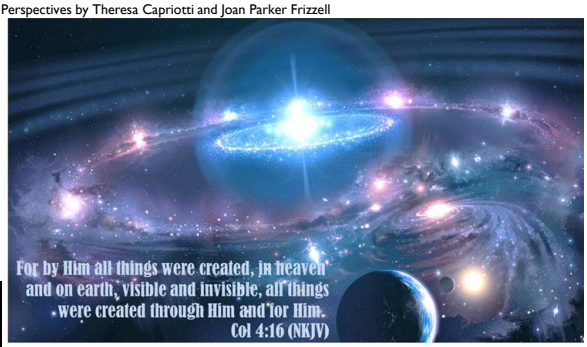
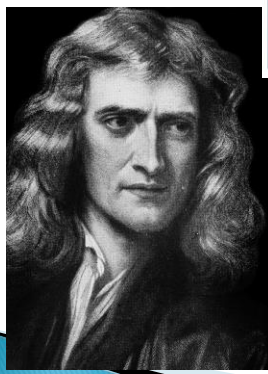
The Cell in Health and Illness

Chapter 1

1





What we know is a **drop,**
what we don't know is an **ocean.**

–Isaac Newton

AZ QUOTES

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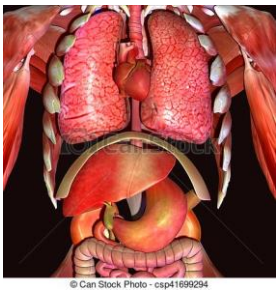

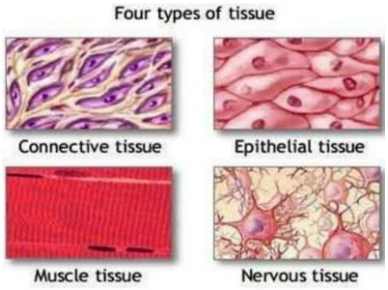

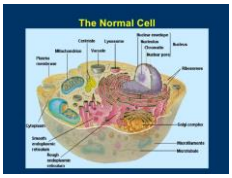

- Body → consists of organs
- Organs → consist of tissues
- Tissues →consist of cells
- Cells → consist of ultrastructures

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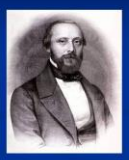
Rudolf Virchow

- The father of modern pathology
- The basis of all disease is injury to the cell



Rudolf Virchow 1858

Cell Theory

- **All living things are composed of one or more cells**
- **In organisms, cells are the basic units of structure and function.**
- **All cells are produced only from existing cells.**

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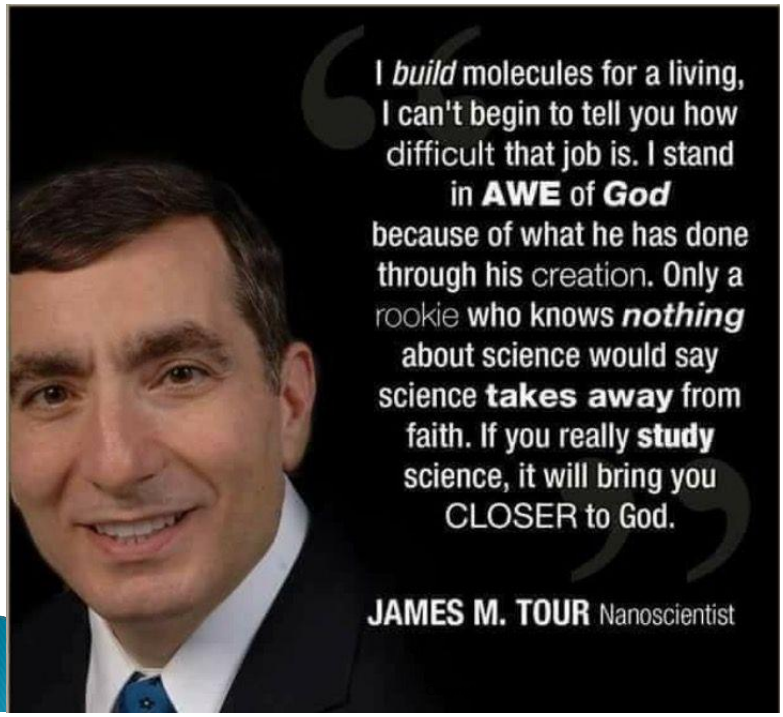

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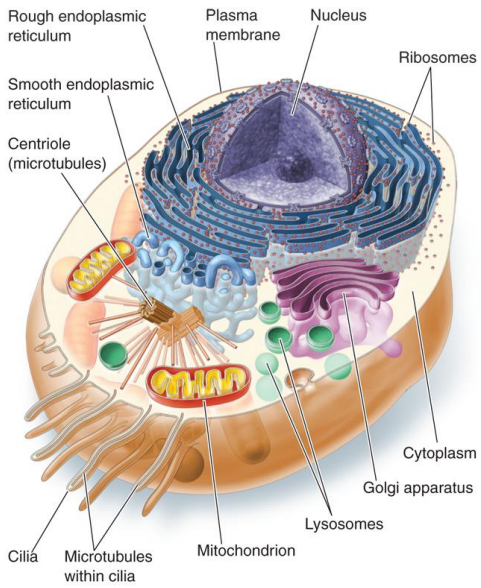

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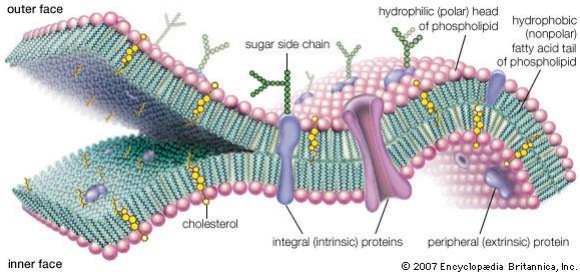
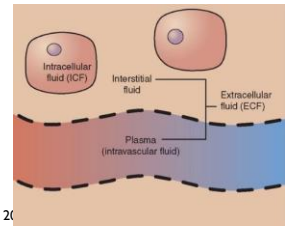
The Plasma Membrane



- What it is:
  - A double layer of lipid molecules with carbohydrates and proteins interspersed
  - Selectively semipermeable; acts as a barrier
- Function:
  - Restricts intracellular losses
  - Governs intracellular entry
  - Separates intracellular fluid (ICF) from extracellular fluid (ECF)



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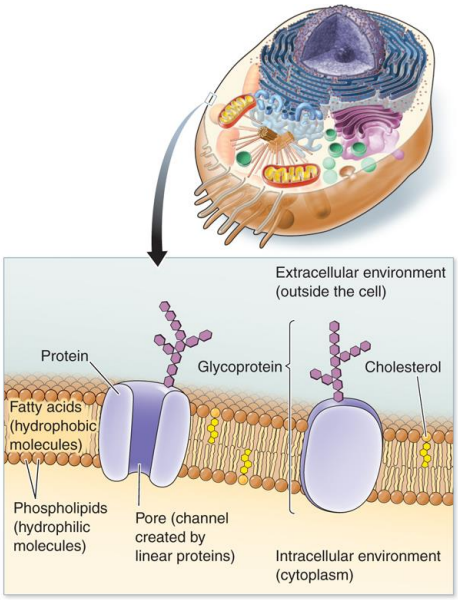

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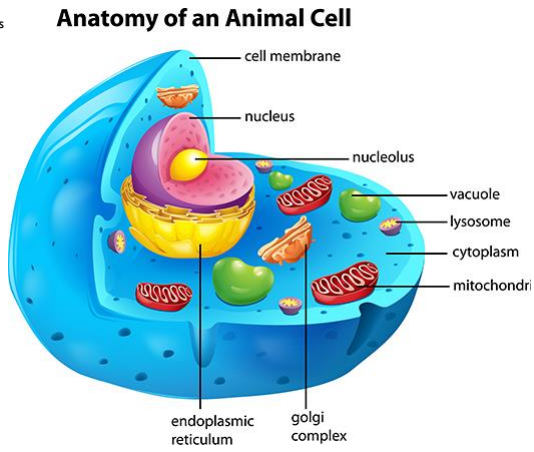
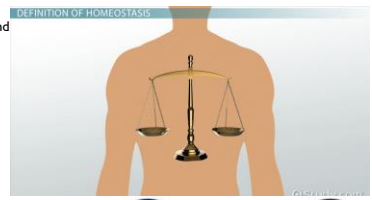
Plasma Membrane

- Maintains the integrity of the cell and guards the contents of the cell



- Cells constantly interact with their environment and try to maintain homeostasis
- cells respond to stress (e.g., physiologic and toxic) via adaptation to maintain viability and function
- cell injury results when the cell can no longer adapt to the stress, which can be
  - REVERSIBLE
    - implies that once the stress is removed the cell can return to its original state
  - IRREVERSIBLE
    - when the *stressful stimuli is excessive or persistent* the cellular damage becomes irreversible and cells undergo CELL DEATH



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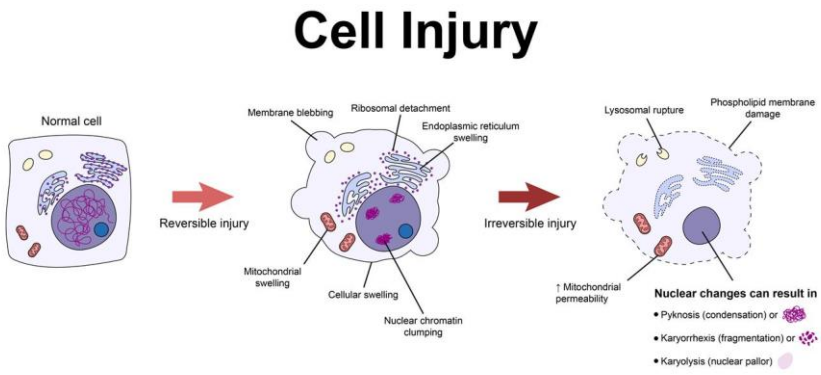
- **Cell damage** (also known as **cell injury**) is a variety of changes of stress that a cell suffers due to external as well as internal environmental changes.
- Amongst other causes, this can be due to physical, chemical, infectious, biological, nutritional or immunological factors.



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Injurious Agents of Plasma Membrane

- *Free radicals* (substances with free electron on an oxygen molecule)
- *High pressure* forces (eg, hypertension)
- *Radiation* (eg, sunlight)
- *High glucose* concentrations (eg, uncontrolled diabetes)

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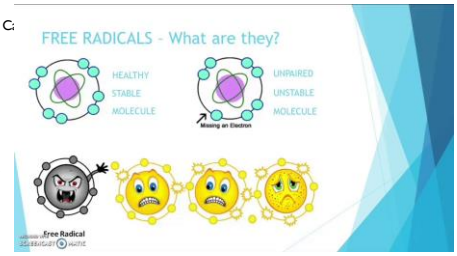
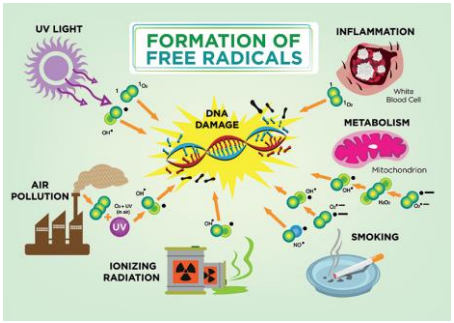
Free Radicals

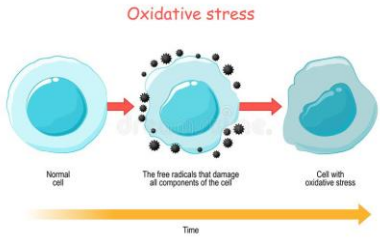
Free radicals **OXIDIZE** cell structures and can be called **OXIDANTS**.

They disrupt the integrity of the cell membrane and damage organelles and DNA, causing cell dysfunction.

ANTIOXIDANTS such as vitamins A, E, C, and beta-carotene counteract free radicals.







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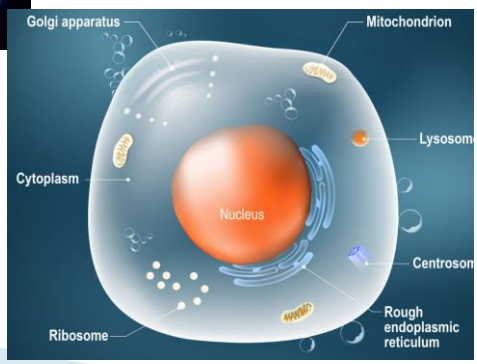
- We will see more of injuries *later*
- *Now* →We will go back to a normal cell



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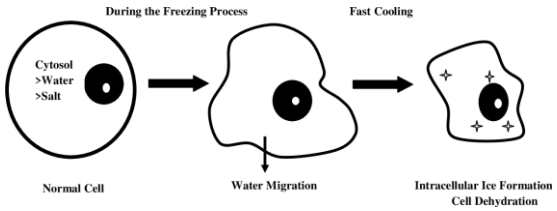
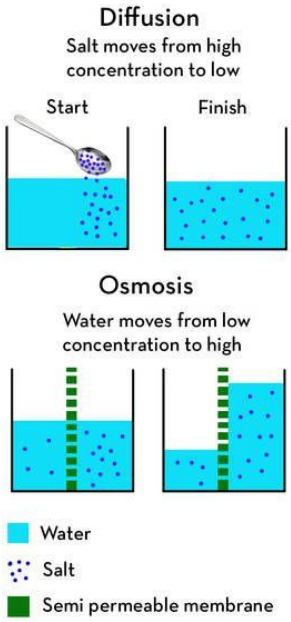
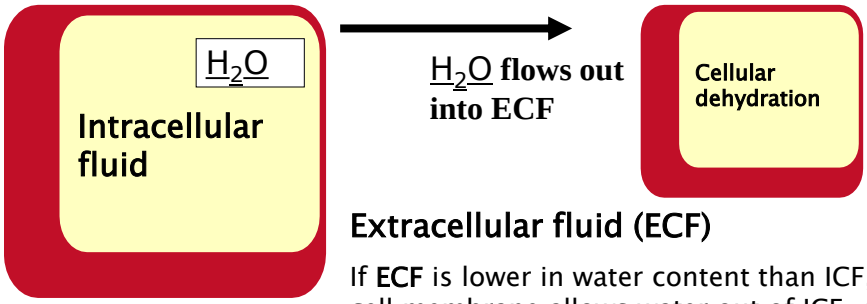
Cell dehydration





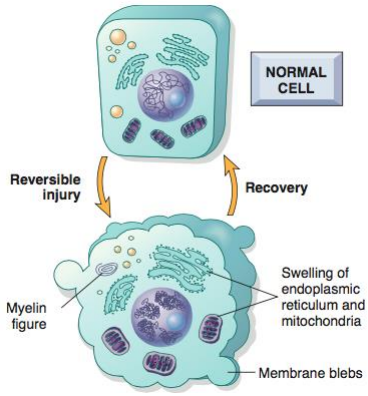
Plasma Membrane Allows for Exchange With Environment



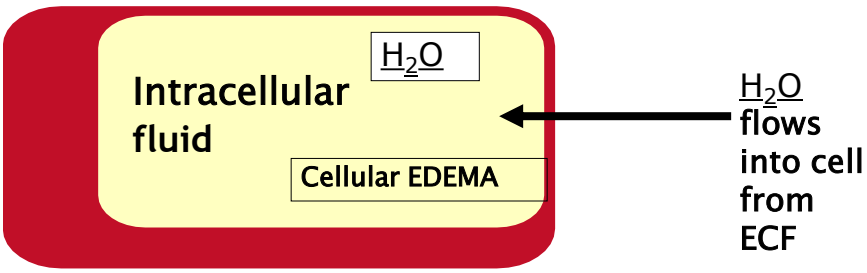
Extracellular fluid (ECF)

If **ECF** is lower in water content than ICF, cell membrane allows water out of ICF, **cell shrinks** = **cellular dehydration**

Cellular edema



Plasma Membrane Allows for Exchange With Environment



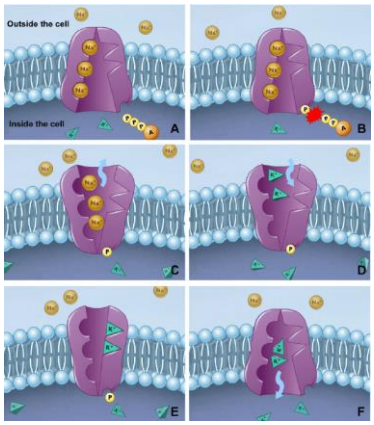
Extracellular fluid: If ECF is higher in water content than ICF, cell membrane allows water to flow into ICF, cell **SWELLS** = **EDEMA**

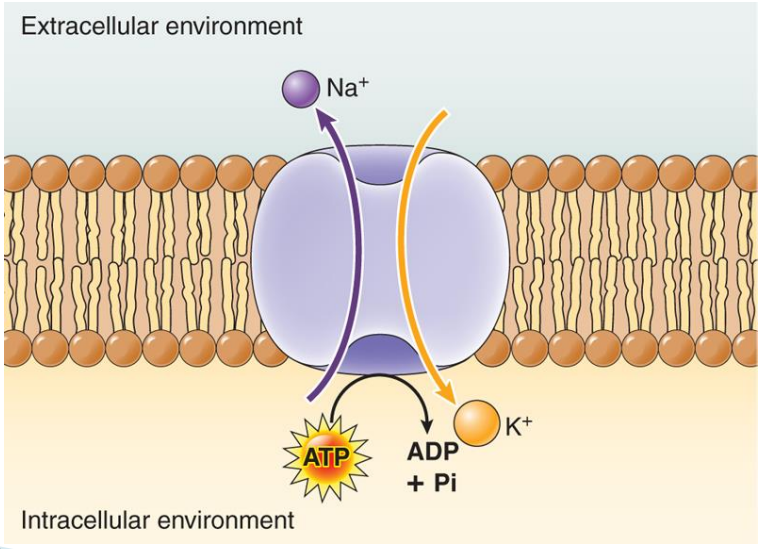
Sodium–Potassium Pump/Active Transport

For *optimal cell function*, it is necessary for:

- potassium (**K+**) ions to be at a higher concentration inside the cell, and for
- sodium (**Na+**) to be at a higher concentration outside the cell.

- The sodium–potassium pump (*Na+ K+ ATPase*) constantly pumps Na+ out in exchange for K+ in.





Mitochondrion

- Rod shaped
- Synthesizes adenosine triphosphate (ATP) (energy source of the cell)
- Process of energy production = oxidative phosphorylation (AEROBIC metabolism)
- Requires proteins, fats, and carbohydrates to produce energy
- Where the **"Krebs cycle"** is occurring

Aerobic metabolism:

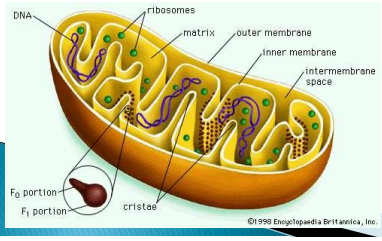
OXYGEN

↓

Mitochondria

↓

34 ATP (energy)



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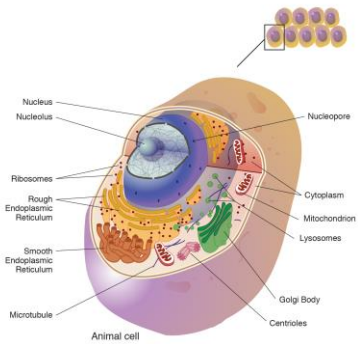

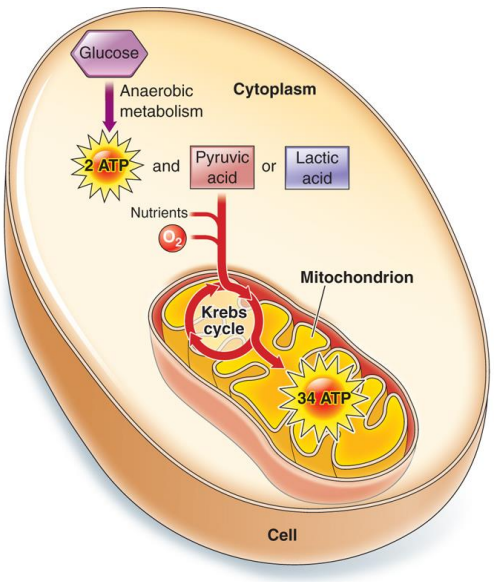

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Cellular Metabolic Processes

- Aerobic metabolism (Krebs cycle) ----->*34 ATP*

  What is the **Krebs cycle** in simple terms?

  - A *series of chemical reactions* that occur in most aerobic organisms and are part of the process of aerobic cell metabolism, by which glucose and other molecules are broken down in the presence of oxygen into carbon dioxide and water to release chemical energy in the form of **ATP**.

- Anaerobic metabolism (GLYCOLYSIS) ----->*2 ATP* + lactic acid

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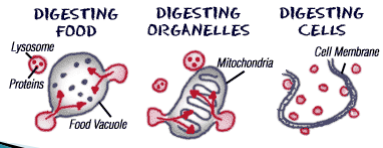
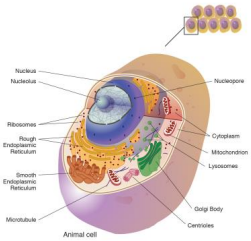
Lysosomes

- Spherical membrane-bound organelles
- Contain **digestive enzymes**
- Digest particles brought in by endocytosis, pinocytosis, or phagocytosis (heterolysis)
- Also digests worn out cell parts
- *In cell death* ---> autolysis occurs (enzymes rupture from lysosome and *digest whole cell*)
- **White blood cells** (WBCs) (macrophages that constantly survey body for antigen) have *many lysosomes*





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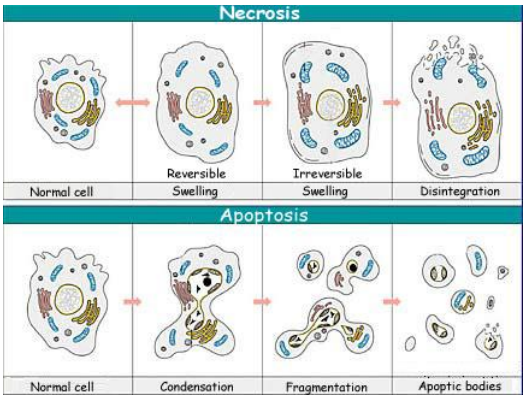
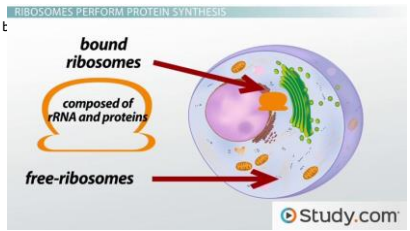
Example of Lysosomal Action

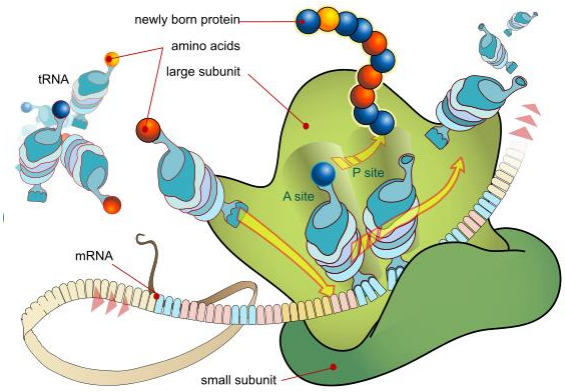
- In *myocardial infarction* (MI; cardiac muscle cell death)
  - -> *autolysis* occurs (enzymes rupture from cardiac muscle cell lysosomes to digest dead cardiac muscle cells)--->
  - *serum cardiac enzymes = CPK/ LDH/ SGOT*
  - **Laboratory test:** blood drawn for these lysosomal enzymes to indicate MI has occurred



Ribosomes



- Attached to ER
- Unattached, freely suspended in cytoplasm
- "Factories" of proteins
- Where "protein synthesis" occurs



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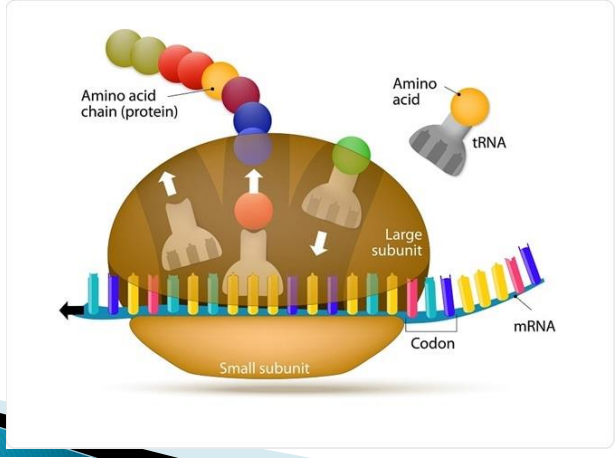
Ribosomes

- How do ribosomes "know" what proteins to make and how to make proteins?
- The NUCLEUS gives directions---->



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Nucleus

- Houses the DNA of the cell
- DNA = double strand of chromosomes linked together (imagine a "zipper")
- Chromosomes = chains of genes
- Direct all cell activities and all structural plans

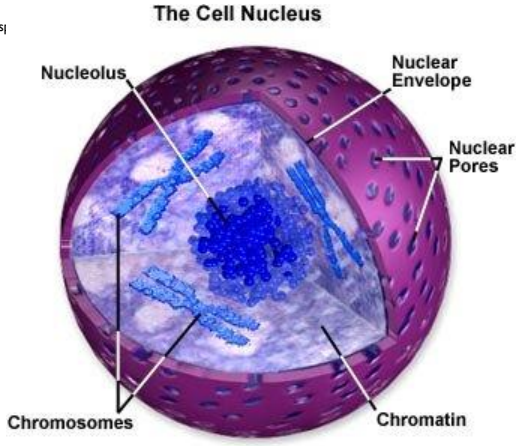

Figure 1

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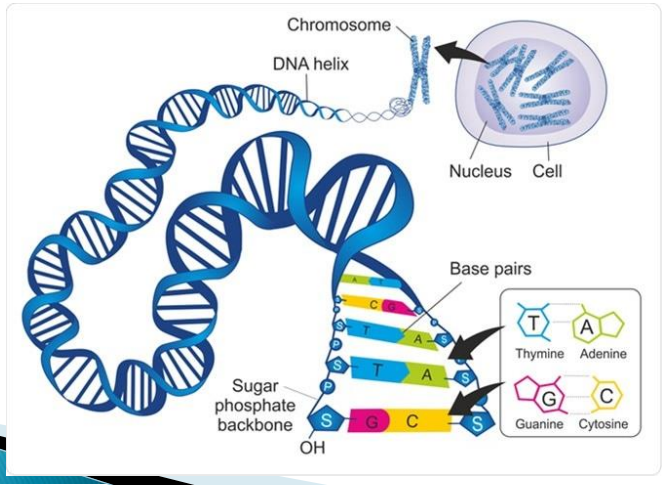
DNA ----> double-helix strand
----> individual chromosomes = "karyotype"



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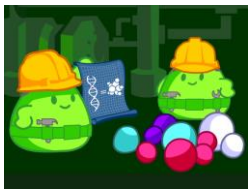
What is DNA and How Does it Work?



Check this out:

https://www.youtube.com/results?search_query=dna

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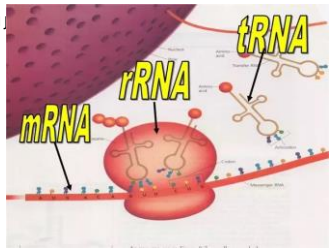
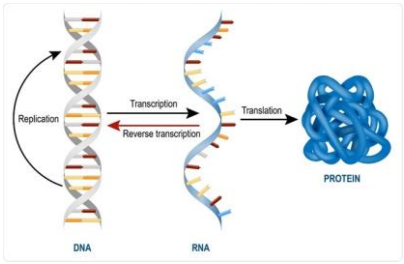
How Do Genes Direct Our Body to Make Proteins?

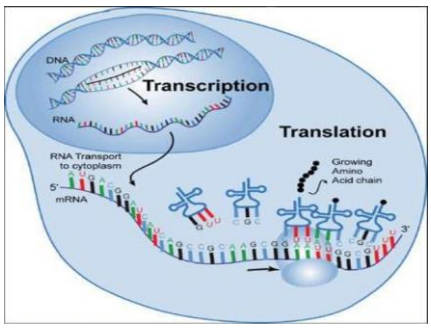


- DNA ->transcription process -> RNA
- RNA strand = mRNA, tRNA, and rRNA
- Messenger RNA (mRNA)
- The mRNA is a mirror image copy of DNA.
- The mRNA tells the ribosomes what specific protein to build.
- Transfer RNA (tRNA) helps ribosome build the specific protein by linking the correct amino acids together.



What Occurs Inside the Cell That Allows DNA to Direct Cell Activity?

- **Transcription**: process in the nucleus where the DNA makes an RNA molecule
- **Translation**: process outside the nucleus at the ribosome where the RNA directs the synthesis of proteins



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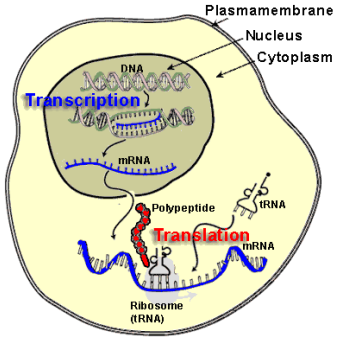
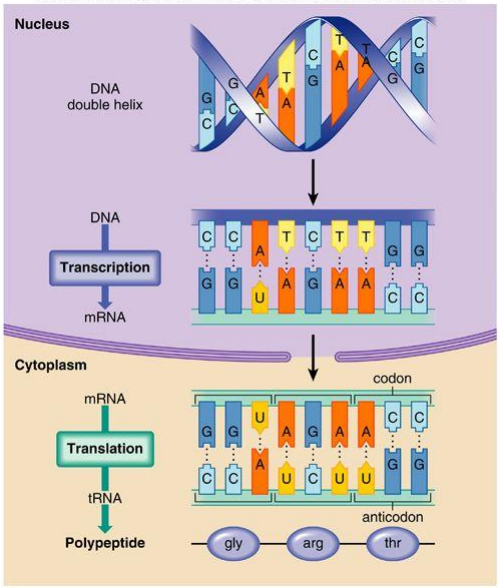
- Inside the nucleus…DNA "transcribes" itself for cells to function





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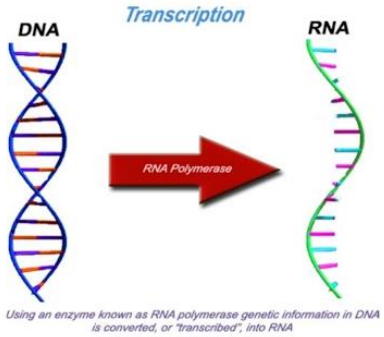
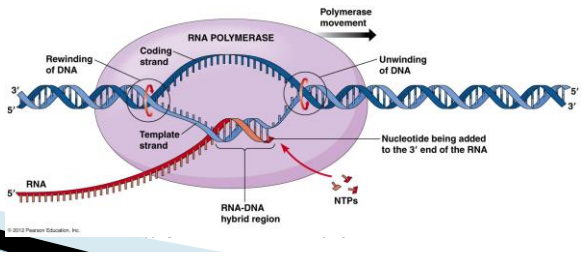
Transcription

- INSIDE NUCLEUS: One strand of DNA acts as a template to make a strand of RNA…DNA rezips and then the strand of RNA leaves the nucleus …



- *RNA* = three parts: mRNA, tRNA, and rRNA



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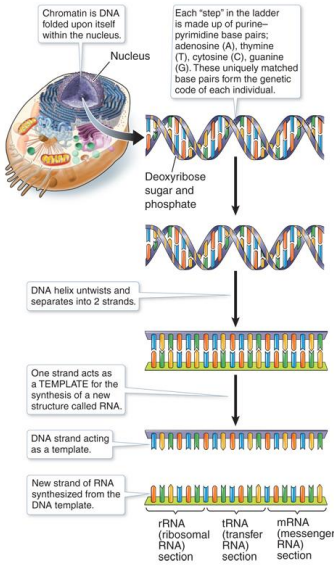
Transcription



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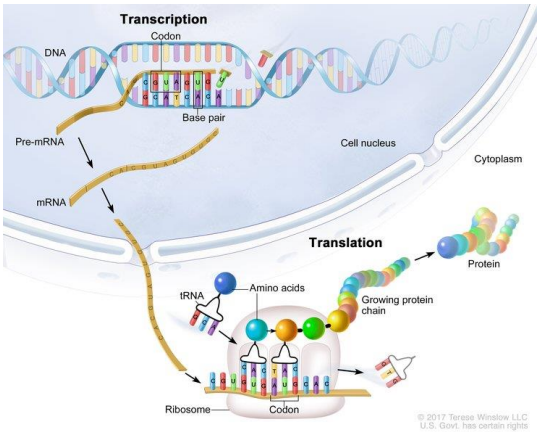
Translation

- "Translation": mRNA --> directs ribosome to synthesize specific amino acids

  ↓

- --> tRNA directs the chain formation of amino acids to form proteins



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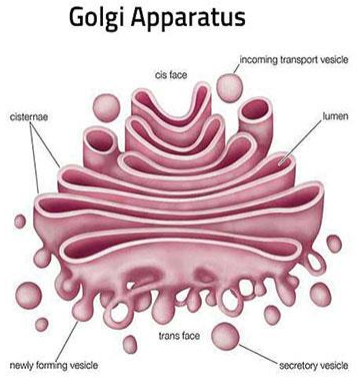
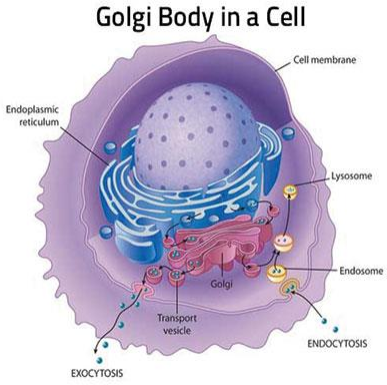
Golgi Apparatus

- Processes proteins synthesized by the ribosomes
- Prepares proteins for secretion





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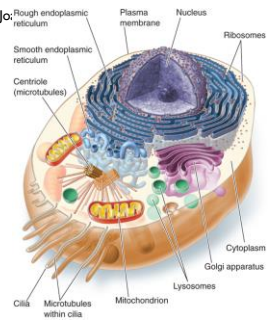
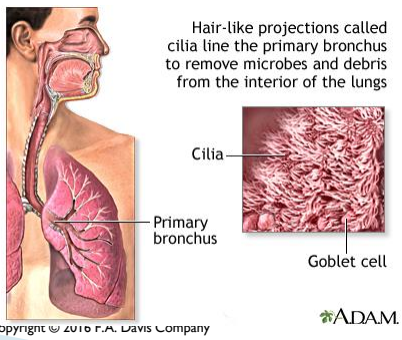
Pathophysiology: Introductory Concepts and Clinical Perspectives by Theresa Capriotti and Jo;

Cilia

- Extensions of the plasma membrane with coordinated **whiplike motion**
- Found on some cells that require motion
- Example: respiratory tract cells **"sweep"** away debris, propel mucus





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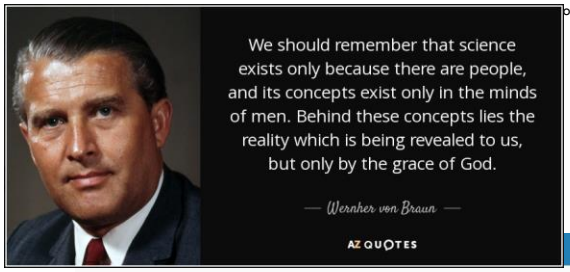

ban Parker Frizzell

THE MORE WE LEARN ABOUT GOD'S CREATION, THE MORE I AM IMPRESSED WITH THE ORDERLINESS AND UNERRING PERFECTION OF THE NATURAL LAWS THAT GOVERN IT.

- WERNHER VON BRAUN -

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