

Ch 3: Compartmentation: Cells & Tissues

Or, Anatomy class in one lecture!

Background Basics:

Units of measure

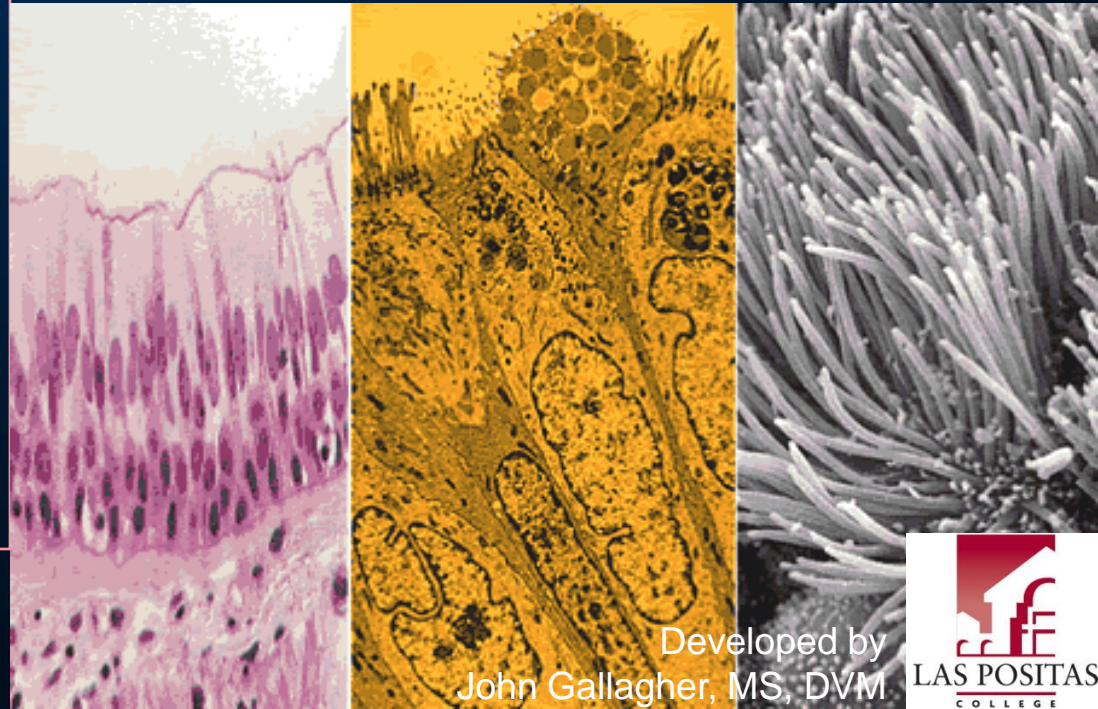
Hydrophobic/philic
molecules

Proteins

Compound molecules

pH

DNA and RNA



Developed by
John Gallagher, MS, DVM

Key Concepts

- ⇒ Cell anatomy
- ⇒ Tissue types
- ⇒ **Tissue remodeling**
- ⇒ Organs

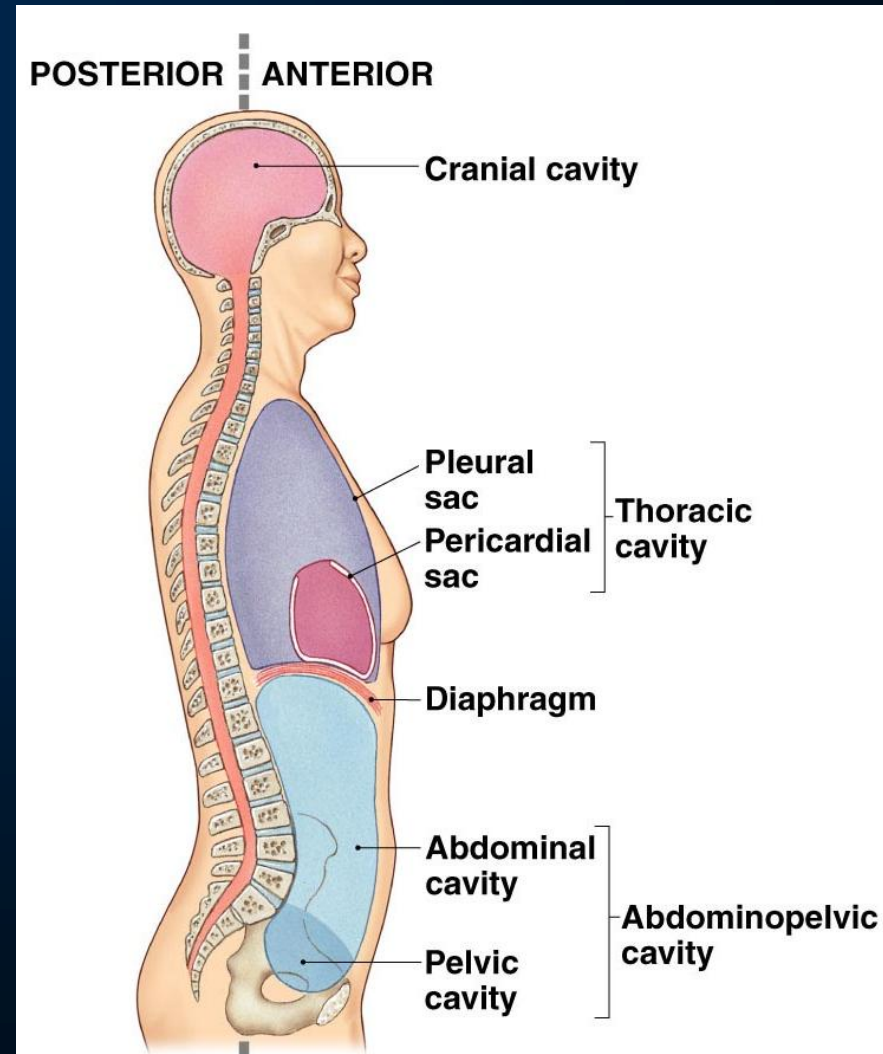
**Study of cell
structure = ?**

**Study of tissue
structure = ?**

**Study of how cells
work = ?**

Compartments

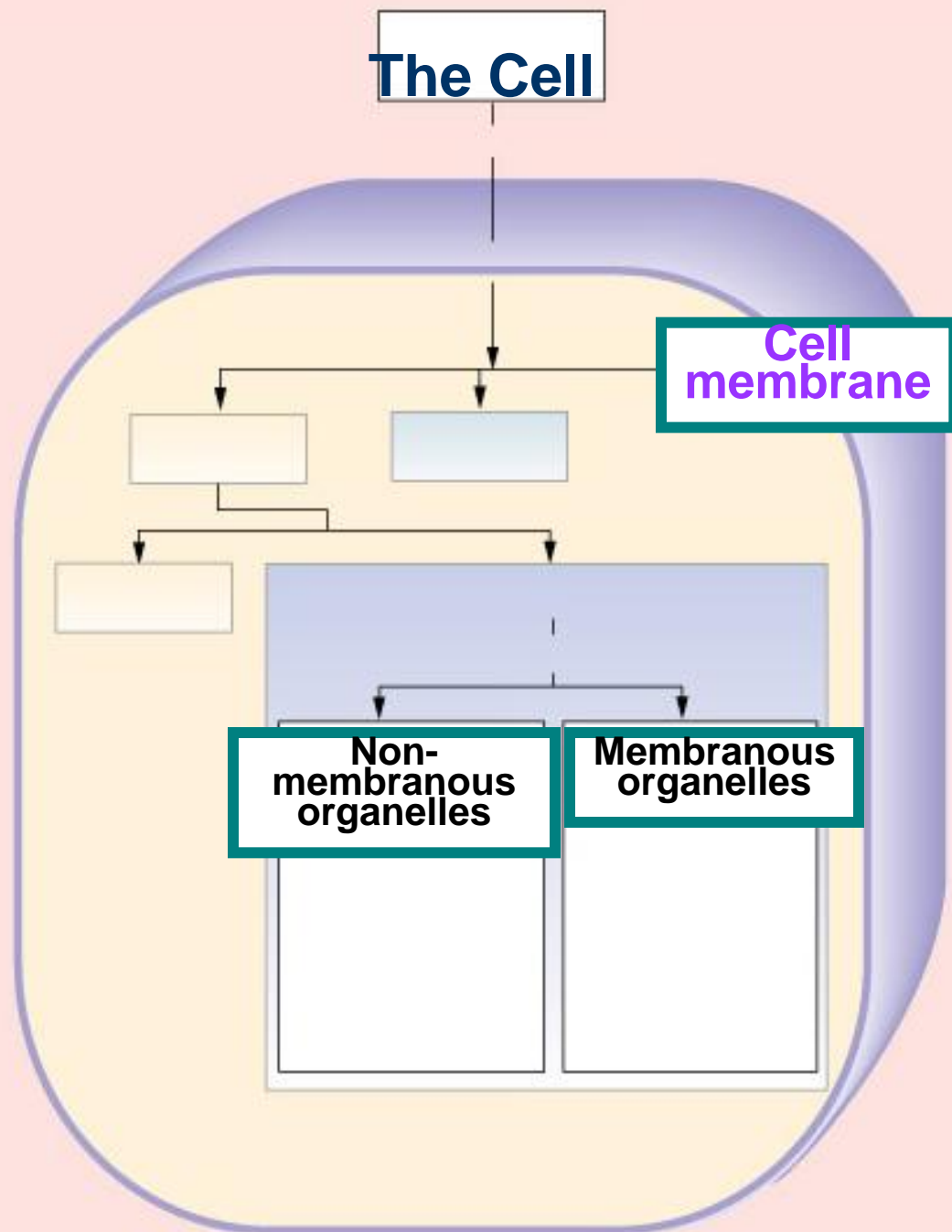
- Major Body Cavities (thorax, etc.)
- Fluid Compartments
 - Intracellular Fluid (ICF) or cytosol
 - Extracellular fluid ECF
 - Between Cells
 - Circulatory System (plasma)
- Intracellular compartments
 - Membranous organelles



Biological Membranes

- Two definitions:
 - Body's borders, e.g.,
 - Peritoneal membrane
 - Skin
 - Cell membrane
 - Phospholipid bilayer
 - Proteins and cholesterol interspersed

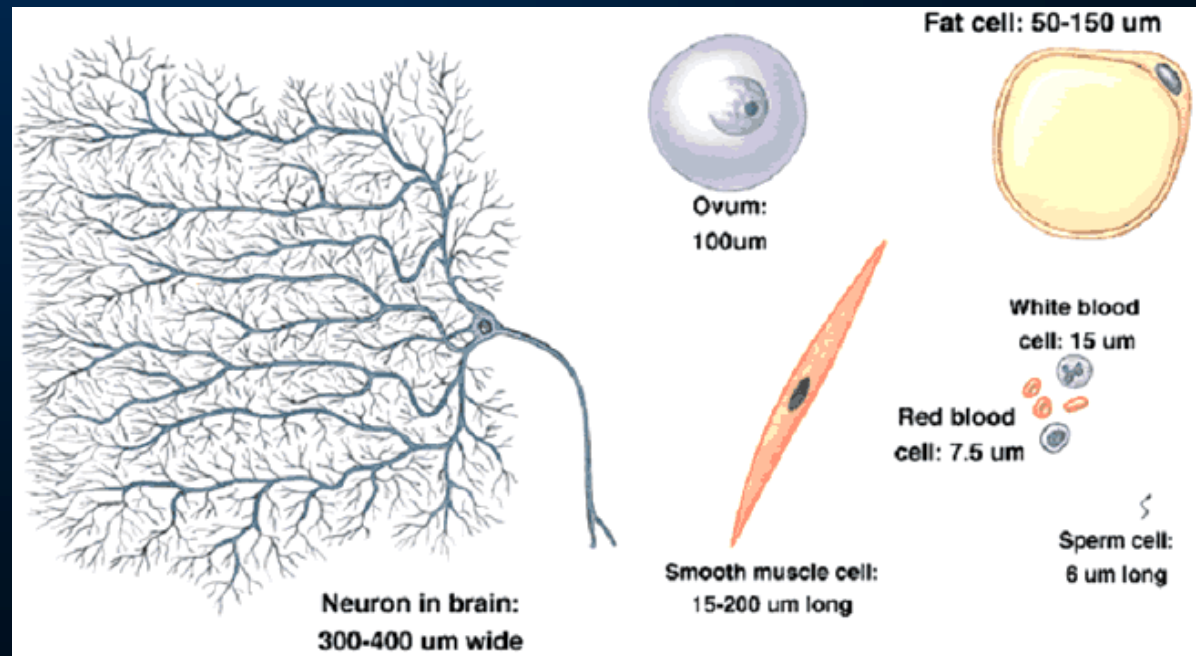
Cell Anatomy



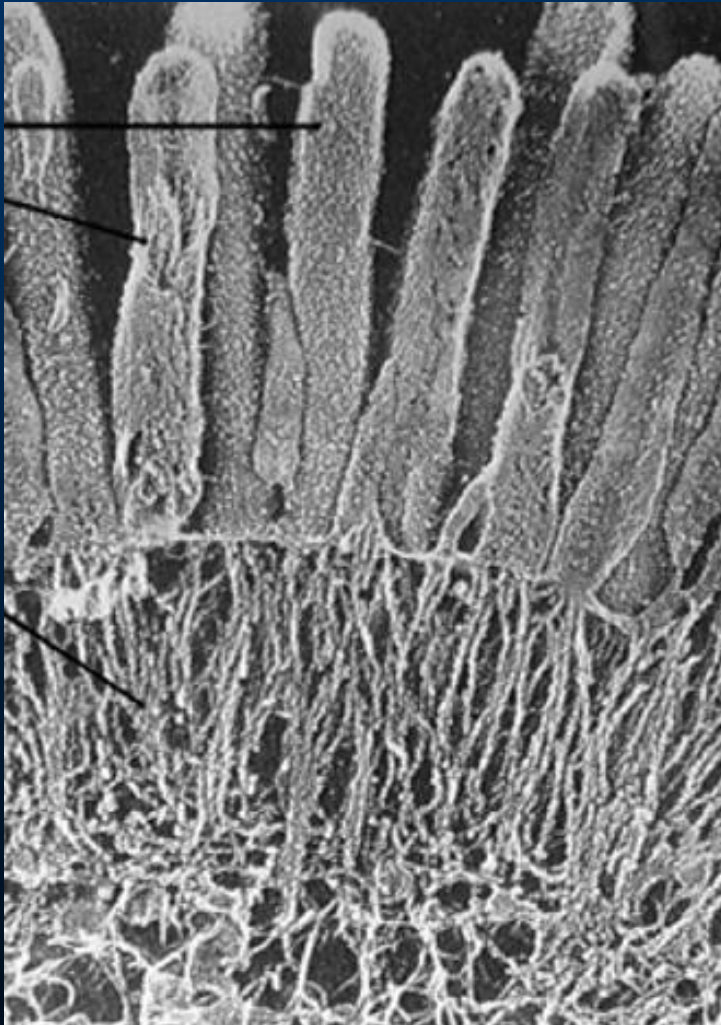
Cell differentiation

From 1 zygote to 200 different types of cells

Mechanism: differential gene activation allows creation of specialized cells

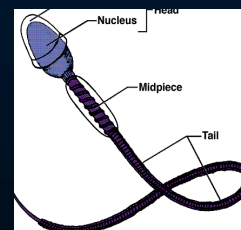


Special Structural Features of Cell Membranes



- Microvilli
- Cilia
- Stereocilia
- Flagella

Function?



Cytoplasm

```
graph TD; Cytoplasm --> Cytosol; Cytoplasm --> Organelles; Organelles --> Membranous[Membranous organelles]; Organelles --> NonMembranous[Non-membranous organelles];
```

Cytosol:

= *semigelatinous intracellular fluid*

Medium for suspension of

1. Organelles,
2. Ions, nutrients, wastes, enzymes etc.....
3. Inclusions

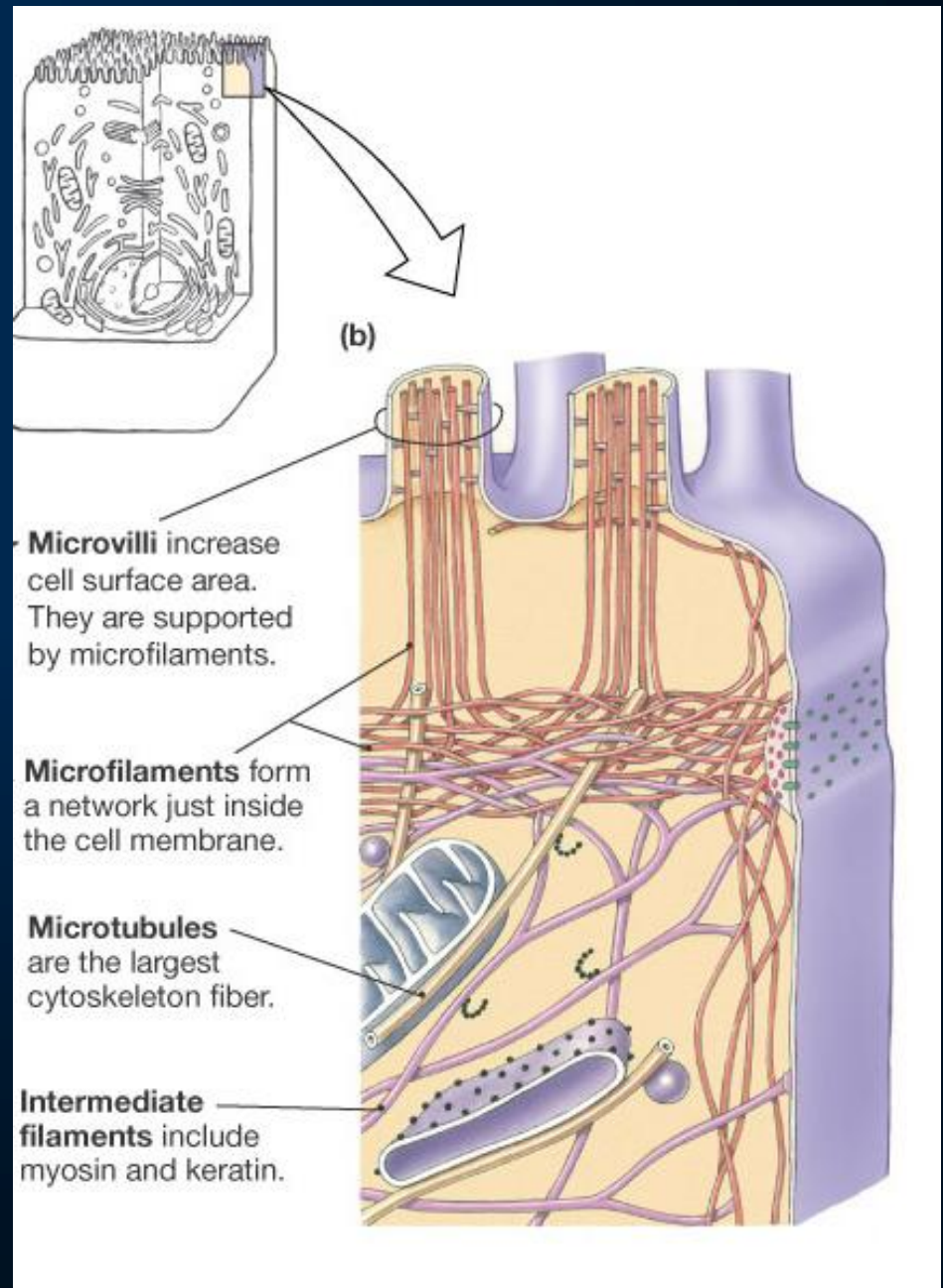
Organelles perform specialized tasks.

Membranous organelles

Non-membranous organelles

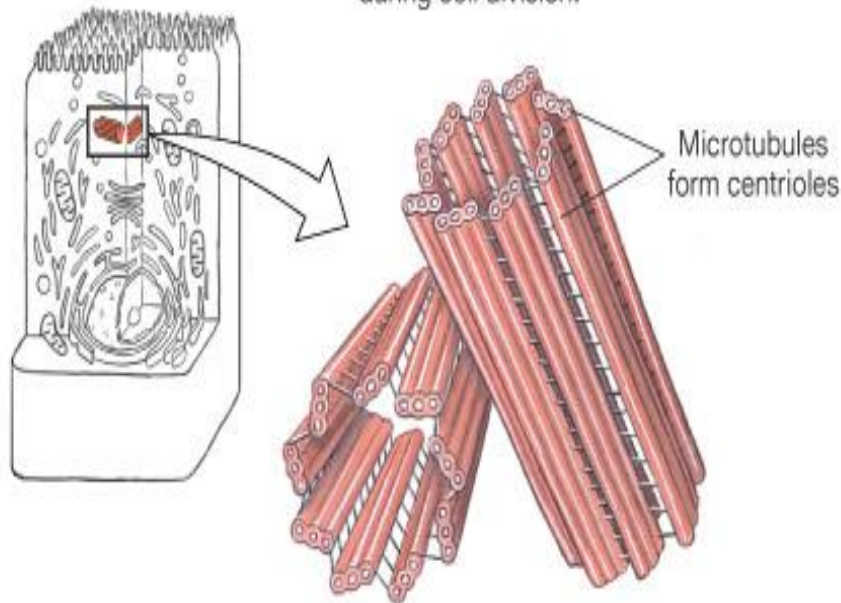
Cytoskeleton

- Strength
- Support
- Shape
- Transport
- Cell to cell links
- Protein fibers
 - Microfilaments
 - Intermediate
 - Microtubules

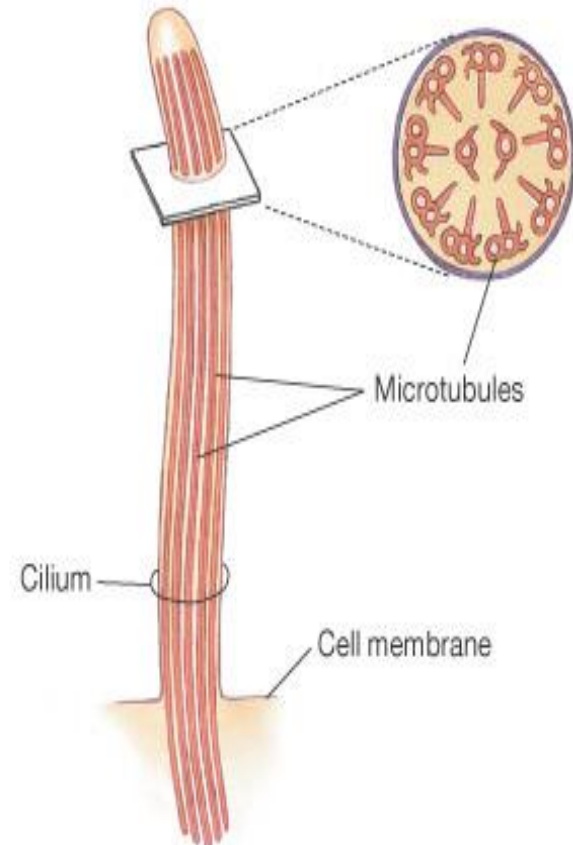


Centrosomes and Centrioles

(a) Centrioles direct DNA movement during cell division.



(c) Cilia and flagella have 9 pairs of microtubules surrounding a central pair.



1 centrosome contains 2 centrioles

Centrosomes organize microtubules

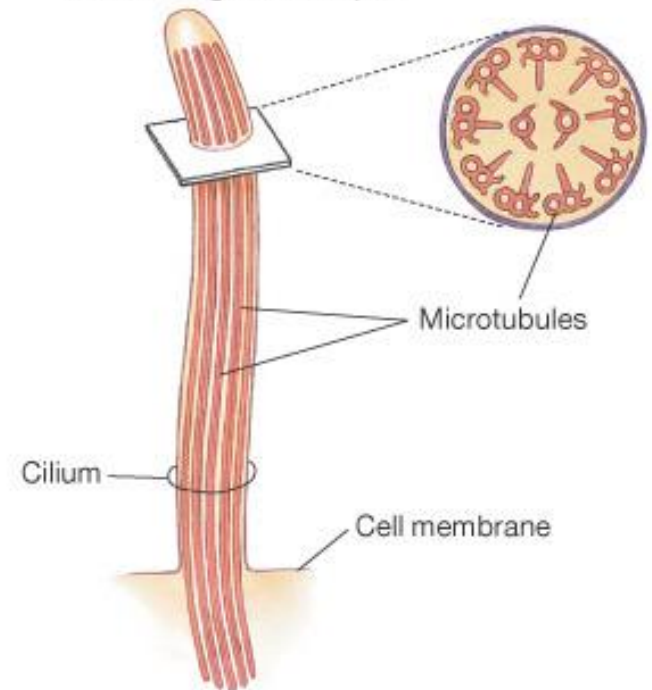
Centrioles: bundles of microtubules

Pull chromosomes, form core in cilia

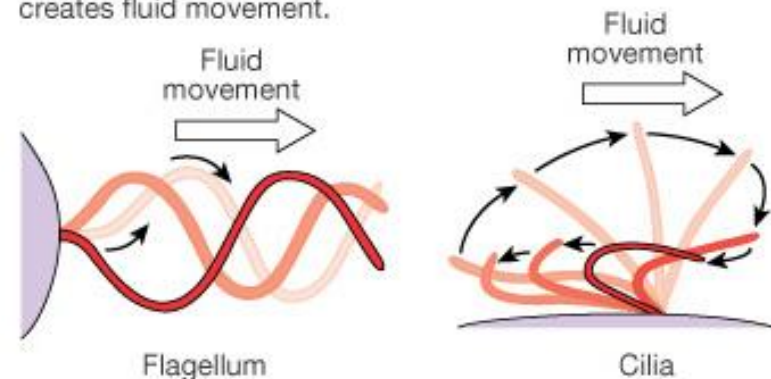
Cilia and Flagella

- Contain motor proteins
- 2:9 microtubule pattern
- Cilia move fluids
- Flagella move sperm cells

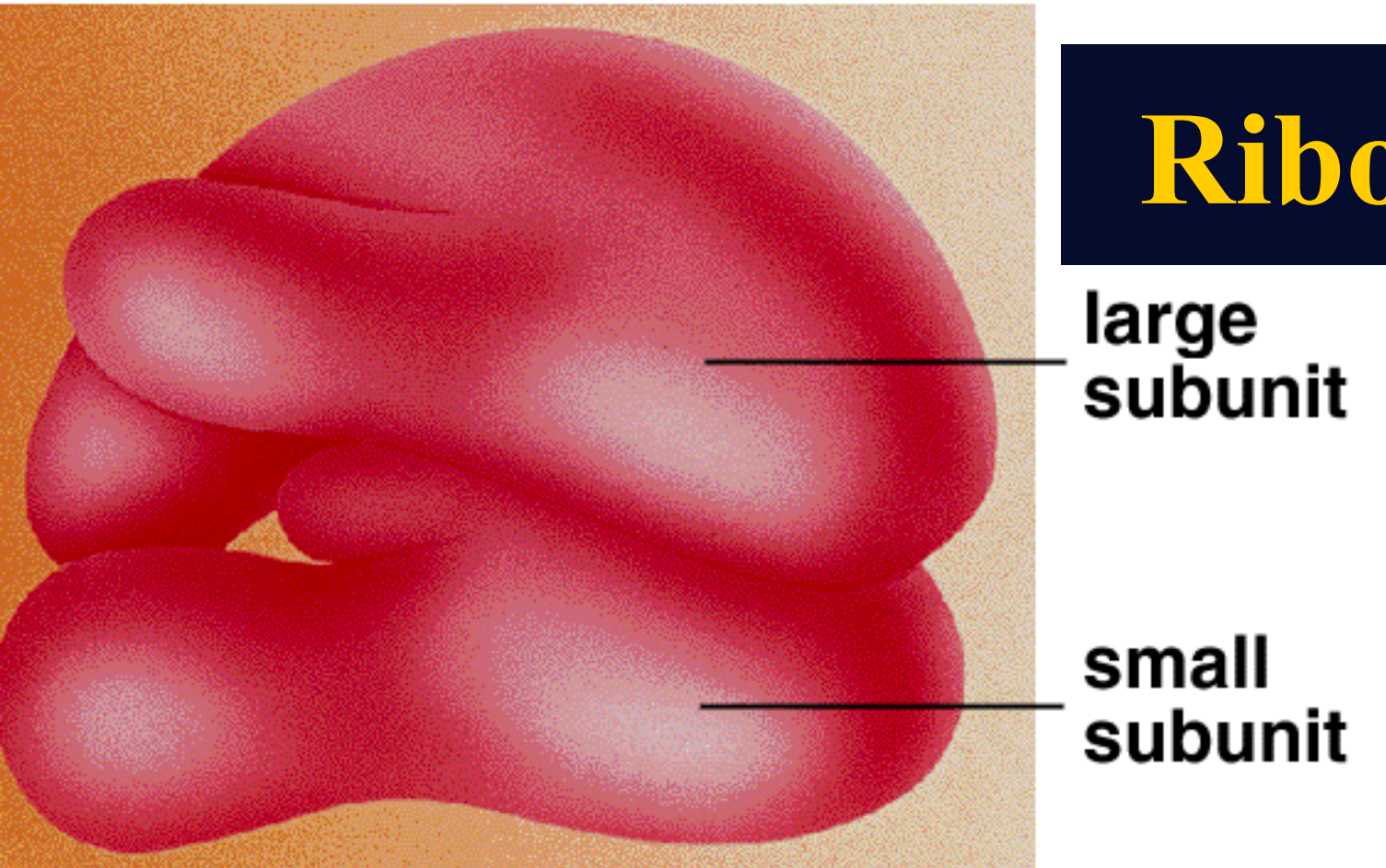
(c) Cilia and flagella have 9 pairs of microtubules surrounding a central pair.



(d) The beating of cilia and flagella creates fluid movement.



Ribosomes



- **Function: Transfer of messages from DNA**
- **Fixed to ER or free in cytoplasm**

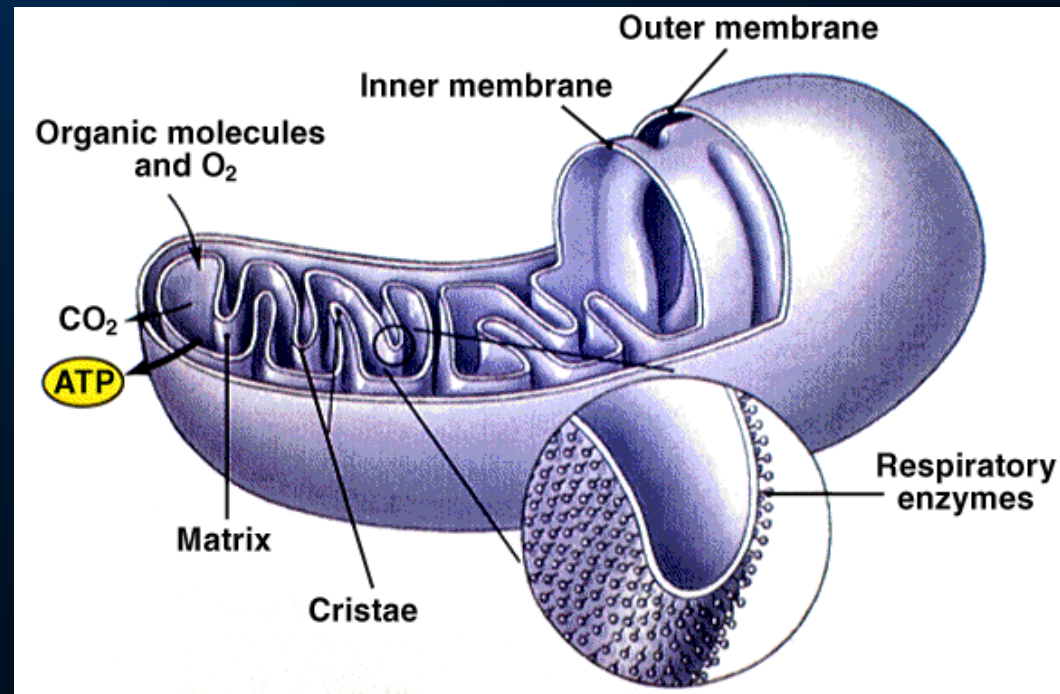
Membranous Organelles

Special compartments for special functions

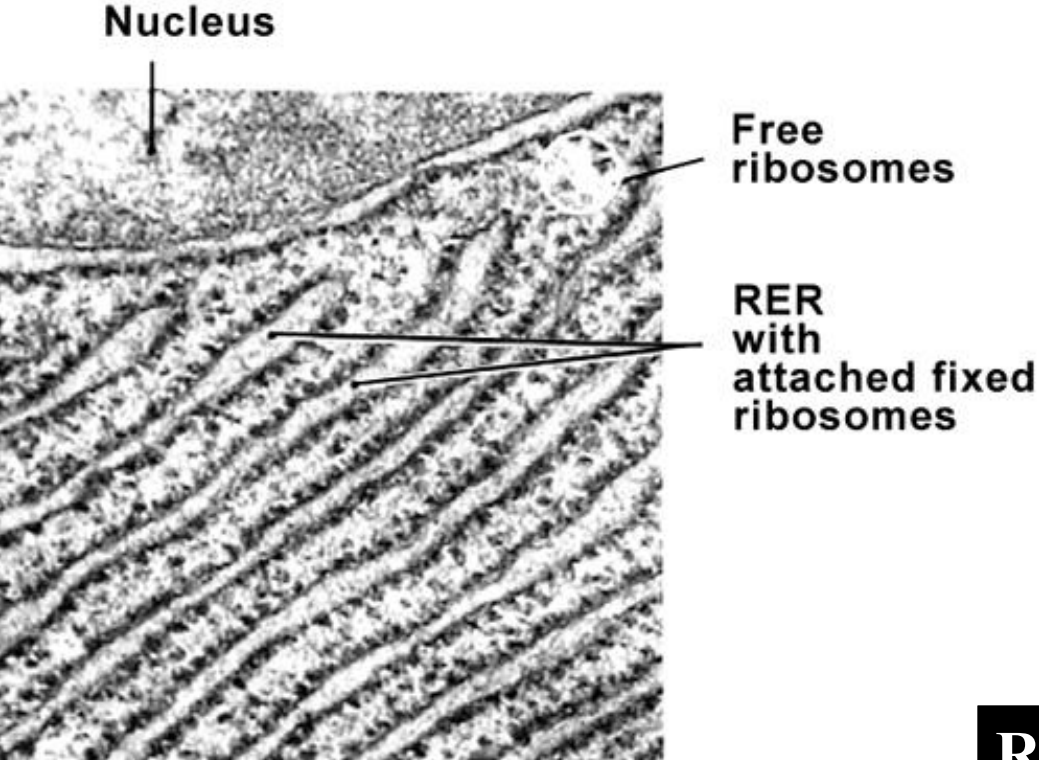
- Separate harmful substances from other cell areas
- Separate function from other cell areas

Mitochondrion =
powerhouse of cell.
Energy (ATP)
production

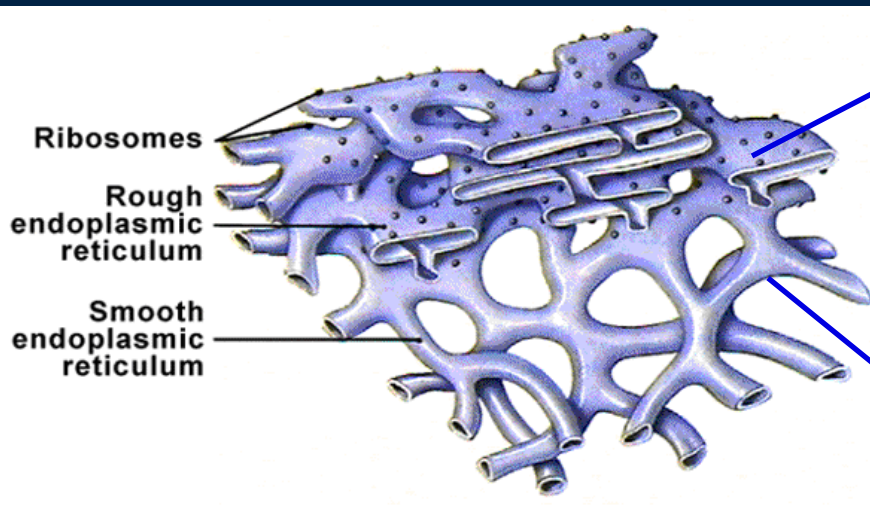
Has own DNA, self-replicating



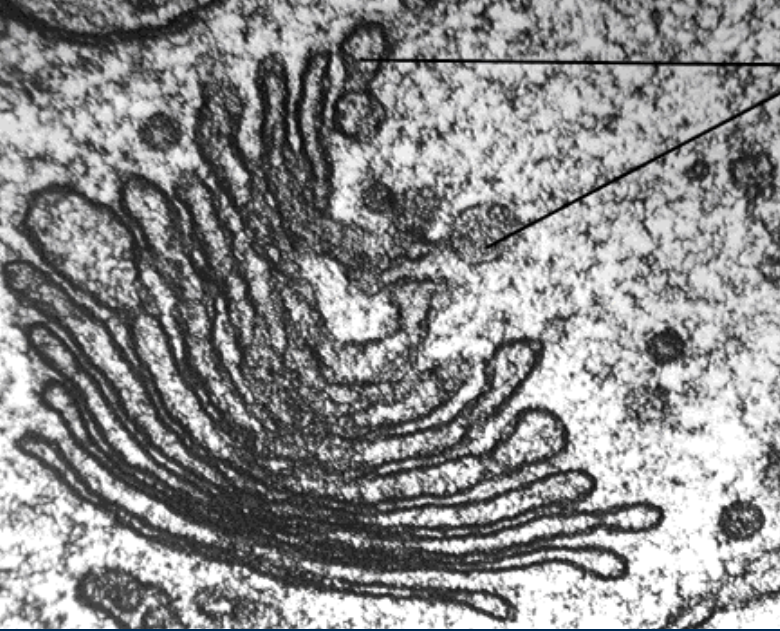
RER & SER



RER: Protein synthesis, storage, modification & transport vesicles



SER: Synthesis and conversion of FA, steroids, lipids
In muscle: Ca^{2+} storage

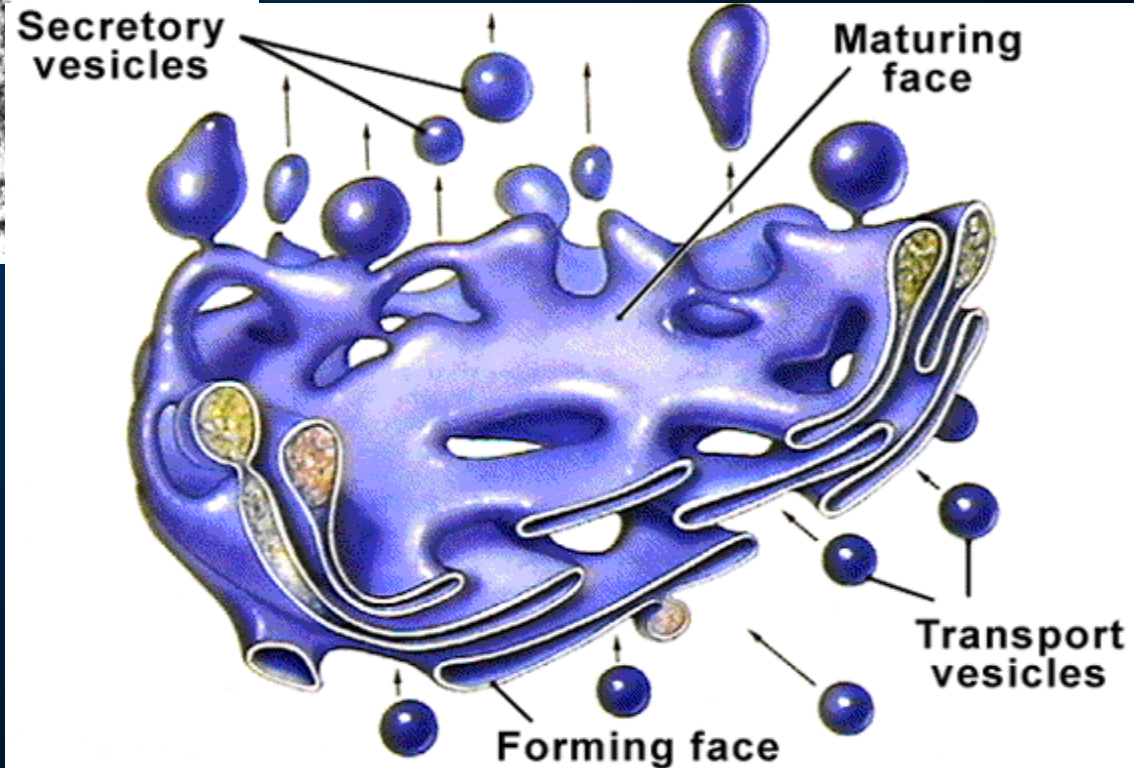


Secretory vesicles

TEM

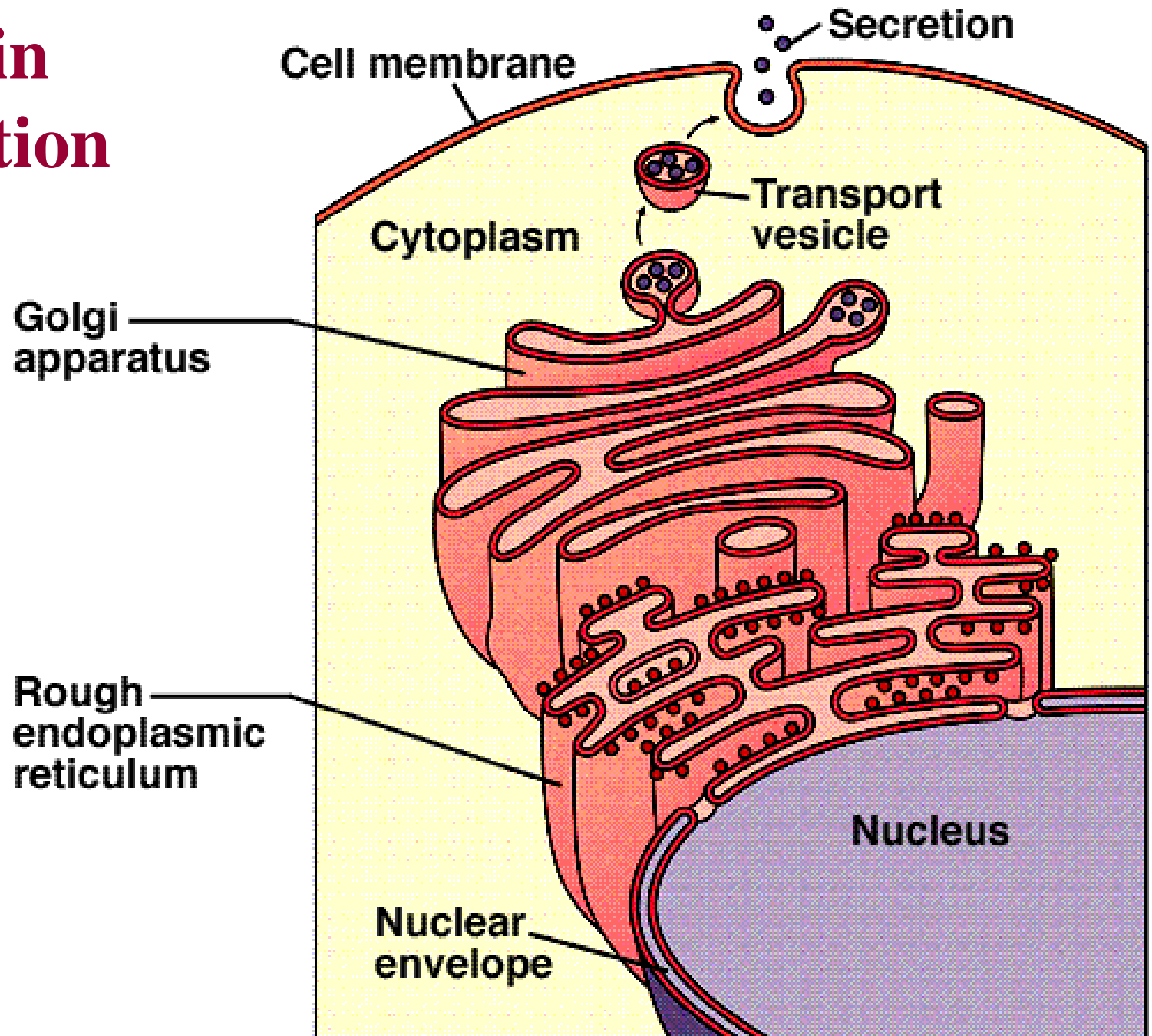
Golgi Apparatus

“Post office” of cell

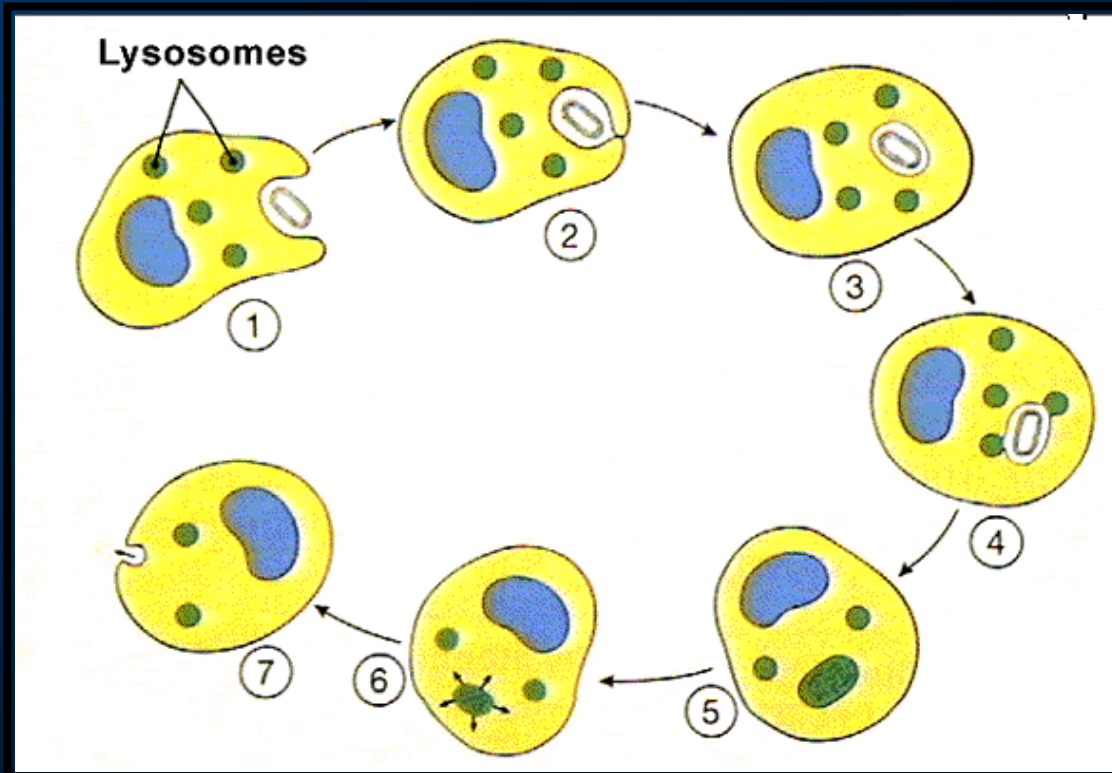


- Modification (labeling) of proteins
- Packaging into secretory (to ECF) or storage vesicles

Protein Secretion



Lysosomes

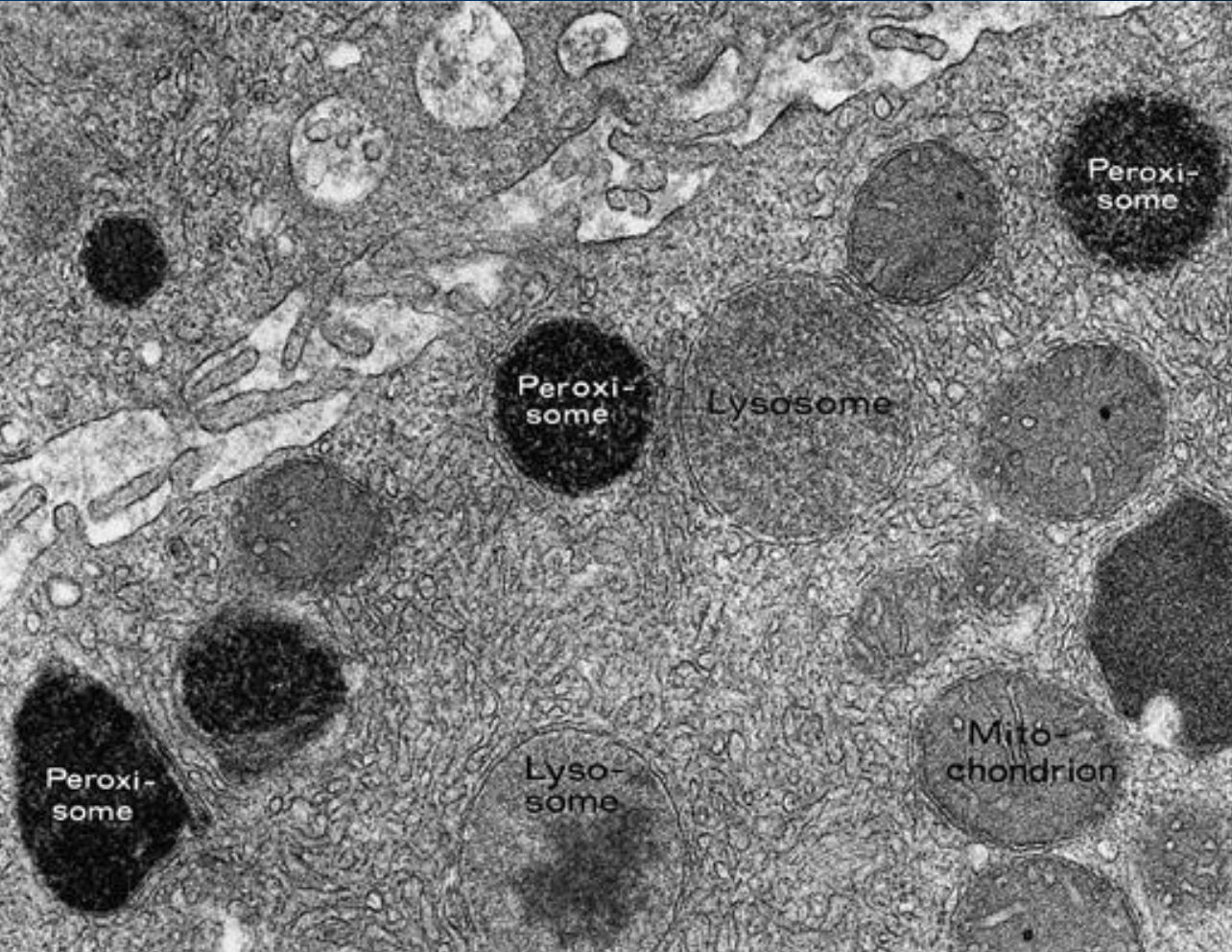


Digestion (~ 50 enzymes) of bacteria and old organelles

Enzymes only active at pH of 100 – 1,000 x < cytoplasm
 $\Rightarrow \text{pH} = ?$

Also used to dissolve Ca-carbonate of bone and for self destruction of damaged cells

Disorders such as rheumatoid arthritis and Tay-Sachs disease



Peroxi-somes

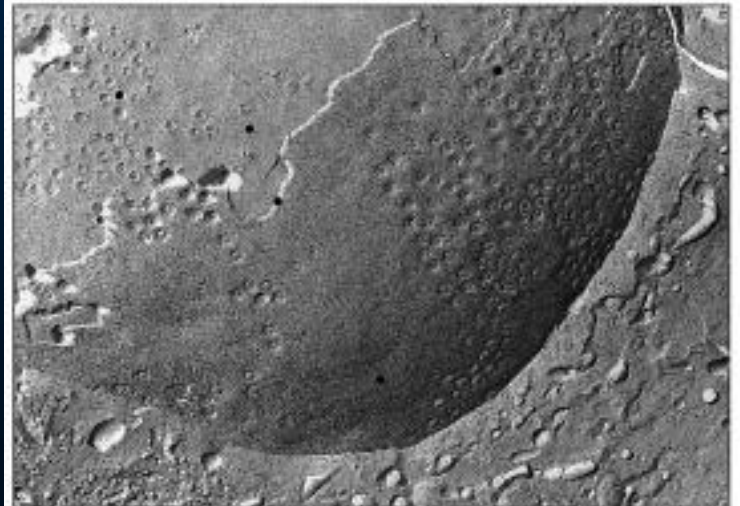
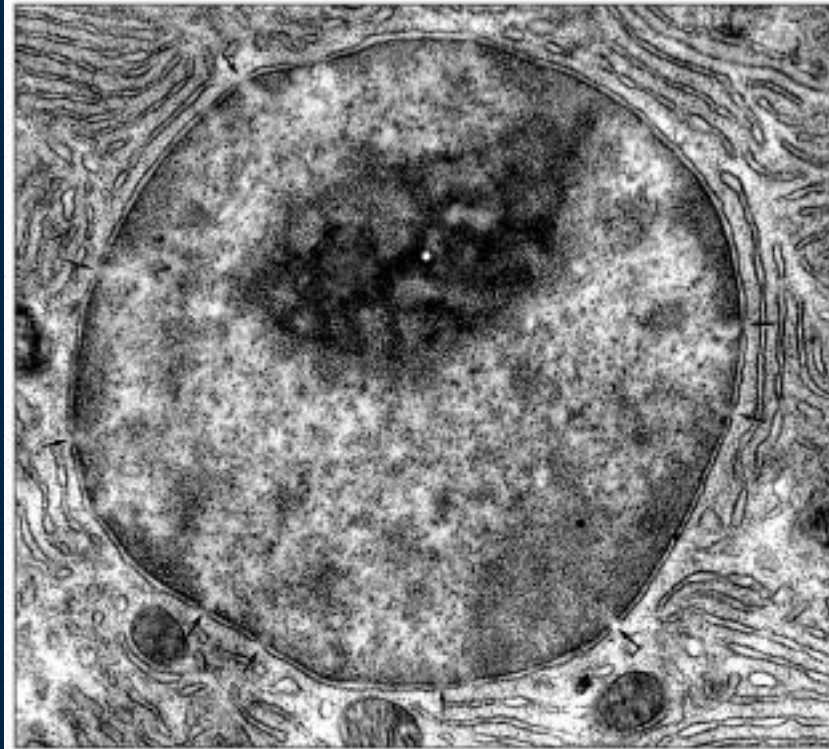
**Smaller than
Lysosomes -
Different set of
enzymes**

Major function: Degradation of long chain FAs

Generate hydrogen peroxide \Rightarrow contain catalase

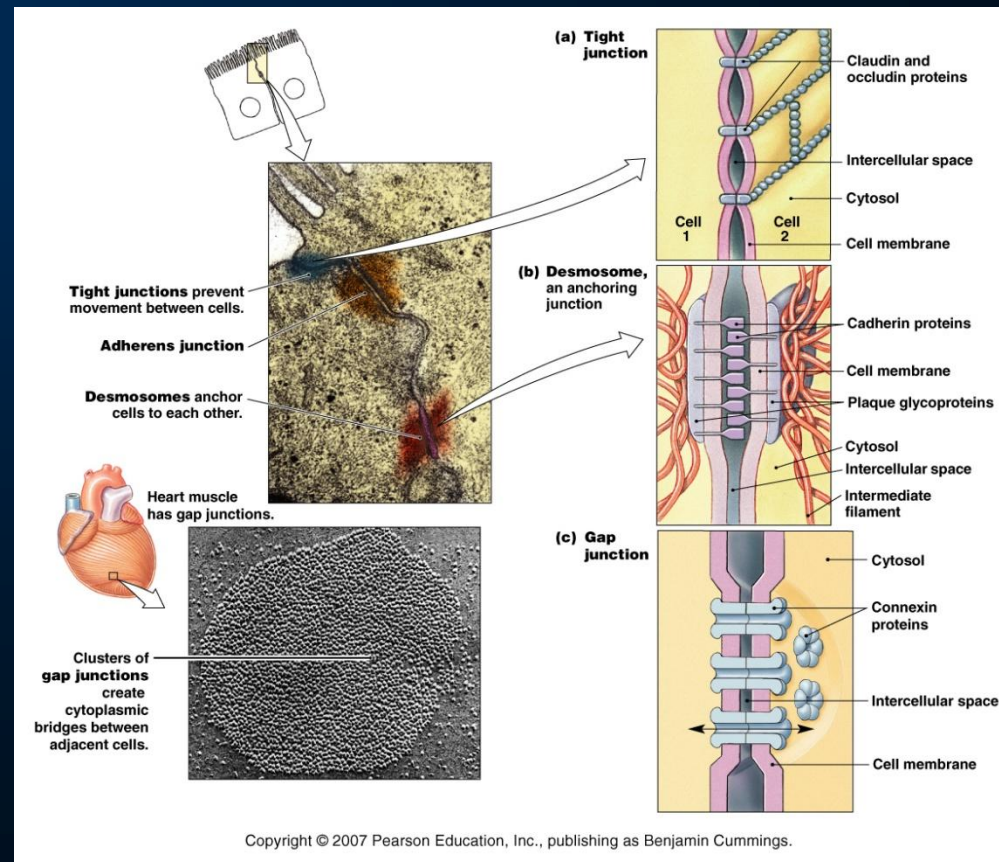
Nucleus

- Control Center
- Nuclear envelope with nuclear pore complexes for diffusion and active transport
- Chromatin (DNA and proteins)
- DNA forms genes
- One or more nucleoli

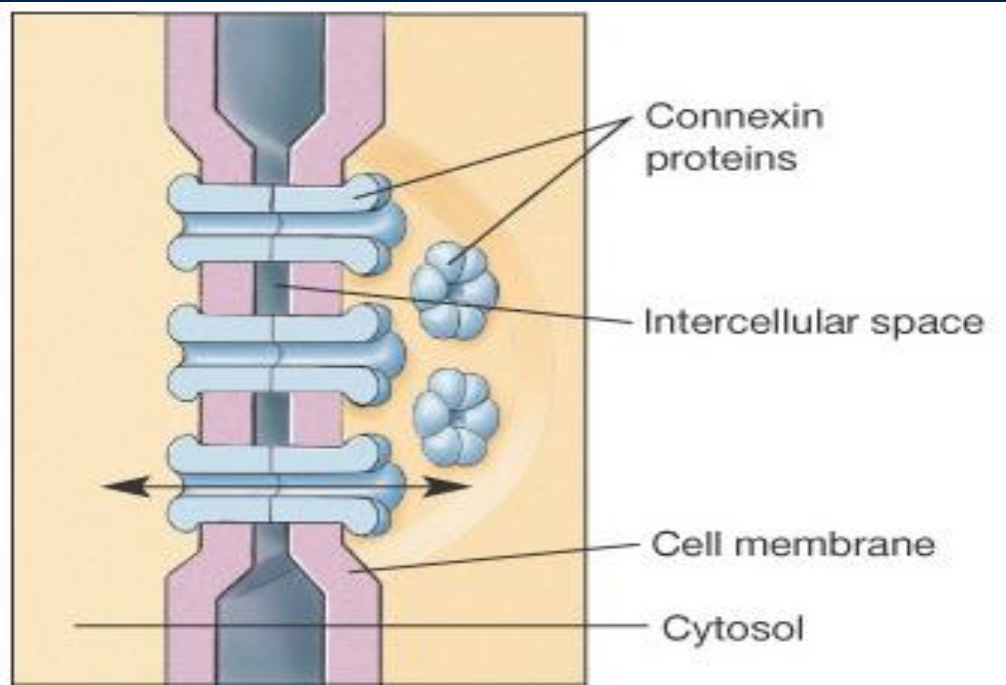


Cell to Cell Junctions

- Utilize CAMs (Cell Adhering Molecules)
 - Tight Junctions
 - Anchoring Junctions
 - Desmosomes
 - Gap Junctions



Gap Junctions



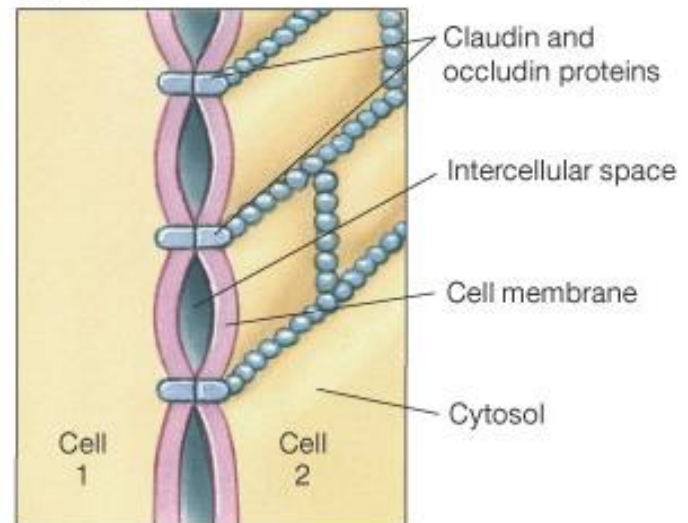
- **Cylindrical proteins form channels**
- **Can open and close**
- **Electrical synapses**
- **Rapid transfer of signals in cardiac & smooth muscle**

Tight junctions

- Complete barrier (brick wall)
- Fusion of adjacent cell membranes via claudin and occludin
- Found in
 - BBB
 - GI tract, kidneys

Tight vs. leaky epithelium

(a) Tight junction



Movement of substances across tight and leaky epithelia

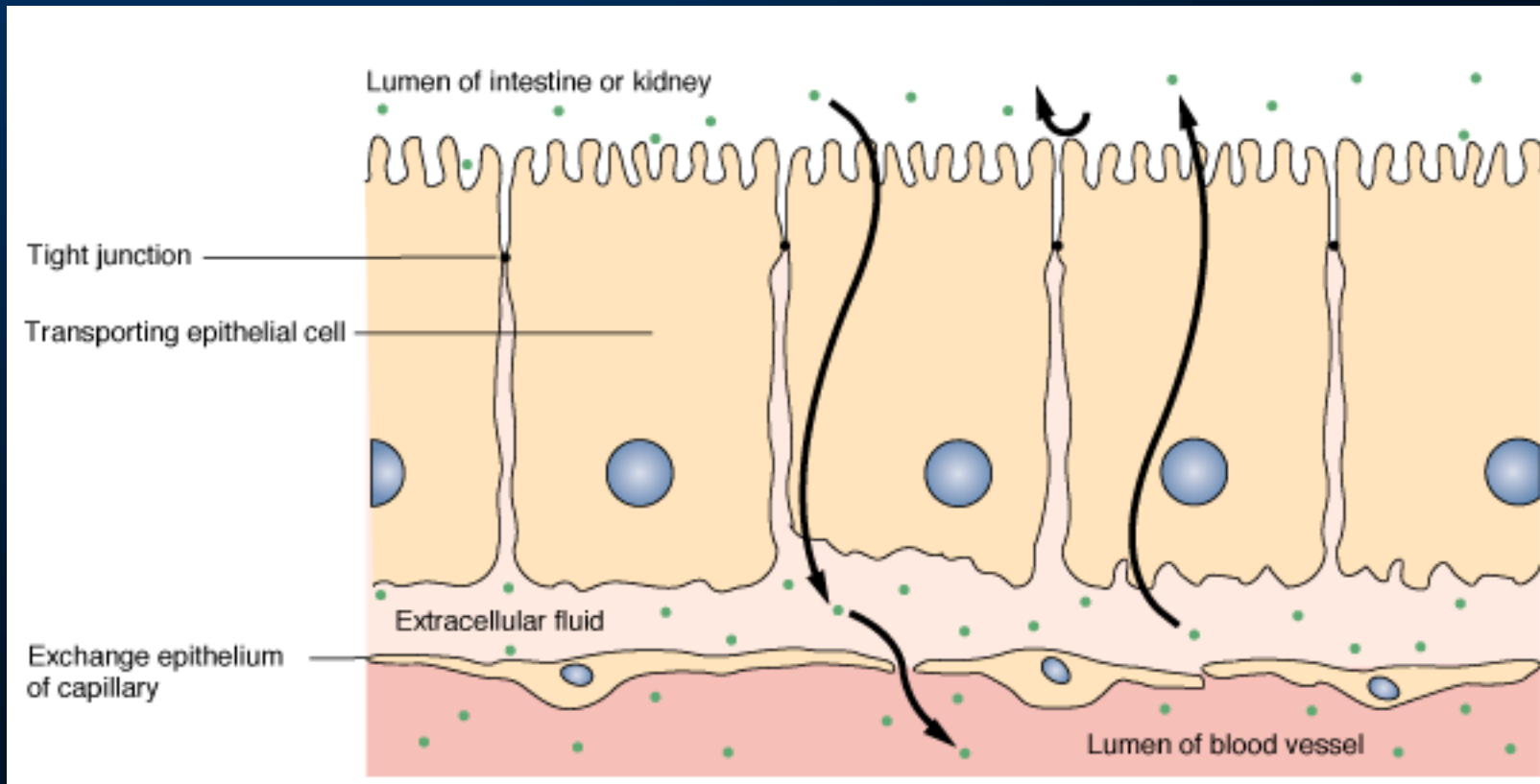
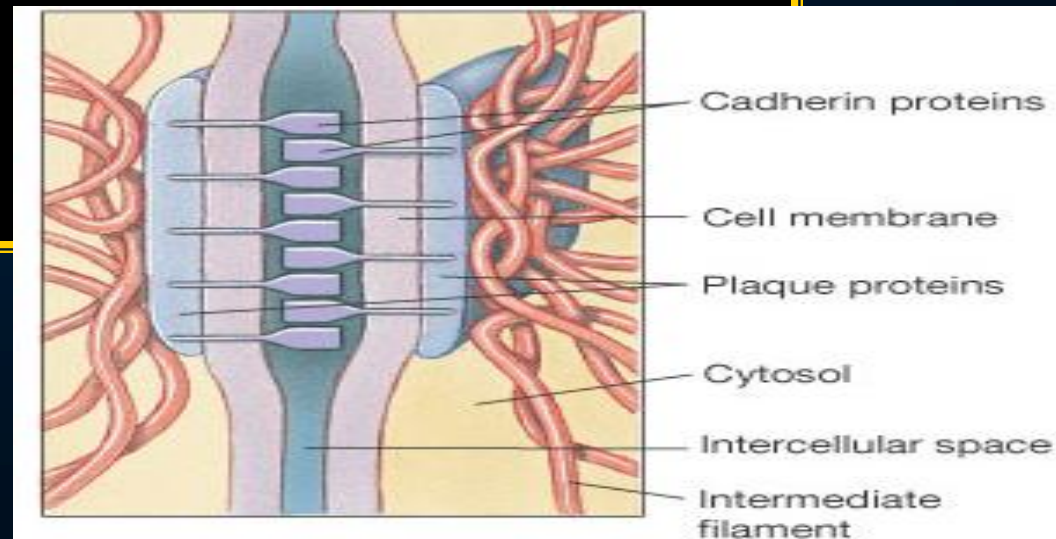


Fig 3-18

Anchoring Junctions

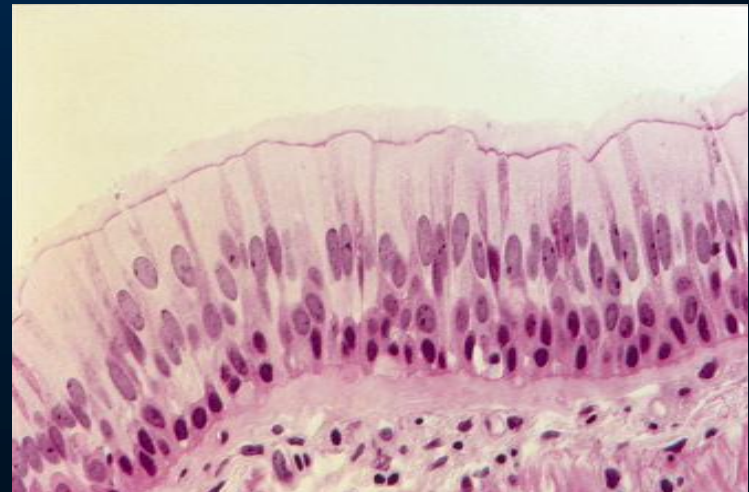
- Cell to cell or cell to CT matrix
- Anchoring junctions (CAMs: cadherins)
 - Desmosomes
 - Adherens junctions
- Cell matrix attachments (CAMs: integrins)
 - Hemidesmosomes
 - Spot desmosomes or focal adhesions

In cancer: Loss of desmosomes
⇒ *consequence?*



Histology

- Structure and function of all four **basic tissue types**: remember from Anatomy or review on your own (starting p. 72 with epithelia)
- Definition of **organ**?
Example: skin (*see p 83*)



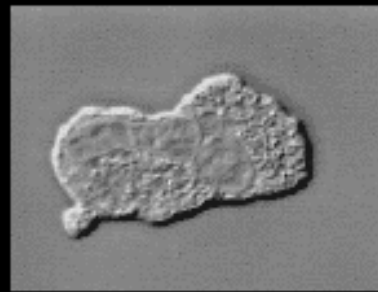
The Four Tissue Types

- Epithelia
 - Protection, exchange, etc.
- Connective
 - Extracellular Matrix (ground substance)
 - Includes adipose, blood, lymph
- Muscle
 - Smooth, cardiac, skeletal
- Neural
 - Neurons and neuroglia

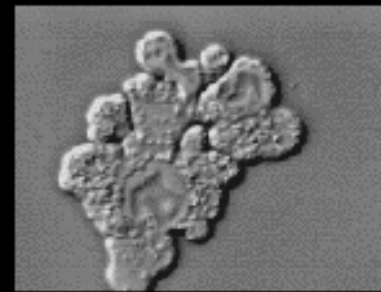
Stem Cells

- Review concept of **stem cells** (*see p 81 - 82*)
 - Totipotent – earliest cells in zygote
 - Pluripotent – starting specialization
 - Multipotent – more specialized (bone marrow)
- Research:
 - Fetal stem cells
 - Plasticity of adult stem cells

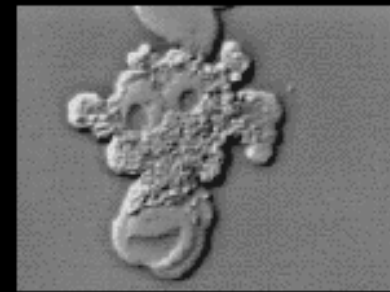
Tissue Remodeling



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www.cellsalive.com

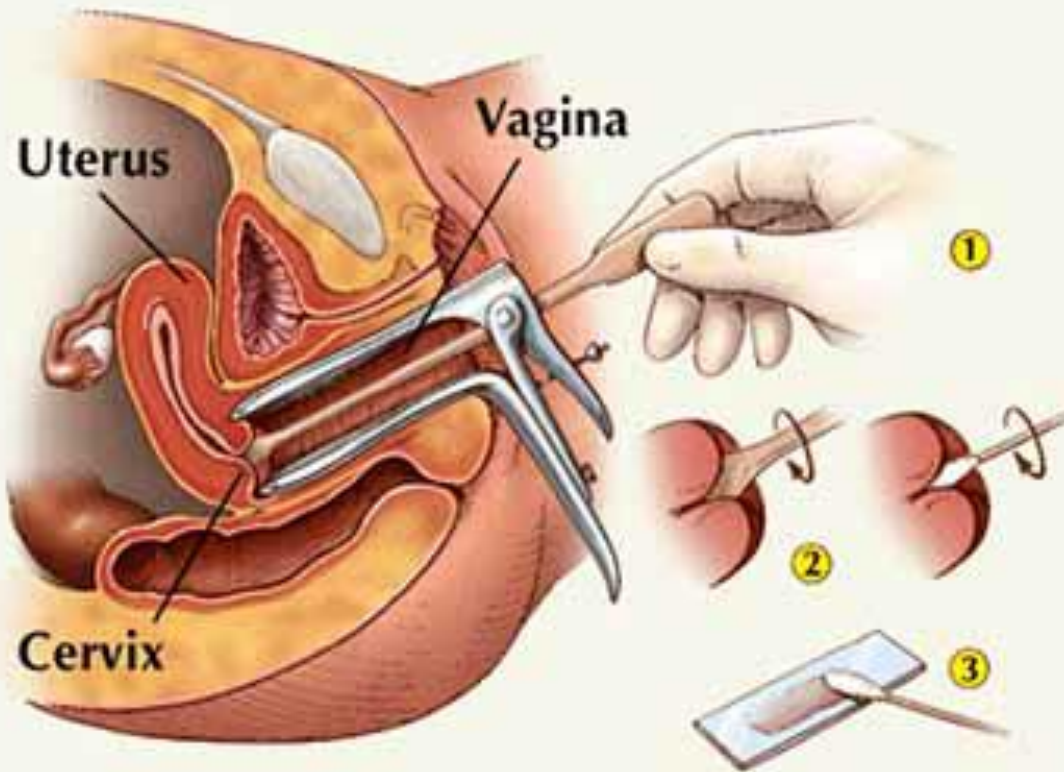


Tissue remodeling throughout a person's life

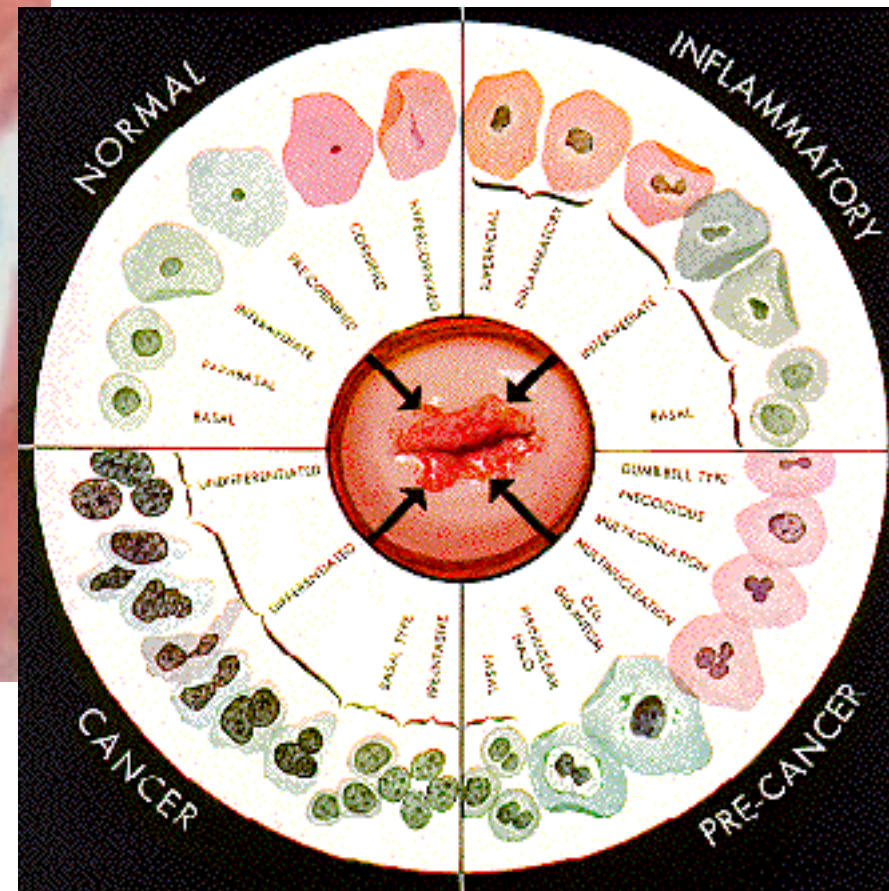
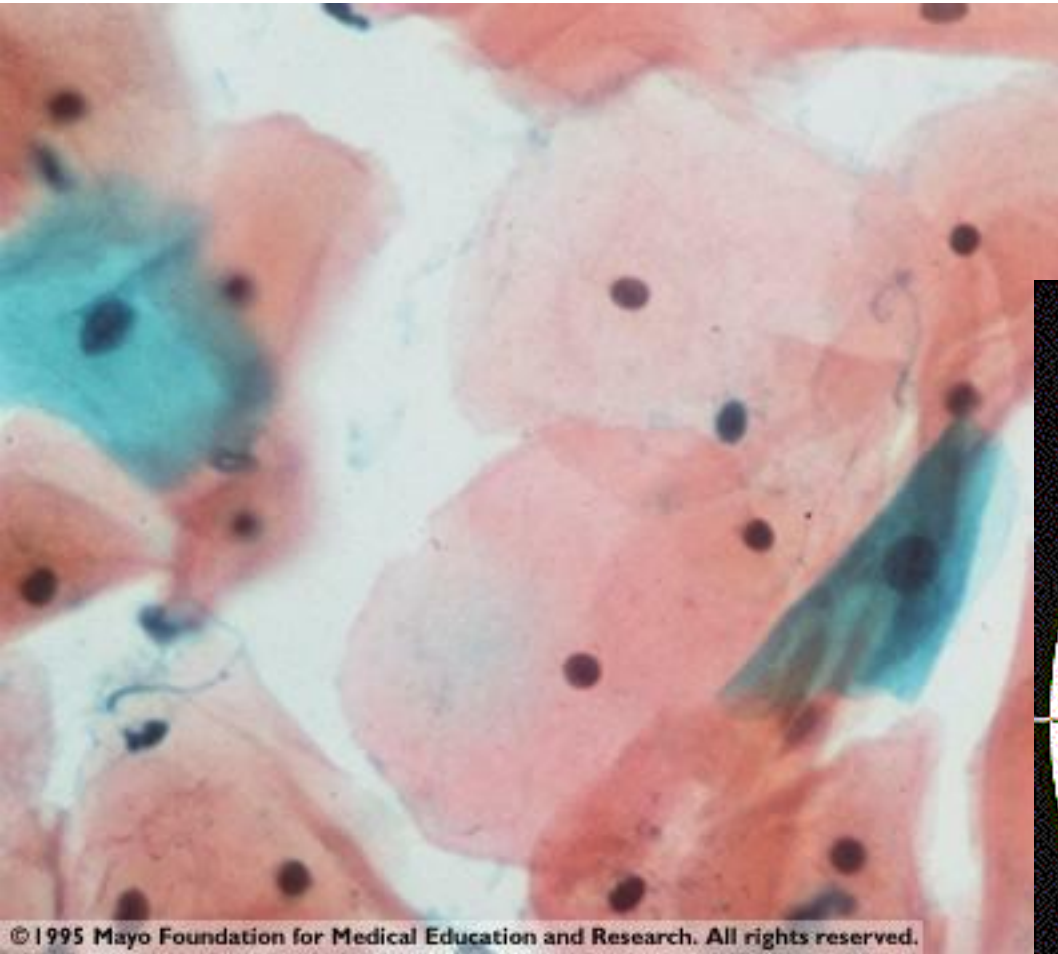
- **Apoptosis = Programmed cell death (suicide)**
 - Cell breaks up into membrane bound blebs which will be phagocytosed by other cells.
- **Necrosis = traumatic cell death**
 - Lack of O₂, trauma, toxins
 - Cells rupture \Rightarrow tissue damage & inflammation

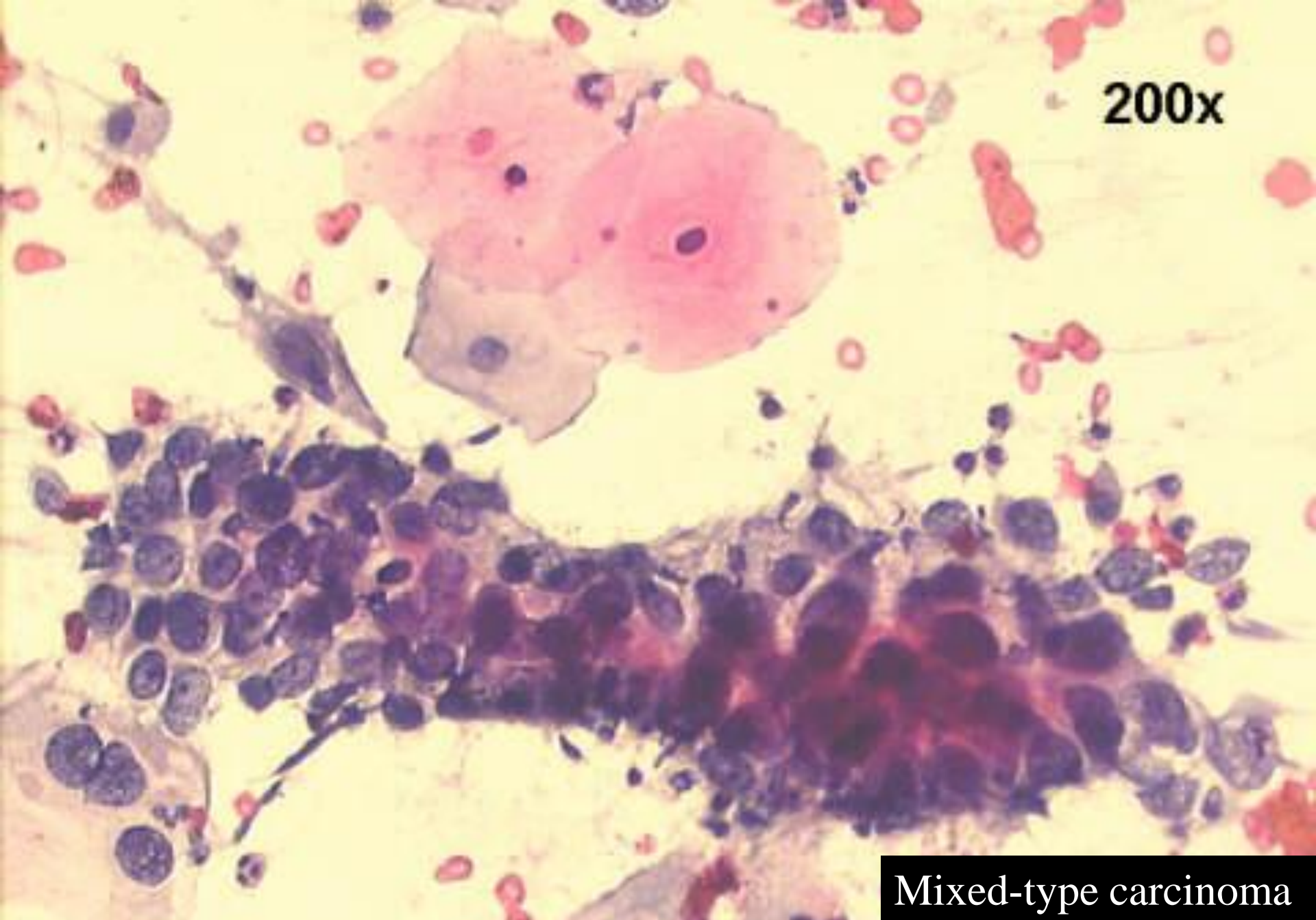
Running Problem: The Pap Smear

Page 51 on



Cervical cells. Uniform in size and shape ➔ normal





200x

Mixed-type carcinoma

Drs. Prolla and Diehl's INTERESTING CASE OF THE MONTH

