**Lec. 2 *Food Technology***

**Constituents of Food**

***Introduction:***

**In order to process foods by converting raw materials into creative, desirable and attractive products that are both safe to consume and have year-round consistency, as well as water, foods also include carbohydrates, proteins, fats and oils. Also present in lesser but nonetheless important amounts are flavours, vitamins, minerals and additives such as preservatives. Not all foods contain all of these components nor in equal quantities.**

***Water:***

**In many foods, water is the most abundant constituent. Fruit, vegetables, juices, milk, fish and meat all contain high levels of water. Cheese, bread, biscuits and cakes on the other hand, contain relatively less levels of moisture while dehydrated foods and powders contain virtually none. The presence of moisture is critical in the textural properties of a food but is often responsible for its microbial, enzymatic and chemical deterioration.**

***Carbohydrates*:**

**Carbohydrates provide much of the energy in our diets, most is found in the form of polysaccharides as starch derived from plant cells. Simple sugars as mono or disaccharides are mainly derived from cane, beet sugar and honey which contribute to sweetness, texture and colour in foods. The main constituents of starch are amylose and amylopectin. Starch does not dissolve in cold water, but when heated to 60oC, water diffuses through the walls of the starch granules, causing swelling and the viscosity of the starch suspension to increase. Further heating causes the granules burst giving a viscous gel. When starch is heated in an acidic medium, however, the starch becomes partly hydrolysed to a mixture of sugars and dextrins causing a reduction in viscosity.**

 **Caramelisation is the application of heat to the point that sugars dehydrate and breakdown and polymerize, this is called non-enzymatic browning” because it does not involve enzymes. Caramel has a pungent taste and is often bitter, it is much less sweet than the original sugar, is non-crystalline, and is soluble in water. Both the extent and rate of the caramelisation reaction are influenced by the type of sugar being heated.**

**The Maillard reaction is the reaction between the amino group of a protein and the reducing group of a reducing sugar. The type of sugar and the type of amino acids influence the colour obtained which may range from yellow to red. Not all sugars are reducing sugars. The most effective reducing sugars are fructose, glucose, maltose, galactose and lactose.**

***Fats and oils:***

**As well as being a major source of energy in the diet, fats and oils play an important role in the palatability of foods. In terms of bakery properties both fats and margarine are important in that they: influence eating properties, influence flavour release, influence batter and baking properties, provide consistency to doughs, allow aeration to be possible, contribute to colour, provide a shining or glossy appearance to bread, influence shelf-life through moisture loss reduction. The main difference between fats and oils is that oils are liquids at room temperature whereas fats are solid, the term “fat is commonly used for lard (pork fat) or tallow (beef fat).**

 **The extraction of fats and oils is achieved by:**

**Rendering: used mostly for fat tissue from slaughtered animals, this includes beef, pork and sheep.**

**Pressing: used for oil-containing seeds and fruits, oils include peanuts, olive, corn, sesame, soy, sunflower and palm.**

**Extraction: used for fat-containing material using organic solvents.**

**Most refined fats and oils are used as a raw material for the production of margarine, mayonnaise, fat for frying, baking and roasting, the process of changing their consistency includes:**

**Hydrogenation: This hardening process gives a firmer consistency to oils.**

**Fractionation: Used to separate fats into fractions with different melting points.**

**Esterification: Used to give a suitable firmness and spreadability as fats.**

**Edible fat is a mixture of animal and/or vegetable fats, the term “butter” is applied only for the fatty substance from milk which has been obtained from the butter-making process, the term “margarine”, on the other hand, is a copy of butter. The type of fat or oil present directly affects the textural qualities of foods, including a smooth mouth-feel and the flavor of many dishes and foods. Chips cooked in a vegetable oil have a different flavour from of a fat is dependent on its physical state; suet (beef fat) is hard at room temperature, whereas vegetable cooking oils are liquid and some margarines are soft at this temperature. The melting point of a fat or oil depends on the fatty acid chain length and their degree of saturation. Chemically, fats and oils consist of glycerol esterified with three fatty acids to form a triglyceride.**

**There are more than 50 different fatty acids and vary structurally in terms of chain length (2 to 24 carbon atoms) and the number of double bonds between the carbon atoms. Where there are more than one or more double bonds, they are termed mono or polyunsaturated fatty acids, respectively. The melting point of a fat increases with fatty acid chain length Suet, which is composed of stearic acid, has a higher melting point than butter, which contains butyric acid. The presence of double bonds lowers the melting point; Olive oil contains unsaturated oleic acid and melts at a lower temperature than stearic acid. Oleic acid can be converted by the addition of hydrogen into saturated stearic acid giving a harder fat. A high percentage of unsaturated fatty acids in triglycerides results in a more liquid consistency at room temperature, while a high percentage of saturated fatty acids gives a more solid consistency. In addition to triglycerides, natural fats and oils contain other components, these include waxes, phospholipids, sterols, pigments such as carotenes and chlorophyll, and vitamins such as A, D, E and K. With the exception of frying, there is a structural change to fats and oils during processing, with intense heating; fats or oils increase in viscosity with a darkening colour and the formation of polymeric compounds. With repeated heating olive oil and other oils may undergo a reaction that leads to oxidative rancidity, associated with bitter “off” flavours and acrid odours, found in vegetable oils. When fat is heated to a very high temperature as in frying, it begins to smoke; this smoke consists of gaseous products resulting from the breakdown of fats into glycerol and free fatty acids, it is therefore desirable to use fats or oils with a high smoke point for frying.**

**The term margarine applied to certain types of shortenings as well as spreads and is manufactured from vegetable oils that have been hydrogenated or crystallized to form the required spreading texture. The vegetable oils may also be blended with lesser quantities of animal fats. Like butter, there is a legal requirement for margarine to contain no less than 80% fat. Emulsifiers are also added along with salt, butter flavour and a permissible level of preservatives such as sodium benzoate, Vitamins A and D may also be added.**

***Proteins:***

**As well as providing nutritionally essential amino acids, proteins contribute to the acceptability of foods. Many of the properties if proteins are also utilized in many food processes. When meringue is made, for example, the egg white protein complex albumen is coated allowing air to be incorporated. As the albumen foam is gently heated in an oven, the transparent liquid protein denatures, turns white and solidifies, thus ensuring that the structure of the meringue is held firm. Meat is a major dietary source of protein, which consists of muscle cells held in a matrix of connective tissue, composed of the protein collagen. When meat is cooked the collagen of the connective tissue is hydrolyzed to gelatine. Gelatin, in common with other proteins, has the ability to imbibe water and swell. Muscle proteins also have the ability to hold water in a bound form; this is termed the water binding capacity of the protein. Plant and animal proteins are composed of amino acids, which can be combined in a variety of ways to form muscle, skin, fingernails, feathers, silk, haemoglobin, enzymes, antibodies and hormones. Proteins are therefore polyamides and the order in which amino acids are sequentially joined together in a protein molecule.**

**Protein denaturation is the loss of the higher structural features caused by disruption of hydrogen bonding and the non-covalent forces that hold it together, the result is the loss or change in many of the functional properties of the protein. Pressure, temperature, pH, detergents, radiation, oxidizing or reducing agents can also cause denaturation. Boiling an egg is an example of an irreversible denaturation in which the colourless albumins unfold and precipitate resulting in a white solid. When milk sours, the change in pH arising from lactic acid formation causes curdling or precipitation of soluble proteins. Some proteins are quite resistant to denaturation, while others are more susceptible. Denaturation may be reversible if a protein has been subjected to only mild denaturing conditions.**

***Vitamins and Minerals:***

**Vitamins and minerals are substances normally present in many different foodstuffs in very small amounts and are essential in the diet to maintain normal growth and development of the human body. A lack of vitamins and minerals cause a number of different unpleasant deficiency symptoms to occur which disappear again as soon as the vitamin or mineral is supplied in sufficient quantity.**

**Within the body, vitamins behave as biological catalysts starting chemical reactions without themselves becoming involved .Some vitamins, however, are only a part of a catalyst, Vitamin K, for example, is important for the blood’s ability to clot or coagulate. New-born babies, whose intestinal bacteria are not yet fully developed, are sometimes given an injection of vitamin K shortly after birth to enable their blood to coagulate normally; all vitamins have been extracted from foods and can now be synthesized in the laboratory.**

**Fat-soluble vitamins require fat to be absorbed in the intestine and are the reason why they should be taken at meal times. Harmful side effects or poisoning can result by taking too high a dosage over a long period. Water-soluble vitamins do not present the same risk since any excess is excreted in the urine.**

**Fat Soluble Vitamins**

**Vitamin A: Found in liver and milk, vitamin A is necessary for maintaining the mucous membranes of the respiratory and digestive systems, and the cells of the skin in a healthy condition. β-carotene is a preliminary stage of vitamin A or pro-vitamin and occurs as the orange colouring in certain vegetables and in particular, carrots.**

**Vitamin D: The main function of vitamin D is to help the body to absorb phosphorus and deposit calcium in the bones so that they become hard and strong. Children and young people require additional calcium to build up their bones; otherwise there is a risk that they could develop rickets. Vitamin D is considered the most poisonous of all vitamins. Excessive doses can cause thirst, loss of weight and a risk of kidney failure, Vitamin D is found in oily fish, cod-liver oil and fish oil, and is also created in the skin when it is exposed to the sun.**

**Vitamin E: An important antioxidant in that it neutralizes free radicals within the body, unless controlled, free radicals can destroy cell membrane as well as alter genetic material (DNA) increasing the risk of cancer. Like other antioxidants vitamin E can prevent this damage from occurring, Vitamin E is responsible for regulating the balance of certain hormones in the body. The male sex hormone testosterone depends on vitamin E to produce sperm in the testicles while the female hormones estrogen and progesterone need both vitamin E and B to be biologically active. Vitamin E is therefore important for normal pregnancy and may lead to sterility in men if deficient.**

**Vitamin K: Vitamin K is essential in blood-clotting mechanisms, vitamin K is found in green vegetables such as cabbage, spinach and cauliflower, deficiency causes reduced activity of prothrombin resulting in haemorrhage.**

**Water Soluble Vitamins**

**The B vitamins each function differently; some affect the metabolism of the cells in the body and the production of energy while others are responsible for the formation of red blood cells and DNA.**

**Vitamin B1 (Thiamin): Essential for the well-being of the nervous system and the digestion of carbohydrates in food. Thiamin is the coenzyme, which helps to break up carbohydrates.**

**Vitamin B2 (Riboflavin): Promotes growth and healthy skin and eyes. It forms complex molecules which act as hydrogen carriers in oxidation-reduction reactions and is part of the two co-enzymes which are responsible for catalyzing a series of chemical reactions necessary for energy formation in the mitochondria.**

**Vitamin B3 (Niacin): Responsible for maintain the healthy skin and the intestinal tract, it is found as the co-enzyme nicotinamide adenine dinucleotide (NAD) which are important to the cells energy production.**

**Vitamin B6 (Pyridoxine): B6 is vital for the normal breakdown of proteins in food as well as maintaining healthy skin and nervous system.**

**Vitamin B12 (Cyanocobalamin): Like folic acid, B12 is important for the formation of the genetic material DNA.**

**Pantothenic acid: Essential for metabolism of carbohydrates, proteins, and fats, and the formation of certain hormones, deficiency includes nervous and intestinal disorders.**

**Biotin: Produced by intestinal bacteria and important in fatty acid biosynthesis and gluconeogenesis, it is essential to many chemical systems in the body.**

**Folic acid: Important for synthesis of the component comprising the genetic material DNA.**

**Vitamin C: Scurvy is a vitamin-deficiency disease brought on by a lack of fresh vegetables and fruit and was once a widespread and fatal disease, ascorbic acid has many important roles in the body and is particularly concerned with the growth and repair of body cells and tissue helping to fight infection, and with the absorption of iron from food. Iron is required in the manufacture of haemoglobin; the red pigment in the blood which transports the vital oxygen from the lungs to the rest of the body.**

**Macro Minerals**

**Calcium: Required for hard bones, transmission of nerve impulses activates certain enzymes, necessary for maintenance of membrane potential and muscle contraction.**

**Magnesium: Co-factor of enzymes in energy metabolism.**

**Phosphorus: Component of bone, ATP, nucleotides and co-enzymes.**

 **Trace Minerals:**

**Zinc: Co-factor of several enzymes in energy metabolism, immune function.**

**Copper: co-factor to oxidase enzyme.**

**Iron: Necessary component of haemoglobin, myoglobin transport of oxygen, facilitates transfer of electrons in electron transport system.**

**Additives and Antioxidants**

**Many food additives are anti-oxidants and used to preserve or enhance certain foods, the most familiar examples are the browning of cut apples or potatoes when exposed to air. The use of lemon juice demonstrates the principle of anti-oxidation since lemon juice contains vitamin C, which is one of the most antioxidants. Oxidation can cause breaks in DNA (and hence the risk of cancers), increasing the intake of antioxidants has a preventative effect against both cancer and heart disease.**

**Acids are a major component of natural foods, phosphoric acid gives the sharpness in cola drinks; all fruits contain characteristic acids such as citric in lemons, malic in apples, tartaric in grapes. The acids that are added to food are all, except phosphoric acid found in natural foodstuffs.**