Cells physiology

إعداد

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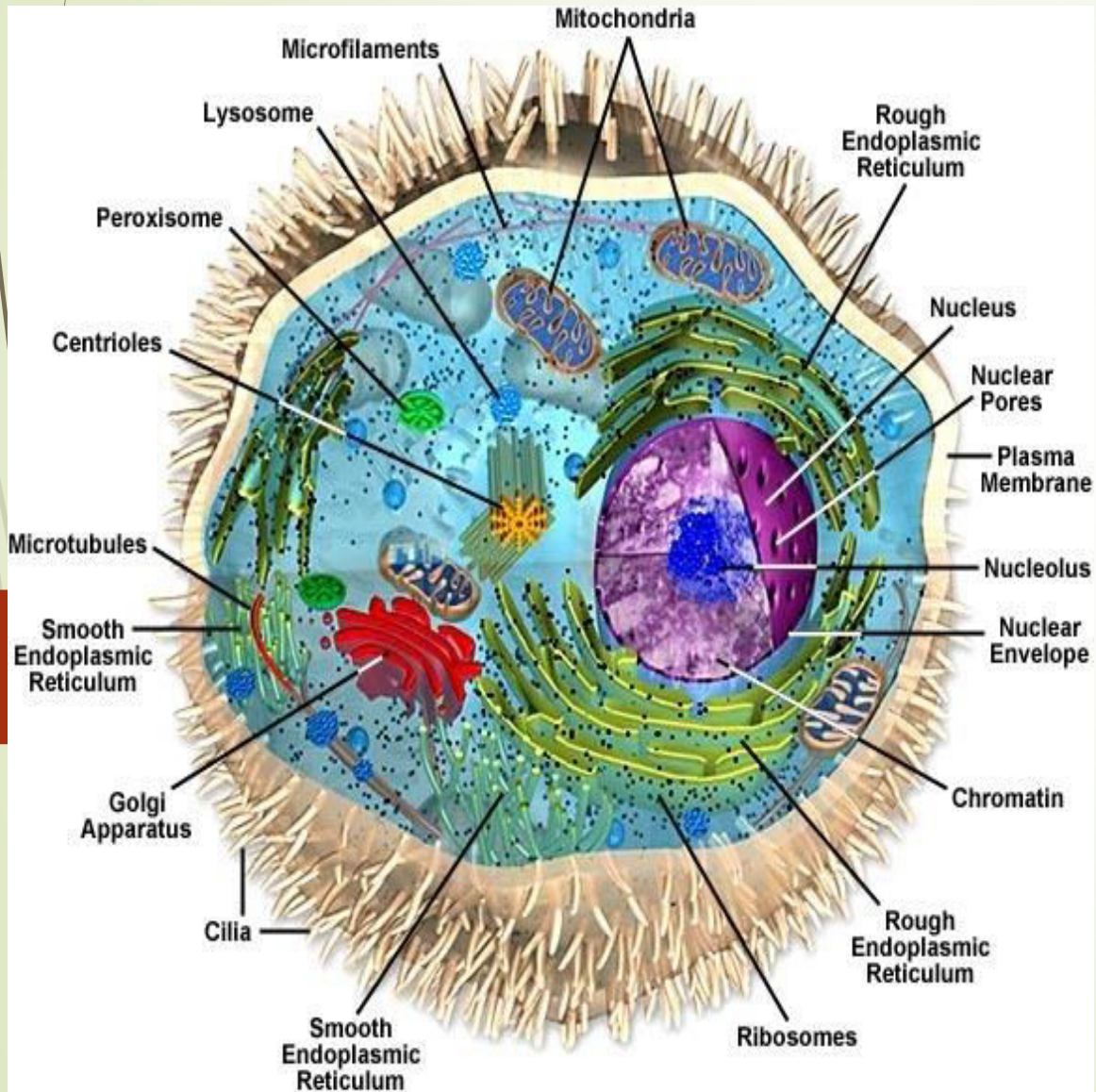
Introduction

- The basic organizational structure of the human body is the cell.
- There are 50-100 trillion cells in the human body.
- Differentiation is when cells specialize.
- As a result of differentiation, cells vary in size and shape according to their unique function.

CELL PHYSIOLOGY



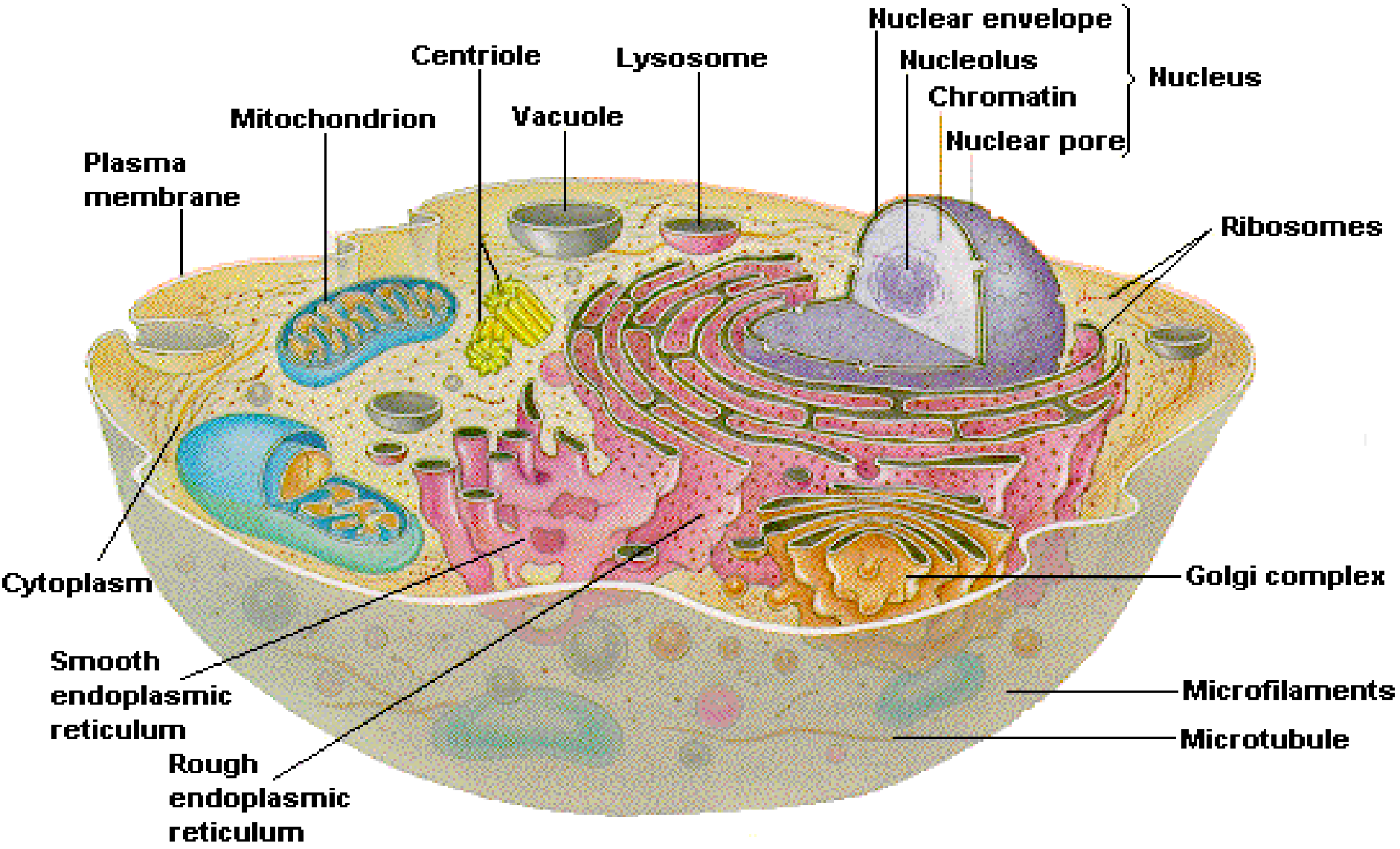
Cells are the basic unit of life

Cell physiology

There are two types of cells that make up all living things on earth:

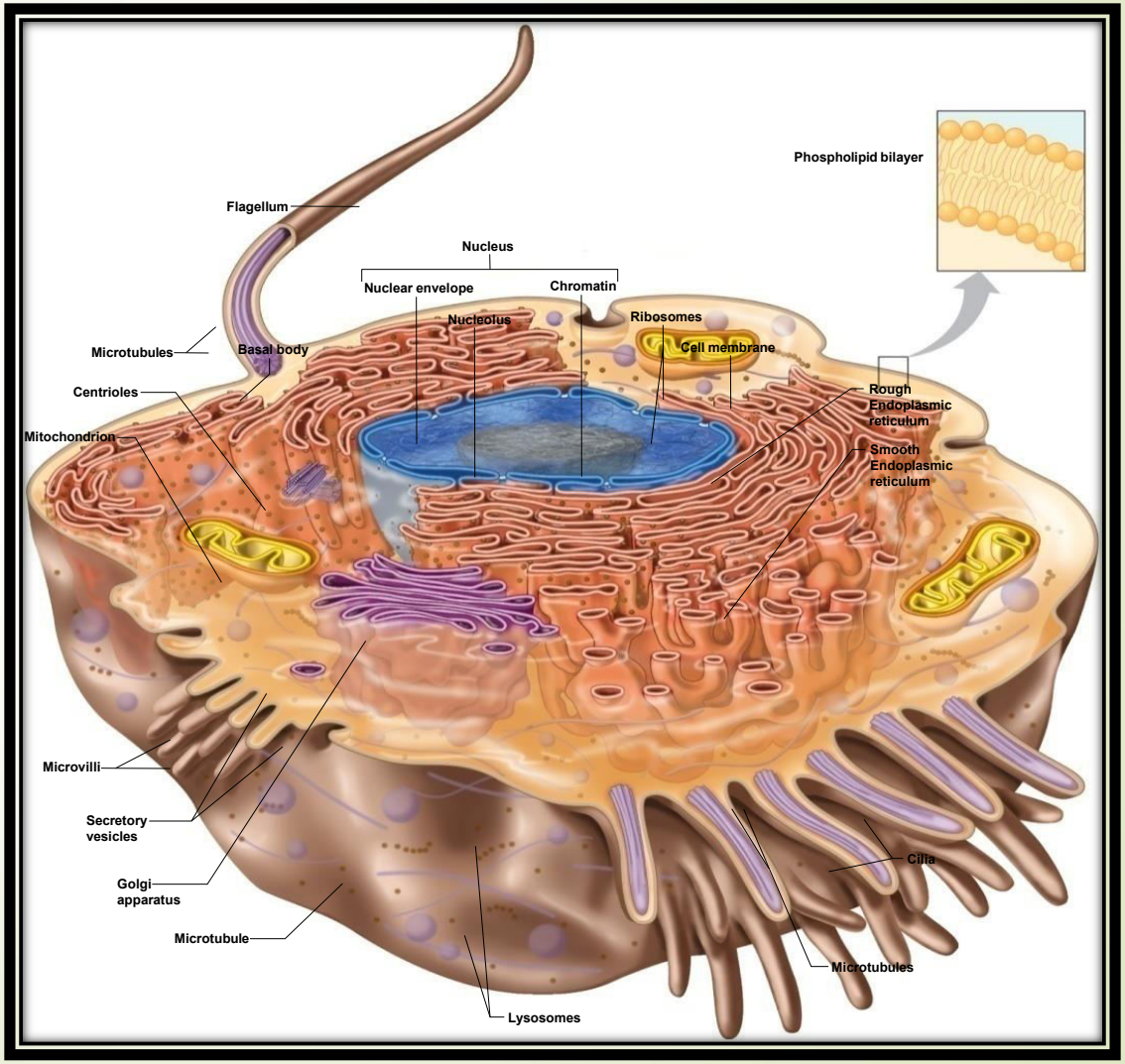
1) Prokaryotic cells, like bacteria, have no 'nucleus'.
2) eukaryotic cells, like those of the human body.

Cell structure and Functions

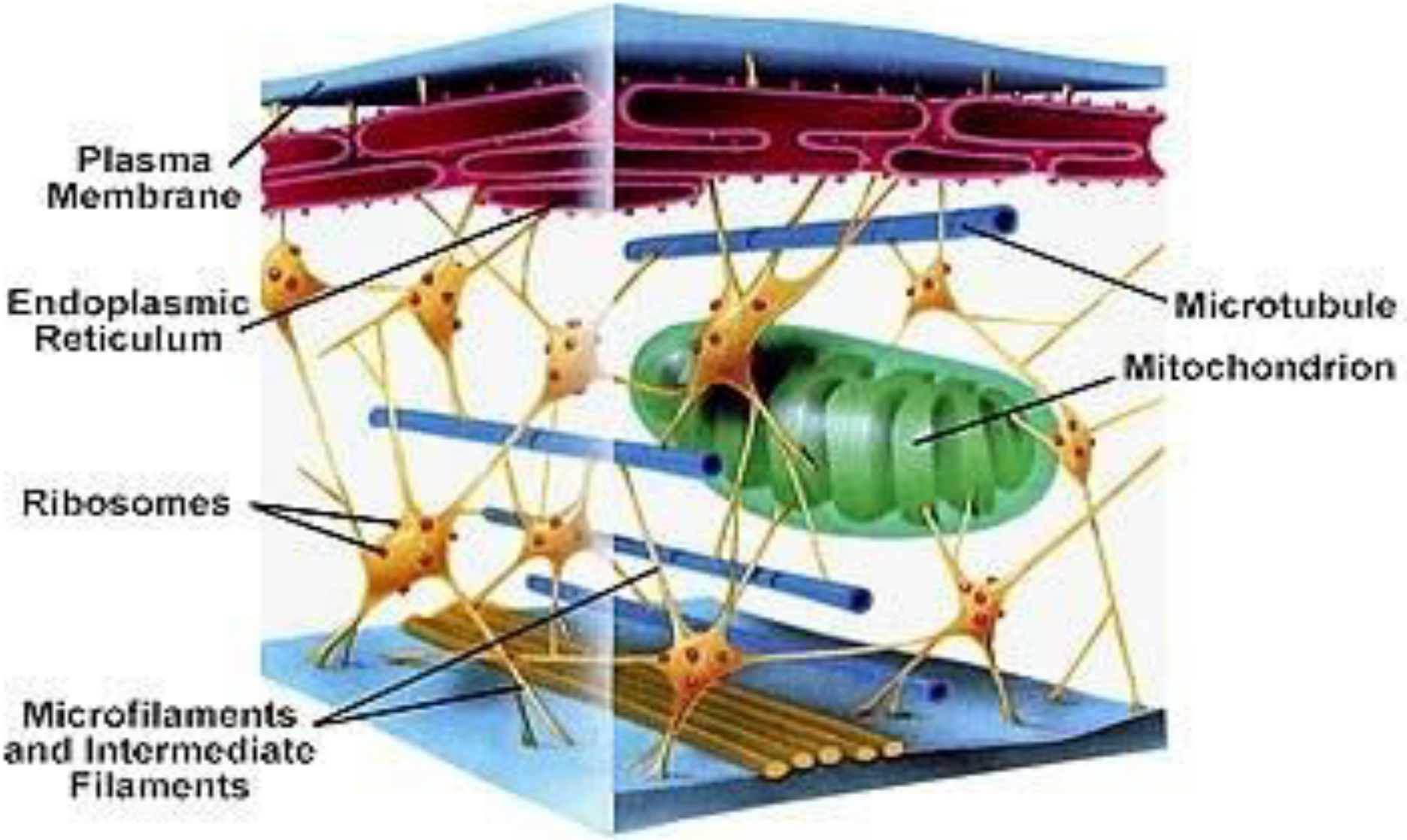


Cell structure and Functions

- Typical cell has 3 major parts include:
  1) **Nucleus**
  2) **Cytoplasm**
  3) **Cell membrane**



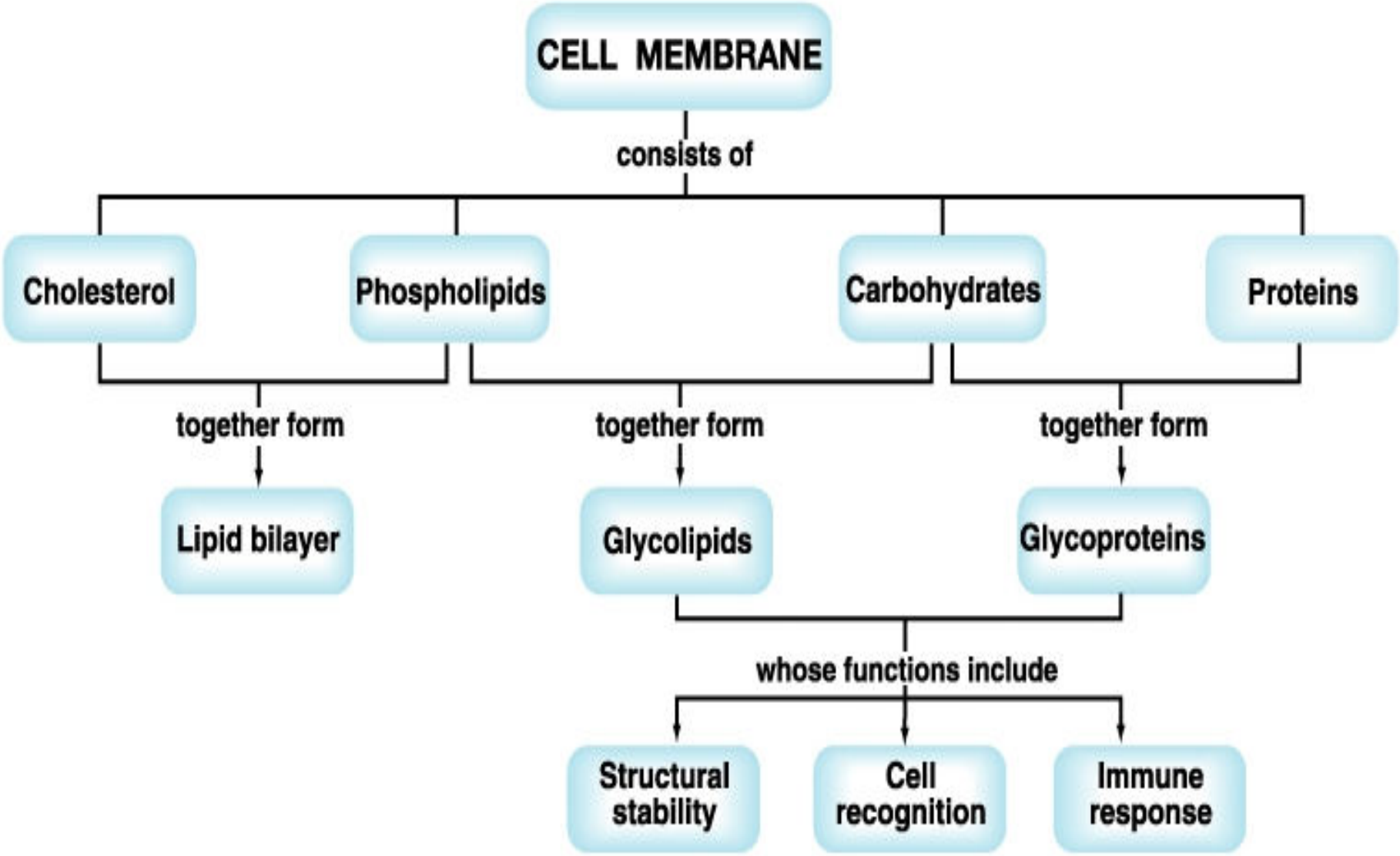
Cell structure and Functions



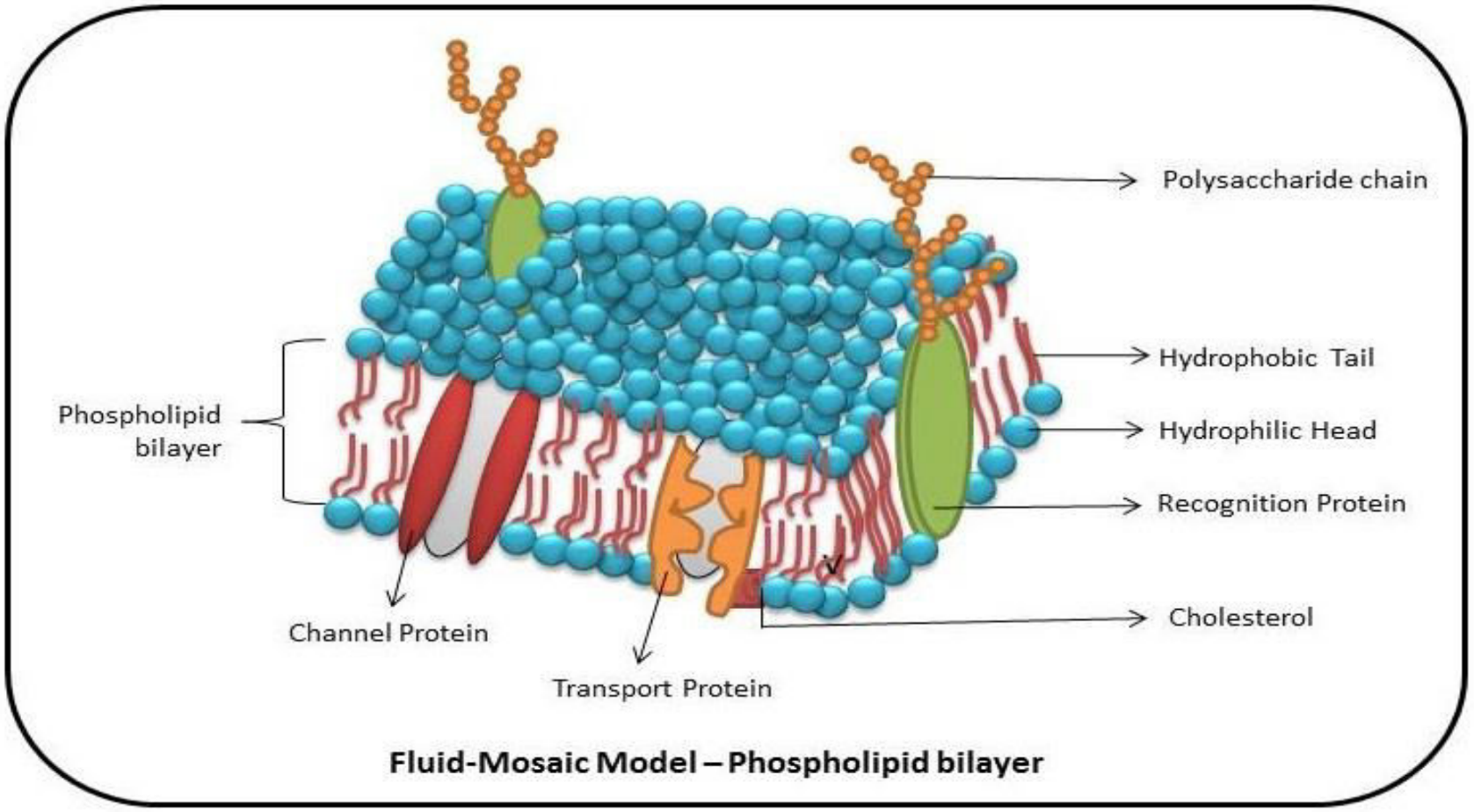
Cell/Plasma Membrane

- Outer limit of the cell
- Controls what moves in and out of the cell.
- Selectively permeable
- Phospholipid bilayer
  - Water-soluble form surfaces (hydrophilic)
  - Water-insoluble form interior (hydrophobic)
  - Permeable to lipid-soluble substances
- Proteins:
  - Receptors
  - Pores, channels and carriers
  - Enzymes

Cell/Plasma Membrane



Cell/Plasma Membrane



Fluid-Mosaic Model – Phospholipid bilayer

Cell/Plasma Membrane

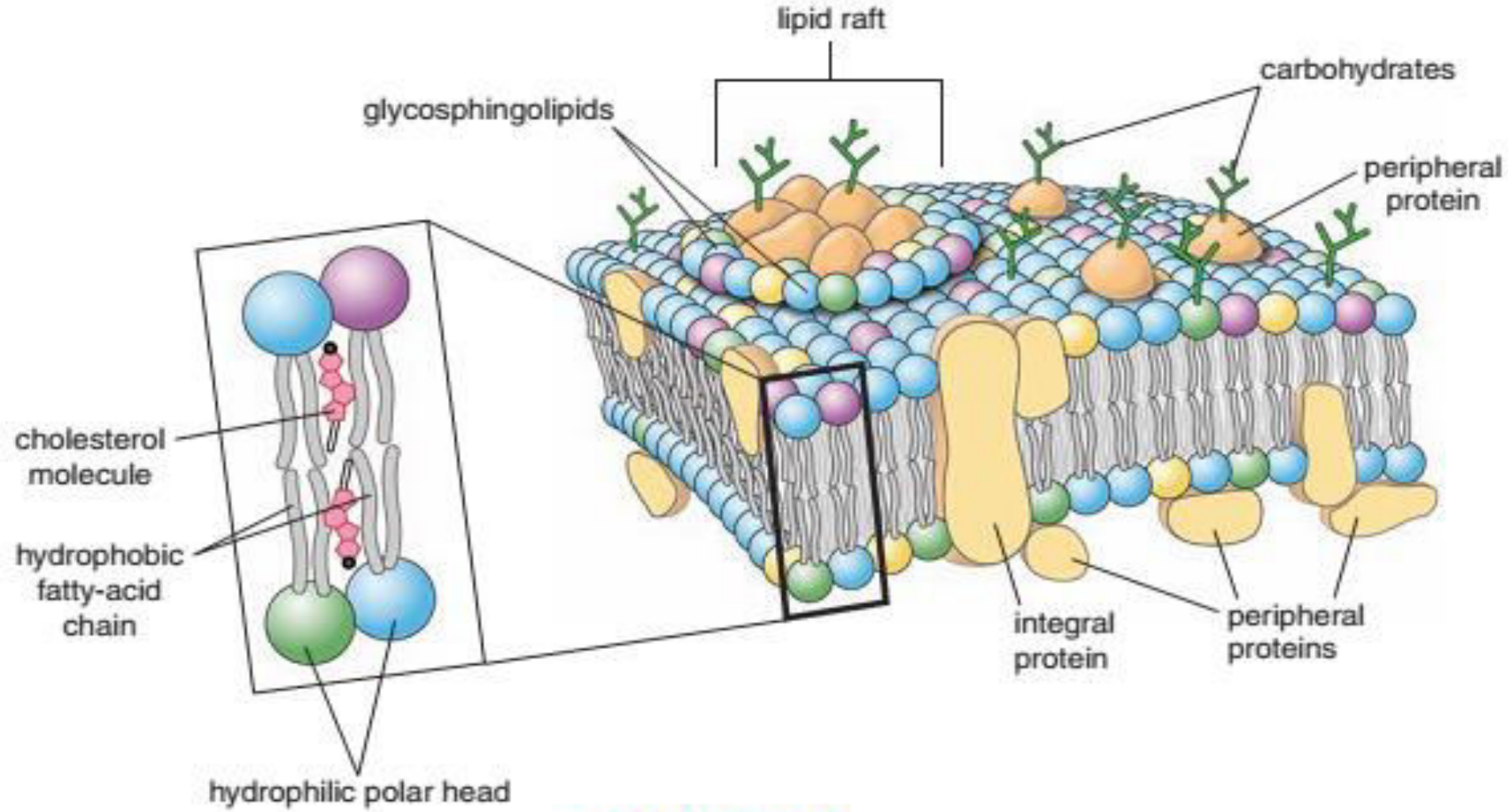
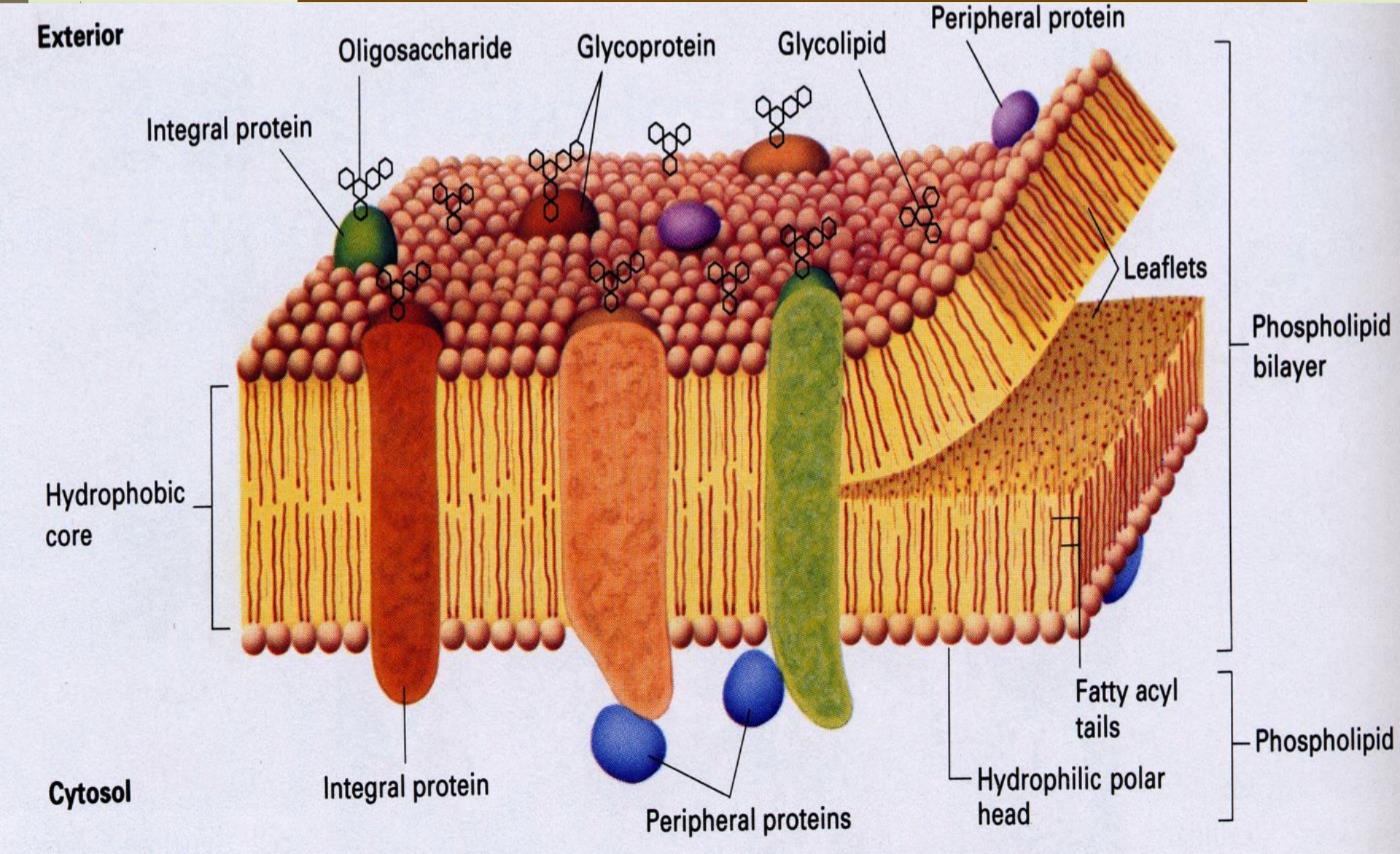


Figure 32

Cell/Plasma Membrane



Cytoplasm

•jelly-like fluid (70% water) that holds the cellular organelles and occupies the space between the nucleus and cell membrane.

• It contains abundant protein rods and tubules that form a supportive framework (cytoskeleton)

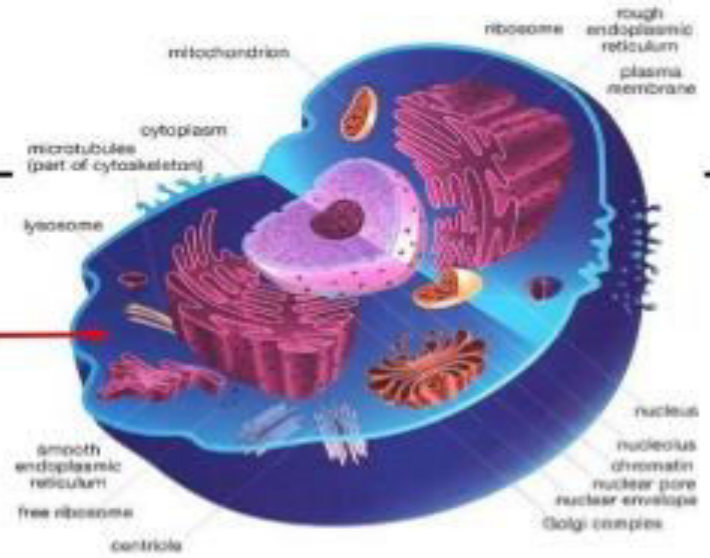
• Organelles = solids

Cytoplasm

Cytoplasm

Structure	Function
Jelly-like substance made up mainly of water (70% water)	Acts as a medium for most **chemical activities** of the cell to occur; Contains **enzymes** and **organelles**.

Cytoplasm

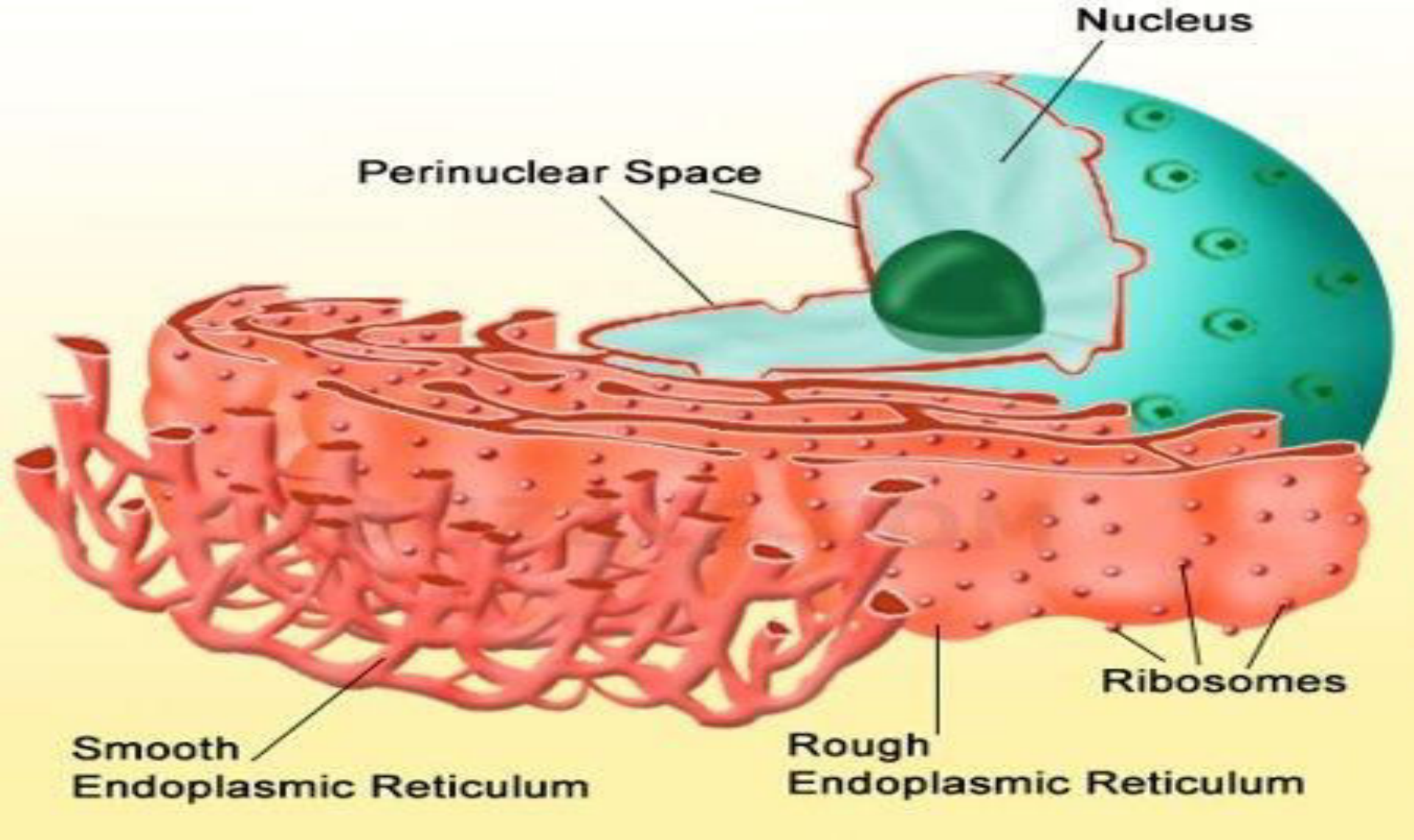


Organelles

Endoplasmic Reticulum (ER)

- A network of interconnected parallel membrane, canals, vesicles and sacs, that is continuous with the nuclear membrane;
- It is transport system.
- Rough ER (RER)
  - Studded with ribosomes
  - Function – Protein Synthesis
- Smooth ER (SER)
  - lacks ribosomes
  - Function = lipid & cholesterol synthesis
  - Stores calcium ions
  - Abundant in liver cells (hepatocytes)
  - Break down of drugs

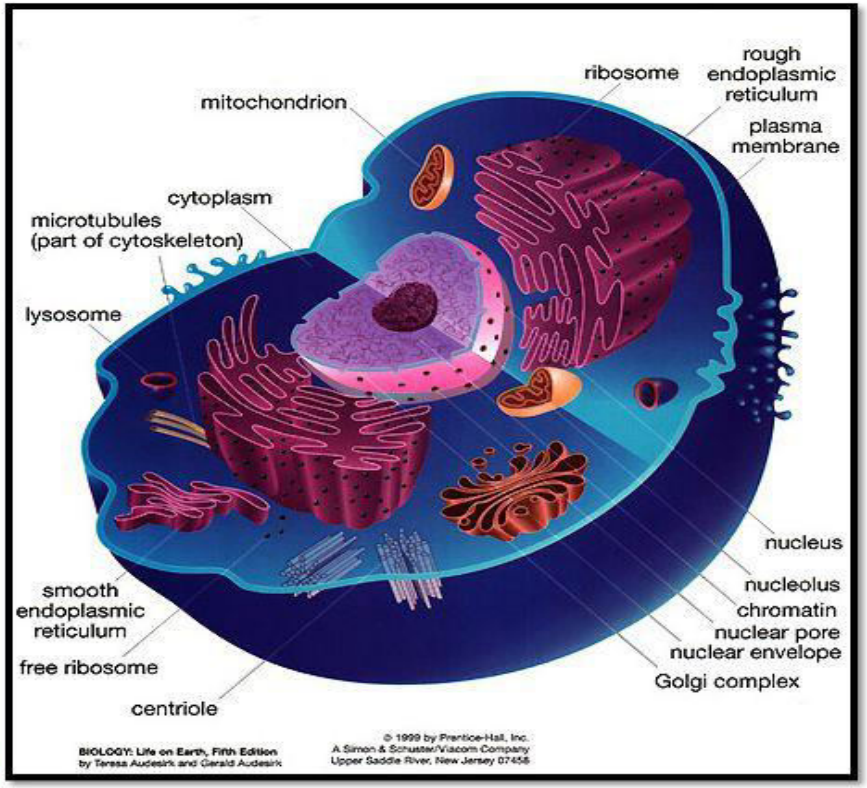
Endoplasmic Reticulum (ER)



Endoplasmic Reticulum (ER)

Endoplasmic Reticulum

- Analogy: "Highway of the cell"
- Function: Site where proteins/lipids are assembled and delivered through the cell.
  - Rough ER: studded with ribosomes; it makes proteins
  - Smooth ER: no ribosomes; it makes lipids



Organelles

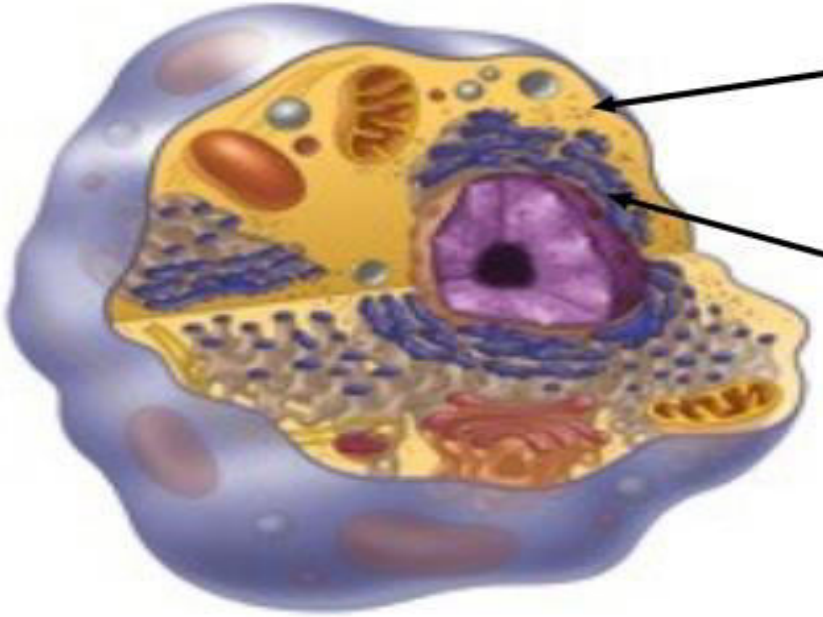
Ribosomes:

1. Free floating small granules dispersed throughout the cytoplasm and on the membranes of some endoplasmic reticulum (rough endoplasmic reticulum)
2. Composed of RNA and protein
3. Function = **protein synthesis**.

Ribosomes

Ribosomes

Ribosomes are cellular machines that produce <u>proteins</u>, important biological molecules

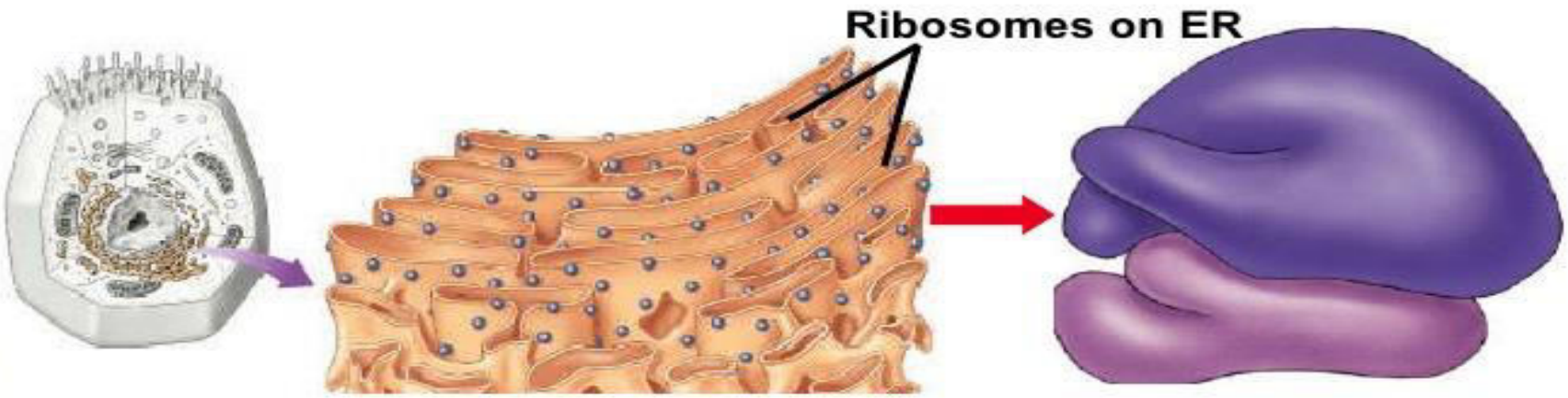


Ribosomes are either free in the cytoplasm or attached to the Endoplasmic Reticulum

Ribosomes

Ribosomes

- **Function**
  - **protein factories**
  - read instructions to build proteins from DNA
- **Structure**
  - some free in cytoplasm
  - some attached to ER



Organelles

Golgi apparatus

- Stack of flattened, membranous sacs (cisternae), arranged in stacks.
- Associated with many vesicles (membrane bound sacs containing proteins)
- Function = modification, packaging, and transport of proteins.

Golgi apparatus

Golgi Apparatus Structure

Lumen

- Contains enzymes which modify the carbohydrate portion of glycoproteins

Vesicles

- Transport proteins and lipids built in the smooth and rough endoplasmic reticulum

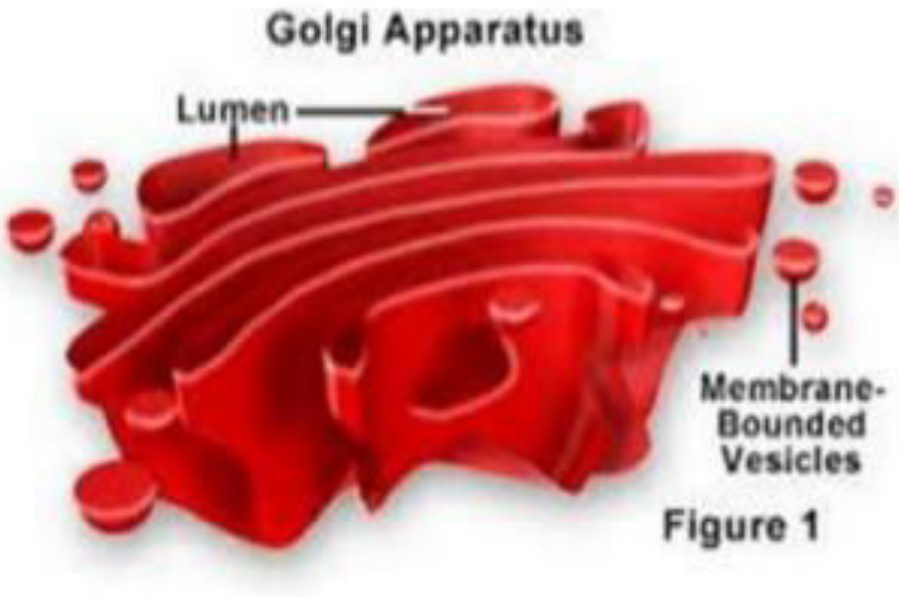


Figure 1

Golgi apparatus

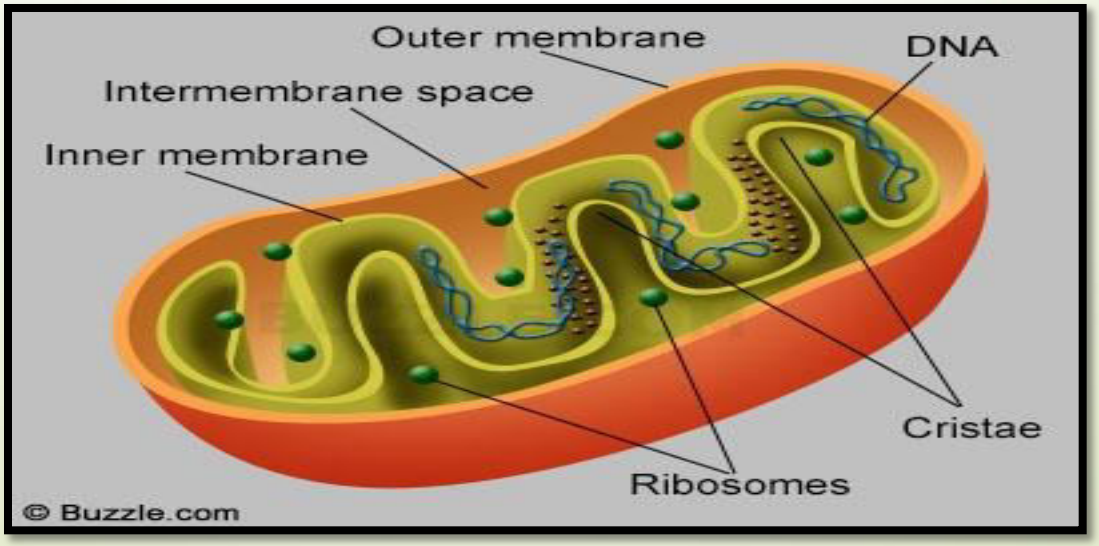
Golgi Apparatus (Complex)

- **Structure** - A series of flattened sacs with a characteristic convex shape
- **Function(s)** – Processes and packages proteins and substances produced by cells; instructs the substances where to go
- **Found In** - Animal and Plant Cells

Organelles

Mitochondria

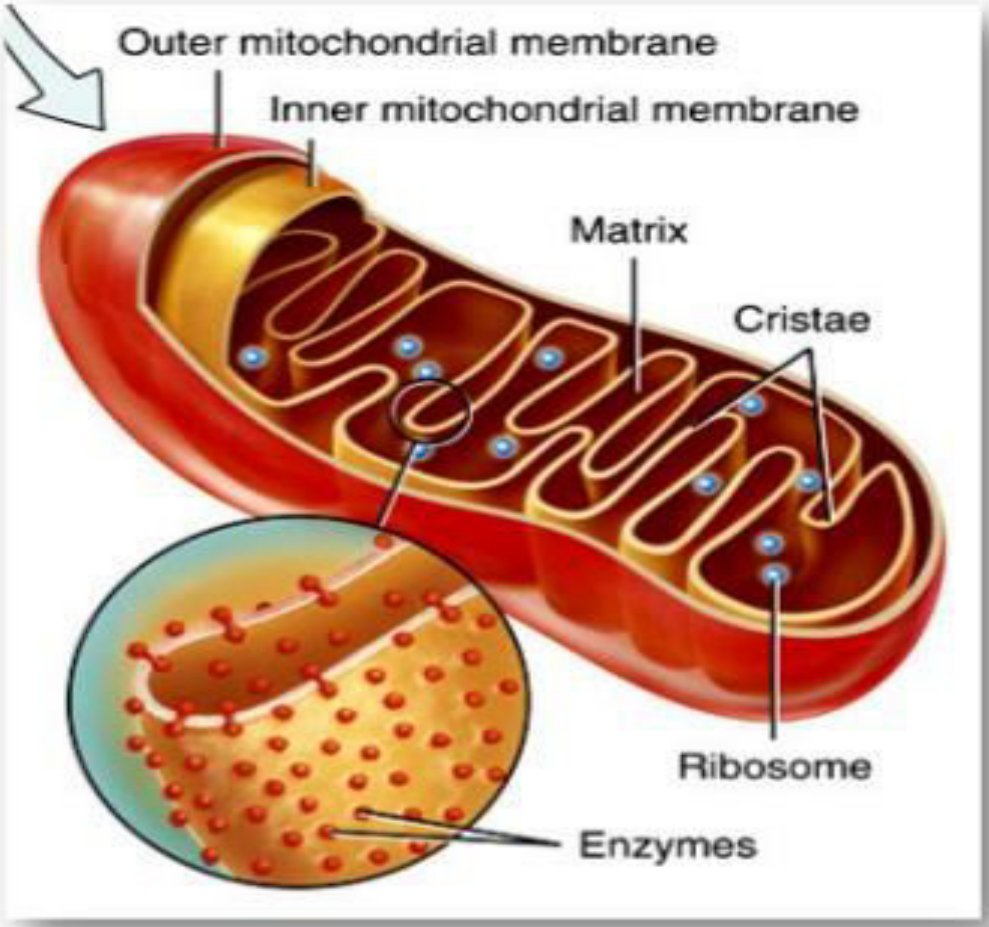
- Kidney-shaped organelle whose inner membrane is folded into shelf-like partitions called **cristae**
- "Powerhouse" of the cell = site of cellular respiration, where energy is released from glucose.
- Contains their own DNA & RNA



Mitochondria

Mitochondria

- Outer & inner membrane (**cristae**)
- **Matrix**
- **Aerobic cellular respiration** (makes ATP)



Organelles

Lysosomes

- Spherical membranous sacs containing digestive enzymes (acid hydrolases).
- "Suicide sacs" which destroy anything the cell no longer wants or needs.

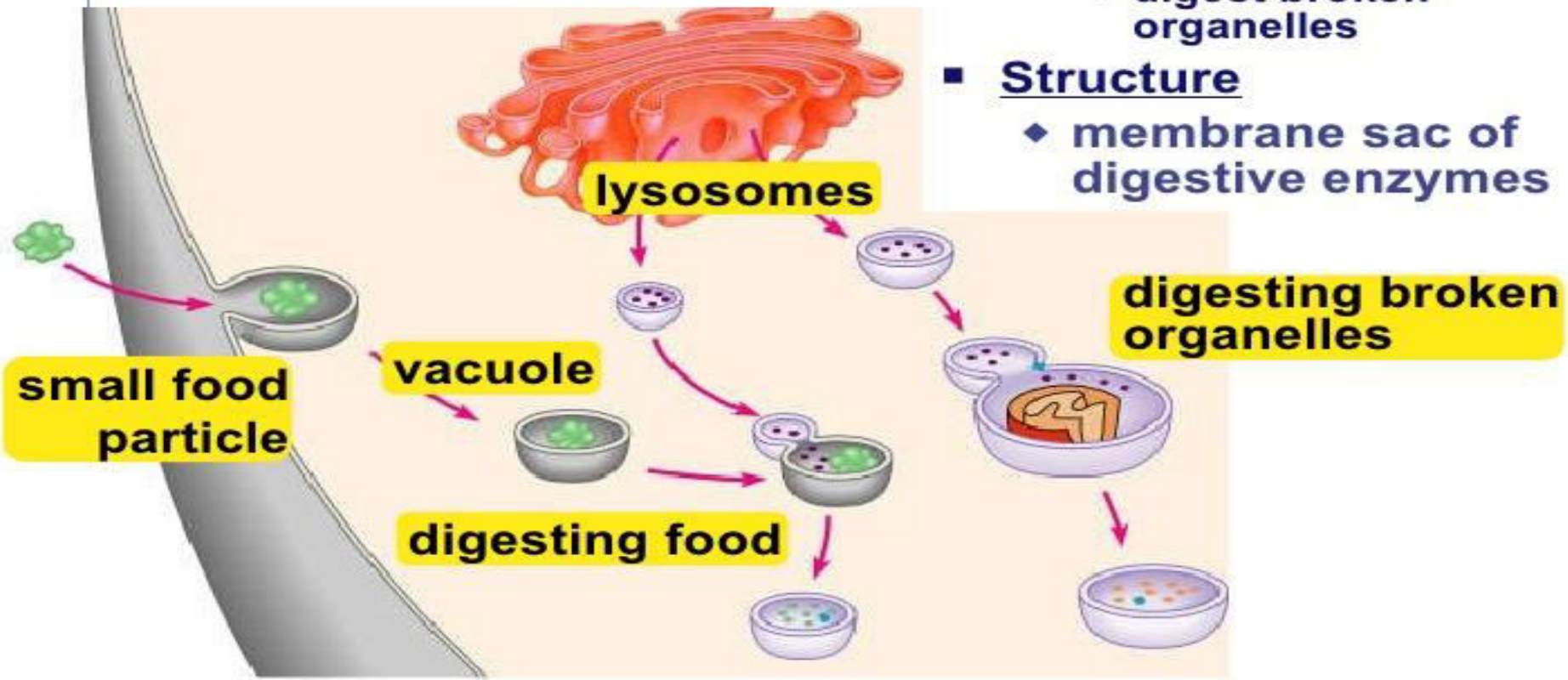
❖ Function:

1) Digest ingested bacteria, viruses, and toxins
2) Degrade nonfunctional organelles
3) Break down and release glycogen
4) Break down bone to release Ca^{2+}

Lysosomes

Lysosomes

- **Function**
  - **digest food**
    - used to make energy
  - **clean up & recycle**
    - digest broken organelles
- **Structure**
  - membrane sac of digestive enzymes



Organelles

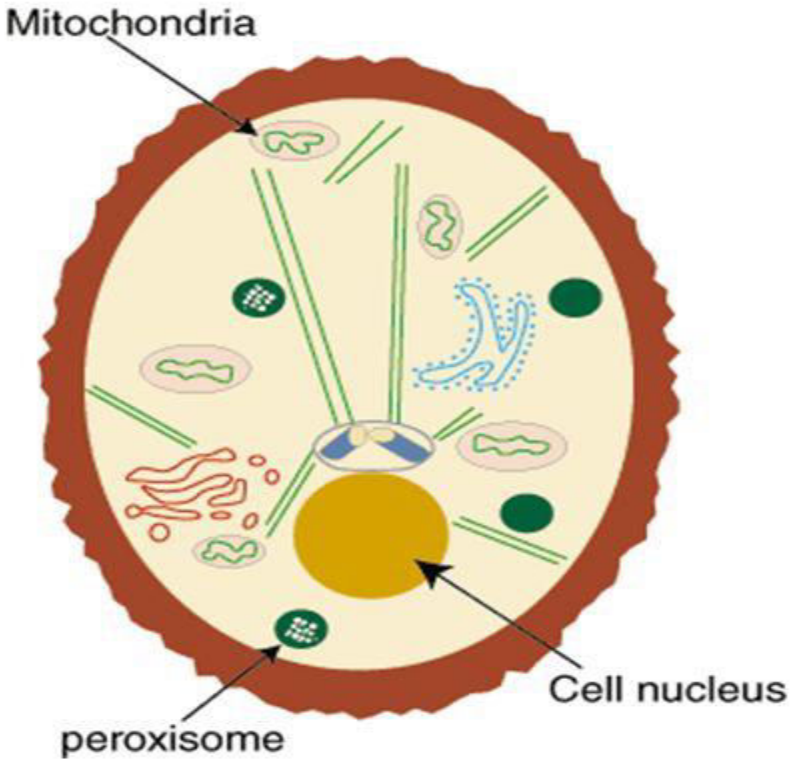
Peroxisomes

- Membranous sacs containing oxidase enzymes.
- Function:

1) detoxification of harmful or toxic substances (i.e. alcohol, oxygen free radicals)
2) Breaks down organic molecules.

Peroxisomes

Peroxisomes



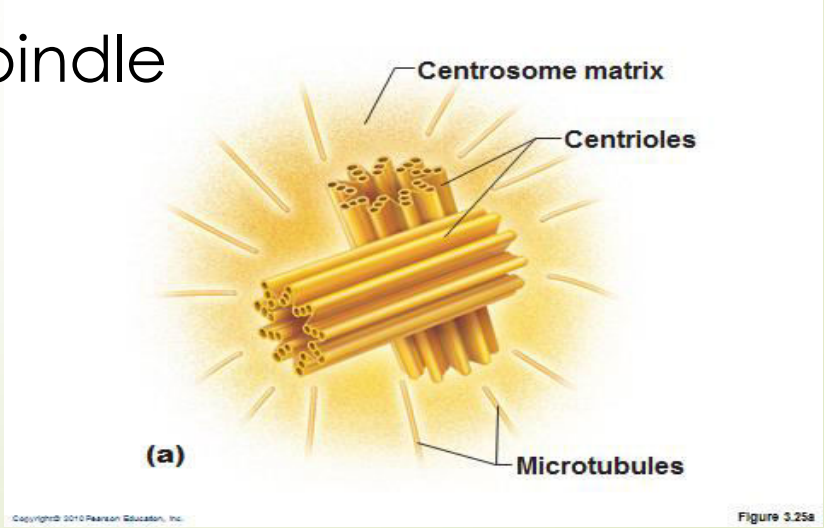
- Contain enzymes that transfer hydrogen from substances to produce hydrogen peroxide as a by-product hence the name!
- Use oxygen to break fatty acids down
- Detoxify alcohol
- H_2O_2 is toxic to the cell, but it produces an enzyme that converts it to water

Organelles

Centrosome:

- Pair of microtubules located near the nucleus
- Two rod-like centrioles
- Used to produce cilia and flagella
- "Cell center" near nucleus

- Generates microtubules.
- organizes mitotic spindle



Centrosome

CENTROSOME: CENTRIOLES

- They have NO membrane.
- They are 2 in perpendicular.
- They help in movement and in division.
- They are ONLY in animal cells.

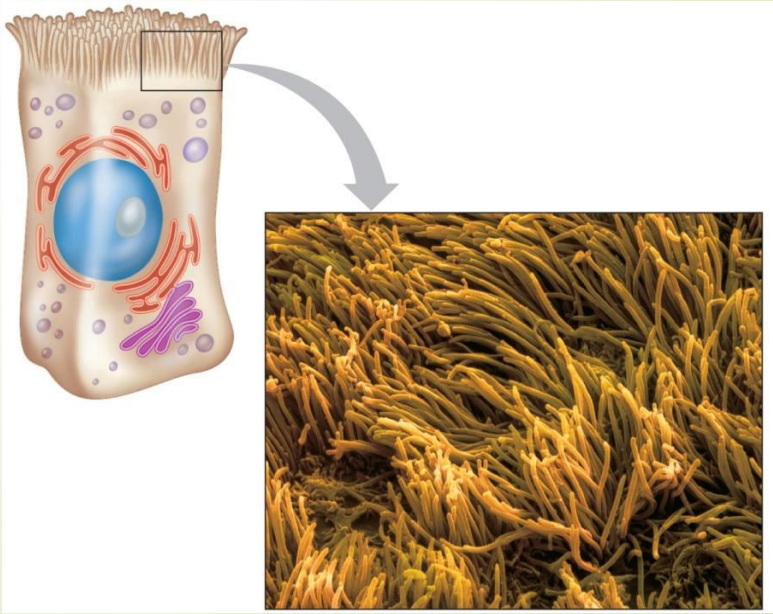
Organelles

Cilia

- ✓ Short hair-like cellular projection
- ✓ Propel substances through passage ways and on cell surface.
- ✓ Located in the lining of trachea and fallopian tube.

Flagella

- ✓ Long tail-like projection
- ✓ Only one per cell in humans
- ✓ Provides motility to sperm
- ✓ Aids in cell locomotion



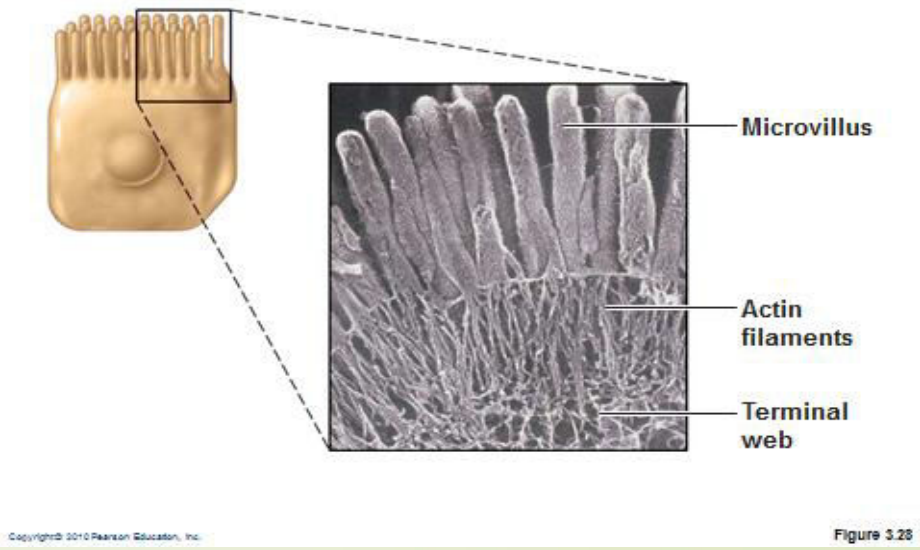
Organelles

Microvilli:

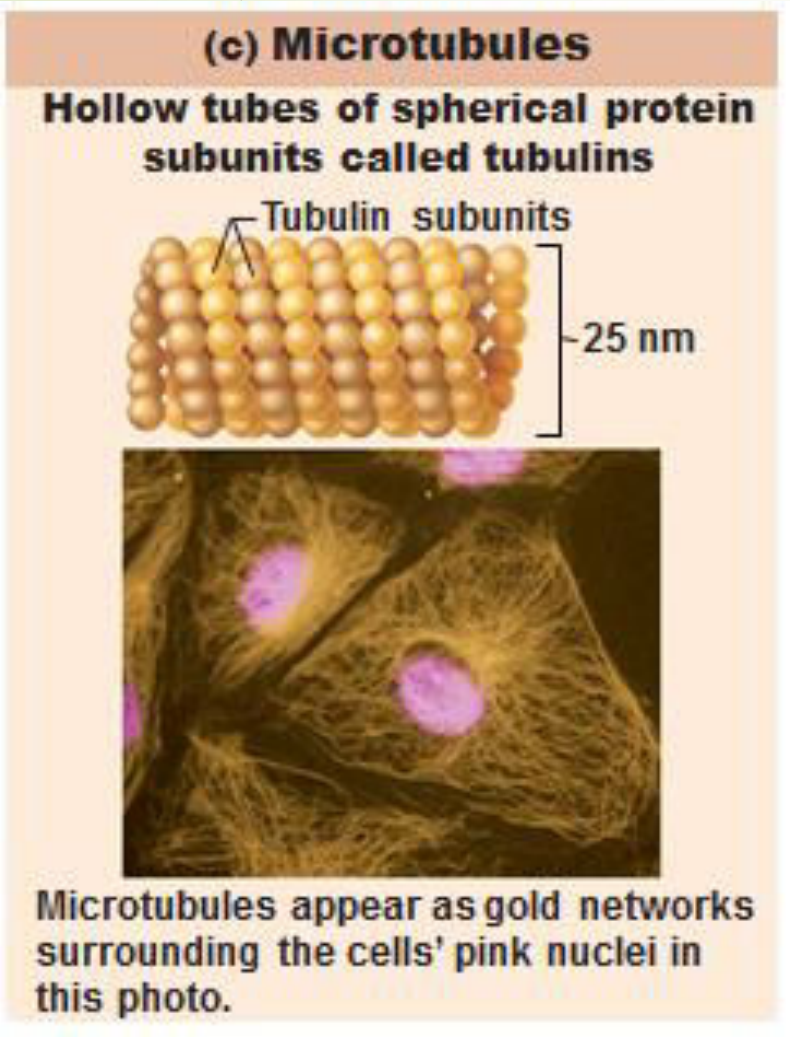
Fingerlike extensions of plasma membrane/external surface of the cell.

Function:

✓ increase surface area for absorption



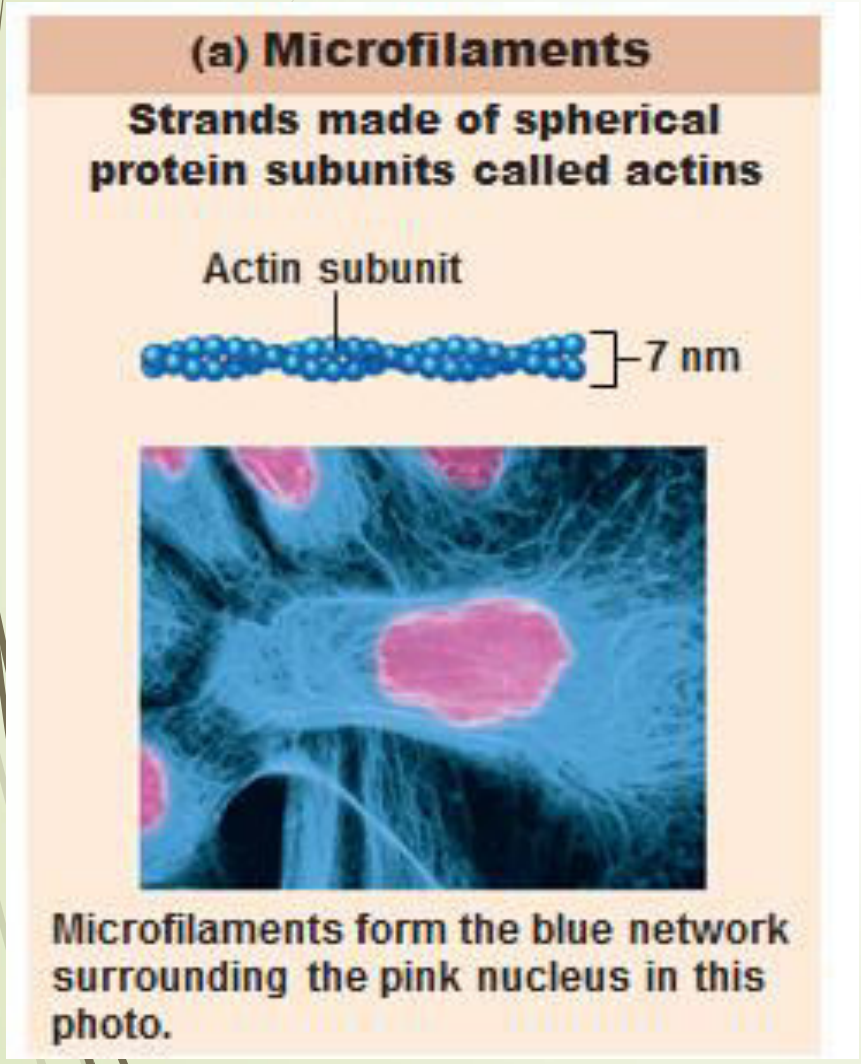
Organelles



Microtubules:

- Dynamic hollow tubes
- Most radiate from centrosome
- Determine overall shape of cell and distribution of organelles

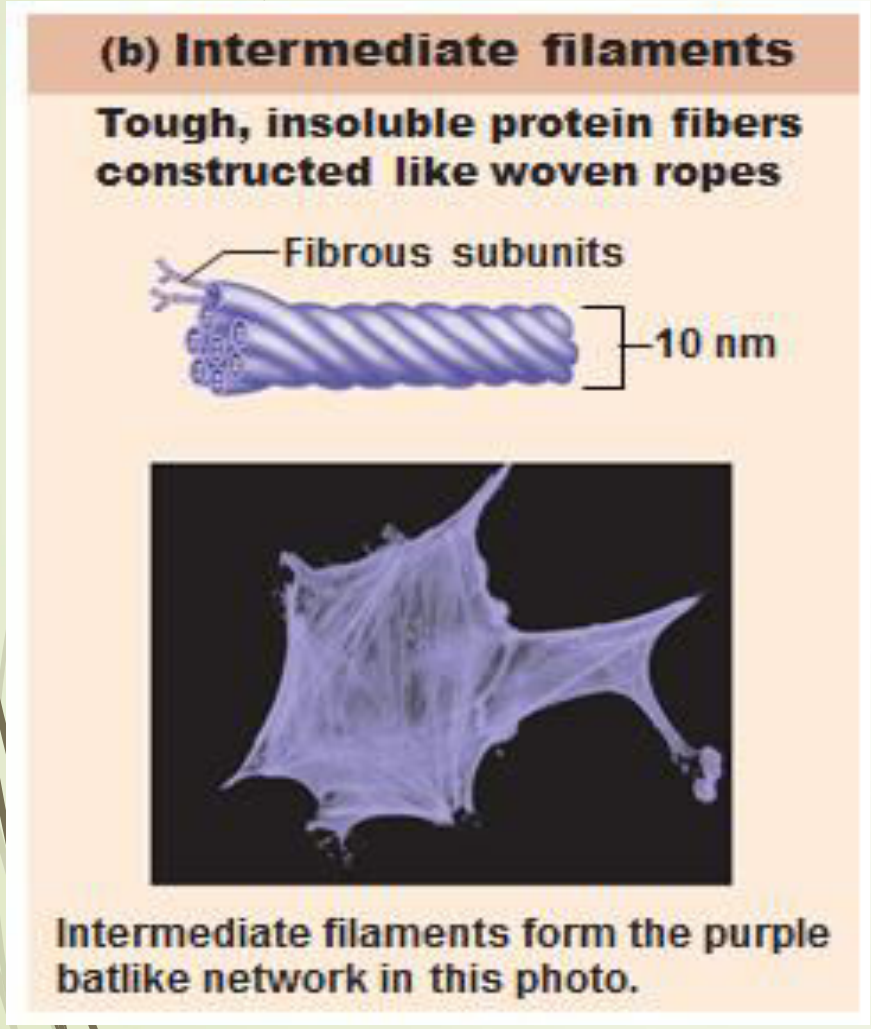
Organelles



Microfilaments:

- Dynamic actin strands attached to cytoplasmic side of plasma membrane.
- Involved in cell motility, change in shape, endocytosis and exocytosis

Organelles



Intermediate Filament:

- Tough, insoluble protein fibers.
- Resist pulling forces on the cell and attach to desmosomes.

Cell Nucleus

- it is the control center of the cell.
- The largest organelle of the cell.
- Genetic library with blueprints for nearly all cellular proteins.
- Responds to signals and dictates kinds and amounts of proteins to be synthesized.
- Most cells are uninucleate.
- Red blood cells are anucleate.
- Skeletal muscle cells, bone destruction cells, and some liver cells are multinucleate
- Contains 3 different regions:
  - Nuclear envelope
  - Nucleolus
  - Chromatin

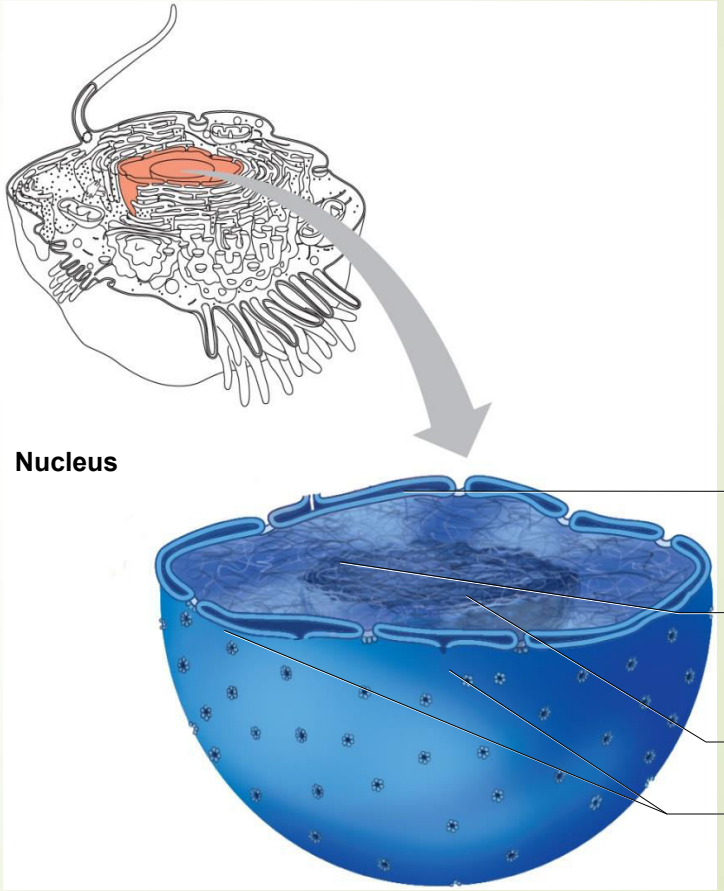
Cell Nucleus

Nucleus

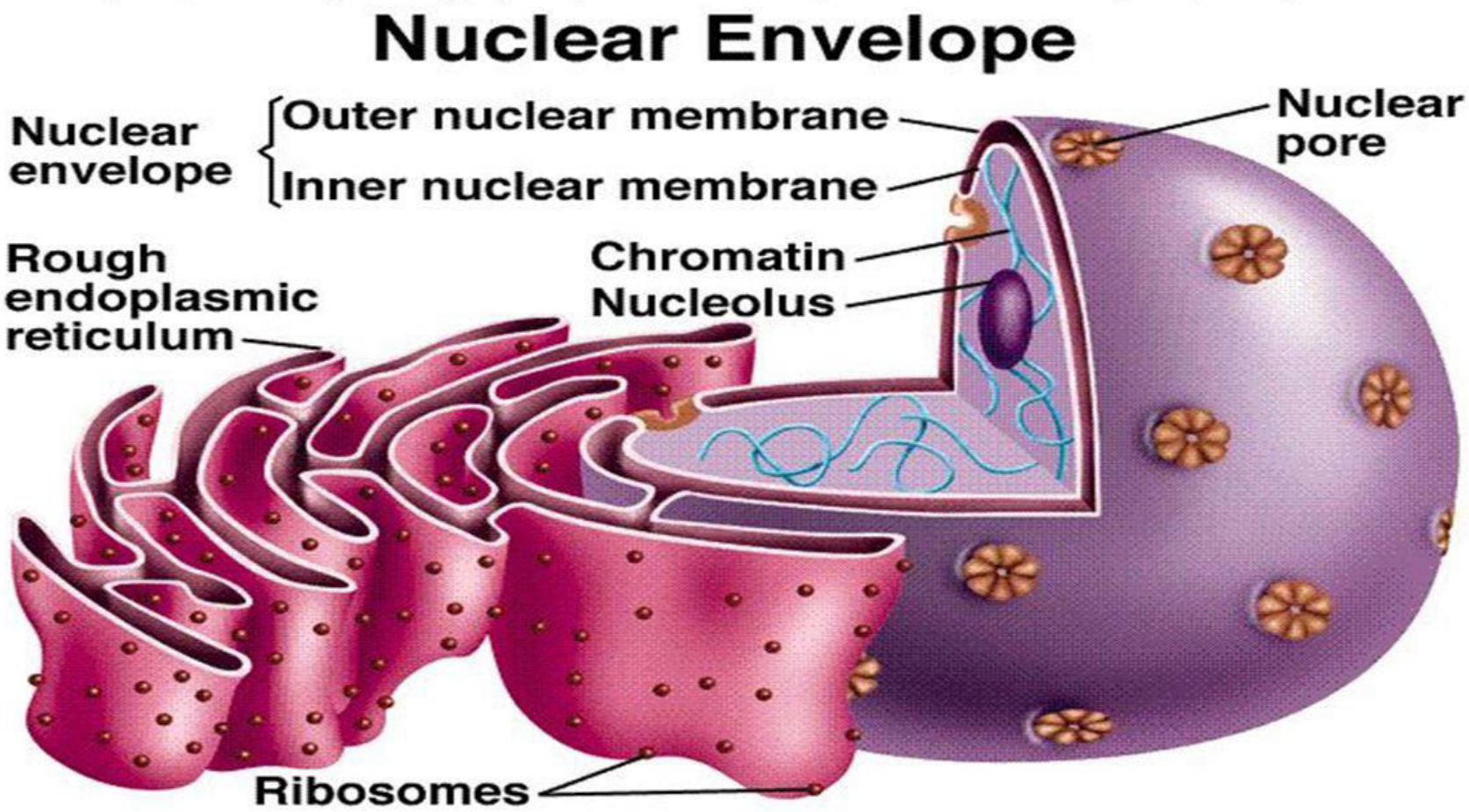
- **Structure** – The most prominent organelle, surrounded by a double membrane perforated with pores
- **Function(s)**
  – Regulates all cell activities
  – Contains the DNA of the cell
- **Found In** – Animal and Plant Cells

Cell Nucleus

- **Nuclear envelope:**
- **Porous double membrane**
- **Separates nucleoplasm from cytoplasm**
  - **Outer layer is continuous with rough ER and bears ribosomes.**
  - **Inner lining (nuclear lamina) maintains shape of nucleus.**
  - **Pore complex regulates transport of large molecules into and out of nucleus**



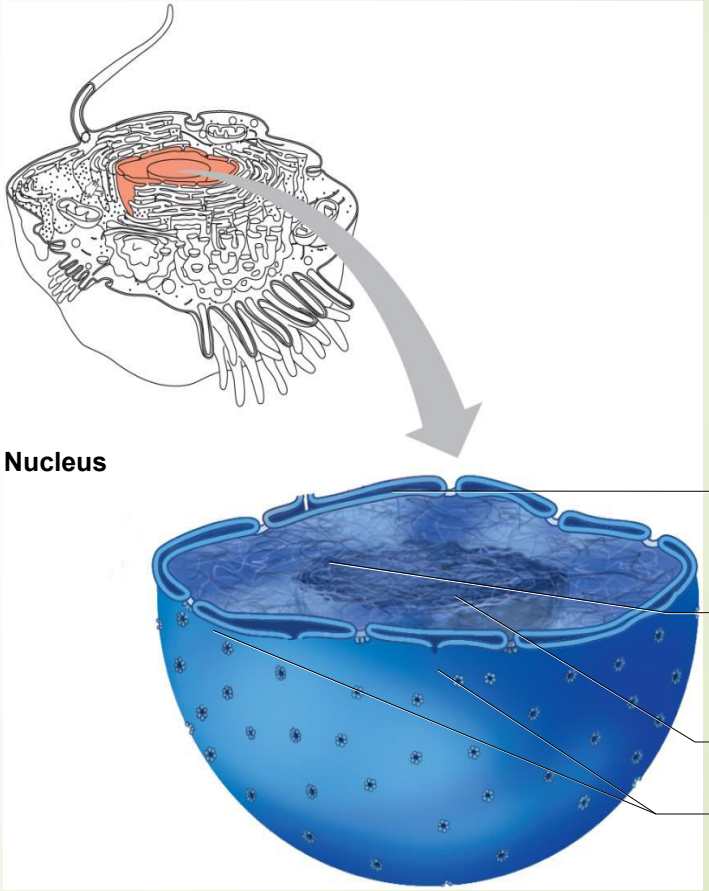
Nuclear envelope



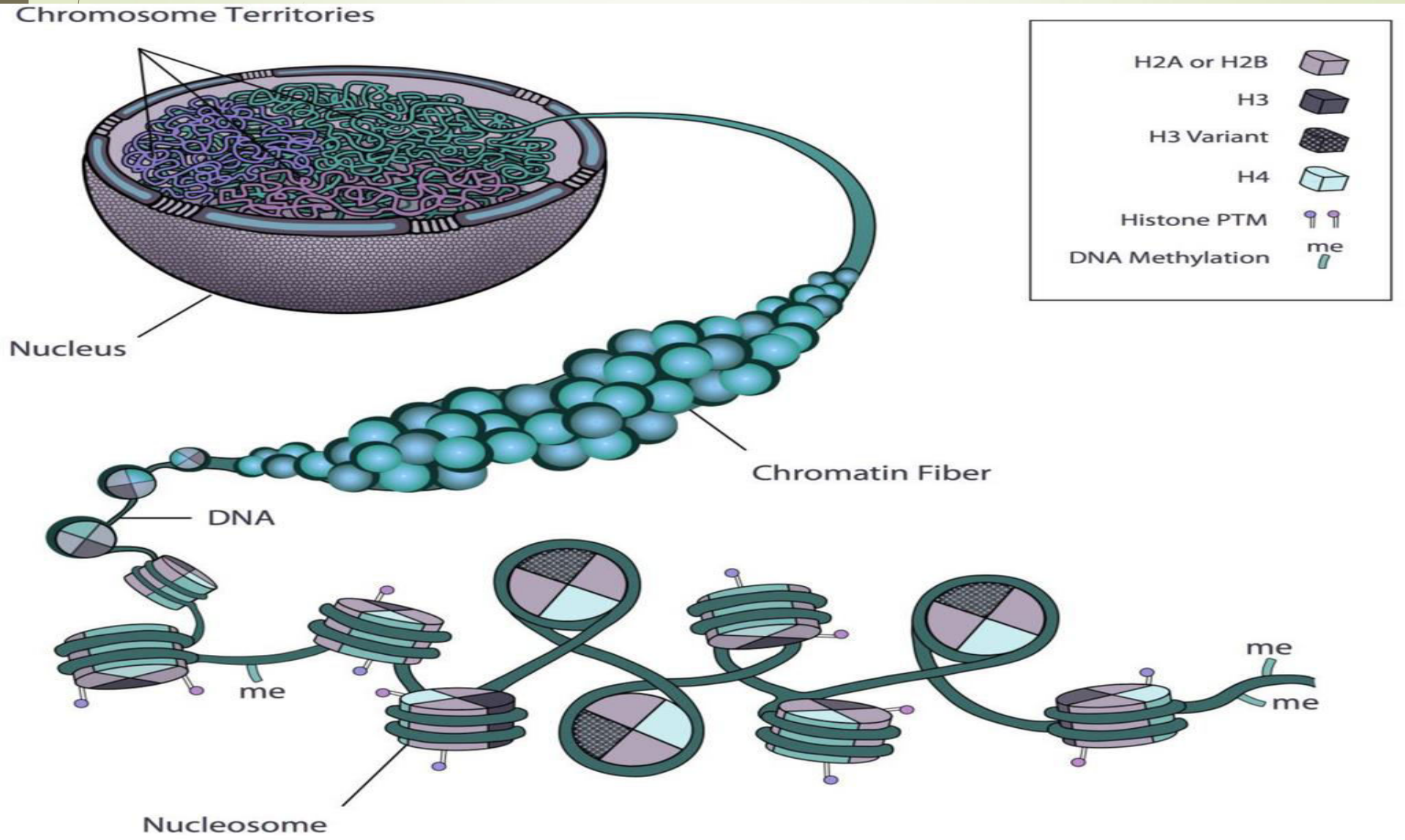
Cell Nucleus

Chromatin:

- Threadlike strands of DNA (30%), histone proteins (60%), and RNA (10%)
- Arranged in fundamental units called nucleosomes
- Condense into barlike bodies called chromosomes when the cell starts to divide.



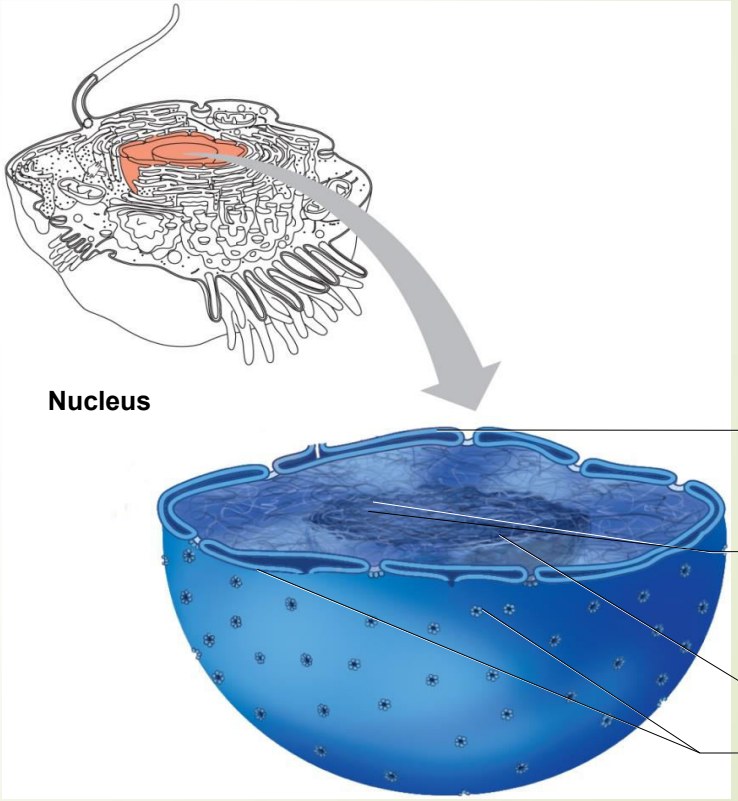
Chromatin


Chromosome Territories
Nucleus
Chromatin Fiber
DNA
Nucleosome
me
me
me
me
H2A or H2B
H3
H3 Variant
H4
Histone PTM
DNA Methylation

Cell Nucleus

Nucleolus

- Dark-staining dense spherical bodies within the nucleus
- Collection of RNA and proteins
- **Function** :synthesis of ribosomes.



Nucleolus

Nucleolus

- **Structure** - Small circular structure(s) within nucleus
- **Function(s)** - Synthesis and partial assembly of ribosomes
- **Found In** - Animal and Plant Cells

Nucleolus

Nucleolus

- **Nucleolus:** structure inside nucleus
- Location of ribosomal RNA (rRNA) synthesis
- **Ribosomes:** cell structure responsible for protein sysnthesis
  - Composed of rRNA