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JOURNEY OF GOOD HEALTH STARTS FROM MICRONUTRIENTS & ENDS AT MACRONUTRIENTS

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ABSTRACT

A carbohydrate is a biomolecule consisting of carbon (C), hydrogen (H) and oxygen (O) atoms, usually with a hydrogen–oxygen atom ratio of 2:1 (as in water) and thus with the empirical formula $C_m(H_2O)_n$ (where m may or may not be different from n). However, not all carbohydrates conform to this precise stoichiometric definition (e.g., uronic acids, deoxy–sugars such as fucose), nor are all chemicals that do conform to this definition automatically classified as carbohydrates (e.g. formaldehyde). The term is most common in biochemistry, where it is a synonym of saccharide, a group that includes sugars, starch, and cellulose. The saccharides are divided into four chemical groups: monosaccharides, disaccharides, oligosaccharides, and polysaccharides. Monosaccharides and disaccharides, the smallest (lower molecular weight) carbohydrates, are commonly referred to as sugars. The word saccharide comes from the Greek word σάκχαρον (sákkharon), meaning "sugar". While the scientific nomenclature of carbohydrates is complex, the names of the monosaccharides and disaccharides very often end in the suffix –ose, which was originally taken from glucose (gluekos), and is used for almost all sugars e.g. fructose (fruit sugar), sucrose (cane or beet sugar), ribose, amylose, lactose (milk sugar) etc. Carbohydrates perform numerous roles in living organisms. Polysaccharides serve for the storage of energy (e.g. starch and glycogen) and as structural components (e.g. cellulose in plants and chitin in arthropods). The 5–carbon monosaccharide ribose is an important component of coenzymes (e.g. ATP, FAD and NAD) and the backbone of the genetic molecule known as RNA. The related deoxyribose is a component of DNA. Saccharides and their derivatives include many other important biomolecules that play key roles in the immune system, fertilization, preventing pathogenesis, blood clotting, and development. Carbohydrates are central to nutrition and are found in a wide variety of natural and processed foods. Starch is a polysaccharide. It is abundant in cereals (wheat, maize, rice), potatoes, and processed food based on cereal flour, such as bread, pizza or pasta. Sugars appear in human diet mainly as table sugar (sucrose, extracted from sugarcane or sugar beets), lactose (abundant in milk), glucose and fructose, both of which occur naturally in honey, many fruits, and some vegetables. Table sugar, milk, or honey are often added to drinks and many prepared foods such as jam, biscuits and cakes. Cellulose, a polysaccharide found in the cell walls of all plants, is one of the main components of insoluble dietary fiber. Although it is not digestible, insoluble dietary fiber helps to maintain a healthy digestive system by easing defecation. Other polysaccharides contained in dietary fiber include resistant starch and inulin, which feed some bacteria in the microbiota of the large intestine, and are metabolized by these bacteria to yield short–chain fatty acids.

Proteins are large biomolecules, or macromolecules, consisting of one or more long chains of amino acid residues. Proteins perform a vast array of functions within organisms, including catalysing metabolic reactions, DNA replication, responding to stimuli, providing structure to cells and organisms, and transportin molecules from one location to another. Proteins differ from one another primarily in their sequence of amino acids, which is dictated by the nucleotide sequence of their genes, and which usually results in protein folding into a specific 3D structure that determines its activity. A linear chain of amino acid residues is called a polypeptide. A protein contains at least one long polypeptide. Short polypeptides, containing less than 20–30 residues, are rarely considered to be proteins and are commonly called peptides, or sometimes oligopeptides. The individual amino acid residues are bonded together by peptide bonds [–NH–CO–] and adjacent amino acid residues. The sequence of amino acid residues in a protein is defined by the sequence of a gene, which is encoded in the genetic code.

In general, the genetic code specifies 20 standard amino acids; but in certain organisms the genetic code can include selenocysteine and—in certain archaea—pyrrolysine. Shortly after or even during synthesis, the residues in a protein are often chemically modified by post–translational modification, which alters the physical and chemical properties, folding, stability, activity, and ultimately, the function of the proteins. Some proteins have non–peptide groups attached, which can be called prosthetic groups or cofactors. Proteins can also work together to achieve a particular function, and they often associate to form stable protein complexes. Once formed, proteins only exist for a certain period and are then degraded and recycled by the cell's machinery through the process of protein turnover. A protein's lifespan is measured in terms of its half–life and covers a wide range. They can exist for minutes or years with an average lifespan of 1–2 days in mammalian cells. Abnormal or misfolded proteins are degraded more rapidly either due to being targeted for destruction or due to being unstable. Like other biological macromolecules such as polysaccharides and nucleic acids, proteins are essential parts of organisms and participate in virtually every process within cells. Many proteins are enzymes that catalyse biochemical reactions and are vital to metabolism. Proteins also have structural or mechanical functions, such as actin and myosin in muscle and the proteins in the cytoskeleton, which form a system of scaffolding that maintains cell shape. Other proteins are important in cell signaling, immune responses, cell adhesion, and the cell cycle. In animals, proteins are needed in the diet to provide the essential amino acids that cannot be synthesized. Digestion breaks the proteins down for use in the metabolism.

In nutrition, biology, and chemistry, fat usually means any ester of fatty acids, or a mixture of such compounds; most commonly those that occur in living beings or in food. The term often refers specifically to triglycerides (triple esters of glycerol), that are the main components of vegetable oils and of fatty tissue in animals; or, even more narrowly, to triglycerides that are solid or semisolid at room temperature, thus excluding oils. The term may also be used more broadly as a synonym of lipid — any substance of biological relevance, composed of carbon, hydrogen, or oxygen, that is insoluble in water but soluble in non–polar solvents. In this sense, besides the triglycerides, the term would include several other types of compounds like mono– and diglycerides, phospholipids (such as lecithin), sterols (such as cholesterol), waxes (such as beeswax), and free fatty acids, which are usually present in human diet in smaller amounts. Fats are of two types: saponifiable fat which undergo hydrolysis and unsaponifiable fat which does not hydrolyse. Fats are one of the three main macronutrient groups in human diet, along with carbohydrates and proteins, and the main components of common food products like milk, butter, tallow, lard, bacon, and cooking oils. They are a major and dense source of food energy for many animals and play important structural and metabolic functions, in most living beings, including energy storage, waterproofing, and thermal insulation. The human body can produce the fat that it needs from other food ingredients, except for a few essential fatty acids that must be included in the diet. Dietary fats are also the carriers of some flavor and aroma ingredients and vitamins that are not water–soluble.

A vitamin is an organic molecule (or a set of molecules closely related chemically, i.e. vitamers) that is an essential micronutrient which an organism needs in small quantities for the proper functioning of its metabolism. Essential nutrients cannot be synthesized in the organism, either at all or not in sufficient quantities, and therefore must be obtained through the diet. Vitamin C can be synthesized by some species but not by others; it is not a vitamin in the first instance but is in the second. The term vitamin does not include the three other groups of essential nutrients: minerals, essential fatty acids, and essential amino acids. Most vitamins are not single molecules, but groups of related molecules called vitamers. For example, there are eight vitamers of vitamin E: four tocopherols and four tocotrienols. Some sources list fourteen vitamins, by including choline, but major health organizations list thirteen: vitamin A (as all–trans–retinol, all–trans–retinyl–esters, as well as all–trans–beta–carotene and other provitamin A carotenoids), vitamin B_1 *(thiamine), vitamin* B_2 *(riboflavin), vitamin* B_3 *(niacin), vitamin* B_5 *(pantothenic acid), vitamin* B_6 *(pyridoxine), vitamin* B_7 *(biotin), vitamin* B_9 *(folic acid or folate), vitamin* B_{12} *(cobalamins), vitamin C (ascorbic acid), vitamin D (calciferols), vitamin E (tocopherols and tocotrienols), and vitamin K (phylloquinone and menaquinones). Vitamins have diverse biochemical functions. Vitamin A acts as a regulator of cell and tissue growth and differentiation. Vitamin D provides a hormone–like function, regulating mineral metabolism for bones and other organs. The B complex vitamins function as enzyme cofactors (coenzymes) or the precursors for them. Vitamins C and E function as antioxidants. Both deficient and excess intake of a vitamin can potentially cause clinically significant illness, although excess intake of water–soluble vitamins is less likely to do so. Before 1935, the only source of vitamins was from food. If intake of vitamins was lacking, the result was vitamin deficiency and consequent deficiency diseases. Then, commercially produced tablets of yeast–extract vitamin B complex and semi–synthetic vitamin C became available. This was followed in the 1950s by the mass production and marketing of vitamin supplements, including multivitamins, to prevent vitamin deficiencies in the general population. Governments mandated addition of vitamins to staple foods such as flour or milk, referred to as food fortification, to prevent deficiencies. Recommendations for folic acid supplementation during pregnancy reduced risk of infant neural tube defects. The term vitamin is derived from the word vitamine, which was coined in 1912 by Polish biochemist Casimir Funk, who isolated a complex of micronutrients essential to life, all of which he presumed to be amines. When this presumption was later determined not to be true, the "e" was dropped from the name. All vitamins were discovered (identified) between 1913 and 1948. Fat soluble vitamins are Vitamin A, D, E & K; water*

soluble vitamins are Vitamin B1 (thiamine), Vitamin B2 (riboflavin), Vitamin B3 (niacin), Vitamin B5 (pantothenic acid), Vitamin B6 (pyridoxine), Vitamin B7 (biotin), Vitamin B9 (folic acid or folate), Vitamin B12 (cobalamins), Vitamin C (ascorbic acid).

In the context of nutrition, a mineral is a chemical element required as an essential nutrient by organisms to perform functions necessary for life. However, the four major structural elements in the human body by weight (oxygen, hydrogen, carbon, and nitrogen), are usually not included in lists of major nutrient minerals (nitrogen is considered a "mineral" for plants, as it often is included in fertilizers). These four elements compose about 96% of the weight of the human body, and major minerals (macrominerals) and minor minerals (also called trace elements) compose the remainder. Nutrient minerals, being elements, cannot be synthesized biochemically by living organisms. Plants get minerals from soil. Most of the minerals in a human diet come from eating plants and animals or from drinking water. As a group, minerals are one of the four groups of essential nutrients, the others of which are vitamins, essential fatty acids, and essential amino acids. The five major minerals in the human body are calcium, phosphorus, potassium, sodium, and magnesium. All of the remaining elements in a human body are called "trace elements". The trace elements that have a specific biochemical function in the human body are sulfur, iron, chlorine, cobalt, copper, zinc, manganese, molybdenum, iodine, and selenium. Most chemical elements that are ingested by organisms are in the form of simple compounds. Plants absorb dissolved elements in soils, which are subsequently ingested by the herbivores and omnivores that eat them, and the elements move up the food chain. Larger organisms may also consume soil (geophagia) or use mineral resources, such as salt licks, to obtain limited minerals unavailable through other dietary sources. Bacteria and fungi play an essential role in the weathering of primary elements that results in the release of nutrients for their own nutrition and for the nutrition of other species in the ecological food chain. One element, cobalt, is available for use by animals only after having been processed into complex molecules (e.g., Vitamin B12) by bacteria. Minerals are used by animals and microorganisms for the process of mineralizing structures, called biomineralization, used to construct bones, seashells, eggshells, exoskeletons and mollusc shells.

KEYWORDS: Carbohydrate, Protein, Fats, Vitamin, Mineral.

CARBOHYDRATES: Carbohydrate means carbon hydrate or simply carbs are hydrates of carbon. Carbohydrates are naturally occurring sugar, starches and fibers in food. It is one of the three main classes of food and source of energy. In scientific literature, the term “carbohydrate” has many synonyms, like “sugar”, “hydrate of carbon” or “polyhydroxy compounds with aldehyde and ketone”. Carbs chemically is defined as a biomolecule consisting of carbon (C), hydrogen (H) and oxygen (O) atoms, usually with a hydrogen–oxygen atom ratio of 2:1 same as water and thus with the empirical formula $C_m(H_2O)_n$. Carbohydrates may be defined as polyhydroxyaldehydes or ketones or compounds which produce them on hydrolysis. There is term known “Glycome” represents the entire spectrum of carbohydrates of an organism, present in either free or complex form of molecules.

“Saccharides” comes from Greek word “Sakron” which means sugar. On the basis of number of sugar molecule sachharides/ carbohydrates are divided into four categories: Monosaccharide, Disaccharide, Oligosaccharide and Polysaccharide, further the polysaccharide is divided into two categories: Structural polysaccharide and Storage polysaccharide.

Monosaccharide– Polyhydroxy aldehyde or ketone which can’t be composed by further hydrolysis. (Eg– Glucose, Fructose, Galactose).

Disaccharides– Any class of sugars whose molecules contain two monosaccharide residues linked by glycosidic bond. (Eg – Sucrose, Maltose, Lactose).
GLUCOSE + FRUCTOSE = SUCROSE
GALACTOSE + GLUCOSE = LACTOSE
GLUCOSE + GLUCOSE = MALTOSE

Oligosaccharide– It is a saccharide polymer containing a small number (typically three to nine) of monosaccharides residue. (Raffinose, Stachyose).

GLUCOSE + FRUCTOSE + GALACTOSE = RAFFINOSE

Polysaccharides– Long chains of monosaccharides linked by glycosidic bonds. The structural polysaccharides that take part in forming the structural framework of the cell wall in plants and skeleton in animals (Eg– cellulose, chitin). Whereas storage polysaccharides are those that serves as a form of stored energy in living organisms. (Eg– starch, phytolycogen, fructosans).
Both monosaccharides and polysaccharides provide energy. The monosaccharides yield energy quickly for cells, while polysaccharides provide longer energy storage and structural stability. Both are essential to all living things as the largest source of food and food energy. Polysaccharides from cell walls make up the fiber humans eat, while monosaccharides provide the sweetness in foods. As humans eat, chewing breaks down polysaccharides into smaller particles that eventually, through digestion, yield up the simple

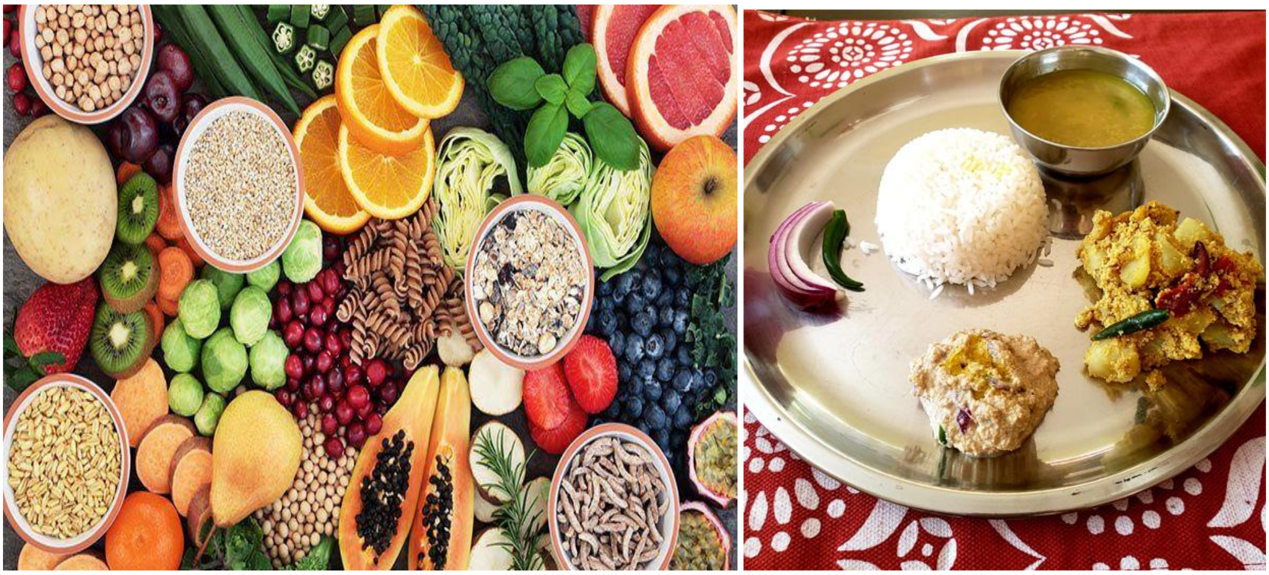
monosaccharides that can pass into the bloodstream. This what makes monosaccharide more useful from other division of saccharides.[1]

SOURCE: Carbohydrates are the body's main source of energy. The fruit, vegetables, dairy, and grain food groups all contain carbohydrates. Carbohydrates are found in a wide array of both healthy and unhealthy foods—bread, beans, milk, popcorn, potatoes, cookies, spaghetti, soft drinks, corn, and cherry pie. They also come in a variety of forms. The most common and abundant forms are sugars, fibers, and starches.

- The healthiest sources of carbohydrates—unprocessed or minimally processed whole grains, vegetables, fruits and beans—promote good health by delivering vitamins, minerals, fiber, and a host of important phytonutrients.
- Unhealthier sources of carbohydrates include white bread, pastries, sodas, and other highly processed or refined foods. These items contain easily digested carbohydrates that may contribute to weight gain, interfere with weight loss, and promote diabetes and heart disease.

Carbohydrates cannot be produced by the human body. So, they should be taken through diet which can be classified as following:

Simple Carbohydrates: Fresh fruits like apples, oranges, banana, pineapple, sweet potatoes, berries are rich sources of healthy simple carbohydrates. Foods that have artificial sugars and highly processed foods are unhealthy sources of it. Milk is also a rich source of simple carbohydrates.



Figure–1: Source of Carbohydrate.

Starchy Carbohydrates: Grains are rich sources of carbohydrates. Grains include whole grains, grain bread, etc. Some foods that are rich in carbohydrates are beans, potatoes, sweet potatoes, and some nuts. Cereals are also a rich source of carbohydrates.

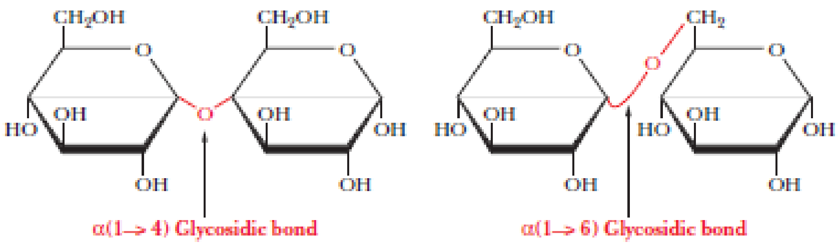
Fibrous Carbohydrates: Fibrous carbohydrates can be found in fresh vegetables like pumpkin, carrot, tomatoes, beans, broccoli, cucumbers, squash, etc.

Complex Carbohydrates: Complex carbohydrates are found in beans, peas, whole grains, barley, oats, wild rice, brown rice, etc. Complex carbohydrates are good carbohydrates as they contain starch and fibre. Also, these carbohydrates do not spike sugar levels in the blood thereby helping in minimal sugar level in blood.

GLYCOSIDIC BOND: Let’s discuss the bond that links all the monosaccharide residue; The bond is glycosidic bond which is defined as a covalent bond formed between a carbohydrate molecule and another molecule (in this case, between two monosaccharides). It is a covalent bond that joins the hemiacetal group of a saccharide molecule and the hydroxyl group of another molecule of saccharide. Glycosides are comprised of two chemically and functionally independent parts; the aglycone (genin) and the glycone (saccharide) parts.

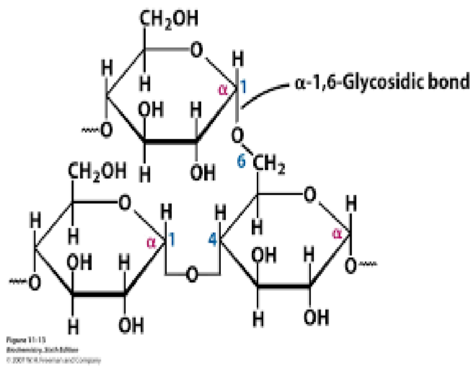
If the anomeric carbon of the sugar forms the bond with the oxygen atom in the hydroxyl group in the alcohol, the bond is named an O–glycosidic bond. Conversely, if the anomeric carbon of the sugar forms the bond with the nitrogen atom of an amine, the bond is then called a N–glycosidic bond.
When there are two sugar molecules linked by one glycosidic link, the resulting molecule is known as a disaccharide, when there are several sugar molecules linked together in this way they are known as oligosaccharides, and when there are long chains of sugar molecules linked in this way, they are known as polysaccharides. Glycosidic links also come in different forms and are named according to which carbon atoms on the sugar molecule are involved in the linkage. For example, we can have 1,4–glycosidic bond, which

involves carbon atom number 1 on one sugar and carbon atom number 4 on another sugar. These types of bonds form straight chains. There are also 1,6–glycosidic bonds where carbon atom number 1 on one sugar is linked to carbon atom number 6 on another, this form branch points in the molecule for example in the structure of glycogen and starch.



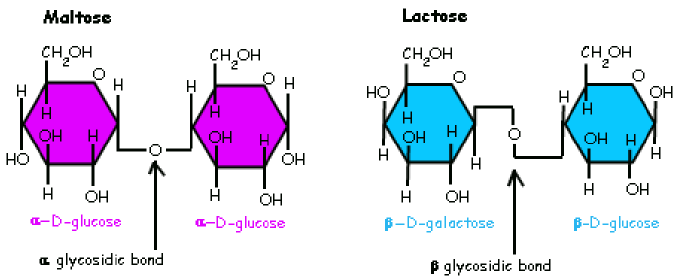
Figure–2: Glycosidic Bonds.

The combination of 1,4–glycosidic bonds and 1,6–glycosidic bonds in a polysaccharide makes it unique and chemically identifiable by specific enzymes and receptors.



Figure–3: Alpha 1,6–Glycosidic Bond.

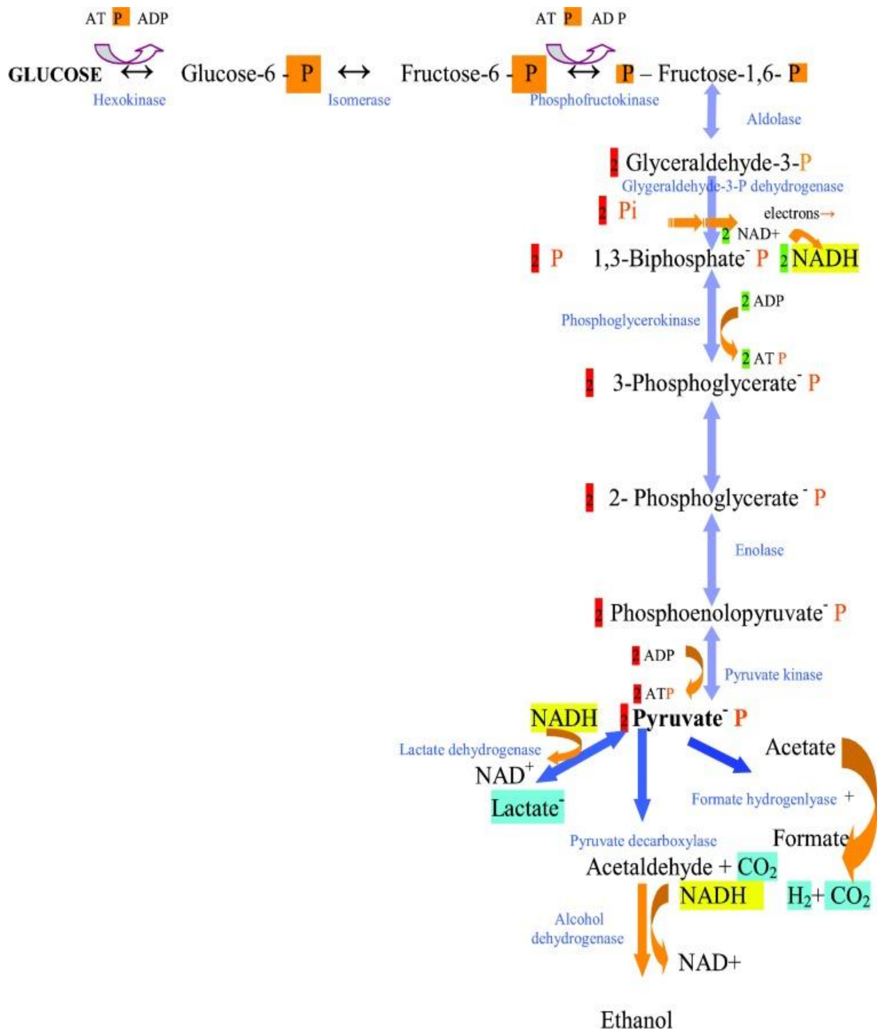
The 1,4 glycosidic bond is formed between the carbon–1 of one monosaccharide and carbon–4 of the other monosaccharide. There are two types of glycosidic bonds – 1,4 alpha and 1,4 beta glycosidic bonds. 1,4 alpha glycosidic bonds are formed when the OH on the carbon–1 is below the glucose ring; while 1,4 beta glycosidic bonds are formed when the OH is above the plane.[2]



Figure–4: Alpha & Beta Glycosidic Bonds.

METABOLISM: Carbohydrate metabolism is the whole of the biochemical processes responsible for the metabolic formation, breakdown, and interconversion of carbohydrates in living organisms. During digestion, carbohydrates are broken down into simple, soluble sugars that can be transported across the intestinal wall into the circulatory system to be transported throughout the body. Carbohydrate digestion begins in the mouth with the action of salivary amylase on starches and ends with monosaccharides being absorbed across the epithelium of the small intestine. Once the absorbed monosaccharides are transported to the tissues, the process of cellular respiration begin. Major pathways of the carbohydrate metabolism are:

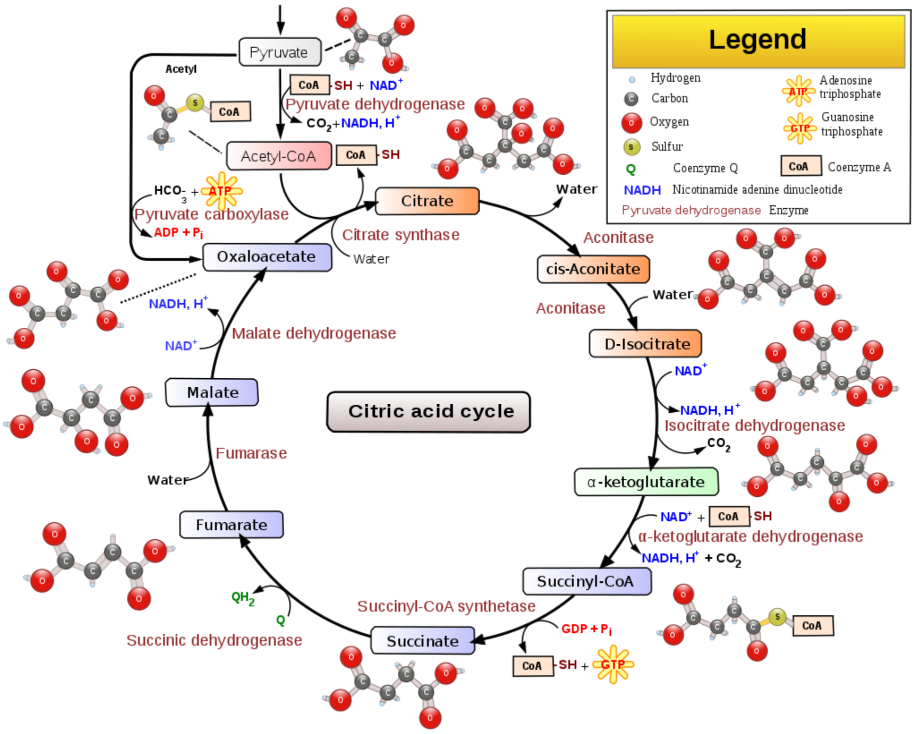
1. GLYCOLYSIS (Embden–Meyerhof pathway): Cells in the body take up the circulating glucose in response to insulin and, through a series of reactions called glycolysis, transfer some of the energy in glucose to ADP to form ATP.



Figure–5: Embden–Meyerhof pathway.

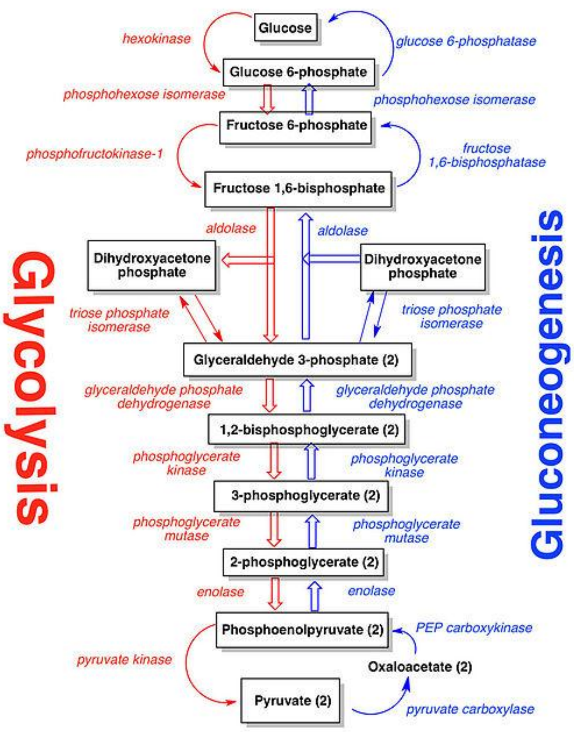
The last step in glycolysis produces the product pyruvate. Glycolysis begins with the phosphorylation of glucose by hexokinase to form glucose–6–phosphate. This step uses one ATP, which is the donor of the phosphate group. Under the action of phosphofructokinase, glucose–6–phosphate is converted into fructose–6–phosphate. At this point, a second ATP donates its phosphate group, forming fructose–1,6–bisphosphate. This six–carbon sugar is split to form two phosphorylated three–carbon molecules, glyceraldehyde–3–phosphate and dihydroxyacetone phosphate, which are both converted into glyceraldehyde–3–phosphate. The glyceraldehyde–3–phosphate is further phosphorylated with groups donated by dihydrogen phosphate present in the cell to form the three–carbon molecule 1,3–bisphosphoglycerate. The energy of this reaction comes from the oxidation of (removal of electrons from) glyceraldehyde–3–phosphate. In a series of reactions leading to pyruvate, the two phosphate groups are then transferred to two ADPs to form two ATPs. Thus, glycolysis uses two ATPs but generates four ATPs, yielding a net gain of two ATPs and two molecules of pyruvate.

2. KREB'S CYCLE (Citric acid cycle): The citric acid cycle: In the citric acid cycle, the acetyl group from acetyl CoA is attached to a four–carbon oxaloacetate molecule to form a six–carbon citrate molecule. Through a series of steps, citrate is oxidized, releasing two carbon dioxide molecules for each acetyl group fed into the cycle. In the process, three NAD+ molecules are reduced to NADH, one FAD molecule is reduced to FADH2, and one ATP or GTP (depending on the cell type) is produced (by substrate–level phosphorylation). Because the final product of the citric acid cycle is also the first reactant, the cycle runs continuously in the presence of sufficient reactants.

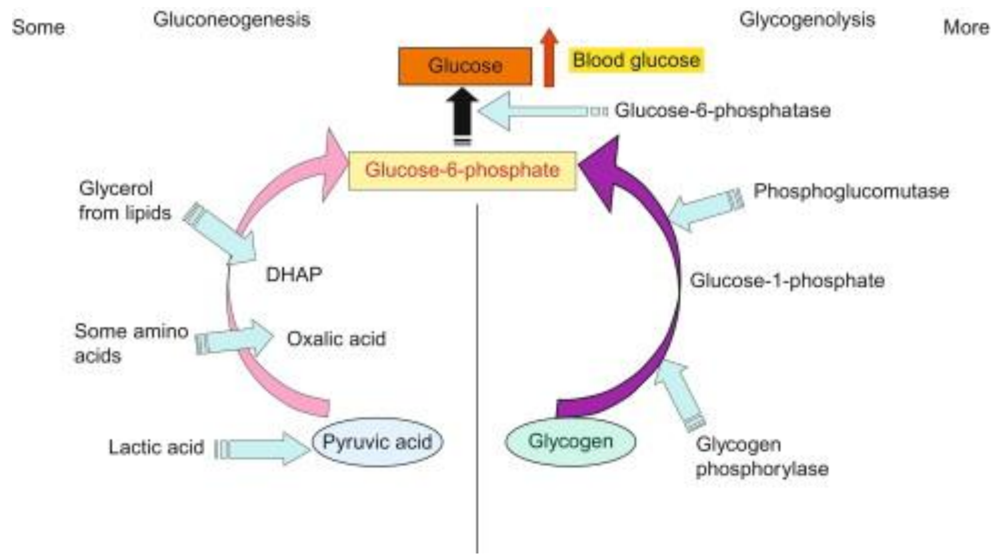


Figure–6: Krebs cycle.

3. GLUCONEOGENESIS: Gluconeogenesis is the reverse process of glycolysis. It involves the conversion of non–carbohydrate molecules into glucose. The non–carbohydrate molecules that are converted in this pathway include pyruvate, lactate, glycerol, alanine, and glutamine. This process occurs when there are lowered amounts of glucose. The liver is the primary location of gluconeogenesis, but some also occurs in the kidney. The liver is the organ that breaks down the various non–carbohydrate molecules and sends them out to other organs and tissues to be used in Gluconeogenesis. This pathway is regulated by multiple different molecules. Glucagon, adrenocorticotropic hormone, and ATP encourage gluconeogenesis. Gluconeogenesis is inhibited by AMP, ADP, and insulin. Insulin and glucagon are the two most common regulators of gluconeogenesis.

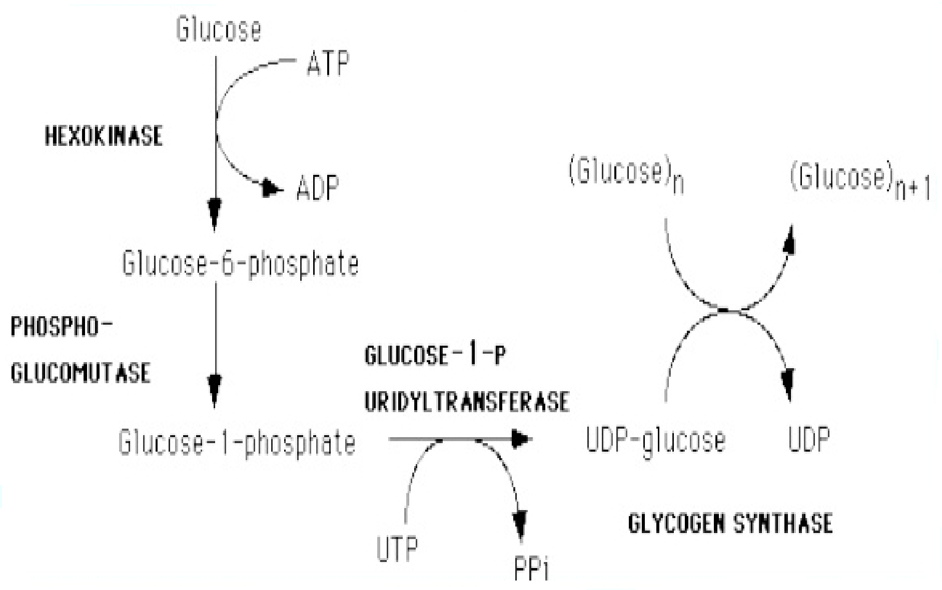


Figure–7: Gluconeogenesis.



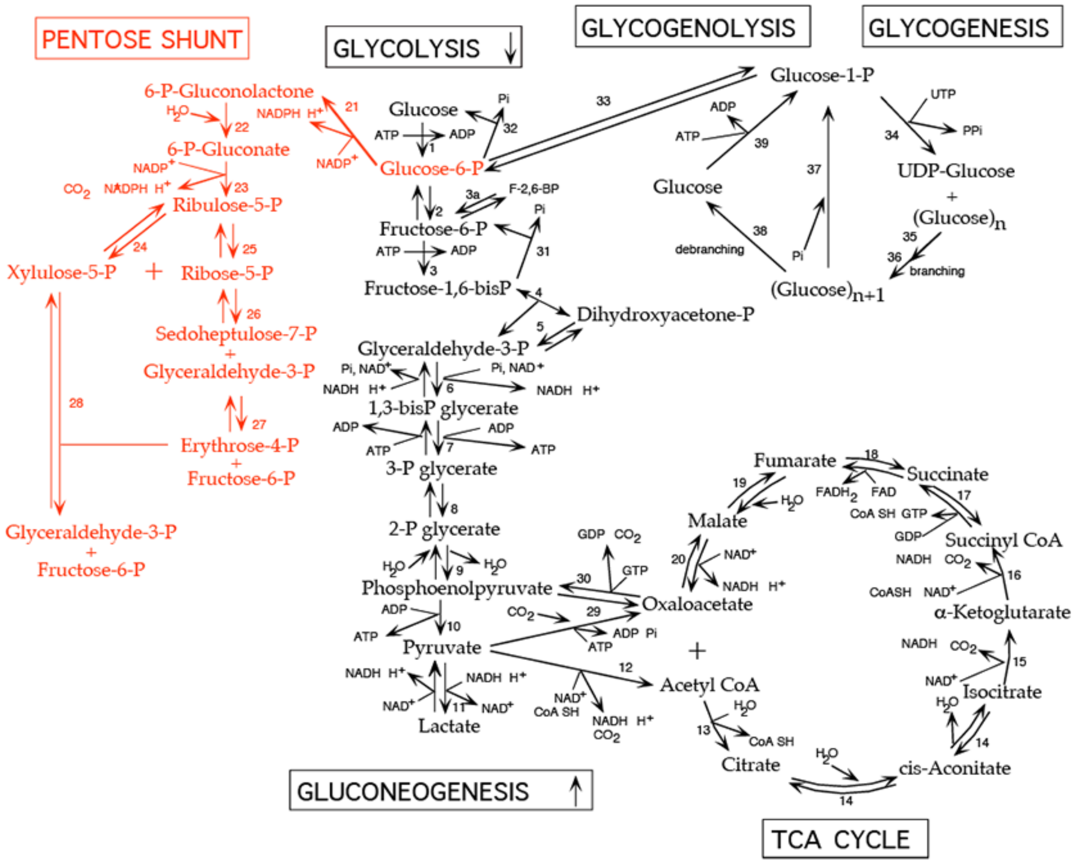
Figure–8: Glycogenolysis.

4. GLYCOGENOLYSIS: Glycogenolysis refers to the breakdown of glycogen. In the liver, muscles, and the kidney, this process occurs to provide glucose when necessary. A single glucose molecule is cleaved from a branch of glycogen and is transformed into glucose–1–phosphate during this process. This molecule can then be converted to glucose–6–phosphate, an intermediate in the glycolysis pathway. Glucose–6–phosphate can then progress through glycolysis. Glycolysis only requires the input of one molecule of ATP when the glucose originates in glycogen. Alternatively, glucose–6–phosphate can be converted back into glucose in the liver and the kidneys, allowing it to raise blood glucose levels if necessary. Glucagon in the liver stimulates glycogenolysis when the blood glucose is lowered, known as hypoglycemia. The glycogen in the liver can function as a backup source of glucose between meals. Adrenaline stimulates the breakdown of glycogen in the skeletal muscle during exercise. In the muscles, glycogen ensures a rapidly accessible energy source for movement.[3]



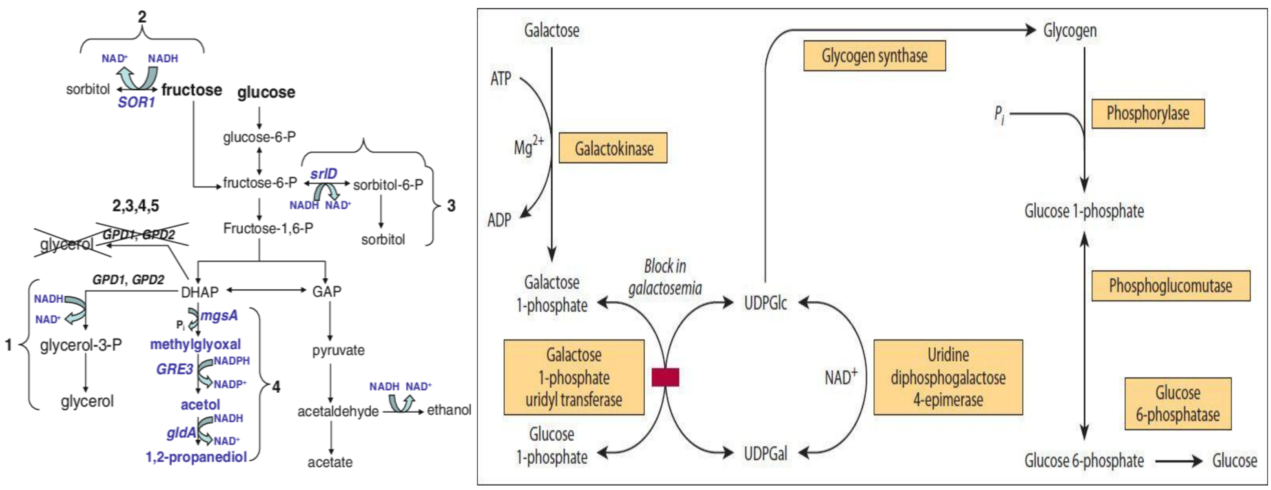
Figure–9: Glycogenesis.

5. GLYCOGENESIS: Glycogenesis refers to the process of synthesizing glycogen. In humans, excess glucose is converted to glycogen via this process. Glycogen is a highly branched structure, consisting of glucose, in the form of glucose–6–phosphate, linked together. The branching of glycogen increases its solubility and allows for a higher number of glucose molecules to be accessible for breakdown. Glycogenesis occurs primarily in the liver, skeletal muscles, and kidney. The Glycogenesis pathway consumes energy, like most synthetic pathways, because an ATP and a UTP are consumed for each molecule of glucose introduced.



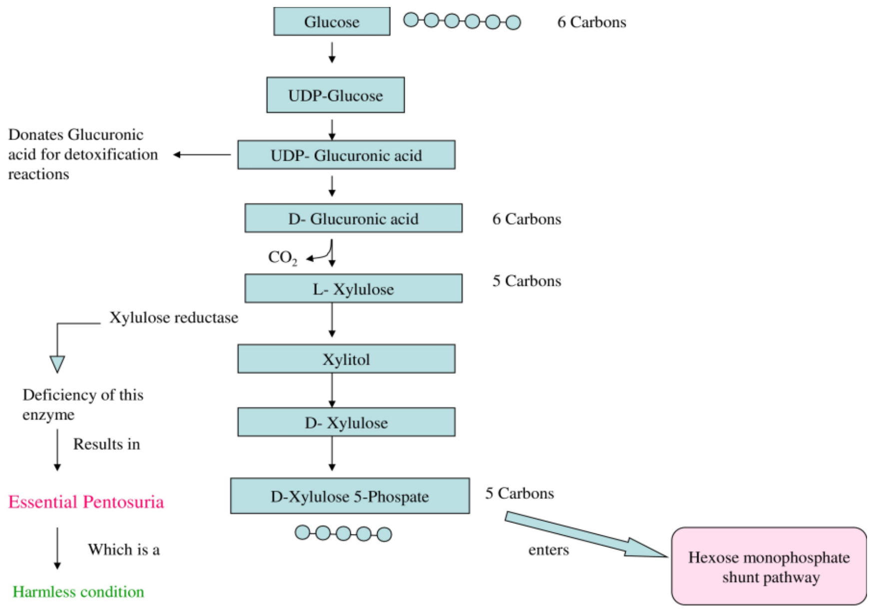
Figure–10: Pentose phosphate pathway.

6. PENTOSE PHOSPHATE PATHWAY: The pentose phosphate pathway is an alternative method of oxidizing glucose. It occurs in the liver, adipose tissue, adrenal cortex, testis, milk glands, phagocyte cells, and red blood cells. It produces products that are used in other cell processes, while reducing NADP to NADPH. This pathway is regulated through changes in the activity of glucose–6–phosphate dehydrogenase



Figure–11: Fructose & Galactose metabolism.

7. FRUCTOSE METABOLISM: Fructose must undergo certain extra steps in order to enter the glycolysis pathway. Enzymes located in certain tissues can add a phosphate group to fructose. This phosphorylation creates fructose–6–phosphate, an intermediate in the glycolysis pathway that can be broken down directly in those tissues. This pathway occurs in the muscles, adipose tissue, and kidney. In the liver, enzymes produce fructose–1–phosphate, which enters the glycolysis pathway and is later cleaved into glyceraldehyde and dihydroxyacetone phosphate.[4]



Figure–12: Uronic acid pathway.

8. GALACTOSE METABOLISM: Lactose, or milk sugar, consists of one molecule of glucose and one molecule of galactose. After separation from glucose, galactose travels to the liver for conversion to glucose. Galactokinase uses one molecule of ATP to phosphorylate galactose. The phosphorylated galactose is then converted to glucose–1–phosphate, and then eventually glucose–6–phosphate, which can be broken down in glycolysis.

9. URONIC ACID PATHWAY: The glucuronic acid pathway is a quantitatively minor route of glucose metabolism. Like the pentose phosphate pathway, it provides biosynthetic precursors and inter–converts some fewer common sugars to ones that can be metabolized.

FUNCTION

Carbohydrates serve several key functions in your body.

- They provide you with energy for daily tasks and are the primary fuel source for your brain's high energy demands.
- Carbohydrates storage, in the form of glycogen, provides a short–term energy reserve.
- They supply carbon atoms for synthesis of other biochemical substances (protein, lipids and nucleic acid)
- Carbohydrates form part of the structural framework of DNA and RNA molecules.
- Carbohydrates linked to lipids are structural components of cell membrane.
- Carbohydrates linked to proteins function in a variety of cell and cell–molecule recognition process.
- In plants, they are rich source of fibers.
- In animals, they are important constituent of connective tissue.
- Carbohydrates regulates the nerve function.
- Carbohydrates after getting associated form surface antigen receptor molecules vitamins and antibodies.

PROTEIN: Any of a class of nitrogenous organic compounds which have large molecules composed of one or more long chains of amino acids and are an essential part of all living organism. Protein, highly complex substance that is present in all living organisms. Proteins are of great nutritional value and are directly involved in the chemical processes essential for life. The importance of proteins was recognized by chemists in the early 19th century, including Swedish chemist Jöns Jacob Berzelius, who in 1838 coined the term *protein*, a word derived from the Greek *prōteios*, meaning “holding first place.” Proteins are species–specific; that is, the proteins of one species differ from those of another species. They are also organ–specific; for instance, within a single organism, muscle proteins differ from those of the brain and liver. A protein molecule is very large compared with molecules of sugar or salt and consists of many amino acids joined together to form long chains, much as beads are arranged on a string. There are about 20 different amino acids that occur naturally in proteins. Proteins of similar function have similar amino acid composition and sequence. Proteins are large biomolecules, or macromolecules, consisting of one or more long chains of amino acid residues. Proteins perform a vast array of functions within organisms, including catalysing metabolic reactions, DNA replication, responding to stimuli, providing structure to cells and organisms, and transporting molecules from one location to another. Proteins differ from one another primarily in their sequence of amino acids, which is dictated by the nucleotide sequence of their genes, and which usually results in protein folding into a specific 3D structure that determines its activity.

A linear chain of amino acid residues is called a polypeptide. A protein contains at least one long polypeptide. Short polypeptides, containing less than 20–30 residues, are rarely considered to be proteins and are commonly called peptides, or sometimes oligopeptides. The individual amino acid residues are bonded together by peptide bonds and adjacent amino acid residues. The sequence of amino acid residues in a protein is defined by the sequence of a gene, which is encoded in the genetic code. Some proteins have non–peptide groups attached, which can be called prosthetic groups or cofactors. Proteins can also work together to achieve a particular function, and they often associate to form stable protein complexes.

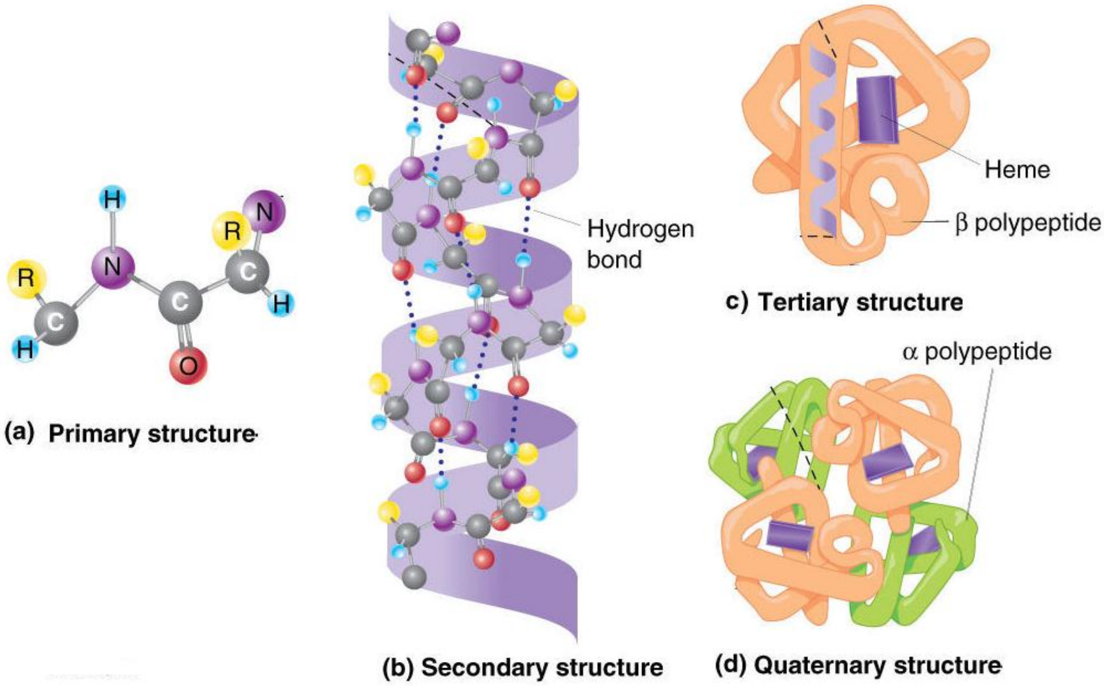
Broadly there are three categories of protein based on composition;

1. **SIMPLE PROTEINS** – A protein that contains amino acids only (Eg – albumin, globulin and histones)
2. **CONJUGATED PROTEIN** – A protein that have some non–protein moiety in its structure along with the protein part (Eg– myoglobulin, cytochromes)
3. **DERIVED PROTEIN** – Proteins derived from simple and conjugated proteins by physical or chemical treatment. (Eg – denatured proteins and peptones peptides)

On the basis of shape and size protein is divided into two parts:

1. **FIBROUS PROTEINS** – They are found only in animals. They usually serve as structural entities and are normally insoluble in water. (Eg – Insulin, plasma alumin)
2. **GLOBULAR PROTEINS** – They usually donot serve a structural function, they act as transporters and are usually water soluble. (Eg – collagen, keratin, elastin)

As we mentioned, the shape of a protein is very important to its function. To understand how a protein gets its final shape or conformation, we need to understand the four levels of protein structure: primary, secondary, tertiary, and quaternary:



Figure–13: Four structures of proteins.

1. **PRIMARY STRUCTURE** – The simplest level of protein structure, primary structure, is simply the sequence of amino acids in a polypeptide chain. The simplest level of protein structure, primary structure, is simply the sequence of amino acids in a polypeptide chain. A protein's primary structure is the unique sequence of amino acids in each polypeptide chain that makes up the protein.
2. **SECONDARY STRUCTURE** – The secondary structure of protein is defined by steric relationships between the amino acids that are close to each other in the primary amino acid sequence. Protein secondary structure is the three–dimensional form of *local segments* of proteins. The two most common secondary structural elements are alpha helices and beta sheets, though beta turns and omega loops occur as well. Secondary structure is formally defined by the pattern of hydrogen bonds between the amino hydrogen and carboxyl oxygen atoms in the peptide backbone.
3. **TERTIARY STRUCTURE** – Protein tertiary structure is the three–dimensional shape of a protein. The tertiary structure will have a single polypeptide chain "backbone" with one or more protein

secondary structures, the protein domains. Amino acid side chains may interact and bond in a number of ways. The interactions and bonds of side chains within a particular protein determine its tertiary structure. The protein tertiary structure is defined by its atomic coordinates.

4. **QUATERNARY STRUCTURE** – Protein quaternary structure is the number and arrangement of multiple folded protein subunits in a multi–subunit complex. It includes organizations from simple dimers to large homooligomers and complexes with defined or variable numbers of subunits. The quaternary structure of a protein is the association of several protein chains or subunits into a closely packed arrangement. Each of the subunits has its own primary, secondary, and tertiary structure.[5]

SOURCE

Protein from food comes from plant and animal sources such as meat and fish, eggs, dairy products, seeds and nuts, and legumes like beans and lentils. Some food sources of dietary protein include:

- Lean meats – beef, lamb, veal, pork, kangaroo
- Poultry – chicken, turkey, duck, emu, goose, bush birds
- Fish and seafood – fish, prawns, crab, lobster, mussels, oysters, scallops, clams
- Eggs
- Dairy products – milk, yoghurt (especially Greek yoghurt), cheese (especially cottage cheese)
- Nuts (including nut pastes) and seeds – almonds, pine nuts, walnuts, macadamias, hazelnuts, cashews, pumpkin seeds, sesame seeds, sunflower seeds
- Legumes and beans – all beans, lentils, chickpeas, split peas, tofu.

Some grain and cereal–based products are also sources of protein but are generally not as high in protein as meat and meat–alternative products.

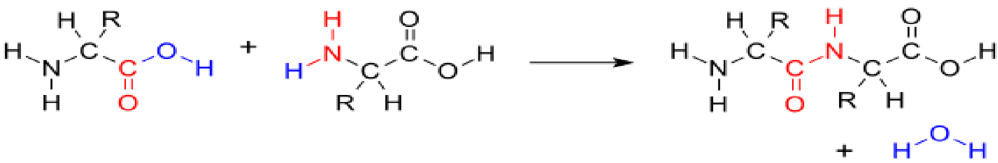
Meat, dairy, eggs, soy, fish, whole grains, and cereals are sources of protein. Examples of food staples and cereal sources of protein, each with a concentration greater than 7%, are (in no particular order) buckwheat, oats, rye, millet, maize (corn), rice, wheat, sorghum, amaranth, and quinoa. Some research highlights game meat as a protein source.

Vegetarian sources of proteins include legumes, nuts, seeds and fruits. Vegetarian foods with protein concentrations greater than 7% include soybeans, lentils, kidney beans, white beans, mung beans, chickpeas, cowpeas, lima beans, pigeon peas, lupines, wing beans, almonds, Brazil nuts, cashews, pecans, walnuts, cotton seeds, pumpkin seeds, hemp seeds, sesame seeds, and sunflower seeds.

Figure–14: Sources of Yummy Protein Ready to go inside Tummy.

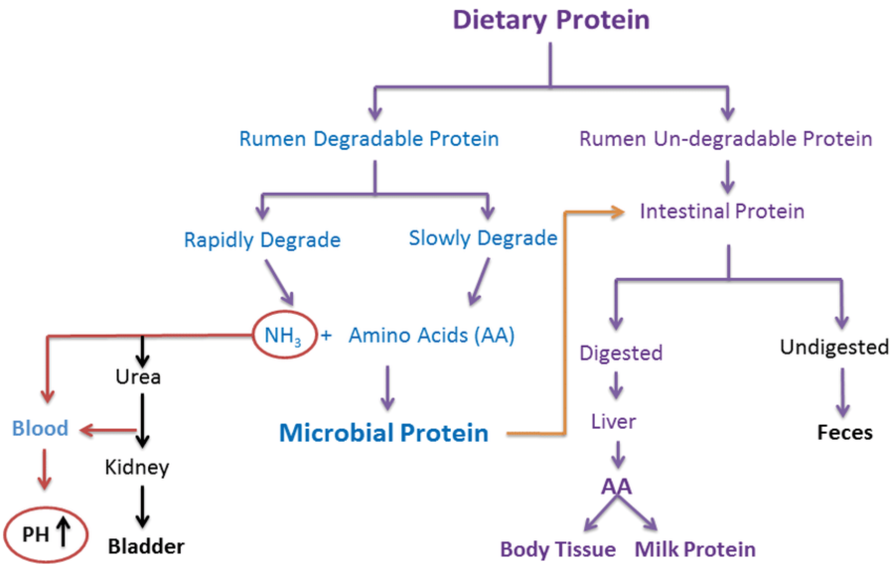
PEPTIDE BOND: A peptide bond [–NH–CO–] is a chemical bond formed between two molecules when the carboxyl group of one molecule reacts with the amino group of the other molecule, releasing a molecule of water (H_2O). This is a dehydration synthesis reaction (also known as a condensation reaction), and usually occurs between amino acids. A peptide bond is an amide type of covalent chemical bond linking two consecutive alpha–amino acids from C–1 (carbon number one) of one alpha–amino acid and N–2 (nitrogen number two) of another, along a peptide or protein chain. It can also be called an eupeptide bond to separate it from an isopeptide bond, a different type of amide bond between two amino acids.

When two amino acids form a *dipeptide* through a *peptide bond*, it is a type of condensation reaction. In this kind of condensation, two amino acids approach each other, with the non–side chain (C–1) carboxylic acid moiety of one coming near the non–side chain (N–2) amino moiety of the other. One loses a hydrogen and oxygen from its carboxyl group (COOH) and the other loses a hydrogen from its amino group (NH_2). This reaction produces a molecule of water (H_2O) and two amino acids joined by a peptide bond (–CO–NH–). The two joined amino acids are called a dipeptide.



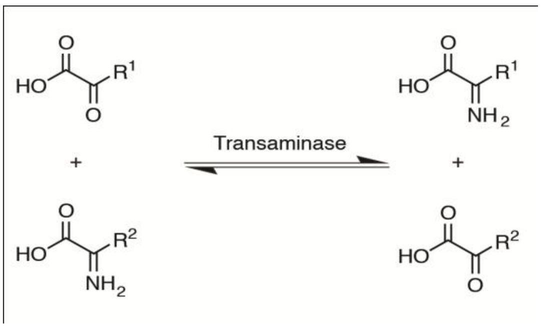
Figure–15: Dipeptide Bonds.

METABOLISM: Protein metabolism denotes the various biochemical processes responsible for the synthesis of proteins and amino acids (anabolism), and the breakdown of proteins by catabolism. Protein metabolism occurs in liver, specifically, the deamination of amino acids, urea formation for removal of ammonia, plasma protein synthesis, and in the interconversions between amino acids. Ingested protein is the sole source of the ten essential amino acids, and the primary source of nitrogen necessary for the synthesis of other amino acids. Protein is digested and broken down to amino acids which are absorbed into the circulation and taken to cells throughout the body, primarily the liver and quickly become combined by peptide linkages.[6]



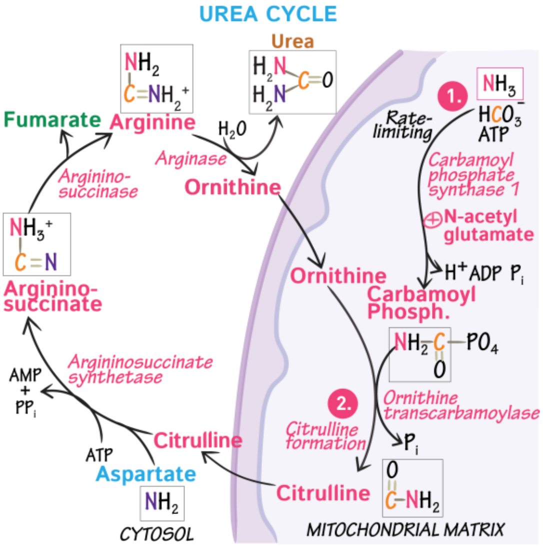
Figure–16: Protein metabolism.

Absorbed proteins are used for anabolic purposes such as synthesis of nonessential amino acids, tissue protein synthesis, enzyme or hormone synthesis, deamination, or transamination. The liver is the major site of amino acid metabolism. The liver has enzymes such as transaminases and is responsible for nonessential amino acid synthesis through a process called transamination. In this reaction, an amino group from one amino acid is transferred to an organic acid to form a new amino acid. Vitamin B6 (pyridoxine) is needed for transaminase activity. Transamination also provides a link between protein and carbohydrate metabolism, where certain amino acids can use their C skeleton for glucose synthesis. Deamination is the removal of amino groups from amino acids to form ammonia. This process is needed for getting rid of nitrogen from the animal's body. After deamination or transamination, C skeletons are left and are used for making glucose, ketone bodies, or energy production.



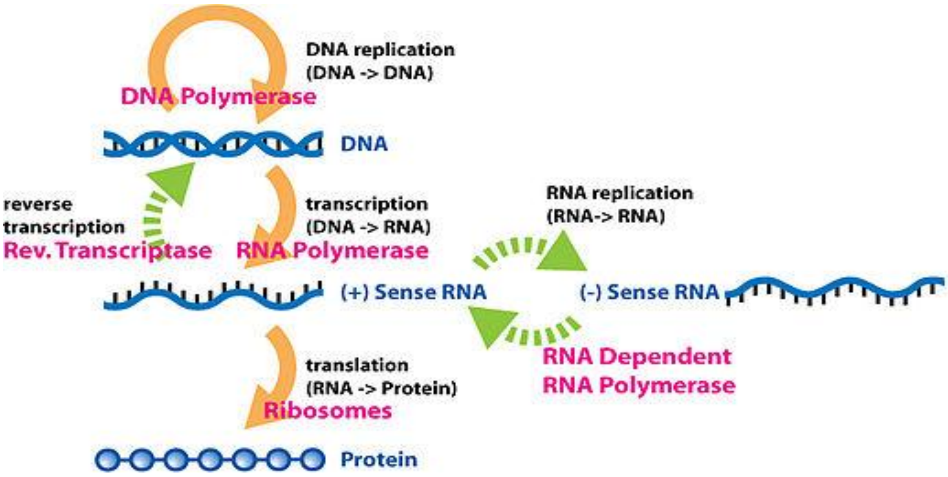
Figure–17: Transamination.

The ammonia liberated from amino acid degradation is toxic to the central nervous and needs to be excreted or detoxified. Most mammals detoxify ammonia and excrete it as urea in the urine, while birds excrete it as uric acid (a white substance in the excreta). The detoxification of ammonia to form urea is brought about by the urea cycle through two tissues. Two nonprotein amino acids (amino acids not used for protein synthesis) involved in the urea cycle are ornithine and citrulline. The first step in the urea cycle is the formation of carbamoyl phosphate through the condensation of ammonium ions with bicarbonate ions in the mitochondria of the liver. Ornithine reacts with a compound called carbamoyl phosphate and forms citrulline. Citrulline is easily permeable and gets into the cytosol and reacts with aspartate, forming argininosuccinate (2 ATP needed). The enzyme argininosuccinate lyase cleaves argininosuccinate into arginine and fumarate and fumarate enters the TCA cycle. Arginine is lysed into ornithine and splits urea off, producing ornithine, to start the cycle again. Hence arginine can be a nonessential amino acid but not available for protein synthesis.



Figure–18: Urea Cycle.

Protein synthesis occurs in every tissue of the body. Protein synthesis lies ultimately in the genetic code. Briefly, nucleic acids such as deoxyribonucleic acid (DNA; molecule that stores genetic information) and ribonucleic acid (RNA) consists of nucleotides. DNA contains the genetic code of the animal and is the blueprint of protein synthesis. DNA controls the formation of RNA (a template for transcription). Each tRNA carries a specific amino acid. Messenger RNA determines the sequence of amino acids (translation) in the protein formed. Both messenger RNA (mRNA) and tRNA are produced from the DNA template. The synthesis of each protein is controlled by a different mRNA. As the peptide chain is formed, an empty space cannot be formed, which limits the peptide chain formation and protein synthesis. All 20 amino acids are needed for protein synthesis. For example, lack of essential amino acid in the diet can stop peptide chain formation and protein synthesis and affect body weight gain and animal performance.



Figure–19: Central Dogma.

Protein turnover is a dynamic process involving continuous and simultaneous protein synthesis and protein degradation. The net rate of protein gain or loss is governed by the balance of synthesis and degenerative processes.[7]

FUNCTION

1. Protein has a critical physiological function. It is primarily used in the body to build, maintain, and repair body tissues.
2. In the event that protein intake is greater than that required by the body for this primary function, excessive protein is converted to energy for immediate use or stored in the body as fat.
3. Protein energy will be used only after other energy (carbohydrate and fat) are exhausted or unavailable.
4. Proteins transport small molecules through the organism. Hemoglobin is the protein that transports oxygen to cells and it is called as transport protein.
5. Proteins called antibodies help rid the body of foreign protein and help prevent infections, illness and diseases. (Eg– Immunoglobulins)

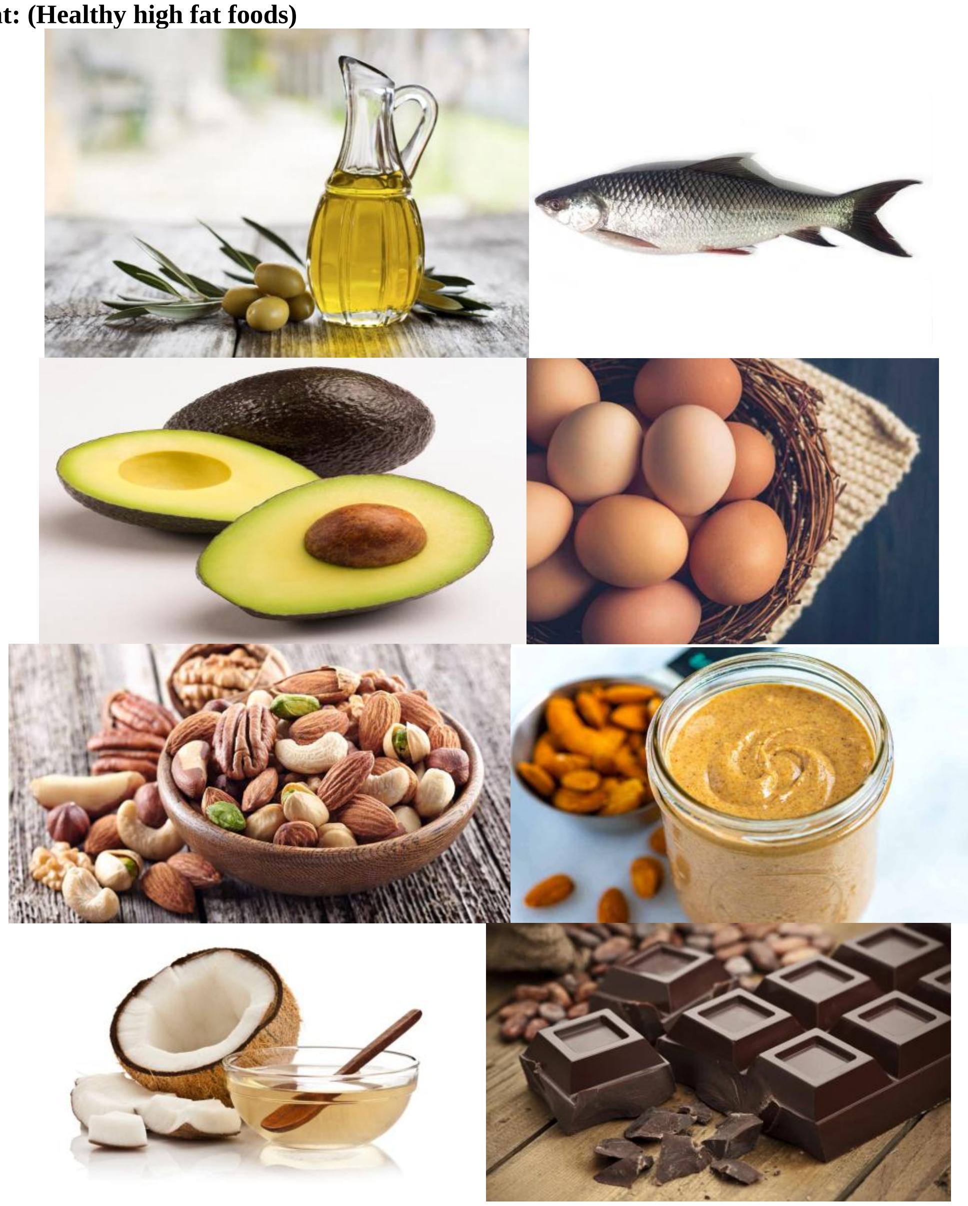
6. It helps store other substance in the organism. For example, iron is stored in the liver in a complex with the protein ferritin.
7. Protein produces enzymes that increase the rate of chemical reactions in the body.
8. Protein is involved in the creation of some hormones; help control body functions that involve the interaction of several organs and help regulate cell growth. (Eg– Insulin)
9. Movement proteins are muscle proteins.
10. Nerve impulse transmission proteins are receptor of small molecules that pass between gaps separating nerve cells.
11. Structural proteins define cell shape and comprise body structures.

FAT: Fat is an essential part of our diet and is important for good health. There are different types of fats, with some fats being healthier than others. To help make sure you stay healthy, it is important to eat unsaturated fats in small amounts as part of a balanced diet.

When eaten in large amounts, all fats, including healthy fats, can contribute to weight gain. Fat is higher in energy (kilojoules) than any other nutrient and so eating less fat overall is likely to help with weight loss.

Eating less saturated and trans fats may help lower your risk of heart disease. When buying products check the labels and choose the varieties that are lower in saturated and trans fats and higher in poly and monounsaturated fats. So a diet that is low in saturated fats and Trans fats, but that also includes moderate amounts of unsaturated fats will help you stay healthy.

Sources of Fat: (Healthy high fat foods)



Figure–20: Source Of Fat.

Olive Oil: Olive oil is the original healthy fat. A tall body of research finds that it helps lower your risk for heart disease, cancer, and diabetes. Most recently, Spanish researchers publishing in the journal *Molecules* reported that the various components of olive oil including oleic acid and secoiridoids protect your body on the cellular level to slow the aging process. "To get the most health benefits, choose extra–virgin olive oil, as it is extracted using natural methods and doesn't go through as much processing before it reaches your plate," says Elliott. Research shows that veggies sautéed in olive oil are also richer in antioxidants than boiled ones—and they taste better too! Don't go crazy though. All fats are relatively high in calories and 1 tablespoon of olive oil has about 120 calories.

Fish: You may have heard your mother or grandmother describe fish as "brain food." That's because these swimmers are brimming with omega–3 fatty acids, which are essential for brain function, says Elliot. "Your brain is made up of mostly fat, so you need to consume them in order to stay sharp and healthy," she says. The new Dietary Guidelines recommend eating 8 ounces per week to get healthy amounts of polyunsaturated omega–3 fatty acids, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), all of which feed your brain and fight inflammation and chronic disease. If you're concerned about mercury, choose salmon, anchovies, herring, shad, sardines, Pacific oysters, trout, and Atlantic and Pacific mackerel (*not* king mackerel), according to the USDA.

Avocados: Avocados do more than provide the keystone ingredient for amazing guac. They also help lower inflammation, which is linked to cardiovascular disease. In a 2014 study, a team of Mexican researchers fed a group of rats too much sugar, which gave them symptoms of metabolic syndrome, including high blood sugar, cholesterol, and triglycerides. They then fed the rats avocado oil, which lowered levels of triglycerides and LDL (bad) cholesterol in their blood, while keeping protective HDL (good) cholesterol levels intact. "You need to consume healthy fats in order for your body to absorb fat–soluble vitamins A, D, E, and K—pair them with a salad so you can reap the benefits of all those veggies!" says Elliot. Keep your overall calorie intake in mind; one avocado is about 320 calories. An easy way to get a good dose is with avocado toast, which can work as a complete breakfast, snack, lunch or even an easy dinner.

Eggs: The 2015–2020 Dietary Guidelines lifted the longstanding hard limit on cholesterol, as many researchers now believe the cholesterol you eat doesn't have that much bearing on the amount of artery–clogging LDL cholesterol floating in your bloodstream, and that saturated fat (like fatty meats) and genetic makeup are the real driving force behind dangerously high cholesterol. That's good news, since research finds that eating eggs in the morning can help you feel full and satisfied longer, making it easier to resist those pastries in your office pantry. "Eggs from hens that are raised on pastures or fed omega–3 enriched feed tends to be higher in omega–3s," says Elliot.[8]

Tree Nuts: Nuts are nature's most perfect portable snack. Each handful packs a powerhouse of nutrients including amino acids, vitamin E, and unsaturated fatty acids. In one long–term study published last year in the *British Journal of Nutrition*, eating a daily one–ounce serving of nuts was associated with a 50% lower incidence of diabetes, a 30% reduction in heart disease, and a nearly 50% lower incidence of stroke. (Note: The International Nut and Dried Fruit Council helped fund this particular study, but the general health benefits of nuts have been well established.) Before you chow down, beware the "candyfication" of nuts. Skip any that say "candied," "honeyed," or "glazed," and read ingredients lists carefully. "Make sure there aren't any added ingredients, such as sugar and other vegetable oils," Elliot says. "There is no need for oils to be added to nuts because they already have their own!"

Nut Butter: Those PB&J's your mom put in your lunch bag (and maybe you put in your own kid's now) are also really good for you. In a 2013 study published in *Breast Cancer Research Treatment* and funded in part by the National Institutes of Health, girls who regularly ate peanut butter between the ages of 9 and 15 were 39% less likely to develop benign breast disease by age 30. Today, you can buy nut butters of all kinds including almond, cashew, and more. "The healthy fats in nut butters can help to keep you full and satisfied," says Elliot. "Just make sure that the nut is the only ingredient listed (along with salt with some brands). Avoid those that have added sugars or vegetable oils."

Coconut Oil: Coconut oil used to get a bad rap because its calories come predominantly from saturated fats. Now it's receiving some well–deserved vindication, says Elliot. The main type of saturated fat in coconut oil is lauric acid, "which is known for its anti–inflammatory and anti–bacterial properties," says Elliot. "Coconut oil is also unique from other sources of saturated fats because it contains medium chain triglycerides (MCTs) which are metabolized differently—they go straight from the liver to the digestive tract and can then be used as a quick source of energy rather than getting stored. It's also a very stable fat and is great for cooking with high temperatures." For a tasty treat whip up a coconut oil latte!

Dark Chocolate: For years, many of us reserved chocolate for an occasional indulgence. Now we know that a daily chunk of dark chocolate, which is a source of healthy fats, actually protects the heart. Researchers from Louisiana State University reported that when you eat dark chocolate, good gut microbes like Bifidobacterium and lactic acid bacteria feast on it and they grow and ferment it, which produces anti–inflammatory compounds that protect your cardiovascular health. The sweet may also keep you slim. One study published in Archives of Internal Medicine found that folks who eat chocolate five times a week have a lower BMI and are about 6 pounds lighter than those who don't eat any.

Greek Yogurt: About 70% of the fat in Greek Yoghurt is saturated, but you may notice about a gram of trans fat on the label. Not to worry: unless you see partially hydrogenated oil on the ingredients list (which is unlikely), then it's a naturally occurring type of trans fat called conjugated linoleic acid (CLA). "While man–made trans fats are very unhealthy, ruminant trans fats like CLA may help to protect against type 2 diabetes, heart disease, and cancer," Elliot explains. "To get the most bang for your buck when it comes to yogurt, aim for grass–fed, full–fat yogurt. You'll also want to make sure to choose plain yogurt because flavored yogurts are typically full of added sugars and artificial sweeteners."

The new guidelines recommend choosing low fat or fat free dairy, including milk, when possible.

Olives: The oil from these pressed gems steals the health spotlight, but the fruits themselves deserve a prominent position on stage—and your plate. Naturally, they are rich in oleic acid, the monounsaturated fatty acid that protects your heart. They're also rich in antioxidant polyphenols, which protect you from cell damage, as well as iron, fiber, and copper. "Expand your horizons beyond the ripe black olives found on pizzas," says Leslie Bonci, RD, sports nutritionist at Pittsburgh–based Company Active Eating Advice. "Markets have huge olive bars with a wide array of sizes, colors, and textures. Even if you think you don't like olives, there may be a kind you do; you just haven't found it yet." Just keep in mind that they can be high in sodium. The Guidelines recommend no more than 2,300 mg of sodium per day for those 14 and older.

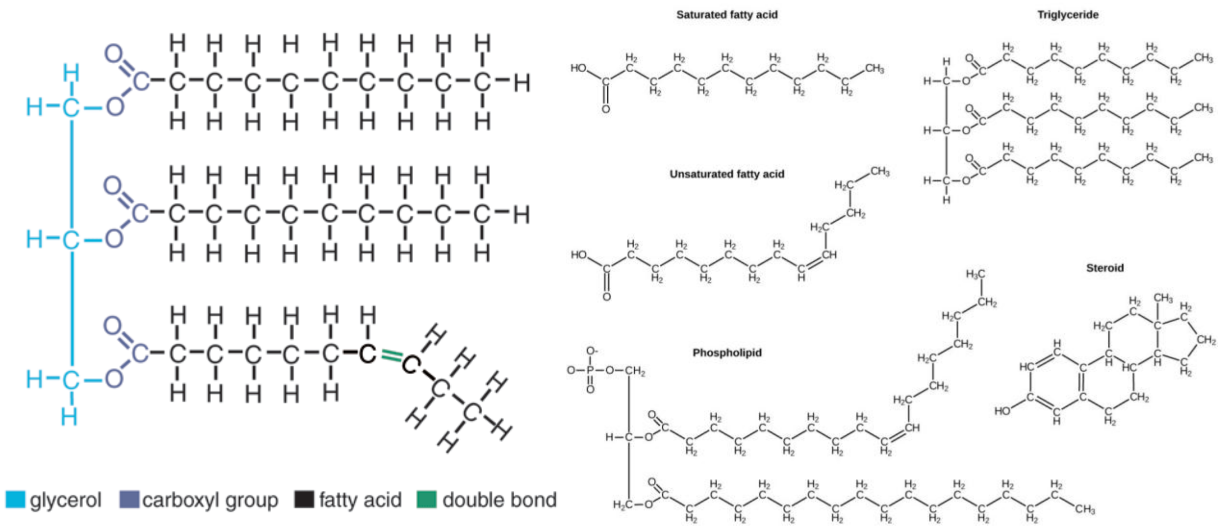
Seeds: Seeds are so tiny; it's easy to dismiss them as sprinkles for salads or flavoring for bread. But it's time to regard these crunchy add–ons as more than a garnish and as the nutritional powerhouses they are. Seeds like pumpkin, hemp, flax (grind these in a coffee grinder to release nutrients), chia, and sunflower are rich in monounsaturated fats like omega–3 fatty acids, which suppress inflammation. They're also a good source of protein, fiber, and vitamins and minerals like vitamin E, iron, and magnesium. "Pumpkin seeds have been found to be especially helpful for balancing blood sugar," says Stanford University nutrition scientist Stacy Sims, PhD.

Soybeans: Soybeans are one of the few beans that are not only rich in protein, but also a good source of essential fatty acids. So they make a fiber–rich meat substitute. "Soybeans—dried or fresh—are healthy sources of complete protein as well as is flavones (a form of plant–based estrogen), fiber, and vitamins and minerals," says Bonci. "That's also true for soy milk, miso and tofu." That's not to say veggie corn dogs are a health food, however. "Meat analogs like Fakin Bacon are primarily soy protein without the other healthful components. So choose whole soy foods for health benefits."

Cheese: Cheese has long been regarded as dietary villain that packs up your arteries like a stuffed pizza crust. Curbing highly processed, sodium–packed cheese products is still smart, but you can make room for a good cheese plate. In fact, some studies have found that people who regularly eat cheese have lower risk of high LDL cholesterol and heart disease. Aged cheeses like Parmesan are also a good source of probiotics, which promote healthy digestion and weight. "Cheese is full of good nutrients like phosphorous, protein, and calcium that people forget about because of the fat issue," says Sims. "It also increases levels of butyric acid in the body, which has been linked to lower obesity risk and a faster metabolism." One of the healthiest ways to get your cheese fix: As a garnish on a salad. It adds flavor to your bowl, and the fat helps you absorb the nutrients in the veggies.

Types of fat: Fat is organized into two subgroups: **saturated fa**t, and **unsaturated fat**. Unsaturated fat is further classified as **monounsaturated fat**, **polyunsaturated fat**, and **trans–fat**. These different classifications determine the effects of these fats on an organism, and the roles that they have in metabolism.

Saturated fat, or animal fat, is composed of a glycerol backbone with three fully saturated fatty acids attached. *Saturated* refers to all the carbons in the backbone being sp^3 hybridized, with two hydrogen atoms covalently bonded per carbon. This class of fats has higher viscosity and energy content than their unsaturated cousins. Due to poor solubility issues, this is the type of fat that is most commonly associated with heart disease. Examples of saturated fat include animal fat found on beef, pork, and chicken. Since these types of fats are also called "animal fats", they are primarily found in animals. Saturated fat measurements are used in medical diagnostic tests as inverse indicators of a healthy lifestyle.[9]



Figure–21: Fat structures.

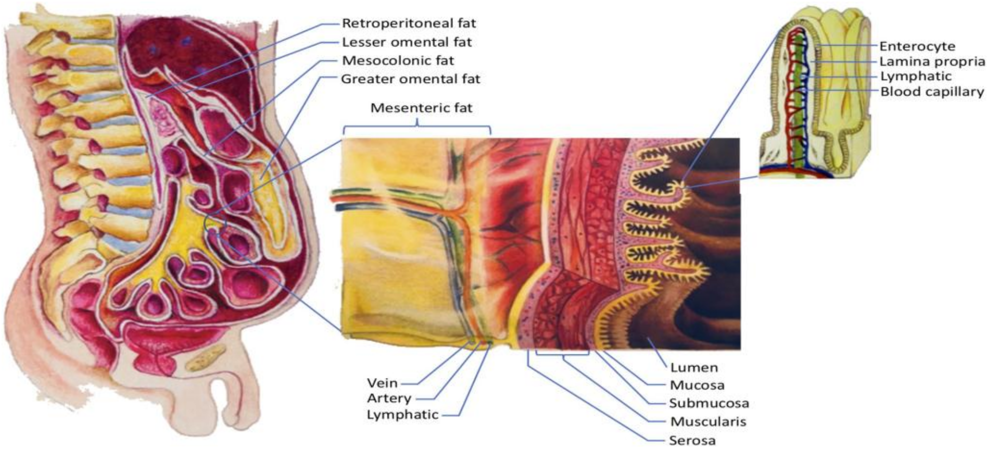
Unsaturated fat, or vegetable fat, is composed of a glycerol backbone with three fatty acid chains where there is at least one sp^2 hybridized carbon. This forms a double bond somewhere in the chain. Monounsaturated fats have one double bond in the chain, while polyunsaturated fats have two or more. Naturally occurring unsaturated fats, since they are produced by enzymes, have specific stereochemistry. Natural fats always show the *cis* conformation, which has a higher solubility in water, and is easily broken down by the metabolic machinery. Artificially produced fats, since they are produced using organic synthesis techniques, contain a racemic mixture of trans and cis bonds. Tran's fats are less soluble – like saturated fats. However, they are not readily metabolized by cellular machinery. Monounsaturated fats are often referred to as "good" fats. They make up the oils and fats found in avocados and olive oil. Polyunsaturated fats are found in canola oil and other less viscous plant oils.

Types of Unsaturation: The unsaturated fats are classified by the position of the Unsaturation. This designation is denoted by the ω symbol, then the number of carbons with the Unsaturation. For example, ω–3 fats have an Unsaturation at the third carbon position. Ω–3, 7 polyunsaturated fats have an Unsaturation at the third and seventh carbon position. The position of the Unsaturation determines the metabolic pathway that the fat will follow.

Tran's fats are chemically produced fats. They are generally considered to be unhealthy and are found in mass produced oil found in processed and fried foods. Tran's fats have a controversial history. They have even been banned for consumer use in some countries.

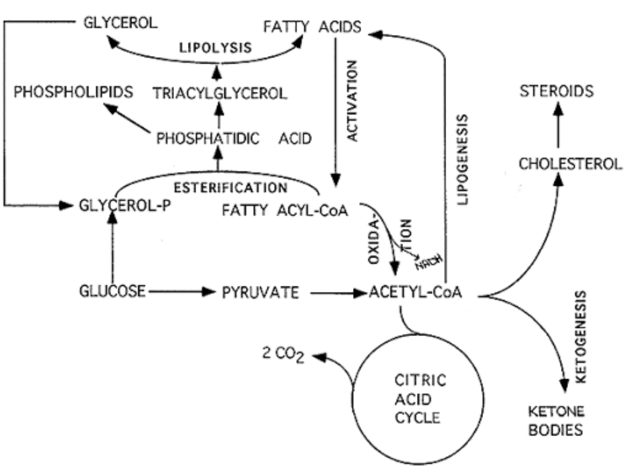
Mechanism of fat absorption in human body

Most dietary fat of either vegetable or animal origin comprises of triglycerides in which glycerol is combined in low–energy ester linkages with three fatty acids and the fatty acids are of even number of carbon atoms. Fatty acids are both saturated and unsaturated which are almost entirely palmitic and stearic in case of former and in case of the latter oleic and linoleic acids. These are long–chain fatty acids. Milk fat contains 3–10% (C_4–C_{14} acids) contributing shorter–chain fatty acids. Since fats are insoluble in water and immiscible in chyme, so fat neither is absorbed as such nor is digested by lipase (due to lack of contact with lipase) to fatty acid and glycerol for absorption. Emulsification of fat by different emulsifying agent is required for preparing it suitable for both digestion and absorption and this process (emulsification) possible in small intestine where bile salt and other agents are present. Bile salts themselves are relatively weaker than the mixture of bile salts and a polar body—lecithin, lysolecithin or monoglycerides as emulsifying agent. The latter two are produced by the action of pancreatic lipase on lecithin or triglycerides. Thus the enzymic action tends to stabilize the emulsion. So fat digestion and absorption do not occur in stomach significantly which is devoid of emulsifying agent but natural (milk fat) or artificial emulsions are digested in the stomach. Recent studies account for many aspects of fat absorption better than previous supposition.



Figure–22: Different types of stored fat.

Aspects of Fat Absorption: It has been observed that fatty acid is absorbed more readily than any other components, i.e., triglycerides, I–monoglycerides, 2–monoglycerides, diglycerides and free fatty acids (which are formed in the sample collected near– the duodeno–jejunal junction) and the hydrolysis occurring in the lumen is faster than the absorption of free fatty acid. There is spontaneous migration of fatty acids from one alcohol group to another in the glycerol. The chief products of luminal hydrolysis of triglycerides are 2–monoglycerides and free fatty acid. Glycerol and 1–monoglycerides are quantitatively less important while fat are undergoing digestion and absorption. The fat is distributed among the emulsified fat droplets, micelles (small), hydrated polymolecular aggregates and molecular solution. Micelles of intestine contain three major components as bile salts, monoglycerides and fatty acids. The salts spontaneously aggregate with monoglycerides and form micelles when the concentration of bile salts attains a certain value known as critical micellar concentration. Since the concentration of conjugated bile salts remains always higher than the critical micellar concentration (at ordinary circumstances), the monoglycerides rapidly form micelles as soon as they are liberated from triglycerides by lipase actively with bile salt. As the micelle once formed it dissolves free fatty acid, cholesterol and fat–soluble vitamins and dissolution varies directly up to a limit with the amount of monoglycerides contained in it. But the unconjugated bile salt has got higher critical micellar concentration for which fat absorption is inhibited when bile salts are deconjugated in the gut. The inhibition of absorption of fat (due to de–conjugation) is for the inability of micellar solution at this condition of holding monoglycerides and free fatty acids liberated from lipolysis and thereby these are precipitated and become unavailable for absorption. Lipid molecules in solution can diffuse into the epithelial cells through its lipoprotein membrane. So the metabolic machinery contained in the endoplasmic reticulum of the cell takes up monoglycerides and free fatty acid and rapidly synthesizes them into triglycerides.[10]



Figure–23: Fat metabolism.

Diffusion gradient from lumen to cell down which free fatty acid and monoglycerides flow is present till the completion of absorption. The gradient is produced by immediate replacement of monoglycerides and free fatty acids in the solution from the micellar phase as they leave the luminal solution and consequently the luminal solution remains saturated with free fatty acid and monoglycerides. Of the fat digestion products, the monoglycerides and fatty acids are separated from micelles to be absorbed in the duodenum and jejunum and conjugated bile salts only in the terminal ileum. The bile salts being insoluble in the cell membrane (due to their charge) must be actively transported. The rate of their absorption is proportional to their solubility and hence the more soluble monoglycerides are absorbed first and then follow other substances in the order of their solubility, viz., long–chain fatty acid, cholesterol, short and medium–chain fatty acids. And the triglycerides of these acids are absorbed without passing through the micellar phase since they are relatively solution as well as in the cell membrane. Fat aggregation does not take place in the space between the microvilli and endoplasmic reticulum when fat re–synthesis occurs. Lysolecithin enters into the mucosal cell as such and its base is separated there by phosphodiesterase and its fatty acid by lysophosphatidase and finally glycerol and phosphate are separated by non–specific phosphates. Within the cells monoglycerides without further hydrolysis (of long–chain fatty acid) are resynthesized to triglycerides or phospholipids. The shorter–chain fatty acid ester is hydrolysed by lipase (intracellular) and not those of long–chain fatty acids, (i.e., dietary fat). Mucosal cells can synthesis long–chain fatty acid, i.e., stearic acid (C_{18}) from acetic acid as well as palmitic acid (C_{16}) to stearic acid (C_{18}) with acetic acid. Glycerol liberated in the lumen by hydrolysis of triglycerides is partly oxidized in mucosal cell to CO_2 and partly goes to liver for its conversion to glycogen and remaining is utilized in the re–synthesis of triglycerides. The glycerol required for the re–synthesis of triglycerides is also derived from glucose (glycolytic path). Resynthesized fat is absorbed into the lymph.

Intracellular Fat Transport: After re–synthesis, the fats are accumulated more in the apical cells of the tip of villi than at the sides and they are restricted in the supranuclear part of the cell. It appears first as discrete particles in the endoplasmic reticulum. Microsomes derived from the reticulum contain enzymes which resynthesize triglycerides. So fat is seen to be deposited in the reticulum. Re–synthesis and absorption take place simultaneously. The entire reticulum is filled with fat droplets and then the fat moves to the supranuclear part of the cell acquiring along its way an envelope of phospholipid and protein and finally they are expelled from the sides of the cell at or below the level of the nucleus.

Adverse effects of fat on human body: Saturated fatty acids are commonly judged to have a negative health impact as they lead to increased serum cholesterol levels and a higher risk of coronary heart disease. Therefore, all recommendations stress the importance to limit the intake of saturated fatty acids. Monounsaturated fatty acids, on the other hand, have a positive impact on the serum lipid profile, lead to decreased LDL–oxidation and favourably influence the metabolism of diabetics. However, it is essential that monounsaturated fatty acids be mainly supplied by plant oils like rape seed or olive oil and not by foods that are simultaneously rich in saturated fatty acids. Concerning polyunsaturated fatty acids, it is important to increase the supply of n–3 fatty acids (ratio of n–6: n–3: about 5:1) as there is substantial evidence for their protective effects. If the fatty acid composition of the diet is optimized, even a total dietary fat content of 35% of total energy intake can be adequate as long as there is enough physical activity and the diet is rich in plant–derived foods like vegetables, fruits, cereals, potatoes, beans and legumes.

Nervous System: Being overweight or having obesity greatly increases the risk of stroke, where blood stops flowing to your brain. Obesity can also have a profound effect on your mental health. This includes a higher risk of depression, poor self–esteem, and issues with body image.

Respiratory System: Fat stored around the neck can make the airway too small, which can make breathing difficult at night. This is called sleep apnea. Breathing may actually stop for short periods of time in people with sleep apnea.

Digestive System: Obesity has been associated with a higher risk of gastro esophageal reflux disease (GERD). GERD occurs when stomach acid leaks into the oesophagus. In addition, obesity increases the risk of developing gallstones. This is when bile builds up and hardens in the gallbladder. This may require surgery. Fat can also build up around the liver and lead to liver damage, scar tissues, and even liver failure.

Cardiovascular Endocrine System: In people with obesity, the heart needs to work harder to pump blood around the body. This leads to high blood pressure, or hypertension. High blood pressure is the leading cause of stroke. Obesity can also make the body's cells resistant to insulin. Insulin is a hormone that carries sugar from your blood to your cells, where it's used for energy. If you're resistant to insulin, the sugar can't be taken up by the cells, resulting in high blood sugar. This increases a person's risk of having type 2 diabetes, a condition where your blood sugar is too high. Type 2 diabetes is linked to a range of other health issues, including heart disease, kidney disease, stroke, amputation, and blindness. High blood pressure, high cholesterol, and high blood sugar on top of excess body fat can make the blood vessels that carry blood to the heart become hard and narrow. Hardened arteries, also called atherosclerosis, can increase the risk of heart attack and stroke. Diabetes and high blood pressure are also common causes of chronic kidney disease.[6]

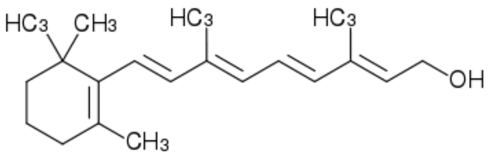
Reproductive System: Obesity can make it more difficult for a woman to get pregnant. It can also increase a woman's risk of having serious complications during pregnancy.

Skeletal and muscular system: Obesity can cause deteriorating bone density and muscle mass. This is referred to as osteosarcopenic obesity. Osteosarcopenic obesity can lead to a higher risk of fractures, physical disability, insulin resistance, and poorer overall health outcomes. Extra weight can also put too much pressure on the joints, leading to pain and stiffness.

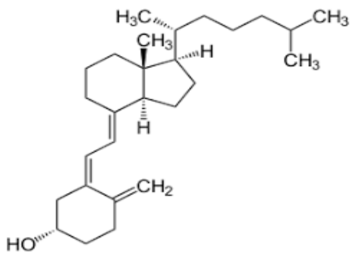
Integumentary Skin System: Rashes can occur where the skin of body fat folds. A condition known as acanthosis nigricans can also occur. Acanthosis nigricans is characterized by discoloration and thickening of the skin in the folds and creases of your body.

Other effects on the body: Obesity has been linked with an increased risk of many different types of cancers, including endometrial, liver, kidney, cervical, colon, esophageal, and pancreatic cancer, among others. As your body mass index (BMI) increases, so does your risk of developing cancer.

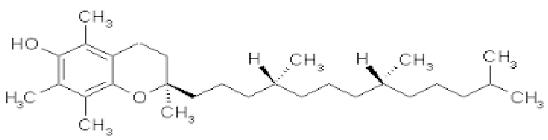
VITAMINS: The term *vitamin* is derived from the word *vitamine*, which was coined in 1912 by Polish biochemist Casimir Funk, who isolated a complex of micronutrients essential to life, all of which he presumed to be amines. When this presumption was later determined not to be true, the "e" was dropped from the name. All vitamins were discovered (identified) between 1913 and 1948.



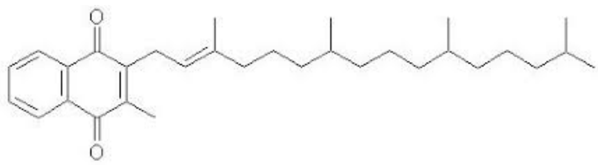
Vitamin–A



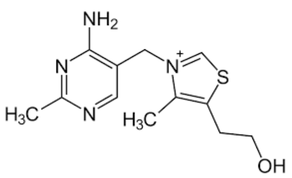
Vitamin–D



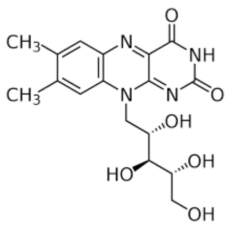
Vitamin–E



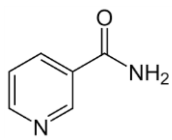
Vitamin–K



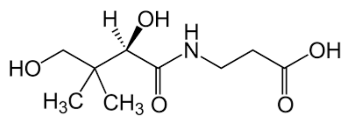
Vitamin–B1



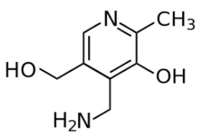
Vitamin–B2



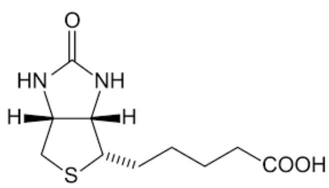
Vitamin–B3



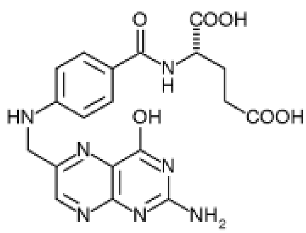
Vitamin–B5



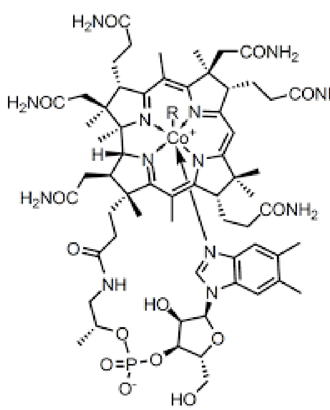
Vitamin–B6



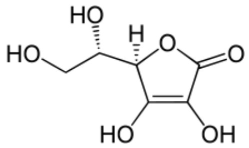
Vitamin–B7



Vitamin–B9



Vitamin–B12



Vitamin–C

Figure–24: Vitamines.

Classification: Vitamins are classified as either water–soluble or fat–soluble. In humans there are 13 vitamins: 4 fat–soluble (A, D, E, and K) and 9 water–soluble (8 B vitamins and vitamin C). Water–soluble vitamins dissolve easily in water and, in general, are readily excreted from the body, to the degree that urinary output is a strong predictor of vitamin consumption. Because they are not as readily stored, more consistent intake is important. Fat–soluble vitamins are absorbed through the intestinal tract with the help of lipids (fats). Vitamins A and D can accumulate in the body, which can result in dangerous hypervitaminosis. Fat–soluble vitamin deficiency due to malabsorption is of particular significance in cystic fibrosis.

Anti–vitamins: Anti–vitamins are chemical compounds that inhibit the absorption or actions of vitamins. For example, avidin is a protein in raw egg whites that inhibits the absorption of biotin; it is deactivated by cooking. Pyrithiamine, a synthetic compound, has a molecular structure similar to thiamine, vitamin B_1, and inhibits the enzymes that use thiamine.

Biochemical functions: Each vitamin is typically used in multiple reactions, and therefore most have multiple functions. **On foetal growth and childhood development:** Vitamins are essential for the normal growth and development of a multicellular organism. Using the genetic blueprint inherited from its parents, a foetus develops from the nutrients it absorbs. It requires certain vitamins and minerals to be present at certain times. These nutrients facilitate the chemical reactions that produce among other things, skin, bone, and muscle. If there is serious deficiency in one or more of these nutrients, a child may develop a deficiency disease. Even minor deficiencies may cause permanent damage.[11]

On adult health maintenance: Once growth and development are completed, vitamins remain essential nutrients for the healthy maintenance of the cells, tissues, and organs that make up a multicellular organism; they also enable a multicellular life form to efficiently use chemical energy provided by food it eats, and to help process the proteins, carbohydrates, and fats required for cellular respiration.

Sources: For the most part, vitamins are obtained from the diet, but some are acquired by other means: for example, microorganisms in the gut flora produce vitamin K and biotin; and one form of vitamin D is synthesized in skin cells when they are exposed to a certain wavelength of ultraviolet light present in sunlight. Humans can produce some vitamins from precursors they consume: for example, vitamin A is synthesized from beta carotene; and niacin is synthesized from the amino acid tryptophan. The Food Fortification Initiative lists countries which have mandatory fortification programs for vitamins folic acid, niacin, vitamin A and vitamins B1, B2 and B12.

Deficient intake: The body's stores for different vitamins vary widely; vitamins A, D, and B_{12} are stored in significant amounts, mainly in the liver, and an adult's diet may be deficient in vitamins A and D for many months and B_{12} in some cases for years, before developing a deficiency condition. However, vitamin B_3 (niacin and niacinamide) is not stored in significant amounts, so stores may last only a couple of weeks. For vitamin C, the first symptoms of scurvy in experimental studies of complete vitamin C deprivation in humans have varied widely, from a month to more than six months, depending on previous dietary history that determined body stores.

Figure–25: Food and Chemical Sources Vitamin.

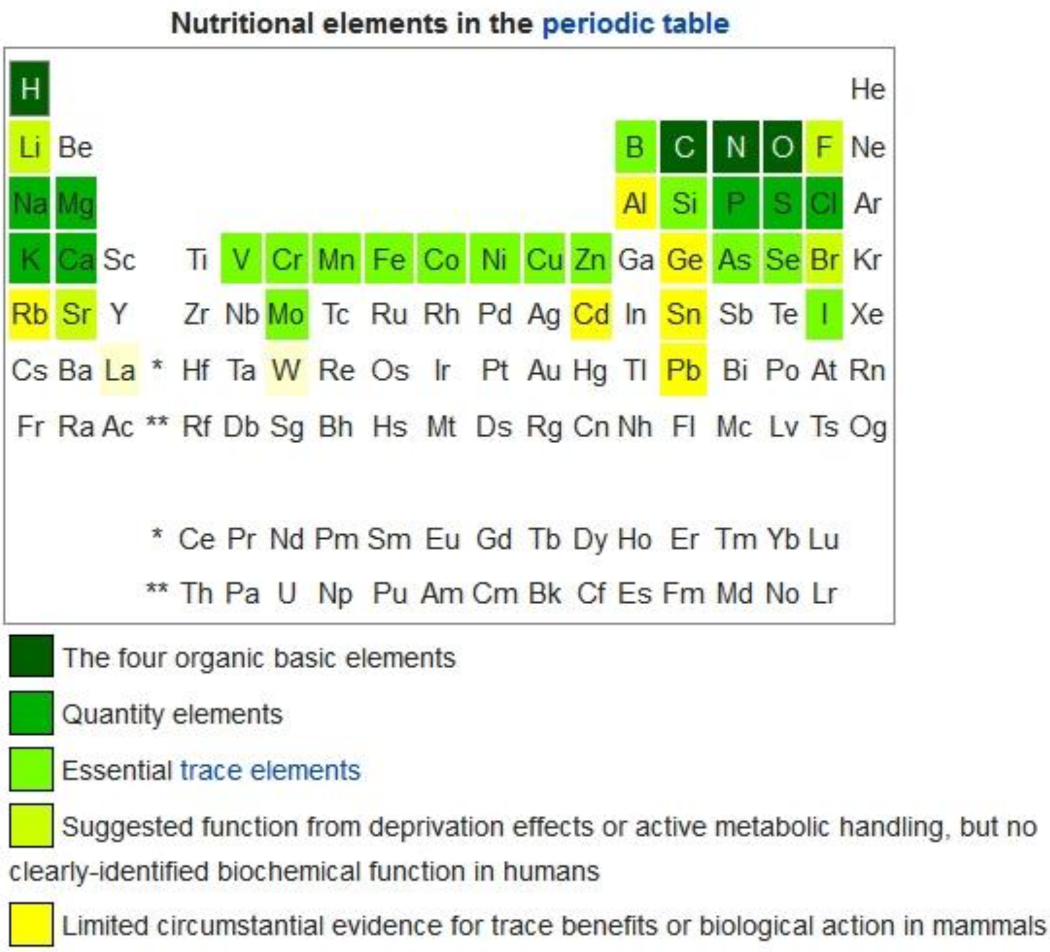
Deficiencies of vitamins are classified as either primary or secondary. A primary deficiency occurs when an organism does not get enough of the vitamin in its food. A secondary deficiency may be due to an underlying disorder that prevents or limits the absorption or use of the vitamin, due to a "lifestyle factor", such as smoking, excessive alcohol consumption, or the use of medications that interfere with the absorption or use of the vitamin. People who eat a varied diet are unlikely to develop a severe primary vitamin deficiency, but may be consuming less than the recommended amounts; a national food and supplement survey conducted in the US over 2003–2006 reported that over 90% of individuals who did not consume vitamin supplements were found to have inadequate levels of some of the essential vitamins, notably vitamins D and E. Well–researched human vitamin deficiencies involve Vitamin A (Eye problems, Night Blindness), thiamine (beriberi), niacin (pellagra), vitamin C (scurvy), folate (neural tube defects) and Vitamin D (rickets), Vitamin E (muscle weakness). In much of the developed world these deficiencies are rare due to an adequate supply of food and the addition of vitamins to common foods. In addition to these classical vitamin deficiency diseases, some evidence has also suggested links between vitamin deficiency and a number of different disorders.

Excess intake: Some vitamins have documented acute or chronic toxicity at larger intakes, which is referred to as hypertoxicity. The European Union and the governments of several countries have established Tolerable upper intake levels (ULs) for those vitamins which have documented toxicity. The likelihood of consuming too much of any vitamin from food is remote, but excessive intake (vitamin poisoning) from dietary supplements does occur. In 2016, overdose exposure to all formulations of vitamins and multi–vitamin/mineral formulations were reported by 63,931 individuals to the American Association of Poison Control Centers with 72% of these exposures in children under the age of five. In the US, analysis of a national diet and supplement survey reported that about 7% of adult supplement users exceeded the UL for folate and 5% of those older than age 50 years exceeded the UL for vitamin A.

Essential chemical elements for humans: At least twenty chemical elements are known to be *required* to support human biochemical processes by serving structural and functional roles as well as electrolytes.

Figure–26: Natural and Chemical Source of Medicine.

Oxygen, hydrogen, carbon and nitrogen are the most abundant elements in the body by weight and make up about 96% of the weight of a human body. Calcium makes up 920 to 1200 grams of adult body weight, with 99% of it contained in bones and teeth. This is about 1.5% of body weight. Phosphorus occurs in amounts of about 2/3 of calcium and makes up about 1% of a person's body weight. The other major minerals (potassium, sodium, chlorine, sulfur and magnesium) make up only about 0.85% of the weight of the body. Together these eleven chemical elements (H, C, N, O, Ca, P, K, Na, Cl, S, Mg) make up 99.85% of the body. The remaining ~18 ultratrace minerals comprise just 0.15% of the body, or about one hundred grams in total for the average person. Total fractions in this paragraph are WP: CALC amounts based on summing percentages from the article on chemical composition of the human body. Different opinions exist about the essential nature of various ultratrace elements in humans (and other mammals), even based on the same data. For example, there is no scientific consensus on whether chromium is an essential trace element in humans. The United States and Japan designate chromium as an essential nutrient, but the European Food Safety Authority (EFSA), representing the European Union, reviewed the question in 2014 and does not agree. Most of the known and suggested mineral nutrients are of relatively low atomic weight, and are reasonably common on land, or for sodium and iodine, in the ocean:



Figure–27: Nutrition in periodic table.

Blood concentrations of minerals: Minerals are present in a healthy human being's blood at certain mass and molar concentrations. The figure below presents the concentrations of each of the chemical elements discussed in this article, from center–right to the right. Depending on the concentrations, some are in upper part of the picture, while others are in the lower part. The figure includes the relative values of other constituents of blood such as hormones. In the figure, minerals are color highlighted in purple.

Dietary nutrition: Dietitians may recommend that minerals are best supplied by ingesting specific foods rich with the chemical element(s) of interest. The elements may be naturally present in the food (e.g., calcium in dairy milk) or added to the food (e.g., orange juice fortified with calcium; iodized salt fortified with iodine). Dietary supplements can be formulated to contain several different chemical elements (as compounds), a combination of vitamins and/or other chemical compounds, or a single element (as a compound or mixture of compounds), such as calcium (calcium carbonate, calcium citrate) or magnesium (magnesium oxide), or iron (ferrous sulfate, iron bis–glycinate). The dietary focus on chemical elements derives from an interest in supporting the biochemical reactions of metabolism with the required elemental components. Appropriate intake levels of certain chemical elements have been demonstrated to be required to maintain optimal health. Diet can meet all the body's chemical element requirements, although supplements can be used when some recommendations are not adequately met by the diet. An example would be a diet low in dairy products, and hence not meeting the recommendation for calcium.

Safety: The gap between recommended daily intake and what are considered safe upper limits (ULs) can be small. For example, for calcium the U.S. Food and Drug Administration set the recommended intake for adults over 70 years at 1,200 mg/day and the UL at 2,000 mg/day. The European Union also sets recommended amounts and upper limits, which are not always in accord with the U.S. Likewise, Japan, which sets the UL for iodine at 3000 µg versus 1100 for the U.S. and 600 for the EU. In the table above, magnesium appears to be an anomaly as the recommended intake for adult men is 420 mg/day (women 350 mg/day) while the UL is lower than the recommended, at 350 mg. The reason is that the UL is specific to consuming more than 350 mg of magnesium all at once, in the form of a dietary supplement, as this may cause diarrhea. Magnesium–rich foods do not cause this problem.

Element	Description	Excess
Bromine	Possibly important to basement membrane architecture and tissue development, as a needed catalyst to make collagen IV.	bromism
Arsenic	Essential in rat, hamster, goat and chicken models, but no research has been done in humans.	arsenic poisoning
Nickel	Nickel is an essential component of several enzymes, including urease and hydrogenase. Although not required by humans, some are thought to be required by gut bacteria, such as urease required by some varieties of Bifidobacterium. In humans, nickel may be a cofactor or structural component of certain metalloenzymes involved in hydrolysis, redox reactions and gene expression. Nickel deficiency depressed growth in goats, pigs, and sheep, and diminished circulating thyroid hormone concentration in rats.	Nickel toxicity
Fluorine	Fluorine (as fluoride) is not considered an essential element because humans do not require it for growth or to sustain life. Research indicates that the primary dental benefit from fluoride occurs at the surface from topical exposure. Of the minerals in this table, fluoride is the only one for which the U.S. Institute of Medicine has established an Adequate Intake.	Fluoride poisoning
Boron	Boron is an essential plant nutrient, required primarily for maintaining the integrity of cell walls. Boron has been shown to be essential to complete the life cycle in representatives of all kingdoms of life. In animals, supplemental boron has been shown to reduce calcium excretion and activate vitamin D.	No acute effects (LD50 of boric acid is 2.5 grams per kilogram body weight) Chronic effects of long–term high dose boron exposure are not fully elucidated
Lithium	It is not known whether lithium has a physiological role in any species, but nutritional studies in some mammals have indicated its importance to health, leading to a suggestion that it be classed as an essential trace element.	Lithium toxicity
Strontium	Strontium has been found to be involved in the utilization of calcium in the body. It has promoting action on calcium uptake into bone at moderate dietary strontium levels, but a rachitogenic (rickets–producing) action at higher dietary levels.	Certain forms of Rickets
Other	Silicon and vanadium have established, albeit specialized, biochemical roles as structural or functional cofactors in other organisms, and are possibly, even probably, used by mammals (including humans). By contrast, tungsten, the early lanthanides, and cadmium have specialized biochemical uses in certain lower organisms, but these elements appear not to be utilized by mammals. Other elements considered to be possibly essential include aluminium, germanium, lead, rubidium, and tin.	Multiple

How the calculation works
BEE [Male]= 293−3.8×age (years)+456.4×height (meters) +10.12×weight (kg) [BEE=Bureau of Energy Efficiency]

BEE [Female] = 247−2.67×age (years)+401.5×height (meters) +8.6×weight (kg)

Sedentary: PA = 1.0, when $1.0 \leq PAL < 1.4$.

Low active: PA = 1.12, when $1.4 \leq PAL < 1.6$. [PA=Physical Activity, PAL=Physical Activity Level]
Active: PA = 1.27, when $1.6 \leq PAL < 1.9$.

The **physical activity level** (PAL) is a way to express a person's daily physical activity as a number and is used to estimate a person's total energy expenditure. In combination with the basal metabolic rate, it can be used to compute the amount of food energy a person needs to consume to maintain a particular lifestyle. The physical activity level is defined for a non-pregnant, non-lactating adult as that person's total energy expenditure. (TEE) in a 24-hour period, divided by his or her basal metabolic rate (BMR): $PAL=TEE_{24hour}/BMR$.

The physical activity level can also be estimated based on a list of the (physical) activities a person performs from day to day. Each activity is connected to a number, the **physical activity ratio**. The physical activity level is then the time-weighted average of the physical activity ratios.[12]

The following table shows indicative numbers for the Physical activity level for several lifestyles:

Lifestyle	Example	PAL
Extremely inactive	Cerebral palsy patient	<1.40
Sedentary	Office worker getting little or no exercise	1.40-1.69
Moderately active	Construction worker or person running one hour daily	1.70-1.99
Vigorously active	Agricultural worker (non-mechanized) or person swimming two hours daily	2.00-2.40
Extremely active	Cyclist racer	>2.40

Figure–28: Steps of energy to be succeed.

VITAMIN: RETINOIDS AND CAROTENE (vitamin A; includes retinol, retinal, retinyl esters, and retinoic acid and are also referred to as "preformed" vitamin A. Beta carotene can easily be converted to vitamin A as needed.) Essential for vision Lycopene may lower prostate cancer risk. Keeps tissues and skin healthy. Plays an important role in bone growth and in the immune system. Diets rich in the carotenoids alpha carotene and lycopene seem to lower lung cancer risk. Carotenoids act as antioxidants. Foods rich in the carotenoids lutein and zeaxanthin may protect against cataracts. Men: 900 mcg (3,000 IU), Women: 700 mcg (2,333 IU). Some supplements report vitamin A in international units (IU's). 3,000 mcg (about 10,000 IU). Sources of retinoids: beef liver, eggs, shrimp, fish, fortified milk, butter, cheddar cheese, Swiss cheese.

Sources of beta carotene: sweet potatoes, carrots, pumpkins, squash, spinach, mangoes, turnip greens. Many people get too much preformed vitamin A from food and supplements. Large amounts of supplemental vitamin A (but not beta carotene) can be harmful to bones.

THIAMIN (vitamin B1): Helps convert food into energy. Needed for healthy skin, hair, muscles, and brain and is critical for nerve function. Men: 1.2 mg, Women: 1.1 mg. Pork chops, brown rice, ham, soymilk, watermelons, acorn squash. Most nutritious foods have some thiamin.

RIBOFLAVIN (vitamin B2): Helps convert food into energy. Needed for healthy skin, hair, blood, and brain. Men: 1.3 mg, Women: 1.1 mg. Milk, eggs, yogurt, cheese, meats, green leafy vegetables, whole and enriched grains and cereals.

NIACIN (vitamin B3, nicotinic acid): Helps convert food into energy. Essential for healthy skin, blood cells, brain, and nervous system. Men: 16 mg, Women: 14 mg. Meat, poultry, fish, fortified and whole grains, mushrooms, potatoes, peanut butter. Niacin occurs naturally in food and can also be made by your body from the amino acid tryptophan, with the help of B6.

PANTOTHENIC ACID (vitamin B5): Helps convert food into energy. Helps make lipids (fats), neurotransmitters, steroid hormones, and hemoglobin. Men: 5 mg, Women: 5 mg. Wide variety of nutritious foods, including chicken, egg yolk, whole grains, broccoli, mushrooms, avocados, tomato products. Deficiency causes burning feet and other neurologic symptoms.

PYRIDOXINE (vitamin B6, pyridoxal, pyridoxine, pyridoxamine): Aids in lowering homocysteine levels and may reduce the risk of heart disease. Helps convert tryptophan to niacin and serotonin, a neurotransmitter that plays key roles in sleep, appetite, and moods. Helps make red blood cells Influences cognitive abilities and immune function. Men: 1.3 mg, Women: 1.3 mg. Meat, fish, poultry, legumes, tofu and other soy products, potatoes, noncitrus fruits such as bananas and watermelons. Many people don't get enough of this nutrient.

BIOTIN (vitamin B7): Helps convert food into energy and synthesize glucose. Helps make and break down some fatty acids. Needed for healthy bones and hair.

Men: 30 mcg, Women: 30 mcg. Many foods, including whole grains, organ meats, egg yolks, soybeans, and fish. Some is made by bacteria in the gastrointestinal tract. However, it's not clear how much of this the body absorbs.

FOLIC ACID (vitamin B9, folate, folacin): Vital for new cell creation. Helps prevent brain and spine birth defects when taken early in pregnancy; should be taken regularly by all women of child–bearing age since women may not know they are pregnant in the first weeks of pregnancy. Can lower levels of homocysteine and may reduce heart disease risk May reduce risk for colon cancer. Offsets breast cancer risk among women who consume alcohol. Men: 400 mcg, Women: 400 mcg. Fortified grains and cereals, asparagus, okra, spinach, turnip greens, broccoli, legumes like black–eyed peas and chickpeas, orange juice, tomato juice. Many people don't get enough of this nutrient. Occasionally, folic acid masks a B12 deficiency, which can lead to severe neurological complications. That's not a reason to avoid folic acid; just be sure to get enough B12.

COBALAMIN (vitamin B12): Aids in lowering homocysteine levels and may lower the risk of heart disease. Assists in making new cells and breaking down some fatty acids and amino acids. Protects nerve cells and encourages their normal growth. Helps make red blood cells and DNA. Men: 2.4 mcg, Women: 2.4 mcg. Meat, poultry, fish, milk, cheese, eggs, fortified cereals, fortified soymilk. Some people, particularly older adults, are deficient in vitamin B12 because they have trouble absorbing this vitamin from food. Those on a vegan or vegetarian diet often don't get enough B12 as it's mostly found in animal products. They may need to take supplements. A lack of vitamin B12 can cause memory loss, dementia, and numbness in the arms and legs.

ASCORBIC ACID (vitamin C): Foods rich in vitamin C may lower the risk for some cancers, including those of the mouth, esophagus, stomach, and breast. Long–term use of supplemental vitamin C may protect against cataracts. Helps make collagen, a connective tissue that knits together wounds and supports blood vessel walls. Helps make the neurotransmitters serotonin and norepinephrine Acts as an antioxidant, neutralizing unstable molecules that can damage cells. Bolsters the immune system. Men: 90 mg, Women: 75 mg. Fruits and fruit juices (especially citrus), potatoes, broccoli, bell peppers, spinach, strawberries, tomatoes, Brussels sprouts. Evidence that vitamin C helps reduce colds has not been convincing.

CHOLINE. Helps make and release the neurotransmitter acetylcholine, which aids in many nerve and brain activities. Plays a role in metabolizing and transporting fats. Men: 550 mg, Women: 425 mg. Many foods, especially milk, eggs, liver, salmon, and peanuts. Normally the body makes small amounts of choline. But experts don't know whether this amount is enough at certain ages.

CALCIFEROL (vitamin D): Helps maintain normal blood levels of calcium and phosphorus, which strengthen bones. Helps form teeth and bones. Supplements can reduce the number of non–spinal fractures. Men: 15 mcg (600 IU) Women: 20 mcg (800 IU). Fortified milk or margarine, fortified cereals, fatty fish.

ALPHA–TOCOPHEROL (vitamin E): Acts as an antioxidant, neutralizing unstable molecules that can damage cells. Protects vitamin A and certain lipids from damage. Diets rich in vitamin E may help prevent Alzheimer's disease. Men: 15 mg, Women: 15 mg.

Wide variety of foods, including vegetable oils, salad dressings and margarines made with vegetable oils, wheat germ, leafy green vegetables, whole grains, nuts. Vitamin E does not prevent wrinkles or slow other aging processes.

PHYLLOQUINONE, MENADIONE (vitamin K): Activates proteins and calcium essential to blood clotting. May help prevent hip fractures. Men: 120 mcg, Women: 90 mcg. Cabbage, liver, eggs, milk, spinach, broccoli, sprouts, kale, collards, and other green vegetables. Intestinal bacteria make a form of vitamin K that accounts for half your requirements. If you take an anticoagulant, keep your vitamin K intake consistent.

MINERAL

CALCIUM [Ca]: Builds and protects bones and teeth. Helps with muscle contractions and relaxation, blood clotting, and nerve impulse transmission. Plays a role in hormone secretion and enzyme activation. Helps maintain healthy blood pressure. Men: 1,000 mg, Women: 1,000 mg. Yogurt, cheese, milk, tofu, sardines, salmon, fortified juices, leafy green vegetables, such as broccoli and kale (but not spinach or Swiss chard, which have binders that lessen absorption). Adults absorb roughly 30% of calcium ingested, but this can vary depending on the source. Diets very high in calcium may increase the risk of prostate cancer.

CHLORIDE [Cl]: Balances fluids in the body. A component of stomach acid, essential to digestion. Men/Women: 2.3 g, Salt (sodium chloride), soy sauce, processed foods.

CHROMIUM [Cr]: Enhances the activity of insulin, helps maintain normal blood glucose levels, and is needed to free energy from glucose. Men: 35 mcg, Women: 24 mcg. Meat, poultry, fish, eggs, potatoes, some cereals, nuts, cheese. Unrefined foods such as brewer's yeast, nuts, and cheeses are the best sources of chromium, but brewer's yeast can sometimes cause bloating and nausea, so you may choose to get chromium from other food sources.

COPPER [Cu]: Plays an important role in iron metabolism and immune system. Helps make red blood cells. Men: 900 mcg, Women: 900 mcg. Liver, shellfish, nuts, seeds, whole–grain products, beans, prunes, cocoa, black pepper.

FLUORIDE [F]: Encourages strong bone formation. Keeps dental cavities from starting or worsening. Men: 4 mg, Women: 3 mg. Water that is fluoridated, toothpaste with fluoride, marine fish, teas. Harmful to children in excessive amounts.

IODINE [I]: Part of thyroid hormone, which helps set body temperature and influences nerve and muscle function, reproduction, and growth. Prevents goiter and a congenital thyroid disorder. Men: 150 mcg, Women: 150 mcg. Iodized salt, processed foods, seafood. To prevent iodine deficiencies, some countries add iodine to salt, bread, or drinking water.

IRON [Fe]: Helps hemoglobin in red blood cells and myoglobin in muscle cells ferry oxygen throughout the body. Needed for chemical reactions in the body and for making amino acids, collagen, neurotransmitters, and hormones. Men: 8 mg, Women: 18 mg. Red meat, poultry, eggs, fruits, green vegetables, fortified bread and grain products. Many women of childbearing age don't get enough iron. Women who do not menstruate probably need the same amount of iron as men. Because iron is harder to absorb from plants, experts suggest vegetarians get twice the recommended amount (assuming the source is food).

MAGNESIUM [Mg]: Needed for many chemical reactions in the body. Works with calcium in muscle contraction, blood clotting, and regulation of blood pressure. Helps build bones and teeth. Men: 420 mg, Women: 320 mg (Note: This upper limit applies to supplements and medicines, such as laxatives, not to dietary magnesium.). Green vegetables such as spinach and broccoli, legumes, cashews, sunflower seeds and other seeds, halibut, whole–wheat bread, milk. The majority of magnesium in the body is found in bones. If your blood levels are low, your body may tap into these reserves to correct the problem.

MANGANESE [Mn]: Helps form bones. Helps metabolize amino acids, cholesterol, and carbohydrates. Men: 2.3 mg, Women: 1.8 mg. Fish, nuts, legumes, whole grains, tea. If you take supplements or have manganese in your drinking water, be careful not to exceed the upper limit. Those with liver damage or whose diets supply abundant manganese should be especially vigilant.

MOLYBDENUM [Mo]: Part of several enzymes, one of which helps ward off a form of severe neurological damage in infants that can lead to early death. Men: 45 mcg, Women: 45 mcg. Legumes, nuts, grain products, milk. Molybdenum deficiencies are rare.

PHOSPHORUS [P]: Helps build and protect bones and teeth. Part of DNA and RNA. Helps convert food into energy. Part of phospholipids, which carry lipids in blood and help shuttle nutrients into and out of cells. Men: 700 mg, Women: 700 mg. Wide variety of foods, including milk and dairy products, meat, fish, poultry, eggs, liver, green peas, broccoli, potatoes, almonds. Certain drugs bind with phosphorus, making it unavailable and causing bone loss, weakness, and pain.

POTASSIUM [K]: Balances fluids in the body. Helps maintain steady heartbeat and send nerve impulses. Needed for muscle contractions. A diet rich in potassium seems to lower blood pressure. Getting enough potassium from your diet may benefit bones. Men: 4.7 g, Women: 4.7 g. Meat, milk, fruits, vegetables, grains, legumes. Food sources do not cause toxicity, but high–dose supplements might.

SELENIUM [Se]: Acts as an antioxidant, neutralizing unstable molecules that can damage cells. Helps regulate thyroid hormone activity. Men: 55 mcg, Women: 55 mcg. Organ meats, seafood, walnuts, sometimes plants (depends on soil content), grain products. Researchers are investigating whether selenium may help reduce the risk of developing cancer, but with mixed results.

SODIUM [Na]: Balances fluids in the body. Helps send nerve impulses. Needed for muscle contractions. Impacts blood pressure; even modest reductions in salt consumption can lower blood pressure. Men: 2,300 mg, Women: 2,300 mg. Salt, soy sauce, processed foods, vegetables. While experts recommend that people limit sodium intake to 2,300 mg, most Americans consume 4,000–6,000 mg a day.

SULFUR [S]: Helps form bridges that shape and stabilize some protein structures. Needed for healthy hair, skin, and nails. Protein–rich foods, such as meats, fish, poultry, nuts, legumes. Sulfur is a component of thiamin and certain amino acids. There is no recommended amount for sulfur. Deficiencies occur only with a severe lack of protein.

ZINC [Zn]: Helps form many enzymes and proteins and create new cells. Frees vitamin A from storage in the liver. Needed for immune system, taste, smell, and wound healing. When taken with certain antioxidants, zinc may delay the progression of age–related macular degeneration. Men: 11 mg, Women: 8 mg. Red meat, poultry, oysters and some other seafood, fortified cereals, beans, nuts. Because vegetarians absorb less zinc, experts suggest that they get twice the recommended requirement of zinc from plant foods.

Normal: Sodium (mmol/L) 142.4 (1.58), Athletes: 141.5 (4.04)
Normal: Potassium (mmol/L) 4.5 (0.41), Athletes: 4.5 (0.52)

Normal: Chloride (mmol/L) 105.8 (1.96), Athletes: 101.0 (4.02)
Normal: Carbon dioxide (mmol/L) 29.3 (1.38), Athletes: 27.6 (1.35)
Normal: Anion gap (mmol/L) 11.8 (1.25), Athletes: 17.5 (1.85)
Normal: Glucose (mg/dL) 99.4 (26.54), Athletes: 110.3 (24.18)
Normal: Total protein (g/dL) 7.1 (0.34), Athletes: 7.4 (0.39)
Normal: Albumin (g/dL) 4.0 (0.23), Athletes: 4.5 (0.30)
Normal: Uric acid (mg/dL) 4.8 (1.15), Athletes: 5.7 (1.23)
Normal: Globulin (g/dL) 3.1 (0.27), Athletes: 2.9 (0.28)
Normal: Calcium (mg/dL) 9.2 (0.34), Athletes: 9.4 (0.51)
Normal: Phosphorus (mg/dL) 2.8 (0.44), Athletes: 3.2 (0.80)
Normal: Magnesium (mEq/L) 1.7 (0.13), Athletes: 1.5 (0.16)
Normal: Serum urea nitrogen (mg/dL) 16.0 (5.52), Athletes: 19.5 (4.35)
Normal: Creatinine (mg/dL) 1.0 (0.16), Athletes: 1.3 (0.32)
Normal: Bilirubin (mg/dL)
Direct 0.2 (0.10), Athletes: 0.3 (0.16)
Total 0.5 (0.27) 0.8 (0.44) 0.8 (0.59) <.0001 .22
Normal: Triglycerides (mg/dL) 114.2 (58.13), Athletes: 109.5 (60.43)
Normal: Cholesterol (mg/dL) 194.9 (29.09), Athletes: 196.5 (29.44)
Normal: Alkaline phosphatase (U/L) 66.9 (16.00), Athletes: 70.3 (16.97)
Normal: Alanine aminotransferase (U/L) 21.8 (14.40), Athletes: 24.8 (11.49)
Normal: Aspartate aminotransferase (U/L) 29.3 (12.76), Athletes: 51.6 (17.98)
Normal: Total creatine kinase (U/L) 131.9 (57.80), Athletes: 843.8 (782.3)
Normal: Osmolality (mOsm/kg H_2O) 293.9 (6.86), Athletes: 295.8 (11.42)
Normal: Creatine kinase-MB (ng/mL) 2.3 (1.61), Athletes: 23.8 (25.17)
Normal: Troponin I (ng/mL) 0 (0). Athletes: 0.02 (0.04)
Normal: Myoglobin (µg/L) 83.1 (28.3), Athletes: >500 (0)

CONCLUSION

Two things are immortal in this world. One is **nature** and another is **signature**. **Nature** is the storehouse of enormous powerhouse & storehouse of nutrients coming from holistic pathway and these nutrients are of two types: macronutrients and micronutrients which give energy to the homeostatic system to write “yes I am alright”; by placing **signature** which is own unique style of human; both nature & signature can’t be altered by any cost. Both macro & micronutrients are mandatory to carry out the lifestyle in own style. Protein, Carbohydrate, Fat are three musketeers to make building block of human body and Vitamins, Minerals are two legs to give nutrition to the body. Previous three are macronutrients and rest two are micronutrients. These five–man army is the powerhouse from nature to create its own signature!

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