The autonomic nervous system

Maintains body homeostasis by increasing or decreasing the activity of the various organs. It functions without conscious control. Its main effect is on cardiac muscle and visceral smooth muscles.

Visceral organs and structures maintain a base level of function without innervation. Severing of their nerves may make them more sensitive.

This pathway involves two neurons in the efferent flow:

1. Preganglionic neuron - from spinal cord (or brain) to the autonomic ganglion.
2. Postganglionic neuron - from the autonomic ganglion to the cells of the effector organ.

The autonomic system is divided into two systems:

1. Sympathetic (fight or flight - stressful)
2. Parasympathetic (rest and digest - peaceful)

In both of these systems we will see a two neuron system. The will be a preganglionic fiber and a post ganglionic fiber.

All autonomic preganglionic fibers release Acetylcholine
All Parasympathetic postganglionic fibers release Acetylcholine
Most sympathetic postganglionic fibers release norepinephrine

These can be stimulatory or inhibitory depending on the receptor/organ.

Sympathetic system (thoracolumbar) - its preganglionic neurons originate in the lateral horn of the spinal cord and exit the vertebral column from T1 to L2. The neurotransmitter in the chain ganglion is usually Acetylcholine and at the end terminal is usually Norepinephrine.

The preganglionic sympathetic neurons are myelinated and look white, thus they travel in white rami. These travel with the spinal nerve (ventral rami) to reach the white ramus. These usually synapse with their postganglionic neurons at their spinal level, but may ascend or descend a few levels before synapsing, they may also pass through the ganglion and exit the chain without synapsing. In this last case they help to form the splanchnic nerves which synapse in prevertebral ganglia.

The postganglionic sympathetic neurons are unmyelinated and thus appear gray. They form the Gray rami. These travel directly back to the spinal nerve and then travel with the spinal nerve to the effector organ.

Parasympathetic system (craniosacral) - preganglionic neurons originate in the brain and from S2 to S4. These synapse with postganglionic neurons in ganglia that are near (or within) the organs innervated (these are called terminal ganglia). Most parasympathetic neurons do not travel in spinal nerves.

We see parasympathetic preganglionic fibers in four cranial nerves

CN III - to the ciliary body of the eye
CN VII - to lacrimal gland and nasal mucosa. Also submandibular and sublingual glands.
CN IX - to parotid gland
CN X - to heart, lungs, liver, gall bladder, stomach, pancreas, kidney, large intestine, small intestine.

We will see the formation of a Cardiac plexus, pulmonary plexus, and esophageal plexus.

The anterior and posterior vagal trunks will ride on the esophagus into the abdomen where they help to form the aortic plexus.

The Sacral parasympathetics originate in the lateral horn of the sacral region of the spinal cord. These will run with the ventral rami of spinal nerves to form pelvic splanchnic nerves.

Generalities to remember

Sympathetics have short preganglionic fibers and long postganglionic fibers.

Parasympathetics have long preganglionic fibers and short postganglionic fibers.

Visceral Reflex arcs

These reflex arcs are essentially the same as somatic reflexes except that this system utilizes a two neuron pathway. Note that these neuron bodies are located in the dorsal root ganglion and the anterior horn. This means that visceral pain afferents travel in the same pathways as somatic pain fibers. This helps to explain Referred Pain.

Fibers which release Ach are referred to as cholinergic fibers
Fibers which release Norepinephrine are referred to as adrenergic fibers (noradrenaline)

Receptors are referred to as either Nicotinic or Muscarinic. So named because of drugs that bind to them and mimic the effects of Ach.

Nicotinic - Ach binding to nicotinic fibers is always stimulatory.
Muscarinic - Ach binding to muscarinic fibers is either stimulatory or inhibitory depending on the target organ.

Adrenergic Receptors are separated into two classes:

1. Alpha (α) - Ne binding to alphas is generally stimulatory
2. Beta (β) - Ne binding to Betas is generally inhibitory

Keep in mind that NE is generally thought of as our “feeling good” neurotransmitter.

If we bind to a beta fiber at the heart then the heart rate will increase (THINK ABOUT THIS).
Therefore if we give a “Beta blocker” the effect of the Beta fiber is negated and the heart rate will decrease.

Keep in mind that there is some cortical control of the autonomic nervous system. This is important in the field of biofeedback.