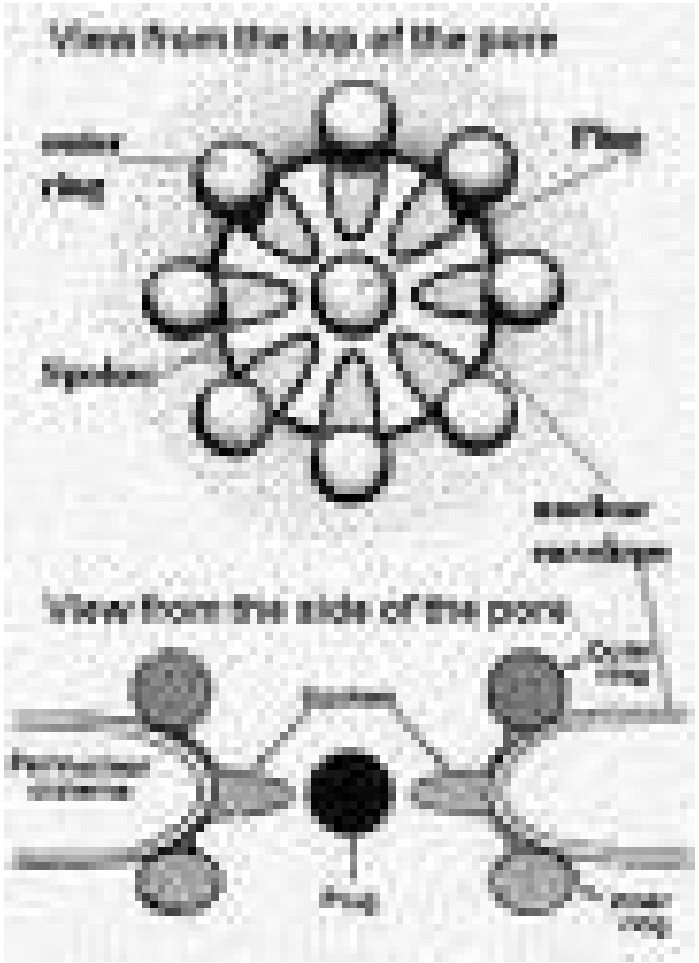
Ribosomes on

On outer side

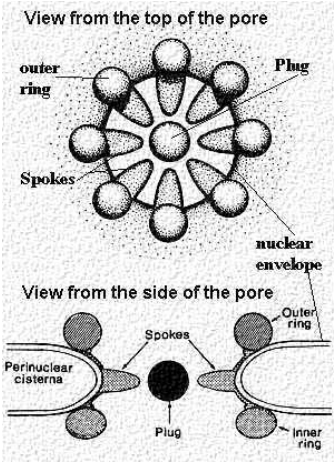
Continuous with rER

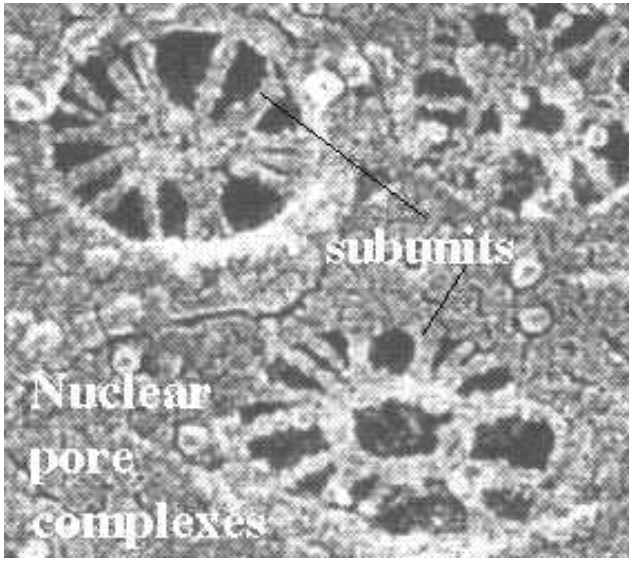


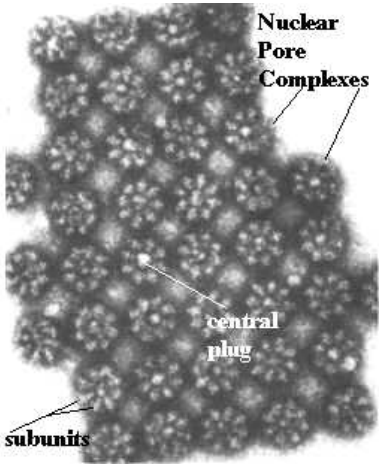

Cytoplasm
Nuclear pore
Cytoplasmatic ring
Central granule
Nuclear envelope
Nuclear lamina
Chromatin
Nucleus

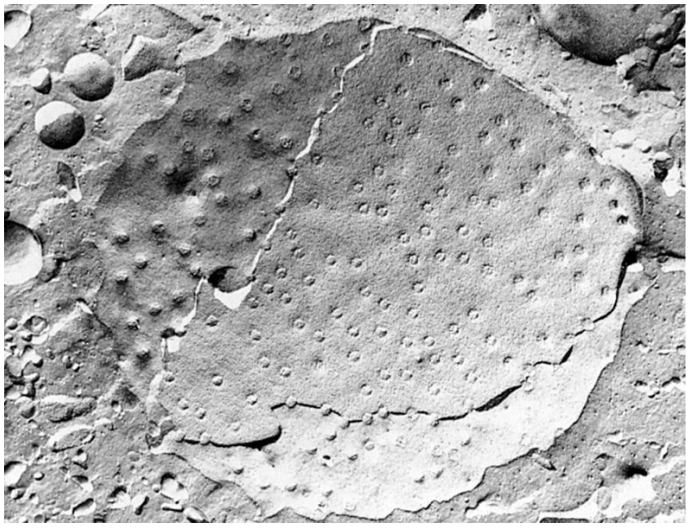

View from the top of the pore
View from the side of the pore

Nuclear pores







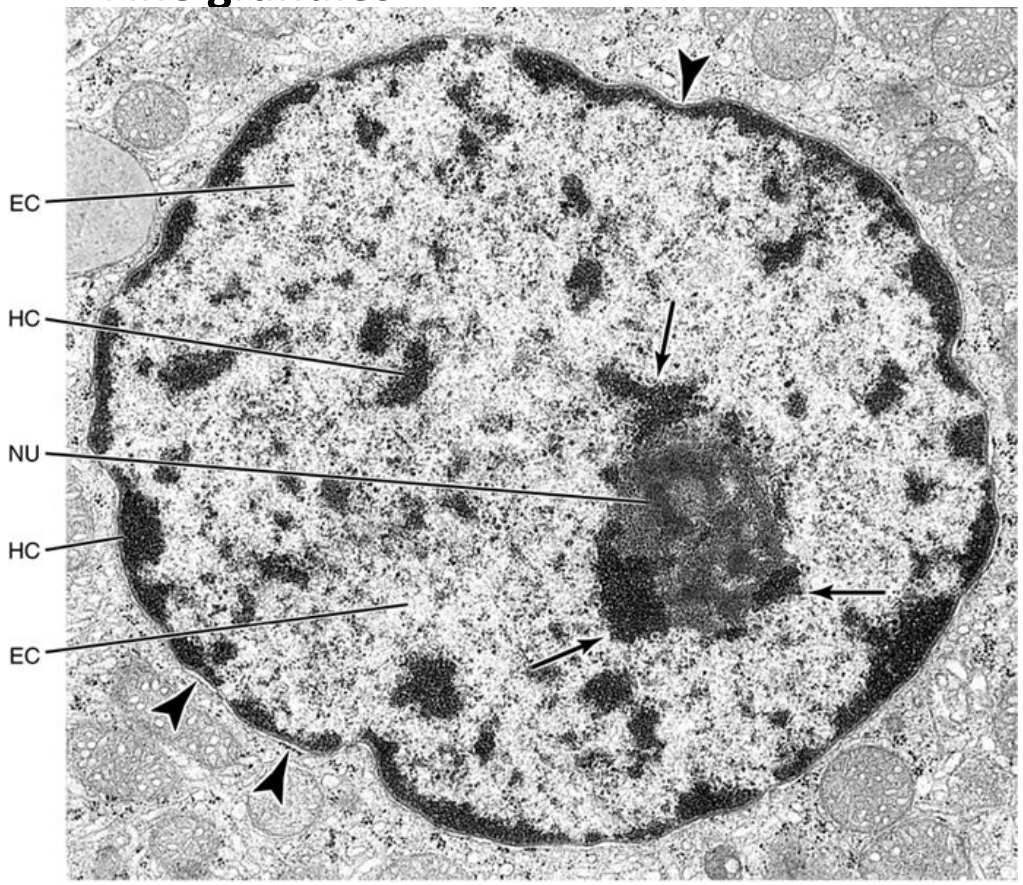


EM of chromatin

Coiled DNA strands on basic protein (hisones)

1. Euchromatin:

Fine granules



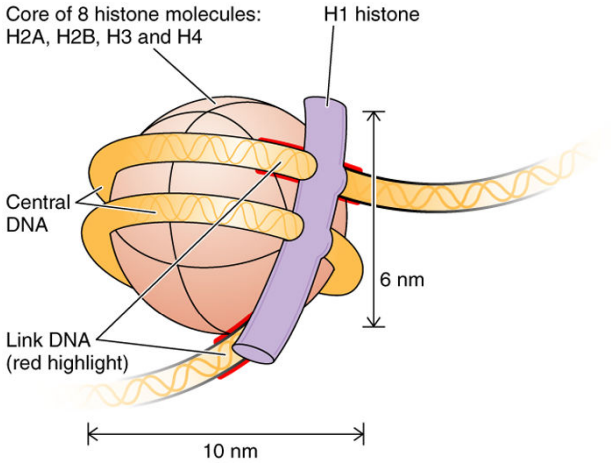
2. Heterochromatin:

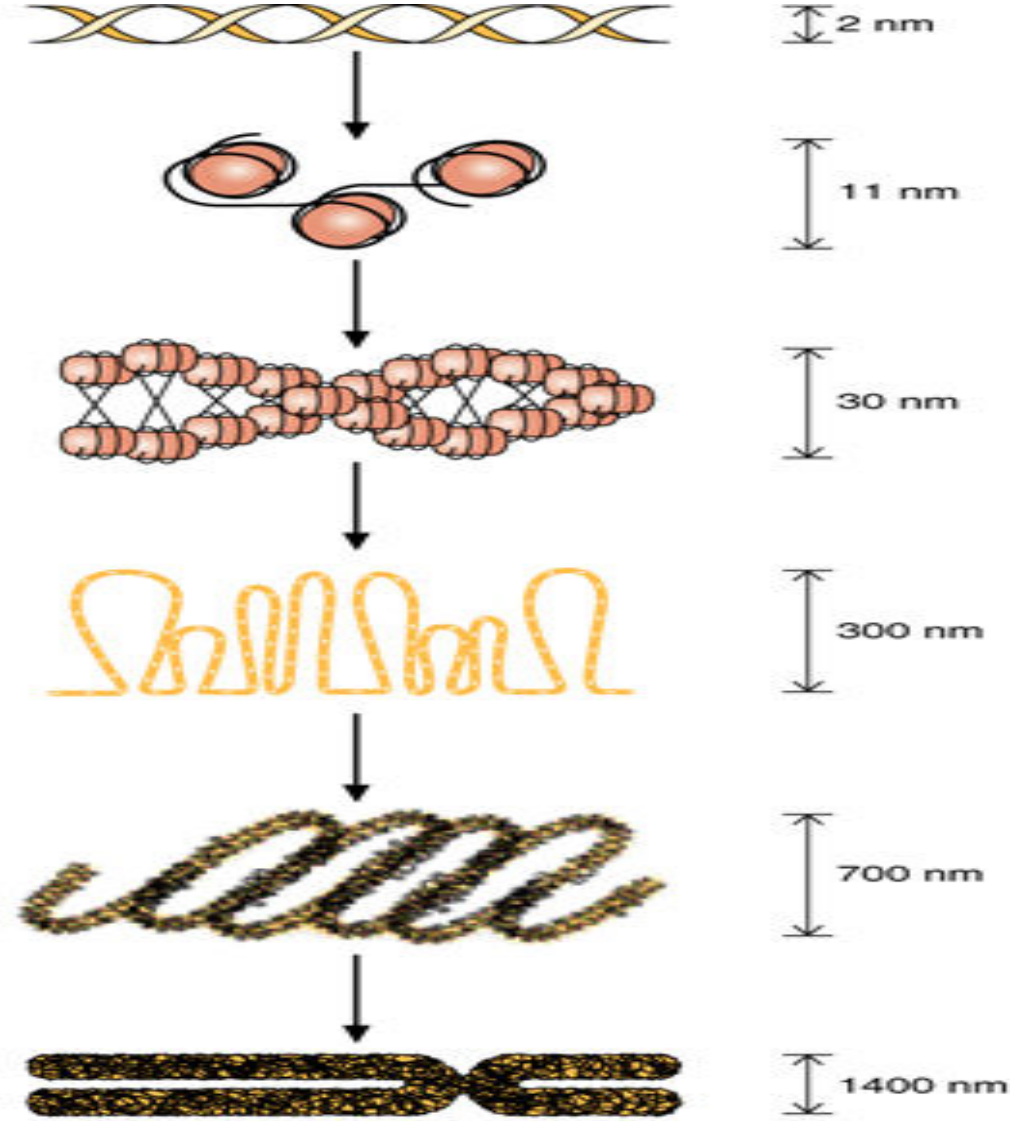
Condensed at different sites

A) Peripheral chromatin

B) Chromatin islands: scattered

c) Nucleolus-associated chromatin


Core of 8 histone molecules:
H2A, H2B, H3 and H4
H1 histone
Central
DNA
6 nm
Link DNA
(red highlight)
10 nm


2 nm
11 nm
30 nm
300 nm
700 nm
1400 nm

Structure:

1.Nuclear membrane (nuclear envelope):

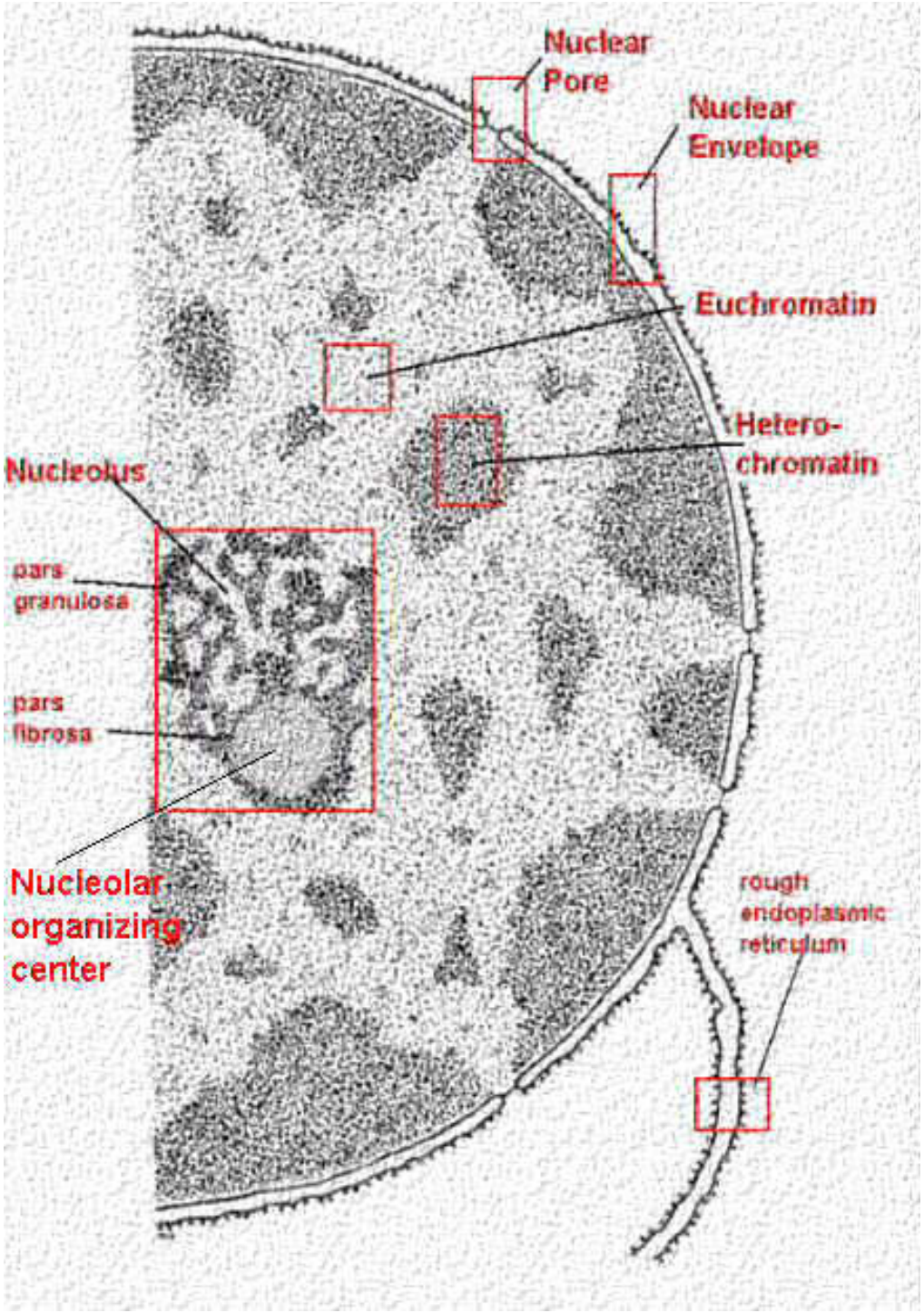
LM: Basophilic line (inner chromatin and outer ribosomes)

EM: Double wall interrupted separated by perinuclear Space & interrupted by nuclear pores.

Outer membrane: Granular (ribosomes attached to rER).

Inner membrane: Fibrillar (peripheral chromatin).

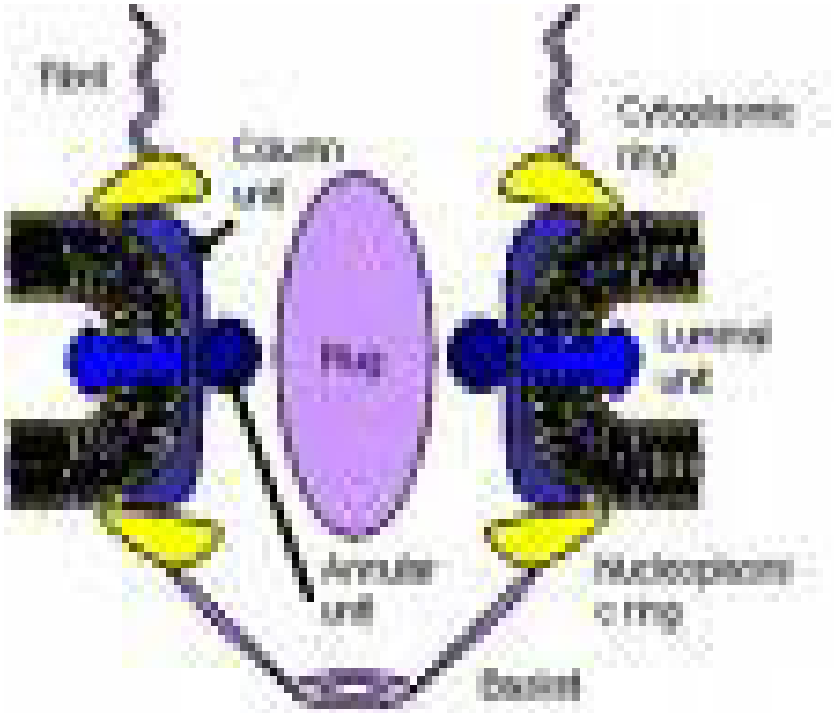
Nuclear pores: Outer and inner membranes fuse.

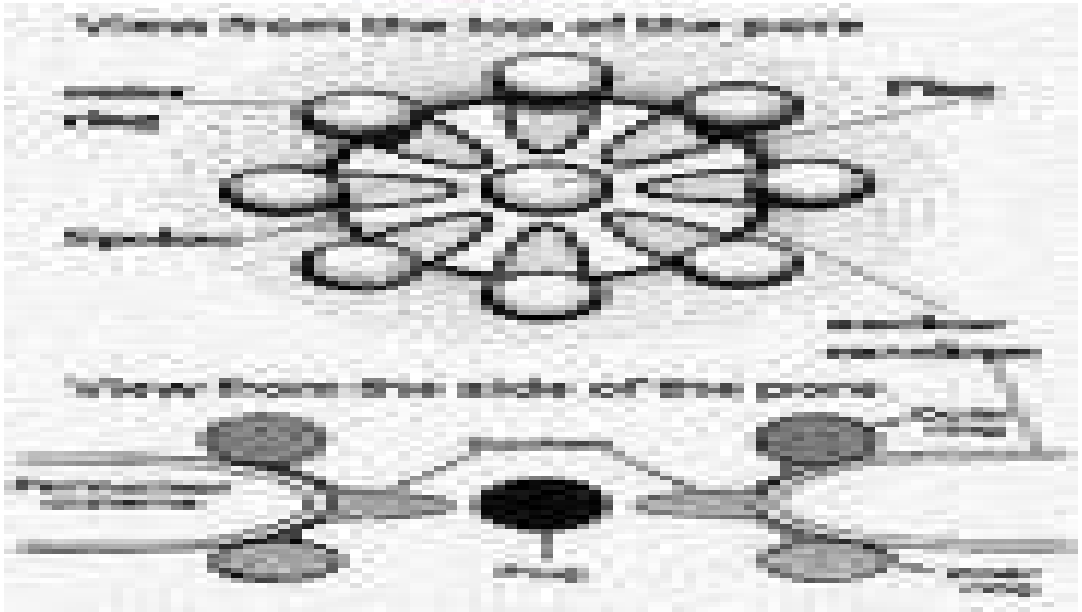


Nuclear pores:

Circular openings
at intervals
where outer & inner
membranes fuse.
Diaphragms formed
of 8 subunits (octagonal)
radial around the
pore (annulus) & a

plug in the center called
nuclear pore complex





2.Chromatin:

Formed of nucleoprotein
(DNA + histones)

LM: Basophilic particles and threads. 2 types:

Euchromatin: Extended, active, pale.
It is formed of extended chromosomes with active genes responsible for protein synthesis.

Heterochromatin: Condensed, inactive, dark.
It is formed of coiled chromosomes with inactive genes.

EM:

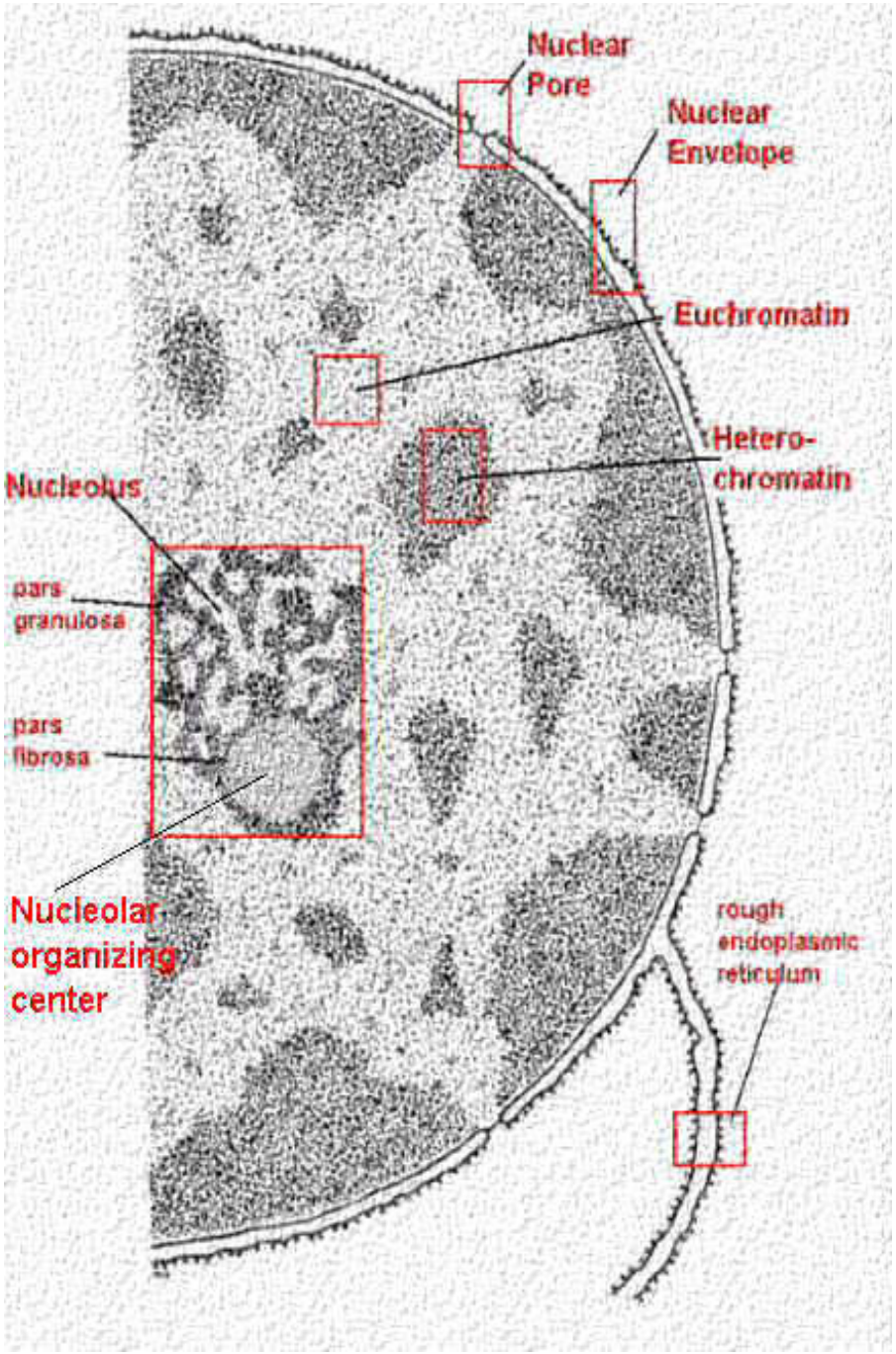
Euchromatin: fine granules.

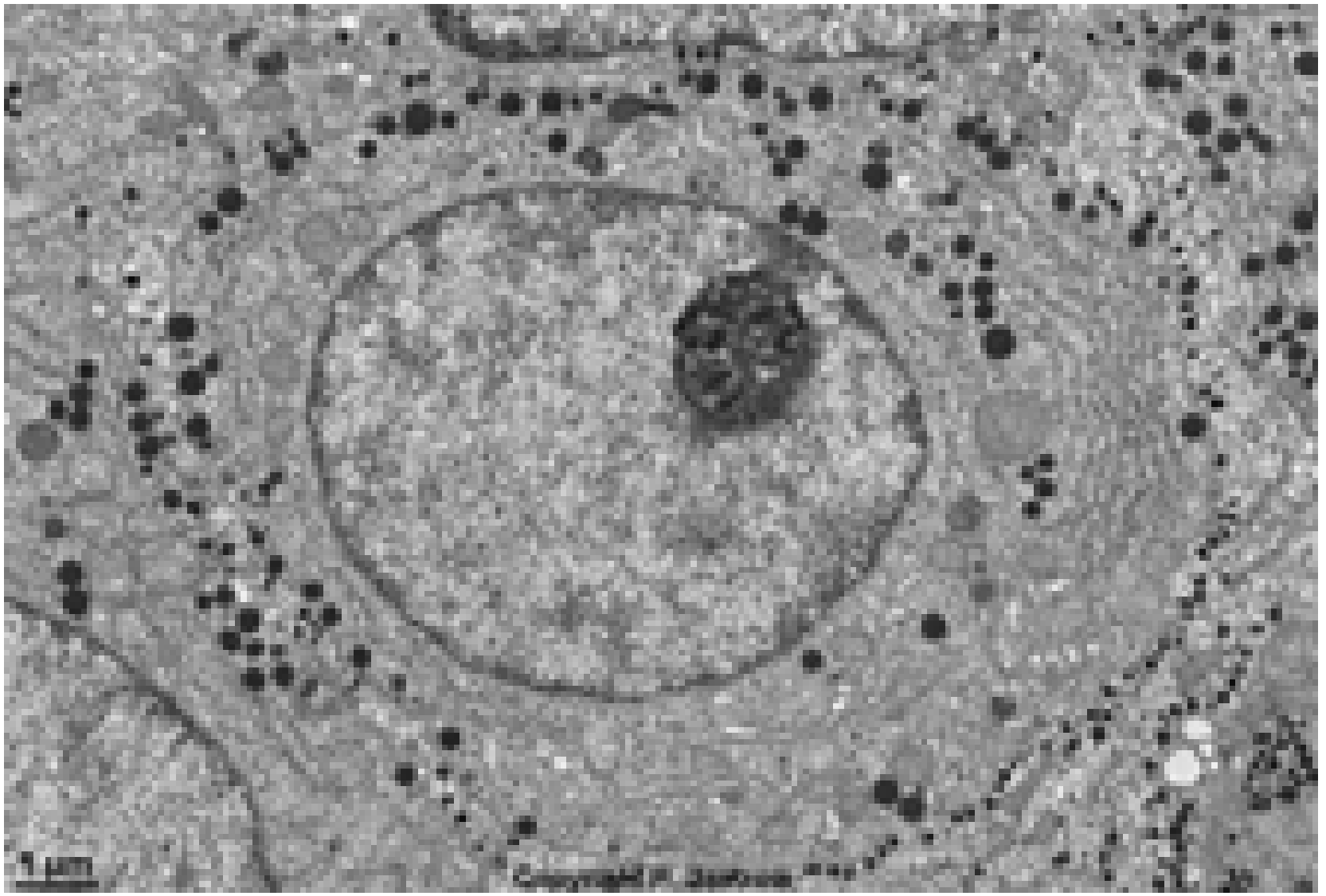
Heterochromatin: Arranged as:

- **Peripheral chromatin at inner nuclear membrane**.
- **Chromatin islands in nuclear sap**.
- **Nucleolus associated chromatin related to nucleolus**.

Function:

- Genetic information (DNA).
- Formation of rRNA, mRNA, tRNA.
- Protein synthesis.




1 µm

3. Nucleolus:

LM: Rounded, basophilic (rich in ribonucleic acid).

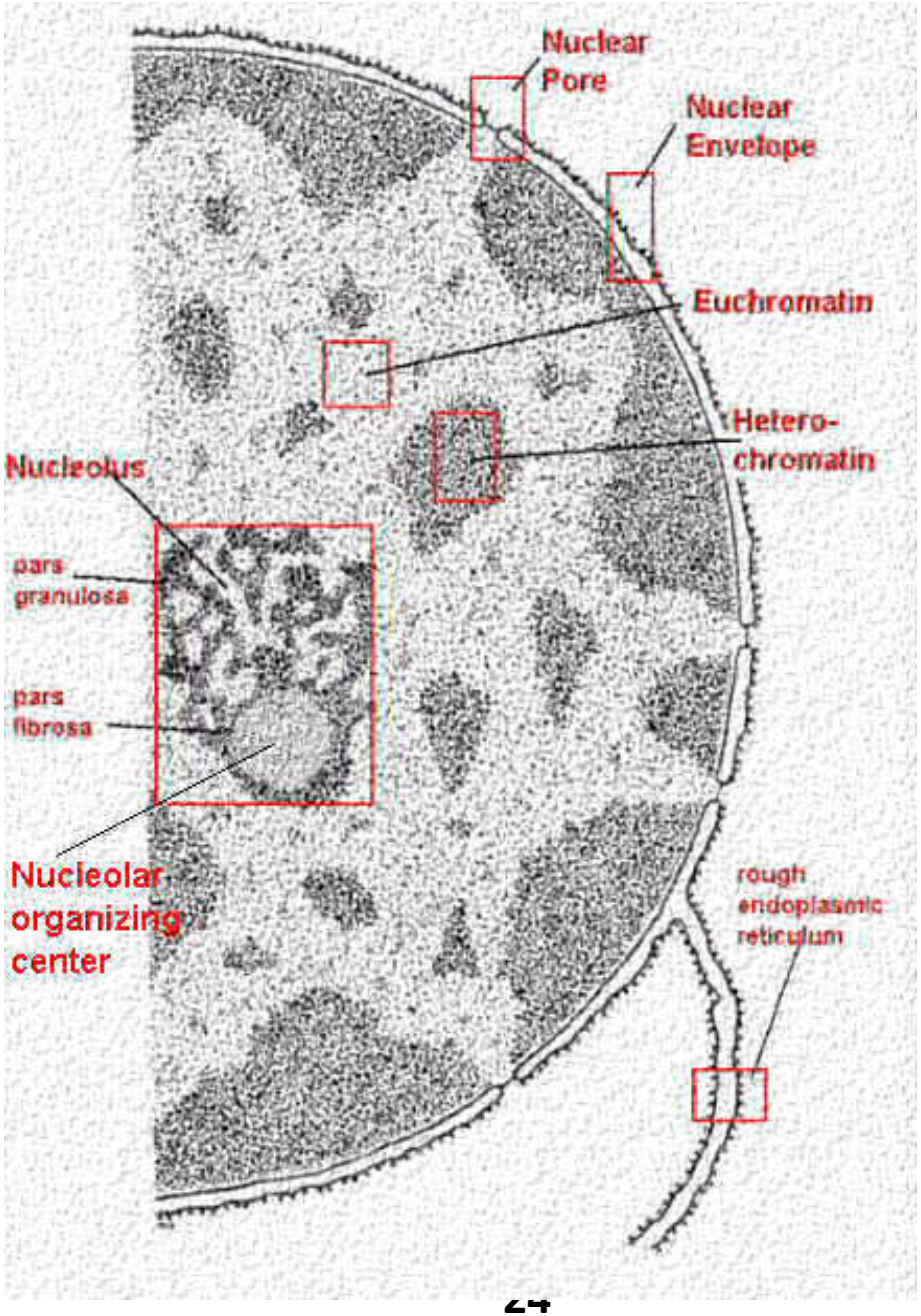
EM: Spongy, not limited by membrane:

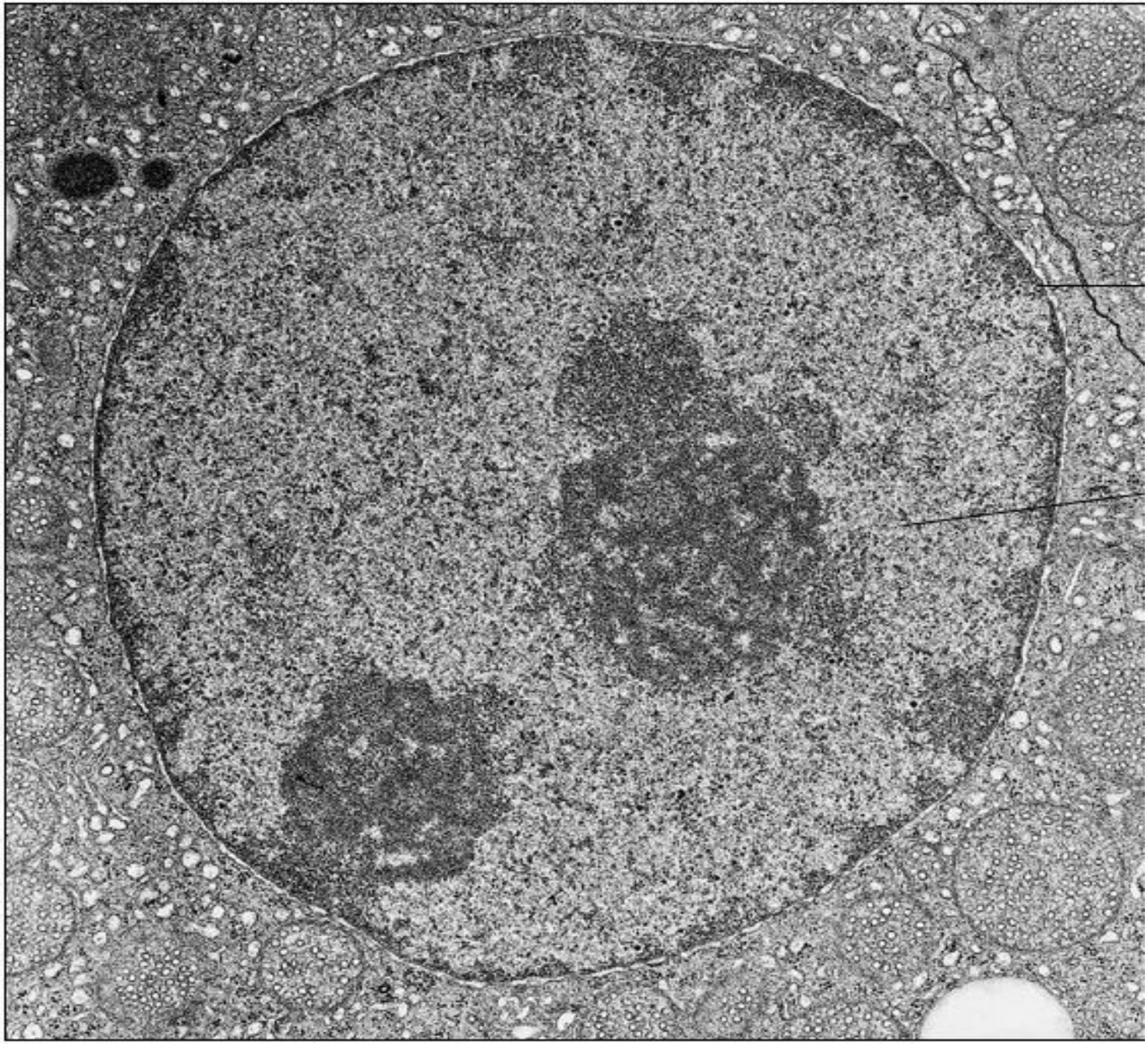
Dark areas: formed of:

1.Pars amorpha of DNA filaments.
2.Pars fibrosa of newly formed rRNA.
3.Pars granulosa of mature rRNA.
2.+3. are called nucleonema

Light areas: Nucleolar sap.

Function: rRNA passes through nuclear pores to the cytoplasm to form ribosomes





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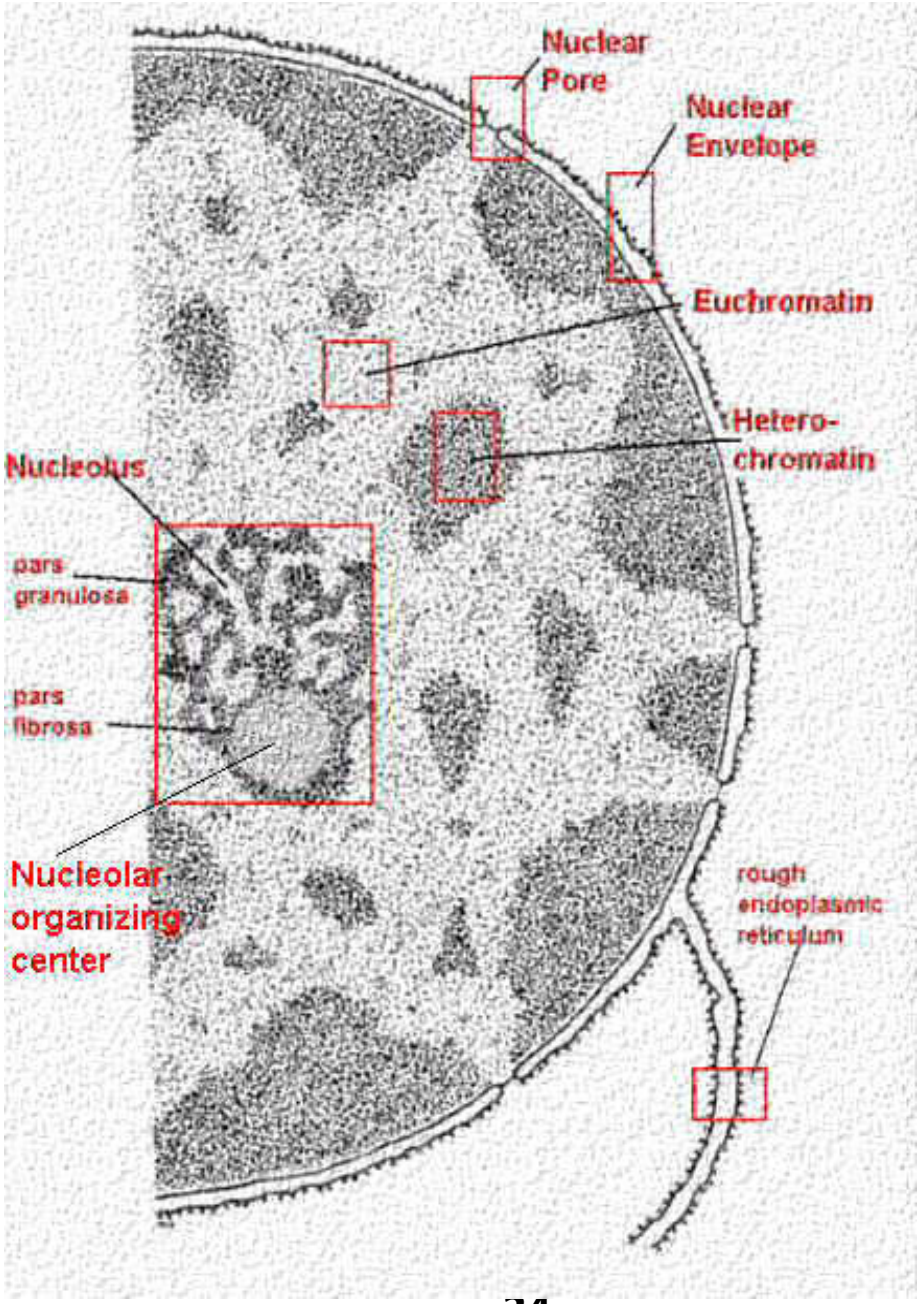

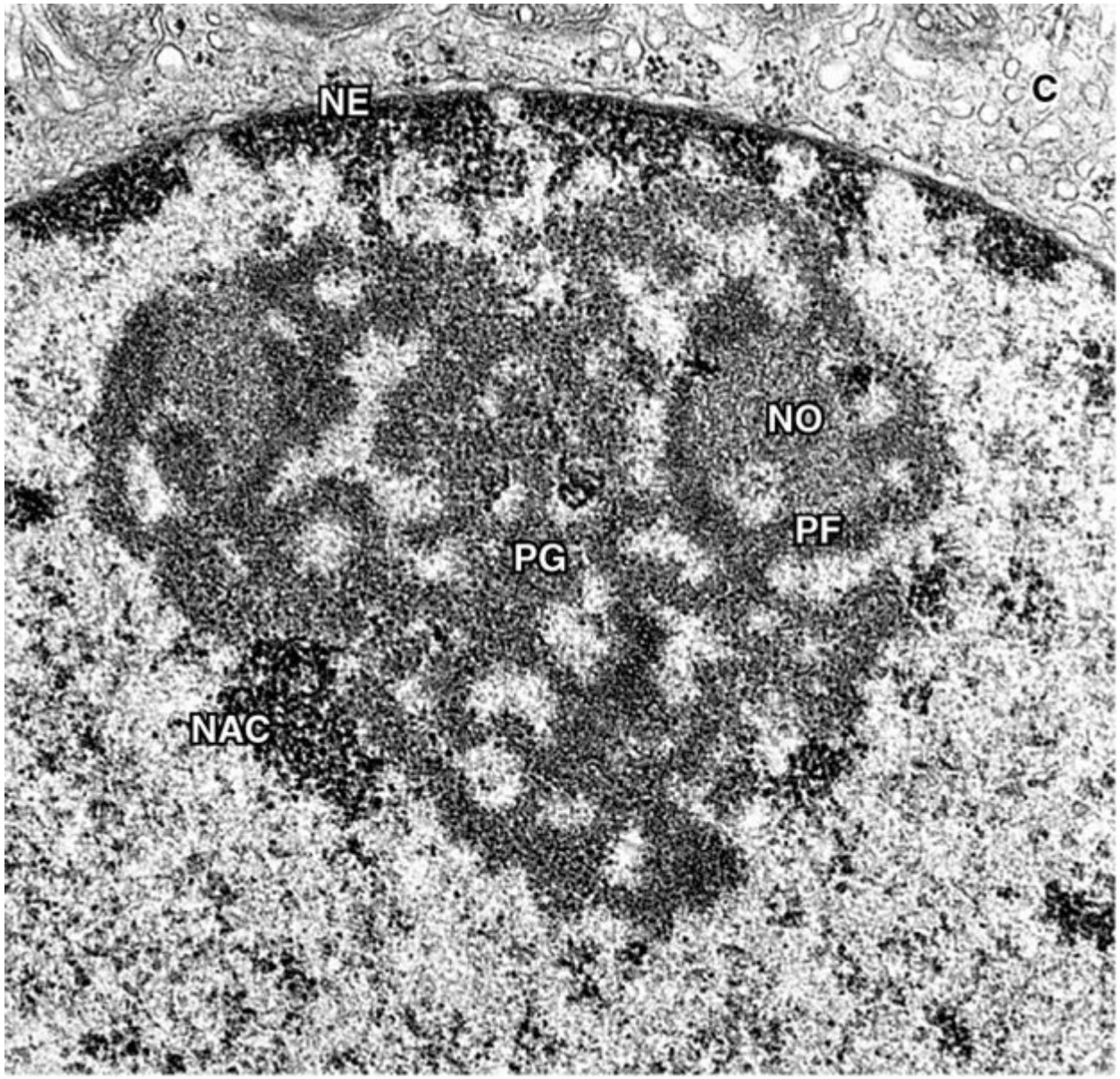
NE
C
NO
PF
PG
NAC

4.Nuclear sap:

- Colloid solution between chromatin and nucleolus.
- Formed of nucleoproteins, enzymes, sugars, Ca, K, P.
- Function: Transport of RNA which pass through pores to the cytoplasm

- Function of nucleus:
- 1- responsible for cell structures & activities.
- 2- replicate its DNA and sythesize RNA
- 3- cell division
- 4- doesn’t produce protiens. Its needs of proteins are imported from cytoplasm.


Thank You