

1. NUTRIENTS BIOCHEMISTRY AND ITS SOURCES

Aris Kaksis 2012year Riga Stradin's University

<http://aris.gusc.lv/NutritionBioChem/3LipidiDabasViel310311Eng.doc>

Living organisms are directly dependent on environment, which consist of organic and inorganic minerals-compounds.

Biochemistry investigates **nutrient compounds** and its conversions in living organisms.

We uptake **nutrients** every day which make excellent our health and mood if really correct have been used **nutrient compounds**.

About **nutrient compounds** call substances which are involved in living organisms into exchange processes with environment, for example:

respiration is uptake of oxygen O_2 in living cells and excretion process of carbon dioxide- carbon(IV) oxide CO_2 ;

drinking of water liquids is uptake process of water soluble nutrients and minerals;

meal compound eating is nutrients uptake process.

From organism excreting compounds are in biochemical converting processing lost value of nutrient compounds.

Proteins, carbohydrates or sugars, fats or oils are organism nutrients, which necessary for building of organism and for growth of cells. Those collaborates with nucleic acids and are source or energy for organisms and sustain genetic information storage and transfer.

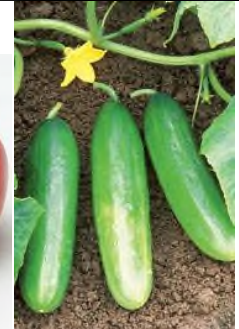
Very high importance in our life has correct and balanced food, which contains: carbohydrates, fats (lipids), proteins, minerals, vitamins and many different biological active compounds, which affects our life quality, and which are included in content of many medicines.

Nutrients are in food used compounds, which sustain the life functions of organism and determines the quality of organism health.

For sustainable life quality of health organism each body has compulsory balanced food, which all necessary nutrients would be in sufficient amounts. Over dosage some of nutrients in organism happens and means if uptake of compound is too much high and uncontrolled. If some compound in food composition is deficient or absent than it in medicine is called deficiency or missing.

Water H_2O is living systems sustainable medium. Water is living organism bulk mass fraction. Adult human body contains 60% mass fraction of water.

In living organisms uptake of nutrient compounds happens thru water medium where foods are dissolve within. Bulk fraction 99% of chemical conversions in organism with nutrient compounds occurs in water dissolve state. To find life on other planets scientists at first looking for water!



1. Fig. Some food products in shops and stores containing the nutrients: milk, bread, salt, sugar, tomatoes, cucumbers, meat, cheese.

Way water has not been used as nutrient?

Exercises and questions

2. FATS, VEGETABLE OILS AND LIPIDS IN NATURE



3 Fig. See animals: seal, vales, dolphins and sea lions.



4 Fig. Household products: olive oils, raps oil, butter pack and lard.

All **lipids** are water **insoluble** natural compounds, for example, cholesterol, fats, vegetable oils or simple oils and fat soluble vitamins K,E,D,A occurs both in plants and in animals and also in all others living organisms. In human body fats accumulate into adipose cells, where deposited fats amount in mass fraction percent oscillates around value 19%. In organisms of animals fats accumulate under skin or around internal organs. Fats poor conduct the heat, therefore under skin layer of fats defense bodies of animals and its organs from excessive cooling, for example, seals, vales, dolphins and sea lions. Well feed pig contains 25-30% fats, eels 26% fats, cow milk 3,7%, goat milk 4,8% fats and butter 82,5% (look on the butter pack in store).

Plants have oils in seeds, fruits and rare in some palm stems. Also plant oil content is different, for example, palm fruits 62-72%, linseeds 37-40%, peanuts 35-42%.

Fats and oils in living organisms are storage form of energy. Fat beta oxidation in mitochondria have evolved energy 38,9 kJ or 9,3 kcal, oxidizing 1g fats, we can compare with combustion reaction to burn stearic acid ester triglyceride fats up to combustion final products carbon(IV) oxide CO_2 and water H_2O :



To combust 1 g fats is necessary 10.17 liters air, which contains 2.03 liters pure oxygen. That explain why on hot frying-pan fats don't burn, because access to frying-pan surface from above by oxygen is not possible.

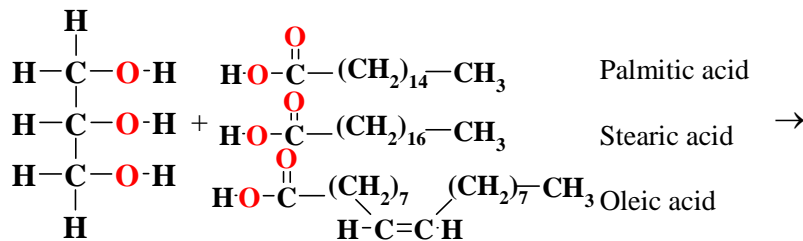
In human body fats appear with food fats as well as all lipids are water insoluble. Bile acid and lipase (enzymes-biological catalysts) separates fat peaces into smaller particles, which absorb cells in converted forms. In blood plasma arrive with specific proteins joined lipid vesicles, which are called lipoproteins. Fats and oils small emulsion vesicles with blood supply to organism cells fatty acids, cholesterol (including steroid hormones and doping for sportsmen's), into fat soluble medicine etc. and four fat soluble vitamins K,E,D,A. Fat soluble vitamin K,E,D,A uptake with food in organism possible only together with fats or oils, because are insoluble in water, for example, with oil poured carrots salads transfer into organism in carrots present A vitamin, and with sunflower oil transfer into organism E vitamin, eating bacon meat or egg yellow into organism transfers also D, K_1 un K_2 vitamins (besides E and A), which responsible about healthy, strong and hardy teeth and bones.

Fatty hands can not wash with clear water, but can clean with large amount of soaps, because soaps converts fats in small peaces, which forms in water emulsions (see disperse systems).

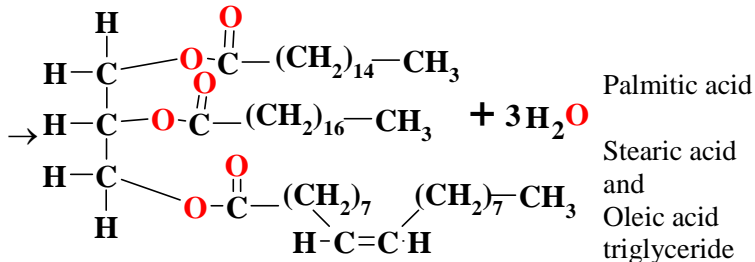
3. BUILDING AND PROPERTIES OF FATS AND OILS

Fats are solid compounds but oils are liquid compounds. Also butter is made fat of milk, what one obtains from sour cream to churn it. If add to butter vegetable oil, then obtain milk fat and vegetable oil mixture, which is much soft, in winter good spread on bread, but on warm summer day completely melt down.

Fats and oils are tri-esters what have made the trivalent spirit glycerol and three carbonic acids and such carbonic acids call also about fatty acids, because isolated and obtained pure type in hydrolyze of fats and oils. Chemical process hydrolyze of fats call as saponification reaction or soaps boiling from fats, with what in olden history occupy many households also in territory of Latvia, that manufacture of soaps. A fat and oil esters formation reaction with trivalent spirit glycerol occurs as condensation esterification reaction, in which arise triglyceride and three water molecules:



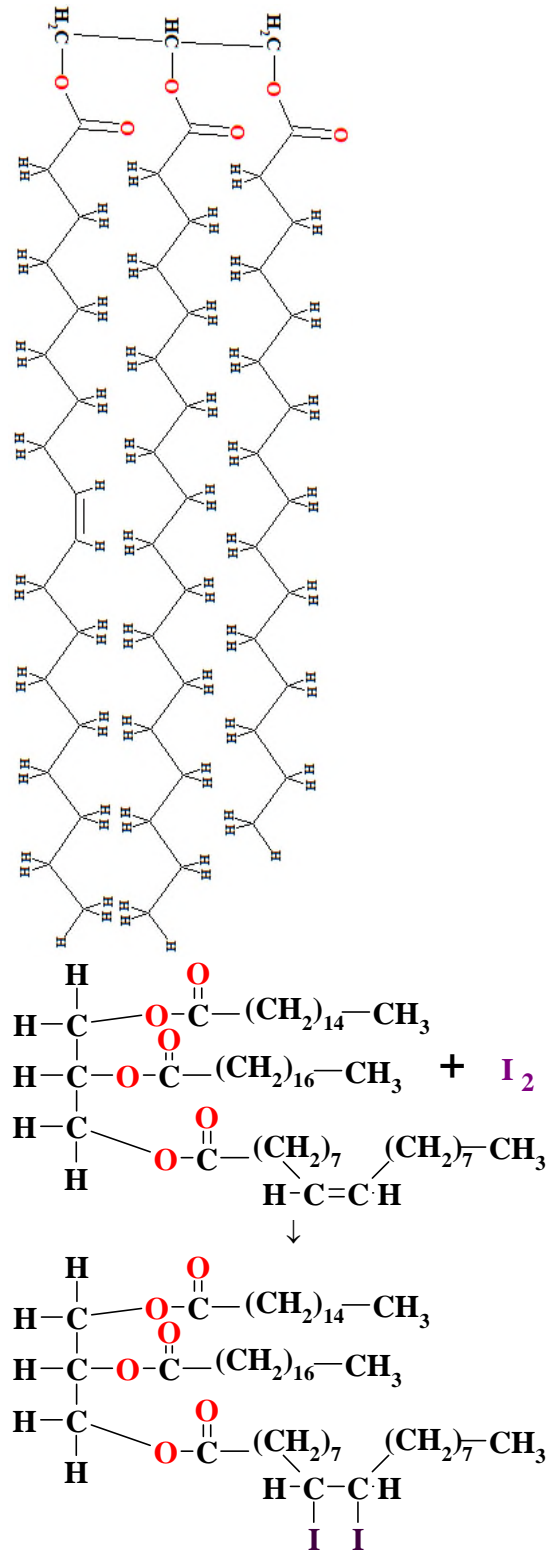
Glycerol + three fatty acids – carbonic acids



The trivalent spirit glycerol ester compound of fats and oils structure contains carbonic acids with even number of carbon atoms from 4C to 20C. Carbon atom chain of carbonic acids are linear shapes – unbranched and count of carbon atoms changes per every two carbon atoms 4C, 6C, 8C, 10C, 12C, 14C, 16C, 18C and 20C. Essential fatty acids are unsaturated, which contains one or many (maximum four) double bonds.

Maintenance of living functions for human organism are essential unsaturated carbonic acids, which in medicine designated as omega ($\omega=3$ or $\omega=6$) fatty acids, what shows the double bond position from the tail $-\text{CH}_3$ of fatty acid chain.

Double bond amount in fats and oils determines one with **iodine number**. **Iodine number** shows what grams iodine adds unsaturated double bonds of fatty in account per 100 grams of fats. Every **one mol** of unsaturated double bond $>\text{C}=\text{C}<$ adds one mol of iodine molecule I_2 , which molar mas is 254 grams. Fat molar mas are 897,5 g/mol.

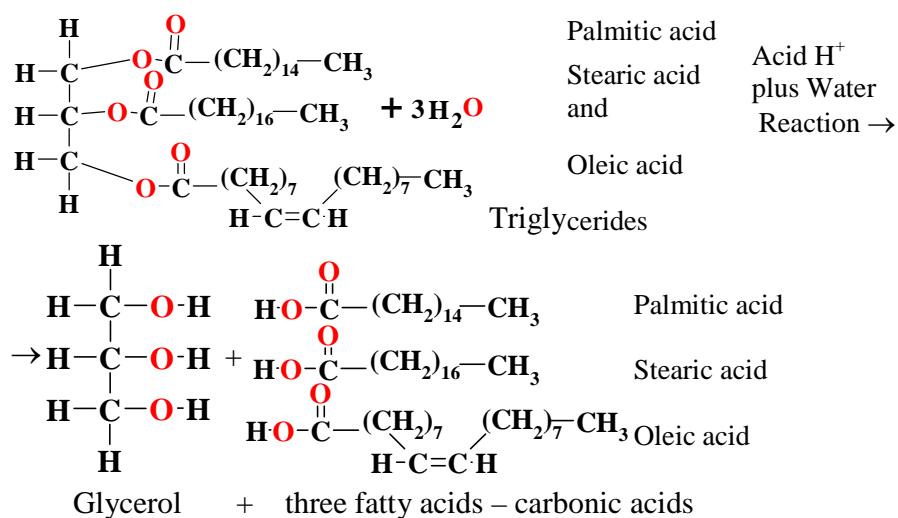


Medicine shops have to sell Iceland fish oil which contains high amount of unsaturated fatty acids 80 gram iodine number and it means approximately every fat molecule contains one double bond. Is suggested uptake ones per week one spoonful fish oil. 3

4. Chemistry of Fats and Vegetable Oils

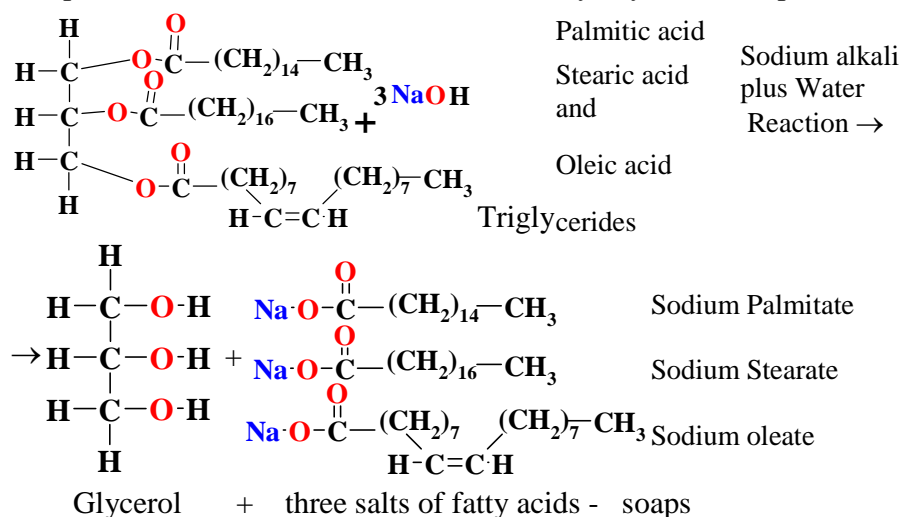
Hydrolyze Reactions of Fats and Vegetable Oils

Hydrolyze is the reaction of fats and oils with water, which in products gives fatty acids and glycerol. Hydrolyze takes a place both in acidic and basic medium and has only one required condition in mixture reaction must be water present, because reaction takes not place without water. That is reverse reaction to esterification reaction, in which water appears in products. For example in acidic medium reaction with water takes a place following:



From three water molecules three **OH** atom groups binds at three acids carboxylic groups forming free fatty acids, but three **H** hydrogen atoms binds at glycerol three oxygen molecules forming trivalent spirit.

At home this reaction hardly possible to realize, because fatty acids are water insoluble compounds. Water soluble only fatty acids sodium and potassium salts are, which we use in every day life as soaps.

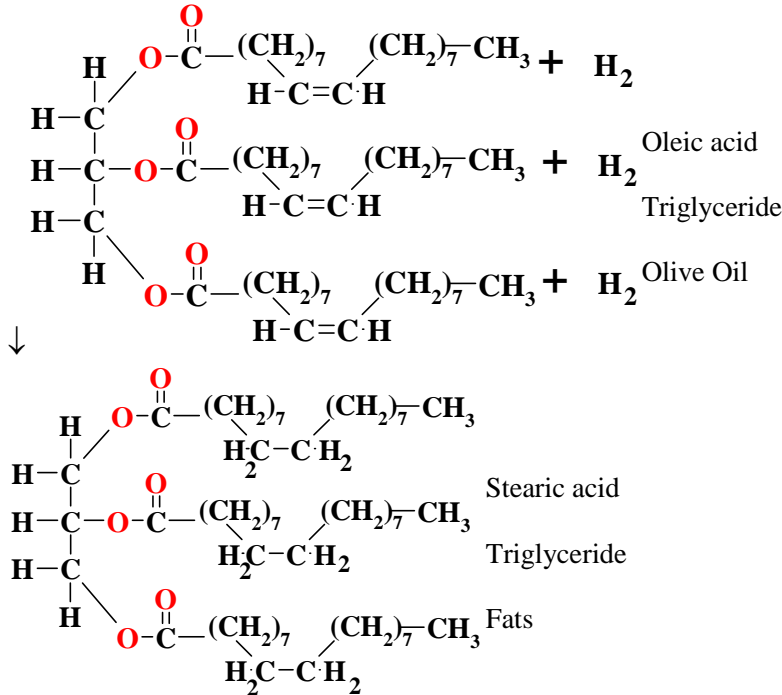


In olden history stores have to sale soapstone. So that time one calls sodium hydroxide for need of manufacture of soaps.

Hydrogenation of Vegetable Oils and Margarine Fats

Hydrogenation is reaction of oils with hydrogen, which results in rise of solid vegetable fats, which can spread on bread as butter. In stores for sale is margarine, which obtains one hydrogenating of oils.

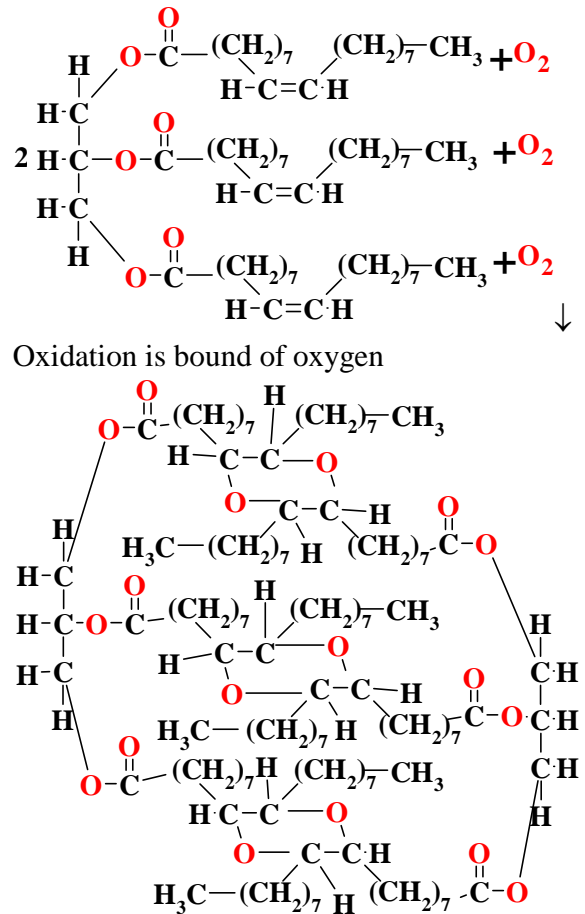
Oils are liquid consistence compounds, because its content has more important unsaturated fatty acids with double bonds as fats. Binding to double bonds hydrogen H_2 creates saturated fatty acids, which remarkable more amounts are in fats as in oils.



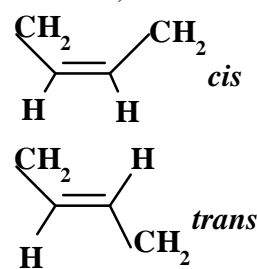
Fats in Greek call using word stearos. If translate stearic acidum from Greek language, than it's would call simple fatty acid and obtained triglyceride would be called fatty acid triglyceride.

Linseed oil contains unsaturated fatty acids, which has to use as the lacquer in oil paints preparation and in stores has to be sale boiled linseed "Painteco" for wood painting, which actually is pure linseed oil. Oxidation with air oxygen O_2 brakes double bonds, which binds two fatty acids with Oxygen Bridge, and forms in space framed polymers, for example, oil paint and boiled oil lacquer in air solidifies and painters say "paint to get dry".

Vegetable oils and fats contains only **cis fatty acids**, which acyl-enzymes in cells elongate or with Krebs's cycle joined beta oxidation enzymes burn down to CO_2 and H_2O , accumulated energy in ATP and NADH form. **Trans fatty acids** not in body processed but just accumulate in organism and increasing risk for low density lipoproteins-cholesterol concentration level in blood. Extra virgin oil and in boiled water ($100^\circ C$) smelt animal fats does not contain **trans fatty acids**, which are forming at strong heating above temperature $t > 200^\circ C$ degree.



5 Fig. Polymerization of olive oil in kitchen staying warm and in contact with air oxygen into unplugged bottle solidifies like boiled linseed oil lacquer. Oxygen atoms bind triglyceride molecules in united frame work polymer. Olive oil has to keep in plugged bottles, that isolates of oxygen and suggested to keep in freezer, because at low temperature decreases the reaction rate of oxidation, make save olive oil to get spoilt.



6 Fig. In natural fatty acids are present just **cis** double bonds. **Trans** double bodns are formed to heat over $t > 200^\circ C$ degrees.

Extra virgin oil efficiency from plant products is very small, what is half from oil content, therefore such oil is twice expensive as hot ($t > 200^\circ C$) pressed vegetable oil.

Obesity and cholesterol esters plaque on Blood Vessels

Fat soluble compounds in human organism call about **lipids**. For example, fats, vegetable oils, vitamins, cholesterol, cholesterol esters (cholesterines), hormones as well as fat soluble medicines and drugs.

Already at eighties on 20. century scientists reveal, that lipids circulation in human blood in globular form of spherical lipoproteins is important transport way of water insoluble compounds in organism, that transfer up to any organism cell necessary compounds: fats, cholesterol, cholesterol esters, hormones, vitamins K, E, D, A and introduced in body fat soluble curative medicines and drugs.

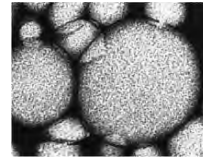
Compounds exchange for life happy human organism in healthy and in harmony with nature take a part on life friendly environmental medium, which is formed cosy and human life friendly, provided sustainable healthy development of human society as a whole.

Obesity, cholesterol ester precipitation in blood vessels as plaque and blood vessels blocking frustrate the healthy harmony with nature. That raises blood circulation disturbances, what we recognize under disease terms: hart strikes -infarcts and blood effusions in brain – insults.

To caching cold or mechanical trauma occasions or infection influence blood vessels cell walls inflame and that involve protection cells leucocytes exited gathering activity against inflammation focus and who, attacking infection agents, bombard agents with peroxide H_2O_2 molecules chemically changed foreign bodies and binds with them clean organism of foreign bodies. Unfortunately near these events are also low density lipoprotein vesicles, whose Protein compound too oxidizes with peroxide, and after oxidation firm stick to blood vessel wall. In years process accumulates forming cholesterol plaque, which insoluble in blood, because are insoluble in water. Blood vessel inflammation provoke also increased radiation, for example, in Chernobilja crash liquidator organism usually has observed blood vessel cholesterol blocking, which rises due to blood vessel inflammation with getting in organism radio active atom isotopes and its high energy radiation of α , β , γ particles.

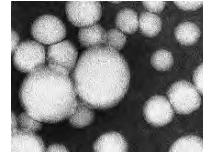
Excessive abuse fats and oils on nutrition provoke as well as in organism unconsumed fats accumulate in adipose cells increasing fatty cells size and take place body obesity. Fats in human organism “burn down” in result of high physical load and that happens in sportsman organism match time. That fats “burn down” process would not take place traumatic for muscle cells (over load provoke muscle also hart cells inflammation and destruction), than organism has to be well trained, because fat burn down necessary mach oxygen, what supply well developed blood circulation system, what can improve correct training of organism in longer time period.

as Hart strike and Brain insult cause

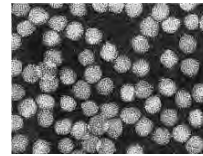


80...200 nm
Chylomicrons
Hylē *Greeks* is substance, materi

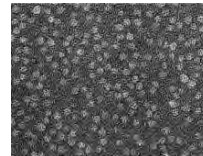
lipoprotein’s initial form after eating.
Translation from *Greeks* micron material



28...70 nm
VLDL
very low density lipoproteins



20...25 nm
LDL
low density lipoproteins



8...12 nm
HDL
high density Lipoproteins

7. att. On electron microscope in blood can observe small size fat vesicles, which size decreases in such sequence chylomicrons, very low density lipoproteins, low density lipoproteins and high density lipoproteins. Lipids are fats, cholesterol and vitamins K,E,D,A, which are water insoluble and insoluble in blood. Bile, intestinal and liver cells convert in small vesicles with food ingested lipids, which free swim in blood water medium. Lipids binding protein molecule covers vesicle surface and prevent it from adhesion and precipitation on blood vessel wall. Therefore these fat vesicles are called lipoproteins. Lipoproteins are just shape for human organism how delivers to any organism cell water insoluble lipids: fats, cholesterol, cholesterol esters, hormones, vitamins K, E, D, A and curative compounds of medicines.