Compare and contrast the structures of the sympathetic and the parasympathetic divisions, including functions and neurotransmitters.

Show the levels of integration in the ANS, and compare these with the SNS.
ANS is all efferent!
Overview of ANS

Pathway for **Visceral Motor Output**

The somatic NS uses one effector nerve but the ANS output always involves **two** neurons between the CNS (brain and spinal cord) and effector.
Overview of ANS

ANS has two divisions with both structural AND functional differences:

1. **Parasympathetic – Rest and Repose**
   1. Craniosacral output
   2. Digestion, “housekeeping”
   3. Postganglionic axons release Ach (Cholinergic)

2. **Sympathetic – Fight or Flight**
   1. Thoracolumbar output
   2. Heart Rate, Respiration
   3. Vasoconstriction
   4. Postganglionic axons release NE (Adrenergic)
ANS: Some Nomenclature

Naming of neurons:

<table>
<thead>
<tr>
<th>Neuron #1: preganglionic (presynaptic)</th>
<th>Neuron #2: ganglionic (postsynaptic)</th>
<th>effector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preganglionic fiber (=axon): Lightly myelinated</td>
<td>Postganglionic fiber Unmyelinated</td>
<td>effector</td>
</tr>
</tbody>
</table>
1. Parasympathetic Division

- **AKA Craniosacral** division

- Preganglionic neurons (cell bodies) located in brain stem & sacral segments of spinal cord.

- **Cranial Nerves III, VII, IX, X**
  - Pupils (III), Lacrimal and Salivary Glands (VII), Viscera (X)

- **Sacral segments S\(_2\)–S\(_4\)**
  - Bladder, Genitals
1. Parasympathetic Division, cont’d

- Ganglionic neurons (cell bodies) in ganglia near target organs: **Intramural ganglia**
- Effects of parasympathetic division: R & R
- Synapses:
  - All use ACh
1. Parasympathetic Division, cont’d

Some functions:

- Constriction of Pupils (opposite sympathetic)
- Secretion of Digestive Glands
- Secretion of Digestive Hormones
  - Insulin, etc.
- Visceral Smooth Muscle
- Defecation and Urination
- Constriction of Respiratory System, decreases rate
- Decrease Heart Rate
- Sexual Arousal
1. Parasympathetic Division, Summary

A. Rest and repose

B. Neurons #1 are long, thinly myelinated, come from the brain stem (N III, VII, IX, X) or sacral spinal cord (S₂-₄), run with the spinal or pelvic nerves and produce ACh.

C. Neurons #2 are short, nonmyelinated, produce ACh, and may be either excitatory or inhibitory to muscarinic receptors.

D. Mostly control of internal physiology
2. Sympathetic Division

**AKA Thoracolumbar division**

Preganglionic neurons (cell bodies) located between T1 & L2 of spinal cord

Ganglionic neurons (cell bodies) in ganglia near vertebral column, AKA “Chain Ganglia.”

**Paravertebral ganglia** = sympathetic chain ganglia

**Prevertebral ganglia** = collateral ganglia

Effects of Sympathetic Division? F or F

Special case: adrenal medulla is a modified ganglion
2. Sympathetic Efferent Pathways: Examples

Fig 15.11

Fig 15.12
2. Sympathetic Neuroeffector Junctions

Differ from somatic neuromuscular junctions

Varicosities contain NT
Special Case: Adrenal Medulla

“Modified sympathetic ganglion”

Terminus for neuron #1, stimulates specialized 2nd order neurons with very short axons in adrenal medulla to release NT into blood stream (= hormones)

Epinephrine (adrenaline) ~ 80% and norepinephrine (noradrenaline)

Endocrine effects are longer lasting than nervous system effects
Sympathetic Receptors
(not in book)

**Alpha (α-)** (Smooth muscle in blood vessels)

**Beta (β-)** (Heart, resp tract, skeletal muscle)

An enormous number of drugs have their effect at these receptors
2. Summary of Sympathetic Division

A. Neuron #1 is short, neuron #2 is long

B. Synapsing occurs in paravertebral chain ganglia or prevertebral collateral ganglia

C. Neuron #1 releases Ach, usually neuron #2 releases NE ("adrenergic")

D. Prepares for emergency action, excitatory to many organs, inhibitory to others (digestive for example) "F or F"

E. Effects are very widespread and somewhat persistent; (not as slow as endocrine system)
Dual Innervation

Each organ receives innervation from sympathetic and parasympathetic fibers.

Fibers of both divisions meet & commingle at plexuses (fig 17-9) to innervate organs close to those centers.

Names of plexuses derived from locations or organs involved.

Fig. 15.6
ANS

Summary

AUTONOMIC NERVOUS SYSTEM

Consists of 2 divisions

Sympathetic (Thoracolumbar) Division

Preganglionic neurons in lateral gray horns of spinal segments T₁-L₂

Ganglia near spinal cord

Preganglionic fibers release ACh (excitatory), stimulating ganglionic neurons

Which send postganglionic fibers to

Target organs

Most postganglionic fibers release NE at neuroeffector junctions

“Fight or flight” response

Parasympathetic (Craniosacral) Division

Preganglionic neurons in brain stem and in lateral gray horns of spinal segments S₂-S₄

Ganglia in or near target organs

Preganglionic fibers release ACh (excitatory), stimulating ganglionic neurons

Target organs

All postganglionic fibers release ACh at neuroeffector junctions

“Rest and repose” response
Visceral Sensory

- The interior monitoring
- Much of the input via CN X (Vagus)
- Visceral pain is often perceived as somatic pain—"referred pain."
Horner’s Syndrome

- Loss of sympathetic innervation to an eye
- Ptosis
- Miosis
- Anhidrosis
- Causes are varied: tumor, aortic aneurism, trauma
Higher Levels of Control

- Common sense tells us that the ANS isn’t only automatic. “Higher centers” exert significant control over the ANS
  - Anger => rapid HR
  - Nervousness => sweat