BIOLOGY: is the study of life.

a. plant life

b. animal life

c. life of human

d. life of microorganisms.

Biology includes many special branches :

1. **General biology** : include study of living things in general ,the relationship of living things to their surrounding and to each other.

2.**Botany** :the specialized study of plant life and the relationship of plants to other living things .

3.**Zoology :** the specialized study of animal life and the relationship of animals to other living things.

4.**Microbiology**: the specialized study of microorganism (unicellular organisms)

These general branches are in turn separated into further fields of specialized study such as :

Ecology : Study of the interaction of organisms with their environment.

Taxonomy: The study of the kinds and diversity of organisms and the evolutionary relationships among them.

Histology: The study of tissues.

Physiology: is the study of the functions of the human body.

Bacteriology , cytology , immunology ,mycology , genetics , anatomy …. etc .

cell theory: A fundamental theory in biology.

For all organsims the cell is the basic unit of structure. The Schlieden &Schwann(1838-1839) they are suggested three basic tents that :

1.All organsims consist of one or more cells.

2. The cell is the basic unit of life in all living things.

3. All cells arise from pre-existing cells by division.

Types of cells:

Cells can be subdivided into the following subcategories:

1.Prokaryotes: Prokaryotes lack a nucleus (though they do have circular DNA) and other membrane-bound. Organelles (though they do contain ribosomes). Bacteria and Archaea are two domains of prokaryotes.

2. Eukaryotes: Eukaryotes, on the other hand, have distinct nuclei bound by a nuclear membrane and membrane-bound organelles (mitochondria, chloroplasts, lysosomes, rough and smooth endoplasmic reticulum،vacuoles). In addition, they possess organized chromosomes which store genetic material.

Living organisms are characterized by several properties which include :

1.cellular structure (except viruses) (viruses are not membrane bounded as cells)

2.Irritability.

3.Contactility (shorting of the cell).

4.Expand energy

5.Assimilation food and absorption.

6.Excretion.

7.Secretion.

8.Respiration.

9.Growth and Reproduction

Growth :is the formation of new tissue or new substances.

Reproduction : is the formation of new individuals similar to the parents.

The **cell**: is the major structural and functional unit of biology.

most chemical reactions take place within cells.and modern biology involves the together of three strands :

First strand : biochemistry

The chemistry of living organisms and of vital processes. Also known as physiological or biological chemistry. The study of the molecular basis of life.

Most of the development in this field have occurred within the last fifty years. Especially after has been development of techniques such as centrifugation and chromatography ,electrophoresis for the separation of cellular components and molecules.

Second strand :cytology

Study of the structure and function of cells.

Third strand :Genetics

Study of the mechanisms of transmission of traits from parents to offspring.The importance of genetics strand came with the realization that DNA (Deoxyribonucleic acid) is the bearer of genetic information in most life forms.

Biological chemistry :

Atoms and molecules of living materials divided to :

1.micromolecules (inorganic molecules):

2.macromolecules (organic molecules):

micromolecules (inorganic molecules):

- Water

-Mineral salt

Minerals: are inorganic substances that also are essential because no other substance can serve their metabolic functions.large number of chemical elements find in the human body.these element can be considered in four groups:

1.The first group includes : carbon ,hydrogen ,oxygen ,nitrogen and sulfur.The major components of body molecules,these elements are obtained through intake of water and food fats,carbohydrates and proteins.these group form more than 90% of the mass of living material.

2.the second group includes the nutritionally important mineral calcium Ca, phosphorus ,magnesium , sodium, potassium,,and chloride that are required in the diet in a amount greater than 100 mg /dl.These form about 9.5% of living mater.

3.The trace elements ,chromium ,cobalt, copper ,iodine ,iron, manganese, zinc,molybdenum ,selenium.required in the diet in much smaller amounts.

4.The fourth group contains additional elements required for animal nutrition but having no known essential function arsenic ,cadmium ,nickel and silicon.

Water :

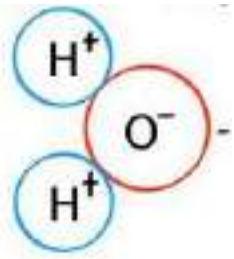
Water in animals or human body on two types:

1.free water 95%

2.bound water 4-5%

Biological properties of water :

1.water is dipole ,a particle with two charges of opposite sign.



2.water has one of the highest heat capacity of any liquid .

3.water has high heat vaporization which is important to any organisms.the heat of vaporization is the amount of heat absorbed when a liquid is transformed into gas.This is an important mechanism in temperature regulation.

4.It is liquid within a wide temperature range (0-100 C^0).

5.High surface tension.

6.has high density at 4 C^0 .

7.Pure water at 25 C^0 has a PH 7.0 (the PH scale range from 0 very acid ,low[H^+] high [H+] to 14 very alkaline.

Salt:

Salt Compound that releases ions other than H and OH in solution.salt in living materials are found in ionic form because of the water in addition to tghose found in undissociation .Salts are ionic compound ,They are classed as electrolytes .Na^+ ,and Cl^- are two of most common ions in cells. Important cations are ,Na^+ , K^+,Ca^{++} ,Mg^{++} ,Cu^{++} , Fe^{+2} or Fe^{+3} .important anions are ,Cl^- , HCO_3, No_3.

The function of these Minerals salts :

1.As constituent of various : chemicals and structures.

2.As enzyme .ex.calcium.

3.As metabolic activator.

4.certain pigment ex:iron Fe^{+2} in hemoglobin.

5.determinants of the anion-cation balance and osmotic pressure.

macromolecules (organic molecules):

These molecules includes:

1.carbohydrates

2.protein

3.Lipids

4.Nucleic acid

5.Enzymes

Carbohydrates : A biological molecule built of carbon, hydrogen, and oxygen atoms, usually in a 1:2:1 ratio. All cells use carbohydrates as structural materials, energy stores, and transportable forms of energy.The three classes of carbohydrates include monosaccharides, disaccharides, and polysaccharides.The simplest carbohydrate are the monosaccharide and the important monosaccharides (sugar) have between three ,and seven carbon atoms and therefore classified as :

1.Trios (three carbon)

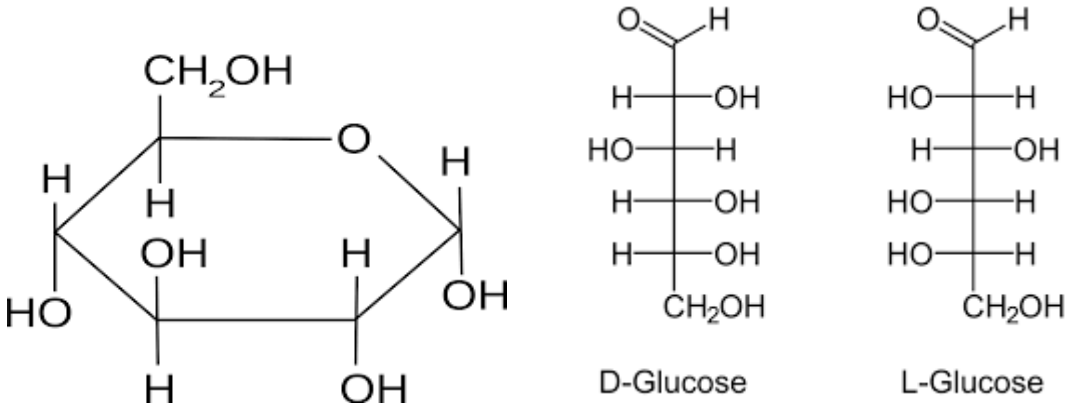
2.Tetrose (four carbon)

3.pentosr (five carbon)

4.Hexose (six carbon)

5.Heptose(seven carbon)

The single most common sugar in the biological world is **D-Glucose**,Which is represented by the formula $C_6H_{12}O_6$.



D-glucose :-the repeating unit of starch and glycogen.

Disaccharides:

Consist of two monosaccharide unit linked covalently.

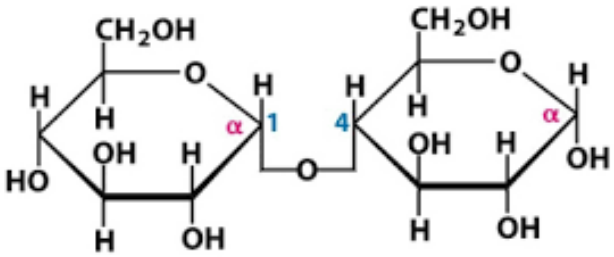
There are three common disaccharides:

1.Maltose : glucose + glucose.

2.Sucrose (table sugar) :glucose + fructose.

3.Lactose (milk sugar): glucose +galactose.

Disccharides formed by linked together by the elimination of water,the result bond is called glycosidic bond.



Maltose

polysaccharides

A straight or branched chain of covalently bonded monomers of the same or different kinds of sugars.Monosaccharides can polymerize to form polysaccharides

such as glycogen(in animal cells) Starch and Cellulose (in plant cells).Glycogen and starch are storage polysaccharides cellulose is structural polysaccharide six carbon sugar (glucose)as its single repeating unit.

Polymer: is a large molecule built of three to millions of subunits. The subunits،called monomers, may be the same or different.

The most important polysaccharides are :

1.Glycogen is stored mainly in the liver and muscle tissue.in the liver it is used as a source of glucose to maintain blood sugar levels.in muscle it severs as fuel source to generate the ATP needed for muscle contraction.

2.Starch occurs as amylose or amylopectin.starch is stored in plants cells as a granules within the plastid.

amylose: is long chains of monosaccharides multi- non branched.

amylopectin: is long chains of monosaccharides multi-branched.

3.Cellulose: The best example for structural polysaccharide found in plant cell wall.

Plants store a large amount of glucose in the form of cellulose. Humans don't have digestive enzymes that can break down the cellulose in whole grains, vegetables, fruits, and other plant tissues. We do benefit from it, however, as undigested "fiber" that adds bulk and so helps move wastes through the lower part of the digestive tract.

Lipids :

A greasy or oily compound of mostly carbon and hydrogen .They are not macromolecules because have few number of C carbon atoms ,and they are not soluble in water because they have a high proportion of nonpolar C-H bonds but soluble in polar solvents such as alcohol ,ether ,benzen , chloroform.they are found

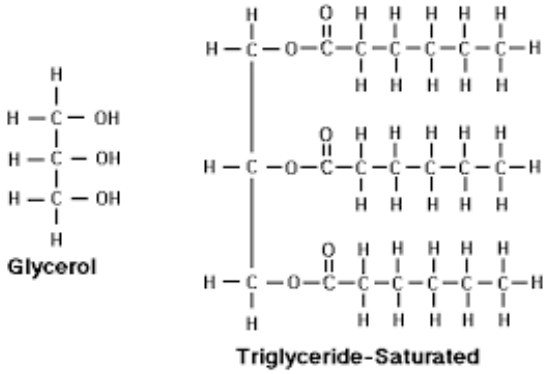
complex with protein in the cell and they consist of C,H,O.Cells use lipids as energy stores and structural materials, especially in membranes.

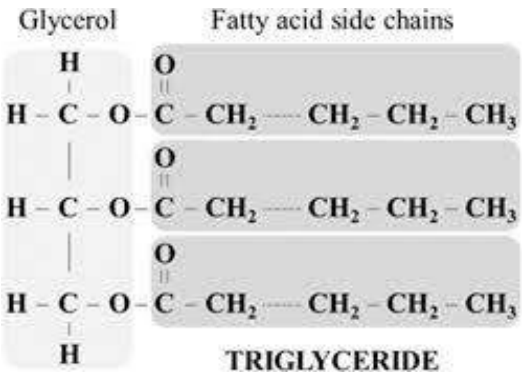
They include:

1.Fatty acids: are Compounds with a backbone of carbon atoms bonded to a carboxyl group.an important class of lipids serving as a building blocks of more complex lipids such as phospholipids (important elements in membrane structure and a source of energy for cells).two type of fatty acids :saturated (solid), unsaturated(fluid).

2.Fats:

Fats are defined as solid at 20 C^0 ,example for that triglyceride (esters of fatty acids and glycerol).

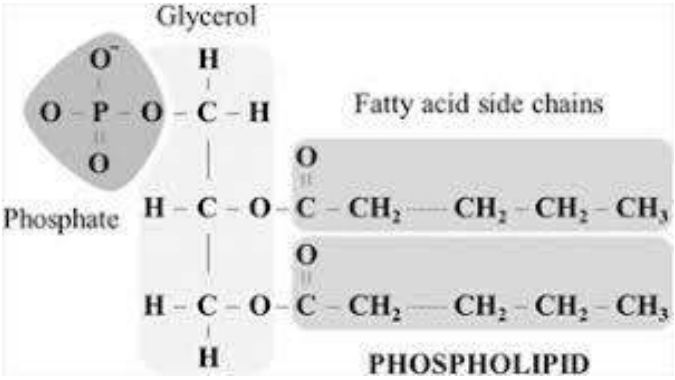




Triglyceride:(neutral fat) A lipid having three fatty acids tail attached to a glycerol backbone. Triglycerides are the body's most abundant lipids and richest energy source.Its primary important or purpose in cells is a storage form of energy and they are element of membrane structure and also this is the form in which fatty acids are important during hibernation migration and starvation.

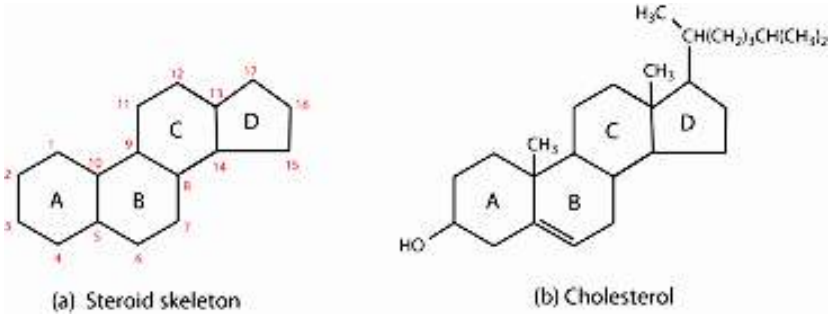
3.Phospholipids: A type of lipid that is the main structural component of cell membranes. Each has a hydrophobic tail(of two fatty acids) and a hydrophilic head that incorporates glycerol and a phosphate group.

Phospholipids found in plasma and cell membrane.The presence of negatively charged phosphate and a positively charged makes the phospholipids electrically neutral but highly polar in the head region.phospholipids are found in plasma membrane .The polar side is outside where as the non-polar inside the cell.



4.Steroids :

The most common steroid in animal is **Cholesterol** widely found in membrane.The steroids are ring compound.



(a) Steroid skeleton (b) Cholesterol

Several classes of mammalian hormones as steroid such as :

1.Adrenocortical hormones :

Hormone which secreted from the adrenal cortex .such as cortisone .

2.Sex hormone :

Which are secreted from the testes and ovaries such as as estrogen , progesterone ,and testerone.

5.Wax :

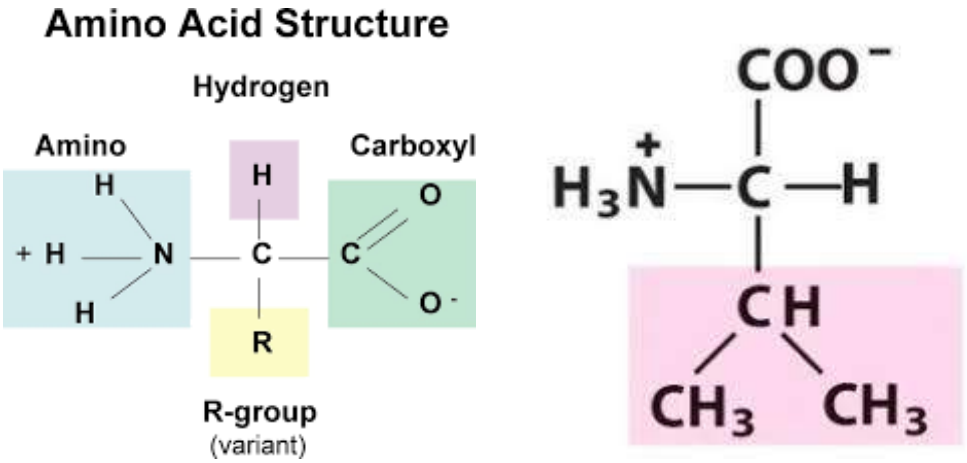
Ester of fatty acids with higher molecular weight and insoluble in water (fatty acids +alcohol).There is found in animals and plants ,and its used to reduce the amount of water lost.also found in exoskeleton in insects and Arthropoda.

Proteins :

is an organic compound built of one or more chains of amino acids. Proteins play a central role in cell function and they may be classified according to their biological functions for example as a structural .catalytic(enzymes) or transport proteins.

The properties of simple proteins :

Proteins are polymers built up from about 20 different amino acids and the general structure of the amino acids found in proteins is



Valine

amino acid: is a small organic compound that consists of an amino group, a carboxyl group (an acid), an atom of hydrogen, and one or more atoms called its R group.The structural formula indicate that amino acids are charged molecules (dipole) at neutral PH .

R:is the amino acid side chain or side group that distinguishes the various amino acids.

Amino acids are classified primarily on the polar or non-polar nature of the distinguishing side groups, which are very important to the nature and properties of the proteins that contained them .

When a cell makes a protein, amino acids become linked one after the other, by peptide bonds to form a dipeptide.moderate –size chains of amino acids joined by peptide bonds are polypeptides.

peptide bond: Covalent bond that joins the amino group of one amino acid to the carboxyl group of a second amino acid.

Protein conformation:

1.Primary structure

2.Secodary structure

3.Tertiary structure

4.Quaternary structure

Most protein structure are stabilized by:-

1.Class of strong bonds (disulfide and peptide).

2.Class of weak bond (hydrogen ,hydrophobic and electrostatic or salt)

Important of Proteins :

1.They are part of basic structure of living cell. Serves as building materials for cells and tissues. for Examples :collagen fibers that strengthen skin.

2.All enzymes are proteins (the live depend on enzyme). **enzyme:** One of a class of proteins that greatly speed up (catalyze) reactions chemical between specific substances.Digestive enzymes that speed the breakdown of complex carbohydrates, fats, and dietary proteins in the digestive system.

3.Some hormones are proteins .ex: Insulin.

4.They form receptor on cell surface. Binds molecules to or inside cells .Example: Receptors that bind hormones to target cells.

5.The form part of Immuno system. ex : plasma globulin.

6.They are important in the transport of gases (O_2 &CO_2) i.e. Hemoglobin.

7.They are carriers of ions &some molecules through the cell membrane.i.e albumin.

8. Movement : Produces movements of cells and cell parts. Examples: Contraction of muscle cells; swimming by sperm cells.

Release of energy inside the cells:

Total chemical reactions in a cell is it **metabolism.** Some reactions release energy and others require it. metabolism is divided into :

1.Catabolism : A metabolic activity that breaks down large molecules into simpler ones, releasing the components for use by cells.

2.Anabolism : A metabolic activity that assembles small molecules into more complex molecules that store energy.

cellular respiration:- Process by which energy is released from organic compounds within cells. The process that involves glycolysis, the Krebs cycle, the electron transport chain and oxidative phosphorelation.

All cells have evolved enzyme systems that can obtain useful energy from the chemical energy of glucose.In all cells there are a basic similarity in reactions sequences of glycolysis and Tricarbonic acid cycle (TCA) pathway for glucose oxidation and energy release.

Energy metabolism can be considered to begin with the conversion of the 6-carbon glucose to two 3-carbon fragments (pyruvate or lactate) in a series of anaerobic reactions (non-oxygen requiring) known as glycolysis.glycolysis prepares intermediates to enter the complete oxidation scheme of (TCA) cycle and oxidative phosphorelation.

Glycolysis :

process that breaks 6-carbon glucose molecule to two 3-carbon molecules (pyruvate) in a series of anaerobic reactions (non-oxygen requiring) in the first stage of cellular respiration, these reactions take place in cytoplasm.

Krebs cycle:

Process that produces energy-rich compounds (NADH and $FADH_2$)that deliver electrons to electron transport systems in mitochondria. The cycle also produces a small amount of ATP.called also TCA or tricarboxylic acid cycle.

electron transport chain:

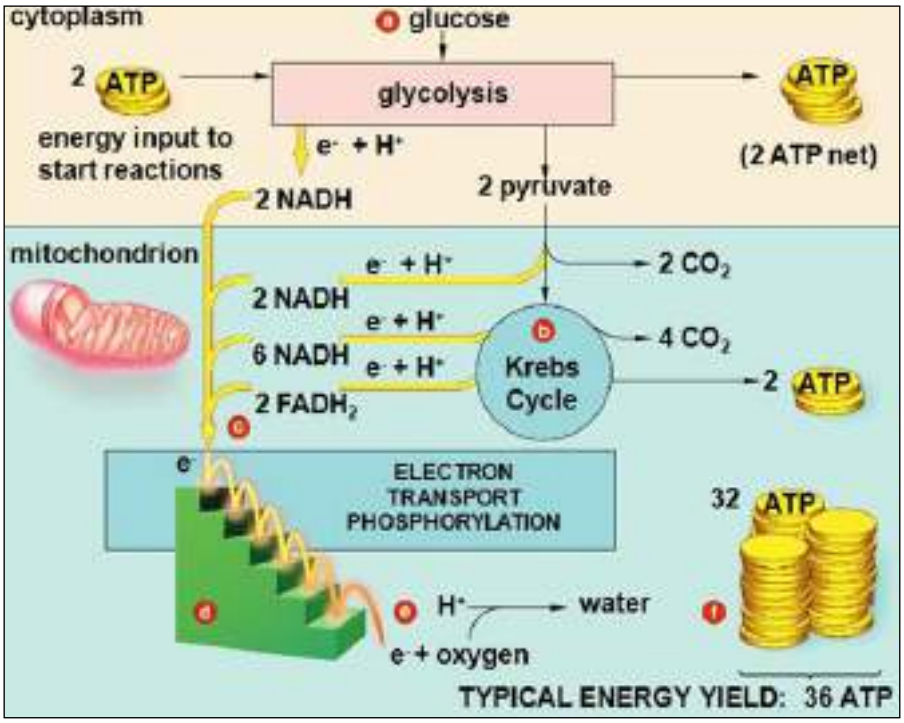
Chain of reactions in mitochondria that use energy from electrons to generate many ATP molecules.

Oxidation –Reduction and cytochromes :

Oxidation is generally defined as the loss of electron (e) by reducing agent (donor) and must always be coupled with the gain of electrons by an oxidizing agent (acceptor).

Cellular oxidation –reduction occurs via the cytochrome chain in a series of steps.

Cytochrome: are electrons carriers , large proteins complex with a heme group that contains an atom of iron acting as an electron acceptor / donor.the major classes of cytochromes include cytochrome a,b,c.



Cellular respiration

Molecular genetics

The flow of information(The gene):

When you hear the word genetics one of your first thought may be gregor mendel ,Whose experiments with peas laid the foundations for our understanding of heredity,and his work led to an understanding of chromosome and genes.

The discovery of DNA:

Miescher:

In his initial experiments , he isolated nuclei from the white blood cells present in pus cell ,he was able to prepare a nuclear extract containing a substance that he called nuclein but that we now known as DNA.

It was to be more than 80 years before DNA would be established as the genetics material.

Viruses on the other hand use either DNA or RNA as their genetic material.

In viruses and prokaryotes the genetic material is stored as molecules of DNA or RNA called **genophores**.All eukaryotic organisms organize and store their DNA in more complex structure called **chromosomes.**

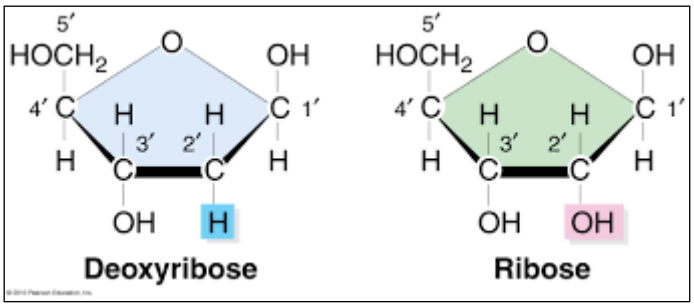
Alfred Hershy &Martha Chase:

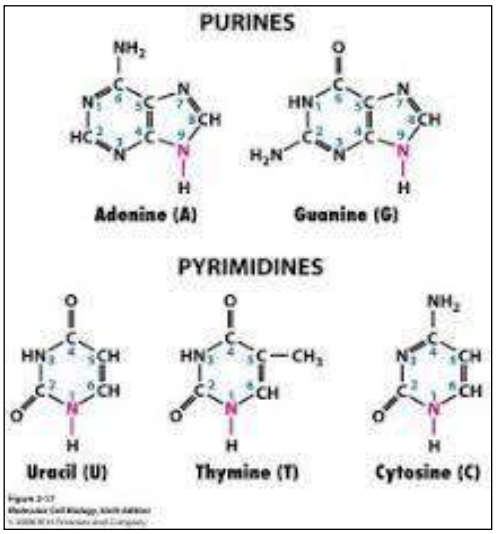
used Bacteriophages to prove that DNA and not protein is the genetic material of bacteriophages.They were able to lable the protein of some phage with the radioactive isotope S^{35} and to lable the DNA of other phages with the isotope P^{32} ,by using radioactive isotope in this way .they were able to trace the fat of both protein and DNA during the infection process.

Nucleic acids :

Are informational macromolecules very important to cell because of their role in the storage , transmission and expressions of genetic information.nucleic acid is A long, single- or double-stranded chain of four different nucleotides joined at their phosphate groups. Nucleic acids differ in which nucleotide base follows the next in the sequence. The two major types of nucleic acid are DNA (deoxyribonucleic acid) and RNA (ribonucleic acid).RNA plays several different roles in expression genetic information.

Nucleotides :A small organic compound having 1.five-carbon sugar (deoxyribose $C_5H_{10}O_4$ or ribose $C_5H_{10}O_5$) 2. Nitrogen-containing base, 3. Phosphate group. Nucleotides are the structural units of adenosine phosphates, nucleotide coenzymes, and nucleic acids.Nucleic acids are polymers (linear) of nucleotides.





Two type of Nitrogen bases :

1.Purines :Adenine(A) ,Guanine (G)

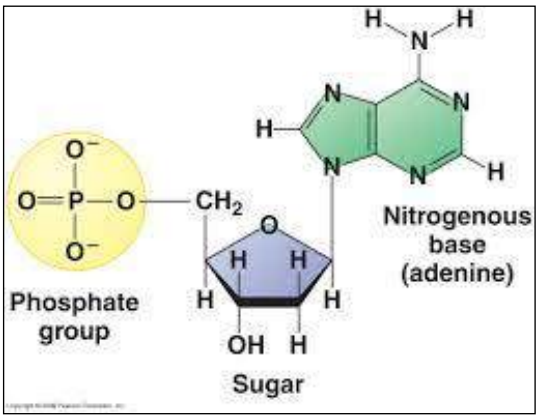
2.Pyrimidines : Uracil (U),Thymine (T),Cytosine (C)

The bases in DNA are the purines adenine and guanine and the pyrimidine thymine and cytosine.In RNA the bases thymine is replaced by uracil.

A—T U—A

G—C G—C

DNA RNA

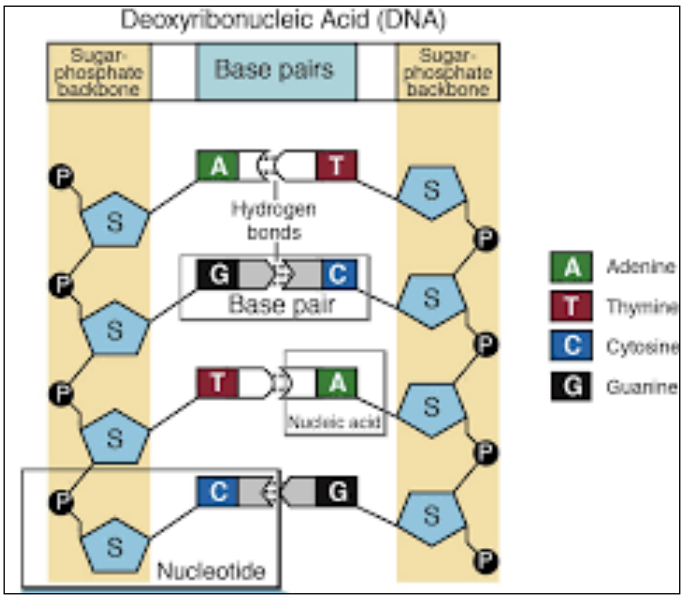


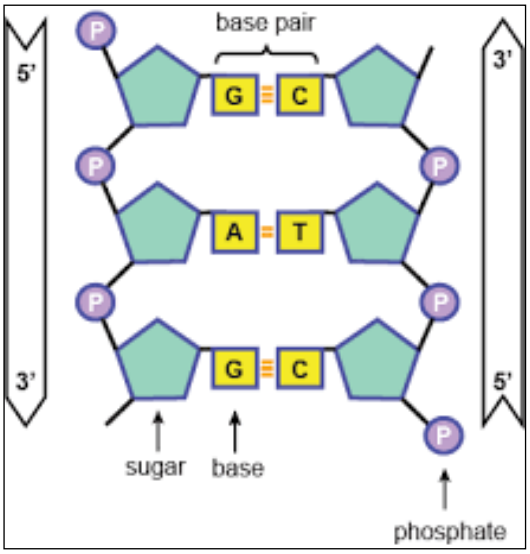
Nucleotide structure

DNA	RNA
Deoxyribose sugar	Ribose sugar
A-G-C-T .Thymine	A-G-C-U Uracil
Double strand,one type of DNA	Single strand ,there are 3 types :tRNA ,rRNA, Mrna

DNA contains deoxyribose ,functionally ,DNA serves primarily as the storage of genetic information.

Watson and Crick postulated a double–strand helical structure (double helix).Essentially double helix consist of two complementary chains of DNA twisted together to form helix.

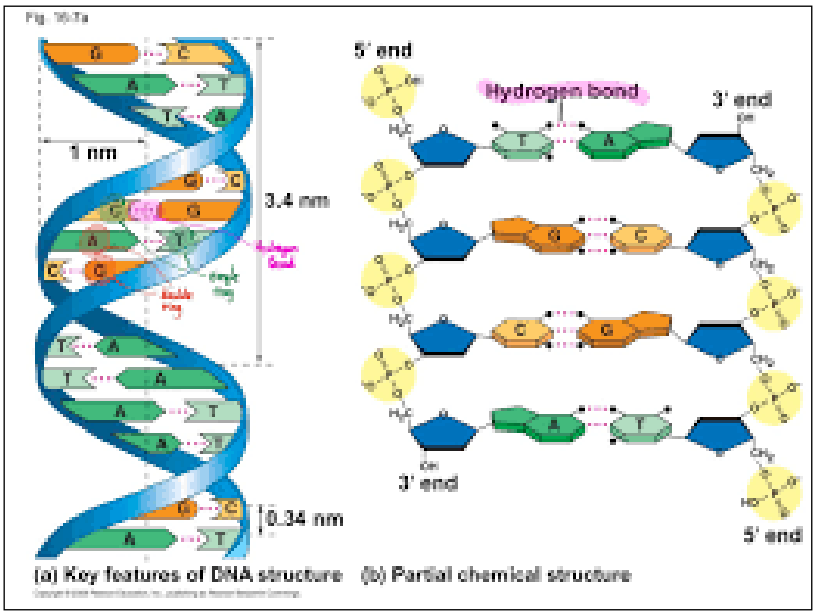




To form a stable double helix ,the two component strand must be complementary, by this we mean that each base in one strand can form specific hydrogen bonds to the base in the other strand.RNA structure also depends on base pairing but this is usually between complementary regions within the same strand.Watson and Crick deduced their model for the double stranded structure or DNA from its X-ray diffraction pattern as determined by Rosalind Franklin.

The backbone of each strand is a repeating sequence of deoxyribose and phosphate groups with a purine and pyrimidine base attached to each sugar.

The helix contains about 10 nucleotides pair turn and advances 0.34nm per nucleotide pair . Each turn of the helix adds 3.4nm to the length of the molecules.



DNA replication:

The process by which the hereditary material in a cell is duplicated for distribution to daughter nuclei.During replication, enzymes called DNA polymerases and other proteins unwind the DNA molecule keep the two unwound strands separated, and assemble and seal a new strand on each one. The unwinding exposes stretches of the molecule'nucleotide bases. Cells contain unattached nucleotides that can pair with the exposed bases. A pair with T and G pairs with C; they are linked by hydrogen bonds. Each parent strand stays intact while a new strand is assembled on it, nucleotide by nucleotide.

DNA polymerases: are Enzymes that function in DNA replication and repair, capable of adding successive nucleotides to a growing DNA strand.

The genetic code and Protein Synthesis:

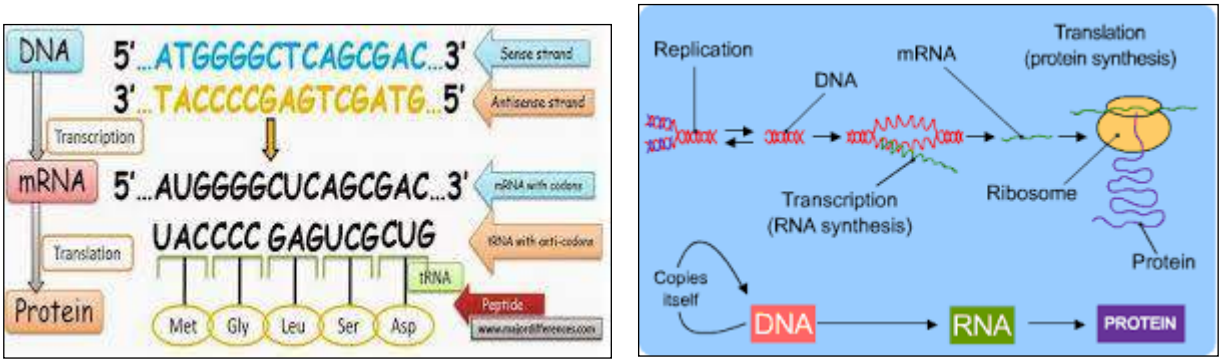
The flow of genetic information from DNA to protein is always a two-step process ,with RNA as an intermediate as an intermediate.

Not that DNA serves as the templet both for its own replication and for RNA synthesis the RNA intermediate in this sequence is called **Messenger RNA**

(mRNA) because it carriers the genetice message from the DNA to the ribosomes where protein synthesis occurs.

In addition to mRNA, two additional classes of RNA are required , Ribosomal RNA(rRNA) and transfer RNA (tRNA).

The synthesis of RNA using DNA as a template is called **transcription**, and the process of protein synthesis is called **translation** because it involves a change in the language itself from the nucleotide sequence of the mRNA and the amino acid sequence of the protein.



Protein Synthesis

Genetic code:

Each "word" in the mRNA instructions for building a protein is a set of three nucleotide bases that are "read" by a cell's protein making machinery. These base triplets are called **codons**. There are sixty-four kinds of codons .Together they are the genetic code—a cell's direct instructions for making proteins .The order of different codons in an mRNA molecule determines determines the order of amino acids that are assembled into a protein.

codon : A set of three nucleotide bases in mRNA; they are the three-letter "words" of the genetic code.

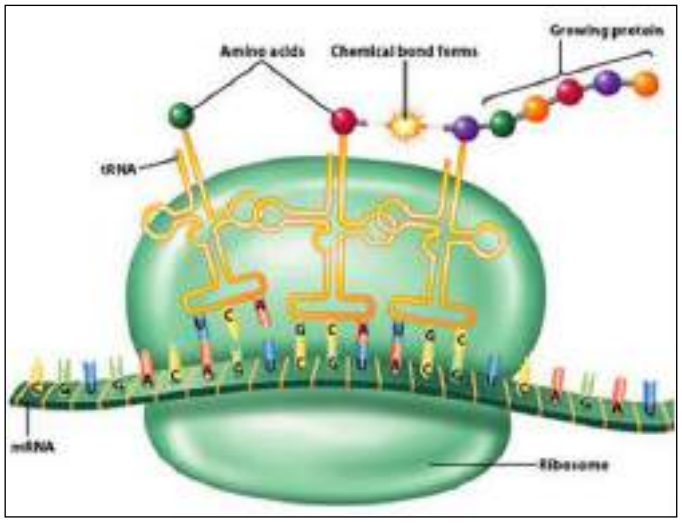
Genetic code : The correspondence between nucleotide triplets in DNA (then in mRNA)and specific sequences of amino acids in the resulting polypeptide chains; the basic language of protein synthesis.

Ribosome serve as the intracellular site of translation and mRNA molecules are the agent that ensure insertion of the correct amino acid at each position in the polypeptide.each ribosome consist of two subunits ,large and small ,each of which is made up of RNA plus a large number of proteins.

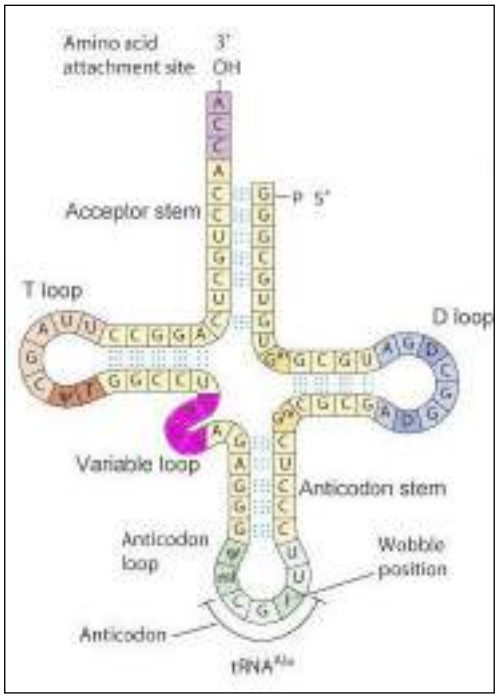
rRNA : Component of the ribosome that serve as the site of protein synthesis.

mRNA: directs amino acid sequence of polypeptide.

tRNA : binds to amino acids and , direct them to proper location within the growing polypeptide chain.



Translation of mRNA



tRNA

Mutation : Heritable change in the gen structure of a chromosome that can produce structural variation in offspring.or Mutaion : are changes in the genetics

material which are reflect in the form of morphology or physiological abnormality. Mutation rate is very low , according to some estimates an average gen accumulates one mutation every 200000 years. Which are spontaneous ,unpredictable alterations in the genome .usually involving changes in specific bases or rearrangements in the order of nucleotides.

Causes of mutations :

1.error in DNA replication or in mRNA.

2.Abnormal division(cell division).

3.Chemical and physical factors some chemicals called mutagens ,radiation such as: X-ray -Gamma ray-U.V (ultra violet)-Phenol .

Animal nutrition &Digestion

Animal nutrition has been defined as the series of processes by which an animal takes in and assimilates the various foods needed to promote growth and maintain and replace worn tissues.

The Science of animal nutrition is including elements biochemistry ,physiology ,thermodynamics, microbiology ,animal behavior and ecology .

All life is based on the ability of plants to synthesize organic constituents from the inorganic materials of the soil and atmosphere.

Organisms that can synthesize ,all essential organic compounds from inorganic source are autotrophs and include the chlorophyll containing green plants ,most animals require an intake of organic compounds and are heterotrophs.

We discussed the major organic constituents of animals ,the amino acids and protein ,carbohydrates ,lipids.

There are about 20 a.a which are found in proteins ,but only a few are essential and must be obtain through the , diet in human the essential amino acid include valine ,leucine , isoleucine ,lysine ,methionine , threoinin ,phenylalanine , and tryptophan.some fatty acids are also essential .

A material becomes an essential nutrient when an organism lacks the enzymes to synthesis from other materials.

In additional to the basic nutrients ,such as protein ,carbihydrates and lipids animals may also required other organic compound in trace a amounts.There are vitamins , which in many cases appear to be needed as part of coenzyme molecules.

Coenzyme: Enzyme “helper ”molecule that moves hydrogen atoms and electrons to the sites of chemical reactions in cells.NAD+ is an example.

Nutrients:

Substances that we must have in our diets in order for our cells to function properly.Are devided into :-

Macronutrient : needed in large quantities ,includes:- water ,carbohydrates , fats ,and protein.

Micronutrient : required in small amounts ,includes :Minerals and vitamins.

Minerals:

The term minerals refers to inorganic chemical elements and ions.they are required only in small amount ,but are essential for the healthy functioning of the body.

element	Main sources	Why needed ?	Effect of lack shortage
Major elements			
Sodium	Table salt, soy sauce,prepared foods	Healthy salt – water balance,muscle and nerve cells function	Muscle cramps
Calcium	Dairy products, dark green vegetables, dried legumes	Bone,tooth formation ؛blood clotting; neural and muscle action	Stunted growth ,soft bones in children(rickets)
Iron	Whole grains, leafy greens ،legumes, nuts, eggs, red meat،shellfish, dried	Formation of hemoglobin and cytochrome used in electron	Iron-deficiency anemia impaired immunity,tiredness

	fruit	transport	
Phosphorus	Whole grains,poultry red meat,all foods	Healthy bones, teeth; forming nucleic acids, ATP,phospholipids	Muscular weakness; loss of minerals from bone.
Minor (trace element)			
Iodine	Marine fish, shellfish, iodized salt,dairy products and drinking water.	Formation of thyroid hormone (thyroxin)	Enlarged thyroid (goiter) metabolic disorders
Fluorine	Drinking water,tea	Maintaining teeth ,bones	Tooth decay
element	Main sources	Why needed ?	Effect of lack shortage
Zinc	Whole grains, legumes, nuts،meats, seafood	Formation of digestive enzymes ؛normal growth, wound healing ، sperm formation, senses of taste and smell	Stunted growth; scaly skin,impaired immunity
Magnesium	Whole grains, legumes,nuts ،dairy products	Coenzyme role in ATP/ADP cycle؛ proper muscle, nerve function	Weak,sore muscles ؛impaired nerve function

Vitamins : are organic substances with essential functions in metabolism.

1.water soluble :-B-complex ,C

2.Fat –soluble :-A,D,E,K

It is difficult to assess the exact amount of vit .require in diet.Provitamins are converted to vitamins .at varying rates by the body .Antivitamins oppose vitamin activity. Some vits are in bound form and are thus not available to the body.

Some vits can synthesis by bacteria as Vit K ,B_{12} ,nicotinic acid , riboflavin (B_2) and folic acid ,in the large intestine.Some bacteria actually vits from the diet.

Some important vitamins required by humans

Vitamin	Main sources	Why needed ?	Effect of lack shortage
Fat soluble			
Vitamin A	Orange fruits and vegetables,leafy greens, egg yolk	Component of visual pigments, maintains epithelia	Night blindness, skin problems
Vitamin D	Fatty fish,egg yolk	Aids uptake and use of calcium	Weak/soft bones, rickets in children
Vitamin K	Green vegetables	Needed for blood clotting	Long clotting time
Water soluble			
B_1(thiamin)	Meats, legumes,cereals ,yeast	Coenzyme in carbohydrate metabolism(cellular respiration)	Beri-beri (neurological and heart problems).
B_2(riboflavin)	Meats, eggs,, milk ،green	Component of the	Anemia, sores in mouth, sore

	vegetables	coenzyme FAD	throat
B_3(Niacin)	Meats, fish, dairy products ، nuts, legumes	Component of the coenzyme NAD	Diarrhoea , skin and mucous membrane sore, gut pain, psychosis, dementia
B_6	Meats,fish, starchy vegetables ، noncitrus fruits	Coenzyme in protein metabolism	Anemia, sores on lips,depression, impaired immune function
B7 (biotin)	Meats, fish, nuts, legumes ، whole grains	Coenzyme in many reactions.	Hair loss, dry skin, dry eyes, fatigue،insomnia,depression
B_9(folic acid)	Meats,fruits,green vegetables ، whole grains	Coenzyme in nucleic acid synthesis and amino acid metabolism.	Anemia, sores in mouth; deficiency during pregnancy causes neurological birth defects
B_{12}	Meats, seafood, dairy products	Coenzyme in amino acid synthesis	Anemia,fatigue,neurological problems
C(ascorbic acid)	Citrus fruits ,green vegetable	Required for collagen synthesis, anitooxidant	Scurvy (anemia, bleeding gums, impaired wound healing, swollen joints)

Food additives :

A food additives is a chemical substance , natural or synthetic, which is added by the manufacture to food.

Additives sweeten,flavor ,colour,stabilize or preserve the food.stabilizers prevent chemical reactions taking place in the food which might spoil its consistency.

Preservatives include anti –bacterial and anti –fungal agents which help to prevent the food going bad.

Sweeteners include saccharine ,a non –fattening ,synthetic substance about 300 times sweeter than sugar.

Advantages and disadvantages of food additives:

Advantages :they make the food look and taste more attractive ,and prolong its life.

Disadvantages : some people are allergic to certain additives, make children hyperactive and some may have long –term damaging effects on health.

Calorie values of food stuffe :

Calorie(cal) : amount of heat energy necessary to arise the temperature of 1 gm of water 1 degree.

Water ,minerals and vitamins have no calorie values.

Organic food stuffe has different calorie values.

	Calorie /gram	
Protein	4.4	K.Calorie =1000
Fats	9.3	

Carbohydrates	4.1	

Malnutrition:

It is due to either :

In adequate amount of calories .or

Deficiency in some nutrients especially

A / proteins

B /Vits

C / Trace elements

Nutritionally Amino acid are devided into two groups :-

-The essential amino acid should be include in the food because the body is not capable of making them .

-Non essential amino acid can be made inside the boody .

Essential amino acid include :

Valine ,leucine , isoleucine , methionine ,phenylalanine ,lysine,tryptophan.

Nutrition divided into :

Autotrophic nutrition :

This types of feeding is employed by plants

Involves synthesis of organic compound from inorganic raw materials (some times is called holophytic nutrition).

Heterotrophic nutrition :

Organisms that are unable to synthesize their food from simple inorganic raw materials.

They must obtain their food in organic form .they include all animals ,fungi,most bacteria ,protists and a new flowering plants.

There are three types of heterotrophic nutrition are recognized :

1.Holozoic nutrition :

Involves feeding on solid organic material.food materials to be made available to the body must be in form of simple molecules to pass through the cell membrane into the body.

In terms of the type of food they eat , animals devided into :-

a.Herbivores :- animals feed on plants (plants eater)i.e sheep , cattle .

b. Carnivores :- animals feed on other animals (animals eater) i.e: fox

c.Ominvores :- animals eating animals and vegetable.(eat both plants material and animal tissues)

2.Saprophytic nutrition :

Involves feeding on dead and decaying organic material (animal &plant).

Fungi ,Protista , bacteria , some animals .

3.Parasitic nutrition :-

Involves feeding on the organic compounds present in the body of another living organism (called the host) .the parasite may cause harm to the host.i.e: lice ,malaria.

Feeding mechanisms :-

The ways in which animals obtain their food ,it can placed into three main groups:-

Microphagous feeder :-

Aquatic animals feed on relatively small food particles suspended in water .they feed continuously ,examples of microphagous animal are paramecium ,and mytilus (marine ,mussel).

Macrophagous feeder :-

Feed on relatively large food particles. They feed occasionally ,the large food particles need to be broken up by mechanical and chemical action .example :Hydra ,cockroach and most vertebrates (including human).

Fluid feeder (or liguid feeder):

Most animal which feed on fluid ,They have special tubular mouth parts.

Sand fly (Leishmania mosquito)

Anopheles (malaria mosquito)

Cimex lectularins (bed –bag)

Lipidoptera (butterflies& moths)

Animals also require inorganic materials in their diets.Some are needed in large amount for example ,sodium ,potassium , chloride ,phosphate and magnesium ,Iron .animals also require micronutrients such as trace elements :cobalt ,copper ,fluoride .

Digestion:

Is a series of processes by which food particles and molecules are broken down into simpler substances that can be absorbed or utilized by cells.

Digestion may be intracellular ,extra cellular or both.Intracellular digestion is considered to be the primitive method found in all protozoa and sponges.

There are two types of digestion:

1.Mechanical digestion:-

breaks food down into smaller pieces,is specially needed in herbivores animals .cellulose for example must be crushed before enzymes can be reaching the plant macromolecules.

2.Chemical digestion:- enzymatic break down of large organic molecules into their components.

The final steps in the degradation of food is accomplished by chains of enzymes nearly all hydrolytic in nature.They include proteinases that break down proteins and peptides , lipase and esterase that act on lipid materials and carbohydrates or glycosidase that break down poly and disaccharides.

Digestive system: is long tube with specialized regions where food is ingested, digested, and absorbed and undigested residues are stored, then eliminated.

Human digestive system consists of :-

(1) An alimentary canal : Mouth, pharynx, esophagus, stomach, small intestine, large intestine also known as the colon, rectum and anus.

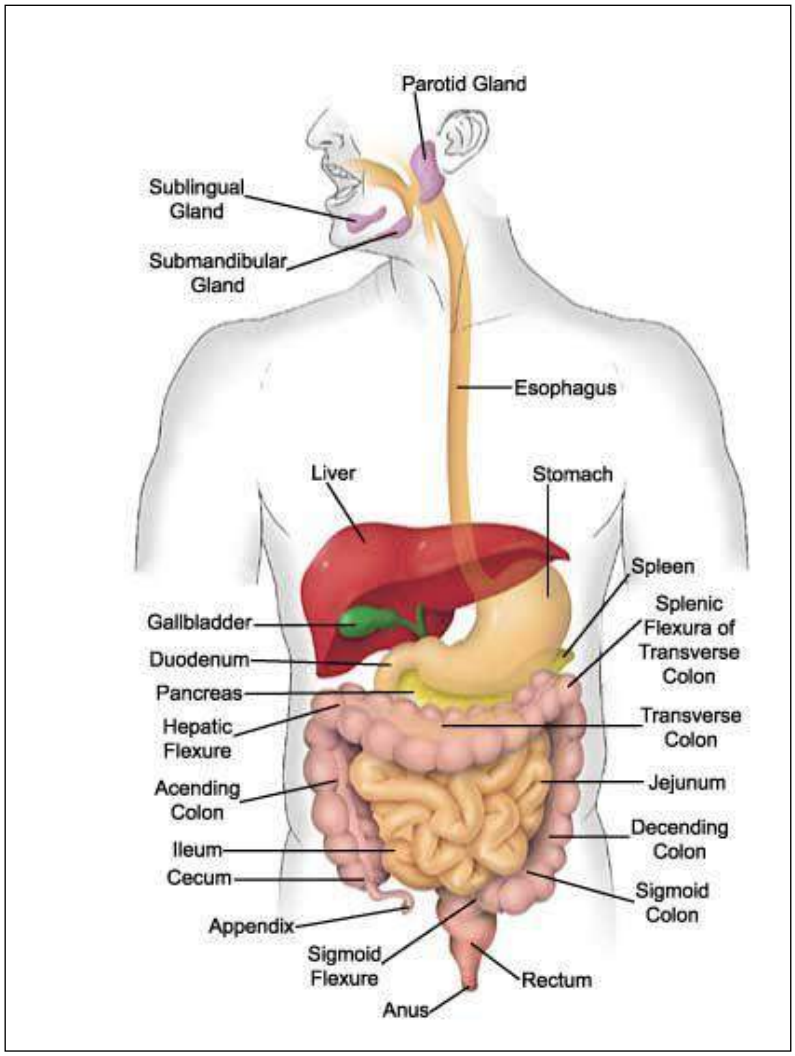
(2) Accessory Organs: salivary glands ,liver ,gallbladder,pacrease.

Chemical digestion is initiated in mammals by the **saliva** secreted by glands of the oral cavity.(Three major pairs of glands under nervous control)

1.parotide

2.Sublingual

3.Submandibular



Saliva is watery substance formed in the mouths of animals ,secreted by the salivary glands .Human saliva consist of 99.5% water and electrolytes ,mucus ,WBC ,epithelial cell ,enzymes and antibacterial agents such as lysozyme.

Saliva contain amylase ;which begins the digestion of starches in some mammals but the major component of saliva is a mucus secretion that serves to lubricate the passage of food masses through the esophagus during swallowing.

Both olfactory and gustatory stimuli act to initiate the secretion of saliva.The sensory fibers initiate action in the stomach resulting in the release of pepsin.

The release of pepsin by the long tubular cells of the fundus of the stomach.pepsin is an endopeptidase that breaks peptide bonds inside polypeptide chains and that required an acid pH for optimum activity (about pH :1.8).

The proper environment for **pepsin** activity is achieved through the secretion of HCL by parietal cells of gastric mucosa.HCL secretion is initiated by the release of the hormone **Gastrin** by pyloric wall of the stomach.

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The major phase of chemical digestion take place in the small intestine it secretes peptidase ,which cleave specific located peptide bonds within the polypeptides and include pepsin ,trypsin and Chemotrypsin .

Lipids are hydrolyzed by lipase and esterase in the small intestine to yield fatty acids and glycerol.

Fats are emulisifed in order to present a large surface area for enzymatic action and much fat appears to be directly absorbed in the form of fine droplets (less than a bout 0.5 u in diameter and with a negative charge).

Emulsification : In digestion, the breaking of large fat globules into a suspension of fat droplets coated with bile salts released from the gallbladder.

Such droplets pass directly the intestinal wall and into the circulation.A variety of enzyme that break down carbohydrates are released by the pancreas and intestinal mucosa ,such as glycosidase that which hydrolyze polysaccharides.and the final

degradation of carbohydrate and peptides may be intracellular events combined with the transport system for glucose and other simple sugars and amino acids.

Pacreas: The pancreas nestles behind and below the stomach,assist digestion but are outside the digestive tube. It contains exocrine cells that release digestive enzymes into the duodenum, the first section of the small intestine. The pancreas also contains endocrine cells that release hormones into the blood. The hormones help regulate blood sugar.

There are four types of pancreatic enzymes, which can chemically degradation the four major categories of food—complex carbohydrates, proteins, lipids, and nucleic acids ,are secreted in the pancreatic juice , These enzymes work best when the pH is neutral or slightly alkaline PH :7 or above , so the "pancreatic juice" also contains large amounts bicarbonate ($HCO3^-$), which neutralizes the acid in chyme moving into the duodenum from the stomach.

Pancreatic secretion :

In under hormone control , Pancreozymin ,this hormone stimulates the release of enzymes by the pancreas ,when the acids are present in the intestine.Secretin (other hormone) initiates the flow of pancreatic fluid rich in bicarbonates that can neutralize the acid mixture of the stomach.

Nervous and hormonal control:

In animals that are discontinuous feeder ,hormonal mechanisms usually serve to produce a regular ,order secretion of appropriate enzymes at the proper time and in proper a mounts within the digestive tract ,and the sensory fibers involved are stimulated by the intake of food and initiate action in both sympathetic and parasympathetic fibers of the autonomic nervous system to cause glandular secrtion .It may be noted that in many animals action in the anterior portion of gastrointestinal tract are initiated by nervous action ,where hormonal control dominate in other regions of the tract .

The release of the hormone **gastrin** (stimulates cells that secrete HCl and pepsinogen) by the pyloric wall of the stomach is initiated by mechanical or chemical stimulation of the pyloric wall.

The bile salts ,which are released from the gallbladder (Bile is stored in the gallbladder, a small sac tucked behind the liver. As needed, the gallbladder contracts and empties bile into the small intestine where it aids in the digestion and absorption of fats. When no food is in the small intestine, a sphincter closes off the main bile duct ،and bile backs up into the gallbladder.) ,controlled by the hormone Cholecystokinin, which is secreted when chyme is present in the duodenum.

The presence of fats in the intestine also triggers the release of Enterogastrone a hormone that is released into the blood and that inhibits the gastric secretion.

Liver :

The liver is the largest internal organ, weighing about 1.5 kg in the adult.and is positioned immediately beneath the diaphragm in the abdominal cavity.

Liver Functions :

1. Detoxication of Blood : Phagocytosis by Kupffer cells,Chemical alteration of biologically active molecules (hormones and drugs), Production of urea (from ammonia),uric acid,and other molecules that are less toxic than parent compounds.

2. Carbohydrate Metabolism:. Stores some excess blood glucose as glycogen and fat Production of glucose.

3. Lipid Metabolism :Synthesis of triglycerides and cholesterol ,Excretion of cholesterol in bile.

4. Protein Synthesis: production of albumin , plasma transport proteins and clotting factors(fibrinogen, prothrombin).

5.Formation the bile used in fat digestion.

6. Storage of blood.

7. Storage of some vitamins(A,D) and minerals (iron).

Principle digestive enzymes

Source	Enzyme	Activator	Substrate	Gatalytic function or (product)
Salivary	Salivary amylase , ptylin	---	starch	maltose
Stomach	Pepsin,pepsinogen	HCL	Proteins and polypeptides	Amino acid
Exocrine pancreas	Trypsin Trypsinogen	Enterokinase	Proteins &peptides	Amino acids
	Pancreatic lipase	Emulsifying	Triglycerides	Fatty acids
	Pancreatic amylase	Cl	starch	maltose
Intestinal mucosa	Maltase	----	maltose	Glucose
	lactase	-----	lactose	Glucose +galactose
	sucrase	------	sucrose	Fructose +glucose
	Intestinal lipase	-----	Monoglyceride	Glyceride +fatty acids
	Chymotrypsin	trypsin	Protein&peptide	Amino acids
	Ribonuclease	----	RNA	Nucleotides
	Deoxyribo nuclease	----	DNA	nucleotides

Absorption:

The movement of nutrients, fluid, and ions across the gastrointestinal tract lining and into the internal environment.

Food materials , especially in the form of amino acids , monosaccharides and fatty acids and glycerol are taken into intestinal cells by the transport processes.In the digestive tract there is usually a region specialized for the absorption of food molecules.in vertebrates this is the small intestine (brush border regions of intestinal epithelial cells).

The sugars molecules pass from the mucosal cells to the blood in the capillaries draining into the portal vein.some hexoses and the pentoses are absorbed by diffusion ,but glucose and galactose are absorbed by active transport.The maximal rate of glucose absorption from the intestine is about 120g /hour.

The absorption of a.a is rapid in the duodenum and jejunum but slow in the ileum.the transport of a.a is facilitated by high Na + concentration on the mucosal sides of the intestinal epithelial cells.

Fat absorption :

40% to 50% of the triglycerides in the diet are hydrolyzed only to monoglyceride and absorbed into to intestinal mucosa cells and pass directly into the portal blood where they are transported as free fatty acids .

Fat absorption is greatest in the upper parts of the small intestine ,95% or more of the ingested fat is absorbed.

Vitamins :

Absorption of the water –soluble vitamins is rapid.but absorption of the fat –soluble vitamins A,D,E and K .Is depressed due to lack of pancreatic enzymes or if bile is excluded from the intestine.Most vitamins are absorbed in the upper small intestine.

Water &Na &Ca ++

Water : moves freely in both directions across the mucous of the small and large intestines and to a lesser degree across the gastric mucous.

Na^+ : diffuses into or out of the small intestine depending upon the salinity of the intestinal contents .It is also actively transported out of the lumen in the small intestine and colon.

Calcium : 30% - 80 % of ingested calcium is absorbed ,active transport of Ca^{++} out of the intestinal lumen occurs primarily in the upper small intestine .

Different animals eat many different types of food and use many diverse mechanisms to take in food.

There are three major classes of feeders (for invertebrates) :-

1) Microphages : animals that eat small food particles.

2) Macrophages : animals the eat large food particles or masses.

3) fluid feeders : a small group of animals that feed on the fluids or tissues of animals.The food of fluid feeders is generally of small dimensions and in dissolved state.

Animals respiration :

Is process composed of the uptake of oxygen from the environment and its utilization by the animals ,together with the production of carbon dioxide by cells and its release by the animal into the environment .

All animals require oxygen because it serves as the final hydrogen and electron acceptor in the cytochrome chain of mitochondrial oxidative phosphorylation.only a very few animals can survive using only anaerobic glycolysis.

Carbon dioxide is one of the major waste products of the oxidation of carbohydrate , proteins , and lipids .This gaseous acidic substance must be excreted by the animal.

Animal respiration is divided into three phases :-

1) External respiration (Ventilation) :- The mechanism by which an animal obtain oxygen from its environment ,and those by which an animal releases carbon dioxide into its environment.

2) Gas transport (gas exchange):- The mechanisms used to distribute oxygen to all of an animals body cells ,and the mechanisms by which carbon dioxide CO_2 is moved from body cells to sites of release into the environment.

3) Internal respiration (cellular respiration):- The metabolic reactions in which oxygen is utilized by cells to produce energy and the reactions that produce carbon dioxide in cells.

Oxygen has diffused from the atmosphere across the respiratory surface and into the blood it is often transported by means of respiratory pigments. Vertebrate blood plasma can contain maximally about 0.3 ml of O_2 per 100 ml.

By using transport pigments the concentration of oxygen carried by the blood may amount to 5 to 30 ml of O_2 per 100 ml depending on the species.

Human blood can carry about 20 ml O_2 / 100 ml blood.

Oxygen transport pigments are conjugated protein, that is proteins complexed with another organic molecule or with one or more metal atoms. These transport molecules are colored, thus the term respiratory pigment.

Transport pigments contain metal atoms such as Cu^{+2} or Fe^{+2} to which oxygen can reversibly attach or (combine with molecular oxygen) because the quickly remove oxygen from solution at the respiratory surface, thus maintaining a concentration gradient down which oxygen can diffuse.

In all vertebrates and many invertebrates the respiratory pigment is hemoglobin.

Hemoglobin has a molecular weight of 68000 and is composed of two pairs of polypeptide chains. Each chain carries an iron-containing heme group.

When four oxygen attached to hemoglobin the resulting complex is oxyhemoglobin.

Hemoglobin acts as a transport pigment in different vertebrate groups, lamprey hagfish and also found in many invertebrates but its presence is not indicative of an oxygen transport function, some snails hemoglobin acts as an oxygen storage pigment and acts as a transport pigment in most annelids.

Circulation :

As animals increased in size or became more active, a transport system was needed to ensure that all body cells were supplied with nutrients oxygen and that metabolic waste products were quickly removed to a place where they could be excreted.

In addition to transport functions the circulatory system becomes of importance because:

1- The role in homeostasis.

2- They can serve as mechanisms aiding in the control of water content of ions and other solutes and of pH.

3- Serves as a medium for heat exchange between the inner and outer regions of the body and between the body and the external environment.

4- The circulatory system carries important nutrients such as glucose or amino acids to body cells. It also is a pathway for the transport of many hormones.

5- To carry antigens and cells which act as a defense.

The circulatory system itself must be closely controlled. There are for example, controls over flow rate, fluid volume flow, directions of blood flow, distribution of blood, composition of blood.

The hearts, arteries, arterioles, capillaries venules and veins make up the closed circulatory system and each component has specific functions.

In most circulatory systems the driving force is provided by muscular contractions of a pumping organ or hearts, which produces a forward movement of fluid.

Valves are a basic feature nearly of all circulatory systems and are required to maintain a one way flow of blood.

There are large vessels deigned to carry the blood to various parts of the body, include:

1- Aorta and the large or major arteries.

2- Arterioles.

3- Capillaries (the smallest vessels of the closed circulatory system) (and the open system lacks capillaries)

Muscular pumping organs are of several types:

1- **Pulsating vessels:** blood vessels with heavy muscular layer that contracts in peristaltic waves such vessels are found Annelida, Mollusca, Arthropoda.

2- **Tube hearts:** they are highly developed than the pulsating vessel they are found in most arthropods.

3- **Chambered heart:** they are compact muscular structures.

Composed of cardiac striated muscle, which contract spontaneously.

Hearts of vertebrates consist of two chambers as in fishes:

1- Champers as in amphibians and some reptile.

2- Champers in other reptiles, birds and mammals.

The heart is a pump pumps blood into the aorta.

LA: left atrium.

RA: right atrium.

LV: left ventricle.

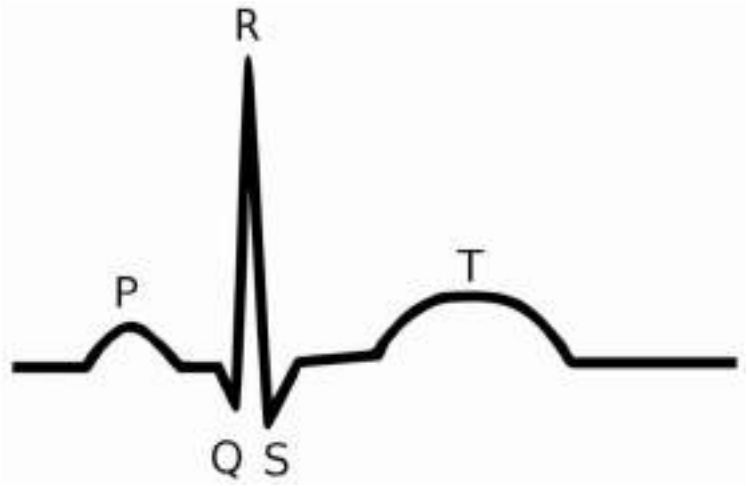
RV: right ventricle

Left ventricle pumps blood into vessels right ventricle pumps blood into the pulmonary artery.

The parts of the heart normally beat in an orderly sequence contraction of the atria (arterial systole) followed by contraction of ventricles (ventricular systole) and during diastole the four chambers are relaxed.

Electrocardiogram used (ECG) :

To study the electrical events for cardiac activity, ECG is an important clinical tool for diagnosing some pathological cardiac conditions and to detect abnormalities in the cardiac rhythm.



P: wave represents the depolarization of the atria.

QRS: complex represents basically the spread of excitation over the ventricles.

T: wave represents the repolarization of the ventricles.

The volume of blood ejected by either ventricle in 1 minute this amount of blood known cardiac output. Which expressed in milliliters of blood ejected / minute / unite of body weight.

1- **Stroke volume:** The milliliters of blood ejected per beat of the heart.

2- **Blood flow:** (liters/minute).

Animals	Cardiac output (Ml/kg b.w. /min)	Heart rate (Beats/min)
White rat	200	350
Dog	150	100
Man (resting)	85	70
Man (heavy exercise)	510	180
Elephant	-	30

At a heart rate of 65 the duration of diastole is 0.62 sec.

At a heart rate of 200 the duration of diastole is 0.14 sec.

The sino-atrial node (SA node).

Atrio ventricular node (AV node).

Bundle of his with it's right and left branches and the purkmje system.

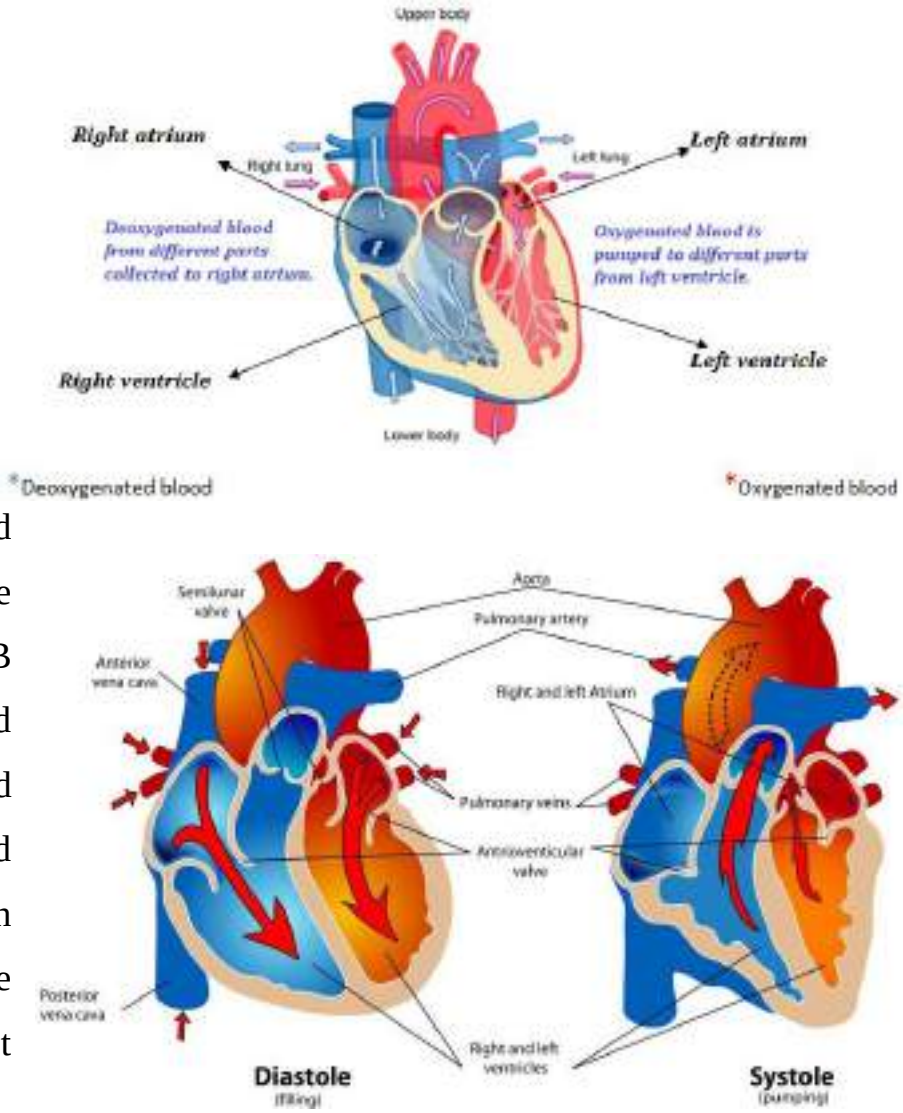
Are the specialized structures that from the cardiac conduction system.

The SA node is the normal cardiac pacemaker, it's rate of discharge determining the rate at which the heart beats.

Impulses generated in the SA node pass through the atrial muscle to the AV node through this node to the bundle of his and through the branches of the bundle of his via the purkmje system to the ventricular muscle.

Blood types:

The membranes of human red cells contain a variety of antigens called agglutinogens. The most important and best known of these are the A and B agglutinogens and individuals are divided into 4 major blood types A, B, AB, O on the basis of the agglutinogens present in their red cells.

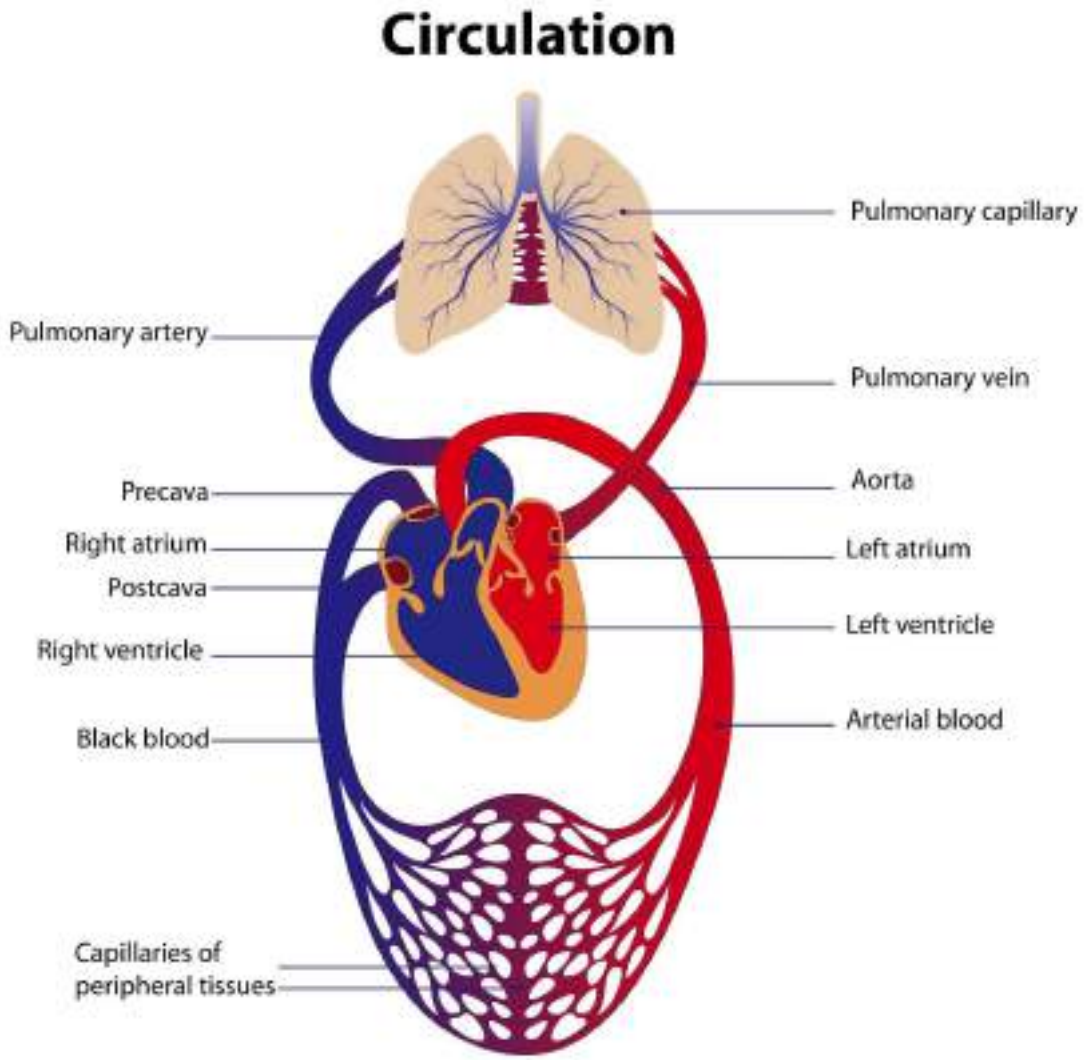


Blood tybe	Agglutinins in Plasma	Antigens
A	Anti-B	A
B	Anti-A	B
O	Anti-A , Anti-B	-
A,B	-	A,B
Rh^+	-	D
Rh^-	Anti-D	-

Blood pressure:

Blood pressure is the product of the cardiac output and the peripheral resistance. The pressure in the aorta and in the branchial and other large arteries in a young adult human rises to a peak value (systolic pressure) of about 120 mm Hg during each heart cycle, and falls to a minimum value (diastolic pressure) of about 70 mm Hg.

The arterial pressure is conventionally written as systolic pressure over diastolic pressure e.g.



Note that the heart is divided into left and right halves: blood flows from the heart to the lungs (where it is oxygenated), then back to the heart, and then to the rest of the body. This is called a double circulation and is typical of mammals.

The Lymphatic System :

The lymphatic system consists of numerous thin-walled vessels contaning lymph. The lymph vessels lead to the veins, so eventually lymph returns to the blood stream.

Where are the main places where lymph nodes occur ?

The main places are the sides of the neck, armpits and groins Lymph tissue is also found in the tonsils and adenoids.

THE CIRCULATION IN OTHER ANIMALS :

* In simple organisms (e.g. Amoeba, Hydra) there is no blood or circulation. Substances are transported by diffusion.

* The earthworm has a simple circulation with blood containing. Blood is pumped by contractions of the dorsal blood vessel.

* Fish have a single circulation; blood (containing, haemoglobin) is pumped from the heart to the gills where it flows to the rest of the body and then returns to the heart (Compare this with the double circulation of mammals).

* Insects have an open circulation; colorless blood (no haemoglobin) is pumped by a tubular heart into the body cavity where it seeps round the body before returning to the heart.

THE LYMPHATIC SYSTEM CONSISTS OF :

***** Lymphatic capillaries.

***** Lymphatic vessels.

***** The thoracic duct.

***** The right lymphatic duct.

***** Lymph nodes.

LYMPHATIC TISSUE :

1) **Tonsils:** between the mouth & oral pharynx.
2) **Adenoids:** on the wall of naso pharynx.
3) **Solitary lymphatic nodules:** in the small intestine.
4) **Aggregated lymphatic nodules:** in the small intestine.
5) **Vermiform appendix:** associated with large intestine.

THE SPLEEN :

Is formed partly by lymphatic tissue and will be described as its function are associated with the circulatory system.

FUNCTION OF SPLEEN:

1) Destruction of worn-out erythrocytes: RBCs breakdown products, bilirubin, biliverdin and iron are passed to liver via splenic and portal veins.
2) A reservoir conditions as a rise in temperature, exercise and emotion as excitement. There was an increase in blood pressure and RBCs numbers. This occurred due to strong contractions of spleen and the pushing out of blood into the circulation.
3) Formation of lymphocytes: Spleen produce some of lymphocytes.
4) Formation of Ab: Spleen forms antibodies and antitoxins.

Neurons :

The fundamental unit of nervous system is the nerve cell or neuron. The neuron is the only cell type that is directly involved in the conduction and transmission of nerve impulses through the system.

Neurons are of different types depending on the function they serve:

1- Sensory neurons.
2- Motor neurons.
3- Interneurons.

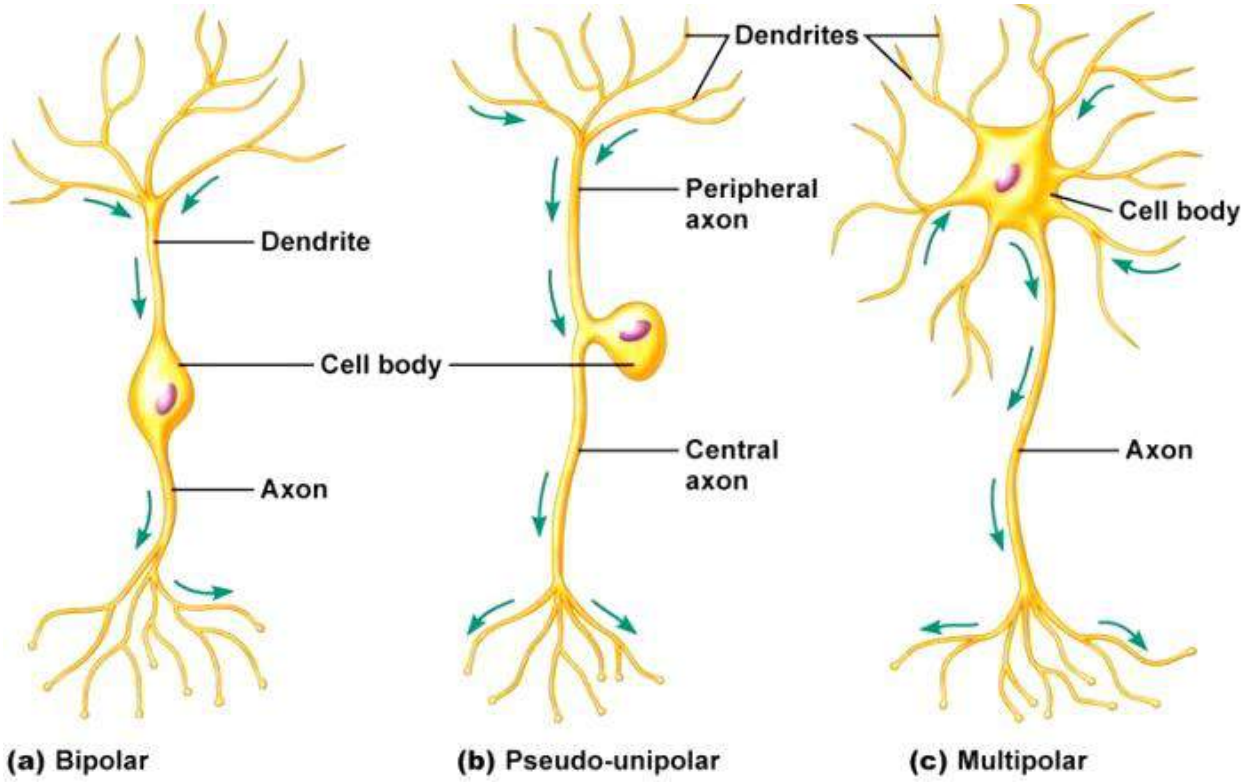
The structure of neuron :

The cell body of the neurons are located in the CNS. The nerve cell body the perikaryon (or soma) contains the nucleus and other typical cell organelles.

These include the Nissl bodies (chromophil substance) mitochondria and Golgi complex and reticular network of neurofibrils. The membrane surrounding the soma is the site of connections with other neurons.

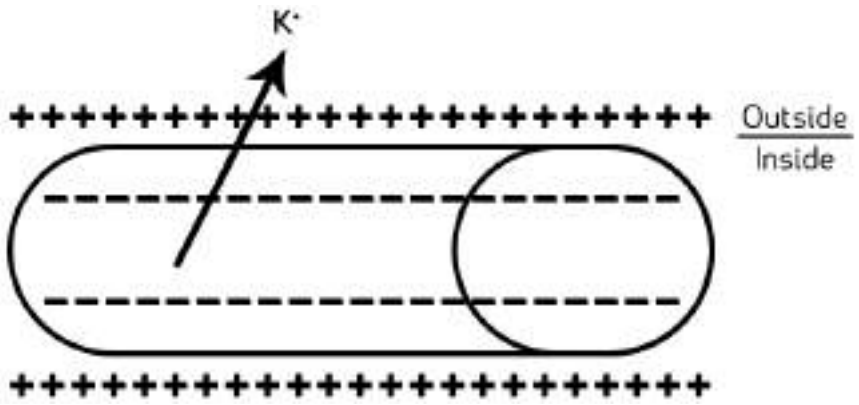
The neurons have multiple, branched dendrites and one axon, the axon of a typical neuron is much longer than the dendrites. Each axon terminates in structure called synaptic knobs. The synaptic knobs are responsible for transmitting the impulse to the next cell. Which may be another neuron or muscle or gland cell. In each case the junctions called a synapse.

Dendrites are usually shorter, highly branched, the sites of connections with axons of other neurons. The functional junction between the dendritic region of one nerve and the axon ending of another neuron is the synapse. The axon is usually, long slender process, sometimes branched.



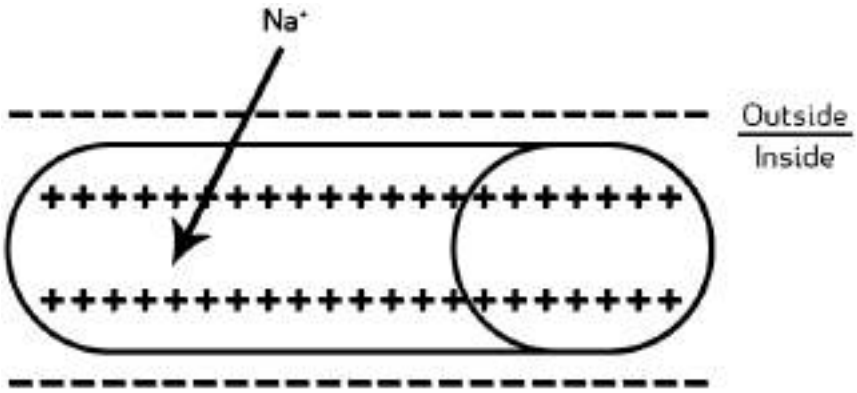
Resting potential of nerve cells :

The nerve impulses are conducted as electrical signals, involving changes in the electrical potential at the cell surface. This potential difference across the nerve cell membrane is called the resting potential. The resting potential of nerve cells was due to an unequal distribution of. K^+ ions across the cell membrane. The membrane is polarized. This unequal distribution of ions results in the inside, of the axon being Negative relative to the outside.



Action potential :

When an impulse passes along the axon the membrane suddenly becomes depolarized. The inside of the axon suddenly is becoming positive. This sudden reversal of the resting potential is called the action potential.



Synaptic transmission :

Nerve cells interact with one another and with glands and muscles at junctions called synapses. The signal is passed from one cell to the next by chemical transmitters. Chemical synapses depend on specific chemicals called neurotransmitters to conduct the signal across the junction. The best-known transmitter substance at the majority of synapses is acetylcholine (Ach). In some cases the signal is passed from one cell to the next by direct electrical connection (electrical synapses).

Excretion

Animal excretion

Body fluids :

In animal with closed vascular system the extracellular fluid (ECF) is divided into 2 components, the interstitial fluid and the circulatory blood plasma. About a third of the total body water (TBW) is extracellular the remaining two- third are in a cellular fluid in the average young adult male, 60% of the body weight is water.

Osmoregulalion :

Osmosis is the movement of water from a less concentration to a more-concetrated solution, when the membrane, which separates the solutions, is impermeable to the solutes. Osmoregulatin is the maintaing the internal concentration at a constant level as the external environment changes.

Excretion : is the removal from the body of the metabolic toxic waste products.

Nitrogen wastes : reactions that lead to the production of useful cellular energy or the destruction of unneeded materials produce as products mainly.

Water, Co_2 and nitrogen containing compounds. The latter are often toxic or can yield no further useful cellular energy and so must be eliminated. Ammonia is the chief product of protein and amino acid metabolism.

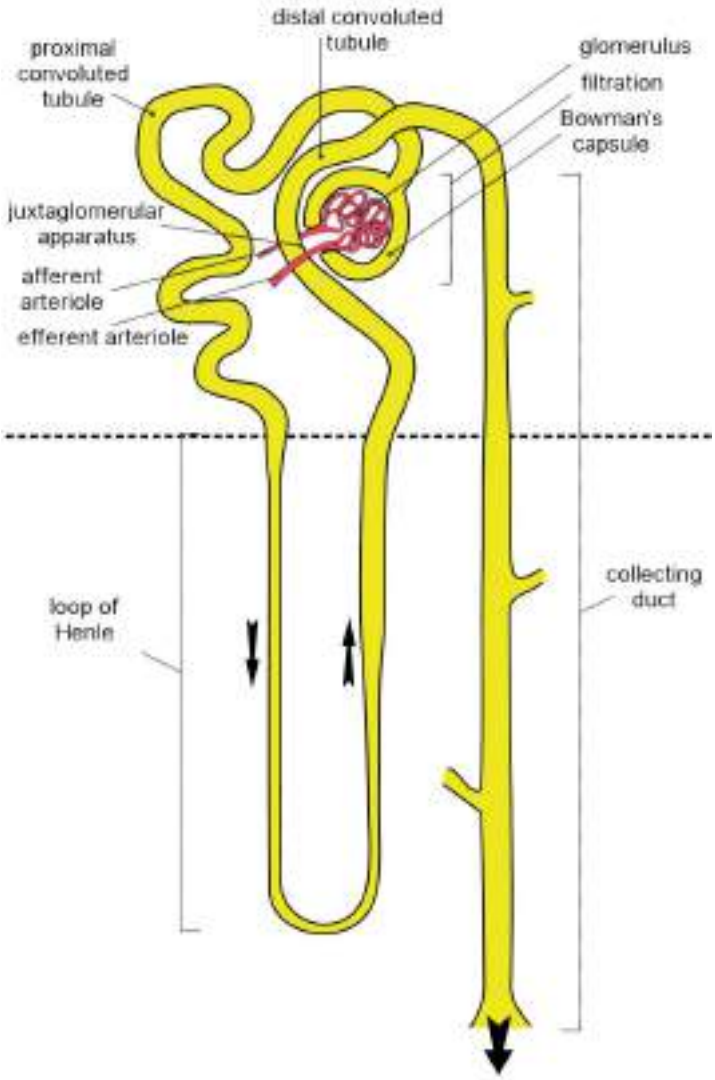
The vertebrate Kidney:

In mammals the kidney performs excretion and osmoregulation,

there are two kidneys, one on each side of the abdomen and each contains

between one and two million nephrons.

The nephron is the functional unit of the kidney the parts of the nephron are illustrated in this figure.



Filtration:

In the kidney, the resembles plasma is filtered through the glomerular capillaries into the renal tubules (glomerular filtration) as this glomeruler filtrate passes down the tubules its volume is reduced and its composition altered by the processes of :

1) Tubular reabsorption : (Removed of water and solutes from the tubular fluid) Such as Na^+, Glucose, water, Kr^+ etc.

2) Tubular secretion : Secretion of solutes into the tubular fluid to form urine such as H^+, NH_3, Na^+, Cl^-

Water and salts reabsorption and under hormonal control (antidiuretic hormone) ADH.

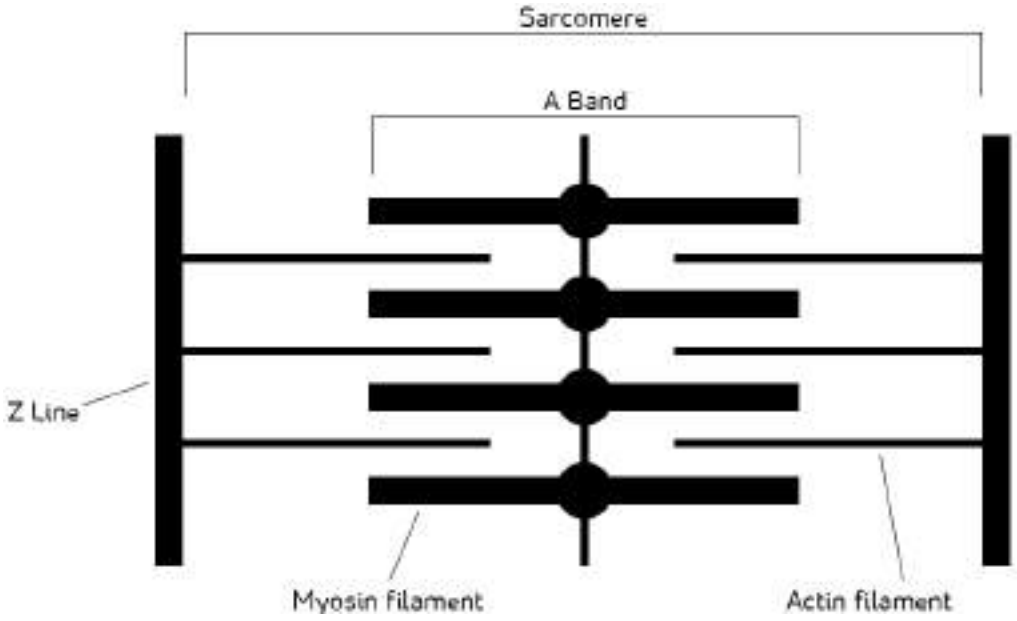
Excretory organs :

1- The contractile vacuole, they are small vacuoles that fill with a clear fluid until a certain volume incached at which time the vacuole empties it's contents to the exterior.
2- Malpighian tubules (insects): The malpighian tubules produce a copious flow of urine.
3- (R) Protonephridia are typical excretory organs in animals that lack a high-pressure circulatory system.
4- Green gland: generally a gland consists of a coelomic sac (end sac), tubule, and excretory duct.

Muscles :

Skeletal muscles are made up of individual muscle fibers which are the building blocks of the muscular system in the same sense that the neurons are the building blocks of the nervous system. Most skeletal muscles begin and end in tendons. Each muscle fiber is a single cell, multinucleated, long, and cylindrical in shape. The muscle fibers are made up of fibrils and the fibrils are divisible into individual filaments.

The filaments are made up of the contractile proteins. Muscle contains the proteins Myosin (Mwt. About 500.000), Actin (Mwt. 60.000), Tropomysin, Tropomysin binds Troponin to actin.



The parts of the cross striations are identified by letters, The light I band is divided by the dark Z line, and the dark A band has the lighter H band in it's center. The area between two Z lines is called sarcomere. The thick filaments are made up of myosin. The thin filaments are made up of actin, tropomyosin and troponin. The T tubules are invaginations of the sarcolemma. The thick myosin filaments are lined up to form A band. The thin filaments forms the less dense I band.

Muscle contraction requires energy, the source is the hydrolysis of ATP to provide the energy.

There is a wide variety of muscle types because there is a wide variety of functions to be served by muscles, including movement of an animal through it's environment, maintenance of body posture and orientation, circulatory movements, gastrointestinal tract movement and so on.

Cardiac muscle :

It is found in myocardium contracts rhythmically and automatically. The striations in cardiac muscle are similar to those in skeletal muscle and Z lines are present. The muscle fibers branch, but each is a complete unit surrounded by a cell membrane. Where the end of one muscle fibers paralled each other through an extensive series of folds.

The areas occur at Z lines are called intercalated disc. Cardiac muscle contains large numbers of elongated mitochondria in close contact with the fibrils.

Muscle fiber is linear unit composed of several cardiac muscle cells joined end to end at junctional zones called intercalated discs.

Smooth muscle :

This type is called unstriped nonstriated muscle. This muscle is mainly visceral in distribution. Forming the contractile portion of the wall of the digestive tract from mid-esophagus to anus. It is found in the respiratory, urinary in arteries, veins, and large lymphatics and in dermis. In these locations it functions in moderating and maintaining lumen diameter.

Smooth muscle fibers when-relaxed are elongated spindle-shaped cells with a wider central nucleus-containing region.

In smooth muscle the contractile unit is the cell and not the sarcomere (which is not present).

Tetanic contraction (tetanus) :

The electrical response of a muscle fiber to repeated stimulation. The contractile mechanism doses not have a refractory period, repeated stimulation before relaxation has occurred. (No relaxation between stimuli)

Muscle contraction :

The process by which the shortening, of the contractile elements in muscle (sliding of the myosin over the actin filaments) Muscle twitch.

A single action potential cause a brief contraction followed by relaxation this response is called a muscle twitch.

Endocrine glands:

Endocrine glands and their function

Endocrine	Hormone	Function
1- Thyroid	Thyroxin Calcitonin	Control metabolic rate control Ca^{+2} concentration
2- Parathyroid	Parathormone	Control Ca^{+2} and Po_4 conc.
3- Pancreas	Lusulin Glucagon	Suppresses sugar conc. Rises sugar conc.
4- Adrenals	1- Aldosteron 2- Adrenaline & non Adrenaline	Prepare body for emergency
5- Testes	Testosterone	Male reproduction and sexondary charcteristic.
6- Overys	Oestrogen	Female reproductive and secondary charcteristic.
7- Pituitary	1- TSH	Thyroid secrete thyroxin
	2- ACTH	Adrenal secrete thyroxin
	3- Prolactin	Mammary Glands
	4- FSH	Spematrgencsis
	5- LH	Ovulation
	6- ADH	Water balance
	7- Melanophore	Melanin Pigment
	8- Oxytocin	Contraction of uterus and mammary glands.