Mistchenko V.P., Tkachenko E.V.

NORMAL PHYSIOLOGY

(SHORT LECTION COURSE FOR THE STUDENTS OF DENTAL DEPARTMENT)

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Dear students!

In a brief course of our lectures on normal physiology for the students of dental faculty, offered to you, the basic concepts about all human organism systems functionning are stated. It is natural, that because of material statement brevity due to very much lectures amount, they can not give the complete answer to numerous questions, which can appear at their reading, all the more so there is no illustrative material in them. However, from our point of view, these lectures can be good addition to the existing textbooks and manuals. All the more so we read lectures from a position of clinical physiology, and not just from those classical performances about physiology, which are stated in the bulk of educational literature. It all does not mean, that in our lectures the knowledge of classical physiology is not used. The thing is that the knowledge is so quickly replenishes with the new items of information, that the known textbooks and manuals at any stage and in any sections obviously lag behind modernity. Besides you have paid, obviously, attention, that in each lecture devoted to this or that physiology section there is a material, in which the data on its value for the doctor – dentist are submitted. In any measure our lectures supplement the elements of dental disciplines propedeutics. Moreover, they contain as well the data, which undoubtedly can be very useful to you at a study of internal diseases, surgery and other clinical disciplines. Especially it concerns dental specialities (sections of therapy, surgery, orthopedics). Whether it is possible to do without our lectures? It is naturally possible. But we consider, that the alive dialogue with the lecturer cannot be replaced by any manuals. Believe our experience, you, being trained on the senior courses, will open these lectures time and again! We wish a success to you!

Yours faithfully, professor V.P.Mishenko and assistant E.V.Tkachenko.

Lection 1.

General physiology of excitable tissues. Physiology of muscles and nerves. Features of functionning of muscles of maxillo-facial area.

Human and animals's organism has the highest ability to adapt to the constantly varying conditions of external and internal medium. In the basis of adaptive organism reactions lies the universal property of alive tissue - **irritability** - the ability to respond to the irritating factors action by metabolism change. The irritability is evolutionally the ancient form of tissues reaction. During evolution gradual differentiation of tissues participating in adaptive organism activity has taken place. The irritability in these tissues has reached the best expression and has received the name an excitability. The **excitability** is an ability of a tissue to respond to an irritation specializedly, singlemindedly and with the maximal velocity. **Excitation** – complex (difficult) biological process expressing by response reaction to an irritation.

A nervous, muscular, epithelial, secretory tissue (excitable tissues) have an excitability. The specialized form of response reaction is an excitation process physiological display. A contraction will be a response reaction in any muscular tissue. At a nervous tissue it will be an impulse conduction. At a secretory tissue it will be a synthesis and allocation of biologically active substance.

The excitability of tissues is various. A measure of an excitability is the **threshold of stimulation** – minimal stimulus force, capable to cause excitation.The stimuli with a size that is less than a threshold one, are called **subliminal** ones.The stimuli, on force exceeding a threshold of stimulation are called **epiliminal** ones.

All stimuli can be divided into three groups: physical, chemical and physico-chemical. **Physical** stimuli - mechanical, temperature, light, sound and electrical ones. **Chemical** stimuli - acid, alkalis, medicines. **Physico-chemical** stimuli –osmotic pressure, pH, ion structure changing. Besides, they distinguish **biological** stimuli - hormones, vitamins and others, biologically active substances. They allocate also a group of **social** stimuli - a word.

All stimuli divide on adequate and inadequate on biological value. **Adequate** stimuli are such stimuli, acting to the given biological structure under natural conditions and to perception of which it is adjusted specially (e.g., for eye retina photoceptors the seen part of light is an adequate stimulus). **Inadequate** stimuli are such, to perception of which the given structure is not adjusted specially (e.g., for a sceletal muscle the adequate stimulus is the nervous impulse, but it can contracts at a mechanical impact too).

Characteristic attribute of exaltation is an electrical current occurrence in tissues (cells). The electrical phenomena (currents or potentials), which arise in organism cells, tissues and organs are named the **biological potentials**.

Biological potentials arise because there is a difference of potentials between the external and internal parts of a cell membrane, which is in a rest status. Potential, which

is registered in a such cell status, is named a **membrane potential (resting potential)**. It is caused by the difference of a potassium, calcium, sodium, chlorine and other ions concentration between intracellular and extracellular medium. So, the potassium ions concentration in a cell exceeds in many times (about 20-40 times) their contents in extracellular medium. Sodium ions concentration, on the contrary, is lower in intracellular medium in 10-20 times. The ions of chlorine, as well as of a sodium, are mainly concentrated outside of cell membrane, where their content is in 15-20 times more than inside. Their such non-uniform distribution till that and other membrane parts provide ion pumps. Ion canals, available in a membrane, can be opened and closed, that depends on a membrane status. So, in a cell which is in a resting status, the sodic canals are closed, and the potassium ones - are opened. Therefore the permeability for different ions is various. If a potassium ions permeability to accept for 1,0, for chlorine it will make - 0,45, and sodium - 0,04. It results that the potassium ions on a concentration gradient diffuse from a cell to extracellular space. The sodium ions counter flow is a very small. In a result the potentials difference between cell internal medium and its outer surface is formed which is from 50 up to 100 mV for different tissues. This potentials difference also refers to as a resting potential or a membrane potential.

At stimulus action there is a membrane status change, ion canals open in it, through which positively charged ions available in excess behind its limits can move in a cell. The "fast" sodic canals opening occured most often. Originally ion current to cell is promoted also by a transmembrane potentials difference. Such process is called depolarization, because it results in this potentials difference reducing. If the stimulus is weaker (subliminal), ion canals are opened a little, therefore the ion current is insignificant. Depolarization occurs slowly. Such changes are named the **local depolarization** or local potential.

If threshold stimulus acts, the depolarization reaches a **critical (threshold)** level. As a result of it all active electroexcitable ion canals are opened. Depolarization is sharply accelerated and there is even a potential reversion (potential mark change). Thus the positively charged sodium ions flow stops, the appropriate canals are closed. Excessive potassium ions from inside direct outside, resulting to the membrane potential restoration. At first it occurs rather quickly (**fast repolarization**), and then, when the potassium ions flow decreases, the membrane potential restoration occurs in a slowed-up way (**slow repolarization**). Further potassium ions exit can proceed and cause a **hyperpolarization**. Potassium-sodic pump work adducting in initial potentials difference restoration (**to polarization**) amplifies at this time. All this process from a beginning up to the end is called as an **action potential**.

As the vital activity of all cells, tissues, organs is accompanied by their electrical activity, the registration of potentials, arising at it, allows to judge processes occurring in them. The diagnostics and control of a treatment of this or that disease is based on it. For example, in a heart such registration of its biological potentials wears the name electrocardiogram (ECG).

In physiology they determine one more property of excitable tissues, which has received the name a **lability**. It is a functional mobility of tissues, its parameter is the potentials action maximal number, which the excitable tissue is capable to generate per 1 second according to a rhythm of a submitted boring (irritation). The normal size of a lability, e.g., for a nervous tissue makes 500-1000 impulses per second, and for sceletal muscles - 150-200 impulses per second. There is a sceletal muscles lability rising with ageing. It is shown in augmentation of irritation freaquency, at which the gear (incomplete) tetanus turns in smooth. In newborn's muscles it occurs at a stimulus freaquency 4-20 per second, at adulthood - 50-100 impulses per second.

The general laws of tissues functionning. Between the irritation character and the answer-back reaction of an alive tissue there are close mutual relations, which find expression in the irritation laws.

Irritation force law: the more force of an irritation, the more strong answer-back reaction (up to known limits). The further stimulus force augmentation any more does not lead to the answer-back reaction increasing, and even can cause return reaction, down to its disappearance. It is explained by that each functional unit of tissues (for example, muscular) has its exaltation threshold. That's why while working the threshold stimulus, those fibers, for which this stimulus is of a such size are only involved in the answer. Others do not react.

At stimulus force augmentation the new fibers are involved, for which the given stimulus is a threshold etc. Further, when the stimulus force will exceed the opportunities of all fibers of the given tissue, its answer-back reaction to the force augmentation will not change (the resources are settled!). Such irritators, which cause the maximal answer-back reaction, are named in physiology **maximal** or **optimum**. At the even greater stimulus force augmentation the answer-back reaction even will decrease, as at such a stimulus force the separate functional fibers of excitable tissues can even be injured. In a result, the answer-back reaction decreases and this phenomenon in physiology is named **pessimum**, and the stimuli causing it -**pessimal**.

The **law "everything" or "nothing"** is shown, first of all, at the cardiac muscle work analysis. According to this law, subliminal stimuli, acting to a cardiac muscle, do not cause an answer in it (it is "nothing"), and threshold and epiliminal stimuli cause answer-back reaction of the same size (it is named "everything"). Under the same law the functional unit of any excitable tissue works. Let's take, for example, a muscular fiber and we shall imagine, that threshold stimulus at it is 2B (electrical current strain or voltage). If we act the stimulus of 1V to it, we naturally shall not receive any reaction ("nothing"), and if we take the stimulus of 4V, the muscle will give the same answer-back reaction, as well as on 2V ("everything"). Naturally, "everything" and "nothing" are relative concepts, as at the subliminal stimulus action there is a local answer (local potential), therefore it already cannot be treated as "anything".

The law of force-time – with the augmentation of a stimulus force it is required less time of its influence to tissue for answer-back reaction reception. The relation between the duration and force can be expressed by hyperbolic curve, the both branches

of which go at any stage in parallel to axes of coordinates. This last circumstance forms the basis that the stimuli of a very small size (less than the threshold) can not cause the answer-back reaction.

Physiology of muscles. As it is known, muscle is the contractile unit of body. Nearly 40% of the body is skeletal muscles. There are 2 muscles types:

1. Striated muscles:
   - Skeletal muscle
   - Cardiac muscle
2. Unstriated muscles - smooth muscles of inner organs, skin and vessels.

One can differentiate 3 muscles types: skeletal, cardiac and smooth.

Skeletal muscles physiological properties. Skeletal muscles possess excitability, conduction, contractility, lability (ability to reproduce the irritation freaquency). At a muscle irritation by single stimulus the single muscular contraction arises. One can distinguish the **latent** period (from irritation beginning to answer-back reaction beginning), **shortnening** period (actually contraction) and **relaxation** period. In reply to a rhythmic irritation (namely the such one our muscles are received) the muscle is reduced lengthly (for a long time). Such contraction has received the name **tetanic** or **summarized**. If each subsequent pulse approaches to a muscle in the period, when it began to be relaxed, there is an **infused** or **incomplete** tetanus. If the interval between irritations decreases so, that each subsequent pulse comes to a muscle, at that moment, when it is in a contraction phase, there is a **smooth** tetanus.

In a certain degree the tetanus formation mechanism is explained by **superposition** phenomenon. However, it can be caused by excitability changing as well. And if to take into account, that the excitability changes are caused by membrane potential change features during exaltation, then it is easy to explain smooth tetanus occurrence and its size. Let's try to understand this phenomenon together. If to render an irritation to muscle during its contraction (smooth tetanus) or relaxation (incomplete or infused tetanus), it is necessary on that moment the excitability increasing existance. Why it's so? At this time the slow depolarization phase develops in a muscle, when the membrane potential is lower, than in rest state, but is higher, than threshold potential. That's why even subthreshold (subliminal) stimulus will cause the depolarization acceleration (i.e. the excitability at this time in a muscle is raised - **supernormal excitability**). Fast depolarization beginning results in the situation when the tissue loses ability to react to an irritation. This phase refers to as **absolute refracterity** (absolute inexcitability). At repolarization time the excitability is restored. This period refers to as **relative refracterity**. An excitability at this moment is below than the initial one, and only strong (epiliminal) stimuli can cause the answer-back reaction. Then when the restful (remainded) repolarization develops, the excitability grows and becomes above initial. This phase refers to as **exaltation** (hyperexcitability). During its occurrence even subliminal stimuli can cause the answer-back reaction. Precisely at this moment the threshold stimuli also cause the phenomenon of a tetanus (both infused, and smooth).

That's why this reaction is more on size, than the single muscular contractrion. Further a membrane hyperpolarization comes and the excitability falls, it is a a **subnormal excitability** phase. At this moment the epiliminal stimulus is required to cause the answer-back reaction.

Under natural (physiological) activity conditions in human being organism the muscle shortness degree can be various.

One can differentiate the following *types of muscular contraction* according to the shortness size:

1) **isotonic** is the muscular contraction, at which its fibers are shortened at a constant external load (under real conditions such type is practically absent);
2) **isometric** is a muscular activation type, at which it develops a strain (tension) without the length change, it underlies the static work;
3) **auxotonic** is a regimen, in which the muscles develop a tension and are shortened, such reducings are the characteristic of walking, run, sailing.

Muscles have certain force. **Myodynamia (muscle force)** is the greatest load size, which it can lift. There is a concept of an **absolute muscle force** - it is a maximal load, which the muscle lifts on 1 sm of transversal physiological section. For example, at a masseter it makes - 10,0 kg /sm^2. Besides there is a concept of a **relative muscle force**. It is the muscle ability to rise of a load on unit of a muscle anatomic section (is measured in kg / sm^2).

Muscular force grows during all period of a childhood, but especially intensively - in young age. At the second childhood period beginning the force of the majority of muscular groups in boys and girls does not differ. By 12-15 years of age, the muscles force in boys becomes approximately on 30 % more, than in girls. With age especially after 8 years, the ability to performance of long muscular work – endurance - is enlarged. It is higher in boys.

Muscular work is determined by product of mass of the lifted load on muscle shortage size. All human muscles **useful action coefficient** is equal to 15-25 %, at trained people it is higher - 35 %. There is a **law of average loads**, at which the muscle is working for a long time at average loads in an optimum (average) contraction rhythm. At long-termed exercise the **working muscular hypertrophy** develops. There occurs the whole musculation mass and each muscular fiber mass augmentation. At a hypodynamia muscles atrophy comes. At long mode of operations of muscles **weariness** comes - subjective status, and then the **fatigue** develops. Objective attributes of ability to work hard decreasing join to the feeling of weariness: force, endurance, rate of impellent (motor) reactions falls. One can distinguish the acute fatigue - the result of a hard work (for example, sport competitions) and the chronic fatigue - the result of repeated regular influence of loads without regular rest.

Fatigue reasons:

1) metabolites accumulation (lactic, pyruvic and other acids, ions suppressing an action potential) in muscular tissue;

2) power (energy) musclular stocks exhaustion (glycogen, ATP);
3) infringement as a result of a muscular circulation tension;
4) nervous centers efficiency (capacity for work) change. The efficiency is quickly restored at active rest, when there is activity kind change or change of working bodies (organs).

In musclular work there can be two statuses:
1) **dynamic** - there is a load moving and movement of bones and joints;
2) **static** - the muscular fibers develop a strain (tension), but are not shortened almost (deduction or restraining of a load). The static work is more tiring, than the dynamic one.

In a whole, the sceletal muscles play an important role not only in body moving in space, parts of a body opposite each other, pose maintenance, but also they take part in blood and lymph movement, heat producing, an inspiration and exhalation (expiration) act, they are the depot of liquids and salts, glycogen, provide mechanical protection of cavitary bodies (organs). And, at last, the movements caused by skeletal musculation work, are the powerful antistressful factor.

Facial-maxillar region muscles functionally are divided into **masticatory** and **mimic**. They belong to sceletal muscles group and possess the same physiological features like other sceletal muscles. For example, in course of masticatory muscles fatigue development their retarded relaxation can occurs that is named as **masticatory muscles contractura.** Mouth opening and thus feeding act and food mechanic processing destroyes at this. Masticatory musculature belongs to force muscles. Muscle with transversal surface in 1 cm^2 can develop force in 10 kg while its contraction. Masticatory muscles transversal surface sum for muscles rising mandibule on one face half is equal to 19,5 cm^2, on both sides – 39 cm^2. Thus, masticatory muscles absolute force is 390 kg. Alongside with big masticatory muscles absolute force there is separate teeth parodont low resiliency. That's why at jaws enforced occlusion painful sensation occurs. For base dental tissues resiliency determining as for pressure one can use **gnathodynamometry** method which is performed by means of special devices (gnathodynamometers). It was established that frontal teeth parodont resiliency is approximately equal to 60 kg, masticatory ones – 180 kg.

Muscular contraction is accompanied by bioelectrical phenomena: action streams occur in muscles, potentials of which one can registrate by means of electronic enforcements as **electromyogram (EMG).** On masticatory muscles EMG one can see muscles-antagonists, providing mandibule movement, alternating activity. Masticatory muscles bioelectrical activity varies significantly dependently from occlusion type, dental rows, dental nervous tissues and parodont state, dentures construction and many others factors.

EMG analysis in investigated people with intact dental rows testifies that under norma one can see symmetrical muscular activity and distinct phase change (of bioelectrical muscular activity and resting period). Biopotential oscillations are spindle-shaped. At relaxation of muscles elevating mandibule potentials are absent. At

masticatory teeth loss from one side masticatory muscles activity on this side is sharply decreased. At a significant teeth loss masticatory muscles potentials decreasing occurs.

EMG is also a method that encourages to discovery of different muscles (mimic too) denervation and paresis. EMG indicates to pathological process localization level.

Besides, muscular and nervous excitability determining for maxillo-facial region is widely used in dentistry. It can be performed by means of **chronaxymetry** method. By means of muscle **chronaxy** measurement (minimal time in course of which a stream that is equal to double threshold – **rheobase** – acts to the tissue and causes excitement) doctor can determine motor nerve fibres injury existance. It is possible because while electrical stimulus application to the muscle electrical current comes through the nerve innervating it too. That's why at muscular irritation excitation appears primarily in nervous fibres and than transmits to the muscle. The result – in fact, at normal muscle chronaxy determining one determine chronaxy of nervous fibres innervating it. If the nerve is injured or spine motoneurons innervating muscle are dead, nervous fibres are degenerated and than electrical stimulus applied to muscle expresses muscular fibres chronaxy that has bigger duration.

Chronaxy and rheobase indexes are inversely proportional to the tissue excitability level. They can vary significantly at trigeminal and facial nerves neuritis and neuralgias as well as at mimic and masticatory musculature myosites.

For dental pulp excitability determining one can use temperature (warmth, coldness) and mechanical (percussion) stimuli as well as electrical current. Electrical current has some advantages in comparison to other stimuli. It permits to act on pulp through enamel and dentine, can be dosated easily and exactly, doesn't hurt tooth pulp, that's why it can be applied many times.

Tooth electroexcitability investigation is in fact an investigation of excitability of corresponding sensory nerves and tooth pulp.

Electrical current application for teeth excitability determining with diagnostical aim is called **electroodontodiagnostics.** Tooth reaction to electrical irritation permits to determine specific picture of tooth electroexcitability changes in course of different pathologic processes. It was established that healthy teeth independently from group belonging have equal excitability answering to the same current force from 2 to 6 mcA. If tooth irritation threshold is less than 2 mcA, it testifies to excitability increasing (it is observed for example at parodontosis). At pulpites on the contrary one can determine irritation threshold increasing more than 6 mcA. Excitability decreasing up to 100-200 mcA is a pulp death sign. In such a case periodont tactile receptors react on.

Oral mucosa is a highly-sensitive to electrical current because it has good electroconductance. From Galvani experiment one can make the conclusion that different metals are the origin of so-called **galvanic current** which can irritate alive tissues. This fact dentist must take into account while teeth denturing and plombing with different metals (gold, inrustining steel et al.) that act as electrodes. In this case saliva is a good electrolyte. Occuring microstreams can be a reason of phenomena called **galvanism** in dentistry.

In dentistry electrical current is used also for treatment. Constant uninterrupted low-tension (30-80 V) and low-forced electrical current (up to 50 mA) for treaty aims is called **galvanization.** In course of such current action vasodilatation occurs in oral mucosa. Blood circulation acceleration, vessel wall permeability increasing are accompanied by temperature increasing and hyperaemia. Vessel reactions permit local metabolism activation, epithelium and connective tissue regeneration.

Electrical current helps to introduce drugs in tissues (**medical electrophoresis**), cause anaelgesia (**electroanaelgesia**).

Nervous fibres and nerves physiology.

Nervous fibres possess excitability and according to morphologic principle they are divided into **myeline** and **myeline-free.** Nervous fibres form nerve or nervous stem, consisting of great amount of them. Nervous fibres transmitting excitation from receptors to central nervous system (CNS) are called **afferent;** from CNS to the effector organs – **efferent.** Nervous fibres possess: excitability, conductance, lability. Nervous tissue **excitability** is higher than muscular one. It is various in different nervous fibres. Myeline (thick) nervous fibres is significantly higher than myeline-free (thin).

Excitement **conductance** through nervous fibres obeyes definite **laws.**

Physiological integrity law

tells that excitation conductance through nervous fibre is possible only in a case of its non-interrupted anatomical structure and physiological features.

Excitement conductance two-sided law

at irritation application on nervous fibre the excitement is diverged through it in both sides from irritation place (at tooth nerve irritation pain is stretched not only on local tissues but also irradiates in other body parts).

Excitement isolated conductance law

excitation through nervous fibres being in a composition of mixed nerves (for example, vagus) is diverged separately, i.e. it doesn't transmit through one nervous fibre to another.

Excitement conductance velocity is different in nervous fibres. It depends on their diameter and structure (myeline membrane existance). All nervous fibres are divided into 3 main types according to their conductance velocity. *Type "A"fibres* – are covered by myeline membrane (sceletal muscles motor fibres), excitement wave conductance velocity is up to 120 m/sec. *Type "B"fibres* – vegetative nerves myeline fibres, excitement wave conductance velocity is up to 18 m/sec. *Type "C"fibres* – myeline-free nervous fibres (vegetative or autonomic nervous system postganglionar fibres), excitement wave conductance velocity is up to 3 m/sec.

Excitement conductance mechanism through nervous fibres. Excitement spreading through nervous fibres is based on bioelectrical potentials ion generation mechanisms. At excitement spreading through type "C" fibre local electrical currents occuring between excited locus, charged electronegatively, and unexcited, charged electropositively, cause simultaneouse membrane depolarization till its critical level with

further action potential generation in every membrane point through all the stretching of nervous fibre. Such excitement conductance is called **uninterrupted.**

Myeline membrane presence, possessing high resistance, and membrane locuses, not having it, creates conditions for **"saltatory"** excitement conductance through myeline nervous fibres of types "A" and "B". Local electrical currents occur between neighboring Ranvier's nodes because excited membrane of node becomes electronegative as for the surface of neighbouring unexcited node. Local currents depolarize membrane of unexcited node till critic level and action potential occurence. Thus, excitation "jumps over" nervous fibre locuses covered by myeline, from one node to another. Such excitement conductance velocity reaches 120 m/sec. At the same time, such excitement wave conductance is more economic than the uninterrupted one.

Nervous fibres possess **lability** – the ability to reproduce definite number of excitation cycles in time unit according to the rhythm of applied irritations. Lability measure is maximal excitation frequency which nervous fibre can reproduce in time unit according to the rhythm of received irritations. Nervous fibre lability is the highest and is approximately 1000 impulses per second.

Important characteristics of nervous fibre is its **relative indefatigueability**, which depends in many aspects on the fact that energy losses in it are insignificant in course of excitement and repair processes pass quickly. Besides, nervous fibre pass excitement wave with large underloading (it can transmit up to 100 impulses/sec but in the most cases transmits less for normal physiological reactions).

In dentistry for unalgaesia in the most often cases one use **local anaesthesia** one type of which is conductive analgaesia. It is based on nervous fibre physiological integrity law. Drug introduction disturbs nerve physiologic integrity that prevents excitation spreading in pharmacological blockade zone. In your future practice you will widely use these physiological data while dentistry practical tasks decision.

Lecture 2
Central nervous system and endocrine glands role in oral cavity physiological functions regulation

Human organism is a complicated, highly-organized system consisting of tissues, organs and system connecting one to another. CNS provides with endocrine apparatus their functions of co-ordination, organism connection with environment and individual human organism adaptation according to their internal necessities. Human activity as complicated reactions realizing with CNS participation is called **reflectory**, with the endocrine apparatus participation – **humoral.** CNS activity main mechanism is **reflex** – conditioned organism reaction by external or internal environment action.

Physiologic functions central regulation. CNS is a complicated structure consisting of

large amount of interacting nervous centers. Anatomically **nervous center** is an integrity of neurons located in a definite brain part and are essential for definite reflex

performing. Physiologically nervous center – is a complicated functional unity of many nervous centers located in different CNS parts and providing difficult reflectory acts and organism functions regulation due to their integrative activity. Examples – respiratory center, heart-vascular center et al.

Nervous centers features. Nervous centers possess a row of character features and peculiarities of excitation conductance, which are determined significantly by synaptic formations presence and structure of neuronal chains forming these centers. These synapses transmitting excitation received the name **exciting.** Some functional features are characteristics of them. They are also nervous centers features.

One-sided excitement conductance in nervous center is determined by its one-sided conductance through synapses.

Excitement conductance lack – is connected with the fact that excitation wave is transmittered slower in synapse than through nervous fibre (it's necessary time for mediator accumulation and exciting post-synaptic potential EPSP forming). EPSP – size on which membrane potential of post-synaptic membrane in decreased while acting mediator portion on it.

Excitement summation – can be temporary or simultanenous (it is delt with EPSP accumulation in one synapse) and space (linked with EPSP accumulation in different synapses of one and the same neuron).

Excitement rhythm transformation – impulses number increasing or decreasing on neuron "exit" in comparison to impulses number which it receives on "entrance".

Afteraction. Reflectory acts are ended not at the same time with stimulus action stoppage but they are lasted for long after action stoppage.

High sensitivity to hypoxy and different chemical substances. It gives opportunity to well-directed brain functions pharmacological regulation.

High fatigue is a result of nervous centers low lability and mediator consumption for EPSP formation.

There are also special **inhibitory synapses** in CNS the role of which are to inhibit excitation wave conductance. The same processes in comparison to exciting synapses take place in inhibitory ones. The difference is that inhibitory mediators cause in such synapses membrane **inhibitory post-synaptic potential (IPSP)** occurence. IPSP – is that size on which post-synaptic membrane potential is increased while action inhibitory mediator on it.

Inhibition in CNS is of great importance. First, it performs **co-ordinative role,** i.e. directs excitation on a definite way to the definite nervous centers. As a result of such action well-directed *elective excitation irradiation* occurs. Excitation in nervous centers due to irradiation can *converge* from different origins to one and the same neuron. Due to interrelations between excitation and inhibition processes in CNS *dominanta principle* is expressed in its work. It is main working principle for nervous centers activity which is expressed in temporary dominant excitation locuses occurence.

Besides very important role in reflectory activity co-ordination, inhibition performs important **protective role** or defencive function. Multiple organism reactions

are formed with obligatory participation of different CNS parts on the basis of excitement and inhibition processes interaction.

In course of some dental diseases durable painful syndrom can create locuses of dominant excitation in corresponding nervous centers. Under such conditions any side stimuli (touching, bright light, strong noise) enforce the pain.

Besides, oral cavity different functions disorders can be determined by central brain structures injury. First of all, posterior brain structures (pons and medulla oblongata), where the centers of trigeminal, facial, glossopharyngeal, sublingual and vagus nerves are located, belong to them. Modern investigation methods **(electroencephalography, EEG)** are used in clinics for determining the role of different brain structures in pain mechanisms forming in dental patients, for oral cavity functions localization in brain, for separate neurons functions peculiarities study in a zone of cortical oral cavity organs representation. It was established on the basis of these investigations that painful excitations occuring at dental pulp irritation irradiate widely in subcortical structures and brain hemispheres that leads to intensive painful sensations occurence.

Oral cavity organs functions are regulated by vegetative nerves. **Autonomic (vegetative) nervous system** – is a complex of central and perypheral structures which regulate internal environment functional level necessary for organism adequate reaction. Anatomically autonomic nervous system is represented by nuclear structures lying in brain and spine, nervous ganglions and nervous fibres. It is divided morphologically and functionally into 3 parts:

- parasympathetic;
- sympathetic;
- metasympathetic.

Autonomic nervous system reflexes morpho-functional peculiarities. *Parasympathetic part.* Parasympathetic unit central part is represented by nuclei, located: in midbrain- oculomotor nerve nucleus (III-rd pair of craniocerebral nerves); in medulla oblongata – facial (VII-th pair), glosso-pharyngeal (IX-th) and vagus (X-th pair) nerves nuclei; in spine – lateral corns of sacral part 3 segments. Perypheral part includes: preganglionar fibres – nervous fibres coming from nervous centers, ganglions and postganglionar nervous fibres – innervating effector organs.

Parasympathetic vegetative functions regulation is realized by both highest nervous centers (cerebral and spinal) and by perypheral ones – ganglions. Ganglion is a morphologic and functional unity of neurons. Excitement transduction from preganglionar nervous fibre to postganglionar is realized in parasympathetic ganglions by means of mediator – acetylcholine. When excitation reaches preganglionar fibre therminal, permeability increasing for extraneuronal calcium occurs. Calcium comes in presynaptic membrane zone and activates vesicules transport with acethylcholine to presynaptic membrane. Vesicular membrane is fused with presynaptic membrane. It creates the conditions for mediator releasing into synaptic fissure. Acethylcholine

interacts with N-cholinoreceptor on post-synaptic membrane and sodium channels are opened as the result of which EPSP occurs. Acethylcholine is destroyed by enzyme acethylcholineestherase after this interaction. Substances which act like acethylcholine are called agonistes, inhibiting excitement conductance in ganglions – ganglioblockers.

In postganglionar parasympathetic nervous fibres on their endings realization is performed through synapses by means of acethylcholine which in visceral organs (heart, alimentary organs, bronchi et al.) acts through M-cholinoreceptors (muscarine-dependent). Such receptors are not equal. One can differentiate $M_1 \ldots M_5$ receptors. Besides, one can differentiate also N-cholinoreceptors (nicotine-sensitive), located on post-synaptic mebranes of sceletal muscles, in central nervous system. Physiologic effects depend on which receptors acts acethylcholine.

Parasympathetic influences peculiarity on different organs is the following: effect comes quickly because they mainly consist of preganglionar nervous fibres of group "B" where excitement wave spreading velocity is relatively high. But effect also disappears quickly because mediator acethylcholine is destroyed fast. That's why action of this part of autonomic nervous system is quick and in more extent local (in the place of mediator releasing).

Sympathetic part. Central part is origined from spine nuclei in grey substance beginning from I-II thoracic till II-IV lumbal segments. Perypheral part is represented by postganglionar neurons beginning from paravertebral and prevertebral ganglions. Excitement conductance in ganglions in this part of autonomic nervous system is realized by mechanisms similar to those in parasympathetic nervous system. Excitation wave is transmitted from postganglionar fiber to effector by means of mediator – noradrenaline (or adrenaline). Noradrenaline produces in body, axonal therminal part and its varicosus dilations. Noradrenaline is located in neuronal vesicles, its part is dissolved in cytoplasm. It is released from vesicules in course of depolarization of presynaptic ending membranes that is accompanied by their permeability changes to calcium ions. Calcium releasing into synaptic fissure occurs by means of exocytosis – vesicular membrane fusing with axonal ending membrane. Noradrenaline or adrenaline reaching postsynaptic membrane interacts with specific receptors which name is adrenoreceptors. They are divided into 2 groups – alpha- and beta-adrenoreceptors. In turn, every group is subdivided into subgroups. Alpha-adrenoreceptors activation leads to skin, mucosas, kidney, abdominal cavity organs, lung, brain, sceletal muscles vessels constriction. At the same time it results in contraction of sphincters smooth muscles and pupil ciliary muscle, causing midriasis (pupil's dilation).

Beta-adrenoreceptors activation causes vasodilatation in sceletal muscles, coronars, lung, brain, abdominal cavity organs. It also leads to heart beat, freaquency and excitement conductance velocity increasing in typical (working) and atypical myocardiocytes. Other results of such activation – pupillar muscles, biliary tracts smooth muscles relaxation; urinary vesicle tone decreasing.

Autonomic nervous system sympathetic part makes trophyc influence onto different tissues and organs. It means that metabolic processes complex occurs in tissues

supporting tissue structure and providing its function and metabolic reactions in it. For example, it enforces energy substances resynthesis processes, changes receptors excitability et al. Biologically active substances – noradrenaline and adrenaline – participate in trophyc processes. They while absorbing into blood are spread to organs and tissues which have no sympathetic innervation and act to them (for example, sceletal muscles).

Comparatively to parasympathetic part, sympathetic one influences more diffusily. It is connected with adrenaline and noradrenaline action because they reach practically all tissues and organs and possess stronger effect in comparison with acethylcholine. Besides, sympathetic nervous system action and influence is more durable.

Metasympathetic part is a complex of structures providing their own nervous regulation of main visceral organs possessing functional automatism (cardiometasympathetic, enterometasympathetic, urethrometasympathetic). Its main functions are as follows as: providing excitement conductance from nervous system structures to effectors, regulatory influences co-ordination performing (of smooth muscles motor activity, alimentary tract organs secretory, excretory and absorbtive activity, local circulation regulation and others).

The base of metasympathetic part are neurons different in their shape, synapses existance, processes amount and length. This system ganglions are located intramurally – in organs walls. Parasympathetic and sympathetic fibres penetrate these ganglions. Central influencings are realized through these fibres. Ganglionar neurons receive and process the information from efectors and are under modulating and correcting influence of impulses coming from brain and spine centers. Information processing is performed in ganglions, excitement transmitting in them is realized with acethylcholine participation (through M- and N-cholinoreceptors) and noradrenaline (through alfa-adrenoreceptors). Impulses are transmitted from postganglionar neurons to effectors by means of such mediators as ATP, serotonine, noradrenaline, acethylcholine, substance "P" and others. Significant role in effects realizing to effector tissues and organs have modulators – kinines, prostaglandines, opioid peptides, renine, angiotensine and others. They change effectors functional answer enforcing or decreasing their activity.

Thus, autonomic nervous system action onto organs and tissues is not equal. Sympathetic part causes their diffuse excitement. This is the system of anxiety, protection, mobilization of reserves necessary for organism interaction with environment. Such mobilization is reached by means of many systems and organs generalized involvement in reaction. Probably, that's why sympathetic ganglions are situated far from innervated organs and possess the ability to impulses multiplication that provides fast influencing generalization.

Slower but also generalized process appears at adrenaline releasing into blood. Such releasing is considered to be fluid sympathetic nervous system. Sympathetic impulses activate brain activity, mobilize defence reactions, thermoregulative processes, blood coagulation mechanisms, immune reactions. Sympathetic nervous system excitement is

an obligatory condition of emotional state and tension, it is hormonal reactions initial stage (link) at stress. Its influencings have adaptative and trophyc character.

Parasympathetic part and, especially, metasympathetic are the systems of current organism physiologic functions regulation. Such functions provide homeostasis. Metasympathetic neurones possess the features like brain nuclear structures. This system has its own integrative chain for information processing. If parasympathetic system influencings are mainly indirected (although there are also direct influencings to some organs) and more local than in sympathetic, metasympathetic one has only visceral functions (peristalsis saving, absorption, smooth muscles contraction) and it is base, local for these organs.

Vegetative functions regulative centers are practically all parts of central nervous system. Spinal part has segmentary and metameric organization. It's a very important for clinics (hyperaesthesia, hyperalgesia – tactile and nociceptive sensitivity increasing in limited body parts at inner organs diseases). Pains occuring at inner organs diseases are called reflected (Ged's zones).

In brain stem there are multiple vegetative structures – nuclei and centers of heart activity, vessel tone, respiration, swallowing regulation and others. They must belong such reflexes as olfactory, lacrimal, pupillar, sneeze and others to these reflectory acts.

In diencephalon particularly in hypothalamus humans have central mechanism of homeostasis, alimentary, respiratory functions, heart-vascular activity, endocrine system, metabolism regulation, thermoregulation.

Somatosensor and other cortical zones are center of localization not only of somatic but also visceral systems.

Autonomic nervous system reflectory reactions. One can differentiate 3 reflexes groups:

- viscero-visceral;
- viscero-somatic;
- viscero-sensor.

Viscero-visceral reflexes are origined and are ended in inner organs. For example, peritoneum receptors in course of their excitement give impulses changing heart activity (Golz reflex, epigastral reflex). Such reflexes may be closed by type of axon-reflex (in limits of one axon branches). It's necessary to take into account such mechanism of their occurence in clinic practice in course of therapeutical procedures performing (mustard plusters, cupping-glasses, compresses).

Viscero-somatic – include ways on which excitement cause also somatic answers (contraction or inhibition of sceletal muscles current activity) in addition to visceral reflexes. Segmentary innervation of some organs (heart, intestines) are on the base of these reflexes. It's accompanied by integrative reactions of both visceral and somatic organs. For example, abdominal cavity receptors irritation can cause anterior abdominal wall muscles contraction or extremities movement that it is connected with afferent

impulses convergence to interneurons of different spine segments. Such segments create common scheme for autonomic and somatic influencings transmission.

Viscero-sensor – include ways in which in answer to autonomic sensor fibres irritation reactions occur not only in inner organs, muscular system but also somatic sensitivity is changed. Due to segmentary organization, autonomic and somatic innervation at inner organs diseases in limited skin locuses tactile and nociceptive sensitivity increasing (reflected pains) is appeared. In course of some diseases (stenocardia, ulcer disease, cholecystitis, pancreatitis et al.) the patients' complaint is painful sensation in corresponding proectional zones.

Vegetative innervation disorders are often observed in dentistry. They have very different signs. For example, salivary glands secretion changes (glands have double innervation – sympathetic and parasympathetic), at swallowing, food gustatory qualities assessment. One can see oral cavity tactile, temperature sensitivity disorders and many others.

Oral cavity physiological functions nervous regulation is the highest stage of development and organism adaptation to environment changing conditions. Nervous regulation is more perfect and more complicated by its mechanisms. But there exists also more ancient form of interaction between cells of multi-cellular organisms – chemical influence of metabolism products secreted by special cells and organs (endocrine glands) – hormones. It's difficult to separate these 2 functions today because brain one can consider endocrine gland. Functions regulation is realized through blood. Thus, humoral regulation is more ancient. Under natural physiological conditions they work with co-operation.

Endocrine system role in oral cavity physiologic functions regulation.

Humoral regulation is performed by means of special internal environment chemical regulators – **hormones.** These are chemical substances producing and releasing by specialized endocrine cells, tissues and organs. Hormones differ from other biologically active substances (metabolites, mediators) by their producing in specialized endocrine cells and because they act to organs located far from them.

One consider that hormonal regulation is realized by endocrine system. This functional unity consists of endocrine organs or glands (for example, thyroid, suprarenal glands et al.); endocrine tissue in organ (endocrinocytes accumulation for example Lanhergans' insulas in pancreas); organ cells possessing (besides their main function) endocrine function too (atriums myocytes alongside with their contractile function produce and secrete hormones influencing on diuresis).

Hormonal regulation management apparatus. Hormonal regulation has its own management apparatus. One of such management ways is realized by separate structures of CNS directly transmitting nervous impulses to endocrine elements. This is nervous or *cerebro-glandular way* (brain-gland). Other way is *hypophysal.* Third way of some endocrinocytes activity control is *local self-regulation* (secretion of sugar-regulating hormones by Langerhans' insulas is regulated by glucose level in blood; of calcitonine – by calcium level).

Hypothalamus is a central structure of nervous system that regulates endocrine apparatus functions. Such hypothalamus function is linked with neuronal groups existance haveng the ability to synthesize and to secrete special regulative peptides – neurohormones. Simultaneously hypothalamus is both nervous and endocrine structure. Hypothalamic neurones feature to synthesize and to secrete regulatory peptides receives the name neurosecretion. We would like to mention that in fact all neurons possess this quality – they transport proteins, enzymes synthesized in them. Neurosecrete is transmitted into brain structures, liquor and hypophysis. One can differentiate 3 groups of hypothalamic neuropeptides:

- viscereroceptive – primarily act to visceral organs (oxytocine, vasopressine);
- neuroreceptive – neuromodulators and mediators possessing expressed effects to nervous system functions (endorphines, encephalines, neurotensine, angiotensine);
- adenohypophyso-receptive – realize adenohypophysal glandulocytes activity.

Lymbic system belongs to endocrine elements activity management common link with hypothalamus.

Hormones synthesis, secretion and releasing.

Hormones classification (according to their chemical structure):

1) aminoacids derivates:
   - thyroid hormones;
   - adrenaline;
   - hypophysal hormones;
2) peptide hormones:
   - hypothalamic neuropeptides;
   - hypophysal hormones;
   - pancreatic insular apparatus hormones;
   - parathyroid hormones;
3) steroid hormones (are formed from cholesterine):
   - suprarenal glands hormones;
   - sexual hormones;
   - renal hormone – calcitryol.

Hormones are usually deponated (accumulated) in those tissues where thay are formed (thyroid follicules, suprarenal glands medulla - as granules). But some of them are deponated by non-secretory cells (cathecholamines are catched by blood cells).

Hormones transport is performed by internal environment fluids (blood, lymph, cells microenvironment) in 2 forms – connected and free. Connected (with erythrocytic, thrombocytic membranes and proteins) hormones have low activity. Free hormones are the most active, they pass through barriers and interact with cellular receptors.

Hormones metabolic transformations lead to new informational molecules forming with qualities different from main hormone. Hormonal metabolism is performed by means of enzymes in endocrine tissues themselves and also in liver, kidney and tissues-effectors. Hormonal information molecules and their metabolites

releasing from blood is realized through kidney, sweat glands, salivary glands, bile and alimentary juices.

Hormones action mechanism. They differentiate several kinds, types and mechanisms of hormones action to tissues-targets:

1) *metabolic action* – causes metabolism change in tissues (cellular membranes permeability, cellular enzymatic activity, enzymatic synthesis change);
2) *morpho-genetic action* – hormones influence on processes of structural elements shape-forming, differentiation and growth (genetic apparatus and metabolism change);
3) *kynetic action* – ability to switch on effector activity (oxytocine – uterus musculature contraction, adrenaline – glycogenolysis in liver);
4) *corrigating action* – organ activity change (adrenaline – heart contractions freaquency increasing);
5) *reactogenic action* – hormone ability to change tissue reactivity to the action of the same hormone, other hormones or mediators (glucocorticoids release adrenaline action, insuline increases somatothropine action realizing).

Hormones action ways to cells – targets – can be realized as 2 possibilities. Hormone action from cellular membrane surface after binding with specific membrane receptor and after that switching on biochemical reactions chain in membrane and cytoplasm. Peptide hormones realize their activity by this way. Another way – penetrating the membrane and connection with cytoplasmic receptors after which hormone-receptor complex penetrates nucleus and cellular organoids. Such way is a characteristics of steroid and thyroid hormones.

In peptide, protein hormones and catecholamines hormone-receptor complex leads to membrane enzymes activation and hormonal regulative effect secondary messengers formation. They know next secondary messengers systems:

- adenylatecyclase-cyclic adenosinemonophosphate (cAMP);
- guanylatecyclase-cyclic guanosinemonophosphate (cGMP);
- phospholipase C – inositoletryphosphate (IP3);
- ionized calcium.

In the most organism cells practically all messengers mentioned above with the exception of cGMP are present or may be formed. There are different interrelations between them (equal participation, one - main, others – agonistes, act simultaneously, double one another, are antagonistes).

In steroid hormones membrane receptors provides specific hormone recognition and its transport to cell; special cytoplasmic protein – receptor with which hormone is connected – is located in cytoplasm. Then interaction of this complex with nuclear receptor occurs and reaction cycle with DNA participation and ending protein and enzymes biosynthesis on rhybosomes is switched on. Additionally, steroids change intracellular cAMP and ionized calcium content. In this aspect different hormones action mechanisms have similar features.

In last decades **tissular hormones** large group has been discovered. For example, alimentary tract, kidney and practically all the tissues hormones. Prostaglandines, kinines, hystamine, serotonine, cytomedines and others belong to them.

Second half of last century in biology and medicine is characterized by fast development of peptide role study in organism activity. Every year great amount of publications dedicated to different physiologic functions course appear. Nowadays from different (practically all) organism tissues more than 100 peptides are extracted. One group of neuropeptides is among them. To present time peptide regulators are found out in alimentary tract, heart-vascular system, respiratory and excretory organs. Thus, there exists diffused neuroendocrine system called sometimes third nervous system. Endogenous peptide regulators containing in blood, lymph, intersticial liquid and different tissues, can have at least three origins of their development: endocrine cells, organ neuronal elements and peptide axonal transport depot from central nervous system. Brain synthesizes constantly and thus contains with the small exception all peptide bioregulators. That's why brain is called to be endocrine organ. At the end of last century information molecules existance in organism cells was proved. These molecules provide interactions in nervous and immune system activity. They received the name cytomedines. These are substanses realizing connection between small cellular groups that influence greatly on their specific activity. Cytomedines carry definite information from cell to cell. Such information is written by means of aminoacids sequences and conformational modifications.

Cytomedines cause maximal effect in tissues of organ from which they are excreted. These substances support definite cell correlation in populations situated on different developmental stages. They perform informational exchange between genes and intercellular environment. They participate in cells differentiation and proliferation processes while changing genome functional activity and protein biosynthesis.

Nowadays thesis about united neuro-endocrine-cytomedine regulatory system in organism is putted forward. We would like to mention specially that our Normal Physiology Chair delt and deals with cytomedines action mechanism study. Cytomedines are multiple substances group. They are of protein nature and are released nowadays practically from all organs and tissues being one of the most important links in organism physiologic functions regulation. Some of these substances were checked up experimentally particularly at our chair. Today these substances are described as medicines (thymogen, thymaline – from thymus, cortexine – from brain tissues, cardialine – from heart tissues – the preparations were received in Russia). Our collaborators studied action mechanisms of such cytomedines – from salivary glands tissues – V.N.Sokolenko; from hepatic tissues and erythrocytes – L.E.Vesnina, T.N.Zaporozhets, V.K.Parchomenko, A.V.Katrushov, O.I.Tsebrzynsky, S.V.Mistchenko; from cardiac tissues – A.P.Pavlenko; from kidney tissues – I.P.Kaydashev, from brain tissues – N.N.Grytsay, N.V.Litvinenko; cytomedine "Vermilate" from Califronia nematoda tissues – I.P.Kaydashev, O.A.Bashtovenko.

These peptides play important role in antioxidative protection regulation, immunity, non-specific resistance, blood coagulation, fibrinolysis and other reactions.

Interrelations between nervous and humoral mechanisms in physiological functions regulation.

Regulation nervous and humoral principles described above are united morphologically and functionally in one *neuro-humoral regulation.* Such regulatory mechanism initial link, as a rule, is afferent sygnal on entrance and informational connection effector channels are either nervous, or humoral. Organism reflectory reactions are initial in complicated integrated reaction, but only in complex with endocrine apparatus organism alive activity regulation system functionning is provided to its optimal adaptation to environmental conditions. One of such alive activity organization mechanisms is *general adaptational syndrom or stress.* Stress is neuro-humoral regulation, metabolism systems and physiological functions non-specific and specific reactions integrity. Neuro-humoral regulation system level is expressed in course of stress as a whole organism susceptibity increasing to environmental factors action particularly harmful for organism. You will discuss stress mechanisms in details in course of pathological physiology. But now, please, put your attention to the fact that under stress conditions interrelations between nervous and humoral regulatory mechanisms are very brightly expressed. In organism these regulatory mechanisms add one another while forming functionally united mechanism. For instance, hormones influence on processes taking place in brain (behaviour, memory, study). Brain, in turn, controls endocrine apparatus activity.

Organism interrelation with external environment which influences on its functions so much is realized by analizators – special nervous system apparatus.

Endocrine glands significantly influence on maxillo-facial region morpho-functional state, especially one can see such influence under endocrinopathology. Endocrinopathies (hypo- or hyperfunction) leads to special diseases with accompanying changes in oral cavity. These signs in the most cases are far secondary expressions observed in disease height and that's why they are easily to be diagnostically found out. Most often changes in oral cavity occur at pancreas, sexual glands disorders, more seldom – in course of hypophysis, thyroid, parathyroid and suprarenal glands dysfunctions.

Pancreas disturbances are widely-spread. At insuline insufficiency diabetes mellitus is developed. Distinguishing features: tissular reactions change to local stimuli, organism resiliency decreasing to infections, predisposition to inflammatory processes, retarded wounds repair. Many of this is delt with oral cavity. Though such changes are non-specific they are observed not only in course of diabetes. Main patients' complaints are the following: dryedness in mouth of different degree, increased appetite and thirst. Oral mucosa is dry or weakly-washed. Dryedness is the dehydratation (liquid loss by tissues) result. One can see also small vessels changes, oral mucosa hyperaemia, tongue increasing, dental stone big coverings, teeth increasing motility and light bleedings from gums.

Sexual hormones physiological secretory fluctuation due to sexual development, pregnancy and other states causes definite changes in oral mucosa too. More seldom such symptoms are observed in connection with endocrine glands diseases. Oral mucosa is changed under estrogen and progesterone influence. Under estrogen action water is delayed in tissues, keratinization is decreased, mitotic activity is enforced. Progesterone causes increased vascularization as a result of which predisposition to bleeding is increased in oral cavity. Gonadothropic hormones cause oral cavity and gums mucosa swelling.

At **hypophysis** hyperfunction due to jaws increasing and soft tissues (lips, gums, tongue) growing up acromegaly is developed. Hypophysis thyreothropic hormone enforces connective tissue ability to keep water that leads to mucosa oedema. Somatothropic hormone secretion increasing can lead not only to acromegaly, acrocheylia (lips dimensions increasing), macroglossia (tongue size increasing) but also to gums hyperplasia (tissular structural elements excessive forming). Dilated interdental spaces in increased dental arch provides food putting between teeth and parodont injury.

Thyroid hyperfunction results in gums swelling, other oral cavity tissues are not changed. Tongue tremor is often observed, multiple caries is possible. Thyroid hypofunction or its removal leads to mandibule atrophy, multiple caries near cervix and intracervically (with circulatory situation in the latest case) because of phosphorus-calcium exchange disorder.

Suprarenal glands cortex anomalies are accompanied by first disease signs (Addison's disease) as skin and mucosae pigmentation. That's why dentist can see such pigmentation before other symptoms appearence. Most often one can observe pigmentation on cheeks mucosa, on lips, on tongue limb. Pigmented locuses size is from 1 to several square millimeters. They are uncorrect-shaped, plate, are not protruded above mucosa level. Their appearence reason is melanine accumulation in connective tissue and in bazal epitheliocytes due to hypophysal hormone melanophore stimulating action.

Knowledge of endocrine glands developmental peculiarities can help to dentist connected to children. In children's dentistry study the questions delt with endocrine glands and oral cavity tissues embryogenesis, differentiation and hystogenesis in embryo, fetus and child in his first years of life is of special interest and of great importance. Such correlations are important for determining the role of one or other gland in dental-maxillary system development. It is known for example that hormones influence on hysto- and organogenesis. Suprarenal gland cortex and thyroid during their embryogenesis begin their functionning before others (correspondingly on 8-th and 12-th weeks) and are dominant endocrine glands during this onthogenetical period. They stimulate growth and influence greatly upon tissues and organs of all embryo organism and on dental-maxillar system organs too. Beginning from 6-7 th weeks of embryogenesis, soft and hard palate are formed, the division of primary oral and nasal cavities, oral cavity and tongue vestibule development take place. Dental plate begins its formation in course of this period, milky (primary) teeth layings and germs formation

occur. Thyroid function maturation in humans coincides with milky teeth germs differentiation period.

One more endocrine system problem is of great importance in dentistry. It is different mother's (maternal) endocrinopathies influence onto embryo. It was established that preliminary beginning of thyroid functionning in mother and parathyroids in embryo can be at resection of these glands in mother. System hypoplasia (tissular elements insufficient formation) of teeth and their dentition terms disorders take place as the result of such phenomenon.

In children at endocrinopathies one can see differencies in teeth formation and dentition: milky teeth malacia (resorption) retardation, retinated teeth, dentine structure change, hypercementosis, non-caries solid dental tissues injuries (hypoplasia, necrosis, erosion, pathologic desquamation). In course of hyperthyreosis changes in oral cavity will be non-specific and will be expressed mainly in accelerated dentition. On the contrary, changes in oral cavity will be very specific: dentition disorders, enamelogenesis anomalies, lips and tongue size increasing, leading to speech and swallowing retardation. Mucosa is swelled, gums are pale, swelled.

Parathyroids functionning anomalies also have their consequences because it influences on calcium and phosphorus exchange in organism. At parathyroid hyposecretion in childhood one can see enamel hypoplasia and dentinogensis disorders. In 20-50 per cents of cases at these glands hypersecretion one can determine parodont change.

Endocrine glands hypofunction or hyperfunction, hormones overdosage or gland death during puberty is expressed earlier in comparison with developing organism, after growth period ending because developing dental germ and parodont are very sensitive to all organism hormonal status anomalies. Primary (milky) and definite (constant) teeth dentition time is a very important diagnostic symptom at some endocrine diseases determining, for example, congenital hypothyreosis, toxic ingluvies or crop, hypophysal hyperfunction.

Thus, in organism neurochemical and endocrine system add one another, form functionally united mechanism. Hormones influence on processes taking place in brain and brain in turn controls endocrine glands activity. For instance, sympathetic nervous system excitement is accompanied by adrenaline hyperproduction. Hypothalamus causes change in hormones production. Emotional excitement through limbic system and hypothalamus influences greatly on hormonal production. All these reactions influence on dental-maxillary apparatus too.

Lection 3

Analizators. Oral cavity role in purposeful behaviour.

Human being constantly receives information about multiple changes taking place in external and internal environment. It is realized by means of **analizators** or sensor systems. Each analizator consists of 3 parts:

1) *perypheral or receptor part*– performes stimulus energy perception and its transformation in specific excitement process;
2) *conductive part* - is represented by afferent nerves, spinal and stem centers. It performs specific excitement primary processing and its transmission to brain cortex;
3) *central, brain or cortical part* – corresponding cortical zones, where ending excitement processing – the highest analysis and corresponding sensation forming – is performed.

Thus, **analizators** – is structures integrity providing:

- irritator energy perception;
- its transformation into specific excitement process;
- this excitement transmission through CNS structures;
- its analysis, assessment by specific cortex zones with subsequent forming of corresponding sensation.

Peripheral (receptor) analizator part features.

In activity of each analizator and its parts independently from characteristics of stimuli percepted by it one can differentiate several common features. These features are common for perypheral part of any analizator.

1) *Specificity* – ability to percept only definite, i.e. adequate for given receptor, stimulus. This receptor ability has been formed in course of evolution.
2) High sensitivity – ability to answer to very small by intensivity parameters of adequate stimulus.
3) Rhythmical excitement impulses generation in answer to the stimulus action.
4) Adaptation – ability to adapt to stimulus action which is expressed in receptor activity and excitement impulses generation freaquency reducing.
5) Functional mobility – increasing or decreasing of functional receptors amount dependently of environmental conditions and organism functional state.
6) Specialization of receptors to adequate stimulus definite parameters. Receptors in perypheral analizator part composition are unequal as for their attitude to stimulus. One of them answer only to the origin of its action, others – on it stoppage, third – on intensivity change.

Oral cavity mucosa is innervated rich, its receptors are represented by free nervous endings and special structures (Krauze colbs, Ruffini bodies, Meissner's bodies, Merkel's bodies et al.).

1) *According to information character coming to CNS* from oral cavity one can differentiate not less than *6 sensitivity types*:

- gustatory;
- of coldness;
- of warmth;
- tactile;
- nociceptive;
- proprioreceptive;

2) *according to functionning specificity* – there are 3 receptors types:

a) chemoreceptors (gustatory);

b) somatosensor:

- tactile;
- of warmth;
- of coldness;
- of pain;

c) proprioreceptors.

Every group is the origin of corresponding analizator.

First signs of many dental diseases can be expresssed by perceptive processes and oral cavity sensor system adaptive mechanisms disorders. Dentist in his daily practice in course of patients examination usually puts his attention only to nociceptive sensitivity disturbances but it doesn't usually reflect proper time of disease beginning time and recovery, so it doesn't always correctly orient (direct) the doctor to proper treatment method choosing. That's why it's necessary to remember that for receiving more full disease picture it's necessary to investigate other sensitivity types too.

Gustatory reception. Gustatory sensitivity is oral mucosa sensor function specific peculiarity. Gustatory analizator physiology knowledge is a very important because change of its function may testifies to serious disorders both in oral cavity and in other organism parts. One can differentiate such problems with taste:

- *agevzya* –gustatory sensitivity loss;
- *hypogevzya* – gustatory or taste sensitivity reducing;
- *hypergevzya* - gustatory or taste sensitivity increasing;
- *paragevzya* - gustatory or taste sensitivity distortion;
- *dysgevzya* – gustatory substances detailed analysis disorders;
- *gustatory gallucinations.*

But gustatory analizator role and its importance is difficult to determmine separately because natural adequate stimulus - food, coming into oral cavity – excites simultaneously other analizators receptors. Thus, gustatory sensation is a complicated sum of excitements coming into cortex from gustatory, olfactory, tactile, temperature and nociceptive receptors. First of all, in oral mucosa tactile receptors are excited, later – temperature and than receptors answering to chemical food content. Impulses from them go into CNS through different fibres with different velocity. Result - dyspersion on excitement spreading through nervous centers. Different shades of gustatory sensations also depend on the complex of occuring excitations. Gustatory receptor cells are united in gustatory bulbs which are primarily located in tongue papillas: fingiformed, foliatae and vallate. Taste analizator sensitivity assessment is performed by method of *gustatory sensation threshold determining* as well as by *functional mobility* method. Gustatory thresholds are defined separately for every stimulus from 4 main gustatory stimuli according to taste fields topography because separate tongue locuses possess different sensitivity to substances of various gustatory quality in the majority of people: tongue

end is the most sensitive to sweet, lateral surfaces – to salty and sour, root – to bitter. It was established by means of functional mobility method that active lingual papillas amount is constantly changed according to alimentary tract functional state. Receptor mobilization maximal level is observed on an empty stomach, it is reduced after its irritation with food. This phenomenon is known as **gastro-lingual reflex.** Gustatory receptors play the effector role in this reflex. Some dental diseases for example *glossalgia* (pain in tongue), *glossitis* (tongue inflammation) and others may appear at alimentary tract disorders. There can be taste loss and gastro-lingual reflex disorder that can be used as diagnostic criterium. Gastro-lingual refelx study in these cases help diseases aethiology assessment.

Tactile reception. Oral mucosa tactile reception is an important part of somato-sensor analizator. It is represented by touching and pressure receptors. These receptors are in strong functional interconnection with parodont mechanoreceptors and masticatory muscles proprioreceptors. Their interrelations define muscle participation in course of mastication act. Besides, on tongue back one can see filiaformed papillas that play touch organs role and perform mechanic function. They look like cone-shaped eminences closely attached one to another. That's why tongue surface is velvety. Epithelium covering filiaformed papillas is keratinized (cornificated). Filiaformed papillas epithelium superficial layer desquamation is the physiological regeneration process expression. Filiaformed papillas epithelium superficial layer desquamation is retarded at alimentary organs diseases, common inflammatory and infectious diseases. Tongue becomes coated in a result of such unpleasant states.

Tactile sensitivity study demonstrated receptors distribution unequality in facial-maxillar region different regions. Maximal sensitivity has tongue end and red lip limb because these structures are the first instation for the analysis of substances coming into oral cavity. Superior lip (mucosa and red limb) possesses more expressed sensitivity comparatively to inferior one. Tactile sensitivity high level has hard palate mucosa. It is of great importance in course of swallowing act (orienting mastication phase) and in course of food piece forming, swallowing. Vestibular gum surface mucosa possesses minimal tactile sensitivity. One can see decreasing sensitivity gradient to the left and to the right from alveolar arch center in the gingival (gum) papillas region. Sensitivity is more from the right side than from the left. Asymmetry is explained by innervation peculiarities: maximal neurons quantity is located on the right face side.

Tactile sensation study in regions covered by dentures that are denturing bed helps to develop individual peculiarities of adaptation to dentures in dental patients.

Temperature reception. Temperature analizator belongs to somato-sensor analizator too. Some sensor regions possess high sensitivity to temperature fluctuations. Temperature receptors are divided into receptors of warmth and of coldness. Their maximal quantity is located in facies and neck skin.

One can determine increasing gradient from oral cavity anterior to posterior part for thermal sensitivity, for the cold one - on the contrary. Cold receptors predominance in oral cavity anterior part and thermal – in posterior ones is connected with specificity

of their functions and their importance in organism thermoregulation processes. Receptor system of coldness being predominant in thermoregulation, answers faster and more adequate to external environment temperature change and thermal one is a characteristics of homeostasis of an organism himself.

Cheek's mucosa has a little sensitivity to coldess and less one – to warmth. Warmth perception is completely absent in hard palate center and central part of tongue posterior part percepts neither cold nor thermal stimuli. Tongue end and red lip limb possess high sensitivity to temperature irritations. It is determined by functional properity because in course of food taking these regions are irritated first. Information about substances temperature from these regions will switch on corresponding protective reactions if it's necessary.

Teeth possess both thermal and cold sensitivity. Cold sensitivity threshold for incisive teeth is 20°C, for the rest of teeth – 11-13°C; thermal sensitivity threshold for incisive teeth – 52°C, for rest teeth – 60-70°C. For dental temperature sensitivity study they are washed by water of high or low temperature or use cotton-wool tampon washed in water or either which while fast vaporization leads to the tooth coldness. If temperature stimuli cause adequate sensations it is testifies to absence of any pulp pathological change. Thermal irritation of caries regions is accompanied by pain in course of caries. Depulpated tooth doesn't answer to such stimuli. Nociceptive sensation can occur either at injured stimulus action to special "noceoceptive" receptor – nociceptor, or at superstrong irritations of other receptors. Nociceptors are 25-40 per cent of all receptors. Nociceptors both of skin and of mucosa are represented by free non-incapsulated nervous endings of different shape (hairiness, spirals, plates et al.). The most investigated in oral cavity is nociceptive sensitivity of alveolar processes and hard palate mucosa that are denturing bed regions. Expressed noceosensitivity possesses mucosal part on mandibule vestibular surface at lateral incisive teeth region. Gums mucosa oral cavity possesses minimal noceoceptive sensitivity.

On cheek internal surface there is narrow locus without noceosensitivity. Maximal quantity of noceoreceptors is in dental tissues. On 1 cm^2 of dentine 15000-30000 noceoceptive receptors are located, on enamel-dentine boundary – their amount reaches 75000, on skin – not less than 200 noceoreceptors. Pulpal receptors irritation causes extremely strong painful sensation. Even light touching is accompanied by acute pain. Dental pain which belongs to the strongest pains occurs in course of tooth injury with pathological process. Tooth treatment stops it and liquidates pain. But treatment itself may be very painful manipulation. Besides, in course of denturing one should preparate often healthy tooth too that causes painful sensations.

Pain analizator (noceoceptive analizator). Nociceptors are divided into 2 types: mechanoreceptors and chemoreceptors. Mechanoreceptors are getting excited as the result of mechanical movement of membrane that allows to sodium ions to penetrate inside and to cause nerve ending depolarization. Mechanoreceptor is located so that it provides the control of skin, epidermis, articulatory sacs, muscular surface and periodont integrity. Excitement from the most mechanoreceptors are transmitted through "A"

fibres. Chemoreceptors are located in the deeper tissular layers. They control oxidative processes level in tissues: at oxidation level reducing their self-excitement occurs. Ishemia (tissue blood supply decreasing or stoppage) independently from its reason leads to strong painful sensations development. Specific irritators for chemoreceptors are the substances released at cells injury: acethylcholine, hystamine, serotonine, potassium ions and some others. Some products of plasma, tissualr liquid may be activated while contact with side body, acid metabolic products, inflammation products and act to chemoreceptors. Prostaglandine E (is released at inflammation), blood coagulation contact factor – factor XII (Hageman's factor), plasmine, bradykinines. Excitement from nociceptors of oral mucosa, periodontal, lingual, pulpal receptors are transmitted through nervous fibres of "A' and "C" group. The biggest part of these fibres belongs to trygeminal nerve second and third branches. Central processes are directed to medulla oblongata where they are finished on neurons of nuclear complex consisting of main sensor nucleus and spinal tract. Trygeminal nerve spinal tract nuclei after the clearence of oral cavity, dental tissues and facial regions receptors are divided into 3 parts: nucleus oralis, interpolaris and caudalis. On the latest 2 trygeminal nerve ganglion neurons central processes are finished. They transmit information from nociceptors (second analizator neurons). Mainly information from mechanoreceptors comes to anterior and main sensor nucleus of this nerve. Excitement comes from second neurons to posterior and ventral specific thalamic nuclei, from which nociceptive excitement is directed to sensor zone and medial parts of brain hemispheres orbital cortex. The result of excitements coming into central brain parts is pain sensation forming with more or less expressed behavioral, emotional and vegetative reactions directed to oral cavity tissues integrity preserving. The term "pain" has different essence. One can differentiate pain as usual sensor modality similar to hearing, taste, vision, that is a sygnal about reaching the physiological function boundaries out if which injury is located. The example of this pain definition is pain sensation appearence while trying to gnaw too solid nuts. Pain can be the result of pathologic processes, for example, pulpitis and periodontitis. Chronic durable pain can become the origin of new pathologic conditions for instance mania-deppressive states and odontogenic trygeminal nerve neuralgia. Primarily pain is situated in injured tooth region but also it can irradiate to neihbouring jaw locuses, in eyeball, head frontal, temporal and occipital regions. Painful sensations also occur at mucosa inflammatory processes: stomatitis, glossitis, at galvanism phenomena et al.

Some CNS structures perform antinociceptive functions. These are separate nuclei of medulla oblongata, midbrain, hypothalamus and big hemispheres. Besides brain structures mentioned above there exist others, cellular elements, disseminated in CNS participating in noceoceptive sensitivity control. Together with well-known opiate and serotonineergic mechanisms we should mention dophamine-, choline- and adrenergic mechanisms switched on in noceoceptive sensitivity regulation at different CNS levels. Pain threshold size depends on nociceptive analizator interconnection to antinociceptive system and can be modulated due to changes the activity of not only noceoceptive

analizator afferent systems but also due to nociceptive system activity. Pain threshold is often changed at emotional states which are in dependence on emotions type either activate antinoceptive system (aggression, fury), increasing pain threshold, or decrease its activity (fear), reducing pain threshold.

Purposeful behaviour and oral cavity role in its realizing.

Purposeful behaviour is the base of the highest nervous activity. These are complicated reflectory reactions providing individual organism adaptation to simultaneously changing environmental conditions, i.e. human behaviour. Alongside with congenital (***unconditioned***) reflexes there exist aquired (***conditioned)*** reflexes. Common for human being and animals are ***analysis*** and ***synthesis*** of direct, concrete sygnals of surrounding world subjects and phenomena, which come from different organism receptors and are the **first sygnal system.** In human being besides in course of working activity and social development **second sygnal system** appeared. It is delt with word sygnals. This signalization system is in perception and analizing of listened and pronounced (speech) or visible (text) words. Word sygnal importance is defined by not only simply combination of sounds but also by its semantic context. Human being as animal has only unconditioned reflexes at his birth. In course of life conditioned-reflectory connections forming occurs by first sygnal system. Further, second sygnal system is simultaneously formed on the base of the first one. It is human behaviour the highest regulator. Due to the highest nervous activity (HNA) and psyche peculiarities definite attitude to his state is formed in a patient as well to dental diseases. It influences on dental wards visits, therapeutic measures effectiveness and adaptation terms in course of orthopedic treatment. Any denture of any construction and function is a complex of inadequate stimuli. Applied with preventive or medical aim denture is percepted as side body by patient, his attention is concentrated for long on this sensation, it troubles him in his work and rest. In people with unstable nervous system, hardly coming through the least irritation there occurs very big desire to remove the denture and often do this in clinics. Salivation is enforced in parallel to the sensation of denture as side body. Such sensation occurs almost right after denture application and it testifies to salivatory reflex appearence at oral mucosa receptors irritation. This reflex is unconditioned by nature and it reminds the reaction caused by action of removed substances. It is expressed not only in excessive salivation but also in qualitative saliva content change.

Besides, in first time of denture usage food bite, proper masticatory act and swallowing act take place not-coordinatively, insimultaneously, with speech changing, sometimes vomiting reflex occurs. All this requires large physical forces from patient and emotional tension. Such state is determined by the fact that denture is oral cavity sensor apparatus active irritator, from which afferent impulses powerful stream comes into CNS. This afferentation causes strong excitement not only of specific structures but also irradiates in brain non-specific structures. Adaptation velocity to dentures depends both on HNA individual features and on organism functional state (fatigue, agitation, psychiatrical trauma). It's necessary to remember that word being the irritator of the second sygnal system can act very strongly to one's organism. The highest

communication form between people is possible due to speech communicative function. Speech can also perform regulatory function in course of communication between people. That's why dental patients with speech disorders are in special psycho-emotional state. Psychotherapy in dentistry is first of all a fear sense prevention and liquidating. It's necessary to use digressive (distractive) measures (*external inhibition*) e.g. interesting topics for the patient for fear inhibiting and emotional tension liquidation.

Main expressions of human purposeful activity with oral cavity organs participation are the following: sucking, mastication, speech-forming. *Sucking* act is formed in human being in the early developmental period and it is completely expressed after birth. New-born can not neither masticate nor talk in comparison to adult person. Adequate for swallowing alimentary piece forming begins its functionning with first teeth dentition (in 6-8 months) and finishes with root milky (primary) teeth dentition ending (up to 2-3 years). To first teeth dentition moment a child can't masticate. Mandibule masticatory movements become more differentiated with milky teeth amount increasing. But ending adequate for swallowing alimentary piece forming occurs only up to 12-13 years (after primary teeth change to constant ones). In elderness alimentary piece forming time increasing occurs due to involuntary processes taking place in dental-maxillar system because of ageing.

Speech-forming begins its formation from 8-10 months and finishes till 2-3 years. Oral cavity organs and neuroendocrine apparatus state is a very essential for speech-forming. Because of growth of relative weight growth for professions delt with speech activity orthopedic dentistry problems became more directed to the significance of speech-forming adequate repair and speech behaviour.

Lecture 4
Blood circulation and its regulation. Blood circulation and its regulation peculiarities in maxillar-facial region

Blood circulation and its regulation. Blood circulation main significance is organs and tissues blood supply. Blood, as it is well-known, performs its vital functions while its movement through vessels. Main force providing blood movements through vessels are heart periodic contractions.

Cardiac muscle like sceletal muscles possesses physiological features:

- excitability;
- conductance;
- contractility;
- automatism – this feature differs cardiac muscle from sceletal muscles and means the ability to be excited under impulses influences appearing in itself.

Heart muscle **excitability** is fluctuated in cardiac cycle different phases. If one put stimulus on heart in course of its contraction (systole) than cardiac muscle doesn't answer to these irritations with contraction even if their force is bigger than threshold

size because cardiac muscle is in *absolute refracteveness* phase. At the end of systole cardiac muscle excitability begins to restore – *relative refractiveness* phase. In course of this phase only superliminal (strong, higher than threshold one) stimulus can cause cardiac muscle contraction – ***extrasystole***. More durable than usually pause occurs after extrasystole – so-called ***compensatory pause.*** It appears because next impulse appears in sinus node in the absolute refracteveness period of preliminary systole. Short phase of increased excitability – *exhaltation* phase comes after relative refracteveness period. It coincides cardiac muscle relaxation beginning (dyastole). In this period heart muscle answers to subliminal stimuli (lower than threshold). After exhaltation phase excitability restoration to origin size occurs. Heart work is performed with phases changings.

Heart activity phases. Heart work beginning is ***atriums systole***. Right atrium contracts before left atrium on 0,01 sec because main pacemaker is in right atrium. Excitement spreading through heart begins from it. This phase duration is 0,1 sec. During atrium systole pressures in atriums are increased: in right – to 5-8 mm, in left – till 8-15 mm mercury col. Blood moves to atriums and it is accompanied by atrio-ventricular foramens closage. ***Ventricles systole*** takes place simultaneously (atriums are relaxed in that time). Ventricles systole duration is about 0,3 sec. Ventricles systole begins with *asynchronic contraction phase.* It lasts about 0,05 sec and is the process of excitement spreading and contraction through myocardium. Pressure in ventricles is practically constant. While further contraction when pressure in ventricles increases to the size sufficient to atrio-ventricular valves closage but insufficient to semilunar valves opening, *isometric contraction phase* occurs. Its duration is up to 0,03 sec. Sometimes these phases are united in one and are called by *tension phase* (0,05-0,08 sec). In this phase pressure in right ventricle increases up to 30-60 mm merc.col., in left one – up to 150-200 mm merc.col. Tension is increased (valves are closed) and muscular fiber length doesn't change in course of asynchronic contraction. At the end of tension phase pressure provides semilunar valves opening and ventricle systole next phase is begun – *of fast blood expulsion.* In course of this phase which lasts from 0,05 to 0,12 sec, pressure reaches its maximal ziphras. Later pressure reduces up to 20-30 and 130-140 mm merc. col. in corresponding ventricles and this moment of their work is called *slow blood expulsion.* This ventricle systole phase duration is from 0,13 to 0,20 sec. Pressure is sharply reduced with its ending. Pressure is decreased rather slower in magistral arteries that provides later clapping of semilunar valves and prevent blood regurgitation. But it occurs in the moment when *ventricle* muscle begins its relaxation and their *dyastole* takes place. Space time from ventricles relaxation beginning to semilunar valves closage is first dyastole *phase – protodyastolic*. Next dyastole phase – *tension reducing* or *isometric relaxation* takes place. It is expressed at closed valves and lasts approximately 0,05-0,08 sec from the moment when pressure in atriums is higher than in ventricles (206 mm.merc.col.) that leads to atrio-ventricular valves opening after which blood comes in ventricle. First, it occurs quickly (for 0,05 sec) – *ventricles fast filling with blood phase* and then slowly (for 0,25 sec) - *ventricles slow filling with blood phase.* Uniterrupted blood coming from magistral veins both in atriums and in ventricles

takes place at the beginning of this phase. And, finally, last phase of ventricles dyastole is their filling due to atriums systole (0,1 sec). If to sum ventricles systole and dyastole time than we will receive time corresponding to complete **cardiac cycle** which is 0,8 sec in adults. In course of heart work there is such moment when both atriums and ventricles together (simultaneously) are in dyastole state. This heart work period is called **heart pause** the duration of which is 0,4 sec.

In course of systole heart pumps in blood circulation up to 70-100 ml of blood. This blood volume is known as **systolic volume (SV).** If SV multiply on heart contraction freaquency (HFC) we will receive **minute volume (MV)** of heart work the size of which is about 4,0-5,0 l.

Heart tones. These are sound phenomena by which heart work is accompanied by. Different heart structures fluctuations (of valves, muscles, vessel wall) are on the basis of their occurence. As any fluctuations, tones are characterized by intensivity (altitude), freaquency and duration. There are 2 clinical methods of their assessment: auscultation (hearing by sthethoscope) and graphical one – phonocardiography.

I-st tone – systolic – is lower and more prolonged, it occurs in atrio-ventricular valves region simultaneously with ventricle systole beginning. Duration: 0,08-0,25 sec, freaquency – 15-150 Gz. Optimal place for auscultation: heart apex. Its reasons:

- atrio-ventricular valves closage and tension;
- heart cavity walls fluctuation in course of systole;
- ventricles musculature contraction.

II-nd tone – dyastolic – is higher and shorter. Its duration is 0,04-0,12 sec, freaquency – 500-1250 Gz. Optimal place for auscultation: second intercostal space on the right and on the left from sternum. Reason: semilunar valves fluctuation. Sometimes these fluctuations are so expressed that tone's division into two is observed.

III-rd tone – ventricular gallop – is delt with ventricles muscular wall fluctuations at their stretches right after the second tone. It is sometimes called as tone of filling. It is most often auscultated or registrated on phonocardiogram (PCG) in children and sportsmen. One can hear it as a weak, muffled sound, the most comfortable place – on heart apex (when patient is lying) and sternum region (when he is standing).

IV-th tone – atrial gallop – is connected with atriums contraction when they fill actively ventricle with blood. It is auscultated seldom, more often it is registrated on phonocardiogram.

Registration and analysis of electrical potentials occuring in course of heart activity has received the widest spreading in clinical practice.

Electrocardiogram – is a curve, periodically repeated and reflecting heart excitation process spreading in course of time. Separate ECG elements have received their special names: denses, segments, intervals and complexes. Every ECG element reflects excitation process spreading through definite heart regions and has time (in seconds) and altitude (in mV) characteristics. ECG analysis independently from

abduction (lead) is given on the bas eof denses study (P,Q,R,S,T), intervals (PQ, ST, TP, RR), segments (PQ, ST) and complexes (P – atrial and QRST – ventricular).

As cardiac cycle begins with atriums excitation the first dens on ECG – is ***dens P.*** It characterizes atriums excitement. Its ascendant part – of right, descendant - of left one. Its characteristics under norma: duration - from 0,07 to 0,11 sec, altitude - from 0,12 till 0,16 mV. It may be absent in III-rd standard lead (abduction), two-phased or negative. In V_1-V_2 - it is positive, V_3-V_4 - it is gradually increased. In one-poled abductions form extremities: aVR – it is negative, in aVL and aVF – positive.

Segment PQ – is a right line section on isoelectric axis from dens P end to dens Q beginning. It characterizes atrio-ventricular lack time and is about 0,04-0,1 sec.

Interval PQ - ECG locus from dens P beginning till dens Q beginning, it characterizes excitement distribution from atriums to ventricles. Its duration is 0,12-0,21 sec.

Dens Q – characterizes interventricular septum and papillar musculature excitement. Its duration under norma is from 0,02 till 0,03 sec, altitude – up to 0,1 mV. It may be absent in the I.

Dens R – characterizes main ventricles musculature excitement. Its altitude is 0,8-0,16 mV, duration – 0,02-0,07 sec. In thoracic abductions V_1-V_2 it is small, V_3-V_4 - it is increased, in V_5-V_6 it is reduced again.

Dens S – describes excitement in distant ventricles locuses. Its altitude reaches up to 0,01 mV and duration – up to 0,02-0,03 sec. It may be absent in I. In V_1-V_2 it is deep, then it is decreased, in V_5-V_6 it may be absent.

Segment ST - is a right line section on isoelectric axis from dens S end till dens T beginning and describes the moment when both ventricles are simultaneously excited. Its duration is from 0,1 till 0,15 sec.

Dens T – describes myocardium repolarization process, it altitude is 0,4-0,8 mV, duration – 0,1-0,25 sec. In I it is always positive, in II - often positive and in III – may be positive, two-phased and negative. In V_1-V_2 it is negative sometimes, in aVF – usually negative.

Interval TP – characterizes common heart pause, its duration is 0,4 sec.

Interval R-R – characterizes complete cardiac cycle, its duration is 0,8 sec.

Complex P – atrial.

Complex QRST – ventricular.

As heart excitation begins from its base, than this region is a negative pole, apex region – positive one. Heart electromoving force (EMF) has its size and direction. EMF direction is considered to call ***heart electrical axis.*** In the most common cases it is located in parallel to heart anatomical axis (*normogram*). Direction of one or another dens on ECG reflects an integral vector direction. When vector is directed to heart apex, one can registrate positive (as for electrical axis) denses, if to the heart base - negative. Due to definite heart location in thorax and human body shape, electrical force lines occuring between excited and unexcited heart locus, are distributed unequally on body

surface. If heart axis becomes horizontal (lying heart) than such situation is called *left-gram*, in a case of its vertical localization (hanging heart) – *right-gram.*

Blood circulation system work regulation.

Heart-vascular regulative center – is a rather complicated structure in which dominant importance has its "working" part, located in medulla oblongata. It was there where neurons are located from which excitement are transmitted on effector ways (parasympathetic and sympathetic) while reaching heart and vessels. That's why their reflectory regulation is always performed simultaneously. When **sympathetic nervous system tone is dominant (hypersympaticotony)** than heart activity is increased:

- its contraction freaquency is rised up – ***positive chronotropic effect;***
- contraction force is increased – ***positive inotropic effect;***
- excitability is increased – ***positive bathmotropic effect;***
- conductance is rised up- ***positive dromotropic effect;***
- tone is increased – ***positive tonotropic effect.***

At **hyperparasympatheticotony** – on the contrary, all mentioned effects will be negative.

Vascular tone will be changed too: in the first case – to increase, in the second – to decrease. It will influence on size of their filling with blood and arterial pressure.

"Working" part of heart-vascular regulation center consists of **2 parts**:

- *pressor* – its irritation causes vasoconstriction;
- *depressor* – its irritation causes vasodilatation.

These parts of "working" center receives the information from different receptor groups located in heart, vessels and out of blood circulation system.

That's why while characterizing blood circulation system **reflectory regulative mechanism** one can differentiate 2 reflexes types: proper and conjugated.

Proper reflexes – are such acts occuring in the structures of a given system and realizing in it. Such receptive zones in blood circulation system are vascular *presso-* and chemoreceptive zones. Special place in this reflectory group has sino-carotid zone. Reflectory act from carotid zone pressoreceptors is called as *sino-carotid reflex (Chermak's reflex).* This reflectory act is performed at blood pressure increasing in a given zone. Pressoreceptors irritation leads to nervous impuls occurence, further coming through sino-carotid nerve in medulla oblongata where it passes on vessel-motor depressor part. From depressor part information is switched to sympathetic nervous system through inhibiting reticular neurons and through exciting reticular neuron – to parasympathetic part of this system and through efferent fibres - to heart and vessels smooth muscles. As the result of parasympathetic nervous system tone predominance both heart and vessels work is decreased (heart contractions freaquency and force, systolic volume size, blood pressure are decreased).

Another blood circulation system proper reflex type are *chemoreflexes* from same vessels zones. They answer to blood chemical content change, for example, CO_2 excess in blood. Reflectory arch of such reflex is a very similar to sino-carotid reflex reflectory

arch but information comes to pressor part of heart-vascular regulation center. Then information through exciting reticular neurons come to synaptic, through inhibiting – to parasympathetic part of autonomic nervous system. Result: hypersympatheticotony and further heart activity enforcement and vascular tone increasing (heart contractions freaquency and force, systolic volume size, blood pressure are increased). CO_2 is more effectively removed from organism due to such mechanism.

Conjugated reflexes – reflectory acts that are originated from different receptive groups located out of blood system boundaries. As it is known, there are many such zones in organism but according to receptors classification one can differentiate 3 types of such reflexes:

1) *Proprioreceptive* – are originated from supporting-moving apparatus receptors for instance in course of physical activity. From theses receptors (they are localized in muscles, tendons, ligaments) the information occuring in them comes to heart-vascular regulation center pressor part that leads to heart and vessels activity enforcement (see above the mechanism). Pulse freaquency and blood pressure increasing in course of physical training is explained by this (probe with physical activity).

Reflexes of localization are too closely to these reflexes. One of them is known as orthostatic probe: one determine puls freaquency and blood pressure in investigated person while his lying on the bed. Then the investigated person must be gradually putted into vertical state and the measurements are repeated. Under norma these indexes are increased in course of orthostatic probe. The explanation: information flow from proprioreceptors (while someone's staying muscles, joints, ligaments are tensed) is increased in spine. Then information goes to medulla oblongata, to pressor part of heart-vascular regulation center. Clinosthatic probe is the directly opposing to the previous probe: the investigated person is gradually putted from vertical to horizontal status. The information from proprioreceptors is significantly decreased and depressor part of regulative center became dominant that leads to puls and pressure reducing.

2) *Interoreceptive* – are connected with different inner organs activity. Everyone knows very well that heart and vessels activity is always changed in course of respiration, digestion, excretion changings. For example, if one presses on epigastrial region (epigastrial reflex) it's accompanied by vessels hypotony, blood pressure and heart freaquency reducing. Mechanism: at peritoneum receptors irritation (that occurs at pressure to epigastral region) information finally reaches depressor center and then heart, vessels leading to their function decreasing or even stoppage. That's why fights are so dangerous because they may be accompanied by shocks to epigastrial region and in the most horrible cases even to instant (moment) death.

3) *Extero-receptive* conjugated reflexes are multiple nervous acts group occuring at the irritation of body surface and mucosae separate receptive fields. Example: ocular-heart reflex (Danini-Ashner's reflex): at pressure to eyeballs information comes to depressor centre. Result: heart contraction freaquency and blood pressure decreasing.

4) One knows very well vascular reactions to warmth (dilatation), colness (constriction), pain (moderate pain leads to vasodilatation, strong – to constriction), touching

(especially of lovely person). Due to separate points irritation (acupuncture points) on skin surface one can achieve definite success in heart activity and vessels tone regulation that is widely used in clinical practice particularly in facial-maxillary region (at neurites, myosites, myalgias et al.).

Humoral-chemical regulation

of heart and vessels activity is determined by hormones, mediators and different chemical substances (metabolites) action.

Substances increasing heart and vessels activity:

Hormones:

- adrenaline;
- noradrenaline;
- vasopressine;
- thyroxine;
- insuline;
- renine et al.

Mediators:

- noradrenaline;
- serotonine and others.

Metabolites:

- calcium excess;
- oxygen excess.

Substances decreasing heart and vessels activity:

- acethylcholine;
- hystamine;
- many prostaglandines (f.ex. prostacycline);
- acids (lactic et al.);
- CO_2 surplus (excess).

Acid products (lactic acid, CO_2) accumulating in course of physical activity decrease tone of working muscles blood vessels increasing blood supply to them. At this time magistral vessels are in increased tone due to adrenaline and noradrenaline concentration increasing in answer to load. Such tone redistribution in different vessels of blood circulation system provides high reliability of a given system functionning.

Thus, we see that heart-vascular activity regulation is a complicated process in what both reflectory (conditioned and unconditioned) and humoral-chemical mechanisms take part.

How and in what sequence these mechanisms are switched on under physiological conditions for instance in course of physical work? At this activity type increased oxygen consumption and enforced carbon dioxide releasing occurs. It may be achieved due to increased activity not only of respiration system but also blood circulation apparatus. Describe the consequence of switching of all these regulatory mechanisms on. At the early beginning, in the period of preparation to work the blood circulation

system activity is increased by means of 2 mechanisms: conditioned-reflectory and humoral. Conditioned-reflectory – the situation itself before physical activity (sportsmen before running) is conditioned stimuli complex (in example with sportsman these are running way, stadium, spectators, referees and so on) which will cause the changes from the side of heart and vessels. Emotional load at this is a reason of enforced adrenaline releasing from suprarenal glands. The result of this is more expressed increasing of heart and vessels activity. Organism prepares given (cardiac-vascular) system to future wok in such a way.

In course of performing of physical activity itself conjugated reflexes from proprioreceptors, proper reflexes from chemoreceptors (metabolism products accumulation and first of all CO_2) are involved into regulation and hormones (adrenaline, vasopressine et al.) continue to be released. All these factors encourage further heart and vessels activity increasing. At the same time in working organs (muscles) acid products are accumulated, decreasing vessels tone in these organs and blood fills them in more extent providing feeding and removal of metabolism exchange.

After physical activity performing everything came ito its initial level due to involvement ito the work proper receptors from pressoreceptors directed to heart and vessels activity restriction (restoration).

Blood circulation and its regulation peculiarities in maxillar-facial region.

Blood circulation in dental pulp occurs inside its cavity having the walls. Puls fluctuations of blood volume in closed cavity were to cause tissular pressure increasing and as a result physiological processes in pulp disorders. But it doesn't occur due to arterial volume pulsal fluctuation transmission to veins. Pulp vascular net possesses effective antistagnational features. Sum crown's pulp veins space is more than in apical foramen region that's why circulation linear velocity in root apical foramen region is higher than in pulp. Veins puls fluctuations are the similar to brain veins fluctuations. Pulpal abducting venous vessels anastomosize with periodontal veins and such rich anastomozes net with periodontal veins increases blood circulation system opportunities in pulp.

Blood circulation regulation of this region is performed by nervous, humoral and myogenic mechanism. *Nervous mechanism:* tonic impulsation comes to these vessels from vascular-motor center through nervous fibres coming from superior cervical sympathetical node. Vasoconstricting reactions into maxillar-facial region and dental pulp are determined by noradrenaline releasing in sympathetical nervous fibre that acts through vascular walls alfa-adrenoreceptors. If it acts to beta-adrenoreceptors – vessels are dilated.

Maxillar-facial region and oral cavity organs vascular space may be also changed under influence of *humoral factor:* hormones (adrenaline and others), cellular metabolism products and electrolites.

Finally, there is a proper vascular tone regulation *myogenic mechanism* in this blood circulation region. Muscular type vessels (arterioles and precapillar sphincters) hypertony leads to functionning capillaries amount decreasing that in turn prevents

intravascular blood pressure increasing and enforced liquid filtration in tissues, i.e. it serves as tissues physiological protection from oedema development. This myogenic blood circulation regulative mechanism plays important role in dental pulp acvtivity providing. Such mechanism is essential for pulp located in closed space and limited by dental cavity walls for microcirculation regulation under norma and pathology for instance at pulp inflammation (pulpitis). Weakness of this vascular myogenic tone mechanism is one of factors for oedema development in pulp, parodont and other oral cavity tissues. Myogenic vascular tone is significantly decreased at functional loads to tissues that leads to regional blood supply increasing and "working hyperaemia" development. At parodontosis, when parodontal tissues blood supply is disturbed, functional loadings decreasing microvessels myogenic tone (for instance, mastication) may be used for medical and preventive aims to parodont trophyes improvement. It has essential importance because vascular tone functional changes play dominant role in course of parodontosis development.

Humoral action to circulation in oral cavity may give many drugs absorbing there.

Any dentist should remember that oral cavity is a powerful reflexogenic zone afferent impulsation from which can change heart activity and vascular tone and that's why doctor shoud apply sparing manipulations there. Any dental manipulation is a complicated emotional-painful factor. Practically all people afraid such manipulations. Such nocecoceptive factor may influence on heart-vascular system state. And such influence may be sometimes even more significant than medical procedure itself. It is especially actual for patients with heart-vascular diseases for instance suffering from hypertonic disease. These patients have expressed haemodynamic changings at dental influencing, in course of its waiting. Sometimes it is accompanied by crisis, giddiness, faint as the result of brain circulation disorders. Special place have nocecoceptive irritations causing significant changings in blood circulation system. Such disorders may vary dependently from painful syndrom intensivity and organism reactiveness. One patients have tachycardia (as a rule, at hypersympathicotony), others – bradycardia (as a rule, at hyperparasympathicotony) as answer reaction to manipulation. Even such process as tooth preparing (in course of orthopedic treatment) is healthy people may cause changes connected to organism individual features. All these must take into account dentist in his daily job.

Rheography is widely used for functional assessment of maxillar-facial region vessels functional state in dentistry. ***Rheodentography*** is a method of pulp haemodynamics assessment; ***rheoparadontography*** – of parodont haemodynamics.

Lection 5
Blood and its defence functions. Oral cavity role in the blood defence function regulation.

Blood is the body's principal extracellular fluid, ensuring the various physiological functions. As the humoral link blood participates in all organism constants stabilizing and provides **homeostasis** – the constant state of its inner medium. Blood is

characterized by presence of a great variety of fixed qualitative features – **constants**. There are two principal groups of such constants: flexible and solid ones. **Flexible constants** may vary in wide ranges not leading to the serious changes of life activity. These constants include circulating blood volume, formed elements number, plasma and formed elements correlation (haematocrit), haemoglobin concentration, specific weight, blood viscosity, blood sedimentation velocity (BSV). **Solid constants** include such ones the deviation of which even in small amounts leads to life activity down-regulation. This constants group contains ion blood composition, pH, osmotic pressure, protein plasma composition etc.

Circulating blood, haematopoiesis organs, blood destruction organs and regulation organs belong to **blood system**.

Main blood functions are: the transport, the defense, the regulative ones. **Transport blood function** – ensures nutrition and respiration. Dring its course through the tissue capillaries blood delivers nutrients from the small intesatine and oxygen from the lungs to the cells. It also removes the toxic waste products of cellular metabolism (metabolites), such as urea and carbon dioxide, from the tissue environment and eliminates them as it circulates through the kidneys and lungs respectively. **Defense blood function** – the immunity, the phagocytosis, the complement system, the haemostasis, the fibrinolysis, the antioxidative and some others. **Regulative blood function** includes the participating in the humoral (the hormones, the mediators and other bioactive substances) and in the physio-chemical regulation (the temperature, the osmotic pressure, the acid-alkaline balance and etc.).

Some defense blood reactions are connected with the erythrocytes. They produce the antitoxins, take part in blood coagulation and fibrinolysis either.

The main white blood cell function is to participate in defense organism reactions against foreign agents. There exist the natural (nonspecific) and specific defence forms.

The nonspecific defence is directed to eliminating any foreign agent. The phagocytosis, the complement system and others humoral defense factors are the main types of such reactions. **Phagocytosis** consists of engulfing the microbes and cells via the formation of the pseudopods followed by endocytosis of the phagocytic vesicle. Next, the endocytotic vesicle is incorporated into the lysosomes of the phagocytes where the microbes and cells are digested by lysosomal enzymes. This phenomenon is adequate the neutrophiles, monocytes, eosinophiles, macrophages and thrombocytes. In the course of the phagocytosis process we differentiate such stages as the phagocyte approaching to the phagocytized object (or ligand), the ligand contact with the phagocyte membrane, the ligand engulfing, digestion and destruction of the phagocytized object. The phagocytes find their way to the site of injury by chemotaxis or similar guiding mechanisms.

Complement system -is a special enzyme system consisting of the proteins (more than 20 types). In includes 9 components (C1…C9). During the activation process some of its components are cleaved in the fragments influencing directly the course of specific and nonspecific defense reactions. There exist the classical and alternative ways

of complement system activation. The destruction of foreign and old cells, the phagocytosis and the immune reactions course activates, the vessel wall permeability increases, the blood coagulation fastens at the complement system activation that influence the pathological process.

The other humoral defense factors – defense reactions connected with the action of such substances as lysozyme and interferon. **Lysozyme** as a protein possesses the enzyme activity suppressing the growth and the development of causative agents and destroying some of the microorganisms. It can be found in nasal mucosa, intestines, salivary secret, lacrimal fluid etc. In small amounts one can find it in the granules of polymorphonuclear leukocytes, in macrophages and when destroyed they fall into the extracellular fluid. **Interferon** as the globulin of blood plasma can be located in the lymphocytes providing antiviral defense and delaying the cancer cell growth.

Specific defense – immunity – is a reaction complex directed to maintaining the homeostasis on meeting the host's body with the antigens which are considered as foreign (despite their forming in the organism itself or if they come into it from outside). Under the action of antigen the host body forms the antibodies, activates lymphocytes and thus they get the ability to participate in the immune response. This antigen ability to cause the specific immune response is due to the presence of multiple determinants on its molecule. The active centers of forming antibodies specifically correspond to the determinants like the key to the lock. The antigen interacting with its corresponding antigen forms the immune complex.

The immune organs are devided into central (thymus, bursa of Fabricius, bone marrow) and the peripheral (lymphatical nodes, spleen etc.). There are two categories of acquired immune responces – humoral or antibody-mediated and cell-mediated.

In addition to the above mentioned information we can say that not only the nervous and humoral regulation of various organism functions but the immunological one exist in the human body. Thus, the lymphokines and monokines secreted by the lymphocytes, the monocytes and the macrophages are capable of changing the central nervous system, the heart, the vessels, the respiratory and digestive organs action. As for the interleukines they are involved in all the physiological body reactions. The immune system itself is not only the defense system (especially the antiinfectious) but the important regulative system too. Functionally it is tied with both nervous and the endocrine organism system. Such an approach to functioning of this system not only extends our data about its activity but permits to outline the new therapy ways of acquired and hereditary disorders.

The defence blood function is closely associated with the platelets (thrombocytes). They have the phagocyte activity, contain the immunoglobulins, are the source of the lysozyme and cytokines, necessary for the reparation processes. But one of their major functions is to participate in the haemostasis.

Because blood flows continuously in the vascular bed, it is prone to leave the body quickly whenever there is either an external or internal injury to the tissues.

The vital importance of blood to tissue survival has produced a variety of preventive and defensive mechanisms aimed at minimizing blood loss during injury.

Haemostasis – is the reactions complex aimed at the blood loss stoppage. In fact the significance of haemostasis system is much more complicated and far exceds the limits of fighting with blood loss.

The main tasks of the haemostasis are the following: the fluid blood state storage, the transcapillary exchange, the vessel wall resistence regulation and the influence the reparation processes and so on.

They distinguish the vessel-platelet haemostasis and blood coagulation (clotting). Speaking about the first case the question is about the blood loss stoppage from the small vessels with low blood pressure; the second one is connected with the blood loss fighting at the arteries and veins rupture. Such division is rather conditional as both at small and large vessels rupture along with the thrombocyte plug forming the blood coagulation is occured. On the other hand such a division is very suitable for clinical practice because at the vessel-platelet haemostasis disorders the finger skin puncture (or the ear lobe) is accompanied by prolonged coagulation time whereas the bleeding time remains normal (for example at haemophilia because of normal platelet count in hemophiliac). Haemophilia is a wide-spread hereditary pathological state. It is the excessive bleeding caused by a congenital lack of a substance (plasma coagulation factor VIII, IX, X or XI) necessary for blood clotting. Treatment consists of administration of the deficient factor.

Vessel-platelet haemostasis comes to the platelet plug (or thrombus) forming. Conditionally it is devided into three stages. The first stage is **temporary (primary and secondary) vasoconstriction** - immediately in a few seconds after the injury the primary vasoconstriction occurs due to it the bleeding at the first moment may not happen or bears the limited character. It is caused by the adrenaline or norepinephrine releasing in response to the pain irritation and lasts for about 10-15 sec. Futher, the secondary vasoconstriction occurs because of the platelet activation and the releasing from them in a blood the vasoactive substances - serotonine, adrenaline, thromboxanes.

The second stage is the **platelet plug forming** because of the **adhesion** (the binding to the foreign surface) and the **aggregation** (clumping of the platelets). The adhesion takes place immediately after the injury to the collagen and other adhesion subendothelium proteins. It occurs because of the glycoproteins action by means of which the platelets clump to the collagen fibres and by means of the Willebrand factor as well that using one of its active centers is bound up to the platelet receptor and the other of its receptors to the collagen or subendothelium. From the adhesive platelets and the injured endothelium as well the ADP (adenosine diphosphate) is released, which is one of the major factors of platelet aggregation. Under the unfluence of ADP the platelets clump, so forming the aggregates. This reaction increasing is due to the platelet activation factor (PAF), thrombin and adrenaline. On this stage the aggregation is **reversible** and the **desaggregation** may happen. To complete the platelet plug forming a number of additional mechanisms (they mainly are associated with the platelets) are

required. When the sygnal comes into the platelets the calcium content increases in them and the phospholipase A2 activation occurs. The latter one leads to the arachidonic acid releasing from the platelets membranes that further converts into the very active prostaglandines and thromboxanes. When removing from the platelets they make the aggregation **irreversible.** As a result the platelet plug or thrombus is formed. But at first it is capable of passing the blood as it is loose. After releasing the actomyosine (thrombostenine) from the platelets during their aggregation the platelet plug is shortened and reinforced. This is the third stage of the vessel-platelet haemostasis – the **platelet plug retraction**.

Under the normal condition the blood loss stoppage from small vessels lasts from 2 to 4 minutes. Such index in the clinic is known as the **bleeding time.**

The arachidonic acid derivates – prostacyclin and thromboxane A2 - play a very important role in the vessel-platelet haemostasis regulation. Prostacyclin is produced by endotheliocytes under the enzyme prostacyclinsynthetase influence. Under the physiological conditions prostacyclin predominates over thromboxane – powerful platelet proaggregant. At any endothelium injury in the trauma place the prostacyclin producing disturbs and the thromboxane action begins to predominate. Thus, the favourable conditions for the platelet aggregation emerge. Some vitamins (A,C,E) and foods (onion, garlic) are the platelet aggregation inhibitors.

Blood coagulation is an enzyme process where both the plasmic and the cell factors participate. Most of the haemocoagulation plasma factors are the proenzymes and their activation occurs due to the limited protheolysis and is accompanied by the peptide inhibitors cleavage. They are designated with the Roman figures. There are 13 such factors in plasma.

The platelets have an important role in a blood coagulation process. They contain a lot of (more than 30) different substances which deal with the haemostasis process. Some of them (according to the various literature scientific sources from 5 to 15) are called the **platelet (thrombocyte) coagulation factors** that are designated the Ciphers.

In the erythrocytes one can found a number of substances like the platelet ones. They are known as the **erythrocyte blood coagulation factors.** They have no figure designation. The leukocytes have the coagulation factors called **leukocyte factors.** For example, monocytes and macrophages upon antigen stimulating synthesize the protein thromboplastine part namely apoprotein III (tissue factor).

Tisue factors the main component of which is thromboplastine play a significant role in a blood coagulation. Thromboplastine or tissue factor consists of the protein part apoprotein III and the phospholipid complex and it is often considered to be a cell membrane fragment. Upon the tissue destruction or endothelium stimulation by means of proinflammatory cytokines or endotoxin the tissue factor can be released in a blood circulation. In various blood circulation regions in the vessels its content differs (e.g. in veins and arteries, lower or upper extremities, on the right or on the left in ones of the same name).

The blood coagulation process may be divided into 3 phases. The first one includes the complex of consequent reactions leading to the **prothrombinase forming**. The prothrombinase forming can be realized via two ways: extrinsic (from injured tissue) or intrinsic (from blood). The **extrinsic way** of the prothrombinase forming provides the obligatory presence of the thromboplastine (or Factor III, tissue factor). The prothrombinase forming via the extrinsic way begins with the factor VII activation by the interaction with the thromboplastine. In its turn, the factor VII transforms the factor X into the active state. Futher the factor Xa activates the factor V. The factors III+IV+ Xa +Va form the complex compound named the prothrombinase. Via the extrinsic way the prothrombinase is synthesized very quickly (it takes the seconds!).

The factor XII (the contact factor) is an important initiator of the **intrinsic** prothrombinase forming **way.** The kallikrein and high – molecular kininogen (HMK) are the participants of this reaction. The contact factor is activated by any injured surface, skin, the collagen, the adrenaline and transforms the factor XI in its active state. The XIa influences directly the factor IX, transforming it into the factor IXa. Its specific activity is directed to the factor X protheolysis (converting it into its active form) and occurs on the platelet phospholipid surface at the necessary factor VIII participating. The whole factor complex on the phospholipid platelet surface received its name as the **thenase** (the **thenase complex**). As it was mentioned above, the kallikrein and high – molecular kininogen (HMK) are the participants in a blood coagulation process by means of which the extrinsic and intrinsic ways combination takes place. The intrinsic pathway is more prolonged in time (up to 5-6 minutes) as it is accomplished with a great number of different blood coagulation factors. It is also implemented without vessel wall injuring (e.g. at the adrenaline concentration increasing that activates the factor XII).

The second phase of blood coagulation is a **transition of prothrombine to thrombine** which is performed by the prothrombinase. It is a protheolytic prothrombine cleavage resulting in the enzyme thrombine presence. This enzyme possesses the coagulative activity. It takes only several seconds.

The third phase of blood coagulation is a **fibrinogen transition to fibrin**. At first under the influence of the thrombine two fibrinopeptides A and two fibrinopeptides B are released. As a result of it the fibrin-monomer is formed. Futher, the soluble fibrin is formed due to the polimerization process. But because of the XIII factor (fibrinase) activation its transition into the insoluble fibrin (fibrin-polymer) is taking place. Next, this fibrin plug is reinforced thanks to the platelets action (they release the protein thrombosthenin). This process is known as a **retraction**. The plug in its turn is named a clot. The fibrin net becomes gradually tight. That's why the clot causes the vessel occlusion and the bleeding is ceased.

Inspite of circulation there are all necessary factors for the clot forming. Under physiological conditions in presence of uninjured vessels a blood remains fluid. It's determined by the presence of components, preventing the blood coagulation (**anticoagulants**) in the circulation. Besides, a blood is kept fluid because of the haemostatic system **fibrinolytic components** in it.

The natural anticoagulants are devided into primary and secondary ones. The **primary** anticoagulants are such substances that are constantly present in the circulation. They may be of three groups: antithromboplastines, antithrombines and fibrin forming inhibitors. Otherwise, all these anticoagulants are the substances that act depending on the blood coagulation process stage.

The substances preventing the prothrombinase forming are the **antithromboplastines** (they are secreted by the vessel wall endothelium, their content in veins is larger than in arteries), vitamin K-dependent protein C (inhibits the factors V, VIII), protein S, the endothelium protein – thrombomodullin, the placenta anticoagulant protein and others.

The substances inhibiting thrombine action are **antithrombines**. They are of different groups but the most important of them are: antithrombin III and heparin. **Antithrombin III** – is a prothein of a globulin origin that is formed in liver, kidneys, spleen, lungs and blood vessels as well. Its content reduces with the age, its concentration is less in women as compared with men (NB! Women have the thrombophlebitis and phlebothromboses more often than men), its content in pregnants gets smaller. Its content is smaller in human beings with the II(A) blood group and the people eating fat food (particularly of animal origin). Its activity decreases at the diseases of those organs where it is formed. Antithrombine III is a heparin cofactor. Besides, it inhibits up to 70 per cent of thrombine occuring in blood as well as the factors IXa, Xa, XIa, XIIa. There are cases of its hereditary insufficiency.

Heparin – is also an antithrombine. It is a polysaccharide transforming antithrombine III in anticoagulant of immediate action thus increasing its activity. In absence of antithrombine III heparin possesses a weak anticoagulant activity. Moreover, heparin without antithrombine III doesn't prevent the external prothrombinase forming way. So, heparin effect may be very weak as a result of antithrombine level decreasing in patients' blood that it's necessary to take into account at its administration. Heparin also forms the complex combinations with thrombogenic protheins and hormones which finally possess anticoagulant and fibrinolytic features. Heparin influences the thrombocyte aggregation, has antiviral action and antiinflammatory properties as well. In blood heparin can be found in basophiles, in vessels – in mast cells. It it degenerated by the heparinase enzyme in liver.

Secondary anticoagulants – are the "worked-off" blood coagulation factors (that participated in blood coagulation process) and degradation fibrin and fibrinogen products or derivates (PDF) having antiaggregative and anticoagulative action. The secondary anticoagulants role comes to limiting of intravascular blood coagulation and thrombus dissemination via vessels.

At various diseases there may appear the pathological anticoagulants dealing with different immunoglobuline classes and inactivating separate blood coagulation factors.

Fibrinolysis – is an integral part of haemostasis system. It always accompanies the process of blood coagulation and even is activated by the same factors (XIIa,

kallylrein, HMK and others). Being the important defence reaction it prevents the occlusion of blood vessels by fibrin clots and leads to the vessel recanalization after the bleeding stoppage. The fibrinolysis components play key role in removing of extracellular matrix. Besides, they regulate the growth and the division of cells, the reparation of wounds, the regeneration of muscles, the growth and metastasis of tumors etc.

The main enzyme destroying the fibrin is **plasmin** (sometimes it is called fibrinolysin), that in a circulation is in non-active state as proenzyme **plasminogen.** Under the influence of the activators there occurs the cleavage of peptide junctions of plasminogen that leads to in it's turn to plasmin forming. Plasminogen may be found not only in plasma and in serum but in other types of liquids (sperm, follicules, saliva), in tissues and leukocytes either. This is a prothein of a globulin origin the biosynthesis of which is performed in a bone-marrow.

To transform into plasmin plasminogen needs to be activated. **Plasminogen activators** - are contained first of all in tissues (vessel wall). **Tissue plasminogen activator (TPA)** – is mainly formed in vessel wall endothelium. **Urokinase** as plasminogen activator is produced in kidneys (juxtaglomerular apparatus), in fibroblastes, epitheliocytes, pneumocytes, placenta, endotheliocytes either. There are also plasminogen actovators in erythrocytes, thrombocytes and leukocytes.

Except plasminogen activators there exist the fibrinolysis inhibitors in plasma.

Fibrinolytic blood activity is greatly determined by the correlation between the fibrinolysis activators and inhibitors.

Fibrinolysis like the blood coagulation process is performed in three phases. The first phase, the forming and secreting of plasminogen activators may occur in extrinsic and intrinsic ways. The **extrinsic way** of plasminogen activation is due to the TAP, urokinase and some others. The **intrinsic way** of plasminogen activation is divided into **Hageman-dependent and Hageman-independent.** The first of them takes place under the influence of the XIIa, kallylrein and HMK factors that transform plasminogen into plasmin. Hageman-dependent fibrinolysis is accomplished very fast and bares urgent character. Its main designation cimes to the circulation clearence from fibrin clots forming in course of disseminated intravascular blood coagulation process. The second one can be realized under the influence of proteins "C" and "S".

In the second fibrinolysis stage under the action of the activators mentioned above plasminogen transforms into plasmin. Finally, in the third stage, plasmin effects on fibrin. As a result at first the early (high-molecular) and then the late (low-molecular) **fibrin degradation products or derivates (PDF)** appear. The early PDF influence the platelet aggregation and blood coagulation thus increasing them. The late PDF are characterized by the anticoagulant features and effort the fibrinolysis reaction.

The oral cavity role in the defence blood functions regulation. Pathological conditions in different regions of oral cavity in particular often oral mucosa are the primary signs of haemopoietic system injury that makes the patients consult the **dentist**.

While examining such patients the dentist must pay attention to the oral mucosa colour, gingivae, tongue, tonsils condition. On the mucosa may happen multiplied and different-sized haemorrhagies. Such signs are non-specific because they are not the distinguishing features of separate blood diseases but they point out to the latent pathological process in human organism. In these cases the clinic examination of dental patients required additional laboratory investigations among which the clinic-physiological blood analysis is of great importance. Such knowledge will help to determine the volume and the type of permitted and necessary doctors' interfearence at the treatment of any dental patient.

What role does the oral cavity play in a regulation of blood protective functions? The special value in an oral cavity protective functions have the antibodies. There is a secretory immunoglobulin "A" (SigA) in an oral liquid. Its contents in a saliva is much higher than in serum. It is synthesized locally by plasma cells formed from B - lymphocytes, mainly, in a submucosal layer. It interferes with antigenes introduction, has antibacterial and virusneutralizing activity. The persons with defect of the given immunoglobulin have often inflammatory diseases of an oral cavity. In a saliva there are the components of a complement (C3, C4), playing the important role in the phagocytosis reactions and also stimulating the cell and humoral immunity reactions. They get in a saliva from circulation through odontogingival sulcus.

Phagocytosis also plays an important role in an oral cavity. For one day from a gingival blood 1/80 of all blood leucocytes is allocated in an oral cavity. At inflammations this digit is enlarged at 2-10 times. There is a leukocytic formula of a saliva. 95-97 % of it make neutrophils, 1-2 % - lymphocytes and 2-3 % - monocytes.

The oral mucosal epithelium serves as a barrier on the way of any antigenes penetration, including cancerogenes. The appreciable amount of neutrophils, and also monocytes is located under an epithelium, through which they migrate from the vessels of an own plate in a gingival sulcus break. Neutrophils migration velocity makes 30 000 in 1 minute. In oral mucosal epithelium one can find out T-lymphocytes and B-lymphocytes. An important role in maintenance of oral mucosal epithelium barrier function play Langerhans' cells, amounting about 2 % of cell population. They, mainly, are in a status of constant movement, that facilitates a meeting with an antigene. There are dendrite antigene-presenting cells, epitheliocytes and others in oral mucosal epithelium.

The oral cavity plays an important role in haemostasis regulation as well. Saliva contains a substance resembling of a tissue thromboplastin properties. It contains in a great number especially in the mixed saliva containing blood cell and desquamated epithelium. However, parotid saliva, as well as centrifugated and released from cells oral liquid, also contains a tissue thromboplastin. Besides there is in a saliva an incomplete thromboplastin representing the complex of negatively charged phospholipids (cell membranes breaks). In a saliva in a small concentration one can found almost all blood coagulation factors containing in a blood plasma, and also the fibrinolytic system components are found out there. The postponed stabilized fibrin (for example, in a removed tooth alveola) is a matrix for development of a connective tissue, that promotes

the reparative processes and fast healing up of wounds in an oral cavity. Fast fibrinous clots formation interferes with an infection hit into the depth of an oral cavity wound.

In parotid and mixed saliva composition plasminogen and plasmin are absent, but there are plasminogen activator and proactivator. On its properties the plasminogen activator reminds of tissue activator. It is quite possible, that it gets in a saliva due to a diffusion from a blood. Besides the desquamated cells and leucocytes, being destructed, allocate trypsin-like and other proteases capable to lyse a fibrin. The fibrinolytic agents result in a vessels recanalization, that is accompanied by circulation restoration in an injured oral cavity. At the same time, the fibrinolytic agents presence in a saliva can render negative action as well. Quite often after odontectomy operation alveolar bleeding arise because of fast dissolution of a fibrinous clot. It is promoted by a stress experienced by many patients at the reference to dentist. The similar picture can arise also at operative measures in an oral cavity, at mandible fractures, gingival fissure liquidation and others. The fibrinolysis inhibitors local application in course of them promotes not only fast bleeding stoppage, but also leds to earlier operational wounds heat.

It's necessary to remember, that at serious operative measures in oral cavity and soft face tissues **disseminative intravascular coagulation (DIC) or DIC-syndrom** can arise. Under these conditions the fibrinolysis inhibitors adsorption can considerably complicate its current.

Lecture 6
Respiration physiology. Oral cavity importance for speech respiration and speech-forming

Respiration is vitally essential for human beings and animals life. **Respiration** is gas exchange between organism external and internal environment. This process is performed in several **stages:**

1) *External or lung respiration* – performs gas exchange between organism external and internal environment (between air and blood).
2) *Gas transition and transfer* – is performed due to alveoles permeability and blood transport function.
3) *Internal or tissular respiration* – performs directly cellular oxidation process.

External respiration – is performed with cycles change, one respiratory act consists of inspiration and expiration phases. As a rule, inspiration is shorter than expiration. ***Inspiration act:*** thorax volume increases in 3 directions – vertical, sagittal and frontal. Why? There are some reasons:

Diaphragm contraction (if diaphragm in rest state is shifted on 1 cm it leads to thorax increasing on 200-300 ml of air). Result of diaphragm contraction: decreasing (flattening) of its cupula; visceral organs (in abdominal cavity) pushing down, throrax increasing in vertical direction.

- Contraction of external oblique intercostal and intercartillaginous muscles: they are fixed to above-lied rib near spinal cord, to below-lied rib – near sternum. Result: throrax volume increasing in sagittal and frontal directions. Ribs are putted forward, up and towards. And it supports such lungs localization change.
- As lungs are connected with thorax through pleura visceral and parietal layers then lungs volume increasing occurs after thorax volume rising up. It leads to pressure decreasing in them. Pressure becomes lower than atmospheric one, air comes into lungs. Thus, negative pressure is third reason (factor).
- This negative pressure increases in course of inspiration because at lungs stretching their elastic draft - force with which lung strives for compression - is increased. Elastic draft is explained by 2 factors: there are many elastic fibres in alveoles walls - the first one – and the existance of surface tension of liquid tunic containing surfactants and covering alveole wall internal surface – the second one. Elastic draft (the 4-th factor of inspiration) is increased in course of inspiration, negative pressure is rised up in pleural cavity that encourages inspiration act.

Thus, inspiration is rather active process.

Expiration act – under usual conditions is performed passively by means of following factors:

- thorax gravity force;
- elastic graft of rib cartilages overwinded in course of inspiration;
- abdominal cavity organs pressure.

But expiration as inspiration may be also active (for instance, at hyperventillation, cough, someone's straining and so on), when internal intercostal muscles contraction occurs. These muscles are fixed near spinal cord to below-lied rib and near sternum to above-lied rib and their contraction cause pushing ribs down, ahead and inside.

Respiratory muscles in course of their activity passe through some *resistance*, 2/3 of which is elastic, defined by lungs and thorax tissues as well as surfactant action; 1/3 – non-elastic caused by gas stream friction with air ways.

Negative pressure appearence in pleural fissure is explained by following fact: new-born thorax grows faster than lungs that's why lung tissue is undergone to constant tension. Pleural layers possess large absorbtive ability that encourages negative pressure creation. That's why gas introducing in pleural cavity is absorbed after some time and negative pressure is restored in pleural cavity. Thus, negative pressure is constantly supported in pleural cavity. If thorax is wounded than pressure in pleural fissure becomes equal to atmospheric one and lung is falling down, **pneumothorax** occurs. If we have liquid, blood and pus – the names will be correspondingly hydrothorax, haemathorax and pyothorax.

One can differentiate **2 main respiration types:**

1) Thoracic (rib) – thorax dilation is connected mainly with ribs rising; respiration is mainly performed by means of intercostal muscles activity, diaphragm is moved passively according to interthoracic pressure change. This respiration type is a female.

2) Abdominal (phrenic or diaphragmal) – diaphragm contraction (flattening) is main respiration factor as the result of which interpleural pressure is decreased and simultaneously interabdominal pressure is increased. This respiration type is more effective because lungs are ventillated in more extent and stronger in course of it and blood venous return is released from abdominal cavity organs to heart. ***Diaphragmal respiration is more physiologic!*** It is called male respiration. ***There exists one important rule for women: they must breath with thorax mainly only when their pregnancy!***

Air amount in lungs after maximal inspiration is known as **common lungs capacity (CLC).** It is 4200-6000 ml in adults. Its compounds are: **vital lung capacity (VLC)** and **residual volume (RV). VLC** – air amount which leaves lungs in course of maximally deep expiration after maximally deep inspiration. It is equal to 3300-4800 ml under norma (in males 4000-4800 ml, in females – 3300-4000 ml). VLC consists of 3 lung volumes:

1) *respirational volume* (RV) of air inspirated and expirated in course of each respiratory cycle under rest state – 400-500 ml;

2) *reserve inspiration volume* – additional air that one can inspirate in course of maximal inspiration after usual inspiration – 1900-3300 ml;

3) *reserve expiration volume* – additional air that one can expirate in course of maximal expiration after usual expiration – 700-1000 ml.

At usual respiration we have reserve expiration volume and respirational volume in our lungs.

Residual volume – everything that is in lungs after deep inspiration - it is equal to 1200-2000 ml. It is in our lungs even after death!

There exists one more volume – ***harmful space volume*** – air part that is remained in air ways (nasal ducts, oral cavity, nasopharynx, nasal additional sinuses, trachea, bronchi) and doesn't reach lungs (this air doesn't participate in gas exchange). Such anatomical space is about 140-200 ml. It very useful despite its name "harmful" because air passing through them (especially when its passage through nasal ducts) becomes warm, humid, protected from side particles, bacterias. ***Respiration through nose is more physiological!***

For 1 minute, at respiration freaquency equal to 16-20, one inspirates volume that has name of **minute volume (MV).** Its size depends on 2 compounds: respiration volume and respiration freaquency. Respiration freaquency 16-20 (norma indicated in all textbooks and manuels) per 1 minute is not ideally physiological. Less respiration freaquency which may be reach by corresponding training (the most often – physical training) - is more physiologic from the point of view delt with diseases prevention not only in respiratory appatarus but also in other organs and systems. Why less respiration freaquency is more physiologic? Describe these advantages on concrete example of trained person respiration. Imagine, please, 2 people before us, of equal constitution, but one of them is regularly done some kind of physical activity (regular morning exercise, running and so on). Respirational volume is always higher in trained person in

comparison to untrained. Example. Respirational volume in trained person – 800 ml; in untrained - 400 ml. After small physical loading their respiration freaquency is getting increased: in trained person – to 20 respiratory acts per minutes, in untrained – rather higher (for example, 40). At such ziphras minute volume in both people will be equal to 16000 ml of air (400 ml x 40 and 800 ml x 20). In what are the advantages of one of them before other? In the first human being (trained) from 800 ml of respiratory volume 600 ml will come to alveoles with every inspiration (if both subjects have harmful space volume equal to 200 ml). In the second (untrained) person only 200 ml of air will come to alveoles. At respiration freaquency 20 in first person 12000 ml of air reach alveoles for 1 minute (20 x 600 ml). At a freaquency 40 in second person this air amount will be only 8000 ml of air (40 x 200 ml). Thus, in untrained person air amount reaching lungs is lower on 4000 ml. That's why ***less respiration freaquency is more physiologic!*** It is reached by training (the best – by physical one). As it is known nowadays, civilized person is healthy, active, energetic and it may be so tens of years if his minute volume is not more than 4-5 l. The more minute volume predominates over this level, the more symptoms are of different organs pathologies occur. In people who have such problems (these are the civilization problems!!!) minute volume is equal to 8-12 litres in resting state. One can't call such respiration healthy. Remember!!! External respiration normalization – reaching minute volume level 3-4 litres per minute! High freaquency of our breathing is delt with its uncorrect character. In the most people amount time for inspiration is approximately equal to time for expiration. Besides, the most people performes their expiration right after their inspiration – it is also out of physiology. It's necessary to lack someone's breathing after inspiration and then slower then inspiration expiration comes, after which – new lack. Such respiration type reminds respiration on Buteyko, Frolov et al. But, unfortunately, people become follow this respiration "culture" only when they fell ill. Really it's necessary to breath in such a way always! This is a Real Way to health and prevention of a great number of diseases!

Lung ventillation. Air-conductive ways, lung parenhyme, pleura, osteo-muscular thorax carcas an diaphragm are united working organ by which lung ventillation is performed. ***Lung ventillation*** – alveolar air gas content renewal process. Such air provides oxygen coming into alveoles and carbon dioxide excessive amount releasing. Ventillation intensivity is determined by respiration depth and freaquency, harmful space. Ventillation occurs due to active physiologic process (respiratory movements). It depends on body stature (vertical or horizontal) and circulation in alveoles.

Gas transition and transfer mechanism. Pressure gradient is vitally essential factor providing gas exchange from one environment to another. What pressure does it mean? Oxygen and carbonic dioxide create definite pressure which is called ***partial pressure*** – common pressure part of a given gas in a given mixture. This part depends on gas per cent content in the mixture. The it is more, the partial pressure of given gas is more.

Oxygen transport.

Oxygen partial pressure:

- in atmosphere is equal to 159 mm merc col.;
- in alveoles – 102-105 mm merc col;
- in venous blood reaching alveoles – 40 mm merc col;
- pressure gradient for oxygen between alveoles and blood is about 60 mm merc col.

Thus, oxygen due to this difference of partial pressure and its tension in different environments passes from atmosphere into alveoles and then in blood and tissues. How oxygen is transmitted?

Oxygen transfer conditions

It is known that blood tranfers 300-350 ml of oxygen for 1 minute under relative rest state (this ziphra significantly increases at physical work). One can differentiate 2 factors of oxygen transfer:

- large alveolar surface (60-100 square meters);
- oxygen fast diffusion ability – at this difference between alveoles and blood in 1 mm merc col 200 ml of oxygen will diffund; at a real difference that is 60 mm merc col – 12000 ml of oxygen (!even in course of intensive physical loading this ziphra is not more than 4000-5000 ml!). You see data about oxygen diffuse ability: it predominates the level necessary for intensive physical trainings in 2,5-3,0 times.

Oxygen transport forms

Particularly oxygen can be dissolved (in 100 ml of blood – up to 0,3 ml of oxygen, thus, in all blood – about 15 ml). Of course, it can't solve the problem of oxygen transport. Main chemical substance necessary for oxygen transport is **oxyhaemoglobine.** It was estimated that 1 g of haemoglobine can transmits approximately 1,31 ml of oxygen. 100 ml of blood contains about 14-16 g of haemoglobine, so, they can carry 18-21 ml of oxygen. This index is known as **oxygen blood capacity** – is is defined as oxygen amount transporting with 100 ml of blood till its full saturation. This index can be changed. It is rised up in course of physical training, at polycitaemia; reduced – at blood diseases for instance at anaemias.

Formed oxyhaemoglobine amount depends on oxygen partial pressure in blood. This dependence is linear that is proved by following data. At oxygen partial pressure equal to 0, oxyhaemoglobine isn't formed; 10 mm merc col. – 10% oxyhaemoglobine; 20 mm.- 30%; 40 mm. – 70%; 70 mm.- 90%; 100 mm. – 96%. If we connect all this points we shall receive curve describing dependence between oxygen tension in blood and amount of forming oxyhaemoglobine. This curve name is **oxyhaemoglobine dissociation curve.** One can make some important conclusions from this curve:

1) At oxygen partial tension decreasing in blood up to 80-70 mm merc col (it corresponds to such partial pressure in mountains at a high 2500-3000 meters above sea level) amount of formed oxyhaemoglobine decreases insignificantly, i.e. its amount is less only on several per cents than on plain. It gives the possibilities to successful work of mountaineers, highland workers and also to life in highlands without any additional devices and forces. At a high level above 4000 metres we'll not be able to breath without additional oxygen coming from gas cylinder.

2) Venous blood is rich in oxyhaemoglobine, i.e. it is saturated by oxygen. At partial tension in venous blood equal to 40 mm merc col, up to 70% of oxyhaemoglobine is formed in blood.
3) Difference between oxyhaemoglobine content in arterial and venous blood is 25-26%. Oxyhaemoglobine content in arterial blood is 95-96%, in venous – 70%. This index is named **arterio-venous difference.** It is rised up in course of physical training, at polycitaemia; reduced – at blood (at anaemias) and heart disorders.

Oxyhaemoglobine dissociation curve moving:

1) to the left (up) – is observed:

- at temperature decreasing;
- pH increasing (alkalosis);
- hypocapnia;
- in blood reaching lungs;
- in new-borns;
- in mountaineers;
- in fliers;
- in cosmonauts.

Essence: at less oxygen partial pressure in atmosphere to form more oxyhaemoglobine in blood.

2) *To the right (down)* – is observed:

- at hyperthermia;
- at fever;
- pH decreasing (acidosis);
- carbonic acid content increasing;
- in blood reaching tissues (for example, working muscles).

Essence: at the same oxygen partial tension oxygen forming is less and free oxygen comes to the tissue where it's necessary for redox reactions performing in them.

Carbon dioxide transport

Carbon dioxide transmission and transfer is realized by same machanisms. Carbon dioxide tension:

- in tissues – maximal – 60 mm merc col.;
- in venous blood outflowing from tissues – 46 mm;
- in alveoles where venous blood inflows – 38 mm merc col;
- in atmosphere – 0,2 mm merc col.

It's quite naturally that pressure and tension gradient in different organism environments and compartments provides carbonic dioxide transition from tissues to blood, from blood into alveoles and from alveoles into surrounding space.

Carbon dioxide forms

Particularly, like oxygen, in little amounts it can dissolve (3-6%). Rest part comes into chemical connections both in plasma and in erythrocytes. Chemical substance of carbonic dioxide with water – carbonic acid (H_2CO_3) – appears in plasma. It takes place

because partial tension of this gas is more than in blood, that's why it transfers into blood plasma where is connected to water. Carbonic acid part in plasma is connected to sodium chloride as the result of which soda is formed ($NaHCO_3$). Plasma transports carbonic dioxide in composition of theses compounds. Its rest part reaches erythrocytes where under influence of special erythrocytic enzyme carboanhydrase the possibility of its connection with water is significantly increased with carbonic acid forming. Little amount of this acid is binded with potassium chloride with potassium bicarbonic ($KHCO_3$) formation. Finally, carbon dioxide part is binded to amine group of haemoglobine with the **carbohaemoglobine** ($KHCO_2$) forming. Thus, in erythrocytes carbonic dioxide is transported in a structure of H_2CO_3, $KHCO_3$ and $HbCO_2$.

When blood reaches alveoles, same enzyme carboanhydrase acts on the contrary: it helps H_2CO_3 dissociation and CO_2 comes into alveoles as the result of these processes. As oxygen partial pressure in alveoles is higher than in blood the gas passes in blood, in red blood cells with oxyhaemoglobine forming in them. Being more powerful acid than carbonic, oxyhaemoglobine takes the bases from bicarbonates and thus provides carbonic dioxide releasing. The result: CO_2 passes into alveoles. In tissues oxyhaemoglobine transformes into haemoglobine giving bases connected with it, increasing blood saturation with CO_2. These examples testify to the fact that oxygen plays essential role in CO_2 forming and releasing.

But at all these reactions CO_2 tension in venous blood remains big (46 mm merc col) and it doesn't differ significantly from its tension in arterial blood. Thus, there exists **carbonic dioxide arterio-venous difference** equal to 6 mm merc col.

There is quite natural question: why organism has big amount of CO_2? The answer is the following: it is essential respiration regulator.

Respiration regulation is performed by means of reflectory reactions occuring as a result of excitement of specific receptors located in lung tissue, vascular reflexogenic zones and other regions. Respiration regulation central apparatus are the structures of:

- spine;
- medulla oblongata;
- hypothalamus;
- brain hemispheres.

Main function of respiration management is performed by stem repiratory neurons which transmit rhythmic sygnals into spine to respiratory muscles motoneurons.

Respiratory nervous center – is central nervous system neurons integrity providing respiratory muscles co-ordinated rhythmical activity and external respiration constant adaptation to changing conditions inside organism and in environment. Main (working) part of respiratory nervous center is located in medulla oblongata. One can differentiate 2 parts in it: ***inspiratory*** (inspiration center) and ***expiratory*** (expiration center). Medulla oblongata respiratory neurons dorsal group primarily consists of inspiratory neurons. They give particularly the stream of descendant ways getting the contact with diaphragmal nerve motoneurons. Respiratory neurons ventral group sends

primarily descendant fibres to intercostal muscles motoneurons. One can see region in pons anterior part called as ***pneumotaxic center***. This center deals with activity both of inspiratory and expiratory center parts providing the change of inspiration and expiration. Respiratory center important part is neurons group of spine cervical part (III-IV cervical segments), where diaphragmal nerves nuclei are situated.

Respiratory center excitement mechanisms are the following.

- One of the most important ways of its excitement is *automatism*. There is not one point of view to automatism nature but there exist data about secondary depolarization occurence in respiratory neurons (like diastolic depolarization in myocardium) which reaching its critical level gives new impuls.
- But one of main ways of respiratory center excitement is its *irritation by carbonic acid*. As it was mentioned above, there remains much carbonic acid in blood leaving lungs. It performs the function of medulla oblongata neurons main irritator. It is mediated through special structures – chemoreceptors, located directly in medulla oblongata structures ("*central chemoreceptors*"). Thus, the second way – through blood.
- They are very sensitive to carbonic dioxide tension and acid-alkaline state of intercellular liquor washing them.
- Carbonic acid can easily diffund from brain vessels in liquor and stimulates medulla oblongata chemoreceptors.
- Reflectory way - there are 2 reflexes groups (like for cardio-vascular system): proper and conjugated.

I. Proper reflexes – the reflexes originated from respiratory system organs and finished in it.

1) ***Reflex from lung mechanoreceptors.*** According to localization and type of percepted irritations, reflectory answer to irritation one can differentiate 3 types of such receptors: receptors of stretching, irritant receptors and lung juxtacapillar receptors.

- *Lung stretching receptors* – are primarily located in air ways (trachea, bronchi) smooth muscles. There are approximately 1000 receptors in every lung and they are connected with respiratory center by large myelinized afferent fibres of vagus with very high conductance velocity. Direct irritator – internal tension in air ways walls tissues. Such impulses freaquency is increased at lung stretching in course of inspiration. Lung swelling causes inspiration reflectory inhibition and transition to expiration. These reactions are stopped at vagus cutting and respiration becomes retarded and deep. Mentioned reactions are called ***Gering-Breyer's reflex***. This reflex is reproduced in adult person when his respiratory volume is more than 1 l (at physical training for instance). It is of essential importance in new-borns. Their adaptation is slow.
- *Irritant receptors* or slowly adaptating air ways mechanoreceptors, trachea and bronchi mucosa receptors. They answer to lung volume significant changes, chemical or mechanical irritators (mucus, tobacco, dust particles and so on) action to mucosa. Their adaptation is fast. At side bodies coming into respiratory ways there occurs cough reflex after irritant receptors activation. Reflectory arch of cough reflex – receptors – superior-

laryngeal, glosso-pharyngeal, trygeminal nerves – expiratory part of respiratory center. Result - strong expiration – cough. At isolated irritation of nasal respiratory ways receptors second immediate expiration occurs – sneezing.

- *Juxtacapillary receptors* are located near alveolar and respiratory bronchi capillaries. Irritators: pressure increasing in circulation small circle and interstitial liquid volume increasing in lungs. Such situation is observed at blood stagnation in small circulation circle, lung oedema, lung tissue injury (at pneumonia et al.). Impulses from these receptors are directed to respiratory center through vagus causing freaquent surface breathing occurence. There may be not only freaquent breathing (tachypnoe) but also reflectory bronchoconstriction.

2) ***Reflexes from respiratory musculature proprioreceptors:***

- *Reflex from intercostal muscles proprioreceptors* is realized in course of inspiration when these muscles while their contraction send information through intercostal nerves to respiratory center expiratory part and as a result expiration occurs.
- *Reflex from diaphragm proprioreceptors* – is performed as an answer to its contraction in course of inspiration. Result: information comes through diaphragmal nerves first in spine, than in medulla oblongata in its expiratory part and expiration occurs.

Thus, all respiratory system proper (own) reflexes are realized in course of inspiration and are resulted in expiration.

II. Conjugated reflexes – reflexes originated out of respiratory system.

1) ***Reflex onto conjugation of blood circulation and respiration systems*** – is originated from perypheral chemoreceptors of vascular reflexogenic zones. The most sensitive of them are located in sino-carotid zone region.

- *Sino-carotid chemoreceptive conjugated reflex* – is performed at carbonic dioxide accumulation in blood. If its tension increases than the irritation of the most sensitive chemoreceptors (they are in this zone in sino-carotid body) occurs, excitement wave comes from them through IX pair of cranio-cerebral nerves and reaches respiratory center expiratory part. Expiration occurs which enforces releasing of excessive carbonic acid in surrounding space. Thus, blood circulation system (while this reflectory act performance it works more intensively: heart contraction freaquency and blood stream velocity increase) influences on respiration system.

2) ***Exteroceptive reflexes*** are originated from tactile (remember your breathing reaction on touching of lovely person), temperature (warmth – increases, coldness – decreases respiratory function), nocieceptive (weak stimuli and of a middle force - increase, strong – suppress breathing) receptors.

2) ***Proprioreceptive reflexes*** – are performed due to irritation of receptors of sceletal muscles, joints, ligaments. It is observed in course of physical training doing. Why? If under rest state it's necessary 200-300 ml oxygen per minute for human than at physical loading given volume must be significantly increased. Under these conditions both minute volume and arterio-venous difference on oxygen are

increased. This indexes increasing is accompanied by oxygen consumption rising up. At work duration of only 2-3 minutes and its significant power oxygen consumption grows uninterruptedly from the very beginning of work and is decreased only after its stoppage. At work duration more, oxygen consumption, while increasing in course of first minutes, is supported all the time on its constant level. Oxygen consumption increases the more the harder physical work it is. Maximal oxygen amount that organism can use per 1 minute at the hardest work for it is called **oxygen maximal consumption (OMC).** Work at which person reaches his OMC level must have duration not less then 3 minutes. There exist many ways of OMC determining. It doesn't predominate 2,0-2,5 l/min in untrained people. It can be twice large in sportsmen and even more. OMC is an index of **organism aerobic productivity.** This human ability to perform very hard physical work, providing his energetic consumption due to oxygen used directly in course of work. It is known that even well-trained person can work at oxygen consumption 90-95% from his OMC level not more than 10-15 min. One having more aerobic productivity reaches better results in work (sport) at practically equal technic adn tactic preparation. Why oxygen consumption is increased in course of physical activity? One can differentiate several reasons:

- additional capillaries opening and blood increasing in them;
- oxyhaemoglobine dissociation curve movement to the right and below;
- temperature increasing in muscles.

For performing their work, muscles need in energy, the accumulations of which are restored while oxygen transport. Thus, there exists definite dependence between work power and oxygen amount necessary for work. That blood amount necessary for work is called **oxygen asking.** Oxygen asking can reach up to 15-20 liters per minute and even more in course of hard work. But maximum of oxygen consumption is less in 2-3 times. Does it possible to perform the work if minute oxygen accumulation predominates OMC? For correct answer this question one should remember for what oxygen is used in course of muscular activity. It is essential for macroergic substances restoration providing muscular contraction. Usually oxygen interacts with glucose and it releases the energy while its oxidation. But also glucose can be destructed without oxygen, i.e. by abaerobic way as a result of which energy releases too. These are also other substances possessing the ability to be destructed without oxygen. Thus, muscular activity can be provided at insufficient oxygen coming into organism too. But in this case many acid products are formed and it's necessary oxygen for their destruction because they are destructed by oxidation. Oxygen amount necessary for metabolism products oxidation that were formed in course of physical activity is called **oxygen debt.** It appears in course of work and is liquidated in restoration period after work end. Usually this disappearing takes from several minutes to 1 hour and a half. Everything depends on work duration and intensivity. Lactic acid plays the most important role in oxygen debt forming. To continue his work at lactate presence in blood in great amounts

organism must have powerful buffer systems and his tissues are to be adapted to work under hypoxy conditions. Such organism adaptation serves as one of factors providing high aerobic productivity. All the mentioned above complicate respiration regulation at physical activity because oxygen taking in organism is increased and its blood hypoxy leads to chemoreceptors irritation. Sygnals from them come in respiratory center as the result of which respiration becomes more freaquent. A great number of carbonic acid is formed in course of muscular activity that comes into blood and it can acts to respiratory center directly through central chemoreceptors. If blood hypoxy leads primarily to breathing quickening than carbonic acid surplus causes its deepening. Both theses factors act simultaneously in course of physical activity and that's why respiration quickening and deepening takes place. Finally, impulses coming from working muscles, reach respiratory center and enforces its activity. At respiratory center functionning all its parts are functionally interconnected by means of following mechanism: at carbonic acid accumulation respiratory center inspiratory part is excited from information comes in pneumotaxic part, then to its expiratory part. The latest, besides, is excited by means of a whole group of reflectory acts – from receptors of lungs, diaphragm, intercostal muscles, respiratory ways, vessels chemoreceptors. Inspiration center activity is inhibited due to its excitement through special inhibitory reticular neuron and inspiration is changed by expiration. As expiration center is inhibited it doesn't send impulses far into pneumotaxic center and information flow is stopped from it to expiration center. Carbonic acid is accumulated in blood by this time and inhibitory influencings on expiratory part are inhibited. Inspiration center is excited due to such information flow redisposition and expiration is changed by inspiration. And everything is repeated again.

Vagus is an essential link in respiration regulation. Main influencings to expiration center come through it. That's why at its injury (like at pneumotaxic center injury) respiration is changed so that inspiration remains normal and expiration is sharply prolonged – ***vagus-dyspnoe.***

As it was mentioned above in course of coming to the highlands lung ventillation increasing occurs based on vascular zones chemoreceptors stimulation.

Heart contraction freaquency and minute volume are increased simultaneously with this. These reactions improve oxygen transport in organism a little but not for long. That's why at durable staying into mountains with adaptation to chronic hypoxy initial (urgent) respiration reactions gradually leave their place to more economic adaptation of gas-transport organism system. In constant residents of highlands respiration reaction to hypoxy is too weak (hypoxic deafness) and lung ventillation is supported practically on the same level like in plane residents. At the same time at durable staying under conditions of highlands vital lung capacity, caloric oxygen equivalent, myoglobine content in muscles, mitochondrial enzymes activity (providing biological oxidation and glycolysis) are increased; organism tissues (particularly central nervous system) sensitivity to insufficient oxygen supply is decreased. At high more than 12000 m air pressure is very small and under these conditions even breathing by pure oxygen doesn't

solve the problem. That's why at flyings at this high one need hermetic cockpits (planes, cosmic ship).

Sometimes human being has to work under increasing pressure conditions (divering). In the depth nitrogen becomes its dissolving in blood and in course of fast rising out off the depth it doesn't manage to release from blood, gas vesicles cause vessel emboly. Occuring condition is called **kessonic disease.** It is accompanied by pain in joints, giddiness, dyspnoe, unconsciousness. That's why nitrogen in air mixtures is changed on insoluble gases (for instance, helium).

Human being can delay free his breath not more than on 1-2 minutes. After preliminary lung hyperventillation this respiration delay is rised up to 3-4 minutes. But durable, for example, diving after hyperventillation is very dangerous. Blood oxygenation sharp decreasing can cause sudden unconsciousness. Under this state swimmer (even experienced one) under stimulus action caused by carbonic acid partial tension increasing in blood can inspirate water and choke (drown).

Oral cavity role in speech breathing and speech creation.

Human respiratory system besides its main function – lung gas exchange providing – participates directly in speech sounds creation. Acoustic effects main creative ways are air stream stoppage by rhythmic voice cords. Tonal and noisy sounds occur while air passage with too large velocity through narrowings formed in this or that place alongside respiratory tracts. Thus, speech appears due to respiratory system actions, providing necessary pressure and air flows in speech-forming tract as well as due to this tract elements movement managing air streams. Oral cavity organs for example lips, tongue and teeth participate in acoustic effect creation because expiration in course of communication occurs through mouth.

Respiratory apparatus activity in course of speech is called ***speech respiration.*** Normal speech with correct and distinct sounds prononciation is tightly connected with dental rows integrity. Teeth loss especially anterior lead to lisping, prononciated sounds clearence decreasing and even to losing of possibility to prononciation of separate from them. There may be salivation and saliva releasing through the gaps forming despite absent teeth. Speech defects can be also determined by disorders of salivary glands functions (dryness in mouth), masticatory musculature (muscules contracture and motor nerves paralysis), temporal-mandibular joint (mandibule contracture) as well as congenital or aquired dfects of facial-maxillar region organs, organs anomalies and uncorrect denturing.

One of main reasons of speech function disorder are dental rows defects especially of dental-maxillar system frontal region. Sound generation distortion, energy consumptions change under speech activity are observed. That's why dentist in course of denturing must choose denture construction at which speech activity becomes optimal as for clarity of generated sounds and minimal energy on its loss.

Human being has no specific speech organs. He uses respiration, mastication and swallowing organs for speech-forming. But he has specialized vocal apparatus (larynx and vocal cords) for speech vocal constituent. Organs participating in speech-forming,

are divided into 2 groups: respiration organs (lungs with bronchi and trachea) and organs directly participating in voice-forming. One can differentiate ***active*** (moved) having the ability to change their volume and shape of speech tract and create obstacles fro expirated air in them; and ***passive*** (motionless) without such ability.

Active speech-forming organs:

- larynx;
- pharynx;
- soft palate;
- tongue;
- lips.

Passive organs:

- teeth;
- hard palate;
- nasal cavity;
- additional sinuses.

All these structures from the point of view of speech-forming perypheral mechanism one can imagine as 3 interconnected parts:

- generatory;
- resonatory;
- energetic.

There are 2 resonators:

- tonal – larynx;
- noisy – due to fissures creature in oral cavity.

Other resonators classification:

- 2 modulating – mouth and pharynx;
- 1 non-modulating – nasopharynx with additional sinuses.

2 energy sources:

- sceletal intercostal muscles, diaphragmal, abdominal;
- tracheobronchial tree smooth muscles.

Vascular reactions in sound-forming have vessel reactions in respiratory ways and vocal tract mucosa. Resonator function in sound-forming process depends on these parts blood filling state.

Respiratory ways and vocal tract mucosa glands secretion also influences on speech-producing. Its increasing influence on vocal tract resonatory features. Excessive secretion in naso-pharynx inhibits nasal sounds reproduction causing nasolaly. Hypersalivation influences on all sounds in which oral cavity, teeth, tongue and lips participate. This is the sphere of speech-forming odontogenic aspect. Every dentist should pay the attention to this aspect. Vocal tract is important executive part of speech-forming system. Here phonemic and whispered constituents of speech are formed. This part activity mostly is under competention of dentist. Dental rows integrity injury (especially incisives) leads to dental sounds forming changing and inhibiting (whistle,

lisping). Pathological structures on tongue back leads to sounds reproducing inhibiting and disorders in labial (of lips) region. Changed occlusion influences greatly onto phonation result. It is especially expressed at opened, crossed occlusions, prognathy and progeny.

Phonation disorders at different changings in oral cavity receive corresponding names. Disorder delt with cleft palate (hard palate fissure) is called ***palatolaly.*** At anomalies in tongue structure and function occuring articulational disorders receive the name ***glossolaly.*** Uncorrect teeth structure and their localization in alveolar archs especially of anterior group (incisives and canines) are often reason of ***dyslalies.*** All mentioned dentist must take into account while treaty influencing in oral cavity performance.

Surgeon-dentist must forecast the possibility of speech-forming function in course of operations in oral cavity organs. Articulation mechanism knowledge is of essential importance for orthopedic dentist. Removable dentures production, especially at wide adenthias or complete teeth absence leads to articulational correlations changing in oral cavity. Naturally, it influences on vocal apparatus resonator function. Occlusion overstating at denturing, artificial teeth uncorrect installation and even well-done denture always at first stages of adaptation lead to speech-forming retardation. Patients with removable dentures often complaint on this or that dyslalies signs: sound-production inhibiting, additional whispering, whistle and lisping. All this is necessary to take into account at dentures constructing and creation, especially for people which use speech actively in their working activity (artists, singers, lecturers, dictors, teachers). Famous statement "to train somebody's voice" to singer, artist, dictor or teacher means to tune respiration and articulation by definite behavioural measures usage.

In course of food mastication and food piece swallowing respiration changings take place which belong to ***protective respiratory reflexes.*** They are expressed in breathing stoppage: in course of swallowing jaws are closed, soft palate is rised, contracting palato-pharyngeal muscles form septum between mouth and nasal cavity. Entrance into larynx is closed by epiglottis and vocal cords close vocal fissure. That's why food piece when pharyngeal muscles contraction can go only in oesophageal foramen.

Thus, at the end of our lecture we must to remember you that healthy breathing – is nasal, as slow and seldom as possible, with its lack in course of inspiration and, especially, after it. While prolonging the inspiration, we stimulate vegetative nervous system sympathetic part work with all following consequences. While prolonging the expiration, we carry carbonic acid in blood more and longer that positively influences on blood vessels tone (decreases it) will all following consequences. Due to this oxygen under such sitiation can come in the farthest microcirculative vessels preventing disorders of their function and development of many diseases. Correct breathing – is a prevention and treatment of big group of diseases not only of respiratory system but also of other organs and tissues! Breath for enjoy!

Lecture 7
Digestion, its types and functions. Oral cavity role in digestion.

Digestion – is an integrity of food products physical and chemical processing, their transformation into components without species specificity and suitable for absorbtion and participation in substances exchange.

Digestion types have been formed in course of alive organisms development and nowadays we differentiate:

- *Intracellular* – food products hydrolysis realized inside cells (it is very limited in human being, the example of which is phagocytosis).
- *Extracellular* – is performed in special cavities (oral cavity, stomach, intestine); enzymes synthesized by secretory cells are released in extracellular environment (cavity).
- *Membrane* – has intermediate state between extra- and intracellular digestion and performed by enzymes localized on enterocytes membrane structures (in zone of enterocytes mucosa striggillate margin).

Alimentary tract main functions:

1) *Secretory* – alimentary juices (saliva, stomach, intestinal, bile) secretion and releasing by glandulocytes.
2) *Motor-evacuational* – food growing shallow, its mixturing with juices, passage through alimentary tract.
3) *Absorbtional* – transport of ending digestion products, water, salts, vitamins through alimentary tract epithelium in blood and lymph.
4) *Excretory* – excretion of non-assimilated food components, some metabolism products, hard metals salts, medicines (drugs) out off organism.
5) *Incretory* – releasing of hormones regulated digestion organs functions.
6) *Protective* – bacteriocide, bacteriostatic, detoxicative action.
7) *Receptor* – many receptive zones existance in alimentary tract for excretory, circulatory system reflexes and so on.
8) *Erythropoietic* – there exists iron depot in stomach, small intestine mucosa, liver participating in haemoglobine synthesis; there is so-called internal Kastl's factor necessary for vitamine B_{12} absorbtion responsible for erythropoiesis regulation.

Digestion process is originated from **oral cavity.** This part of alimentary tract performs 2 functional groups:

1) ***Specific functions*** – food suitability assessment performs by means of chemo-, mechano, thermo-, nociceptors, gustatory receptors in oral cavty. Information comes in central nervous system from these receptors and then – to oral cavity organs (masticatory muscles, salivatory glands, tongue). Food gustatory features determining, food mechanic processing and swallowing are performed due to their action. Food chemical processing is also originated from oral cavity (mainly of carbohydrates). Absorbtion can also perform in oral cavity.

2) *Non-specific* -

- participation in behavioural reactions forming (hunger, thirst);
- thermoregulatory;
- protective;
- excretory;
- incretory;
- participation in articulation and speech forming.

Digestion in oral cavity is mainly realized due to salivary galnds secretory function. *Salivary glands secretory function* is provided by functionning of 3 pairs of large (parotid, sublingual and submandibular) and great amount of small glands disseminated in oral mucosa. Saliva is a mixture of secretes. With the addition of epitheliocytes, food particles, mucus, lymphocytes, neutrophils and microorganisms (they are in oral cavity in large amounts) it formes *oral liquid.* Daily saliva secretion is 0,5-2,0 litres. Its pH fluctuates from 5,25 to 8,0.

Saliva contains up to 99,5% of water. There are many organic and inorganic substances in solid residue. One can say that almost all Mendeleev's table is in saliva (even gold!). There are many organic substances in saliva. They are protheins – albumins, globulins, aminoacids. Nitrogen-containing substances – urea, ammonia, creatine. Bacteriocydic substances – lyzozyme; enzymes – alpha-amylase or ptyalin, maltase, proteases, peptidases, lipase, alkaline and acid phosphatase.

Saliva role in digestion: it gives the beginning to food chemical processing. It occurs due to amylase acting on polysacharides (starch) while their destruction to maltose. Under other enzyme maltase influence maltose destruction to glucose can occur. But enzymes action is very limited because food is in oral cavity very little time. ***One of the most important digestion rules:*** ***careful (durable) food mastication*** due to which saliva can influence on food (in oral cavity) more effectively.

But saliva is not only restricted by food possible chemical processing. Saliva takes part in preparation of food portion to swallowing and further digestion. Food is mixed with saliva in course of mastication and is swallowed better. Saliva equally covers teeth in neutral environment forming special tunic on them. In acid environment releasing mucin covers teeth surface an encourages teeth coating and stones forming. That's why after food taking it's necessary either to brush teeth or to wash oral cavity. Teeth and mucosa state depends on saliva content and features. Saliva volume, chemical content and features change can underline many diseases of oral cavity. For example, saliva, while contact with dental enamel is the calcium, phosphorus, zinc and other microelements sourse for it. If saliva pH is 7,0-8,0 it oversaturated by calcium that creates ideal conditions for ions passage into enamel. At environment acidification (pH 6,5 and lower) oral liquid becomes deficient on calcium ions content that encourages its releasing form enamel and caries development.

According to saliva chemical analysis and even smell, colour one can tell about inner organs diseases. For instance, at nephritis, stomach and duodenum ulcer disease

residual nitrogen amount is increased in saliva. At stroke on the injury (haemorrhagia) side salivary glands excrete great number of protein.

You know about oral mucosa increased regenerative ability. Quickly mucosa restoration after its wounding (it occurs practically every day) is connected not only with tissular immunity but also with saliva antibacterial features. Besides, there are substances in saliva influencing on blood coagulation and fibrinolysis. That's why oral cavity protective function is also delt with this saliva ability to influence on local haemostasis and fibrinolysis.

Saliva formation mechanism. Saliva is formed both in acinuses and in salivary glands ducts. Secretory granules are in glandulocytes cytoplasm. Granules size, amount and localization are changed in course of secretion. They are moved to cellular apex from Golgi complex. Organic substances synthesis passed with water through cell on endoplasmic net is performed in granules. Saliva formation first stage is realized in acinuses – *primary secrete* forming containing amylase and mucin. Ions content in it insignificantly differs from their concentration in extracellular space. Secrete content changes significantly in salivary ducts: sodium ions are actively reabsorbed and potassium ions are actively secreted. As a result, sodium amount in saliva becomes less and potassium – bigger.

Salivary glands in new borns secrete little saliva – 0,4 ml per minute in course of sucking, less – out off sucking. It is in average in 8 times less than in adulthood. Salivation volume is increased from 4 months and reaches up to 150 ml per day to 1 year (it is 1/10 of adult secretion). Amylase activity in new-borned saliva is low and it is increased in second half-year, reaching adult level in course of 1-2 years after birth.

Salivation regulation is performed by complicated-reflectory and humoral ways. Special place in regulation has *complicated-reflectory* mechanism. It consists of conditioned-reflectory and unconditioned-reflectory. Conditioned-reflectory salivation regulation way is connected with food appearence, its smell (in humans and animals), communication about it and other conditioned stimuli (pictures, writings, symbols) delt with alimentary motivation. Unconditioned-reflectory appears as an answer to oral cavity mechano-, chemo-, thermo- and gustatory receptors irritation. Nervous impulses flow comes from these receptors through V, VII, IX and X pairs of cranio-cerebral nerves to medulla oblongata in salivation center. Efferent fibres of given reflectory acts go from this center to salivatory glands. They can carry information to salivary glands through sympathetic and parasympathetic fibres that innervate salivary glands. Sublingual and submandibular salivary glands are innervated by preganglionar parasympathetic nervous fibres coming in composition of chorda tympani (facial nerve branch) to corresponding ganglions located in glands body. Postganglionar nervous fibres innervate glands secretory cells and vessels.

Parotid glands are innervated by preganglionar parasympathetic fibres of inferior salivatory nucleus of medulla oblongata coming in the composition of IX pair in auricular node. Postganglionar nervous fibres are directed to secretory cells and vessels. Sympathetic innervation is represented by preganglionar nervous fibres from lateral

corns of spine II-IV thoracic segments and is finished in superior cervical node, then postganglionar fibres to salivary glands come.

At sympathetic nerve excitement small saliva amount containing mucin doing it viscous and dense is released. At parasympathetic nerve – on the contrary, saliva becomes fluid and its amount is big.

Hypothalamic anterior and posterior nuclear groups participate in salivation regulation. Salivation reflectory regulation is not unique though it is main.

Humoral mechanism is delt with hypophyseal, pancreatic, thyroid, sexual hormones action. Excessive salivation occurs due to salivatory center irritation by carbonic acid. Saliva releasing may be stimulated by vegetothropic pharmacologic substances – pilocarpine, proserine, atropine. Saliva production can decrease too. It may be connected with nocecoceptive and emotional reactions, with fever states, at systematic sleeping pills usage, diabetes mellitus, anaemia, uraemia, salivary glands diseases.

Oral cavity motor activity. Essence:

- food biting;
- getting small;
- grinding;
- mixturing with saliva;
- alimentary piece forming;
- swallowing.

Oral cavity motor function main part is realized in course of mastication.

Mastication – is a complicated act. Its essence is in consequent contractions of masticatory muscles, mandibule, tongue and soft palate movements. Masticatory muscles are fixated to moveless skull part by their one end, by other end – to unique movable skull bone – mandibule. They provide mandibule status change as for maxilla while their contraction. Mimic muscles are close to masticatory muscles on their functions. They participate in food catching, its supporing in oral cavity vestibule, oral cavity closure at mastication. They are essential at sucking in new-borns and at liquid food taking. Tongue has definite role in mastication. It takes active part in food mixture, definition of its place for getting smaller on teeth.

Mastication act by its mechanism is partially arbitrary, partially – reflectory. Human being can free inhibit or enforce masticative movements, change their character. Food biting and mastication is performed at superior jaw teeth occlusion (contact) with inferior jaw teeth. Mandibule performes rhythmic movements in 3 main directions: vertical, sagittal, transversal. Mastication is originated from assessment of received food after which food piece irritates located in oral cavity touch, temperature, gustatory, nociceptive receptors. Besides, due to sense of smell impulses occuring in these receptors come into mentioned above nervous stems in medulla oblongata in mastication center. Then they on trygeminal nerve second and third rami, facial, glosso-pharyngeal and hypoglossal nerve come to masticatory muscles. In parallel with food getting smaller its washing with saliva occurs for better swallowing. Food getting smaller

degree is under oral mucosa receptors control. Non-food elements are pushed at this by tongue (bones, stones, paper et al.). One should remember about necessity of careful food processing in oral cavity. It's an essential preventive measure for many diseases not only of alimentary tract. In babies sucking corresponds to mastication which is provided by mouth and tongue muscles reflectory contractions.

Swallowing – is a complicated reflectory act due to which food is transported from oral cavity into stomach. *Phases:*

- Oral arbitrary – from food common mass in oral cavity small piece is separated which by tongue movements is pressed to hard palate. Jaws are closed, soft palate is rised closing entrance into choanes. Simultaneously with this palato-pharyngeal muscles are contracted. Septum is formed which closes passage between oral and nasal cavity in the result of these processes. Tongue moving ahead pressses onto palate and pushes food piece into pharynx. Because of this food piece is pushed down into pharynx. Entrance into larynx is closed by epiglottis, vocal cord is closed to prevent food coming into trachea. As food piece comes into pharynx, soft palate anterior arch are contracted and together with tongue root prevent food returning into oral cavity.
- Pharyngeal-inarbitrary – is originated when food piece is pushed ahead and pharyngeal-oesophageal sphincter, closing under rest state the entrance to oesophageus, is opened. Sphincter's muscles are relaxed and pressure is decreased in it, food piece passes into oesophageus and sphincter is closed again because of pressure increasing in it. Such reaction prevents food piece passage from oesophageus into pharynx.
- Oesophageal inarbitrary: food piece transmits from oesophageus oral part to cardial.

Swallowing process as reflectory act is performed due to irritation receptor endings of trygeminal, superior and inferior laryngeal, glosso-pharyngeal nerves located in soft palate and pharynx mucosa. Swallowing center is located in medulla oblongata near respiratory center and is in reciproqual (antagonist) interrelations. At swallowing center excitement respiratory center activity is inhibited; respiration is stopped in this moment that prevents food particles passage into respiratory ways. Swallowing act afferent ways – superior and inferior pharyngeal, recurrens nerve and vagus fibres. They direct nervous impulses to muscles participating in swallowing.

Oral cavity is an initial link of reflectory reactions influencing on digestion in stomach and intestine. Oral cavity receptors irritation stimulates stomach juice forming, stomach motor function. Stomach and pancreas secretion depends on mastication act duration. The mastication is less the stomach juice is less. Oral mucosa and tongue is alimentary tract mirror. One can see problems which may occur in stomach and other alimentary tract parts in it. Pathological processes in oral cavity organs can encourage some inner organs diseases occurence, cause or support different complications. In particularly, teeth pathological agility and loss leads to incomplete food processing in oral cavity that in first turn influences on stomach and intestine motor and secretory activity. But digestion disorders in oral cavity caused by mastication change at teeth loss don't always lead to one or another pathology in alimentary tract other parts. Alimentary

tract initial link (oral tract) periodically undergo to action of removable substances (solid subjects, acids, alkalins, excessively warm or cold bodies, strong mechanical actions) that causes hypersalivation occurence as mean as oral cavity and alimentary channel tissues integrity providing. Rich microbe flora containing pathogenic microorganisms comes into oral cavity with alimentary substances. It was the reason of forming tissular and cellular barriers as well as oral cavity specific and non-specific resistance in course of evolution.

Oral cavity protective function mechanisms (see also lecture on blood physiology).

Oral cavity protective function systemic mechanisms are functional integrity of behavioural, conditioned- and unconditioned-reflectory, barrier and immuno-chemical reactions. Information about threat to tissues integrity occurs at super intensive influencings onto mechano-, thermo- and chemoreceptors of tongue, lips, cheeks mucosa, palate, periodont and others. Besides, at oral cavity tissues injury special chemoreceptors (chemonociceptors) percept substances forming in course of cells destruction and direct the information to CNS. On the base of this information compensatory mechanisms are formed the ending aim of which to provide tissues integrity, to protect organism from injury.

One of protective mechanisms is **behaviour** directed to injured factors avoiding (head turn, jaws closure, running from irritator, avoiding dangerous places et al.). Defencive behaviour may be passive and active. Pricking up, covering, harboring, avoiding something (remind children's behaviour in dental clinics) belong to behaviour passive forms; aggression, resistance belong to active ones. But the most important urgent oral cavity protective mechanism is salivation – saliva releasing as answer reaction to removable substances coming. Mechano-, thermo- and chemoreceptors strong irritation and action to nociceptors lead to releasing of great number of saliva poor on enzymes and performing next tasks: ability to the fastest removal of harmful substances out off oral cavity, normalization of coming products temperature. Buffer saliva features are essential and allow to neutralize acids and alkalins of removable substances. Buffer features are connected with alkaline salts existance in a secretion (sodium and potassium chloridum et al.). Besides, saliva possesses other protective qualities. Alongside with alimentary or removable substances toxines and microbe flora (particularly pathogenic one) comes to oral cavity. There are more than 400 types of bacterias in human mouth, some of them may be the reason of infectionning of gums and osseal tissue below them. There exist rather favourable conditions in oral cavity for microflora development – food residues existance, weakly alkaline saliva environment (pH), humidity, optimal temperature. Microorganisms are up to 70 per cent of dental covering. It was estimated that approximately 250 microbe cells are in 1 mg of dental covering dry mass, 1 ml of saliva contains more than 10^8 of microbes. Microbes and viruses distribution in oral cavity is unequal - their main part is located in dental-gingival pockets, mucosa plicas and interdental spaces. Pathogenic microflora is of essential importance at gums injuries. Special attention should be payed to parodontosis

development. Gums inflammation, in course of which they become sensitive to different irritators action and are bleeded – it is the first stage of this disease, affecting millions of people. But not only gums are affected at this disease. But while sick gims are exfoliated out off teeth deeper and deeper pockets are formed where infection penetrates destructing osseal tissue. Teeth are sitting in their nests undensely and that's why finally human being losses them. But simultaneously parodonthosis may accelerate other diseases development in organism or make their course complicated. How defence from pathogenic microflora is performed in oral cavity? In course of oral cavity microflora it was established that it possesses relative stability preventing pathogenic microorganisms spreading. Such stability is defined by saliva content, bacteriocydic and bacteryostatic substances containing in it. Enzyme ***lyzozyme (muromidase)*** plays important role in oral cavity homeostasis supporting. This enzyme bacteriolytic action is delt with muramic acid destruction in some bacterias wall changing its permeability that causes their content diffusion in surrounding environment. Salivary ***lactoperoxidase*** makes bacteriocyde action (participates in gram-negative bacterias lysis). ***Myeloperoxidase*** - enzyme encouraging lipid peroxidative oxidation that results in bacterias death. ***Lactoferrine*** competes with bacterias for iron ion. If bacterias have highly-developed cytochromic system lactoferrine leads to their death. ***Mucin*** encourages bacterias big amount fixation to desquamating epitheliocytes. There are ***betta-lysines*** in oral liquid which penetrate here from blood and cause bacterial cellular membrane lysis. Saliva contains ***interpherones*** having the ability to suppress viral replication, possess antitumorogenic features. Salivary ***protheolytic enzymes*** of wide activity spectrum can injury some bacterias membranes. ***Lithium ions, zyanides*** presence and other components also leads to microorganisms death. As for complement components, immunoglobulins, phagocytosis and haemostatic reactions – see their description in lection on blood physiology.

Finally, it should be mentioned in conclusion that alimentary organs chronic diseases sometimes are accompanied by appearence of antibodies in circulating blood that react to food proteins antigenes and glycoproteids of milk, eggs, fish, citruses, chocholate and other foods. These antibodies to foods participate in alimentary allergy pathogenesis (toxico-allergic stomatitis). But we would like to pay your attention to the fact that antibodies against alimentary antigenes are in blood of healthy people too. That's why, feeding according to blood group, to our point of view, is one of the most important ways of oral cavity diseases prevention as well as other factors of a healthy life style (physical activity, harmful habits et al.).

Thus, oral cavity protective mechanisms providing the integrity of tissues of alimentary channel initial part and organism in a whole are a very complicated system.

Lecture 8

Hunger, appetite and satiation state. Substance and energy exchange, thermoregulation. Oral cavity role in these reactions.

Purposeful behaviour as for food taking is in the state which has received the name ***hunger state.*** This is special motivation directed on dyscomfort liquidation, connected with nutrients insufficiency in organism. Hunger center is located in hypothalamus, its excitement is delt both with nervous and humoral factors. Important role in sensations forming connected with hunger plays afferent impulsation coming in central nervous system from alimentary tract receptors. Its different parts have their own electrical basal rhythms of food taking. Near-houred rhythms are evacuational activity regulators. Intestine main activity rhythm – is of 90-minutes. There is 20-minute period of stomach and small intestine activity, liver, pancreas and intestinal glands secretory activity in this rhythm and 70-minute period of relative rest. Activity occurs in stomach and gradually passes through small intestine. Periodic activity initial reason is physiological hunger state. Empty stomach and small intestine proximal part hungry activity increases hunger state. It causes unconscious motor anxiety in animals and, conscious, in people. Inhibitory influencings of this feeling are connected with autonomic nervous system sympathetic part. Hypoglycaemia acting on specialized hypothalamic glucoreceptors participates in hunger forming.

Appetite – is emotional sensation delt with striving for food taking. This sensation may be hunger part but also it can occur independently from physiological consumption. In this case it is the expression of congenital or aquired individual predisposition to definite food type. One should underline that food taking in human being is not always connected with hunger feeling and it is rather uncorrect. But, unfortunately, it is so. Why? The answer is very simple – habit to take food in definite time (by the way, it is not the worst variant) or because all surrounding people are eating at this time.

Satiation - appears as a result of food taking. It occurs because of oral cavity, pharynx, oesophagus, stomach, duodenum mechanoreceptors as well as olfactory and gustatory receptors stimulation. Such satiation is called *sensor* or *primary.* We have also *secondary* or *metabolic* satiation connected with hydrolysis products coming into blood. It appears usually after 1,5-2,0 hours after primary satiation. Peptide hormones decreasing alimentary behaviour (cholecystokinine, somatostatine, bombesine, calcitonine) or increasing it (gastrine, insuline, oxytocine) are essential for food taking regulation, hunger and satiation sense occurence.

Remember! The slower you will take food (to masticate longer, not to hurry up while transition from one dish to other) the faster and at less food amount (it is the most important!) satiation will come. Commonly, food must be taken till you won't feel that you can eat the same amount. Than you must leave the table. You are feeling hunger but after some time you will fell the satiation. This is one of elements of feeding culture!

Substance and energy exchange – is an integrity of physical, chemical and physiological processes of substances and energy transition in human organism as well as substance and energy exchange between organism and environment. Substance and energy exchange provides organism plastic and energetic needs. One can differentiate 2 interconnected but directed oppositely processes. ***Anabolism*** – is the integrity of organic substances, cellular components and other tissular and organic structures biosynthetic

processes. They are growth, development, biological structures renewal and continuous macroergs resynthesis as well as energetic substrates accumulation. ***Catabolism*** – is the integrity of complicated molecules, cellular components, tissues and organs destructive processes to simple substance. Nutrients rich in energy are assimilated and chemically transformed but ending metabolism products with lower energy content are released from cell. Organism must receive energy in suitable form for it from environment and return into environment corresponding energy amount in a form suitable for further usage. This process in organism is called ***energy exchange.*** All processes generating energy that require molecular oxygen participation are formed ***aerobic exchange system.*** Energy generation without oxygen participation is called ***anaerobic exchange.***

Definite part of energy accumulated in fats, proteins and carbohydrates chemical bonds is used in course of biological oxidation process for ATP synthesis, other part is transformed in warmth. This warmth, released right after in nutrients biological oxidation process has received the name ***primary warmth.*** Energy accumulated in ATP and used further for chemical, transport, electrical processes performance, mechanical work producing transformed in warmth was named as ***secondary warmth.*** If to measure all warmth quantity having been formed in organism for 24 hours then this warmth will be the measure of nutrients chemical bonds sum energy taking into account that these nutrients underwent biological oxidation in course of measurement. According to warmth quantity having been formed in organism one can make the conclusion about energy expenditures to viability processes performance. Main energy source in organism for viability processes performance is nutrients biological oxidation. Oxidation is essential for this oxidation. Thus, having measured consumpted oxygen quantity for 1 min (1 hours, 24 hours) one can say about organism energy expenditures size. There is a connection between oxygen quantity consumpted by organism for time unit and the quantity of warmth having formed in it for the same time. This connection is expressed through ***oxygen caloric equivalent*** – warmth quantity forming in organism at consumption 1 l of oxygen by it. For instance, it is equal to 5,05 kcal at carbohydrates burning.

Organism energy expenditures assessment may be performed by 2 ways:

Direct biocalorymetry – is based on warmth quantity measurement directly disseminated by organism in warmth-isolated camera. It is a very exact method but it is used very seldom because it is cumbersome and expensive. This method principle is based on thermodynamics first law which means that all work transforms into warmth which we measure in calorymeters.

Indirect biocalorymetry – is based on measurement oxygen quantity consumped by organism and further energy expenditures estimation with usage of data about respiratory coefficient (RC) and oxygen calorye equivalent.

Respiratory coefficient – is released carbonic dioxide volume correlation to used oxygen volume. Given method essence can be described on the example of glucose oxidation: $C_6H_{12}O_6 + 6O_2 = 6CO_2+6H_2O$. This reaction is well known for you from biology, chemistry and biochemistry courses. Released carbonic dioxide volume is equal

to one of used oxygen. Thus, at glucose oxidation RC= $6CO_2/O_2$=1. In case of fats oxidation it is equal to 0,7, proteins – 0,8.

As all nutrients in organism are undergone to oxidation simultaneously than after RC size determining one can approximately tell about dominant oxidation of one or other nutrient type. Every nutrient has its own energy valuation. That's why on RC size one can estimate oxygen calorye equivalent. If we know oxygen consumped amount we can estimate energy expenditure.

Organism energy metabolism consists of basal exchange and working addition.

Basal metabolism – is minimal level of expenditures necessary for organism viability support. It is defined under conditions of relatively complete physical and emotional rest. Under relative rest energy is expended to nervous system functions perfomance, constant substance synthesis, ion pumps work, body temperature support, respiratory musculature, smooth muscles, heart and kidney activity.

Basal metabolism determining is realized: in the morning, under rest state, on an empty stomach (the latest food taking must be 10-12 hours before investigation), at comfort temperature (22-24°C). Indicated standard conditions characterizes those factors which can influence on metabolism intensivity in human being. Metabolism intensivity is subjected to daily fluctuations. It is increased in the morning and is decreased in the night. It is changed at environment temperature changing (if it is below comfort zone than metabolism reactions intensivity is increased). In winter – is rised up, in summer – is reduced. Nutrients consumption, their further digestion (especially protheins) influence greatly on metabolism level. Metabolism intensivity and organism energetic expenditures increasing under food influence as for exchange and energy expenditures level taking place before eating is called ***specifically-dynamic food action.*** It is explained by energy expenditures to food digestion. Such food action may be up to 12-18 hours. It is mostly expressed at prothein food taking increasing metabolism intensivity up to 30 per cent and less significant at mixed food taking increasing metabolism intensivity up to 6-15 per cents. In babies specifically-dynamic food action is approximately on 30 per cents weaker than in adults. Prothein food causes basal metabolism increasing in children on 15-18% (in adults – on 30%); carbohydrate – on 10% (in adult – on 15%); fat – on 5% (in adult – on 15%).

In average basal metabolism size for person with mass 70 kg corresponds to 1600-1700 kcal /day (in women – less on 5-10%). Such factors as musculature development degree, liver, brain, heart, kidney, endocrine glands state influence on basal metabolism level. Basal metabolism is increased in small children with maximal velocity in the first year after birth (approximately from 120 to 600 kcal/day). After this basal metabolism growth is retarded again and accelerated again in puberty. But in children of any age basal metabolism level on 1 kg of mass is higher than in adults. It testifies to substance and energy metabolism more intensivity in children's tissues comparatively to those in the adult. Basal metaboilsm in children depends on constitution. In thin and agile children basal metabolism is higher than in thick and dismoved. Basal metabolism is increased at fever (in average, on 5 per cent while body temperature increasing on 1°C).

Basal metabolism changes more than on 10 per cent may serves as diagnostic criterium of such organism states as thyroid dysfunctions, recovery after hard and durable diseases, intoxication and shock.

Basal energy metabolism plus working addition (something delt with working activity type) is equal to **general (gross) metabolism.** It is the characteristics of daily energy consumption. Its level depends on energy scale for different population groups.

Population groups and norm for them in kcal/day:

1-st – servant: men - 2500-2800, women – 2200-2400 (we belong to this group as people of mental activity.

2-nd – workers of light physical activity: men – 2750-3000, women – 2350-2550.

3-rd – of middle on gravity physical activity: men – 2950-3200, women – 2500-2700.

4-th – workers of hard physical activity: men - 3450-3700, women - 2900-3150.

5-th – of very hard work: men - 3900-4300. Women mustn't be in this group.

Some scientists add one group – of non-working pensionners – their energy expenditures after their work stoppage must be significantly shortened and be not higher than in people of the 1-st group.

Mental activity doesn't require too significant expenditures like physical activity. Expenditures are rised up at mental activity in average only on 2-3 per cent. But mental activity accompanied by light muscular activity, psycho-emotional tension, leads to expenditures increasing on 11-19 per cent and even more.

Substance and energy metabolism regulation. It includes regulatory systems of multiple organism functions – respiration, blood circulation, excretion, thermoregulation and others. Hypothalamus plays role of substance and energy metabolism regulator. It is explained by the fact that there are nervous nuclei and centers there influencing directly on hunger and satiation and thermoregulation. Autonomic nervous system parasympathetic and sympathetic parts serve as metabolism regulation efferent system. Mediators releasing on their endings influence directly or indirectly through secondary messengers on tissues function and metabolism. Endocrine system is managed by hypothalamus and serves as substance and energy metabolism efferent system. Hypophysis, hypothalamus and other endocrine glands hormones influence directly on cells growth and development, supporting in blood necessary level of different substances (glucose, free fat acids, mineral ions and others). Cell is essential effector in these reactions. The most freaquent effects of regulatory influencings to cell are the following changes: of catalytic enzymes activity and their concentration, modulators, adenylates, common predecessors and common intermediate products action. Glucose concentration in blood (under norma it is equal to 0,8-1,2 g/l) is one of environmental integral indexes reflecting metabolism in organism. Eating act is both alimentary function powerful stimulator and gas exchange in organism. One can see both qualitative and quantitative metabolism changes. These changes character and level (size) depend on food chemical nature. Protein food taking is a sygnal to change primarily in protein metabolism and carbohydrate food consumption – in carbohydrate

metabolism. Food ration qualitative and quantitative content may occur pathogenetic factor in some dental diseases development. Excessive feeding doesn't influence directly on oral cavity organs state. But there occur metabolism diseases accompanied by teeth and mucosa injury under these states. Raw, solid food usage, its careful mastication encourages dental surface clearence and prevents dental covering forming. In people using porridge-like food dental covering is formed that may lead to caries and parodontosis development. Nutrients correlation disorder in food ration may be the reason of diseases taking place in oral cavity. For example, at excessive carbohydrates usage fermentation processes are enforced that favours microbes reproduction creating acid environment in oral cavity. Dental covering formation is increased on teeth, enamel dissolving is occured under these conditions that lead to cariesogenic teeth injury. That's why carbohydrates predominance in food ration requires vitamine B_1 (thyamine) increased content. Food usage with excessive protein content creates alkaline environment in oral cavity that may be the reason of gums disease (gingivitis). On the contrary, protein insufficiency leads to hypovitaminosis of B group vitamines. Oral cavity and lips are very sensitive indicator of vitamine insufficiency in food ration. It is explained by their rich blood supply and capillary net. Capillaries endotheliocytes respond subtly to vitamines content in blood. Vitamines play important role in oral cavity protection and its regeneration. Mucosa with less resistance is easier injured and harder regenerate than intact tissue of organism well-supplied by vitamines. Bacterias located in oral cavity cause inflammation easily at mucosa increased resistancy. Pathologic symptoms are always originated from the place where mucosa is undergone to mechanic action (mastication).

Avitaminosis may be developed at vitamines consumption decreasing, their usage disorder, increased need in them. Vitamine "A" deficiency causes oral mucosa epithelium keratinification, small submucose salivary glands atrophy (the latest fact lead to hyposalivation). Mucosa becomes dry, many cracks occur on it which are inficated easy that results into inflammational processes. Insufficiency of "B" vitamine group is expressed usually by oral mucosa inflammation, atrophye locuses existance on one's tongue, its swelling, angular cracks. Large vitamine "C" deficiency in the adult causes zinga. Zinga is characterized by spontaneous bleedings particularly from gums. Gums are swelled, red-zyanotic. As a rule, secondary infection is connected that enforces the bleeding. Teeth are covered with inficated and that's why stinking blood clot. Grey coating covers gums margin, painful ulcers are formed. At big inflammation duration gums and interdental papillas necrosis occurs. Vitamine "D" deficiency in odontogenesis disturbs enamelogenesis.

Among many factors determining diet quantitative properity chemical elements (micro- and macroelements) play important role. The biggest amount of elements from Mendeleev's table were found in uninjured tooth. Changes in dental-maxillar system may be linked with insufficient food mineralization (calcium, phosphorus), insufficiency or excessiveness of microelements content (iod, fluorum). While coming in organism through alimentary tract, they influence actively on various physiologic processes

particularly on bones and teeth mineralization. Resistancy or predisposition to caries, mineralization and demineralization processes in course of odontogensis and in formed tooth under norma and at pathology depend on microelements together with many other factors.

Essential condition of alive organism existance is thermal exchange between organism and external environment.

Thermal exchange and body temperature regulation. Temperature influences greatly on alive processes course in organism. Physico-chemical base of this influence is chemical reactions course velocity change. That's why body temperature influences upon its cells activity. Organism tissues temperature is defined by cellular structures metabolic thermal production velocity correlation to forming warmth dissemination velocity into environment. Such processes velocity correlation disorder leads to body temperature change. Mechanisms fixed in course of evolution by means of which organism may express resistance to lower and higher environmental temperature are essential for this.

All organisms according to mechanisms of homeostasis supporting are divided into 3 main groups:

- *poikylothermal* – changeable, which have no the ability to support body temperature on constant level, cold-blooded – amphibias, reptiles, fishes, crustaceas;
- *homoiothermal* – similar, warm-blooded, which can support body temperature on relatively constant level with daily and season fluctuations in the limits of 2 degrees – mammals, human beings;
- *poikylohomoiothermal* – under favourable conditions they belong to homoiothermal organisms, under unfavourable – to poikylothermal. Some insects reproduced by partenogenesis (ants, thermites, beans), colibry, crocodiles, tortoises, rodents, Chiroptera (flying mice) belong to this group.

Body temperature constant level in humans may be served only under the condition of dynamic equllibrium between heat production and heat emission. Such equillibrium is supported by thermoregulation physiologic mechanisms. One can differentiate 2 ways of thermoregulation: chemical and physical.

1. ***Chemical thermoregulation*** is performed by means of enforcement or weakening of cellular and tissular metabolism intensivity and expressed in heat production amount change. Heat source in organism are many organs and tissues but portion of their participation in heat production is rather various. Maximal heat production in organism occurs in muscles, liver and kidneys. One can say about 2 thermogenesis types:

1) Contractive – is linked with muscular thermoregulative activity. In turn, one can differentiate 2 subtypes of it:

- Thermoregulative tone - is analogous to muscular pose tone. It is performed like low-freaquened incomplete tetanus (impulses freaquency is 16 per 1 minute). Muscles of

neck, trunk and extremities flexors are involved in this reaction. That's why human being changes his pose (curls up into ball).

- Trembling – in switched on when internal body temperature becomes its reducing.

2) Non-contractive – connected with activation of heat special sources is realized due to brown fat tissue existance which in comparison with white fat has more mitochondrias (brown colour is provided by iron-containing enzymes – cytochromes which are important part of mitochondrial oxidative enzymatic system. Fat acids oxidation velocity in it predominates that in white fat in 20 times.

II. ***Physical thermoregulation*** is realized by means of heat emission changes. One can differentiate *several heat emission ways*:

- Heat radiation – heat releasing (emission) by organism due to infrared radiation out off body surface. Under rest state heat emission by this mechanism is about 60 per cent.
- Heat conduction and convection – direct heat emission to subjects attached to skin, air. It is the more intensive the more is temperature difference of body surface, air, surrounding subjects. Organism losses up to 15 per cent of warmth by this method.
- Evaporation – the way of heat dissemination by organism into surrounding environment due to its expenditure to sweat or moisture perspiration from skin surface and moisture from mucosae. Organism looses up to 19-20 per cent of heat by evaporation.

Thermoregulation is body temperature constant level supporting. It is performed by principle of self-regulation. Receptor structures - are receptors of coldness, warmth and burning. They are located in skin and mucosae. Excitement threshold for receptors of coldness (their amount is bigger and they are located more superficial than receptors of warmth) is in limits of 20-33°C (average - 26°C); for receptors of warmth - 40-46°C (average - 43°C) and for receptors of burning – everything that higher than 45°C.

Thermoregulative center is located in hypothalamic nuclei. Physical thermoregulation is performed by hypothalamic nuclear group located between anterior comissure and optic chiasma (heat emission center). Shortly, heat emission center is located in posterior hypothalamus. Under comfort (thermoneutral) conditions thermal equillibrium providing body temperature support at normal level is not in need of correction by special thermoregulative mechanisms. Environment temperature below than comfort causes activity increasing in perypheral receptors of coldness. This "cold" information increases the posterior hypothalamus efferent structures tone and causes hypersympathycotony as the result of such increasing. It is accompanied by cutaneous and subcutaneous vessels tone increasing. Result of these reactions: organism isolation increasing and heat serving by means of heat emission reducing. This process also leads to ***pilomotor reflex*** occurence (activation of smooth muscles fibres function rising hair covering). In parallel to this due to posterior hypothalamus work activating pose muscular tone regulatory system (thermoregulative tone and trembling appearence) heat production increasing occurs in organism (contractive thermogenesis). Due to adrenaline and noradrenaline releasing in course of this reaction energetic exchange in all tissues

becomes stimulated particularly in brown fat tissue (non-contractive thermogenesis). Such heat production adrenergetic stimulation is triggered by thyroid hormones action the releasing of which is increased at cooling. When organism is warmed up coldness receptors activity is reduced that leads to hypothalamic efferent structures tone decreasing. As a result sympathetic nervous system influencies on cutaneous and subcutaneous vessels are reduced and this reaction is accompanied by cutaneous blood supply increasing. Heat exchange adrenergic and thyroid activation is decreased in parallel to this. Thermoregulatory center influencings decreasing causes muscular tone and thermogenesis reducing connected with it. Under over heating conditions special sympathetic structures are activated managing perspiration through cholinergic nervous fibres. Heat emission through evaporating is increased as a result of this.

Human body temperature under norma is about 37°C. It is changeable in course of 24 hours: maximal - to 16-18 hours, minimal – to 4 hours. If temperature is decreased - it's hypothermia, if it is increased – hyperthermia. At temperature reducing below 35°C behaviour disorders take place, up to 31°C - human being is unconscious, at 24-26°C - he is dead. At body temperature increasing up to 39-41°C delirium can begin; at 41-43°C – heat shock and above 43°C - death. Sweat glands activity is essential for heat regulation. Their general amount on human body is up to 2,5 mln. The biggest number – on face, palms, soles, axillas (arm-pits). One can see constant (invisible) evaporation during which sweat is released from skin surface right after its emission. When forming sweat amount is big, it is accumulated near skin surface in drops (visible evaporation). Sweat releasing is observed not only in course of physical activity but also during mental activity. In course of psychical excitement and some emotions (fear, wrath, pain) cold sweat appears in people. Coldness sensation occurs because of skin cooling as vessels are constricted and skin blood supply is decreased simultaneously with sweat emission. Sympathetic nervous endings in sweat glands are considered to be cholinergic i.e. containing mediator acetylcholine releasing while excitement. Impulses causing sweat emission at temperature increasing come into sweat glands through cholinergic nervous endings while causing emotional sweating (sweat releasing) – through adrenergic. Under norma sweat amount per day reaches up to 500-900 ml, in summer – in 2-3 times more. At high temperature and hard physical activity – in 5-10 times and even more significant.

Oral mucosa temperature is determined by sequence of factors:

- environmental temperature and humidity,
- cellular metabolism intensivity;
- tissues anatomo-physiological features;
- their vascular net state.

The latest factor depends on capillaries quantity and degree of their filling as well as on velocity movements in arterioles. Mentioned data explains oral cavity organs temperature indexes different topography. Oral mucosa temperature depends also on saliva evaporation from mucosa surface for example at oral breathing. It is also one of

heat releasing way providing organism temperature constant level support. Besides, saliva and oral mucosa action that makes food temperature cooler or warmer (depending on necessity) is involved in thermoregulative functional system. It was established that every locus of mucosa has definite temperature. Inferior lip skin average temperature is equal to 33,1°C, superior lip - 33,9°C. Temperature is reduced in boarder region between skin and red lip limb (margin). Oral mucosa temperature is increased in caudal direction. Hard palate temperature is higher in its dystal parts and far from middle line.

Tooth temperature is also fluctuated in its different locuses with definite regularity: temperature is lower (30,4-30,5°C) on cutting limb and masticatory surface than in near-cervical region (30,9°C). They determine tendency to gradual temperature increasing in all crown's regions towards from central incisives to molars.

Oral mucosa and maxillar-facial skin initial temperature should be taken into account at treatment application by warmth or coldness. At facial nerve injury in corresponding innervation zones on face temperature is decreased on 8-10°C. Usual thermal procedures application in these cases can cause temperature dyscomfort sensation and even pain. Tooth thermometry plays very important role in rational tooth preparation ways development in such regime at which enamel, dentine and pulp thermal trauma will be minimal. Dentist should remember that in course of caries cavity forming or tooth preparation under crown dental tissues temperature increasing occurs due to resistance (friction) of acting (cutting or grinding) instrument. Tooth temperature rising up higher than 45°C may be enamel and dentin burn reason and lead to pulp thermal trauma. For these phenomena prevention one should select instruments taking into account bors and preparational dises size and shape, their rotation velocity as well as material they are manufactured. Besides, one should follow working regime with all instructions perfomance. Essential condition is also preparation continuosity and usage methods possessing high velocity. Special attention is paid to cooling type, cooling system properity and correct flow direction to contact place of cutting instrument with solid dental tissues.

Oral mucosa may undergo to temperature influencies which differ significantly from body temperature in course of food taking. Cold dishes or drinking cause mucosa injury seldom because their used amount is usually little and they are located in oral cavity for short. Cooling influence on mucosa circulation by following way: vasoconstriction occurs first, then at firther cooling it is enforced and microcirculation is almost completely stopped.

Strong cooling, for example, by chlorethyl doesn't destroy tissues and after its action stoppage their function are restored. Under heat influence hyperaemia is developed in mucosa and then after it - surrounding tissues oedema (swellimg). Hot dishes, warmed dental instruments (in course of activity) may cause mucosa restricted necrosis. Vesicle occurs despite burn which is ruptured soon with erosion forming. Thermal actions from oral receptors change circulation in salivary glands by reflectory way, that leads to saliva secretion increasing with different mucus, water, lyzozyme and other enzymes content.

Lecture 9

Excretion (separate organs and systems role). Oral cavity as excretory organ.

Excretion - is metabolism part realized by ending and intermediate metabolism products, side and excessive substances excretion out off organism for optimal environment content and normal viability providing. Excretion is closely connected with water exchange because main part of substances to be excreted from organism is released in a state soluble in water. Kidneys are main excretory organ secreting and releasing urine and substances necessary for excretion out off organism. Also kidneys are main organ of water-salty metabolism providing.

Excretory organs are following:

- kidneys;
- alimentary tract;
- lungs;
- skin;
- mucosae;
- salivary glands;
- lacrimal glands;
- sweat and sebaceous glands;
- milky glands (during lactation).

Excretory skin function – is mainly provided by means of sweat, sebaceous and milky glands. ***Sweat glands*** are essential for destruction products having been formed in course of metabolism, in heat regulation (sweat evaporation from skin surface enforces heat emission), in osmotic regulation (by means of water and salts excretion). Sweat contains up to 98-99 per cent of water, inorganic substances (sodium and potassium chloride), organic - urea, urinary acid, creatinine, flying fat acids. Up to 300-1000 ml of sweat is excreted in average for 24 hours. ***Sebaceous glands*** have less importance as for excretion than sweat (up to 20 gramms per day). Sebum cutaneum softens skin and lumbricates hairs. It consists of neutral fats. Sebum cutaneum is destructed under sweat acids with fat acids formation possessing special smell. ***Milky glands*** excrete milk, essential feeding product for new-borns. It contains proteins, fats, carbohydrates, vitamines, mineral substances, water. There are bacteriocydic substances, antibodies for chidren passive immunity in milk. Milky hormones are essential for growing organism. Good mother's mood helps normal milk secretion. Hard psychical emotions, fear, inhibited mood decrease milky secretion or even may lead to its complete stoppage. Particularly, rock-music has such influence.

Liver and alimentary tract excretory function is the following: these organs excrete some metabolism products with alimentary juices under normal conditions. ***Liver*** excretes haemoglobine and other porphyrines ending metabolism products with bile as bile; ending cholesterine products - as biliary acids. Thyroxine, urea, calcium, phoshorus, medicines, poisons are excreted with bile out off organism. ***Stomach*** provides metabolism products excretion as juice components (urea and urinary acid),

medicines and poisones (mercury, iod, salicylates). ***Intestine*** excretes food metabolism excessive and harmful products; alimentary juices and bile components, hard metals salts, proteins, water.

Lungs and respiratory ways excretory function is in flying metabolites and exogenic substances - carbonic dioxide, ammonium, acetone, ethanole and others – excretion from organism internal environment. Bronchi ciliate epithelium excretes lung tissue metabolism products as well as surfactant degradation products. Water is partially excreted through lungs as steam (from 400 ml under rest to 1 l at increased breathing).

Kidneys functions are various; but excretory function is dominant. Kidneys participate in organism water and ions equillibrium, osmotic constant level, acid-alkaline balance support; proteins, lipids and carbohydrates metabolism, erythropoiesis and haemostasis regulation thus performing excretory and non-excretory functions.

Uropoiesis is main kidneys function. Urine produces in kidneys from blood. Uropoiesis in kidneys is originated from blood plasma ultrafiltration in kidney glomeruli. 2 mechanisms are esseentlal in this process: filtrating membrane and pressure gradient. ***Filter*** providing uropoiesis consists of 3 layers:

- *capillary endothelium* – it has foramens with diameter up to 100 nm, through which water with substances dissolved in them comes free;
- *basal membrane* – it has very small pores through which formed elements and large molecules don't pass;
- *layer consisting of podocytes* between which fissure-like diaphragms with diameter about 10 nm are remained. These podocytes processes are contracted and relaxed due to myofibrilles and pump filtrate in capsule cavity as micropumps.

Filtrational pressure is created due to blood hydrostatic pressure difference in glomerular capillaries (it is equal to 70 mm of mercury column) and pressures sum impeding filtration (oncotic pressure - 30 mm merc. col. and ultraphyltrate capsular pressure –20 mm merc col). As a result, filtration pressure under norma is equal to 20 mm merc col. Filtration process is stopped when blood hydrostatic pressure in glomerule capillaries is reduced up to 40 mm merc col. Filtration level depends on afferent and efferent vessel cavity namely: efferent vessel constriction leads to filtration increasing, afferent vessel constriction – to its decreasing. Primary urins daily amount is about 180 l per day. It is identical to blood plasma only with protheins exception.

Uropoiesis second stage – is ***channel reabsorbtion*** and secretion. Water reabsorbtion and substances having filtrated in glomeruli occurs in nephron channels. One can tell about proximal and dystal reabsorbtion.

- *Proximal reabsorbtion* determines complete glucose reabsorbtion (that's why sugar glucose is absent in ending urine), protheins, aminoacids (that's why there is no prothein in secondary urine), water and sodium biggest part, potassium, chlorum, urinary acid, urea reabsorbtion. 1/3 ultrafiltrate volume is remained to proximal channel end. Glucose and aminoacids proximal reabsorbtion is performed by special transporters and is tightly

connected with sodium transfer. Such transfer is called active. Water absorbtion is realized passively and depends on sodium and chloridum reabsorbtion.

Distal reabsorbtion – ions absorbtion (about 10 per cents of sodium and chlorum ions) and water. Water is reabsorbed alongside all the channel. Reabsorbtion velocity is increased twice in dystal channel part. Henle loop descendant part epithelium passes water good, and ascendant – actively transports sodium ions from primary urine to tissular liquid due to kidneys outflowing-turning system. Urine concentrating and dissolving occurs in this system because substance transport processes in one knee of system are enforced (multiplied) by means of other knee activity. Ascendant knee performs dominant role in outflowing mechanism mechanism. Its wall actively reabsorbs sodium ions in surrounding intersticial spaces. Ascendant knee wall is permeable for water which comes passively from cavity in intersticial hypertonic environment. Urine becomes more and more hyperosmotic alongside descendant knee. Urine becomes less and less osmotic in descendant knee because of absorbtion and hypotonic urine comes in dystal channel cortex. Collecting tube formes outflowing system with ascendant knee. At vasopressine (antidiuretic hormone) presence collecting tube wall is permeable for water. With urine passage through collecting tubules into the depth of medulla water passes passively in intersticium hypertonic content and urine becomes more and more concentrated. There is also vascular outflowing system.

Outflowing systems action result – is ending (secondary) urine forming. Its character, finally, depends on blood osmotic pressure. Osmotic pressure increasing leads to hypothalamic osmoreceptors excitement, then information moves into neurohypophysis, releasing antidiuretic hormone. This hormone enforces dystal channel wall permeability for water and as the result of this urine becomes hypertonic. If osmotic pressure is reduced mentioned reactions will be weakened and urine will be hypotonic. Children on mother milk excrete hypotonic urine, on caw milk or artificial feeding mixture – more often are released hypertonic urine.

In ending uropoiesis definite place takes ***channel secretion.*** This is channel epithelium active transport in urine substances containing in blood or forming in channel epithelium cells. Channel secretion determines potassium, hydrogenium ions, organic acids, ammonium and other substances passage into urine.

Secondary or ending urine is about 65-80 per cent of used water, this is daily diuresis for 24 hours which is equal to 0,7-2,0 l. Urine reaction is usually light acid, but everything depends on food character. At primarily plant food urine becomes more alkaline, and at animal or prothein – more acid. It has definite colour, transparity, sediment.

Urореleasing is performed in the following order. First, urine comes into renal pelves. Renal pelvis and ureter smooth muscles possess automatism. With pelves filling by urine mechanoreceptors irritation occurs that causes pelvis musculature reflectory contraction and ureters opening. Urine passes into urinary vesicle due to their smooth musculature contractions like peristaltic. It stretches walls while its filling. But this stretching doesn't cause reflectory reactions directed to urine releasing till definite

vesicle volume (it is approximately equal to 250-400 ml). But when urine volume predominates these ziphras urinary vesicle wall mechanoreceptors irritation begins right after this that results in urine releasing. This process is under control of spine sacral parts. Impulses from this part cause urinary vesicle wall smooth muscle contraction and sphincter relaxation through parasympathetic fibres. In the adult day diuresis predominates night one in 2-3 times.

Kidney excretory function is essential for nitrogen metabolism products releasing - urea, urinary acid, creatinine and others. These substances accumulation in blood may cause toxic phenomenon development called uraemia. Uraemia leads to nervous system excitability reducing up to unconscious state (coma), external and tissular breathing, blood circulation disorders, body temperature decreasing and even to exitus letalis. If one kidney works normally uraemia won't occur. In uraemia case haemodyalisis is performed – kidneys artificial clearence from accumulating metabolites. One differentiates extra- and intracorporal haemodyalisis. The first one is artificial kidney, the second one – abdominal cavity washing.

Kidney metabolic function is provided by substrates and metabolites excretion. Kidneys metabolize small-sized peptides, denaturated peptides filtrating with urine and return them into blood. Kidney tissue possess the ability to perform gluconeogenesis. Such ability is higher in kidney than in liver if to count on mass unit. For example, almost 50 per cent of glucose is produced by kidneys in course of durable fasting.

Kidneys role in blood arterial pressure supporting is realized by following way: several substances the function of which is connected with vascular vessels cavity regulation are formed in kidneys. One of them is produced in juxtaglomerular apparatus and is called *renin*. Renin itself doesn't influence on vessels. It is the essential component of so-called renin-angiotensine-aldosterone system that regulates vascular vessels tone, sodium equillibrium in organism, circulating blood volume. Renin passing into blood circulation transforms angiotensine into angiotensine I. Further, in lungs (under special converting enzyme action) it transforms into angiotensine II. Blood pressure level depends on this substance concentration and activity. Renin secretion is increased at blood pressure decreasing (for instance, as a result of blood loss, hypotension of medical origin and other reasons), intrachannel pressure increasing (it can be found at ureter constriction, stones in kidney and ureter), at blood pressure reducing in afferent glomerular arteriole; at hypersympathicotony, sodium concentration increasing into dystal urine (urine of dystal channel).

Arterial pressure level in blood depends not only on renin synthesis in kidneys. Kidneys possess antihypertensive function due to depressors production - neutral medullar lipid, prostaglandines, kinines. Kidneys excrete water and electrolytes and their content in blood, extra- and intracellular environments is essential for arterial pressure support. Kidneys may also regulate arterial pressure on mechanism "pressure-diuresis". Arterial pressure increasing accelerates blood circulation through kidney medulla direct vessels. It leads to sodium and urea osmotic gradient washing (reducing) that decreases water reabsorbtion and, thus, weakenes kidney concentrational ability. Diuresis

increasing decreases blood circulating volume and makes blood pressure normal. At moderate (physiological) water consumption saliva and chimus osmotic pressure is reduced, that is percepted by oral cavity, alimentary tract osmoreceptors and liver osmo- and sodium-dependent receptors. Sygnals from these receptors with reflectory way usage before sodium and osmotic pressure level change in systemic blood circulation decrease vasopressine (antidiuretic hormone) neurosecretion and enforces uropoiesis right after drinking. Blood volume is restricted because of drunk water absorbtion as a result of sodium and water excretion by kidneys. It also can influence on blood pressure level and reflects ***kidneys homeostatic function.*** Excessive water consumption leads to hyperhydratation, osmotic pressure and plasmic sodium content reducing that also inhibits vasopressine neurosecretion. Water surplus is excreted out off blood as water reabsorbtion decreasing in dystal channels and collecting tubules. This process is triggered by urea absorbtion absence in collecting tubules that decreases kidney medulla intersticium osmolarity and restrictes water reabsorbtion in more extent. At described mechanisms insufficiency water is remained in organism. From one side, it may influence on blood pressure level, from another - it causes water exit in tissues and oedemas (swelling). Excessive hydratation leads to water poisoning and, finally, to brain haemorrhagias. On the contrary, water fasting or water excessive loss leading to circulating blood volume decreasing, causes renin secretion enforcement. Angiotensine-II appearence as a result of this, causes thirst development while drinking center stimulation. Angiotensine-II may be produced in brain tissue itself leading to thirst forming. Water fasting or excessive water loss cause cellular dehydratation and potassium ions exit with water that leads to strong disorders especially of central nervous system.

Kidneys participate in ***erythropoiesis regulation.*** Hormone-like substance *erythropoietin* is secreted in juxtaglomerular apparatus. It is as it is well-known is the only specific erythropoiesis regulator. Its concentration increases in blood at blood losses, oxygen low partial pressure (it is essential both for mountain regions residents and for those rising into highlands), at heart and lungs diseases. Erythropoietin action way: it accelerates and enforces stem cells transformation in erythroblasts, increases cellular mitosis amount, accelerates normoblasts and reticulocytes maturation.

Kidneys are delt with ***blood coagulation and fibrinolysis.*** They synthesize substances influencing on all haemostasis links: vessel-thrombocytic, blood coagulation and fibrinolysis. First of all, kidneys are vessel-thrombocytic haemostasis regulators. Probably, it is necessary for activity of kidneys themselves. They contain (and can release into circulation) different prostaglandines (particularly prostacycline), influencing directly on platelets aggregation activating and inhibiting. They either produce coagulational factors (for instance, thromboplastine) or release coagulation factors surplus accumulating in them (for example, fibrin degradation products and others).

Kidneys are essential for fibrinolysis regulation. *Urokinase* – natural plasminogen activator – is excreted from kidneys. This plasminogen activator receives from urine for

thrombosis, thromboembolic diseases, thrombotic disease treatment. In organism there exists very interesting dependence of urokinase producing on sodium chloridum concentration. The more sodium chloridum in organism the worse urokinase is produced. It should be taken into account by all lovers of salty products. In many aspects urine antiinflammational effect is connected with urokinase. People have been using urine for ages at inflammations on skin for example, burns, combustions, traumas. It is not occasional. Active fibrinolytic system is necessary for reparation, regeneration, restoration. Urine is natural product containing plasminogen activators. That's why urinotherapy is considered to be very widely spread nowadays in "folk medicine". Having detemined urine coagulational and fibrinolytic activity one can tell about kidneys functions and their disorders.

Oral cavity as excretional organ. Salivary glands are necessary for excretion together with other organs mentioned above. They excrete different substances form blood: iod, bromium, hard metals salts – mercury, vismute, gold, lead and others. Salivary glands are especially active as for their excretory function at kidneys insufficiency (compensatory principle of organism activity). Salivary glans excrete much urea which is transformed into ammonium under saliva influence. That's why patients are smelly from their mouth. Urinary acid is excreted in saliva at podagra (gut) while bile compounds - at jaundice.

In conclusion, telling "Good-bye" to you we would like to wish you following:

1. Stop to moan, to complaint on smth, to search for guilty every time – because these are main reasons of all your problems.
2. Don't ignore physical loadings, don't do physical trainings the company. Having started to do any physical exercises – continue all your life according to your genetical possibilities.
3. Don't forget that it's necessary to eat for live, not on the contrary. Remember: each 2,5 cm of waist circle as for breast are equal to 2 years of life.
4. Stop smoking, taking drugs and medicines and achieve this from other people.
5. Don't afraid any risk, life difficulties, go forward to them and learn to overcome them. Life is too short to loose it for triviality. Truth and politeness are the most valuable in this life. Smile, clever joke, truly word will help you and your relatives more than all medicines in the world.
6. Take in your Way your knowledge, love to work, because the of sweet "doing nothing" is over and world – is not a hall for loafers but great workshop! Create in it! Have a good journey through the country the of which is Your Life!

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