



Chemistry of lipid

Introduction to lipid

University Of Fallujah
College Of Medicine

Lecture : 4

Stage : first

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Date: 28/3/2025

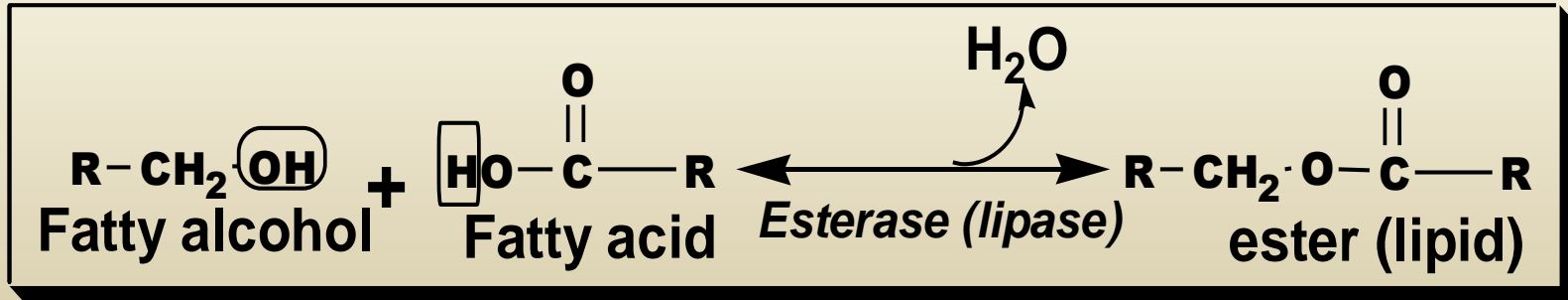
Chemistry of Lipids

Dr. Abdullah Ali

Chemistry of Lipids

Definition:

- Lipids are organic compounds formed mainly from alcohol and fatty acids combined together by ester linkage.



- - **Lipids are insoluble in water, but soluble in fat or organic solvents (ether, chloroform, benzene, acetone).**
- - **Lipids include fats, oils, waxes and related compounds.**
- **They are widely distributed in nature both in plants and in animals.**

Biological Importance of Lipids:

- 1. They are more palatable and storable to unlimited amount compared to carbohydrates.**
- 2. They have a high-energy value (25% of body needs) and they provide more energy per gram than carbohydrates and proteins but carbohydrates are the preferable source of energy.**
- 3. Supply the essential fatty acids that cannot be synthesized by the body.**
- 4. Supply the body with fat-soluble vitamins (A, D, E and K).**
- 5. They are important constituents of the nervous system.**
- 6. Tissue fat is an essential constituent of cell membrane and nervous system. It is mainly phospholipids in nature that are not affected by starvation.**

Classification of Lipids

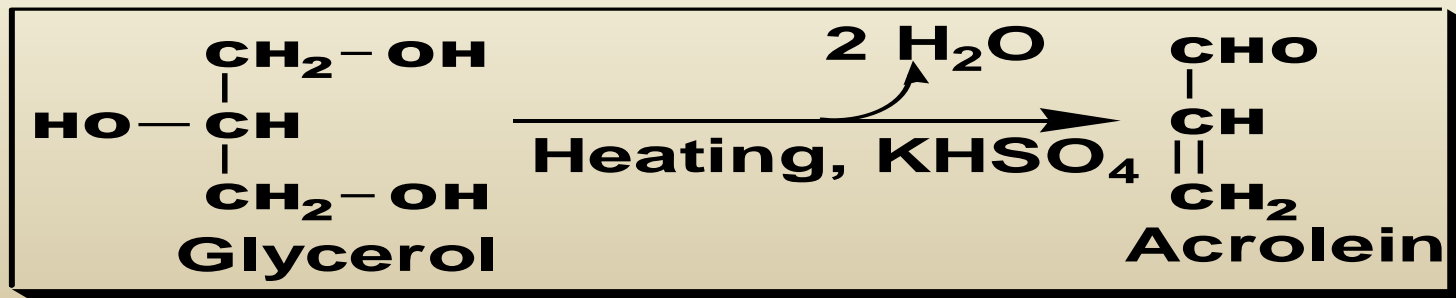
1. Simple lipids (Fats & Waxes)
2. Compound or conjugated lipids
3. Derived Lipids
4. Lipid-associating substances

Fatty alcohols

1-Glycerol:

- It is a trihydric alcohol (i.e., containing three OH groups) and has the popular name glycerin.
- It is synthesized in the body from glucose.
- It has the following properties:

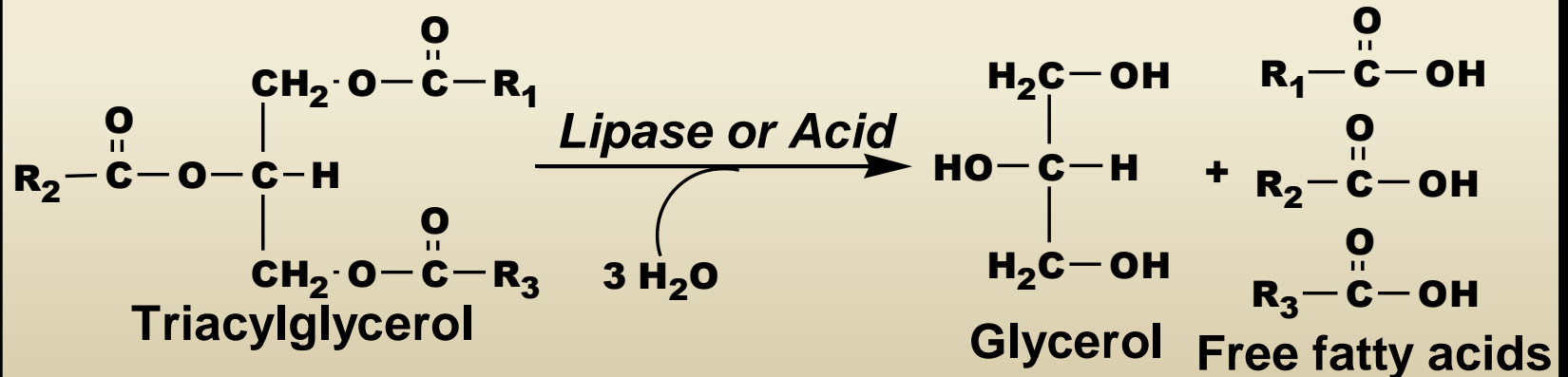
1. Colorless viscous oily liquid with sweet taste.
2. On heating with sulfuric acid or **KHSO₄** (dehydration) it gives acrolein that has a bad odor. This reaction is used for detection of free glycerol or any compound containing glycerol.



Chemical Properties of fats and oils:

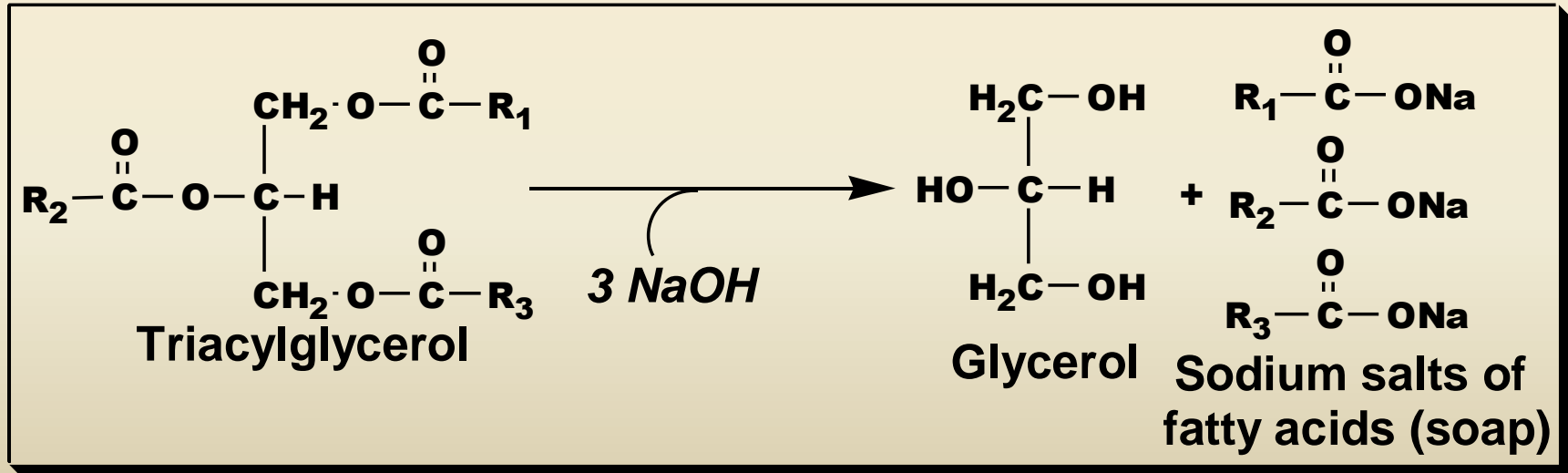
1-Hydrolysis:

- They are hydrolyzed into their constituents (**fatty acids and glycerol**) by the action of super heated steam, acid, alkali or enzyme (e.g., lipase of pancreas).
- - During their enzymatic and acid hydrolysis glycerol and free fatty acids are produced.



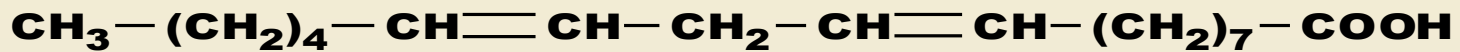
2-Saponification. Alkaline hydrolysis produces glycerol and salts of fatty acids (**soaps**).

- Soaps cause emulsification of oily material this help easy washing of the fatty materials

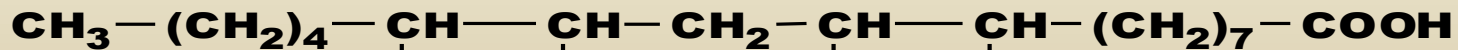
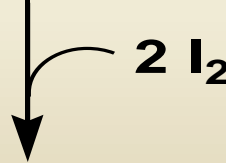


3-Halogenation

- Neutral fats containing unsaturated fatty acids have the ability of adding halogens (e.g., hydrogen or hydrogenation and iodine or iodination) at the double bonds.
- - It is a very important property to determine the degree of unsaturation of the fat or oil that determines its biological value



Linoleic acid



Stearate-tetra-iodinate

4-Hydrogenation or hardening of oils:

- It is a type of addition reactions accepting hydrogen at the double bonds of unsaturated fatty acids.
- The hydrogenation is done under high pressure of hydrogen and is catalyzed by finely divided nickel or copper and heat.
- It is the base of hardening of oils (**margarine manufacturing**), e.g., change of oleic acid of fats (liquid) into stearic acid (solid).
- **It is advisable not to saturate all double bonds; otherwise margarine produced will be very hard, of very low biological value and difficult to digest.**

Oils (liquid) (with unsaturated fatty acids, e.g., oleic)	Hydrogen, high pressure, nickel →	Hard fat (margarine, solid) (with saturated fatty acids, e.g., stearic)
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Advantages for hydrogenated oil or fat are as follows:

1. It is more pleasant as cooking fat.
2. It is digestible and utilizable as normal animal fats and oils.
3. It is less liable to cause gastric or intestinal irritation.
4. It is easily stored and transported and less liable to rancidity.

Disadvantages of hydrogenated

- fats include lack of fat-soluble vitamins (A, D, E and K) and essential fatty acids

5-Oxidation(Rancidity)

- This toxic reaction of triglycerides leads to unpleasant odour or taste of oils and fats developing after oxidation by oxygen of air, bacteria, or moisture.
- Also this is the base of the drying oils after exposure to atmospheric oxygen.

Example is linseed oil, which is used in **paints and varnishes manufacturing**

Rancidity

Definition:

- It is a physico-chemical change in the natural properties of the fat leading to the development of **unpleasant odor or taste or abnormal color** particularly on aging after exposure to atmospheric oxygen, light, moisture, bacterial or fungal contamination and/or heat.
- Saturated fats resist rancidity more than unsaturated fats that have unsaturated double bonds.

Chemical tests for:

1. Solubility in polar and nonpolar solvent
2. Emulsification precursor of many steroid hormones, vitamin D
3. Oxidation of unsaturation FA
4. Qualitative analysis of detection in natural products (salkowski reaction)

1. Solubility in polar and nonpolar solvent

• Reagents

- Olive oil (vegetable oil), butter (animal fat),
- stearic acid (saturated fatty acid), oleic acid (unsaturated fatty acid),
- Solvents: dilute acid and alkali solutions, cold alcohol, hot alcohol, benzene, chloroform, ether and carbon tetrachloride.

Procedure

1. Add a 2drops of the liquid fat or 0.1 g of the solid fat in labeled test tubes.
2. To each test tube add a 1 ml of solvent and write down your observations.
3. Repeat the experiment with a different solvent and make your observations.

2- Emulsification

Reagents

- Neutral olive oil, 0.5 % Na_2CO_3 , Rancid olive oil

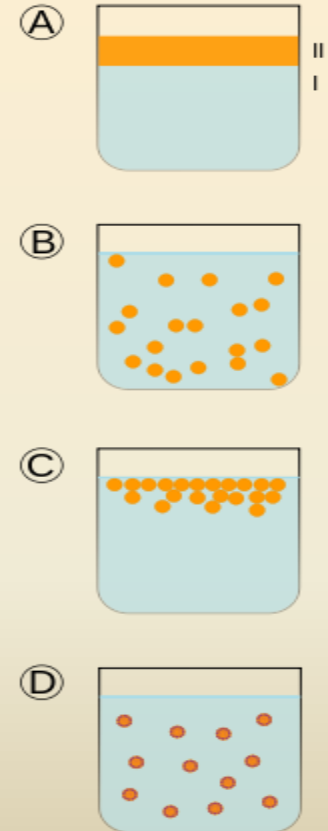
Procedure

1. Shake up a drop of neutral olive oil with a little water in a test tube, the fat becomes finally divided forming an emulsion, upon standing fat separates and rises to the top.
2. To 5 ml water in a test tube add 2 to 3 drops of 0.5 percent Na_2CO_3 . Introduce a drop of neutral olive oil and shake, the emulsion is not permanent and is not so transitory.
3. Repeat step 2 using rancid olive oil. In this case the alkali combines with the free fatty acids to form soap and the soap being an emulsifying agent, it emulsifies the fat.

2- Emulsification

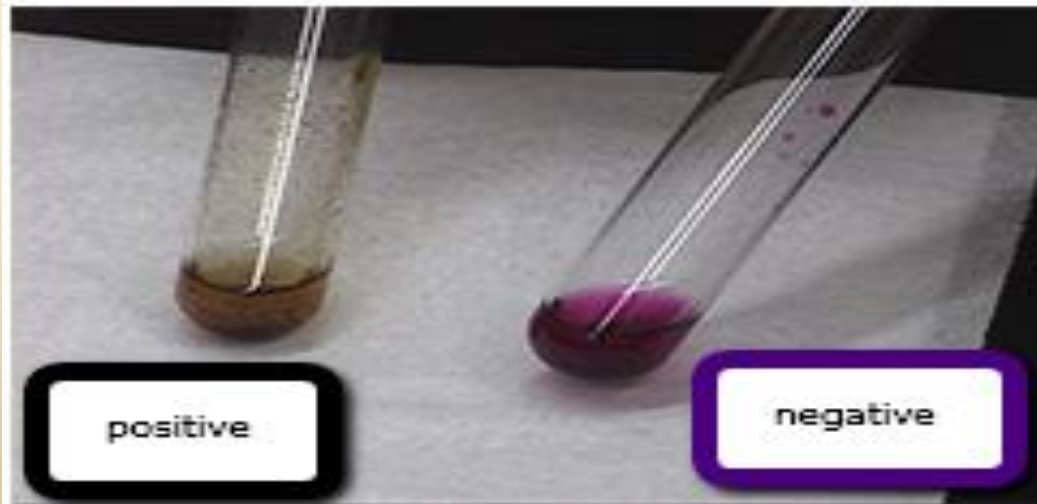
- An **emulsion** is a mixture of two or more liquids that are normally immiscible (no mixable).
- **Bile Salts** Synthesized from cholesterol and stored in the gallbladder When you eat fat, the bile salts act as soap and help emulsify the large globules of fat.

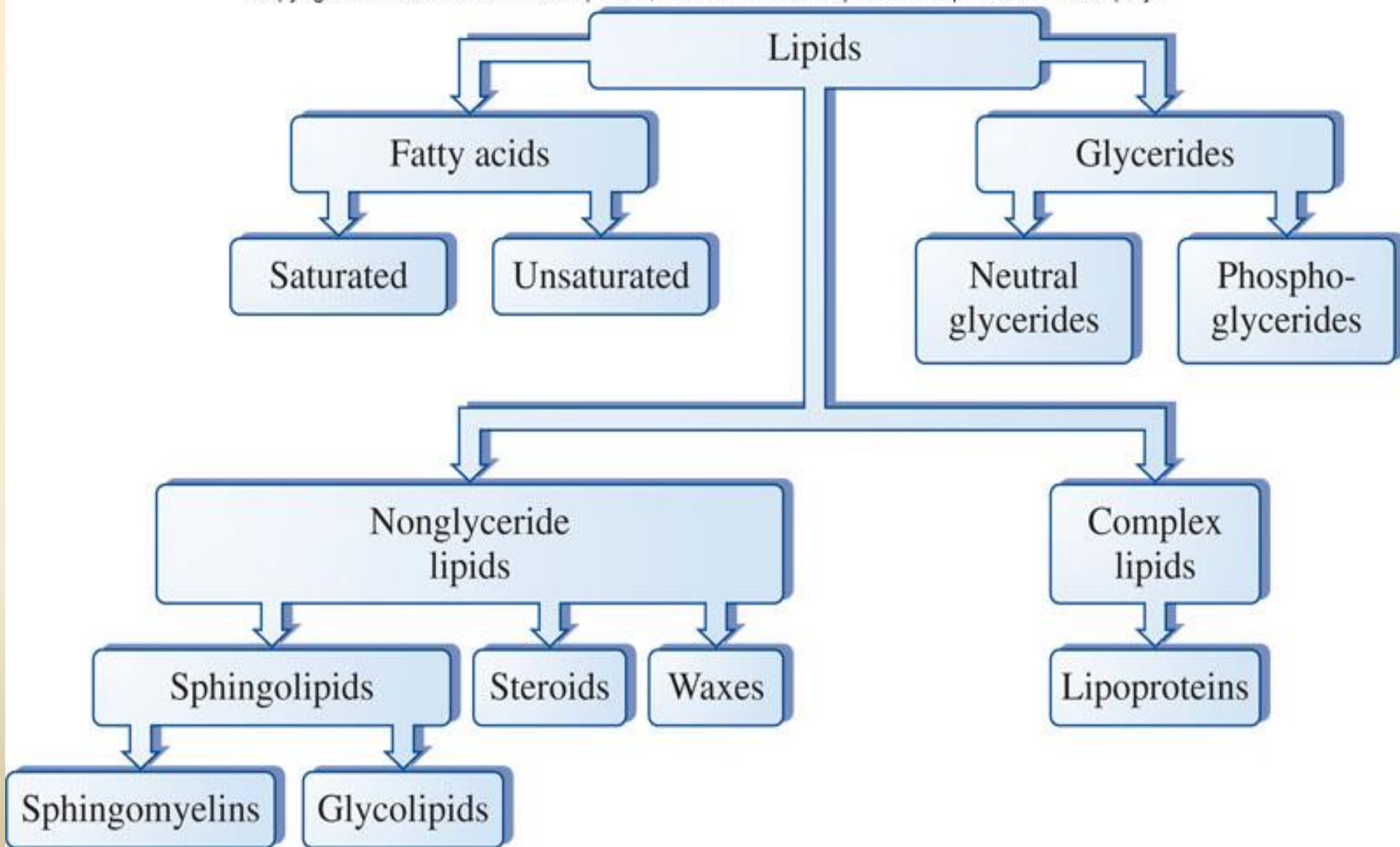
- A. Two immiscible liquids, not yet emulsified
- B. An emulsion of Phase II dispersed in Phase I
- C. The unstable emulsion progressively separates
- D. The surfactant stabilizing the emulsion



1. Oxidation of unsaturation FA

- Into test tube place one drop of oil and 3 ml of Na_2CO_3
- Warm it slightly and drop solution KMnO_4 .after each drop the violet color disappear
- The end of the reaction recognized by ppt brown solid MnO_2





Coronary heart disease

In CHD the coronary arteries that supply the heart muscle with nutrients become narrowed and the heart muscle becomes starved of the blood it needs

Fatty deposit

Weakened blood flow

Aneurysm

Fatty deposits in an artery can cause the artery wall to bulge and weaken. This can rupture with catastrophic consequences

Heart

Aorta

Weakened, bulging artery wall

Fatty deposit

Stroke

When a blood vessel supplying vital nutrients to the brain becomes blocked the brain cells it supplies will die

Brain

Fatty Deposit

Blood clot

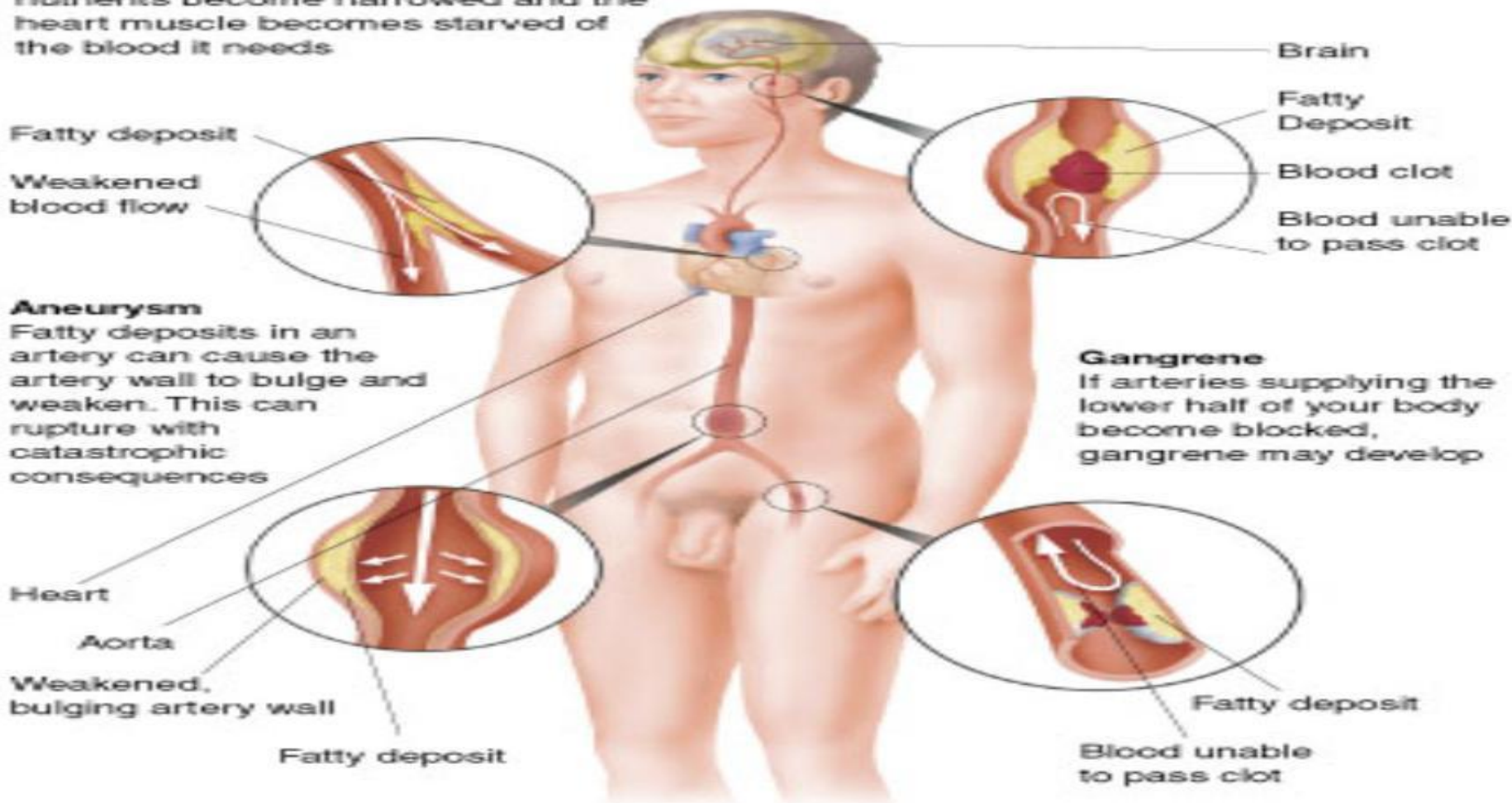
Blood unable to pass clot

Gangrene

If arteries supplying the lower half of your body become blocked, gangrene may develop

Fatty deposit

Blood unable to pass clot



THE END