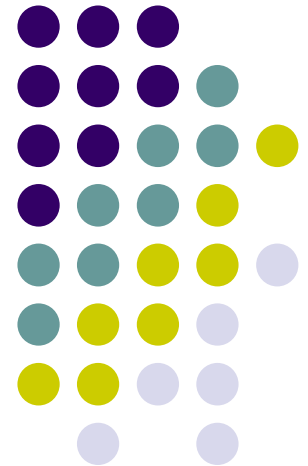
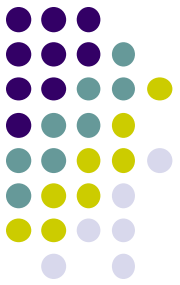


NATIONAL UNIVERSITY OF PHARMACY
DEPARTMENT OF PATHOLOGICAL PHYSIOLOGY

DISTURBANCES
OF LIPID METABOLISM

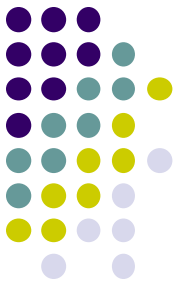




PLAN OF LECTURE

- 1. Lipids: characteristic, types, functions.**
- 2. Types of disturbances lipid metabolism.**
- 3. Obesity: classification, signs, implications.**

Questions of Independent work



1. Disturbance of acid-base equilibrium. The concept of acidosis and alkalosis: the causes, types, principles of correction.
2. Violation of phosphorus-calcium metabolism. Disturbance of microelement exchange.
3. The concept of basic and energy exchanges. Infringement of power supply of a cell: the reasons, consequences.
4. Starvation: causes, types, consequences. The concept of curative starvation.

Suggested Reading



Basic

1. General and clinical pathophysiology/ Editor by Anatoliy V. Kubyshkin. – Vinnytsa : Nova Knyha Publishers, 2016. – 656 p.
2. Lecture notebook pathological physiology. Manual for working in lectures / N.M. Kononenko, S.I. Kryzhna, V.A. Volkovoy et al.; Kh.: NPhaU, 2013. – 99 p.
3. Pathological Physiology: The textbook for the students of higher pharmaceutical educational institutions and pharmaceutical faculties of higher medical educational institutions III-IV levels of accreditation / S.I. Kryzhna, N.M. Kononenko, I.Yu. Tishenko et al.: under edition of the professor A.I. Berezhnyakova. – Kharkiv: NphaU, 2006. – 416 p.

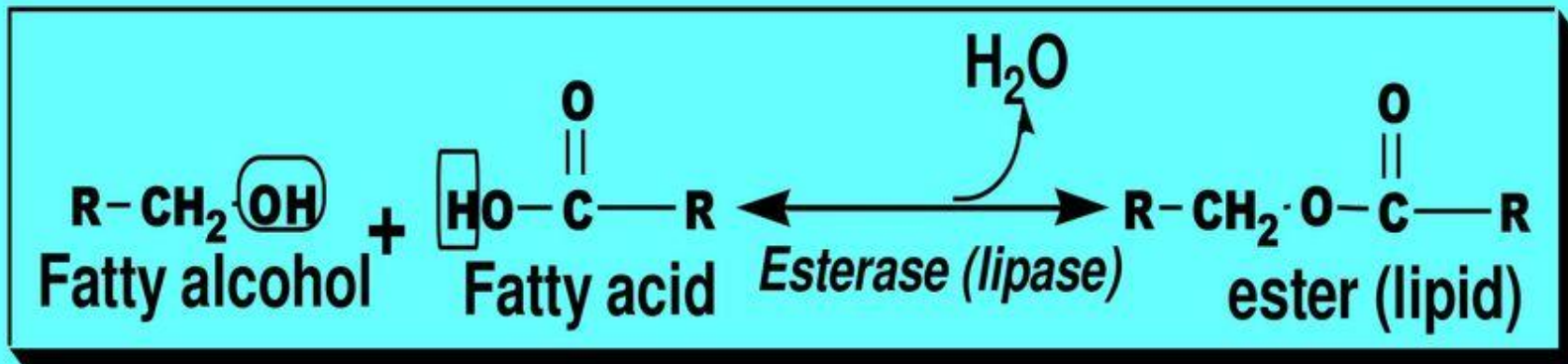
Auxiliary

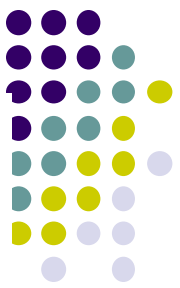
1. Professional guide to Pathophysiology / M.H. Birney, C. L. Brady, K.T. Bruchak et al. – Lippincott Williams and Wilkins. – 2002. – 696 p.
2. Crowley L.V. An introduction to human disease: pathology and pathophysiology correlations / L.V. Crowley . – London : Lones and Bartlett Publishers International Bard House. 2001. – 790 p.

Chemistry of Lipids

Definition:

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





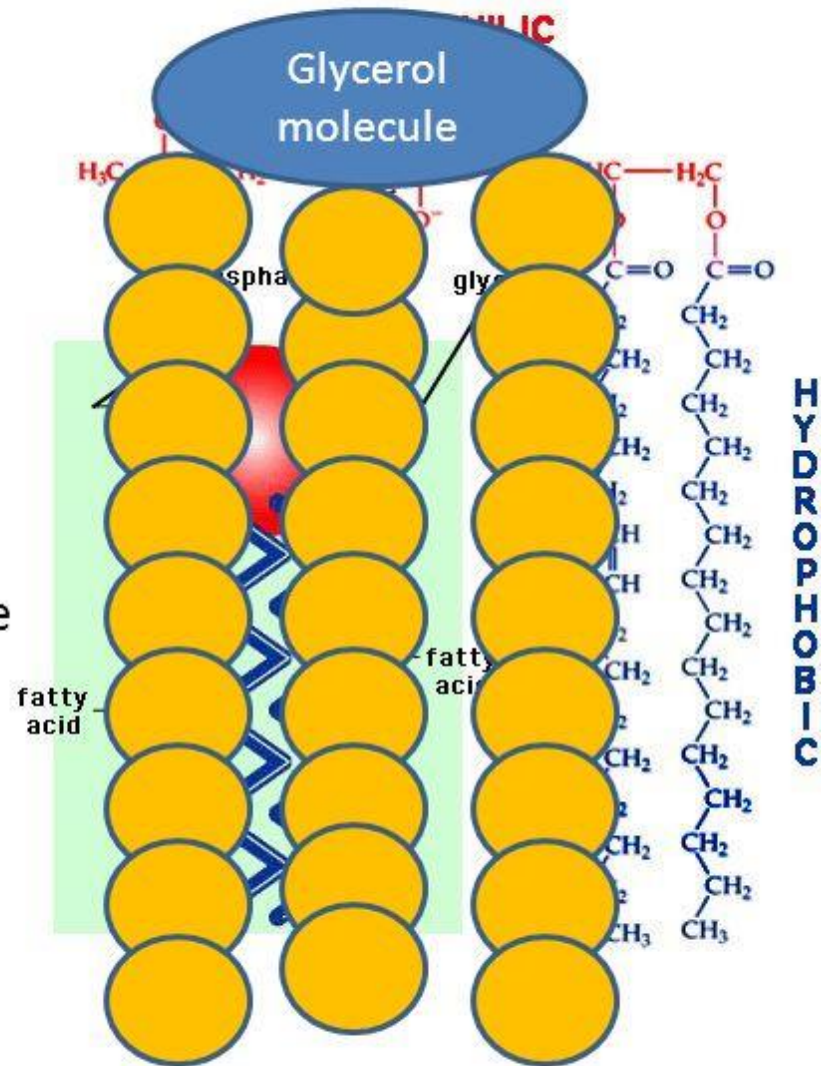
Lipids

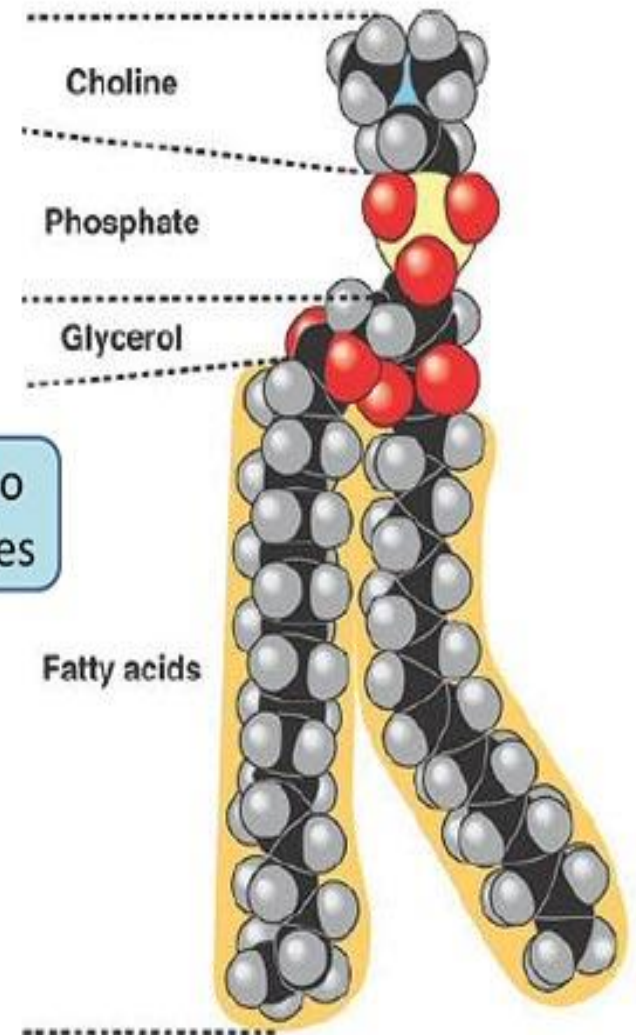
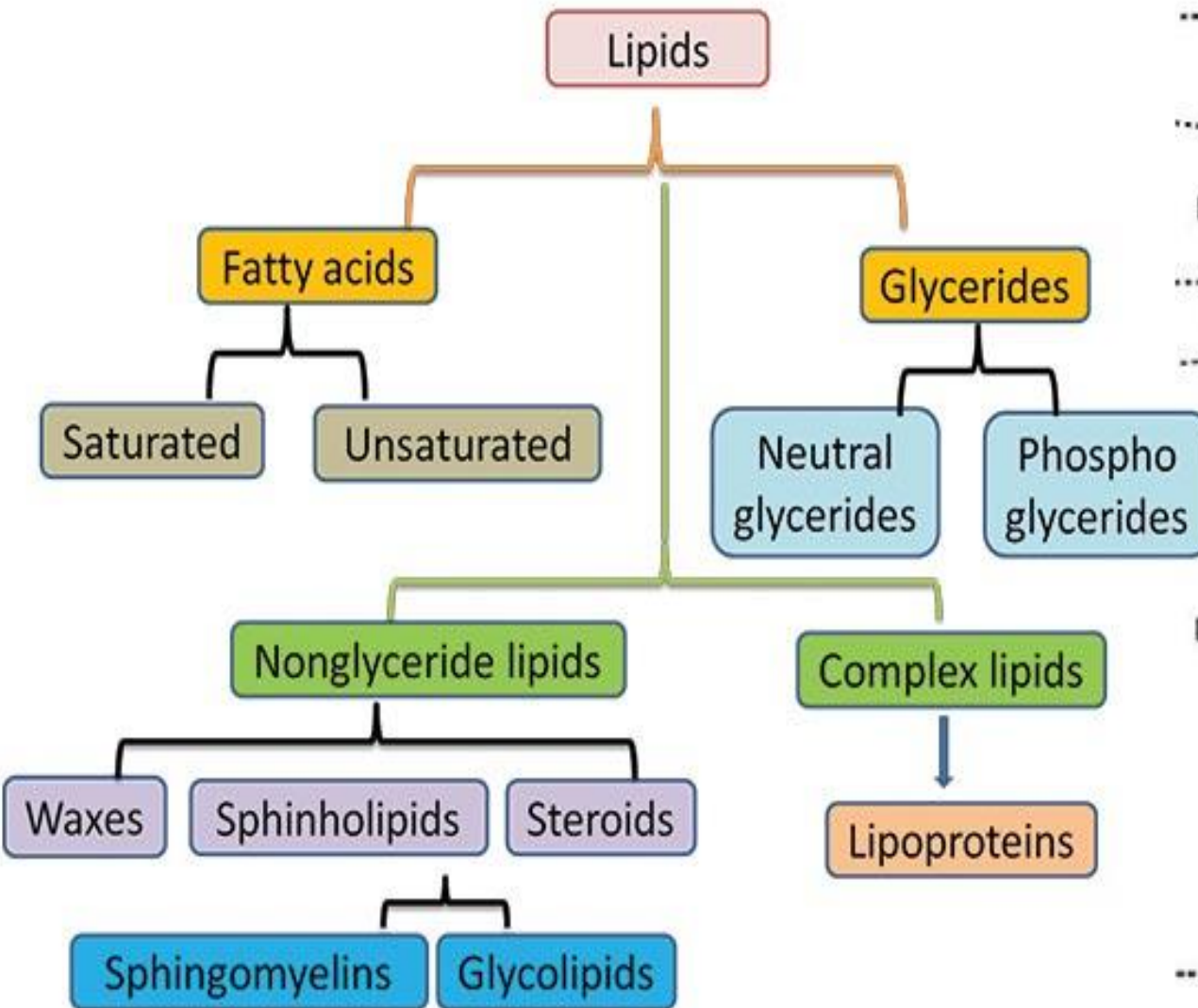
Introduction to Lipids

- **Lipids** are biomolecules that are soluble in organic solvents and insoluble in water.
- They are defined on the basis of a **physical property** *not* by a particular functional group, thus they have a **variety** of structures and functions.
- They contain many nonpolar C—C and C—H bonds and few polar bonds resulting in their water insolubility.

Lipid Structure

- Fats, Oils, Cholesterol, Waxes
- Monomer: Fatty Acid
- Polymer: Lipid
- **Phospholipid:**
 - Structure (3 parts):
 - “Head” = Glycerol & Phosphate
 - “Tails” = 2 Fatty acids
 - Function: Make up the cell membrane
- **Triglyceride:**
 - Structure (2 parts):
 - “Head” = Glycerol
 - “Tails” = 3 Fatty acids
 - Function: Provide energy for cells, insulation
 - Cholesterol: Gives cell membrane flexibility

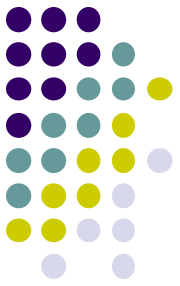




Lipid functions

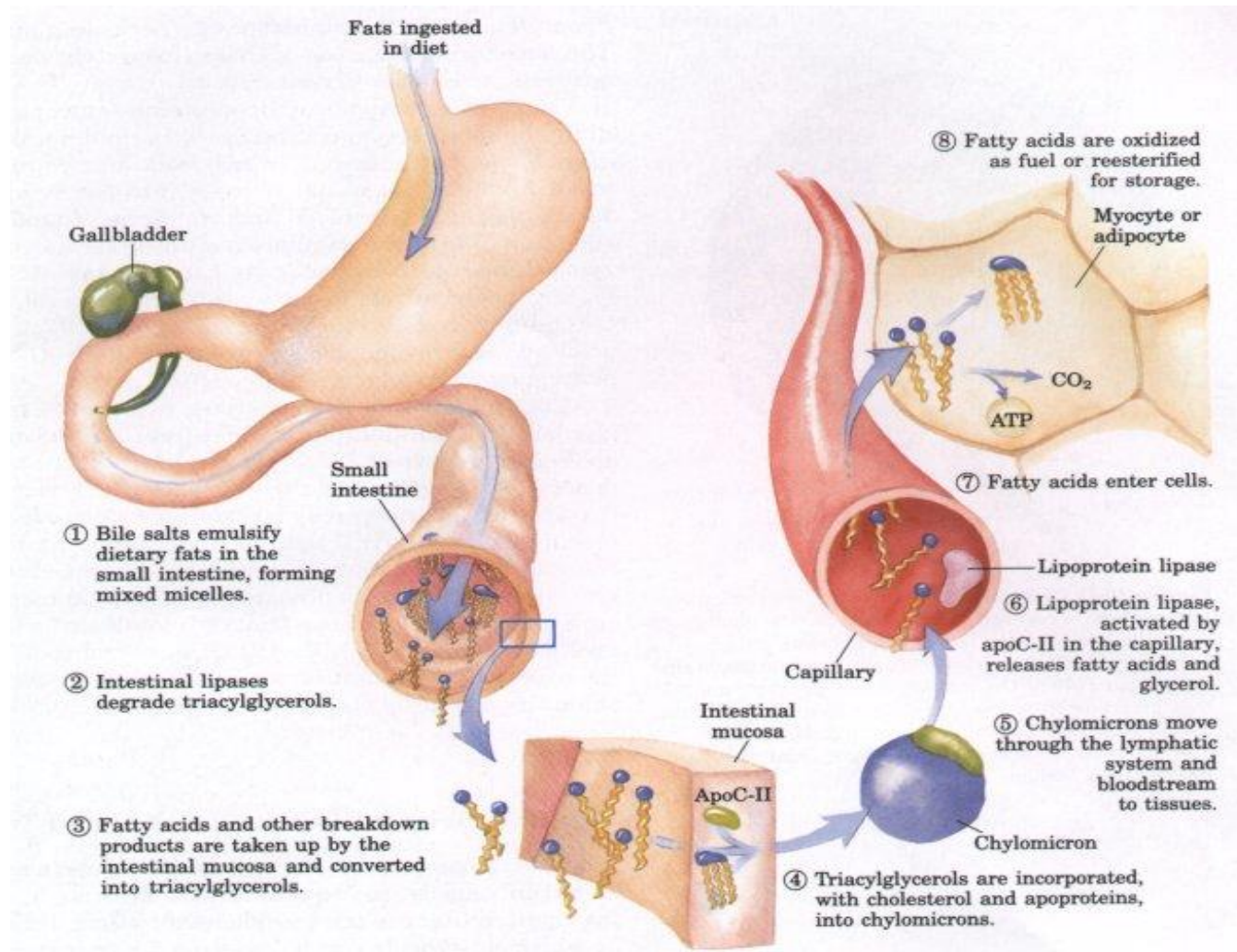
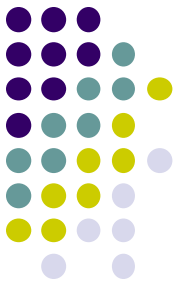
- **Storage form of energy**
- **Supply essential fatty acids**
- **Structural components of cell membranes**
- **Electrical insulation**
- **Protect body from cold**
- **Mechanical protection of internal organs**
- **Metabolic regulators (hormones)**
- **Help transport fat soluble vitamins**

DISORDERS OF LIPID METABOLISM



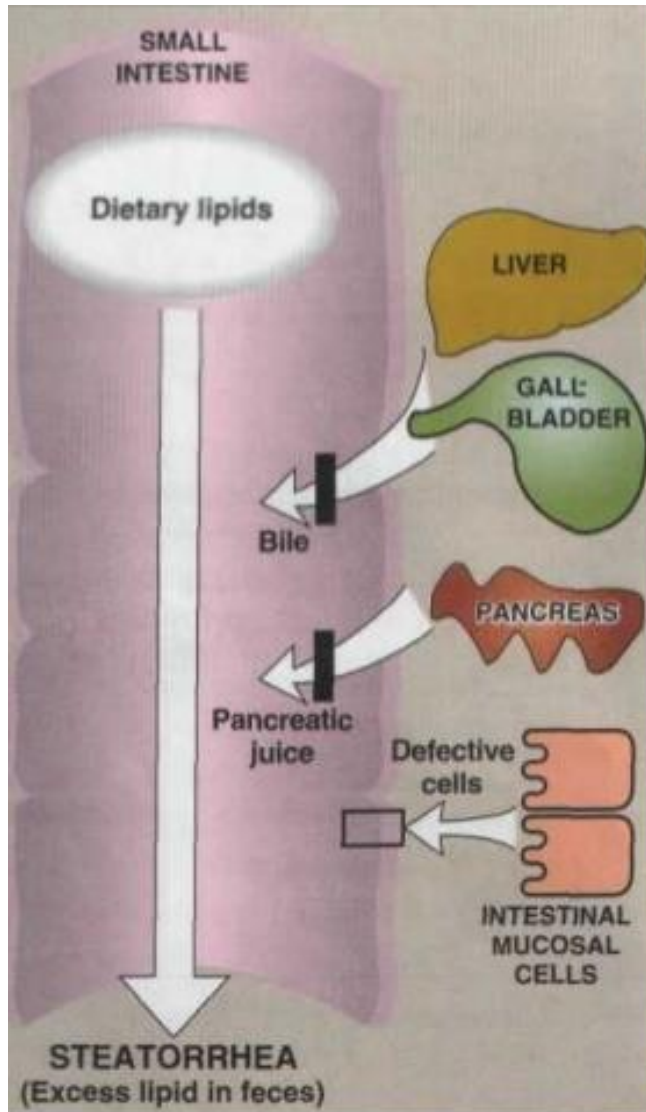
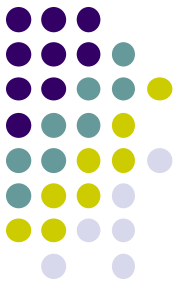
- *disorders of the digestion, absorption and excretion of fats;*
- *disorders of transport lipids and moving it into the tissue;*
- *excessive accumulation of fat in the organs of non-adipose tissue (fat infiltration and fatty dystrophia);*
- *disorders of intermediate metabolism of lipids;*
- *disorders of fat metabolism in adipose tissue.*

Disorders of the digestion, absorption and excretion of fats



Steatorrhea

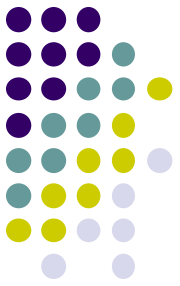
is presence of excess fat in feces



Possible causes of steatorrhea.

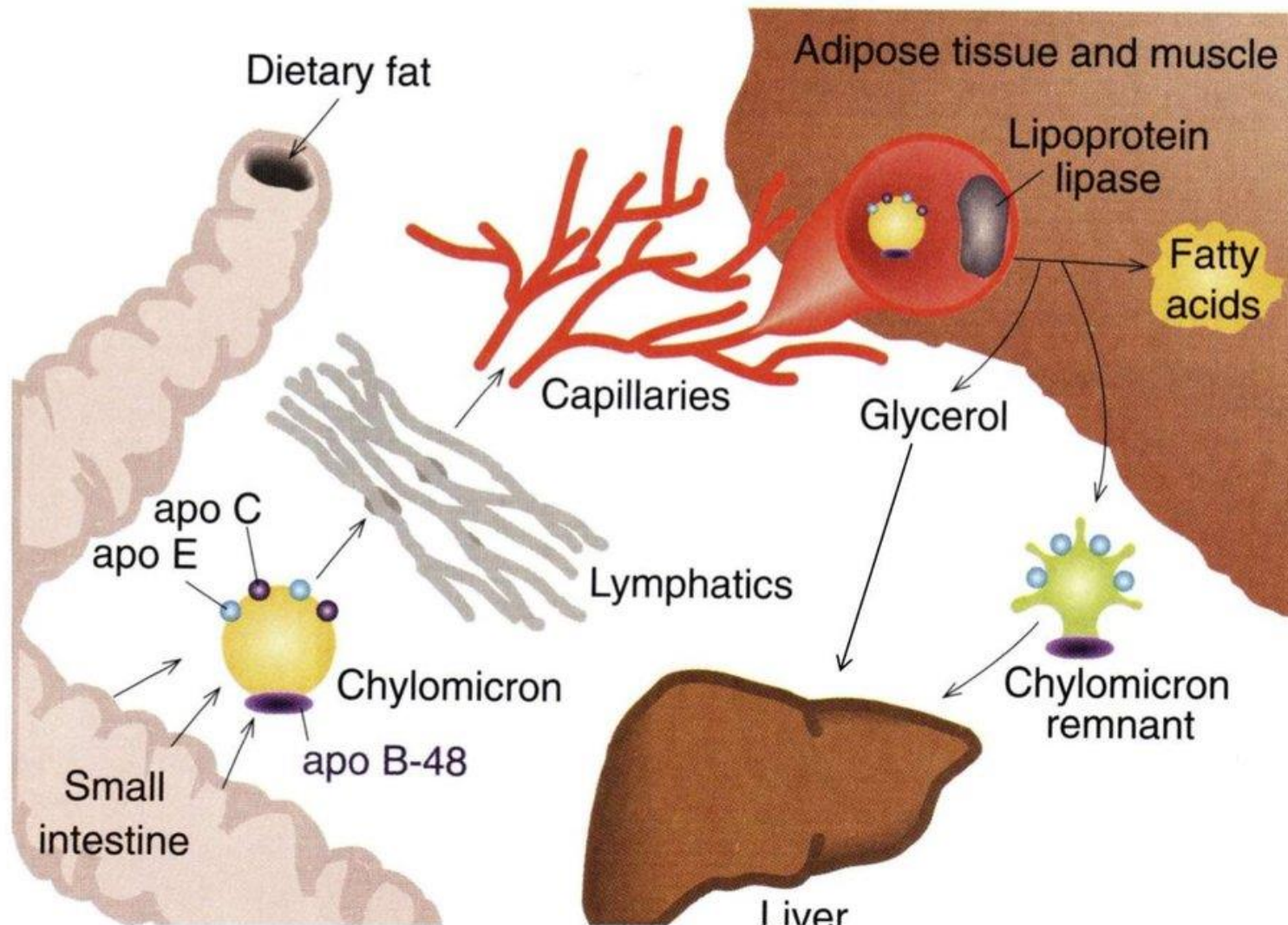
- 1) diseases of liver and gallbladder (inability to synthesize and secrete bile).
- 2) Diseases of pancreas (inability to secrete pancreatic juice).
- 3) Defective intestinal mucosal cells (inability to absorb).

Disorders of transport fat and moving it into the tissue

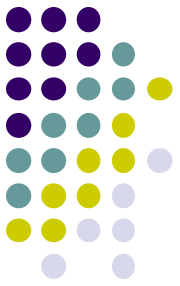


- Fat absorbed from the diet and lipids synthesized by the liver and adipose tissue must be transported between the various tissues and organs for utilization and storage.
- Since lipids are insoluble in water, the problem arises of how to transport them in an aqueous environment – the blood plasma.

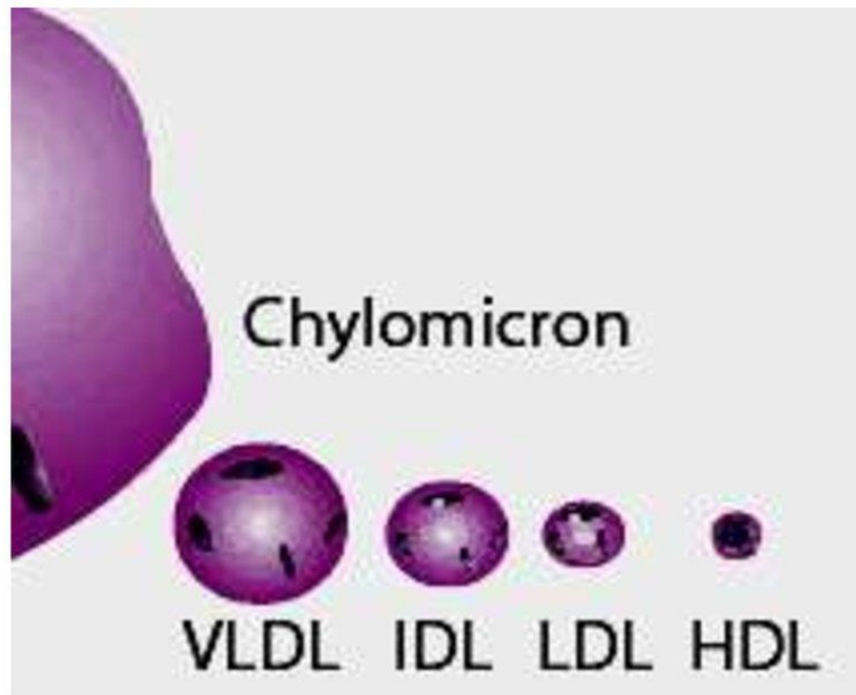
Fat transport

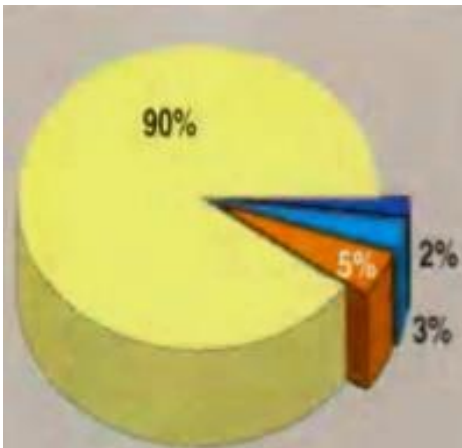
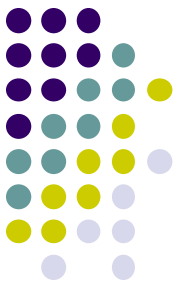


Disorders of transport fat and moving it into the tissue

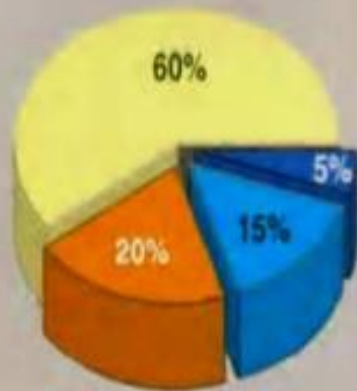


Transport lipoproteins



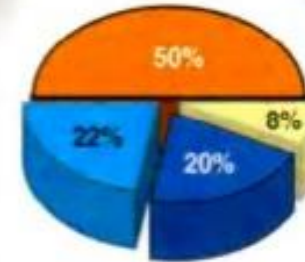


Chylomicron

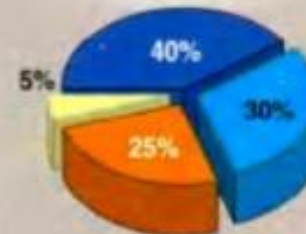


Very-Low-Density Lipoprotein (VLDL)

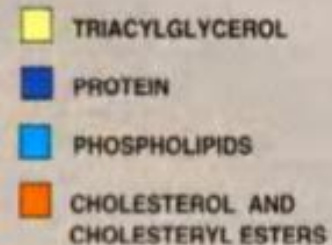
Composition of the plasma lipoproteins.



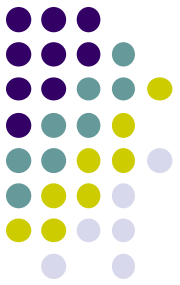
Low-Density Lipoprotein (LDL)



High-Density Lipoprotein (HDL)



HYPERLIPEMIA



It is increase of level of fats in the blood more than 4-8 g/l.

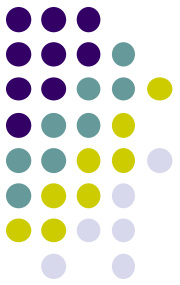
Types of hyperlipemia:

- ***alimentary*** (after eating);
- ***transport*** (moving fat from depot to the liver as result impoverishment of the liver in glycogen (starvation, diabetes mellitus, stress);
- ***retentional*** (a consequence of delays fat in the blood)



Alimentary hyperlipemia.

- **Already within 1-2 hours** after intake of a lipid-rich diet, the alimentary hyperlipemia is observed in the organism.
- This is a transient physiological state, characterized primarily by an increased concentration of triglycerides in the blood and by the occurrence of chylomicrons in it.
- The alimentary hyperlipemia passes its **maximum within 4-6 hours** after the intake of fat-rich food.
- **In 10-12 hours** after the intake of diet, the triglyceride content **comes back to the normal level**, and chylomicrons are no more observed in the blood.



Abnormalities of lipid metabolism

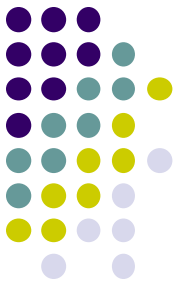
- **dyslipidemia**: abnormal lipid levels
- **causes**: defective synthesis/transport/catabolism of lipoproteins
- **hyperlipoproteinemia**: elevated lipoprotein levels
 - hypercholesterolemia
 - hypertriglyceridemia
 - combined hyperlipidemia
- **hypolipoproteinemia**: decreased lipoprotein levels

Hyperlipoproteinemia

Fredrickson Classification

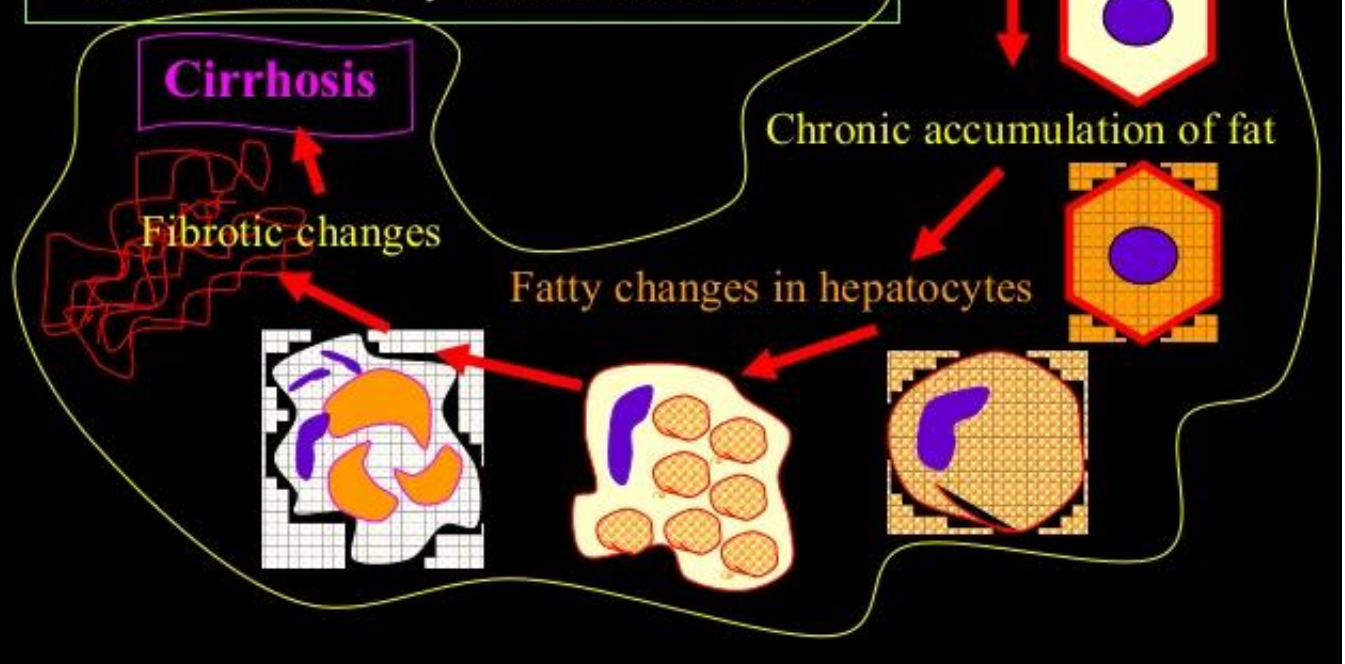
Type	Synonyms	Lipoprotein Elevation
I (rare)	"Primary hyperlipoproteinemia", or "Familial hyperchylomicronemia"	Chylomicrons
IIa	"Polygenic or Familial hypercholesterolemia"	LDL
IIb	"Combined hyperlipidemia"	LDL+VLDL
III (rare)	"Familial dysbetalipoproteinemia"	Chylomicrons+ IDL
IV	"Familial hyperlipemia"	VLDL
V (rare)	"Endogenous hypertriglyceridemia"	VLDL+ Chylomicrons

Excessive accumulation of fat in the organs of non-adipose tissue

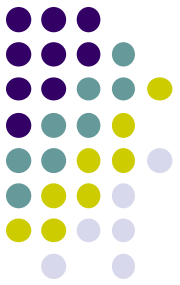


Fatty infiltration of liver

- Accumulation of abnormal quantity more than 25-30% of lipid as TAG in liver is called fatty infiltration of liver

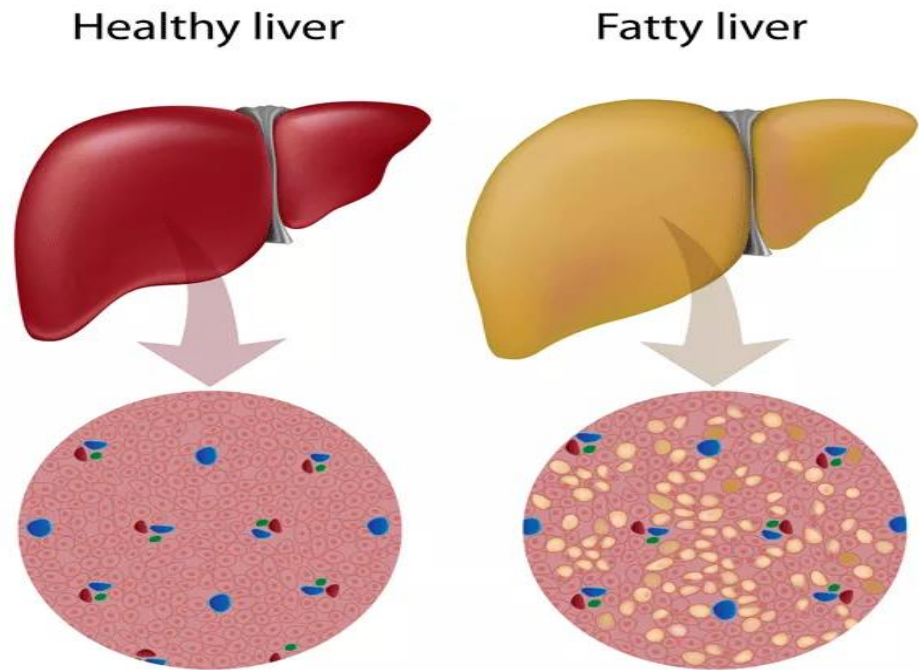


FATTY INFILTRATION AND FATTY DYSTROPHIA

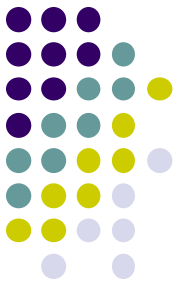


Arriving in the tissue fats are oxidized or deposited.
If accumulation occurs outside the cells of adipose tissue, we speak of **fatty infiltration**.

The combination of infiltration with disruption of the structure of the protoplasm of cells is defined as **fatty dystrophia**.



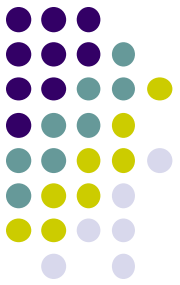
FATTY INFILTRATION AND FATTY DYSTROPHIA



The most commonly develops in the fatty dystrophia of the liver, myocardium, kidney, and accompanied by the following diseases and conditions:

- diabetes,**
- chronic alcoholism,**
- starvation,**
- obesity,**
- intoxication.**

Disorders of intermediate metabolism of lipids

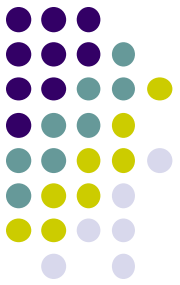


Products of intermediate metabolism of higher fatty acids
are:

- acetone
 - acetoacetic acid
 - β -hydroxybutyric acid
- ketone bodies

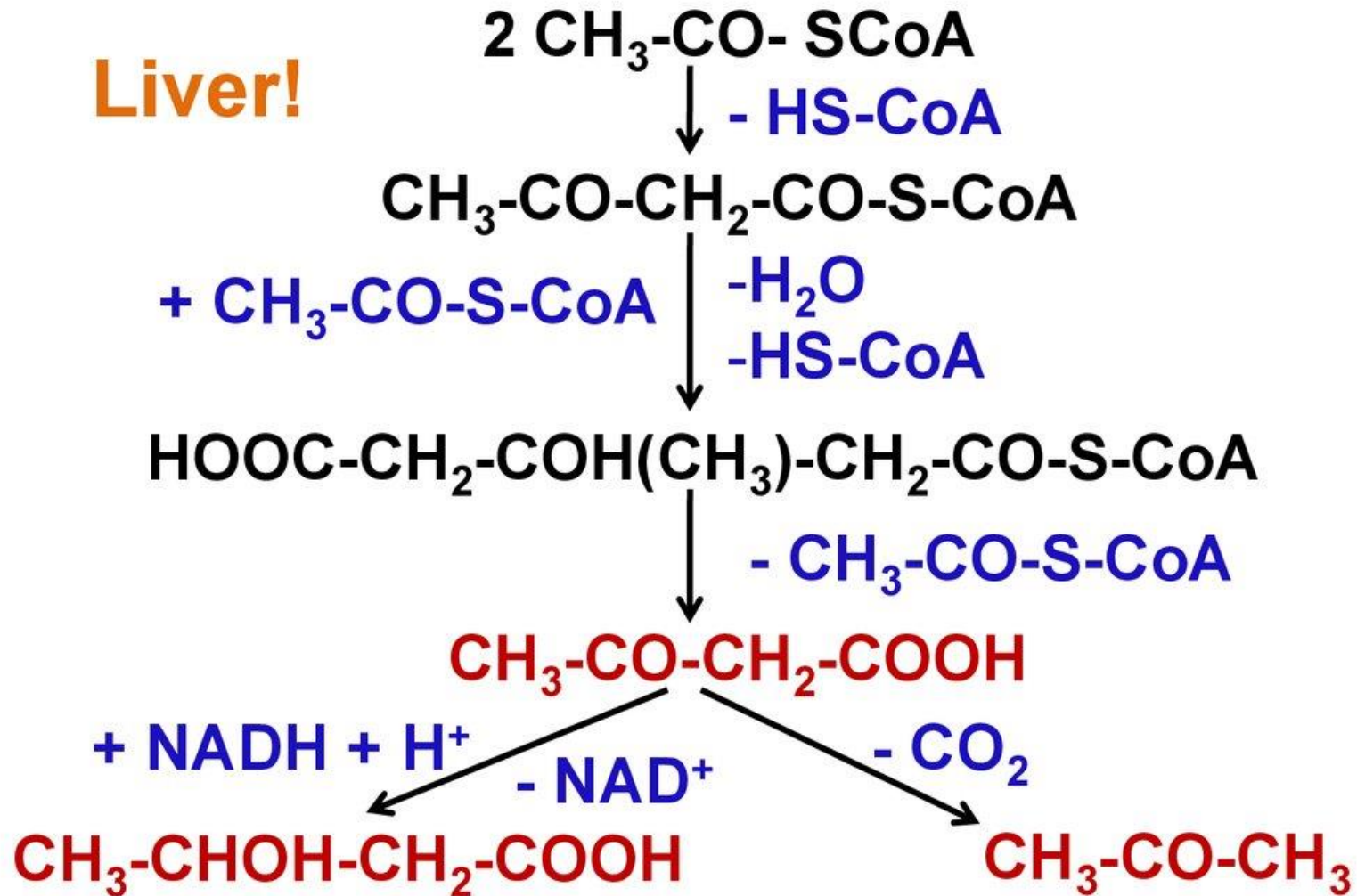
They are formed in the liver and are oxidised to CO_2 and H_2O in other organs: lungs, muscles, kidneys.

Normally amount of ketone bodies in the blood is 0.02-0.04 g/l

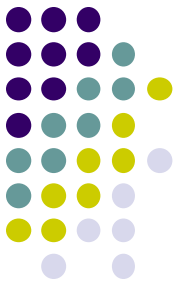


Synthesis of ketone bodies

Liver!



OBESITY



Obesity is abnormal or excessive fat accumulation in adipose tissue.

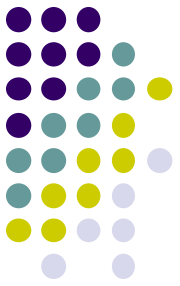


Classification of obesity by mechanism of development

- *alimentary*;
- *cerebral (trauma, brain tumors)*;
- *endocrine* (the Cushing's syndrome, hypothyroidism);
- *hereditary*.



Classification of obesity depending on the number of adipocytes and their size



- **Hyperplastic obesity** - □ number of fat cells.
 - massive obesity & early age of development.
- **Hypertrophic obesity** – normal number and □ size of fat
 - moderate obesity in adults.
- **Mixed obesity** - □ of fat cell size and amount.
 - When all the existing fat cells are filled with lipids new cell are formed
 - the number of fat cells can't be decreased by diet and weight loss



OBESITY



ADIPOSE MASS



Preadipocyte

Hyperplasia

• Commitment

• Differentiation



Adipocytes



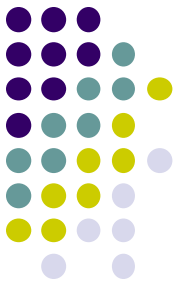
Adipocyte

Hypertrophy



Adipocyte

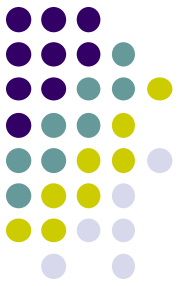
Classification of obesity by external manifestations



- symmetrical type (uniform-distribution of fat);
- upper (face, head, neck, upper body);
- medium (in the stomach in the form of an apron);
- lower (in the hips and legs).



Obesity classification according fat distribution



Android -The apple



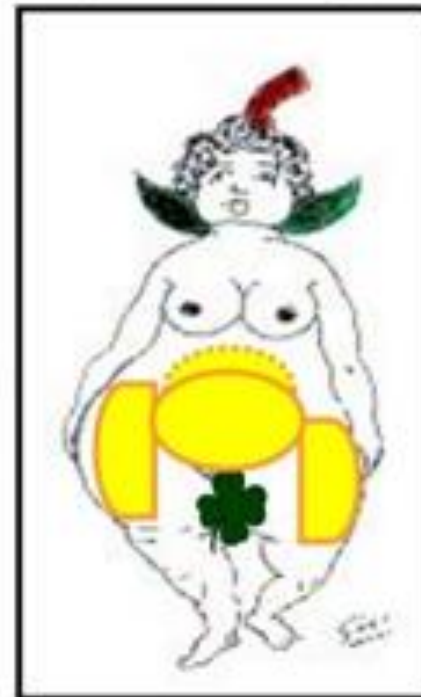
Visceral vs.
subcutaneous
obesity

Gender differences

Differences in risk
for complications

Dyslipidemia, type 2 diabetes,
hypertension, coronary heart disease,

Gynoid -The pear



↑ risk of joints damage

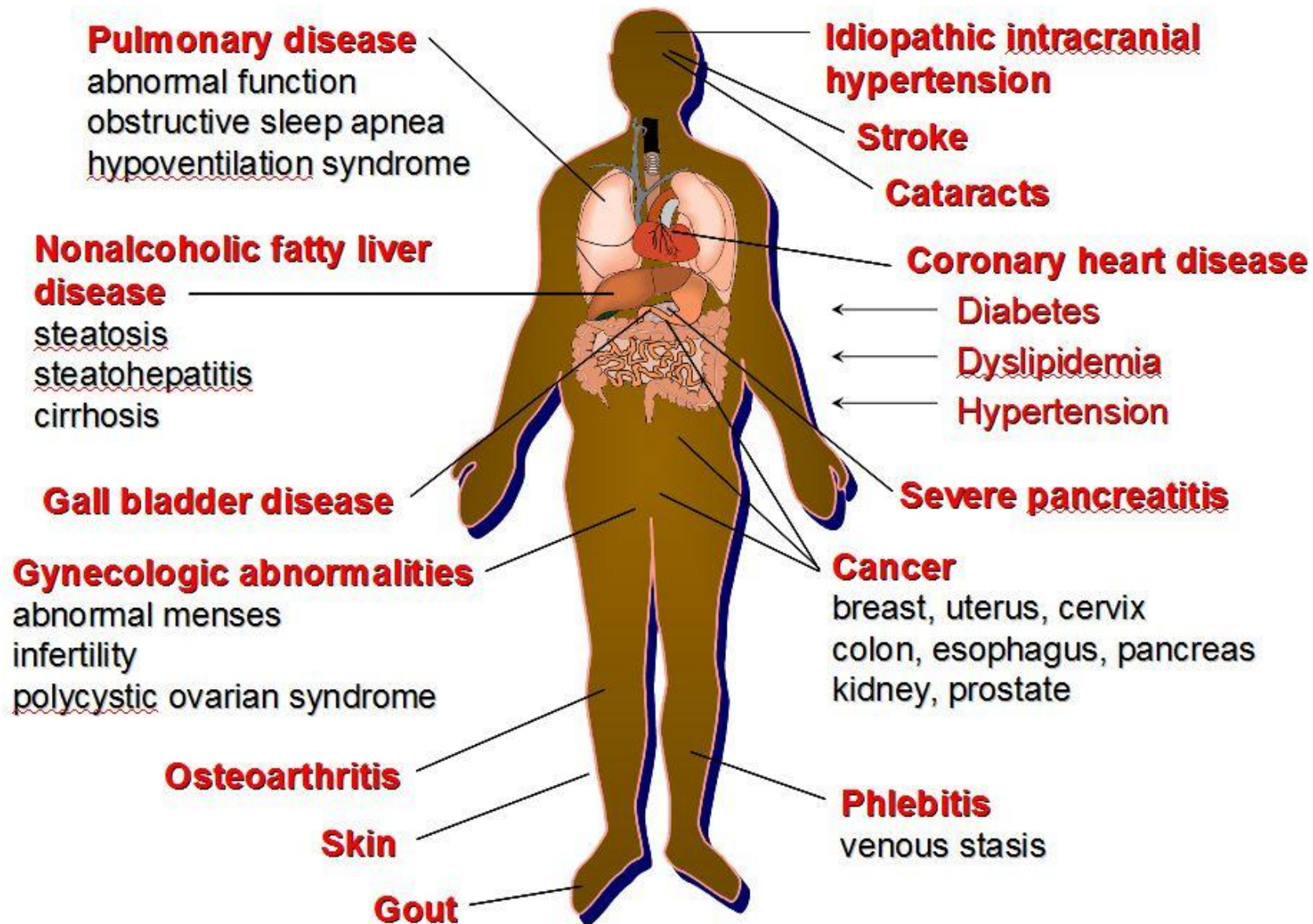
Obesity classification according the percentage of weight gain



- I degree - 20-29%;**
- II degree - 30-49%;**
- III degree - 50-59%;**
- IV degree - 60% or more.**



Medical Complications of Obesity



Body mass index = Weigh (kg) / Height (m²)



BMI classification	
Underweight	<18.5
Normal range	18.5 – 24.9
Overweight:	>=25.0
Preobese	25.0 – 29.9
Obese:	>=30.0
Obese class I	30.0 – 34.9
Obese class II	35.0 – 39.9
Obese class III	>=40.0

**Thank you for your
attention**