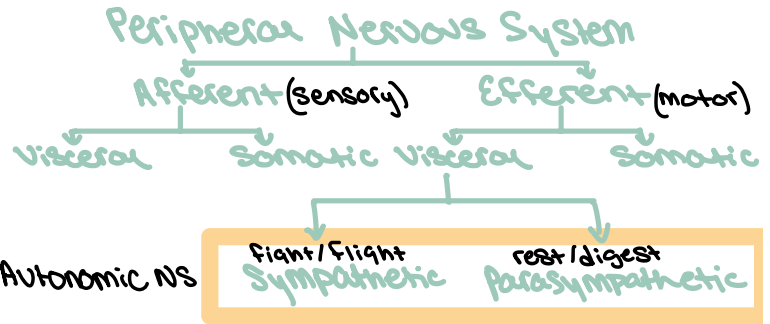
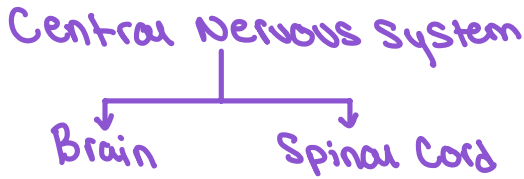


# Nervous System!



**Autonomic Nervous System:** Regulates involuntary physiological processes

- Heart Rate
- Respiration
- Sexual arousal
- Blood Pressure
- Digestion

## Divergence vs Convergence

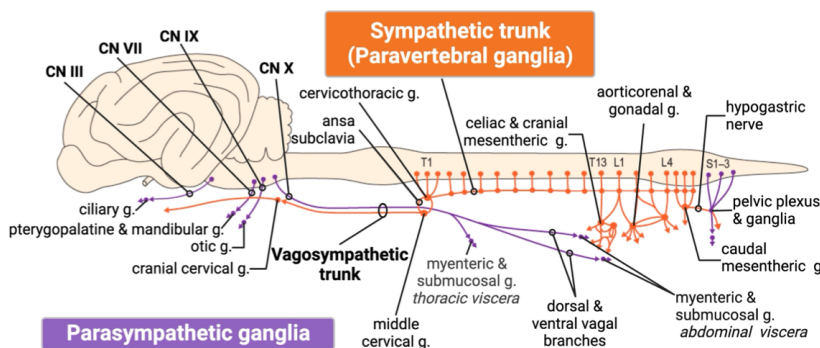
Divergence - One neuron communicates w/ many neurons P: 1:4 S: 1:20

Convergence - One neuron receives input from many neurons S > P

Both the sympathetic and parasympathetic nervous systems are under tonic control (state of cont. activity)

Dual innervation: most effector organs receive competing inputs  
 \* mostly in competing directions but may be synergistic

## ANS anatomic overview



Sympathetic: thoracolumbar

Parasympathetic: craniosacral

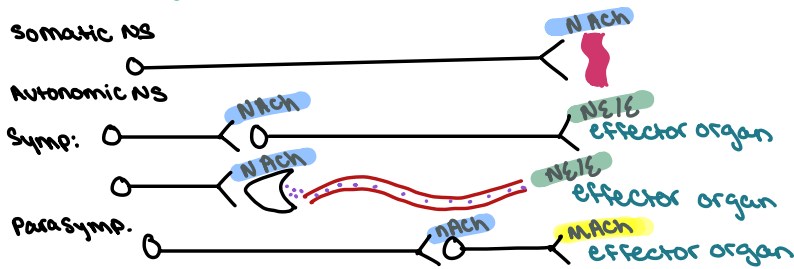
**Stellate ganglion** = cervicothoracic gang

lays parallel to the nodose ganglion

**Petrosal gang.** = sensory ganglion of

CN IX

Parasympathetic ganglion: Jugular, Cranial, Proximal Ganglion  
 Sensory ganglion: Nodose, Caudal, distal



## Autonomic Ganglia

### Sympathetic

Sympathetic chain gang. (Paravertebral)

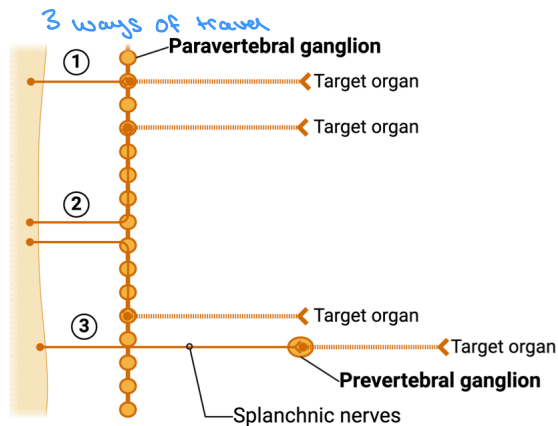
-rows along the vertebral column that receives central input from the lat. horn <sup>upper</sup> of the thoracic + lumbar spinal cord

### Parasympathetic

Terminal ganglia - receive central input from cranial nerves, located close to the target organ

Intramural ganglia: receive central input from CNX or sacral spinal nerves located within the walls of the target organ

→ collateral ganglia  
 Prevertebral: ganglia located outside the chain but have the same function.



### Axonal Varicosities

Enlarged boutons loaded with neurotransmitter vesicles located at the terminal portion of the axon close to the effector cell



Single-unit: synchronous movement

Stomach, intestines, bladder, uterus

Multi-unit: receives a synaptic input which allows a much finer control

Airways of the lungs, blood vessels, and ciliary muscles

Autonomic Plexi: Extensive network of nerve fibers and cell bodies found in the thorax, abdomen, and pelvis

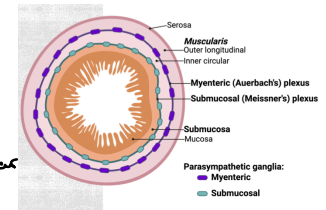
- ↳ contains: Sympathetic **postganglionic** axons
- parasympathetic **preganglionic** axons
- visceral sensory fibers

\* Provides complex ANS innervation pattern to target organ (dual innervation)

### Enteric Nervous System

Myenteric plexus: Auerbach's plexus located between the longitudinal circular muscle layers of the esophagus, stomach, small intestine, and large intestine

Submucosal plexus: Meissner's plexus situated in the submucosa region between the circular muscle and mucosa



### Medulla of the Adrenal Gland

- Innervated by the splanchnic nerve T8-L1 pregang. **Sympathetic fibers**
- Largest symp ganglia w/ modified neurons named **chromaffin cells** \* no nerve process
- Secrete **catecholamines** NE and Epi into capillaries and syst. circ. to amplify fight/flight response

Most parasympathetic and sympathetic functions oppose each other however they work synergistically for penial erection

### Hypothalamus!

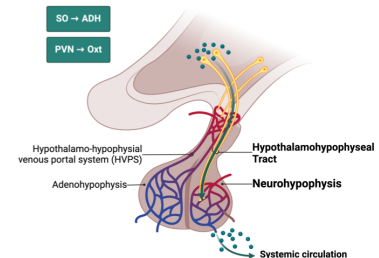
↳ High level sensory integration and motor output that maintains homeostasis by controlling endocrine, autonomic and somatic behavior

- into 11 unique nuclei w/ multiple subnuclei
- receives info from external + internal stimuli

Posterior pituitary lobe (Neurohypophysis): Extension of the hypothalamus

- Magnocellular neurosecretory cells of the supraoptic (SO) and paraventricular nuclei project axons down the infundibulum to terminals in the post. pit. via the hypothalamohypophysial tract.

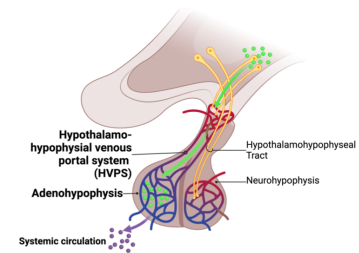
Info projected through a **nerve tract**



Anterior pituitary lobe (Adenohypophysis): Considered part of the endocrine system

- Parvocellular neurosecretory cells in hypothalamic nuclei control adenohypophysis by releasing regulatory hormones via HVPS
- Hormones bind to anterior pituitary endocrine cells which stimulate or inhibit hormone release

NT moves through **blood vessels**  
(GH, ACTH, TSH, LH, FSH, PRL)



Dorsomedial Hypothalamic Nucleus (DMH): key for the expression of numerous behavioral and physiological <sup>suprachiasmatic sends sig.</sup> circadian rhythms and stress response  
 ↳ Basically coordinates the action of all the other nuclei

Reticular Activating System: network of interconnected nuclei throughout the brainstem that serve as a major integration center <sup>and relay</sup>  
 for many vital systems to coordinate functions necessary for survival

LOCUS COERULEUS → NE

Raphe nucleus → Serotonin

RAS receives info from visceral and somatic sensory  
 maintain sleep, arousal and consciousness

Hypothalamic Nuclei help regulate

Circadian rhythm: Light → retina → SCN **Cortisol, GH**

Thermoregulation: mod. symp. input ANH, PMN, MnPO

Metabolism: Leptin → PVN + ANH **TRH, TH**

Growth: **GH**

Stress response: **Cortisol**

Appetite + Satiety: **VMN (Satiety center) LH (Feeding center)**

Osmoregulation: SO + PVN → **ADH** MnPO → thirst

Medial Preoptic Nucleus **Reproduction, Parental behavior, Social bonding**

Sexually dimorphic subnucleus

MnPO

↳ Gonadal hormone receptor sexual dimorphism: **Androgen receptors 2 male Estrogen receptor female**

↳ Anatomical sexual dimorphisms: Larger in males > females

Amygdala

Also controls: GnRH, Prolactin, Oxytocin

Limbic System: Emotion, memory, learning, social processes, motivation, reward

\* mediated by dopamine

Olfactory plays a big role

Influences endocrine system and ANS

mammillary bodies → recollective memory

Visceral Reflex:

**Somatic Reflex Arc \* monosynaptic**

- ↳ 1. Stimulus @ Sensory Receptor
2. Activation of afferent pathway
3. Relay @ integration center
4. Activation of efferent pathway
5. Response by motor effector

\* Innervates skeletal muscle → contraction

**Visceral Reflex Arc \* Polysynaptic**

Same steps as somatic reflex arc but there are

multiple synapses because of the pre and postganglionic

fiber projections

\* Innervates viscera, glands, or smooth muscle → + or -

## Visceral Sensory Neurons and Nucleus Tractus Solitarius

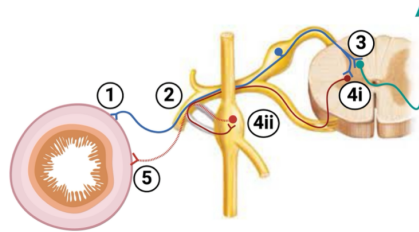
USN - responds to stimuli; CNS interprets input from USN as pain, hunger, satiety etc. but most activity never reaches the level of consciousness

NTS - 1st relay station for general visceral + taste afferents carried by the CN and it innervates a wide variety of reflexes controlling cardiovasc. funct, resp., GI motility CN VII, IX, X

- if input comes lower it will go through spinothalamic and spinoreticular tracts + <sup>interpretation</sup> not necessarily painful
- Gets info from chemoreceptors, baroreceptors, and mechanoreceptors

Spinal cord long loop

### Visceral Reflex Arc Spinal Cord Long Loop



Short loop stays local → NO CNS