ANATOMY AND DIAGNOSTIC USE OF AUTONOMIC NERVOUS SYSTEM PATHWAYS

I. GENERAL REVIEW OF AUTONOMIC NERVOUS SYSTEM - Autonomic nervous system (= Visceral nervous system) is considered part of peripheral nervous that is not under voluntary control (Autonomic means automatic or self-regulating)

A. **OVERVIEW** -

1. Autonomic nervous system innervates visceral structures: smooth and cardiac muscles, blood vessels, glands (sweat glands, salivary glands, etc) and internal organs (ex. GI tract, heart, etc.).

2. The autonomic nervous system is **often thought of as reactive** to stimuli (ex. fight or flight). However, many autonomics provide pathways for the CNS to **continuously regulate and control body functions**:

examples 1) Thermoregulation - regulate body temperature; 2) Cardiovascular function in heart and blood vessels - monitor and regulate heart rate, blood pressure, etc.;3) GI function - secretion, motility.

B. Basic pathway - 2 neuron arc; **pre-ganglionic neuron is in CNS**; axon leaves CNS; synapses in autonomic ganglion - post-gangliionic cell in autonomic ganglion innervates smooth muscle, glands, etc.

C. Divergence - Why have a two neuron arc? Autonomics can activate many targets at the same time. A single pre-ganglionic neuron synapses on many post-ganglionic neurons (ratio 1 pre/15 post up to 1 pre/200 post). This divergence can allow for widespread effects (ex. in thermoregulation, many sweat glands are activated simultaneously).

D. Parts Autonomic Nervous System - Sympathetic and Parasympathetic: Review:

1. **Sympathetics: 'FIGHT OR FLIGHT'** - Out CNS at **Thoraco-Lumbar levels**; **ganglia close to CNS** (paravertebral); pre-ganglionics short, post-ganglionics long; Actions - ex. Increase heart rate, decrease gastric movements and secretions, decrease secretion of salivary glands.

2. **Parasympathetics: 'REST AND DIGEST'** - Out CNS at **Cranio-Sacral levels** (Cranial nerves and Sacral Spinal nerves); **ganglia close to target**; pre-ganglionics long, post-ganglionics short; Actions - ex. decrease heart rate, increase gastric movements and secretions; increase secretion of salivary glands.

E. **Asymmetry - Some body structures receive only Sympathetics NOT Parasympathetics - Classic description: 'Parasympathetics do not go to body wall'; examples:**

1. **Skin** - **sweat glands and arrector pilae** muscles **are only innervate by Sympathetics** not Parasympathetics.

2. **Peripheral blood vessels** - Blood vessels are innervated by Sympathetics not parasympathetics.

Consequence of Asymmetry: **Sympathetics are much more widely distributed than Parasympathetics** - pathways are more complex.

F. **Thermoregulation by sweating** - sweating decreases body temperature by evaporation; mediated by Sympathetics to skin.

G. **CNS Regulation** - Centers in the CNS regulate autonomic function (ex. brainstem reticular formation). The **Hypothalamus** (part of CNS) is a major center for regulation of autonomic function.

II. ANATOMICAL ORGANIZATION OF SYMPATHETIC PATHWAYS

A. **Pathways** - Sympathetics (pre-ganglionic neurons) come out Spinal cord (at Thoracic and Upper Lumbar Levels); can do three things.

1. **Synapse in ganglion at level of outflow** - Pre-ganglionics course in Communicating rami (connect to Sympathetic ganglion); Post-ganglionics join spinal nerve of that segment. (ex. Skin of thorax - innervated by Intercostal nerves).

2. **Ascend or descending chain and synapse in other ganglia of chain**; Post-ganglionics then course in Communicating rami to join spinal nerves at those segments (ex. cervical spinal nerves of Brachial plexus).

3. **Not synapse in chain; pre-ganglionics continue to ganglia nearer to target organ**; ex. Splanchnic nerves to gut (covered in Spring semester)

III. SYMPATHETICS TO HEAD AND HORNER'S SYNDROME

A. Sympathetic pathway - Sympathetics to head come **out T1 and T2**; **ascend sympathetic chain; Synapse in Superior Cervical Ganglion**; Post-ganglionics **distributed with plexus on Carotid arteries**.

B. **Horner's Syndrome** - **interruption/damage to Sympathetic pathway**

Symptom	**Structure innervated**	**Damage**
Anhydrosis (lack of sweating)	**Sweat glands in skin**	**lack of sweating in skin (ex. forehead)**
Ptosis (eyelid droop)	**Levator Palpebrae Superioris - sympathetics to Smooth muscle part**	**Levator lifts upper eyelid; damage produces eyelid droop**
Miosis (constricted pupil)	**Pupillary Dilator muscle**	**Damage paralyzes Dilator muscle; pupil is constricted (Constrictor Pupillae muscle is intact - innervation CN III)**

3. Differential Diagnosis of Ptosis = EYELID DROOP; cause - damage to innervation of **Levator Palpebrae Superioris** - Levator Palpebrae Superioris is **innervated by both Sympathetics and Somatic Motor Neurons (CN III, Oculomotor)**; **however, differential effects on Pupil of Eye, Sweat glands.**

Structure	**Horner's Syndrome**	**Oculomotor Palsy (nerve damage)**
Upper eyelid	**Ptosis (eyelid droop) - paralyze Smooth muscle part of Levator Palpebrae Superioris**	**Ptosis (eyelid droop) - paralyze Skeletal muscle part of Levator Palpebrae Superioris**
Pupil of eye	**Pupil constricted (Miosis) - Pupillary Dilator muscle paralyzed;** Pupillary constrictor muscle intact	**Pupil dilated (Mydriasis) - Pupillary constrictor muscle paralyzed;** Dilator muscle is intact
Sweat glands in skin	**Anhydrosis - lack of sweating in skin** (ex. forehead)	**No effect (**parasympathetics do not innervate skin)

Also: Eye Movements - Oculomotor nerve innervates Extraocular muscles; damage effects eye movements; no deficit in eye movements in Horner's syndrome.

Note: Others causes of Ptosis - Myasthenia Gravis; Aponeurotic ptosis (levator palpebrae loses insertion to tarsal plate); Orbital Fracture; etc.