→2018
→2020

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Carbohydrates

Carbohydrates are most abundant organic molecules in nature. They are primarily composed of the elements Carbon, Hydrogen and Oxygen in ratio 1:2:1.
The name carbohydrate literally means "hydrates of carbon"
They may be defined as;
"polyhydroxy Aldehydes or ketones or compounds which produce them on hydrolysis"
In layman term, they are called "Sugars"

Characteristics:

- They are the most abundant dietary source of energy (4 cal/g) for all organisms.
- They also serve as the storage form of energy to meet the immediate energy demands of body.
- They participate in structure of cell membrane and cellular functions such as cell growth, adhesion and fertilization.
- They are the structural component of many organisms
- They are essential for structure of DNA & RNA

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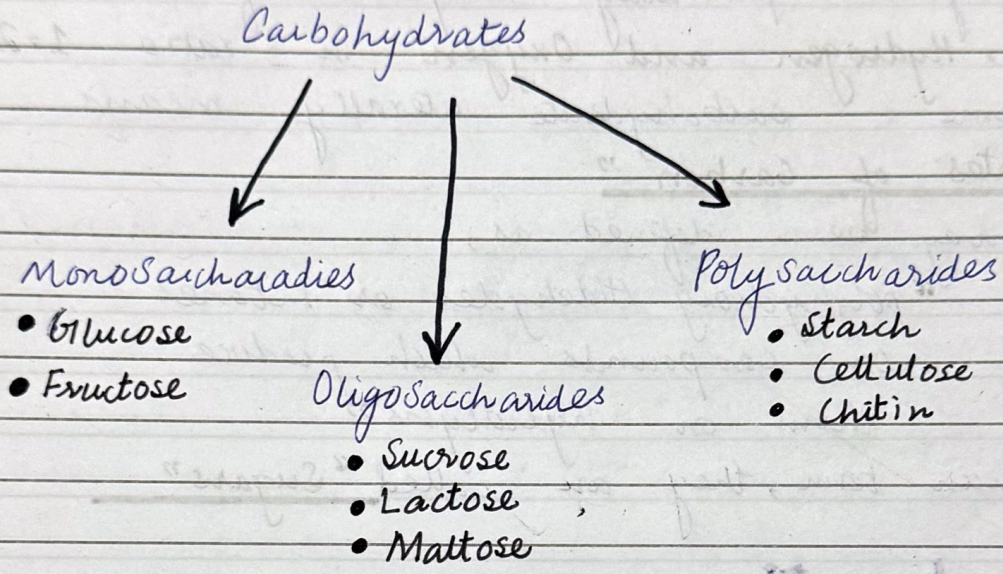
Classification :-

Carbohydrates are classified it into three main types/classes.



MonoSaccharides :

Monosaccharides are the simplest group of carbohydrates and are known as "Simple Sugars" They have the general formula $C_n(H_2O)_n$. and they cannot be further hydrolyzed.
They are further divided into different categories.

On the basis of Functional group, they are divided into Aldoses and Ketoses.

On the basis of no. of Carbon Atoms, they are classified as Trioses, Tetroses, Pentoses, Hexoses and heptoses.

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For Example:

Trioses (3-C sugar)	$C_3H_6O_3$	→	Glyceraldehyde
Teteoses (4-C sugar)	$C_4H_8O_4$	→	Erythrose
Pentoses (5-C sugar)	$C_5H_{10}O_5$	→	Ribose
Hexoses (6-C sugar)	$C_6H_{12}O_6$	→	Glucose, Fructose

Among MonoSaccharides, Glucose is most important energy source of carbohydrates to the mammals. It's the **Sugar Fuel of life.**
All the carbohydrates that are absorbed by human body must be converted to glucose before the body can break it down for energy.

Fructose is abundantly found in fruits. It is also found in semen which is utilized by sperms for energy.
Ribose and Deoxyribose are essential for structure of DNA & RNA

OligoSaccharides:

OligoSaccharides contain (2-10 monosaccharides) molecules which are liberated on hydrolysis. Oligosaccharides with more than 3 monosaccharides units are not usually digested by human enzymes.

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Oligosaccharides on basis of number of monosaccharides units present, are further classified into

- disaccharides (Two Monosaccharides Unit)
- Trisaccharides (Three Monosaccharide Units)

Disaccharides may be Reducing or Non-Reducing.

For Example:

Sucrose → Glucose + Fructose
Maltose → Glucose + Glucose
Lactose → Glucose + Galactose
Lactulose → Galactose + Fructose (Synthetic)

Sucrose;

Sucrose is the sugar of commerce, mostly produced by sugar cane and sugar beets. It's also known as **Table Sugar**.
It is sweeter than other (5kd) Carbohydrates except Fructose. It is employed as sweetening agent in Food Industry.

Lactose:

It is commonly known as **Milk Sugar**
It is most important carbohydrate in the nutrition of young mammals.
It is hydrolyzed by intestinal enzyme **Lactase**.

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PolySaccharides:

Polysaccharides are polymers of monosaccharides units with high molecular weight - They are primarily concerned with two Important functions;
Structural and storage of Energy.

For Example:

- Starch
- Cellulose
- Glycogen

Starch:

Starch is carbohydrate reserve of plants which is the important dietary source for higher animals, including man. High content of starch is found in cereals, roots, tubers, vegetables etc. They are hydrolyzed by **Amylase** to liberate dextrins and finally **maltose** and **glucose** units

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Proteins

Proteins are the most abundant and functionally diverse molecule in living systems. They form the fundamental basis of structure and function of life

Term "protein" is derived from word proteios meaning holding the first place

For the entire study of galaxy of proteins, term proteomics is used.

Proteins are predominantly consisted by five major elements in following proportion

- Carbon
- Hydrogen
- Oxygen
- Nitrogen
- Sulfur

COMPOSITION:

Proteins are polymers made of monomers called Amino Acids. Amino acids are relatively small nitrogen containing molecules that serve as building blocks for proteins and other organic compounds.

Although, >300 amino acids have been described

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in nature, only 20 of them are commonly found as constituents of mammalian proteins. These 20 amino acids are linked together by **Peptide Bond.**

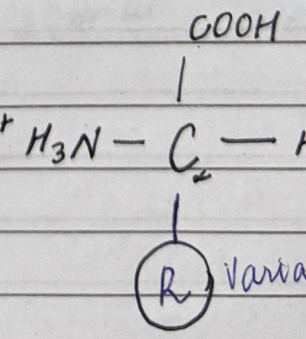
Our body is capable of manufacturing some amino acids; others must be obtained from our food.

- **Essential Amino Acids** are those which cannot be synthesized in body. They must be obtained from dietary sources. They are 9 in number
  Histidine, Leucine, Isoleucine, Lysine, Methionine, Phenyl Alanine, Threonine, Tryptophan, Valine.

- **Non-Essential Amino Acids** are those which can be synthesized in body. These are 10.
  Alanine, Asparagine, Aspartic Acid, Cysteine, (Aspartate) Glutamic Acid, Glutamine, Glycine, Proline, Serine, Tyrosine.

- **Conditionally Essential Amino Acid** is the one which only Adults can synthesize in body, but Infants and children cannot produce Enough to meet their needs_
  e.g Arginine.

Basic Structure of Amino Acids:



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Characteristics : Virtually, every life process depends upon this class of macromolecules

- Proteins are the chief-builders of body.
- They are used to synthesize enzymes, hormones, carrier proteins and contractile proteins
- In bone, certain protein collagen forms a framework for the deposition of calcium phosphate crystals.
- In blood stream, proteins such as haemoglobin, albumin transport molecules essential to life
- Immunoglobulins, fights infectious bacteria and viruses.
- Proteins are responsible for movement as contractile proteins actin and myosin form basic structure of muscles.

It provides **4.1** calories of energy per gram.

In short, proteins display an incredible diversity of functions, yet all share the common structural feature of being linear polymers of amino acids

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Classification:

Proteins

On basis of structure
- Primary
- Secondary
- Tertiary
- Quartenary

On basis of Function
- Structural Proteins
- Catalytic Proteins
- Transport Proteins
- Hormonal Proteins
- Contractile Proteins
- Genetic Proteins

On basis of chemical nature and stability
- Simple
- Conjugated
- Derived

On basis of Nutrition
- Complete Proteins
- Partially Incomplete
- Incomplete

On Basis of Structure:

Primary Structure:

Sequence of Amino Acids in a protein is called primary structure of protein. Proteins are arranged in linear chain of amino acids. They are non-functional proteins

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Secondary Structure:

If polypeptide chain is coiled into a spiral or helix to have a 3-D structure where the amino acids interact by formation of hydrogen bonds.
It's the spatial arrangement of protein by twisting of polypeptide chain.
α-helixes and β-sheets are formed.

Tertiary Structure:

Long polypeptide chains become more stabilized by folding and coiling, by formation of ionic or hydrophobic bonds or disulfide bridges, this results in tertiary structure of protein

Quarternary Structure:

Some of the proteins are composed of two or more polypeptide chain refered to as sub-units. This spatial arrangement of these subunits is known as quaternary structure.

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On basis of Function:

Structural Proteins:

keratin of hair and nails, Collagen of Bone. They aid in strengthening and protecting biological structures.

Enzymes or Catalytic Proteins:

They are the most varied and highly specialized proteins with catalytic activity.

- Urease
- Pepsin
- Catalase
- Cytochrome C

Transport or Carrier Proteins

They aid in transport of ions or molecules in the body.

- Haemoglobin (Hb)
- Serum Albumin.

Hormonal Proteins

(They) Some hormones are proteins

- Insulin
- Growth hormone

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Contractile Proteins

These are essential for muscle movements.

- Actin
- Myosin

On Basis of Chemical nature and Stability

Simple Proteins

They are composed of only amino acid residues. They are mostly globular type of proteins, soluble

- Albumin
- Globulin

Few are Fibrous Proteins, insoluble in water and resistant to digestion

- collagen
- Keratin

Conjugated Proteins

Besides the amino acids, these proteins contains a non-protein moiety known as prosthetic group.

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prosthetic or conjugated group may be

- Nucleic Acids
- Carbohydrate
- Lipid

Derived Proteins

They are denatured or degraded products of simple and conjugated proteins

- Primary derived proteins are produced by agents such as heat, acids, alkalies etc.
- Secondary derived proteins are hydrolytic products of proteins

On Basis of Nutrition:

Nutritive values of proteins is determined by composition of essential Amino Acids

Complete Proteins

They have all the ten essential amino acids in the required proportion by human body to promote good growth

- Also called First class Proteins

eg:

- Egg Albumin
- Milk casein

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Partially Incomplete Proteins

They partially lack one or more essential amino acid and can promote moderate growth.

e.g: (lacking Lys, Thr)
wheat
Rice proteins

Incomplete Proteins

They complete lack one or more essential amino acid. Hence, they do not promote growth at all.

e.g:
gelatin.

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"Lipids"

Lipids are organic substances occuring in plant and animal tissues and belong to a very heterogenous group of substances which have only a few properties in common. They include fats, oils, waxes, steriod and related compounds.

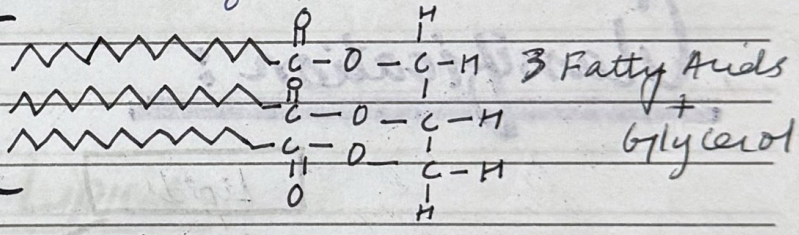
- Term lipid is derived from 'lipos' means fat.
- "Lipidomics" is term for comprehensive study of lipids

Primary building blocks are fatty Acids, glycerol, Sphingosine and sterols

Basic unit of lipids is Triglyceride, synthesized from glycerol and fatty Acids.

Triglyceride are the chemical form in which most fat exists in food as well as in body

Triglyceide molecule



Characteristics:

- Lipids contribute to cell structure, provide stored fuel and also take part in many biological processes
- Lipids provide 9.1 calories energy per gram.
- They are insoluble in water but soluble in non-polar solvents commonly teamed fat solvents e.g ether, alcohol.

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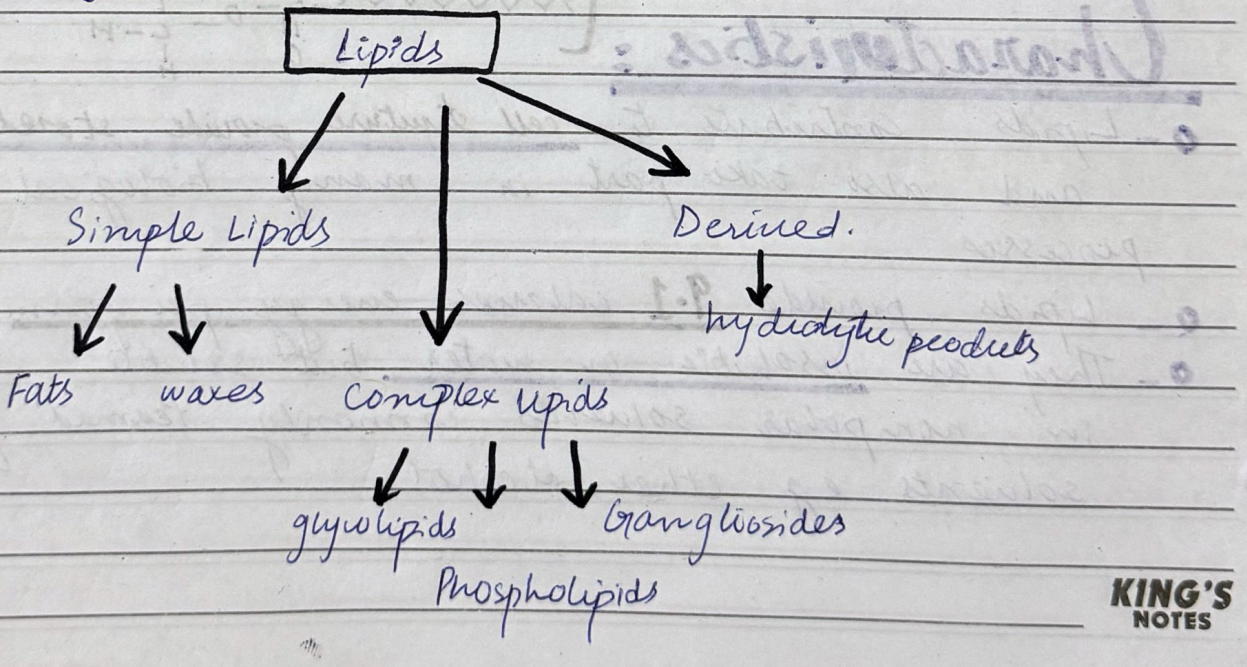
- Lipids in food also act as carriers of fat soluble vitamins and nutritionally essential fatty acids
- Fats (Triglycerides) are good energy reservoirs in body
- Lipids act as electric Insulater in the nervous tissue allowing rapid propagation of action potentials.
- Specific gravity of fats is generally lower than that of water i.e below 1.0

- Oils are fats having low melting points at room temperature and are liquid
- Pure fats possess no color, odor, taste. "Yellow Color of butter" is due to presence of plant pigments like carotene and Xanthophyll.

Classification:



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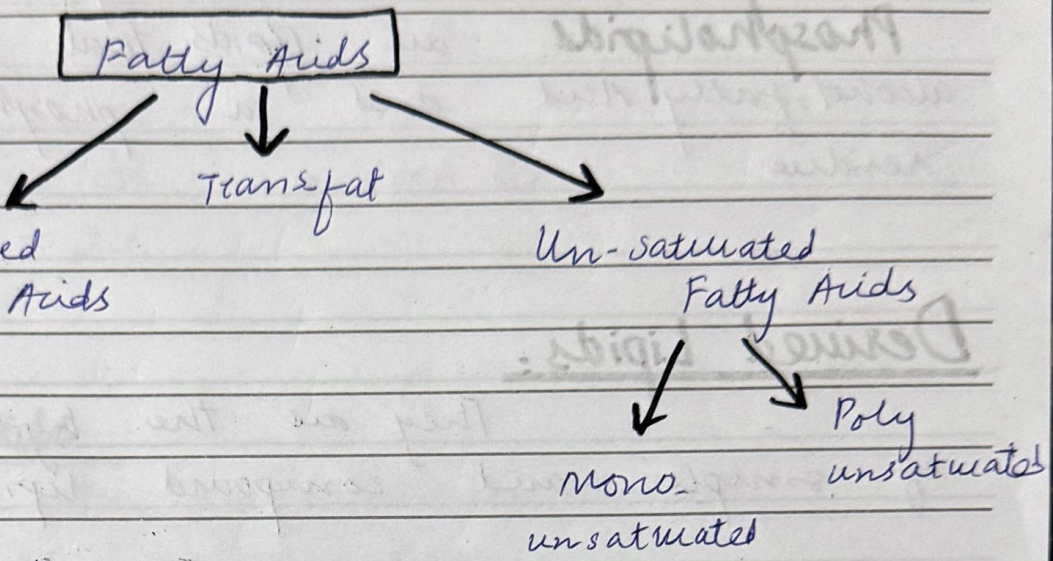

Simple Lipids:

These are compounds of fatty Acids with glycerol like fats, oils, & waxes
Fats are esters of fatty acids with glycerol
Waxes are esters of fatty acids with alcohols other than glycerol.

Complex/Compound Lipids:

They are esters of fatty acids containing groups in addition to an alcohol and a fatty acid. They are sub-divided into following

Glycolipids contain sphingosine, a fatty acid and a monosaccharide/oligosaechaide unit

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Gangliosides are very complex molecules
Phospholipids are lipids that contain an alcohol, fatty Acid and a phosphoric acid residue

Derived Lipids:

They are the hydrolytic products of simple and compound lipids.

- Alcohols
- Sterols
- Vitamin D, E, K
- Carotenoids

Fatty Acids:

Unsaturated Fatty Acids:

They possess one or more double bonds in their chain and are more reactive than Saturated.
They are liquid at room temperature
It is mostly in oil from plants
It lowers LDL cholestrol and raises HDL (good cholestrol).

Monounsatured Fatty Acids are having one double bond.

They are found in

- Avocado
- Nuts
- Olive oil
- Peanut Oil

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Polyunsaturated Fatty Acids are having two double bonds.

They are found in

- Sunflower oil
- Corn Oil
- Sesame Oil

Trans fatty Acids

They are connected through the process of hydrogenation. It is done to increase the shelf life of fat and makes the fat harder at room temperature.

It can raise the level of LDL (bad cholestrol)

These are found in

- processed food
- Snacks / Cookies

Saturated Fatty Acids

These are solid at room temperature. It is mostly found in animal food such as

- cheese
- Milk
- Butter
- Meat.
- Poultry and Fish (Lesser Amounts)

It also raises the level of LDL