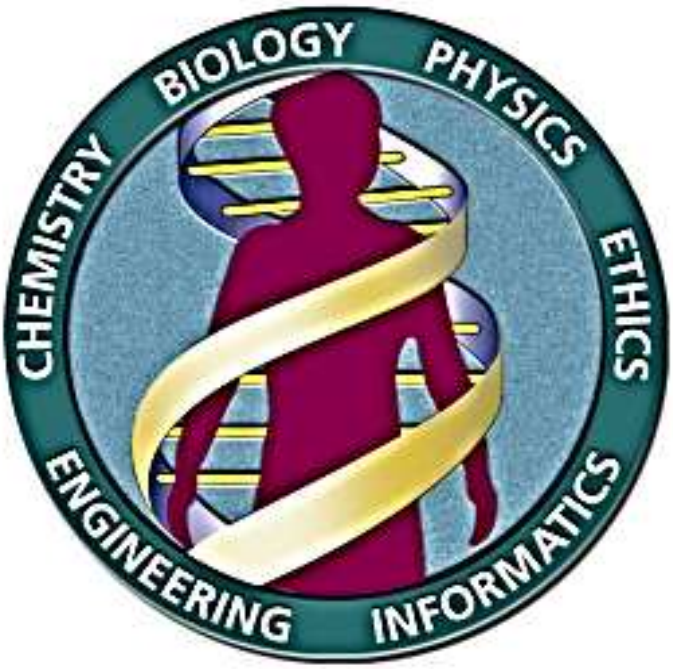
جامعة غزة
كلية العلوم الطبية
قسم التمريض

Medical General Biology

علم الاحياء العامة "الطبية"



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M Sc. In Medical Lab Sciences
Clinical chemistry/Molecular biology

2025

Contents:

Textbook:

- **Biology / Sylvia,** S. Mader. -- 12th ed. 2021.
- **Principles of Biology**, Samantha Fowler, Rebecca Roush, and James Wise, 2013.
- **Human Biology,** John K Inglis. 3rd edition.

CHAPTER – 1: INTRODUCTION TO BIOLOGY

Biology: the science of (life).

The word ***biology*** means, "The science of life", from the Greek **bios,** *life*, and **logos,** *word* or *knowledge.* Therefore, Biology is the science of Living Things and their interactions with one another and their environments.

Medical biology (Biomedicine) is a field of biology that has practical applications in medicine, health care and laboratory diagnostics.

Biology is a branch of science that deals with living organisms and their vital processes. Biology encompasses diverse fields,
including botany, conservation, ecology, evolution, genetics, marine biology, medicine, microbiology, molecular biology, physiology, and zoology.

PROPERTIES OF LIFE (CHARACTERISTICS OF LIVING THINGS): خواص الكائنات الحيه

1- Nutrition


Take food for energy, growth and repair

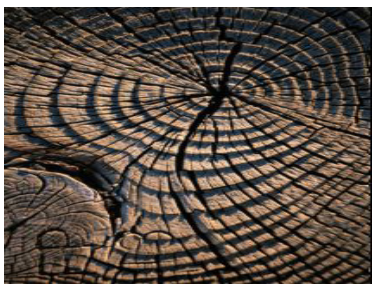
2- Respiration and energy utilization

- Gaseous exchange (breathing), oxidation of food to produce energy.

- All organisms take in energy and use it to perform many kinds of work. Every muscle in your body is powered with energy you obtain from the food you eat.

3- Excretion

Removal of metabolic wastes (not faeces)

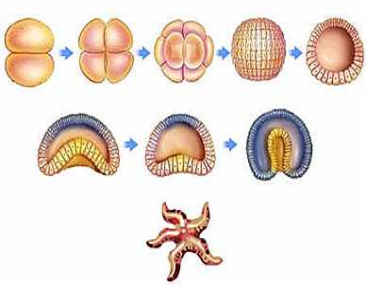


4- Growth

Is the formation of two cells from a preexisting cell.
Increase in size and complexity

5- Reproduction and development

All species have the ability to reproduce, not essential to survival of individual but is essential for continuation of a species.
Increase in size and number
Produce babies of the same species
The process by which an adult organism arise is called development. Repeated cell divisions and cell differentiation

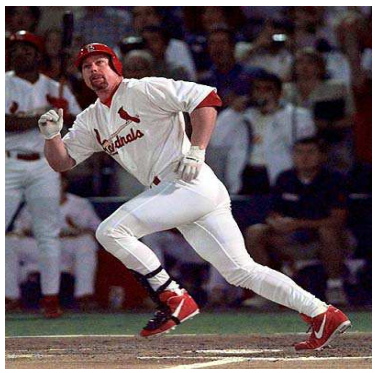


6- Sensitivity

Respond to stimuli in the external environment

Detect and respond to changes in light, heat, sound and chemical and mechanical contact.

7- Movement



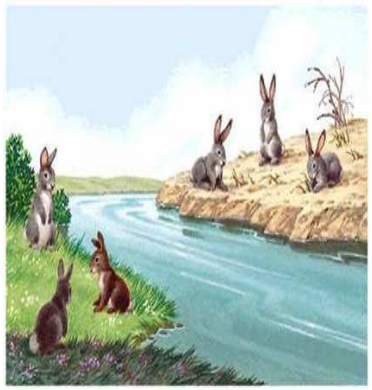
Animals: Whole organism moves from place to place

Plants: Only part of its organ can move about

8- Order

Organisms are highly organized and consist of one or more cells.

9- Evolve (Adaptation)

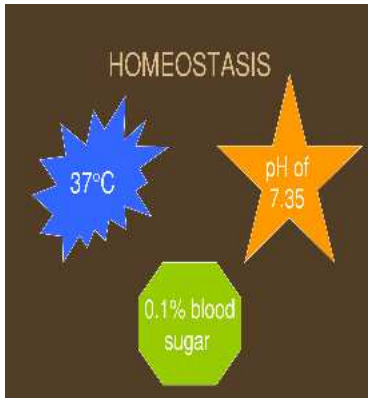


Ability to adapt to their environment through the process of evolution

Favorable characteristics are selected for and passed on to offspring Called adaptations

Driven by natural selection or “survival of the fittest”

10-Homeostasis



process by which organisms keep internal conditions constant despite changes in their external environments.

• DIVERSITY OF LIFE AND TAXONOMY التصنيف الخلوي و تصنيف الكائنات الخيه

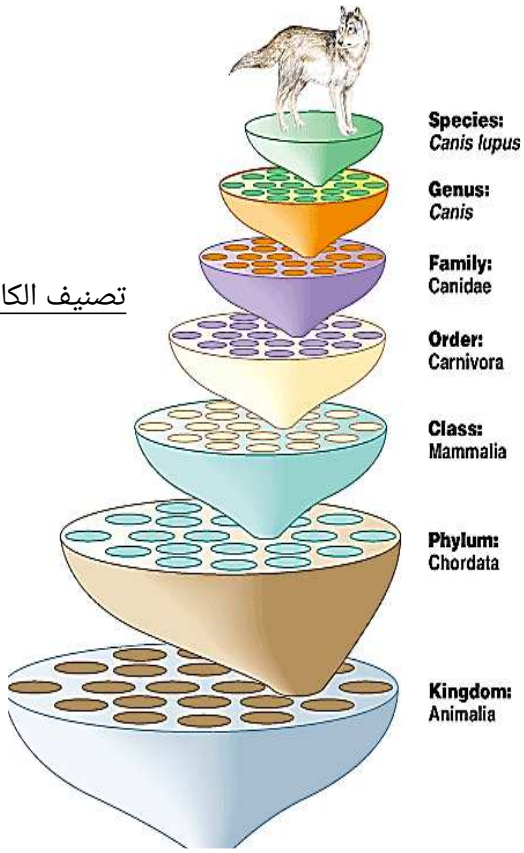
Taxonomy is the branch of biology that names and classifies species into a hierarchical order.

* New methods, including comparisons of DNA among organisms, have led to a reassessment of the number and boundaries of the kingdoms.

* Biologists ordered - or classified – life's huge diversity into **three** **domains** then **five** major **kingdoms**

* Below the kingdom level biologists introduced phyla, classes, orders, families and genera

* At the lowest level is the **species** concept



• Classification of organisms according on: تصنيف الكائنات الحيه

1- Cell organelles type

Prokaryotic or eukaryotic and cell composition

2- Cell type

Unicellular or multicellular

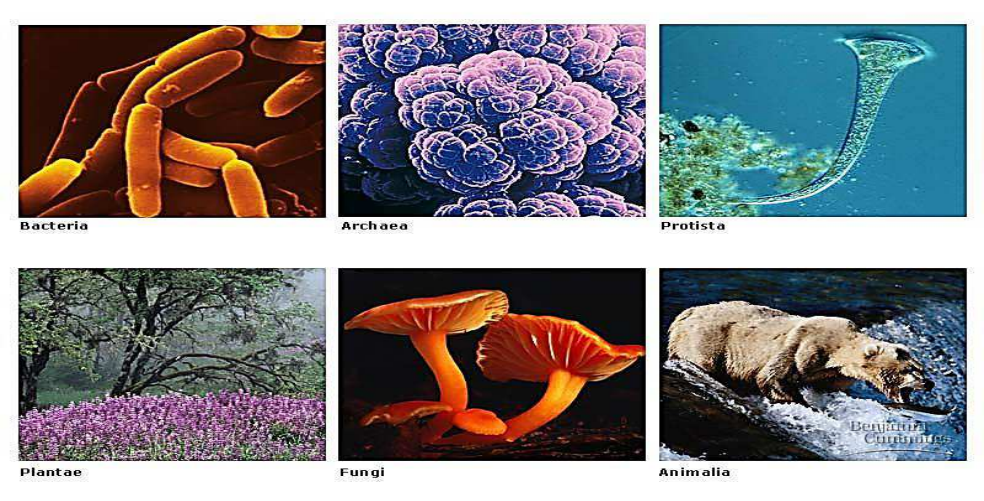
3- The basic characteristic of organisms

Nutrition - Autotrophic, heterotrophic

Size - Microorganism or macroorganism

4- Others special characteristic

Five Kingdoms System (تصنيف الممالك الخمس)

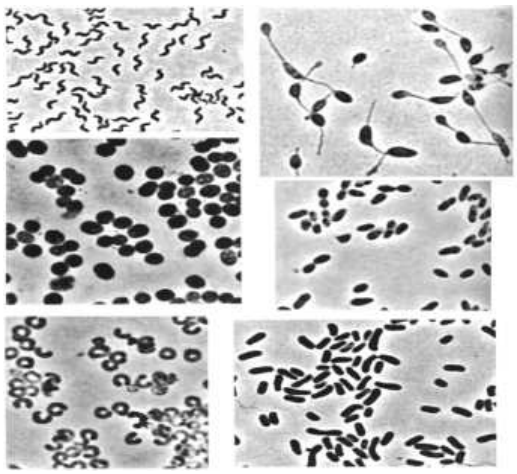


1- Monera Kingdom مملكه الطلائعيات

• Organisms in the kingdom Monera called prokaryotes (bacteria).

• Prokaryotes lack nuclei and the various organelles of eukaryotes.

- Unicellular, microscopic
- No nucleus
  - o Prokaryotic
- No chlorophyll
  - o Saprophytic or parasitic

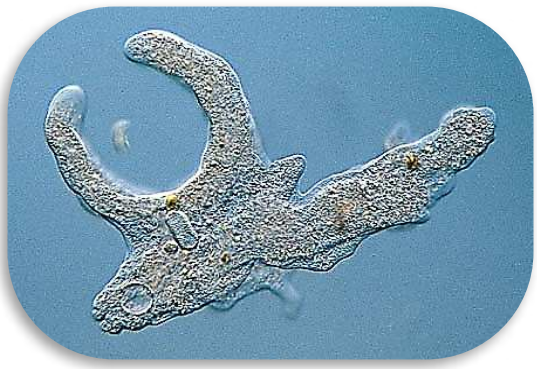


2- Protista kingdom مملكه الاوليات

- Unicellular; microscopic
- Nucleus present

o Eukaryotic

- Autotrophic or heterotrophic



3- Fungus kingdom مملكه الفطريات

- Eukaryotic
- Made up of hyphae
- No root, stem and leaf
- No chlorophyll

o Saprophytic or parasitic

- Reproduce by forming spores

4- Animal Kingdom مملكه الحيوان

- Eukaryotic
- Divided into two groups according to the presence or absence of backbone:

o Invertebrates : without backbone

o Vertebrates : with backbone

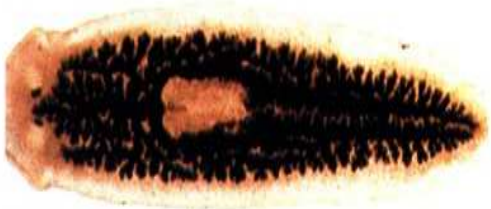
A. Invertebrate اللافقاريات

Coelenterates

- 2 layers of cells
- Have tentacles with sting cells
- One opening

Flatworm الديدان المفلطحه

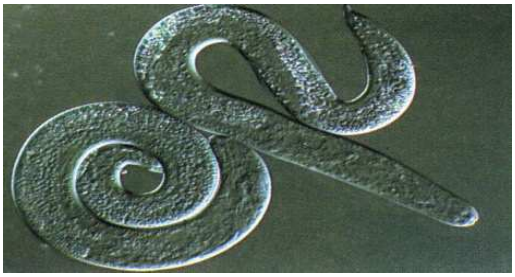
- Long and flattened body
- Free living or parasitic



Ringed worms الديدان الاسطوانيه

- Long and segmented body
- Have chaetae for locomotion

Roundwoms

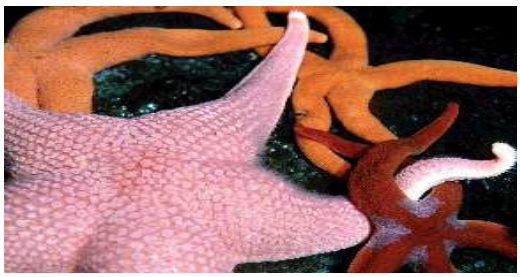


- Long, cylindrical and segmented body
- Most of them are parasites

Molluscs الرخويات

- Soft and unsegmented body
- Covered by a hard shell

Echinoderms الجلدشوكيات



- Marine animals with 5-radial plan body
- Have external spines

Arthropods المفصليات

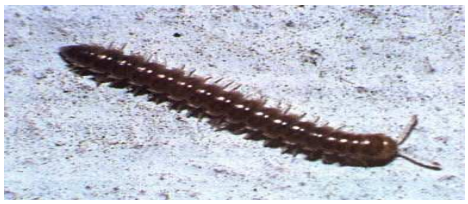
- Segmented body
- Have a hard exoskeleton and several pairs of jointed legs
- Divided into 4 classes

1. **Crustaceans**
2. **Arachnids**
3. **Myriapods**
4. **Insects**

Crustaceans

Arachnids

Myriapods



Insects

B. Vertebrates

- Divided into 5 groups:

1. Fish
2. Amphibians
3. Reptiles
4. Birds
5. Mammals

Fish

- Aquatic
- Cold-blooded
- Body covered with scales
- Streamline body for easy movement through water
- Fins for balance and to control movement
- Gills for breathing
- External fertilization

Amphibians

- Cold-blooded
- Moist, scaleless skin
- Limbs present

o tetrapods

- Larvae (tadpoles) use gills for breathing; adults use lungs
- External fertilization

Reptiles

- Cold-blooded
- Body covered with dry, hard scales
- Live on land
- Breathe with lungs
- Internal fertilization

Birds

- Warm-blooded
- With feathers and wings
- Beak for feeding
- Lungs for breathing
- Internal fertilization

Mammals

- Warm-blooded
- Hairs on skin

- Females have mammary glands for producing milk
- Lungs for breathing
- Diaphragm present
- Internal fertilization; embryos develop inside mothers' bodies

Plant Kingdom

- Eukaryotic
- Most plants contains photosynthetic pigments (e.g. chlorophyll) for photosynthesis

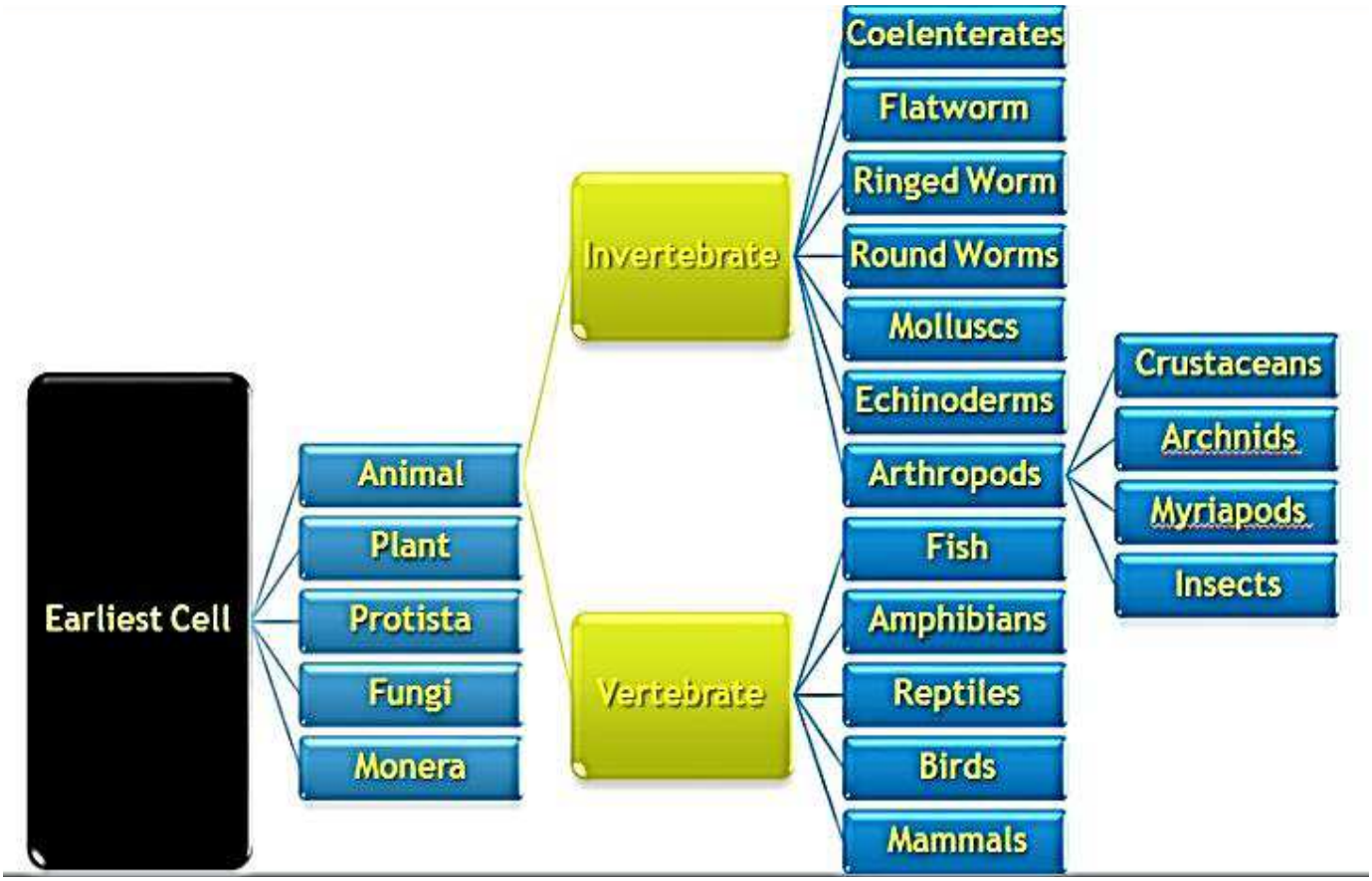
o Autotrophic

- Can be divided into two groups:

o Non-flowering plants

o Flowering plants

Summary of living things classification



CHAPTER – 2: CORE THEMES IN ALL OF BIOLOGY.

Cell Theory, All living things are made of cell.

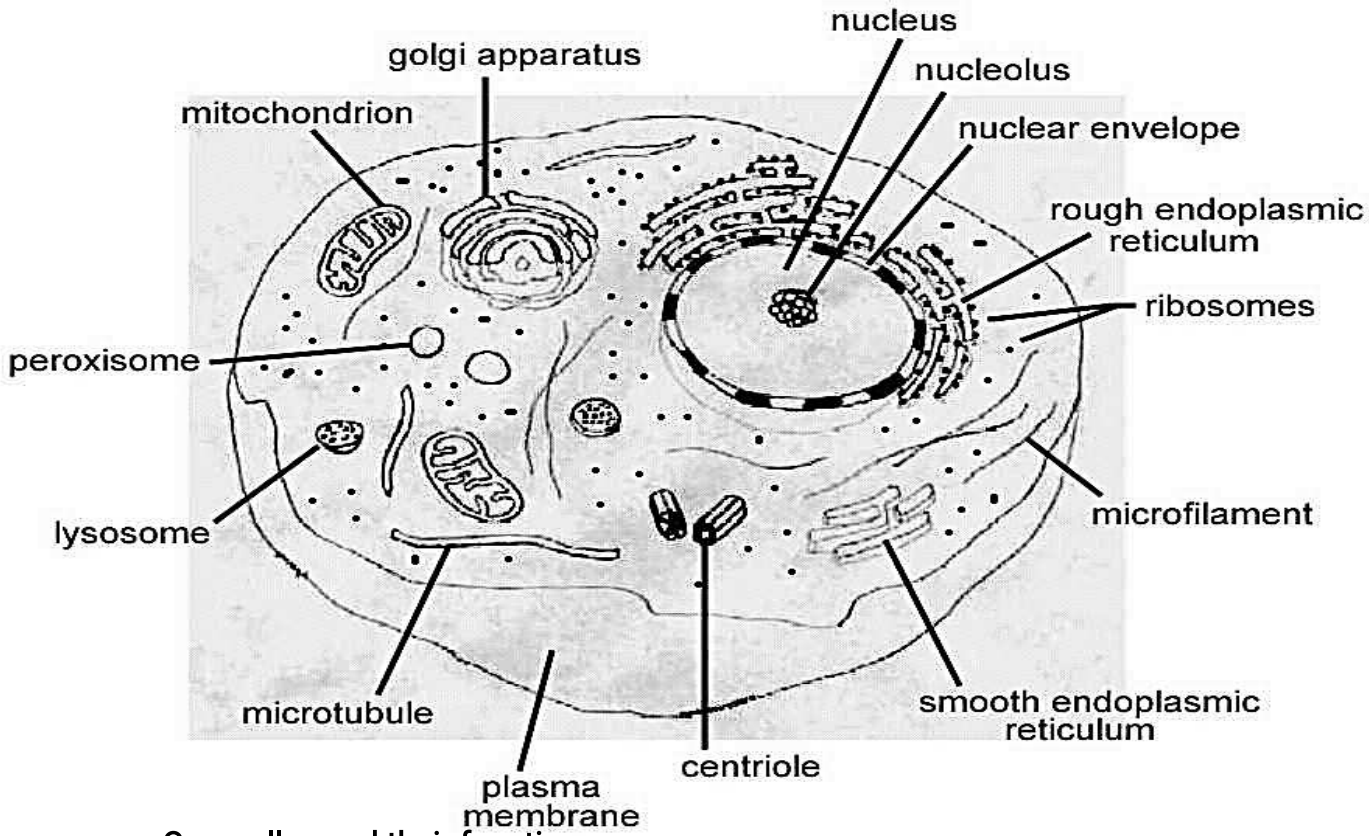
• Cells are the fundamental unit of life.

• Cells are the functional units of life.

• All organisms are constructed of and by cells. Cells contain the information necessary for their own reproduction. No new cells are originating spontaneously on earth today.

• All biochemical processes are carried out by cells.

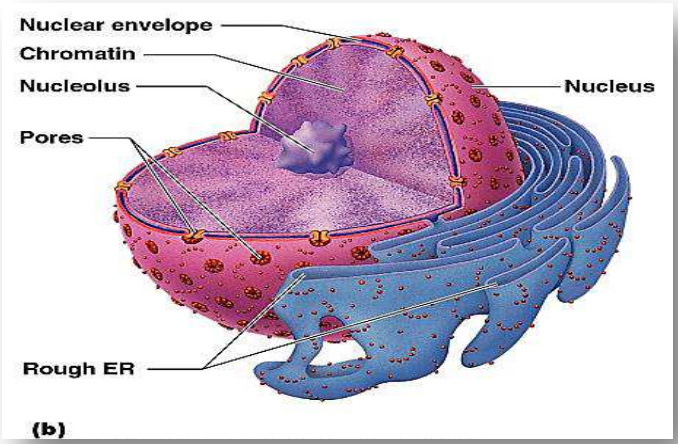
• Groups of cells can be organized and function as multicellular organisms.



- Organelles and their functions

A- Nucleus

The nucleus is the round object in the cell that holds the genetic information (DNA) of the cell. It is surrounded by a nuclear envelope and has a nucleolus inside.

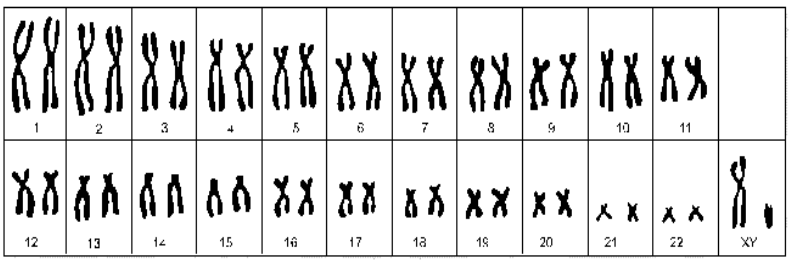


Nucleolus

- Spherical shape
- Visible when cell is not dividing
- Contains RNA for protein manufacture

Chromosomes

- Usually in the form of chromatin
- Contains genetic information
- Composed of DNA
- Thicken for cellular division
- Set number per species (i.e. 23 pairs for human)



So, what is the Chromosomal karyotyping?

Complexity of organism not directly related to cell chromosome number

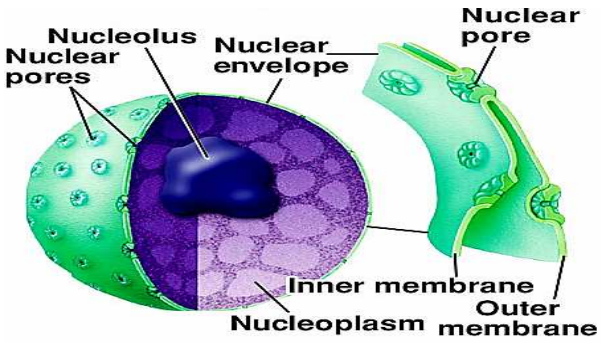
Chromosomes can be viewed by preparation of a karyotype (figure): chromosomes are photographed, enlarged, and the enlarged segments paired by size

In human cells the first 22 equal length chromosome pairs are called autosomes; the twenty-third pair (unequal length in males) is called the sex chromosome (determines sex of offspring).

Males carry XY sex chromosome pair, females XX; who determines the sex of the offspring?

Nuclear membrane

- Surrounds nucleus
- Composed of two layers
- Numerous openings for nuclear traffic

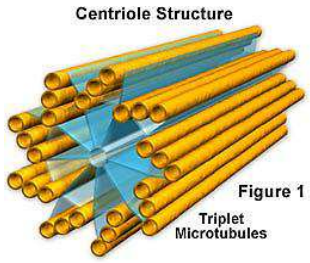


B- Cytoplasm

- Collective term for cytosol and organelles contained within
- Colloidal suspension
- Cytosol mainly composed of water with free-floating molecules
- Viscosity constantly changes

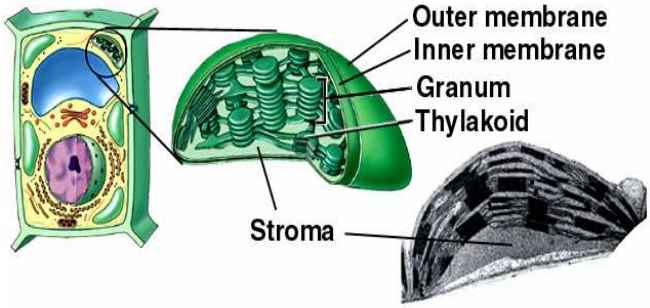
Centrioles

- Paired cylindrical organelles near nucleus
- Composed of nine tubes, each with three tubules
- Involved in cellular division
- Lie at right angles to each other



Chloroplasts

- A plastid usually found in plant cells
- Contain green chlorophyll where photosynthesis takes place

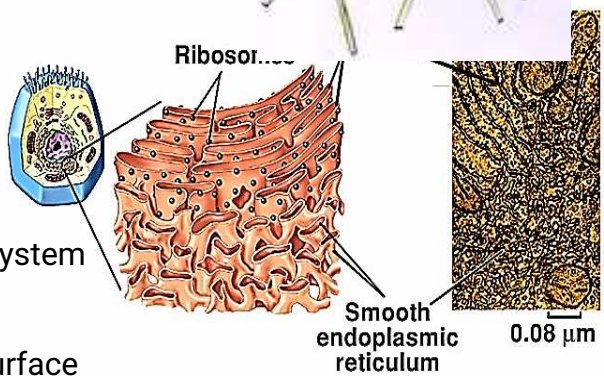


Cytoskeleton

- Composed of microtubules
- Supports cell and provides shape
- Aids movement of materials in and out of cells

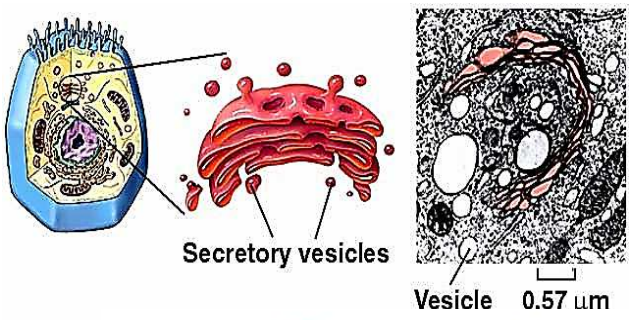
Endoplasmic reticulum

- Tubular network fused to nuclear membrane
- Goes through cytoplasm onto cell membrane
- Stores, separates, and serves as cell's transport system
- Smooth type: lacks ribosomes
- Rough type (pictured): ribosomes embedded in surface



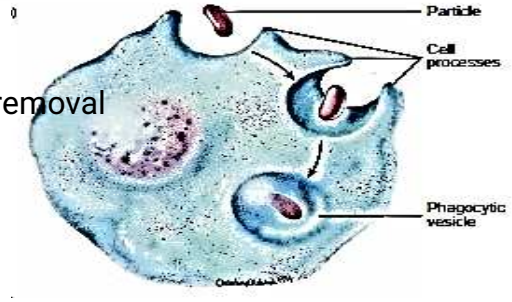
Golgi apparatus

- Protein 'packaging plant'
- A membrane structure found near nucleus
- Composed of numerous layers forming a sac



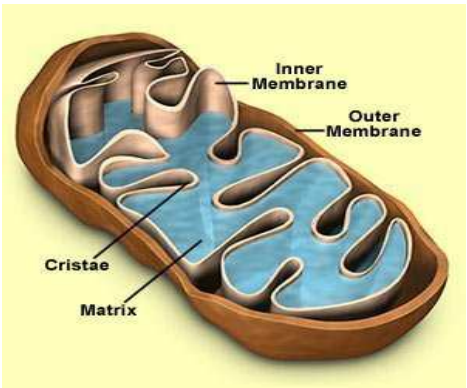
Lysosome

- Digestive 'plant' for proteins, lipids, and carbohydrates
- Transports undigested material to cell membrane for removal
- Vary in shape depending on process being carried out
- Cell breaks down if lysosome explodes



Mitochondria

- Second largest organelle with unique genetic structure
- Double-layered outer membrane with inner folds called *cristae*
- Energy-producing chemical reactions take place on cristae
- Controls level of water and other materials in cell
- Recycles and decomposes proteins, fats, and carbohydrates, and forms urea

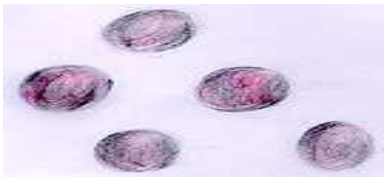


Ribosomes

- Each cell contains thousands
- Responsible for protein synthesis

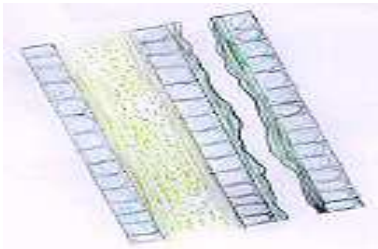
Vacuoles

- Membrane-bound sacs for storage, digestion, and waste removal
- Contains water solution
- Contractile vacuoles for water removal (in unicellular organisms)



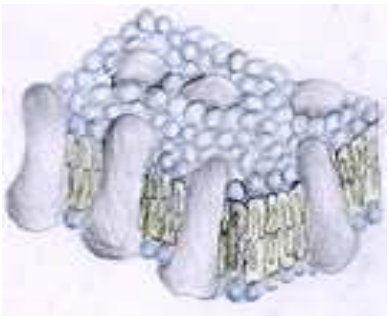
C- Surface

Cell wall

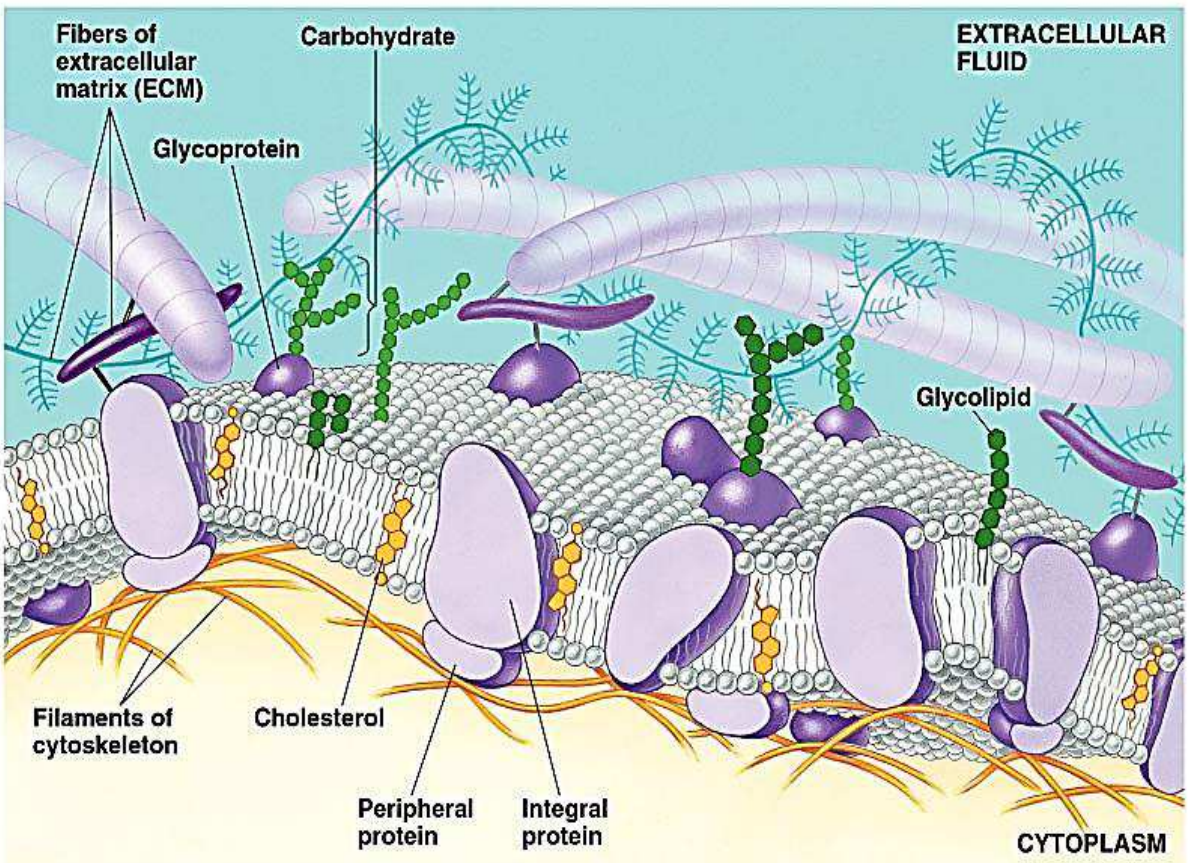


- Most commonly found in plant cells
- Controls turgidity
- Extracellular structure surrounding plasma membrane
- Primary cell wall: extremely elastic
- Secondary cell wall: forms around primary cell wall after growth is complete

Plasma membrane



- Outer membrane of cell that controls cellular traffic
- Contains proteins (left, gray) that span through the membrane and allow passage of materials
- Proteins are surrounded by a phospholipid bi-layer.

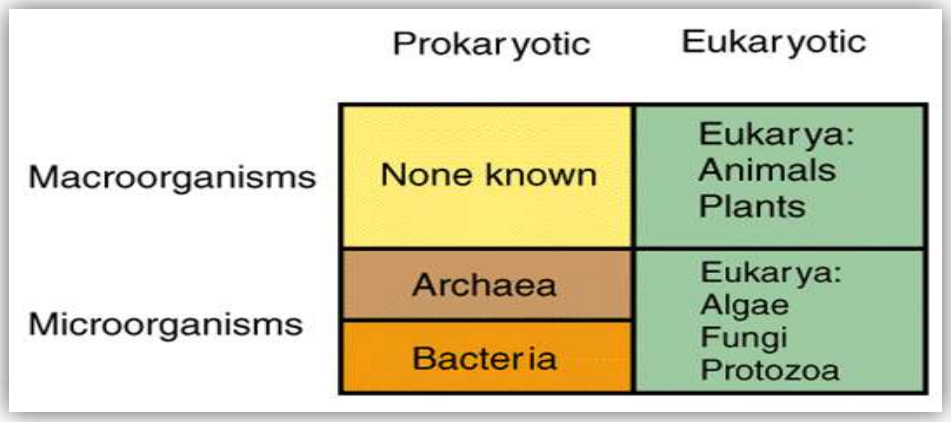


Fluid Mosaic Model (sandwich theory)

CELL TYPES:

Cell is the building and functional unit of living system

Prokaryotic and eukaryotic:



Comparison of Prokaryotic and Eukaryotic Cells

Cell component	Prokaryotes	Eukaryotes
• Size	Generally small (1–10 _m)	Generally large (5–100 _m)
• Nucleus	no membrane, single circular chromosome	Membrane bound, a number of individual chromosomes.
• Cell division	Fission or budding; no mitosis	Mitosis, including mitotic spindle; centrioles in many species
• Extra-chromosomal DNA	present in form of plasmid	Present as mitochondrial DNA
• Organelles in cytoplasm	Non	Mitochondria and chloroplast in photosynthetic organisms
• Cytoplasmic membrane	Contain enzyme of respiration, sit of phospholipids and DNA synthesis	Semi-permeable layer not possessing function
• Cell wall	Rigid layer of peptidoglycan	No peptidoglycan
• Sterols	Absent	Present
• Ribosome	70 S in cytoplasm	80 S in cytoplasmic reticulum

SHAPE AND SIZE OF CELLS:

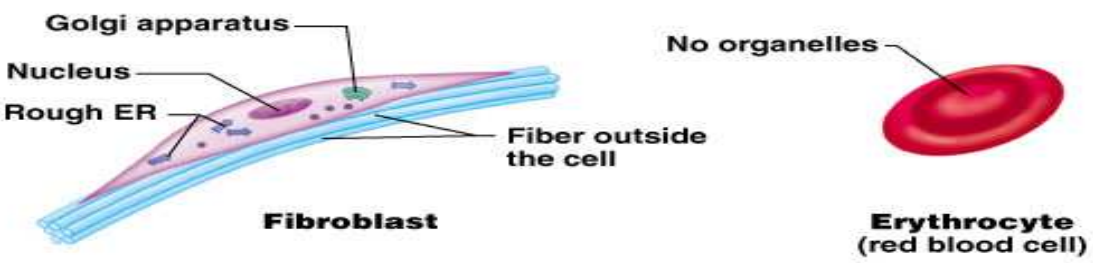
Living things are made up of units called cells

• **Unicellular**: description of an organism consisting of only a single cell

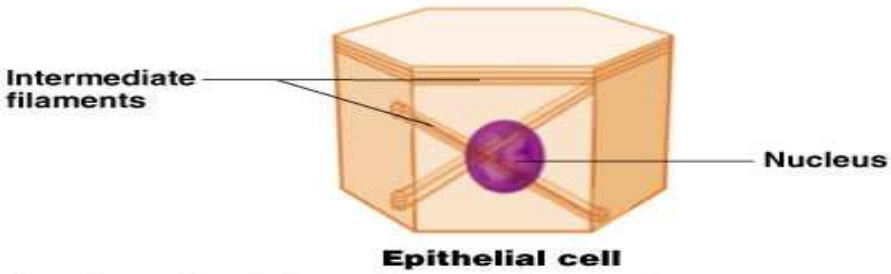
• **Multicellular:** description of an organism consisting of many cells, some of which are typically specialized for particular functions.

The shape and size of cells is genetically determined and is related to their location and function in the body.

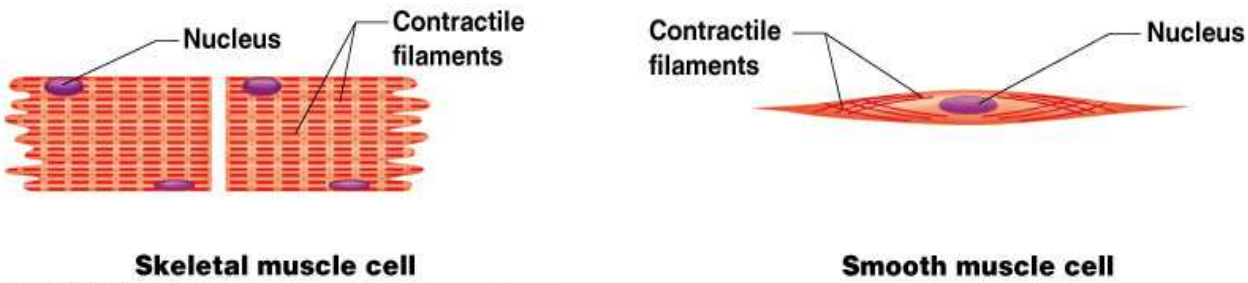
① Cells that connect body parts



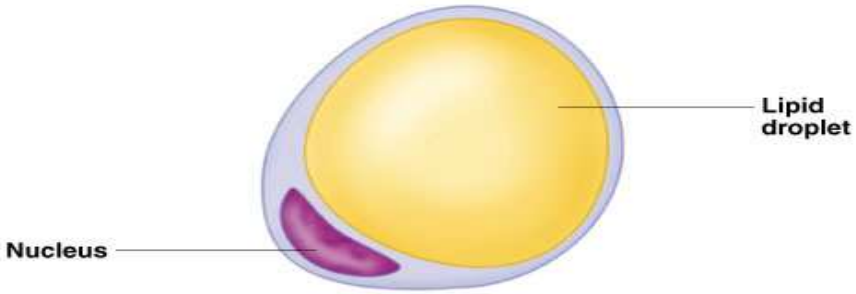
② Cells that cover and line body organs



③ Cells that move organs and body parts

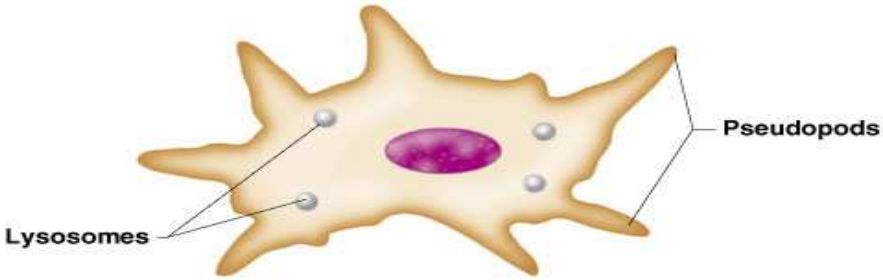


④ **Cell that stores nutrients**

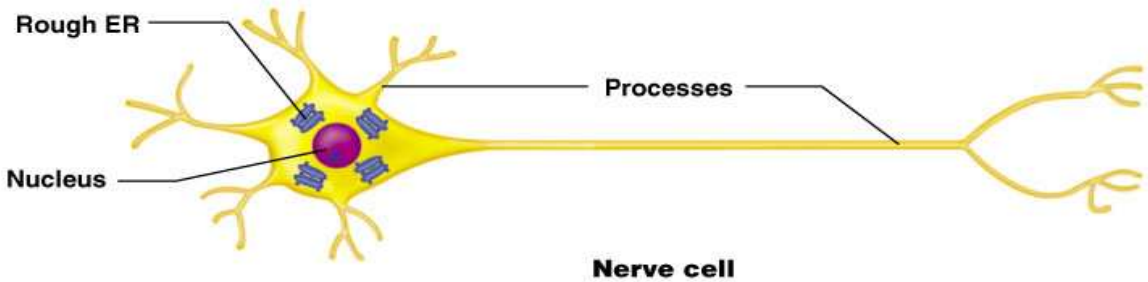


Fat cell

⑤ **Cell that fights disease**

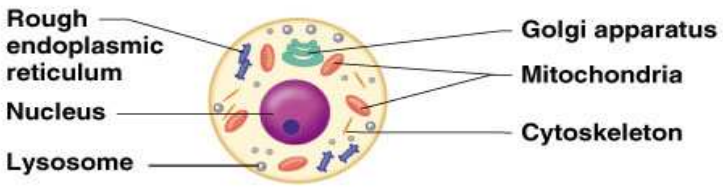


⑥ **Cell that gathers information and controls body functions**

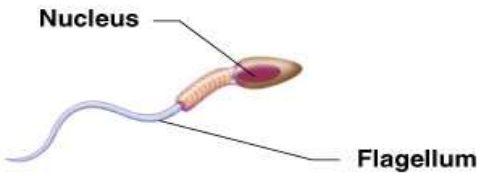


Nerve cell

⑦ **Cells of reproduction**



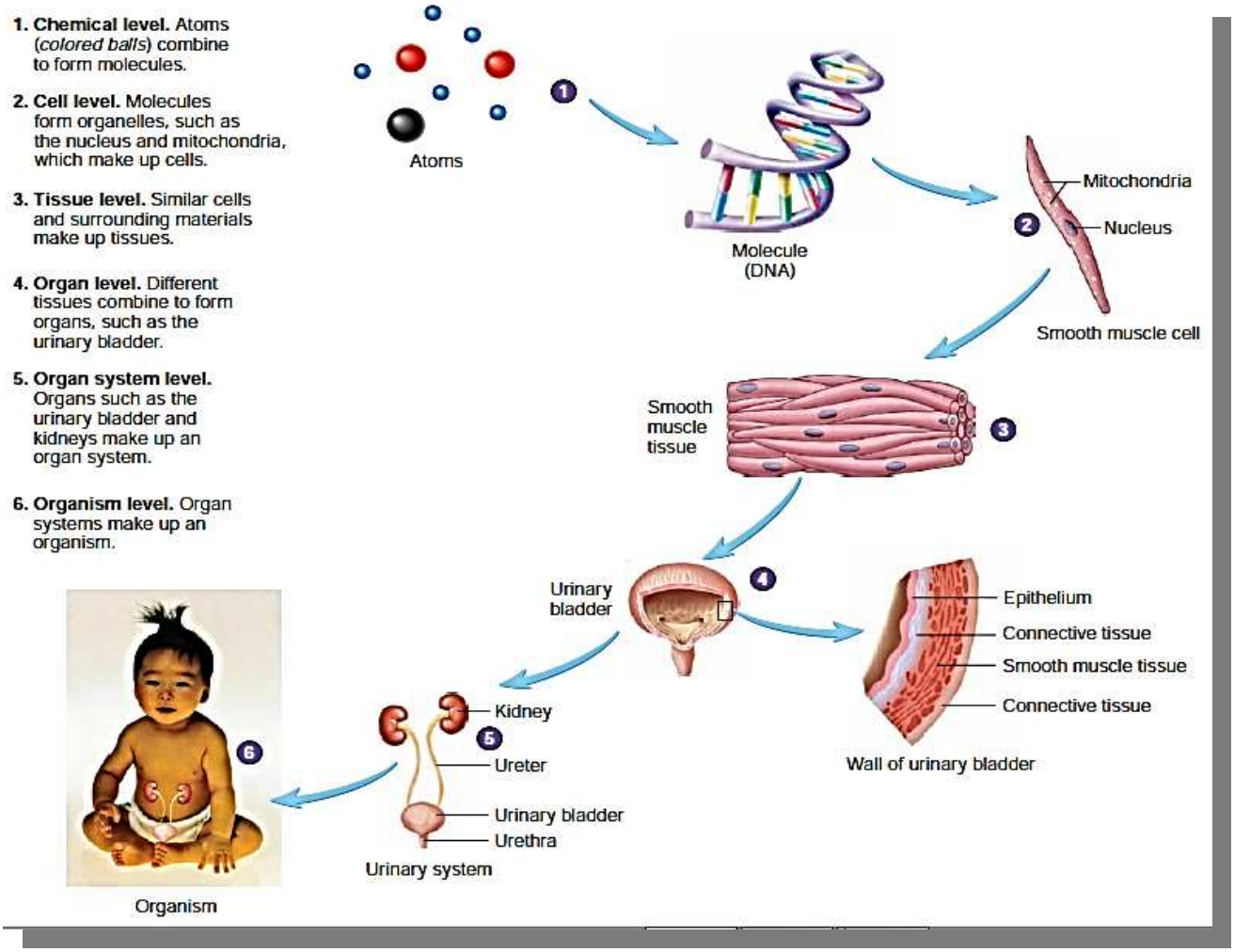
Ovum (egg)



Sperm

ORGANIZATION LEVEL AND MULTICELLULAR SYSTEM

Modem biology study life processes on different levels. These levels are called life organization levels. There is a list of them.



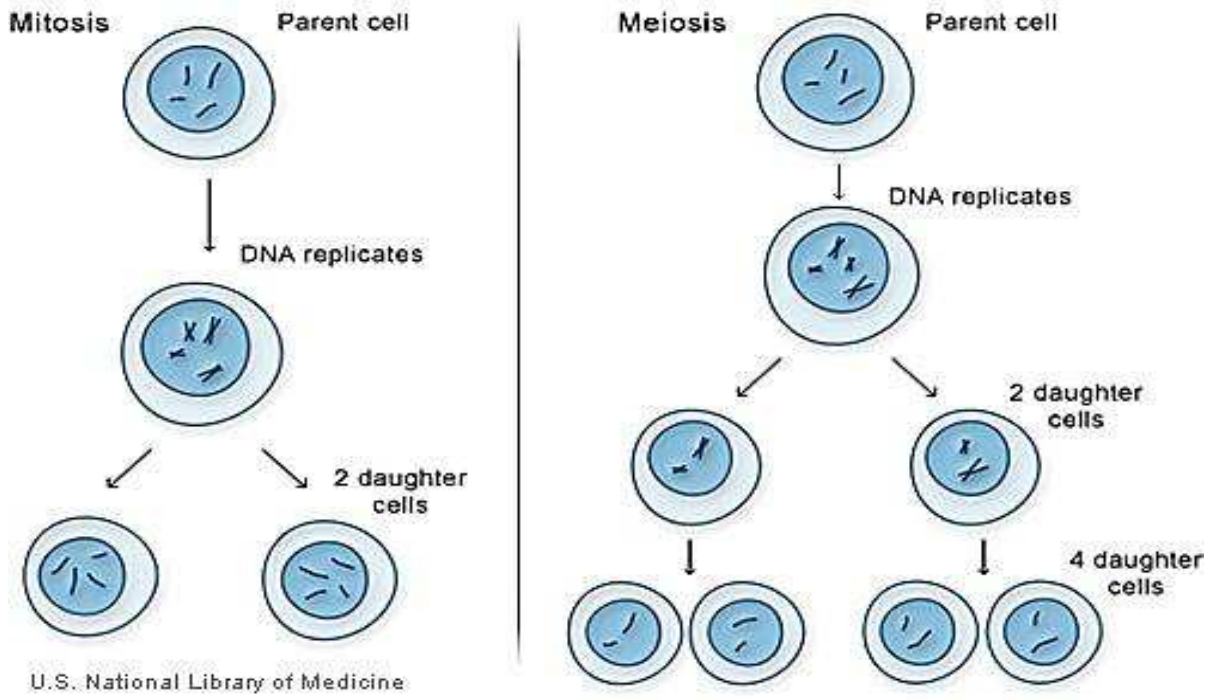
Tissue: is a biological organizational level between cells and a complete organ.

A tissue is an ensemble of similar cells and their extracellular matrix from the same origin that together carry out a specific function.

The functional grouping together of multiple tissues then forms organs. Animal tissues are grouped into four basic types: connective, muscle, nervous, and epithelial.

- **REPRODUCTION AND CELL DIVISION:**

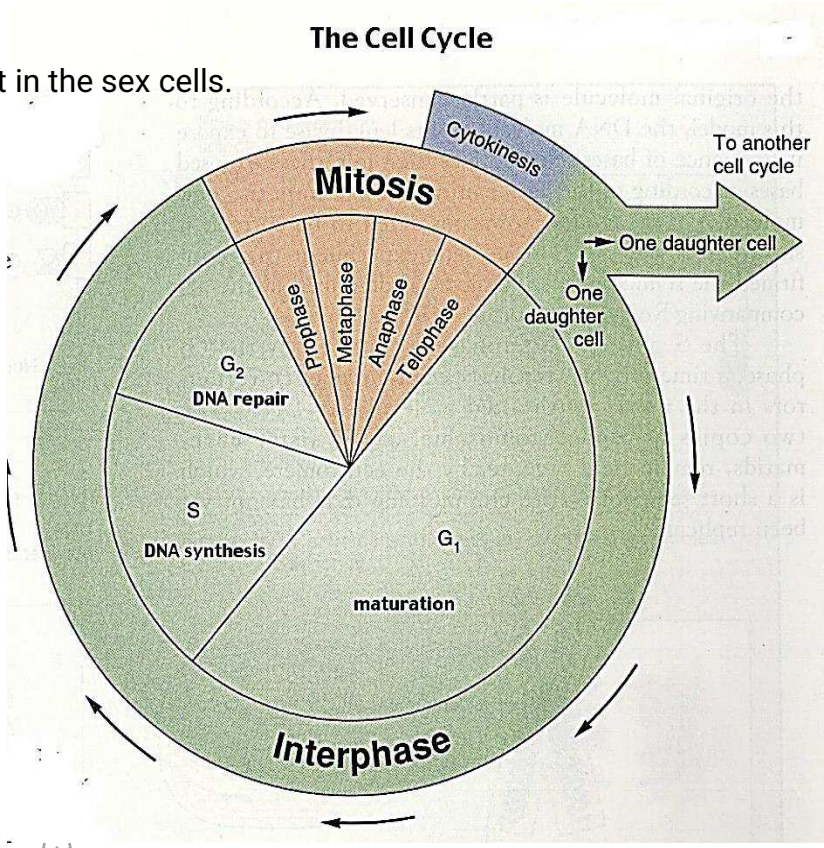
Mitosis, and Meiosis



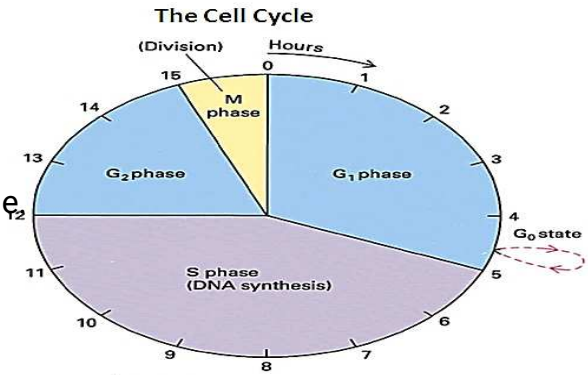
Mitosis (somatic cells (body cells))

* Is the form of cell division, which results in the formation of identical daughter cells, keeps the chromosome no. **constant**.
* Tissue growth and repair.
* Occurs throughout the body except in the sex cells.
* Consist of 6 stages
* The stages of the cell cycle can be broken down into six stages:

Interphase, Prophase, Metaphase, Anaphase, Telophase



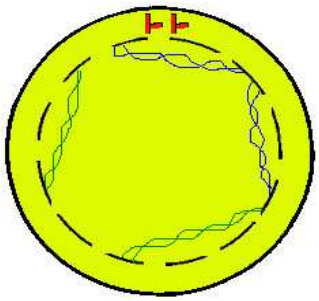
Interphase



- Is the "resting" or non-mitotic portion of the cell cycle.
- It is comprised of G1, S, and G2 stages of the cell cycle.
- DNA is replicated during the S phase of Interphase

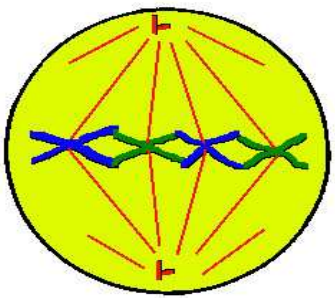
G1 - first gap
S - DNA synthesis (replication)
G2 - second gap
M - mitosis

Prophase - the first stage of mitosis.



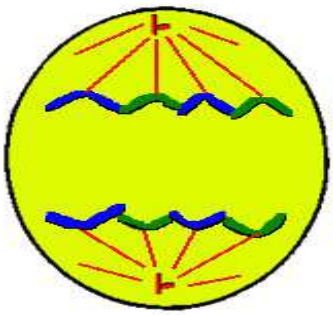
- The chromosomes condense and become visible
- The centrioles form and move toward opposite ends of the cell ("the poles")
- The nuclear membrane dissolves
- The mitotic spindle forms (from the centrioles in animal cells)
- Spindle fibers from each centriole attach to each sister chromatid at the kinetochore

Metaphase



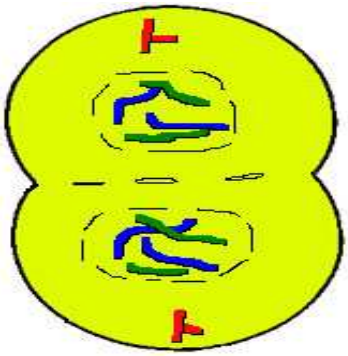
- The Centrioles complete their migration to the poles
- The chromosomes line up in the middle of the cell ("the equator")

Anaphase



- Spindles attached to kinetochores begin to shorten.
- This exerts a force on the sister chromatids that pulls them apart.
- Spindle fibers continue to shorten, pulling chromatids to opposite poles.
- This ensures that each daughter cell gets identical sets of chromosomes

Telophase



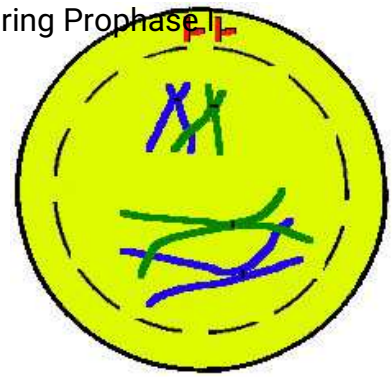
- The chromosomes decondense
- The nuclear envelope forms
- Cytokinesis reaches completion, creating two daughter cell

Meiosis

- Is the form of cell division which results reducing the chromosome number from the diploid no. (2n) to the **haploid** (1n).
- Occurs only in the sex cells, (sperm and ovum).
- Include the crossing over process
- The stages of meiosis can be broken down into two main stages, **Meiosis I** and **Meiosis II**
  - **Meiosis I** can be broken down into four substages: Prophase I, Metaphase I, Anaphase I and Telophase I
  - **Meiosis II** can be broken down into four substages: Prophase II, Metaphase II, Anaphase II and Telophase II

Meiosis I

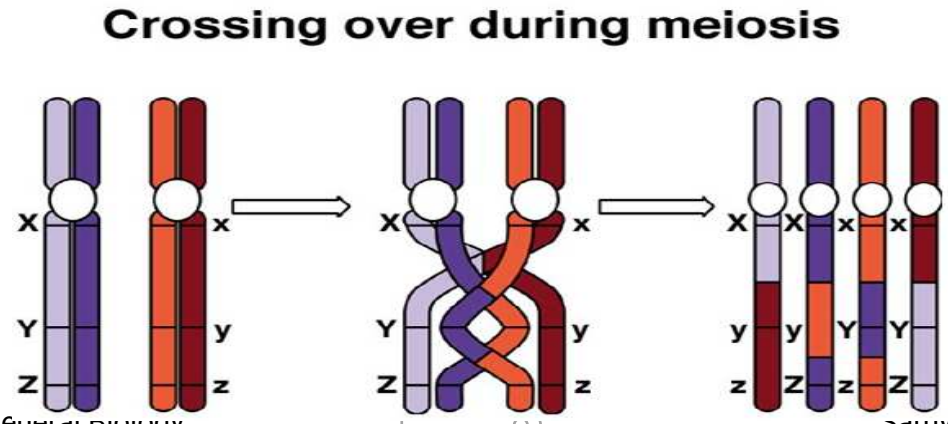
Prophase I - most of the significant processes of Meiosis occur during Prophase I.



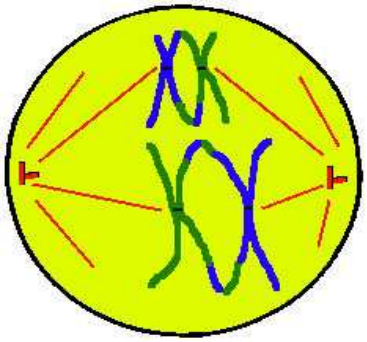
- The chromosomes condense and become visible
- The centrioles form and move toward the poles
- The nuclear membrane begins to dissolve
- The homologs pair up, forming a tetrad
  - Each tetrad is comprised of four chromotids
  - - the two homologs, each with their sister chromatid
- Homologous chromosomes will swap genetic material in a process known as **crossing over** (abbreviated as XO)
  - Crossing over serves to **increase genetic diversity** by creating four unique chromatids

Crossing Over

- Genetic material from the **homologous chromosomes** is randomly swapped
- This creates four unique chromatids
- Since each chromatid is unique, the overall genetic diversity of the gametes is greatly increased

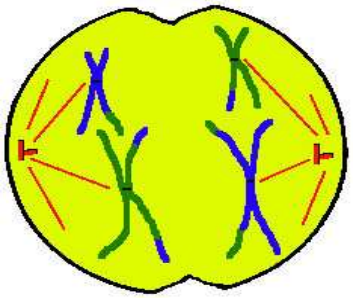


Metaphase I



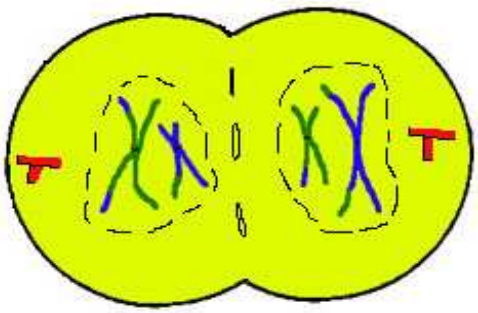
- Microtubules grow from the centrioles and attach to the centromeres
- The tetrads line up along the cell equator

Anaphase I



- The centromeres break and homologous chromosomes separate (note that the sister chromatids are still attached)
- Cytokinesis begins

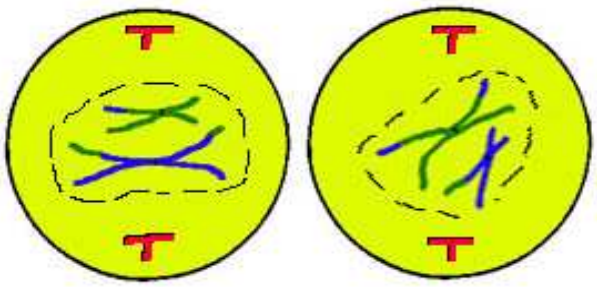
Telophase I



- The chromosomes may decondense (depends on species)
- Cytokinesis reaches completion, creating two haploid daughter cells

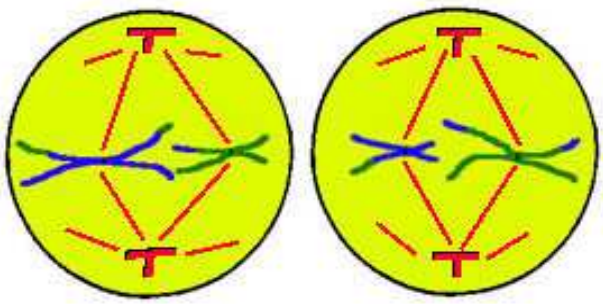
Meiosis II

Prophase II



- Centrioles form and move toward the poles
- The nuclear membrane dissolves

Metaphase II



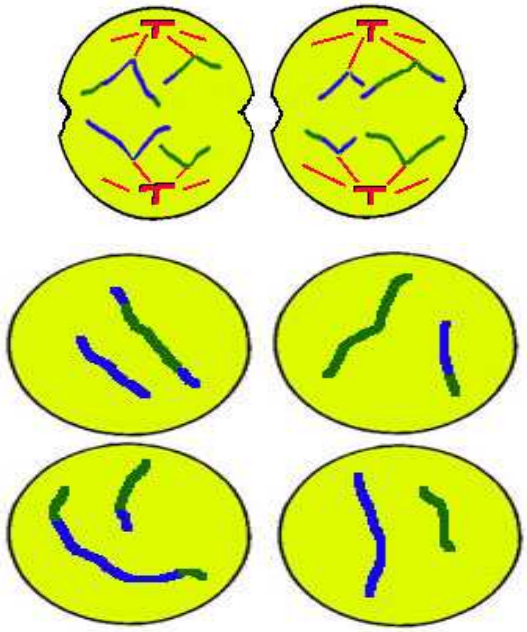
- Microtubules grow from the centrioles and attach to the centromeres
- The sister chromatids line up along the cell equator

Anaphase II

- The centromeres break and sister chromatids separate
- Cytokinesis begins

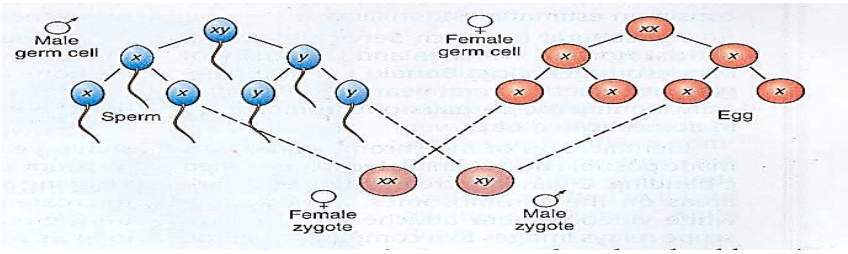
Telophase II

- The chromosomes may decondense (depends on species)
- Cytokinesis reaches completion, creating four haploid daughter cells



- **Determining biological sex in offspring**

Child's biological sex (male or female) is determined by the chromosome that the male parent contributes. Males have XY sex chromosomes while females have XX sex chromosomes; the male can contribute the X or Y chromosome, while the female must contribute one of their X chromosomes. A male infant results if the male contributes his Y chromosome while a female infant results if he contributes his X chromosome.



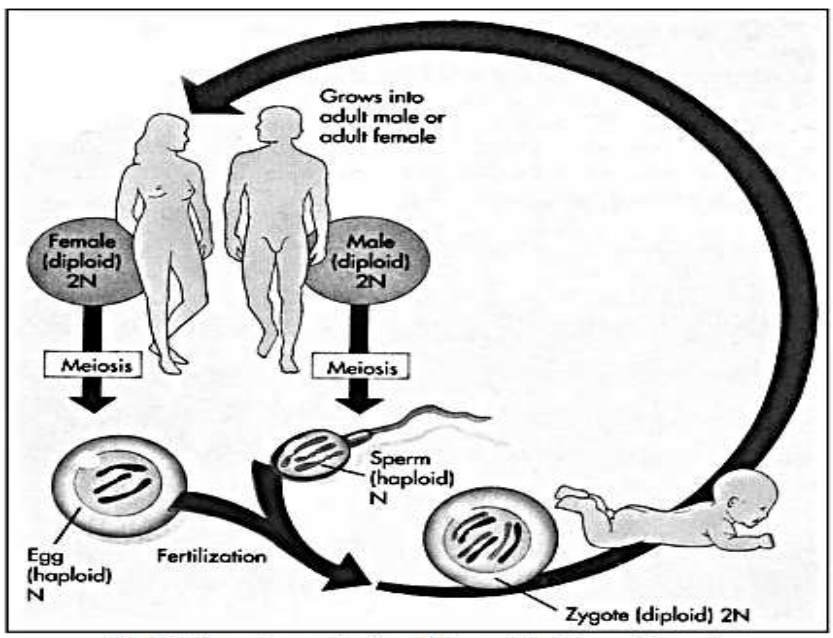


Fig. 4.1. Sexual reproduction of human (by Raven & Jones).

CHAPTER – 3: FUNDAMENTAL OF CHEMISTRY OF LIFE

Organic molecules:

Biological Macromolecules:

A **macromolecule** is a very large molecule commonly created by polymerization of smaller subunits. In biochemistry, the term is applied to the four conventional biopolymers (nucleic acids, proteins, carbohydrates, and lipids)

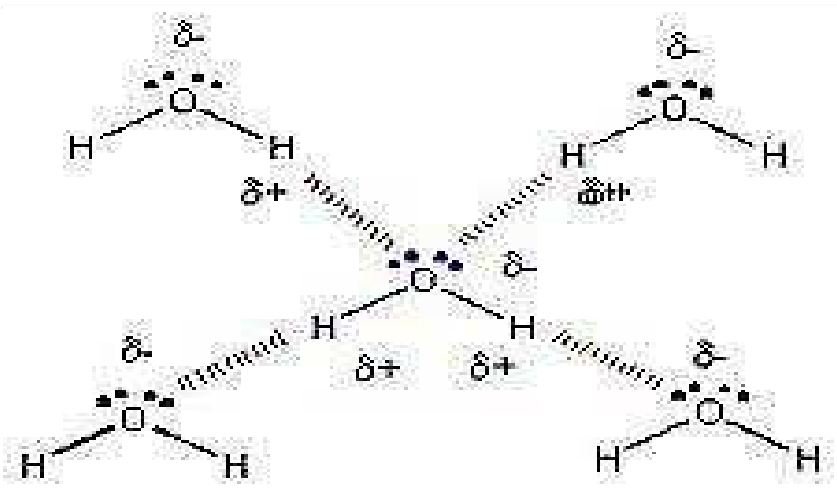
Molecular Components of an *E. coli* Cell

	Percentage of total weight of cell	Approximate number of different molecular species
Water	70	1
Proteins	15	3,000
Nucleic acids		
DNA	1	1
RNA	6	>3,000
Polysaccharides	3	5
Lipids	2	20
Monomeric subunits and intermediates	2	500
Inorganic ions	1	20

Water

Unique properties of water:

- Water is the most abundant substance in living systems making up 70% or more of the weight of most organisms.
- Water is used in most reactions in the body.
- Water is called the universal solvent.
- Hydrogen bonds between water molecules provide the cohesive forces that make water a liquid at room temperature.

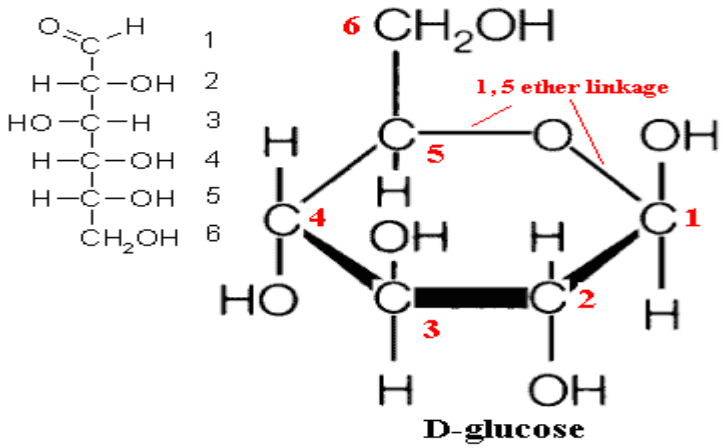


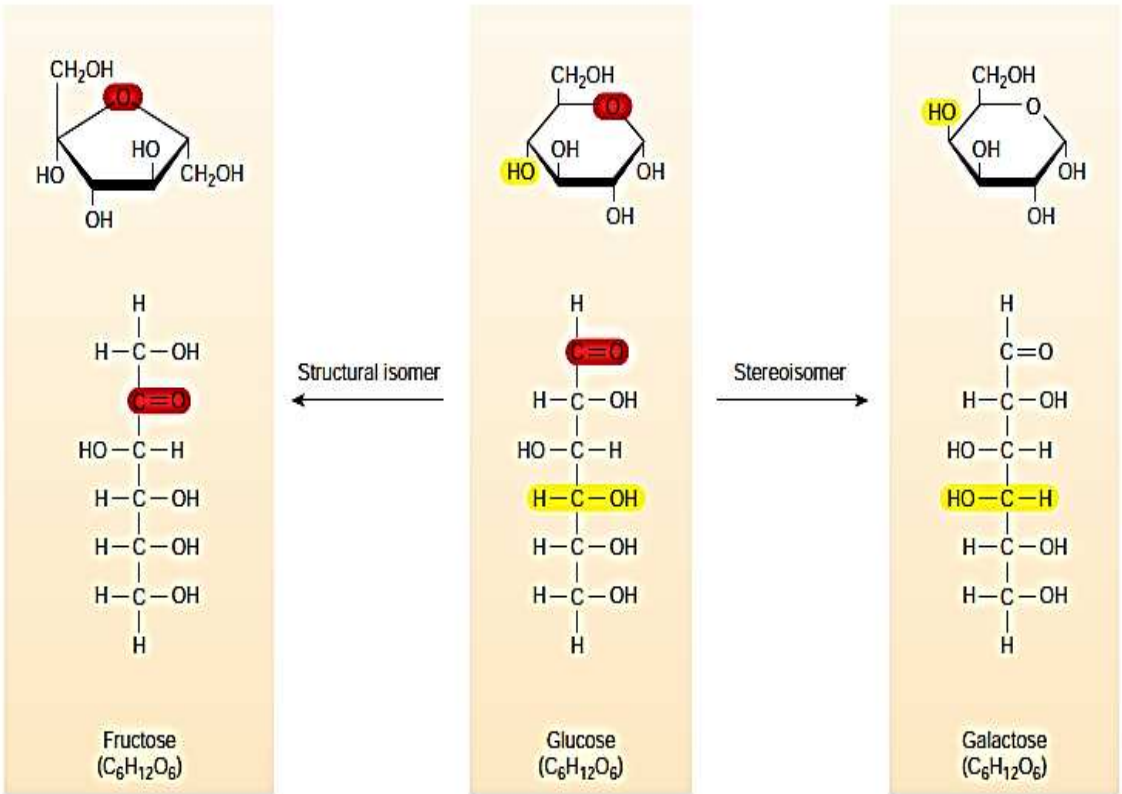
1- Carbohydrates

A **carbohydrate** is an organic compound that consists only of carbon, hydrogen, and oxygen, usually with a hydrogen: oxygen atom ratio of 2:1 (as in water); in other words, with the empirical formula $C_m(H_2O)_n$. The carbohydrates (saccharides) are divided into four chemical groupings: monosaccharaides, disaccharides, oligosaccharides, and polysaccharides.

- **Monosaccharaides**

The simplest type of carbohydrate. Found in grapes and other fruits and also in honey, they can be broken down chemically into their constituent elements.

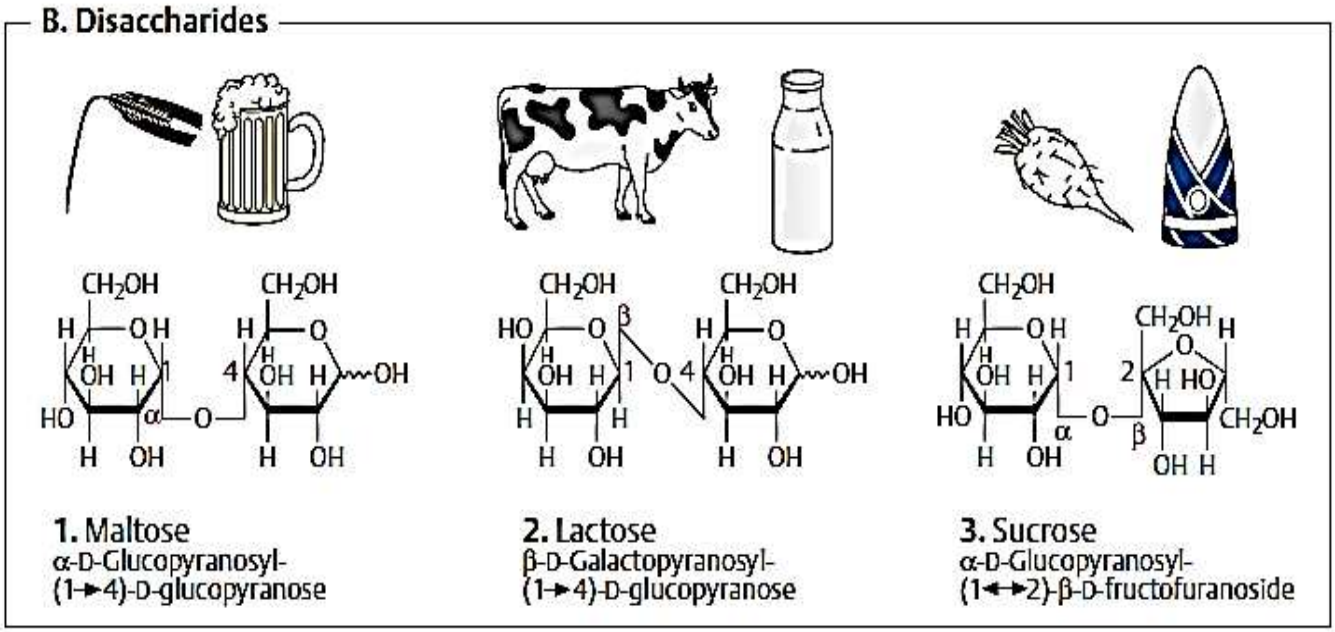




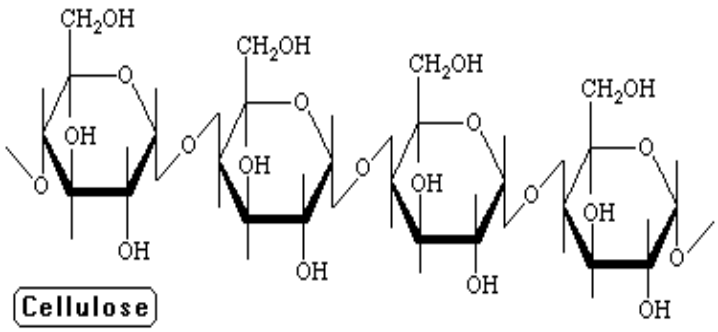
- **Disaccharides**

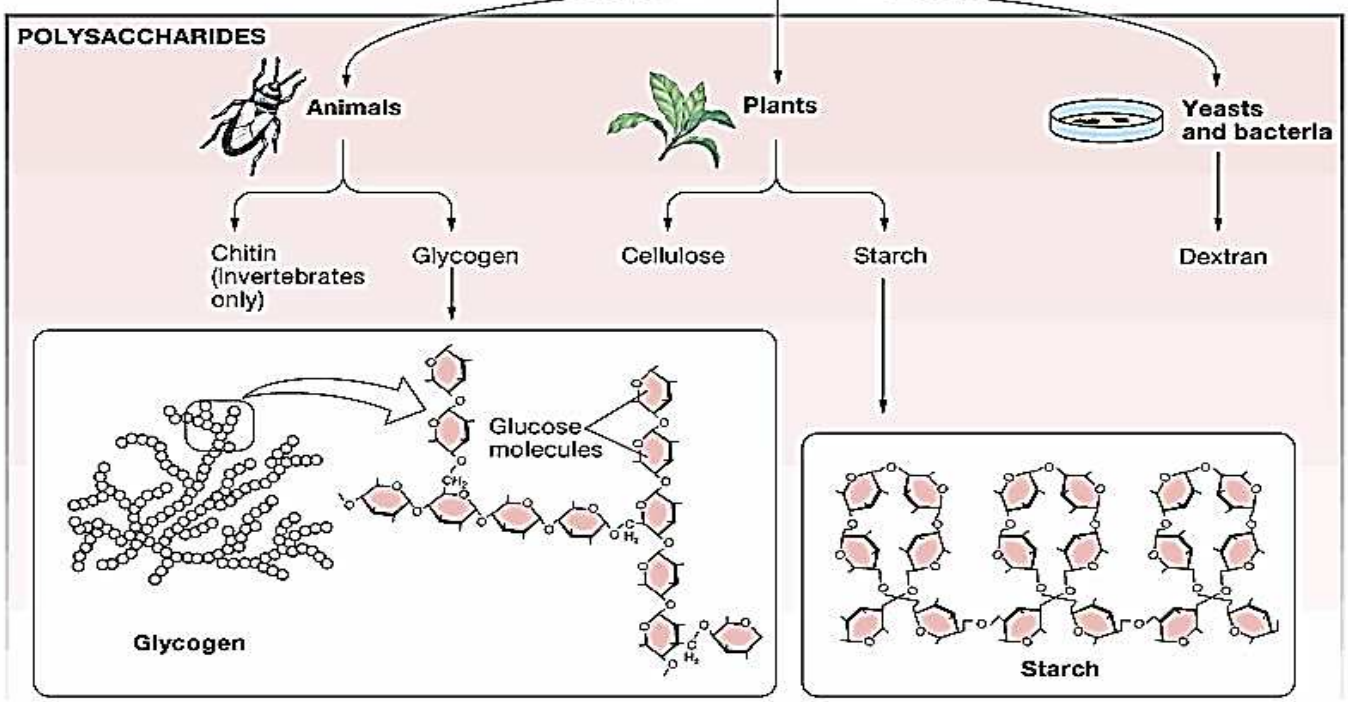
Disaccharides, or double sugars, are composed of two monosaccharaides.

The most well-known examples of a disaccharide are:



- **Polysaccharides**: is a carbohydrate composed of many monosaccharaides.



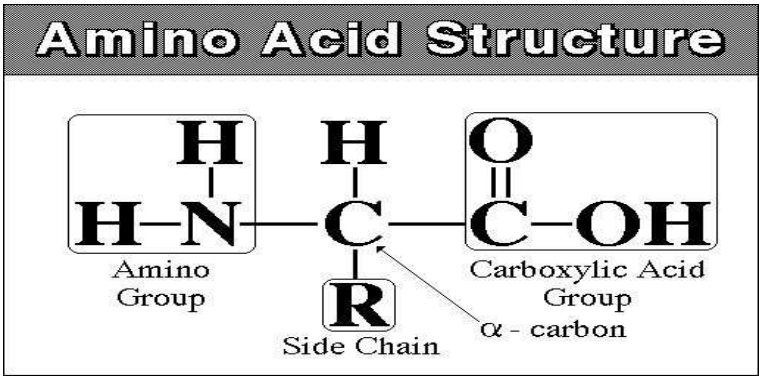


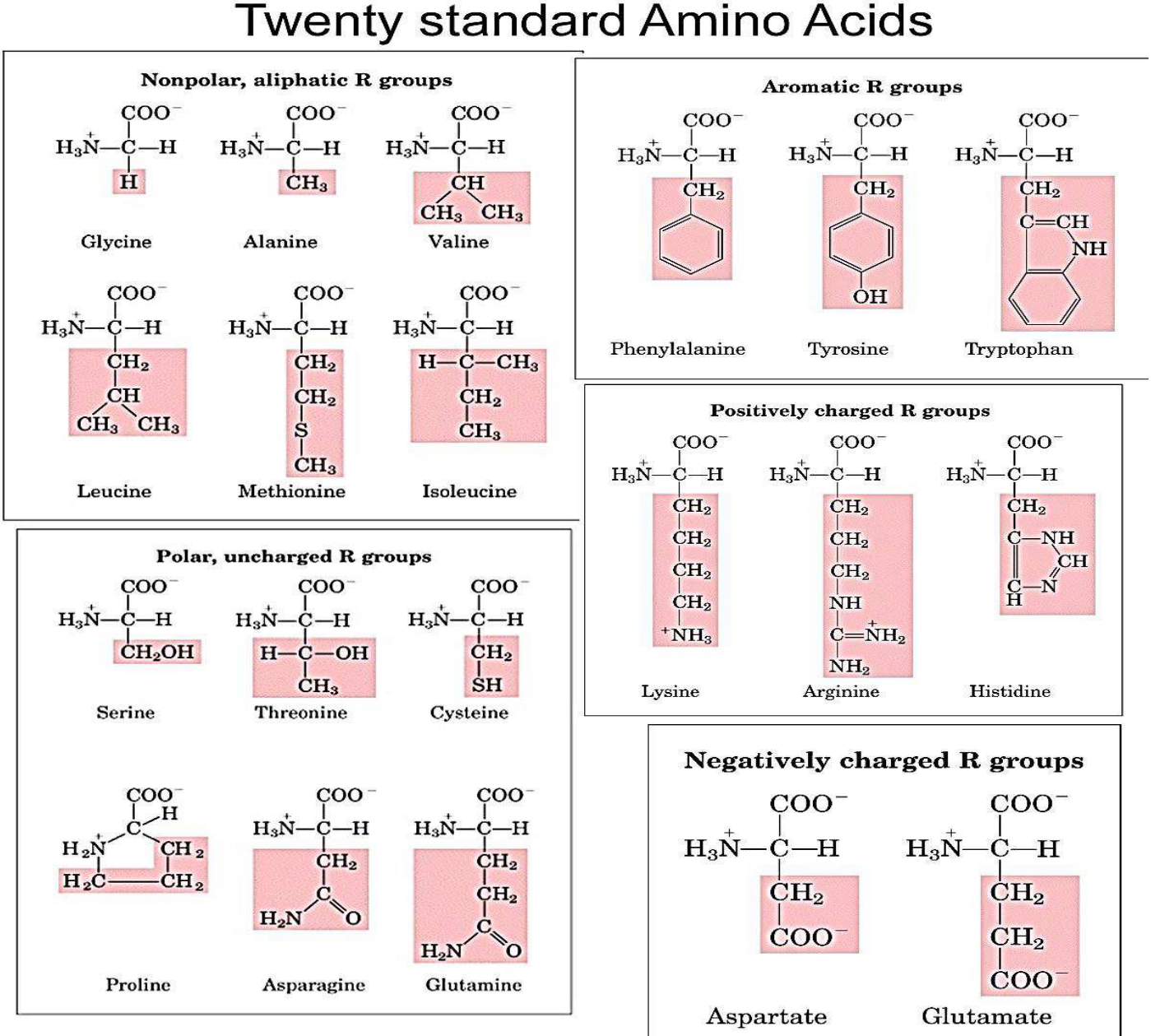
* Notice that the only difference between glucose and galactose is the spatial arrangement of the hydroxyl groups.

2- Protein

Proteins are polymers of amino acids, each protein polymer – also known as a polypeptide consists of a sequence formed from 20 possible amino acids. Each of these amino acids has a fundamental design composed of a central carbon (also called the alpha carbon) bonded to:

- a hydrogen
- a carboxyl group
- an amino group
- a unique side chain or R-group





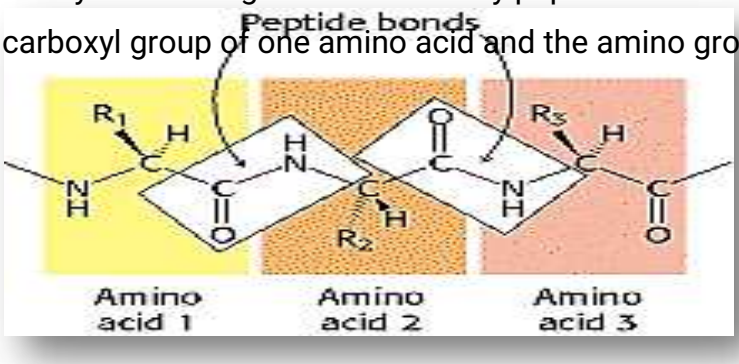
- **Essential Amino Acids:** is an amino acid that cannot be synthesized de novo by humans, and therefore must be supplied in the diet "CAN NOT" be produced by the body. Nonessential amino acids need not be taken in through diet as they can be produced by the body.

  - Example: Phenylketonuria (PKU) is an inborn error of protein metabolism that results from an impaired ability to metabolize the essential amino acid phenylalanine.

Essential	Nonessential
Isoleucine	Alanine
Leucine	Arginine*
Lysine	Aspartate
Methionine	Cysteine*
Phenylalanine	Glutamate
Threonine	Glutamine*
Tryptophan	Glycine*
Valine	Proline*
Histidine	Serine*
Tyrosine*	Asparagine*

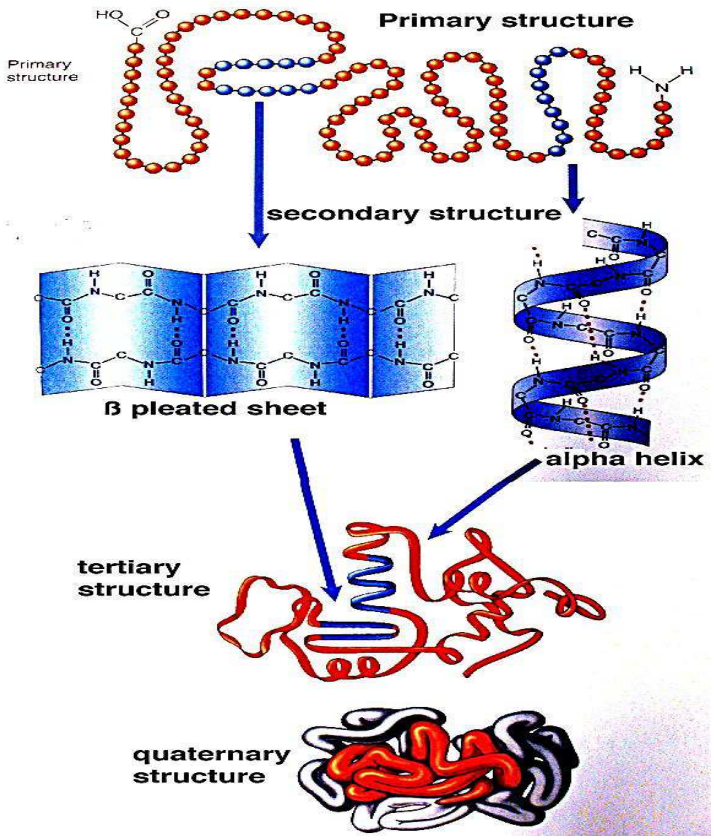
- <u>The peptide ponds</u>

Amino acids are covalently bonded together in chains by peptide bonds. Peptide bonds are formed between the carboxyl group of one amino acid and the amino group of the next amino acid.



❖ **Protein structure:**

1. **Primary Structure:** Proteins are polymers of amino acids.
2. **Secondary Structure:** Segments os polypeptides sequances often fold locally into stable structures that include a-helices and b-pleated sheets.
3. **Tertiary structure**: refers to the complete three dimensional folding of a protein.
4. **Quaternary structure**: many subunits.



- **Fibrous and globular proteins**

Fibrous proteins, having polypeptide chains arranged in long <u>strands</u> or sheets, and

globular proteins, having polypeptide chains folded into a spherical or globular shape.

3- Lipids

Biological lipids are a chemically diverse group of compounds, the common and defining feature of which is their insolubility in water.

The biological functions of the lipids are as diverse as their chemistry.

Fats and oils are the principal stored forms of energy in many organisms (fatty acids, triglyceride).

Phospholipids and sterols are major structural elements of biological membranes.

- **Simple lipid:**

- Lipids (Fats):

- **Fatty acids** consist of a long chain of carbons with a carboxyl group at one end.

Fatty acids are carboxylic acids with hydrocarbon chains ranging from 4C to 36C carbons long.

In some fatty acids, this chain is unbranched and fully saturated (contains no double bonds); in others the chain contains one or more double bonds.

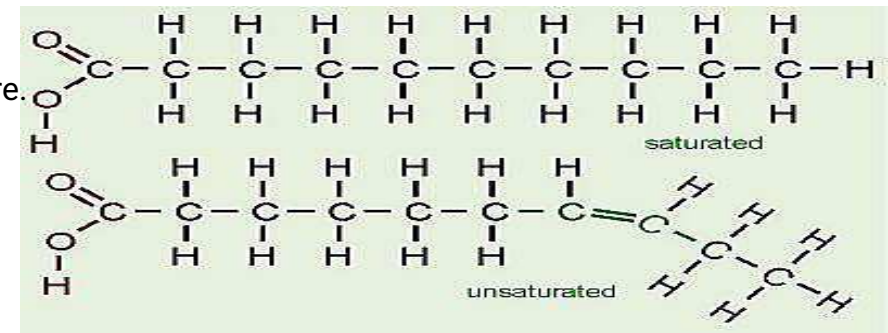
Unsaturated

- Contains double bond or more.

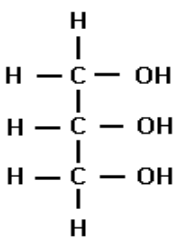
Mainly from plant source.

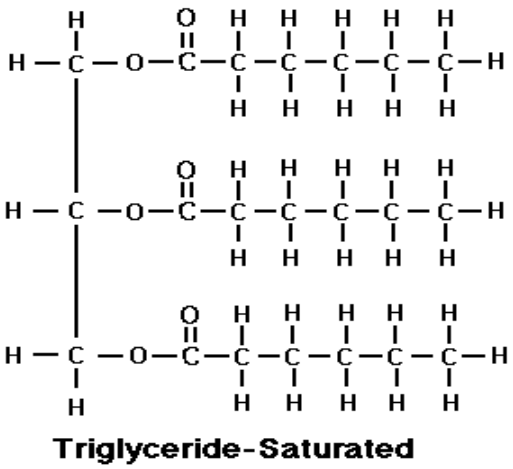
Mainly oily form at RT.

Sometime branched.



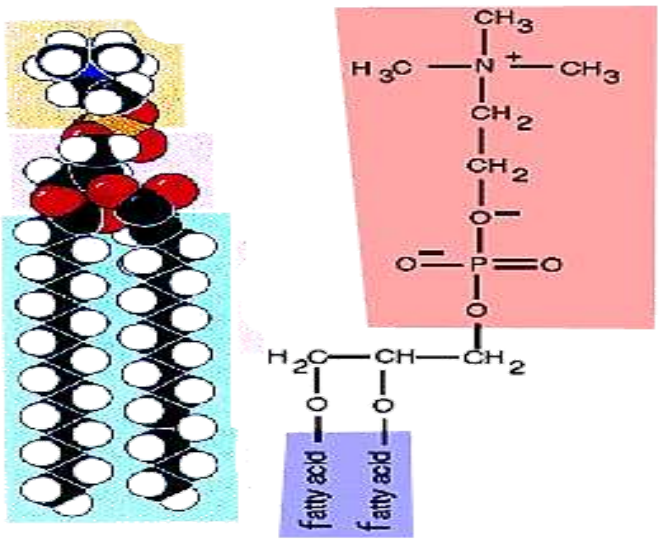
Fats (TG) are composed of three fatty acids and glycerol. These triglycerides can be solid or liquid at room temperature. Those that are solid are classified as fats, while those that are liquid are known as oils.


Glycerol


Triglyceride-Saturated

- **Compound lipid:**

- Lipids: Phospholipids

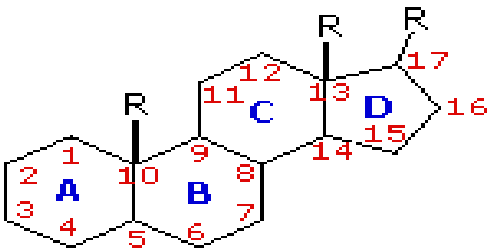


A phospholipids are composed of two fatty acids, a glycerol unit, a phosphate group and a polar molecule. The phosphate group and polar head region of the molecule is hydrophillic (attracted to water), while the fatty acid tail is hydrophobic (repelled by water).

- **Derived lipid:**

- Steroids

Steroids include the dietary fat cholesterol, the sex hormones estradiol and testosterone, and the anti-inflammatory drug dexamethasone. **Steroid** is a type of organic compound that contains a characteristic arrangement of four rings that are joined to each other.



The Steroid Carbon Skeleton

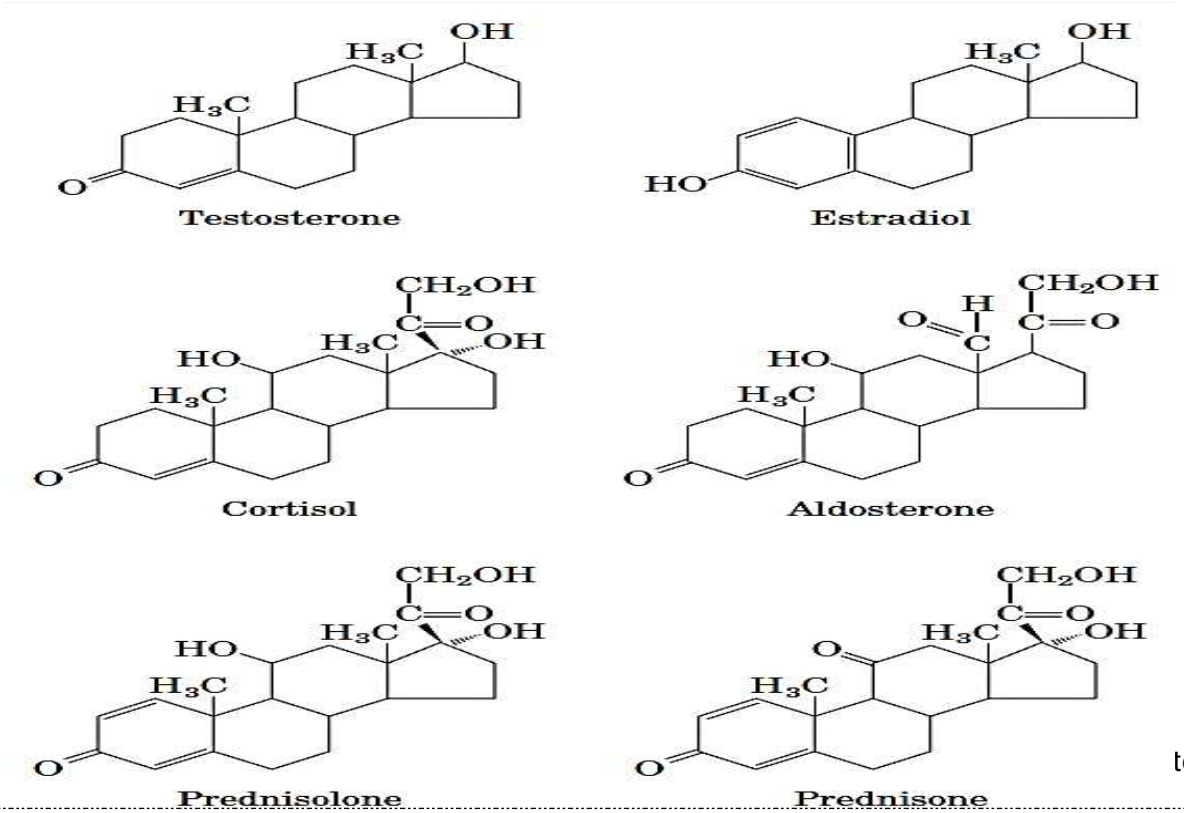


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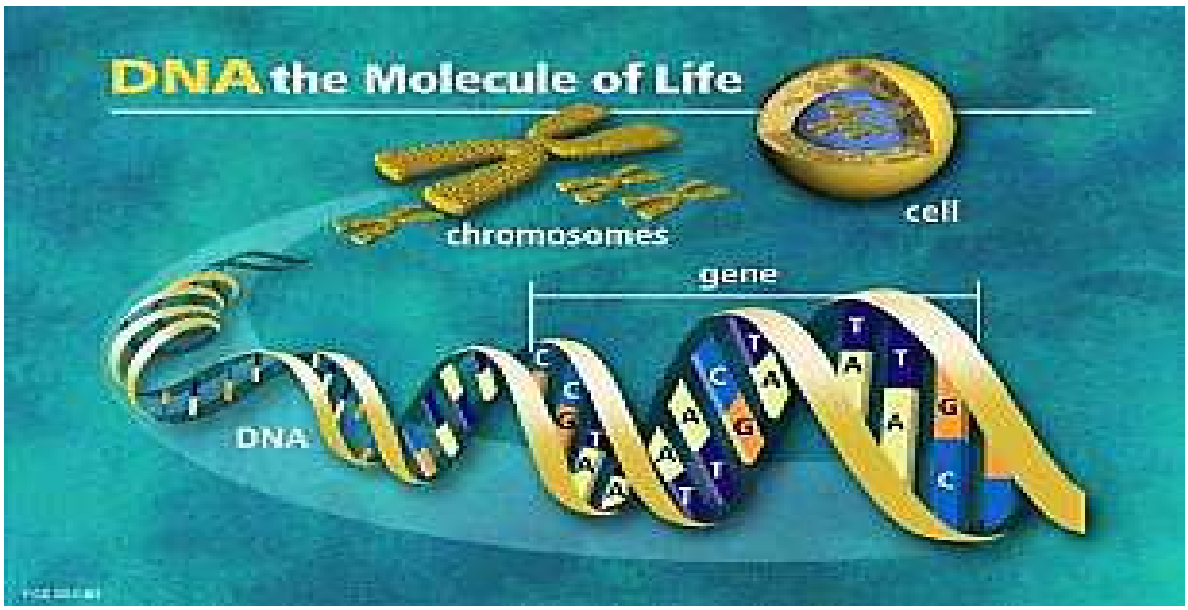
FIGURE 10–19 Steroids derived from cholesterol. Testos-

4- Nucleic acid

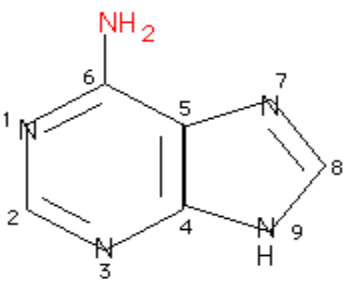


Nucleic acid includes DNA (deoxyribonucleic acid) and RNA (ribonucleic acid). Together with proteins, Nucleic acids are linear polymers (chains) of nucleotides. Each nucleotide consists of three components: a nitrogenous *base* , a Ribose sugar, and a phosphate group.

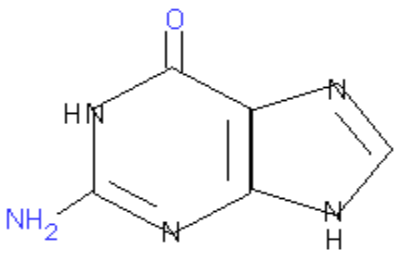
Nitrogen Bases

There are two kinds of nitrogen-containing bases (purines and pyrimidines).

Purines

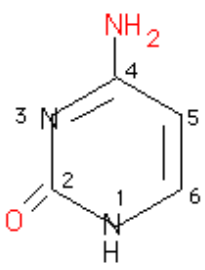


Adenine

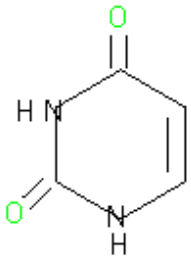


Guanine

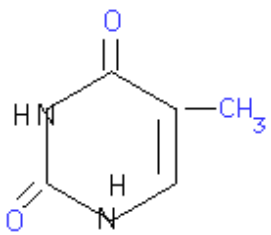
Pyrimidines



Cytosine



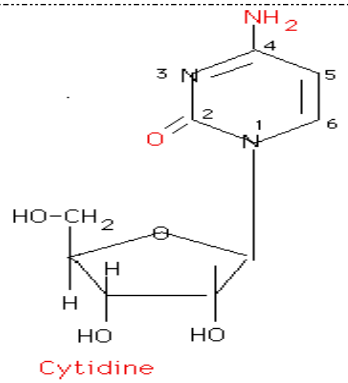
Uracil



Thymine

Nucleosides

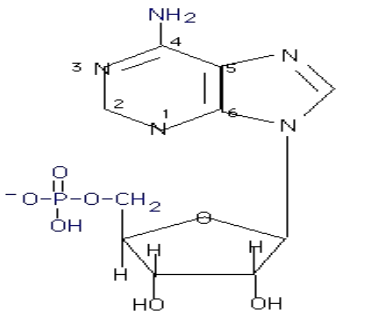
If a sugar is added to a nitrogen base, the resulting compound is called a **nucleoside**.



Cytidine

Nucleotides

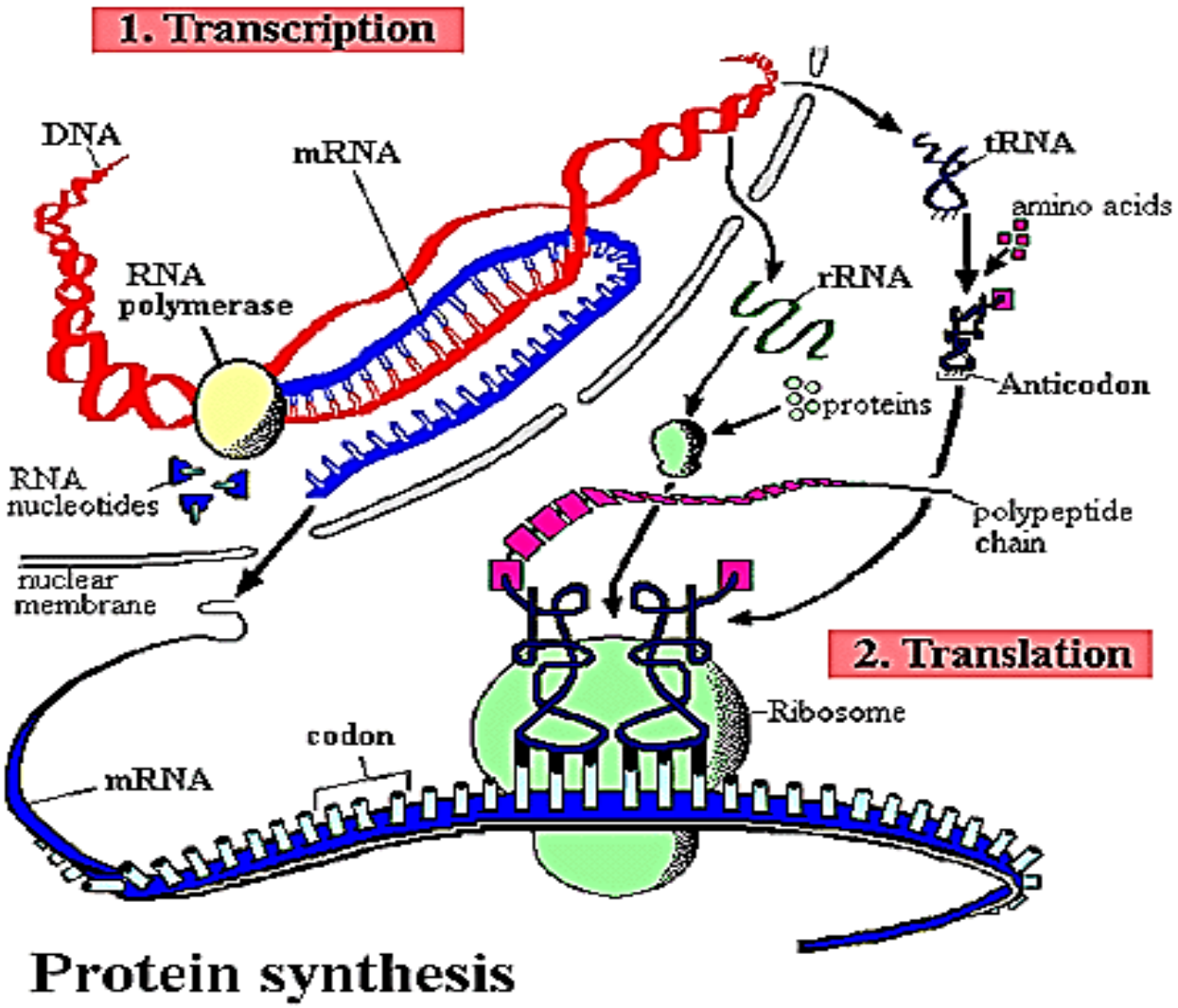
Adding one or more phosphates to the sugar portion of a nucleoside results in a **nucleotide**.



Adenosine Monophosphate
AMP

Protein Synthesis

The two big steps are called transcription and translation.



Protein synthesis

A- Transcription

Transcription is the synthesis of RNA from DNA.

Major RNAs:

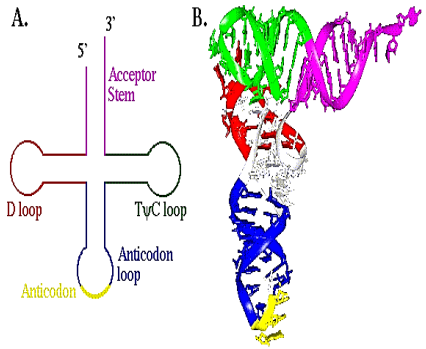
There are three major classes of RNA in the cell:

1- mRNA

Messenger RNA carries the genetic information that will be expressed ultimately as proteins.

2- tRNA

Transfer RNA is bonded to the appropriate amino acid.



tRNA

3- rRNA

Ribosomal RNA is found in the ribosomes.

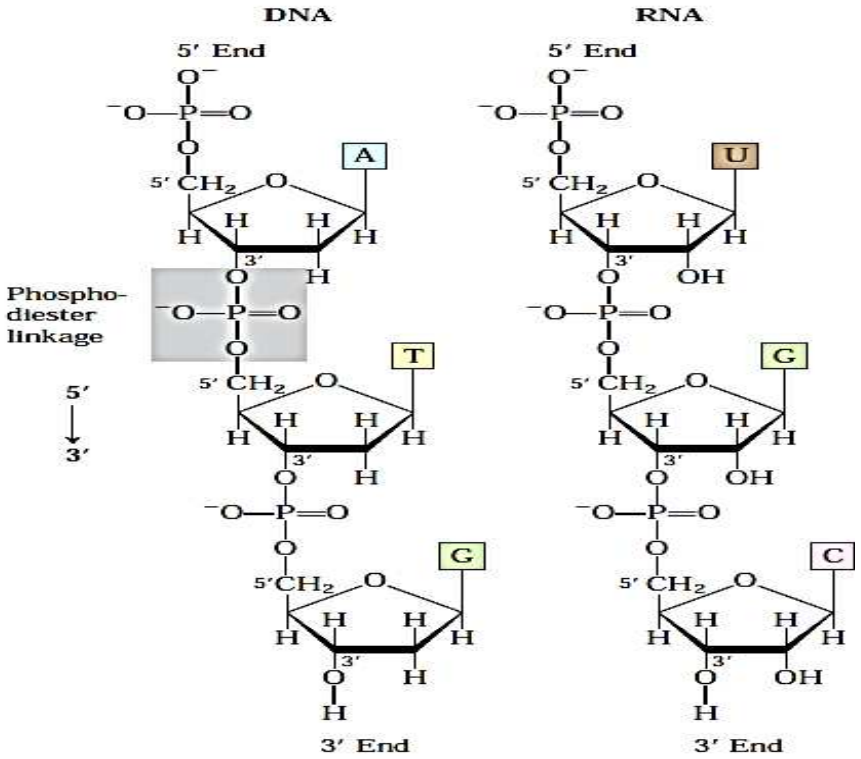
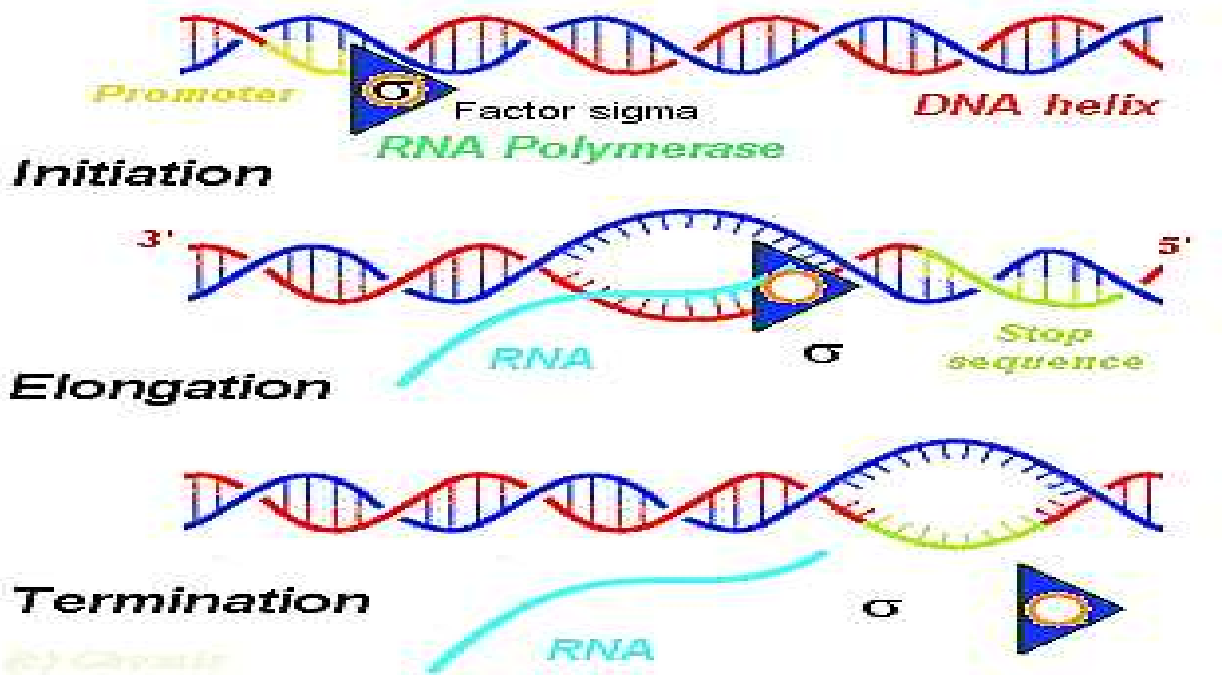


FIGURE 8–7 Phosphodiester linkages in the covalent backbone of

DNA	RNA
Double helix (2 strands)	Single strand
Sugar = deoxyribose	Sugar = ribose
Bases A T C G	Bases A U C G
Found in: • Chromosomes (DNA) • Mitochondria (mDNA) • Chloroplasts (cDNA) • Plasmids of prokaryotes	Found as: • Transfer RNA (tRNA) • Messenger RNA (mRNA) • Ribosomal RNA (rRNA) • The genetic material of some viruses

Transcription has three main events:

1- **Initiation:** Binding of RNA polymerase to double-stranded DNA, RNA polymerase binds at a sequence of DNA called the promoter.
2- **Elongation:** The covalent addition of nucleotides; this involves the development of a short stretch of DNA.
3- **Termination:** Involves the recognition of the transcription termination sequence and the release of RNA polymerase.



- **Post-transcription modification of RNA**

The newly synthesized molecule of RNA is called the primary transcript, and must be modified.

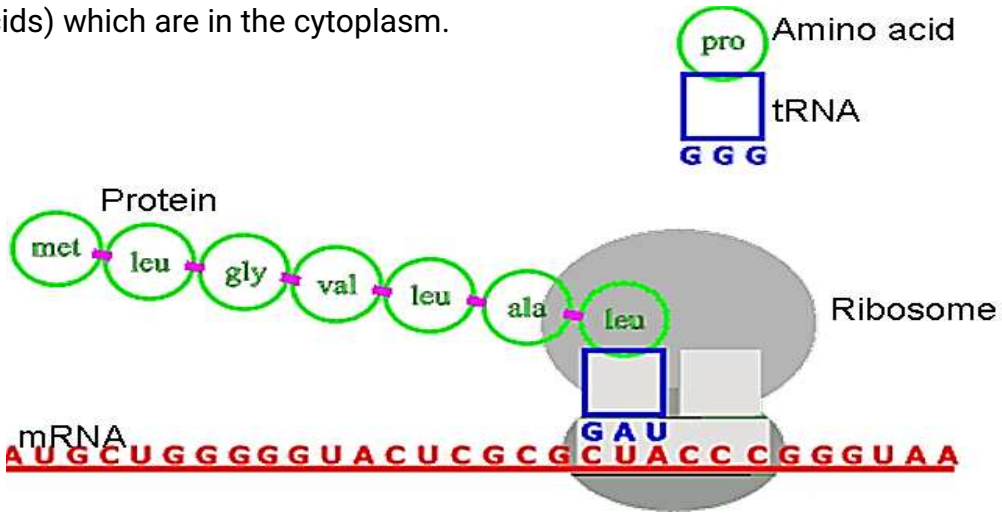
- The first step is the binding of a 7-methylguanosine on to the 5´ beginning of the hnRNA chain, the so called **cap** is formed.

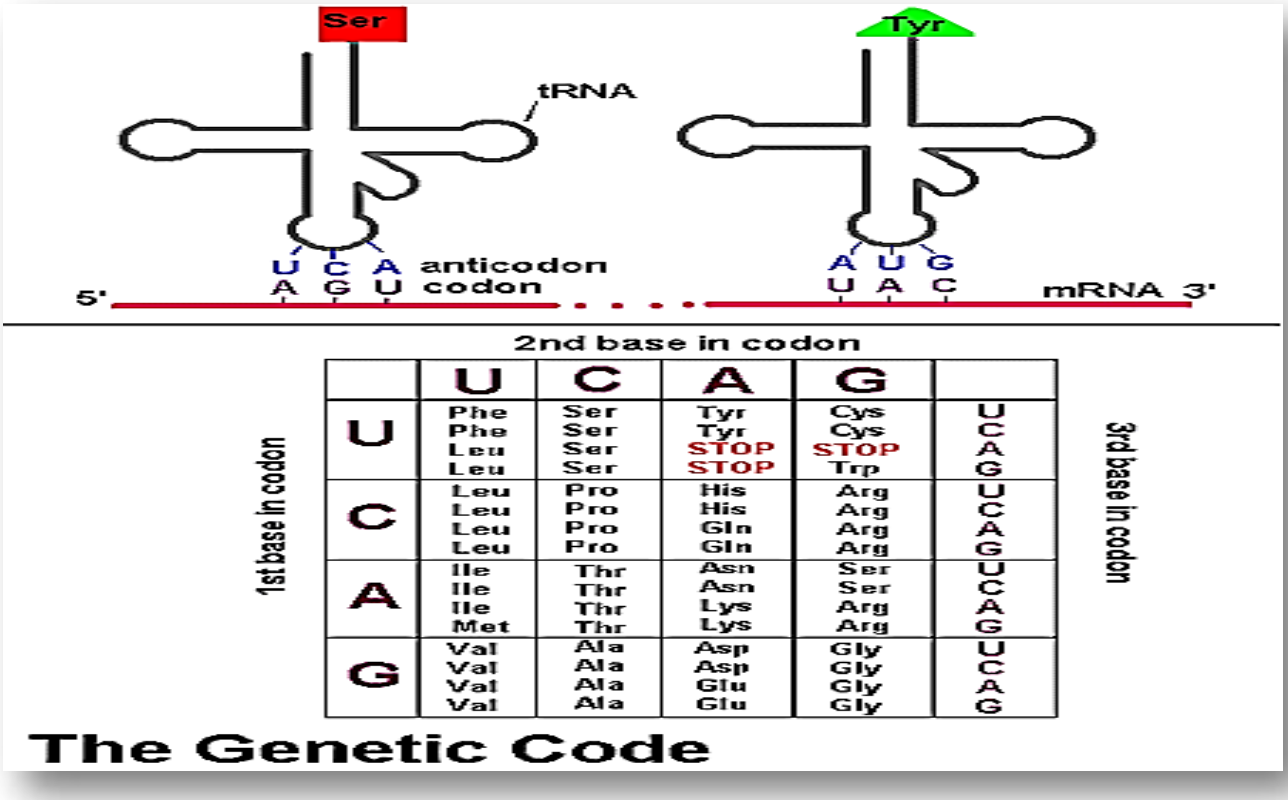
- The second step, in eukaryotic cells, splicing is catalyzed by large enzyme complexes (spliceosomes). They are able (in collaboration with small RNAs) to recognize an intron, cut it out, and connect together the coding sequences – exons.

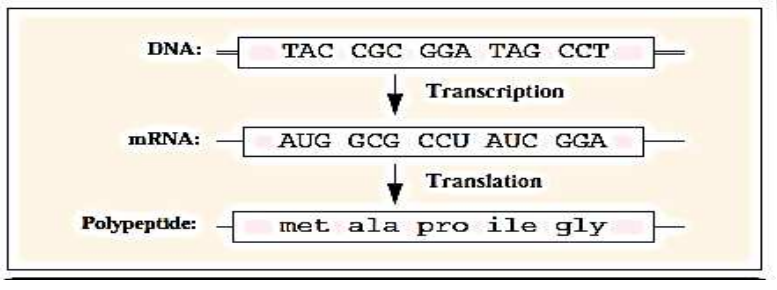
- The third step is the formation of **a polyA** tail on the 3´ end of the mRNA. It is a sequence made up of 100 to 250 remnants of adenine.

B - Translation

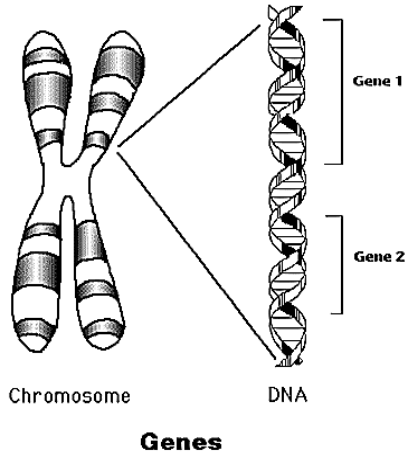
After the transcription process, messenger RNA then passes out of the nucleus and travels to small structures called ribosomes in the cytoplasm. Here the message it contains is interpreted, and a protein is built up, bit by bit, from its individual subunits (amino acids) which are in the cytoplasm.







Genetic and mutations



Genetic Information:

- Gene – basic unit of genetic information. Genes determine the inherited characters.
- Genome – the collection of genetic information.
- Chromosomes – storage units of genes.
- DNA - is a nucleic acid that contains the genetic instructions specifying the biological development of all cellular forms of life.
    - **Locus** – location of a *gene/marker* on the chromosome.
    - **Allele** – one variant form of a gene/marker at a particular *locus*.
- Most human cells contain 46 chromosomes:
    - 2 **sex chromosomes** (X,Y): XY – in males, and XX – in females.
    - 22 pairs of chromosomes named **autosomes**.
    - ***Phenotype*** **-** the physical description of the character in an individual organism, i.e a green eyes
    - ***Genotype*** **-** the genetic constitution of the organism
    - ***Polymorphism*** - a change in the genetic material, usually common and not pathological.

Importance of Genetics to Medicine (Mutation and Cancers):

A mutation is a change in the DNA sequence of an organism. Mutations can result from errors in DNA replication during cell division, exposure to mutagens or a viral infection. Germline mutations (that occur in eggs and sperm) can be passed on to offspring, while somatic mutations (that occur in body cells) are not passed on.

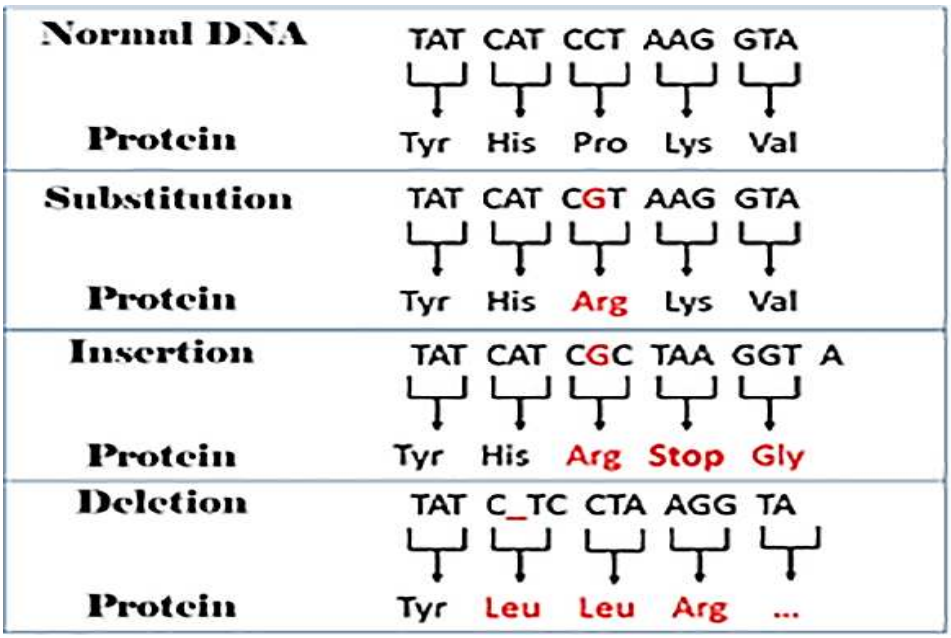
- ≈50% of first trimester abortion are due to chromosomal abnormalities.

• More than half of childhood blindness, deafness and mental retardation are due to genetic disorders.

Cancer is a result of the breakdown of the controls that regulate cells. The causes of the breakdown always include changes in important genes. However, the abnormal behaviors demonstrated by cancer cells are the result of a series of mutations in key

regulatory genes.

These changes are often the result of mutations (chromosomal or point), changes in the DNA sequence of chromosomes. Mutations can be very small changes, affecting only a few nucleotides or they can be very large, leading to major changes in the structure of chromosomes.



CHAPTER – 4: METABOLISM

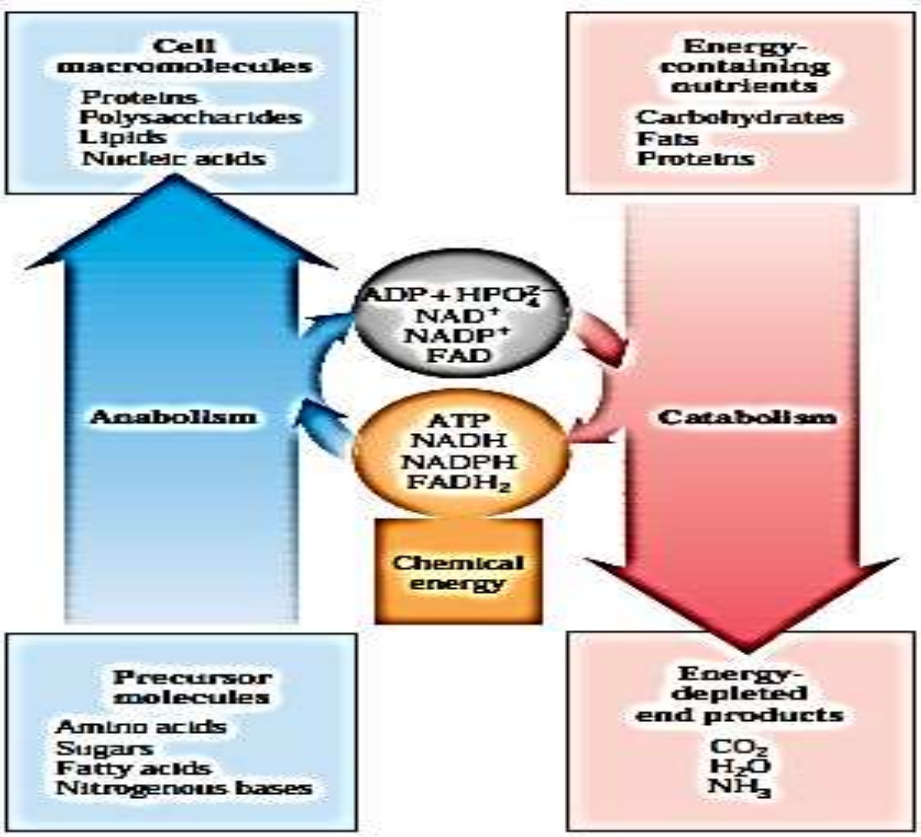


FIGURE 3 Energy relationships between catabolic and anabolic

The concept of metabolism

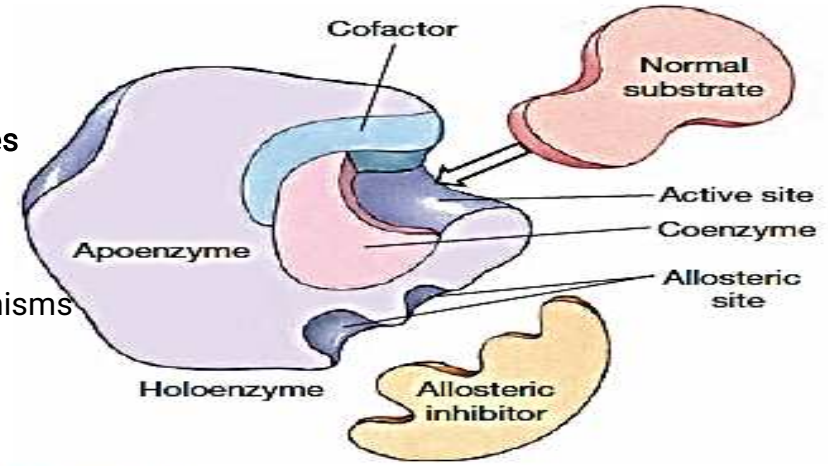
- Metabolism = all the chemical reactions taken place inside the living organisms
- Metabolic reactions produce different life processes, e.g.
  - photosynthesis
  - respiration
  - movement
  - growth
  - reproduction

Types of metabolism

- **Catabolism:**
- break down complex organic molecules into simpler molecules
- e.g. respiration: gives out energy
- **Anabolism:**
- Build up complex organic molecules from simple molecules
- e.g. Photosynthesis: requires energy

❖ **Enzymes**

Nature and properties of enzymes



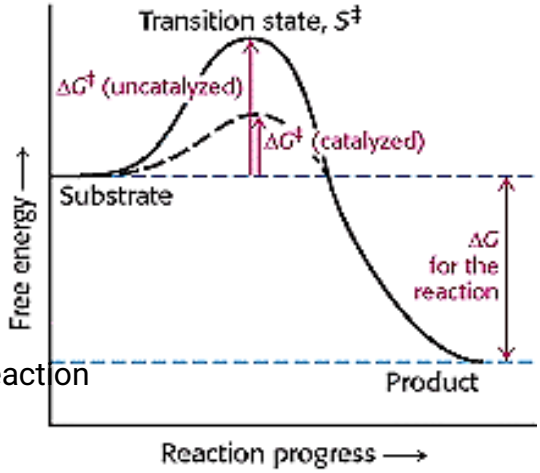
Biological Catalyst

– Biological-found within living organisms

  – Proteins in nature

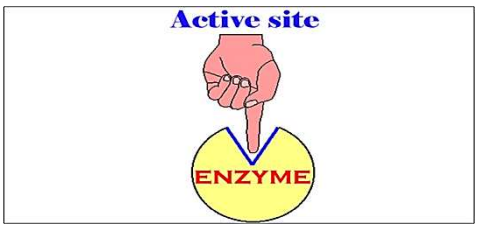
  – Specific in action

– Lowering the needed energy for reaction



– Catalyst-substance which can speed up a chemical reaction

- One kind of enzyme will catalyse only one kind of chemical reaction



Types of Enzymes

Extracellular Enzymes

- leave the cell & exert actions outside the cell

Intracelluar Enzymes

- exert action inside the cell

Control of metabolism

• Metabolic reactions can be controlled and speeded up by enzymes

Metabolic reactions would be too slow to occur if no enzymes are present!

Mechanism of enzyme action

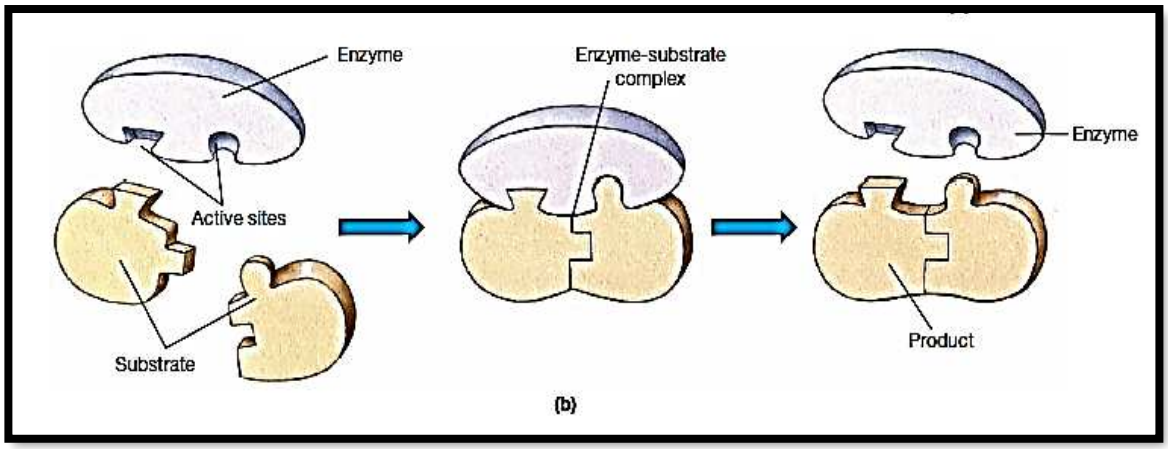
• Each enzyme has an active site

• Active site: the place where substrate binds with the enzyme

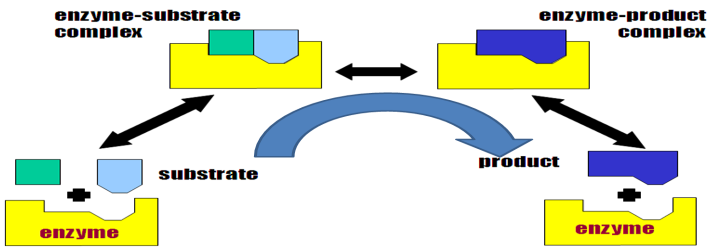
Enzyme-substrate complex

- Each active site can only allow specific substrate to fit in

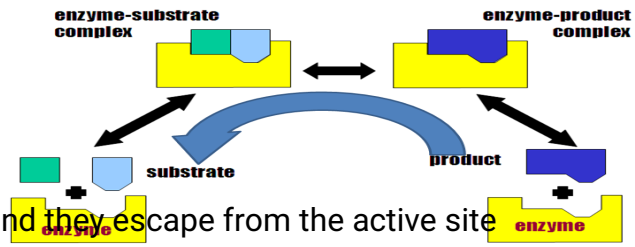
- The enzyme and substrate molecules combine to form a temporary structure called **enzyme-substrate complex**



Action of enzyme (Anabolic reaction)



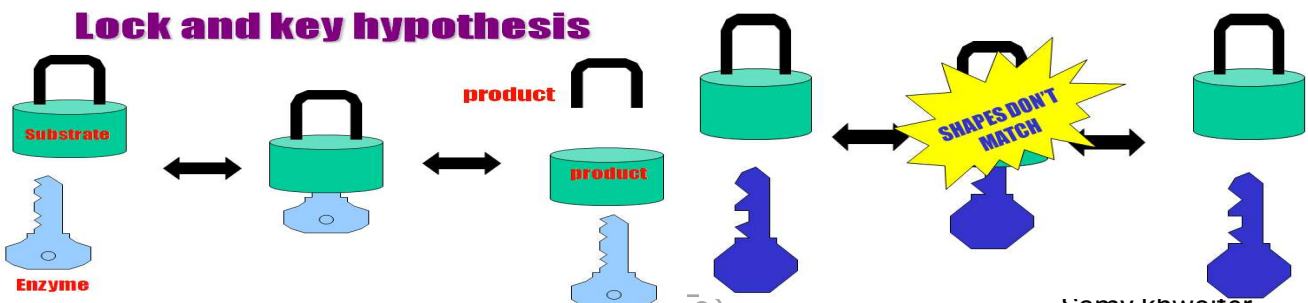
Action of enzyme (catabolic reaction)



- The product molecules are then formed and they escape from the active site

- The active site is free to attach to other substrate molecules again (i.e. it can be reused)

- This hypothesis to explain the specificity of enzyme action is called

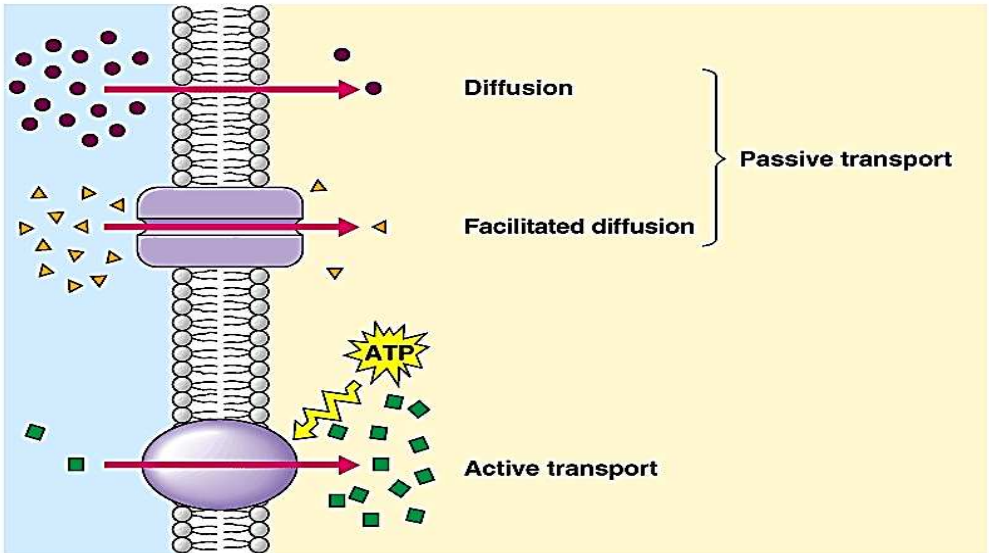


Cell membrane transportation:

Transport of Materials across the Cell Membrane

Why a cell needs transport?

- for obtaining useful materials, and
- for eliminating metabolic waste



A) Passive process
1. Simple diffusion
2. Facilitated diffusion
3. osmosis
4. filtration

B) Active process (needs to energy and gates)	
1. Active transport	2. Bulk transport
· Primary transport	1- Phagocytosis
· Secondary transport	2- Pinocytosis
a. Antiport b. Symbort	3- Receptor mediated · Endocytosis
	· Exocytosis

I- Passive process:

1- Diffusion

a- Simple Diffusion

- Is the movement of substance from a high concentration to a low concentration.
- High → low concentration gradient
- No energy needed
- Molecules will randomly move through the pores in Channel Proteins.

Channels move specific molecules across cell membrane diffusion of polar, hydrophilic molecules through a protein channel

Factors affecting Rate of Diffusion

- Size (larger size, slower rate) (steeper gradient, faster rate)
- Temperature (higher temp, faster rate)
- Concentration gradient (concentration difference between the two areas)
- Medium (gas > liquid > solid)
- Surface area (larger area, faster rate)

Importance of diffusion to living organisms

- get rid of waste products
- involve in gaseous exchange during respiration
- absorb mineral salts in plants
- absorb digested food in mammals

b- Osmosis of water

- Water is very important to life, so we talk about water separately
- Osmosis is the movement of water from high to low.

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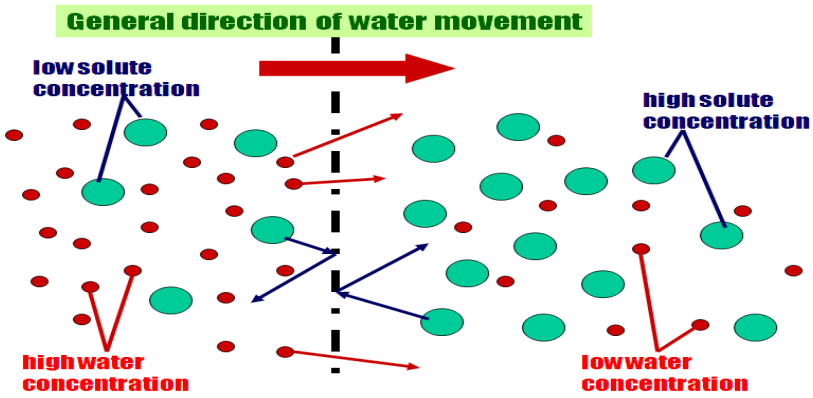
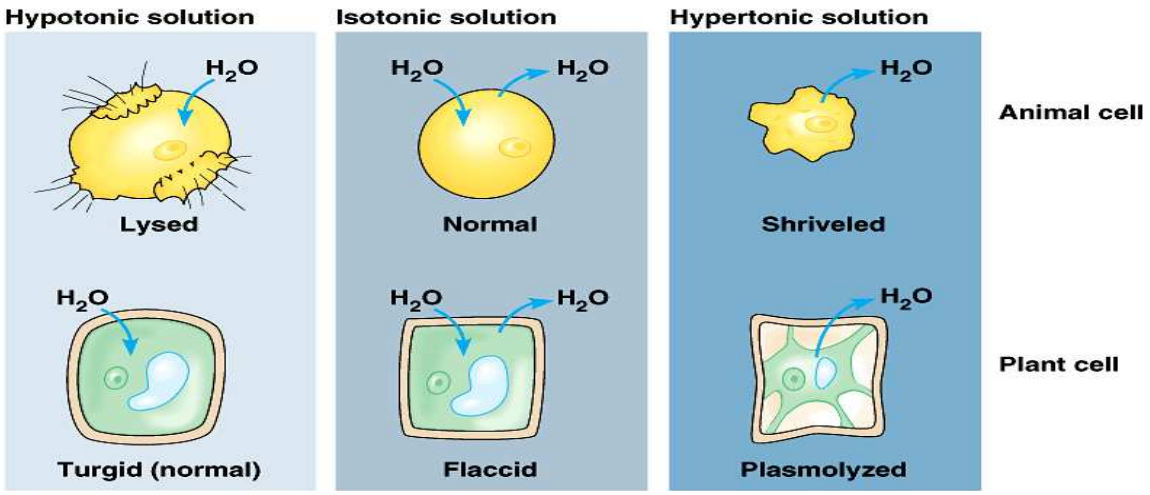


- Diffusion of water from *high concentration* of water to *low concentration* of water
- across a semi-permeable membrane
- Direction of osmosis is determined by comparing total solute concentrations
- Hypertonic - more solute, less water
- Hypotonic – less solute, more water
- Isotonic - equal solute, equal water

Water flows across membrane equally, in both directions, so volume of cell is stable. For human cells the isotonic solutions are 0.9% NaCl saline and 5% glucose solution.



If the solution outside the cell is of lower concentration as in the cell, it is **hypotonic** solution. Water penetrates into the cell. Animal cell increases in size and burst (**cytolysis**); e.g. **haemolysis** of red blood cells. In plant cells only it increases their turgor – cell wall prevents them against **breaking**.

II- Active process

- Transport substances that are unable to pass by diffusion
    - They may be too large
    - They may not be able to dissolve in the fat core of the membrane
    - They may have to move against a concentration gradient

Two common forms of active transport

i. Solute pumping (primary and secondary)

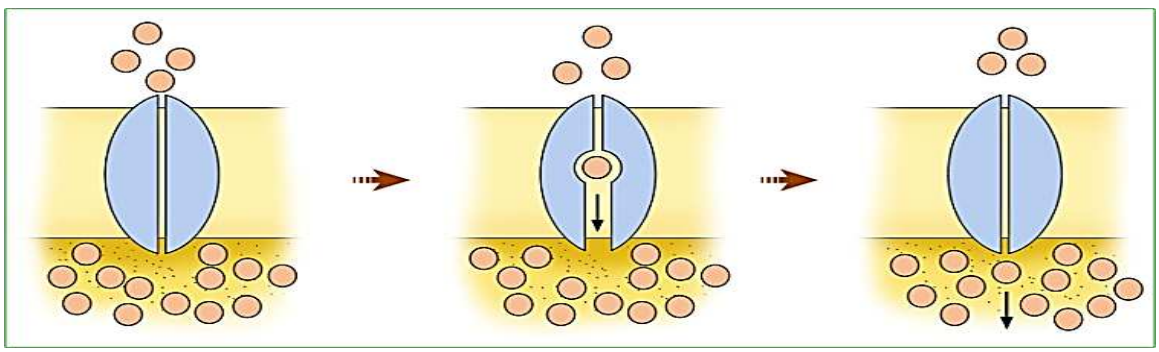
ii. Bulk transport

I- primary active transport

- diffusion *against* concentration gradient
    - low → high
- uses a protein pump
- requires ATP
- occurs in living cells only

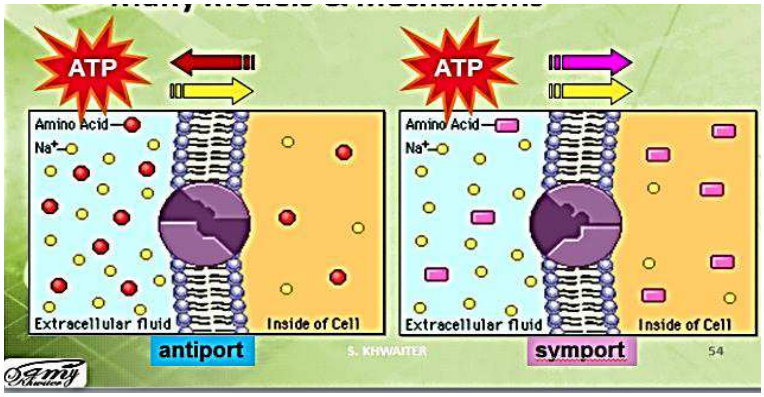
• Cells may need to move molecules *against* concentration gradient

- shape change transports solute from one side of membrane to other
- protein "pump"
- "costs" energy = ATP



b- Secondary active transport

- Many models & mechanisms



c- Bulk transport

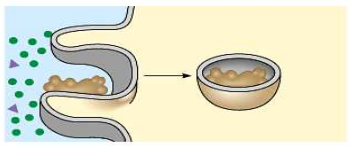
How about large molecules?

1- Endocytosis

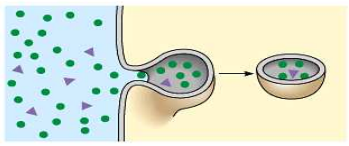
- Moving large molecules into & out of cell
  - through vesicles & vacuoles

Extracellular substances are engulfed by being enclosed in a membranous vesicle.

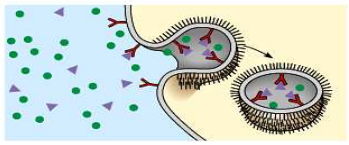
1- phagocytosis = "cellular eating"



2- pinocytosis = "cellular drinking"



3- receptor-mediated endocytosis

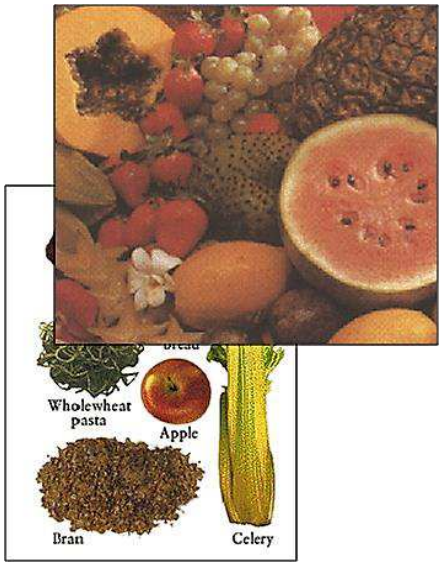


2- Exocytosis

The opposite of endocytosis is exocytosis.

Large molecules that are manufactured in the cell are released through the cell membrane.

BIOLOGICAL MICROMOLECULES



- Vitamins

- They form a cohesive group of organic compounds that are required in the diet in small amounts (micrograms or milligrams per day) for the maintenance of normal health and metabolic integrity.
- Vitamins are very sensitive to heat. Over cooking leads to destruction of its chemical nature and sometimes leads toxic.
- no energy value
- Fat soluble vitamin: a vitamin that can be stored and accumulated in the liver and other fatty tissues.
- Water soluble vitamin: a vitamin that cannot be stored in the tissues.
- Must be provided regularly as deficiencies can develop in a short time.
- water soluble vitamins (B, C)
- fat soluble vitamins (A, D, E, K)

Vitamin	Sources	Deficiency Disease
A	Egg yolk, milk, cheese, carrot, green vegetables	Night blindness
C	Fresh fruits & green vegetables	Scurvy
D	Cod liver oil & egg yolk	Rickets

Vitamin A

- The chemical name of vitamin A is retinol. The major storage site of vitamin A in the body is in the liver.
- Formed in the body from Carotene (a yellow pigment in carrots)
- destroyed at high temperature
- Essential for forming visual purple (maintain dim light vision)

Vitamin B

- The B-group vitamins are a collection of 8 water-soluble vitamins essential for various metabolic processes.
- Extended cooking, food processing and excess alcohol consumption can destroy or reduce the availability of many of these vitamins.

Needed for energy production and help a variety of enzymes do their function.

Vitamin C

- Destroyed after prolonged cooking
- Necessary for wounds-healing.
- Vitamin C deficiency over 3-5 months results in *symptomatic scurvy.*
- Scurvy leads to the formation of liver spots on the skin, spongy gums, and bleeding from all mucous membranes.

Vitamin K

- Function Essential for blood clotting and its regulation
- Sources Cooked dark green vegetables, such as spinach, kale and broccoli
- Deficiency disruption of blood clotting
- Absorption along with fat that assisted by emulsifying action of bile

Vitamin D

- Formed in Skin from Ultraviolet Light or consumed from Daitery food
- Help to regulate Ca & P metabolism

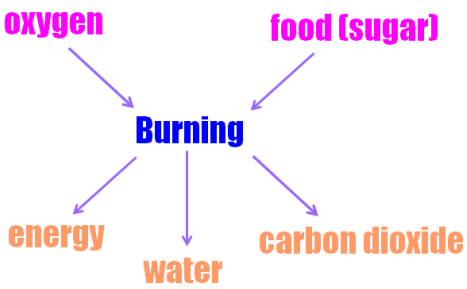
CHAPTER – 5: CELLULAR RESPIRATION

What is Respiration?

- a process of oxidizing food to release energy inside cells

Burning of Food

- A demonstration of energy released from food



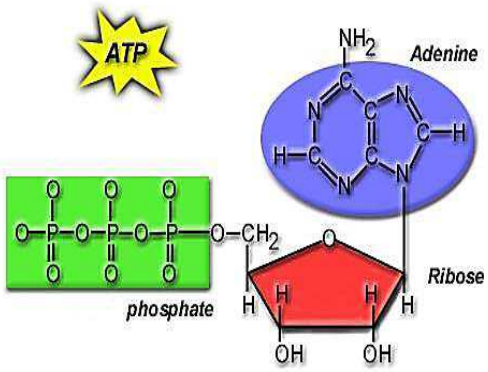
Respiration

- reactions are catalyzed by enzymes
- main food substance which oxidized in cells is glucose

$$C_6H_{12}O_6 + 6O_2 \xrightarrow{\text{enzymes}} 6CO_2 + 6H_2O + \text{energy}$$

- as it takes place in all living cells, it is called cellular respiration which is used to produce energy for cells to use

ATP



- energy is mainly released as heat and ATP during respiration in cells
- however, during respiration, some ATP should be consumed first before other ATP can be formed
- the ATP consumed is used to form other ATP from ADP and phosphate groups
- ATP is a high-energy compound while ADP is a low-energy one
- ATP can only store energy for a short period
- ATP is made inside organelles, mitochondria, which is scattered in the cytoplasm of a cell.

$$ADP + phosphate + energy \longrightarrow ATP$$
(from breakdown of glucose)

Anaerobic Respiration

- ★ respiration in human is mainly aerobic respiration as oxygen is essential
- ★ when oxygen is not needed during respiration, it is called anaerobic respiration
- ★ yeast and muscle cells are examples which they can respire anaerobically for a short time

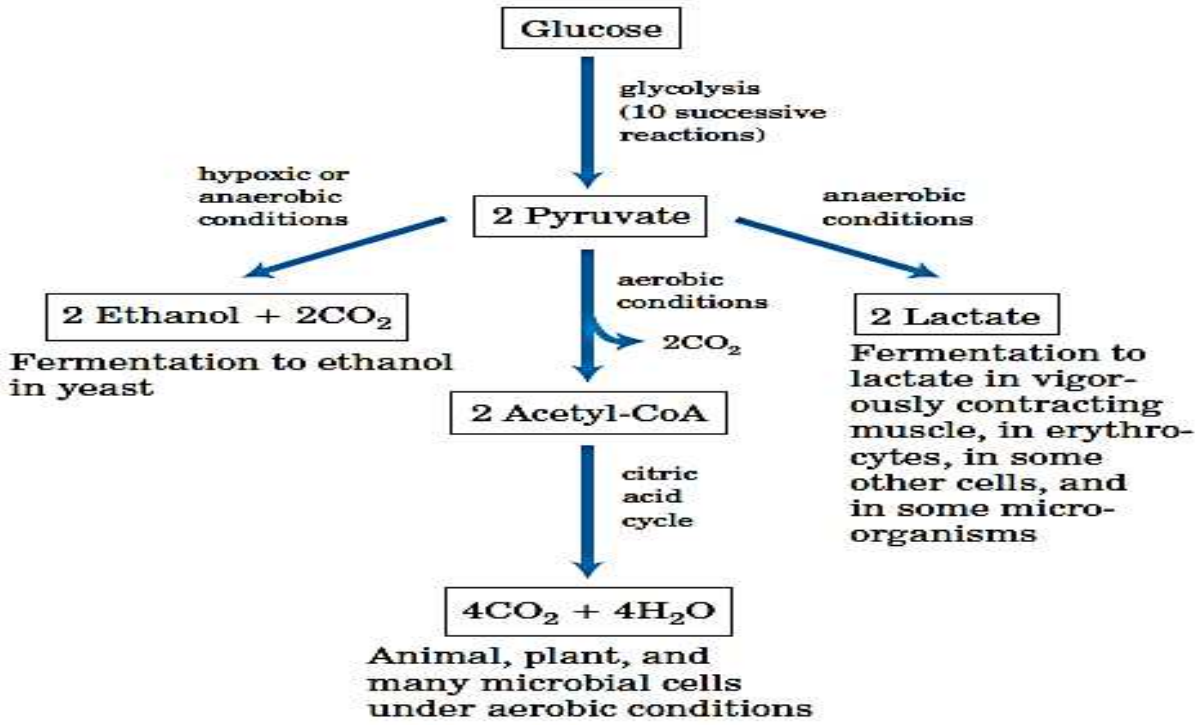


FIGURE 14–3 Three possible catabolic fates of the pyruvate formed in glycolysis. Pyruvate also serves as a precursor in many anabolic reactions, not shown here.

Alcoholic Fermentation

- without oxygen, yeast cells respire as follows:

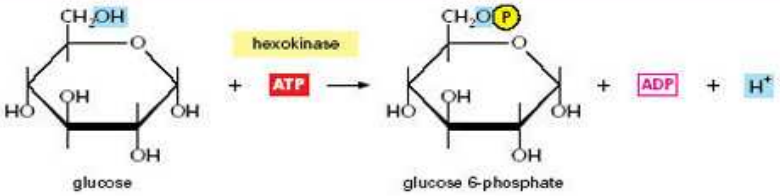
$$C_6H_{12}O_6 \xrightarrow{enzymes} 2CO_2 + 2C_2H_5OH + energy$$
(ethanol)

- amount of energy released anaerobically is smaller when compared with the aerobic method

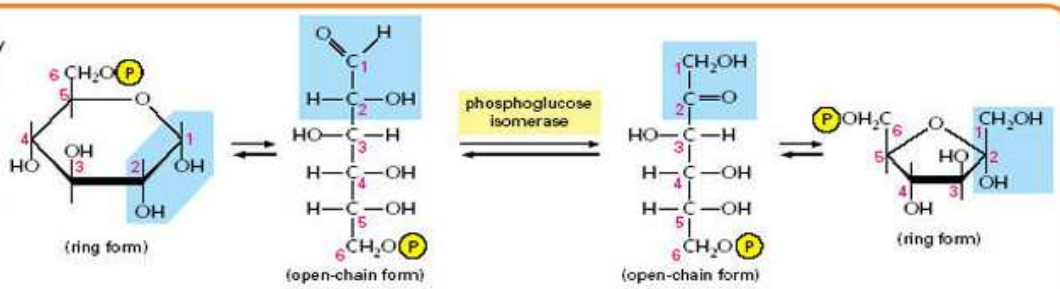
1- Glycolysis

For each step, the part of the molecule that undergoes a change is shadowed in blue, and the name of the enzyme that catalyzes the reaction is in a yellow box.

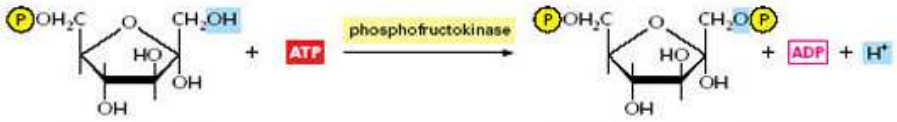
Step 1 Glucose is phosphorylated by ATP to form a sugar phosphate. The negative charge of the phosphate prevents passage of the sugar phosphate through the plasma membrane, trapping glucose inside the cell.



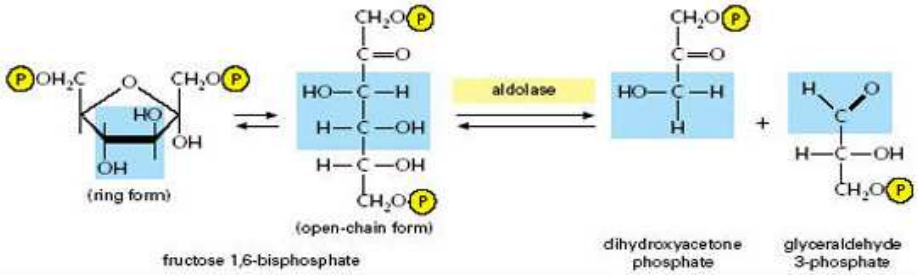
Step 2 A readily reversible rearrangement of the chemical structure (isomerization) moves the carbonyl oxygen from carbon 1 to carbon 2, forming a ketose from an aldose sugar. (See Panel 2–3, pp. 70–71.)



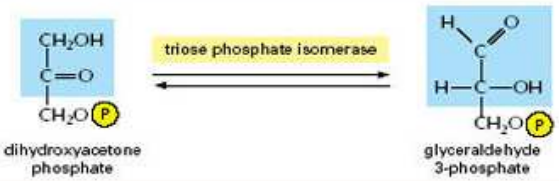
Step 3 The new hydroxyl group on carbon 1 is phosphorylated by ATP, in preparation for the formation of two three-carbon sugar phosphates. The entry of sugars into glycolysis is controlled at this step, through regulation of the enzyme *phosphofructokinase*.



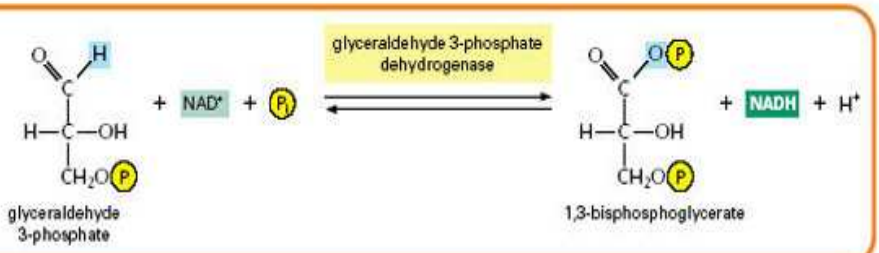
Step 4 The six-carbon sugar is cleaved to produce two three-carbon molecules. Only the glyceraldehyde 3-phosphate can proceed immediately through glycolysis.



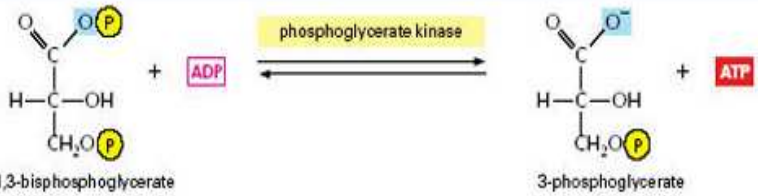
Step 5 The other product of step 4, dihydroxyacetone phosphate, is isomerized to form glyceraldehyde 3-phosphate.



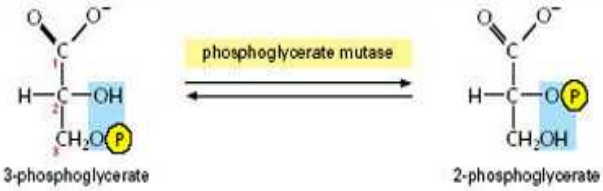
Step 6 The two molecules of glyceraldehyde 3-phosphate are oxidized. The energy-generation phase of glycolysis begins, as NADH and a new high-energy anhydride linkage to phosphate are formed (see Figure 13–5).



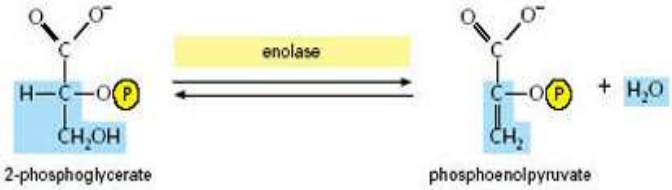
Step 7 The transfer to ADP of the high-energy phosphate group that was generated in step 6 forms ATP.



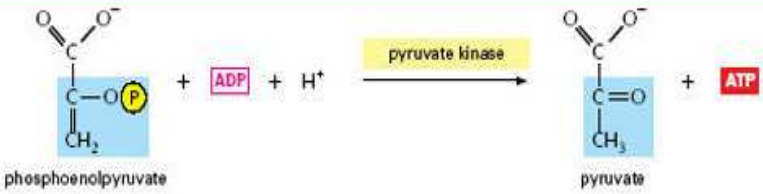
Step 8 The remaining phosphate ester linkage in 3-phosphoglycerate, which has a relatively low free energy of hydrolysis, is moved from carbon 3 to carbon 2 to form 2-phosphoglycerate.



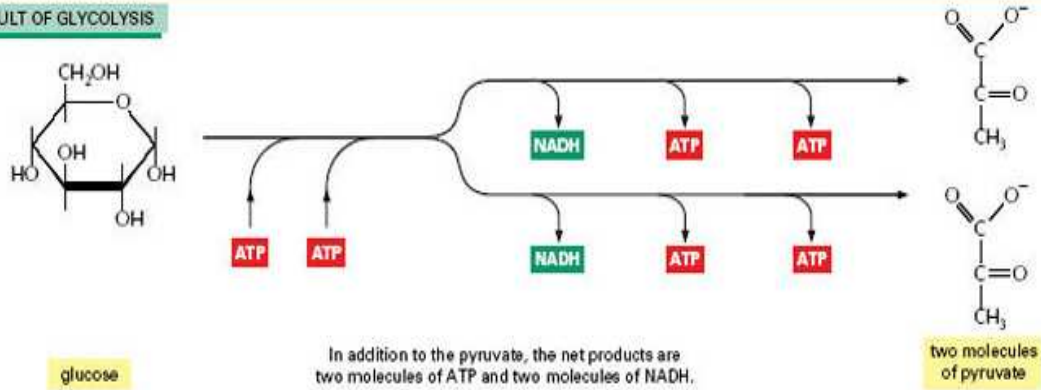
Step 9 The removal of water from 2-phosphoglycerate creates a high-energy enol phosphate linkage.



Step 10 The transfer to ADP of the high-energy phosphate group that was generated in step 9 forms ATP, completing glycolysis.



NET RESULT OF GLYCOLYSIS



2- Krebs Cycle

a) Krebs cycle occurs in matrix of mitochondria.

b) Only occurs if O_2 present.

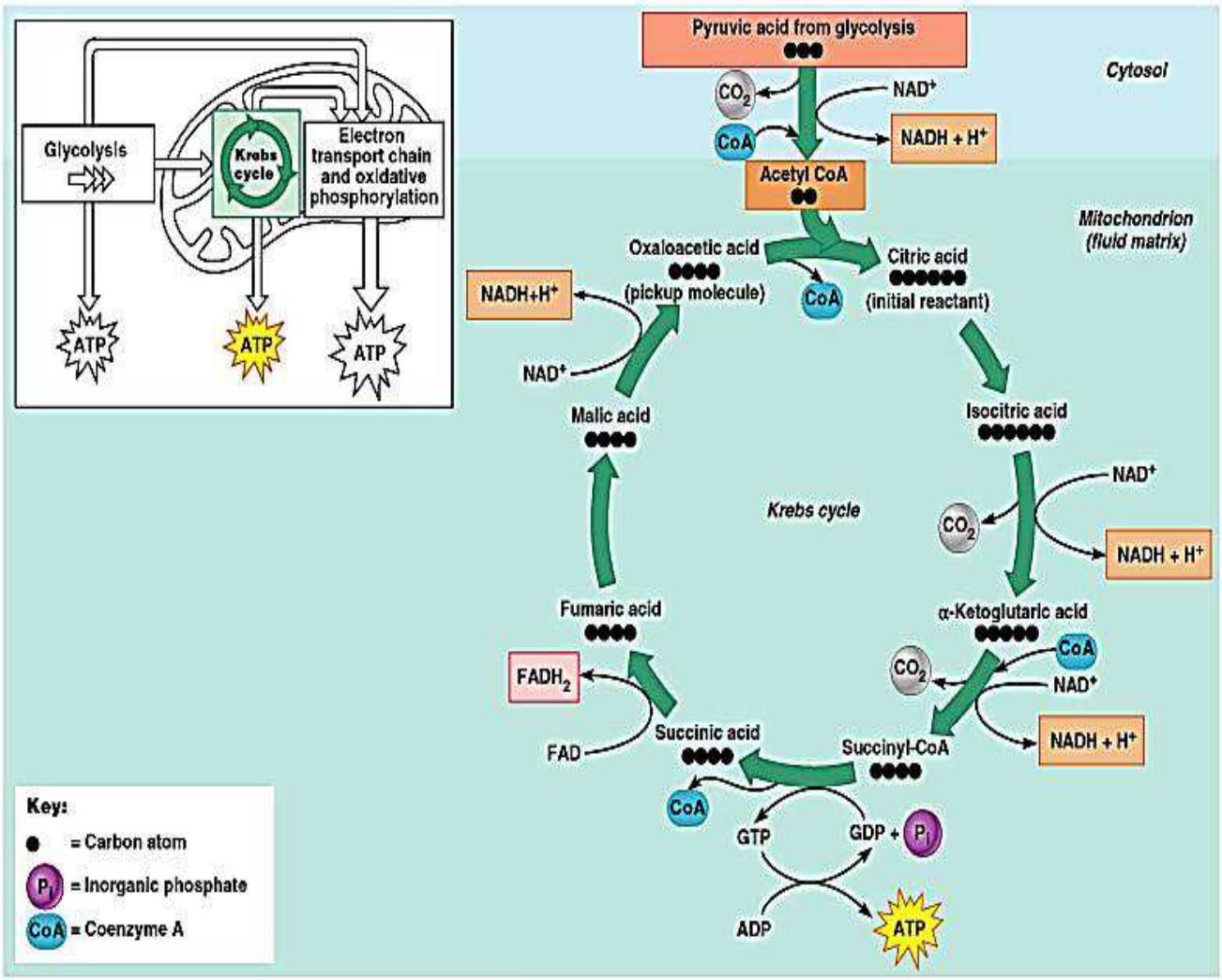
c) Link Reaction: Pyruvate moves into matrix & loses 1 carbon as 1 CO_2. 1 more NADH is made.

d) The remaining 2C molecule enters the Krebs Cycle.

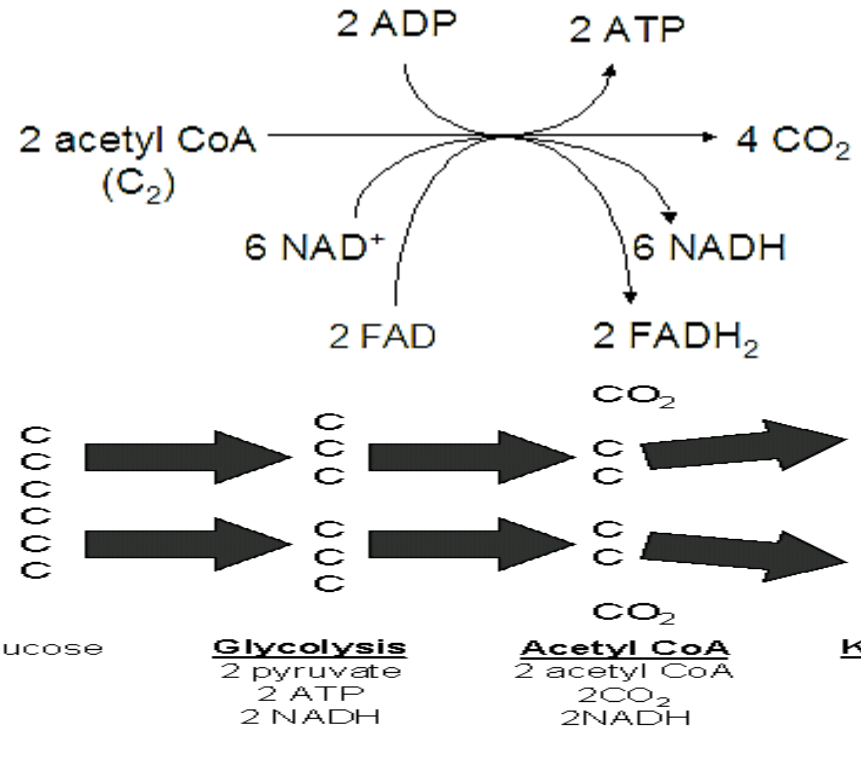
e) In several steps, energy & hydrogens are removed from the 2 carbons and changed to more NADH & $FADH_2$. These migrate to Electron Transport.

f) 1 more ATP is made. The cell can use this.

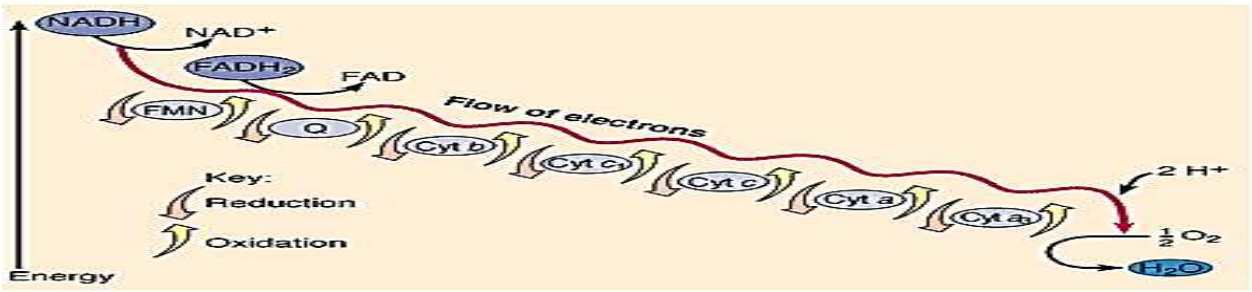
g) Each remaining carbon is removed as CO_2 & released to air.

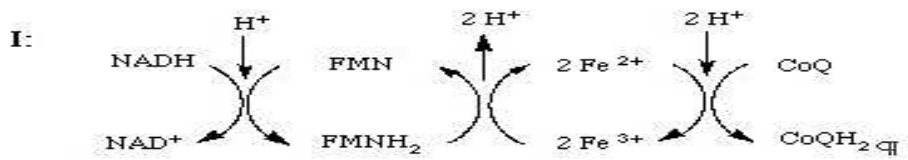


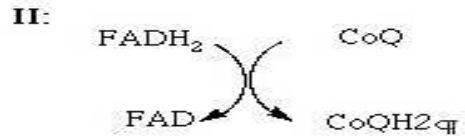
2 Acetyle CoA ⟶ Consumed ⟶ 4 CO_2, 2ATP, 6 NADH and 2 $FADH_2$

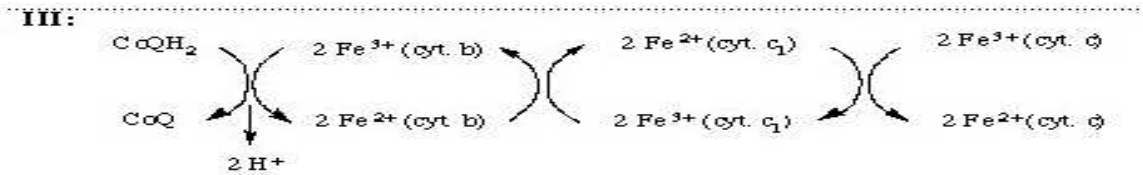


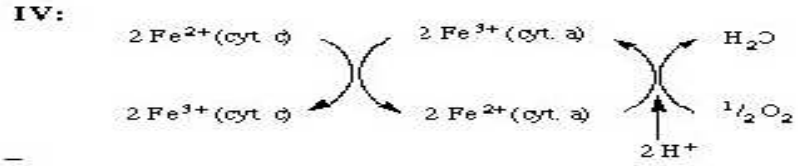
3- Electron transport chain











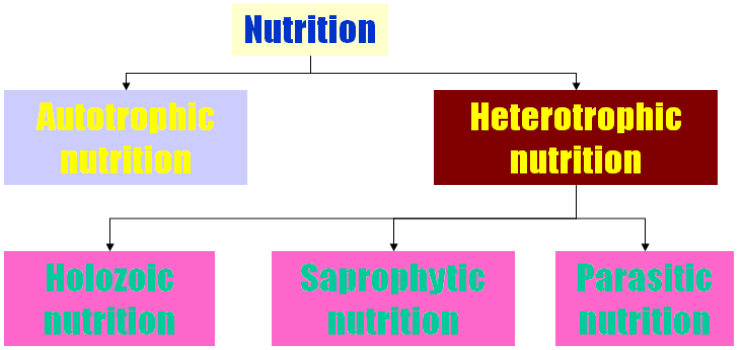
CHAPTER – 6: NUTRITION IN ORGANISMS

Nutrition

Process by which organisms obtain and use the nutrients required for maintaining life.

Modes of nutrition

Ways of obtaining and using nutrients



Autotrophic nutrition

Make their own food (complex organic substances) using simple inorganic substances

- the organism → autotrophs
- e.g. Green plants
- by photosynthesis

Heterotrophic nutrition

- depends on other organisms or dead organic matters as their food sources
- the organism "Heterotrophs" cannot make their own food and obtain their food in organic form

Holozoic nutrition

- Organisms take in solid organic food from ingesting other living organisms
- Food needs to be broken down into small molecules (i.e.digested) before they can be absorbed and used by the organisms

Types of animals taking holozoic nutrition

- **Herbivores**
  - Feed on plants only

- **Carnivores**
  - Feed on animals only

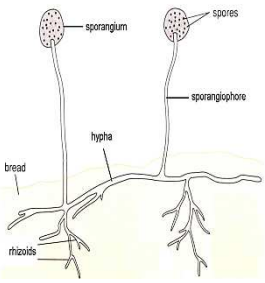
- **Omnivores**
  - Feed on both plants and animals

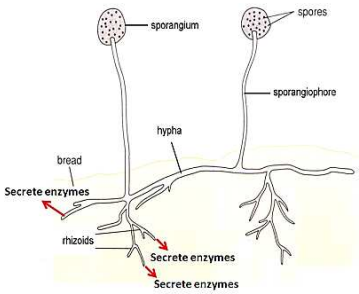
Saprophytic nutrition (Saprophytism)

- Organisms feed on dead organisms or non-living organic matter
  - Saprophytes (e.g. fungi, bacteria)

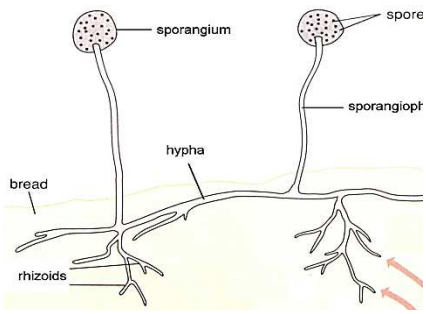
How a saprophyte obtains its nutrients?

Example : *Mucor* & *Rhizopus*
(bread mould)





- Hyphae release digestive enzyme into the bread
- Enzymes digest complex organic molecules in bread into simple, soluble molecules *(extracellular digestion)*



- Digested products are absorbed by hyphae
- Mass of hyphae = mycelium
- Sporangium : produces spores for reproduction

Importance of saprophytes

- As decomposers
  - Allow essential materials (e.g. C, N) to be recycled in the ecosystem

Complex organic substances —(Enzyme from saprophytes)→ **Simple soluble compounds**

NUTRITION IN MAMMALS

The processes of nutrition

Ingestion

- a process by which food is taken in through the mouth
- a reflex action which is involuntary
- it occurs when the food is put at the posterior position of the tongue

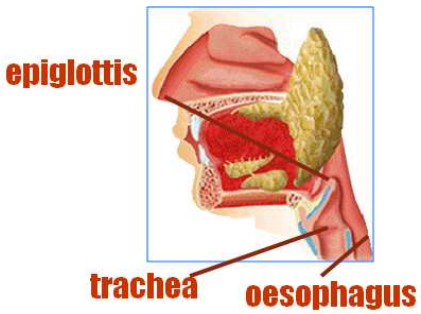
Movement of Food

Mouth:

Food chewed by teeth

→ mixed with saliva to form bonus

→ swallowed down the oesophagus through pharynx

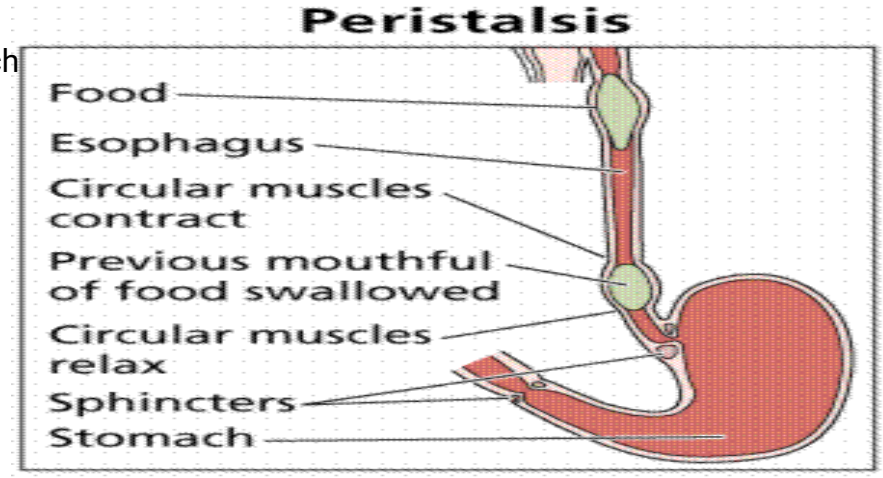


[Note: Epiglottis (a piece of cartilage) covers the entrance to the trachea while swallowing to prevent food going down into lungs.]

Oesophagus:

Outer longitudinal & inner circular muscles contract & relax alternately (peristalsis)

→ Push food bolus to stomach

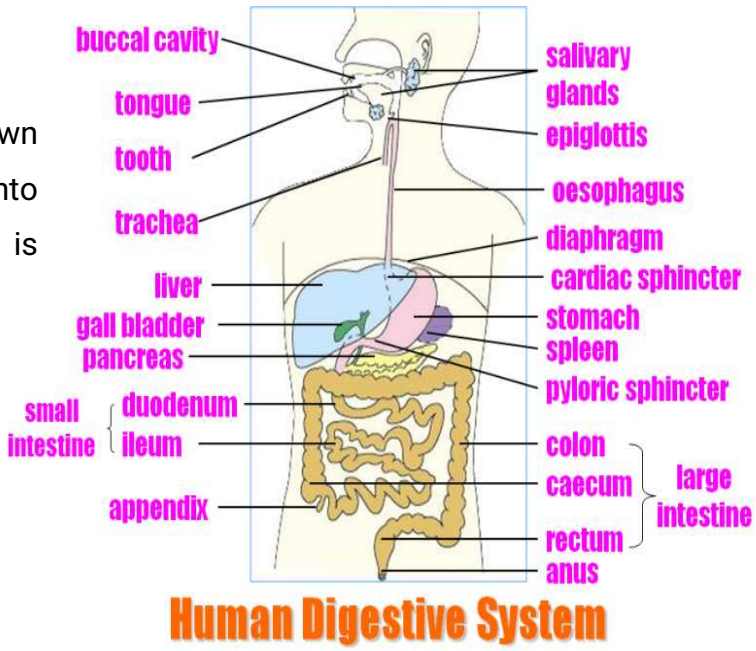


Digestion

A process by which large food molecules are broken down into smaller pieces

Why is digestion needed?

So, food pieces should be broken down into smaller pieces and then into substances with molecular size which is small enough to be absorbed



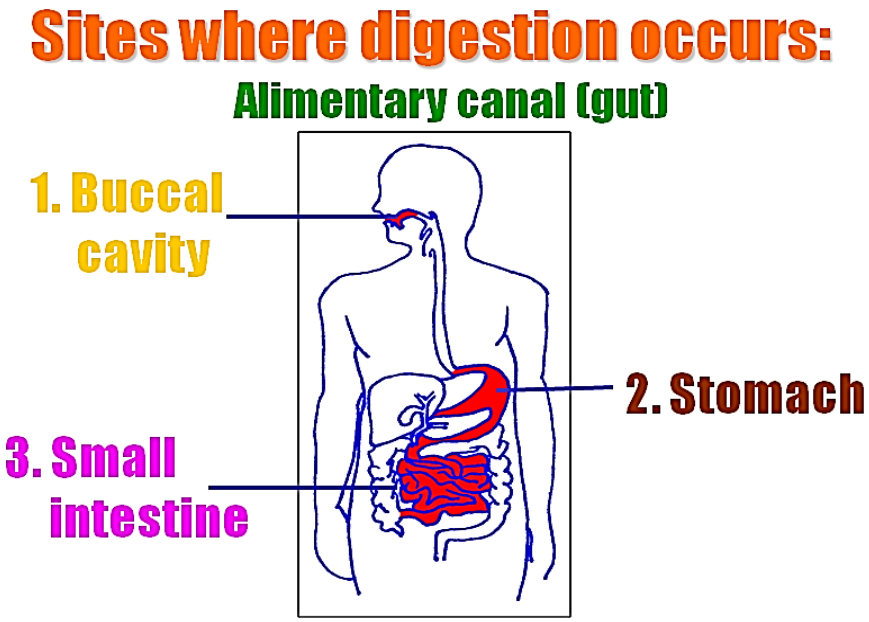
Mechanical Digestion

Chewing: break down food into smaller pieces by teeth to increase the surface area for enzyme action (physical digestion)

Chemical Digestion

Enzymatic Reactions that digest food into simpler chemical forms

Where is food digested?

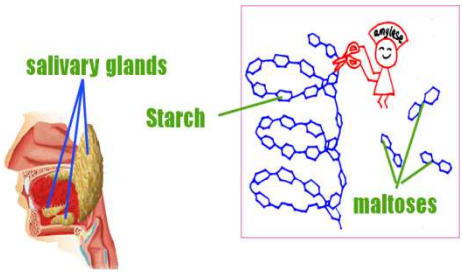


How is food digested in these sites?

Digestion in Buccal Cavity

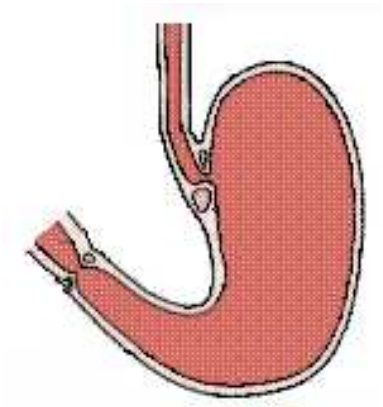
- There are 3 pairs of salivary glands
- Saliva contains water, mucus & enzyme (amylase)
- Water: moistens dry food
- Mucus: lubricates food
- Amylase: digests about 5% of starch in mouth

Chemical Digestion



Break down of starch molecules into maltose molecules by salivary amylase (from salivary glands)

Stomach (Physical Digestion)



- ✔ Stomach Entrance: Cardiac Sphincter
- ✔ Stomach Exit: Pyloric Sphincter
- ✔ Relaxation of cardiac sphincter & contraction of pyloric sphincter enable storage of food in stomach for a longer period of time
- ✔ Squeezing & churning actions of stomach break down the partly digested food into smaller pieces which forms a semi-fluid called Chyme

Stomach (Chemical Digestion)

- digestive juice : gastric juice (pH 2) (by gastric glands)
- enzymes : protease
- break down of protein molecules into polypeptides or dipeptides

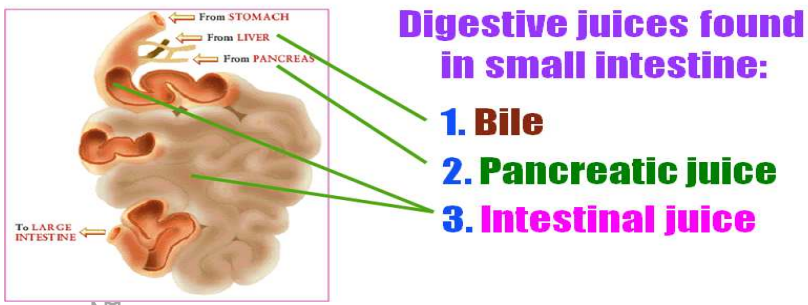
hydrochloric acid :

- to provide acidic medium for maximum activity of enzyme
- to kill bacteria
- to stop the activity of salivary amylase

(Stomach wall secretes a mucous layer to cover its inner surface: prevents autodigestion by protease)

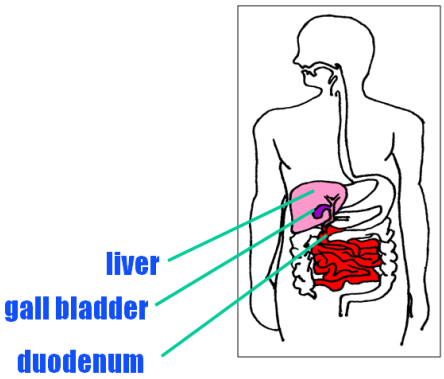
Small Intestine (mainly chemical digestion)

Digestion of various food substances by several kinds of digestive juices



Bile

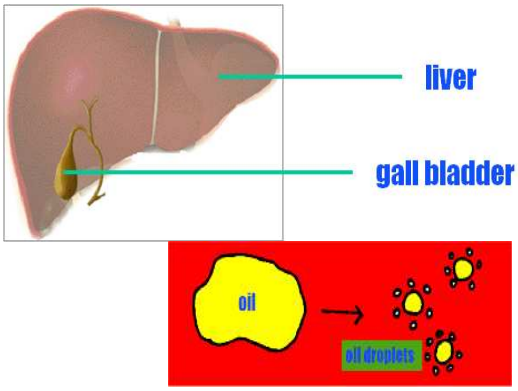
- with bile salts (not an enzyme)
- produced in liver
- stored in gall bladder
- transport to duodenum through bile duct
- take action in duodenum



- bile pigment (excretory waste from breaking down of haemoglobin)

- contain bile salts which emulsify lipids into smaller droplets without chemical change (∴ NOT digest fats)

- provide alkaline medium for enzymes to work

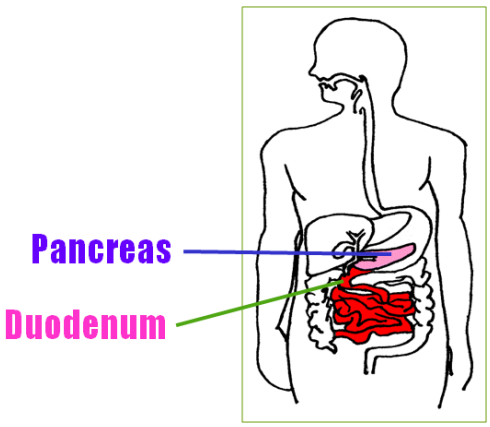


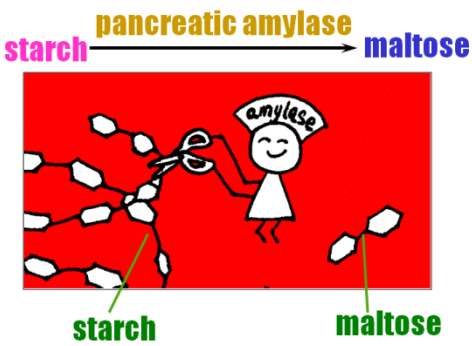
Pancreatic Juice

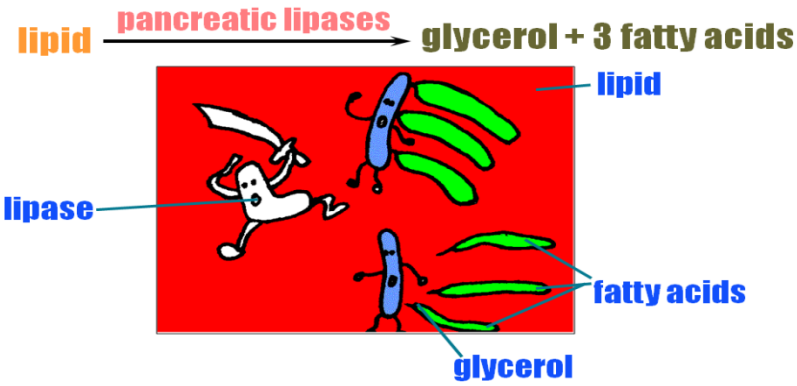
- produced in pancreas
- action in duodenum
- contain enzymes of 3 categories:

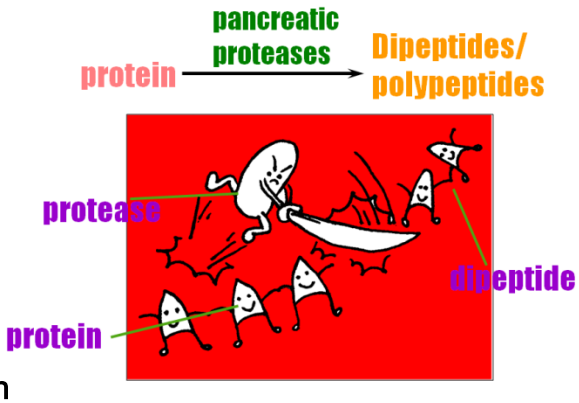
1. Carbohydrase (Amylase)
2. Proteases
3. Lipases

- provide alkaline medium for enzymes to work







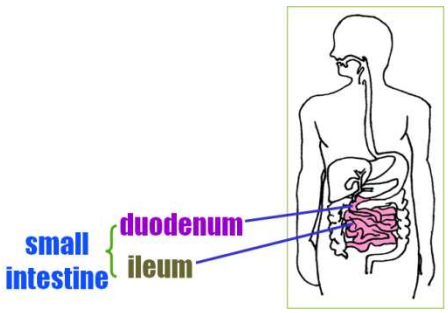


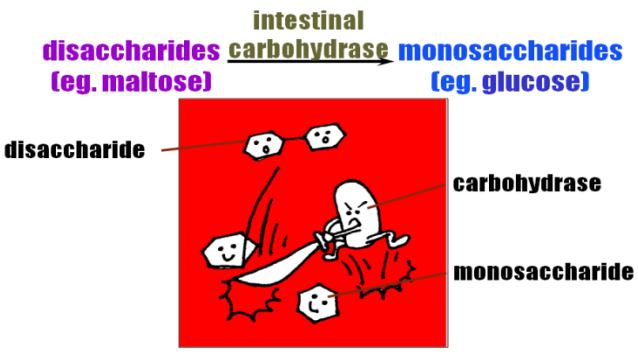
Digestion in ileum

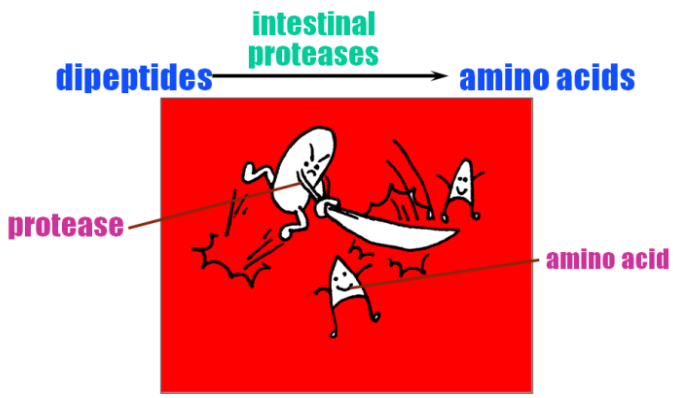
Intestinal Juice

- produced and take action in <u>small</u> intestine (duodenum & ileum) to complete the digestion of food
- Contain enzymes of 2 categories:

  1. Carbohydrase (eg. maltase)
  2. Protease

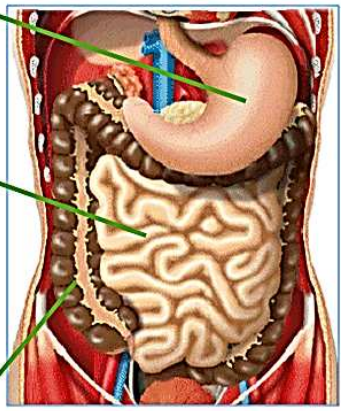


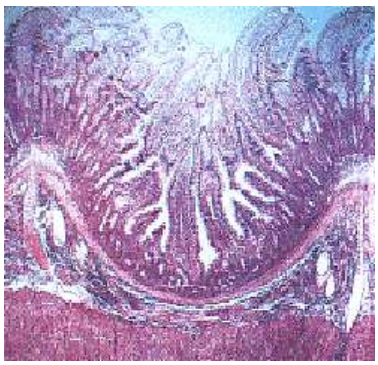




Absorption

- **stomach : absorbs alcohol & drugs**
- **ileum : absorbs digested food (with a large amount of water) (∴ it absorbs the largest amount of water)**
- **colon : absorbs water & mineral salts**





Absorption of food in ileum

- It is long, with many finger-like villi

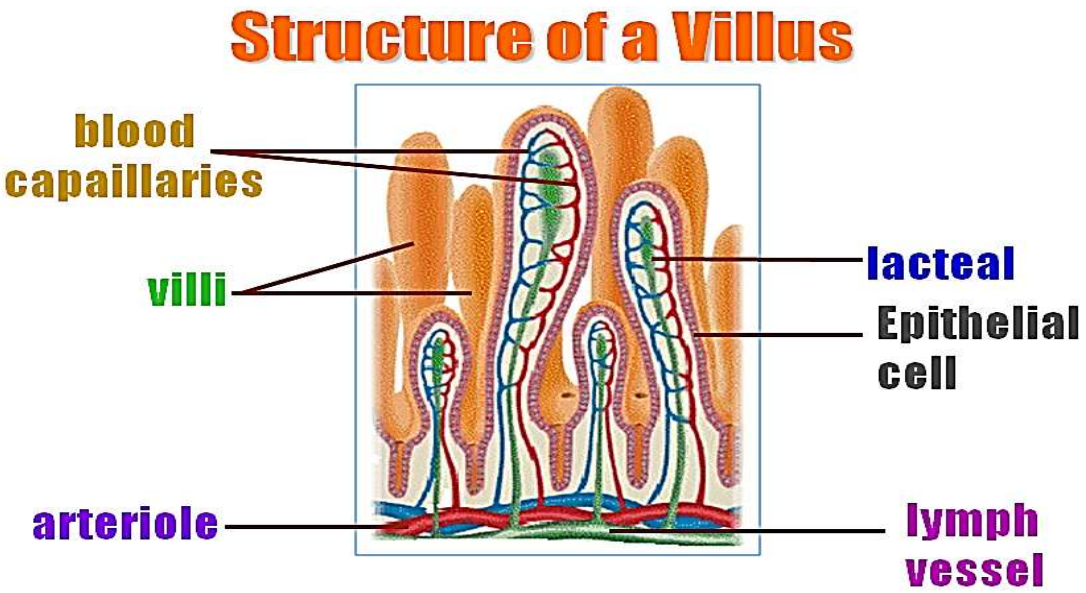
– to provide large surface area for absorption of digested food

- It has thin wall

– to decrease the diffusion distance for easy diffusion of food

- It has well developed transport system (blood capillaries & lacteal)

– to maintain high concentration gradient for the diffusion of food

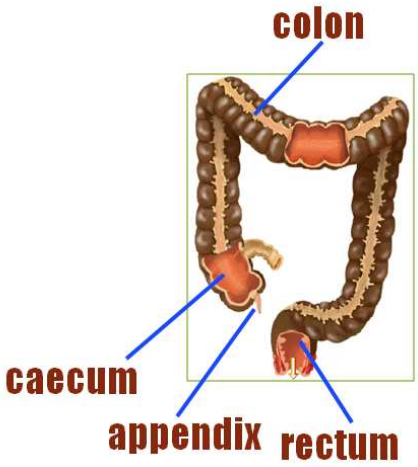


Transportation of absorbed food in villi

- blood capillaries : absorb glucose & amino acids (which are smaller molecules)
- lacteal : absorb fatty acids & glycerol (which are larger molecules)
  - transport fats (glycerol & fatty acids recombine together after being absorbed)
- involve both diffusion & active transport

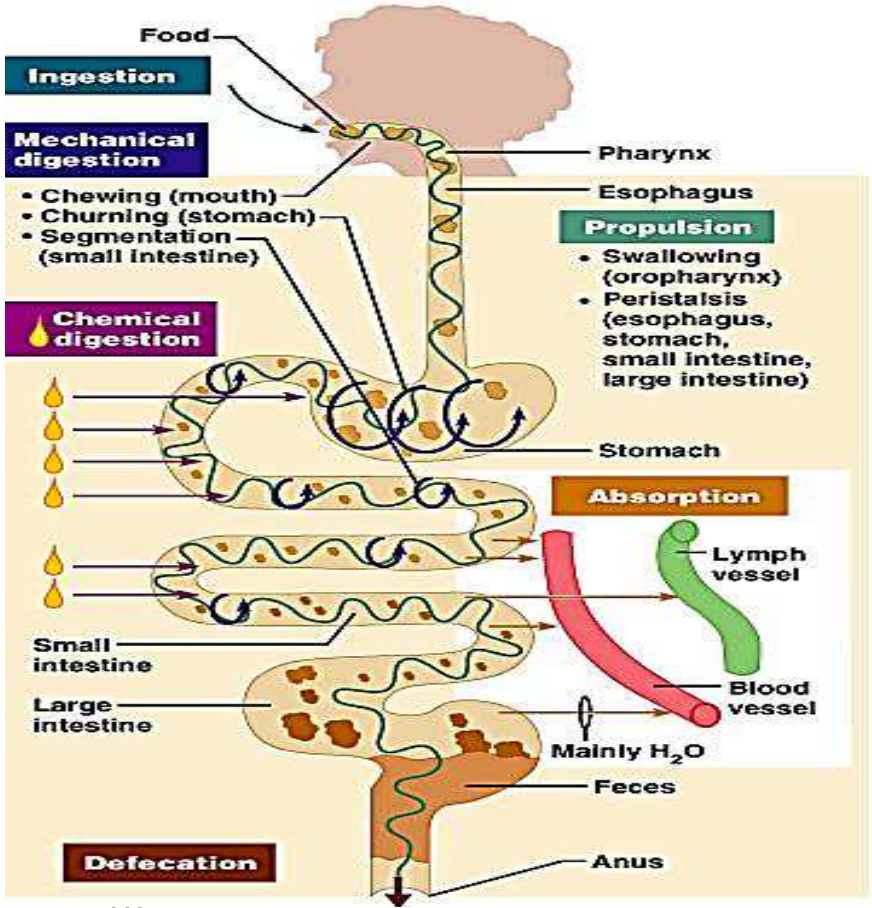
Large intestine

- caecum & appendix
  - no function in human (∴ small in size)
- colon
  - absorbs water & mineral salts
  - failure to reabsorb water: *Diarrhea*
- rectum
  - stores faeces temporarily
  - for egestion (defaecation)



Egestion (Defaecation)

- removal of undigested or unabsorbed food substances
- faeces: semi-solid brown mass (includes undigested food, dead & live bacteria)
- faeces is temporarily stored in rectum & eventually be expelled through anus

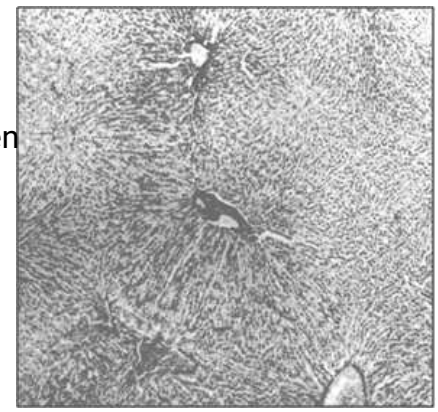


Assimilation

- a process which absorbs food incorporated as a part of body cells
- digested food is transported to liver by hepatic portal vein
- lacteal transports fat into lymph vessels & then into the bloodstream
- malfunction of pancreas to secrete *insulin: Diabetes*

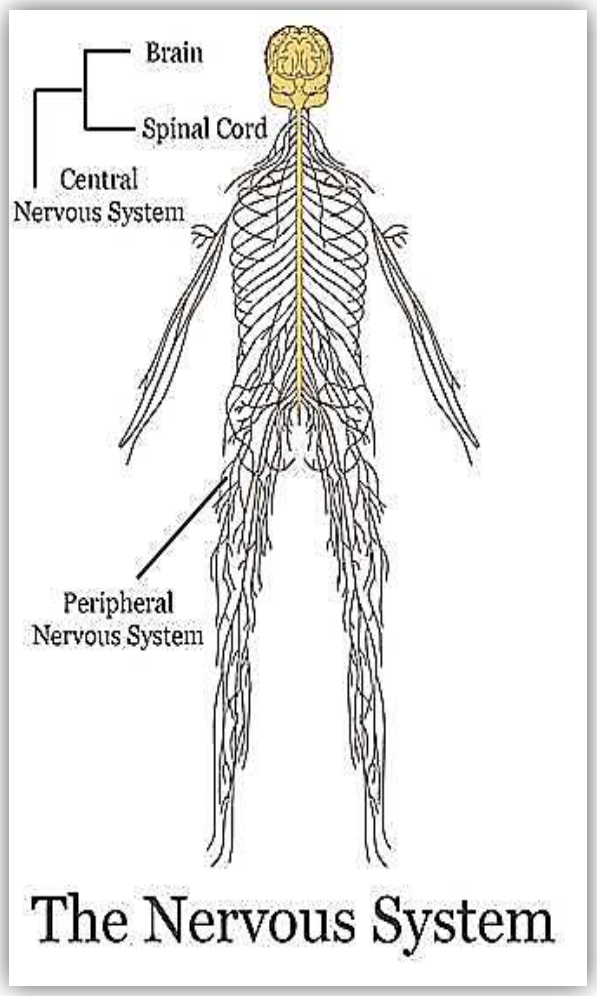
Functions of Liver

- changes excess blood glucose to glycogen & stores in liver to regulate blood glucose level
- deaminates excess amino acids
  - to urea which is excreted by kidney
  - to glycogen for energy storage
- stores vitamins A, D, E, K (which are fat soluble) iron & glycogen
- changes Carotene to Vitamin A
- secretes *bile* for fat emulsification
- **Detoxification**: turns mild toxins into harmless substances



CHAPTER – 7: HISTOLOGY AND MAJOR BODY SYSTEMS.

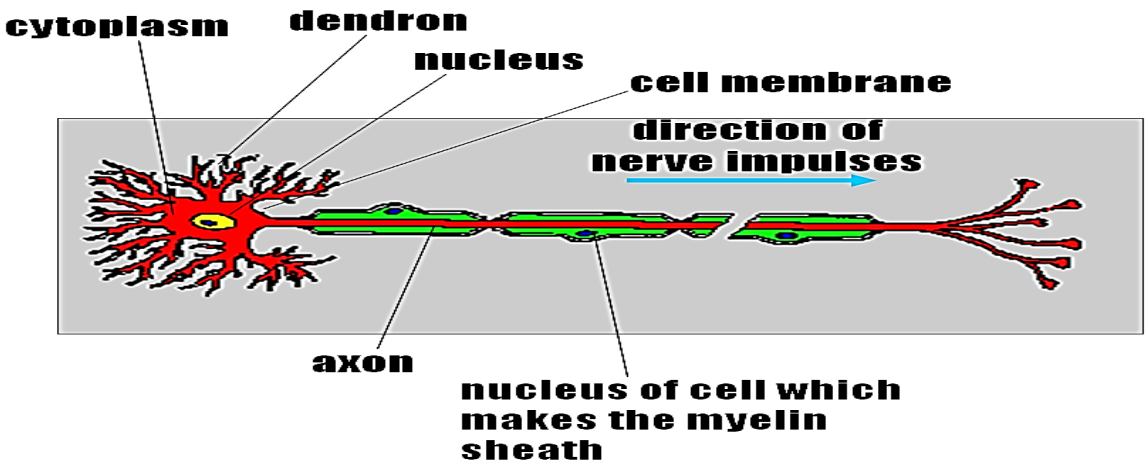
NERVOUS SYSTEM OF MAMMAL



- Nervous system of mammal consists of central nervous system(CNS) and peripheral nervous system
- CNS includes brain and spinal cord and the peripheral nervous system includes cranial nerves and spinal nerves

Structure of Neurons

- Neurons make up nervous system in mammal
- Each neuron has a cell body and nerve fibers
- Cell body is a mass of cytoplasm with nucleus inside and it is called ganglion
- Nerve fibers are cytoplasmic processes of neurons and there are two types, one is dendron and the other is axon
- Dendron transmits nerve impulses towards cell body while axon transmits nerve impulses away from cell body
- nerve fibers may be protected by a fatty layer which serves as an insulator to prevent the spread of nerve impulses and help to speed up the rate of transmission

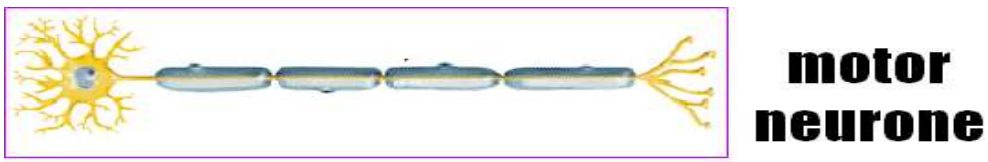


Types of Neurons

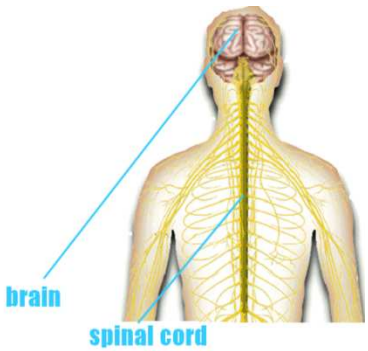
- there are three types of neurons: sensory neuron, motor neuron and association neuron

- Sensory neuron: transmits nerve impulses from receptor to the central nervous system

- Motor neuron: transmits nerve impulses from central nervous system to effectors. The axon branches at its end to form many motor end plates which are attached to muscle fibers



- Association neuron: connects the sensory neuron to the motor neuron and also the neurons in the central nervous system



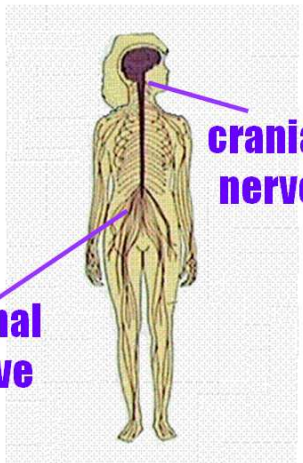
Central Nervous System

- Includes brain and spinal cord in higher animal

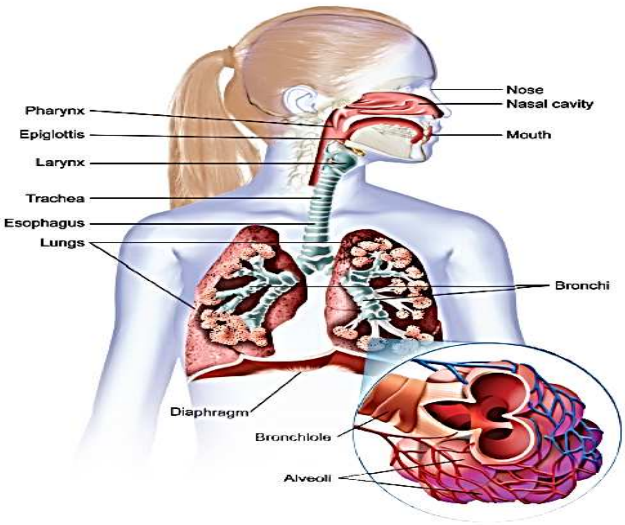
Peripheral Nervous System

☑ consist of cranial nerves and spinal nerves

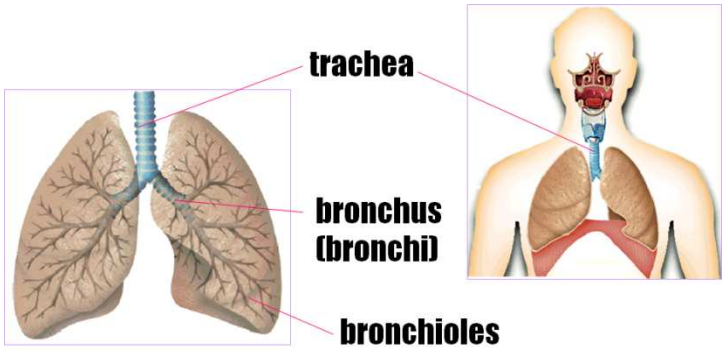
☑ these nerves leave CNS and run out to every part of the body

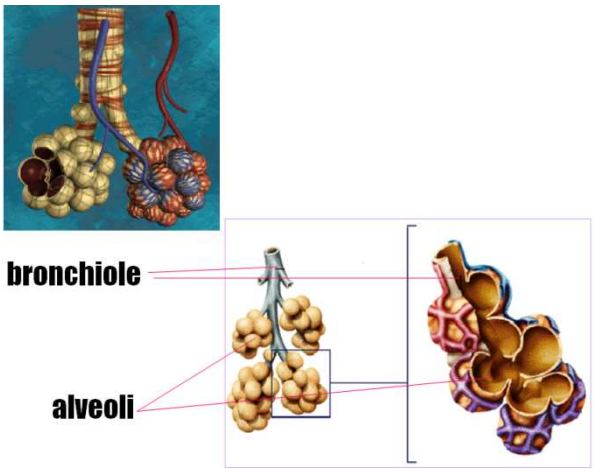


RESPIRATORY SYSTEM

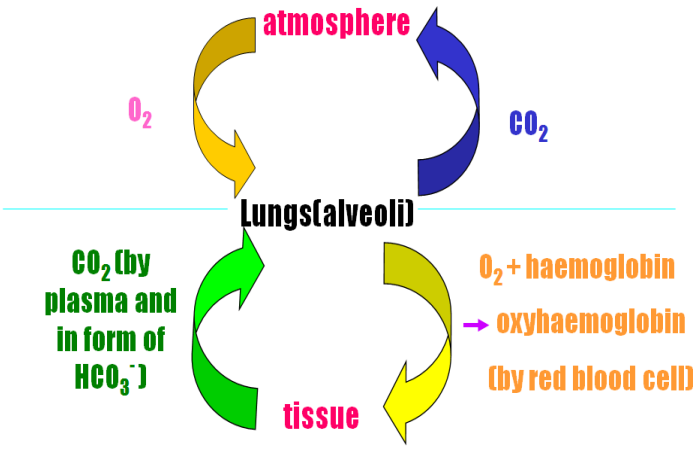


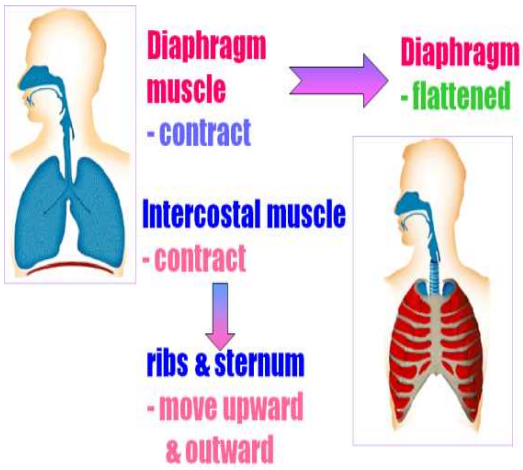
Bronchioles & Alveoli

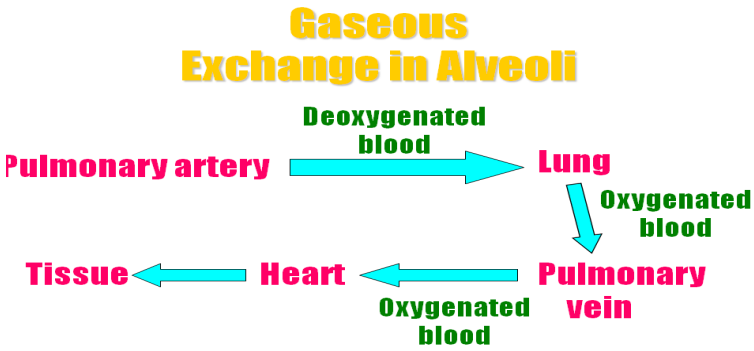




Gaseous Exchange in Alveoli

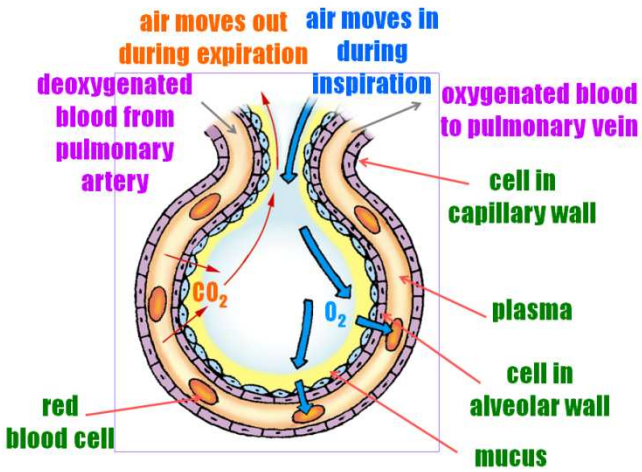






Mechanism of Breathing

- brought about by the action of diaphragm & intercostal muscles
- divided into two processes : inhalation (inspiration) & exhalation (expiration)



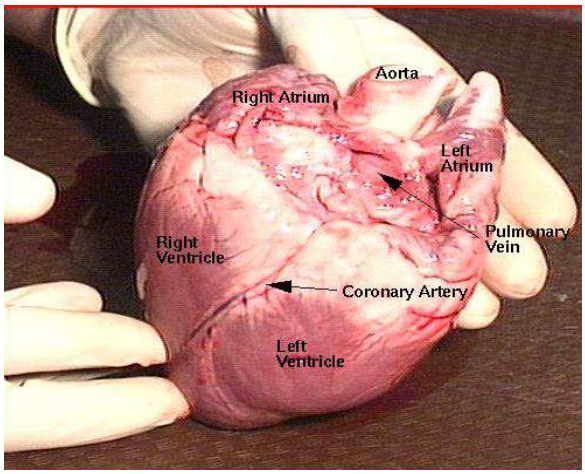
THE CIRCULATORY SYSTEM

- Humans have a closed circulatory system, typical of all vertebrates, in which blood is confined to vessels and is distinct from the interstitial fluid.

– The heart pumps blood into large vessels that branch into smaller ones leading into the organs.

– Materials are exchanged by diffusion between the blood and the interstitial fluid bathing the cells.

Three Major Elements – Heart, Blood Vessels, & Blood

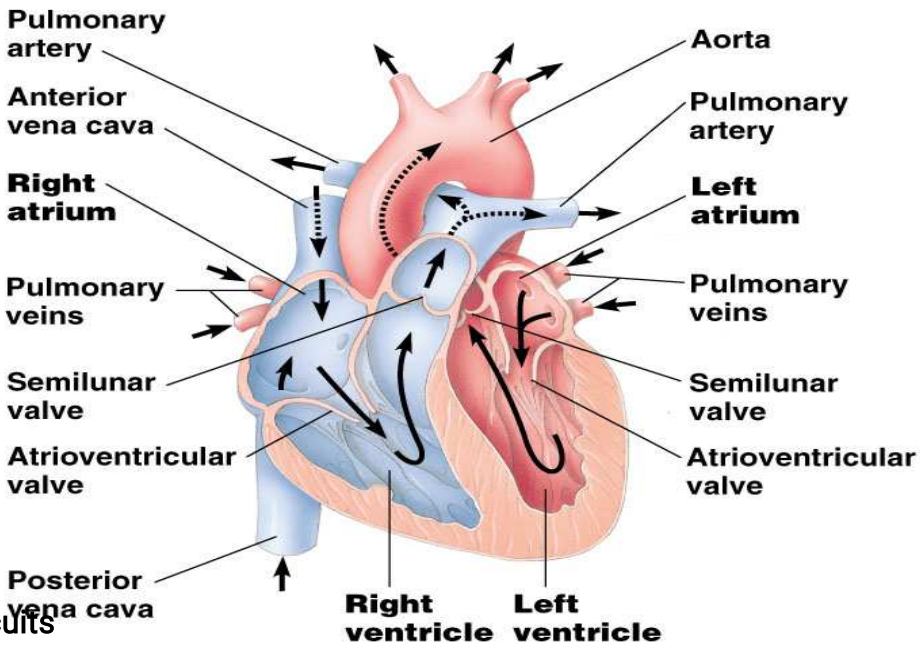


1. The Heart- cardiac muscle tissue

– highly interconnected cells

– four chambers

- Right atrium
- Right ventricle
- Left atrium
- Left ventricle



Circuits

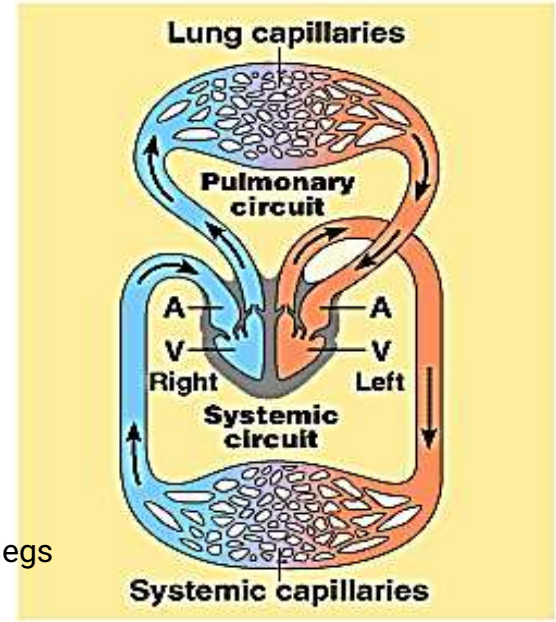
- **Pulmonary circuit**
  - The blood pathway between the right side of the heart, to the lungs, and back to the left side of the heart.

- **Systemic circuit**
  - The pathway between the left and right sides of the heart.

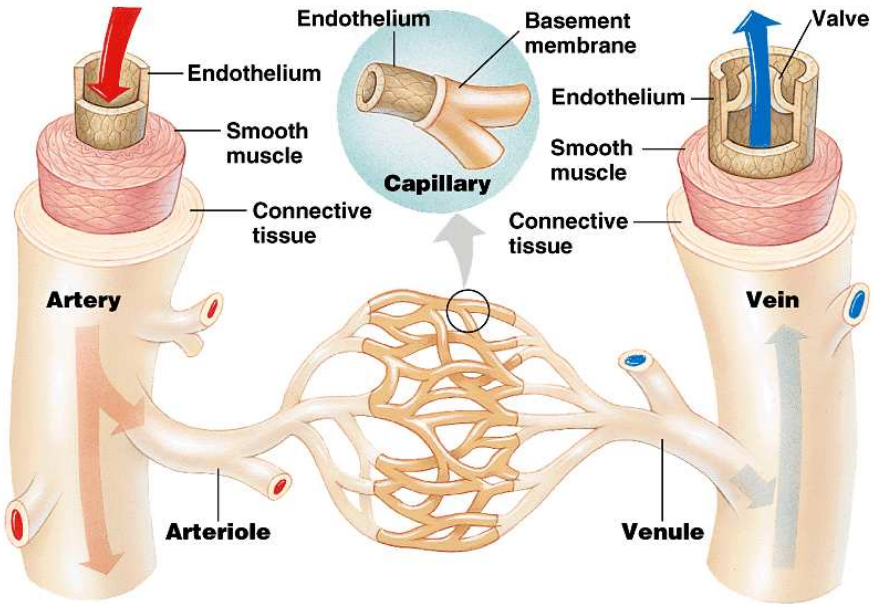
The Cardiovascular System

2. Blood Vessels -A network of tubes

- Arteries→arterioles move away from the heart
  - Elastic Fibers
  - Circular Smooth Muscle
- Capillaries – where gas exchange takes place.
  - One cell thick
  - Serves the Respiratory System
- Veins→Venules moves towards the heart
  - Skeletal Muscles contract to force blood back from legs
  - One way values
  - When they break - varicose veins form

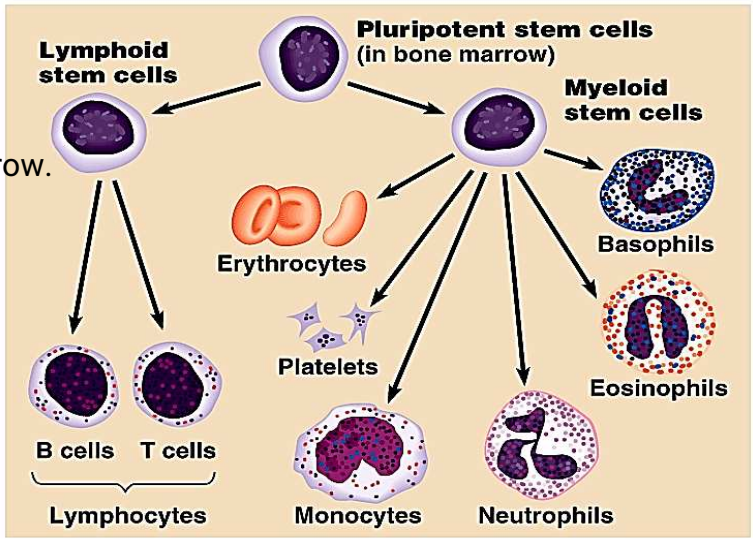


(c) Mammal



3. The Blood:

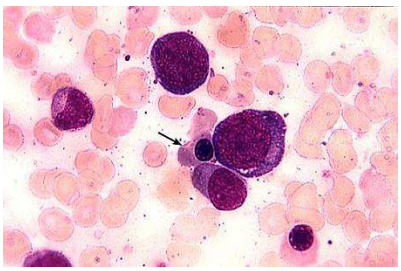
Blood cells are produced from Bone Marrow.



A. Plasma

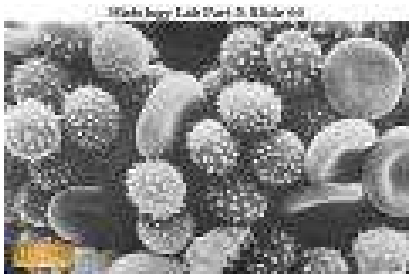
Liquid portion of the blood. Contains clotting factors, hormones, antibodies, dissolved gases, nutrients and waste

B. Erythrocytes - Red Blood Cells



- Carry hemoglobin for transporting Co2 and O2.
- Do not have a nucleus and live only about 120 days.
- Cannot repair themselves.

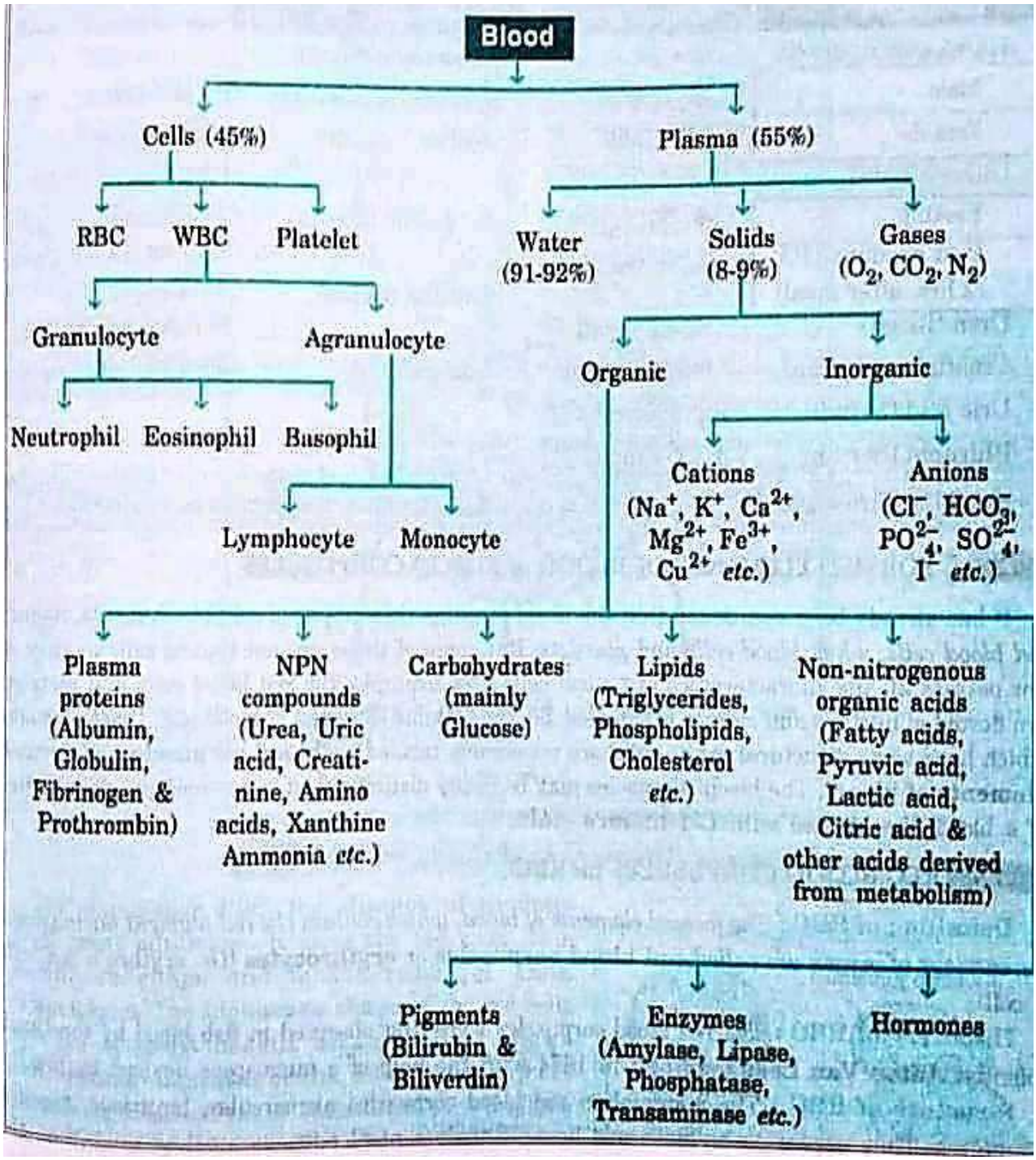
C. Leukocytes – White Blood cells



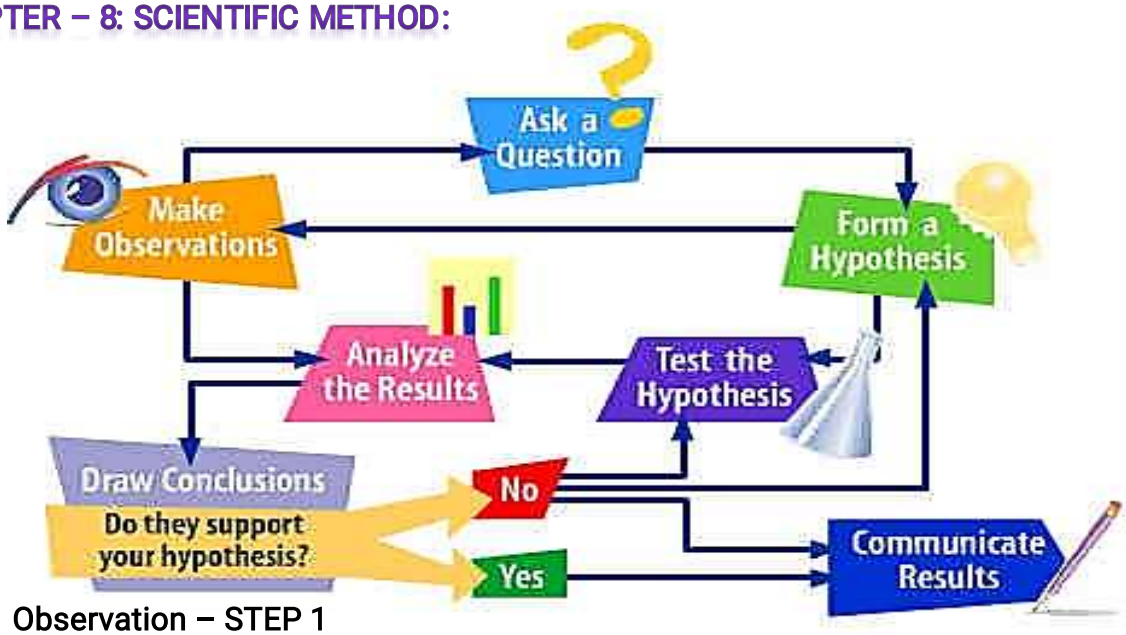
- Fight infection and are formed in the bone marrow
- Five types – neutrophils, lymphocytes, eosinophils, basophils, and monocytes.

D. Thrombocytes – Platelets.

- These are cell fragment that are formed in the bone marrow from megakaryocytes.
- Clot Blood by sticking together – via protein fibers called fibrin.


Blood
Cells (45%)
Plasma (55%)
RBC
WBC
Platelet
Water (91-92%)
Solids (8-9%)
Gases (O_2, CO_2, N_2)
Granulocyte
Agranulocyte
Organic
Inorganic
Neutrophil
Eosinophil
Basophil
Lymphocyte
Monocyte
Cations (Na^+, K^+, Ca^{2+}, Mg^{2+}, Fe^{3+}, Cu^{2+} etc.)
Anions (Cl^-, HCO_3^-, PO_4^{2-}, SO_4^{2-}, I^- etc.)
Plasma proteins (Albumin, Globulin, Fibrinogen & Prothrombin)
NPN compounds (Urea, Uric acid, Creatinine, Amino acids, Xanthine Ammonia etc.)
Carbohydrates (mainly Glucose)
Lipids (Triglycerides, Phospholipids, Cholesterol etc.)
Non-nitrogenous organic acids (Fatty acids, Pyruvic acid, Lactic acid, Citric acid & other acids derived from metabolism)
Pigments (Bilirubin & Biliverdin)
Enzymes (Amylase, Lipase, Phosphatase, Transaminase etc.)
Hormones

CHAPTER – 8: SCIENTIFIC METHOD:



- **Observation – STEP 1**

Employing your five senses to perceive objects or events

Asking a Question: Based on observations; one or more questions are generated

Forming a Hypothesis – STEP 2: A statement is testable if evidence can be collected that either does or doesn't support it

It can never be proven beyond doubt

Often must be refined and revised or discarded

The Hypothesis –-Is a statement made in advance that states the results that will be obtained from testing the hypothesis, often written in the form of an "if-then" statement

- **Experimenting – STEP 3**

Testing a hypothesis or prediction by gathering data under controlled conditions – conducting a controlled experiment

Based on a comparison of a control group with an experimental group

Both groups are identical except for one factor (independent variable)

Observations and measurements are taken for a particular factor (dependent variable) in both groups

Driven by or results from independent variable

- **Measuring**

Involves quantitative data that can be measured in numbers &/or qualitative data information that isn't numbers

- **Sampling**

Technique of using a sample – a small part – to represent the entire population

- **Organizing Data – STEP 4**

Involves placing observations and measurement (data) in order

Graphs, charts, tables, or maps

Collected and organized data must be analyzed

Process of determining whether data are reliable or whether they support or do not support a hypothesis or prediction

- **Conclusion – STEP 5**

Conclusions are made on the basis of facts, not observations

Often drawn from data gathered from a study or experiment

Should support the hypothesis

Should be re-testable

- **Communication – STEP 6**

Scientists must share the results of their studies with other scientists (peers)

Publish findings in journals

Present their findings at scientific meetings

Scientists must be unbiased

Should not tamper with their data

Only publish & report tested & proven ideas

Sharing of information is essential to scientific process

Subject to examination and verification by other scientists

Allows scientists to build on the work of others

- **Theories**

A theory may be formed after many related hypotheses have been tested and supported with experimental evidence

A broad and comprehensive statement of what is thought to be true

Supported by considerable evidence

Ties together related hypotheses

- **Laws**

A Statement of fact that concisely explains an action or group of actions e.g. Law of Gravity

Accepted to be true

Universal

May be expressed as a math equation e.g. $E=mc^2$

Good Luck