

Sympathetic and Parasympathetic Action

This answer is oriented to dentistry students.

Autonomic Centers in the CNS

- Mechanisms related to maintaining homeostasis acts on three major systems
 - Endocrine System
 - Autonomic Nervous System
 - Behavioral homeostatic mechanisms

Spinal Cord, Brain Stem

Autonomic centers integrate signals from autonomic and somatic receptors, and from the higher brain centers (hypothalamus, limbic system)

- Spinal cord → Intermediolateral cell column (thoracolumbar & sacral division)
- Brain stem → Cranial nuclei and autonomic centers
 - Respiratory centers
 - Vasomotor & cardiorespiratory centers
 - Control of pupil diameter center
 - Micturition center
 - Sexual reflexes center
 - GIT motility & secretion center

Hypothalamus

- Control functions
 - Energy balance, food intake
 - Body fluid homeostasis, water balance, water intake
 - Thermoregulation
 - Sexual function
 - Autonomic control (respiration, vasomotor reactions, activity of heart)
 - Body rhythms
 - Mechanisms of immunity
 - Emotional behavior
- Receptor functions
 - Glucoreceptors
 - Osmoreceptors
 - Thermoreceptors
 - Receptors for hormones
- Effector functions
 - Hormone production
 - Neural control of the ANS
 - Neural control of the brain activity (modulatory neural pathways)
 - Behavior (sexual, feeding, thermoregulatory behavior)

Epithalamus, Pineal Gland

- Body rhythms → Circadian, annual cycles

Basic characteristics of Sympathetic & Parasympathetic functions

- Synaptic transmitters
 - All preganglionic neurons are cholinergic (acetylcholine, nicotinic) in both SYM & PAR fibers
 - The postganglionic neurons of PAR are cholinergic (acetylcholinergic, muscarinic)
 - The postganglionic neurons of SYM are adrenergic (Norepinephrine)
 - Post sympathetic neurons to sweat glands, piloerector muscle and some few blood vessels are cholinergic
 - Post sympathetic neurons to sweat glands, piloerector muscle and some few blood vessels are cholinergic
- Acetylcholine
 - Is synthesized and stored in the terminal endings of cholinergic nerve fibers
 - Secreted acetylcholine is split to acetate & choline by enzyme (acetylcholinesterase) in the local connective tissue
 - Choline is then transported back into the terminals and used for the synthesis of new Acetylcholine

- Norepinephrine
 - Synthesis of Norepinephrine begins in the axoplasm of the terminal nerve endings of adrenergic fibers and is completed inside the vesicles
 - Tyrosine → DOPA → Dopamine → Transport into vesicles → Norepinephrine
 - After secretion Norepinephrine is removed
 - Reuptake into the adrenergic nerve terminal (70%)
 - Diffusion and removal by blood
 - Destruction by enzymes (MAO, COMT)
 - Norepinephrine secreted into a tissue remains active for few seconds
 - Norepinephrine secreted into the blood remain active for 10 to 30 seconds (up to several minutes) and then it is destroyed (mainly in liver)

Receptors of acetylcholine & catecholamines

- The receptor is usually on the outside of the cell membrane. When the transmitter binds, it causes conformational change in the structure of protein molecule, causing:
 - A change in the cell membrane permeability to one or more ions (Ca^{2+} , Na^{2+} - depolarization, K^{+} - hyperpolarization)
 - Activation of an enzyme attached to the other end of the receptor protein protruding in the interior of the cell (Adenylcyclase - cAMP)
- Acetylcholine activates two different types of receptors
 - Muscarinic receptors
 - In all effector cells of the parasympathetic (PAR) neurons and parasympathetic cholinergic neurons of the SYM system
 - Nicotinic receptors
 - In synapses between the pre- & post ganglionic neurons of both the SYM & PAR system
 - Neuromuscular junctions of the skeletal muscle
- There are two major types of adrenergic receptors
 - Alpha receptors
 - Excited by epinephrine, and strongly sensitive to norepinephrine
 - Certain alpha functions are excitatory, other are inhibitory
 - Beta receptors
 - Excited by epinephrine, weakly sensitive to norepinephrine
 - Certain beta functions are excitatory, other are inhibitory