Definition and example

Biomolecules may be defined as complex lifeless chemical substances which form the basis of life.
Examples : Carbohydrates, proteins, enzymes etc.

Sugar

All those carbohydrates which contain aldehydic or ketonic group in the hemiacetal or hemiketal form are called as sugars, e.g. glucose, maltose etc.

Non-sugar

The carbohydrates which are not sweet in taste are called non-sugars. They are usually amorphous in nature and are insoluble in water, e.g., starch, cellulose etc.

Classify carbohydrates on the basis of reducing sugar

1. Reducing sugar
2. Non - reducing sugar

Define and give example of reducing sugar

The carbohydrates which are capable of reducing Tollen's reagent and Fehling's solution are called reducing sugars, e.g., sucrose.

Define and give examples of non-reducing sugar

Non-reducing sugars: The carbohydrates which are unable to reduce Tollen's reagent and Fehlings's solution are called non-reducing sugars. Sucrose is a non-reducing sugar.

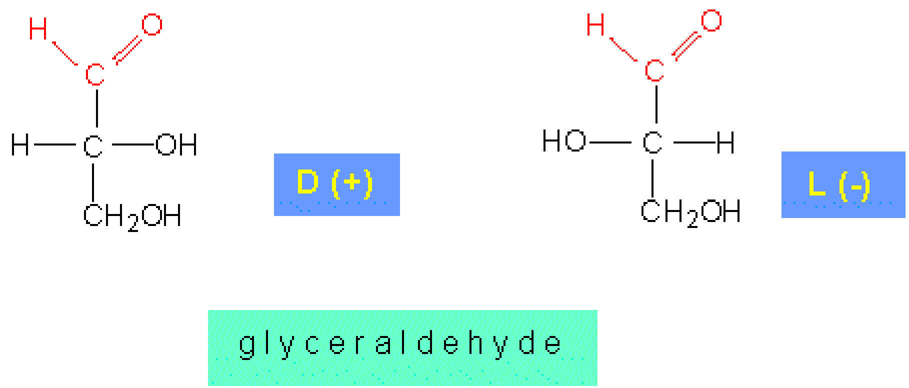
definition and example of aldoses

Monosaccharide containing an aldehyde (-CHO) group are called aldoses.
Example: Aldotrioses, Aldotetroses etc.

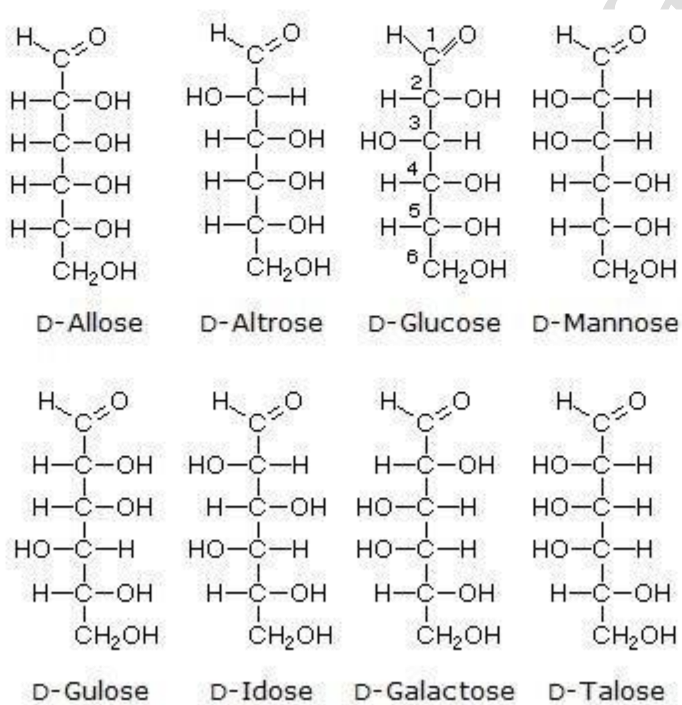
definition and examples of Ketoses

Monosaccharide containing a keto (>C=O) group are called as ketoses.
Example: Ketotrioses, Ketotetroses etc.

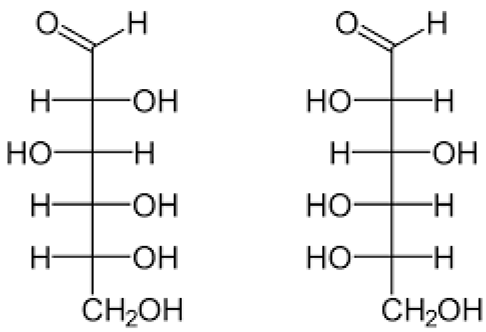
Draw D and L configuration of triose



Hexoses along with their structure



Configuration of glucose



D-Glucose L-Glucose

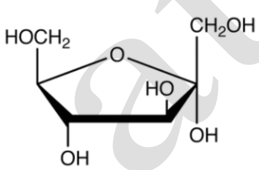
Occurrence of Glucose

Glucose occurs freely in nature as well as in the combined form. It is present in sweet fruits and honey. Ripe grapes also contain glucose in large amounts.

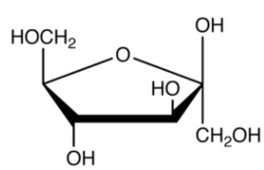
Evidence in support of open-chain structure of glucose

The open structure of glucose is based on following evidences :
1. Molecular formula: The molecular formula of glucose was found to be $C_6H_{12}O_6$C6H1206.
2. Presence of a straight chain of six carbon atoms: Glucose on prolonged heating with HI, forms n-hexane. This suggests that all the six carbon atoms are linked in a straight chain.
3. Presence of carbonyl group: Glucose reacts with hydroxylamine to form an oxime and adds a molecule of hydrogen cyanide to give cyanohydrin.
These are the characteristic reactions of carbonyl group indicate presence of carbonyl group in open glucose molecule.

Structure of furanose

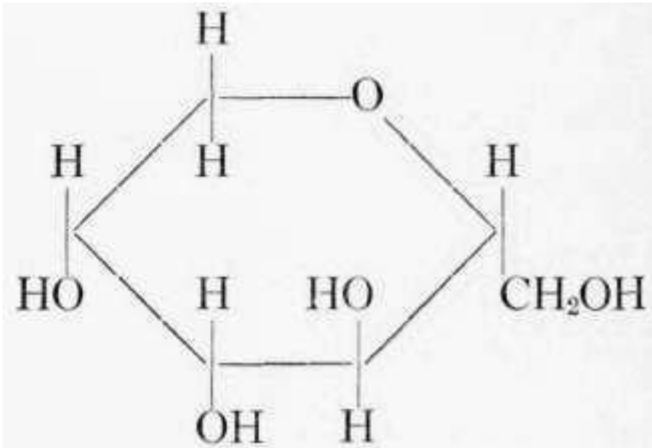


a furanose



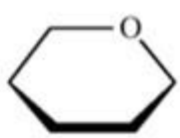
a furanose

Definition and example of pyranose form

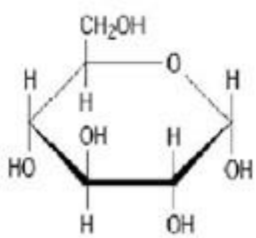


The six membered carbon ring resemble to pyron is called as pyranose form.
Example : Fructo-pyranose.

Structure of pyranose form



Pyranose



Glucopyranose

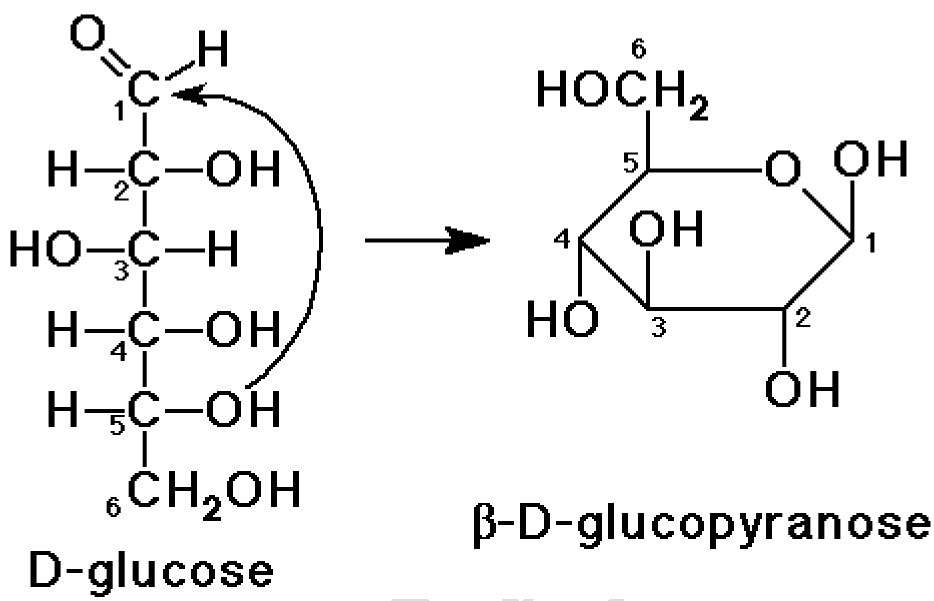
Definition and example of anomers

Anomers are cyclic monosaccharides or glycosides that are epimers, differing from each other in the configuration of C-1, if they are aldoses or in the configuration at C-2, if they are ketoses. The epimeric carbon in anomers are known as anomeric carbon or anomeric center.

defects of open chain structure

1. In spite of the presence of an aldehyde group, glucose does not give 2, 4 -DNP test and shiff's test.
2. The pentaacetate of glucose does not react with hydroxylamine indicating the absence of free -CHO groups.

Haworth projection formulae of monosaccharides

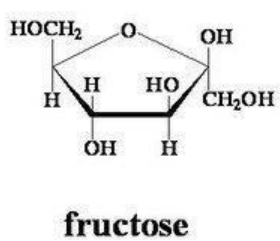


Haworth projection formulae is a structural representation of cyclic structure of monosaccharides either in pyranose or furanose form.

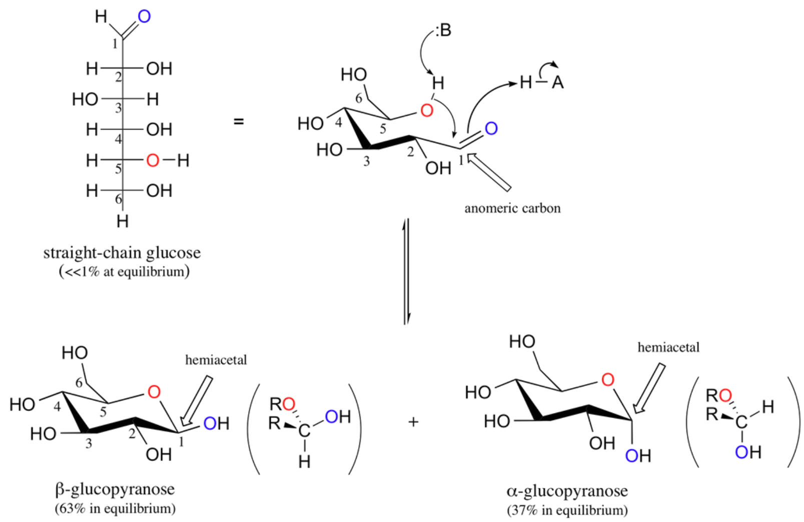
Occurrence of Fructose

Fructose occurs free along with glucose in honey and sweet fruits.

Cyclic structure of Fructose



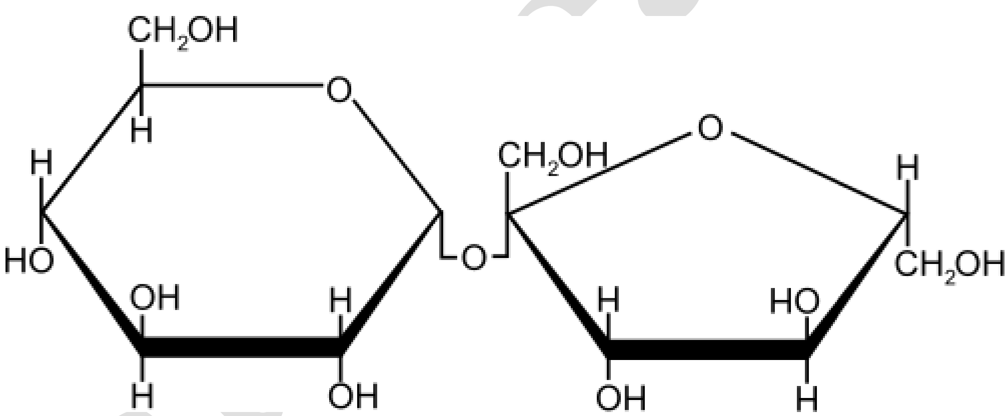
Fischer projection formulae of alpha-D-frctofuranose



Definition and example of glycosidic linkage

The linkage or bond which joints a carbohydrate molecule to another group is called as glycosidic linkage. Example: Formation of ethyl glucoside by glucosidic linkage between ethyl alcohol and glucose molecule.

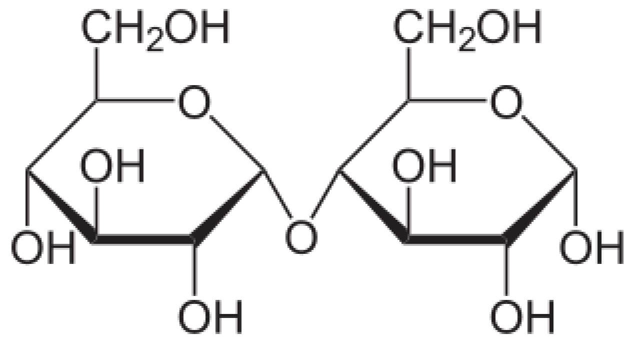
Sucrose



Inversion of sugar

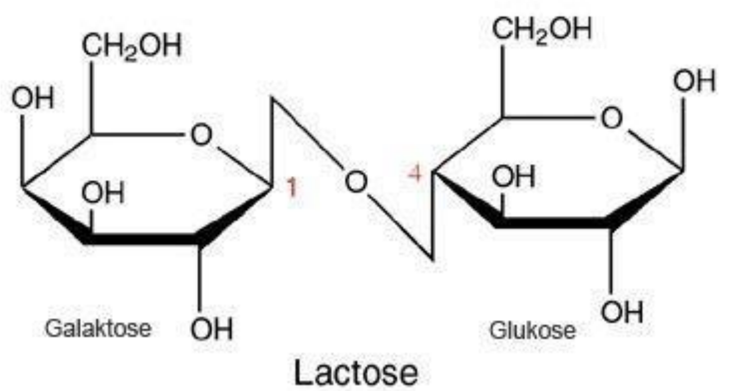
When the configuration of sugar molecule is changed, i.e., dextro sugar to leavo sugar or vice versa, is called as inversion of sugar.

Maltose



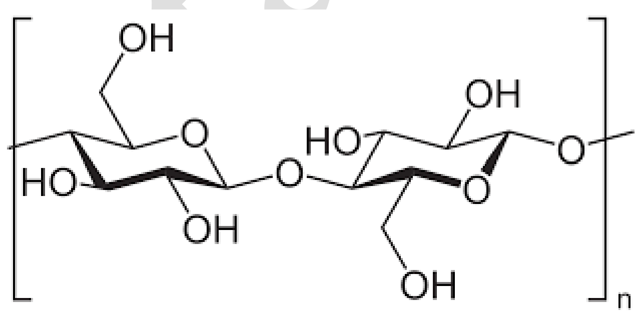
The sugar molecule, which is obtained by partial hydrolysis of starch, by the enzyme diastase, which is present in malt (sprouted barley seed) is called as maltose.

Lactose



The disaccharides which gives a molecule of glucose and galactose on hydrolysis is called as lactose.

Cellulose



1. Cellulose is the major structural polysaccharides present in higher plants.
2. The bulk of cell walls of plants and vegetables tissues are made of cellulose.
3. It is mainly present in wood (45-50%), cotton seeds (90-95%), flax (80-85%) etc.

4. Cellulose reduces neither Fehling's solution nor Tollen's reagent .
5. It does not form osazone and is not fermented by yeast.

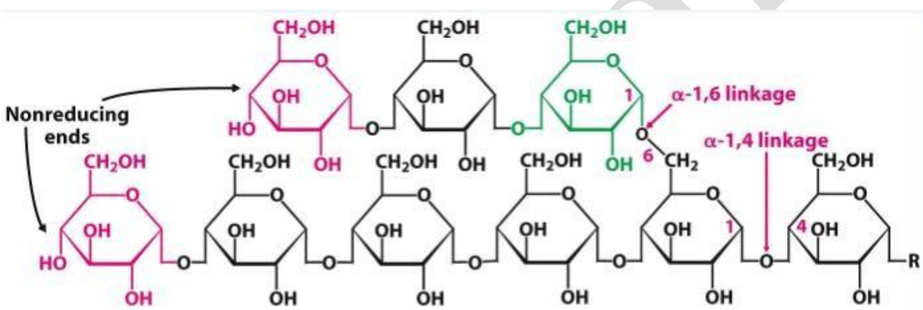
Properties of cellulose

1) It does not reduce Tollens reagent and Fehling solution .
2) It does not form Osazone.
3) It does not undergo hydrolysis.
4) Cellulose is a linear polymer of β-glucose. The glucose units are linked together through ββ-glycosidic linkage between C1 to one glucose unit and C4 of the next glucose unit.
5) It is white colour water insoluble compound.

Indigestion of cellulose

The human digestive system doesn't contain enzyme cellulase which can hydrolyse cellulose into glucose and hence, can't digest Cellulose.

Glycogen



Glycogen is short term food reserve, which is stored in the cells of liver and muscles of animals. Therefore, it is also known as animal starch. It is also a polymer of glucose and its structure is similar to that of amylopectin.

Gum

Gums are polysaccharides of natural origin, capable of causing a large increase in a solution's viscosity even at small concentrations.

Pectin

Pectin is a structural heteropolysaccharide contained in the primary cell walls of terrestrial plants.

Importance of carbohydrates

Carbohydrates are essential for life in both plants and animals. They form a major portion of our food. Honey has been used for long time as an instant source of energy by 'Vaids' in ayurvedic system of medicine. Carbohydrates are used as storage molecules as starch in plants and glycogen in animals.

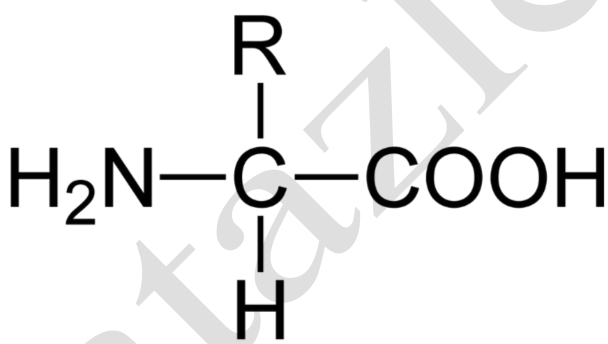
Functions of carbohydrates

Provide energy
Store energy
Build macromolecules
Spare proteins and fat for other uses.

Proteins

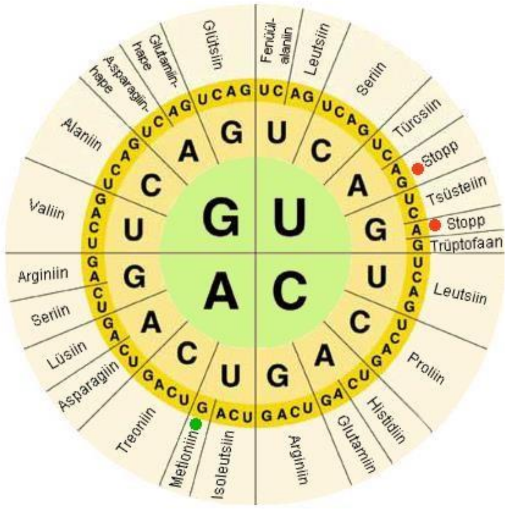
Proteins are highly complex nitrogenous organic compound of very high molecular masses. All proteins are polymers of alpha amino acids.
Example: Glycine, Alanine, Valine etc.

Definition and examples of alpha amino acid



Amino acids are the basic building units of proteins.Their molecule posses both an amino group as well as a carboxylic group. The amino acids having amino and carboxyl group attached to the same carbon, i.e., alpha-carbon atom is called as alpha-amino acids.
Example: Glycine , Alanine etc.

Rules for nomenclature of amino acid

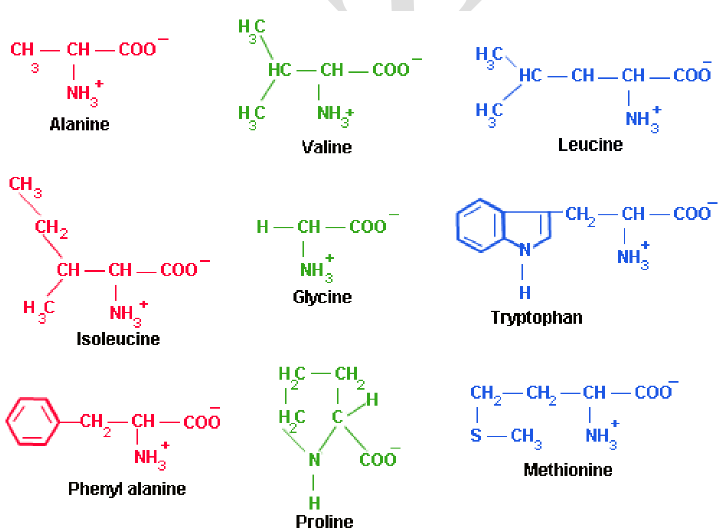


Amino acids are generally known by their common names. In IUPAC system each amino acid has been given standard abbreviation or a code which usually consists of first three letters of the common name. For example, glycine is given the code ala. Sometimes one letter symbol is also used. For example, glycine is represented by G and alanine by A.

classification of amino acids

1. Neutral amino acid
2. Acidic amino acid
3. Basic amino acid

Neutral amino acids



The amino acid containing one -NH2NH2 and one COOH groups, are called neutral amino acids. Example: Alanine.

Essential and non-essential amino acids

Essential	Non-Essential
Histidine	Alanine
Isoleucine**	Arginine
Leucine**	Asparagine
Lysine	Aspartic acid
Methionine	Cysteine
Phenylalanine	Glutamic acid
Threonine	Glutamine
Tryptophan	Glycine
Valine**	Proline
	Serine
* Branch Chain Amino Acids	Tyrosine

The amino acids which human body can not synthesize and must be supplied in the diet are called essential amino acids. Example, Valine, leucine etc.
The amino acids which are synthesized by the human body termed as non-essential amino acids. Example, Glycine.

Complete and incomplete amino acids

Proteins which contain 9 essential amino acids are called as complete proteins Proteins which contain 1 essential amino acid less than complete proteins is called as incomplete proteins.

Physical properties of alpha-amino acids

The important physical properties of alpha-amino acids are as follows.
1) Amino acids are usually colorless, crystalline solids with high melting point
2) They are soluble in water. The aqueous solution is neutral and shows amphoteric behavior

Chemical properties of amino acids

Alpha-amino acid contain both amino as well as acidic group .They form salts with acids as well as with base.

Zwitter ion

Zwitter ion prepared by loss of proton by acidic carboxyl group which is taken up by the basic amino group in alpha-amino acids. Zwitter ion is neutral but contains both positive and negative charges. Due to its dipolar nature it is referred to as a dipolar ion.

Isoelectronic point of amino acids

As, an amino acid exists as a positive ion in acidic solution and negative ion in the basic solution, therefore on passing electric current, it will migrate towards the cathode in acidic solution and towards the anode in basic solution. Hence, at a particular pH of the solution, the amino acid molecule should not migrate to either electrode and should exist as a neutral dipolar ion.This pH is known as isoelectric point.

Acidity and basicity of amino acids

The first member of alpha-amino acid have both acidic and basic functional groups. Hence, it is neutral but as the number of basic or acidic group increases it become either more acidic or more basic.

Peptides classification on the basis of number of amino acids

Peptide molecules are classified according the number of amino acid molecule undergo condensation :
The peptide bond by the condensation of two amino molecule is called as dipeptide bond
The peptide bond formed by the condensation of three molecule is called as tripepetide molecule

Rules for writing and naming system of polypeptides

1) The free amino acid of peptide chain (N-terminal) is written to left and free carbonyl end (C-terminal) to the right.
2) Linkage of many aa's through peptide bonds called polypeptides.
Each 'aa' in polypeptide is called a 'residue'.
3) When named 'aa' residue have their suffixes (-ine, -ic, or -ate) changed to -yl, except C-terminal 'aa', e.g., a tripeptide of N-terminal Val, Gly, C-terninal Leu is valglycylleucine.

Oligopeptides

Oligopeptides are relatively shorter peptides which contain less than 100 amino acid molecule.
Example : Alanine, valine.

Polypeptides

The peptides contains more than 100 amino acid units is called as polypeptides.
Example : Amalin, Glucagon.

Properties of polypeptides

1) Amphoteric in nature
2) The total content of smaller peptides in tissues is small as compared to proteins
3) Polypeptides molecules contain molecular formula greater than 10,000 u are referred as proteins

Classify Proteins on the basis of Molecular structure

1) Fibrous proteins.
2) Globular proteins.

Characteristics of fibrous proteins

1) Linear thread like structure.
2) Long chain is held together by hydrogen bond and some disulphide bonds.

Globular proteins

The proteins which consists of polypeptide chains folded in such a way so as to give a spherical shape to the protein molecule are called globular proteins.
All enzymes, several hormones such as insulin etc are example of globular proteins.

Characteristics of globular proteins

Globular proteins have some following characteristic:
1) Spheroidal shape
2) Interaction forces between different sites in the same polypeptides:
  a) Disulphides bridging
  b) Hydrogen bonding

c) Van der waals
3) These are soluble in water
4) They are very sensitive to change in temperature and pH

Classify protein on the basis of chemical composition

Simple protein
Conjugated Protein
Derived Protein

Simple Protein

These protein on hydrolysis gives only αα amino acids are called as simple proteins. Example: albumin in eggs etc.

Conjugate Protein

The proteins on hydrolysis give a non-protein portion in addition to the αα amino acids.
Example, Glycoprotein, Phosphoprotein, Hemoprotein etc.

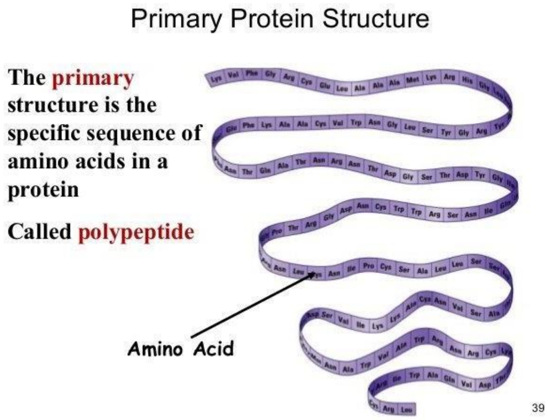
Derived Protein

These are the degradation products obtained by partial hydrolysis of simple or conjugated protein with acids, alkalies or enzymes.
Example : proteoses , peptones etc.

Structures of protein

The complete structures are usually discussed at 4 different levels.
Primary structure
Secondary structure
Tertiary structure
Quaternary structure

Primary structure of proteins



Configuration and conformation of the peptide bond in polypeptide

The lone pair of electrons on the N-atom in the peptide bond is delocalized over the C=O group. As a result, carbon-nitrogen bond acquires some double bond character, because of that C-N bond is hindered and hindered rotation causes geometrical isomerism. Further because of much larger steric repulsions between R and R" group, cis isomer become less stable than trans isomers.

Secondary structure of proteins

The conformation which the polypeptide chains assume as a result of hydrogen-bonding is called the secondary structure of the protein. Depending upon the size of the R groups, the following two different secondary structures are possible.
1) α-Helix structure
2) β-Pleated sheet structure

Tertiary structure of fibrous protein

The tertiary structures refers to the three dimensional shape of the protein molecule which results from the twisting, bending, and folding the helix. Fibrous proteins tertiary structure involves large helical content and is very rigid.
It's very rigid. It possess almost shape of a rope. Fibrous structure is found in silk, collagen and alpha-keratines.

tertiary structure of globular protein

Tertiary structure of globular proteins possesses a polypeptide chain which consists partly of helical sections and folded about the random coil sections to give a spherical shape.In globular proteins, most of the polar groups lie on the surface of the molecule and most of the hydrophobic side chains lie inside the molecules.

Quaternary structure of proteins

Some of the proteins are composed of two or more polypeptide chains which are referred to as sub-units. The spatial arrangement of these sub-units with respect to each other is known as quaternary structure of proteins.

Stabilization factor for protein

Forces which stabilize the protein structure,

Van der waals interactions
Disulphide interactions
Electrostatic interactions
Hydrogen interactions

Subunits or promters

Although many proteins exist as a single polypeptide chain, there are certain proteins which exist as assemblies of two or more polypeptide chains called Subunits or promoters,

Denaturation of protein

Proteins when subject to external factors such as heat, alkalies, and several electrolytes, they undergo coagulation to form fibrous proteins which are insoluble in water. This leads to change in physical and biological properties of proteins. This type of proteins are called as denatured and process is called as denaturation.

Native protein

When the proteins are present in the native state without being altered by heat, alkalies, chemicals etc. are called as native protein.
Example : Fibrous proteins.

Irreversible protein denaturation

The process of denaturation of protein does not change the primary structure but it change the secondary and tertiary structure.In most of cases the process of denaturation is irreversible. Example: Boiling of egg and preparation of cheese from milks.

Renaturation

The reverse process of denaturation is called as renaturation of proteins in which secondary and tertiary structure is restored by restoring the conditions of temperature and pH.

Biological function of protiens

The important biological functions of proteins are as follows:
1) As structural materials: Proteins serve as basic building materials for the tissues of animals
2) As communication agents: Certain proteins help in communications in the through nerves
3) As catalysts: Some proteins act as enzymes which catalyze the biological reactions occurring in the bodies of animals
4) As transport agents: Certain proteins serve the purpose of transport agents and act as delivery vans in the body

Properties of enzymes

1. Act as bio-catalyst.
2. Always produce same end products.
3. Individual enzymes work best at particular temp and pH.

Coenzymes

All enzymes are globular proteins. However, some enzymes are associated with some non-protein component called prosthetic group. When the prosthetic group is small organic molecules, it is refereed to as a co enzymes.
Example: Niacin, thiamine etc.

Prosthetic groups

Prosthetic group are cofactors that bind tightly to proteins or enzymes. They can't be removed easily. They can be organic or metal ions and are often attached to proteins by a covalent bond.

Uses of enzymes

Following are the applications of enzymes:

Production of alcohols from cellulose
Improve phosphate utilization
Used in photography processes

Diseases cause by enzyme deficiency

Herediatary coproporphyria, acute intermittent porphyria, ALAD porphyria

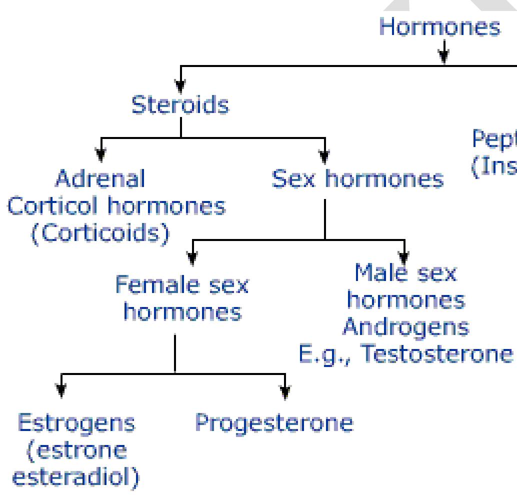
Hormones

Hormones are a group of biomolecules which are produced in the ductless glands and are carried to different parts of the body by the blood stream where they control various metabolic processes or show physiological activity. Example: insulin, glucagon etc.

Function of harmons

Hormones are chemical substances that affect the activity of another part of the body. Hormones serve as messengers, controlling and coordinating activities throughout the body.

Classify hormones on the basis of its structure



Hormones are classified on the basis of :
1) Their structure
2) Their site of activity in the cell

Classify hormones on the basis of site of activity in the cell

Hormones	Site of activity
(a) Androgens	Testes
(b) Estrogens	Overy
(c) Gestogens	Corpus iutnum
(d) Insulin	Pancreas
(e) Thyroxine	Thyroid gland

Steroid harmones

Hormones whose structures are related to steroids are called steroid hormones. These are of two types :

1. Sex hormones: Androgens
2. Adrenal cortex hormones: Cortisone.

Types of Steroid harmones

Steroid hormones are of two types :

1. Sex hormones
2. Adrenal cortex hormones

Sex hormones

These hormones are responsible for primary sexual process and secondary characteristic which differentiate males from females.

These are of three types :

(1) Androgens are male sex hormones
(2) Estrogens are female hormones
(3) Gestogens are corpus lutenum hormones

Types of sex hormones

Androgens - male sex harmones (eg. testostreone)
Estrogens - female sex hormones (eg. estrone)
Gestrogens - corpus luteum hormones (eg. progesterone)

solubility of vitamins

1. Water soluble
2. Fat soluble

Water soluble vitamins

Vitamins which are soluble in water at ordinary temperature is called as water - soluble vitamins. These includes vitamin-B complex and vitamin C.

Fat soluble vitamins

Those vitamins which are soluble in fat is called as fat soluble vitamin.These are oily substance not readily soluble in water but easily soluble in fat. Example: Vitamin A, D, E, and K.

Fat soluble vitamins

The vitamin which is not readily soluble in water but easily soluble in fat is called as fat-soluble vitamin. Example, A, D, E, and K.

Avitaminoses

Lack of a particular vitamin causes a specific deficiency disease. Multiple deficiencies caused by lack of more than one vitamin is called avitaminoses.

Vitamin classification on the basis of chemical structure

1. Aliphatic series
2. Aromatic series
3. Alicyclic series
4. Heterocyclic series

Vitamins of aliphatic series

Derivative of the unsaturated polyoxy-γγ-lactones.
Derivative of the gluconic acid esters.
Derivative of the ββ-aminoacids.

Vitamins of aromatic series

Vitamin with aromatic ring present in their structure is called as vitamin of aromatic series. Example: Vitamin K.

Vitamins of alicyclic series

Vitamin with alicylic structure in their molecule is called as vitamin of alicyclic series. Example: Vitamin D.

Vitamins of heterocyclic series

Vitamin containing heterocyclic rings in their structure is called as vitamin of heterocyclic series. Example: Vitamin P, Vitamin E etc.

Characteristics of vitamins

1) Vitamin are organic molecule which are essential for body to perform specific biological functions for the life.
2) Vitamin cannot be produced by the body and must be supplied in small amounts in diet .
3) Deficiencies of vitamin causes disease in body.
4) Vitamin D is the only vitamin which synthesized in body by the irradiation of ergosterol with ultraviolet light.

Nucleic acids

Nucleic acids are biopolymers, or large biomolecules, essential for all known forms of life. Nucleic acids, which include DNA (deoxyribonucleic acid) and RNA (ribonucleic acid), are made from monomers known as nucleotides.

Nitrogenous bases

A nitrogenous base is simply a nitrogen containing molecule that has the same chemical properties as a base. They make up the building blocks of DNA and RNA.

Types of nitrogenous bases along with their structure

The nitrogen base residue present in a nucleotide is a heterocyclic nitrogenous base and is a derivative of either purine or pyrimidine.

Pyrimidines- have one ring in their structure.

Cystine
Thymine
Purine- have two ring in their structure

Adenine
Guanine

Nucleosides

The base sugar unit present in a nucleic acid chain is termed as a nucleoside.
Base + sugar = Nucleoside
Nucleoside are of two types:
(i) Ribonucleosides
(ii) Deoxyribonucleoside

Types of nucleosides

Purine nucleoside ends in "-sine"
a) Ribonucleoside
- Adenosice
- Guanosine

b) Deoxynucleoside
- Deoxyadenosine
- Deoxyguanosine

Pyrimidine nucleosides end in "-dine"
a) Ribonuceloside
- Cytidine
- Uridine

b) Deoxynucleoside
- Deoxythymidine
- Deoxycytidine

Ribonucleoside

A ribonucleoside is a type of nucleoside including ribose as a component. For example, cytidine.

Deoxyribonucleoside

A deoxyribonucleoside is a type of nucleoside including deoxyribose as a component. For example, deoxycytidine.

Deoxyribonucleosides

A deoxyribonucleoside is a type of nucleoside including deoxyribose as a component. An example is deoxycytidine.

Types of nucleotides
The four types of nucleotides in DNA are Adenine,Thymine, Guanine, and Cytosine.
The RNA contain nucleotides Adenine, Guanine, Cytosine and Uracil.

Ribonucleotides

A ribonucleotide or ribotide is a nucleotide containing ribose as its pentose component. It is considered a molecular precursor of nucleic acids. Nucleotides are the basic building blocks of DNA and RNA. The monomer itself from ribonucleotides forms the basic building blocks for RNA.

Deoxyribonucleotides

A deoxyribonucleotide is the monomer, or single unit, of DNA, or deoxyribonucleic acid. Each deoxyribonucleotide comprises three parts: a nitrogenous base, a deoxyribose sugar, and one phosphate group. The nitrogenous base is always bonded to the 1' carbon of the deoxyribose, which is distinguished from ribose by the presence of a proton on the 2' carbon rather than an -OH group. The phosphate groups bind to the 5' carbon of the sugar.When deoxyribonucleotides polymerize to form DNA, the phosphate group from one nucleotide will bond to the 3' carbon on another nucleotide, forming a phosphodiester bond via dehydration synthesis. New nucleotides are always added to the 3' carbon of the last nucleotide, so synthesis always proceeds from 5' to 3'.

Classify lipids on the basis of structure

Lipids are classified according to their structures as:
Simple lipids, complex lipids, Derived lipids.

Functions of lipids

Lipids form following functions in human body:
1) Storage form of energy
2) Insulation
3) Protect internal organs
4) Absorption of fat soluble vitamins

metabolic pathway

1. Metabolism is a process in which anabolic and catabolic reactions are taking place.
2. The pathway by which this process is going on is called as metabolic pathway.

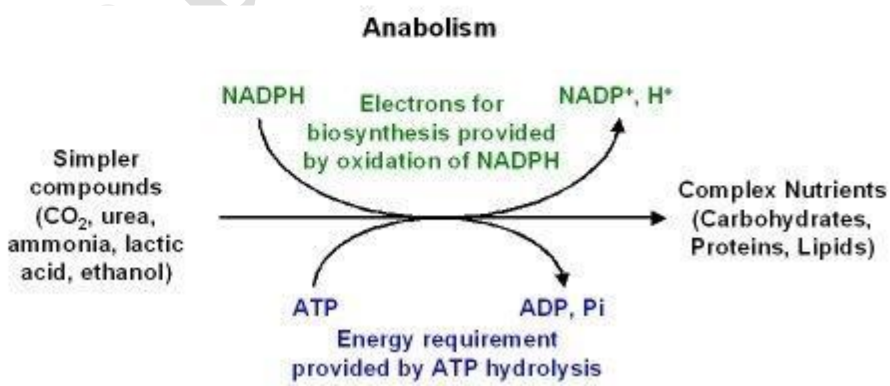
Cell and it's structure

1. Cells may be regarded as the smallest and fundamental units of life.
2. They are very small and not visible by naked eyes.
3. Cells of various organism vary from 5 micrometers to 15 micrometers.
4. Cells vary greatly in shape , they may be disc like, polygonal , cuboid, rectangular, thread like or even irregular.

Chemical reactions in living organism

Living organism involves different types of chemical reaction:
1. Digestion of food.
2. Respiration in mitrochondria to generate ATP.
3. Filtration by kidney
4. Secretion of different types of hormones in presence of enzymes.

Anabolism



The set of reactions by which the various molecules present in cell are synthesized is called as anabolism.
For example: formation of DNA and RNA.

Catabolism

The set of reactions involving the degradation of complex organic molecule into smaller ones with the liberation of energy is called catabolism.
For example: Breaking of molecule of carbohydrate in mitrochondria.

Free energy change in biological reactions

According to the principles of thermodynamics, a chemical reaction occurring at constant temperature and pressure is feasible only when it is accompanied by a decrease in free energy of the system. This condition of free energy change is valid for biological reactions.

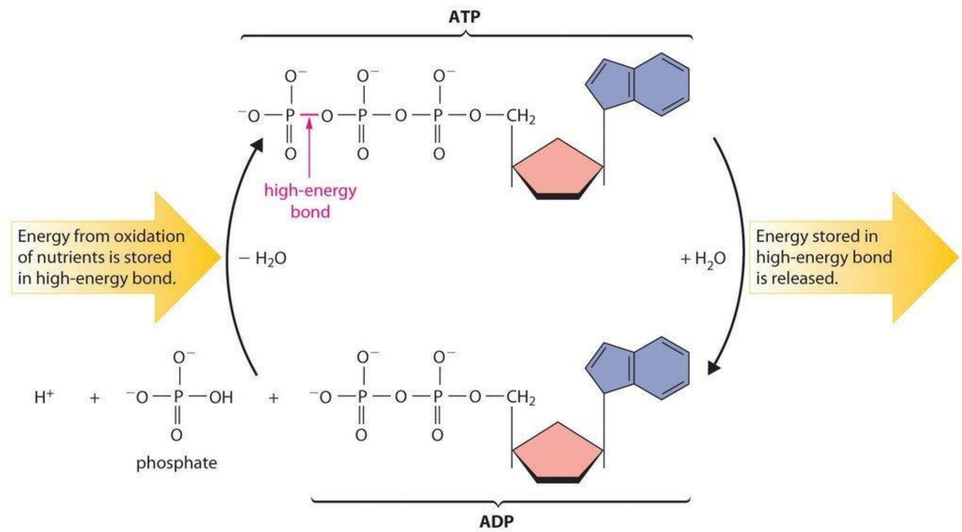
Exergonic and endergonic reaction

Exergonic reactions: The reaction in which step- wise degradation of sugar molecules to carbon dioxide and water takes place, which involves a decrease in the free energy of the system, these spontaneous reaction are called as exergonic reactions. Example: Breaking of sugar molecule .
Endergenic reactions: The reactions involve an increase in the free energy of the system are called as endergenic reactions.

ATP

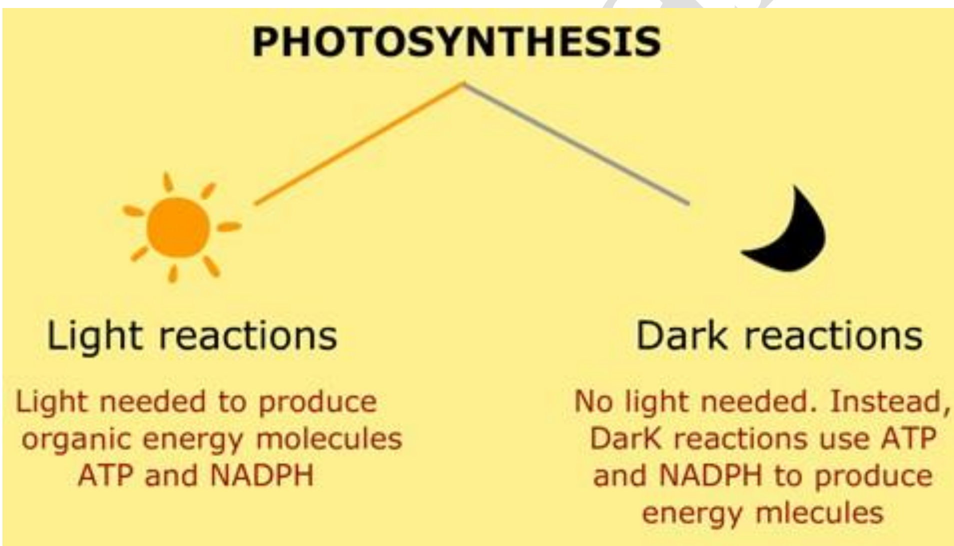
1. Adenosine triphosphate acts as source of energy for the energy-requiring reactions and makes them feasible by providing the required energy.
2. It has purine base adenine, a pentose sugar ribose and three interlinked phosphate units.
3. It contains two oxygen-phosphorus bonds, which are referred to as high energy phosphate bonds.

Energy cycle



The cyclic process of conversion of one form of energy into other forms through metabolic processes is called energy cycle.

light and dark reactions



Carbohydrates

Optically active polyhydroxy aldehydes or polyhydroxy ketones or substances which give these on hydrolysis are termed as Carbohydrates.