AUTONOMICS II
Somatic vs. Autonomic

Body Wall & Limbs
- Motor (Voluntary)
  - Skeletal m.
- Sensory (Skeletal m.)
  - Pain
  - Pressure
  - Proprioception
  - Temp
  - Touch
  - Glands
  - Cardiac m.
  - Smooth m.
  - Physiological (reflex)
  - Pain

Visceral (glands, smooth and cardiac muscle)
- Motor (Involuntary)
  - Rest / Digest
    - Body Cavities
  - Fight / Flight
    - Everywhere
- Sensory
  - Glands
  - Cardiac m.
  - Smooth m.

Parasympathetic
- Rest / Digest
- Body Cavities

Sympathetic
- Fight / Flight
- Everywhere
Sympathetic fibers – routes from the chain to **thoracic organs**

A) Preganglionic sympathetics with cell bodies in lateral horn from T1-T4 enter chain via WRCs, synapse in chain ganglia, postganglionic axons exit the chain “medially” and travel to the cardiopulmonary plexus.
Sympathetic fibers – routes from the chain to **thoracic organs**

B) Other preganglionic sympathetics with cell bodies in lateral horn from T1-T4 enter chain via WRCs, *ascend in the chain and synapse in cervical chain ganglia*, postganglionic axons exit the chain and travel to the cardio-pulmonary plexus.
Sympathetic fibers – routes from the chain to **thoracic organs**

During development, the heart descends through the cervical region to the thorax, picking up and carrying along some of its sympathetic innervation from cervical chain ganglia – the ORIGIN of preganglionics is the same – T1-4 lateral horns, etc.
Sympathetic fibers – routes from the chain to *abdominal organs*

Preganglionic axons with cell bodies in the lateral horn from T5–L2 enter the chain, pass on through ganglia WITHOUT synapsing, then the (still) preganglionic fibers leave the chain ganglia medially and travel to a sympathetic ganglion along the abdominal aorta (preaortic = prevertebral ganglia) where they synapse; postganglionic fibers then travel along arteries to the GI tract.

Examples – Thoracic and lumbar splanchnic nerves
T5-9 = Greater thoracic splanchnic nerve

T10-11 = Lesser thoracic splanchnic nerve

T12 = Least thoracic splanchnic nerve

L1-2 = Lumbar splanchnic nerves

These sympathetics pass on beyond the chain still as preganglionics – therefore they have to synapse in pre-aortic ganglia (named at the arteries at which they are located e.g. celiac ganglion)

Preaortic ganglia

The post-ganglionic fibers follow arteries to the GI tract
Visceral sensations are generally unconscious except for those that result in pain (which then becomes conscious).

Visceral sensory fibers traveling with sympathetics and parasympathetics are called **visceral afferents**

Generally, **visceral afferents** traveling with parasympathetics mediate **unconscious sensations** (eg. GI stretch) resulting in involuntary physiological responses, eg. enhanced peristalsis, decreased heart rate, etc.

Generally, **visceral afferents** traveling with sympathetics mediate **conscious sensations** that are usually painful, eg. heart attack pain, gas pains, appendicitis pain, gall bladder pain, etc. and are caused by anoxia/ischemia, distension, inflammation, or spasmodic contraction of smooth muscles.
Visceral afferents for pain from heart (via cardiopulmonary nerves)

Segments T1-T4

Cardiopulmonary plexus

Skin, joints, tendons, etc.

Somatic afferent

Visceral afferent

Preganglionic

Postganglionic
Visceral afferents from GI tract – accompanying thoracic splanchnic nerves

Segments T5-L2

Preaortic ganglion

WRC

Skin, joints, tendons, etc.

Somatic afferent

Visceral afferent

Preganglionic

Postganglionic
Heart (cardiopulmonary) autonomics
Greater thoracic splanchnic nerve (T5-9)

Lesser thoracic splanchnic nerve (T10-11)

Least thoracic splanchnic nerve (T12)
Greater thoracic splanchnic nerve

Pre-aortic ganglion (celiac)

Chain ganglia - T5-9

WRC
Sympathetic chain (lumbar part)

Superior hypogastric plexus

Preaortic ganglia

Intermsenteric plexus

Lumbar splanchnic nerve

Sympathetic chain (what part?)
Visceral fibers travelling along arteries to the small intestines (sup. mesenteric a.)

(visceral fibers consist of both efferents and afferents)
Visceral fibers travelling along arteries to the large intestine (visceral fibers consist of both efferents and afferents)
Preganglionic parasympathetics with cell bodies in a “lateral-horn-like” area of sacral (S2-4) segments of the spinal cord travel on the ventral (motor) roots to spinal nerves, then on ventral rami of S2,3 and 4. They then leave the ventral rami as Pelvic Splanchnic Nerves to enter the inferior hypogastric (pelvic) plexus found adjacent to the pelvic organs. Fibers destined for the hindgut pass mainly retroperitoneal to this part of the gut.

Postganglionic parasympathetic nerves are located at or in the walls of target organs in the pelvis (eg, the urinary bladder) and the hind gut.
Demarks change in nerve supply

Vagus N. CN X (parasympathetic) & Sympathetic fibers from preaortic ganglia all running along blood vessels

Pelvic Splanchnic nn. (S2,3,4- parasympathetic)

Legend:
- Sympathetic efferents
- Parasympathetic efferents
- Somatic efferents
- Afferents and CNS connections
- Indefinite paths
SOME AXIOMS OF THE ANS

1. **All** sympathetic and parasympathetic fibers originate from the CNS. Thus, these nerves must be preganglionic (presynaptic).

2. **All** preganglionic sympathetics **must** enter the sympathetic chain from spinal nerves (or ventral rami of spinal nerves) via **WRC**.

3. **All** WRC are found only at spinal cord segments T1-L2. Thus, there are **no** WRCs above T1 spinal nerve or below L2 spinal nerve.

4. **Some postganglionic sympathetics** leave the sympathetic chain via GRCs to enter somatic (spinal) nerves. Thus, post-ganglionic sympathetic fibers traversing the GRC innervate body wall structures.
SOME AXIOMS OF THE ANS

5. **ALL** somatic nerves contain **postganglionic sympathetics** but **NO** preganglionic sympathetics and **NO** prarasympathetics. Thus, GRCs connect the **sympathetic chain** to **ALL** spinal nerves (allowing for passage of postganglionic sympathetic axons from the chain to the somatic nerves).

6. The term "**splanchnic**" only means **visceral**. Thus, the term splanchnic when used in “**thoracic splanchnics**”, “**lumbar splanchnics**”, “**sacral splanchnics**” and “**pelvic splanchnics**” only means that they are **visceral nerves** innervating appropriate visceral structures (and doesn’t differentiate sympathetic from parasympathetic or pre-ganglionic from post-ganglionic).

7. Splanchnic nerves that leave the sympathetic chain ganglia may leave as **pre-** or **post-ganglionic fibers**, the preganglionics are destined for other ganglia (pre-aortic).

8. Pelvic splanchnics are **preganglionic** parasympathetics originating from spinal cord segments S2,3,4.
Basic Characteristics of Sympathetic and Parasympathetic Function - Neurotransmitters

Cholinergic nerves – synthesize and secrete acetylcholine (ACh)
Adrenergic nerves – synthesize and secrete norepinephrine (NE)

**Preganglionics**
1) All preganglionic neurons are **cholinergic** (both sympathetic and parasympathetic nervous systems)

**Postganglionics**
2) *Almost all* parasympathetic postganglionic neurons are also **cholinergic** (the few exceptions are best described case by case)
3) *Most* sympathetic postganglionic neurons are **adrenergic**
4) Postganglionic sympathetic nerve fibers to the sweat glands, to the piloerector muscles of the hairs, and to a *very few* blood vessels are **cholinergic**
Most targets

Sweat glands, pilo-erector mm.
How do neurotransmitters act?

The preganglionic neuron is activated and an action potential propogates to the ending.

The AP reaches the terminal, resulting in exocytosis of ACh stored in vesicles.