

# **The particularities of metabolism in children. Clinical semiotics.**

M. D, Assistant Professor Patsera M. V.

Zaporyzhya State Medical University  
Propedeutics of Pediatrics Department

# Plan of lecture:

- Basal metabolism
- Fluid and electrolyte balance
- Protein metabolism, protein-energy malnutrition
- Carbohydrate metabolism.
- Fat metabolism.
- Vitamins.

# Metabolism and energy

This set of processes of transformation of matter and energy that occur in living organisms, and the exchange of matter and energy between the organism and the environment.

In children, unlike adults, much of the energy consumed for the growth and plastic processes, which are especially large in infants and children in the first three years of life.

# For the child's body is characterized by:

- High tension power and oxidation processes.
- Intensive basic metabolism in all age groups.
- Significant energy consumption for processes of assimilation and growth.
- Imperfection of the regulation of metabolism, which determines its instability and the development of lung violations.
- Uniqueness of each of the main types of exchange - protein, carbohydrate and fat.

# Basal metabolism in children

- The primary metabolism in children varies depending on the child's age and the type of food.
- In the infant and in the first years of life there is the maximum intensity of metabolism and energy, and then there is a slight decline in basal metabolism.
- Compared with the first days of life, to eighteen months metabolism increases by more than half.

# Water-salt metabolism in children

- Features water-salt metabolism in children.
- Role in maintaining homeostasis of electrolytes.
- Causes of dehydration in infants.
- Forms of the dehydration.

# Water in the body of the child is:

- Neonates - 75% of total body weight
- With age, it gradually decreases and is completed in the period of growth of 65%
- In the body of water is distributed among several sectors of liquid.
- In the cells (intercellular space) is 60% of the total
- Extracellular water in the intercellular space and plasma, as well as part of the so-called transcellular fluid (in the spinal canal, the camera eye, gastrointestinal tract, exocrine glands, renal tubules and urinary ducts).

# Water balance

Water enters a child's body with food and drink, as well as formed by oxidation of fats.

Displayed through the water:

- Kidneys – 49%
- Evaporation of sweat, feces, urine – 49%
- Through breathing – 2%

Regulation of water and ion exchange is carried out complex neuroendocrine responses aimed at maintaining a constant volume and osmotic pressure of the extracellular sector, primarily blood plasma.



# Homeostasis

- A set of physical and chemical constants characterizing the internal environment of the body and especially the constancy of exchange and qualitative composition of body fluids.

An important indicator of homeostasis in children, is the concentration of hydrogen ions in blood and extracellular fluids.

# Depot body fluid

In humans, there are three fluid depot:

1) bloodstream to the volume of circulating blood

2) intercellular space with a certain amount of intercellular or interstitial, liquid

**Note:** The blood plasma and interstitial fluid together form a so-called extracellular depot, or extracellular, the liquid.

3) intracellular liquid.

# Plasma electrolytes

- **Sodium** cations - 137 to 145 mmol / L and varies little with the age of the child. Sodium determines the magnitude of the osmotic pressure of blood plasma.
- **Chlorine** anions - 92-107 mmol / L as determined by the osmotic pressure of the extracellular fluid.
- **Calcium** - 5 mmol / L plasma .
- **Sodium bicarbonate** - blood pH 7.35-7.45.

## Electrolytes cytoplasm

- Potassium - 120-140 mmol / L potassium in the cells.
- Phosphate ions.

# Semiotics water and electrolyte metabolism

All violations of water exchange can be grouped into two forms:

- **hyperhydration** characterized by excess fluid in the body content;
- **dehydration** - is to reduce the total volume of liquid.

# Children are vulnerable to loss of fluid (water) in connection with:

Significant loss of water in children with breathing and possible evaporation from the skin surface.

Especially easy to create water shortages in the body of the child in the stomach and intestine diseases (acute gastroenteritis).

Under normal conditions, a large number of children fluid released into the gastrointestinal tract from digestive juices (saliva, gastric, pancreatic and intestinal secretions).

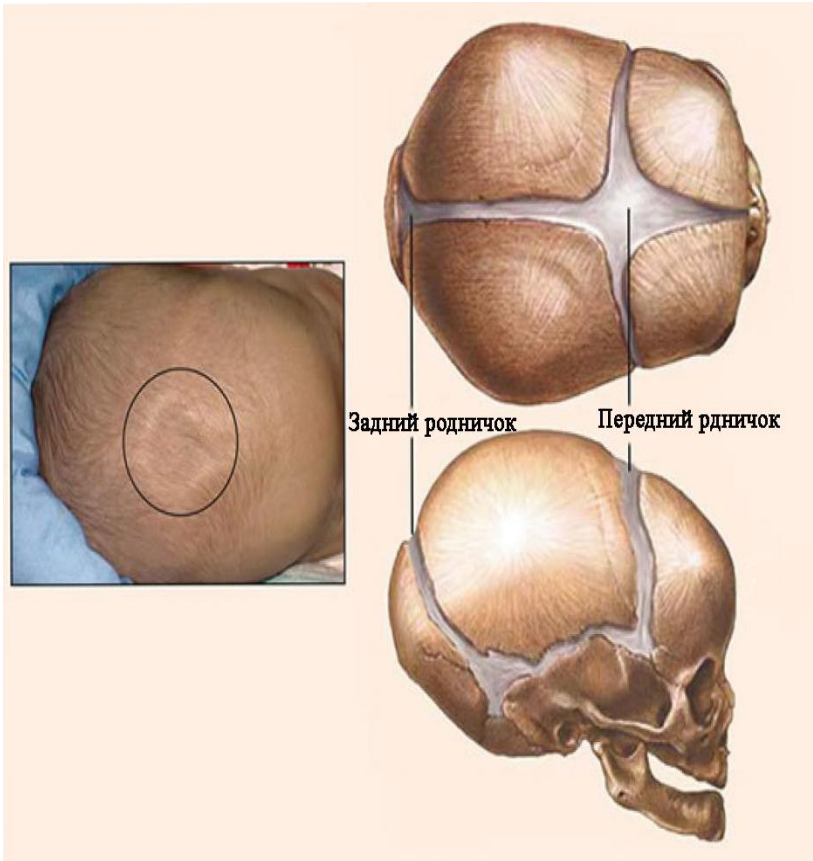
# The main causes of the syndrome of dehydration are:

- 1) Incoming water deficit (inability to eat and drink, defects in the care and treatment)
- 2) pathological loss (vomiting, diarrhea, excessive sweating with fever, the evaporation of water at rapid breathing, rapid diuresis in diabetes, bleeding).
- 3) a combination of reasons.

# Causes of dehydration

- If **vomiting** occurs a significant loss of water from the gastric juice and the contents of the upper small intestine. Together with vomiting are also lost **sodium**, potassium and **chloride** ions is particularly significant (hydrochloric acid).
- When **diarrhea** occurs **hypotonic** fluid loss due to increased secretion of digestive juice with a significant loss of water and ions, **potassium**, sodium, **magnesium, bicarbonate**.

# Dehydration



- Sunken fontanel large skull
- Sunken "hollow eyes"
- Dry tongue
- Loss of skin turgor and weight loss
- Child listless, inactive



# Proteins

This is one of the basic and vital products in the body of the child. For normal growth it needs a protein which can not be replaced either fats or carbohydrates.

The biological value protein is determined by amino acid composition and their ability to hydrolysis by the enzymes of the digestive tract.

# Essential amino acids for children:

Arginine

Histidine

Isoleucine

Leucine

Lysine

Methionine

Threonine

Tryptophan

Phenylalanine

Valine

Proteins are synthesized from amino acids that enter the body with food.

In the body breaks down protein synthesis, amino acids are not essential if ingested in the diet.

In the absence of **essential amino acids** in the diet, they can be synthesized from the essential.

For example, the lack of lysine in the diet leads to stunted growth, depletion of the muscular system, the lack of valine - balance disorders in children.

# The daily requirement of protein per 1 kg of body weight of the child:

**1 year - 4.8 g**

**1-3 years - 4-4.5 g**

**6-10 years - 2.5-3 g**

**12 or more - 2.5 g**

**adults - 1.5-1.8 g**

On the number of entering the body and destroyed it proteins judged by the value of nitrogen balance, ie the ratio of the nitrogen that enters the body through food and output from the body through urine, sweat and other bodily secretions.

The younger the body, the higher the positive balance and the ability to detain food nitrogen.

40% of the demand for amino acids should be borne by the essential amino acids. Of particular importance for the child's body has a ratio of certain amino acids. During the period of the most favorable ratio is:

**tryptophan : lysine (methionine + cysteine) = 1: 3: 3**

Children need more than adults, the protein of animal origin.

As insufficient and excessive protein intake in the diet of children adversely affects their growth and psychomotor development.

# Protein-energy malnutrition

- Clinical outcomes in children with chronic malnutrition typically include short stature, poor weight gain or weight deficit and subcutaneous fat.

And also: reduced physical activity,

- mental apathy,
- psychomotor delay and mental development

# Kwashiorkor



Severe malnutrition

# Nutritional marasmus



- Marasmus – in Greek - depletion, extinction. It is a form of protein-energy malnutrition, usually in children under 1 year of age.

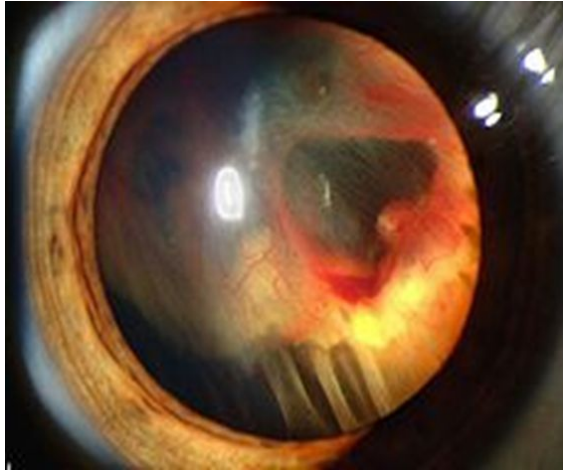


# Phenylketonuria - disrupted synthesis of phenylalanine to tyrosine



# Gomotsistinemiya -

homocysteine is an intermediate degradation product of methionine and is not normally found in plasma and urine



# Celiac Disease

- congenital disorder caused by deficiency of enzymes that break down the gluten protein cereal to amino acids.



The disease manifests itself more with the introduction of semolina porridge and oatmeal. The child says: copious frothy stools, anorexia, vomiting, symptoms of dehydration, a false picture of ascites. Develop severe dystrophy.

# Celiac Disease



# Carbohydrate metabolism

Carbohydrates - the main source of energy. Carbohydrates enter the body in the form of complex polysaccharides - starch, disaccharides and monosaccharides.

Plastic material, carbohydrates are included in the ground substance of connective tissue in the form of mucopolysaccharides forming cell membrane.

# Carbohydrate metabolism

- In children, there is a physiological tendency to **ketosis**, in the occurrence of which may play a role minor glycogen. The water content in the tissues and the child is higher in infants  $\frac{3}{4}$  weight and decreases with age.

# Carbohydrate metabolism

- By the time of puberty, the energy consumption for basal metabolism is reduced by 300 kcal / cubic meter. While boys energy costs on a major exchange in terms of one kilogram higher than in girls. With increasing energy costs increased muscle activity.

# Carbohydrate metabolism

Carbohydrate in the body in a free state and in connection with proteins, fats as glycoproteins, glycosaminoglycans (mucopolysaccharides).

A significant role is played in the biosynthesis of carbohydrates nucleic acids, formation of blood group specificity, immunological and other processes



## Disturbed carbohydrate intake with food:

**Insufficient** amount of carbohydrates in the diet leads to impaired child digestibility of individual food ingredients worsen digestive processes.

If **excessive** use of carbohydrates occurs increased formation of fat that is deposited in the subcutaneous tissue. With increased amounts of carbohydrates lowers your resistance to infectious agents child, there is a possibility of developing diabetes.

# Disaccharidase deficiency in children

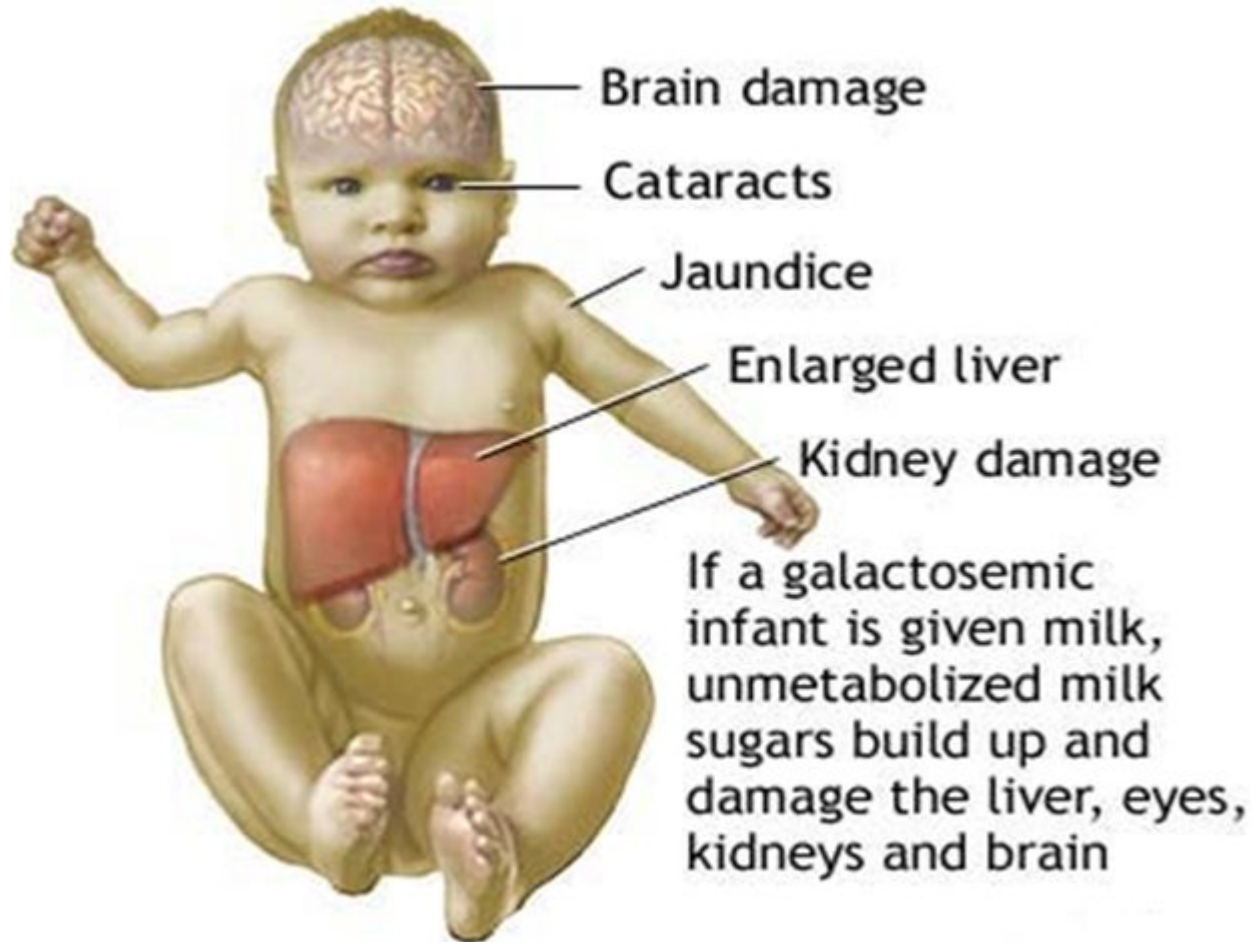
- lactose intolerance (lactase deficiency)



- Clinical symptoms:
- flatulence
  - watery stools with sour smell
  - development of malnutrition

# Galactosemia

disrupted conversion of galactose to glucose



# Lipids

Fats - complex organic compounds differ from each other in structure and functional significance.

The body provides a simple fat - triglycerides or neutral fats, and their derivatives, fatty acids, sterols (cholesterol), steroids, vitamins E, D, K

Complex lipids - phospholipids, cerebrosides, sphingomyelin.

## Functions of fats:

Energy

Construction

Support

Protective

# Lipogenesis and lipolysis in children

- 1) In childhood, fat synthesis is most intense.
- 2) Fat formed from carbohydrates, edible fats inferior quality, since it does not contain essential fatty acids - **linoleic, linolenic and arachidonic**.
- 3) In terms of lack carbohydrate fat splitting is accompanied by formation of excessive amounts of ketone bodies as well as the complete combustion of fat is only possible in the presence of carbohydrates.

# Fatty acid

- **Polyunsaturated** fatty acids. Value vegetable fats due to their content of phosphatides ( lecithin ) , have a profound influence on the activity of the liver , the nervous tissue. Lecithin also rich buckwheat , peas, eggs, dairy products . Source PUFA vegetable oils - sunflower, corn , cottonseed .
- **Saturated** fatty acids. This animal fats entering the body of butter, eggs, meat and dairy products . Their results in excess accumulation of excess weight, but is essential for absorption of fat soluble vitamins.

**Lack of fat** in the diet of the child adversely affects its growth and development, leading to a decrease in the body's defenses, the development of disorders of the skin and mucous membranes.



# Excess fat



Impairs digestion processes due to oppression activity of digestive glands, decreased body resistance, interfere with the absorption of protein.



# Lipidoses

- This is a large group of inherited or acquired disorders of lipid metabolism in the pathogenesis of which is the accumulation of (inherited pathology caused by enzymatic disturbances in lipid metabolism).

# Niemann-Pick disease

## sphingomyelin storage disease



Skin grayish-yellow color, hepatosplenomegaly, child lags behind in mental development



The symptom of "cherry-red" in the ocular fundus

# Gaucher disease

characterized by excessive deposition of abnormal cerebroside



Neurological symptoms:

Strabismus,

Spastic paralysis,

Ataxia,

Convulsions

# Vitamins

Vitamins - biologically active organic compounds of various chemical nature.

Have a significant effect on the reactivity and the metabolic processes of the child's growing body in small amounts (milligrams).

Child's need for most vitamins increased the tensions metabolism.



# Functions of vitamins

- Contribute to the normal course of metabolic processes.
- Are part of many enzymes and coenzymes body.
- Bookmark affect organs and systems, child growth and development, the activities of the blood, the nervous system, immune status, and more.



# Vitamins classification according to their functions in the body:

- Involved in energy and carbohydrate metabolism. This group is represented by B vitamins, pantothenic, folic acid, vitamin PP, biotin.
- Possess antioxidant activity, counteract the damaging effects of free radicals. This vitamin C (ascorbic acid), vitamin E, carotenoids (vitamin A).
- Precursors of hormones.



# Vitamins based on solubility are divided into groups:

- 1) Fat-soluble - A, D, E and K.
- 2) Water soluble - C, P, B, etc.
- 3) Vitamin-compound - bioflavonoids, choline, inositol, lipoic acid, and others.



# Water soluble vitamins

- Vitamin B1
- Vitamin B2
- Vitamin PP
- Vitamin B6
- Pantothenic
- Biotin (vitamin H)
- Inositol





# Water soluble vitamins

- Para-aminobenzoic acid (bacterial growth factor and factor pigmentation)
- Folic acid (vitamin antianemic vitamin growth for chickens and bacteria)
- Vitamin B12 (vitamin antianemic)
- Vitamin B15 (pangamic acid)
- Vitamin C (antiskorbut)
- Vitamin P (vitamin permeability)

# Fat-soluble vitamins

- Vitamin A
- Vitamin D
- Vitamin E
- Vitamin K



# Scurvy - vitamin C deficiency



Generalized weakness

Bleeding gums,

Distortion of the structure of cartilage  
and bone.

# Beri-beri – a deficiency of vitamin B 1



Reduced physical and mental stability of the child,  
muscle weakness,  
reduced intestinal motility - constipation,  
polyneuritis.

# Pellagra - a deficiency of vitamin B, nicotinic acid

Dermatitis on exposed skin (face, neck, back of hands)



Рисунок 1. Изменения кожи при пеллагре



# Rickets - vitamin D deficiency



# Hemorrhagic syndrome - a deficiency of vitamin K



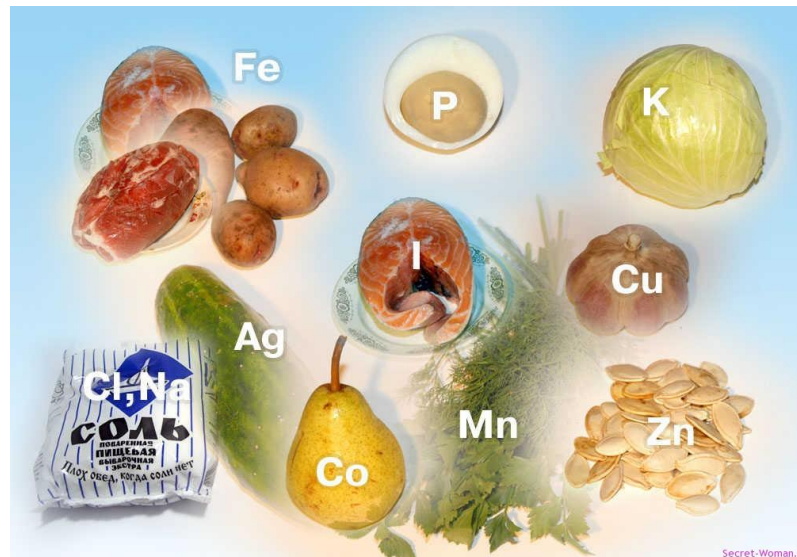
# Hemorrhagic syndrome - a deficiency of vitamin K





# Minerals

- Macronutrients (which is really a lot)
- Trace elements in it which only 0,04 - 0, 06%.
- Content and those and other man has continuously replenished.



# Macronutrients

- Calcium -- Ca
- Phosphorus – P
- Magnesium --- Mg
- Potassium --- K
- Sodium --- Na
- Chlorine --- Cl
- Sulphur --- S

Need: 2 - 3 grams per  
day

# Micronutrients

- Iron – Fe
- Copper - Cu
- Manganese - Mn
- Zinc - Zn
- Cobalt - Co
- Iodine - I
- Fluoro - F
- Chrome - Cr
- Molybdenum - Mo

Requirement per day: several  
milligrams

# Children's bodies are different from adults:

- Rapid growth and development
- high physical activity
- child active communication with the outside world

In childhood, formed **food stereotype** laid typological features of adult metabolism.

# Thanks for your attention!



Дети – всегда отражение своих родителей.  
Будь таким, какими хочешь видеть своих детей.