

Physiology of the Autonomic Nervous System or Hypothalamic Pituitary System

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Abstract: The neurophysiology of alertness. Definition of Awakening. Physiological, somatic, autonomic and behavioral indicators of alertness. Levels of alertness, behavioral manifestations, electrophysiological expression. Characteristics of the activity of neurons in different brain structures in different functional and behavioral states. Morpho-functional organization of the waking state. Structure, afferent and efferent connections of the reticular formation (RF) of the medulla oblongata, midbrain and pons. Features of cell structure, convergent and divergent properties of RF trunk neurons. Areas of sensory and reticular activation of the cerebral cortex (CHC) in the cerebral cortex. Features of the topography of somatosensory, visual, auditory, nociceptive, proprioceptive impulses in different parts of the RF trunk. Mediator systems of the brain stem: cholinergic (midbrain tegmentum and pons), noradrenergic (locus coeruleus and lateral tegmental nucleus), serotonergic (raphe nuclei), dopaminergic (substantia nigra, ventral tegmental area and retrorubral area). Innervated structures, areas of efferent projections, main functions. Preparations "isolated brain" and "isolated forebrain". Effects of high-frequency and low-frequency RF stimulation of intact and anesthetized animals (works by G. Moruzzi and H. Magun) and at different levels of brainstem transection. Non-specific, activating, tonic effect on the cerebral cortex of the Russian Federation. Pons. RF bridge. Pretrigeminal and posttrigeminal drugs. The idea that RF integrity of the medulla oblongata, midbrain, and pons is necessary to maintain alertness.

Key words: Functional organization of cerebral cortex, Instinctive behavior, emotions, motivation, Regulation of visceral functions.

Neurophysiology of sleep. Clinical observations. Works of Bremer. Stages of sleep, behavioral, somatic, vegetative, electrophysiological characteristics, metabolic rate. Theories of sleep: toxic, anabolic, IP concept. "Sleep center" according to Pavlova, Hess, the vegetative nature of sleep, the role of deafferentation in the emergence of sleep, the concept of active and passive sleep, sleep as a factor of psychological adaptation, sleep as an instinctive behavior, the role of sleep. sleep while processing information, etc. Orthodox (slow sleep) and paradoxical sleep (rapid sleep): stages, behavior, myographic, pneumographic, ECG, EEG characteristics, temporal relations, functional significance. Effects of brainstem RF ablation and ablation on sleep development. Structures of the brain stem responsible for the slow-wave phase of sleep (medulla oblongata, nuclei of the solitary tract, raphe

nucleus, pons). Neurophysiology of paradoxical sleep, Jove's work, brainstem and pons structures responsible for the development of paradoxical sleep and its various parts. Neurochemistry of sleep. The role of serotonin, norepinephrine, acetylcholine and other mediators, neuropeptides, pineal nucleases, lipopolysaccharides, prostaglandins, oligopeptides, polypeptides in the occurrence of sleep and its stages. Immune theory of sleep: muramyl peptides, interferon- $\alpha 2$. Delta sleep peptide - functional significance, effect on different stages of sleep. Evolution of sleep (fishes, amphibians, reptiles, birds, mammals), behavioral, myographic, EEG and ECG features. Sleep characteristics of aquatic mammals. Ontogeny of sleep.

4. The role of the mesencephalon, limbic system and cerebral cortex in the regulation of sleep and wakefulness. Nonspecific nuclei of the thalamus, morphology, afferent and efferent connections, functional organization and properties of neurons. The synchronizing mechanisms of the thalamus, the "attraction" reaction, the hypothesis of Anderson and Eckals about the thalamus as a filter of the increased activating effect of the Russian Federation. The hypothalamus as a center that regulates sleep and wakefulness. Features of the effect of stimulation of the anterior and posterior hypothalamus. Interaction of brainstem and cerebral cortex with RF. The limbic system is the second arousal system. Hippocampal theta rhythm as an indicator of sleep and wakefulness. The role of the cerebral cortex (CBC) in the regulation of brain activation. Phenomena associated with decortication, features of the regulation of sleep and wakefulness by different parts of the brain.

Regulation of visceral functions.

1. Autonomic nervous system. Autonomic nervous system (ANS): division into sympathetic (SNS) and parasympathetic (PNS) nervous systems. Main directions of ANS research. The principles of the anatomical and morphological structure of the ANS, the main differences from the spinal cord system. SNS. Central section, anatomy, morphology. Peripheral section, paravertebral and prevertebral nodes and fibers. Innervated organs. SNS intermediaries. Physiological effects of SNS. PNS. Central part (midbrain, medulla oblongata, sacral spinal cord), main nuclei. Peripheral part of PNS, main nodes, pre- and postganglionic fibers, innervated organs and tissues. PNS mediators, physiological effects. Physiology of the vagus nerve. Types of reflex arcs formed by the ANS and the main reflexes. Drooling, tearing, sneezing, etc. Comparative descriptions of SNS and PNS functions. Metasympathetic nervous system (Auerbach and Meissner's plexuses), functional significance, connection with SNS and PNS, reflex arcs, mediators.

2. Regulation of breathing. Understanding of respiratory physiology: organs, muscles, tissues involved in breathing. Breathing reflexes. Reflex arcs. Mechano- and chemoreceptors. The respiratory center of the medulla oblongata. Inspiratory and expiratory areas (giant cell and lateral reticular nuclei, area of solitary tract nuclei, nuclear indeterminate area). The effect of incentives. Characteristics of neurons in these areas. Interaction of neurons in the inspiratory and expiratory zones. Understanding the autorhythm of breathing. The effect of stretching the upper respiratory tract, lungs, intercostal muscles on the inhalation-exhalation cycle. The role of the vagus, solitary tract, hypoglossal nerves in the regulation of breathing. Chemoreceptive zones of the ventral surface of the brain stem. Effects of blood pH on

respiration. The pneumotoxic center of the bridge, inspiratory and expiratory neurons, activation characteristics during inhalation and exhalation, interaction of the medulla oblongata with the respiratory center. Effects of bridge removal on respiratory rhythm. Spinal cord. Interaction of intercostal nerve nuclei with motor neurons and phrenic nerve nucleus, respiratory center of medulla oblongata. The role of the cerebral cortex in the regulation of breathing.

3. Regulation of blood pressure and blood flow. Vasomotor center of the medulla oblongata. Pressor, depressor areas of the medulla oblongata, stimulating effects. Chemo- and baroreceptors of blood vessels. Afferent inputs, efferent connections with vasomotor sympathetic nerves. Regulation of cardiovascular reflexes, communication with the respiratory center of the medulla oblongata, and functions of the nucleus of the single pathway of sensory information. Effects of midbrain RF on vasomotor responses, stimulatory effects.

4. Hypothalamic regulation of visceral functions. Hypothalamus, morpho-functional organization, main nuclear groups, afferent connections, efferent projections, histochemical classification of hypothalamic nuclei. Ergotropic and trophotropic areas, stimulating effects. Regulation of blood pressure, breathing.

5. Nervous regulation of endocrine system functions. Endocrine glands, functional properties, hormones. Pituitary gland: neurohypophysis, adenohypophysis, phylo- and embryogenesis. Connection system between hypophysis and hypothalamus: hypothalamus-pituitary pathways, hypophysis portal system. Hypothalamic hormones: antidiuretic hormone (ADH, vasopressin) and oxytocin. Functions of ADH, localization of its secretion in the hypothalamus (supraoptic and paraventricular nuclei), transport and storage in the pituitary gland. Factors causing ADH secretion. The role of osmoreceptors of the hypothalamus in the regulation of ADH secretion. Mechanism of action of ADH on urination. Mediator features. Functions of oxytocin, localization of secretion in the hypothalamus, transport and storage in the pituitary gland. Effects of oxytocin on uterine contractions and milk production. Phylogenetic and ontogenetic aspects of ADH and oxytocin functions. Hypothalamic control of adenohypophysial functions. Embryogenesis of the anterior and middle lobes of the pituitary gland. Tropic hormones of the anterior and middle lobes of the pituitary gland, chemical nature, physiological effects, target glands. Tropic hormone release factors (release and inhibition), localization of secretion in the hypothalamus, transport to the pituitary gland. Feedback principle in nervous regulation of endocrine functions. The role of the brainstem, limbic structures and cerebral cortex in the regulation of endocrine functions. Adaptation-trophic syndrome, stress. Stages of stress, involvement of the hypothalamus-pituitary and sympatho-adrenal systems in the body's adaptation to harmful factors. Hormonal imbalance during stress (adaptation disease).

6. Regulation of body temperature. The idea of self-regulatory systems, feedback and set point. Mechanisms of thermolysis. The role of the anterior and preoptic hypothalamus, the effects of stimulation, destruction. Heat, cold, thermosensitive receptor neurons of the hypothalamus. Role of peripheral thermoreceptors. Hot and cold receptors of the spinal cord, connections with the anterior hypothalamus. Set the surface temperature of the skin, internal organs and brain. Mechanisms of thermogenesis and heat preservation. The role of the posterior hypothalamus, the effect of stimulation.

Interaction with thermoreceptors of the preoptic area of the hypothalamus, midbrain and medulla oblongata. The role of thermosensitive RF neurons of the midbrain and medulla oblongata in maintaining a certain body temperature. Integration of visceral, endocrine, somatic and behavioral responses.

7. Regulation of eating behavior. Understanding body weight regulation and set point. Food motivation. The lateral nucleus of the hypothalamus as a center of hunger, the effect of stimulation, destruction. The ventromedial nucleus of the hypothalamus is the center of satiety, extinction and stimulation effects. Neurochemical organization of the hunger and satiety center. Glucose-sensitive neurons of the hypothalamus, functional properties, interaction of glucoreceptors of the lateral and ventromedial nuclei. Peripheral glucoreceptors. Afferent inputs of taste, smell, visceral and other receptors characterizing food. Neurochemical organization of eating behavior (norepinephrine, cholecystokinin, galanin, glucose, neuropeptides). Body weight regulation through the integration of visceral, endocrine, and behavioral responses. The role of limbic structures and cerebral cortex in the regulation of eating behavior.

Instinctive behavior, emotions, motivation.

1. Regulation of sexual behavior. Factors determining sexual behavior. Time of embryogenesis and physiological activity of gonads in animals of different sexes. Effects of gonadal hormones (androgens and estrogens) on sexual differentiation of the hypothalamus. Experiments on land reconstruction. The role of follicle-stimulating and luteinizing hormones of the hypothalamus in the regulation of gonadal functions. Tonic and cyclic centers of the hypothalamus. Estrus cycle. Phylogenetic features of sexual behavior of vertebrates. Effects of sex hormones on sexual behavior. Hypothalamic centers of sexual behavior, the effects of stimulation and extinction. The role of limbic system structures in the formation of sexual behavior (amygdala, hippocampus, septum, anterior thalamus, mammillothalamic tract, medial forebrain fasciculus). Influence of the medulla oblongata and pons structures on the spinal and autonomic reflexes of the lumbar and sacral parts of the spinal cord.

2. Limbic system. Morpho-functional organization of the limbic system. Hierarchy of structures that make up the limbic system. Hippocampal circle, cortical formation of the limbic system. Intralimbic connections with RF of the midbrain, hypothalamus, amygdala, cerebral cortex, afferent and efferent connections of limbic structures. Functional significance of the limbic system. The idea of the limbic system as an olfactory analyzer, an emotional brain, a visceral analyzer, and a second arousal system.

3. Neurophysiology of emotions. Definition of emotion. Structures of the limbic system involved in emotional reactions of the body. Characteristic emotional reactions and their behavior in stimulating or destroying various structures of the limbic system (hippocampus, septum, amygdala, hypothalamus, entorhinal and orbital cortex, cingulate gyrus, piriform and frontotemporal lobes). Functional meaning of emotions. Basic theories of emotions: PK Anokhin's biological theory of emotions, PV

4. Neurophysiology of motivation. Definition of the concept of motivation (needs, feelings, motivation interdependence). Neurophysiological studies of motivation, J. Olds' method of self-motivation. Structures and areas of positive and negative self-stimulation, their connection with the basic needs of the body. Self-motivation as a reinforcement factor.

Functional organization of the cerebral cortex.

1. Representation of functions in the cerebral cortex. The structure of the cerebral cortex. Division into cytoarchitectonic areas. Specialization of cortical neurons, types of synaptic devices, functional properties. Afferent, efferent, intracortical, interhemispheric connections. Columns as an elementary functional ensemble of cortical neurons. Convergent properties of cortical neurons, detection, polysensory, multimodality. Glial elements, classification, functional role. Projection of primary, secondary and tertiary zones of analyzers. Characteristics, functional organization of afferent and efferent connections. Association areas of the cerebral cortex, morpho-functional organization. Expression of functions in the cerebral cortex. Theories of narrow localization and equipotentiality of functions. IPPavlov's dynamic localization of the cortex and analyzer functions, current state of the problem, phylogeny, morpho-functional organization, effects of stimulation, lesions, animals and humans. Temporal region of the cerebral cortex, morpho-functional organization. Afferent and efferent connections. Effects of stimulation, withdrawal, damage in animals and humans. Control of vestibular apparatus activity. Parietal cortex, localization, development in evolution, morpho-functional organization. Structural features of primates. Afferent and efferent connections. Functional properties of neurons.

2. Speech function. Speech is a product of the evolutionary development of the animal world, as a tool of thought and a category of higher nervous activity. Expressive and effective speech. Broca's speech center, localization, motor functions. Wernicke Writing Center. Effects of damage to the motor center of speech, motor efferent aphasia. Wernicke's speech perception center in the temporal lobe of the cerebral cortex, its functional role, features of speech dysfunction when different areas of Wernicke's area are damaged, sensory aphasia. The center of perception of written speech, localization, lesion effects. Interaction of speech centers of different areas of the cerebral cortex, an integral mechanism of speech function. Subcortical areas of mental and speech functions, NP Bekhtereva.

3. Joint work of cerebral hemispheres and its functional asymmetry. The principle of bilateral symmetry of the body and the central nervous system. Dominance and subdominance of CBP in relation to speech, motor and sensory functions. Wada test. Anatomical conditions, ontogenetic conditions of strengthening the dominance of the hemisphere. Suggestions about the causes of functional asymmetry of the cerebral cortex. Pair work of the cerebral cortex, anatomical and physiological conditions. Synergy and interaction in the work of the cerebral hemispheres. IMSechenov, NEVvedensky, IP Afferent and efferent transmission of conditioned reflexes. Effects of corpus callosum dissection on behavior and conditioned reflex activity, analytical and gnostic functions.

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