

Lipids, fat and exercise



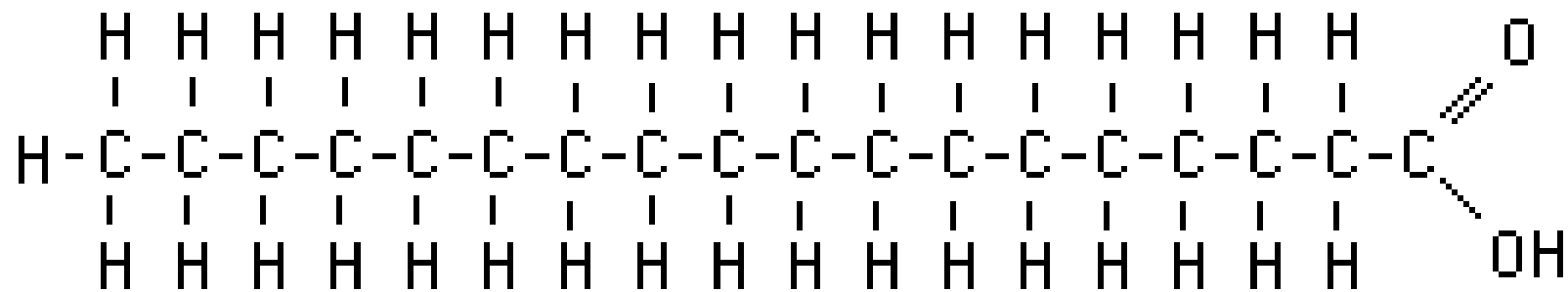
Fats

- a wide group of compounds that are generally soluble in organic solvents and largely insoluble in water
- solid (fats) or liquid (oils)
- Subset of the class of lipids
 - Simple lipids - fats (triglycerides) and wax
 - Complex lipids – phospholipids, glycolipids, lipoproteins
- Source of energy
 - 1 g fat = 9 kcal = 38 kJ

Fatty acids –classification

- **The length of the carbon chain**
 - SCFA (< 6C) - butter
 - MCFA (6 – 10 C) – butter, coconut and palm oil
 - LCFA (12 – 24C) – meat, fish, oil, seeds, nuts
- **The degree of unsaturation**
 - Saturated (SFA)
 - fully loaded with hydrogen atoms, only single bonds
 - Unsaturated
 - Monounsaturated (MUFA) - 1 double bond
 - Polyunsaturated (PUFA) - > 1 double bond

Saturated FA – Stearic acid

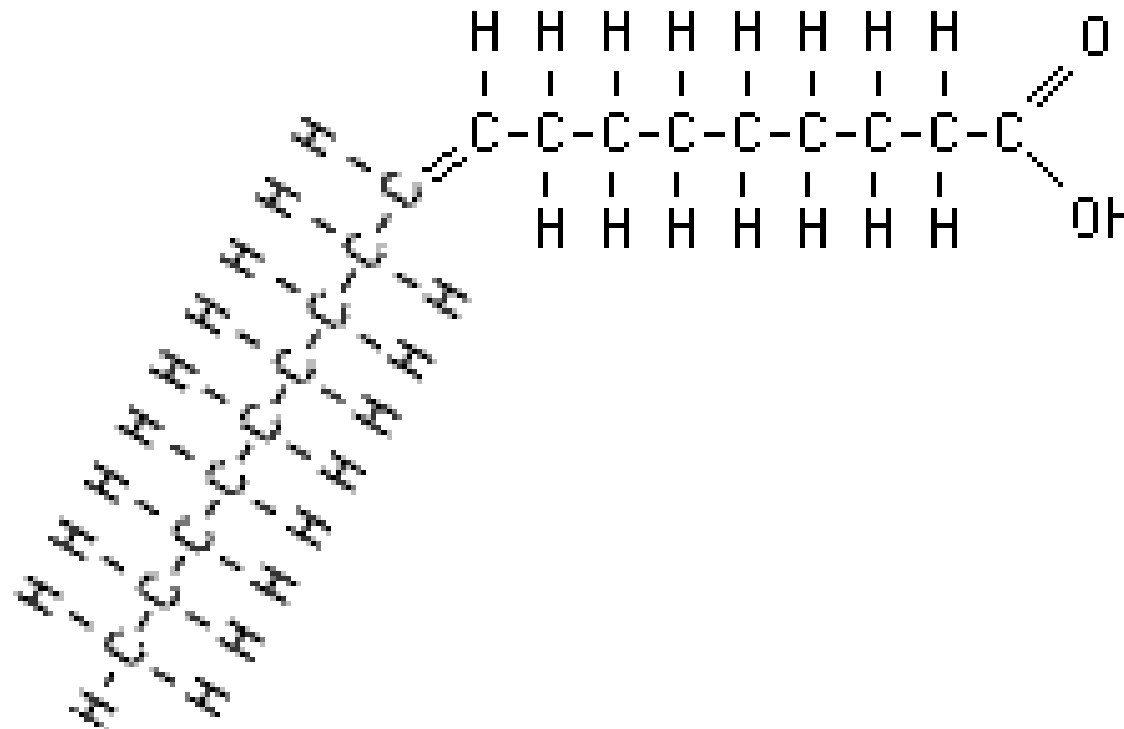


long hydrocarbon chain

carboxylic
acid group

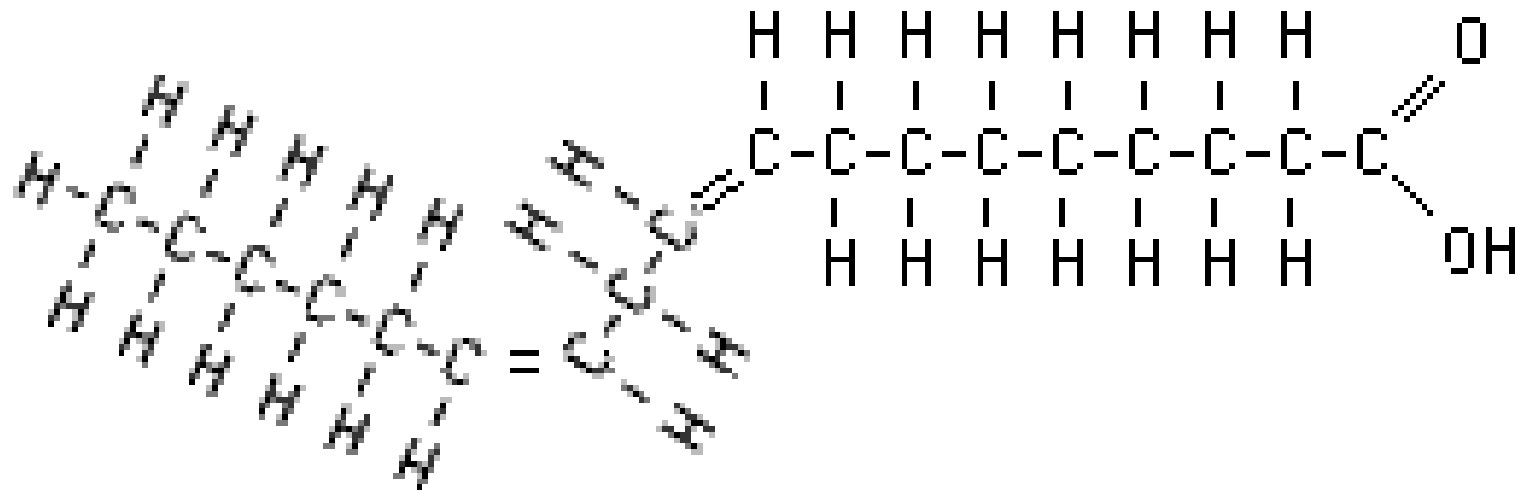
Essential features of a fatty acid

Monounsaturated FA



Oleic acid, a monounsaturated fatty acid.
Note that the double bond is *c/s*; this is
the common natural configuration.

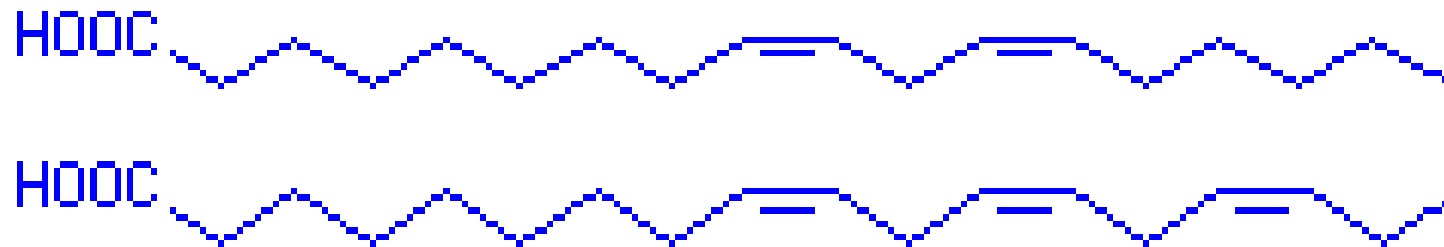
Polyunsaturated FA



Linoleic acid, a polyunsaturated fatty acid.
Both double bonds are *cis*.

Fatty acids –classification

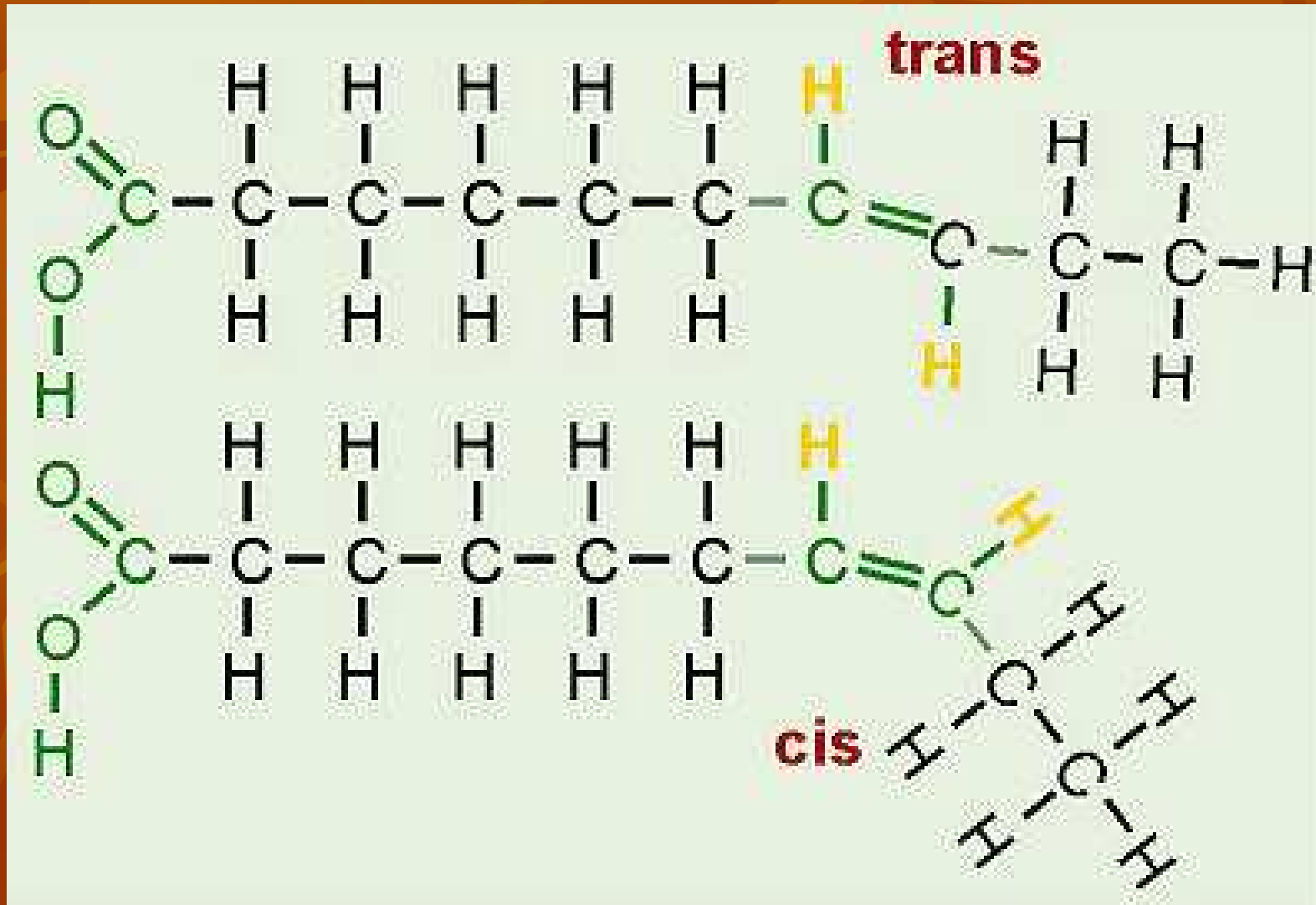
- The location of double bonds (only PUFA)
 - According the position of the double bond nearest the methyl end of the carbon chain
 - **Omega-3 fatty acids**
 - **Omega-6 fatty acids**



■ **Omega-6**

■ **Omega-3**

Trans-fatty acids



Cholesterol

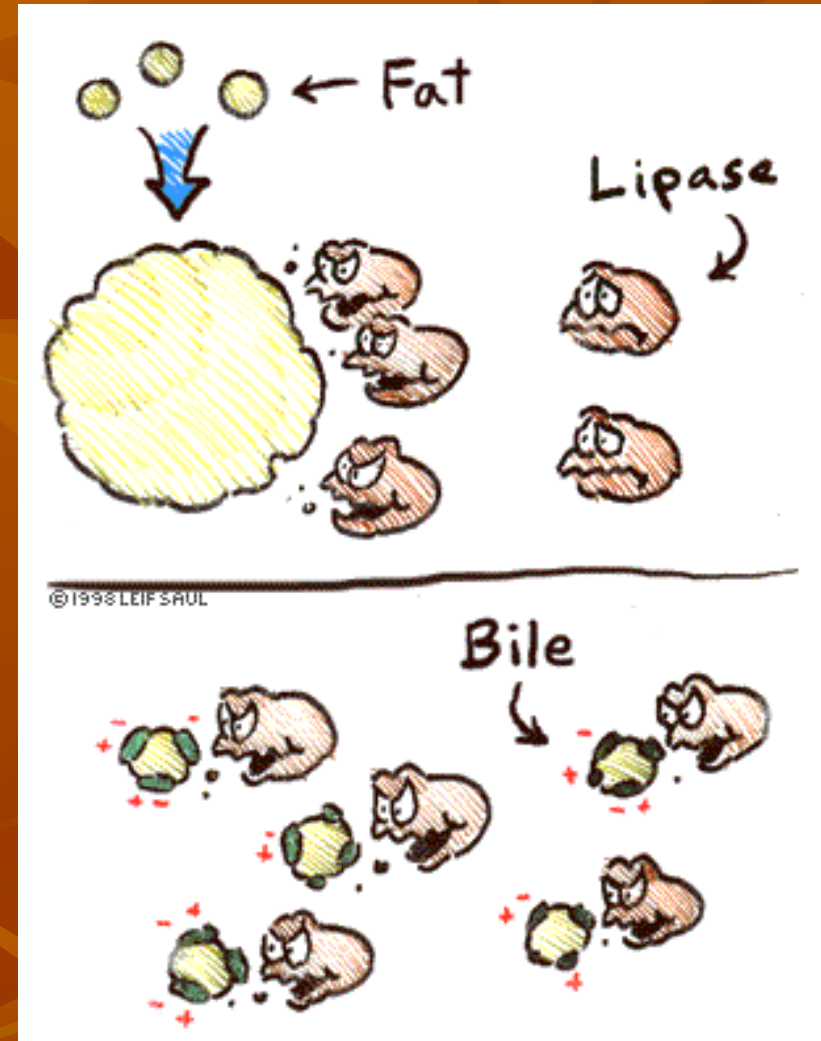
- *Sterols*
 - Plant
 - Animal contain cholesterol (animal fat)
- *Roles of sterols*
 - Vitally important body compounds - bile acids, sex hormones (testosterone), adrenal hormone (cortisol), vitamin D, cholesterol
- **Cholesterol – function**
 - Starting material for the synthesis of these compounds
 - Structural compounds of cell membranes
- **Cholesterol – sources**
 - Endogenous – made in the body 0,8 – 1,5 mg per day
 - Exogenous – from outside of the body (from food) 0,3 mg per day
- *Harmful effects of cholesterol*
 - It can form deposits in the artery walls (atherosclerosis => heart attacks, strokes)

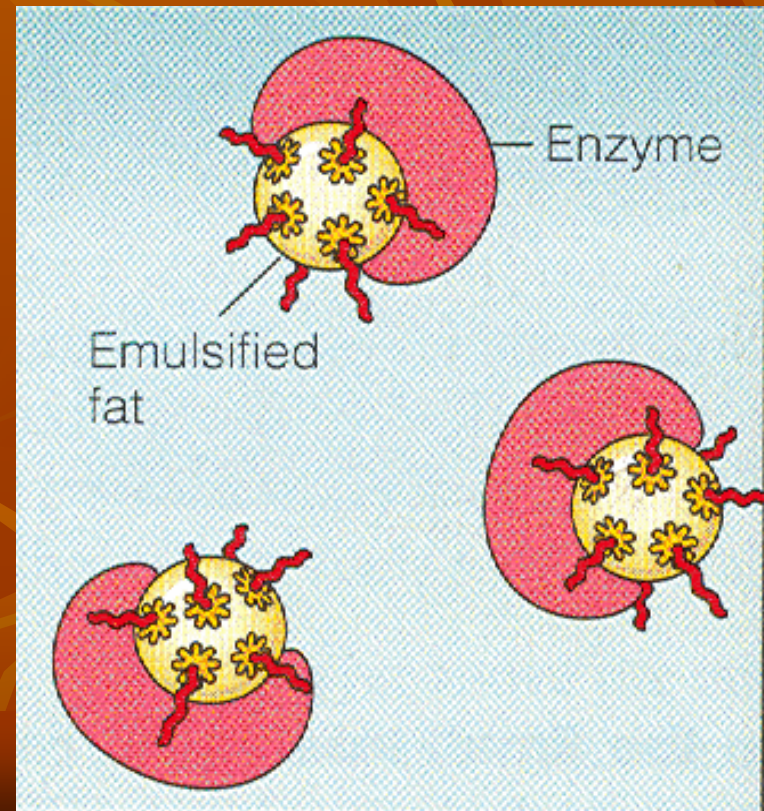
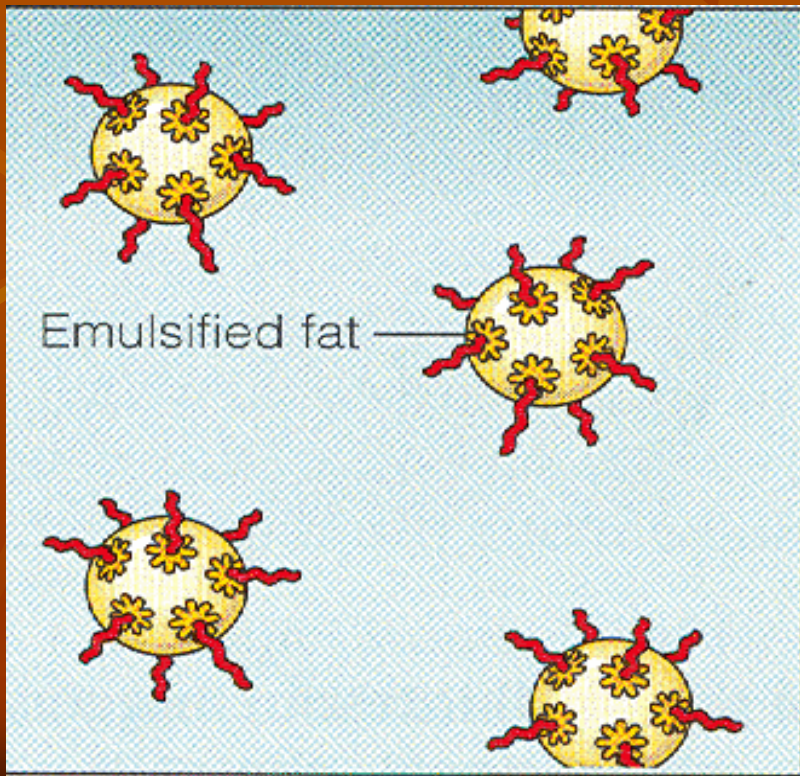
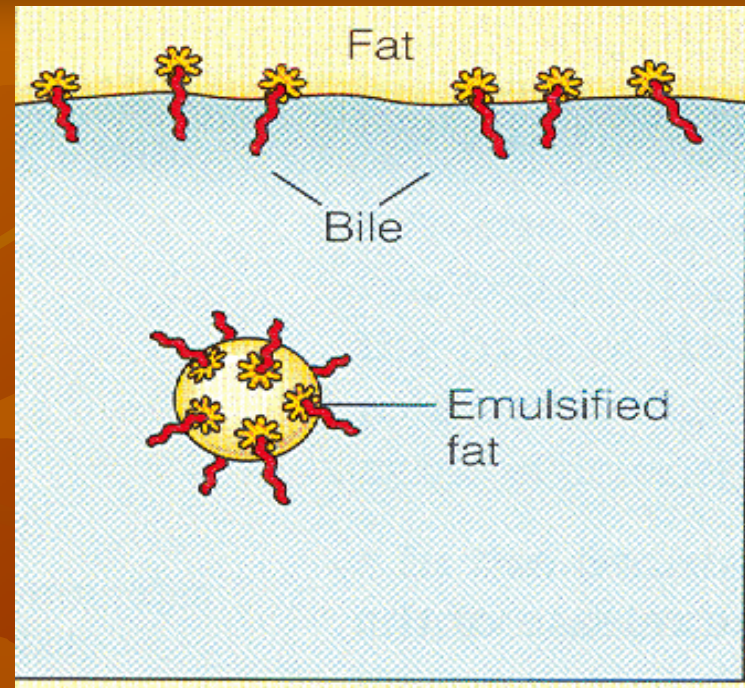
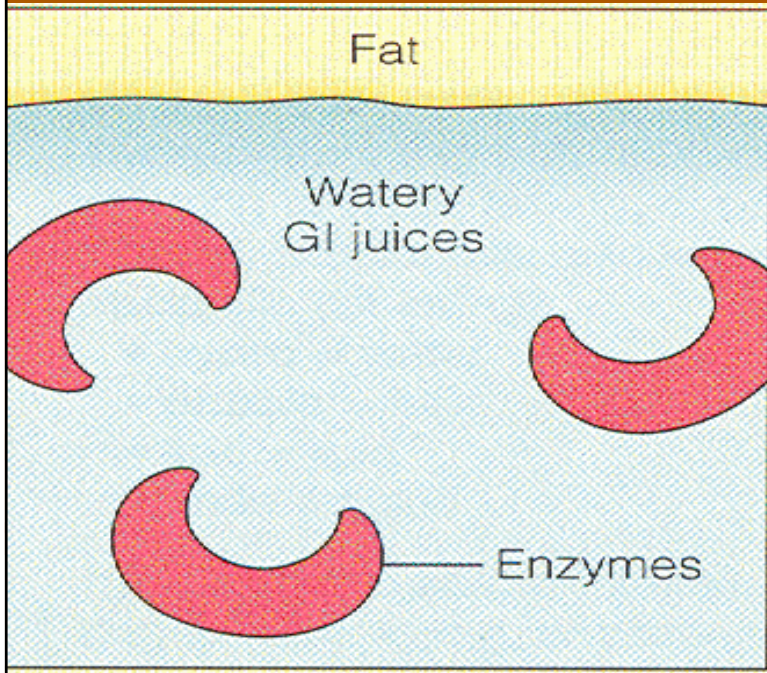
Roles of triglycerides

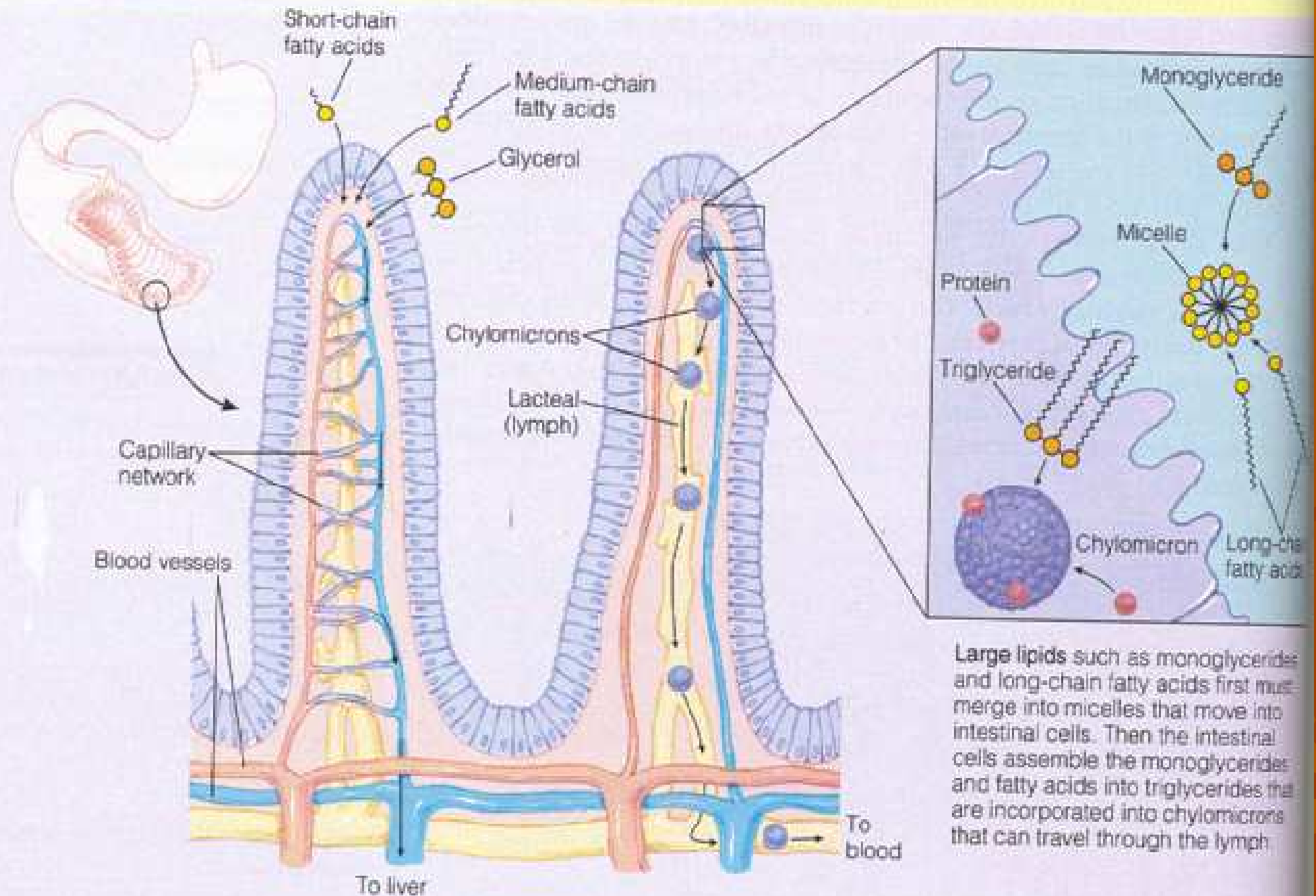
- Fat store – store of energy (50 000 kcal)
- Insulate of body, maintaining body temperature
- Cover inner organs
- Help body use carbohydrate and protein efficiently
- Help absorption of fat soluble vitamins (A,D,E,K)
- Source of essential fatty acids – linoleic and linolenic acid
- Importance role in healthy skin and hair
- Source of energy – FA and glycerol

Digestion of triglycerides

- **Mouth and salivary glands**
 - lingual lipase
- **Stomach**
 - lipid digestion by lingual lipase
- **Small intestine**
 - Fat by bile => emulsified fat
 - Emulsified fat by pancreatic and intestinal lipase => **monoglycerides, glycerol, fatty acids**







Large lipids such as monoglycerides and long-chain fatty acids first must merge into micelles that move into intestinal cells. Then the intestinal cells assemble the monoglycerides and fatty acids into triglycerides that are incorporated into chylomicrons that can travel through the lymph.

Glycerol and small lipids such as short- and medium-chain fatty acids can move directly into the bloodstream.

Lipid transport

- ***Lipoproteins***
 - **Chylomicrons (CL)**
 - transport vehicles for fat from the intestine to the rest of body
 - **VLDL (very low density lipoproteins)**
 - Make from CL
 - Transport TG to other part of the body
 - **LDL (low density lipoproteins)**
 - Transport cholesterol to the cells of all tissue
 - Bad cholesterol – is linked to heart disease
 - **HDL (high density lipoproteins)**
 - Transport cholesterol from the cells back to the liver
 - Good cholesterol - a protective effect

Metabolism of fat

- **Storing fat as fat**
 - In adipose tissue
- **Making fat from carbohydrates or protein**
 - FA can be made from 2C fragments derived from carbohydrates or protein
- **Making fat from fat**
- **Using fat for energy 60 %**
 - During prolonged light to moderate intense exercise

Health effects of lipid

- **Heart disease** - \uparrow chol - major risk factor
- **Risks from saturated fat** – \uparrow LDL chol
- **Risks from trans-fats** \Rightarrow \uparrow chol
- **Benefits from MUFA** - \downarrow risk for heart disease
- **Benefits from ω -3 PUFA** - \downarrow chol and prevent heart disease
- **Cancer** – total fat intake (saturated) is associated with c.
- **Obesity** – high-fat diets

Recommended intakes of fat

- Total fat < 30 % of energy intake
- SFA < 10 % of energy intake
- Cholesterol < 300 mg daily
- *Example*
 - *A person 2000 kcal a day, 600 kcal and less form fat (65 g), 200 kcal and less form SFA (20 g)*
- Select lean meats and nonfat milk
- Eat plenty of vegetable, fruits and grains
- Use fat and oils sparingly
- Look for invisible fat
- Read food labels

Fat metabolism and exercise

- Source of energy

- FA – oxidation in several types of tissue
- Glycerol – for glycolysis, gluconeogenesis

- **Fat mobilization**

- Adipose tissue
- ↑ glucagon, epinephrine, cortisol
 - => hormone sensitive lipase (HSL) - TG → FA
- ↑ FFA in the blood => ↑ oxidation FFA in the muscle (during exercise and fasting)

Fat metabolism during exercise

■ Sources of FA for muscle

- FA inside a muscle fiber
- FA outside a muscle fiber - adipose tissue in muscle, in the body, circulating lipoproteins

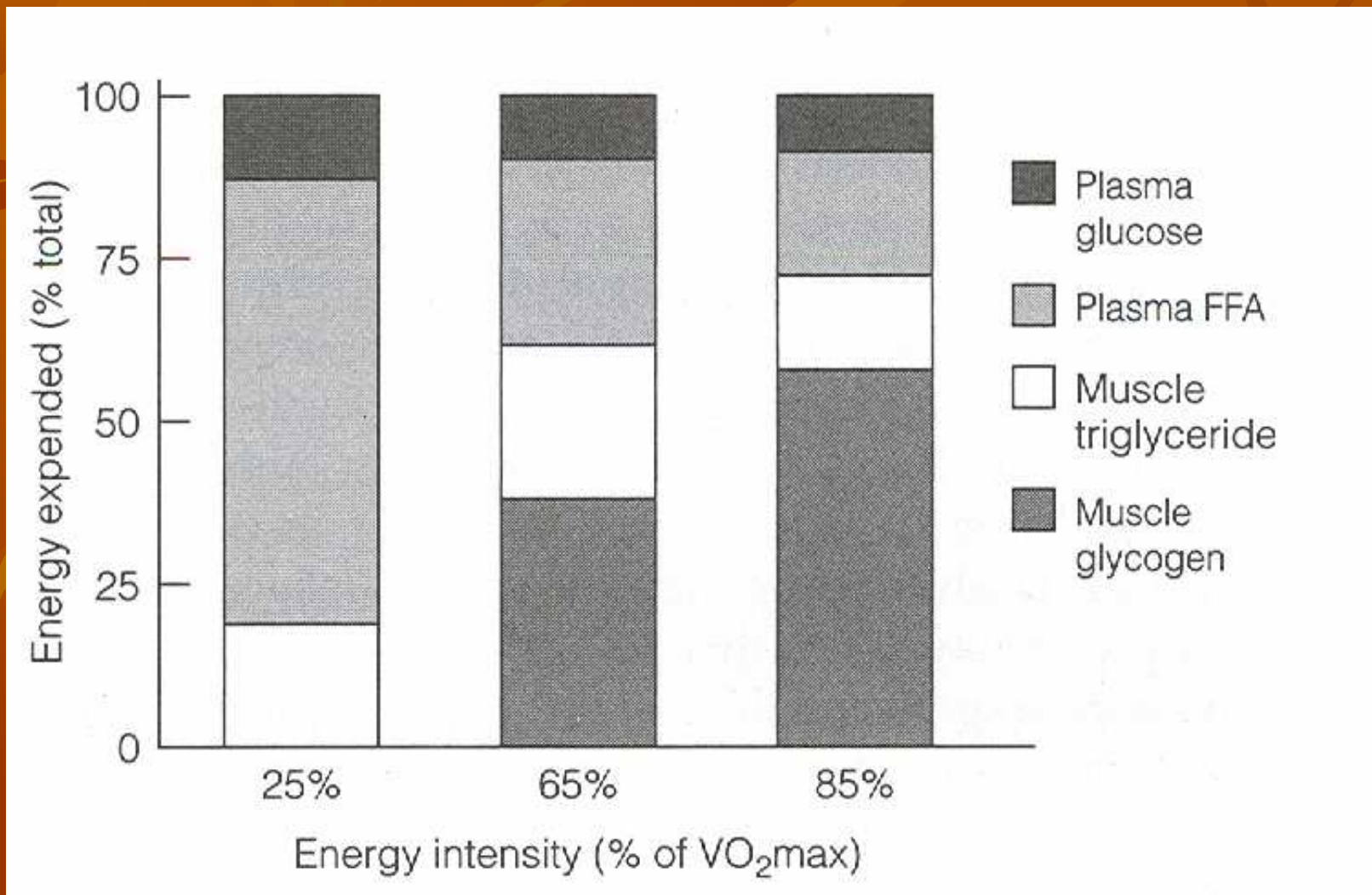
■ Hormonal influence

- Glucagon, cortisol \Rightarrow \uparrow HSL (hormone sensitive lipase) \Rightarrow lipolysis
- Insulin \Rightarrow \downarrow HSL \Rightarrow inhibition of lipolysis
- Concentration of glucose in the blood
 - $\uparrow \Rightarrow \downarrow$ HSL
 - $\downarrow \Rightarrow \uparrow$ HSL

■ Time of oxidation

- 15 – 30 min. after start

Intensity of exercise and fat utilization



Fat energy expended per hour and intensity of exercise

