Lecture 31. Digestion in the small and large intestine. Features of motility and absorption.

Intestinal juice

- **Turbid viscous liquid - 2.5 l / day   pH - 7.2-7.5, maximum - 8.6**
- **Inorganic substances - 10g / l - chlorides, hydrocarbonates and phosphates of sodium, potassium, calcium**
- **Organic substances - mucus, amino acids, proteins, urea and other metabolic products**
- **Thick part juice - lumps of mucus and epithelial cells undamaged, fragments thereof, and enzymes**

Intestinal juice enzymes

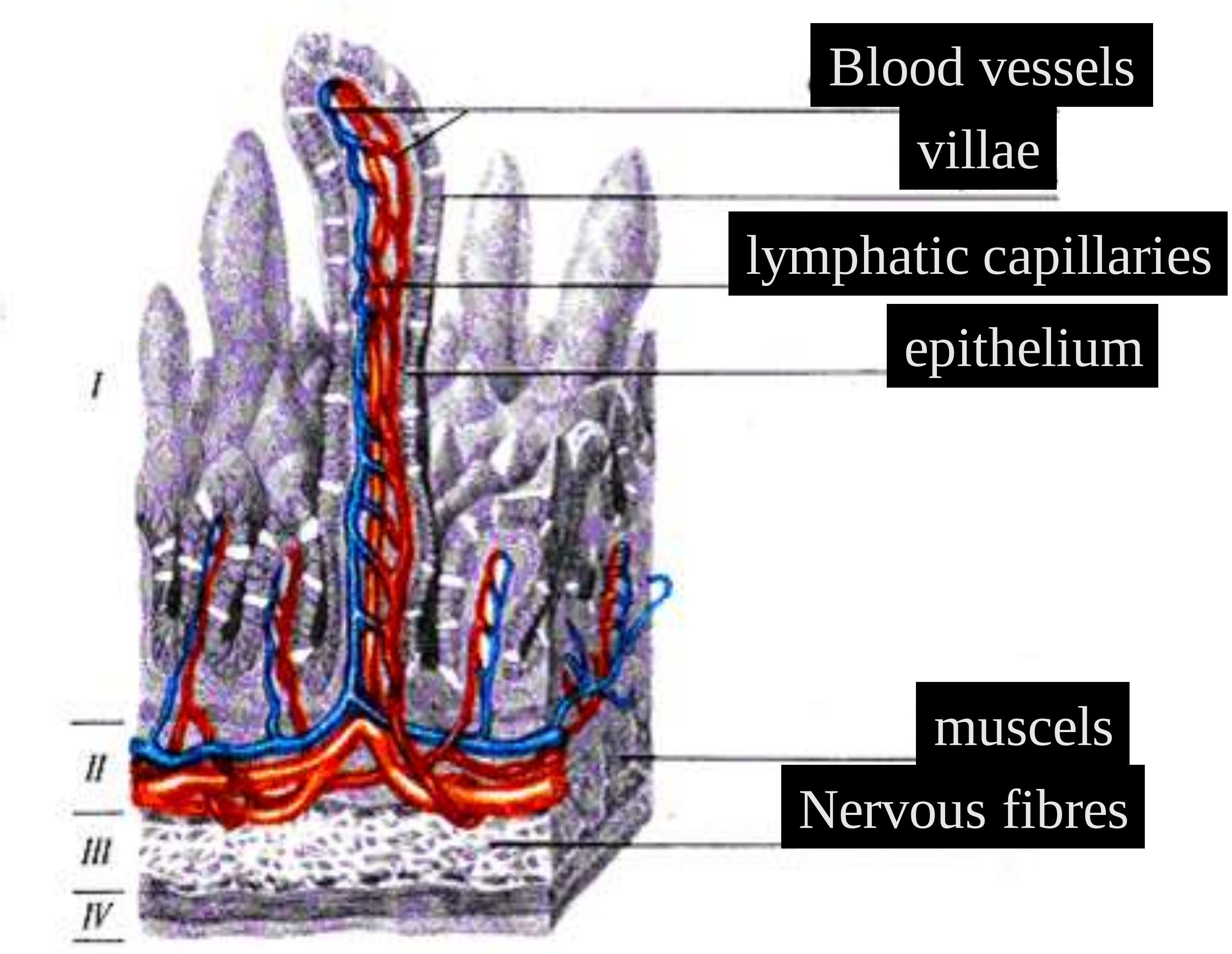
- **Peptidases: aminopolypeptidases, dipeptidases, leucine aminopeptidases, etc. - common name – erypsins**
- **Inhibin is a human proteolytic enzyme.**
- **Nucleotidase and nuclease**
- **Lipase, phospholipase and cholesterol esterase**
- **Amylolytic - amylase, lactase, sucrase, gamma-amylase, enterokinase**

Membrane digestion

Goes in succession in three zones:

- **In mucus**
- **In glycocalyx**
- **On the apical membrane of enterocytes**

Was discovered by prof. Ugolev A.M.


Blood vessels
villae
lymphatic capillaries
epithelium
I
II
III
IV
muscels
Nervous fibres

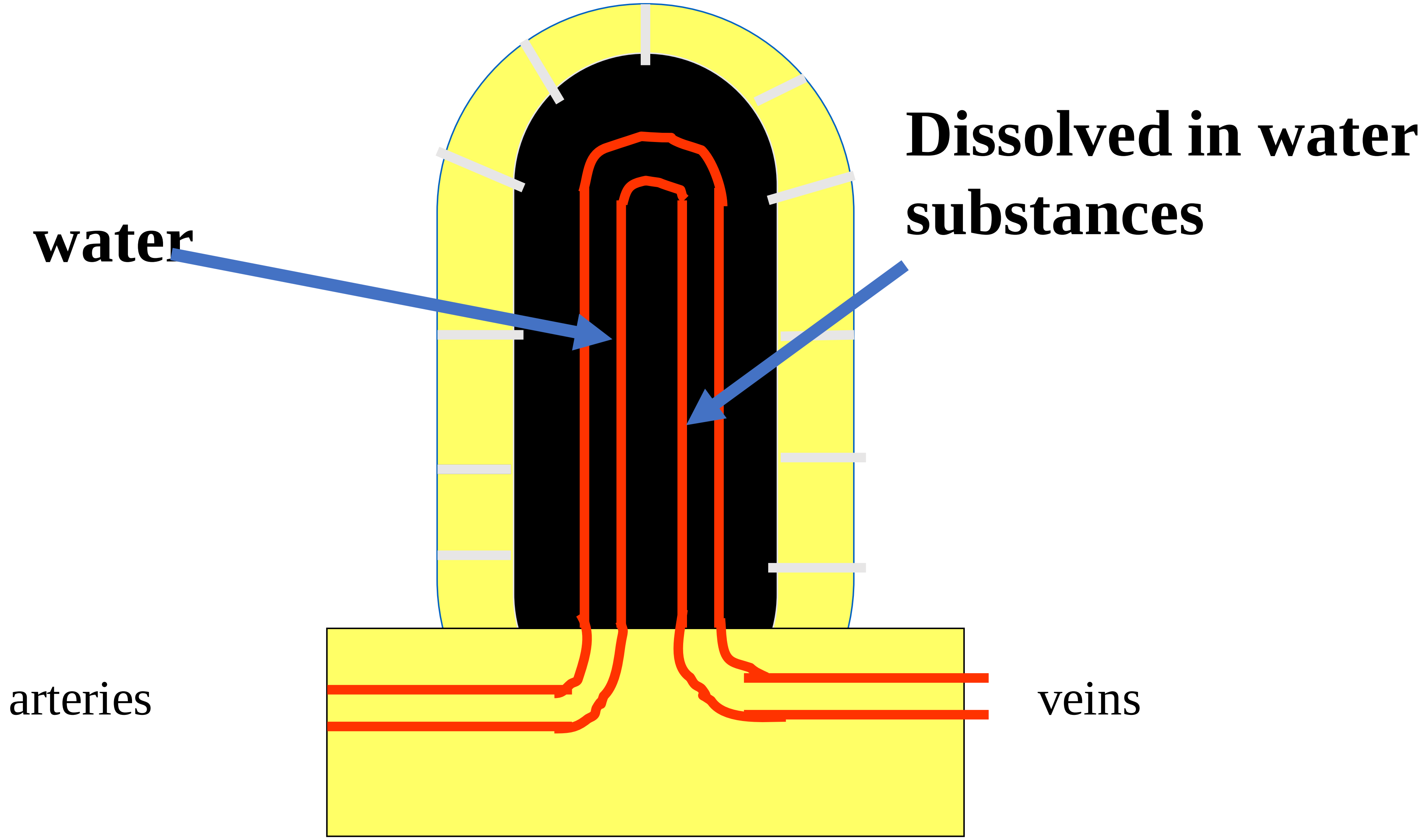
Properties of membrane digestion

1. Large catalytic surface
2. Highly effective
3. Sterile
4. Closely connected with absorption

absorption

- **This is a complex physiological process of penetration of various substances through the biological membrane into the blood and lymph**
- **As a result, the body receives nutrients, water, salts, vitamins and medicinal substances.**

macrovilli



Macrovilli contents

- **arteriola**
- **Capillary net**
- **venula**
- **Lymphatic capillary**
- **Muscle fibres**
- **Nervous ending**
- **Enterocytes with brush boarder**
- **Surface of absorption is about 200 m^2**

Types of transport

passive:

- **filtration**
- **osmosis**
- **diffusion**

Goes along the gradients created by macrovilli

contraction

15-20 ml of fluid is absorbed per 1 minute

Active

- **Primary active (sodium-potassium pump)**
- **Secondary active (glucose & amino acids transport)**

Water transport

Goes via gaps between the enterocytes along the gradients:

- **Hydrostatic**
- **Osmotic (created additionally by sodium absorption)**
- **Dissolved in water substances are absorbed**

Water can be secreted from blood into the intestinal cavity

1. **Active secretion of anions**
2. **Decrease of active absorption**
3. **High osmotic pressure in the intestinal cavity**
4. **Increased hydrostatic pressure in the serose layer**
5. **Increased permeability of intracellular gaps for ions**

Bacterial toxins
(Cholera toxin, coletoxin)

Hormones
(prostaglandies, secretin, VIP)

↑cAMP

↓

Calcium concentration in the enterocytes changes,
Chlorine permeability increases

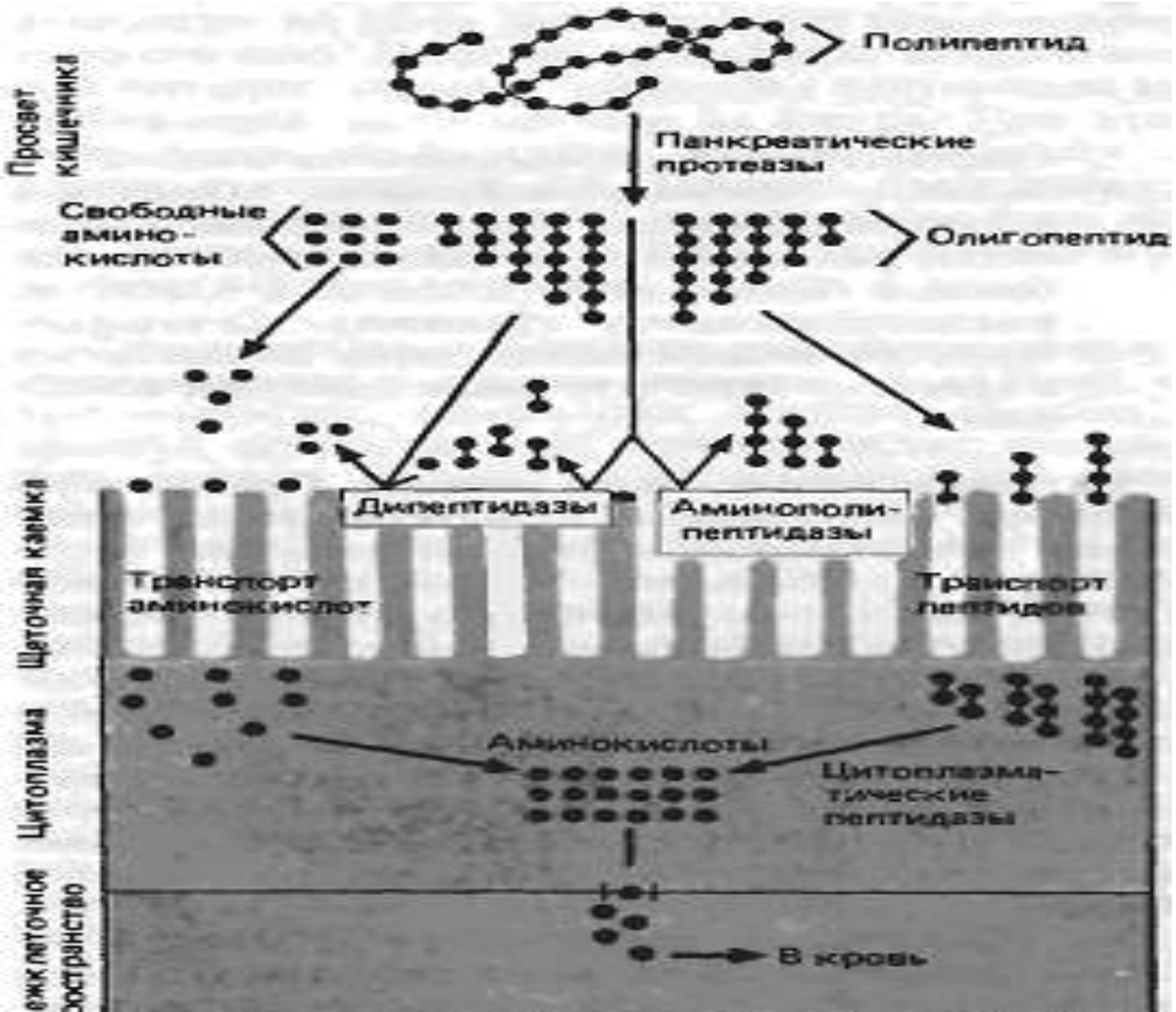
↓

Chlorine gets into the cavity,
sodium follows along the electrical gradient ,
water follows along the osmotic gradient

Proteins

- **70-90 g per day with food 60 г белка с пищеварителными соками (ферменты и энтероциты).**
- **В полости 30% расщепляется до нейтральных и основных АК – 70% до олигопептидов**
- **Ологипептиды расщепляются до АК в щеточной кайме (10%) и в цитоплазме**

Digestion & absorption of proteins



Amino acids absorption

- **Goes in duodenum (50-60%) & jejunum (30%) by means of secondary active sodium dependent transport**
- **Protein-carriers are selective for:**

✓ **Neutral AA**

✓ **Dicarbonic AA**

✓ **Glycin**

Carbohydrates

Daily dose 250-280 g:

- **60% vegetable starch**
- **30% saccharase**
- **10% lactose, glucose, fructose, glycogen**

Enzymes:

- **In the cavity – alpha-amylaze**
- **On the villi – olygosacharidazes: lactatdehydrogenaze (lactase), glycosidase**

Fats

- **60-100 g of fat per day**

90% of them are thryglcerides

5-7 g are excreted with faeces

- **Emulsified in duodenum (fat drop in stomach is 100 nm in diameter, I the intestines – 5 nm)**
- **Absorbed in the form of fine emulsions or micells with bile acids** 95% in duodenum

Large intestine

Absorption is completed here & faeces are formed:

- **400 g of chyme per day enters from small intestine**
- **150-200 g of faeces is formed – 70-80% of water; 20-30% of dry matter (cellulose, non-organic substances; fats)**
- **The number of microorganisms is exceptionally great—up to tens of milliards per kg of contents.**

FUNCTIONS OF LARGE INTESTINE MICROFLORA

- Enzymatic cleavage of food;
- Additional removal of food components from food residues;
- Synthesis of vitamins C, B, K;
- Inhibition of reproduction of pathogenic bacteria;
- Production of metabolites that affect the activity of the immune system;
- Limitation of immune aggression and autoimmune aggression.

Physiological bases of hunger and satiety

- ☻Regulation of body weight and eating behavior is interpreted in the categories of long- and short-term signals.
- ☻The first (insulin, leptin and others) affect the reserves of energetically important substances (weight body).
- Short-term signals - cholecystokinin and mechanical factors (stomach distension)create a feeling of satiety.
- ☻Intermediate role is played by the peptide YY, which suppresses appetite, and ghrelin, which stimulates it. Glucagon-like peptide 1 also suppresses appetite.

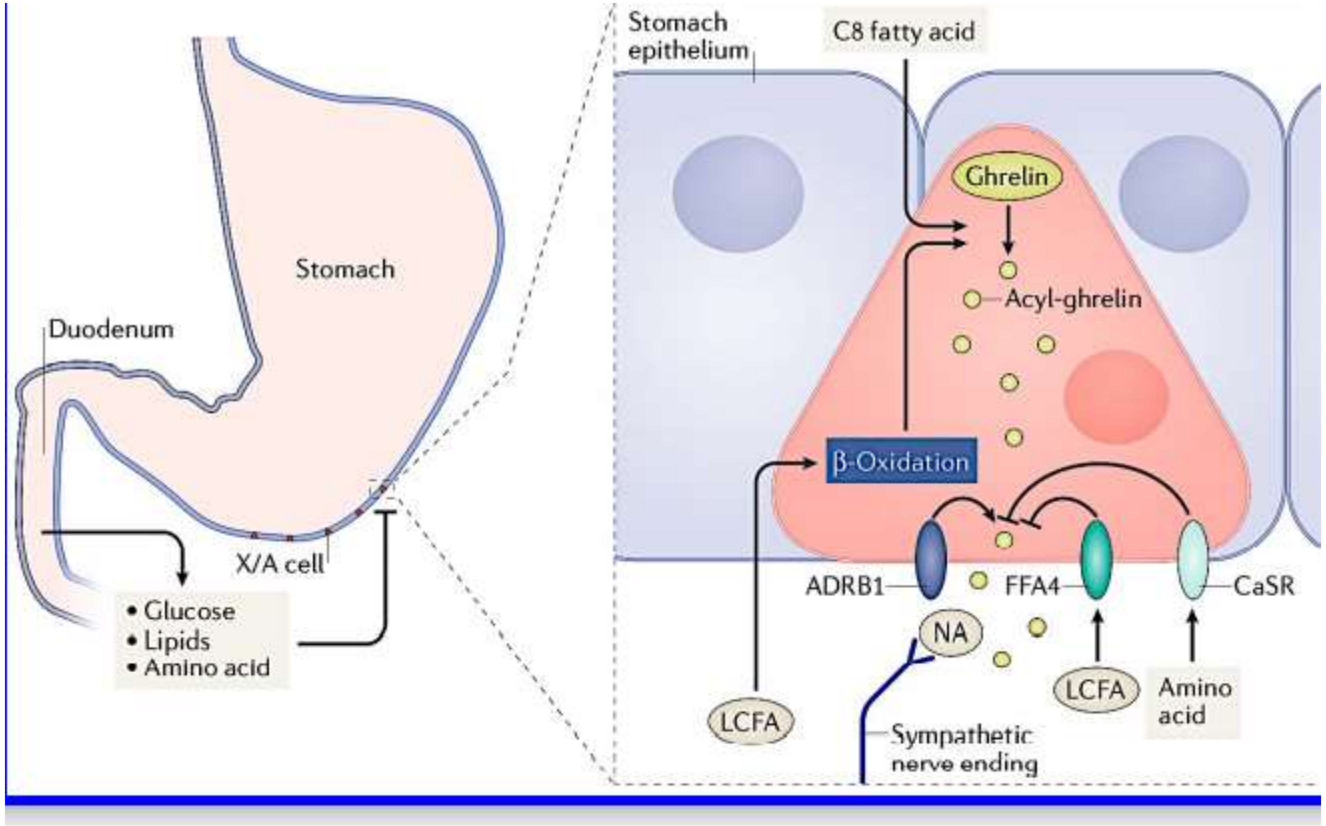
Physiological bases of hunger and satiety

- ☻Peripheral signals are integrated in the arcuate nucleus of the hypothalamus. Neurons in the medial parts of the nucleus that co-express neuropeptide Y and agouti-related peptide stimulate food intake and weight gain. Neurons of another group in the lateral part of the nucleus that express proopiomelanocortin, suppress appetite and stimulate weight loss.
- ☻The feeling of satiety is also regulated by the medulla oblongata. Single path core (IOT) and area postrema receive inputs from vagus nerve afferents and humoral factors, and are reciprocally associated with the hypothalamus. In addition, there are cortical entrances to hypothalamus, affecting energy balance

Physiological bases of hunger and satiety

- ☻Leptin acts directly on the neurons of the arcuate nucleus. Cholecystokinin binds to receptors on vagus nerve fibers, thus activating IOP and directing information to hypothalamus.
- OYaOT neurons expressing GLP-1R form projections to hypothalamic regions that involved in appetite control, including arcuate, dorsomedial and paraventricular nuclei. Ghrelin and peptide YY act both directly on the cells of the arcuate nucleus and through the vagus nerve and brain stem.

control of ghrelin secretion



control of ghrelin secretion

- Ghrelin-producing X / A cells are located in the gastric epithelium. They belong to the cells closed type, ie those that come into contact only with tissue fluid, but not with the stomach contents.
- ☻In order to realize the effect of ghrelin at the level of its receptors it is necessary to acylate its molecule. It unique property of ghrelin as a hormone.
- ☻For this purpose, mainly C8 fatty acids coming from the gastric lumen are usedthrough the epithelium, or arise from endogenous fatty acids as a result of oxidation.
- ☻Secretion of ghrelin is inhibited by long-chain fatty acids (LCFAs) acting throughFFA4 receptor, and aminoxylates that act through the CaSR receptor.7
- ☻Both receptors are conjugated to the G protein.
- ☻ Ghrelin secretion is stimulatedthrough β1-adrenergic receptors(ADRB1) in response tonorepinephrine released fromnerve endings sympatheticnervous system.

The end