Polymers, Biomolecules and Chemistry in action

Polymers

Polymers are substances of high molecular mass formed by the combination of large number of simple molecules called monomers.

Classification of polymers : Polymers can be classify on the following basis :

(1) **Classification based on the source :** Polymers are two types :

(i) **Natural polymer :** The polymers which are found in nature are called natural polymers *e.g.* proteins, polysaccharides, natural rubber are some examples.

(ii) **Synthetic polymers :** The polymers which are synthetic or man made. *e.g.* polyethene, nylon, dacron etc.

(2) **Classification based on structure of polymers :** On the basis of structure polymers are three types :

(i) **Linear polymers :** Generally have higher magnitude of inter particle forces and thus possess high density and high m.pt. such polymers have high tensile strength in the direction of polymer chain and very low tensile strength at right angle to it.

(ii) **Branched polymers :** Generally have low density and low m.pt. such polymers have almost equal tensile strength in all direction which is less than that in linear chain polymers . *e.g.* amylopectin, glycogen etc.

(iii) **Three dimensional net-work polymers :** In these polymers the initially formed linear polymers chains are joined together through two or more cross-links to form three-dimensional network structure. These are also called cross-linked polymers these are hard brittle and rigid *e.g.* Bakelite, urea, formaldehyde, melmac etc.

(3) **Classification based on synthesis :** The process by which the monomers are converted in to polymers is called polymerization. The number of times a monomer unit is repeated in a polymer is called **degree of polymerization.**

Addition polymerization : In this process the simple monomers are joined together without loss of molecules like H_2O, NH_3 etc. for *e.g.* Polythene , Polystyrene, PVC etc.

Condensation polymerization : In this process the simple monomers are combined together with the loss of simple molecules like H_2O, NH_3 etc. *e.g.* Nylon, terylene etc.

Co-ordination polymerization : In this process, the alkene is treated with a catalysts consisting of $(C_2H_5)_3 \ Al + TiCl_4$ or $(TiCl_3)$ (Zeigler-natta catalyst) under suitable conditions. It is also called Zeigler-natta polymerization

On the basis of synthesis polymers can be classified in to two types :

Addition Polymers	Condensation Polymers
Formed by addition reaction.	Formed by condensation polymerization
Molecular mass is whole number multiple of monomer.	Molecular mass is not whole number multiple of the monomer.
Generally involve one monomer unit.	Generally involve more than one unit.
Monomers are unsaturated molecules.	Monomer units must have two active functional group.
They are generally chain growth polymers.	

(4) **Classification based on molecular forces :** On the basis of intermolecular forces of attraction polymers can be classified in following types :

(i) **Elastomers :** In this type, the polymer chains are held together by weak intermolecular forces *e.g*. Natural rubber, vulcanized rubber, SBR (Styrene butadiene rubber) etc.

(ii) **Fibres :** In this type, the intermolecular forces between the chains are hydrogen bond or dipole - dipole interaction *e.g*. Nylon, polyester and orlon etc.

(iii) **Thermoplastics :** In this type, the intermolecular forces are intermediate between those of elastomers and fibers. *e.g*. polystyrene, PMMA etc.

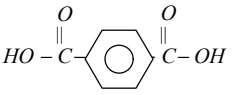
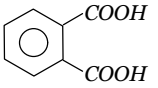
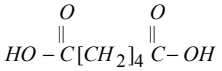
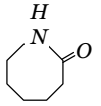
(iv) **Thermosetting :** They are highly cross-linked hard, infusible and insoluble polymers .*e.g*. Bakelite, phenol formaldehyde etc.

Thermosetting polymer	Thermoplastic polymer
Do not soften on heating.	Soften on heating.
Generally formed by condensation.	Formed by addition as well as condensation.
They have cross linked structure.	Generally have linear structure.

Important synthetic polymers along with their starting materials

Name of polymer	Abbreviation	Starting Materials	Nature of polymers	Properties	Applications
(1) **Addtion Polymers**					
(i) **Polyolefines**					
Polyethylene Or Polyethene	HDPE (High density polyethene)	$CH_2 = CH_2$	Low density homopolymers (branched) chain growth.	Transparent, moderate tensile Strength high toughness	Packing material carry bags insulation for electrical wires and cables, buckets, tubs house ware, pipes, bottles and toys.
	LDPE (Low density polytehene)	$CH_2 = CH_2$	High density homopolymer, linear, chain growth.	Transluscent chemically inert greater tensile strength toughness.	
Polypropylene Or Polypropene	PP	$CH_3CH = CH_2$	Homopolymer, Linear, chain growth.	Harder and stronger than	Packing of textiles

				polyethene.	and foods, liners for bags, heat shrinkage wraps carpet fibers ropes, automobile mouldings, stronger pipes and bottles.
Polystyrene Or Styron		$C_6H_5CH = CH_2$	Homopolymer, linear, chain growth	Transparent	Plastic toys, house hold wares, radio and television bodies refrigerator linings
(ii) **Polydienes**					
Neoprene		$CH_2 - CH - \overset{Cl}{\overset{\vert}{C}} = CH_2$ Chloropren e or 2- Chloro -1, 3-butadiene	Homopolymer, chain growth.	Rubber like, inferior to natural rubber and a superior resistant to aerial oxidation and oils gasoline etc.	Hoses, shoe heels stoppers.
Buna-S (Styrene, Butadiene Rubbber)	SBR	$CH_3 = CH - CH = CH_2$ 1 and 3–butadiene and and $C_6H_5CH = CH_2$ (styrene) in the presence of Na	Copolymer chain growth.	Rubber like. Inferior to natural rubber and a superior resistation to aerial oxidation and oils gasoline etc.	Manufacture of tyres rubber sols water proof shoes.
(iii) **Polyacrylates** Polymethacrylate (flexiglas, lucite, acrylite and perspex	PMMA	$CH_2 = \overset{CH_3}{\overset{\vert}{C}} - COOCH_3$	Copolymer.	Hard transparent, excellent light transmission, optical clarity better than glass takes up colours.	Lenses light covers lights, shades Signboards transparent domes skylight aircraft window, dentures and plastic Jewellery.
Polyethylacrylate		$CH_2 = CH - COOC_2H_5$	Copolymer.	Tough. rubber like product	
Polyacrylonitrile	PAN	$CH_2 = CH - CN$	Copolymer.	Hard, horney and high melting materials	Orlon, acrilon used for making clothes, carpets blankets and preparation of other polymers.
(iv) **Polyhaloolefines** Polyvinyl chloride	PVC	$CH_2 = CH - Cl$ Vinyl chloride	Homopolymer chains growth.	Thermoplastic.	(i) Plasticised with high boiling esters PVC used in rain coats hand bags, shower curtains, fabrics, shoe soles, vinyl flooring (ii) Good electrical insulator (iii) Hose pipes
Polytetrafluoroet-hylene or Teflon	PTFE	$F_2C = CF_2$	Homoplymer, high melting point	Flexible and inert to solvents boiling acids even aqua regia. Stable upto 598 K.	(i) For nonstick utensils coating (ii) Making gaskets. Pump packings valves, seals, non lubricated bearings.
Polymonochlorotri-fluorethylene	PCTFE	$ClFC = CF_2$	Homopolymer	Less resistant to heat and chemicals due to presence of chlorine atoms	Similar to those of teflon.

(2) **Condensation polymers**					
(i) **Polysters**					
Terylene or Dacron	PET (Polyethylene terephthalate)	$HO-CH_2-CH_2-OH$ Ethylene glycol or Ethane -1, 2 - diol and  Terephthalic acid	Copolymer, Step growth linear	Fibre crease resistant, low moisture absorption, not damaged by pests like moths etc.	For wash and wear fabrics, tyre cords seat belts and sails.
Glyptal or alkyd resin		$HO-CH_2-CH_2-OH$ Ethylene glycol and  Phthalic acid	Copolymer, linear step growth	Thermoplastic, dissolves in suitable solvents and solutions on evaporation leaves a tough but not fexiable film	Paints and lacqures.
(ii) **Polyamides**					
Nylon 66		 Adipic acid and and $H_2N-[CH_2]_6-NH_2$ Hexamethyl lenediamin e	Copolymer, linear, step growth	Thermoplastic high tensile strength, abrasion resistant.	Textile febrics, bristles for brushes etc.
Nylon 610		$H_2N-[CH_2]_6-NH_2$ Hexamethyl ene diamine and $HOOC[CH_2]_8COOH$ Sebacic acid	Copolymer, linear, step growth	Thermoplastic, high tensile strength, abrasion resistant.	(i) Textile fabrics, carpets, bristles for brushes etc. (ii) Substitute of metals in bearings (iii) Gears elastic hosiery. Mountainering ropes, tyre cords, fabrics.
Nylon 6 or Perlon		 Caprolactu m or $H_2N=[CH_2]_5-COOH$ $\in$–Aminocapro ic acid	Homopolymer, linear	Thermoplastic high tensile strength, abrasion resistant.	
(3) **Formaladehyde resins**					
Phenol formaldehyde resin or Bakelite		Phenol and formaldehyde.	Copolymer, step growth	Thermosetting polymer, hard and brittle	(i) With low degree polymerisation –as bindings glue for wood, varnishes, lacquers. (ii) With high degree polymerisation-for combs, for mica table tops, fountain pen barrels electrical goods (switches and plugs). Non-breakable crockery.
Melamine formalde hyde resin.		Melamine and formaldehyde.	Copolymer, step growth	Thermosetting polymer, hard but not so breakable.	

Some Important Points

(1) **Homopolymers :** Polymers made of molecules of same substance are called homopolymers.

(2) **Co-polymers :** The polymers made and different types of molecules are copolymers.

(3) Polymers havings ester linkage are called polyesters.

(4) Polymers of alkenes are generally called polyenes.

(5) Thermosetting polymers cannot be remoulded but thermoplastic polymers can be remoulded.

(6) Vulcanization is a process of treating natural rubber under heat and sulphur. Sulphur introduces cross –linkes. Vulcanization was introduced by **Charles Goodyear**.

(7) Natural silk on burning gives a smell of burning hair and shrinks in to a ball of cinder while artificials silk gives a thread of ash.

(8) Terylene is a British name of **Dacron**.

(9) Co-polymer of vinyl chloride 90% and vinyl acetate 10% is called **Vinyon.**

(10) Co-polymer of acrylonitrile 40% and vinyl chloride is called **Dynel.**

(11) Co-polymer of vinyl chloride and vinyledene is called **Saran.**

(12) Buty rubber is a copolymer of isobutylene and isoprene.

(13) Thiokol is another variety of synthetic rubber which is a copolymer of ethylene chloride and sodium tetrasulphide (Na_2S_4).

(14) Buna-S rubber is copolymer of *butadiene* and styrene. Copolymerisation is carried out in the presence of sodium (*Na*).

(15) Buna-*N* rubber is a copolymer of butadiene and acrylonitrile. Copolymerisation is carried out in the presence of sodium (*Na*).

(16) Gutta percha is a naturally occuring polymers in plants. It is an all trans-steroisomer and is non-elastic.

(17) Proteins, nucleic acids and polysaccharides which control various activities of plants and animals are called biopolymers.

(18) Natural rubber is cis-polyisoprene and is prepared from latex which is obtained from rubber tree (Hevea brariliensis).

(19) *PDi* (polydispersity index) $= \frac{\overline{M}_w}{\overline{M}_n}$; In natural polymers; $PDi = 1 \quad \because \quad \overline{M}_w = \overline{M}_n$

In synthetic polymers $PDi > 1 \qquad \because \overline{M}_w > \overline{M}_n$

(20) *Cashmilon, Orlon* and *Acrilon* are commercial names of polyacrylonitrile .

(21) A thin film of polyester is known as **Mylar film.**

(22) PET plastic commonly used for soft drink bottles, transparent jars and bottles for use in kitchen are made up of polyethylene terephthalate, chemically same as terylene (a polyester).

(23) **Glyptal** resins or Alkyd resins obtained from ethylene glycol and phthalic acid are thermoplastic However, resins obtained from glycerol and phthalic acid are thermosetting polymers, due to the formation of cross-links by the third $-OH$ group present in glycerol.

(24) **Kevlar** is a nylon-polymer and is obtained by condensation copolymerization of terephthalic acid with 1,4-diaminobenzene (*p*-phenylenediamine). The fibres of this polymer are so strong that they are used to make bullet-proof vests.

(25) **Lexan** is a polycarbonate(polyester) and is prepared by condensation copolymerization of diethyl carbonate and bisphenol A . It has unusually high impact strength and hence is used in making bullet-proof windows and safety or crash helmits.

(26) **Nomex** is a polyamide made from m-phathalic acid and m-diaminobenzene. It is known for its fire-resistant properties and is used in protective clothing for firefighters, astronauts and race car drivers.

(27) **Ebonite** is high sulphur (20-30 %*S*) rubber and is obtained by vulcanisation of natural rubber.

(28) **Rayon** was originally called artificial silk but now the name rayon is given to all fibres obtained by chemical treatment of cellulose. Thus, artificial silk is polysaccharide , *i.e.*, cellulose derivative.

(29) Stereochemical arrangement of polymers are :

Isotactic (Greek meaning 'same order') **:** With all the methyl groups on one side of the opposite sides of the zig-zag backbone.

Syndiotactic (Greek meaning 'alternating order'): With the methyl groups alternating regularly on the opposite sides of the zig-zag backbone.

Atactic (Greek meaning 'no order'): With the methyl groups randomly oriented.

Biomolecules

Biomolecules are the complex organic compounds which built up living organism and are required for their growth and maintenance. For examples, carbohydrates, proteins, lipids, nucleic acids.

Carbohydrates

These are polyhydroxy aldehydes and ketones or substances which gives such compounds on hydrolysis.

Classification of carbohydrates

(1) **Sugars :** These are crystaline substances with sweet taste and are soluble in water.

(2) **Non-Sugars :** These are naturally occurring polymers with very high molecular mass and do not have sweet taste.

(3) **Monosaccharides :** These are the simple carbohydrates which do not hydrolyse to still simpler carbohydrates. Chemically, they are polyhydroxy aldehydes or ketones.

(4) **Oligosaccharides :** These are carbohydrates which on hydrolysis give 2 to 9 units of monosaccharides. They can be further classified into *di*, *tri* and *tetra* saccharides. Common examples of :

Disaccharides are : Sucrose and maltose, *Trisaccharides is* : Raffinose, *Tetrasaccharides is* : Stachyose.

(5) **Polysaccharides :** These are carbohydrates, which on hydrolysis give large number of monosaccharide units. Cellulose and starch are common examples.

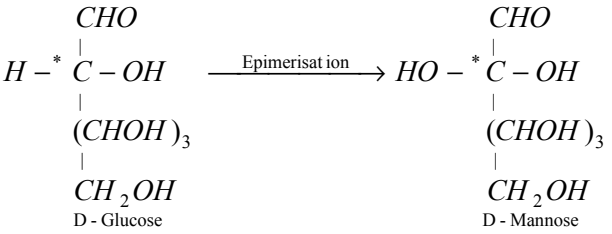
Reducing and Non Reducing sugars : The carbohydrates which are capable of reducing Fehling solution or Tollen's reagent are called reducing sugars. They contain $-CHO$ group in their molecules. On the other hand sugars, which do not reduce Fehling solution or Tollen's reagent, are called non-reducing sugars.

Glycoside Linkage : The linkage which holds the monosaccharides units in oligo or polysaccharides is called glycoside linkage.

Mutarotation : Glucose exist in two forms α - *D* glucose and β - *D* glucose. Optical rotation of α - *D* glucose is $+112^{o}$ where as that of β - *D* glucose is $+19^{o}$. The optical rotation of equilibrium mixture of α - *D*

glucose and β - *D* glucose is 52°. The process which involves the change in the optical rotation of either form of glucose to that of equilibrium mixture is called mutarotation. The two forms of glucose α - *D* and β - *D* forms are also called **anomers**.

Epimerisation : It is a process of inversion of configuration at one of the assymmetric (or chiral) centre of the molecule which contain several chiral centres.



Proteins

These are complex nitrogenous organic compounds found in animals and plants. These are essential constituents of all living cells. Structurally, proteins are long polymers of amino acids bonded by peptide linkages. The structure of proteins is described as follows:

(1) **Primary structure :** It refers to the sequence of various amino acid in proteins. The biological activity primarily depends upon primary structure.

(2) **Secondary structure :** This refers to the arrangement of polypeptide chains in space with respect to one another.

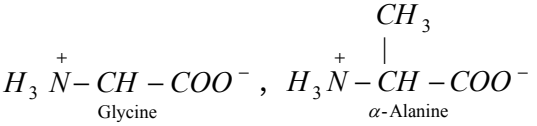
(3) **Tertiary structure :** This tertiary structure describes as to how the proteins have coiled or folded up as a result of interparticle attraction.

Biological functions of proteins : (1) Structural material of animal tissues. (2) Transport agent (3) Enzyme (4) Antibodies (5) Metabolic regulators.

Denaturation of Proteins : When proteins are heated above the temperature characteristic of living organism or when they are subjected to unusual acidic or basic conditions they begin to undergo change in their secondary and tertiary structure. This is refer to as denaturation of proteins.

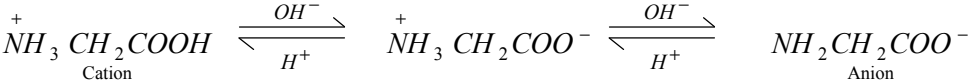
Amino acids

These are the compounds containing carboxyl and amino groups. Almost all amino acids obtained from proteins are α-amino acids *i.e.,* amino group is linked to the carbon atom having carboxyl group attached to it. Some common examples are glycine, α-alanine, valine etc. α- amino acids generally exists in the form of zwitter ion structure. For example zwitter ion structure of glycine and α-alanine.



It may noted that:

(1) In alkaline solutions amino acids exists as anion while in acidic medium they exist as cation.



The *pH* of a solution of amino acids at which it exist in the form of a dipolar ion is called its **iso-electric point.**

(2) Different amino acids have different iso-electric points.

Peptides Linkage : The linkage which unites the α-amino acid molecules together is called peptide linkage. It is, $-CO-NH-$ linkage.

Nucleic acid

These are biological significant polymers which are present in all living cells. They direct the synthesis of proteins and are responsible for the transfer of genetic information, *i.e.,* hereditary characteristics. The two types of nucleic acids are : RNA(Ribonucleic acid) and DNA (Deoxyribonucleic acid).

Both RNA and DNA are polymers of nucleotides. A nucleotide consists of a sugar unit linked to nitrogen base as well as phosphoric acid unit as follow :

$$\text{Base} - \text{Sugar} - O - \underset{\underset{OH}{|}}{\overset{\overset{O}{||}}{P}} - OH \quad \text{(A nucleotide)}$$

Phosphoric acid unit

In RNA the sugar unit is : *D*-ribose, Bases are: *Adanine, guanine, uracil* and *cystosine* ,

In DNA, the sugar unit is: Deoxyribose and Bases are: *Adanine, guanine, thiamine* and *cytosine.*

Some important points of differences between RNA and DNA are given below :

DNA	RNA
It has a double helix structure.	It has a single helix structure.
Sugar unit is deoxyribose.	Sugar unit is Ribose.
Base units are adanine, guanine, thyamine and cytosine	It contains uracil base instead of thyamine, other bases being same as those in DNA
Responsible for inheritance of character.	It is responsible for protein synthesis.

Lipids

These are oily, fatty or waxy substances present in living organisms. Their main functions are to form a part of structure of biological membranes and to store energy for cells.

Triglycerides : These are esters of glycerols and higher fatty acids and are the main form in which fat is stored in plants and animals cells.

Phospholipids : These are mixed glycerides of higher fatty acids and phosphoric acid in which two of the *OH* groups of glycerol are esterified by fatty acids and third *OH* group by some derivative of phosphoric acid.

Vitamins

These are group of organic substances other than carbohydrates, proteins and fats, which are necessary to maintain normal health, growth and nutrition. Vitamins differ from hormones in the fact that these are

supplied by the food stuff, whereas hormones are produced by the body's own glands. Although vitamins are complex molecules, yet for the sake of simplicity they are represented by letters *A*, *B*,*C*, *D*, *E*, *K*.

Some important vitamins and diseases caused by their deficiency are being given as follows :

Deficient Vitamins	Diseases	Symptoms
Vitamin A	(i) Night blindness (ii) Xerophthalmia	Inability to see in dim light. Discharge of mucous from eyes corneal keratinization, clouding leading to ulceration and photophobia.
Vitamin B_1	Beriberi	Retarded growth, less in appetite and weight nervous degeneration, muscular atrophy, oedema.
Vitamin B_2	Cheilosis	Inflammation and sometimes cracking at corners of mouth.
Niacin	Pellagra	Digestive disorder and irritability.
Vitamin B_6	Anaemia	Retarded growth, loss of appetite, apathy.
Vitamin B_{12}	Pernicious Anaemia	Immature, enlarged and nucleated *RBC*s deficient in haemoglobin.
Vitamin *C*	Scurvy	Delayed healing,bleeding gums, fragile bones.
Vitamin *D*	Rickets (in children), Osteomalacia (in adults)	Bending and softening of bones, swelling on joints.
Vitamin *K*	Bleeding Disease	Poor blood clotting.

Hormones

These are the chemical substances secreted by ductless glands, which influence and control biological reactions. Some important hormones alongwith their source and function are being given below :

Hormones	Sources	Functions
(1) Steroid hormones		
(i) Testosterone (Androgens)	*Testis*	Regulates development of reproductive male organs.
(ii) Estrogene and progesterons	*Ovary (Uterus)*	Female sex hormones : control normal functioning of female sex organs.
(iii) Cortisone and related hormones	Adrenal cortex	Regulates the metabolism of fats, proteins, carbohydrates and mineral salts.
(2) Amine Hormones		
(i) Adrenalino (Epinephrine)	Adrenal medulla	Increase the pulse rate and blood pressure : reduces glucose from glycogen and fatty acids from fats.
(ii) Thyroxine	Thyroid	Stimulates rate of oxidative metabolism and regulates general growth and development.
(3) Peptide hormones		
(i) Oxitocin	Posterior pituitary	Causes contraction of some smooth muscle. Also causes contraction of uterus during child birth.
(ii) Vasopressin	Posterior pituitary	Inhibits excretion of water from the body by way of urine.
(iii) Insulin		

(iv) Glucogen	Pancreas Pancreas	Decreases blood glucose level. Elevates blood glucose level.

Some Important Points

Biotechnology : The branch of science which deals with the study of synthesis and improvement of the properties of biomolecules such as proteins, enzymes, nucleic acid *etc.,* is called biotechnology or bioengineering. Biotechnology finds tremendous applications in various chemical processes, food industry, agricultural field and also in pollution control. Some biotechnological products along with their applications are being given as follows.

Product	Applications
Human insulin hormone	Treatment of diabetes.
Interferon	Antiviral agent.
Growth hormones	Treatment of abnormal growth related diseases.
Tissue plasminogen factor	Dissolving unwanted blood clots.
Blood clotting factor VIII	Treatment of haemophilias.
Vaccines	Against various infective diseases.

Fermentation : It is a complex chemical process which converts pyruvate ions formed as a result of glycolysis into ethanal and then ethanol under the influence of micro organisms in the absence of light.

Blood : Blood is a complex fluid and is a medium of transport in the circulatory system . Although the chemical composition of blood is very complex yet broadly it may be divided into 2 parts :

(i) **Plasma :** It is an aqueous mixture of ions and organic molecules.

(ii) **Suspended particles :** These are red blood cells (erythrocytes), white blood cell (leucocytes) and blood platelets.

Immunity : The protective mechanism by virtue of which a body resists the invasion of foreign micro organisms.

Antigens : A foreign substance which trigger the formation of some specific antibodies within the living organism.

Antibodies : The proteins produced in respone to the presence of some foreign substance in the blood or tissues.

Replication : It is the property of a molecule to synthesise another molecule. DNA has unique character to duplicate or replicate itself.

Transcription : The transcription involves copying of DNA sequences into a complementary RNA molecule called messenger RNA.

Mutation : It is chemical change in a DNA molecule that could lead synthesis of proteins with different amino acid sequence.

Allergy : It is phenomenon in which antibodies produced by certain substances combine with antigens and force the mast cells to produce cytoplasmic granules such as histamines, seratonin, which induce symptoms like itching, swelling, rashes, redness, etc., in the body.

Anabolism : The process by which various macromolecules present in the cell are synthesised by the cell itself.

Catabolism : The process in which macromolecules break up into smaller fractions.

Photosynthesis : The biochemical process in which carbohydrates are synthesised from carbon dioxide and water in the presence of sunlight occuring in the cells of green leaves of plants called *chloroplasts*. The photosynthesis can be considered in terms of series of reactions as follows :

(i) **Light reactions :** Here solar radiations are absorbed by green pigment of plants called chlorophyll and this energy utilised to synthesize energy rich molecule **ATP.**

(ii) **Dark reactions :** Here the energy rich molecule converts atmospheric carbon dioxide into glucose, starch etc.

Digestion : It is a process by which complex food stuff is broken down into smaller molecules. Digestion of food stuff begins in the mouth where it is chewed. As it passes through alimentary tracks, it gets mixed with enzymes and is broken into smaller and simple molecules these simple molecules are absorbed into blood stream and are carried to different parts of the body.

Metabolism : It refers to sum of all enzyme catalyzed chemical reaction that are constantly occurring in the living organisms and enable to use matter and energy to build up maintain and renew their parts.

- Haemoglobin is a globular protein present in red blood cells.
- The red colour of haemoglobin is due to the presence of non-proteinaceous part called heme.
- Plasma maintains the constant body temperature by carrying heat from the muscle and glands to the other parts of the body.
- The oxidation of carbohydrates in the presence of oxygen is termed as aerobic respiration.
- The degradation of carbohydrates in the absence of oxygen is referred to as anaerobic respiration.
- Anaerobic degradation of glucose into two molecules of pyruvic acid is termed as glycolysis.
- Antiferments are the substances like chloroform, mercury etc.which act as poisons for enzymes.
- Saccharification is the process in the manufacture of alcohol in which starch is converted into fermentable sugar.
- Provitamins are the biologically inactive compounds which have almost similar structure as vitamins and can be converted easily into active vitamins. *e.g.* β-carotene is a provitamin for vitamin-*A*.

British gum : Dextrin is prepared by heating starch about 200°C and is used as adhesive under the name British gum.

- Inter feron is a protein substance produced by virus invaded cells that prevents reproduction of virus.
- *D*-glucose and *D*-mannose are epimers of each other (which differ in configuration about *C*-2)
- α-*D* glucose β-*D* glucose are anomers of each other (which differ in configuration about *C*-1).

- Killiani synthesis is used to convert an aldose into next higher aldose. [*e.g.*, arabinose (5*C*) to glucose (6*C*)]. On the other hand **Ruff's degradation** is used to convert an aldose into next lower aldose.
- Total number of possible optical isomers of glucose are 16 and of fructose are 8.
- Watson, Crick and Wilkins were awarded Noble prize in 1962 for suggesting the structure of DNA.
- Main functions of nucleic acid are:

(i) Direct synthesis of proteins in living cells. (ii) Responsible for transference of genetic information.

- Insulin is a globular protein.
- Myosin is a fibrous protein.
- Starch is also called amylum.
- Gene is a part of the DNA molecule that codes for a specific protein.
- Lactose is known as milk sugar.
- Glucose is called grape sugar or dextrose.
- Fructose is also called laevolase or fruit sugar.
- Gum is a polymer of more than one type of monosaccharides. Gums are acidic polysaccharides.
- Proline is the only natural α-amino acid found which is a secondary amine.
- Only achiral α-amino acid found in proteins is glycine.

Chemistry in action

(1) **Dyes :** These are coloured chemical substances capable of imparting colours to the textiles, food stuff, leather, paper, cosmetics etc. Dyes can be classified on the basis of chemical composition and their applications :

(i) **Direct dyes.** These dyes stick to the fibre through hydrogen bonding. They belong to the class of azo dyes. They are used to dye the fabric directly by placing it in hot aqueous solution of the dye. Some common examples are Martius yellow, Congo red etc.

(ii) **Acid dyes**. They are characterized by the presence of $-COOH, -SO_3H$ or phenolic group. They are applied in the presence of acidic solutions. They are usually applied to wool, silk, nylon. They do not have affinity for cotton. Common examples are orange-I, orange-II, methyl red, methyl orange, etc.

(iii) **Basic dyes.** These dyes contain $-NH_2$ or $-NR_2$ group as colour bearing groups or colour enhancing groups. They are generally used for wool, cotton, leather, paper, polyester, nylon etc. Some common examples are aniline yellow, crysodine *G*, butter yellow, etc.

(iv) **Disperse dyes.** They are usually applied in the form of dispersion of finely divided dye in a soap solution in the presence of phenol, cresol, benzoic acid, etc. They are mainly used to dye decron, nylon and other synthetic fibres. Celliton fast pink *B* and Celliton fast blue *B* are common examples.

(v) **Vat dyes.** These dyes are insoluble compounds which upon reduction give soluble (leuco form) product. The reduced product is generally colourless and has affinity for specific fabrics. Indigo is one such dye.

(vi) **Mordant dyes.** A mordant is any substance which can be fixed to the fibre and which can be dyes later on. Mostly hydroxides or basic salts of chromium, aluminium and iron are used as mordants. A dye which imparts different colours in the presence of different mordants is referred to as mordant dye. For example,

alzarin is a mordant dye. When mordanted with aluminium salt solution, it imparts rose-red colour to fabric but the same fabric is dyed blue when it is mordanted with barium salt. With ferric salts, it dyes violet.

(2) **Medicine and chemotherapy :** Chemical substances used for treatment of diseases and for reducing suffering from pain are called medicines or drugs. The branch of science which deals with the treatment of diseases using suitable chemicals is known as chemotherapy.

(i) **Antipyretics.** Chemical substances used to bring down the body temperature in high fever. Some examples are: aspirin, paracetamol, analgin and phenacitine.

(ii) **Analgesics**. Chemical substances used for relieving pain. Some examples are novalgin, aspirin, analgin etc. It should be noted that aspirin, novalgin act both as analgesic and antipyretic.

(iii) **Antiseptics**. Chemical substances which prevent the growth of micro-organism or kill them but are not harmful to the human beings. Some common examples are chlorine, iodine, bithional, organic dyes, etc.

(iv) **Disinfectants**. Chemical substances which kill micro-organisms but are harmful to human tissues are called disinfectants. It should be noted that phenol acts both as antiseptic (0.1% solution) and disinfectant (1% solution).

(v) **Tranquilizers**. Chemical substances used to cure mental diseases are called tranquilizers. They are also called psycho-therapeutic drugs.

(vi) **Antibiotics**. Chemical substances which are produced by micro-organisms and are capable of destroying other micro-organims. Some common examines are penicillin, ampicillin, streptomycin, chloramphenical etc.

(3) **Propellants**. Propellant is generally a combination of an oxidizer and a fuel which when ignited undergoes combustion to release large amounts of hot gases.

Types of propellants : Depending upon their physical states, propellants can be classified as follows:

(i) **Solid propellants.** These propellants when ignited burn with a predetermined rate. Their major defect is that these do not have the start and stop capability. Solid propellants are of two types:

(ii) **Composite propellant :** It consists of polyurethane or polybutadiene as a fuel and ammonium perchlorate as an oxidizer. Some finely aluminium or mangesium metal is also added to modify its activity.

(iii) **Double-base propellant :** It consists of nitroglycerine and nitrocellulose. On ignition, this undergoes combustion and a large amount of heat is produced.

(iv) **Liquid propellants**. These consists of an oxidiser such as liquid oxygen, nitrogen tetroxide (N_2O_4) or nitric acid and liquid fuel such as kerosene, alcohol, hydrazine or liquid hydrogen. These are further classified as:

(v) **Monoliquid propellants :** In these propellants a single compound decomposes to give out hot gaseous substances, *e.g*. hydrazine, methyl nitrate, nitromethane and hydrogen peroxide. Except hydrazine other substances mentioned contain both the oxidiser and fuel elements in the same molecule.

(vi) **Biliquid propellants :** In these propellants, the fuel and the oxidiser are stored separately but allowed to combine at the instant of combustion. For example, kerosene and liquid oxygen.

(vii) **Hybrid propellants :** This type of propellant usually consists of a solid fuel and a liquid oxidiser. For example, solid acrylic rubber and liquid N_2O_4.

Note : ❑ The energy of the propellant is measured in terms of its specific impulse (I_s) which is related to its flame temperature (T_c) inside the rocket motor and average molecular mass (*M*) of the product gases

$$I_s = \sqrt{T_c / M}$$

It is evident that lower the molecular mass of the product gases and higher the value of T_c, better will be the propellants.

Some important points :

(1) Abscisic acid is a plant growth inhibitor.

(2) Sulpha drugs are bacteriostatic in action.

(3) **Ehrlich** was given the Noble prize in 1909 for his achievements in the field of chemotherapy.

(4) Aspirin was introduced by **Gilm** while penicillin was discovered by **Alexander Fleming**.

(5) APC mixture contains Aspirin, Phenacetin and Caffeine.

(6) Dettol contains chloroxylenol and terpineol.

(7) India launched its first satellite **Aryabhatta** in March 19, 1975

(8) Hydrazine can act both as a monoliquid as well as a biliquid propellant. Hydrazine (H_2N-NH_2) acts as a monoliquid propellant as it decomposes exothermally into hot gaseous mixture of N_2 and H_2

$$H_2N-NH_2 \longrightarrow N_2 + 2H_2 + \text{Heat}$$

As a biliquid propellant with liquid oxygen as oxidiser.

$$H_2N-NH_2 + O_2 \longrightarrow N_2 + 2H_2 + \text{Heat}$$

(9) Drugs or medicines from plants

(i) Bark of willow tree which contains salicyclic acid. It is used to get relief from pain and fever.

(ii) Alkaloid reserpine from **Rauwolfia Serpentina** for high blood pressure (hypertension).

(iii) Alkaloid Quinine from **Cinchona** tree for malaria.

(10) Common 'Neel' used as a blueing agent in laundary to remove yellowish tint on white clothes or in whitewashing is not indigo. It is ultramarine blue – an inorganic complex silicate of aluminium and sodium with about 13% sulphur.

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