S.3 Food and Nutrition | Mr. Kalumira

Topic | NUTRITION

Nutrition: This is the scientific study of all processes of growth, maintenance and repair of living bodies which depend on food intake. **OR** Is the study of food and its uses in the body. It's a process of feeding the body with food and involves taking in food (ingestion), food breakdown (digestion), absorption of the digested food (assimilation) absorption of nutrients into the cell constituents and removal of undigested materials from the body (egestion)

Nutrients

These are the chemical substances found in the food. They include carbohydrates, proteins, vitamins, fats and mineral salts.

Dietetics

This is the study of nutrition in relation to the body's health and diseases. It involves the practical applications of nutritional science.

Nutritional science. This is the study of scientific knowledge governing the nutritional needs of humans especially for maintenance, growth, activity and reproduction. It's concerned with the nature and composition of foods, the amounts required by the body, physical and chemical changes brought about by the intake of food.

MAL-NUTRITION

This is a condition that occurs when the body receives wrong amount of nutrients. Its long term diet imbalance brought about when the intake of one / more nutrients is out of proportion to the needs of an individual.

In certain circumstances malnutrition may be brought about when the intake of one / more nutrients is greater / smaller than that required by the body i.e. too much intake of carbohydrates causes obesity and insufficient intake results into Marasmus.

KINDS OF MAL-NUTRITION

1. **Under-nutrition:** This is where the total intake of one / more nutrients is less than required by the body e.g. little intake of proteins causes kwashiorkor.

2. **Over-nutrition:** A situation brought about when the total intake of a nutrient is greater than / goes beyond that required by the body e.g. too much intake of carbohydrates causes obesity.

Diet therapy: Is the use of food in solid / liquid form to prevent, treat, manage / cure diseases.

Diet status: Is the relationship between dietary intake and metabolic requirements of the body.

Metabolism: This refers to the total sum of all chemical processes in the body which sustains life and health. Series of chemical reactions will utilize nutrients for building, repair and maintenance and energy production.

Two kinds of metabolism

(a) **Anabolism;** A process whereby large molecules are formed from smaller ones i.e. manufacture of cells and it involves utilization of energy. Examples of anabolic process in the body include

(b) **Catabolism:** A process whereby large molecules are broken down to form smaller ones i.e. breaking of food evolves energy. Examples of catabolic process in the body include

Optimum nutrition: this is a condition where by the important nutrients are supplied and utilised to maintain health and well being at the highest possible level. I deal nutrition is reflected in a well developed body consisting of ideal weight for body composition, good muscle development, smooth clear skin, clear and bright eyes, good posture and facial expression, normal appetite and digestion.

Good nutrition. This is the feeding in relation to good health which involves good choice of foods in terms of quantity, quality and variety: which are free from toxic chemicals, microbial contamination and involves foods that meet the body requirements and can easily be digested so that the body can get nourishment from it.

Poor nutrition. This is when one is deprived of food or when one is taking inadequate amounts of essential nutrients required for proper body functioning. Poor nutrition may also refer to excessive intake of nutrients. Borderline nutrition means that one depends on the minimum need from day to day. Such people lack nutrition reserves to meet any added physiological or metabolic demands from injury or sickness. This is due to poor eating habits, low incomes and living in stressed situations like war tone areas.

Balanced diet. This is a diet that provides all the necessary food nutrients in the correct amounts for the body needs at a particular time. Proper nutrition is essential from the time of conception, to birth and up to death.

Diet. This is a mixture of food stuffs which supply nutrients to an organism. It's what we eat or drink each day. Diets must be adjusted at various stages and conditions of life so that the person meets the nutritional requirements.

Food

Food is scientifically defined as any liquid / solid which when eaten or swallowed provides the body with materials enabling it to carry out any of the following:

- growth and repair
- protection and regulation of the body processes
- Energy production.

BASIC FUNCTIONS OF FOOD

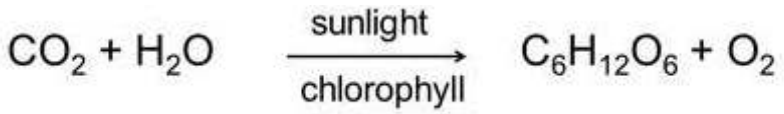
1. For cell growth and repair
2. Supply of heat and energy
3. To protect and regulate body processes thus preventing diseases.
4. Food is eaten to satisfy hunger.

CARBOHYDRATES

Carbohydrates are organic compounds with empirical formula Cn (H2O) n consisting of carbon, hydrogen, and oxygen.

Elemental composition, they are composed of carbon, oxygen and hydron. The hydrogen and oxygen are in ratio of 2:1. Chemical composition are composed of monosaccharides.

Animals are unable to synthesis carbohydrates but most plants can manufacture them from water and carbon dioxide with the help of sunlight in a process known as photosynthesis.



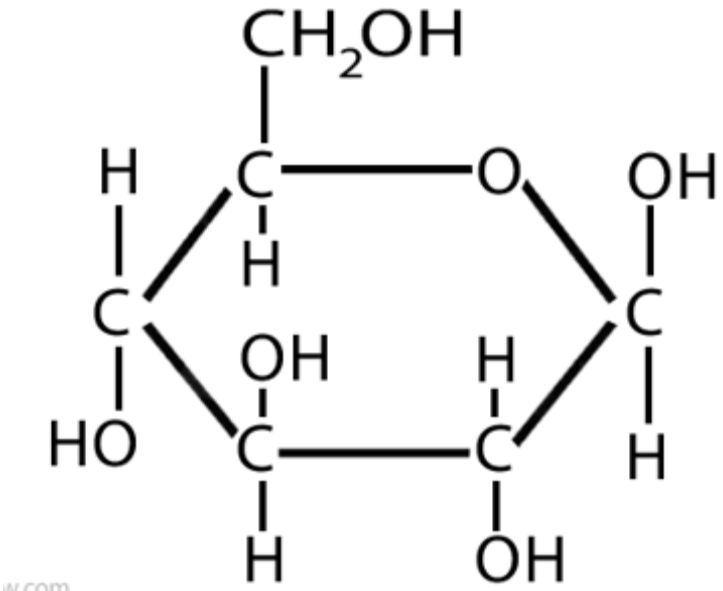
Classification of Carbohydrates

Monosaccharide

- Monosaccharides are the simplest form of carbohydrates which have one sugar molecule or unit which cannot be hydrolyzed or broken down any further by enzymatic actions.
- They have the basic carbohydrate structures and are made of 3-7 carbon atoms ie. Trioses(3carbon), tetroses (4 carbon), pentose (5 carbon), hexoses (6 carbon) and heptose (7 carbon).
- The most important monosaccharides in human nutrition are hexoses which include glucose, fructose and galactose.
- They all have a sweet taste, dissolve in water, easily broken down and reducing sugars.

Glucose (Dextrose, Grape, Corn sugar)

Glucose is the simplest hexose sugar found in sweet ripe fruits. Glucose is a white moderately sweet crystal obtained from hydrolysis of starch. Glucose is a strong reducing sugar and is the form in which sugar circulates in the blood stream to provide the major energy. 3



Fructose (Fruit sugar)

Fructose is the sweetest of all the hexose or simple sugars. Mainly occurs in sweet fruits, honey and sweet vegetables. It can also be got from the hydrolysis of sucrose.

Galactose (Milk sugar)

Galactose results from the hydrolysis of lactose and is changed to glucose in the liver for energy production. The reaction is reversible and during lactation, glucose may be reconverted to galactose for use in breast milk production.

Disaccharides

Disaccharides are also known as double sugars because they are compound of 2 monosaccharide units linked together with the help of a glycosidic bond. Disaccharides are all white solids, water soluble, crystalline and vary in their sweetness and also reducing sugars except sucrose. Disaccharides are formed by condensation reaction of monosaccharides which result to release of water molecule and bonded by 1-4 glycosidic bond.

They include;

Sucrose (table sugar)

Mainly found in sugar cane, syrup, brown sugar and all the sweet fruits. Formed from condensation of fructose and glucose and it is the sweetest sugar among disaccharides.

Lactose (milk sugar)

It is the least sweet of all disaccharides and formed by condensation of galactose and glucose by 1-4 glycosidic bond with release of water molecule.

Maltose

Made up of two glucose units and occurs in malt products of starch hydrolysis, germinating seeds and cereal grains and starchy materials on action of diastase and maltose enzyme. 5

Oligosaccharides

These contain between 3-10 monosaccharide units and they are complex. They are irregular in form and when digested yield few constituent monosaccharide units

Polysaccharides

Polysaccharides are complex carbohydrates that contain more than 10 monosaccharide. They contain long chain and branched formations with relatively high molecular weight. They include;

1.Starch

It is a storage form of carbohydrates in plants and thus it's the most significant source of energy in human nutrition. Starch is in two forms i.e. Amylose and Amylopectin. It is made up of glucose molecules and its insoluble in cold water because it contains a think covering of closely packed cells. Hot water can penetrate the thick covering and makes starch soluble in water.

Cellulose

Form the chief cell structures of plants, skin of fruits, covering of seeds and bran layer of cereals. Cellulose is indigestible but are source of bulk in the diet which stimulates peristaltic movement of gut muscles to remove wastes and thus prevent constipation. This si made up of completicated arrangement of glucose molecules and this makes them insoluble in water and indigestible.

Dextrin; this is the short form of starch formed when starch is acted upon by dry heat or when the enzyme ptyalin acts upon carbohydrates in the mouth. **It** is made up of glucose molecules. These are polysaccharide compounds formed as intermediate produces in starch break down due to action of heat, acid and enzymes. For example, the crusty brown top of bread toast.

Pectin; this is made up of complicated molecules and they are indigestible carbohydrates occurring in ripe fruits and some vegetables. They lack nutritional significance but have the ability to absorb water and form gel. This is used in making of fruit jellies and setting of jam.

Functions of Carbohydrates

Biological functions

- The primary function of dietary carbohydrates is to provide fuel; energy and heat for the body. When oxidized, they release 4kcal/g of energy that is used for proper functioning of the body.
- Excess carbohydrates in the blood stream are converted into body fat which is stored under the skin as a depose tissue.
- This forms the layer which helps in insulating the skin against heat loss but too much can lead to obesity.
- Complex carbohydrates like cellulose, pectin and hemicellulose are useful in stimulating the peristaltic movement of the gastro-intestinal tract.
- Carbohydrates are highly satisfying due to the presence of indigestible carbohydrates like cellulose which are bulky and gives a feeling of satisfaction.

- Dietary carbohydrates have a protein sparing effect hence help to regulate protein metabolism. The body will use carbohydrates preferably as source of energy when they are sufficiently supplied hence sparing proteins for its primary function of tissue building. A constant amount of glucose is necessary for the proper functioning of the brain and central nervous system.
- Glucose is converted to glycogen which acts as an emergency energy reserve for the body. This helps to maintain the normal blood sugar at 90-80mg/dl. This is controlled by insulin and glucagon.
- Carbohydrates are required for normal fat metabolism. When carbohydrates are severely restricted like during fasting, starvation, excess fats will be metabolized faster so as to provide energy. This leads to accumulation of incompletely oxidized products like ketone and acids that cannot be metabolized.
- Carbohydrates combine with protein to form glycoprotein with help in the formation of cell membrane.
- Oxidation of carbohydrates leads to production of heat energy. This produces warmth to the body.
- Lactose also enhances the absorption of calcium by forming calcium lactate which is soluble.

Functions of Carbohydrates in Cookery

Effects of Heat on Carbohydrates

Moist and dry heat affects the physical and chemical properties of carbohydrates differently as shown below;

Moist heat

- Starch; Starch grains absorb water, swell, softens and burst releasing the starch cells and amylopectin (gel) which thickens the liquid e.g when making porridge, white sauces, millet bread(kalo) and soup. This process is called Gelatinization.
- Cellulose; Moist heat causes cell walls of fruits and vegetables to soften and become more digestible. If over cooked, they will disintegrate.
- Sugar; moist heat causes sugar to dissolve more easily to form syrup.
- Further heating causes the syrup to darken in color

- Sugar will burn or carbonize at 160 c

Dry heat

- Dry heat causes the starch grain to burst eg pop corns, maize.

- Surface or outside starch grains are converted to pale brown compounds known as dextrins. This improves the flavor and appearance of food. This process is known as dextrinization.

- Excess or overheating leads to burning or blackening. Dry heat causes sugar to melt and form a brown coloured molden liquid known as a caramel. This is known as caramelization.

- Overheating will develop bitter unpleasant flavor.

Further heating will lead to burning and form charcoal (carbon).

Digestion of Carbohydrates

1. Mouth

- Digestion of carbohydrates starts off with mastication by the teeth to breakdown food into small particles.

- Food is then mixed with saliva which contains salivary amylase (ptyalin) enzyme.

- Salivary amylase converts cooked starch to maltose. Salivary amylase has no action on un cooked starch, therefore cooking helps to rapture the starch cell walls to ease action of enzymes. Food is then pushed to the stomach.

2. Stomach

- Food is mixed with gastric juice which contains gastric or hydrochloric acid.

- Hydrochloric acid stops the action of the alkaline ptyalin and no further digestion of carbohydrates takes place in the stomach since the enzyme is inactive in acid medium. Peristaltic action pushes food into the duodenum and small intestines.

3. Duodenum

- Food is mixed with pancreatic juice from the pancreas which contains pancreatic amylase.

- Pancreatic amylase converts the remaining starch to maltose. Food is pushed to the small intestines.

4. Small Intestines

The intestinal glands produce 3 enzymes to complete carbohydrates digestion. These include;

- Maltase which converts maltose to glucose

- Sucrose/ invertase which converts sucrose to glucose and fructose.

- Lactose converts lactose to galactose and glucose.

- Indigestible polysaccharides may undergo partial breakdown of the intestinal bacteria.

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5. Absorption

- CHO are absorbed from the small intestines through the villi and into the blood stream inform of glucose with some fructose and galactose. The villi increase surface area for absorption.
- Fructose and galactose are converted into glucose for the final absorption. These travel through the hepatic portal vein to the liver where they are either oxidized to produce energy and heat, combined with phosphate and potassium to form glycogen and stored in the liver for future use.
- The excess is converted to fats and stored as a depose tissue.
- The rest is eliminated as feaces.

Diabetes Mellitus.

It is a chronic metabolic disorder characterized by the absence or inadequate insulin hormone which leads to increased glucose level.

This condition can be hereditary but also common with overweight, obese and elderly people.

Diabetes mellitus is mainly caused by the following;

- Genetic factors which lead to inheriting of altered or mutated genes responsible for production of insulin. This makes insulin un available.

- Failure of defective B-cells of the pancreas to secrete any insulin.

- Obesity and hypertension which increases the sensitivity of tissues to insulin hormone.

Effects of Diabetes Mellitus

The following occur during the initial onset or its uncontrolled state;

- Increased blood glucose (hyperglycemia)
- Excretion or presence of glucose in urine (glycosuria)
- Increased thirst (polydipsia)
- Increased urination (polyphagia)

- Weight loss in type I and obesity and type II . More serious causes can lead to; Mental instability, forgetfulness and confusion., Blurred vision, - Body sores which fails to heal

- General body weakness

Severe causes can lead to;

- Brain damage

- Fluid and electrolyte imbalance which leads to edema and body dehydration.

- Ketoacidosis occurs due to disturbance of the acid base balance from ketone bodies accumulating from excessive fat breakdown. The hydrogen on concentration increases and these appear in urine. This leads to formation of acid urine and renal failure.

- Coma and death.

Diabetes Insipidus

- Diabetes insipidus is a condition or specific injury of the pituitary gland which produces insufficient antidiuretic hormone (ADH) or vasopressin, a hormone that helps the kidney to reabsorb adequate amount of water.
- This leads to copious output of non-sweet urine, great thirst and sometimes a large appetite, large quantities of dilute non-sweet urine may be excreted. This can be as high as 5 t0 30 litres per day.
- The condition can be controlled by daily injection of posterior pituitary extract.

DIETARY FIBER

Dietary fiber is a type of carbohydrate that cannot be digested by our bodies' enzymes. It is found in edible plant foods such as cereals, fruits, vegetables, dried peas, nuts, lentils and grains.

CLASSIFICATION OF FIBRES

Fiber is grouped by its physical properties and is called soluble, insoluble or resistant starch.

Soluble fiber ;which dissolves in water is readily fermented in the colon into gases and physiologically active by-products, such as short-chain fatty acidsproduced in the colon bygut bacteria; it is viscous, may be called prebiotic fiber, and delays gastric emptying which, in humans, can result in an extended feeling of fullness. Examples include; arabinoxylan, fructans, inulin, alginicacids, raffinose

Insoluble fiber; which does not dissolve in water – is inert to digestive enzymes in the upper gastrointestinal tract and provides bulking. Some forms of insoluble fiber, such as resistant starches, can be fermented in the colon. Bulking fibers absorb water as they move through thedigestive system, easing defecation. Examples of insoluble dietary fiber include; cellulose, Chitin, hemicellulose, hexoses, pectose, lignin, xanthan gum, resistant starch.

Physicochemical properties

Dietary fiber has distinct physicochemical properties. Most semi-solid foods, fiber and fat are a combination of gel matrices which are hydrated or collapsed with microstructural elements, globules, solutions or encapsulating walls. Fresh fruit and vegetables are cellular materials.

- The cells of cooked potatoes and legumes are gels filled with gelatinized starch granules. The cellular structures of fruits and vegetables are foams with a closed cell geometry filled with a gel, surrounded by cell walls which are composites with an amorphous matrix strengthened by complex carbohydrate fibers.
- Particle size and interfacial interactions with adjacent matrices affect the mechanical properties of food composites.
- Food polymers may be soluble in and/or plasticized by water. Water is the most important plasticizer, particularly in biological systems thereby changing mechanical properties.
- The variables include chemical structure, polymer concentration, molecular weight, degree of chain branching, the extent of ionization (for electrolytes), solution pH, ionic strength and temperature.
- Cross-linking of different polymers, protein and polysaccharides, either through chemical covalent bonds or cross-links through molecular entanglement or hydrogen or ionic bond cross-linking.
- Cooking and chewing food alters these physicochemical properties and hence absorption and movement through the stomach and along the intestine.

Functions

a. Increases food volume without increasing caloric content to the same extent as digestible carbohydrates, providing satiety which may reduce appetite.

b. Attracts water and forms a viscous gel during digestion, slowing the

emptying of the stomach and intestinal transit, shielding carbohydrates from enzymes, and delaying absorption of glucose, which lowers variance in blood sugar levels

c. Lowers total and LDL cholesterol, which may reduce the risk of cardiovascular disease

d. Regulates blood sugar, which may reduce glucose and insulin levels in diabetic patients and may lower risk of diabetes.

e. Speeds the passage of foods through the digestive system, which facilitates regular defecation

f. Adds bulk to the stool, which alleviates constipation

g. Balances intestinal pH and stimulates intestinal fermentation production of short-chain fatty acids

h. Fiber does not bind to minerals and vitamins and therefore does not restrict their absorption, but rather evidence exists that fermentable fiber sources improve absorption of minerals, especially calcium. Some plant foods can reduce the absorption of minerals and vitamins like calcium, zinc, vitamin C, and magnesium, but this is caused by the presence of phytate (which is also thought to have important health benefits), not by fiber

SOURCES OF DIETARY FIBER ACCORDING TO CLASSIFICATION

Some plants contain significant amounts of soluble and insoluble fiber. For example, plums and pruneshave a thick skin covering a juicy pulp. The skin is a source of insoluble fiber, whereas soluble fiber is in the pulp. Grapes also contain a fair amount of fiber.

WATER SOLUBLE DIETARY FIBER

- legumes (peas, soybeans, lupins and other beans)
- oats, rye, chia, and barley

- some fruits (including figs, avocados, plums, prunes, berries, ripe bananas, and the skin of apples, quinces and pears)
- certain vegetables such as broccoli, carrots, and Jerusalem artichokes
- root tubers and root vegetables such as sweet potatoes and onions (skins of these are sources of insoluble fiber also)
- psyllium seed husks (a mucilage soluble fiber) and flax seeds
- nuts, with almonds being the highest in dietary fiber

Sources of **insoluble fiber** include:

a. whole grain foods

b. wheat and cornbran

c. legumes such as beans and peas

d. nuts and seeds

e. potato skins

f. lignans

g. vegetables such as green beans, cauliflower, zucchini (courgette), celery, and nopal

h. some fruits including avocado, and unripe bananas

i. the skins of some fruits, including kiwifruit, grapes and tomatoes

LIPIDS

The word lipids are a biochemical name given to a group of greasy substances which are hydrophobic in nature. They belong to a group of substances called Esters.

An Ester is a compound resulting from the reaction of an alcohol and acids.

Lipids are insoluble in water but soluble in organic liquids like ether, benzene, chloroform, alcohol and, acetone

They are the most concentrated source of energy compared to other food nutrients because they contain the most number of carbon atoms. Their energy yield is 1g of lipids yields 9kilocalories.

Elemental composition

Lipids consist of carbon, hydrogen, and oxygen just like other food nutrients but in different proportions.

Chemical composition

Chemically, lipids are composed of;

1. Glycerol (trihydricalcohol)
2. Fatty acids

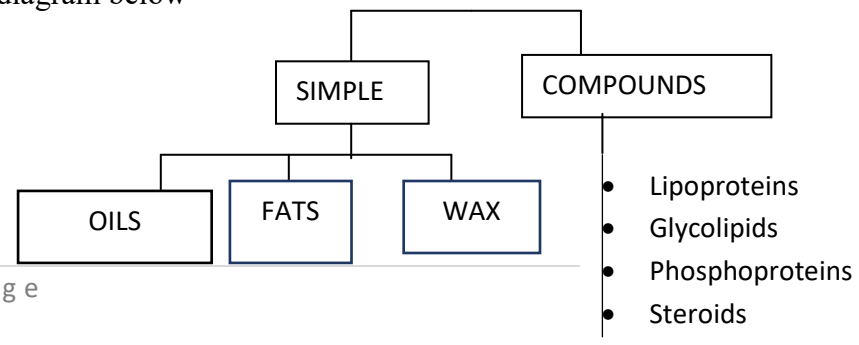
Classification of lipids

Lipids are mainly classified into two.ie.simple and compound lipids or derived lipids.

Simple lipids include; oils, fats, and wax.

Compound lipids include; lipoproteins, glycolipids, phospholipids, and steroids.

see the diagram below



Simple lipids:

These are lipids which are composed of only fatty acids and glycerol in their structure.

Oils; these are lipids which are liquids at room temperature. They contain unsaturated fatty acids in their structure. They mainly come from plants and fish. They contain a good quantity of good fats and are recommended to be used in the diet.

Fats: these are solids at room temperature and they contain mainly saturated fatty acids in their structure. They mainly come from animal sources and they contain bad fats which are not recommended to be eaten regularly in the diets.

Wax; Are made from fatty acids combined with the alcohol except glycerol.these are lipids which do not have a nutritional value.

Complex/compound/derived lipids

These are lipids which contain non lipid substances in their structure. They include the following;

1.Lipo proteins. It's a combination of a lipid and a protein. The two are combined by the body so that lipids are soluble in blood and lymph. Lipids are Insoluble in water and make it very difficult for transporting them in a water based circulatory system.

The body has solved this problem of developing lipoproteins (passages of lipids wrapped in water soluble proteins. The liver is the center for receiving fatty acids, cholesterol from diet and body tissues. It packages them in to lipoproteins and releases the lipoproteins into circulation

Types of lipoproteins

- **Chylomicrons**
- **Very low density lipoproteins.**
- **Low density lipoproteins (LDL)**
- **High density lipoproteins.**

2.Phospholipids

This is a combination of a lipid molecule and a phosphate molecule. They are composed of a glycerol molecule, attached to two fatty acids units and the remaining like is taken up by a phosphate radical. They play a role in the digestion and utilization of fats in the body.

They are useful emulsifier e.g lecithin in the egg yolks. They play a role in the transport of lipids in the blood stream.

Steroids/sterols

One of the example of steroids or sterols is cholesterol. It's a white fatlike substance found in the human body and in animal foods notably in the white brain, kidney, liver, egg yolks, meat and head of fish, milk and milk products.It's mainly manufacture by the liver.

It is a raw material for production of bile acid and several hormones e.g Cortisone, testosterone from adrenal gland and the sex hormones

Uses of cholesterol in the body.

- Used in the synthesis of the rigid structure of the cell membrane in the body.
- It's required in the synthesis ofsteroids hormonese.g.testosterone, oestrogen, cortisone.
- Used in the synthesis of bile salts in the liver this is stored in the gall bladder.
- Useful in transporting other lipids in the body
- Important constitute of the myelin sheath and helps to prevent the outflow of the ions which can circuit the movement of nerve impulses.
- Limits the uncontrolled leakage of small molecules (water and ions) in and out of the cell membrane.
- Allow the body cells to control the passage of solutes using the specialised membrane proteins without using energy.
- Used in the synthesis of vitamin D under the influence of ultra violet rays in the subcutaneous layer of the skin

- Cholesterol pulls together the fatty acids that influence phospholipids restricting movement or not making them solids .

Glycolipids;

They are found inlarge quantities in the brain and less in the liver spleen and kidneys e.g Cerebsosides.

Properties of lipids

1. Physical properties

- **Melting**: lipids melt when heat is applied on them. Solid fat melts at a higher temperature that is why it is solid at room temperature. Oils have a low melting point and that is why they areliquids at room temperature.
- **Smoke point;** When heating continues, a blue haze rises. And at this point it is said that the fat has smoked hot. The temperature at which the fat smokes hot is called the smoke point .It may range from 200-210^{0}C and varies according to the type of lipid. Fats reach smoke point at a lower temperature compared to oils and that is why fats are not used for deep frying. Oils can be heated over 190^{0}C without burning and the smoke point is about 230C.The normal frying temperature should be between 180-190^{0}C.
- **Flash point**: At smoke point, the fat decomposes into fatty acids and glycerol. Above smoke point, the fat may catch fire. The temperature at which the fat catches fire is called the flash point. Oils have a higher flash point compared to fats.

Note; Oils have high smoke points and flash points than solid fats.ie.the flash point of oils is 320-330^{0}C and that of fat is 10^{0}C-15^{0}C less.

When oils or fat are mixed with impurities, their smoke points lower.

Over heating (burning) causes glycerol to decompose into acrolein (a substance that gives the smell of burnt oil.) Saturated fats are solid at room temperature while unsaturated fats at room temperature.

- **Solubility:**

Fats and oils are soluble in organic solvents like benzene, chloroform, ether, alcohol. They are insoluble in water.

- They are bad conductors of heat
- Pure fats and oils are colourless, odourless and taste less.
- They are insoluble in water since water is polar.

2.Chemical properties of lipids.

- **Hydrogenation**

Hydrogenation is the process by which hydrogen is added to a substance. Oils containing unsaturated fatty acids can be hydrogenated in the presence of high temperature, pressure and finely divided nickel. By this process, the oils are converted into solid fats(glycerides of saturated fatty acids). This reaction forms a basis of the industrial production of hydrogenated oil. During the hydrogenation process the number of double bonds in unsaturated oils is reduced causing them to solidify as hard saturated fat and linoleic content decreases. This explains why fats are poor sources of linoleic acid.

Importance of hydrogenation;

- Hydrogenation is used to improve the keeping quality of liquid oils because it reduces the occurrence of oxidative rancidity. During the industrial process of lipids hydrogenation, anti oxidants like butylated hydroxytoluene (BHT) and Butylated hydroxyAnisole(BHA) may also be added to improve the shelf life of the lipids.
- Hydrogenation also increases the use of lipids for example for creaming as a method of cake making.

- Fortification of fat is also possible during hydrogenation. For example addition of vitamin E to margarine this improves nutrition value of the margarine.

- **Plasticity;**

Plasticity is the ability of fat to respond to friction and pressure. The property of plasticity results from a mixture of triglycerides, each having it's own melting point.

When most of the triglycerides are below their melting points, the mixture is solid. In its solid state, it consists of a network of very small fat crystals surrounded by small quantities of liquid triglycerides. The solid network is not rigid that is to say; the crystals can slide over one another giving the plastic property of fats.

When the temperature of the fat is increased, the solid network breaks and plasticity of mixture increases until it becomes a liquid, when all triglycerides have melted. This property of lipids is used during cake making in creaming and rubbing in.

- **Rancidity**

This is the spoilage of fats and oils and it occurs naturally. Rancidity occurs in two ways;

- Oxidative rancidity
- Hydrolytic rancidity

Hydrolytic rancidity; It is caused by presence of moisture in the fat or oil. The glycerol molecule and fatty acids separate by hydrolysis. Hydrolytic rancidity is catalyzed by the presence of lipase enzymes and microorganisms like bacteria moulds and yeast. The remains of food particles in the oil during frying can cause hydrolytic rancicidity.

Oxidative rancidity; It is the most common lipid spoilage due to the presence of oxygen.

The unsaturated fatty acids in the oil react with oxygen and form oxyns compounds with a characteristic bad smell. The reaction can be speeded up by increase in temperature and presence of metals such as copper, nickel, and Iron. Oxidative rancidity can be prevented by addition of

antioxidants to the oil. The antioxidants are; butylated hydroxyl toluene and butylated hydroxylanisole. Store oils in stoppered bottles in cool dark places. Fats can be kept in fridges.

- **Saponification**

This is the formation of soap when fats are acted upon by bases for example sodium hydroxide. Sodium chloride can be used to solidify out the soap. Triglycerides(lipids) can first be hydrolyzed by boiling them with potassium or sodium hydroxide solutions to form glycerol and fatty acids with formation of soap

- **Halogenation.**

When unsaturated fatty acids are treated with halogens like iodine and chlorine. They take up iodine and other halogens at their bond site. This is an indication of unsaturation.

- **Emulsification**

This is the breaking up of lipid globules into smaller fat globules that are then dispersed into the liquid. When you mix water and oil, a layer of oil will be seen on top of the liquid. This shows that fats are insoluble in water and they are immiscible liquids. When shaken vigorously small droplets of fats will be seen dispersed throughout the liquid. This is called an emulsion. If left to stand for some time, the layer of oil will be seen on top meaning that the mixture had formed a temporally emulsion. If a substance called an emulsifier is added, a permanent emulsion will be formed. This occurs when the polar part of the substance dissolves in water and other polar substances while the nonpolar part dissolves in the lipid. Natural emulsifiers include phospholipids lecithin in egg and. Other emulsifying agents are starch, casein in milk, and gums.

- **Hydrolysis**

This is the breakdown of lipids into smaller molecules ie. Glycerol and three fatty acids with the addition of a water molecule. Fats can also undergo hydrolysis when treated with alkalis or fat splitting enzymes lipase or hydrolase to yield glycerol and constitute fatty acids.

Hydrolysis by alkalis such as sodium hydroxide, potassium hydroxide leads to formation of sodium or potassium Salts of fatty acids. The salts are known as soap and the process is called saponification.

Formation of fat or oil

Equation

$$\begin{array}{l} CH_2\text{-}OH \\ CHOH \\ CH_2OH \end{array} + 3RCOOH \longrightarrow \begin{array}{l} CH_2\text{-}O\text{-}C\text{-}OR \\ CH\text{-}O\text{-}C\text{-}OR \\ CH_2\text{-}O\text{-}C\text{-}OR \end{array} + 3H_2O$$

The reverse occurs when fats are digested

The lipase breaks down fats into glycerol and fatty acids.

Triglycerides + water. $\xrightarrow{\text{Lipase}}$ Glycerol + fatty acids

Fatty acids.

Are organic substances found in fats combined with glycerol. They are also called carboxylic acids or alkanoic acids.

<u>Classification of fatty acids</u>.

Fatty acids are classified according to their saturation. These fatty acids are; saturated and unsaturated fatty acids.

Saturated fatty acids

A saturated fatty acid has each carbon atom in its chain linked to each other by a single bond and each carbon atom in the chain linked to two hydrogen atoms.

Examples of saturated fatty acids are;

Palmitic fatty acids

Stearic fatty acids

Butyric fatty acids

Myristic fatty acids

Fats (triglycerides) with saturated fatty acids are referred to as saturated fats. They are solids at room temperature and are mainly of animal origin.

Sources of saturated fatty acids are; butter, cream, hard cheeses, egg yolks, lard and suet.

Saturated fats have a disadvantage that they raise cholesterol level in the blood and cause the hardening and blockage of the coronary arteries resulting into; arteriosclerosis, hypertension, and heart failure.

Unsaturated fatty acids

There are two types of unsaturated fatty acids namely;

Monounsaturated fatty acids

These fatty acids have an adjacent pair of carbon atoms linked by a double bond between them and each linked to one hydrogen atom in the chain.

Example; Oleic acid found in olive oil

Polyunsaturated fatty acids

These are also known as essential fatty acids because they are needed in the body. These are fatty acids which have two or more pairs of adjacent carbon atoms linked by double bonds and each of the two linked to one hydrogen atom, meaning the chain has more than two double bonds.

Examples include;

- Linoleic which has two double bonds
- Linoleic which has three double bonds
- Arachdonic which has four double bonds

They are mainly found in foods of plant origin like olive oil, cotton seed oil, sun flower seeds oil and simsim oil.

Physiological functions of lipids

- Lipids are a concentrated form of energy in relatively low bulk.1gm of fat yields 9kilocalories approximately 37.8kj compared to 45kilocalories (16-17kj) by one gram of either carbohydrates or proteins.
- Lipids assist in the absorption and transportation of the fat soluble vitamins A, D, E and K.
- Excess fats in the body are converted into fuel reserve in the adipose tissue. This adipose tissue plays roles like protecting vital body organs like the kidney.
- Fats in the subcutaneous layer of the skin are an insulator of the body preventing unnecessary loss of heat from the body.
- The polyunsaturated fats prevent the buildup of cholesterol in the blood thus preventing complications like obesity, diseases like atherosclerosis, etc.
- Fats play a vital role in protecting vital body organs like the liver, kidney, and heart.
- Lipids also have a sparing effect on proteins because in the absence of carbohydrates, lipids can be used for energy manufacture instead of proteins which play very vital body functions like repair and maintenance of body tissues. Therefore the proteins are spared for their primary function and the lipids are used.

- They help in maintenance of the body generally since they contain fat soluble vitamins e.g maintaining of vision ,health body growth, health immune system
- They help in thermoregulation like maintaining the body temperature to the minimum.

Uses of lipids in food preparation

- Used as a medium of heat transfer for example during frying as a method of cooking.
- They are used for glazing to prevent sticking food to pans ,cake tins, casserols.
- They add flavor to dishes e.g butter, margarine in cake making.
- They create variety in color and texture of food. E.g fried foods are crisp and have an attractive golden brown colour.
- They are useful shortening agents. They are water proof. Starch and gluten in wheat flour giving tender and flaky products e.g cakes and pastries.
- Used in emulsions e.gin salads dressings which make good the deficiency of fat in vegetable salads (mayonnaise)
- As raising agents in creamed cakes.
- Add energy value to the diet without adding bulk.
- They improve tastes of food / fullness and make food palatable.

The sources of fats and oils.

Suet.

This is prepared beef fat. The best is got from around the kidney of the animal. It is a hard fat which is saturated. It cannot be rubbed into the flour and has no creaming properties. It contains saturated fatty acids mainly stearic and palmitic acids. It is slow to melt it must be grateful or chopped finely before cooking e.g in suet pastry. It is difficult to digest. Prepared ..suet is called **atora** . Storage contains preservatives to delay rancidity

Fats may be got from suet by dry rendering or wet rendering.

Lard.

It is pure white fat rendered from pig fat by the process of hydrogenation. It has no flavor. Has a shortening effect excellent for pastry making. Suitable for frying because it has a high smoke point.

Drippings.

This is beef or mutton fat which is rendered down and strained.

It has a meaty flavor used for frying and roasting meat and in pastries used in Sauted meat, meat stews and best for gravy making.

Marbling fat. It is the fat in the meat inside in the flesh.

Dispose. Fat underneath the skin.

Other sources of lipids include :kimbo, margarine, tamu,vegetable fat.

Digestion of lipids.

- Physically, digestion of fat starts from the mouth but only physically by the process of mastication where there is physical broke down of large fat sizes towards which move down the oesphagus by peristalsis to the stomach. There is no chemical digestion in the mouth.
- In the stomach gastric juice is produced and may act on the fats and kills the microorganisms. The churning action of the stomach makes fat which lower in density to float on top of the chyme. This makes fats take long in the stomach thus delaying a feeling of hunger. Fats are digested slowly because of their low density.
- In the duodenum, the pancreas releases pancreatic juice that enters the duodenum by the way of pancreating duct and contains 3 enzymes Pancreatic lipase, phospholipase,cholesterolesterase.
- Pancreatic lipase act on long chain triglycerides.
- Phospholipase hydrolyzed the phospholipids.
- Cholesterol esterase hydrolyses cholesterol esters to form fatty acids and cholesterol.

Absorption of lipids.

- After digestion in the small intestine, the end products are usually monoglyceride, fatty acids and cholesterol.
- The end product combines with bile to form Micelles and easily be distributed in watery media in very small size lipids particles ready for absorption.
- The primary cycle absorption of the lipids is the surface of jejeum or the middle section of the small intestine with very high and extremely large surface area for absorption. It has good distribution of villus structure that are well supplied with blood vessels and for fats , the absorption is a special lymph called lacteal.

Effects of deficiency of lipids

Deficiency is rare because fats are widely distributed in mainly animal and vegetable food. However if the intake is too low ,the following happen in the body;

- Weight loss progressing to starvation.
- Deficiency of fat soluble vitamins A, D, E, K since in the absence of fat the fat soluble vitamins cannot be absorbed and therefore one will have dry scallyskin, retarded growth, weak bones and teeth and low blood clotting abilities.
- Slow brain development in infants.

Effects of excess intake of lipids

- Over indulgence of fat may cause obesity.
- Since fats are difficult to digest especially those of animal origin except milk and eggs, too much intake will increase the synthesis of cholesterol in the blood causing arteriosclerosis, hypertension and heart disease.
- A rich fat diet may also cause ketosis.

<u>Properties of lipids used in food preparation</u>

- Lipids transfer heat from cooking utensils of good quality evenly and at high temperatures. Temperature is very vital in the cooking process.

- Lipids tenderize baked products; Fats shorten flour protein strands, which cause chewiness and toughness. Fat to flour ratio determines flakiness. Lipids with high melting points work best for biscuits Pies and puffy pastry.
- Lipids aerate batters; Aeration is the addition of air. Saturated fats allow tiny air pockets to form when beaten. Creaming fat and sugar together in cake recipes aerates the batter. Whipped margarine is an aerated form of margarine.
- Lipids enhance flavors of food; Much of the flavor in food is due to the addition of salts, sugar and fat. Common lipids that season foods are; butter, margarine and mayonnaise. Fats dissolve and disperse flavor compounds.
- Lipids serve as liquids in emulsions; An emulsion is a mixture of a 5 and a water based liquid. Phospholipidsstabilize emulsions because they have a polar end that attracts water and a non polar end that attracts the lipids. Examples include; butter, mayonnaise and bottled salad dressings.
- Fats and oils can alter a food's appearance by creating a glossy or moist visual texture. The ability of fat to refract light is also responsible for the opaque appearance of milk. Fats aid in the browning process of many foods like meat, breads giving them an appealing golden brown color.