

# AUTONOMIC NERVOUS SYSTEM

**Sympathetic Nervous System: The branch of the autonomic nervous system that controls our fight or flight response. Originate between T1-L2.**

1. Short preganglionic fiber synapses in the sympathetic trunk, the collateral ganglia or (in one case) directly on the adrenal medulla. Releases ACh onto the dendrites of the postganglionic neuron at the ganglion.
  - Sympathetic trunk synapses go to
    - Blood vessels, sweat glands, arrector pili of skin
    - Face: eye, salivary glands, lacrimal glands
    - Thorax: Heart, bronchioles
  - Collateral ganglia include the: celiac ganglion, superior mesenteric ganglion, and the inferior mesenteric ganglion. These axons leave the spinal cord, then travel via splanchnic nerves to their collateral ganglion in the abdomen.
2. long postganglionic fiber releases norepinephrine onto the adrenergic receptors of the target organ.
  - Heart has **Beta 1 adrenergic receptors** that respond to NE by increasing heartrate and force of each contraction.
  - bronchioles have **Beta 2 adrenergic receptors** (1 heart, 2 lungs). Many medications target these receptors for heart and respiratory problems.
  - Blood vessels of abdominal organs and skin have **alpha 1 adrenergic receptors** and constrict in response to norepinephrine; overall this increases blood pressure and decreases digestive activities
  - Digestive glands are inhibited
  - Arrector pili muscles of the skin constrict and cause goose bumps and hair stands on end.
  - The adrenal medulla is the exception to the "short" preganglionic fiber rule of the sympathetic nervous system; it travels all the way to the target organ. The cells of the adrenal medulla are actually the postganglionic neurons. They release NE and Epinephrine directly into the bloodstream. This enhances all body organs' fight or flight response and makes it last longer, too.

**Parasympathetic Nervous System: The branch of the autonomic nervous system that controls our rest and digest response. Originates from the brainstem (cranial nerves) and the lateral gray matter of S2-S4.**

1. Long preganglionic fiber synapses at or near the target organ.
  - Most leave via vagus – affect heart, lungs and abdominal organs
  - Some leave via oculomotor, trigeminal, facial, glossopharyngeal
  - Release ACh onto dendrites of postganglionic neuron in a ganglion found near the target organ.
2. Short postganglionic fiber releases ACh onto the target organ.
  - Oculomotor: ciliary body contracts to constrict pupil and bend lens
  - Trigeminal ophthalmic branch: lacrimal gland is stimulated to produce tears
  - Facial: lacrimal gland, salivary glands stimulated
  - Glossopharyngeal: salivary glands stimulated
  - Vagus: slows cardiac muscle, stimulates digestive glands and smooth muscle of digestive glands
  - Sacral nerves: stimulates reproductive glands and smooth muscle of reproductive and urinary organs

## SUMMARY OF AUTONOMIC EFFECTS

| ORGAN                                   | PARASYMPATHETIC EFFECTS<br>(acetylcholine released onto muscarinic cholinergic receptors) | SYMPATHETIC EFFECTS (primarily norepinephrine released onto adrenergic receptors)  |
|---|---|--|
| Glands                                  |   |  |
| Salivary                                | Stimulated—cranial nerves VII, IX   | Inhibited—dry mouth  |
| Lacrimal                                | Stimulated—cranial nerves V, VII  | Inhibited—dry eyes   |
| Mucous                                  | Stimulated  | Inhibited  |
| Pancreatic                              | Stimulated—digestive enzymes released   | Inhibited  |
| Sweat                                   |   | Stimulated   |
| Stomach Gastric                         | Stimulated—HCl released   |  |
| Intestinal                              | Stimulated  |  |
| Stress Gland: Adrenal medulla           |   | Releases epi and norepi – enhances all aspects of fight or flight  |
| Smooth Muscle Around Blood Vessels      |   |  |
| skin blood vessels                      |   | Constricted via alpha adrenergic receptors   |
| Kidney blood vessels                    |   | Constricted via alpha adrenergic receptors, decrease urine output  |
| skeletal muscle blood vessels           |   | Dilated via Beta 2 adrenergic receptors  |
| Heart blood vessels (coronary arteries) |   | Dilated via Beta 2 adrenergic receptors  |
| Penis/clitoris blood vessels            | Erection  |  |
| Other smooth muscle sites               |   |  |
| around bronchioles                      |   | Dilated via Beta 2 adrenergic receptors  |
| around stomach and intestines           | Stimulated—movement and digestion occurs  | Inhibited  |
| arrector pili                           | No innervations   | Stimulated—goose bumps and hair stands on end  |
| Penis/clitoris                          |   | Vaginal/penile contractions of orgasm  |
| Cardiac Muscle                          | Inhibited—heart rate slows and force of heart beat lessens                                | Stimulated via Beta 1 adrenergic receptors—heart rate and force of contraction increases; increase BP  |
| Adipose Tissue                          | Lipogenesis: Fatty acids stored as triglycerides  | Lipolysis occurs, fatty acids released into bloodstream  |
| Liver                                   | Glycogenesis: Glucose stored in long chains called glycogen<br>Lipogenesis                | Glycogenolysis: glycogen broken down into glucose; incr. blood sugar<br>Gluconeogenesis: fatty acids and amino acids are used to build glucose<br>Glucose released into bloodstream<br>Lipolysis |