Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (First year)

Subject: G.E Chemistry

Paper Code: CHG-104

Paper Title: Chemistry in Daily Life

Unit: 08

Module Name: Macronutrients: Carbohydrates, Proteins and Fats – Classification, Functions and Sources

Module No: 25

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Notes:

What are carbohydrates?

- Class of naturally occurring compounds.

In the early part of 19th century, substances such as wood, starch, and linen were found to be composed mainly of molecules containing atoms of carbon (C), hydrogen (H), and oxygen (O) and to have the general formula $C_6H_{12}O_6$. Other organic molecules with similar formulas were found to have a similar ratio of hydrogen to oxygen.

- The general formula: $C_x(H_2O)_y$ is commonly used to represent many carbohydrates.

Carbohydrates serve as energy sources and as essential structural components in organisms; in addition, part of the structure of nucleic acids, which contain genetic information, consists of carbohydrate.

Carbohydrates are probably the most abundant and widespread organic substances in nature, and they are essential constituents of all living things.

Carbohydrates are formed by green plants from carbon dioxide and water during the process of photosynthesis.

Classification

Based on number of forming units (three major classes of carbohydrates)

(1) Monosaccharides

- Simple sugars; containing one polyhydroxy aldehydic or ketonic unit.
- Example: D-glucose (dextrose).

(2) Oligosaccharides

- Short chains of monosaccharide units (from 2 to 20) linked one to the next by chemical bounds, called glycosidic bounds.
- Examples: sucrose (table sugar), lactose and maltose.

(3) Polysaccharides

Polymers consisting of 20 to 107 monosaccharidic units.

Omopolysaccharides:

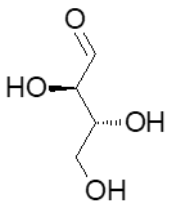
- Contain only one type of monosaccharide
- Examples: starch, glycogen and chitin.

Eteropolysaccharides:

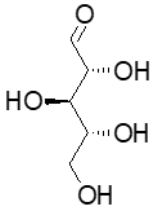
- Contain two or more different kinds of monosaccharides
- Example: hyaluronic acid.

(Based on functional group)

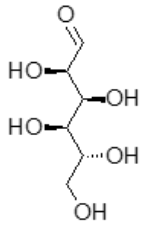
(1) Aldoses: contain aldehyde group.



D-Erythrose

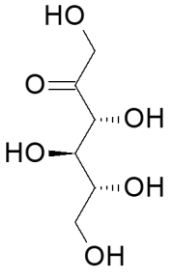


D-Ribose

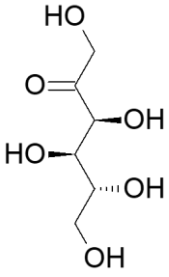


D-Glucose

(2) Ketoses: contain ketone functional group.



D-Psicose



D-Fructose

Functions

1. Providing energy and regulation of blood glucose
2. Sparing the use of proteins for energy
3. Breakdown of fatty acids and preventing ketosis
4. Biological recognition processes
5. Flavor and Sweeteners
6. Dietary fiber

Sources

Fructose

- Honey; dried fruits such as apples, dates and sultanas;
- Fruit jams, chutney's, barbecue & plum sauce, gherkins, sundried tomatoes
- Breakfast cereals with whole wheat, oats and fruits
- Canned fruits such as pineapple, strawberry and plum
- Fresh fruits including grapes, apples, pear, kiwi & banana
- Also derived from the digestion of sucrose

Glucose

- Honey, golden syrup
- Dried fruits such as dates, currants & figs
- Small amounts are found in some fruits (grapes and dried apricots), vegetables (sweet corn) and honey
- Manufactured foods such as juices, cured hams, pasta sauces
- Digestion and conversion of other carbohydrates

Galactose

- Flavoured yogurts or with fruit pieces added
- Lactose-free milk
- Instant coffee granules, ground black pepper
- Digestion of lactose

Sucrose

- Derived from sugar cane and sugar beet
- Table sugar, manufactured foods, such as cakes, cookies, and dark chocolate
- Sweet root vegetables such as beetroot and carrots

Maltose

- Malted wheat and barley
- Breads, bagels, breakfast cereals, energy bars
- Malt extract, molasses, beer

Lactose

- Milk, buttermilk, yogurt, sour cream, condensed milk
- Milk products, frozen yogurts, cottage cheese, evaporated milk, goats milk & ice creams

Raffinose, stachyose, verbascose, inulin, fructo- and galacto-oligosaccahrides

- Legumes, beans, cabbage, broccoli, brussel sprouts
- Onion, artichoke, fennel, asparagus, beans & peas
- Pre-biotics

Polysaccharides

Starch

- Cereal foods, cornmeal, pretzels, flours, oats, instant noodles, pasta, rice
- Potato, corn
- Small amounts in other root vegetables and unripe fruit

Non-starch polysaccharides

- Vegetables, fruit
- Wholegrain cereals
- Pulses

What are proteins?

- 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 molecules made up of amino acids, which are the body’s bricks and mortar for rebuilding muscle, replicating DNA, and catalyzing metabolic reactions.
- The human body can biosynthesize some amino acids, but not all of them, so you need protein in your diet to get the rest.
- Like carbohydrates and fat, protein is classed as a macronutrient, which means it’s required in large amounts in your diet for your body to be able to function properly.

Classification

Type	Examples	Functions
Digestive Enzymes	Amylase, lipase, pepsin, trypsin	Help in digestion of food by catabolizing nutrients into monomeric units
Transport	Hemoglobin, albumin	Carry substances in the blood or lymph throughout the body
Structural	Actin, tubulin, keratin	Construct different structures, like the cytoskeleton
Hormones	Insulin, thyroxine	Coordinate the activity of different body systems
Defense	Immunoglobulins	Protect the body from foreign pathogens
Contractile	Actin, myosin	Effect muscle contraction
Storage	Legume storage proteins, egg white (albumin)	Provide nourishment in early development of the embryo and the seedling

There are many different types of proteins in our bodies. They all serve important roles in our growth, development and everyday functioning. Here are some examples:

- Enzymes are proteins that facilitate biochemical reactions, for example, pepsin is a digestive enzyme in your stomach that helps to break down proteins in food.
- Antibodies are proteins produced by the immune system to help remove foreign substances and fight infections.
- DNA-associated proteins regulate chromosome structure during cell division and/or play a role in regulating gene expression, for example, histones and cohesin proteins.
- Contractile proteins are involved in muscle contraction and movement, for example, actin and myosin.
- Structural proteins provide support in our bodies, for example, the proteins in our connective tissues, such as collagen and elastin.
- Hormone proteins co-ordinate bodily functions, for example, insulin controls our blood sugar concentration by regulating the uptake of glucose into cells.
- Transport proteins move molecules around our bodies, for example, hemoglobin transports oxygen through the blood.

Sources

- 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
- Eggs
- Dairy products – milk, yoghurt (especially Greek yoghurt), cheese
- Nuts (including nut pastes) and seeds – almonds, pine nuts, walnuts, macadamias, hazelnuts, cashews, pumpkin seeds, sesame seeds, sunflower seeds

What are Fats?

- Fat is also known as fatty acid and it is made up of three important elements: carbon, hydrogen, oxygen but the amount of carbon is in maximum quantity.

- It is an important macronutrient and is also an important part of diet for all animals and humans.
- The body stores fat for protection, warmth, and energy.

Sources

Important source of fats are given below:

- Avocados
- Cheese
- Dark chocolate
- Whole eggs
- Fatty fish
- Nuts
- Chia seeds

The functions of fats in the body

Glucose is stored in the body as glycogen. While glycogen provides a ready source of energy, it is quite bulky with heavy water content, so the body cannot store much of it for long.

(1) Storing Energy

- Fats, serve as a larger and more long-term energy reserve.
- Fats pack together tightly without water and store far greater amounts of energy in a reduced space.
- A fat gram is densely concentrated with energy, containing more than double the amount of energy as a gram of carbohydrate.
- The average body fat for a man is 18 to 24 percent and for a woman is 25 to 31 percent, but adipose tissue can comprise a much larger percentage of body weight depending on the degree of obesity of the individual.
- Some of this fat is stored within the abdominal cavity, called visceral fat, and some is stored just underneath the skin, called subcutaneous fat.

(2) Insulating and Protecting

Visceral fat: Protects vital organs such as heart, kidneys, and liver.

Subcutaneous fat:

- Insulates the body from extreme temperatures & helps in keeping the internal climate under control.
- Pads hands/buttocks & prevents friction, as these areas frequently come in contact with hard surfaces.
- Gives the body extra padding required when engaging in physically demanding activities (ice skating, horseback riding, or snowboarding).

(3) Regulating and signaling

- Fats help the body to produce and regulate hormones.
  - (For example, adipose tissue secretes the hormone leptin, which signals the body's energy status and helps to regulate appetite.)
- Fat is also required for reproductive health
  - (A woman who lacks adequate amounts may stop menstruating and be unable to conceive until her body can store more energy as fat.)

Omega-3 and omega-6 essential fatty acids help regulate cholesterol and blood clotting and control inflammation in the joints, tissues, and bloodstream.

Fats also play important functional roles in sustaining nerve impulse transmission, memory storage, and tissue structure.

Lipids are especially focal to brain activity in structure and in function, helping to form nerve cell membranes, insulate neurons, and facilitate the signaling of electrical impulses throughout the brain.

(4) Contributing to the Smell, Taste, and Satiety of Foods

- Fats satisfy appetite (the desire to eat) because they add flavor to foods.
- Fat contains dissolved compounds that contribute to mouth-watering aromas and flavors.
- Fat also adds texture, making baked foods moist and flakey, fried foods crispy, and adding creaminess to foods like ice cream and cream cheese.
- Consider fat-free cream cheese; when fat is removed from the cream, much of the flavor is also lost. As a result, it is grainy and many additives are used in an attempt to replace the lost flavor.
- Fats satisfy ***hunger*** (the **need** to eat) because they're slower to be digested and absorbed than other macronutrients.
- Dietary fat thus contributes to ***satiety***—the feeling of being satisfied or full. When fatty foods are swallowed, the body responds by enabling the processes controlling digestion to slow the movement of food along the digestive tract, giving fats more time to be digested and absorbed and promoting an overall sense of fullness.

Classification

Saturated Fats

- Saturated fat is those fat which remains in solid form at room temperature they are also called solid fats.
- Their basic carbon structure is saturated with hydrogen atoms. This type of fat may increase health risk if it is consumed for a long period.

- A high intake of saturated fat increases the level of low density lipoprotein(LDP) cholesterol in the body, this increases the risk of cardiovascular disease or causes stroke in arteries.
- Various sources are: Dairy products, except those that are fat-free; Baked goods, snack foods, and French fries; Some vegetable oils, including coconut oil, palm oil, etc. It is not healthy to replace saturated fat in the diet with refined sugar, which is also bad for health.

Unsaturated Fat

Unsaturated fat remains in liquid form at room temperature, and they are mostly extracted from plant oils. It is a kind of good fat.

A. Monounsaturated Fats

- They are fat molecules that are not saturated with hydrogen atoms as each fat molecule is bonded with one hydrogen only.
- They may lower low density lipoprotein level or bad cholesterol level.
- It reduces risk of heart attack.
- Sources of monounsaturated fatty acids are: Olives and olive oil, Nuts and nut butters and Avocados.

B. Polyunsaturated Fatty Acid

- They are not saturated with hydrogen atoms, they are good for health especially those from fish and algae , as they are known as omega-3 polyunsaturated fatty acids.
- As omega-3 fatty acids protect the body from heart disease, improve brain, joint and eye health.
- Source of polyunsaturated fats:
- Oily fish, such as sardines, mackerel, trout, salmon, and herring
- Safflower, grapeseed, soybean, and sunflower oils
- Nuts, seeds, and pastured eggs

Essential fats

- There fats also which are taken through diet and this type of fat are called essential fats as they are taken in an indirect way for proper functioning of the body.
- Example: Linoleic, linolenic, and arachidonic acids.

Trans-fats

- They are manufactured fats.

- They are products which add hydrogen to liquid vegetables oil to make them more solid in texture.
- They are also known as hydrogenated fats.
- Major examples of trans fats are cake, cookies, fried potatoes, potato chips, etc.