

# Lecture 11, Feb 16, 2023

## Somatic Nervous System

- The somatic motor system consists of a somatic neuron exciting a muscle
  - The synapse between the neuron and the muscle is called a neuromuscular junction
    - \* Works on the same mechanism with calcium
    - \* Acetylcholine (ACh) is used as neurotransmitter
  - The neuron is myelinated

## Autonomic Nervous System

- The autonomic motor system has a chain of two neurons
  - The cell body outside the CNS is the ganglion
  - The preganglionic neuron is myelinated, the postsynaptic neuron is not
  - The postganglionic fibre can go to gland cells, smooth muscles (surrounding organs and blood vessels) or cardiac muscles (heart)
- The autonomic nervous system is split into the *sympathetic* and *parasympathetic* nervous systems
  - These systems work against each other – sympathetic is the accelerator, parasympathetic is the brake
  - Almost every organ is controlled by both systems, but in different ways
  - Note there is always some tonic activity happening – it's not either on or off

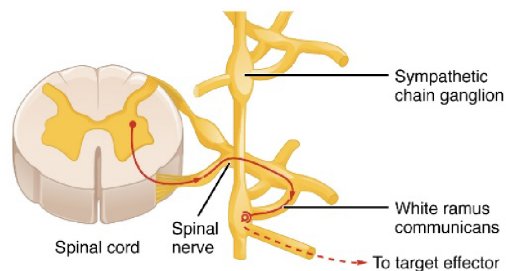


Figure 1: A central neuron synapses with a ganglion at the same level

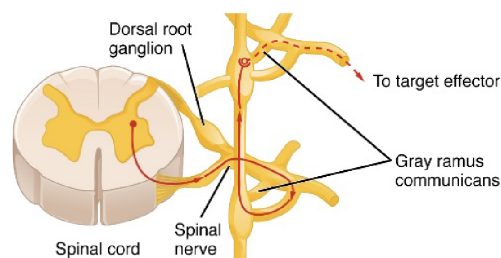


Figure 2: A central neuron synapses with a ganglion at a different level

- In the sympathetic nervous system:
  - The nerves come out of the thorax and lumbar regions (middle of the spine)
  - The preganglionic fibre is very short – the synapse is almost right outside the spinal cord and the postsynaptic fibre goes to the organ
    - \* Near the spinal cord there are chain ganglia, which nerves can travel up and down and then go out
    - \* Some of them might have the synapse (collateral ganglion) past the chain (this is usually with abdominal muscles related to digestion)

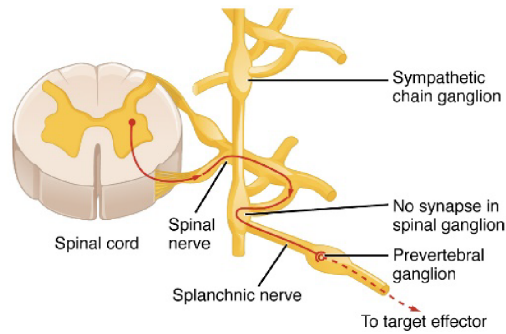


Figure 3: A central neuron that does not synapse within the chain ganglion

- The adrenal gland, sweat glands, and arterials (vasoconstriction, constriction of blood vessels) only have sympathetic nerves
- In the parasympathetic system:
  - Most nerves come out from the cranial nerves
  - The vagus nerve goes to all the organs
    - \* This has a very long preganglionic fibre and goes to a bunch of organs
  - At the very bottom of the spine there are a few more nerves
  - The postganglionic fibre is very short – the ganglion is almost on the organ
  - The cranial and sacral nerves only have parasympathetic nerves
- Sensory and somatic motor neurons are big and heavily myelinated, so they are the fastest; the preganglionic autonomic neurons are myelinated and the postganglionic ones are not, so the parasympathetic nervous system is faster, as it has a longer preganglionic nerve and shorter postganglionic nerve
  - Myelination takes up a lot of room, so there is a tradeoff

## Cholinergic and Adrenergic Receptors

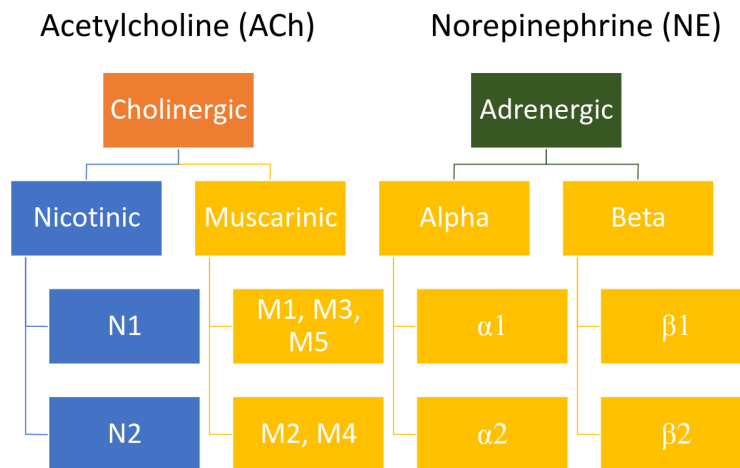


Figure 4: Types of receptors

- The autonomic nervous system has a web of connections
  - Varicosities hold neurotransmitters, which are released when calcium triggers exocytosis
  - This is called a neuroeffector junction (NEJ)
- The sympathetic nervous system uses norepinephrine to signal the effector cells
  - Adrenergic receptors respond to NE and E, separated into alpha and beta receptors
    - \* Alpha receptors respond more to NE than to E

- $\alpha 1$  excites,  $\alpha 2$  inhibits (e.g. inhibiting digestive organs during a sympathetic response)
  - \* Beta receptors
    - $\beta 1$  excites (responds equally to NE and E),  $\beta 2$  inhibits (responds more to E than NE)
  - Epinephrine is used indirectly
- The parasympathetic nervous system always uses acetylcholine (vagusstoff)
  - Cholinergic receptors respond to ACh, separated into nicotinic and muscarinic receptors
    - \* Nicotinic are ionotropic (fast-acting)
    - \* Muscarinic, alpha and beta adrenergic receptors are metabotropic (slow-acting)
  - Nicotinic receptors are all excitatory; there are N1 and N2 subtypes
    - \* N1 go at the neuromuscular junctions
    - \* N2 excite the dendrites on the postganglionic nerve fibres (these are faster, goes on the postganglionic fibres for both sympathetic and parasympathetic systems)
  - Muscarinic receptors have 5 subtypes; M1, M3, M5 excite, M2, M4 inhibit
- For both systems, the preganglionic fibres all release ACh, with nicotinic receptors on the postsynaptic neuron to respond quickly
  - In the parasympathetic system, ACh is released by the postsynaptic neurons and muscarinic receptors respond to them
  - In the sympathetic nervous system E and NE are released by the postsynaptic neurons, with adrenergic receptors responding to them
- The sympathetic nervous system activates chromaffin cells (via ACh) in the kidney which release mostly E (80%) and some NE (20%)
  - The NE goes into the blood stream and becomes a hormone to reach its target
- Sweat glands have cholinergic muscarinic receptors