Also called the involuntary nervous system or the general visceral motor system, reflecting the subconscious control and location of most of its effectors.

The autonomic nervous system is part of the motor aspect of the peripheral nervous system.

Another motor aspect of the peripheral system is the somatic nervous system and differences between the two should be understood.

Differences between Somatic NS and ANS

1. Effectors and Pathways

Somatic NS

- stimulates skeletal muscles
- cell bodies are located in the CNS
- axons extend via spinal nerves all the way to the skeletal muscle they serve
- heavy, myelinated type A fibers

Autonomic N.S.

- always a two neuron chain that innervates cardiac, smooth muscle and glands

- cell body of first neuron (the preganglionic axon) resides in brain or S.C.
- synapses with second neuron (postganglionic neuron) in an autonomic ganglion outside the CNS
- postganglionic axon extends to effector organ (cell body of postganglionic neuron is in the ganglion)
- preganglionic neurons are lightly myelinated; postganglionic ones are thin and unmyelinated

2. Neurotransmitters

- All somatic motor neurons release acetylcholine at their synapse with skeletal muscles
- The effect is always excitatory
- In the ANS, the neurotransmitter released at the synapse between pre- and post-ganglionic neurons is always acetylcholine.
- Most sympathetic postganglionic neurons release norepinehrine while parasympathetic post-ganglionic neurons release acetylcholine.
- The response can be excitatory or inhibitory, depending on the receptors present on the target organ.
Divisions of the Autonomic Nervous System

The two divisions of the ANS (sympathetic and parasympathetic) generally serve the same visceral organs but cause opposite effects. They thus counterbalance each other to provide smooth functioning of the visceral organs depending on the need of the body.

Parasympathetic Division
- is the "resting and digesting" system
- concerned with keeping body energy use as low as possible
- keeps for ex. blood pressure, heart rate, respiratory rate low, eye pupils are constricted, shunts blood to digestion areas (relaxes digestive muscles for peristalsis)

Sympathetic division
- fight or flight system
- provides an optimal conditions for an appropriate response to some threat
- ex. : keeps heart rate up, high rate of breathing, shunts blood to skeletal muscles

Anatomical Differences in the ANS

1. Site of origin
- Parasympathetic fibers originate from the brain and the sacral spinal cord
- Sympathetic fibers originate from thoracolumbar region of SC

2. Length of fibers
- Parasymp. division has long preganglionic fibers, short postganglionic fibers
- Symp. division has opposite condition

3. Location of ganglia
- Parasymp. ganglia are located in the visceral effectors
- Symp. ganglia lie close to the spinal cord

4. Neurotransmitters by postganglionic neuron
- PSNS : ACh
- SNS: NorEpinephrine


**Sympathetic Division**

- Also called the *Thoraco-lumbar* division
- All cell bodies of the pre-ganglionic fibers arise in the Spinal Cord segments T1-L2
- The presence of these cell bodies form the lateral gray horns in the Spinal Cord
- Pre-ganglionic fibers leave the SC via the ventral root and form several synapses with ganglionic neurons to create sympathetic ganglia.
- Three important ganglion areas
  - Sympathetic chain ganglia
  - Collateral Ganglia
  - Adrenal medulla

**A. Sympathetic chain**

- Preganglionic fibers leave the spinal cord to form a chain of ganglia (paravertebral ganglion) located immediately next to the SC (sympathetic chain or trunk)
- Fibers between SC and sympathetic chain = white rami communicates (remember that these preganglionic neurons are myelinated)
- Sympathetic fibers arise only from the thoracic and lumbar spinal cord segments but the sympathetic trunk extends from neck to pelvis, forming 3 cervical (A, B and C in the figure), 12 thoracic, 5 lumbar, 5 sacral and one coccygeal ganglion.
- Those postganglionic fibers that start from the sympathetic trunk and serve the structures in the thorax (such as heart and lungs) are generally referred to as the sympathetic nerves.

**Question**: so why is it that if someone breaks a cervical ventral root, they become paralyzed in neck related motor functions but retain sympathetic function in those areas?
B. Collateral ganglia

• Additional sympathetic fibers pass through the chain without stopping and form synapses in other ganglia
• These presynaptic sympathetic fibers are called the splanchnic nerves
• They form a synapse with postsynaptic neurons in areas anterior to the vertebral column, known as the collateral ganglia

The collateral ganglia are
• The celiac ganglia (D in previous figure)
  • postganglionic neurons serve the stomach, liver, spleen
• The superior mesenteric ganglia (E)
  • postganglionic neurons innervates small intestine and upper part of large intestine
• The inferior mesenteric ganglia (F)
  • postganglionic neurons serve the rest of large intestine, kidneys, urinary bladder and sex organs

C. Adrenal medulla

• Some preganglionic fibers terminate within the adrenal medulla
• Here they activate modified postganglionic neurons, that now act as neuro-endocrine cells
• Thus, in this exception, the preganglionic fiber is long and the post ganglionic is located within the target organ
• These neuroendocrine cells (chromaffin cells) release Epinephrine and nor-epinephrine into the bloodstream

In crises, the entire sympathetic division responds, which is referred to as the Sympathetic activation. It is controlled by nuclei in the Hypothalamus and it the effects include increased alertness, energy and euphoria; increased cardiovascular and respiratory activities, elevation in muscle tone, mobilization of energy resources.
The ParaSympathetic Division

The preganglionic neurons of the parasympathetic system are located in the brainstem (the previously discussed cranial nerves) and sacral segments of the spinal cord.

The preganglionic neurons are long while the ganglionic neurons are short and reside in peripheral ganglia located within or near target organs.

In contrast to SNS, all ganglionic neurons are located in the same ganglion and influence thus the same organ; the effect is thus more localized and specific.

- Preganglionic fibers leave the brain as cranial nerves III, VII, IX, X
- Those from III, VII and IX synapse in the head ganglia knowns as ciliary, pterygopalatine, submandibular and otic ganglia (see figure in textbook as well)
- The vagus nerve (75% of all PSNS activity) provides innervation in the neck, thorax and abdominal cavity
- Sacral neurons form the pelvic nerves
- These latter innervate kidneys, urinary bladder, terminal portion of large intestine, sex organs

Effects produced by the Parasympathetic division are usually opposite to the effects of the sympathetic nervous system. Examples include activation of salivary glands and intestinal glands, food processing by increasing activity of smooth muscle, constriction of respiratory pathways, reduction in heart rate and contraction, Sexual arousal and Energy absorption.