10.1.3

The SNS and the PNS

The table below helps us compare and contrast some of the characteristics of the SNS and the PNS.

	Sympathetic		Parasympathetic	
	Preganglionic Neuron	**Postganglionic Neuron**	**Preganglionic Neuron**	**Postganglionic Neuron**
Neuron Length	Short to Medium	Medium to Long	Long	Short
Neurotransmitter Released	ACH	NE (except sweat glands and some blood vessels – ACH)	ACH	ACH

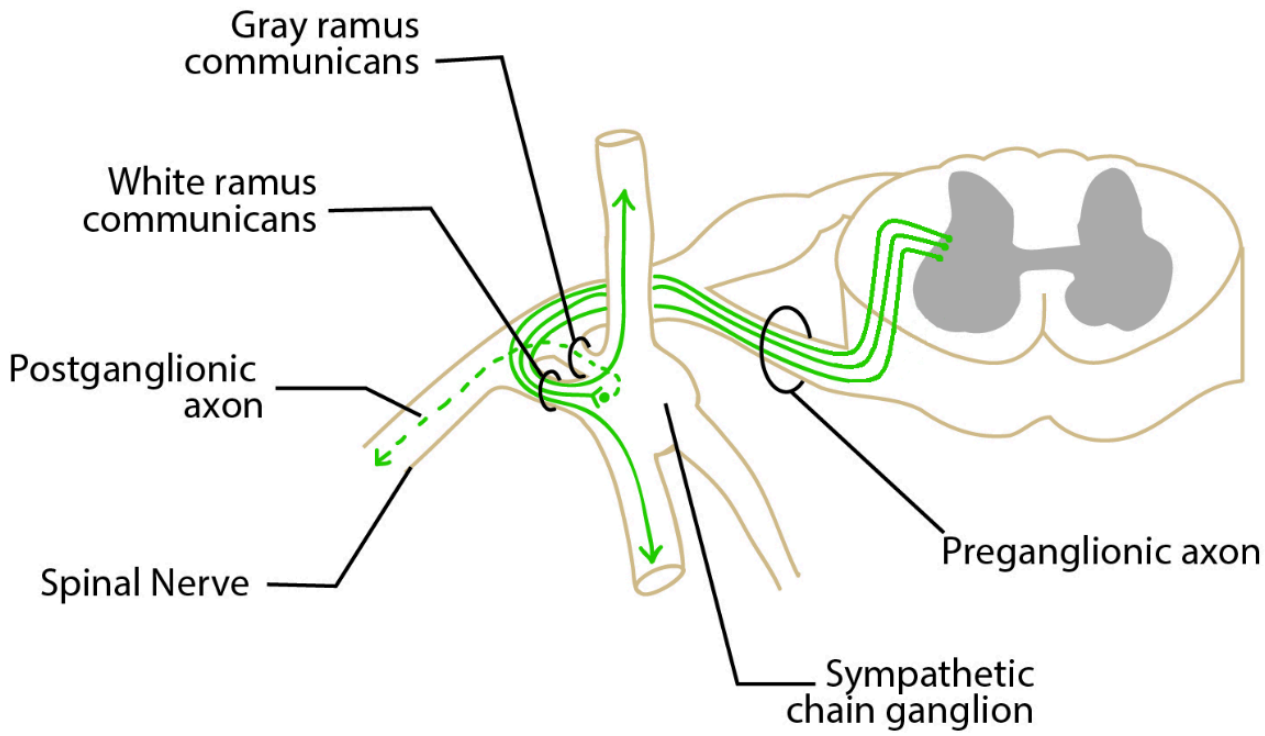
Characteristics of Sympathetic and Parasympathetic Nervous System. *Image by BYU-Idaho Student 2013*

ACH is short for Acetylcholine and NE is short for Norepinephrine. Acetylcholine and Norepinephrine are neurotransmitters.

Sympathetic Division (SNS)

The cell bodies of the preganglionic axons of the sympathetic division are located in segments T1 through about L2 to L3 of the lateral horn of the spinal cord. From here, these axons project away from the spinal cord through the ventral root and enter a spinal nerve. They then exit the spinal nerve through a white ramus communicans (myelinated axons) and enter a sympathetic chain ganglia, which are ganglia located along the spinal cord bilaterally. The following are descriptions of four different routes taken by sympathetic axons traveling from the CNS, to their **effectors** (organs, glands, and vessels) (see figures below).

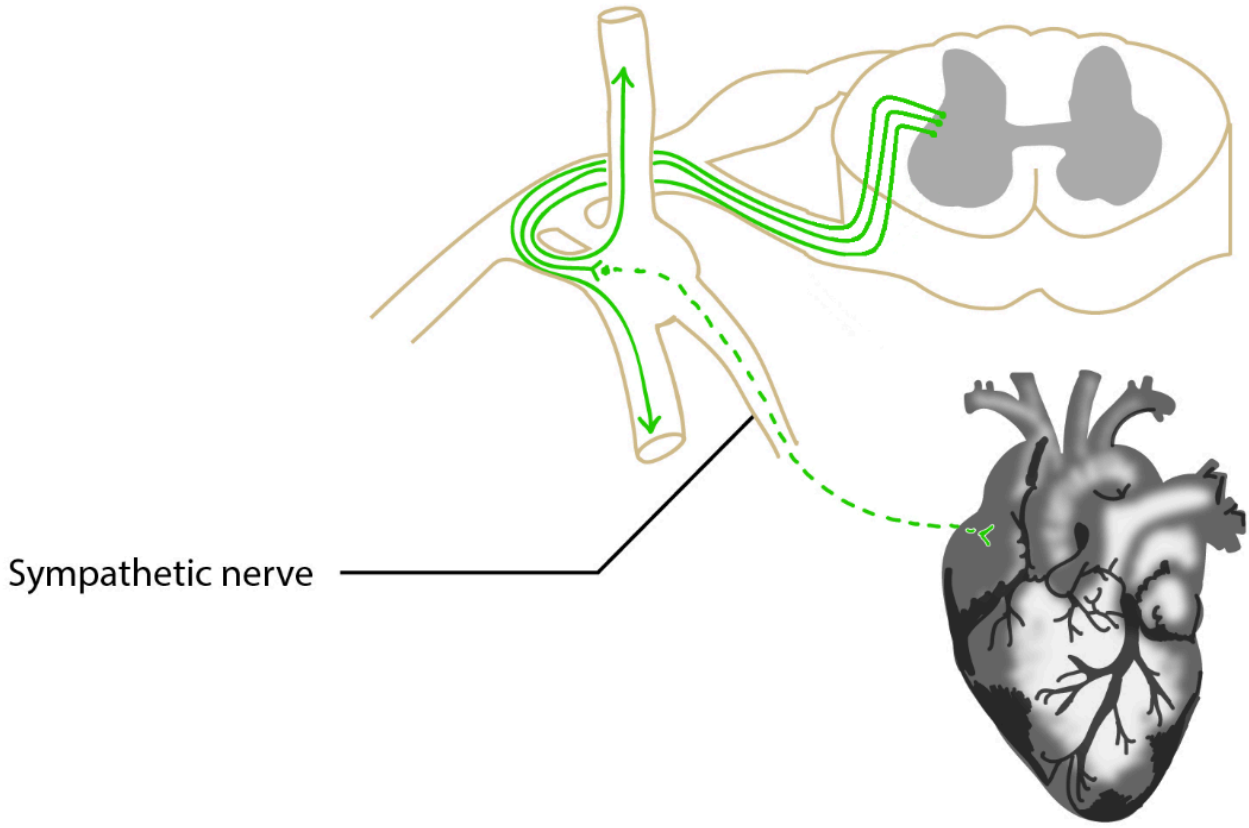
1. Preganglionic axons synapse at the sympathetic chain ganglia with a postganglionic neuron. The postganglionic neuron then leaves the sympathetic chain ganglia through a gray ramus communicans (unmyelinated axons) and reenters the **spinal nerve** and travels to the skin and blood vessels throughout the body.



Sympathetic Chain Ganglion. *Image by BYU-Idaho student, Kaylyn Lloyd Winter 2014*

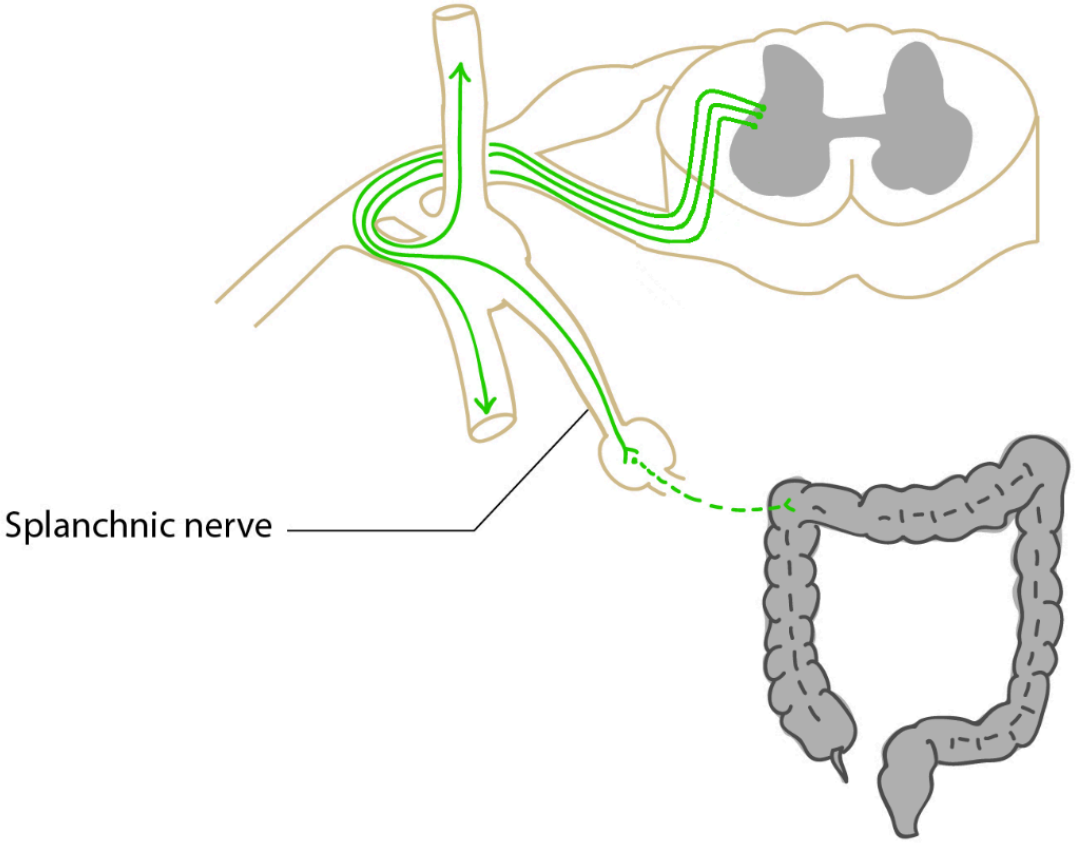
In the image above, preganglionic axons enter a sympathetic chain ganglion via a white ramus communicans (called white because the axons are myelinated which gives a more whitish appearance to this "bridge). Some axons synapse with postganglionic neurons in the sympathetic chain ganglion, while others travel to inferior or superior sympathetic chain ganglia before synapsing. Postganglionic axons leave sympathetic chain ganglia via a gray ramus communicans (called gray because the postganglionic neurons are not myelinated which gives a grayish appearance to the "bridge") and enter a spinal nerve. The spinal nerve carries the postganglionic axon out the peripheral body with other sensory and motor neurons.

2. The second type is very similar, but instead of the postganglionic neuron entering a spinal nerve, it enters a **sympathetic nerve** and travels to organs of the thoracic cavity. See below.



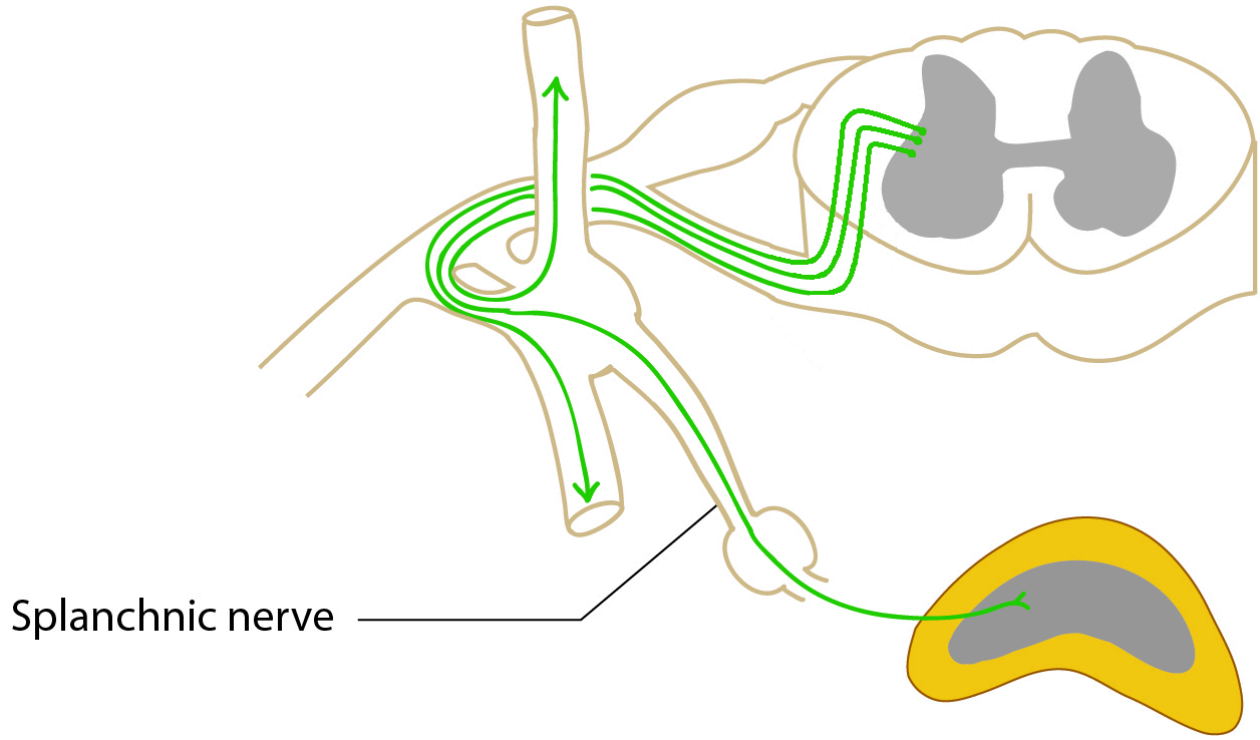
Sympathetic Nerve Signaling Heart. *Image by BYU-Idaho student, Kaylyn Lloyd Winter 2014*

3. The preganglionic neuron enters and leaves the sympathetic chain ganglion without synapsing and forms a **splanchnic nerve** and travels to collateral ganglia. At these ganglia, the preganglionic neurons synapse with postganglionic neurons which then extend to organs, glands, and vessels of the abdominopelvic cavity. See below.



Splanchnic Nerve Acting on Intestines. *Image by BYU-I student, Kaylyn Lloyd Winter 2014*

4. The last route for sympathetic axons is similar to those traveling through splanchnic nerves, but instead of synapsing, they travel straight through collateral ganglia. They then extend to the **medulla of the adrenal gland**, where they synapse with cells that produce epinephrine (EPI) and norepinephrine (NE). These medullary cells function as modified postganglionic neurons and release secretory product directly into the blood rather than into a synapse. About 80% of adrenal medullary cells produce EPI and the other 20% produce NE. After release into the blood, these hormones travel to receptors throughout the body to elicit a "fright, flight, or fright" response. See below.



Splanchnic Nerve Signaling Medulla of the Adrenal Gland Releasing Neurotransmitters directly into the Blood Stream for a System-wide Sympathetic Response. *Image by BYU-I student, Kaylyn Lloyd Winter 2014*

Click on this highlighted link to follow an image search that will show some more pictures for pathways of the sympathetic nervous system.

About 8% of the fibers in the 31 pairs of spinal nerves are postganglionic sympathetic fibers. Some of these fibers innervate the effectors of the skin-particularly capillaries and sweat glands. The sympathetic division also innervates the iris lens, nasal mucous membranes, salivary glands, the heart, lungs, stomach, intestines, adrenal gland, and urinary bladder (see figure below).

Parasympathetic Division (PNS)

The parasympathetic division does not follow 4 pathways like the sympathetic division. The parasympathetic division sends preganglionic neurons from the cranial area and the sacral area. This is why it is also known as the craniosacral division.

Cranio: Preganglionic cell bodies for coming from the brain are located in the brainstem and make up part of the cell bodies of cranial nerves - namely, cranial nerves III (oculomotor) which control the size of the pupil and shape of the lens, VII (facial) which control nasal mucous membranes and lacrimal and salivary glands, IX (glossopharyngeal) which controls the parotid salivary gland, and the X (vagus) which innervates organs of the thoracic cavity and upper abdominal cavity including the lungs, heart, stomach, pancreas, small intestine, liver, and upper portion of the large intestine. The vagus nerve is the major nerve of the cranial parasympathetic division. 75-80% of all parasympathetic fibers are found in the vagus nerve.

Sacral: There are a few preganglionic neuron cell bodies of the parasympathetic division that are located in the sacral region of the lateral horn of the spinal cord. Axons from these neurons enter **pelvic splanchnic nerves** and then extend to **terminal ganglia** which are located near or on the effector. Effectors innervated by the lower portion of the parasympathetic nervous system include the lower half of the large intestine and organs of the reproductive and renal systems. It helps to have images of the ANS anatomy in hand as you study these ANS divisions.

It would be a good idea to review the ANS anatomy pictures presented in 10.1.2.