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 & cardioregulatory 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
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- 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

- Norepinenphrine
  - 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 → Norepnienphrine
  - 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 (Ca2+, Na2+ - depolarization, K+ - hyperpolarization)
  - Activation of an enzyme attached to the other and 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 postganglionic PAR neurons and postganglionic 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
- The 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 be epinephrine, weakly sensitive to norepinephrine
    - Certain beta functions are excitatory, other are inhibitory