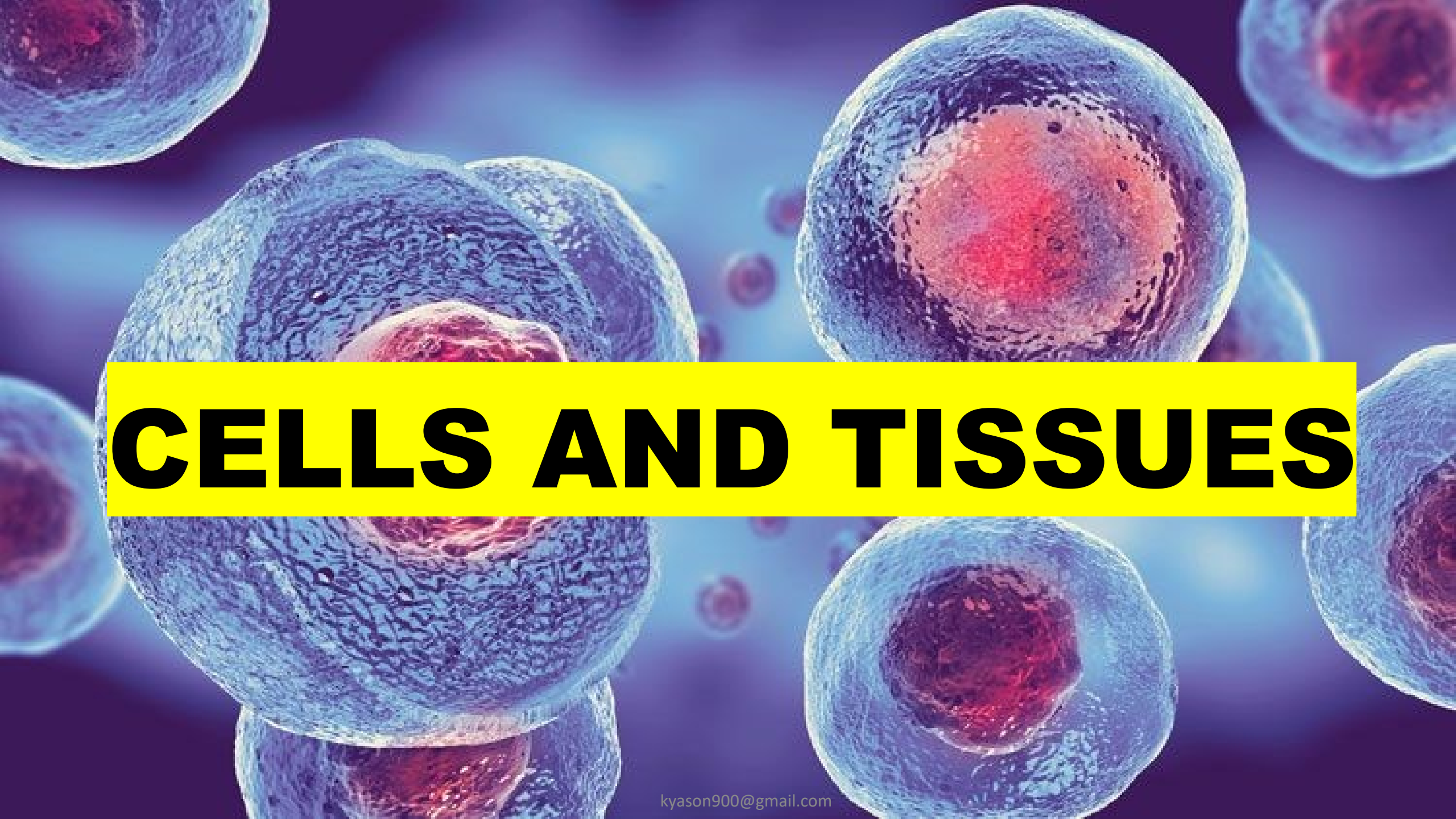

# CELLS AND TISSUES

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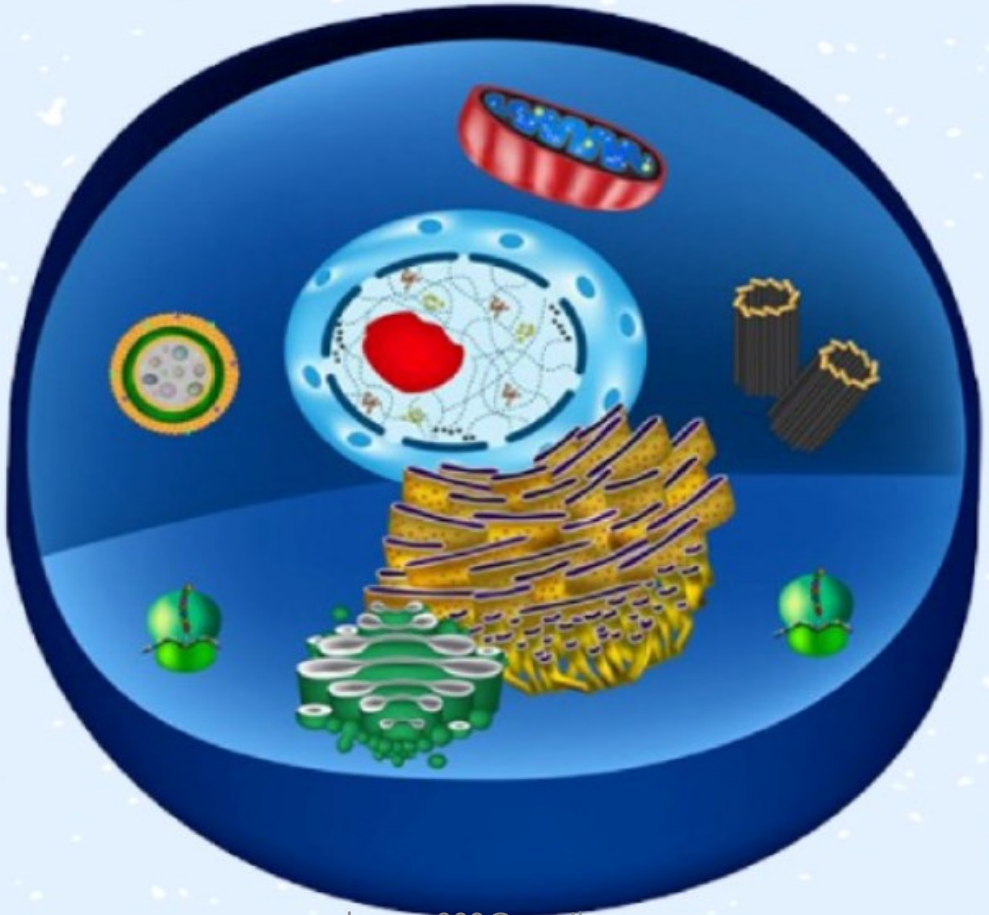
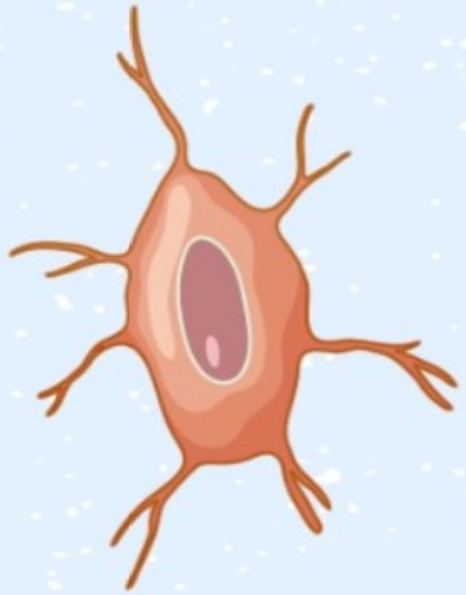
| Chapters | Learning Objectives |
| --- | --- |
| ❖ **Cells** | • Describe the structural components of a typical cell<br>• Describe the functional roles of cell organelles<br>• Describe cell cycle and cell division |
| ❖ **Epithelial Tissue** | • Definition and special x-tics<br>• Classification of epithelial tissues<br>• Describe the location and function of different epithelial tissue types in the human body. |
| ❖ **Connective Tissue** | • Definition and special x-tics<br>• Describe the structural elements and the respective functions<br>• Classification of connective tissues<br>• Describe the location and function of different connective tissue types in the human body. |
| ❖ **Muscle Tissue** | • Definition and special x-tics<br>• Describe the structural elements of each type and respective functions in the human body.<br>• Describe how different muscle tissues contract and relax |
| ❖ **Nervous Tissue** | • Definition and special x-tics<br>• Describe the different cell types under nervous tissue and respective functions |

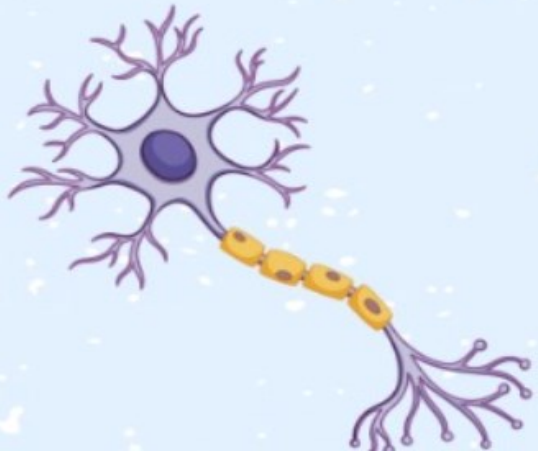


# Cell Structure and Function









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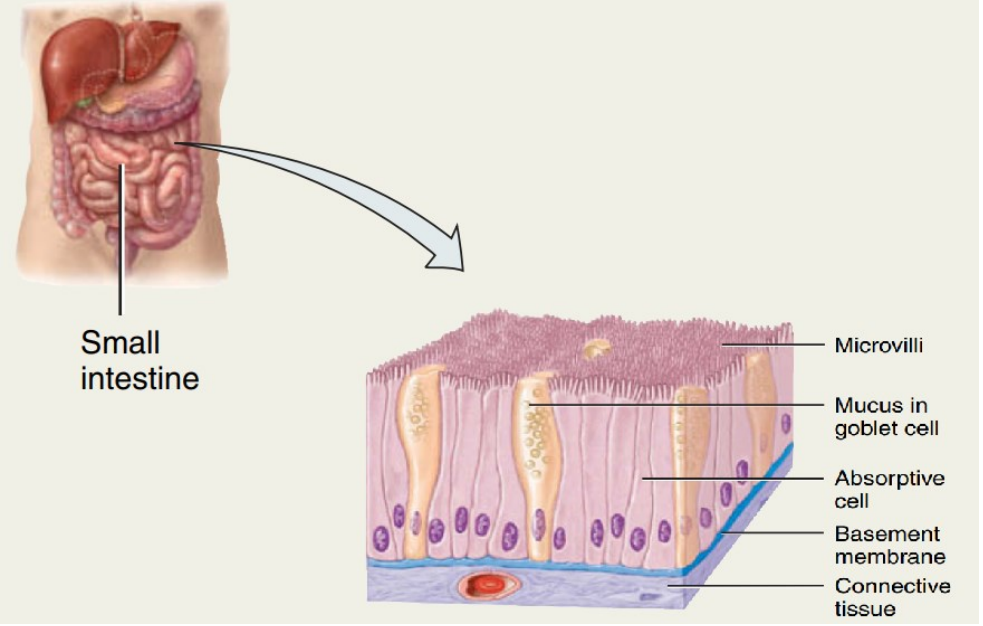
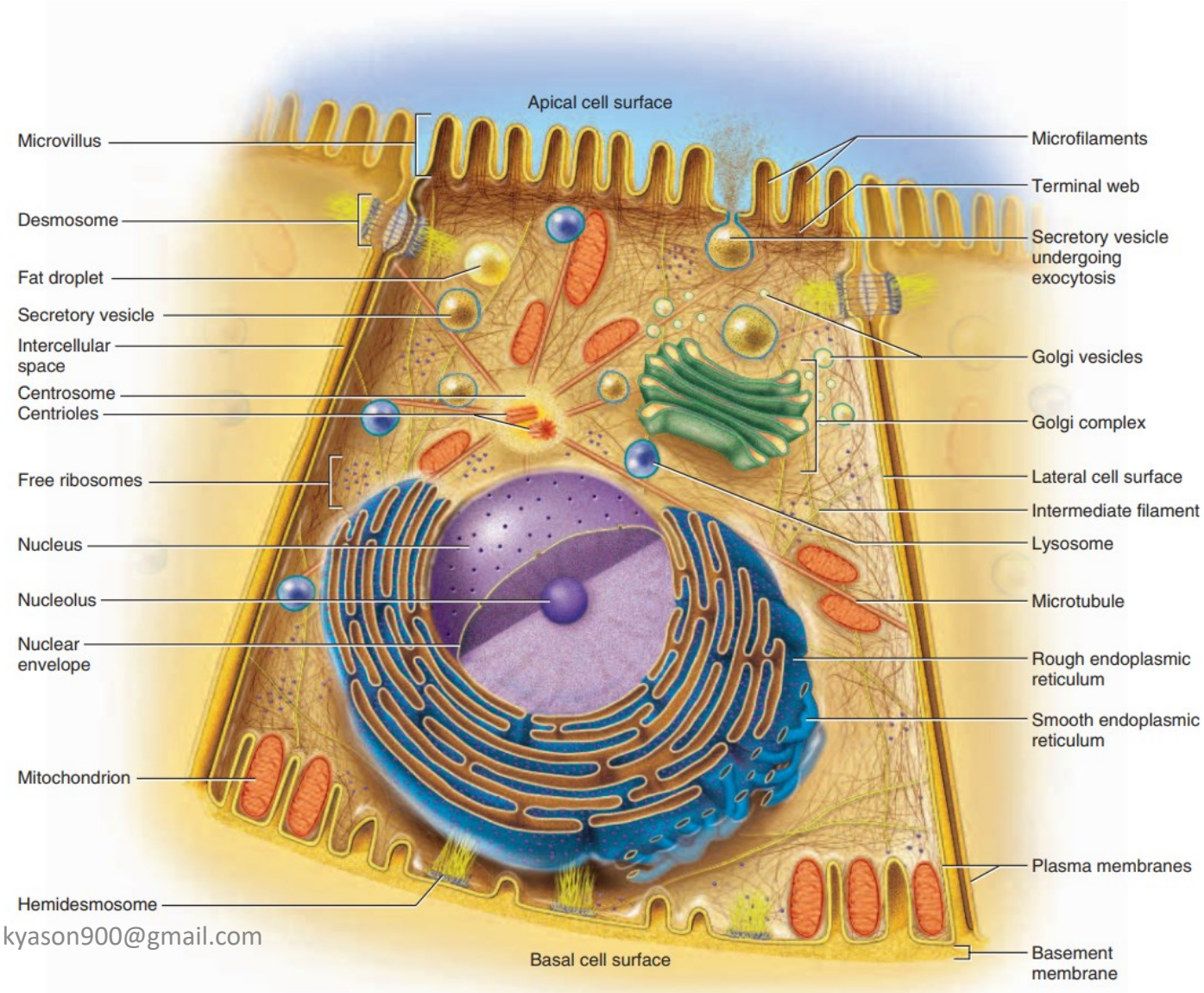
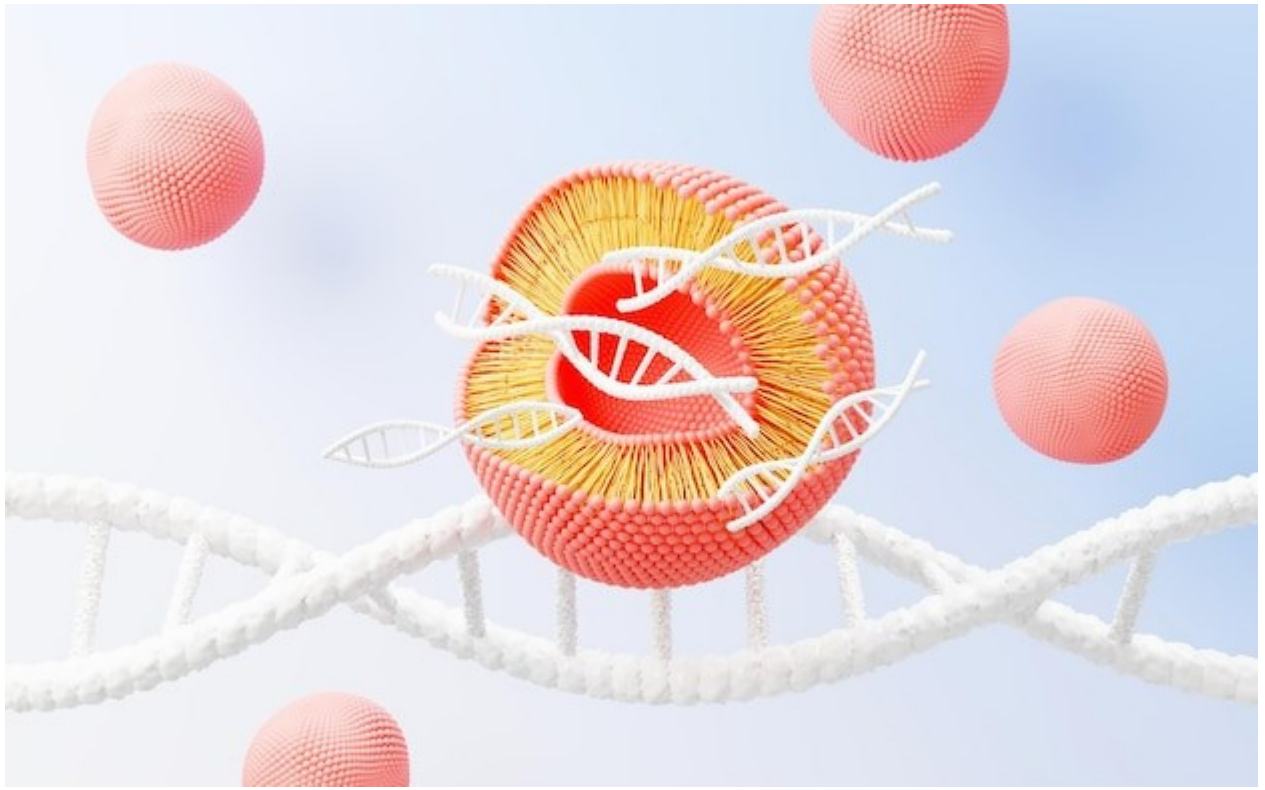


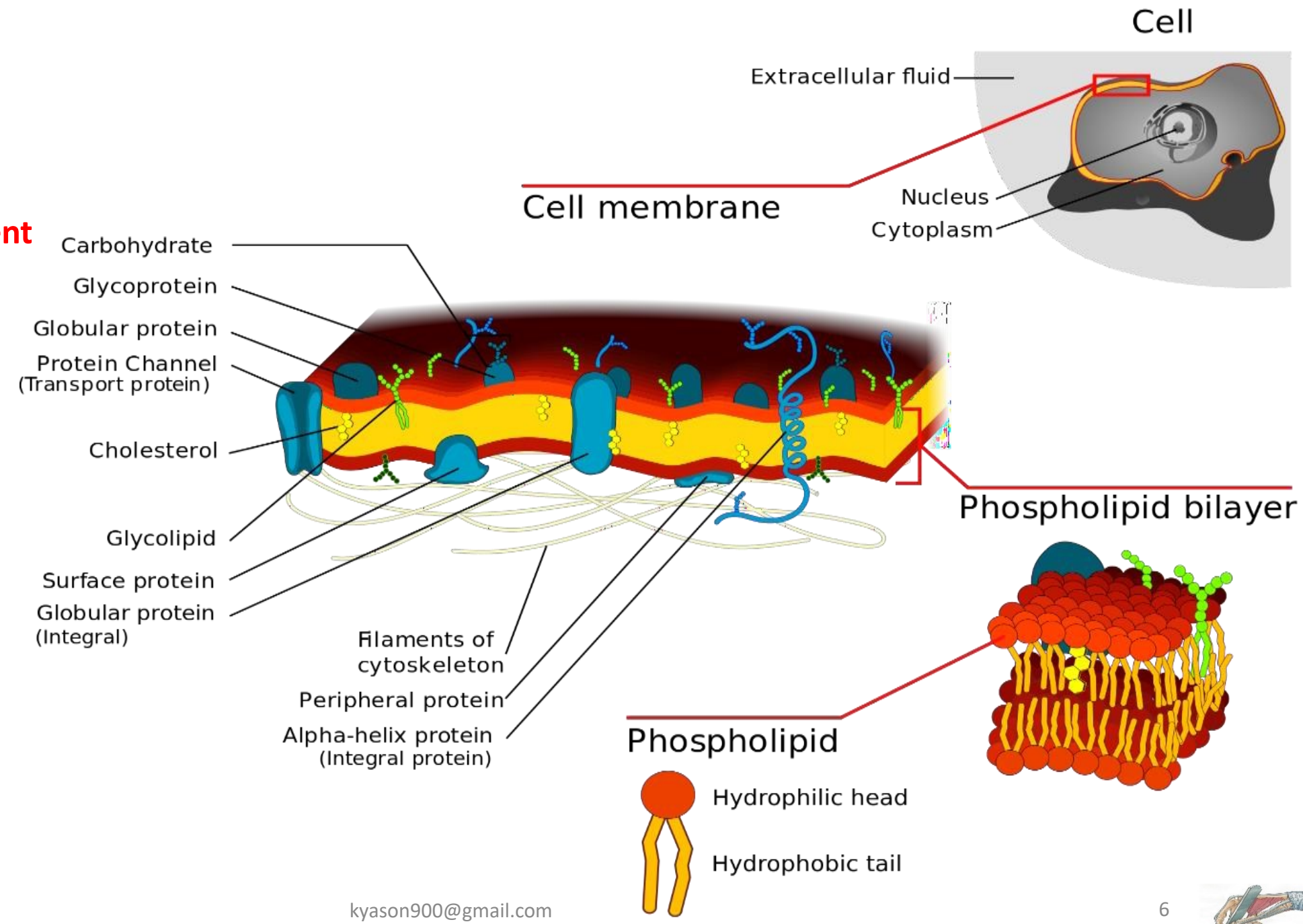
# 1. Cell membrane

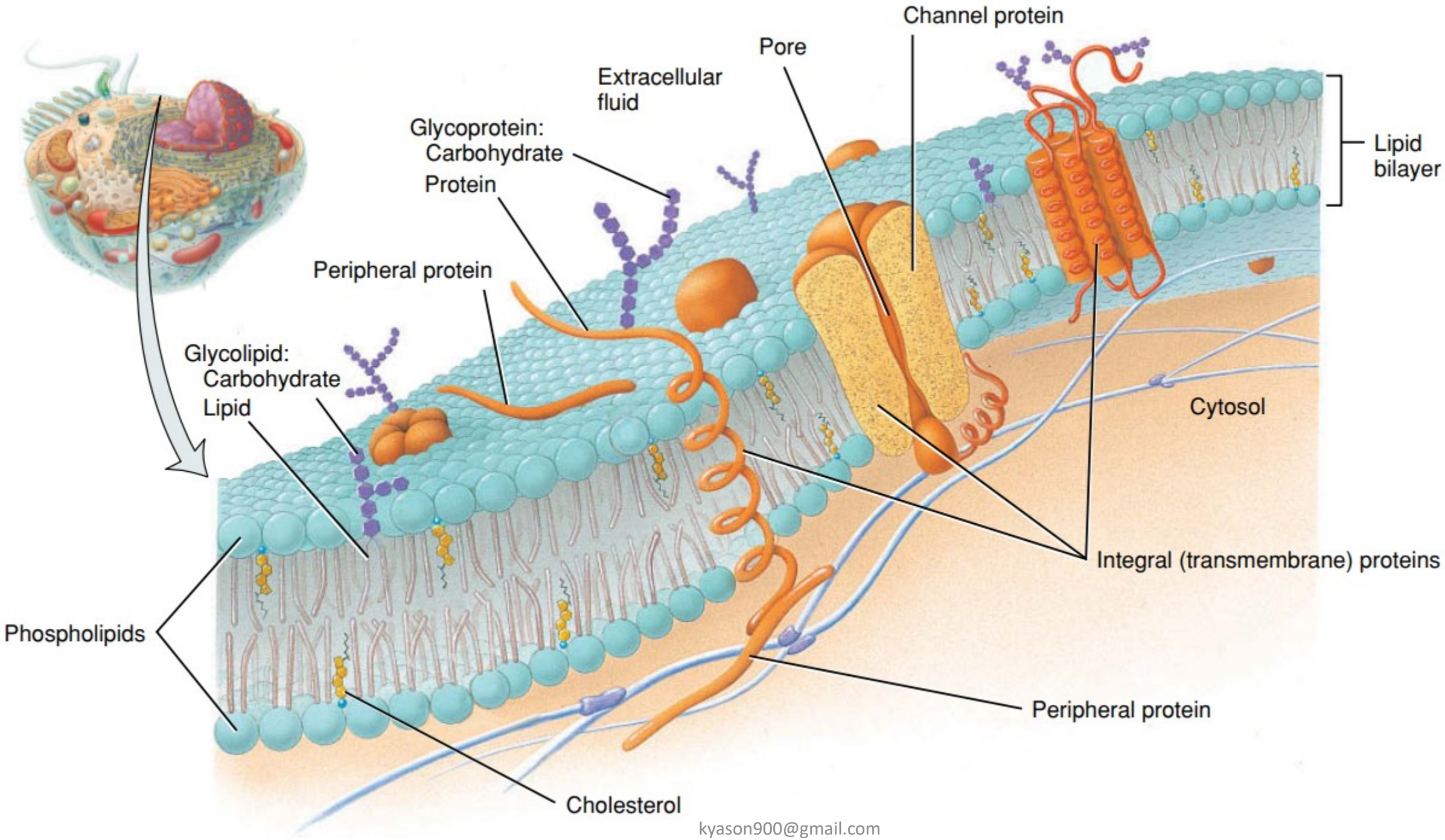
- Cell membrane is a protective sheath, enveloping the cell body.
- It is also known as the **plasma membrane.**



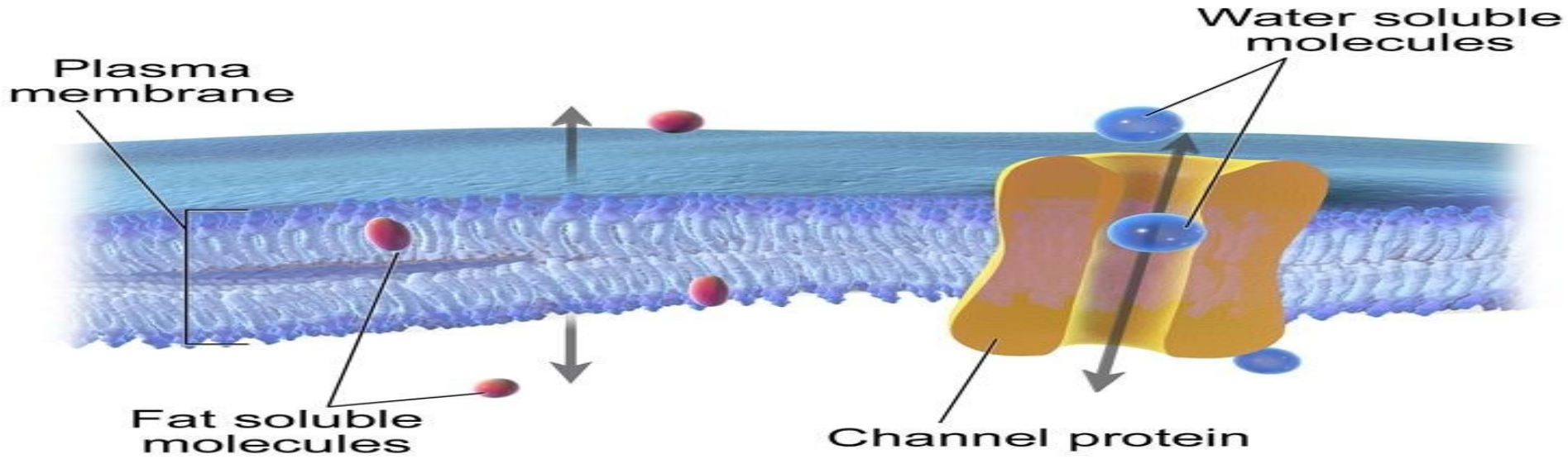
It consists of 3 components:

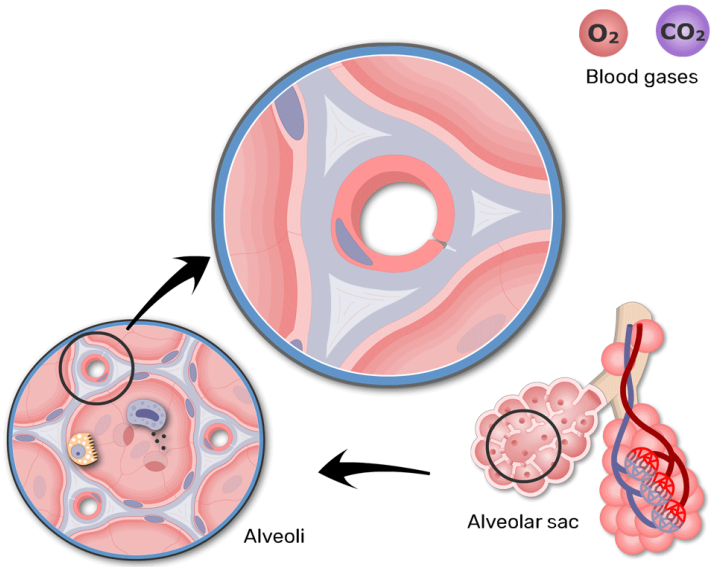
- **Lipid component**
- **Protein component**
- **Carbohydrate component**





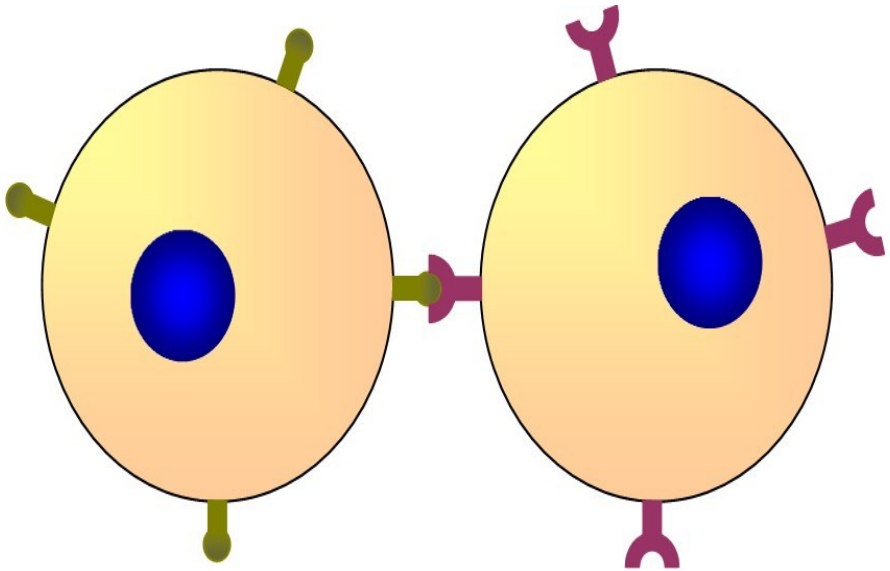
# Lipid and protein components aid in cellular transport

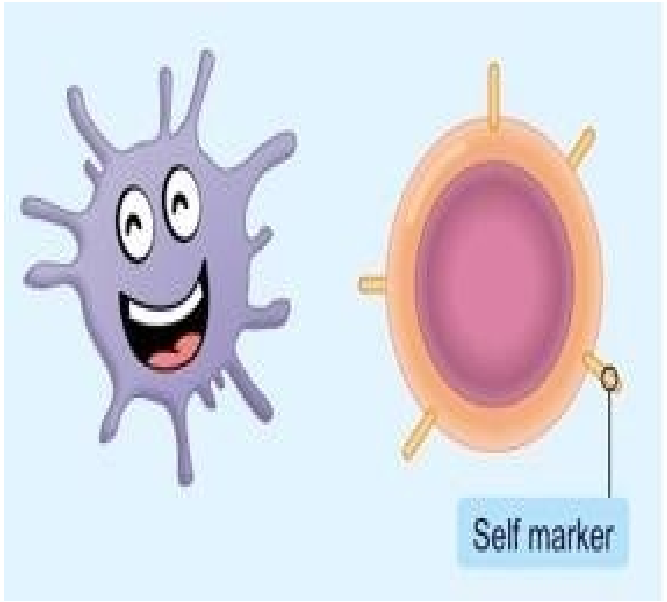


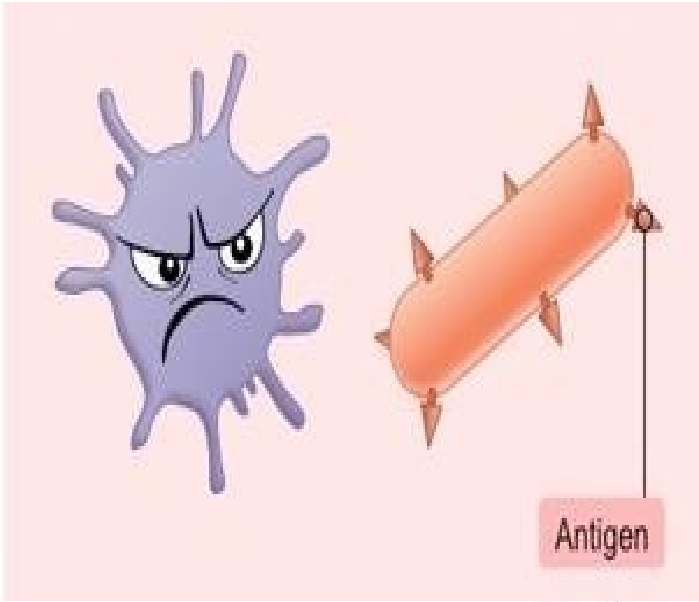



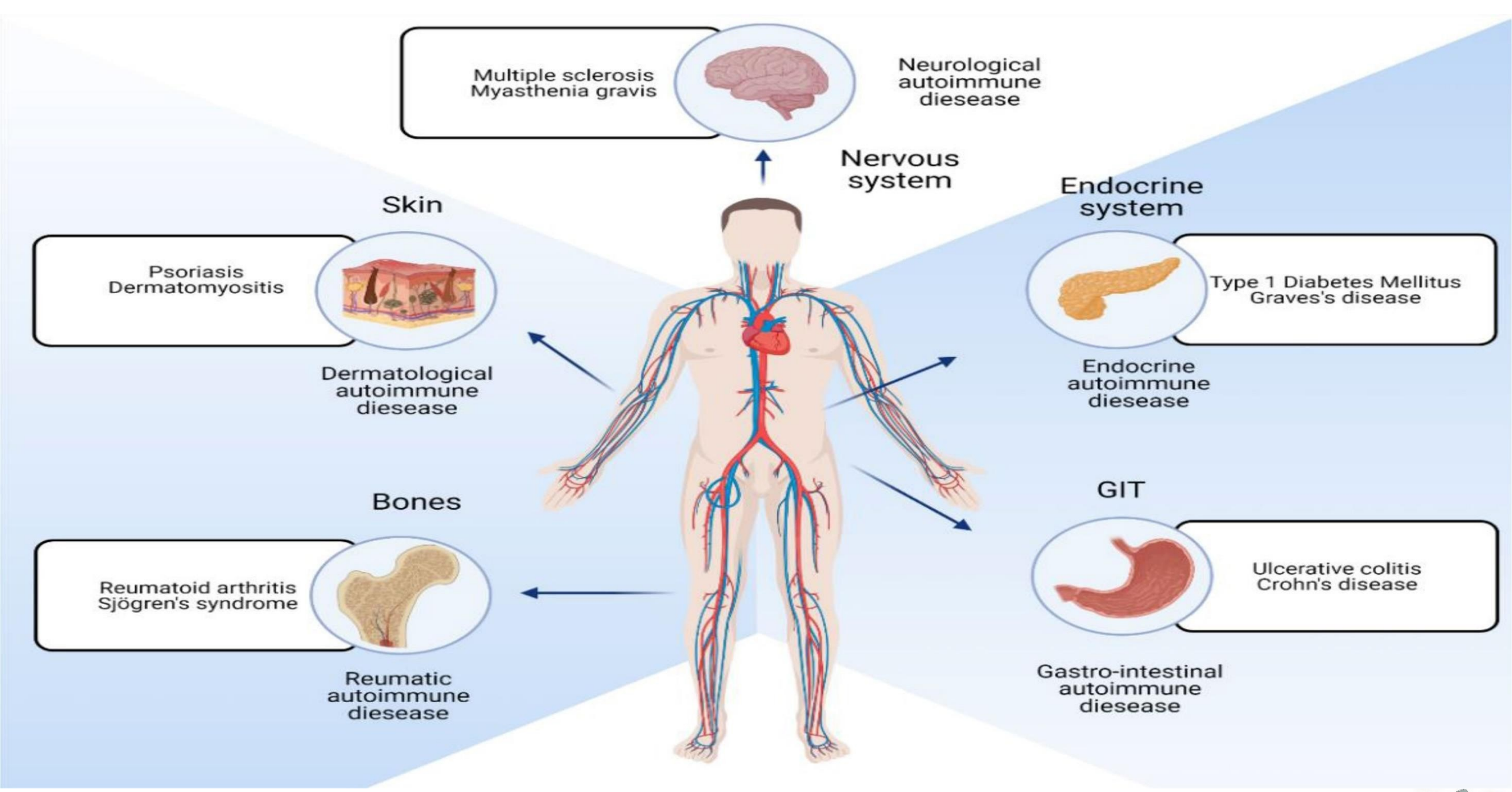
# Carbohydrate component

- Its made up of carbohydrate molecules attached to proteins and lipids to form glycoproteins and glycolipids respectively.
- Their role is to facilitate **cellular recognition**

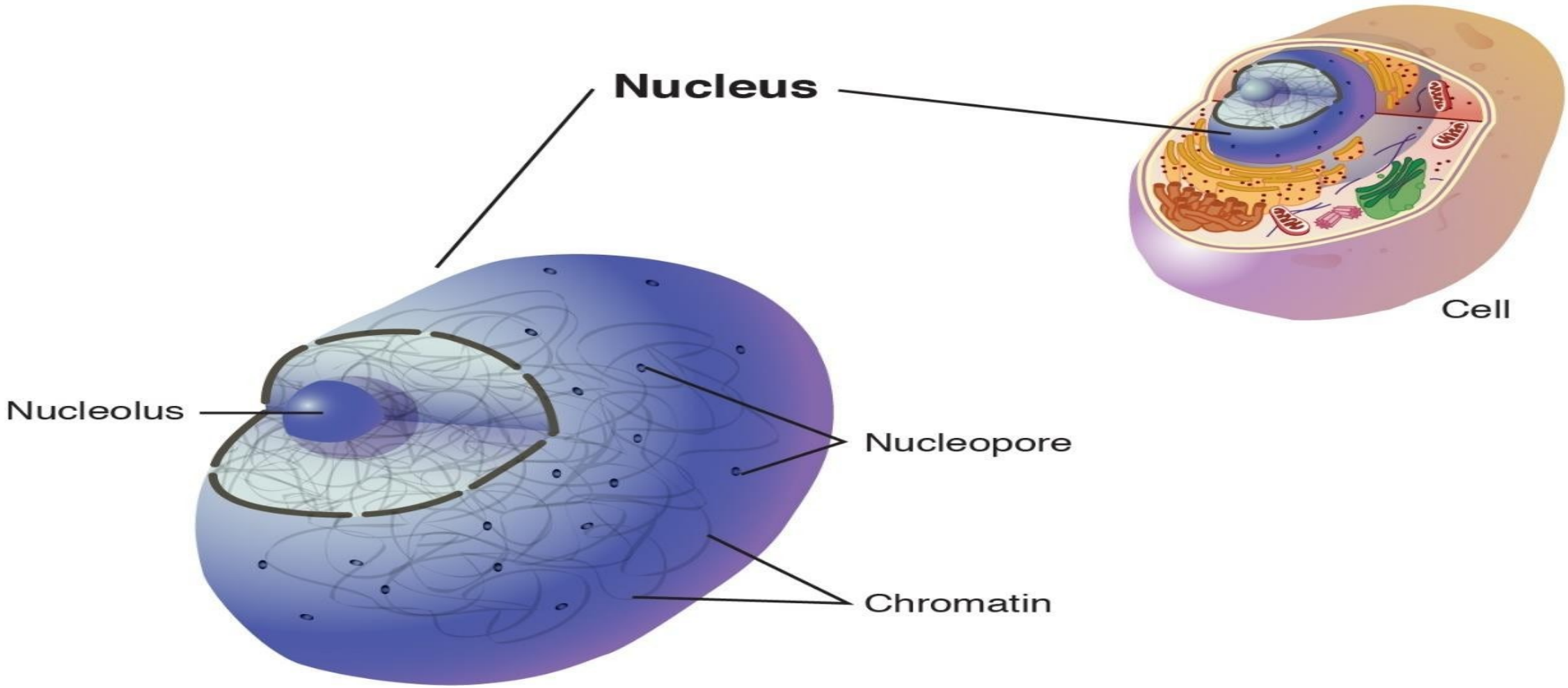


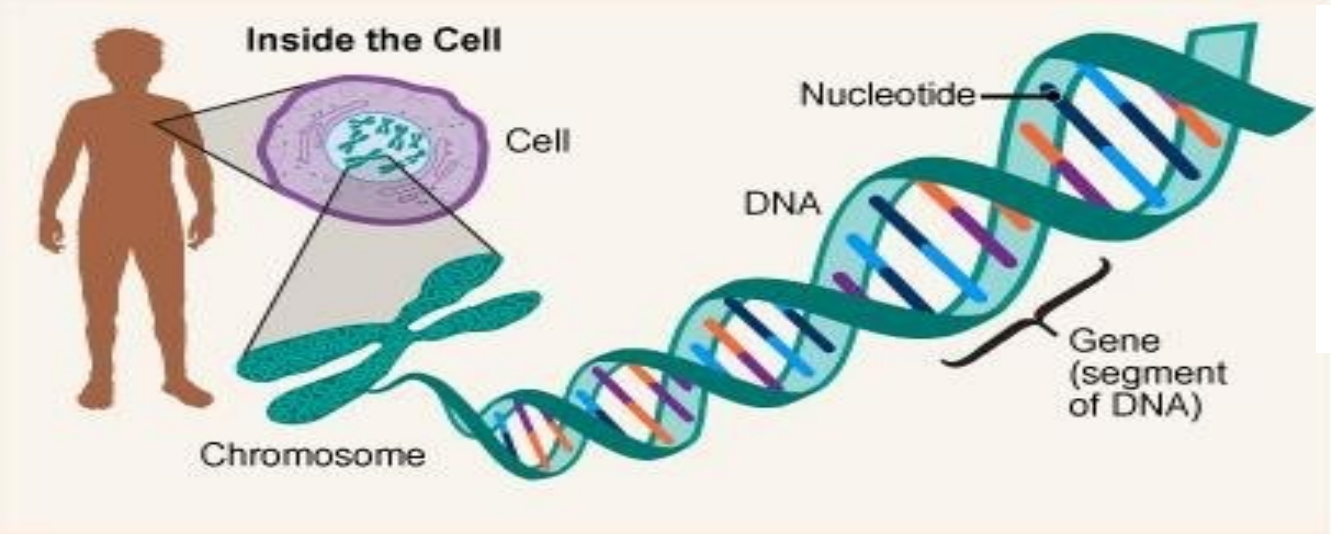


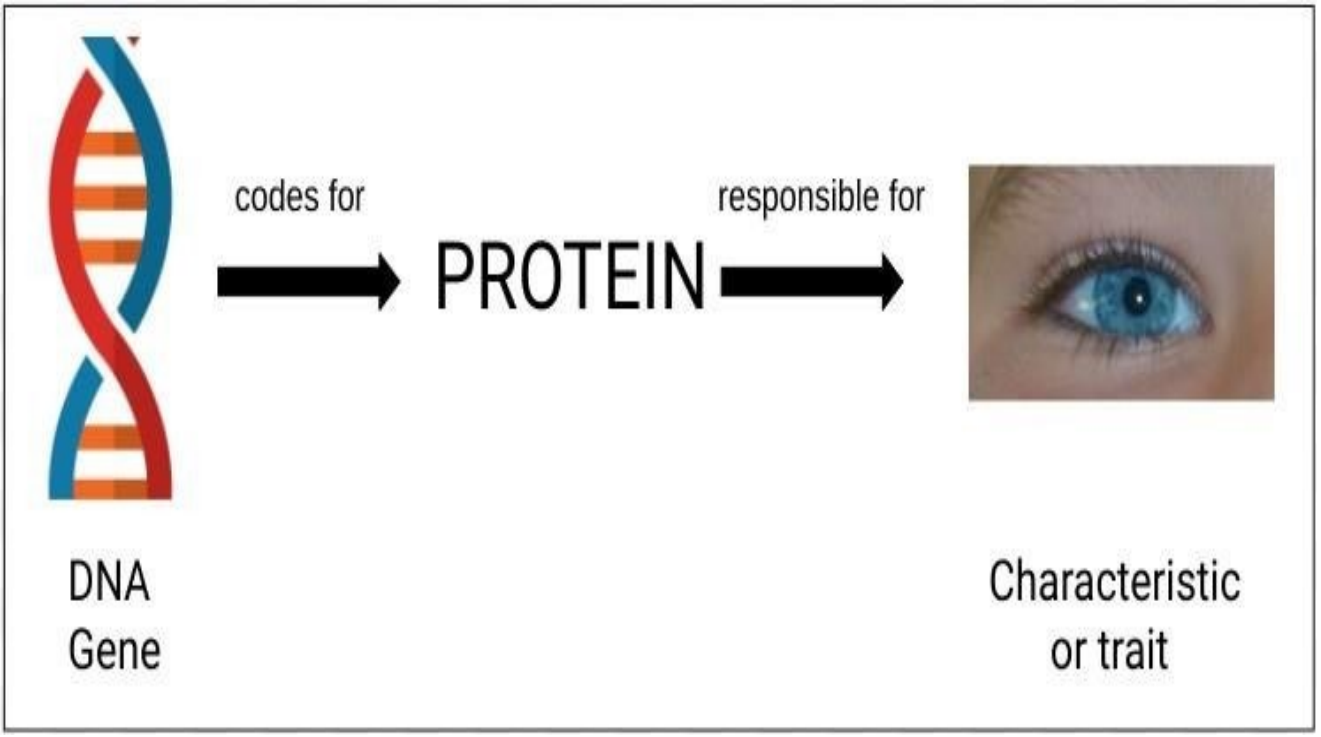



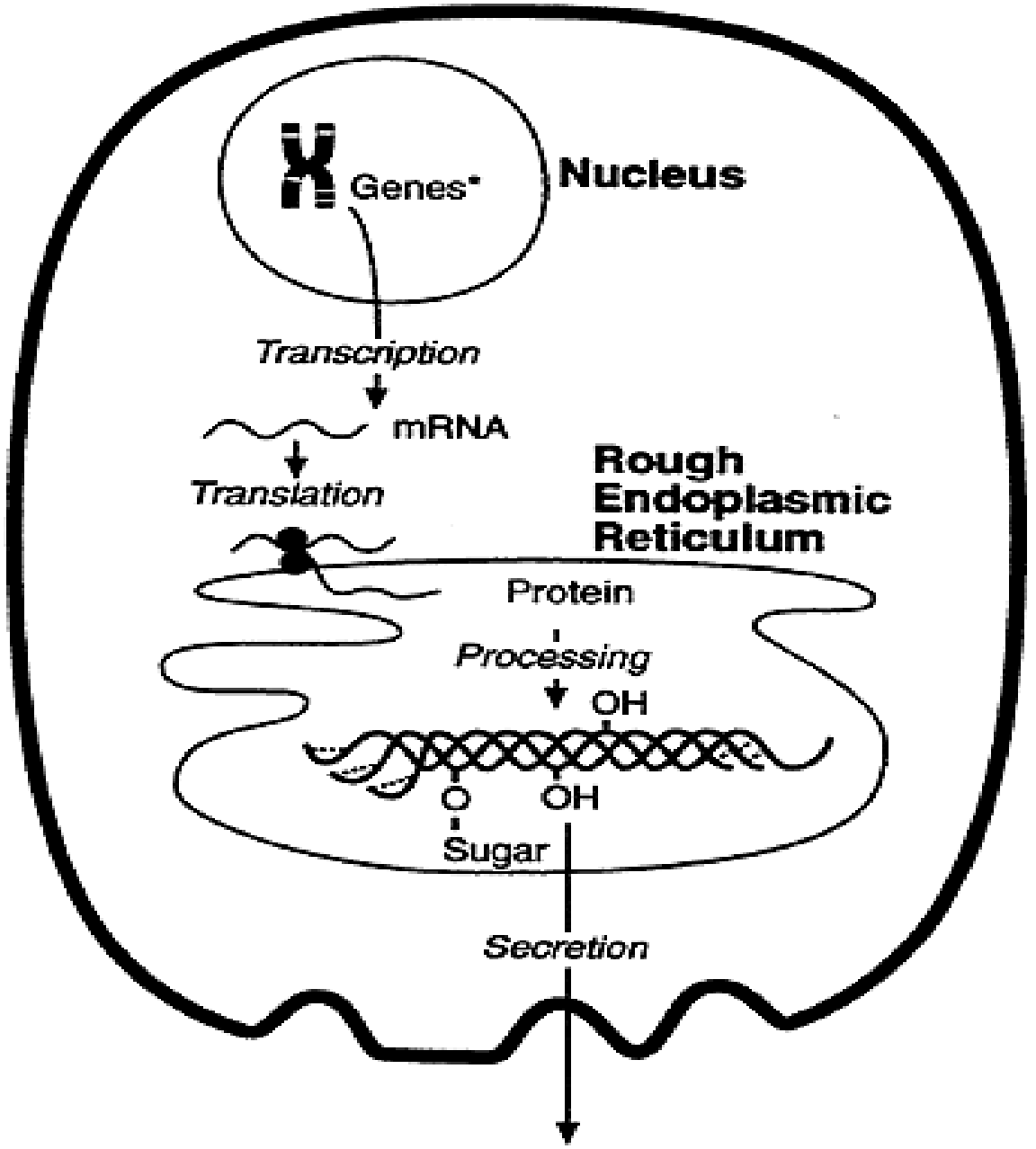

Multiple sclerosis
Myasthenia gravis
Neurological autoimmune diesease
Nervous system
Skin
Psoriasis
Dermatomyositis
Dermatological autoimmune diesease
Endocrine system
Type 1 Diabetes Mellitus
Graves's disease
Endocrine autoimmune diesease
Bones
Reumatoid arthritis
Sjögren's syndrome
Reumatic autoimmune diesease
GIT
Ulcerative colitis
Crohn's disease
Gastro-intestinal autoimmune diesease

# 2. Nucleus

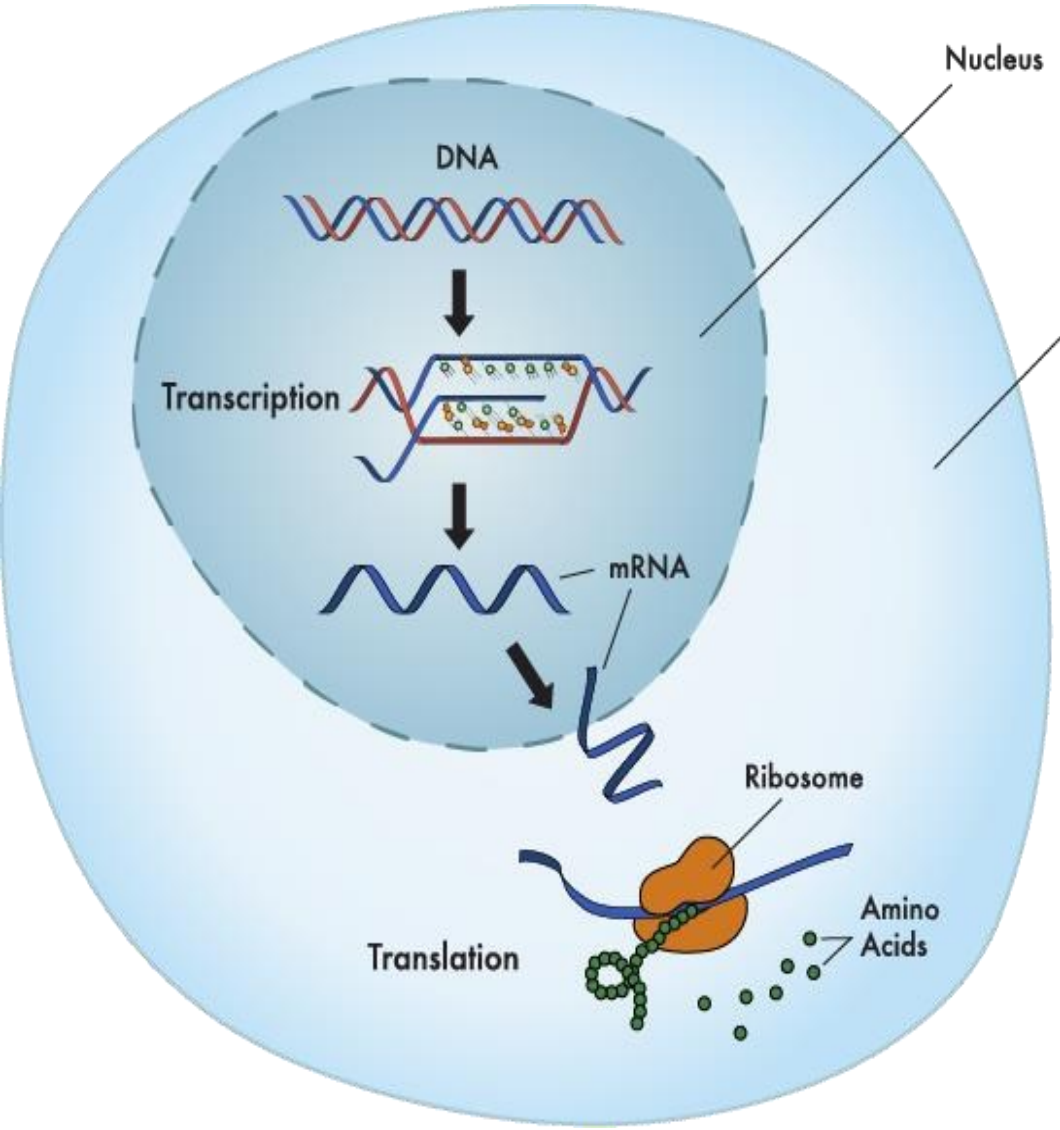


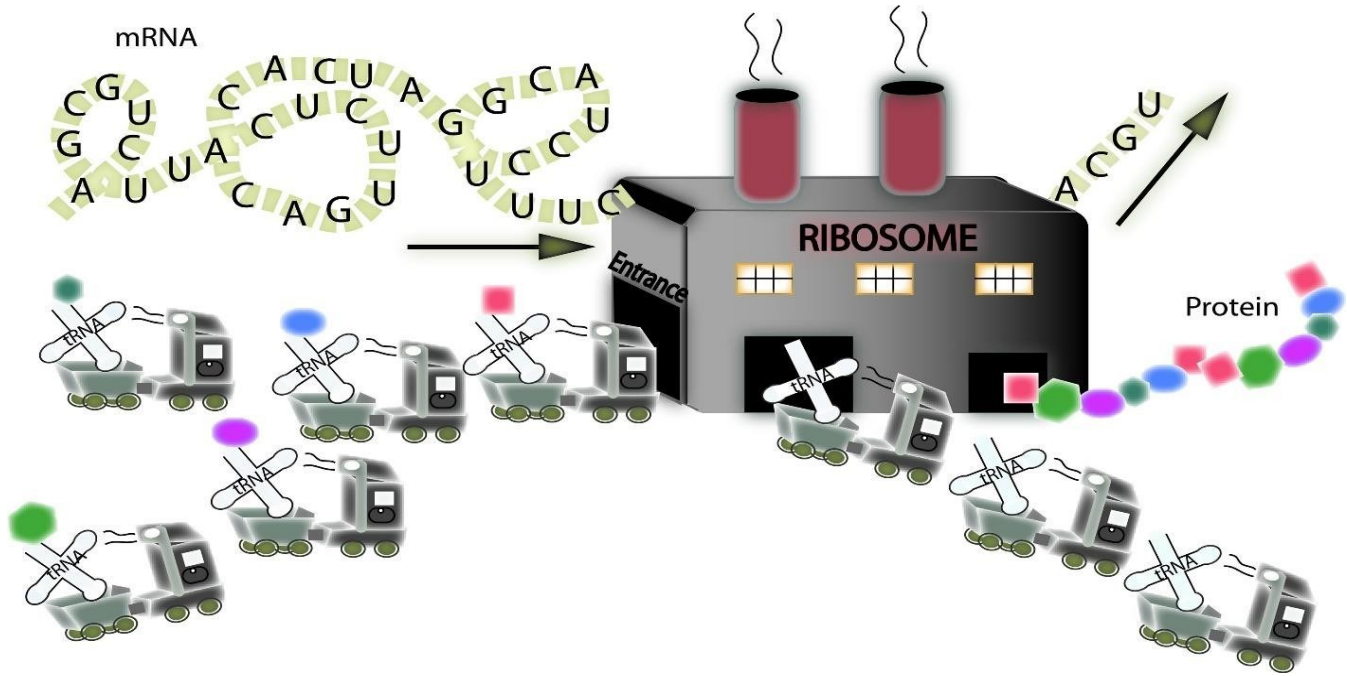

Inside the Cell
Cell
Nucleotide
DNA
Gene
(segment
of DNA)
Chromosome


codes for
PROTEIN
responsible for
DNA
Gene
Characteristic
or trait


Genes
Nucleus
Transcription
mRNA
Translation
Rough
Endoplasmic
Reticulum
Protein
Processing
OH
O
OH
Sugar
Secretion

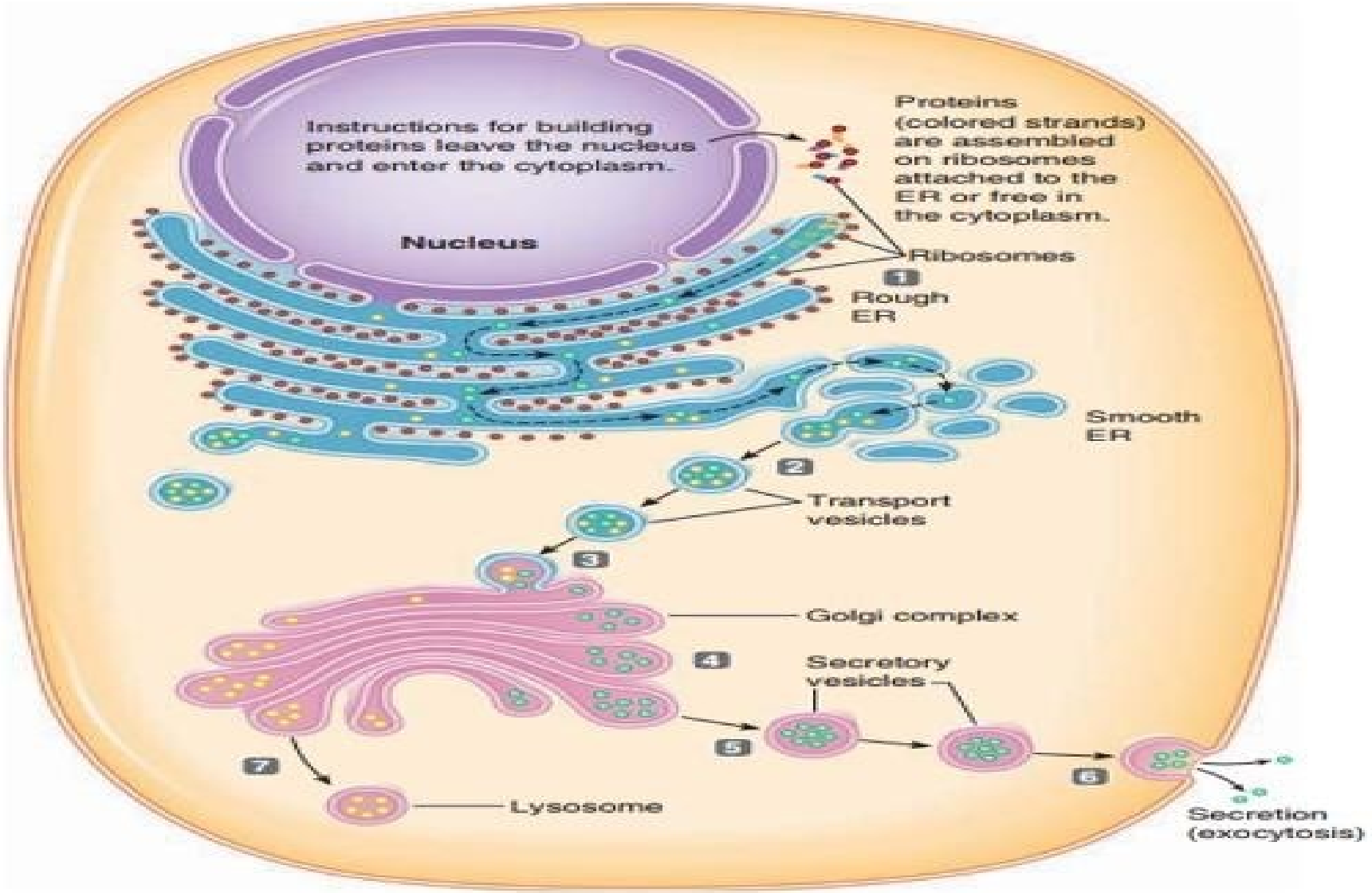
# 3. Ribosomes


Nucleus
Cytoplasm
DNA
Transcription
mRNA
Ribosome
Translation
Amino Acids

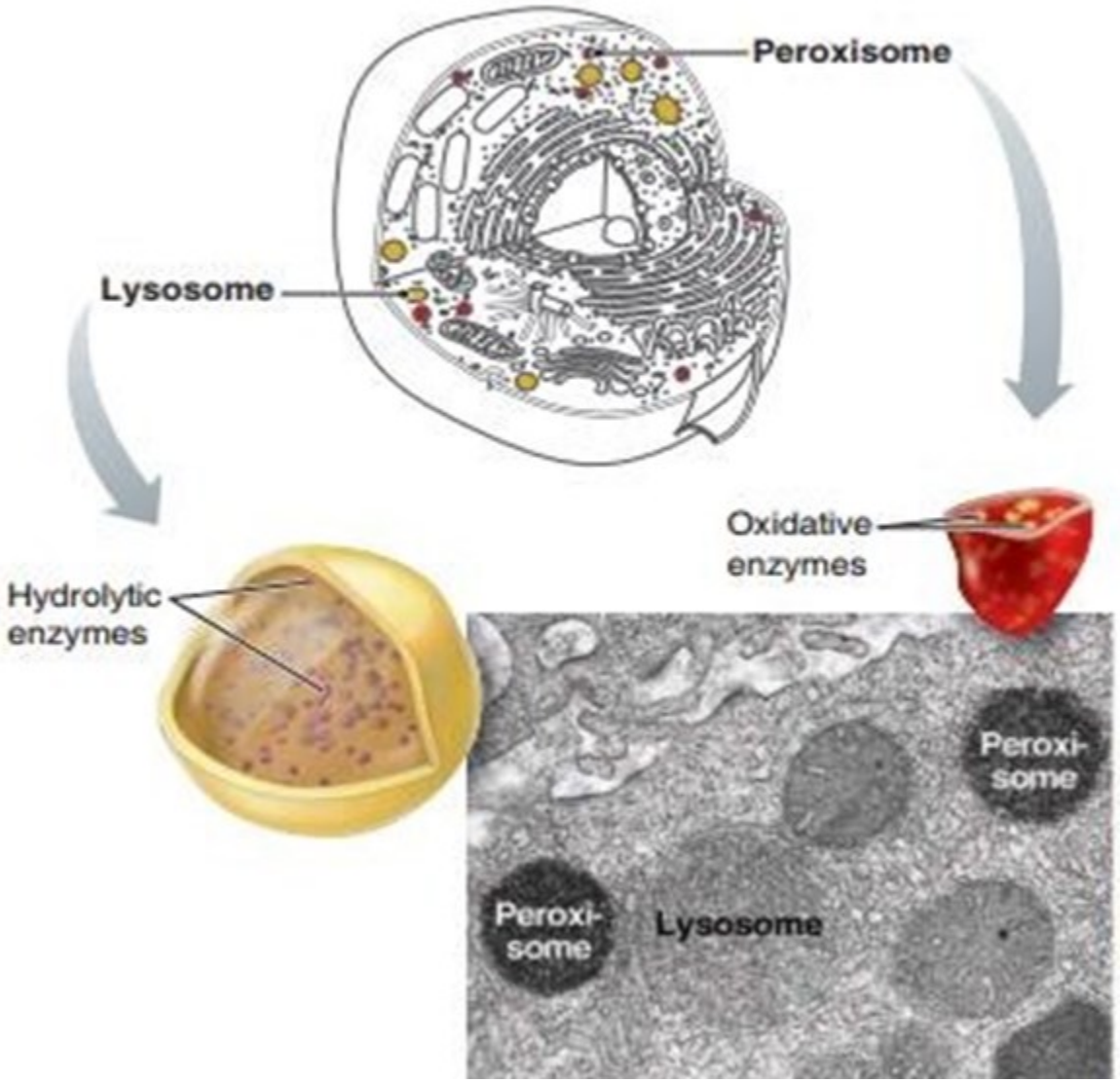

mRNA
RIBOSOME
Entrance
Protein
tRNA

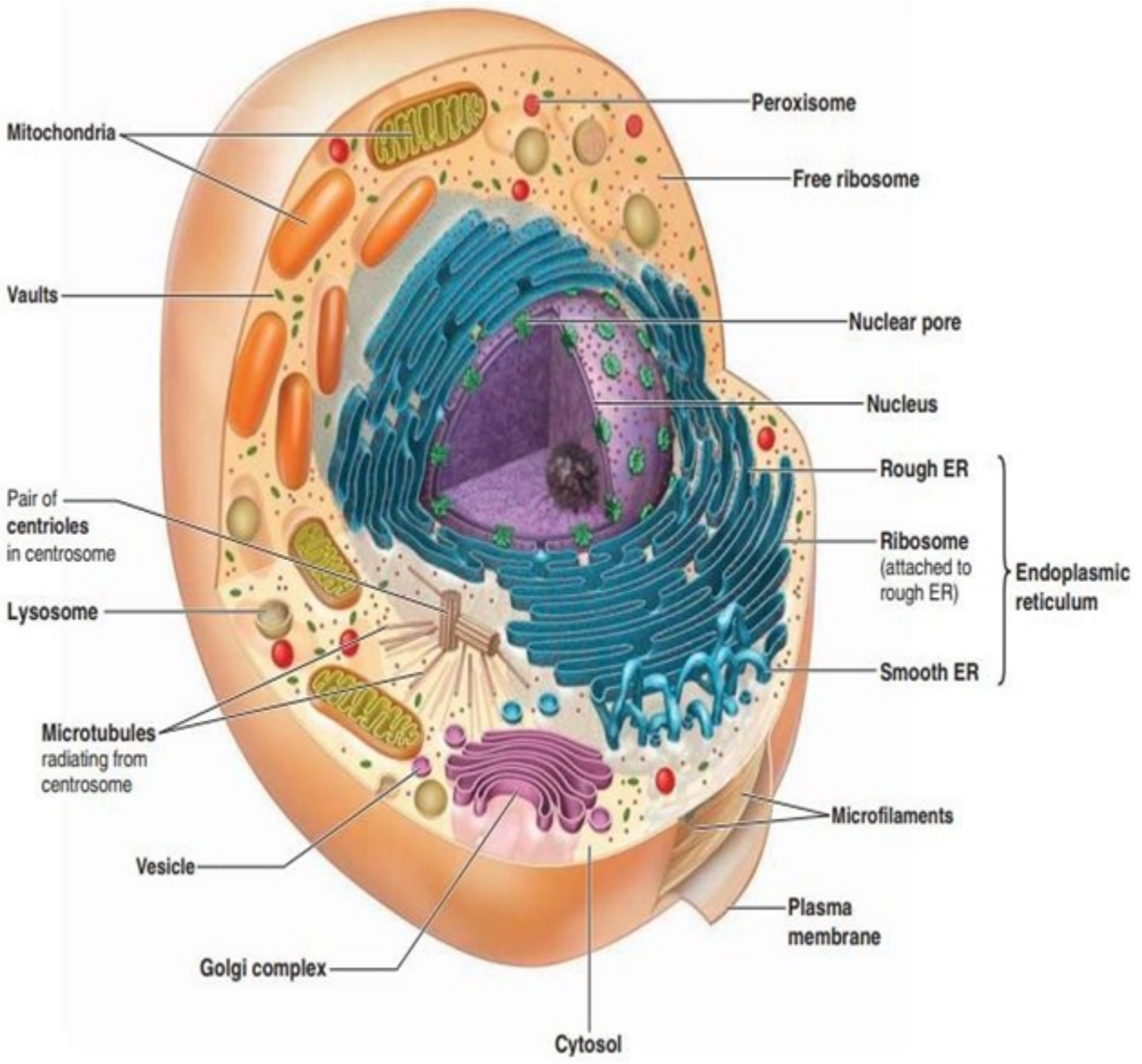
# 4. Endoplasmic reticulum

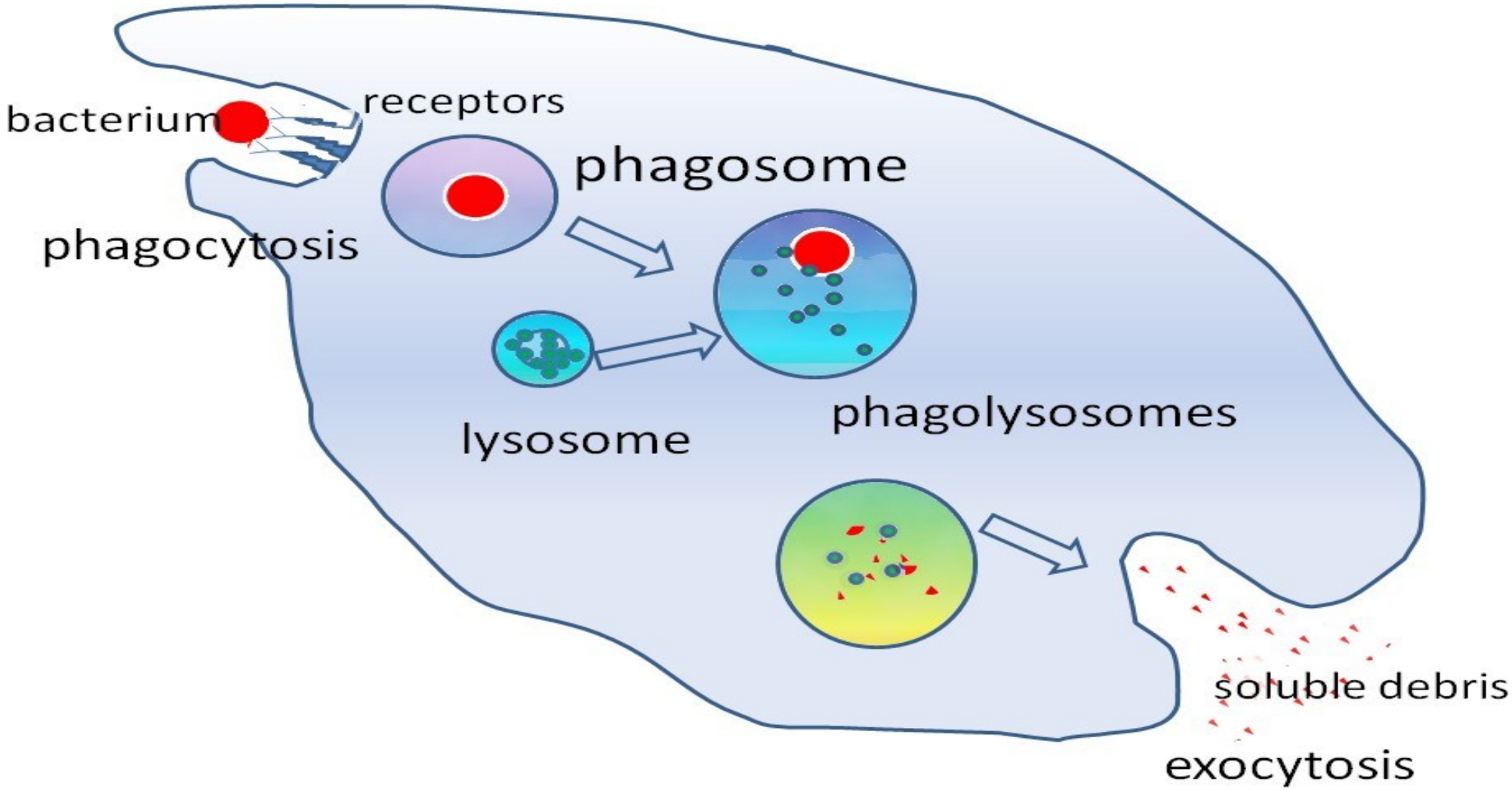
# 5. Golgi apparatus



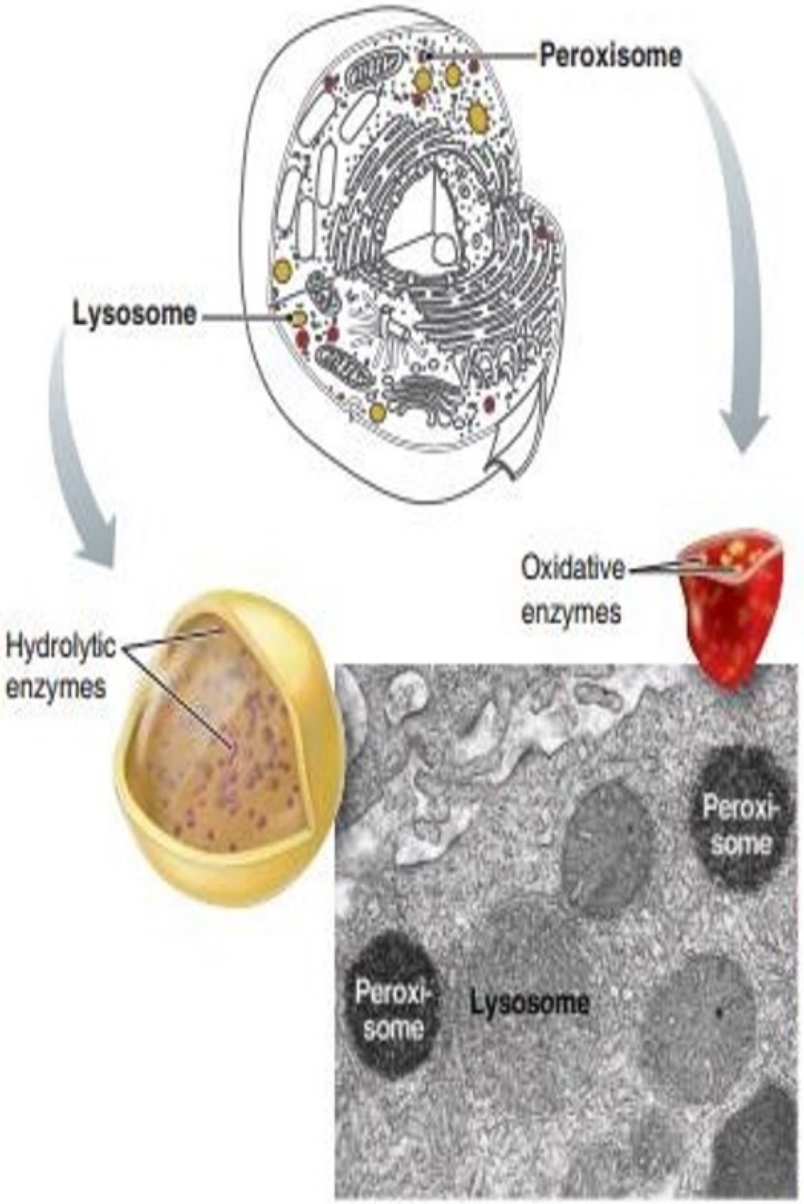
# 6. Lysosome

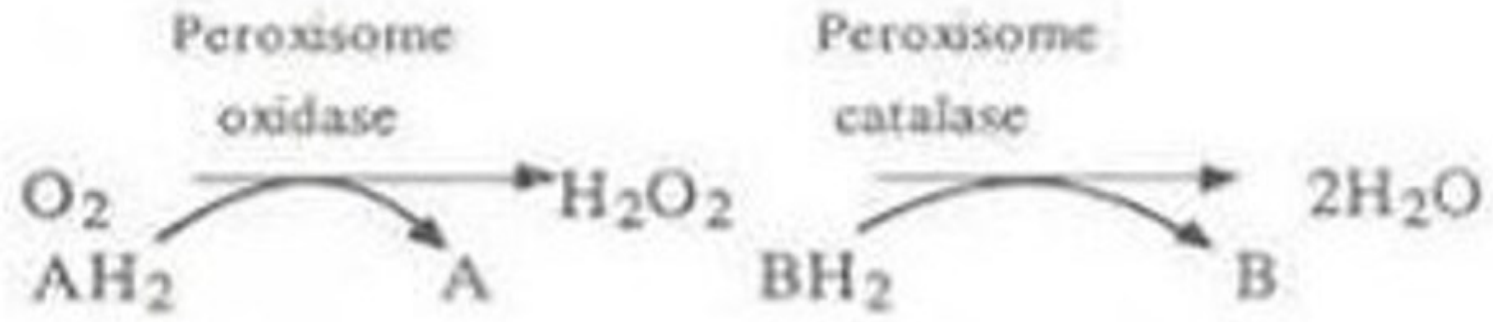

Peroxisome
Lysosome
Oxidative enzymes
Hydrolytic enzymes
Peroxi-some
Peroxi-some
Lysosome


Mitochondria
Peroxisome
Free ribosome
Vaults
Nuclear pore
Nucleus
Rough ER
Pair of centrioles in centrosome
Ribosome (attached to rough ER)
Endoplasmic reticulum
Lysosome
Smooth ER
Microtubules radiating from centrosome
Microfilaments
Vesicle
Plasma membrane
Golgi complex
Cytosol

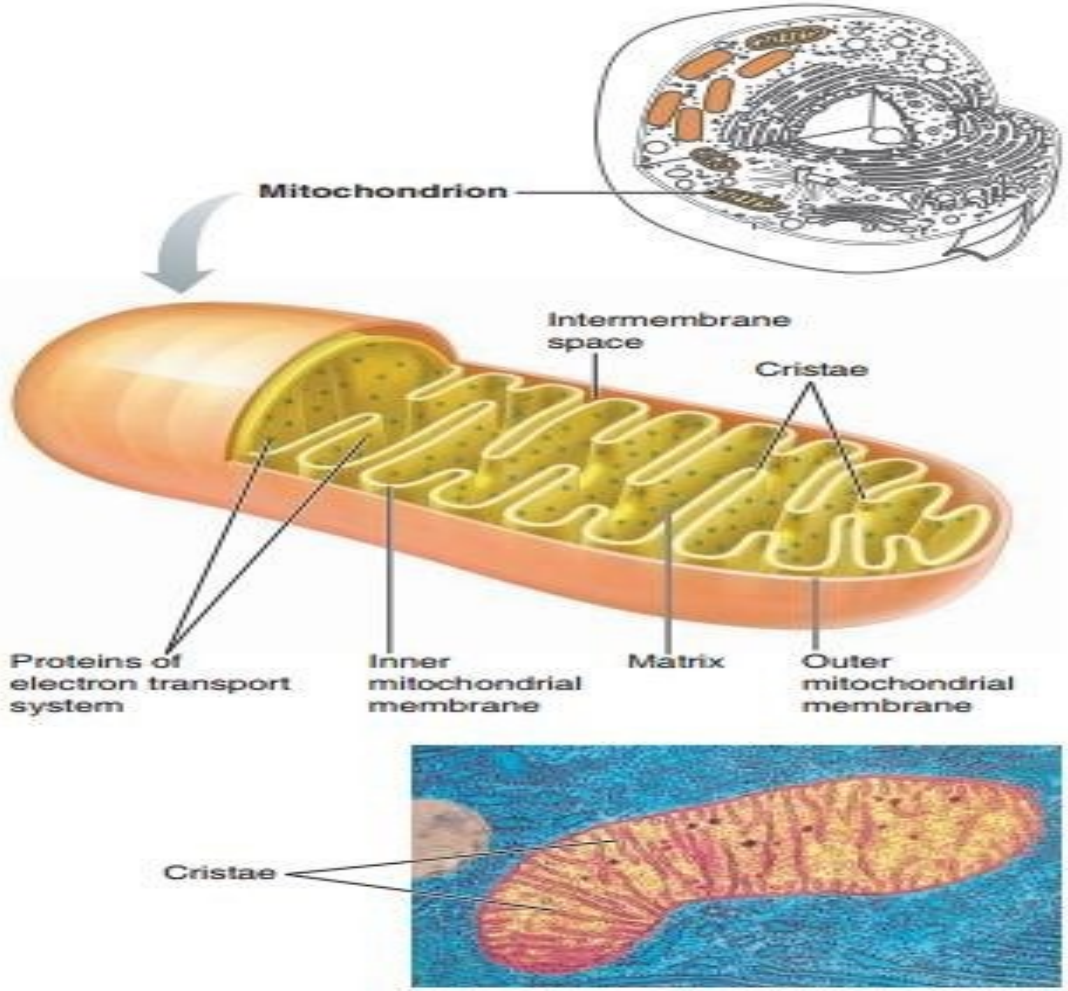

bacterium
receptors
phagosome
phagocytosis
lysosome
phagolysosomes
soluble debris
exocytosis

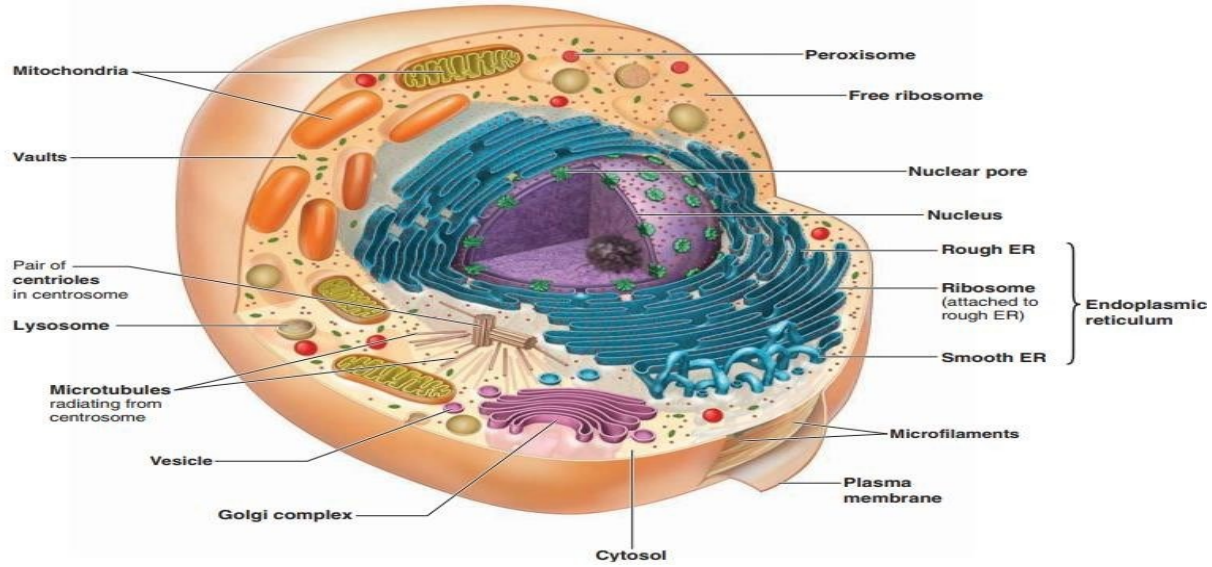
# 7. Peroxisome

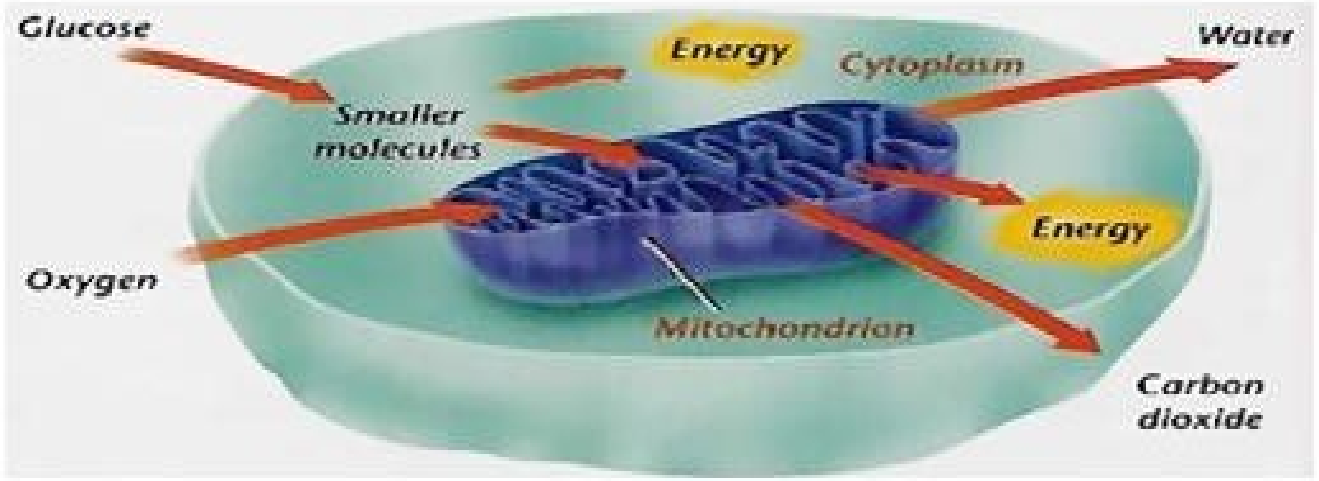


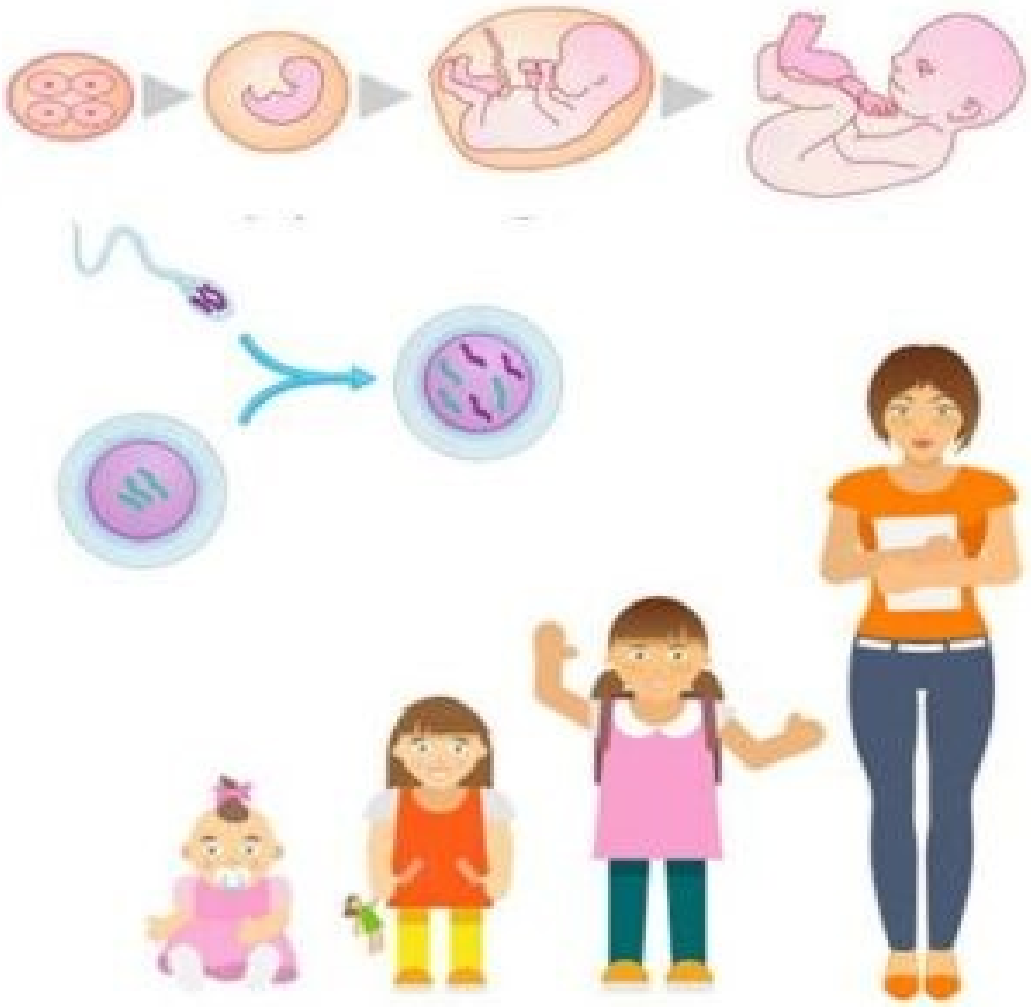
# 8.Mitochondria

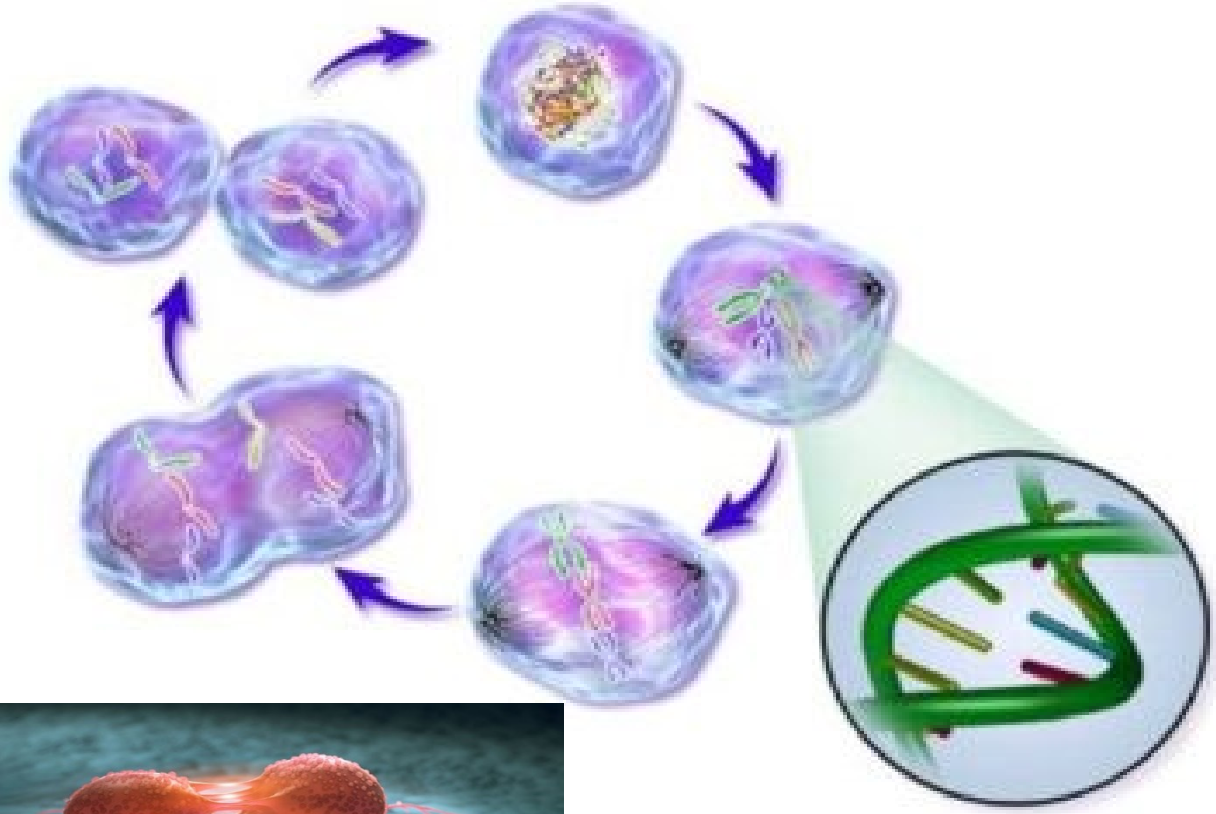


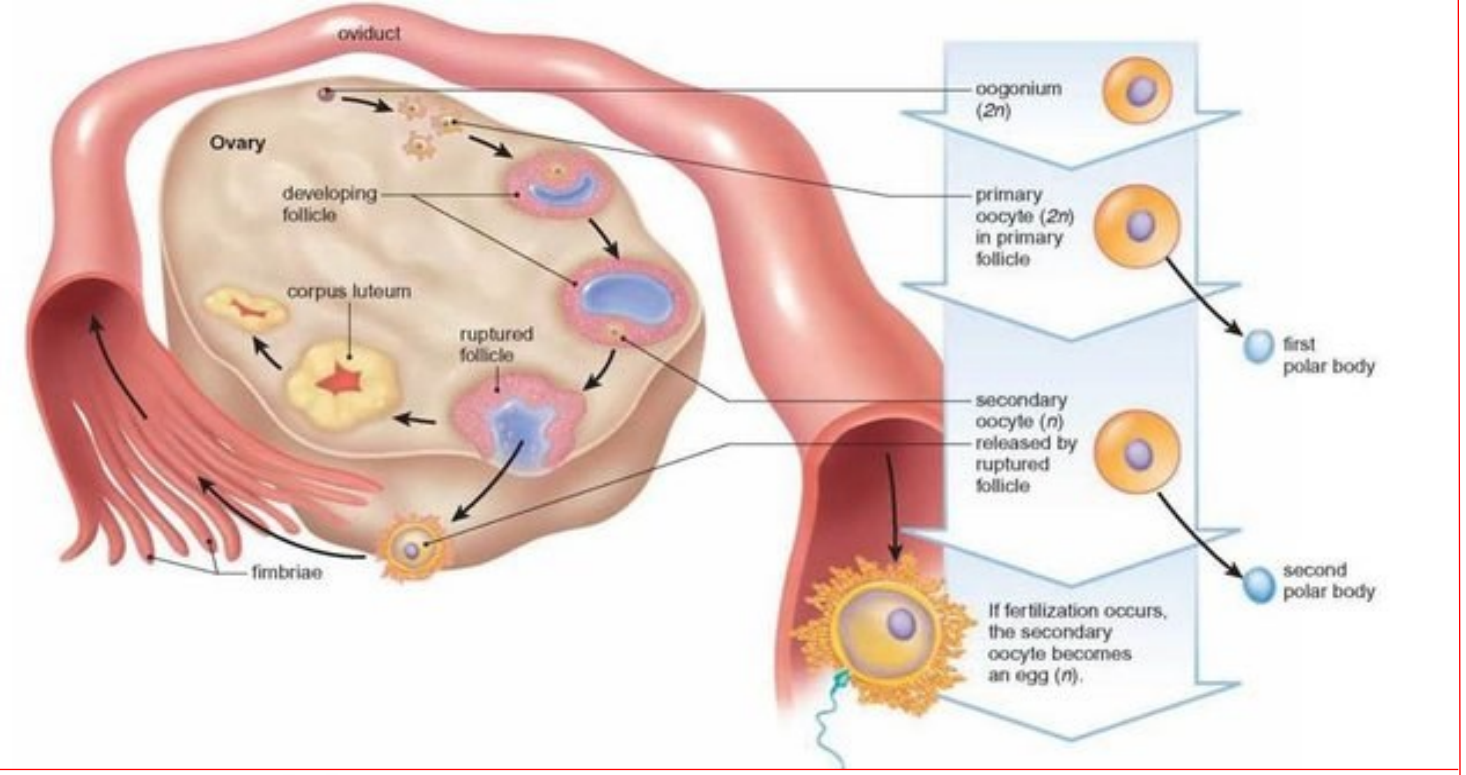



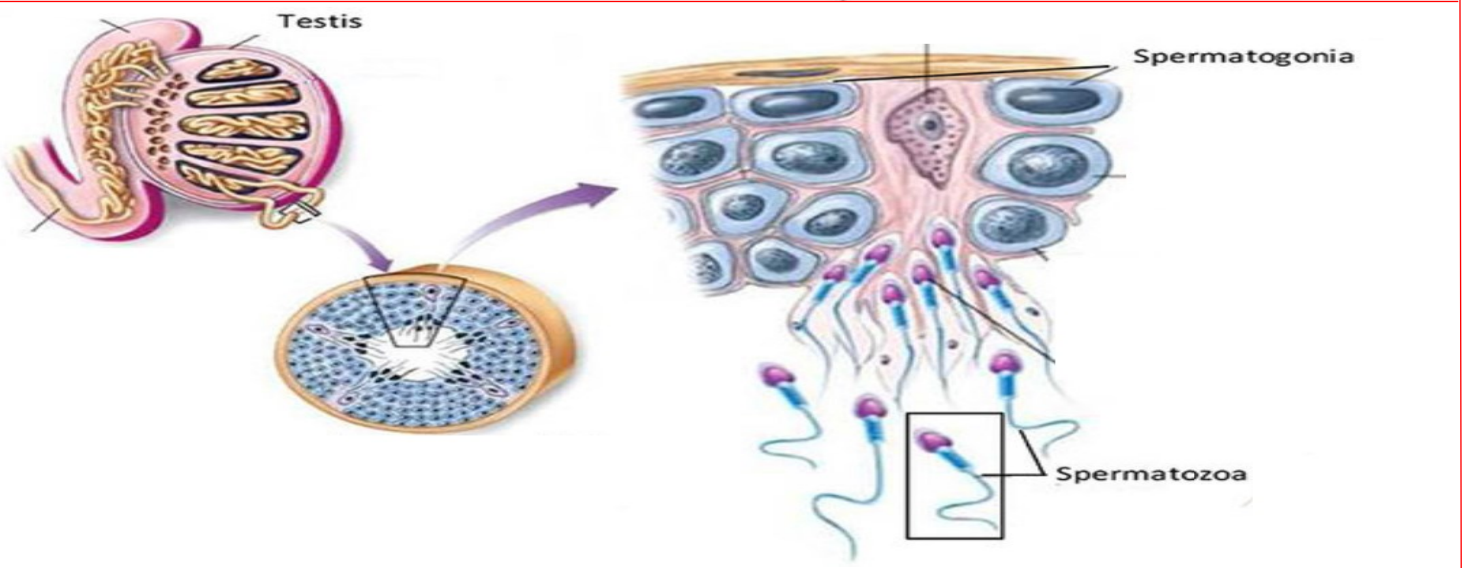



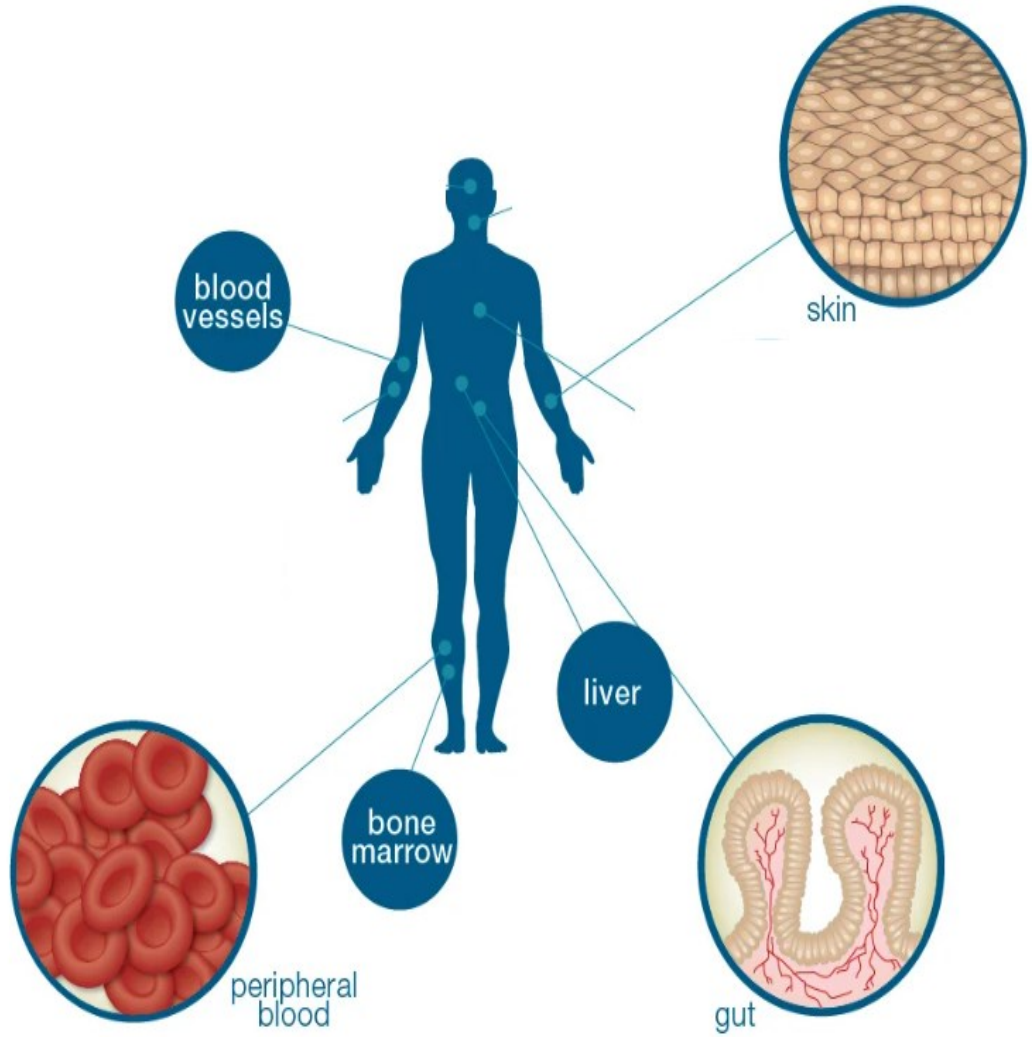
# CELL CYCLE AND CELL DIVISION









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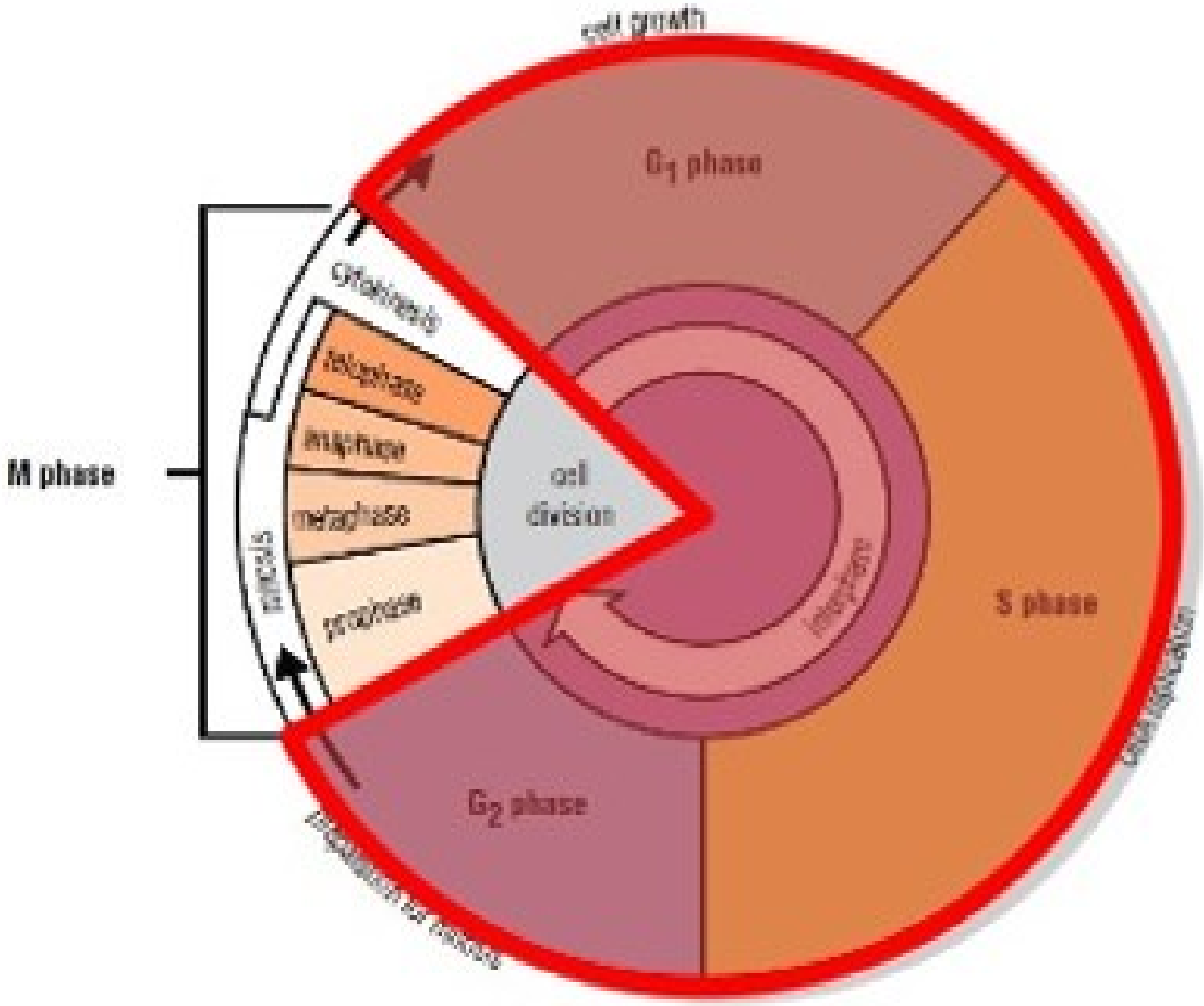
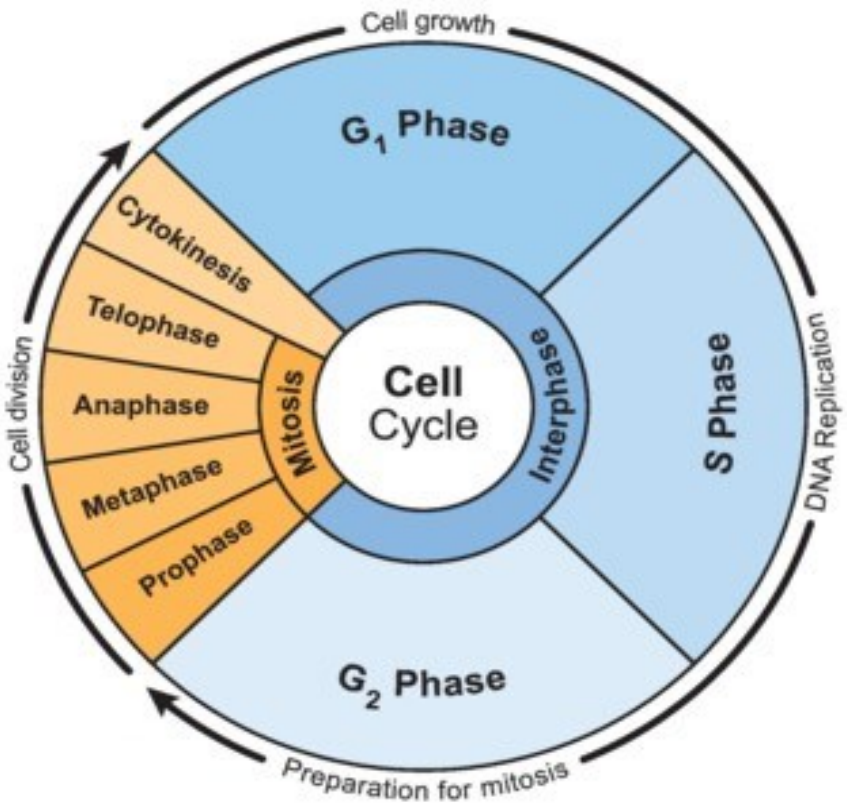
- The cell cycle has four phases:
  - $G_1$ Phase
  - S Phase
  - $G_2$ Phase
  - M Phase

Interphase



# INTERPHASE




- Cell prepares for cell division and carries out its normal cellular functions.
- It comprises three distinct sub-stages: G1, S & G2.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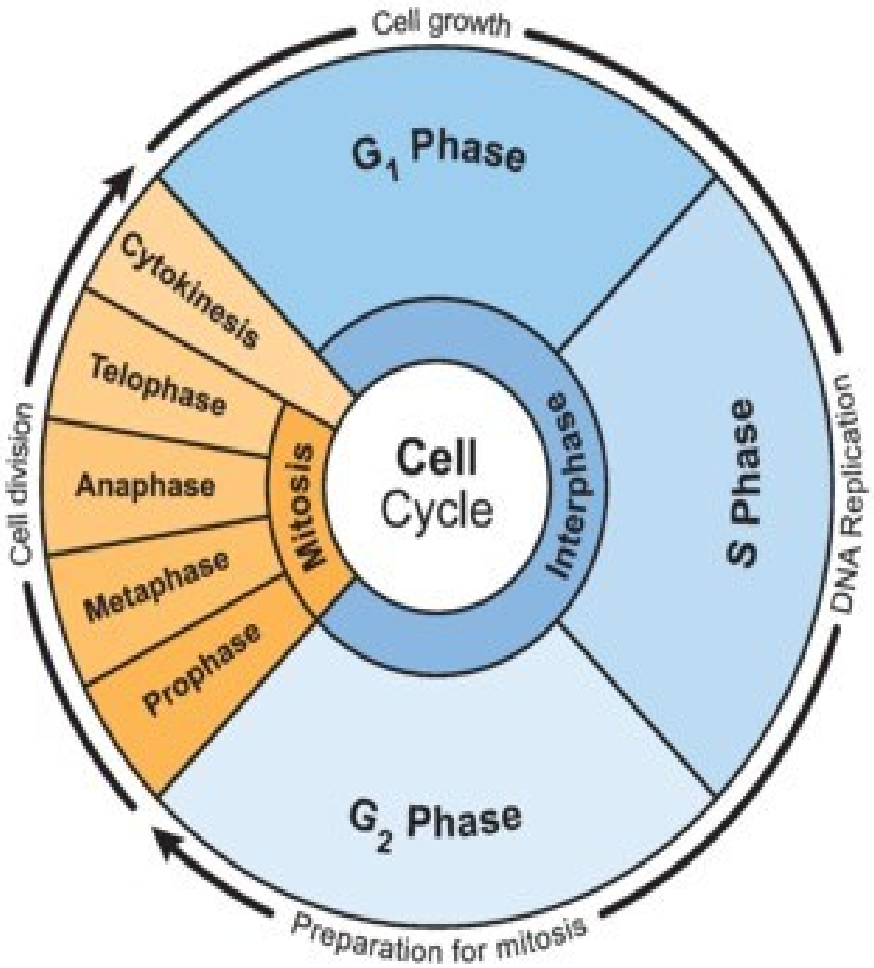
# $G_1$ Phase

- During this time organelles are reproducing
- Protein synthesis is occurring





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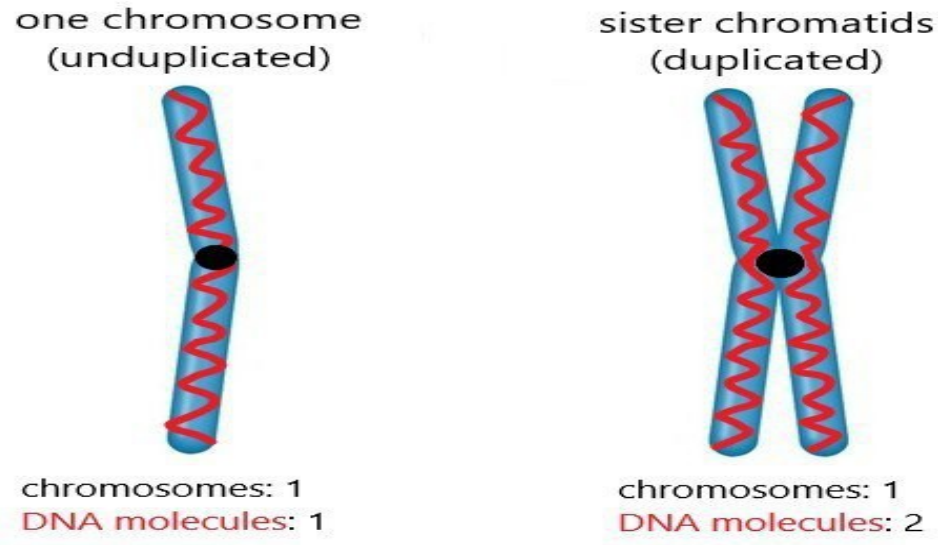
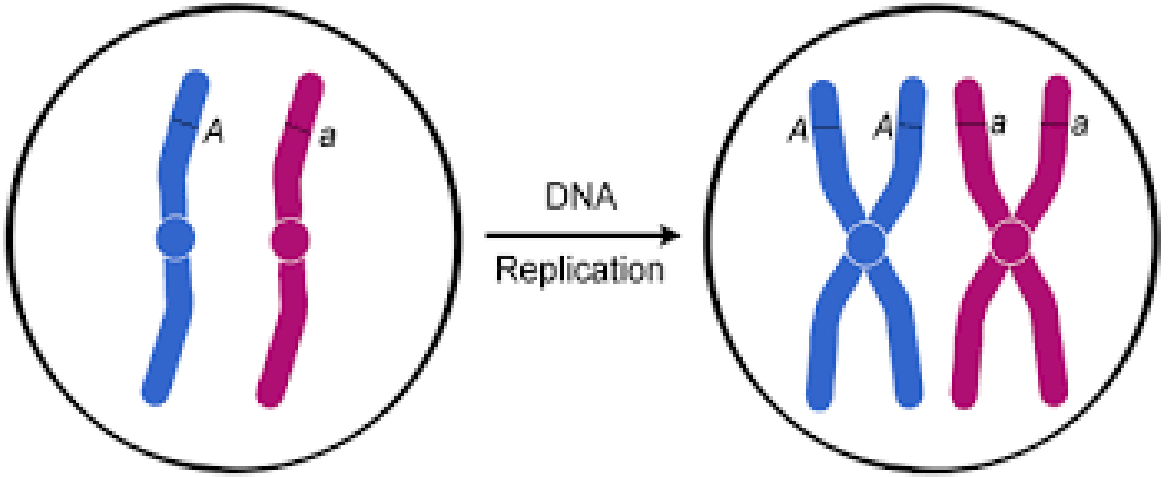
# S Phase

- The cell's DNA is replicated
- Resulting in the formation of identical sister chromatids.





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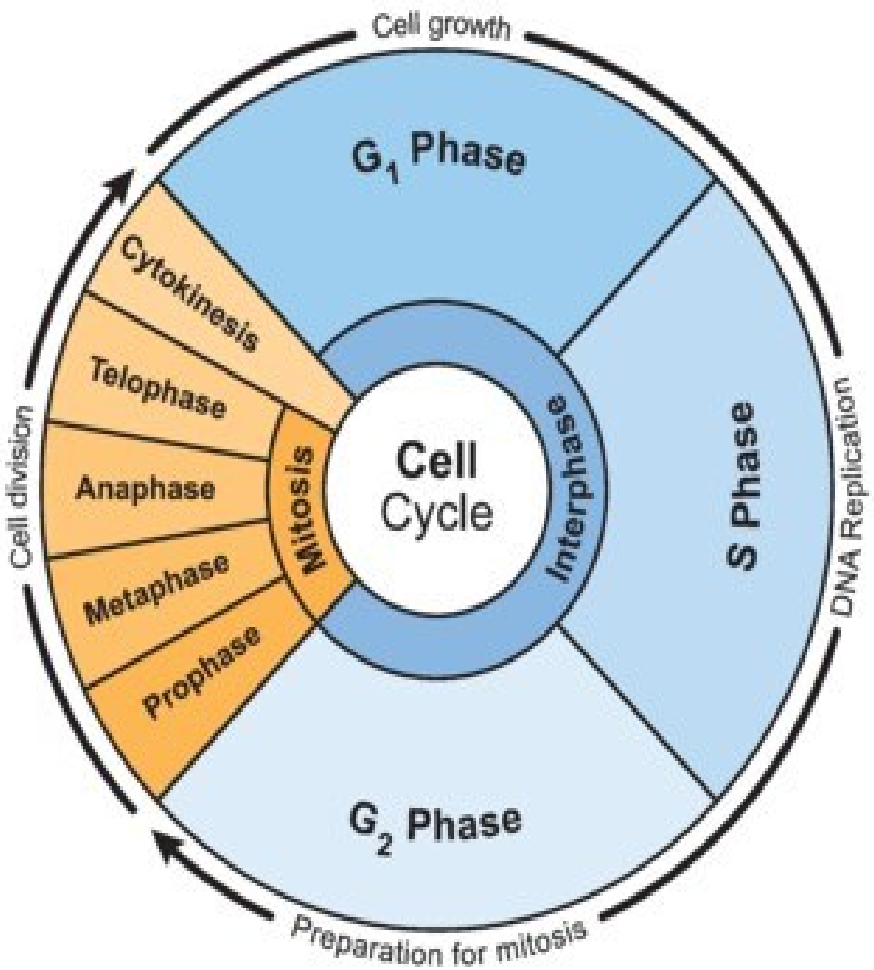
# G2 Phase

•The cell continues to grow, producing the necessary organelles, proteins, and molecules needed for cell division.





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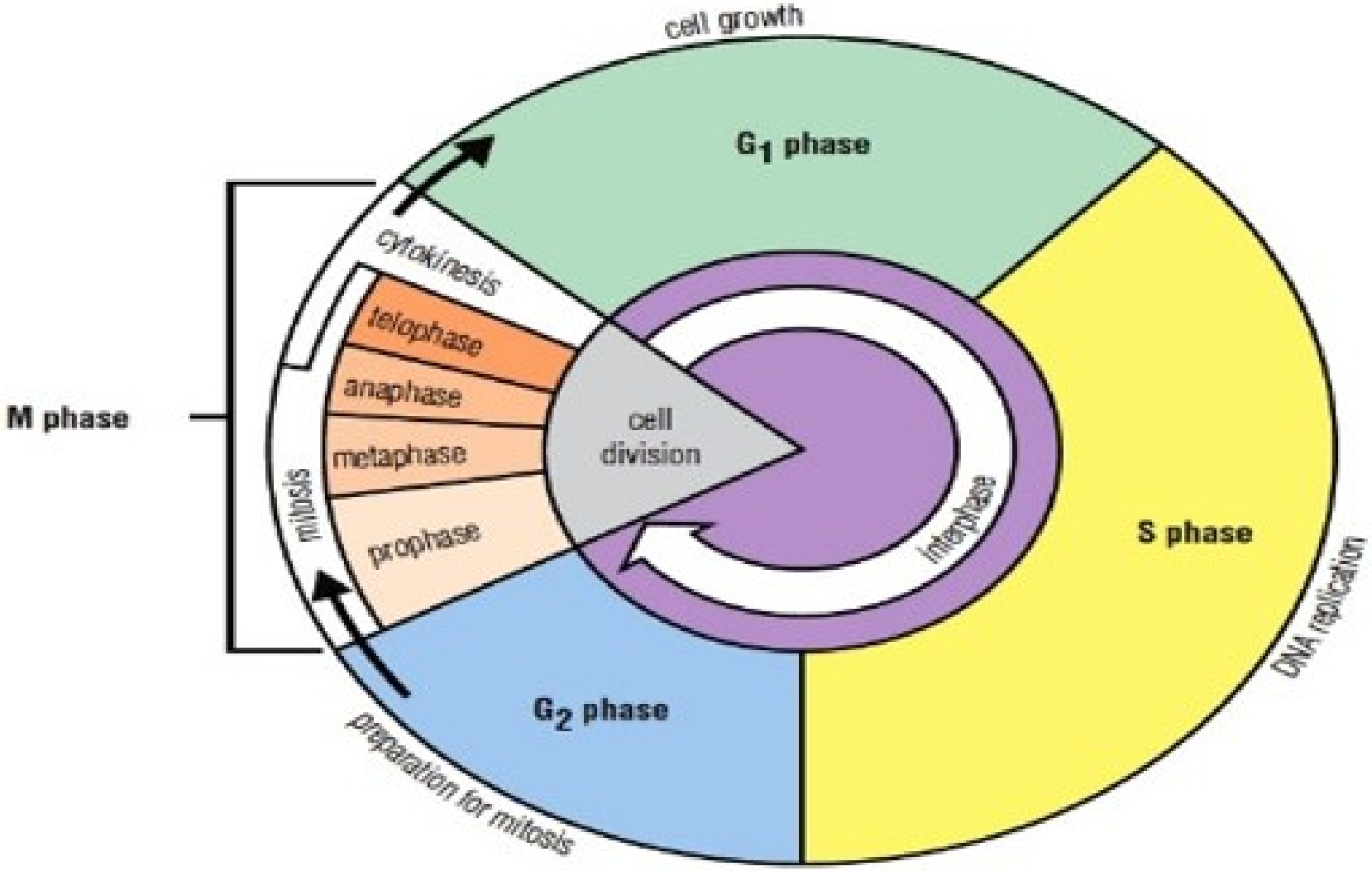
# M-Phase





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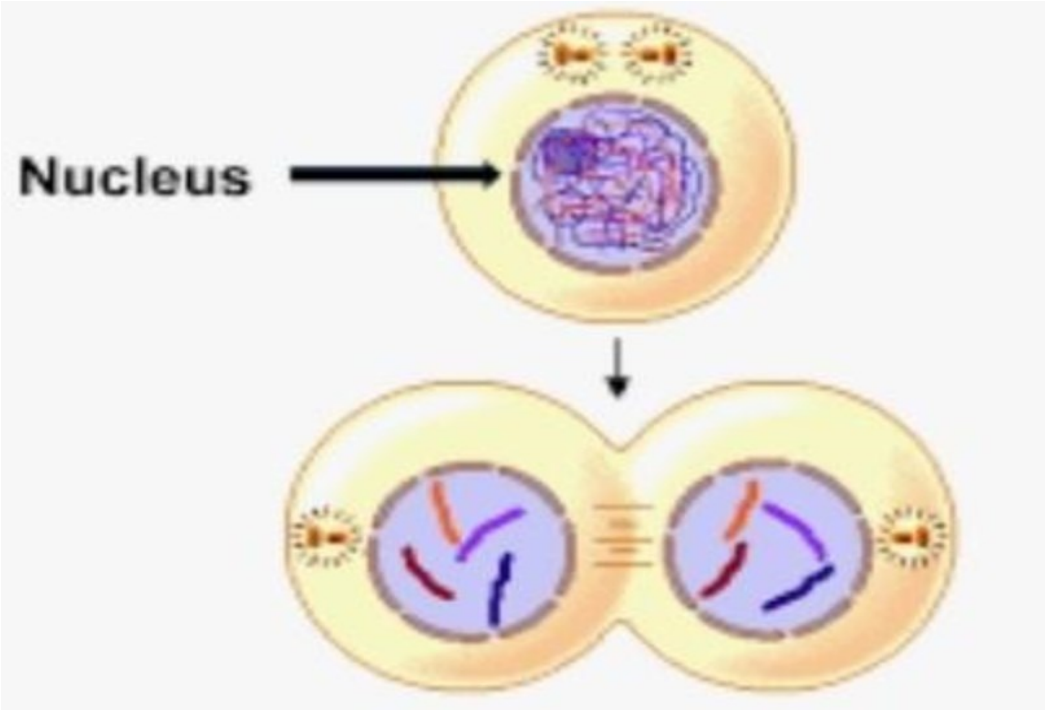
- Cell division occurs in M phase
- M phase is composed of two processes

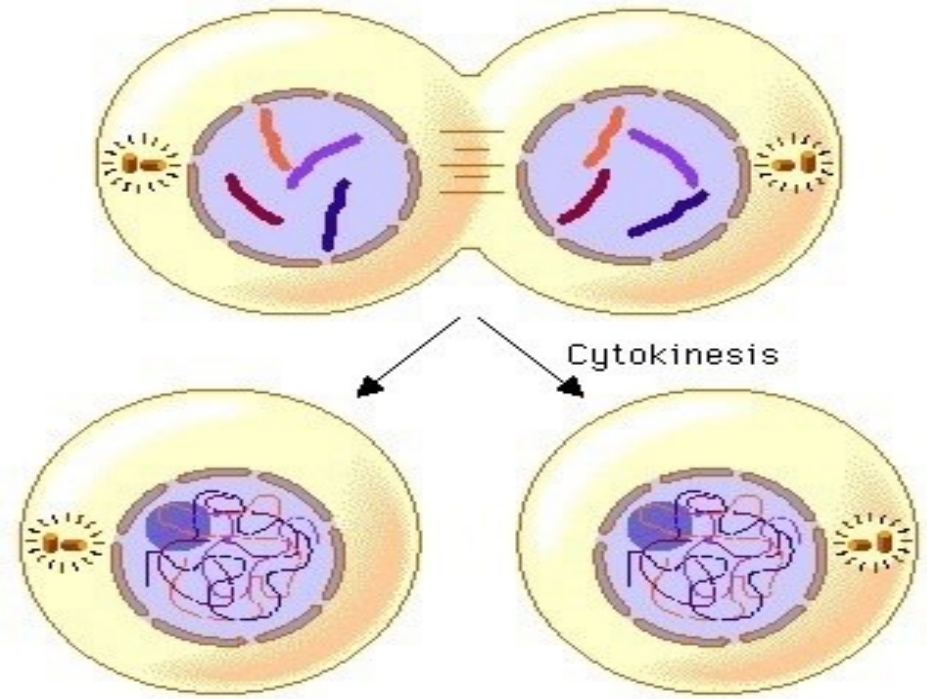
**i) Karyokinesis**

- Division of nucleus into two daughter nuclei




**ii) Cytokinesis**

Division of cytoplasm resulting in two daughter cells




*Explain the differences between mitosis and meiosis, and describe how meiosis contributes to genetic diversity.*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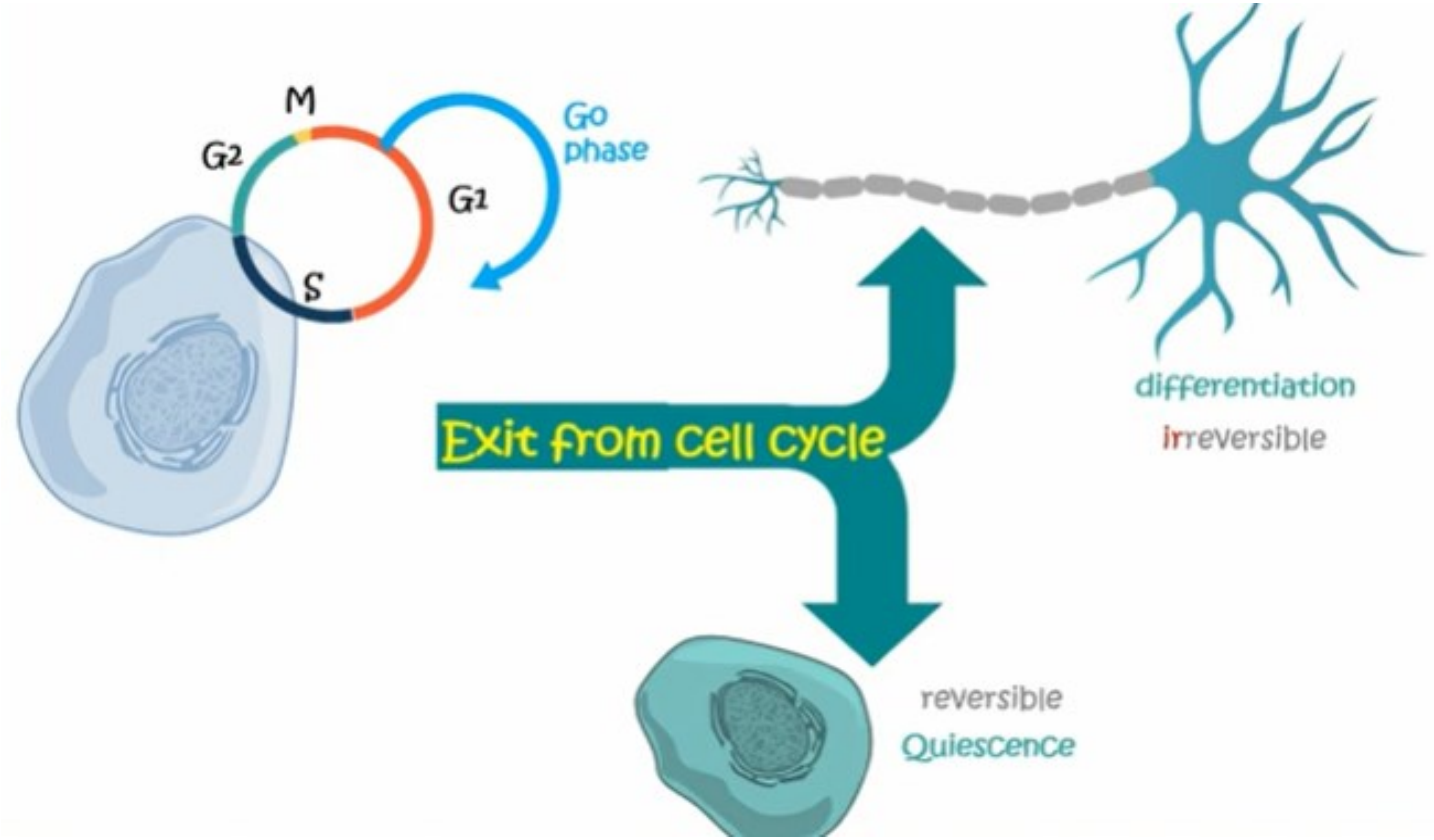
- While some cells are constantly dividing, others are **quiescent**.
- These cells exit G1 and enter a resting state called G0.
- In G0, **a cell is performing its function** without actively preparing to divide.
- G0 is a permanent state for some cells, while others may re-start division if they get the right signals.





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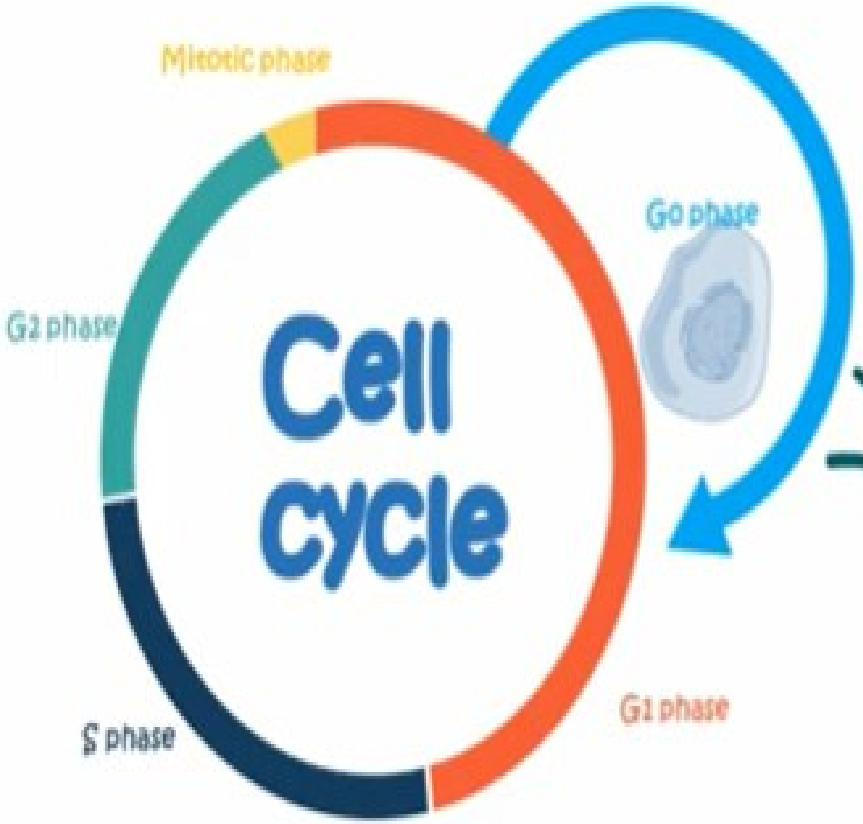
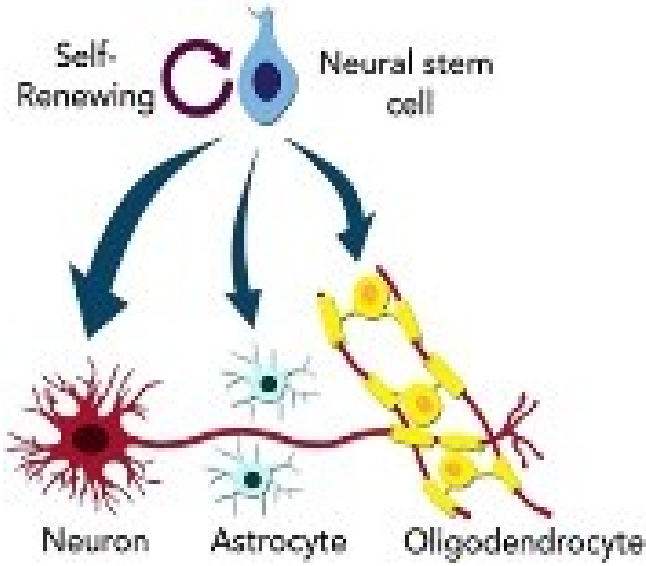
# What causes a cell to enter the G0 stage?




**Internal factors**
**(genetic programs)**

Many specialized cells permanently exit the cycle to perform their functions




**External factors**
**(nutrient availability )**

- Nutrient deficiency
- Lack of growth signals
- DNA damage

**Cell division is an energy expensive process; without nutrients and growth factors, cells would enter the Go stage instead of dividing.**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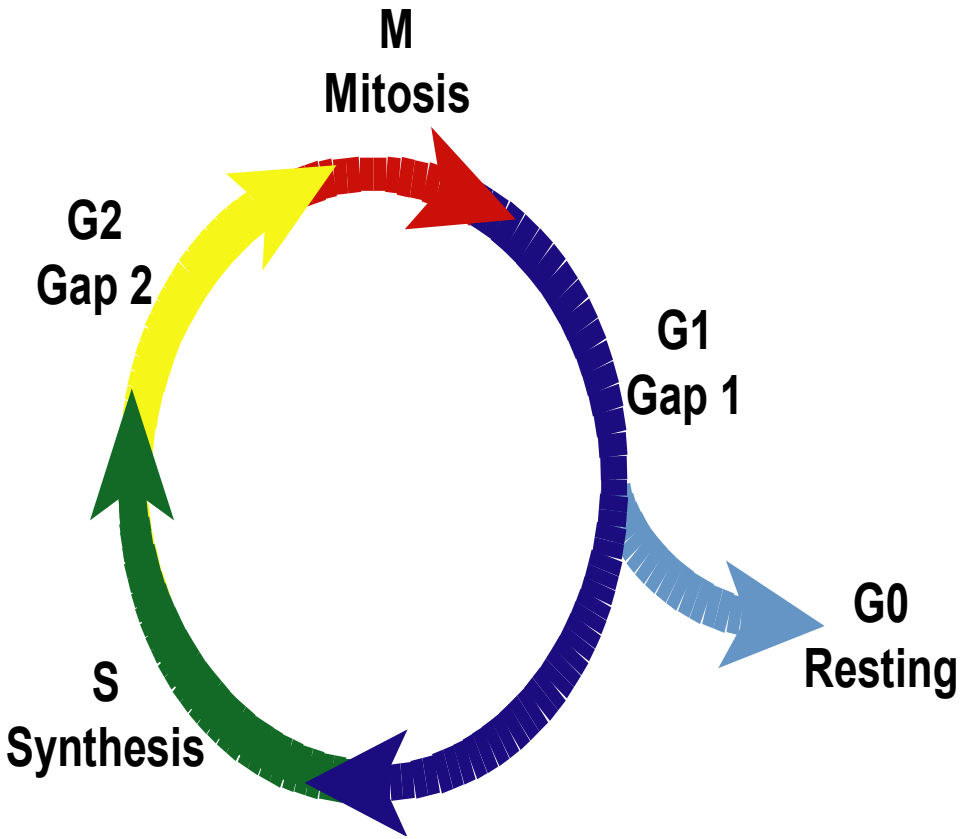


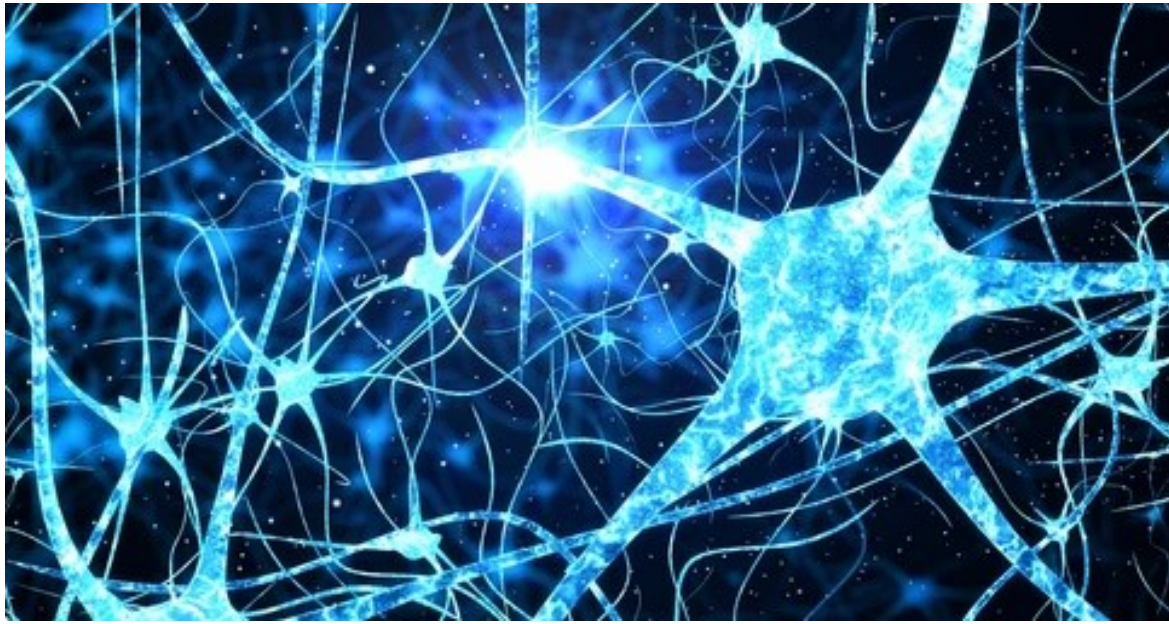

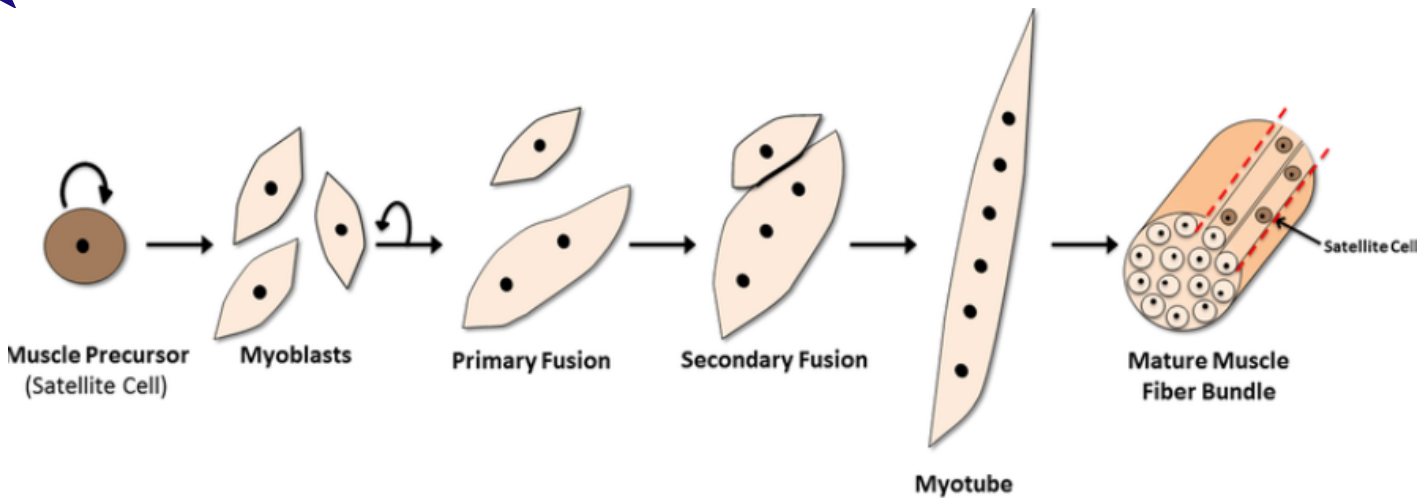



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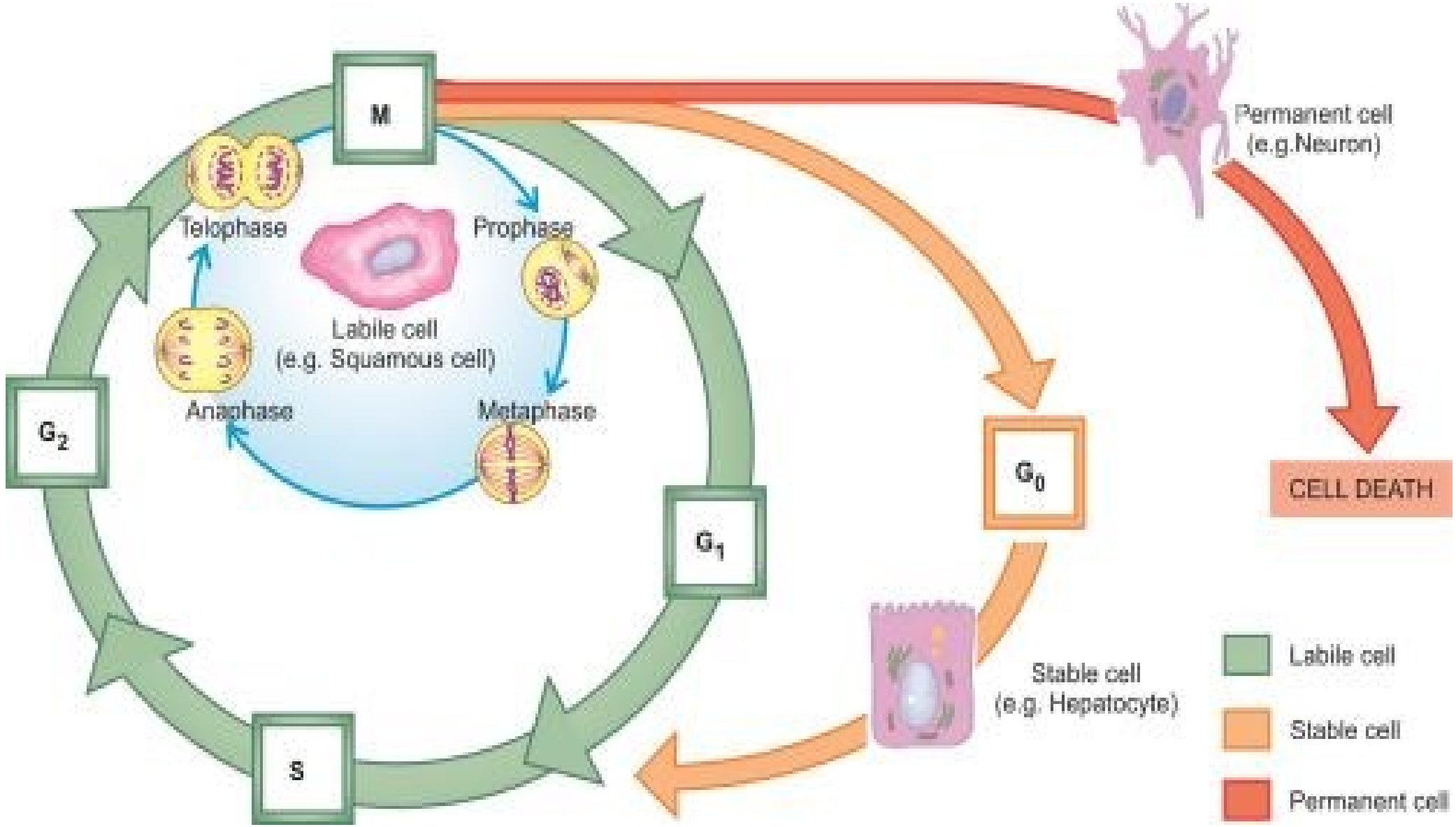



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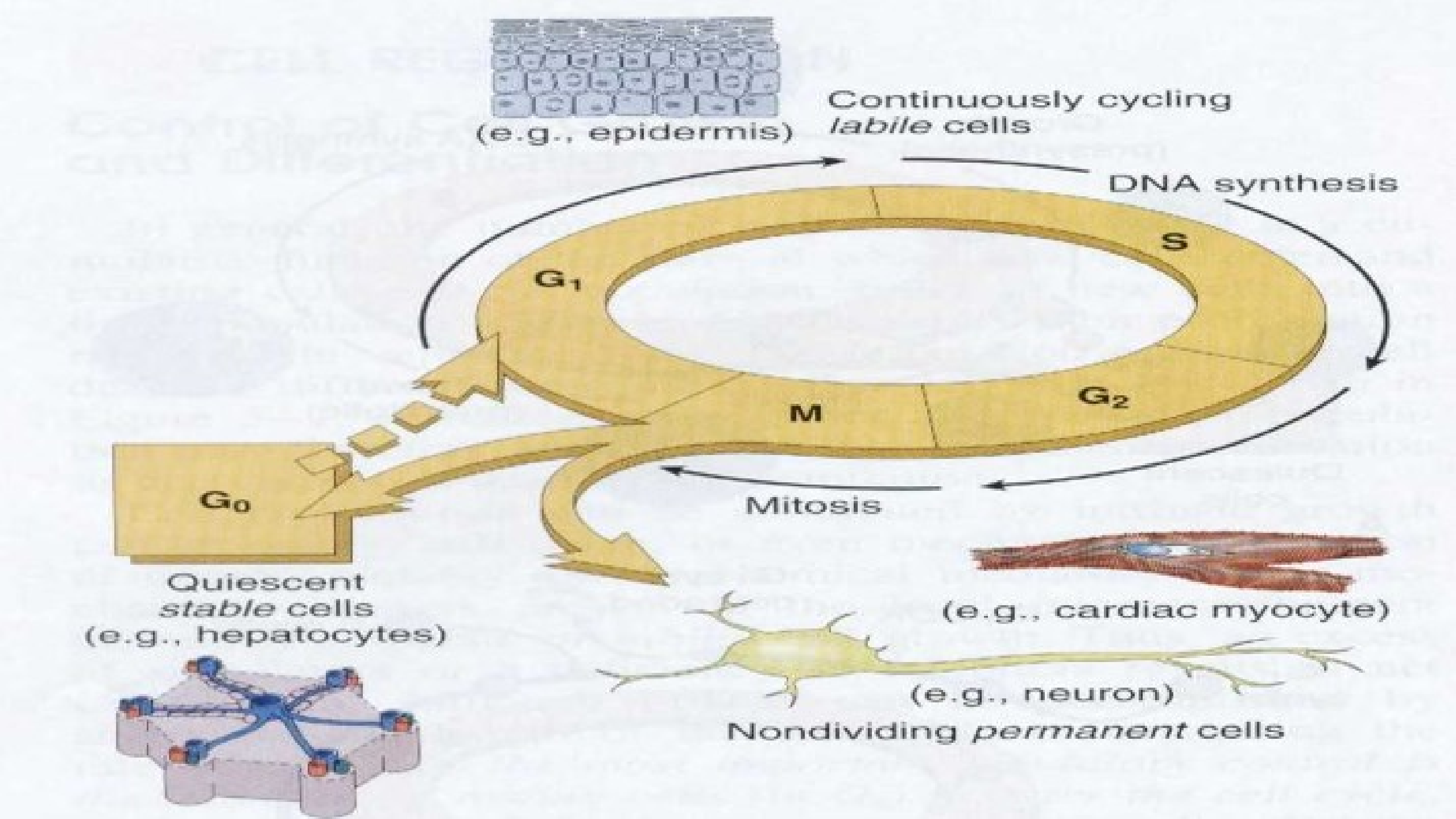
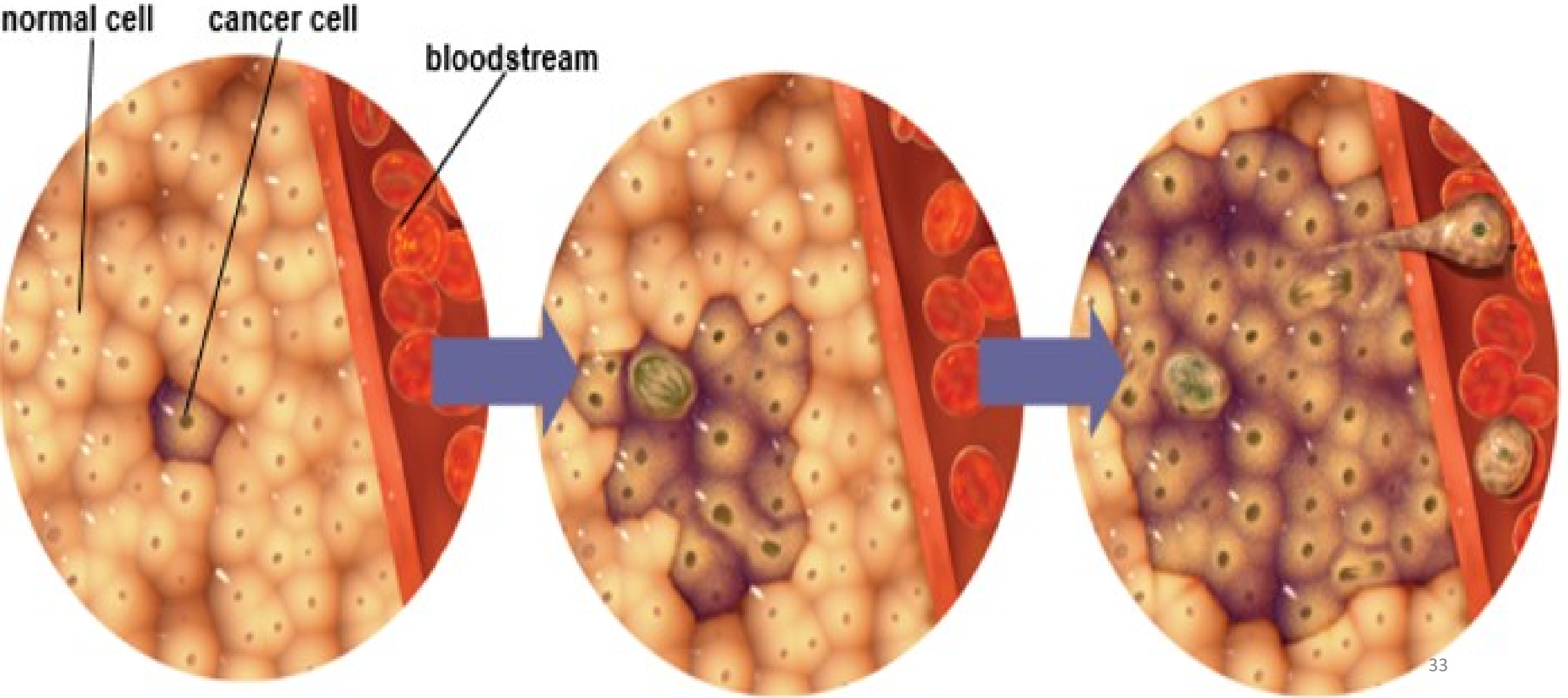
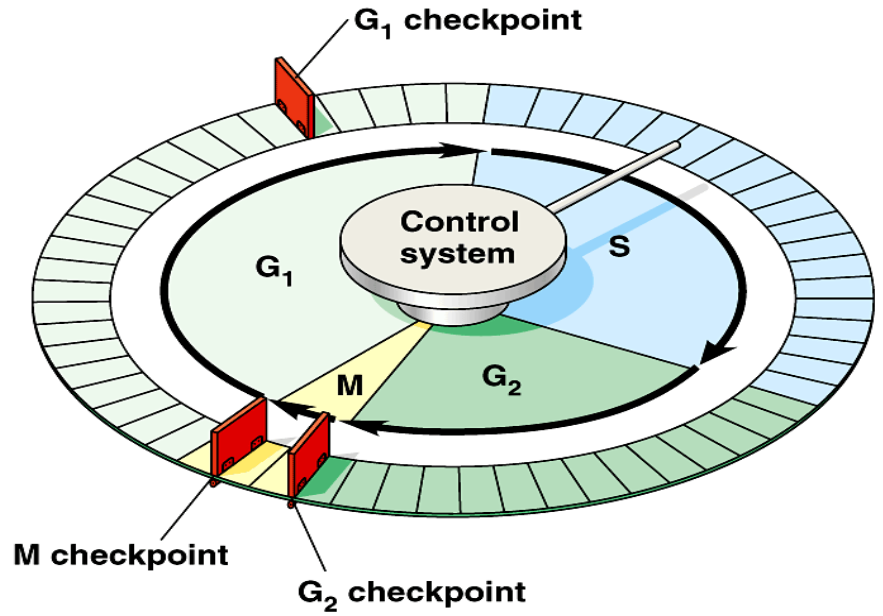

(e.g., epidermis)
Continuously cycling
*labile* cells
DNA synthesis
S
$G_1$
$G_2$
M
$G_0$
Mitosis
Quiescent
*stable* cells
(e.g., hepatocytes)
(e.g., cardiac myocyte)
(e.g., neuron)
Nondividing *permanent* cells

**The regulation of the cell cycle is crucial to maintaining the proper functioning of cells and preventing cancer**



# Cell cycle control

- Cell cycle control refers to the mechanisms that regulate the progression of a cell through the cell cycle.
- The control of the cell cycle is primarily achieved through a series of **checkpoints** that ensure the proper completion of each phase before the cell progresses to the next phase.





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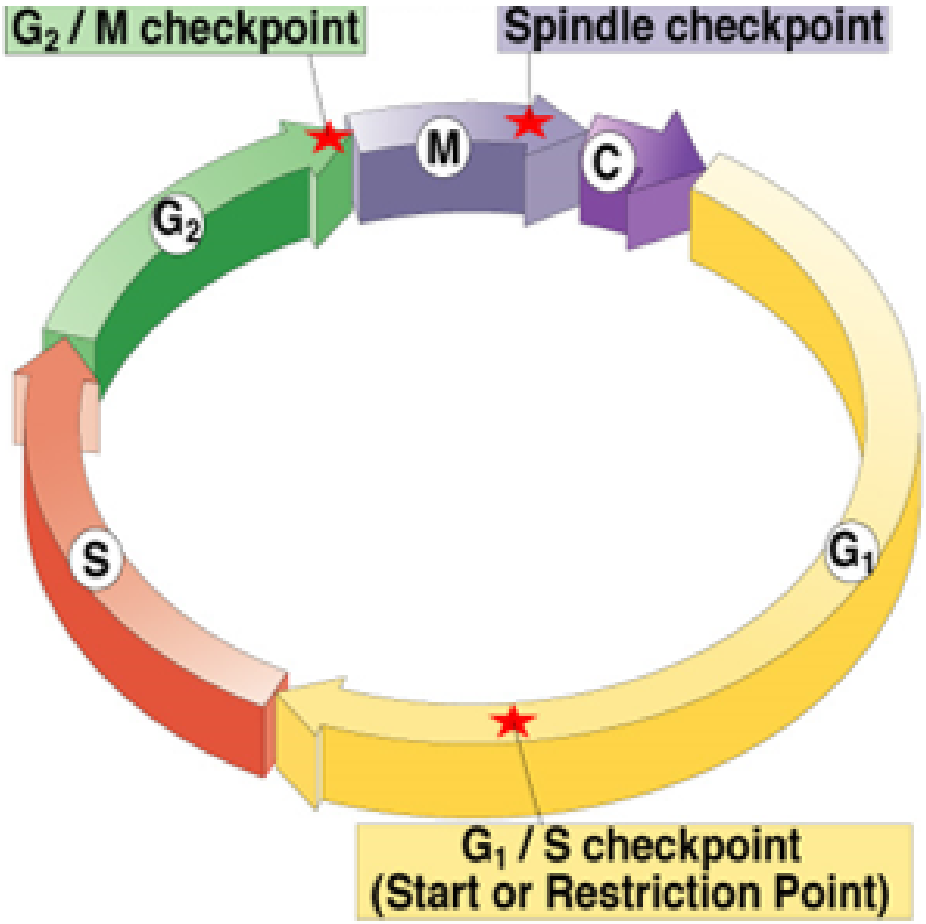
- The 3 major checkpoints:
  - $G_1/S$
    - can DNA synthesis begin?
  - $G_2/M$
    - has DNA synthesis been completed correctly
  - spindle checkpoint
    - are all chromosomes attached to spindle?
    - can sister chromatids separate correctly?





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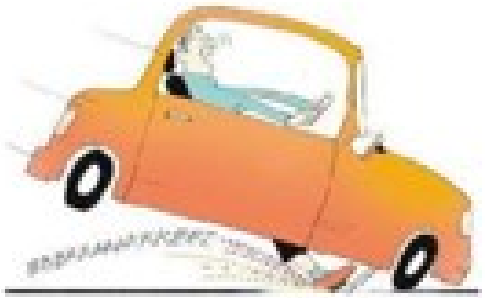
# GENES ESSENTIAL IN CELL DIVISION

- Proto-oncogenes and tumor suppressor genes are two types of genes essential for the control of cell division at the cell cycle check points

• proto-**oncogenes** trigger cell division, direct cell to continue in the cycle ***turn on the gas!***

• **tumor-suppressor** genes shut down the cycle ***hit the brakes!***





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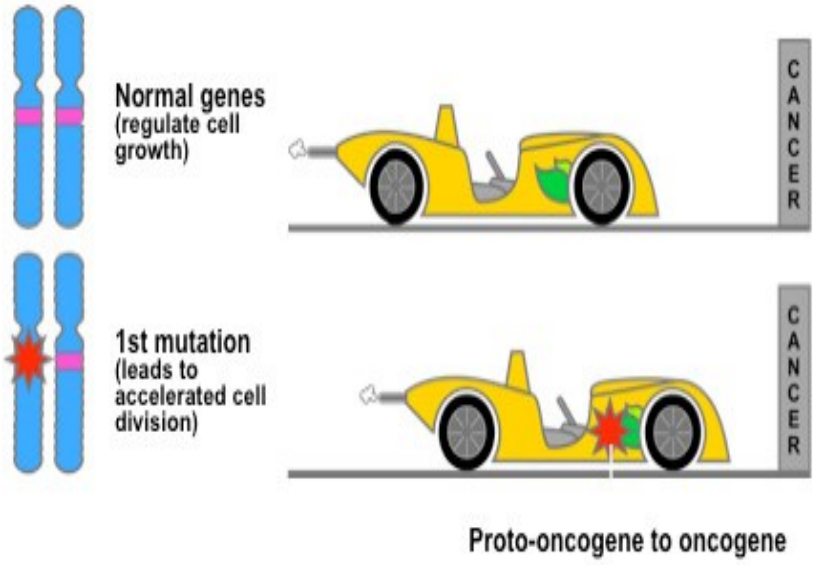
# PROTO-ONCOGENES

- These genes make proteins that help cells grow, divide, and survive
- They act like the cell's "green lights" telling it when to grow or divide based on signals from around the cell.
- **Sometimes, these proto-oncogenes get changed (mutated).**
- When that happens, they turn into oncogenes, telling the cell to keep growing and dividing without stopping.



Proto-oncogene to oncogene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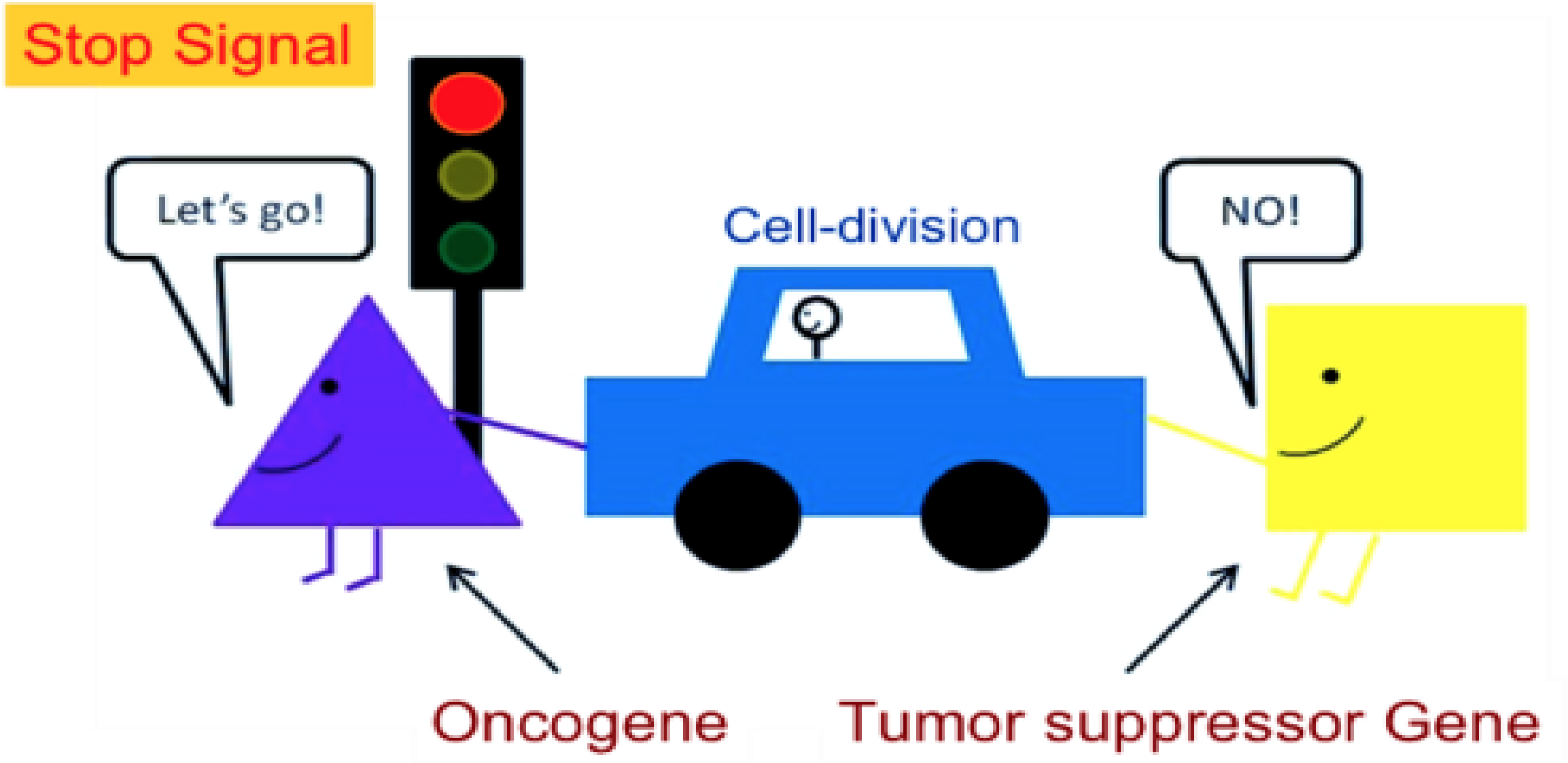



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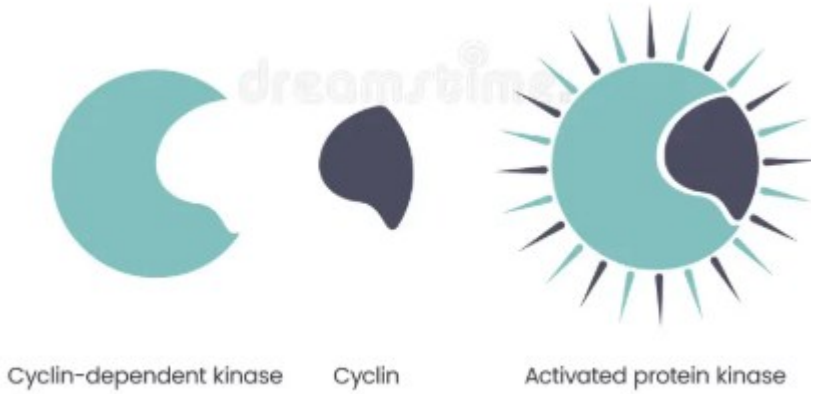
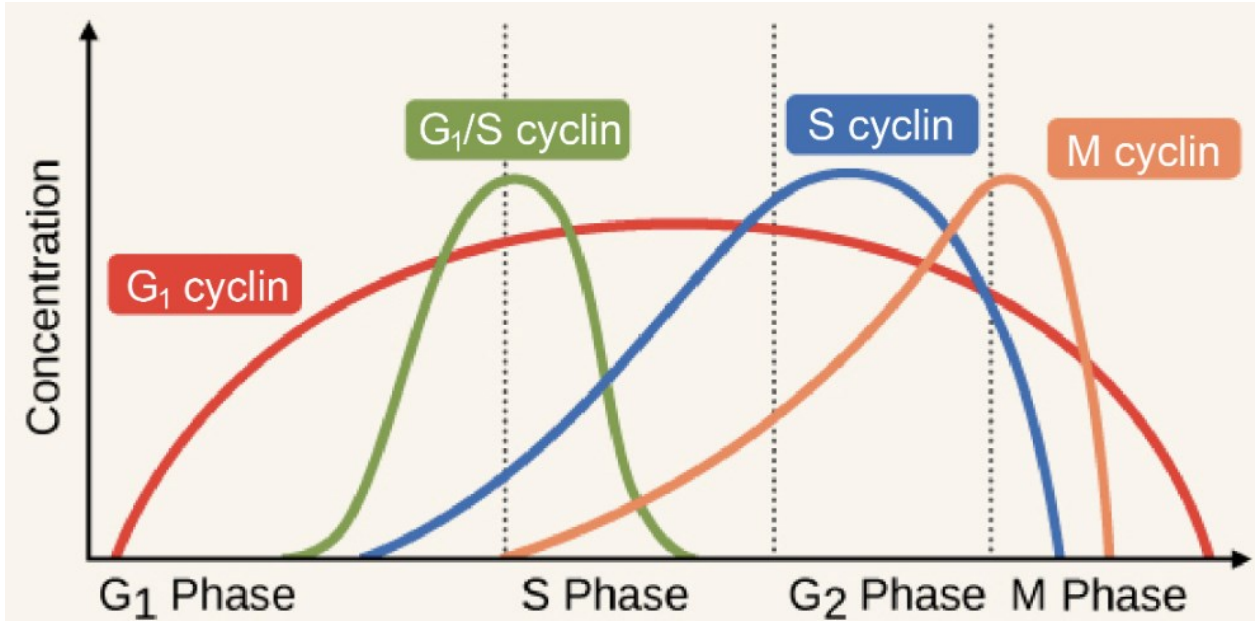
# How do the proto-oncogenes allow cell cycle to progress?

- They encode for **proteins** that are essential for various cellular functions.
- These proteins are called **cyclin proteins**





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NO CYCLIN:

Cdk

Cdk is inactive

target 1 | target 2 | target 3

∅

S phase factors "off"

+G1/S CYCLIN:

G1/S cyclin

Cdk

Cdk is activated

P P P

target 1 | target 2 | target 3

G1/S targets phosphorylated

S phase begins
(DNA replication enzymes are activated)

phosphate group



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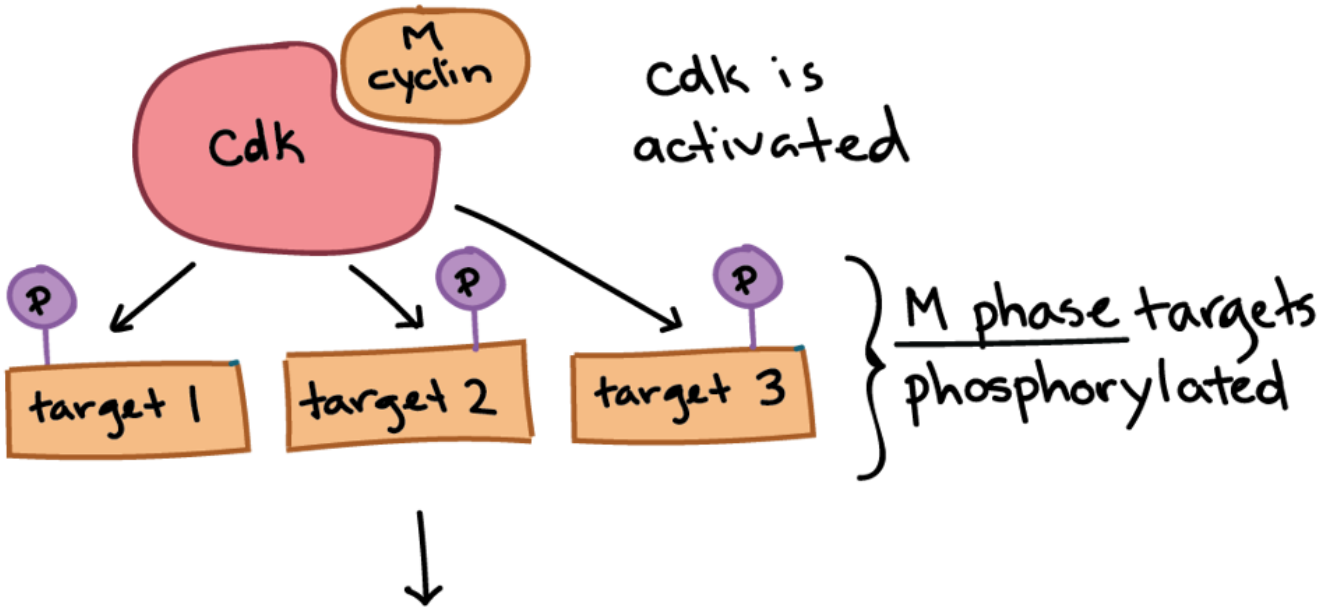
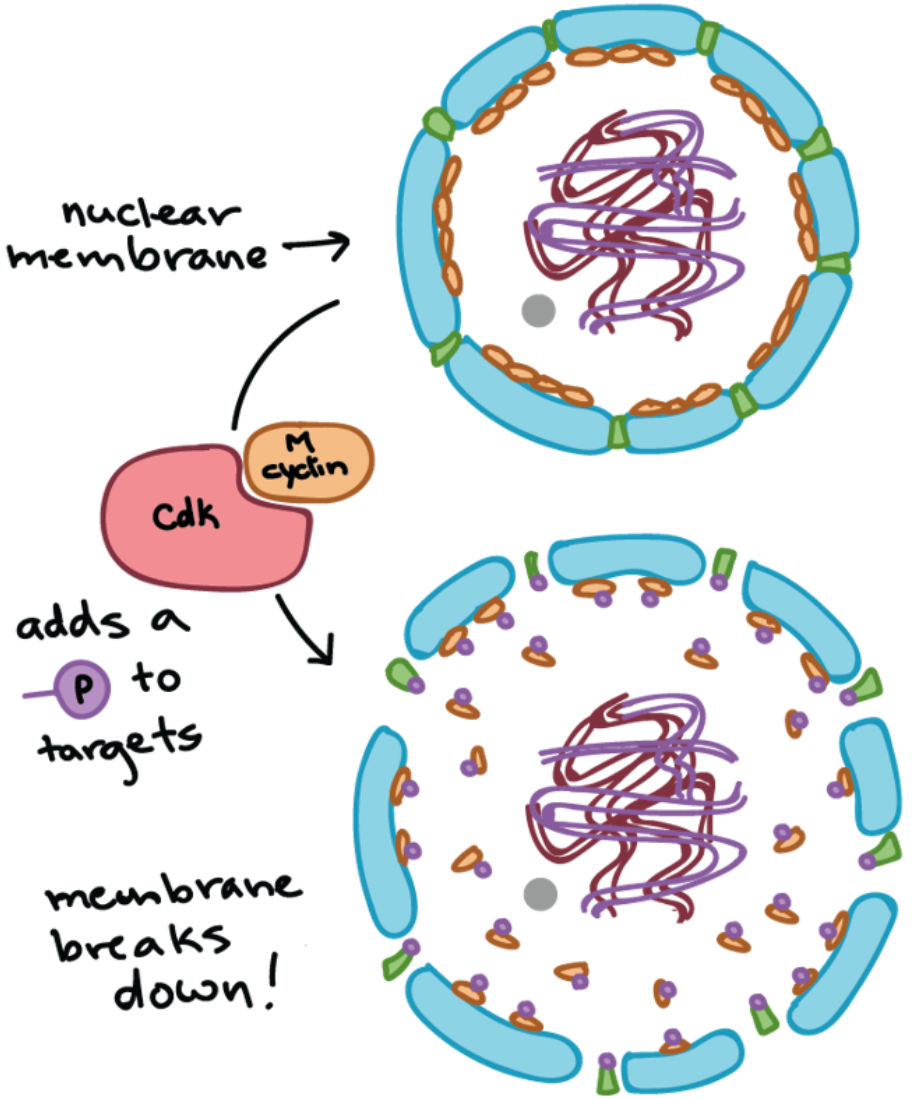
+ M CYCLIN:




M phase begins
(spindle forms, chromosomes condense, nuclear membrane breaks down)





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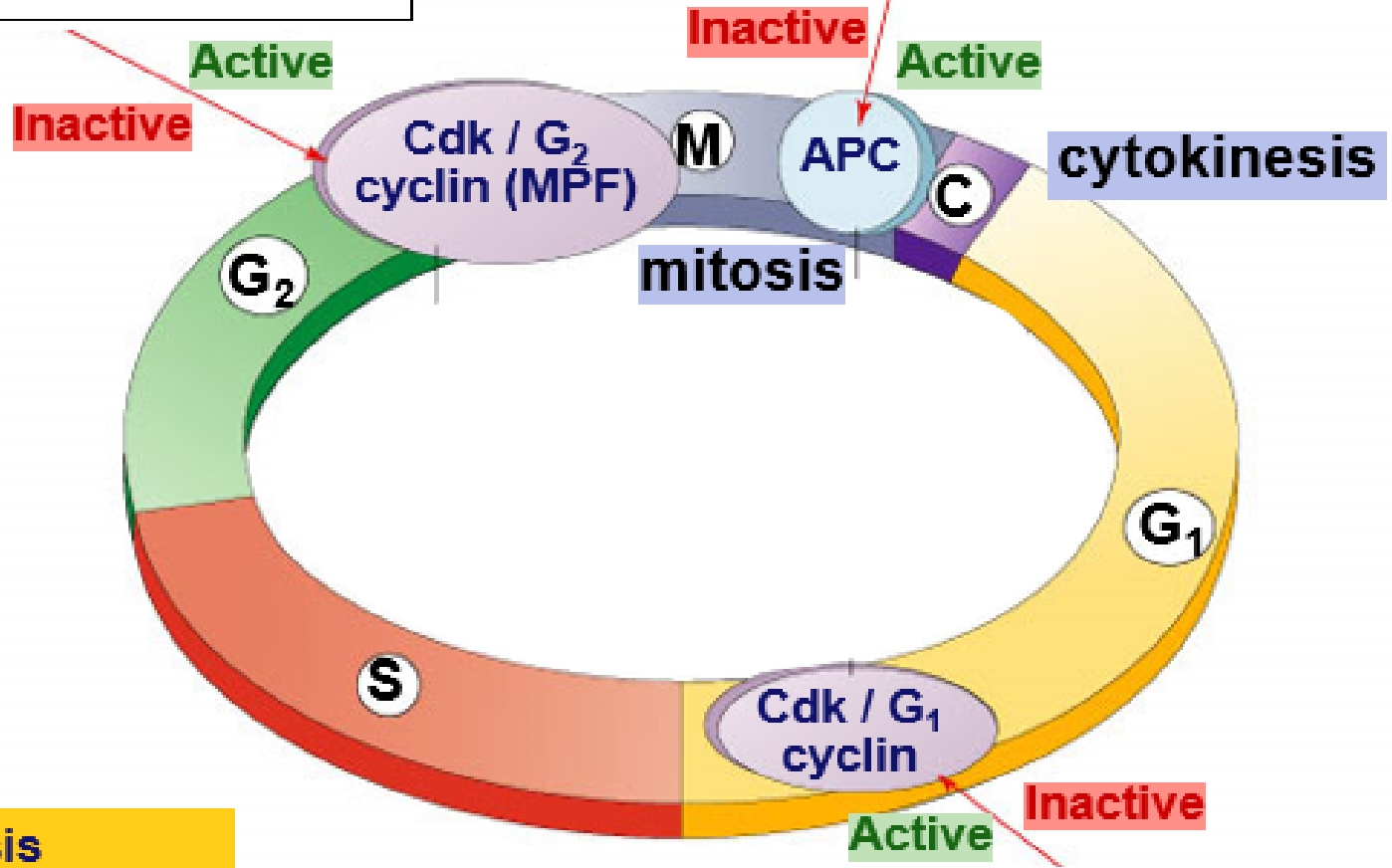
## $G_2$ / M checkpoint

- Replication completed
- DNA integrity

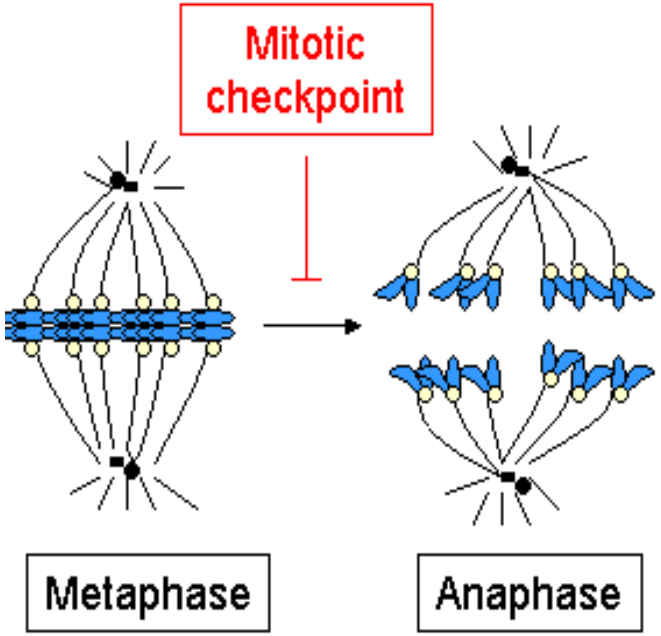
## Spindle checkpoint

Chromosomes attached at metaphase plate




## $G_1$ / S checkpoint

- Growth factors
- Nutritional state of cell
- Size of cell




**MPF** = Mitosis Promoting Factor
**APC** = Anaphase Promoting Complex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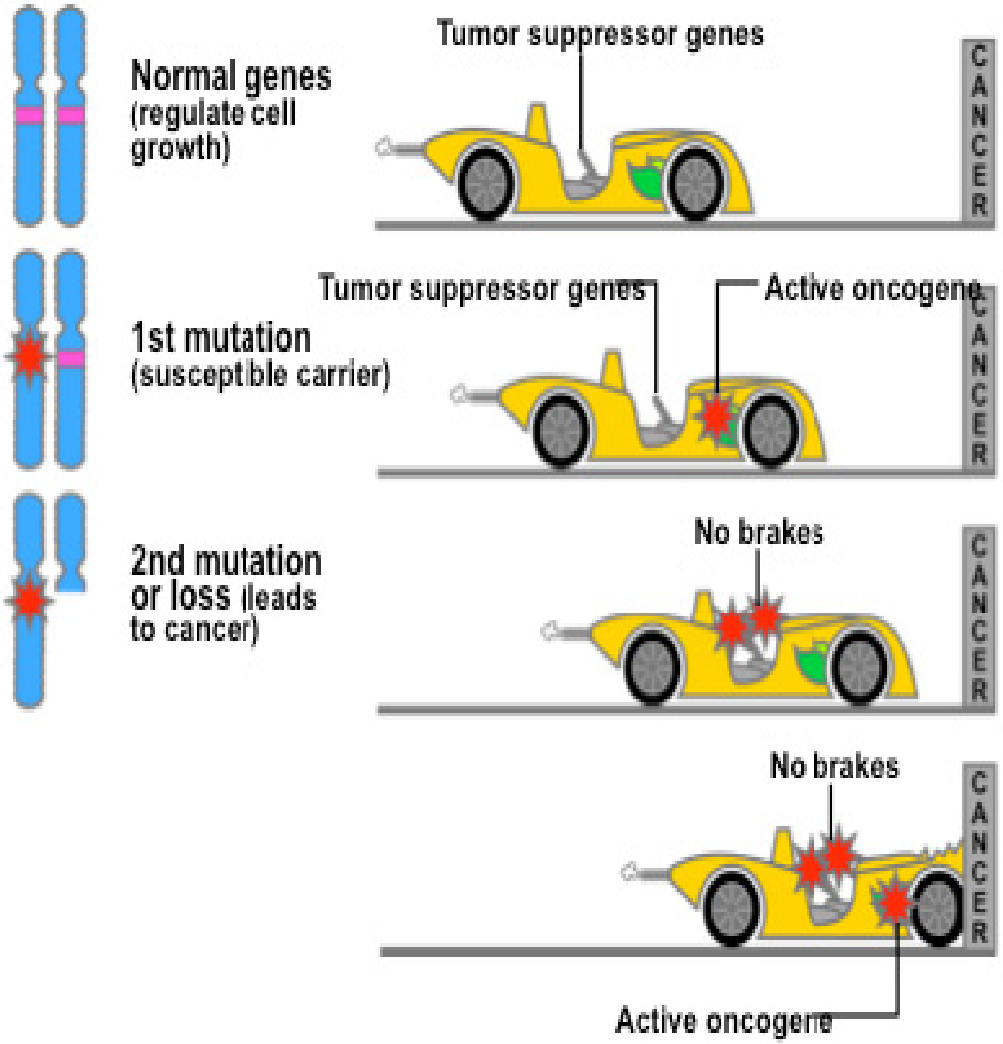
# TUMOR SUPPRESSOR GENES; The good guys, turn cell growth off

- Genes that normally help to regulate cell growth and prevent the development of cancer.
- Act as **braking signals** during phase G1 of the cell cycle, to stop or slow the cell cycle **before S phase.**
- **If tumor-suppressor genes are mutated, the normal brake mechanism will be disabled, resulting in uncontrolled growth >>>>> cancer.**





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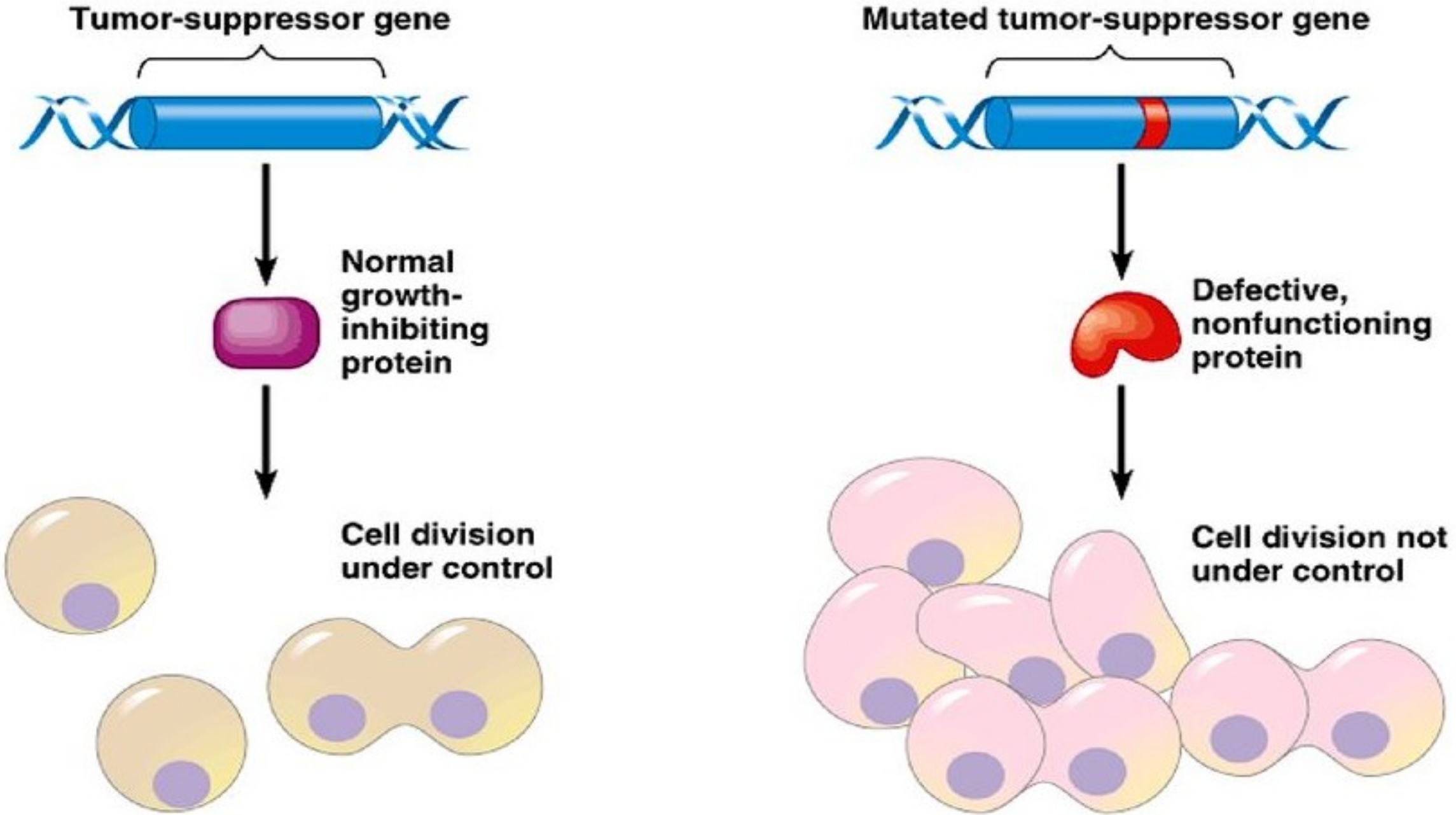
| Gene | Role | Incase of a mutation | Cancer Risk |
| --- | --- | --- | --- |
| • **P53** | • Stops damaged cells | • Damaged cells divide | • Many types of cancer |
| • **BRCA1/2** | • Repairs DNA | • DNA damage accumulates | • Breast and ovarian cancer |
| • **RB1** | • Controls cell division | • Cells divide uncontrollably | • Retinoblastoma |
| • **APC** | • Controls cell growth | • Too much cell growth | • Colon cancer |







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| Risk Factor | Effect | Possible Cancers |
|---|---|---|
| **Tobacco smoke** | Contains carcinogens that damage DNA and cause mutations | Lung, mouth, throat, bladder, pancreas |
| **Ultraviolet (UV) radiation** | Causes DNA damage by forming thymine dimers in skin cells | Skin cancers (melanoma, basal cell carcinoma) |
| **Chemical exposure** | Chemicals like asbestos, benzene cause DNA mutations | Mesothelioma, leukemia, liver cancer |
| **Radiation (X-rays, radioactive substances)** | Causes breaks in DNA strands | Leukemia, thyroid cancer, bone cancer |
| **Viruses (e.g., HPV, Hepatitis B & C, EBV)** | Insert viral DNA into host genome, disrupt normal cell growth | Cervical, liver, nasopharyngeal cancers |
| **Chronic inflammation** | Causes repeated cell damage, increasing mutation risk | Colon, stomach, liver cancers |
| **Diet and Obesity** | Excess fat and some dietary factors can promote inflammation and hormonal changes | Colon, breast, pancreas, esophageal cancers |
| **Alcohol** | Metabolites cause DNA damage and weaken immune response | Liver, esophageal, mouth, throat cancers |
| **Genetic predisposition** | Inherited mutations increase risk of cancer | Breast, ovarian, colon, retinoblastoma |
| **Age** | Accumulated DNA damage over time and weaker repair mechanisms | Many types of cancer |



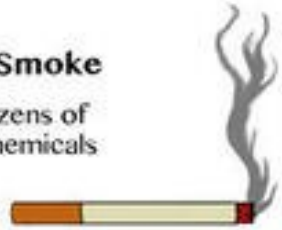
# Radiation

**UV Radiation**
Both natural sunlight and tanning beds

**X-Rays**
Medical, dental, airport security screening

# Chemicals

**Cigarette Smoke**
Contains dozens of mutagenic chemicals



**Nitrate & Nitrate Preservatives**
In hot dogs and other processed meats

**Barbecuing**
Creates mutagenic chemicals in foods

**Benzoyl Peroxide**
Common ingredient in acne products

# Infectious Agents

**Human Papillomavirus (HPV)**
Sexually transmitted virus

***Helicobacter pylori***
Bacteria spread through contaminated food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# TUMORS


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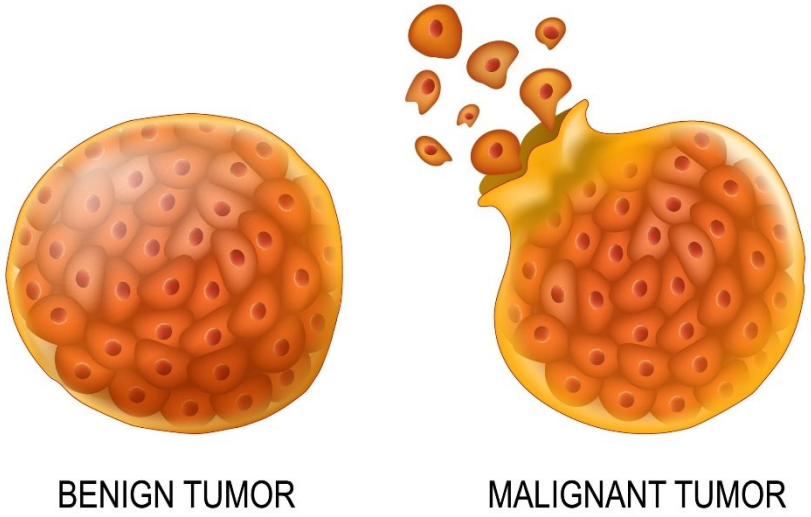
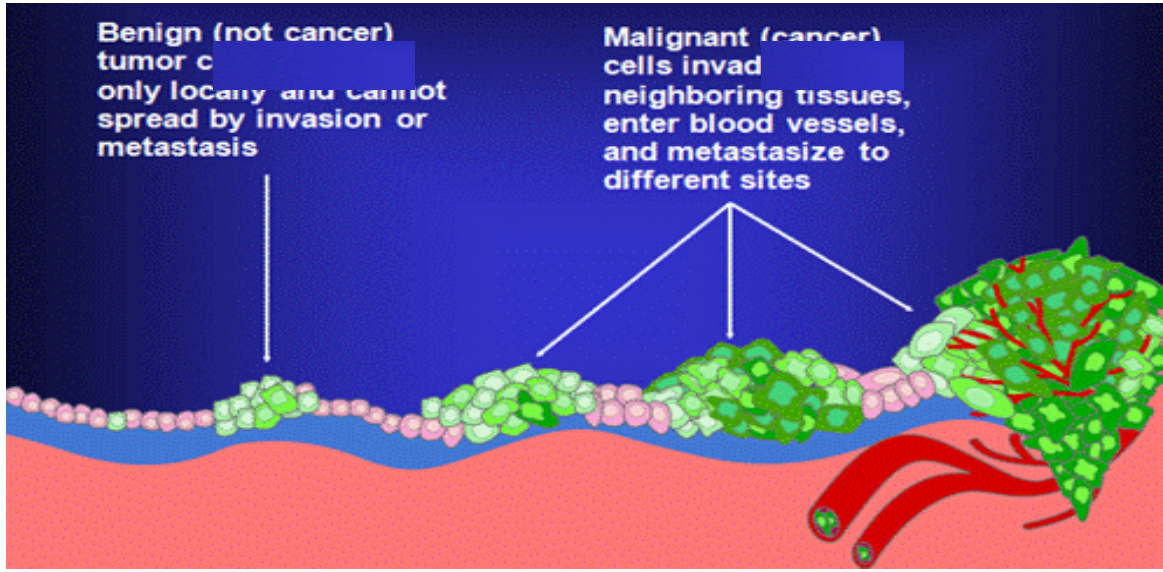
- A tumor is an abnormal mass or lump of tissue that arises from the uncontrolled and abnormal growth of cells.

- Tumors can develop in various parts of the body, including organs, tissues, bones, or even in the blood.

- There are two main types of tumors:





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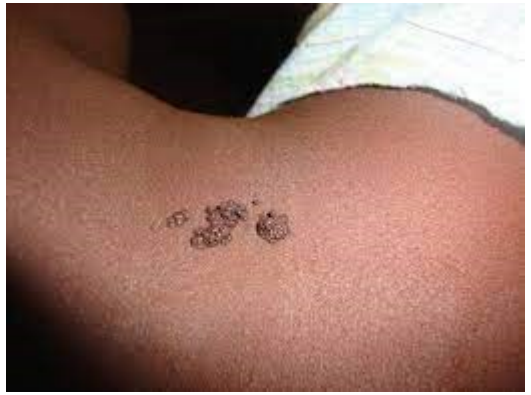
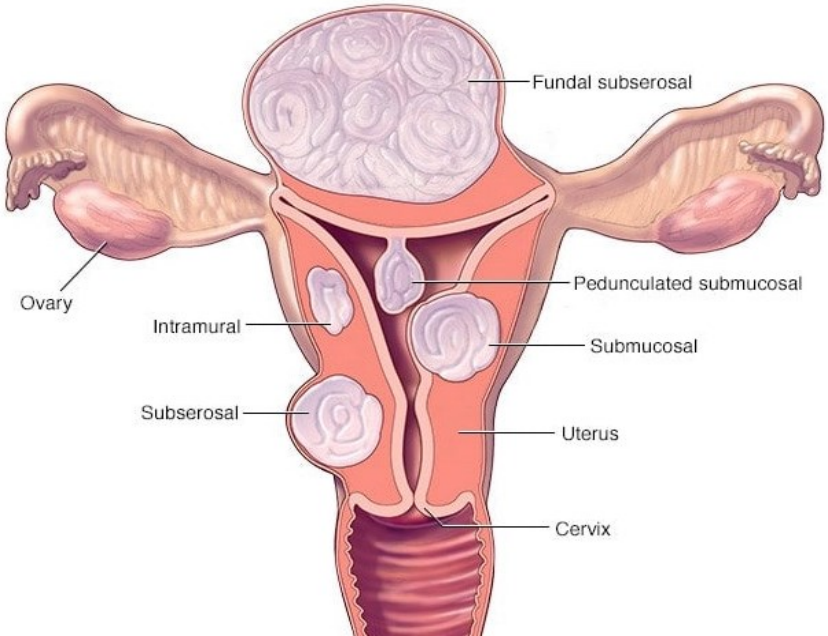
# A. Benign Tumors:

- These are non-cancerous growths.
- They do not invade nearby tissues or spread to other parts of the body (metastasize).
- Tend to grow slowly and have a well-defined boundary.
- They usually do not cause serious health problems unless they press on nearby organs or tissues.







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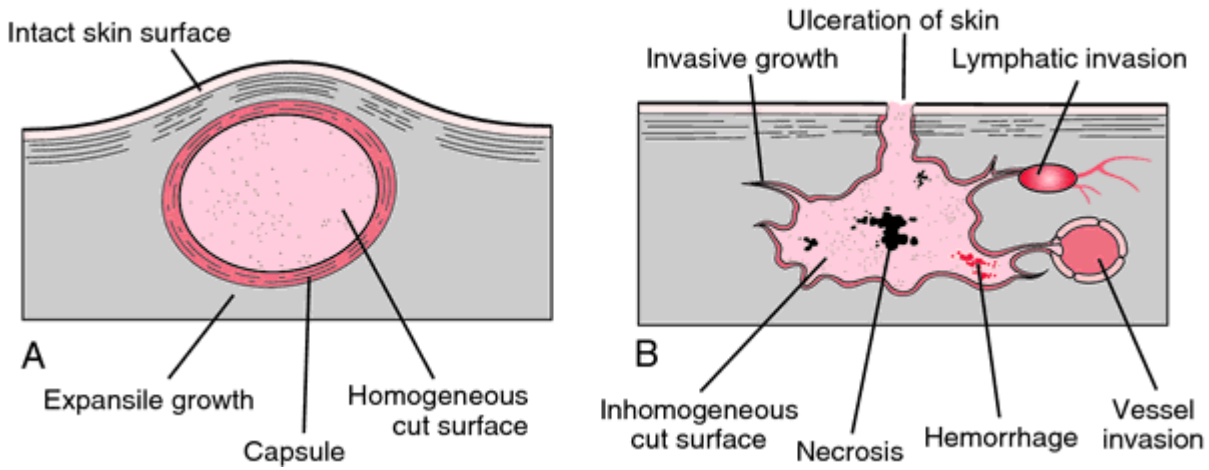
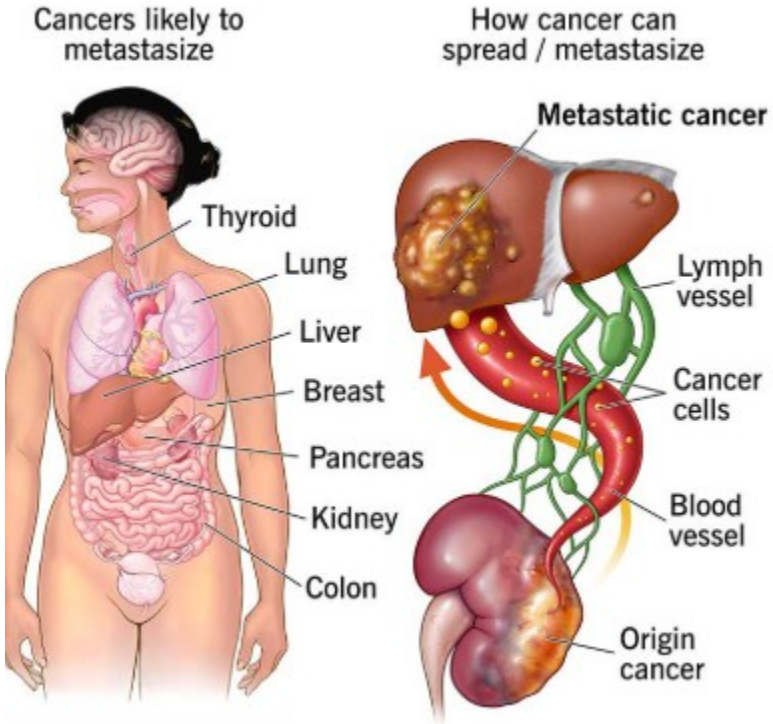
**B. Malignant Tumors**:

- These are cancerous growths.
- They have the potential to invade surrounding tissues and spread to other parts of the body through the **bloodstream or lymphatic system.**
- Malignant tumors can be life-threatening if not detected and treated early.
- <u>They tend to grow more rapidly and may not have well-defined boundaries.</u>





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| Tumor Type | Cell of Origin | Location |
| --- | --- | --- |
| **Carcinomas** | Epithelial cells | Skin, glands, organs (lung, breast, colon) |
| **Sarcomas** | Connective tissue cells | Bone, cartilage, muscle |
| **Lymphomas** | Lymphatic system cells | Lymph nodes, spleen, other lymphatic tissues |
| **Leukemias** | Blood-forming cells | Blood and bone marrow |
| **Gliomas** | Glial cells | Brain and spinal cord |
| **Melanomas** | Melanocytes | Skin, sometimes eyes |
| **Adenomas** | Glandular epithelial cells | PSituitary |


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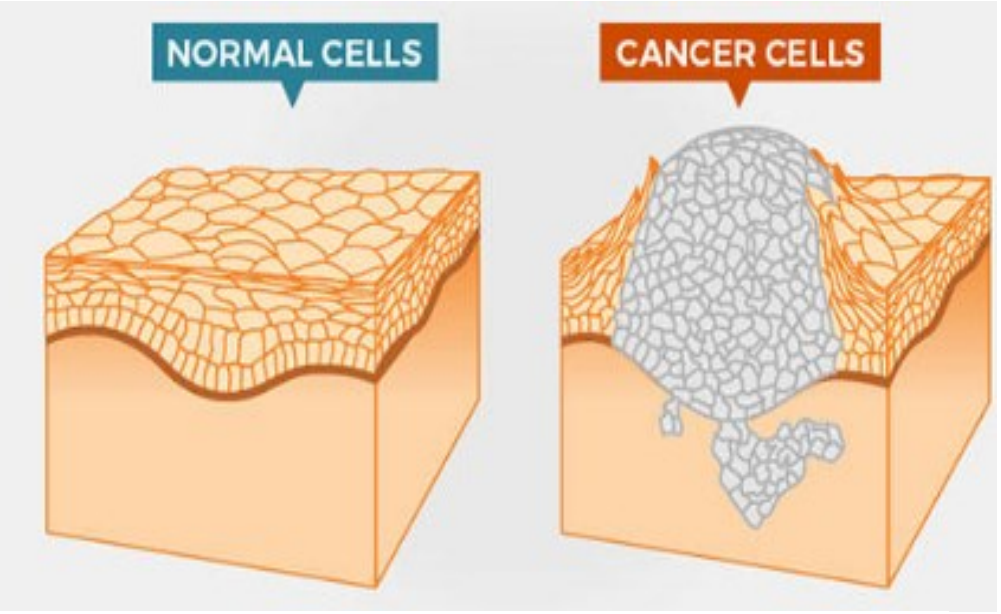
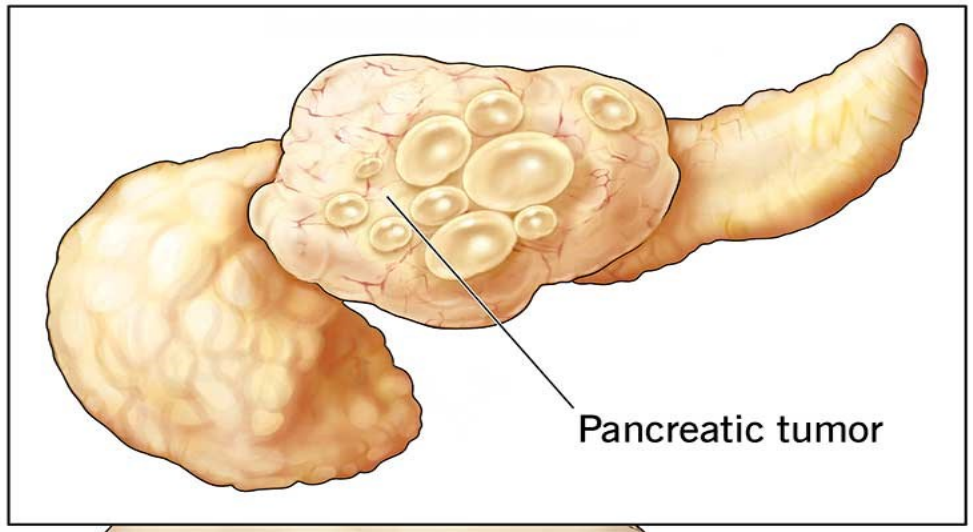
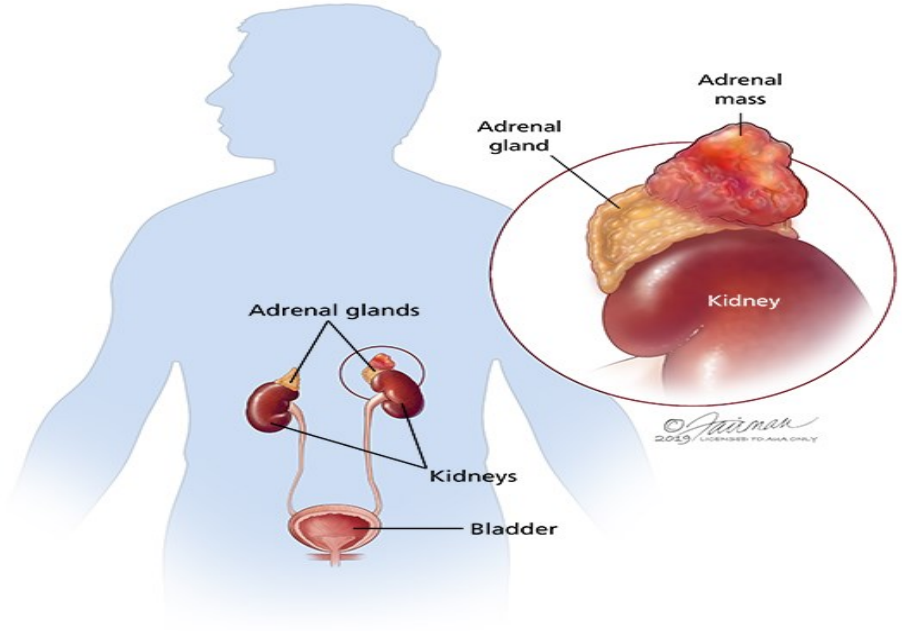
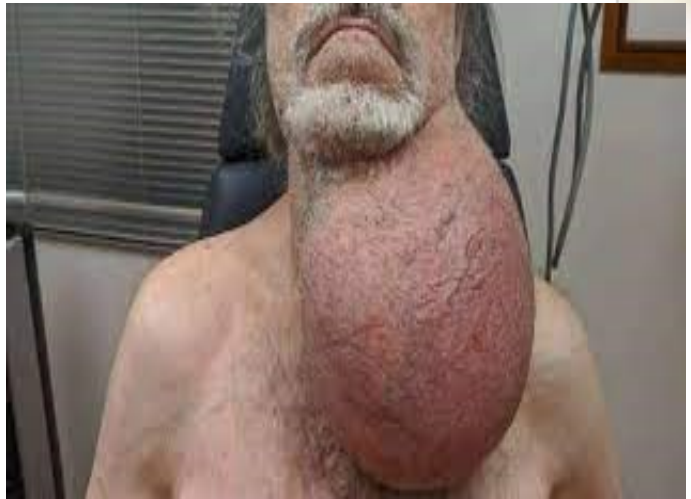
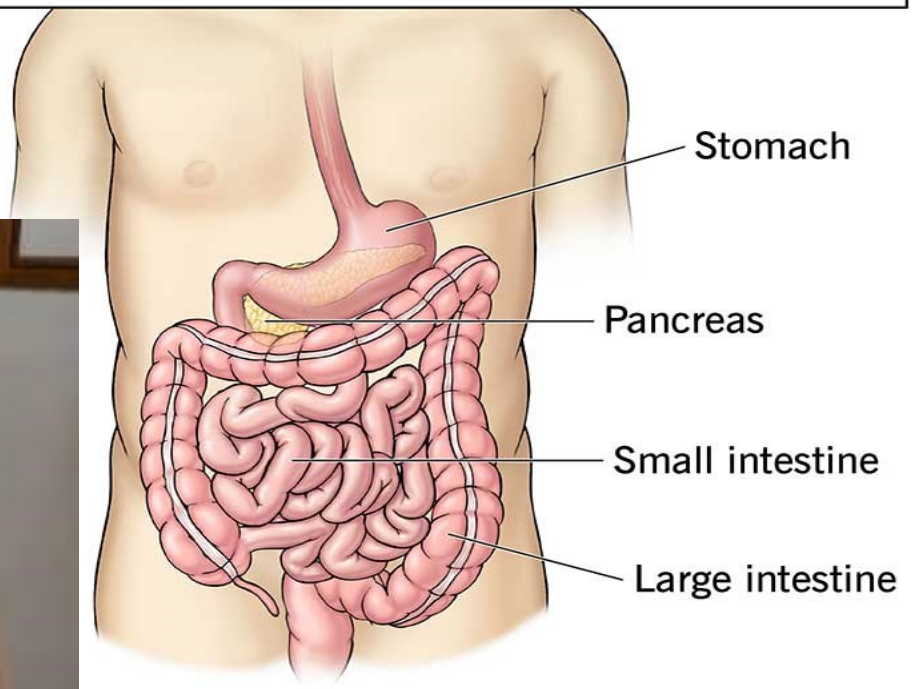
# This unfortunate tragedy can occur in any part of the human body.



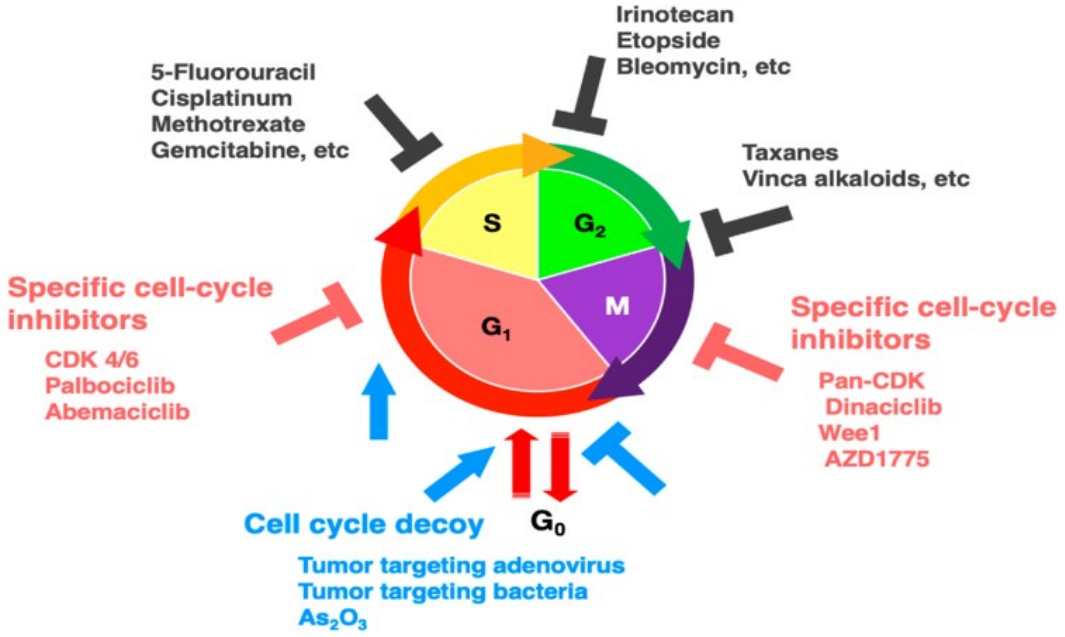



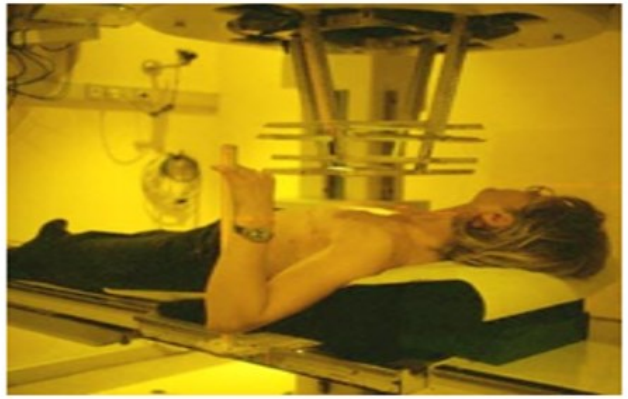



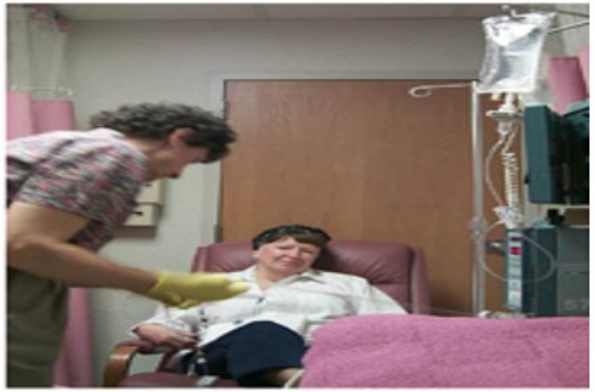


# Cancer treatments.

- Treatments target rapidly dividing cells
  - high-energy radiation
    - kills rapidly dividing cells
  - chemotherapy
    - stop DNA replication
    - stop mitosis & cytokinesis



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