CHAPTER 6
FOOD CONSTITUENTS/ FOOD COMPONENTS

Nutrients (food components) divided into 2 categories:

MACRONUTRIENTS	MICRONUTRIENTS
Nutrients which are needed in large amount	Nutrients which are needed in small amount
For example: Carbohydrates, Lipids, Protein, Water	Vitamins and Minerals
Provides energy	Essential for good health and growth

WATER

"Water is chemically composed of two molecules of hydrogen and one molecule of oxygen."
It is present in all foods in large amount except a few like common salt, sugar and cooking oils.
Foods rich in water are:

- Fruits
- Vegetables
- Milk
- Beverages such as tea, coffee, carbonated drinks, juices etc.

The human body consists of about 60 to 70% water. It is estimated that the normal person should take 2 liter of water every day.

Forms of water in food

Water exist in 3 forms in food

1. **Free water**

Free water can be easily removed or extracted from food by squeezing, cutting or pressing.
It can be removed by freezing and drying.
For example: citrus, tomato, cucumber, melon, coconut, pineapple.
Free water is available for chemical and biochemical reactions as well as for use by microorganisms (can cause spoilage of food).

2. **Physically bound water**

Bonding is physical in nature and this water cannot be removed easily.
For example: custard, jelly, emulsion.

3. **Chemically bound water**

This type of linkage involves Chemical linkage of water molecules to other food constituents such as carbohydrates and salts. It cannot be removed easily by drying or freezing. So, there are less chances of biochemical reactions and microbial activity.

Importance / Role of water

- Essential for all chemical reactions that occur in living organism
- Water provides the medium in which enzymes and other chemical substances are dispersed
- The presence of water in correct form and amount is necessary for the acceptable quality and storage life of food
- Fresh fruits and vegetables have high amount of water and less stable as compared to grains and dry fruits that contains less water.

EMULSION

"Two immiscible liquids are mixed together with the help of emulsifying agent to form a solution called emulsion."

These emulsifying agents are called emulsifiers that increase the stability of an emulsion.

Types of emulsion

- **Water in oil emulsion :** Butter, Margarine
- **Oil in water emulsion :** Milk, Mayonnaise

CARBOHYDRATES

"Carbohydrates are compound that chemically contains carbon, hydrogen and oxygen".

Carbohydrates form in green parts of the plants from CO_2 from atmosphere and water from the soil through the process of photosynthesis.

$$6CO_2 + 6H_2O \text{ ----------} \rightarrow C_6H_{12}O_6 + 6O_2$$

CLASSIFICATION OF CARBOHYDRATES

Carbohydrates are classified in to two broad groups:

I. Simple carbohydrates

- **Monosaccharides** that cannot be further hydrolysed or breakdown into simpler compounds. Monosaccharides are simplest form of carbohydrates.

For example, Glucose, fructose (freely present in plants)
Galactose (obtained by hrdrolysis of lactose)

- **Disaccharides** are formed when two monosaccharides combine together with loss of one water molecule.

For example, Glucose + Fructose ----------→ Sucrose + H_2O
Glucose + Glucose ----------→ Maltose+ H_2O
Glucose + Galactose----------→ Lactose+ H_2O

Sucrose also called cane sugar, table sugar, beet sugar.

Lactose present in milk.

II. Compound carbohydrates

- **Oligosaccharides** When 3-7 monosaccharides molecules linked together

For example : Trisaccharide (raffinose) and Tetrasaccharide (starchyose). Both are present in Legumes

- **Polysaccharides** When more monosaccharides linked together.

  For example, **Starch** (amylose and amylopectin are main components of starch). Starch present in cereals, roots and tubers.

Amylose is straight chain contain between 70-350 glucose units.

Amylopectin has several hundreds of glucose units in branched chain form.

Starch

It is non-crystalline white powder insoluble in cold water. It can be hydrolyzed in to simpler molecules by acid, heat or enzyme.

When starch is heated in water it produces a gel which is an important property utilized in the thickening of gravies, soup, sauces, custard etc.

Other polysaccharides include cellulose, glycogen and pectin

- ✓ **Cellulose** is the principal carbohydrate in plants. It cannot be digested by humans because cellulose enzyme is not present. It serves as a fiber and provides bulk to the diet. While in herbivores cellulose enzyme is present in their stomach that can help in digestion of cellulose.
- ✓ **Glycogen** is the stored form of carbohydrates in animal body and utilize in response to energy needs.
- ✓ **Pectin** is mainly found in fruits and some root vegetables. It has gelling property and used in the manufacturing of jams, jellies and marmalades.

Carbohydrates in Human nutrition

Carbohydrates after digestion provide 3.75 Kcal of energy/gram.

Excess carbohydrates stores as glycogen and remaining converted to fat for storage in adipose tissues.

Sources of carbohydrates

Major sources of carbohydrates in diet are:

- ✓ Cereals (wheat, rice, corn) and their products (bread, biscuits, cake)
- ✓ Roots and tubers (potato and sweet potato)
- ✓ Fruits and vegetables (Sugar and fiber)

LIPIDS/ FATS

"Lipids are group of compounds soluble in organic solvents (chloroform, ether, carbon tetrachloride and petrol) and insoluble in water."

This group includes: waxes, carotenoids, steroids, fats and oils.

Chemically, lipids consist of carbon, hydrogen and they also contain oxygen in their structure.

Fats and Oils

"Fats and oils are esters of saturated or unsaturated fatty acids with glycerol."

Fatty acids are building block of fats.

When one molecule of fatty acid combines with one glycerol then **monoglyceride** is formed.

When two molecules of fatty acid combine with one glycerol then **diglyceride** is formed.

Three molecules of fatty acids reacting with one glycerol give rise to **triglyceride.**

Types of fatty acids

1. **Saturated fatty acids** have only single bond.

Examples: Butyric in butter
Caproic in butter
Caprylic in coconut

2. **Unsaturated fatty acid** contains more than one double bond.

Further 2 types:

- **Monounsaturated fatty acids** contains one double bond

Example: Palmitic acid in palm oil
Oleic acid in olive oil

- **Polyunsaturated fatty acid** contains more than one double bond

Examples: Linoleic acid in linseed
Linolenic in soybean

Properties of fats and oils

1. Fats are solid at room temperature due to presence of more saturated fatty acids and they have high melting point.
2. Oils are liquid at room temperature due to presence of more unsaturated fatty acids and they have low melting point.
3. Fats and oils are immiscible in water but they can be mixed with the help of emulsifier.
4. Fats and oils react with alkalies to form soap.

Smoke point

Fats and oils produce smoke when heated above 200ºC. The smoke point of vegetables oils is higher than that of animal fat. That's why vegetable fat should be used for deep frying.

Flash point

The temperature at which fats and oils start ignite, completely burned and broken in to its constituents known as Flash point.

Triglycerides ----------→ Glycerol + free fatty acid

Free fatty acids are not good for health. These free fatty acids become carcinogenic on continuous burning.

RANCIDITY

"When fats and oils are stored for long periods, changes in odour occur and the commodity is regarded as spoiled."

2 Types of rancidity

Oxidative rancidity

In this type oxygen is responsible for the rancidity which is catalyzed by inorganic elements in the presence of light and high temperature .Oxygen initiates / starts this reaction and free fatty acid radicals produce at the start of oxidative process. After that hydroperoxides and peroxides are produced which later breakdown into odorous compounds such as aldehydes, ketones and alcohols having bad smell and taste.

Hydrolytic rancidity

Fats and oils react with water in the presence of lipase enzyme. Lipase enzyme is naturally present in fats and oils. This enzyme breakdown fatty acid glycerol bond and produce free fatty acid radicals. After that hydroperoxides and peroxides are produced which later breakdown into odorous compounds such as aldehydes, ketones and alcohols having bad smell and taste.

Prevention of Oxidative and Hydrolytic rancidity

- Lipase enzyme can be denatured by heat.
- Store fats and oils in air tight containers in a dark and cool place.
- Addition of antioxidants such as tocopherol (vitamin E) which helps to retain the natural characteristics of fats and oils.

Applications and sources of fats and oils

Applications:

- Baking
- Frying
- Cooking
- Preservation

Sources:

- Animal source (Butter, ghee, tallow)
- Plant source (cotton seed oil, ground nut, soybean oil, canola oil, corn and sunflower oil)

Nutritional significance of fats and oils

- Fats and oils after digestion provides 9 kcal of energy/ gram
- The excess fat consumed by individual is stored in the body and serve as energy reserve in time of need.
- The stored fat in adipose tissues provides insulating layer between skin and body
- Fat around the delicate organs such as kidneys protects them from physical injury
- Fats and oils are good source of essential fatty acids and fat soluble vitamins (A, D, E, K).

PROTEINS

"Proteins are complex nitrogenous compounds of very high molecular weight."
It has been estimated that about **2000** different proteins exist in nature.

Amino acids

Amino acids are the building blocks of proteins. There are **20** naturally occurring amino acids. Different proteins are formed due to different arrangement of 20 amino acids. Each amino acid has an amine group (NH_2), Carboxylic group (COOH) and Side chain (R). Hence, they may be alkaline, acidic or amphoteric in nature.

CLASSIFICATION OF PROTEINS

1. **On basis of reaction to heat**
   - Coagulable protein (egg)
   - Non-coagulable protein (Casein protein in milk)

2. **On the basis of solubility**
   - In water (Albumin)
   - In salt (Globulin)

CLASSIFICATION OF AMINO ACID ON BASIS OF NUTRITION

Nutritionally, all amino acids are broadly classified into 2 groups:

Essential amino acids	Non essential amino acids
Essential amino acids cannot be synthesized by human body and must be included in diet	Non-esssential amino acids can be synthesized from other amino acids in the human body and not essential in the diet
9 amino acids are essential	11 amino acids are non essential
Examples: Histidine, isoleucine, leucine, lysine	Examples: Alanine, argininie, asparagine, aspartic acid
Sources: Animal products (meat, milk, egg and fish) and Plant foods (Cereals, legumes and leafy vegetables)	

Formation of proteins

In the formation of proteins, the amino group of one amino acid reacts with the acidic group of another amino acid, liberating a molecule of water and forming the peptide link.

- **Dipeptide** when only two amino acids link together through a peptide bond
- **Tripeptide** when three amino acids link together through a peptide bond
- **Polypeptide** when several/many amino acids link together through a peptide bond

Application of proteins

Proteins are added to food for variety of reason.

- **Emulsifying agent** (egg is used in mayonnaise as emulsifier)
- **Foaming agent** (in ice cream and whipped toppings, food foams are produced with proteins)
- **Gelling ability** (In the production of gelatin and yoghurt)
- **Improve nutritional quality** (formulated milk)

Proteins in Human body

1. Proteins after digestion provide 4 kcal of energy/g
2. Proteins are needed in the body for building and maintenance of tissues
3. In case of shortage of carbohydrates and lipids, proteins provides energy
4. Some proteins such as enzymes, hormones and antibodies have special role in living organisms.
    - Enzymes act as a biological catalyst
    - Hormones are essential to regulate different functions in body
    - Antibodies help to fight against infections
5. Children need more protein on body weight basis than adults because they are growing and building body tissues.

Sources of protein

Animal source: Meat, egg, milk, cheese, seafood

Plant source: Beans, pulses, Nuts, cereals