**INTRODUCTION TO NUTRITION**

Nature has provided a variety of foods for man to consume and be healthy. We consume food for maintenance of health, growth and to develop greater resistance against infections.

Foods contain substances called nutrients in varying proportions, which are needed for proper growth and maintenance of life processes. Knowledge of the functions of these nutrients and major food sources is necessary for man to formulate a nutritious diet.

Nutrition is defined as a science concerned with the role of food and nutrients in the maintenance of health.

**Nutrition** as defined by Robinson (1982) is “the science of foods and nutrients, their action, interaction and balance in relationship to health and disease, the processes by which the organism ingests, digests, absorbs, transports and utilizes nutrients and disposes of their end product”.

**Nutrients** are the nourishing substances in food that are essential for growth of the infant, development from childhood to adulthood and the maintenance of bodily function throughout life. They must be supplied to the body in adequate amounts. These include Carbohydrates, Proteins, Fats, Minerals and Vitamins. Nutritional status is the condition of health of the individual as influenced by the utilization of the nutrients.

**RELATION BETWEEN GOOD NUTRITION AND HEALTH**

**Health** is defined by the World Health Organization (WHO) as the “State of complete physical, mental and social well being and not merely the absence of disease or infirmity”.

To maintain good health and nutritional status one must eat a balanced food, which contains all the nutrients in the correct proportion.

The essential requisites of health would include the following:

1. Achievement of optimal growth and development, reflecting the full expression of one’s genetic potential.
2. Maintenance of the structural integrity and functional efficiency of body tissues necessary for an active and productive use.
3. Mental well-being and emotional rest
4. Ability to withstand the inevitable process of aging with minimal disability and functional impairment.
5. Ability to combat diseases such as

– resisting infections (immunocompetence)

– preventing the onset of degenerative diseases

– resisting the effect of environmental toxins/ pollutants

**Till three decades ago the role of nutrition in growth and development and tissue integrity alone was clear, but now the persuasive role nutrition plays in the other dimensions of health is implicit. Hence an optimal nutritional status is an indication of good health. This recent advance has brought about a large-scale change in dietary habits and practices of the population.**

**CONCEPTS OF MALNUTRITION – UNDER**

**NUTRITION AND OVER NUTRITION**

**Desirable nutrition** refers to the nutritional status for a particular nutrient which is desirable when body tissues have enough of the nutrient to support normal metabolic function as surplus stores that can be metabolized in terms of increased needs.

**Malnutrition** as defined by World Health Organization (WHO) is a pathological state resulting from a relative or absolute deficiency or excess of one or more essential nutrients, this state being clinically manifested or detected only by biochemical, anthropometric or physiological tests.

Four forms can be distinguished:

1. **Under nutrition** – the pathological state resulting from the consumption of an inadequate quantity of food over an extended period of time.

**i.Marasmus** is synonymous with severe undernutrition. Starvation implies total elimination of food and hence the rapid development of under nutrition and marasmus.

**ii.Specific deficiency** – the pathological state resulting from a relative or absolute lack of an individual nutrient.

1. **Over nutrition** – the pathological state resulting from a disproportion of essential nutrients with or without the absolute deficiency of any nutrient or excess of one or more essential nutrients as determined by the requirement of a balanced diet. Eg:-Obesity,Toxicity of Vit.A &D etc.

**FOOD**

Food is the basic necessity of man. It is a mixture of different nutrients such as carbohydrate, protein, fat, vitamins and minerals. These nutrients are essential for growth, development and maintenance of good health throughout life. They also play a vital role in meeting the special needs of pregnant and lactating women and patients recovering from illness.

**1.1 Classification of food**

Food may be classified according to their functions in the body.

Functions of Food



\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



|  |  |  |
| --- | --- | --- |
| Physiological | Social | Psychological |
| Functions | Functions | functions |



\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



|  |  |  |  |
| --- | --- | --- | --- |
| Energy yielding | Body building foods | Protective foods |  |
| Foods | (Protein) | (Vitamins and |  |
| (Carbohydrate, |  | minerals) |  |
| Fat& protein,) | **Fig1.1 Functions of food** | |  |
|  |  |

1. **Pysiological functions of food:**
2. **Energy yielding foods:**

Foods rich in carbohydrates and fats are called energy yielding foods. They provide energy to sustain the involuntary processes essential for continuance of life, to carry out various professional, household and recreational activities and to convert food ingested into usable nutrients in the body.

The energy needed is supplied by the oxidation of foods consumed. Cereals, roots and tubers, dried fruits, oils, butter and ghee are all good sources of energy.

They are rich in carbohydrates, protiens and fats.

Examples:

* Cereals, Pulses, nuts and oilseeds, roots and tubers
* Cereals - energy, protein, vitamins and minerals.
* Pulses - energy, protein and Vit.B
* Nuts and oilseeds - energy, fats, proteins
* Roots and tubers - energy, minerals and vitamins
* Pure carbohydrates like sugars, fats and oils.
* Sugar- free energy
* fats and oils – Concentrated energy and fat soluble vitamins.

ii. Body **building foods:**

Foods rich in protein are called body building foods. Milk, meat, eggs and fish are rich in proteins of high quality. Pulses and nuts are good sources of protein but the protein is not of high quality. These foods help to maintain life and promote growth. They also supply energy.

* Milk, eggs, meat and fish – rich in proteins of high biological value and contain all the essential amino acids.
* Pulses, oil seeds and nuts – rich in protein but may not contain all the essential amino acids required by human body.

iii. **Protective and Regulatory foods:**

Foods rich in protein, minerals and vitamins are known as protective and regulatory foods. They are essential for health and regulate activities such as maintenance of body temperature, muscle contraction, control of water balance, clotting of blood, removal of waste products from the body and maintaining heartbeat. Milk, egg, liver, fruits and vegetables are protective foods.

* Foods rich in vitamins and minerals and proteins of high biological value e.g., milk, egg, fish, liver
* Foods rich in certain vitamins and minerals e.g., green leafy vegetables and fruits.

iv. **Repair or maintenance of health**

Food contain certain phytochemicals and antioxidants which help in preventing degenerative diseases. Food plays an important role in the prevention of cancers, heart diseases and in controlling diabetes mellitus.

Eg :- Colored fruits ,whole grains, green leafy vegetables, soya bean and spices.

**2. Social functions of food:**

Food has always been the central part of our community, social, cultural and religious life. It has been an expression of love, friendship and happiness at religious, social and family get-togethers.

**3. Psychological functions of food:**

In addition to satisfying physical and social needs, foods also satisfy certain emotional needs of human beings. These include a sense of security, love and acceptance. For example, preparation of delicious foods for family members is a token of love and affection.

**FOOD GROUP: ICMR FIVE FOOD GROUPS**

**TABLE – 1.A**

**Five Food Group System**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Food Group** | |  | **Main Nutrients** | |  |
| **I. Cereals, Grains and Products** : | | | | Energy, | protein, |  |
| Rice, Wheat, Ragi, Bajra, Maize, | | | | Invisible | fat Vitamin – |  |
| Jowar, Barley, Rice flakes, Wheat | | | | B1, Vitamin – B2, Folic | |  |
| flour. |  |  |  | Acid, Iron, Fiber. | |  |
| **II. Pulses and Legumes :** | | |  | Energy, | Protein, |  |
| Bengal gram, Black gram, Green | | | | Invisible | fat, Vitamin – |  |
| gram, Red gram, Lentil (whole as | | | | B1, Vitamin – B2, Folic | |  |
| well as dhals) Cowpea, Peas, | | |  | Acid, | Calcium, Iron, |  |
| Rajmah, Soya beans, Beans. | | |  | Fibre. |  |  |
| **III. Milk and Meat Products :** | | | | Protein, Fat, Vitamin – | |  |
| **Milk :** | Curd, Skimmed | | milk, | B12, Calcium. | |  |
| Milk, |  |  |  |
| Cheese |  |  |  |  |  |  |
| **Meat :** |  |  |  |  |  |  |
| Chicken, Liver, Fish, Egg, Meat. | | | | Protein, Fat, Vitamin – | |  |
|  |  |  |  | B2 |  |  |
| **IV. Fruits and Vegetables** : | | |  |  |  |  |
| **Fruits :** |  |  |  | Carotenoids, Vitamin – | |  |
| Mango, | Guava, | Tomato | Ripe, |  |
| Papaya, | Orange. | Sweet | Lime, | C, Fibre. | |  |
| Watermelon. | |  |  |  |  |  |
| **Vegetables (Green Leafy)** : | | |  | Invisible Fats, | |  |
| Amaranth, Spinach, Drumstick | | | |  |
| leaves, | Coriander | leaves, Mustard | | Carotenoids, Vitamin – | |  |
| leaves, fenugreek leaves . | | |  | B2. Folic Acid, Calcium, | |  |
| **Other Vegetables** : | | |  | Iron, Fibre. | |  |
| Carrots, Brinjal, Ladies fingers, | | | |  |  |  |
| Capsicum, Beans, Onion, | | |  | Carotenoids, Folic Acid, | |  |
| Drumstick, Cauliflower. | | |  |  |
|  |  |  |  | Calcium, Fibre | |  |  |  |
| **V. Fats and Sugars :**  **Fats :**  Butter, Ghee, Hydrogenated oils,  Cooking oils like Groundnut,  Mustard, Coconut.  **Sugars :**  Sugar, Jaggery | | |  | Energy, Fat, Essential  Fatty Acids | |  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
| Energy | |  |  |  |
|  |  |  |

**Significance of the five-food group system:**

The five food group system can be used for the following purposes:

1. Planning wholesome balanced menus to achieve nutritional adequacy.
2. Assessing nutritional status – a brief diet history of an individual can disclose inadequacies of food and nutrients from any of the five groups.

Based on the assessment, nutrition education can be imparted to the individual.

**FOOD PYRAMID:**

**A food pyramid or diet pyramid is a triangular diagram representing the optimal number of**[**servings**](https://en.wikipedia.org/wiki/Servings)**to be eaten each day from each of the basic**[**food groups**](https://en.wikipedia.org/wiki/Food_group)**.**

The food guide pyramid was introduced in 1992 by USDA (United States Department of Agriculture) as a general plan of what to eat each day. The food guide pyramid is a valuable tool for planning a health promoting diet. By incorporating the principle of balance, variety and moderation, an individual can still eat their favorite foods while following the food guide pyramid.

**Balance**: It means choosing food from different food groups.

**Variety:** This means including different foods within each food group. For eg. Consuming a variety of fruits.

**Moderation:** This means keeping serving sizes reasonable. This involves self control.

**Bread, Grain, Cereal and** **pasta** form the base: At the base of the food pyramid is the group that contains breads, grains, cereals and pastas. These foods provide complex carbohydrates, which are an important source of energy. 6 to 11 servings of these foods in a day. One serving of this group can be

1 slice of bread

2. ½ cup of rice, cooked cereal or pasta

3. 1 cup of ready to eat cereal

4. 1 flat tortilla

**Fruits and vegetables:** fruits and vegetables are rich in nutrients. Many are excellent sources of vitamin A, vitamin c, potassium. They are low in fat and sodium and high in fiber. The food pyramid suggests 3 to 5 servings of vegetables each day. One serving of vegetables can be 1 cup of raw leafy vegetables, ½ cup of other vegetables, cooked or raw, ¾ cup of vegetable juice.

The food pyramid suggests 2 to 4 servings of fruits each day. One serving of fruit can be One medium apple, orange or banana, ½ cup of chopped, cooked fruit, ¾ cup of fruit juice.

**Dairy Products:** Products made with milk provide protein and vitamins and minerals, especially calcium. The food pyramid suggests 2 to 3 servings each day. 1 cup of milk, 1 ½ ounce of natural cheese, 1 ounce of process cheese.

**Eggs, Lean Meat and Fish:** Meat, poultry and fish supply protein, iron, and zinc. Non-meat foods such as dried peas and beans also provide many of these nutrients. The food pyramid suggests 2 to 3 servings of cooked meat, fish or poiultry. Each serving should be between 2 and 3 ounces. The following foods count as one ounce of meat:

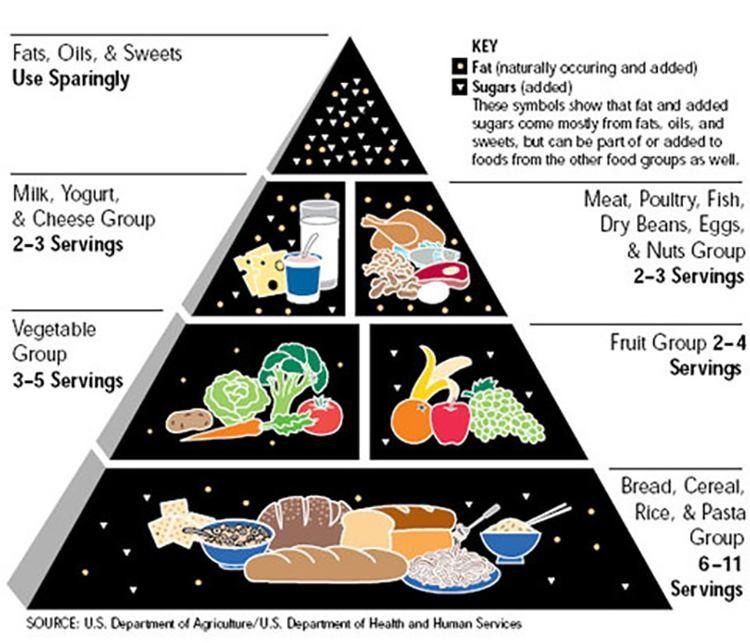
One egg

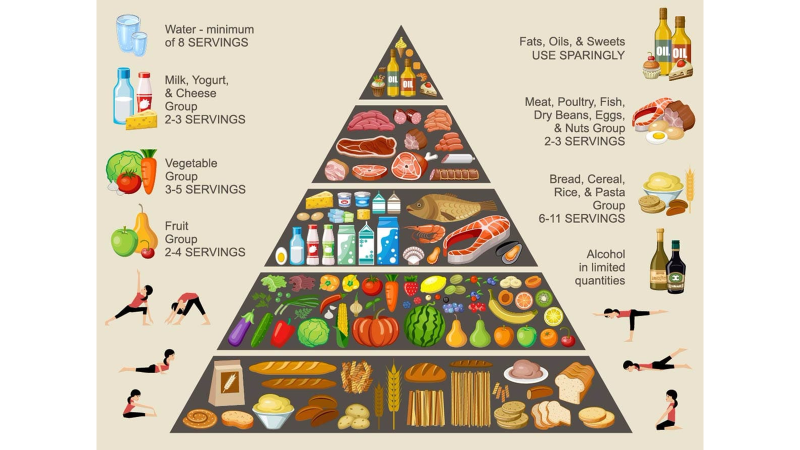
½ cup cooked dry beans

2 tablespoons of peanut butter

1/3 cup of nuts

**Fats and sweets:** A food pyramids tip is the smallest part, so the fats and sweets in the top of the food pyramid should comprise the smallest percentage of your daily diet. The foods at the top of the food pyramid should be eaten sparingly because they provide calories but not much in the way of nutrition. These foods include salad dressings, oils, cream, butter, margarine, sugars, soft drinks, candies and sweet desserts. The food guide pyramid can be extremely useful – whether you want to gain weight, lose weight or maintain your weight. Eating healthy diet simpler easier if you base your choices on the food pyramid.

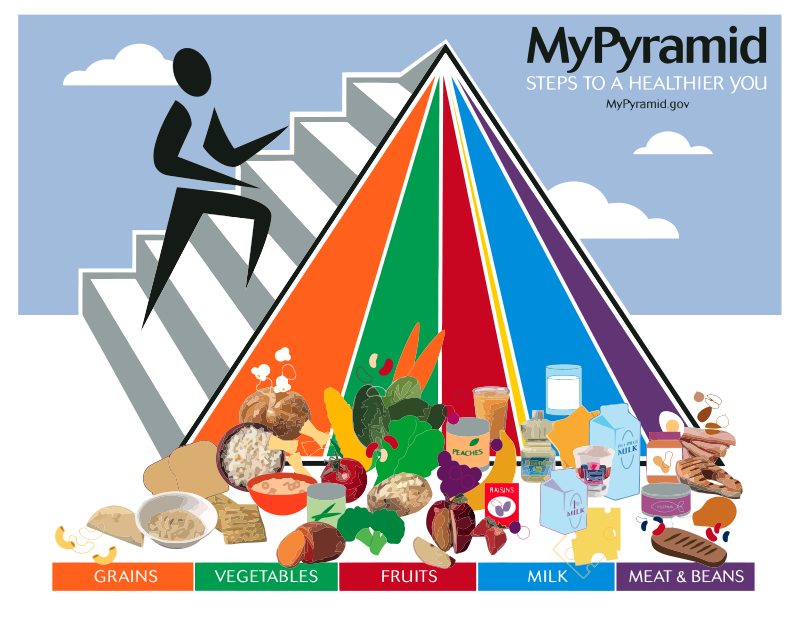




The diagram clearly represents that cereals should form the major bulk of the diet followed by fruits and vegetables, pulses, milk and meat products and sugars and oil.

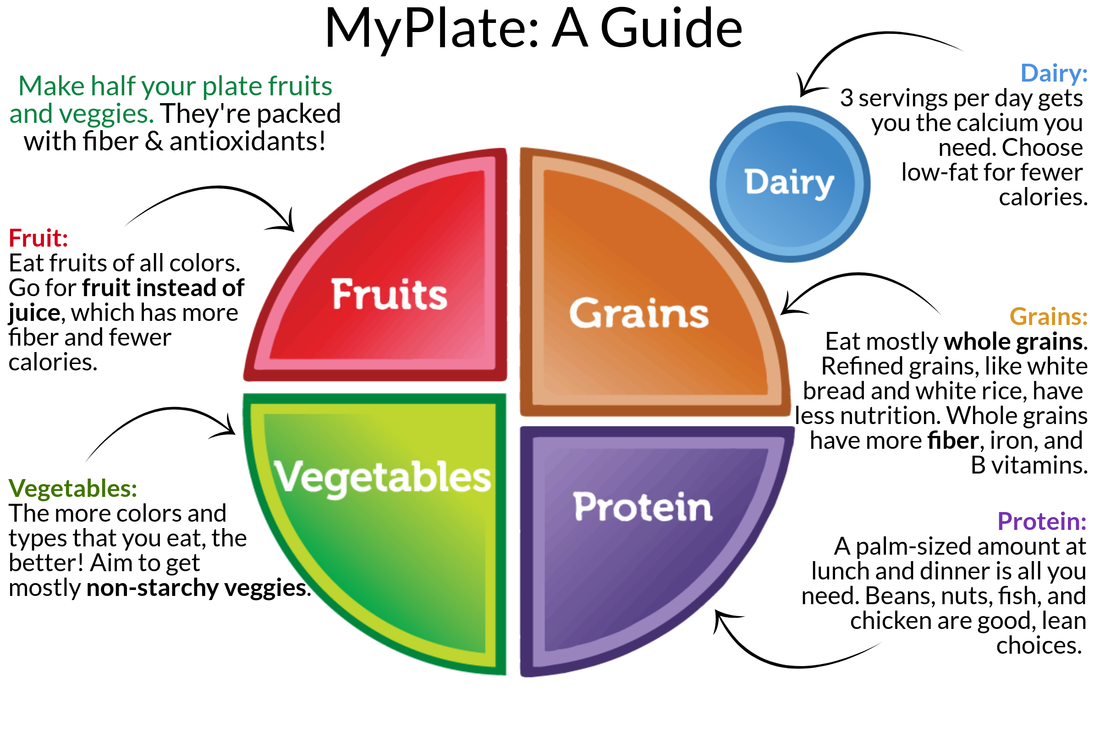
**The New Food Pyramid**

The new food pyramid become three dimensional and has a figure climbing up the side of it, the horizontal lines have been replaced by vertical lines starting from the tip of the pyramid and radiating downward. The new food pyramid is color coded. The six colored stripes denote the quantities of food you should consume. An orange stripe represents grains, a green stripe for vegetables, a red stripe for fruits, yellow stripe denotes how much fats and oils should have, a blue stripe for the milk and dairy products that your allowed, and a purple stripe shows the quantities if meat, fish, beans and pulses that you should eat in a day. Today the food pyramid is being replaced by a plate which health care professionals feel will be easier to follow and have a more positive impact on the nutritional status of the population.



My plates – eats a variety of foods and eat less of some foods and more of others. The main message is that fruits and vegetables take up half the plate, with the vegetable portion being a little bigger than the fruit section. The plate has been divided so that the grain section is bigger than the protein section. Because nutrition experts recommend you eat more vegetables than fruits and more grains than protein foods.

The plate is simple and useful and helps an individual to view his or her own plate a little differently.



**Balanced diet**: A Balanced Diet is one which includes a variety of foods in adequate amounts and correct proportions to meet the days requirements of all essential nutrients such as proteins, carbohydrates, fats, vitamins, minerals, water and fiber. Such a diet helps to promote and preserve good health and also provides a safety margin or reserve of nutrients to withstand short durations of emergency.

Balanced diet is the diet which contains different types of food in such quantities and proportions so that the need for calories, proteins, minerals, vitamins and other nutrients is adequately met and a small provision is also made for extra nutrients to withstand short duration of leanness. The balanced diet should be prepared keeping in mind the nutritional requirement of the individual so as to maintain good health. A balanced diet should be made by including food from all the food groups in a balanced amount so that the individual gets all types of food and nutrients to meet his/her requirement. Additionally balanced diet should provide bioactive phytochemicals such as dietary fiber, antioxidants and other nutraceuticals which have positive health benefits.

A balanced diet should provide around 60-70 per cent of total calories from carbohydrates, 20 – 25 per cent of total calories from fat and 10 – 12 per cent from protein. As the energy requirement is met from the major nutrient that doesn’t mean that one should ignore including fruits and vegetables, emphasis should also be laid on including fruits and vegetables as they are source of vitamins and minerals that provides immunity to the body.

**Criteria for balance diet:**

1. Should meet the nutritional requirements of the individual
2. Should prevent degenerative diseases
3. Should improves immunity
4. Should increase stamina
5. Should helps in coping up stress
6. Should develop optimum cognitive ability.

**A Balanced diet takes care of the following aspects:**

1. It includes a variety of food items
2. It meets the RDA for all nutrients
3. Nutrients are included in correct proportions
4. Provides a safety margin for nutrients
5. It promotes and preserves good health
6. It helps maintain acceptable body weight for height.

**RECOMMENDED DIETARY ALLOWANCE**

The recommended dietary allowance (RDA) is the guideline stating the amount of nutrients to be actually consumed in order to meet the requirements of the body. The RDA is based on requirements. The requirement for a particular nutrient is the minimum level that needs to be consumed to perform specific functions in the body and to prevent deficiency symptoms.

RDA = Requirement + Margin of safety

The margin of safety is added to take care of factors such as

1. Losses during cooking and processing
2. Short periods of deficient intake
3. Nature of the diet
4. Individual variations in requirements

For example the requirement of vitamin C is actually 20 mg, but since the vitamin is easily destroyed during pre-preparation, cooking and storage, the recommended intake is twice the requirement and is 40 mg/day.

The RDA applies to healthy individuals and are set high enough to cover individual variation. They are based on gender, age, body size, activity level and special physiological state.

**RDA for specific nutrients:**

1. The RDAs are expressed in metric units such as kilocalorie, grams, milligrams and micrograms
2. They are based on gender and activity levels
3. The RDA for B-complex vitamins B1, B2 and niacin are based on kilocalories or energy.
4. The RDA for protein is based on body weight. Adults need 1 g/kg body weight while infants, children, adolescents and pregnant and lactating mothers need more protein to meet the demands of growth and body building.
5. The RDA for infants are expressed per kg body weight
6. The RDA for vitamin A is expressed in terms of retinol and B-carotene.

How much food each individual will need will depend on many factors which have been considered while computing the Recommended dietary Allowances. Factors such as age, gender, and special physiological needs have been kept in mind.

**Classification of Nutrients**

Nutrients are the essential constituents of food that are required by the body in suitable amounts. There are approximately 50 nutrients which are placed in six categories, proteins, carbohydrates, fats, vitamins, minerals and water.

**Classification on the basis of amount required everyday**:

Based on their requirement in the body, nutrients are divided into two major groups. The macronutrients and the micronutrients. Most of the food we eat is that of proteins, carbohydrates, fats and water. These are the **macronutrients.** Vitamins and minerals are required in minute amounts and are also present in food in very small quantities. They are classified as **micronutrients.** Both macro and micronutrients are equally important for good health.

**Classification on the basis of function**: Nutrients can be classified according to their function in the body. Different nutrients have different functions. Foods such as proteins, fats and carbohydrates are called as body building food. They are the nutrients that form body tissues. Proteins make up 20 percent and fats make up another 20 percent and carbohydrates make up about 1 percent.

**Vitamins and minerals** are the nutrients that function to regulate body processes. Minerals make up 4 per cent of the body weight and vitamins make up about 28 g of the body weight. Proteins, vitamin A, vitamin C and iron protect the body against infection and are called protective nutrients.

**Classification on the basis of chemical properties:**

The nutrients are further classified as organic and inorganic. Those nutrients that contain carbon such as proteins, carbohydrates and fats are called organic nutrients. While those

Nutrients that do not contain carbon element such as minerals and water are called inorganic nutrients.

**Classification on the basis of essentiality**

Some nutrients cannot be synthesized by the body in required amounts and must be included in the diet, essential amino acids, essential fatty acids, minerals and most vitamins. While all nutrients are required by the body daily, and all are essential and important.

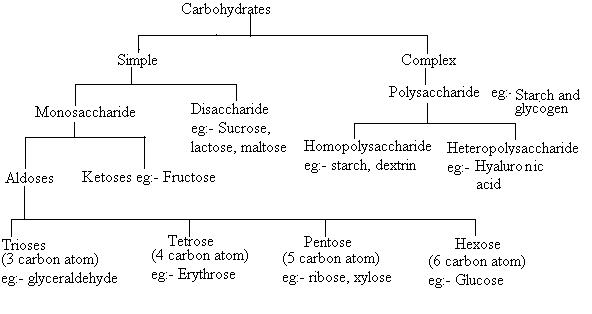
**CARBOHYDRATES**

Energy that is needed to move, perform work and live is chiefly consumed in the form of carbohydrates. Carbohydrates, primarily starches, are least expensive, easily obtained and readily digested form of fuel

**COMPOSITION**

Carbohydrates are organic compounds composed of carbon, hydrogen and oxygen, with the later elements in the ratio of 2:1. The general formula is CnH2nOn. They are viewed as hydrated carbon atoms.

**CLASSIFICATION – SIMPLE AND COMPLEX:**



Carbohydrates are classified, depending on the number of sugar units they contain, as simple carbohydrate and complex carbohydrates.

Monosaccharide’s and disaccharides make up simple carbohydrates, called simple sugars containing one and two sugar units respectively. Polysaccharides called complex carbohydrates are structurally larger and more complex than simple sugars. They include starch, dietary fiber and glycogen.

There are two main classes of monosaccharide’s based on the carbonyl group present in them. They are aldoses and ketoses, aldoses (eg; glucose) containing the aldehyde group (CHO) and ketoses, (eg;- fructose) containing the ketone group (C=O).

Aldoses are further divided into trioses, tetroses, pentoses and hexoses based on the number of carbon atoms

The common disaccharides are Maltose, Lactose and Sucrose which on hydrolysis yield two monosaccharide units.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Maltose | |  | hydrolysis | |  | Glucose | + | Glucose |
| Lactose | |  | hydrolysis | |  | Glucose | + | Galactose |
| Sucrose |  |  | hydrolysis |  |  | Glucose | + | Fructose |
|  |  |  |  |  |  |  |  |  |

Polysaccharides have high molecular weight and are insoluble in water. They are in the form of long chains either branched or un-branched.

The polysaccharides are further classified into groups depending upon the products they yield on hydrolysis. Homopolysaccharides yield only one type of monosaccharide units on hydrolysis eg:- starch, dextrin, cellulose, glycogen

Heteropolysaccharides yield more than one type of monosaccharide units on hydrolysis eg:- Heparin, Hyaluronic acid. Heparin is an anticoagulant found in the liver, spleen, lungs and blood. Hyaluronic acid is found in the umbilical cord synovial fluid and vitreous humor. It has a lubricating action. In tissues it forms an important part of the cementing ground substance.

The sugars are also classified as reducing and non reducing sugar. The reducing property is attributed to the free aldehyde or keto group.

**FUNCTIONS**

Carbohydrates perform the following functions.

**1. Energy :**

The principle function of carbohydrates is to serve as a major source of energy for the body. Each gram of carbohydrate yields 4Kcal of energy regardless of its source. In Indian diets 60 – 80 % of energy is derived from carbohydrate.

**2. Glucose:**

Glucose is indispensable for the maintenance of the functional integrity of the nervous tissue and is the sole source of energy for the proper functioning of the brain.

Prolonged lack of glucose may cause irreversible damage to the brain.

**3. Protein Sparing Action :**

Carbohydrates exert a protein sparing action. If sufficient amounts of carbohydrates are not available in the diet, the body will convert protein to glucose in order to supply energy.

Hence to spare proteins for tissue building, carbohydrates must be supplied in optimum amounts in the diet. This is called the protein sparing action of carbohydrates.

**4. Fat Metabolism :**

Carbohydrates are essential to maintain normal fat metabolism.

Insufficient carbohydrates in the diet results in larger amounts of fat being used for energy than the body is equipped

to handle. This leads to accumulation of acidic intermediate products called ketone bodies.

**5. Synthesis of Body Substances**

Carbohydrates aid in the synthesis of nonessential amino acids, glycoprotein’s (which function as antibodies) and glycolipids (which form a part of cell membrane in body tissues especially brain and nervous system).

Lactose remains in the intestine longer than other disaccharides and thus encourages growth of beneficial bacteria.

**6. Precursors of Nucleic Acid :**

Carbohydrates and products derived from them, serve as precursors of compounds like nucleic acids, connective tissue matrix and galactosides of nervous tissue.

**7. Detoxification Function :**

Glucuronic acid, a metabolite of glucose serves as a detoxifying agent.

It combines with harmful substances containing alcohol or phenolic group converting them to harmless compounds which are later excreted.

**8. Roughage of the Diet :**

Insoluble fibres known as composite carbohydrates can absorb water and give bulk to the intestinal contents which aids in the elimination of waste products by stimulating peristaltic movements of the gastrointestinal tract.

**Food Sources**

             There are three main sources of carbohydrates (1) Starches (2) Sugars and (3) Cellulose.

(1)   Starches are present in cereals (eg. Rice, wheat, maize, sago, and all bakery products) pulses, potatoes, sweet potatoes, yam and dry fruits.

(2)   Sugars are present in cane sugar, jiggery, honey, jam, jellies, dry fruits, sweets and fresh fruits, eg. Banana, sapoto, grapes, mango.

(3)   Cellulose is the fibrous substance. eg. whole grains, whole pulses

**Recommended Daily Dietary Intakes**

As carbohydrate is utilized as main source of energy, at least 40 percent of the total energy in the food should come from Carbohydrates.

In our country 60 – 80 percent of a day’s energy needs are met from carbohydrates in the form of starch furnished by cereals and pulses.

In developed countries only 30 – 40 percent of days energy needs are met from carbohydrates

      There is no fixed amount recommended for carbohydrates, but even then it should provide about 60-70% of the total energy. The daily diet of an adult should contain at least 40 gms of dietary fiber.

**Deficiency**

               The energy needs are not met if the diets are deficient in carbohydrates. The work efficiency is lowered. Also person becomes underweight. Growth will be slow in the case of children. Symptoms of ketosis may also develop. Lack of dietary fiber in the diet leads to constipation and colon cancer.

If carbohydrates are consumed in excess they get accumulated as fat in the body leading to obesity and predisposes to diabetes and heart ailments.

**DIETARY FIBRE**

Dietary fiber is defined as that portion of plant material ingested in the diet that is resistant to digestion by gastro intestinal secretions. It consists of hemicelluloses, cellulose, lignin’s, oligosaccharides, pectin’s, gums and waxes.

Some bacteria in the large intestine can degrade some components of fiber releasing products that can be absorbed into the body and used as energy source.

Two categories of fiber are found in food. Crude fiber is defined as the residue remaining after the treatment with hot sulphuric acid, alkali and alcohol.

The major component of crude fiber is a polysaccharide called cellulose. Crude fiber is a component of dietary fiber. Several other carbohydrate and related compounds called pectin’s, hemicelluloses and lignin’s are the second category found in plant foods and are also resistant to digestion.

These together with cellulose are collectively known as dietary fiber.

**PROTEINS**

The word protein means to “take the first place”. In 1938 a Dutch Chemist Mulder, described that all living plants and animal contain certain substance without which life was not possible and this was identified as proteins. In constitution of body they stand next to the water. Indeed proteins are of the greatest importance in human nutrition.

They are complex organic compounds containing the carbon, hydrogen, oxygen, nitrogen, and usually sulphur. Some proteins also contain phosphorus, iron, iodine, copper and other inorganic elements. The proteins differ from carbohydrates and fat as they contain nitrogen, Proteins are made up of much smaller units known as amino acids.

**Function**

Proteins are very essential for life processes, as there is hardly any important physiological function in which proteins do not participate. The important functions of proteins are:

(1)  **Body building:** It is the most important function of protein. These are the major structural components of body tissues. Infact every living cell contains protein. The first need for proteins therefore is to supply the materials for the growth and development and the continuous replacement of the cell protein.

(2)  **Body Regulatory:** Many proteins have highly specialized functions in the regulation of body processes. All chemical reaction in the body are carried out by enzymes, which are protein in nature. Proteins are also a constituent of hemoglobin, which is necessary to carry oxygen from lungs to tissues and bring back CO2.Governing the body reaction are hormones, which are also proteins. Plasma protein has a fundamental role in the maintenance of water balance. Blood proteins also help in maintaining acid base balance of the body.

(3)  **Body protection:** There is a protein called gamma globulin, which has a capacity to fight against invading organism. The body’s resistance to disease is maintained in part by antibodies, which are protein in nature.

(4)  **Energy Yielding:** The energy needs of the body take priority over other needs, and if the diet does not furnish sufficient energy from carbohydrates and fats. The proteins of the diet as well as tissue protein will be used up for giving energy. One gram of protein gives 4 calories.

(5)  **Maintenance of body temperature:** During the metabolism of proteins extra heat is liberated, which is used for maintaining the body temperature.

## Protein Quality

            It is not only the quantity of protein, which is important but also the quality. This depends mainly on the type of amount of particular amino acids present in the particular protein.

There are twenty-two amino acids, which are needed by the human body out of which eight are called “essential”. It is because the body cannot synthesize them; therefore, they must be obtained from the diet. Rest of the amino acids are termed as “non-essential” as they can be synthesized in our body.

Essential amino acids are isoleucine leucine, lysine, methionine, phenylalanine threonine, tryptophan and valine. In addition to these infants require histidine for growth.

 Non-essential amino acids are those that the body can synthesize. They are alanine, arginine, aspargine, aspartic acid, cysteine, glutamic acid, glutamine, glycine, proline, serine and tyrosine.

Based on the quality of proteins, they can be classified into three classes.

(1) Complete protein (First Class)

(2) Partially complete proteins (Second Class)

(3) Incomplete proteins (Third Class)

(1) **Complete Proteins:**  These contain all the essential amino acids in sufficient quantities so that a normal rate of growth can be maintained by the body. Mainly proteins from animal source belong to this class i.e. milk, meat, eggs, fish, and poultry. Wheat germ and dried yeast have a biologic value approaching that of animal sources.

(2)  **Partially complete proteins:** They can maintain life, but they lack sufficient amount of some of the amino acids necessary for growth. Proteins from plant source like pulses, wheat and nuts belong to this class.

(3) **Incomplete proteins:** They can neither promote growth nor maintain life because they lack many of the amino acids or even if they contain, it is in very small amounts, Gelatin and zein which is found in corn are the examples which belongs to this class.

Proteins may be classified on the Basis of structure

1. Simple proteins – These proteins are made up of amino acids only. Eg. Zein in corn, Albumin in egg white and gliadin in wheat.
2. Conjugated proteins – These proteins have a non-protein molecule attached to the protein Eg. Blood protein haemoglobin, which contains a heme(Iron) attached to protein and Milk protein casein which has a phosphate group attached.
3. Derived proteins – These results from a partial breakdown of a native protein. Proteoses, peptones and polypeptides are formed when digestive enzymes begin their action on proteins.

**Supplementary Value of Proteins** is the capacity of one protein to make good the deficiency of another protein. This is also known as the “mutual supplementation effect”.

The Chief source of protein in diets for most of the world’s people is from plants. Just because plant foods, when fed alone do not provide necessary quota of essential amino acids is no reason to condemn them as protein sources. However four possibilities exist for improving the quality of protein.

First, is to feed some amount of animal or complete protein with second and third class protein e.g. to include little amount of animal protein at each meal.

Second, to use a combination of various vegetable proteins so that they would make up the deficiency of each other e.g. mixture of cereals and pulses.

Third, to add the lacking essential amino acids synthetically.

Fourth, by germination and fermentation e.g. sprouting of pulses, cereals etc.

## Food Sources

 There are two main dietary sources of proteins

(1) Animal source: Milk and milk products excluding butter and ghee, eggs, meat, fish and poultry.

(2) Plant sources: Pulses e.g. Soybean, Bengal gram, red gram dal, green gram, black gram dal; Cereals e.g. wheat maize, rice, barley, jowarbajra; and nuts e.g. peanuts, almond, cashew nuts. Fruits and vegetables are poor sources

**Recommended Daily Dietary Allowances**

            The protein requirements vary from individual to individual. Apart from age and physiological conditions, factors like emotional disturbances infection and stress can affect a person’s protein requirement. For proper utilization of protein, energy intakes should be adequate. Maximum amount of protein per Kg. of body weight is required during infancy i.e. till one year of age. The requirement per Kg. of body weight slowly decreases as one reaches the adulthood and then it is stable i.e. 1 gm. Per Kg. of desirable body weight. .

**Deficiency**

          A reduced protein intake or constant consumption of poor quality proteins over an extended period of time leads to depletion of the tissue reserves and lowering of blood protein levels. The protein deficiency occurs mostly during infancy, early childhood, pregnancy and lactation.

            In children protein deficiency leads to occurrence of maramus and kwashiorkor. They show retarded growth, oedema and diarrhea. In adults usually proteins deficiency causes loss of weight, weakness and lowered resistance to diseases.

**LIPIDS OR FATS**

Lipids more commonly known as fats and oil, are integral part of our food. They are insoluble in water but soluble in organic solvents. They occur in both plant and animals. Lipids are a concentrated source of energy

Fat is an important component of our diets and serve a number of functions. These are also organic compound of carbon, hydrogen and oxygen. These differ from carbohydrates is that they have much smaller proportion of oxygen and much greater proportions of carbon and hydrogen.

**CLASSIFICATION**

Lipids are classified into simple, compound and derived lipids which are further subdivided as follows.

Lipids

|  |  |  |
| --- | --- | --- |
| Simple | Compound | Derived |
| a) Fats and oils | (a) Phospho lipids | (a)Sterols |
| b) Waxes | (b) Glyco lipids | (b)Fatty acids |
|  | (c) Lipo proteins |  |

**Simple lipids**

Fats and Oils are included in this type. At room temperature, oils are liquids and fats are solids. Fats and oils contain esters of fatty acid and glycerol, a form in which lipids are present in food.

**Compound lipids**

They are esters of fatty acids containing phosphorous carbohydrate or protein. Phospholipids contain a phosphoric acid in addition to the alcohol and fatty acids.

Glycolipids contain a fatty acid, carbohydrate and a nitrogenous base. Phospholipids and glycolipids form part of the cell membrane and the nervous system.

Lipoproteins are macromolecular complex of lipids with proteins.

**Derived lipids**

These are substances liberated during hydrolysis of simple and compound lipids which still retain the properties of lipids. The important members of this group are sterols, fatty acids and alcohol.

**Sterols**

Sterols are solid alcohols and form esters with fatty acids. In nature they occur in the Free State in the form of esters. Based on their origin sterols are classified as cholesterol (animal origin) and phytosterol (in plants).

Cholesterol is a complex type of lipid that is regularly synthesized by and stored in the liver. It is present in all animal products.

**Fatty acids**

Fatty acids are the main building blocks of fat. They have a methyl group (CH3) at one end and a carboxyl group (COOH) at the other end with a chain of carbon and hydrogen atom in the middle. They have a basic formula CH3(CH2)n COOH. Where ‘ n’ denotes the number of carbon atoms which may vary from 2 to 2l.

Fatty acids can be classified into Saturated Fatty Acids(SFA) and Unsaturated Fatty Acids (UFA)

**Saturated Fatty Acids**

Saturated fatty acids are those that are unable to absorb more hydrogen. They are usually stiff and hard fats. Eg. Ghee, and Butter.

**Unsaturated fatty acids**

Unsaturated fatty acids have one or more double bond in their molecule and are thus not saturated with hydrogen. They are liquid at room temperature. Eg. Sunflower oil.

Unsaturated fatty acids may be monounsaturated or polyunsaturated depending on the number of double bonds.

**Monounsaturated fatty acids (MUFA)**

MUFA have only one double bond in their molecule. Eg. oleic acid found in olive oil, peanut oil

**Polyunsaturated fatty acids(PUFA)**

PUFA have 2 or more double bonds in their molecule. Eg. linoleic acid, linolenic acid, and Arachidonic acid. They are present in corn, safflower, soyabean, sunflower oils and fish oils.

Monounsaturated and polyunsaturated fats are usually soft or liquid at room temperature

The term fat is generally applied to all triglycerides regardless of whether they are solid or liquid at room temperature. Triglycerides from animal sources contain a higher percentage of saturated fatty acids and are normally solids at room temperature and known as fats.

The plant triglycerides are rich in unsaturated fatty acids and are generally liquids at room temperature and called oils.

Essential Fatty Acids

            Certain fatty acids should be provided essentially in the diets, as they are not synthesized in the body. These are polyunsaturated fatty acids, namely linoleic, linolenic and archidonic acids and are grouped as “essential” fatty acids. They are required for metabolism and for maintenance of normal health of the skin. .

**Non -essential fatty acids**

Non-essential fatty acids are those which can be synthesized by the body and which need not be supplied through the diet. Palmitic acid, oleic acid and butyric acid are examples of non – essential fatty acids

**Functions**

The functions of fats are:

(1)  **Energy fielding:** Fats are concentrated source of energy. One gram of fat gives 9 calories. Compared to carbohydrate it not only gives more amounts of energy but at a faster rate too.

(2) **Fats also perform the protein sparing action** in the same way as carbohydrate does.

(3)  **Storehouse of energy for the body’s needs:** In fact not only amount of fats as such are stored in adipose tissue, but any amount of glucose, amino acids, not promptly utilized are also synthesized and stored in the body, thereby energy is continuously available from the stores in adipose tissues.

(4) **Insulation and padding:** The subcutaneous layer of fat is an effective insulator and reduces losses of body heat in cold weather, thus regulating the body temperature. The vital organs such as the kidneys are protected against physical injury by a padding of fat around the organs.

(5)  **Fats help in absorption and transportation** of fat-soluble vitamins in the body.

(6) **Provides essential fatty acids:** Fat is also the source of certain fatty acids which are essential for metabolism and for maintaining a normal skin.

(7) **Fats acts as a lubricant**for various body organs especially the organs of the gastrointestinal tract.

(8)**Gives satiety value:** Fat depresses the secretion of hydrochloric acid in the stomach, thus the food stays in the gastrointestinal tract for a longer time and feeling of hunger is delayed.

(9)  **Fat also increases the palatability** of the diet by adding flavor to many cooked preparations.

Food Sources

Dietary fats are derived from two main sources

(1) Animal sources: It includes butter, ghee, curd, whole milk, and its products meat, fish, poultry, and eggs.

(2) Plant sources: They include all vegetables oils e.g. groundnut, gingili, mustard, cottonseed, sunflower, and coconut oil. Also it will include hydrogenated fats, margarine, nuts and oil seeds like cashewnut, peanuts, almonds, and mustard seeds.

**Recommended Daily Dietary Intakes**

The fat requirement mainly depends upon the energy needs of the individual. From physiological point of view there can be wide variation in fat intake and still good health can be maintained. On an average about 15-20% of the total energy should be supplied from fats. The dietary fats should be a good source of essential fatty acids and hence at least 50% of  the dietary fat should be from vegetables oils rich in essential fatty acids.

## Deficiency

               Just like carbohydrates deficiency, the energy needs will not be met if the diet is deficient in fat content. Hence leading to underweight, weakness and lowered work efficiency.

In addition to this the deficiency of the essential fatty acids play a role in several metabolic reactions, a deficiency of these fatty acids is believed to lead to a skin condition known as ‘phyrnoderma’ (toad skin) in which the skin becomes rough and thick horny papules of the size of a pinhead irrupt in certain areas of the body, notably the thighs, buttocks and trunk.

In addition to this, the deficiency of fat-soluble vitamins and essential fatty acids will also result. This will cause the aliments related to skin, eyes, bones, etc.

## Excess

            If excessive fat is consumed it will result in obesity gastrointestinal disturbances, and predisposal to many other diseases like diabetes and cardiovascular ailments.

In recent years there has been a revival of interest in the nutritional aspect of excessive intake of the fat in the diet in increasing the level of cholesterol in the blood, Excessive cholesterol in blood gradually causes it to deposit under the lining of blood vessels, resulting in “atherosclerosis” wherein the blood vessels are narrowed and hardened leading to heart diseases.

**UNIT-3**

**MINERALS AND VITAMINS**

Until the middle of the nineteenth century, the importance of minerals and vitamins was not known. It was observed that carbohydrate, fat, protein alone were incapable of promoting and sustaining growth.Hence scientists attempted to find out the “missing elements”, namely minerals and vitamins which are essential for growth and maintenance.

**Vitamins**

Vitamins are organic substances present in small amounts in food, they are required for carrying out vital functions of the body. They are involved in the utilization of the major nutrients like proteins, fats and carbohydrates.

Though needed in small amounts, they are essential for health and well being of the body. When these Vitamins were discovered on the basis of their function and before their chemicalnature were elucidated, they were designated as A,B,C,D or in terms of their major functions like, antineuritic, antirichitic Vitamins. Vitamins are classified based on their solubility as fat soluble and water soluble vitamins

**CLASSIFICATION OF VITAMINS**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Vitamins | | |  |
|  |  |  |  |  |  |  |
| 1. Fat |  | soluble |  |  |  |  |
|  |  | 2. Water soluble | |  |
|  |  |  |
| Vitamin A,D,E,K | | |  | Vitamin B1,B2,B6,B12 | |  |
|  |  |  |  | (Niacin) Nicotinic Acid | |  |
|  |  |  |  | FolicAcid and Vitamin- C. | |  |
|  |  |  |  |  | |  |

Water soluble vitamins are not accumulated in the body , but are readily excreted while fat soluble vitamins are stored in the body. For this reason excessive intake of fat soluble vitamins, especially Vitamin A and D can prove toxic. Excessive intake leads to the condition called hypervitaminosis.

**Functions, food sources, requirements and effects of deficiency**

**Fat soluble vitamins:**

**Vitamin A**

Vitamin A was the first fat soluble vitamin to be recognized. Three forms of Vitamin A are active in the body,retinol, retinal and retinoic acid. They are collectively called as retinoids .

Beta carotene is the provitamin of Vitamin A. Provitamins are substances that are chemically related to a vitamin but must be changed by the body into the active form of the vitamin. Vitamin A in the diet comes in two forms.

Retenoids (preformed Vitamin A) and carotenoids. Vitamin A is present in vegetable foods which contain yellow pigment called carotenes. It was isolated from carrots hence called carotenoids which are provitamins of Vitamin A.

**Functions.**

1. A well understood function of retinol is in the visual process. The retina of the human eye contains two distinct photo receptors of which one is sensitive to light intensities . Vitamin A is essential for the formation of rhodopsin and normal functioning of the retina for clear vision in dim light. Lack of Vitamin A leads to impaired adaptation to darkness.
2. Participates in protein synthesis and cell differentiation and thereby maintaining the health of the epithelial tissues and skin.
3. Supports reproduction and growth
4. Vitamin A regulates the antibodies and cellular immune response. It is essential for maintaining the epithelial tissue which is the first line of defence against invading microorganism.
5. Beta carotene acts as an antioxidant capable of protecting the body against disease like cancer, cardiovascular diseases and cataract.

**Sources**

Vitamin A in the human diet exist as retinol or as retinal or beta carotene which has to be converted to Vitamin A. Foods of animal origin contain retinol.Plant sources are rich in Beta carotene. Only one third of the dietary beta Carotene is absorbed.Beta Carotene from green leafy vegetables is well utilized than from carrots and papayas.Good sources of Vitamin A are sheep liver, butter, ghee, egg, milk, curds, liver oils of shark and halibut.Good sources of beta carotene are agathi, amaranth, drumstick leaves, green leafy vegetables, mango, papaya, carrot and jack fruit.

**Requirements**:The ICMR recommended dietary allowance for retinol is given in table-21C.

**Table 21 C**

**ICMR recommended dietary allowance for Retinol**

|  |  |
| --- | --- |
| **Group** | **Retinol µg/day** |
|  |  |
| Man | 600 |
| Woman | 600 |
| Pregnant | 600 |
| women |  |
| Lactation | 950 |
| Infants | 350 |
| Children | 400-600 |

**Effects of Deficiency**

Deficiency of Vitamin A is manifested as nutritional blindness and increased susceptibility to infection. Nutritional blindness is an important public health problem among young children in India.

Night blindness is an early symptom of Vitamin A deficiency. The individual cannot see in dim light. This can be corrected with adequate supply of Vitamin A. In the absence of adequate Vitamin A intake the outer lining of the eye ball loses its usual moist, white appearance and becomes dry and wrinkled called xerosis.

This condition is followed by raised muddy dry triangular patches on the conjunctiva called the bitots spots. Redness and inflammation of the eye and gradual loss of vision may follow. The central portion of the eye loses its transparency and becomes opaque and soft if not treated and leads to total blindness termed Xeropthalmia. Xeropthalmia encompasses all ocular manifestations of Vitamin A deficiency.

Increased susceptibility to infection occurs because the mucous membrane lining becomes dry and rough which is easily invaded by the micro – organism.

**Hypervitaminosis**: Intake of large amount of Vitamin A for prolonged periods can lead to toxic symptoms which include irritability, headache, nausea and vomitting.

**Vitamin D**

Vitamin D can be synthesized in the body in adequate amounts by simple exposure to sunlight, even for 5 minutes per day is sufficient.It is essential for bone growth and calcium metabolism. It acts as a hormone in the body by facilitating calcium absorption and deposition in the bone.

**Functions**

1. Vitamin D helps in the absorption of calcium and phosphorous by increasing the synthesis of calcium binding protein.
2. Vitamin D helps to maintain the calcium and phosphorous levels in the body by stimulating,
   1. Absorption in the gastro intestinal tract.
   2. Retention by the kidney
3. Vitamin D helps in deposition of calcium in the bones.

The bones grow denser and stronger.

**Food Sources**

The Vitamin D content of food sources from animals varies with the diet, breed and exposure to sunlight of the animal.The good sources of Vitamin D are cod liver oil, shrimp, liver, butter, yolk, cheese, milk, spinach and cabbage.

**Requirements**

The expert group of ICMR has not recommended dietary intake of Vitamin D for Indians.

Only in those cases where the Vitamin D requirement is not met due to inadequate exposure to sunlight the ICMR recommends 400 µg/day of Vitamin D .

**Deficiency**

Deficiency of Vitamin D leads to decreased absorption of calcium which is manifested as muscular tetany, rickets in children and osteomalacia in adults.

Due to faulty calcification of bones the following derfomities is manifested in children which is called rickets. It is a disease in which there is weakness and abnormalities in bone formation. Rickets primarily affects children.

**Rickets Manifestations:**

1. faulty deposition of calcium on the bones.
2. Bowing of legs
3. Enlargement of ends of long bones
4. Deformities of ribs – beading of ribs
5. Delayed closing of frontanel
6. Slow erruption of teeth.
7. Malformed, decay – prone teeth

**Osteomalacia in Adults**: Osteomalacia is a condition where the quality of the bone is reduced. It occurs in women who are not exposed to sunshine and who have depleted mineral reserves resulting from successive pregnancies and prolonged lactation. Osteomalacia is associated with low phosphorous level but low blood calcium level is the most frequent cause. The following symptoms occur

1. softening of the bones
2. deformities of the limbs, spine, thorax and pelvis
3. demineralization of the bones
4. pain in pelvis, lower back and legs

frequent bone fractures.

**Hypervitaminosis**

As in the case of Vitamin A intake of excessive amounts of Vitamin D leads to toxic symptoms which include irritability, nausea ,vomiting and constipation.

**Vitamin E**

Vitamin E is known as antisterility vitamin because it is required for normal reproduction in animals and men.

**Functions**

1. Vitamin E is the primary antioxidant in the body and serves to protect polyunsaturated fatty acids (PUFA) from oxidation in cells and maintain integrity of the cell membrane. It also prevents the oxidation of beta carotene and Vitamin A. Vitamin E helps to maintain cell membrane integrity and protect RBC against hemolysis.
2. Vitamin E reduces platelet aggregation
3. Vitamin E is essential for the iron metabolism and the maintenance of nervous tissues and immune function.
4. Vitamin E is been promoted as an anti-aging vitamin, because as cells age they accumulate lipid breakdown products. Vitamin E prevents this accumulation in

maintaining cell health.

**Food Sources**

Vitamin E is widely distributed in foods. It is present in high concentration in vegetable oils and in cereal grains. Wheat gum, sunflower seeds, almonds, safflower oil, eggs, butter are good sources.Meat, fruits and vegetables contain small amounts. Sesame oil and mustard oil are good sources of Vitamin E.

**Requirement :**The requirement of Vitamin E is linked to that of essential fatty acids (linoleic and linolenic acids). The requirement of Vitamin E is 0.8 mg/g of essential fatty acid

1. **Deficiency**: Prolonged intake of Vitamin E deficient diets produces uncoordinated movement, weakness and sensory disturbances.
2. It causes haemolyticanaemia in low birth weight infants
3. Defective functioning of the retina leading to permanent blindness in premature infants occurs.
4. It leads to reproductive failure in humans
5. Vitamin E deficiency is associated with decreased ability

of the lymphocytes.

**Vitamin K :**

Vitamin K is recognized as the anti haemorrhagic factor owing to its vital role in blood clotting mechanism.

**Functions**

Synthesis of blood clotting proteins. Vitamin K is essential for the activation of prothrombin. This gets converted to thrombin, which in turn activates fibrinogen to form fibrin.

The process of blood clotting occurs as follows:

Injured tissue releases thromboplastin, which catalyses prothrombin formation. Vitamin K catalyses, conversion of prothrombin to thrombin. This in turn causes conversion of fibrinogen to fibrin which forms the clot.

**Food Sources:**Dark green leafy vegetables are good sources of vitamin K. Fruits, tubers, seeds, dairy and meat products contain

Vitamin K.

**Requirements** :The ICMR committee considered that no recommendation is needed for this Vitamin, as the synthesis of Vitamin K occurs in the lower intestine by the colonic bacteria and present widely in foods.

**Effects of Deficiency:**Primary deficiency arises in infants resulting in delayed blood clotting and hemorrhage. This is because the new born babies have a sterile intestinal tract thus lack in the colonic bacterial colonies which produces Vitamin K. Vitamin K deficiency does not occur in adults.

**Water soluble Vitamins:**

**Vitamin C** (Ascorbic Acid):

The chemical name for Vitamin C is ascorbic acid. It was discovered in 1747 by the British physician Lind and demonstrated that citrus fruit juices prevented and cured scurvy.

**Functions :**

1. Ascorbic Acid is essential for formation of cement substances and collagen which is found in blood vessels teeth and bones.
2. It helps in the biosynthesis of non-essential amino acids (eg) hydroxy proline, tyrosin.
3. It is required for absorption of iron as it reduces ferric to ferrous form which is easily absorbed.
4. Vitamin C is essential for the formation of collagen a major structural protein of connective tissues.
5. It is required for normal wound healing because it helps in the formation of connective tissue.
6. Vitamin C is required for carnitine synthesis which aids in the transport of fatty acids in the cell.
7. Vitamin C is essential for the synthesis of norepinephrine a neurotransmitter.
8. It activates hormones (eg) growth hormone, gastrin releasing peptide, calcitonin, gastrin oxytocin.
9. Drug detoxifying metabolic systems in the body require Vitamin C for its optimal activity.
10. Vitamin C is an excellent anti-oxidant. It combines with free radicals oxidizing them to harmless substances that can be excreted.

**Food Sources:**

Amla, drumstick leaves, guava, cashew fruit, agathi, cabbage, bitter gourd, oranges, tomatoes are good sources of ascorbic acid. Cereals and pulses are poor sources. Vitamin C content of pulses increases on germination.

**Requirements:**

1. The recommended dietary allowances of ICMR for ascorbic acid is as given in table-21D

**Table 21 D**

**ICMR Recommended Dietary Allowances for Vitamin C**

|  |  |
| --- | --- |
| **Group** | **Requirement** |
|  | **mg/day** |
| Adult | 40 |
| Pregnant women | 40 |
| Lactation | 80 |
| Infants | 25 |
| Children | 40 |

**Effects of Deficiency:**

Prolonged deficiency of ascorbic acid produces a disease condition called as ‘ scurvy’ in both infants and adults.

**Infantile scurvy:**

There is loss of appetite, failure to gain weight, irritability, palor, defective growth of bones. Haemorrhage occurs under the skin. There is defective formation of teeth and gums are swollen. The ends of the ribs become prominent resulting in beaded appearance called scorbutic rosary.

**Adult Scurvy:**

1. General manifestation are fever, susceptibility to infection, and delayed wound healing.
2. Anaemia: Microcytic hypochromic anaemia develops due to failure of absorption of iron.
3. Gums become spongy and bleed easily. Gums become swollen and ulcerated.
4. The blood vessels become fragile and porous due to defective formation of collagen. Joints become swollen and tender.
5. Clinical symptoms appear when total body pool of ascorbic acid decreases. Skin becomes rough and dry. There are small petechial hemorrhages around hair

follicles.

**Thiamine**

Thiamine is known as Vitamin B1. Deficiency of thiamine leads to beri – beri. This condition is widely prevalent among population whose diet contains more of polished cereals.

**Functions**

1. Thiamine is converted to thiamine pyrophosphate (TPP), which is an important co enzyme in the carbohydrate metabolism.
2. It is involved in transmission of nerve impulses across the cells
3. Thiamine as TPP is an essential cofactor for the conversion of amino acid tryptophan to niacin.
4. Yeast, whole wheat, millets, hand pounded rice, parboiled rice are good sources of thiamine. The bran contains most of the thiamine in the cereals. Gingelly seeds, groundnut, soyabean, cashewnuts, organ meats, pork, liver and eggs supply thiamine.
5. **Requirements**
6. Thiamine is involved in the carbohydrate metabolism. Its requirement is related to energy derived from carbohydrate. The ICMR expert group recommends an allowance of 0.5 mg per 1000 Kcal for adults and for infants 0.3 mg/1000 Kcal is suggested. The recommended dietary allowance per day is given in table-21E.

**Table 21 E**

**ICMR Recommended Dietary Allowance For Thiamine Per Day**

|  |  |  |
| --- | --- | --- |
| **Group** | **Thiamine requirement mg/day** |  |
| Man | 1.2 |  |
| Sedentary |  |
| Moderate | 1.4 |  |
| Heavy work | 1.6 |  |
| Woman | 0.9 |  |
| Sedentary |  |
| Moderate | 1.1 |  |
| Heavy work | 1.2 |  |
| Pregnant woman | +0.3 |  |
| Lactation | +0.3 - +0.2 |  |
| Infants | 55 mg/kg – 50 mg/kg |  |
| Children (1 – 9 years) | 0.6 – 1.2 |  |
| Boys (10 – 18 years) | 1.1 – 1.3 |  |
| Girls (10 – 18 years) | 1.0 |  |

**Effects of Deficiency**

Deficiency of thiamine is associated with low calorie intake. Severe deficiency of thiamine produces a disease known as beri – beri.

It is manifested as

* 1. Dry beri – beri
  2. Wet beri – beri
  3. Infantile beri – beri

In later stages complete loss of sensation in hands and legs occur. It is characterized by foot and waist drop. Mental depression and confusion occurs.

**a. Dry beri – beri**

There is loss of appetite, tingling numbness and burning sensation in hands and feet. Calf muscles are tender. Knee and ankle jerks are sluggish.In later stages complete loss of sensation in hands and legs occur. It is characterized by foot and waist drop. Mental depression and confusion occurs

**b. Wet beri – beri**

In this case there is enlargement of heart and the cardiac output is high. Oedema or accumulation of fluid in legs, face and trunk is observed. palpitations are marked.

**c. Infantile beri – beri**

It occurs in first few months of life if the diet of the mother is deficient in thiamine. Symptoms are restlessness, sleeplessness, constipation, enlargement of the heart and breathlessness.

**Riboflavin**

Riboflavin or Vitamin B2 is the yellow enzyme which is heat stable unlike other B Vitamins. Riboflavin in the combined form with proteins form flavo proteins or yellow enzymes.

This enzyme is of two types FAD – Flavin-di-nucleotide. FMN- Flavin mono-nucleotide.

1. These substances act as coenzymes in many biological reactions primarily in oxidation –

reduction, and dehydrogenation reaction

1. Release of energy from glucose, fatty acids and amino acids.
2. Conversion of vitamin B6 and folate to active coenzymes.
3. It is essential for the formation of red blood cells
4. It is required for the synthesis of glycogen

**Food Sources:**Rich sources are liver, dried yeast, egg, milk , meat, fish, whole cereals, legumes, and green leafy vegetables.

**Requirements**: Riboflavin requirement is related to energy intake – 0.6 mg/1000Kcal. The ICMR recommends the following requirement per day as given in table-21F.

**Table 21 F**

**ICMR Recommended Dietary Allowance for Riboflavin**

|  |  |  |
| --- | --- | --- |
| **Group** | **Riboflavin mg/day** |  |
| Man | 1.4 |  |
| Sedentary |  |
| Moderate | 1.6 |  |
| Heavy work | 1.9 |  |
| Woman | 1.1 |  |
| Sedentary |  |
| Moderate | 1.3 |  |
| Heavy work | 1.5 |  |
| Pregnant woman | +0.2 |  |
| Lactation | +0.3 |  |
| Infants | 65 mg/kg – 60 mg/kg |  |
| Children (1 – 9 years) | 0.7 – 1.2 |  |
| Boys (10 – 18 years) | 1.3 – 1.6 |  |
| Girls (10 – 18 years) | 1.2 |  |

**Effects of Deficiency**

Riboflavin deficiency is prevalent mainly among the low - income groups particularly the vulnerable group and the elderly adults. Riboflavin deficiency is characterized by

1. Soreness and burning of the mouth and tongue.
2. Lesions at the angles of the mouth called Angular Stomatitis.
3. The inflammation of the tongue called glossitis
4. Dry chapped appearance of the lip with ulcers termed cheilosis.
5. The skin becomes dry and results in seborehoeic dermatitis.
6. Photophobia, lacrimation, burning sensation of the eyes and visual fatigue.
7. Decreased motor co-ordination
8. Normocytic anaemia

**Niacin**

Niacin or Nicotinamide (amide form) is required by all the cells of our body.Like thiamine and riboflavin it plays a vital role in the release of energy from carbohydrates , protein, fat and alcohol.

**Functions**

1. Nicotinamide is essential for tissue metabolism. The active forms of nicotinanide are NAD – Nicotinamide adenine dinucleotide and NADP - Nicotinamide adenine dinucleotide phosphate.
2. NAD and NADP are involved as coenzymes in large number of reversible oxidation reduction reactions.
3. Nicotinic acid enhances stomach secretion
4. NAD is involved in catabolic reactions and NADP is involved in anabolic reaction in our body.

**Food Sources**

Dried yeast, liver, rice polishing, peanut, whole cereals, legumes, meat, fish, are good sources.Tryptophan present in dietary protein is converted to niacin in humans. 60 mg of tryptophan yields 1 mg of niacin.

**Requirements** :

ICMR recommended dietary allowance of Niacin per day is given in table 21G.

**Table 21 G**

**ICMR Recommended Dietary Allowance for Niacin**

|  |  |
| --- | --- |
| **Group** | **Niacin requirement mg/day** |
| Man | 16 – 21 |
| Woman | 12 – 16 |
| Pregnant woman | +2 |
| Lactation | +4 |
| Infants | 710 mg/kg – 650 mg/kg |
| Children (1 – 9 years) | 8 – 13 |
| Boys (10 – 18 years) | 15 – 17 |
| Girls (10 – 18 years) | 13 – 14 |

**Effects of Deficiency**: Deficiency of nicotinic acid causes a disease known as pellagra. It is characterized by three D's → Dermatitis, Diarrhoea and Dementia.

1. **Dermatitis** – Name pellagra comes from pelle-skin andagra-rough. Marked changes occur in the skin especially in the skin exposed to sun and friction areas like elbows, surfaces of arms, knees.

Lesions are symmetrically distributed, in the affected parts. At first there is reddening, thickening and pigmentation of the skin.

Later on there is exfoliation leading to ultimately parchment of skin – butterfly like appearance.

1. **Diarrhoea**– Diarrhoea enhances the deficiency state.There are structural and absorptive defects in the small intestine. Tongue appears raw, and mucous membrane of the tongue is inflammed.
2. **Dementia** – There is irritability, depression, poorconcentration and loss of memory. Delirium is a common mental disturbance.

**Folic Acid**

Folic acid was first extracted from dark green leafy vegetables. It forms yellow crystals and is a conjugated substance made up of three acids namely pteroic, para amino benzoic acid and glutamic acid.

**Functions**

1. Folic acid coenzyme is essential in bringing about transferring single carbon units for many interconversions. A number of key compounds are formed by these reactions like (i) Purines which are essential constituents of living cells.
   1. Thymine – this essential compound forms a key part of DNA.
   2. the formation of haem group of haemoglobin.
2. The conversion of phenylalanine into tyrosin.

**Food Sources:**Green leafy vegetables, liver, kidney, gingelly seeds, cluster beans, are rich sources of folic acid.

**Requirements**

The recommended dietary allowances of Folic acid by ICMR are given in table-21H .

**Table 21 H**

**ICMR Recommended Dietary Allowance for Folic acid**

|  |  |  |
| --- | --- | --- |
| **Group** | **Folic acid mg/day** | |
| Man | 100 | |
| Woman | 100 | |
| Pregnant woman | 400 | |
| Lactation | 150 | |
| Infants | 25 |  |
| Children (1 – 9 years) | 30 | – 60 |
| Boys and girls (10 – 18 years) | 70 | – 100 |

**Deficiency**

1. Simple folate deficiency results in the bone marrow producing immature cells (megaloblasts cells) and few matured red blood cells. This results in reduced oxygen – carrying capacity causing anaemia termed – Megaloblastic anaemia.
2. Folate deficiency during pregnancy causes neural tube disorders of the foetus.
3. Folate deficiency impairs the ability of the immune system to fight infection.

**Pyridoxine (B6)**

Pyridoxine is unique among B – complex Vitamins in that it functions primarily in protein metabolism.Pyridoxine denotes related substances such as Pyridoxine, Pyridoxal and Pyridoxamine are three forms in which it is present in our body.

**Functions:**Vitamin B6 in the form of pyridoxal phosphate functions as a co-enzyme in many biological reactions

1. Pyridoxine is essential for the process of
   1. Transamination : transfer of amino group from one aminoacid to another.
   2. Deamination : Removal of the amino group
   3. Decarboxylation: Removal of the carboxyl group
2. Vitamin B6 is involved in several biochemical steps for the conversion of the amino acid tryptophan to niacin
3. It aids in the formation of elastin, synthesis of messenager RNA and haem part of haemoglobin.
4. It aids in the conversion of linoleic acid to arachidonic acid.
5. In the carbohydrate metabolism it aids in the release of glycogen from liver and muscle.

**Food sources:**

Meat, pulses and wheat are rich sources. Other Cereals are fair sources of this vitamin. Fruits and vegetables are poor sources. Cooking and processing of food causes loss of this vitamin.

1. **Requirement:** The ICMR recommended dietary allowance forpyridoxine is given in table-21 I.

**Table 21 I**

**The ICMR Recommended Dietary Allowance for Pyridoxine**

|  |  |
| --- | --- |
| Group | Pyridoxine mg/day |
| Adults | 2.0 |
| Pregnant woman | 2.5 |
| Lactation | 2.5 |
| Infants | 0.1 – 0.4 |
| Children (1 – 9 years) | 0.9 – 1.6 |
| Boys and girls (10 – 18 years) | 1.6 – 2.0 |

**Deficiency**

Vitamin B6 deficiency leads to abnormalities in protein metabolism which is manifested as poor growth, convulsions,anaemia, decreased antibody formation and skin lesions. Severe deficiency leads to microcytic hypochromic anaemia.Symptoms such as weakness, nervousness, irritability, insomnia and difficulty in walking is predominant.

**Vitamin B12 (Cyanocobalamin)**

Until 1926, pernicious anaemia was a fatal disease of unknown origin with an unknown cure. In 1926 Minot and Murphy found that pernicious anaemia could be cured by feeding a patient atleast 0.3 kg of raw liver per day.

Also in 1926 Castle noted that patients with pernicious anaemia had a low level of gastric secretion. He suggested that the anti-pernicious anaemia factor had two components.; an ‘ extrinsic factor’ found in food and an ‘ intrinsic factor’ within normal gastric secretions. The extrinsic factor is now known as vitamin B12 – cobalamine.

**Functions :**

* 1. Vitamin B12 is necessary for normal growth and maintenance of healthy nervous tissue and normal blood formation.
  2. Vitamin B12 is involved in DNA synthesis and thus in cell replication. It facilitates the formation of folate co-enzymes needed for nucleic acid synthesis.
  3. In the bone marrow the Vitamin B12 co-enzymes are essential for the formation of red blood cells.
  4. Vitamin B12 is also required for the synthesis of myelin sheath that surrounds the nerve fiber.

**Food sources**: Vitamin B12 is present only in foods of animal origin. Liver sheep, shrimp, mutton , egg, milk are good sources of Vitamin B12.Vitamin B12 is synthesized by the colonic bacteria.

**Requirements** :The recommended dietary allowance prescribed by ICMR for B12 are given in table 21J.

**Table 21J**

**The ICMR Recommended Dietary Allowance for VitaminB12**

|  |  |
| --- | --- |
| **Group** | **Vitamin B12 mg/per day** |
| Man | 1.0 |
| Woman | 1.0 |
| Pregnancy | 1.0 |
| Lactation | 1.5 |
| Infants | 0.2 |
| Children boys and girls | 0.2 – 1.0 |

**Deficiency**

Pernicious amaemia is the major problem arising from an inadequate amount of vitamin B12.Pernicious amaemia is a condition characterized by very large, immature red blood cells with normal amounts of haemoglobin.

**MINERALS**

Until the middle of the nineteenth century, the importance of minerals and vitamins was not known. It was observed that carbohydrate, fat, protein alone was incapable of promoting and sustaining growth.

Hence scientists attempted to find out the “missing elements”, namely minerals and vitamins which are essential for growth and maintenance. Mineral elements are inorganic substances found in body tissues and fluids. They occur in foods as salts. They constitute 4 per cent of our body weight. They have many functions in our body such as tissue building and regulation of body fluids. Like vitamins they are required in small quantities and are vital to the body.

Minerals are present in the body

1. As components of organic compounds
2. As inorganic compounds
3. As free ions in very cell in the body
4. In all body fluids.

Classification of minerals

Minerals may be classified into three groups

1.Major minerals or macro minerals – seven minerals are required in large amounts of over 100 mg/day

2. Minor minerals these are required in small quantities less than 100 mg/day

3. Trace elements A few micrograms to a few milligrams are required per day

General functions of minerals

1. Minerals form the structural components of bones, teeth, soft tissues, blood and muscles
2. They regulate activity of nerves with regard to stimuli and contraction of muscles.
3. Maintain acid-base balance of body fluids.
4. They control water balance by means of osmotic pressure and permeability of cell membrane
5. They constitute of vitamins
6. They form part of molecules of hormones and enzymes
7. They activate enzymes
8. They regulate cellular oxidation
9. Necessary for clotting of blood.

Essential minerals which are inorganic substances are classified as macro and micronutrients based on the amount needed by humans per day.

Macro minerals are those which are vital to health and that are required in the diet by more than 100mg per day and those required in the diet less than 20mg per day are called micro minerals or trace minerals.

The essential macro minerals are Calcium, Phosphorous, Magnesium, Sulphur, Potassium and Chloride. Important micro minerals of relevance in human nutrition are Iron, Zinc, Copper, Sodium, Cobalt, Fluoride, Manganese, Chromium, Iodine and Molybdenum.

**FUNCTIONS, FOODSOURCES, REQUIREMENTS AND EFFECTS OF DEFICIENCY**.

**Calcium and Phosphorus:**

Calcium is an essential element required for several life processes. The requirements of Calcium and Phosphorous are considered together as their function and requirement are closely linked.Over 99% of the Calcium and Phosphorous is present in the bones and the remaining 1% in the body fluids.

The Calcium and Phosphorous are present in the ratio of 2:1 in our body. In the skeletal system Ca and P is present in the form of hydroxyapatite crystals.

Hydroxyapatite is a compound made up of calcium and phosphate that is deposited into the bone matrix to give it strength and rigidity.

**Functions:**

1. Bone formation:

The major mineral ions of the bone are Calcium, Phosphorous and Magnesium.Calcium and phosphorus forms a lattice like crystal hydroxyapatite which binds to the collagen fibers. This allows bone to be resilient and strong. For proper calcification of bones, (deposition of minerals on the bone matrix) which occurs during the growing years, adequate supply of these minerals is essential.

1. Tooth formation: - Calcium and Phosphorous together as a compound is essential for the formation of dentin and enamel.
2. Physiological Process: -
   1. Calcium is essential for the clotting of blood as it is required for prothrombin activation. Which in turn leads to formation of fibrin, the main protein component of a blood clot.
   2. Calcium regulates the permeability of the capillary walls and ion transport across the cell membranes.
   3. It is essential for the contraction of the heart and skeletal muscle.
   4. Ca regulates the excitability of the nerve fibres.
   5. Ca acts as an activator for enzymes such as rennin and pancreatic lipase.
3. Phosphorous is essential for the storage and release of adenosine triphosphate (ATP) molecules.
4. Phosphates plays an important role as buffers to prevent changes in acidity of the body fluids.
5. Phoshpolipids are major components of cell membrane and intra cellular organelles.
6. In the DNA and RNA phosphate is an essential part of the nucleic acids.

**Food sources**

Among cereals ragi contains large amounts of calcium. Bengalgram whole, gingely seeds, cuminseeds, poppy seeds, agathi, amaranth, drumstick leaves are good sources of calcium. Milk and milk products are good sources of calcium and phosphorous. Only 20 – 30 % of the calcium in the diet is absorbed, which is facilitated by Vitamin – D. All foods contain significant amounts of phosphorous.

**Requirements**

The recommended dietary allowances for Calcium, as suggested by the ICMR is given in table-21A.

**Table 21 A**

**ICMR recommended dietary allowances for Calcium**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Age Group | | RDA for calcium mg/day |
| Infant | 0 | – 12 months | 500 |
| Children | 1 | – 9 years | 400 |
| Children | 10 – 15 years | | 600 |
| Adolesent | 16 – 18 years | | 500 |
| Adult |  |  | 400 |
| Pregnant women |  |  | 1000 |
| Lactating women |  |  | 1000 |

**Deficiency**

Calcium related health problems occur due to inadequate intake, improper absorption or utilization of calcium.

**Osteoporosis:**

Osteoporosis is a condition found primarily among middle aged and elderly woman, where the bone mass of the skeleton is diminished.

It is a condition of multiple origin. It results due to the following reasons:

1. Prolonged dietary inadequacy
2. Poor absorption and utilization of calcium
3. Immobility
4. Decreased levels of oestrogen in post-menopausal women.
5. Hyper parathyroidism
6. Vitamin – D deficiency

**Osteomalacia-** is a condition in which the quality but not thequantity of bone is reduced. This condition is dicussed in detail under deficiency of Vitamin – D.

**Tetany-**Tetany occurs when Calcium in the blood drops below the critical level. There is a change in the stimulation of nerve cells resulting in increased excitability of the nerve and uncontrolled contraction of the muscle tissue. Hence Calcium and Phosphorous ratio in the diet should be maintained at 1:1 for proper utilization of Calcium in the body.

**Microminerals**

Microminerals are also known as trace elements. The microminerals are Iron, Iodine, Zinc, Copper, Fluoride, Selenium, Chromium, Manganese, cobalt and Molybdenum. However only the deficiency of few of these elements is observed in humans. Iron and Iodine deficiencies are wide spread while deficiency of Cu, Zn, Cr and Se have been reported in recent years.

**Iron**

The total body iron is 4g in adults. Iron exists in a complex form in our body. It is present as

1. Iron porphyrin compounds – hemoglobin in RBC, myoglobin in muscle.
2. Enzymes – (eg) peroxidases, succinase dehydrogenase and cytochrome oxidase.
3. Transport and storage forms: - (eg) transferrin and ferritin.

**Functions:**

The chief functions of iron in the body are:

1. Iron forms a part of the protein – haemoglobin which carries oxygen to different parts of the body.
2. It forms a part of the myoglobin in muscles which makes oxygen available for muscle contraction.
3. Iron is necessary for the utilization of energy as part of the cells metabolic machinery.
4. As part of enzymes iron catalizes many important reactions in the body. Examples are
5. Conversion of beta carotene to active form of Vitamin A
6. Synthesis of carnitine, purines, collagen and neuro transmitters.
7. Detoxification of drugs in the liver.

**Food Sources**

The iron present in food can be as haem and non-haem iron depending upon the source from which it is obtained. Haem iron – is obtained from animal tissues, non-heam iron – is obtained from plant foods.

Sources of non-haem iron are ragi, green leafy vegetables, dried fruits and jaggery. Liver, fish, poultry, meat, eggs dates are good sources of haem iron .

Haem iron is absorbed and utilized better than the non-haem iron. Iron absorption from Indian diets is only 3 percent as it is mainly cereal based diet.

**Requirement**

Iron requirements for various age groups is listed in table-21B

**Table 21 B**

**ICMR – Recommended dietary Allowances for Iron**

|  |  |
| --- | --- |
| Group | Iron requirement (mg/day) |
| Birth – 1 year | 1 |
| 1 – 5 year | 15 – 20 |
| 6 – 12 years | 15 – 20 |
| 13 – 18 years |  |
| Boys | 25 |
| Girls | 35 |
| Man | 20 |
| Woman | 30 |
| Pregnancy | 40 |
| Lactation | 30 |

**Deficiency**

Dietary iron deficiency leads to nutritional anaemia. Nutritional anaemia is defined as the condition that results from the inability of the erythropoetic tissue to maintain a normal haemoglobin concentration.

Anaemia occurs when the haemoglobin level falls below 12 gm /dl in adult man and woman. During pregnancy haemoglobin level below 11 gm /dl is termed anaemia.

Nutritional anaemia is the common form of anaemia affecting women in reproductive years, infants and children which is mainly due to poor intake and absorption.

Iron deficiency anaemia is wide spread in our country. The prevalence varying from 45% in men and 70% in women and children. The major cause of anemia in India is because of Iron and folic acid deficiency.

**Nutritional anemia is manifested as:**

1. Reduced Haemoglobin level. (less than 12 g /dl)
2. Defects in the structure, function of the epithelial tissues
3. Paleness of skin and the inside of the lower eyelid is pale pink
4. Finger nails becoming thin and flat and eventually (spoon shaped nails) koilonychia develops.
5. Progressive untreated anaemia results in cardiovascular and respiratory changes leading to cardiac failure. The general symptoms include lassitude, fatigue, breathlessness on exertion, palpitations, dizziness, sleeplessness, dimness of vision, and increased susceptibility to infection.

**Iodine**

Iodine is an essential constituent of the thyroid hormone produced by the thyroid glands. It occurs as free iodide ions or as protein bound iodine in our body. About 15 – 23 mg of iodine is present in the adult human body.

The body store of iodine is predominantly present in thyroid gland and also in salivary gland, mammary glands gastric glands and in kidneys to a certain extent.

**Function**

Iodine is essential for the synthesis of the thyroid hormones T3 and T4.

**Sources**

Richest source of iodine are sea foods like sea fishes and common salt from sea water. Iodine content of vegetables, fruits and cereals depends upon the iodine content of the soil in which they grow. The soil of mountainous regions contains less iodine.

**Requirement**

The ICMR recommended dietary allowance for Iodine is 150 µg/day.

**Deficiency**

Iodine deficiency in the diet, causes enlargement of the thyroid gland called as “goitre”. Goitre occurs in people staying in hilly regions where the iodine content of water and soil is comparatively less.

In India goitre is common in hilly districts of Himalaya. Goitre can be treated by administration of iodine. If treatment is given in early stages goitre can be corrected.

Severe iodine deficiency in children leads to hypothyroidism resulting in retarded physical and mental growth. This condition is known as cretinism.

Goitrogens are substances present in foods which cause goitre. These substances react with iodine present in the food making it unavailable for absorption. Foods like cabbage, cauliflower, raddish contain goitrogens.

**Fluorine**

Fluoride is an [essential mineral](http://www.foodpyramid.com/6-essential-nutrients/minerals/) that aides in the development of strong bones and teeth. Fluoride is derived from the chemical element Fluorine, and works to prevent bone weakening and promote new bone growth. It is considered as double sword mineral. Water should contain 1 ppm/L of fluoride.

**Function:**

Fluoride is best known for its role in preventing tooth decay. While fluoride does help overall bone strength, the effects of fluoride are most visible when it comes to teeth. The formation of teeth involves a combination of phosphorous and calcium. When these two combine they form a structure called hydroxyapatites. When Fluoride is consumed, it immediately intervenes with the crystal and forms an even stronger structure which gives teeth a greater resistance to decay, plaque and weakening.

Additionally, fluoride works towards activating a number of enzymes within the body that help with overall regulation. It’s also credited with having positive effects towards reducing symptoms of osteoporosis. Children with healthy fluoride levels are also less likely to developed cavities during their childhoods.

**Sources:**

Most public water systems include fluoride as an agent in purified water. This means that for the majority of people, their necessary fluoride consumption happens through the digestion of tap [water](http://www.foodpyramid.com/6-essential-nutrients/water/). It’s important to note that while most cities do regulate fluoride levels in water, there are exceptions. For this reason, it’s important not to assume that fluoride is found in all tap water.

Cities that do incorporate fluoride into their public water content provide the means to fluoride consumption in cooking. Food that is cooked with fluoridated water will retain the benefits of fluoride as well.

Outside of tap water, there are some foods that contain fluoride naturally. These include teas and gelatins that are available for consumption. Sodium fluoride is present in the ocean, therefore, most seafood contains fluoride as well.

It’s important that infants receive proper amounts of fluoride and normally consume this mineral in infant formula or breast milk. Fluoride is a common ingredient in toothpaste, which is how older children are exposed to the mineral which helps strengthen their teeth and prevent decay.

**Deficiency**

It’s extremely rare that people end up with a fluoride deficiency as it is commonly present in public water systems and toothpaste. However, it does occasionally occur in areas where water is not fluoridated or children do not have access to proper dental care. The symptoms of fluoride deficiency can include a high number of cavities or weak or decaying teeth and bones.

## Helpful food sources, supplements and additional benefits of Fluoride

Fluoride is available in supplemental form by prescription only. This helps regulate fluoride intake, because too much fluoride in the system can lead to stomach cramps, spotted tooth enamel, nausea, vomiting or diarrhea. More often than not, fluoride prescriptions are written for young children who live in remote areas that do not provide fluoridated water.

**Sodium**

Sodium is a mineral that the body needs to function properly. It is also one of the electrolyte minerals that conduct electricity when dissolved.

It works closely with the other electrolyte minerals potassium and chloride. While potassium is mostly stored inside cells, 60% of sodium is found in the fluids surrounding cells, with 10% within the cells and 30% in the bones. It is critical, together with potassium, for the proper functioning of nerves and muscles, and correct balance of body fluids. It is also the main ion in extra-cellular fluid (fluid around cells).

**Functions of Sodium:**

1. essential for regulating muscle contractions and nerve transmissions
2. helps maintain proper balance of water and body fluids
3. important for maintaining the proper blood pH
4. plays a crucial role in regulating blood pressure and volume
5. needed for stomach function

**Sodium deficiency**: It is extremely rare, but it can occur. Low concentration of sodium in the blood is known as hyponatremia, and can be dangerous.It can be caused by excessive sodium loss, for example due to prolonged activity and excessive sweating, or chronic diarrhea or vomiting, or use of diuretics, or adrenal gland disorder. Severe fasting or malnutrition can also cause deficiency. Symptoms include

* dehydration
* low blood sugar
* heart palpitations
* muscle cramps
* weakness or lethargy
* confusion or disorientation
* slurred speech
* nausea
* seizures,coma or death if untreated

Sources: table salt or sea salt (sodium chloride) **·** sodium salts such as sodium bicarbonate (baking soda), monosodium glutamate (MSG), sodium nitrite, and sodium benzoate, that are added to food products **·** seasonings such as soy sauce, garlic salt, onion salt, oyster sauce, stock cubes, ketchup, preserved meats such as bacon, ham, sausages **·** processed or canned or fast foods are generally high in salt, and therefore high in sodium.Other sources of sodium in foods **·** naturally in almost all foods, such as milk, meat, shellfish, vegetables

**Sodium Overdose Symptoms, Toxicity Level & Side Effects**: An excess is more common than a deficiency. Most people take much more sodium in their diets than is needed. A key to a healthier diet is to lower our intake of salt, bearing in mind that most foods naturally contain sodium even before salt is added. The Food and Nutrition Board’s recommended upper limit is 2.3 g of sodium per day for adults, equivalent to one teaspoon of table salt.

High sodium intake is frequently linked to increased blood volume and high blood pressure (hypertension). This is especially so if the kidneys cannot get rid of excess efficiently, leading to a build-up of sodium, particularly if potassium levels are low, as potassium balances out some of the effects of sodium.

Excess sodium may also cause a dangerous build-up of fluid in those with liver cirrhosis, congestive heart failure, or kidney disease.

Patients in such cases are usually advised by their doctors to reduce their salt intake. Those with high blood pressure should take no more than 1.5 g per day, while people with cirrhosis, heart failure or kidney disease may need to keep within even stricter limits as prescribed by their doctors.

The Food and Nutrition Board of the Institute of Medicine has set Tolerable Upper Intake Levels (UL) for sodium. These are levels above which there is risk of sodium overdose, especially when taken over a long time.

**potassium**

The importance of potassium is highly underestimated. This mineral is classified as an electrolyte because it’s highly reactive in water. When dissolved in water, it produces positively charged ions. This special property allows it to conduct electricity, which is important for many processes throughout the body. Interestingly, a potassium-rich diet is linked to many powerful health benefits. It may help reduce blood pressure and water retention, protect against stroke and help prevent osteoporosis and kidney stones ,plays an essential role in activating nerve impulses throughout your nervous system. Nerve impulses help regulate muscle contractions, the heartbeat, reflexes and many other processes.

## Sources of Potassium

Potassium is abundant in many [whole foods](https://www.healthline.com/nutrition/50-super-healthy-foods), especially fruits, vegetables and fish. Most health authorities agree that getting 3,500–4,700 mg of potassium daily appears to be [the optimal amount](https://authoritynutrition.com/how-much-potassium-per-day/)

**Ex:-Beet greens,** ,**Yams, Pinto beans, White potato’s, Portobello mushrooms**, **Avocado, Sweet potato,** **Spinach, Kale, Salmon, Bananas**, **Peas.**

**Deficiency:** Potassium deficiencies or excess rarely occur through the diet. Despite this, maintaining an adequate potassium intake is important for your overall health.

**UNIT-4**

**COOKING METHODS – MERITS AND** **DEMERITS**

Food preparation is an important step in meeting the nutritional needs of the family. Food has to be pleasing in appearance and taste in order to be consumed. Foods like fruits, vegetables and nuts can be eaten raw but most foods are cooked to bring about desirable changes. The process of subjecting food to the action of heat is termed as cooking.

**Objectives of Cooking**

1. Cooking sterilizes food: Above 40 C the growth of bacteria decreases rapidly. Hence food is made safe for consumption.
2. Cooking softens the connective tissues of meat and the coarse fiber of cereals, pulses and vegetables so that the digestive period is shortened and the gastro intestinal tract is less subjected to irritation.
3. Palatability and food quality is improved by cooking – Appearance, flavor, texture and taste of food are enhanced while cooking.
4. Introduces variety – Different dishes can be prepared with the same ingredients. (Eg.) Rice can be made into biriyani and kheer.
5. Increases food consumption – Cooking brings about improvement in texture and flavor thereby increasing consumption of food.
6. Increases availability of nutrients – Example in raw egg, avidin binds biotin making it unavailable to the body. By cooking, avidin gets denatured and biotin is made available.

**COOKING METHODS**

Heat is transferred to the food during cooking by conduction, convection, radiation or microwave energy. Cooking takes place by moist and dry heat. Moist heat involves water and steam. Air or fat are used in dry heat.

**TABLE – 2A Cooking methods**

|  |  |  |
| --- | --- | --- |
| **Moist Heat** | **Dry Heat** | **Combination** |
| Boiling | Roasting | Braising |
| Stewing | Grilling |  |
| Steaming | Toasting |  |
| Pressure Cooking | Baking |  |
| Poaching | Sauteeing |  |
| Blanching | Frying |  |

**MOIST HEAT METHODS**

**Boiling:**

Boiling is a method of cooking foods by just immersing them in water at 100 C and maintaining the water at that temperature till the food is tender. Water receives heat by conduction through the sides of utensil in which the food is cooked and passes on the heat by convection currents which equalize the temperature and become vigorous when boiling commences Rice, egg, dhal, meat, roots and tubers are cooked by boiling.In boiling foods should get vigorous boiling first and the heat is then turned down, as violent boiling throughout tends to break the food.

**Merits**

1. Simple method - It does not require special skill and equipment.
2. Uniform cooking can be achieved.
3. Soluble starches can be removed and rice grains are separated
4. Proteins gets denatured, starch gets gelatinized and collagen gets hydrolyzed.

**Demerits**

1. Loss of texture-Continuous excessive boiling leads to damage in the structure and texture of food.
2. Loss of heat labile nutrients such as B and C vitamins if the water is discarded.
3. Time consuming – Boiling takes more time to cook food and fuel may be wasted.
4. Loss of color – water soluble pigments may be lost.

**Stewing**

It refers to the simmering of food in a pan with a tight-fitting lid using small quantities of liquid to cover only half the food. This is a slow method of cooking. The liquid is brought to boiling point and the heat is reduced to maintain simmering temperatures (82C - 90 C). The food above the liquid is cooked by the steam generated within the pan. Apple, meat along with roots, vegetables and legumes are usually stewed.

**Merits**

1. Loss of nutrients is avoided as water used for cooking is not discarded.
2. Flavor is retained.

**Demerits**

1. The process is time consuming and there is wastage of fuel.

**Steaming:**

It is a method of cooking food in steam generated from vigorously boiling water in a pan. The food to be steamed is placed in a container and is not in direct contact with the water or liquid. The water should be boiled before the food is placed in steamer. Idly, custard, dhokla, ragi puttu and idiappam are made by steaming. Vegetables can also be steamed. Steaming can be

1. Wet steaming: Here steam is in direct contact with the food. E.g., Idli
2. Dry steaming: Here double boiler is used for cooking the food. Double boiling is cooking in a container over hot or boiling water. This process is used for preparations as sauces and custards where temperatures below boiling point are desirable. The food is laced in the utensil which is kept in another utensil containing water.When the water is heated or boiled the food gets cooked.
3. Waterless cooking: In steaming, food is cooked by steam from added water while in waterless cooking the steam originates from the food itself. Cooking food in wrapped in aluminum foil is another way of cooking.In this case there is a advantage of preventing the transmission of flavor from or to the sealed cover.

**Merits**

1. Less chance of burning and scorching.
2. Texture of food is better as it becomes light and fluffy. Eg.Idly.
3. Cooking time is less and fuel wastage is less.
4. Steamed foods like idly and idiappam contain less fat and are easily digested and are good for children, aged and for therapeutic diets.
5. Nutrient loss is minimized.

**Demerits**

1. Steaming equipment is required.
2. This method is limited to the preparation of selected foods.

**Pressure cooking:**

When steam under pressure is used the method is known

as pressure cooking and the equipment used is the pressure cooker. In this method the temperature of boiling water can be raised above 100 C. Rice, dhal, meat, roots and tubers are usually pressure cooked.

**Merits**

1. Cooking time is less compared to other methods.
2. Nutrient and flavor loss is minimized.
3. Conserves fuel and time as different items can be cooked at the same time.
4. Less chance for burning and scorching.
5. Constant attention is not necessary.

**Demerits**

* 1. The initial investment may not be affordable to everybody.
  2. Knowledge of the usage, care and maintenance of cooker is required to prevent accidents.
  3. Careful watch on the cooking time is required to prevent over cooking.

**Poaching:**

This involves cooking in the minimum amount of liquid at temperatures of 80o C – 85o C that is below the boiling point. Egg and fish can be poached.

**Merits**

1. No special equipment is needed.
2. Quick method of cooking and therefore saves fuel.
3. Poached foods are easily digested since no fat is added.

**Demerits**

1. Poached foods may not appeal to everybody as they are bland in taste.
2. Food can be scorched if water evaporates due to careless monitoring.

Water soluble nutrients may be leached into the water.

**Blanching:**

In meal preparation, it is often necessary only to peel off the skin of fruits and vegetables without making them tender. This can be achieved by blanching. In this method, food is dipped in boiling water for 5 seconds to 2 minutes depending on the texture of the food. This helps to remove the skin or peel without softening food.

Blanching can also be done by pouring enough boiling water on the food to immerse it for some time or subjecting foods to boiling temperatures for short periods and then immediately immersing in cold water. The process causes the skin to become loose and can be peeled off easily.

**Merits**

1. Peels can easily be removed to improve digestibility.
2. Destroys enzymes that bring about spoilage.
3. Texture can be maintained while improving the color

and flavor of food.

**Demerits**

* 1. Loss of nutrients if cooking water is discarded.

**DRY HEAT METHODS**

**1.Roasting:**

In this method food is cooked in a heated metal or frying pan without covering it. Eg. Groundnut.

**Merits**

1. Quick method of cooking.
2. It improves the appearance, flavor and texture of the food.
3. Spices are easily powdered if they are first roasted.

**Demerits**

1. Food can be scorched due to carelessness.
2. Roasting denatures proteins reducing their availability.

**2. Grilling:**

**2.**

Grilling or broiling refers to the cooking of food by exposing it to direct heat. In this method food is placed above, below or in between the grills. The heat more slowly conducted thr ough the surfaces of the food downward. As heating is more superficial foods are usually reverse and rotated.

**Merits**

1. Enhances flavor, appearance and taste of the product.
2. It requires less time to cook.
3. Minimum fat is used.

**Demerits**

1. Constant attention is required to prevent charring.

**Toasting:**

This is a method where food is kept between two heated elements to facilitate browning on both sides. Bread slices are cooked by toasting.

**Merits**

1. Easy and quick method.
2. Flavor improved.

**Demerits**

1. Special equipment required.
2. Careful monitoring is needed to prevent charring.

**Baking:**

In this method, the food gets cooked in an oven or oven-like appliance by dry heat. The temperature range maintained in an oven is 120o C – 260 oC.

The food is usually kept uncovered in a container greased with a fat coated paper. Bread, cake, biscuits, pastries and meat are prepared by this method.

**Merits**

1. Baking lends a unique baked flavor to foods.
2. Foods become light and fluffy – cakes, custards, bread.
3. Certain foods can be prepared only by this method – bread, cakes.
4. Uniform and bulk cooking can be achieved. Eg. bun, bread.
5. Flavor and texture are improved.
6. Variety of dishes can be made.

**Sauteing:**

Sauteing is a method in which food is lightly tossed in little oil just enough to cover the base of the pan. The pan is covered with a lid and the flame or intensity of heat is reduced.

The food is allowed to cook till tender in its own steam. The food is tossed occasionally, or turned with a spatula to enable all the pieces to come in contact with the oil and get cooked evenly.

The product obtained by this method is slightly moist and tender but without any liquid or gravy. Foods cooked by sauteing are generally vegetables which are used as side dishes in a menu. Sauteing can be combined with other methods to produce variety in meals.

**Merits**

1. Takes less time.
2. Simple technique.
3. Minimum oil is used.

**Demerits**

1. Constant attention is needed as there is chance of scorching or burning.

**Frying:**

In this method, the food to be cooked is brought into contact with larger amount of hot fat.

**Stir frying:** The food like meat or vegetable is cooked by constantly stirring at high fire. Often vegetables are sliced diagonally to get exposed to maximum amount of surface area for quick cooking.

**Sautéing:** This method involves cooking in just enough of oil to cover the base of the pan. The food is tossed occasionally or turned over with a spatula to enable all the pieces to come in contact with the oil and get cooked evenly. The heat transferred to the food mainly by conduction.

**Shallow frying:** The food is cooked in fat or oil but not enough to cover it. Heat is transferred to the food partially by conduction by contact with the heated pan and partially by the convection currents of the foods. The finished dish will be crispy brown outside, soft and tender inside. The Iron content of food increases when iron tavas are used.

**Deep frying:** When food is totally immersed in hot oil and cooked by vigorous convection currents and cooking is uniform on all sides of the foods. The temperature used is 180-220o C. The absorption of fat by the food increases the calorific value of the food. Fats when heated to smoking point decompose to fatty acids and glycerol followed by the decomposition of glycerol to acrolein, which causes irritation to eyes and nose. Samosa, chips, pakoda are examples of deep fat fried foods.

**Merits**

1. Taste is improved along with texture.
2. Increases the calorific value.
3. Fastest method of cooking.
4. In shallow cooking the amount of oil consumption can be controlled.

**Demerits**

1. Food sometimes become oily and saggy with too much absorption of oil.
2. More attention is required while cooking to avoid accidents
3. Food becomes expensive
4. Food takes long time to get digested
5. Repeated heating produce harmful substances and reduce the smoking point.

**EFFECTS OF COOKING ON FOOD**

A number of changes occur in food during its preparation. To obtain acceptable food products, it is necessary to understand and manipulate these changes. Basically, the change is the net result of the changes of various components of food viz. its nutrients like carbohydrates, fats, proteins, their derivatives and water. In addition changes occur due to various inorganic, mineral components and a number of pigments, flavour components, vitamins, acids, enzymes etc. let us now talk about these changes in detail.

**A. Colour**

            Colour factors in food such as anthoayanins, carotenoids, chlorophyll etc, are affected by heat. In addition to heat, the acidity or alkalinity of the cooking medium, oxygen and presence or absence of metals, also contribute to colour changes when heated. In some cases, the colour changes that take place in food on cooking are desirable (as in baking) while in some other cases the changes may be undesirable (as in the prolonged cooking of cabbage).  The cooking condition should be so organized as to obtain the desired colour qualities in the cooked food.

***Chlorophyll:*** is the green pigment present in green plants, is not much affected by the heat. The colour of the green leafy vegetables is changed to olive green and then to the brown in the long run, especially when the medium of cooking is acidic i.e. in the presence of little vinegar or lemon juice. On the other hand cooking in the presence of baking soda i.e. in an alkaline medium, the colour intensifies or becomes bright green such bright colour look better in appearance, but cooking in an alkaline medium destroys vitamin C and the thiamine content of the food. To maintain the good colour of green leafy vegetables, it is advisable to cook them uncovered or leaving the pan uncovered for the first few minutes of cooking.

***Carotenoids:***This is the yellow orange colour pigment found in yellow, orange and red coloured vegetables and fruits, like papaya, carrot, tomato and green leafy vegetables etc. this pigment remains unaffected by heat or acidic medium but turns slightly blue in alkaline medium. Thus, the colour of the vegetables and fruits containing carotene remains unchanged on cooking.

***Anthoyanins:*** This pigment is responsible for the red, magenta or purple colour of vegetables and fruits. It is found in black carrots, jamun, phalasas, beetroot, skin or bringjal etc. heat has no marked effect on this pigment, however, cooking in the acidic medium makes it lighter in colour, whereas in the presence of alkaline medium it turns to a bluish tinge.

***Flavones:*** This is the white pigment present in vegetables like potato, cauliflower, onion etc.. This is also not much affected by heat or acidic medium, only alkaline medium makes it turn yellowish in colour.

The effect of various factors (solubility in water, acid, alkali and prolonged heating) is summarized in Table 1.

**TABLE 1**

**EFFECT OF VARIOUS FACTORS**

**ON THE COLOUR OF PLANT PIGMENTS**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name of the pigment** | **Colour** | **Solubity in water** | **Effect of Acid** | **Effect of alkali** | **Effect of prolonged heating** |
| Chlorophyll | Green | Slightly | Changes to olive green | Intensifies Green colour | Olive green |
| Carotenoids | Yellow and Orange | Slightly | Little effect | Little effect | Little effect unless excessive which may darken |
| Anthoyanins | Red | Slightly soluble | Stable (red) | Purple or blue | Little effect |
| Flavones | White | Very soluble | White | Yellow | Darken if excessive |

            Thus we see that usual cooking medium generally does not alter the natural colour of vegetables and fruits, but if cooked in acidic or alkaline medium, it can be adversely affected, hence we should avoid the use of any acid alkali during cooking.

            Apart from these characteristic changes in colour of fruits and vegetables, there are also marked significant differences in the colour of other food stuffs before and after cooking. For example, meat becomes brownish in colour from its original pinkish red, preparations from wheat flour attain a brownish colour on cooking, sugar syrup turns golden brown and finally dark brown in colour, as it is heated more and more.

**B. Texture**

            Cooking in general effects the texture of all foodstuffs. The cellulose present in them becomes softer and this makes the foodstuffs also softer for example, cooked vegetables are much softer than raw. Cooking in an alkaline medium softens the cellulose much faster and gives the foodstuffs a mashie appearance whereas cooking in an acidic medium makes the texture hard and such foodstuffs have to be cooked for a longer period.

            The starch granules present in the raw foodstuffs get gelatinized in the presence of moist heat i.e. when they are cooked in the presence of water, they absorb water and swell up, thus becoming softer and softer and finally some granules even burst and release the starch into the medium. This makes the foodstuffs easily digestible. Such changes are seen in cooking of pulses, rice, potatoes etc, as they are rich in starches. On cooking, proteins get coagulated, for example egg white, but if overcooked they can become hard and over-cooking also renders the proteins indigestible.

            The texture of the food, after cooking is also dependent on the method which is used for cooking. All the moist heat methods i.e. boiling, steaming, pressure cooking and stewing makes the foodstuffs soft and tender. For example, the texture of cooked rice and pulses is soft and tender, as compared to their raw state. Frying and roasting usually gives a crisp texture to the foodstuffs. Similarly, baking and grilling also make the foodstuffs soft and give them some crispness.

**C. Flavour and Taste**

            The natural flavours and taste of the food is somewhat changed after cooking. However, the flavour and taste can be made to cater to one’s taste buds with the help of appropriate spices and condiments. The spices and other flavouring agents used while preparing food and combination of the natural flavours and taste of the foodstuffs imparts a characteristic flavour and taste to the cooked food. The use of fat brings tenderness in texture of cakes and biscuits and frying makes the food crisp.

            Flavour is sensed by taste and smell, the two sense organs of the body. Good flavoured food encourages formation of saliva in mouth which is helpful in digesting food.

**D. Nutrients**

***Carbohydrates:*** Starch, sugar, gums, cellulose are important carbohydrate found in foods. On cooking the starch granules in foods swell as they absorb water. This process is called gelatinization and is in fact  the reason for the thickening of soups, curries, stews to which corn flour  paste is added. Gelatinization takes place in all starch containing foods such as potatoes on heating in the presence of moisture.

            Dry heat causes the starch to break down into smaller molecules called dextrins. For example, in the toasting of bread or making of chapattis or rotis. Dextrins have a mildly sweet flavour.  Sugar on heating from syrup with water. On further cooking syrup thickens and changes colour. This is due to a process called caramelization.  The brown, thick liquid formed is called caramel and is used in a number of preparations such as custard, cakes. Ordinary cooking causes little loss of carbohydrates. Celluose is not digested by humans but becomes softer on cooking and is helpful in smooth movement of food through digestive tract.

**Proteins:**Proteins harden and solidify or coagulate on cooking. The liquid sets on heating and becomes solid. This is the process of coagulation. However, milk protein is an exception. Unlike other proteins it does not coagulate. It is important to cook proteins to the right extent because proteins shrink and becomes harder on overcooking. This also renders them dry and rubbery which is indigestible.

Excessive heating of foodstuffs also affects the nutritive value of proteins. Sugars like glucose and lactose form complexes with ammo acids like lysine. These complexes cannot be broken down by the protein digesting enzymes. The result, of course, is that these amino acids are no longer available to the body.

Some pulses like soyabean and bengal gram contain certain substances which hinder the digestion of the proteins of these foods by the enzyme trypsin present in our intestines. During cooking these trypsin inhibitors are destroyed. This is why it become important not to consume these food raw. In fact, the digestibility of protein in several foods improves as a result of moderate heating in day to day cooking.

**Fats & Oils:**Ordinary cooking has no effect on fat, but prolonged heating, as in the case of frying for long periods thickens and darkens the fat. A part of essential fatty acids present in fat are destroyed and toxic polymerized products are formed. These changes are accompanied by changes in flavour also, which may not be acceptable. Fats and oils, become rancid by action of air (oxidized) water (hydrolysis) and enzymes. These changes must be minimized, so that the food in which fat is used remains acceptable.

**Minerals:**There is no loss of minerals in normal cooking procedures. If cooking water is discarded (a small fraction) water soluble minerals may be lost.

**Vitamins:** Thiamin and Vitamin C are two vitamins, which are most affected by cooking. The losses may occur due to dissolved nutrients being discarded or destruction due to exposure of heat in cooking. The amount depends on the combination of these factors. Discarding the cooking water accounts for a loss of nearly 20-25 per cent of thiamin depending on the quantity of water used in cooking. If sodium bicarbonate is added to pulses during cooking, most of the thiamine is destroyed.

**Vitamin C**is the most liable vitamin lost during washing vegetables after cutting, exposing cut vegetables to air for long periods before cooking and/or serving and leaching of vitamin C in the cooking water which is later discarded, amounts to a loss of 10% to 60% depending on the vegetables cooked and the method of cooking used.

Loss of riboflavin during cooking occur in four ways (i) exposure of the food during cooking to strong light, (ii) loss of riboflavin due to heat (iii) loss of riboflavin due to leaching by discarding excess of cooking water and (iv) loss of riboflavin due to addition of cooking soda during cooking of dal and vegetables. Bottled milk exposed to strong sunlight losses a part of riboflavin present.

Loss of other water soluble vitamins are mainly due to heat or loss in water.

Vitamin A and Carotene are insoluble in water, so no loss occurs by discarding cooking water. There is slight destruction of vitamin A and carotene during cooking in water due to oxidation by air. Frying, baking, roasting and toasting causes considerable losses of vitamin A and Carotene.

Planning of balanced diets

A balanced diet may be defined as one which contains the various groups of foodstuffs such as energy yielding foods, body building foods and protective foods in the correct portions so that an individual is assured of obtaining the minimum requirements of all the nutrients. The component of a balanced diet will differ according to age, sex, physical activity, economic status and physiological state.

The normal diet is used as the basis for all modified diets.

Diet therapy is defined as the use of food in the treatment of a disease. This is done by changing the normal diet in order to meet the selected requirements resulting from the illness.

Purpose of diet therapy

1. Maintain normal nutrition and health
2. Treat deficiency diseases eg. High-protein, high calorie diet
3. Alter nutrient requirement according to bodys ability to use the nutrients
4. Give rest to an organ or to the body
5. Change body weight

Dietetics it is the science and art of feeding individuals or groups under different health and economic conditions according to the principles of nutrition and management.

Classification of modified diets

The diet is normally modified in the following ways

1. Modification in consistency
2. Modification in nutrient content
3. Modification in quantity
4. Modification in method of feeding

* Consistency – clear liquid, full liquid, soft, mechanical soft, light, pureed and bland
* Nutrient content – High protein, low protein, sodium restricted, low fat high fibre.
* Quantity – Obesity, vomiting, diarrhoea, diabetes
* Special method of feeding – Eternal and parental

**Modification in consistency**

**Clear fluid diet** – The clear fluid diet is used for short periods when there is acute vomtiting or diarrhoea, when minimal bowel residue is desired and to test the individual’s ability to tolerate oral food. This diet is free from any solids, even those found in milk. The clear fluid diet is inadequate in all nutrients and should be used only for 1-2 days. The main purpose of this diet is to prevent dehydration and relieve thirst. It is high in simple sugars and needs to be modified for diabetic individuals. The amount of fluid given initially is 40-80 ml/hr. which is gradually increased to 100-120 ml/hr. foods included:

1.Fruit juices – apple, orange, grapes

2. cereal water – barley water,arrowroot water, sago, rice kanji

3. soups – clear consomme, fat free broth

4. Beverages – tea, coffee, lime juice, coconut water

5. Flavoured gelatin and fruit ices.

**Full liquid diet** – This diet is prescribed for individuals who afe unable to chew, swallow or tolerate solid foods. It isgiven after the clear liquid diet and before starting solid foods.

It is composed of foods that are liquid at room temperature. If it is well planned it can meet most of the RDAs. However due to difficulty in consuming adequate amounts of foods from the body building and cereal food groups. Vitamins and mineral supplements should be given if the diet is to be used for longer duration.

It is prescribed during acute infections, gastritis, diarrhoea when milk is permitted after surgery

Foods included:

1. Cream soups, dal soup, whipped potatoes
2. Eggnog, milkshakes, plain ice cream
3. Oatmeal, arrowroot, and sago kanji with milk
4. Soya milk, health drinks lassi,

**Soft diet :** It is given during convalescence, acute infection, gastrointestinal disorders, and after surgery.

The foods include in this diet are soft in texture and consistency, easy to chew and digest with very little fiber, spices, and condiments. Spicy, highly seasoned and fried foods are avoid as they may cause heartburn, belching and indigestion. Strongly flavored vegetables and gassy foods can cause discomfort because of flatus or gas produced by bacterial fermentation of indigestible carbohydrates.

Foods included – a wide variety of foods from the basic food groups can be selected and a nutritionally adequate diet can be planned. Cooking methods should be boiling, steaming, poaching and stewing. Fruits and vegetables with coarse skins, rough fibers and seeds guava, jackfruit should be avoided. Strongly flavored vegetables such as cabbage, cauliflower, onions, Bengal gram, fried eggs, omelets all salads sweet, meat and masalas and pickles should be avoided.

**Mechanical soft diet** – This is also called a dental diet and is a variation of the soft diet. It includes foods which are easy to chew and swallow. There is no restriction on seasoning or method of preparation. The texture of food may be modified be mechanical processing such as mashing, blenderizing, and chopping. This diet is nutritionally adequate if full planned and is given to individuals who have difficulty in chewing or swallowing because of teeth and gum problems.

**Pureed diet-** This is given to individuals who have difficulty in chewing and swallowing food. It includes all liquid and semi-liquid foods which require no mastication.

1. Milk and milk beverages
2. All fruit and vegetable purees and juices
3. Soft scrambled egg, boiled mashed dales
4. Soft cooked cereals and oatmeal.

Bland diet – This diet is prescribed for individuals suffering from gastric,

duodenal ulcers, gastritis and ulcerative colitis. It includes foods which are mechanically, chemically and thermally non- irritating. Foods low in fiber are recommended.

Foods to avoid include strong tea, coffee, alcoholic beverages, condiments and spices.

Foods included \_

1. Milk and milk-based preparations
2. Refined cereals and rice
3. Cream and butter
4. Cooked fruits and vegetables without peel and seeds
5. Boiled, baked, stewed tender cuts of meat and fish
6. All egg preparations except omelet’s and fried eggs.

**High protein and low protein diets**

**High protein diets:** Diets rich in proteins are prescribed for the treatment of protein-calorie malnutrition and protein deficiency in undernourished patients, before and after surgery, after injury and burns and in nephritis. The diets are usually based on milk and contain liberal amounts of cheese, eggs, meat and fish.

**Proteins:** Diets usually contain about 125 – 150 g of proteins in case of adults, and 60 -100 g for children below 10 years depending on age. The protein intake should be 3-4 g per kg

depending on the condition of the patients. The nutritive value of the proteins should be high.

Calories – for the maximum utilization of protein, the diet should be adequate in calories. Hence, the diets should provide the daily requirements of the calories for the patient.

**Vitamins:** Diets containing liberal amounts of milk, egg, meat and fish and green leafy vegetables will also be excellent sources of all essential vitamins and minerals.

**Low protein diets –** Low protein diets are prescribed for patients suffering from glomerulonephritis, chronic uraemia, jaundice and viral hepatitis. Proteins should be mainly derived from milk and other animal foods and should be of high nutritive value. Since these diets contain only small amounts of protective and protein-rich foods, they will be lacking in several vitamins and minerals. Hence the diets should be supplemented with multi vitamin-mineral tablet.

**High calorie and low calorie diets**

**High calorie diets –** High calorie diets are prescribed for patients who are malnourished and underweight. Weight loss also occurs in many diseases such as tuberculosis, hyperthyroidism, prolonged fevers. The composition of high calorie diets are cereals, legumes, cow milk, meat and fish, eggs, nuts, fruits and green leafy vegetables.

**Low calorie diets –** Low calorie diets are prescribed for obese subjects. The aim is to produce calore deficit in the body which will result in the fat stored in the adipose tissue being used to meat the calorie needs. It has been observed in obese adults that a diet providing about half the requirements of calories for persons leading sedentary life will help to reduce the body weight by 1 to 1.5 kg a week. Consumption of diet providing 1300 Kcal may help to reduce the body weight by 0.5 to 1.0 kg per week.

**Low fibre and high fibre diets-** The term fibre and risidue are used interchangeably with respect to the diet, as diet rich in fibre give rise to accumulation of large amounts of undigested residue in the large intestine, while diets low in fibre leave only small amounts of residue in the large intestines. The term fibre includes cellulose, hemicellulose, pentosans. They are present in large amounts in bran of cereal grains, the husk of pulses and mature vegetables.

**Low residue diets**- These are recommended for patients suffering from gastro-intestinal disorders, such as peptic ulcer, ulcerative colitis, celiac diseases, diarrhoea and dysentery. Milled cereal and cereal products, dhal, milk, tender vegetables, potato, fleshy fruits, fruit juice, fats and oils and sugar and jaggery.

**High residue diets –** High residue diets are rich in fibre and recommended for patients suffering from constipation. Such diets leave large amounts of undigested bulk in the intestinal tract which helps to relieve constipation. The high fibre diet is whole cereals, dhal, milk, green leafy vegetables, roots and tubers, fruits.

**Low Sodium diet:** A low sodium diet is designated for use in condition where there is sodium retention, like swelling on the body, nephritis, cardiac diseases, toxaemia of pregnancy and hypertension.

A severe restriction of sodium is generally not necessary. It is not always possible and not advised. It depends upon the patient’s condition.

Mild restriction-2 to 3g sodium per day (intake not allowed)

Moderate restriction-1 to 2 g sodium per day (intake not allowed)

Severe restriction-less than 1 g sodium per day (intake not allowed)

**General Instructions**

1. Limit the use of salt during cooking and avoid using salt on the table.
2. Limit the use of animal foods which are rich in sodium and use more fresh vegetables with less sodium.
3. Boil fresg meats and fish in water and discard the liquid.
4. Avoid baking soda and sodium bicarbonate in the preparation of meals or snacks.

**Food to be avoided:**

1. Papads, pickles, chutneys, sauses and all canned, brined, preserved and seasoned products unless declared to be salt free.
2. Sea fish, salted meat, salted dry fish organ meats.
3. Snack items such as potato chips, salted pop-corn etc.
4. Sodium is found in drugs such as laxatives, antibiotics, cough syrups and sedatives.
5. Salted butter and processed cheese.
6. Baked products such as bread, cakes patries and biscuits etc.
7. Fruits like lichies and musk melon.
8. Vegetables such as knol-knol, amaranth, field beans and tender gram.

**NEUTRACEUTICALS**

The word nutraceuticals originates from the word `nutrition’ and `pharmaceuticals’. It implies the usage of food as protective drugs or as food supplements. The term nutraceutical was coined by Stephen Defelice “A NEUTRACEUTICAL is any substance that is a food or a part of food and provides medical or health benefits, including the prevention and treatment of disease”. Some of the most common ways of classifying nutraceuticals can be based on food sources, mechanism of action, chemical nature etc. The food sources used as nutraceuticals are all natural and can be categorized as:

1. Dietary Fiber
2. Probiotics
3. Prebiotics
4. Polyunsaturated fatty acids
5. Antioxidant vitamins
6. Polyphenols
7. Spices

**1. Dietary fiber**: Dietary fiber is the food material, more precisely the plant material that is not hydrolyzed by enzymes secreted by the digestive tract, but digested by micro flora in the gut. Dietary fibers mostly include non-starch polysaccharides (NSP) such as celluloses, hemicelluloses, gums and pectin’s, lignin, resistant dextrin’s, and resistant starches.

Foods rich in soluble fiber include fruits, oats, barley and beans. Chemically dietary fiber means carbohydrate polymers with a degree of polymerization not lower than 3, which are neither digested nor absorbed in the small intestine. Based on their water solubility, dietary fibers may be divided into two forms: -

1. Insoluble dietary fiber (IDF), which includes celluloses, some hemicelluloses and lignin’s which is fermented to a limited extent in the colon.
2. Soluble dietary fiber (SDF), which includes β-glucans, pectin’s, gums, mucilage’s, and hemicelluloses that are fermented in the colon.

The IDF and SDF compounds are collectively known as non-starch polysaccharides (NSP).

2.**Probiotics**: A probiotic can be defined as live microbial feed supplement, which when administered in adequate amounts beneficially affects the host animal by improving its intestinal microbial balance. Probiotics generally include the following categories of bacteria: -

1. Lactobacilli such as L. acidophilus, L.casei,
2. Gram-positive cocci such as Lactococcus, Streptococcus, Enterococcus.
3. Bifidobacteria such as B.bifidun, B.adolescentis

Probiotics are available in various forms as powder form, liquid form, gel or paste or granule forms, capsule forms etc. Specific probiotics are generally used to treat gastrointestinal (GI) conditions such as lactose intolerance, acute diarrhea and antibiotic-associated GI side effects. Probiotic agents possess the properties of non-pathogenic, non-toxic, resistance to gastric acid, adherence to gut epithelial tissues producing antibacterial substances. There are evidences that administration of probiotics decreases the risk of systemic conditions, such as allergy, asthma, cancer and several other infections of the ear, urinary tract.

**1. Probiotics Help Balance the Friendly Bacteria in Your Digestive System.** Probiotics include "good" bacteria. These are [live microorganisms](https://www.healthline.com/nutrition/probiotics-101/) that can provide health benefits when consumed

**2. Probiotics Can Help Prevent and Treat Diarrhea**

**3. Probiotic Supplements Improve Some Mental Health Conditions**

**4.** Probiotics may help keep your heart healthy by lowering LDL ("bad") cholesterol and blood pressure.

**5. Probiotics May Reduce the Severity of Certain Allergies and Eczema** in children and infants.

**6. Probiotics Can Help Reduce Symptoms of Certain Digestive Disorders**

**7. Probiotics May Help Boost Your Immune System** a boost and inhibit the growth of harmful gut bacteria and reduce the risk of urinary tract infections (UTIs) in women by 50%.

**8.** [Probiotics may help with weight loss](https://www.healthline.com/nutrition/probiotics-and-weight-loss/) and Belly fat through a number of different mechanisms

**3. Prebiotics**

## Prebiotics are dietary ingredients that beneficially affect the host by selectively altering the composition or metabolism of the gut micro biota. These are short-chain polysaccharides that have unique chemical structures that are not digested by humans; in particular fructose-based oligosaccharides that exist naturally in food or are added in the food. The prebiotic consumption generally promotes the Lactobacillus and Bifidobacterial growth in the gut, thus helping in metabolism.

## Vegetables like chicory roots, banana, tomato, alliums are rich in fructo-oligosaccharides. Some other examples of these oligosaccharides are raffinose and stachyose, found in beans and peas.

## The health benefits of the prebiotics include improved lactose tolerance, antitumor properties, neutralization of toxins, and stimulation of intestinal immune system, reduction of constipation, blood lipids and blood cholesterol levels.

## Polyunsaturated fatty acids ( PUFA): PUFAs are also called “essential fatty acids” as these are crucial to the body’s function and are introduced externally through the diet PUFAs have two subdivisions: omega-3- (n-3) fatty acids and omega-6-(n-6) fatty acids. The major omega-3-fatty acids are α-linolenic acid (ALA), eicosapentanoic acid (EPA), docosahexanoic acid (DHA).. EPA and DHA are found mainly in fatty fishes such as mackerel, salmon, herring, trout, blue fin tuna and in fish-oils.

Principal sources of ALA are mainly flaxseed, soybeans, canola, some nuts (e.g. walnuts) and red/black currant seeds. Omega-6-PUFAs mainly consist of linoleic acid (LA), γ-linolenic acid (GLA) and arachidonic acid (ARA). LA occurs mainly in vegetable oils e.g. corn, safflower, soya bean and sunflower. ARA is found in animal products such as meat, poultry and eggs.

Studies suggest that omega-3-fatty acids have three major effects as cardiovascular diseases anti-arrhythmic. the benefits of omega-3-oils in other areas of health including pre-mature infant health , asthma, bipolar and depressive disorders, Omega-3-fatty acids have been shown to be beneficial at various stages of life.

### 5. Antioxidant Vitamins

Vitamins like vitamin C, vitamin E and carotenoids are collectively known as antioxidant vitamins. These vitamins act both singly as well as synergistically for the prevention of oxidative reactions leading to several degenerative diseases including cancer, cardiovascular diseases, cataracts etc. These vitamins are abundant in many fruits and vegetables and exert their protective action by free-radical scavenging mechanisms.

Vitamin E which comprises of tocopherols together with tocotrienols transfer hydrogen atom and scavenge singlet oxygen and other reactive species thus protecting the peroxidation of PUFA within the biological membrane and LDL. Vitamin E and selenium has a synergistic role against lipid peroxidation. Vitamin C, better known as ascorbic acid donates hydrogen atom to lipid radicals, quenches singlet oxygen radical and removes molecular oxygen. Scavenging of aqueous radicals by the synergistic effect of ascorbic acid along with tocopherol supplementation is a well-known antioxidant mechanism. Carotenoids like lycopene, β-carotene, lutein, zeaxanthin are known to be the most efficient singlet oxygen quencher in the biological systems without the production of any oxidizing products. β-carotene traps peroxy free radicals in tissues at low oxygen concentrations. 6. Polyphenols:

### Polyphenols form a large group of phytochemicals, which are produced by plants as secondary metabolites to protect them from photosynthetic stress, reactive oxygen species. There are approximately 8,000 different classes of polyphenols, the most important being flavonols, flavones, flavan-3-ols, flavanones and anthocyanins. The most commonly occurring polyphenols in food include flavonoids and phenolic acids. Dietary polyphenols that they can affect numerous cellular processes like, gene expression, apoptosis, platelet aggregation, intercellular signaling, that can have anti-carcinogenic and anti-atherogenic implications. Legumes also supply the diet with polyphenols like flavonoids, isoflavones and lignans. Of all legumes, soyabean has received most attention. Soyabean is most significant source of dietary isoflavones.

### Spices

Spices are esoteric food adjuncts that are used for thousands of years to enhance the sensory quality of foods. These impart characteristic flavor, aroma, or piquancy and color to foods, stimulating our appetite as well as modify the texture of food. Recent research reveals that dietary spices in their minute quantities has an immense influence on the human health by their antioxidative, chemo preventive, antimutagenic, anti-inflammatory, immune modulatory effects on cells and a wide range of beneficial effects on human health by the action of gastrointestinal, cardiovascular, respiratory, metabolic, reproductive, neural and other systems.

**MODIFIED FOODS**

Bio-technology centers on the microbes and cells taken from plants and animals and their ability to synthesize wide range of valuable substances. The important area of bio-technology application is the qualitative improvement in foods.

The principle governing genetic engineering is that genetic material which is also known as DNA can be transferred from a cell of one species to another unrelated species to express itself in the recipient cells. This is also known as recombinant DNA technology.

Foods modified through the transfer of genes are known as Genetically Modified Foods (GM Foods).

**Advantages of GM Technology:**

1. It is much faster and cheaper and allows a greater precision in selecting desirable characteristics when compared to traditional breeding techniques.
2. It gives rise to pest and virus resistant crops.
3. Nutritional improvement-Genes that control desired micro nutrients can be transferred to obtain new crops with increased vitamin and mineral content.

The introduction of genetically modified crops with increased vitamin and mineral content is of great importance owing to the prevalence of nutrient deficiencies around the world. Iron - rich rice, quality protein-maize, high carotene-sweet potato and micro nutrient rich seeds are some of the outcomes of research in food bio-technology. In our country genetically modified rice, potatoes and tomatoes are under experimentation. The golden rice with enhancement of vitamin A is an example.

1. Adaptive to harsh conditions – Genetic modification enables crops to grow in harsh conditions like drought and temperature extremes.

### FOOD LAWS AND STANDARDS

**Prevention of Food Adulteration Act.**

The prevention of Food Adulteration Act, (PFA) 1954 operated by the Directorate General of Health Services, Ministry of Health was designed for the following purposes:

1. It formulates and monitors the standard of quality and purity of foods with emphasis on prevention of adulteration of foods.
2. It is the basic structure intended to protect the common consumer against the supply of adulterated foods.
3. It makes provision for prevention of adulteration of food and lays down the rule that no person shall manufacture for sale, store, sell or distribute any adulterated or misbranded food or food which contravenes the provision of act or rules.
4. It has set the yardstick to ascertain adulteration.

According to this act, a food is deemed to be adulterated – if:

1. It is not of the nature, substance and quality, which the food ought to be.

1. It contains any other substance which affects, or if the article is so processed so as to affect injuriously the nature, substance and quality of the food.

2. It contains added inferior or cheaper substance that affects the nature and quality of the food.

3. Any constituent of the food is removed so as to affect injuriously the nature, quality and substance of the food.

4. It is prepared, packed, and stored under unsanitary conditions It contains any filthy, disgusting, rotten, decomposed substance of a diseased animal or vegetable substance or is insect-infested or otherwise unfit for human consumption.

5. The article is obtained from a diseased animal.

6. The article contains a poisonous ingredient or any other ingredient injurious to health.

7. The container renders the food injurious to health.

8. It contains excessive or prohibited colors.

9. It contains excessive or prohibited preservatives.

10. It does not satisfy the standards prescribed by the authorities

Under the provision of the PFA Act, the Government of India has promulgated PFA rules which specify the following details:

1. Qualification, duties and functions of food analysts, food inspectors and central food laboratory.
2. Procedure for drawing test samples and sending them to the analyst and laboratory.
3. Specification for the identity and purity of food.

4. Tolerance for contaminants, preservatives, emulsifiers and other additives

**Agmark Standard:**

The word Agmark is derived from the words ‘Agricultural Marketing’. It is a standard of quality based on the physical and chemical characteristics of food, both the natural and those acquired during processing.

Products graded under AGMARK include vegetable oils, ghee, butter, rice, groundnut, pulses and spices. These standards ensure accurate weight and correct selling price.

**Bureau of Indian Standards:**

The Bureau of Indian Standards lays down criteria for standardization of vegetables and fruit products, spices and condiments, animal products and processed food.

Manufacturers are allowed to use the BIS label on each unit of their product, if their products conform with the standards laid down by BIS. The products are checked for quality by laboratories certified by BIS. BIS is also known as ISI (Indian Standard Institution).

Some of the items which require compulsory BIS certification under PFA Act include artificial food colors, natural food colors, food additives, infant formula; milk-cereal based weaning foods, milk powder and condensed milk.

Phytochemicals:

Phytochemicals are compounds that are produced by plants ("phyto" means "plant"). They are found in fruits, vegetables, grains, beans, and other plants. Some of these phytochemicals are believed to protect cells from damage that could lead to cancer.

Some scientists think that you could reduce your cancer risk by as much as 40% by eating more vegetables, fruits, and other plant foods that have certain phytochemicals in them. Research has shown that some phytochemicals may:

* help stop the formation of potential cancer-causing substances
* help stop carcinogens from attacking cells
* help cells stop and wipe out any cancer-like changes

Some of the most beneficial phytochemicals are:

* beta carotene and other carotenoids in fruits and vegetables
* resveratrol in red wine
* polyphenols in tea
* isothiocyanates in cruciferous vegetables - cabbage, broccoli, brussels sprouts, mustard greens, turnip greens, and cauliflower.

Because these phytochemicals are in the fruits, vegetables, beans, and grains you eat, it's fairly easy to include them in your diet. A carrot, for example, has more than 100 phytochemicals. Keep in mind that there is no evidence that taking phytochemical supplements is as good for you as eating the whole fruits, vegetables, beans, and grains that contain them. Most experts strongly believe that it's the combination of these compounds and the other foods you eat that keeps your body healthy. Loading up on one or two phytochemicals in pill form probably won't be as beneficial as eating a balanced diet with a variety of foods that includes 5 or more cups of fruits and vegetables per day and food from other plant sources, such as whole-grain breads, cereals, nuts, seeds, rice and pasta, and beans.

There are several main groups of health-promoting phytochemicals.

**Flavonoids** are found in lots of grains, vegetables, and fruits. The flavonoids in soybeans, chickpeas, and licorice may act a little bit like estrogen, a hormone that might affect the risk of breast cancer that depends on estrogen for its growth.

The estrogen-like compounds in these plants are called phytoestrogens. But most phytoestrogens have very weak estrogen-like activity. When a weak estrogen-like substance replaces your body's natural estrogen's position, then the weak substance can act as a relative anti-estrogen.

**Antioxidants** protect your body's cells from free radicals — unstable molecules created during normal cell functions. Pollution, radiation, cigarette smoke, and herbicides also can create free radicals in your body. Free radicals can damage a cell's genetic parts and may trigger the cell to grow out of control. These changes may contribute to the development of cancer and other diseases.

Antioxidants are found in broccoli, brussels sprouts, cabbage, cauliflower, tomatoes, corn, carrots, mangos, sweet potatoes, soybeans, oranges, spinach, nuts, lettuce, liver, fish oil, seeds, grains, kale, beets, red peppers, potatoes, blueberries, strawberries, and black and green tea. As a rule, dark-colored fruits and vegetables have more antioxidants than other fruits and vegetables.

**Carotenoids**, which give carrots, yams, cantaloupe, squash, and apricots their orange color, may help reduce the risk of cancer.

**Anthocyanins**, which give grapes, blueberries, cranberries, and raspberries their dark color, have been shown in the laboratory to have anti-inflammatory and anti-tumor properties.

**Sulfides**, found in garlic and onions, may strengthen the immune system.

Registered dietitians and other healthcare professionals will always recommend eating a balanced diet that includes a variety of vegetables, fruits, legumes, and whole grains.

Phytochemicals are a large group of nonnutrient secondary metabolites present in vegetables and fruits. A few of the well-known phytochemicals are generally grouped into the alkaloids, terpenoids, and phenolic compounds. Among all phenolic compounds, the most common phytochemical includes flavonoids, phenolic acids, and polyphenols. well-known phytochemicals are the flavonoids, [phenolic acids](https://www.sciencedirect.com/topics/food-science/phenolic-acids), isoflavones, curcumin, isothiocyanates, and carotenoids. The many phytochemicals in common plant foods, herbs, and spices. Phytochemicals are classified as polyphenols, terpenoids, alkaloids, phytosterols, and organosulfur compounds a broad range of chemical compounds.