

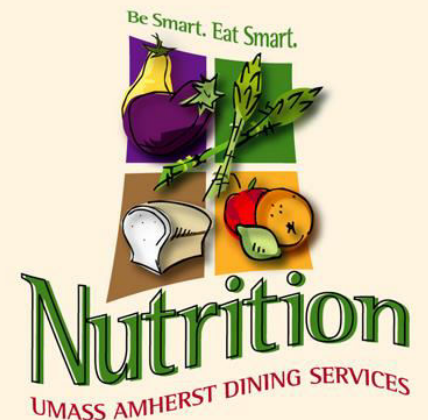
Fats

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Fats

Fats are made up of carbon, hydrogen and oxygen atoms similar to CHOS. They have very different chemical structures and physical properties.

Long chain of C and H but few O only e.g. **the formula $C_{57}H_{110}O_6$**

Lipids are generally greasy to touch and remain insoluble in water but soluble in organic solvents such as ether, chloroform, and benzene.

Classification of Lipids

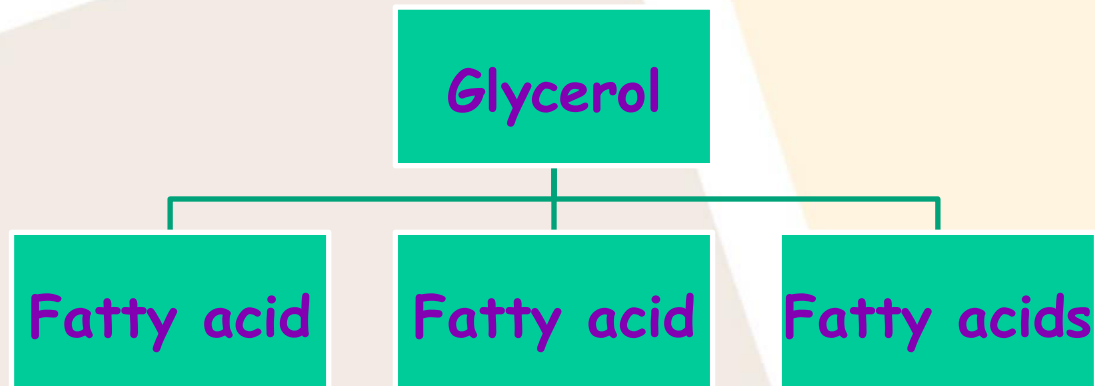
Lipids are classified into three main categories based on their molecular structure

- ❖ Simple fats - Triglycerides
- ❖ Compound fats - Phospholipids, Glucolipids
Lipoproteins
- ❖ Derived fats - Sterols

Each plays a significantly different role in the body.

Triglycerides

- ❖ Triglycerides are commonly occurring fats that are more accurately classified as simple lipids.
- ❖ More than 98 percent of the weight of fat in foods and more than 90 percent of the stored fat in the human body are in the form of triglycerides.



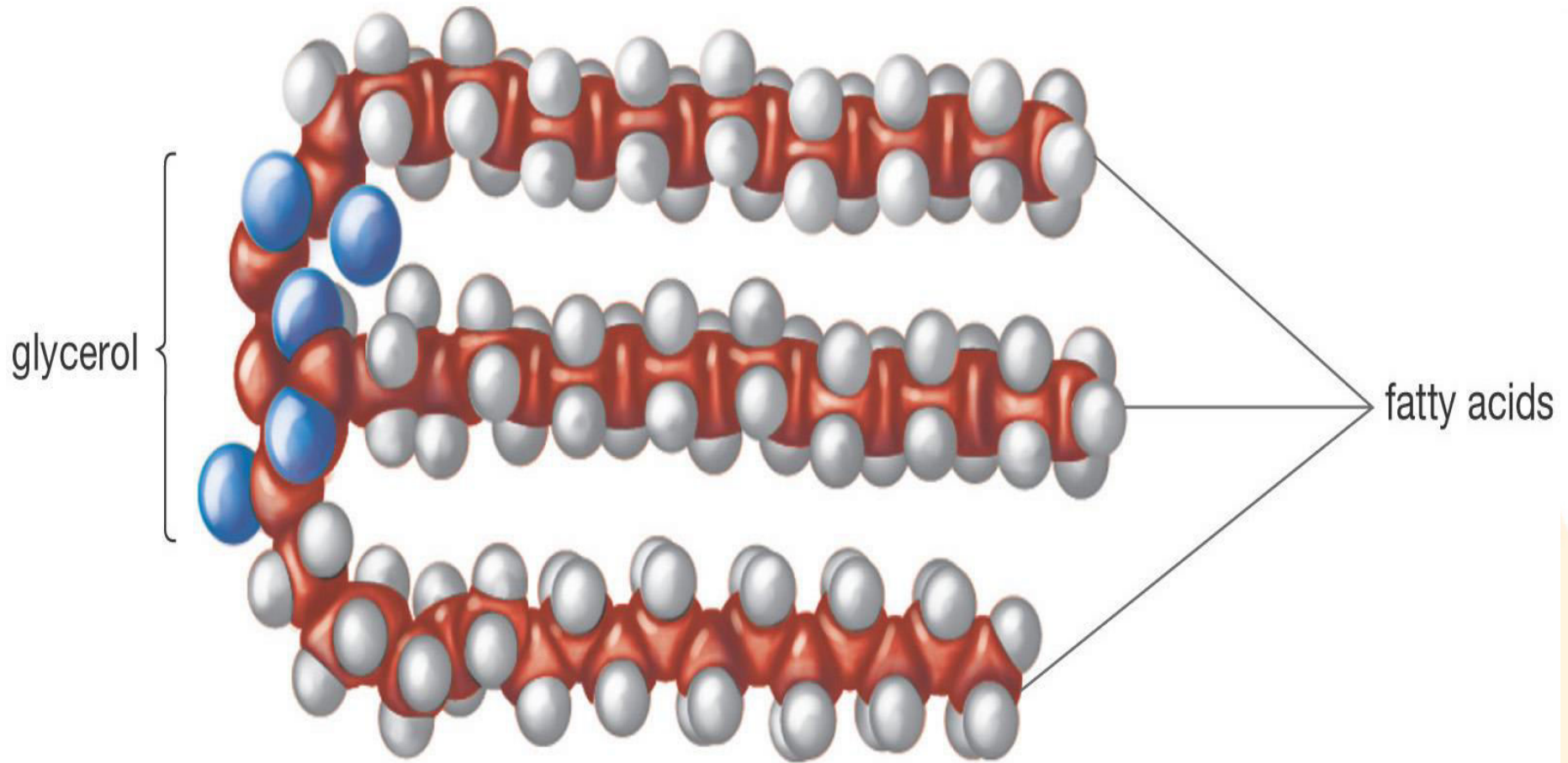
Triglycerides Functions

- ❖ At rest, in well-fed individuals, dietary and stored fats can supply approximately 60-80% of the body's energy needs.
- ❖ Triglycerides serve as predominant energy source during low to moderate exercise intensities.
- ❖ Fat serve as an abundant energy reserve for the body. In total, as much as 80,000-100,000 calories can be stored as fat in a 70-kilogram man.
- ❖ Visceral and subcutaneous fat provide protection to vital organs and serve as a thermal and electrical insulator in the body.

Triglycerides Functions

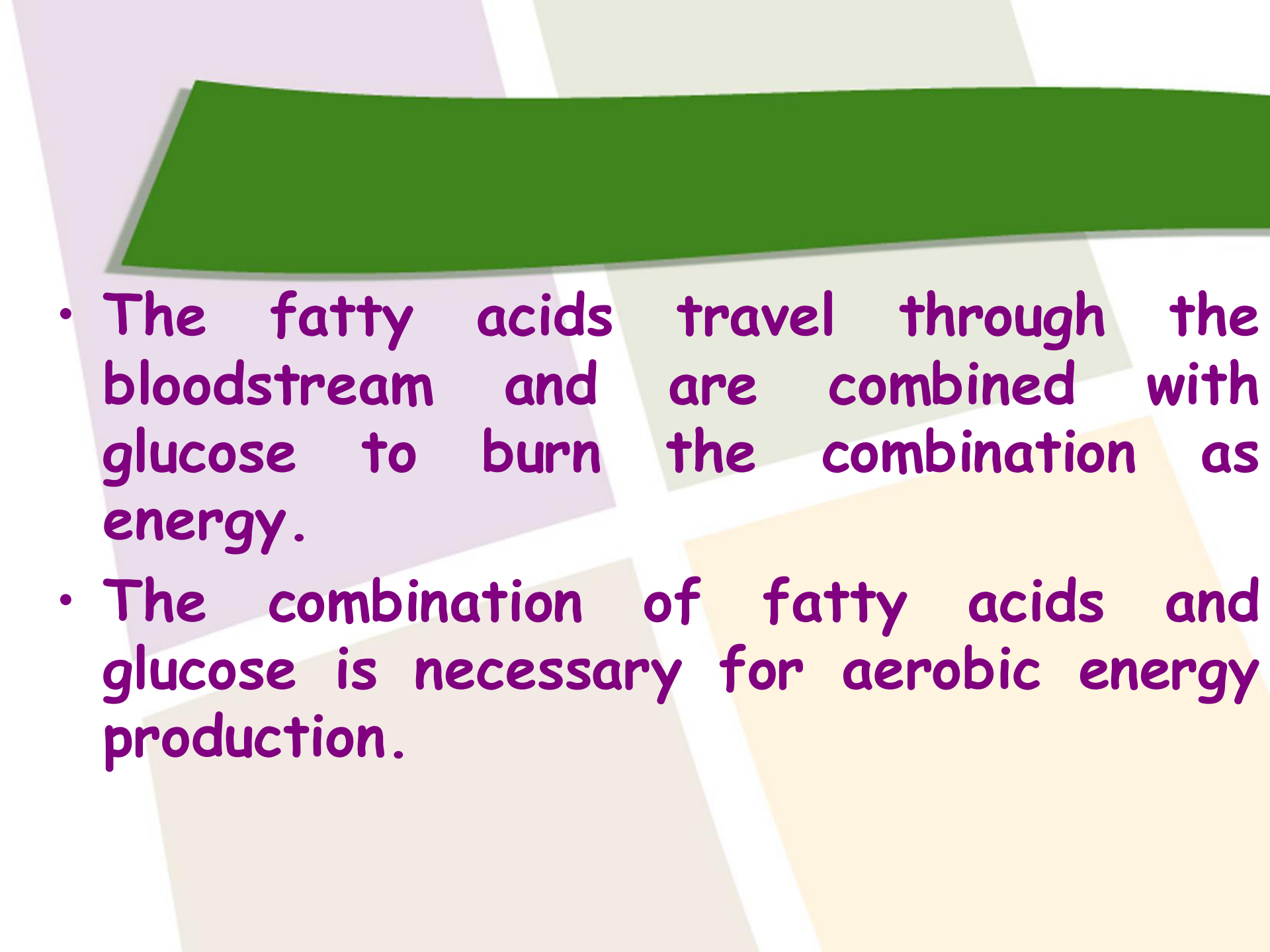
- ❖ Fats play an important role as carriers of substances into the body and within the bloodstream.
- ❖ Fats carry fat-soluble vitamins A, D, E, and K; carotenoids; and other fat-soluble phytochemicals.
- ❖ Fats enhance the sensory qualities of foods.
- ❖ Chemicals within the fat molecules of food provide flavor, odor, and texture.
- ❖ Calorically, lipids are an energy rich nutrient yielding 9 calories / gram.

Triglycerides



Fatty Acids

- ❖ Fats are digested by the enzyme lipase in the small intestines with the assistance of bile salts as emulsifiers.
- ❖ They are then transported through the bloodstream with the assistance of lipoproteins (fat + protein coating + phospholipids) and stored as Triglyceride (glycerol + 3 particles of fatty acids) in fat cells.
- ❖ They are then released into the bloodstream as fatty acids when energy is required.

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- The fatty acids travel through the bloodstream and are combined with glucose to burn the combination as energy.
 - The combination of fatty acids and glucose is necessary for aerobic energy production.

Fatty Acid Structure



degree of saturation

All fatty acids have an organic acid group or a carboxyl acid (COOH) at one end and a methyl (CH₃) group at the other end. The carboxyl group is referred to as the alpha end, and the methyl group makes up the omega end of the fatty acid.

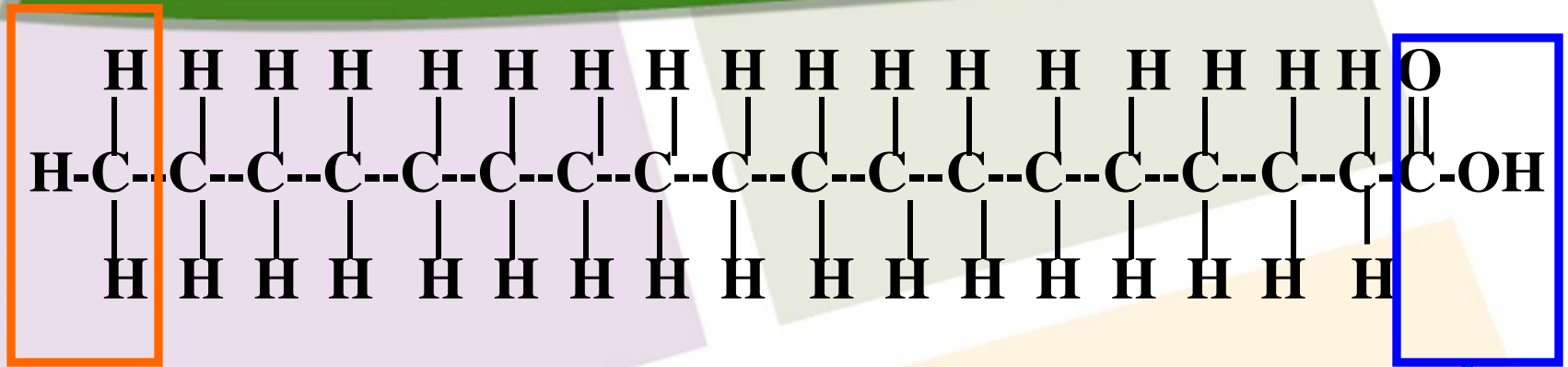
Types of fatty acids

The nutritionally important lipids are fats (solid) and oils (liquids) that consist of fatty acids with 12-20 carbons.

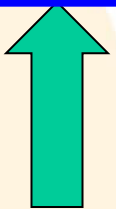
Saturated fatty acids:

The carbon atoms are fully saturated with hydrogen's, therefore only single bonds like the carbon atoms on the chain. These saturated fatty acids referred to as saturated fats.

Saturated Fatty Acid Structure

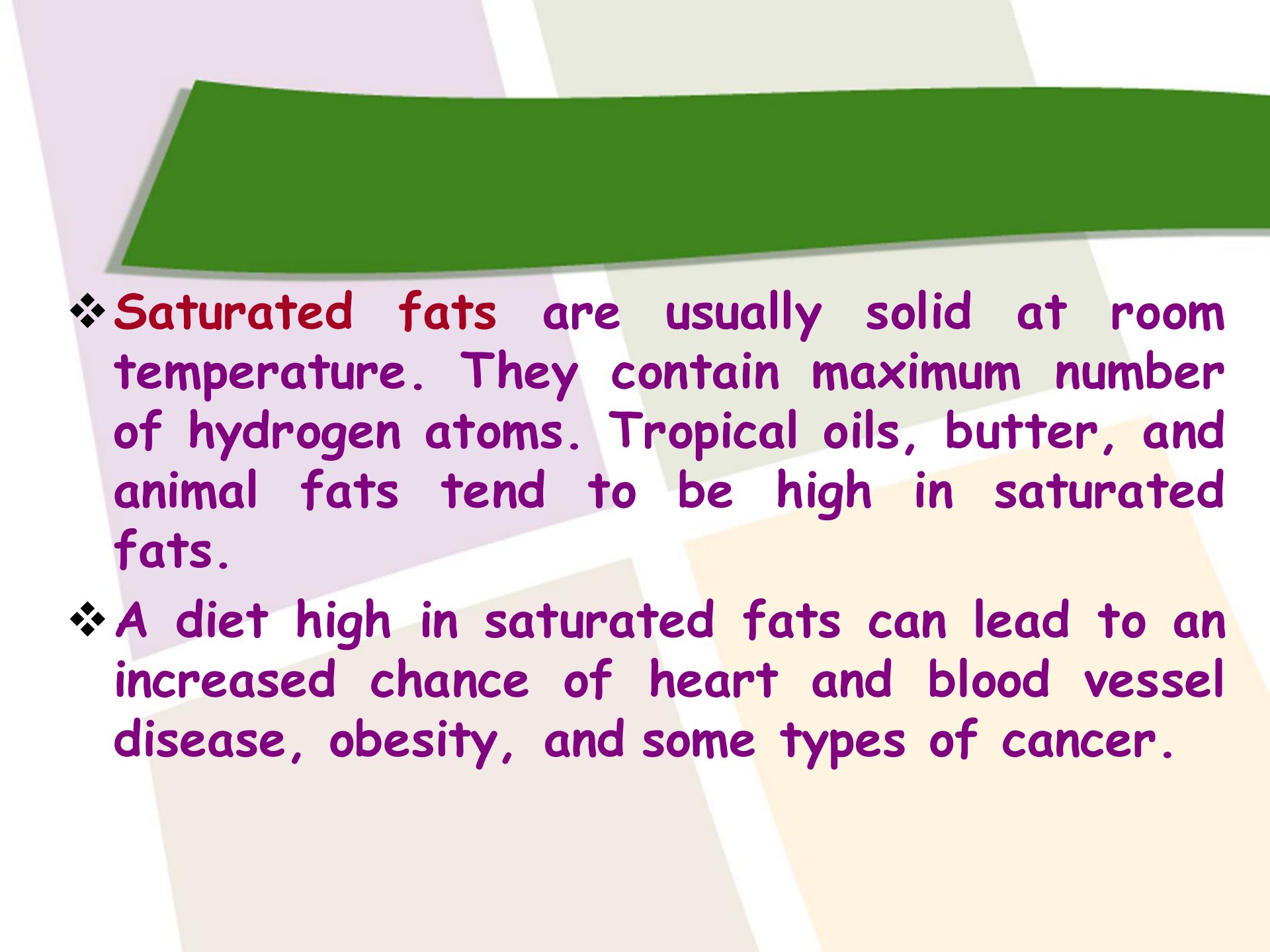


omega end



alpha end

degree of saturation: single carbon bond

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- ❖ **Saturated fats** are usually solid at room temperature. They contain maximum number of hydrogen atoms. Tropical oils, butter, and animal fats tend to be high in saturated fats.
 - ❖ A diet high in saturated fats can lead to an increased chance of heart and blood vessel disease, obesity, and some types of cancer.

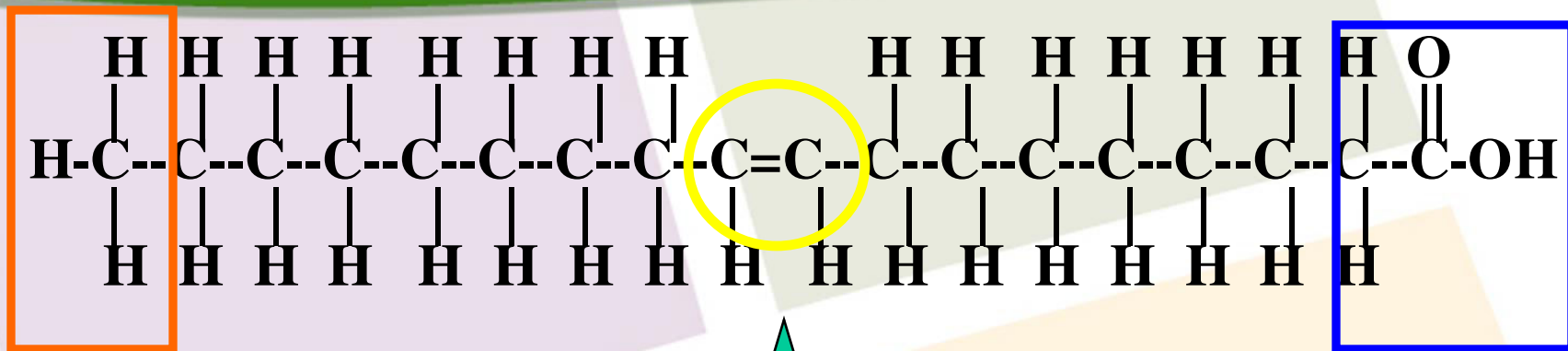
Types of fatty acids

Unsaturated fatty acids:

The carbon atoms are not completely saturated with hydrogen, rather double bonds are formed between the unsaturated carbon atoms. These are generally found in plant products.

- **Unsaturated fats** are those fats that are liquid at room temperature.
- Olive oil and peanut oil are called **monounsaturated fats** because they lack one pair of hydrogen atoms.
- Fish oils and most vegetables oils, such as corn, soybean, and sunflower oils, are called **polyunsaturated fats** because they lack two or more pairs of hydrogen atoms.

Monounsaturated Fatty Acid Structure

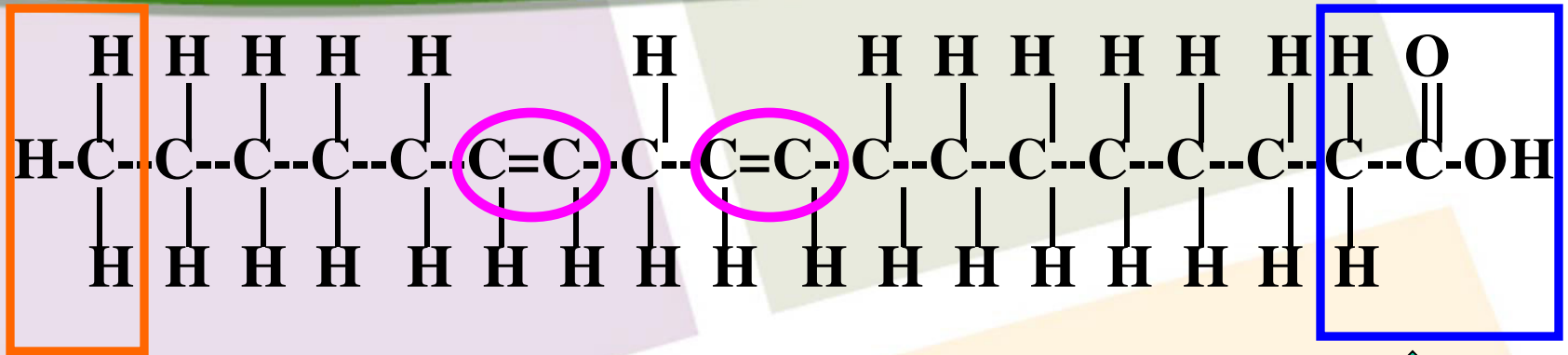


omega end

One double bond

alpha end

Polyunsaturated Fatty Acid Structure



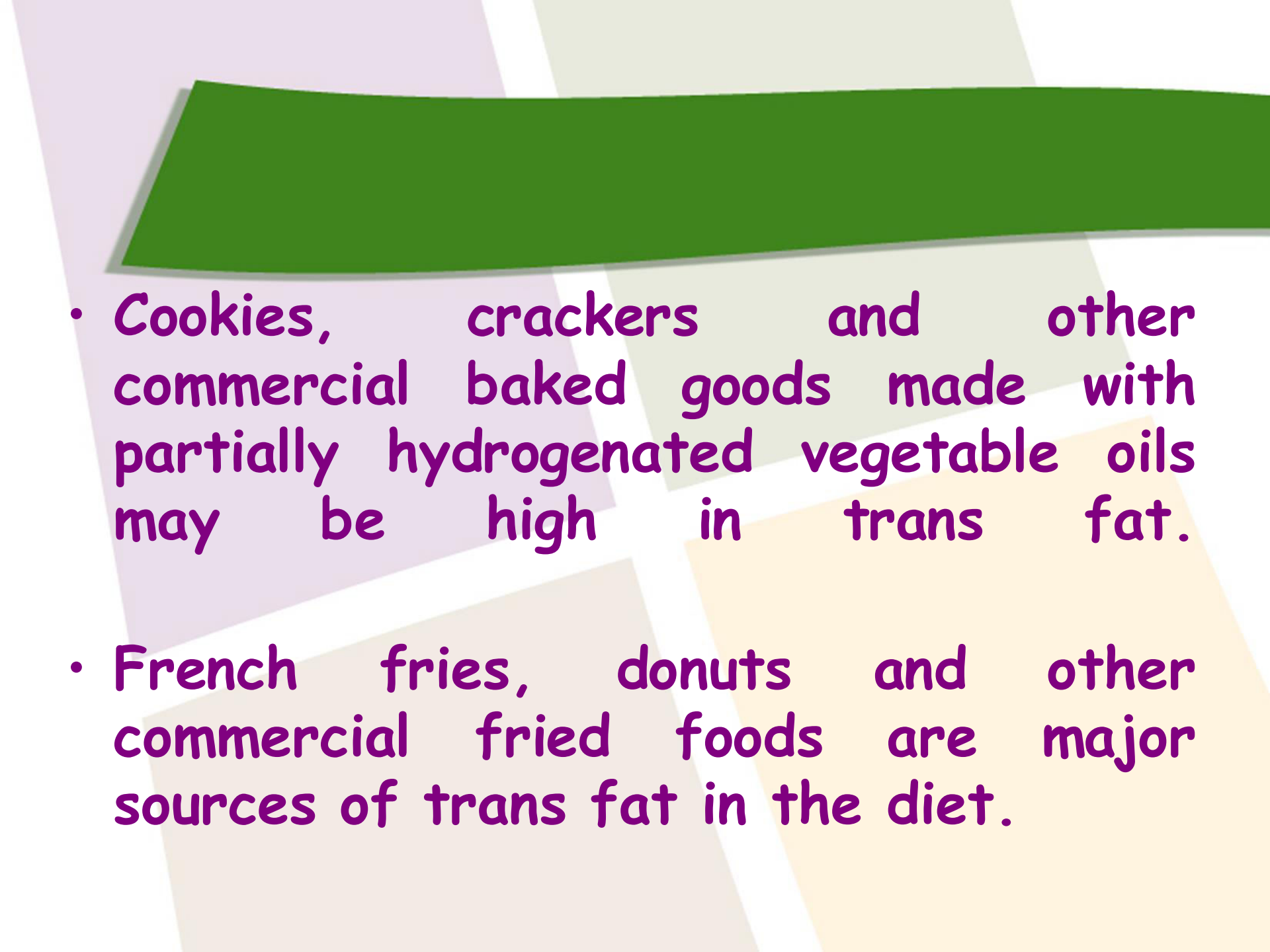
omega end

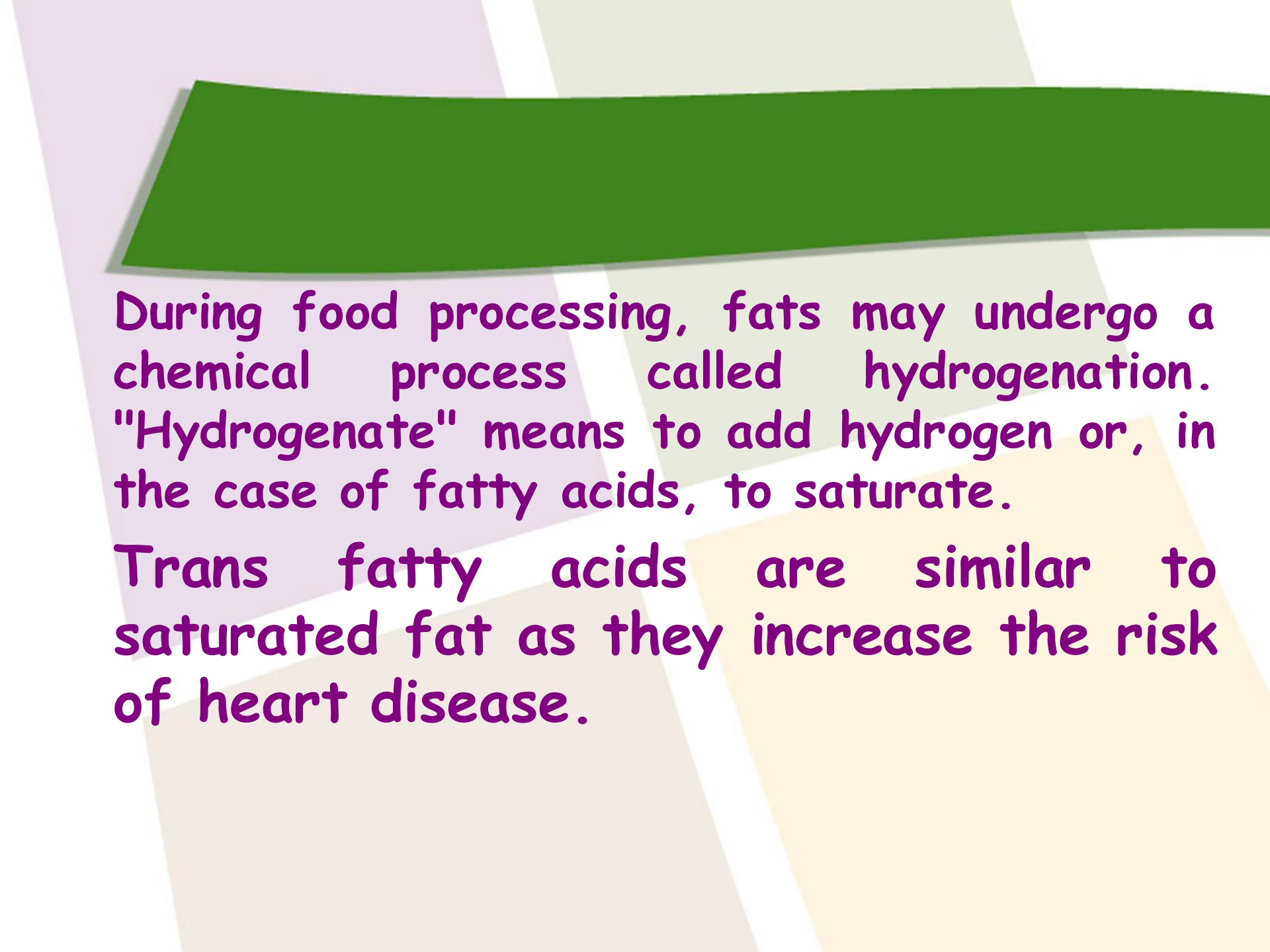
≥ 2 double bonds

alpha end

Tran's fats

Trans fats are unsaturated, but they can raise total and LDL ("bad") cholesterol and lower HDL ("good") cholesterol. Trans fats result from adding hydrogen to vegetable oils used in commercial baked goods and for cooking in most restaurants and fast-food chains.

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- Cookies, crackers and other commercial baked goods made with partially hydrogenated vegetable oils may be high in trans fat.
 - French fries, donuts and other commercial fried foods are major sources of trans fat in the diet.



During food processing, fats may undergo a chemical process called hydrogenation. "Hydrogenate" means to add hydrogen or, in the case of fatty acids, to saturate.

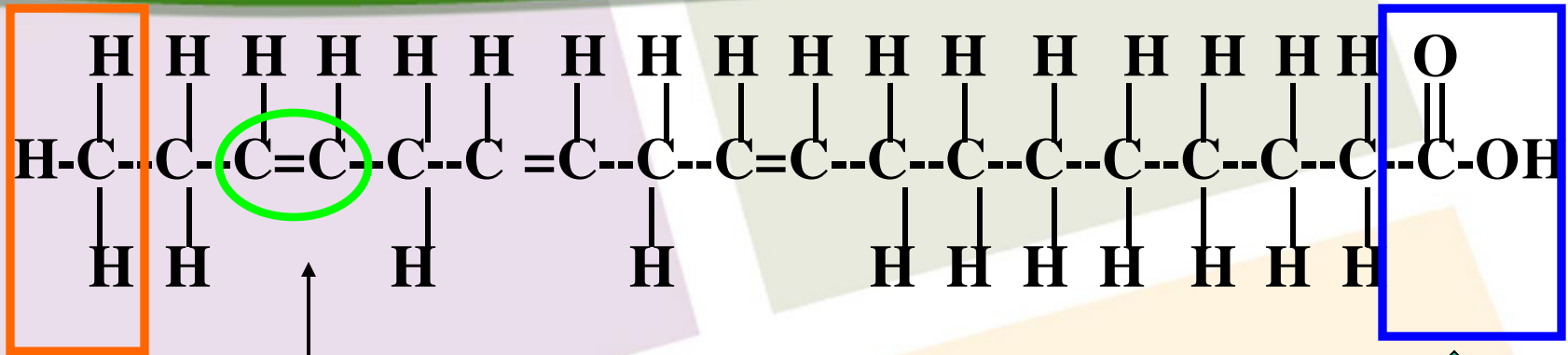
Trans fatty acids are similar to saturated fat as they increase the risk of heart disease.

Essential Fatty Acids

" Omega-3s (linolenic) and omega-6s (Linoleic) are termed essential fatty acids (EFAs) because they are critical for good health.

However, the body cannot make them on its own. For this reason, omega-3s must be obtained from food, thus making outside sources of these fats "essential."

Essential Fatty Acid- Omega-3 (alpha-linolenic acid)



omega end

alpha end

1st double bond is located on the 3rd carbon from the omega end

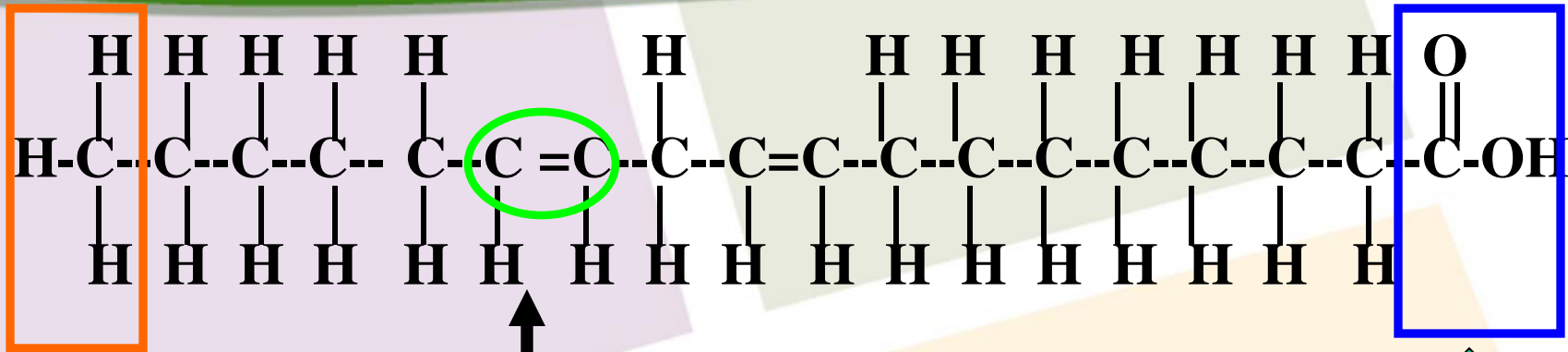
Essential Fatty Acids

Omega-3 fatty acids are a form of polyunsaturated fats, one of four basic types of fat that the body derives from food. (Cholesterol, saturated fat, and monounsaturated fat are the others.) All polyunsaturated fats, including the omega-3s, are increasingly recognized as important to human health.

Essential Fatty Acids

Linoleic (omega-6s), another type of polyunsaturated fatty acids. Linoleic acid is an essential part of lipid membranes and is required for normal skin health, found in grains, most plant-based oils, poultry, and eggs.

Essential Fatty Acid- Omega-6 (linoleic acid)



omega end

alpha end

1st double bond is located on the 6th carbon from the omega end

Non Essential Fatty Acids

The body can make saturated and omega 9 fatty acids; therefore, they are considered nonessential fatty acids. It is not essential to consume these fat in the diet.

Compound fats

Compound fats are a combination of simple fats and other chemicals. Examples of compound fats are:

- Phospholipids
- Glycolipids and
- Lipoproteins.

Phospholipids

An organic compound made from a combination of glycerol, two fatty acids, and a phosphate group. Phospholipids are major components of all cell membranes. They are involved in the transport of fat in the blood and lymph, and also take part in many other metabolic reactions throughout the body.

- Phospholipids are important in blood clotting and structure of the insulating sheath around nerve fibers.
- Phospholipids are found in a small number of specific foods such as egg yolks, liver, soybeans, and peanuts. Fortunately, phospholipids are not essential in the diet because the body can readily synthesize them when needed.

Glycolipids

Glycolipids are formed by a combination of carbohydrates, fatty acids and nitrogen.

They are present in large amounts in the white matter of the brain and in the myelin sheathes of nerves.

Lipoprotein

- A complex of lipid and protein, the way lipids travel in the blood.
- Cholesterol, a building block of the outer layer of cells (cell membranes), is transported through the blood in the form of water-soluble carrier molecules known as lipoproteins.

Derived fats

Derived fats are a combination of simple and compound fats. Cholesterol or Sterols are an example of derived fats.

Cholesterol

- Eating foods high in fats, especially saturated fats may increase the level of **cholesterol**, a waxy, fat-like substance produced by body.
- Cholesterol is part of cell membranes and nerve tissues. It is used by body to form vitamin D and other hormones. It is found *only* in foods that come from animals, such as butter, eggs, and meats. It is not an essential nutrient because the body produces cholesterol in liver.

- As cholesterol levels in the body increase, the risk of heart and artery diseases increase. Some of the cholesterol tends to be deposited on the walls of the arteries, thereby reducing the flow of blood to the cells supplied by those arteries.

Two Forms of Cholesterol

- Cholesterol is transported in the blood in two forms. LDL is the "bad" form that tends to deposit cholesterol on the walls of the blood vessels.



- HDL is the “good” form that removes cholesterol from the cells and brings it back to the liver and intestines to be recycled or excreted.
- Exercise has been proven to raise HDL, low-fat diets lower LDL.



Importance and Functions of fat

- Fat is useful in the absorption of fat-soluble vitamins like Vitamin A, D, E and K in the intestines.
- Fat also helps in the development of brains by providing the structural components of cell membranes, myelin, and the insulating sheath of nerve fiber.
- Fat molecules also release energy.
- It also acts as the body insulation by regulating the body temperature.

- Fats are also important for the proper functioning of the cell, as they constitute a vital portion of the cell membrane.
- Fats also contribute in the formation of hormones as they form the structural components of several body substances like prostaglandins. They also regulate sex hormones production.
- Also, fats play as protective cushion as they form a layer of cushion around the delicate and vital organs like heart, kidneys, and intestines.

Recommended Daily Allowance

Fat is an essential nutrient in the diet, the acceptable range for fat intake has been set at 20-30% of total energy for adults.

- Fat intake should make up no more than 30% of total kilocalories.
- 10% polyunsaturated fatty acids
- 10% monounsaturated fatty acids and
- 7- 10% saturated fatty acids

Keeping individuals with high cholesterol level at or below 7%.