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From Tissue to Autonomic Nervous System

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1. Behavior, defined as purposeful motor action of the organism in the environment, is generated by coordinated activation of the somatic, autonomic and neuroendocrine motor systems. The internal milieu of the organism is actively prepared and adjusted by the brain via the autonomic and neuroendocrine systems.

2. The autonomic nervous system is involved in many regulations to adapt the organs and tissues to the internal and external demands on the body. The peripheral building blocks of these regulations are the autonomic pathways, consisting of populations of pre- and postganglionic neurons that are functionally defined according to the effector cells they supply (vascular smooth muscle cells, non-vascular smooth muscle cells, secretory epithelia, endocrine cells, etc.).

3. Each group of target cells is innervated (and regulated) by one (rarely two) autonomic peripheral pathways. Neurons of a functionally defined autonomic pathway exhibit a typical discharge pattern which is the result of integrative processes in distinct neural circuits of the spinal cord, brain stem, hypothalamus and telencephalon.

4. Impulse activity in preganglionic neurons is transmitted in the autonomic ganglia to postganglionic neurons of the same functional type. There is no communication between functionally different autonomic pathways in the ganglia. Activity in postganglionic axons is transmitted to most effector cells via anatomically and functionally defined neuroeffector junctions.

5. Spinal cord, brain stem and hypothalamus contain functionally distinct neural circuits that are connected to the final autonomic pathways. The lowest level of central integration occurs in the spinal cord for spinal autonomic systems and in the brain stem for cranial parasympathetic systems. The basic reflex circuit is the spinal autonomic reflex or the equivalent reflex pathway in the brain stem between primary afferent neurons and preganglionic neurons. This basic reflex is integrated in every regulation mediated by the autonomic pathways.

6. The lower brain stem (pons and medulla oblongata) contains the neural circuits involved in homeostatic cardiovascular regulation and its integration with the regulation of respiration, body core temperature, pelvic organs, and gastrointestinal tract (including regulation of food intake and metabolism).

7. Neural circuits in the spinal cord and lower brain stem, which represent the different types of homeostatic regulation, are integral components of complex regulations represented in the hypothalamus and mesencephalon. These complex regulations include neuroendocrine systems and somatomotor systems and constitute elementary behaviors. They are related to regulation of body core temperature, reproduction, fluid homeostasis, metabolism and nutrition, body protection and circadian timing of body functions. The telencephalon (neocortex and limbic system) adapts these functions to the external state of the organism.

8. The sympathetic nervous system is involved in the regulation of protection of body tissues against external and internal threats. This function is closely related to the neural control of the immune system. During fast defense (confrontational defense [fight] or flight when threat is escapable; quiescence, immobility or decreased responsiveness when threat is inescapable) the body is prepared for protection, and during slow defense, characterized by a behavioral pattern during inescapable threat, the organism switches to recuperation. Both involve the sympathoneural systems and the sympathoadrenal system; they are related to the neural control of inflammation and sensitivity of nociceptors. The sympathetically mediated protective functions are controlled by neural circuits in the spinal cord, lower and upper brain stem (in particular the periaqueductal gray) and hypothalamus. These in turn are potentially under telencephalic control.

9. The core concept of osteopathic medicine, as it has developed in the last century, is to use the body's endogenous recuperative power and promotion of self-healing in the manual therapeutic approach. This concept connects the biological and pathobiological processes in the deep body domains and their regulation by the brain, involving afferent systems, neuroendocrine systems and neural motor systems, with health and disease of the organism. Is this concept still tenable in the light of modern neurobiological research in the fields of pain, neural regulation of autonomic targets and regulation of the somatomotor system? Does this concept reflect mechanistically the neurobiological complexities on which the functioning of the body in health and disease and the curative manual interventions in disease are based? Will this concept lead to answers explaining why manual therapeutic interventions can be successful in the treatment of dysfunctional states of the body involving the autonomic nervous system and the small diameter afferent systems, including their central representations? Does the concept supply us with ideas as to how functional disorders of the body are anchored in modern neurobiology? We have to reformulate the concept of osteopathic medicine on the basis of modern research in neurobiology. Clinical investigations on patients, research on the human subject as model (healthy subjects and patients) and research on animal models have to be more closely integrated.

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