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Autonomic nervous system

ANS vs. somatic NS

Comparison of Somatic Motor and Autonomic Divisions		
	SOMATIC MOTOR	**AUTONOMIC**
Number of neurons in efferent path	1	2
Neurotransmitter/receptor at neuron-target synapse	ACh/nicotinic	ACh/muscarinic or NE/α- or β-adrenergic
Target tissue	Skeletal muscle	Smooth and cardiac muscle; some endocrine and exocrine glands; some adipose tissue
Neurotransmitter released from	Axon terminals	Varicosities and axon terminals
Effects on target tissue	Excitatory only: muscle contracts	Excitatory or inhibitory
Peripheral components found outside the CNS	Axons only	Preganglionic axons, ganglia, postganglionic neurons
Summary of function	Posture and movement	Visceral function, including movement in internal organs and secretion; control of metabolism

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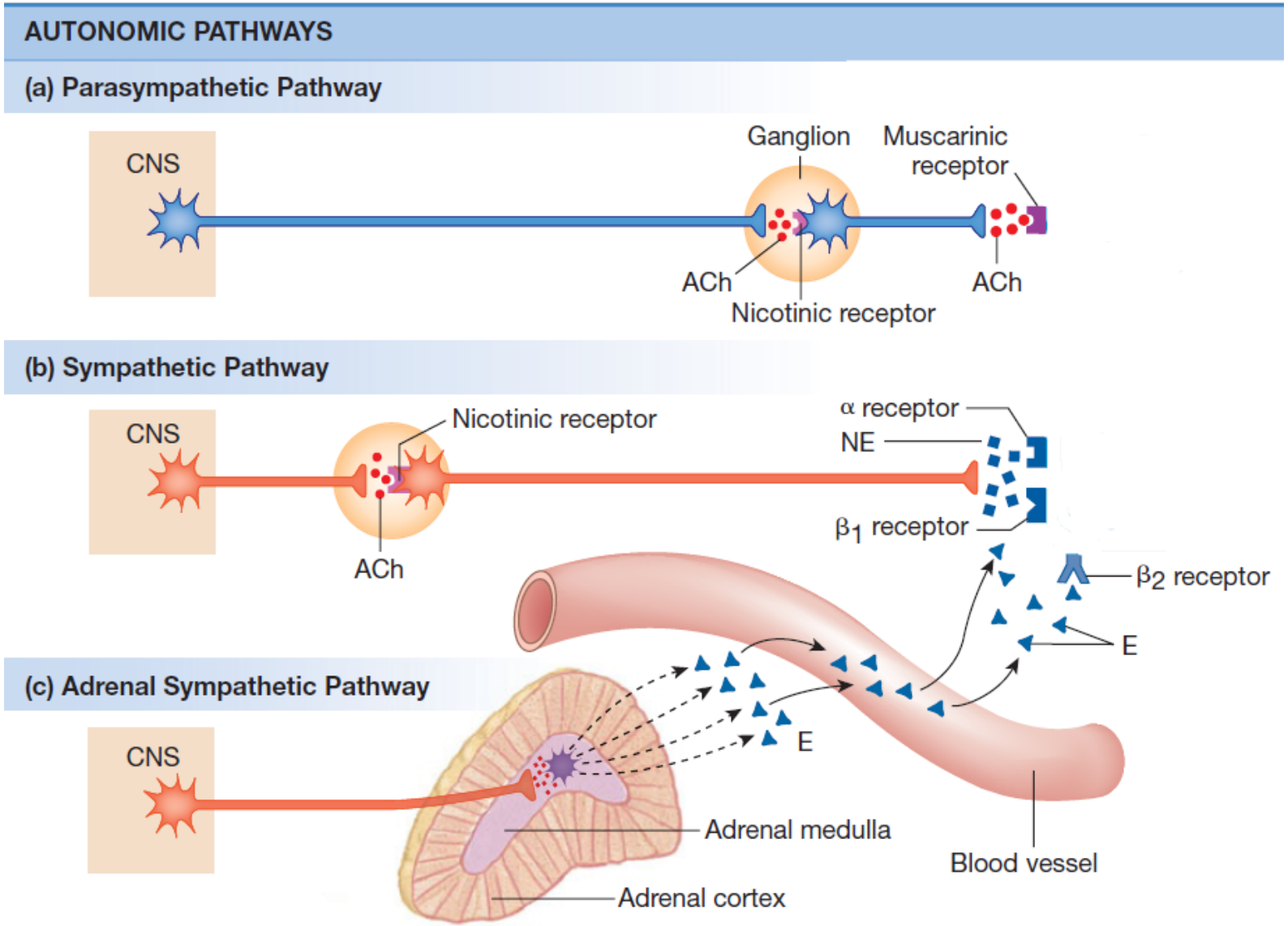
Autonomic nervous system

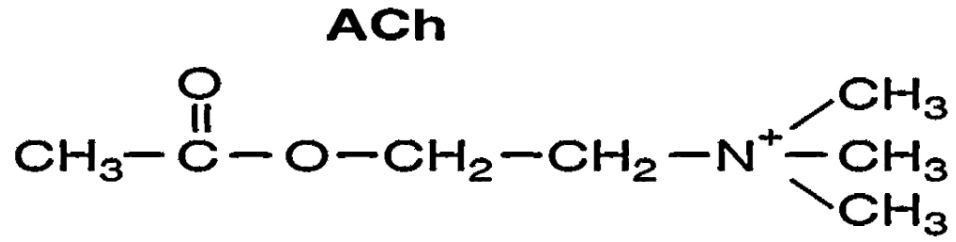


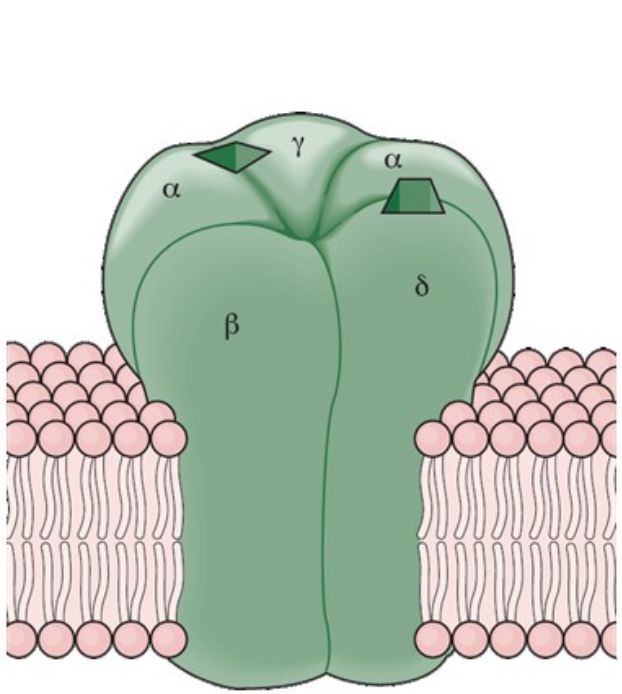
Autonomic nervous system

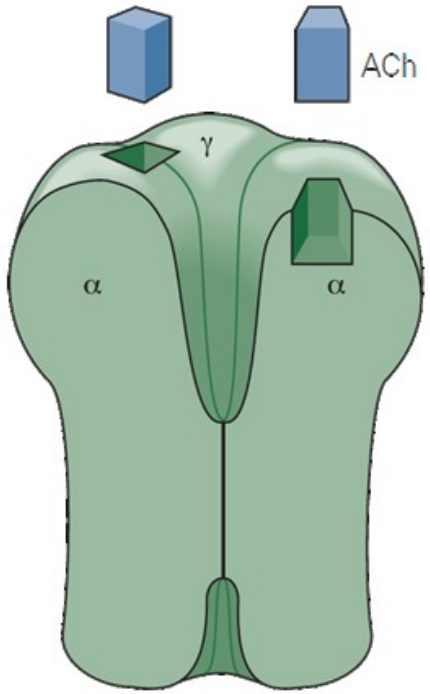
Preganglionic fibers

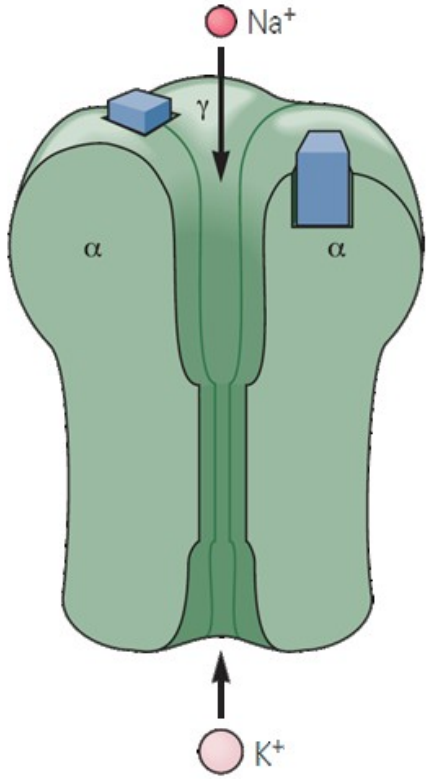
- SNS, PNS
- *Nikotinic recep*
  - N_N type and N_M typ
  - Excitatory receptor

ACh









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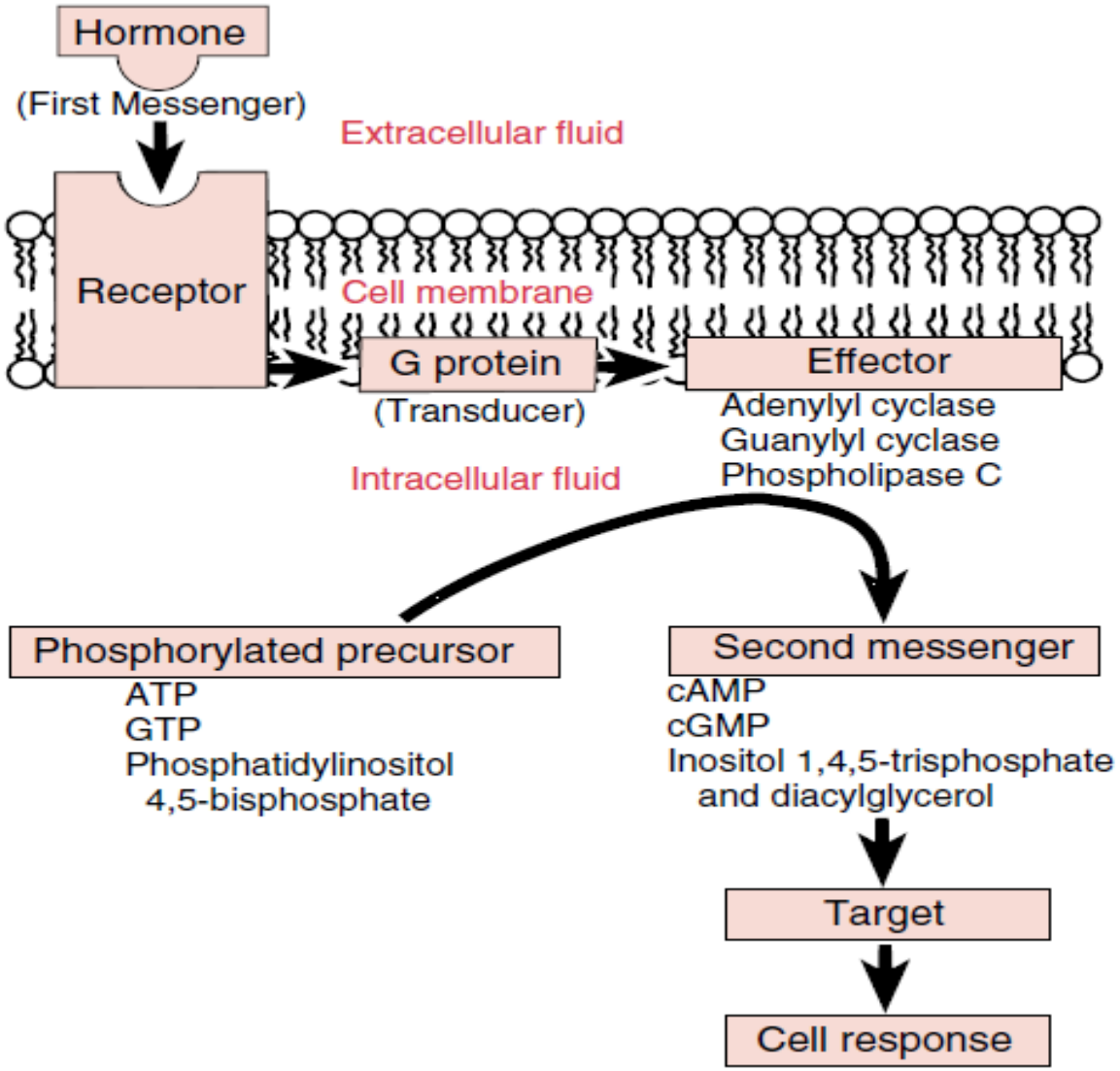
Second messenger systems



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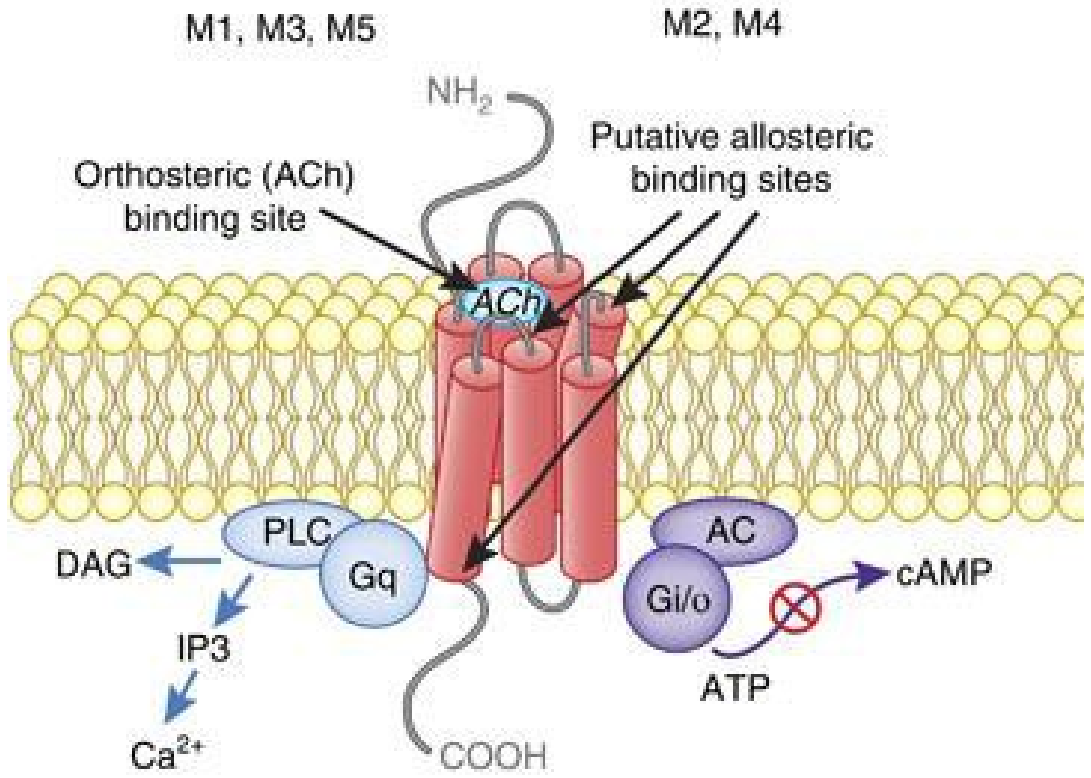
Autonomic nervous system

Postganglionic fibers

- PNS
- ***Muscarinic receptor***
  - G-protein coupled
  - Excitatory receptors (M_1, M_3, M_5)
  - Inhibitory receptors (M_2, M_4)



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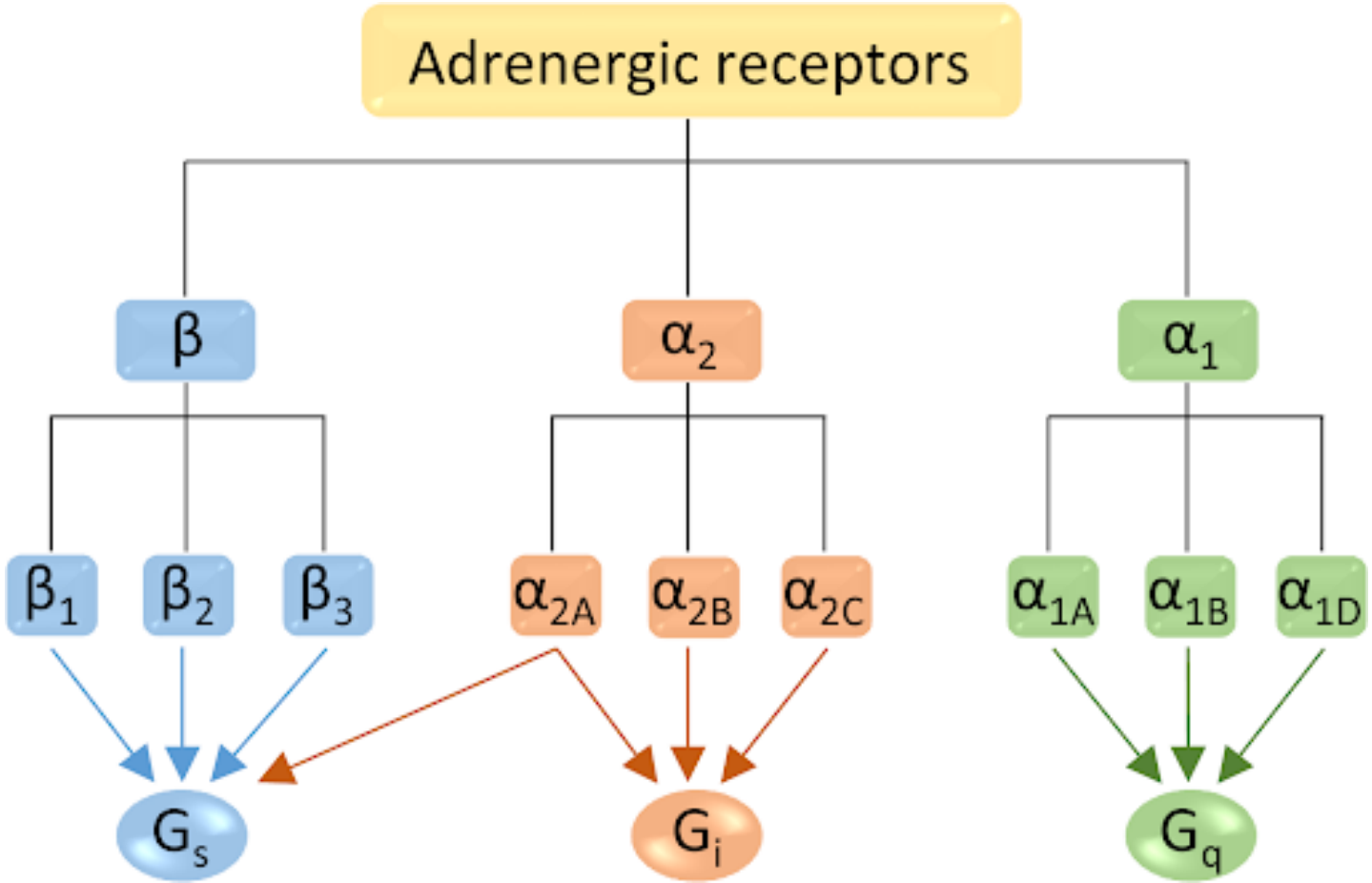
Autonomic nervous system

- **Postganglionic fibers**
- SNS
- ***Adrenergic receptor***
  - G-protein coupled



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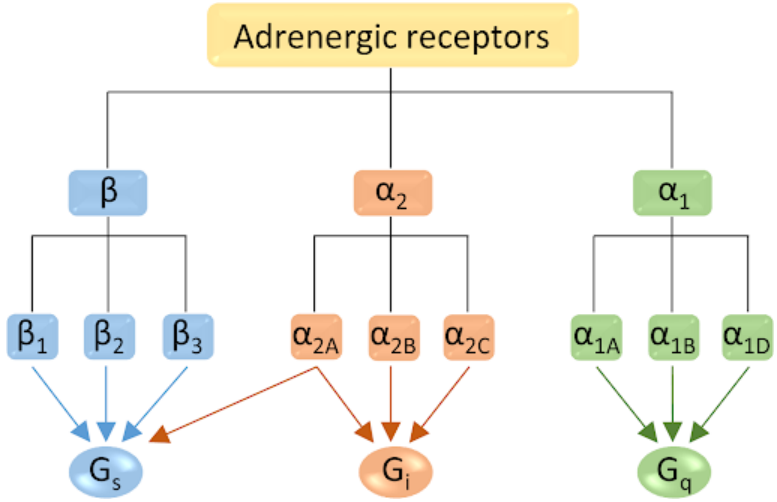
Autonomic nervous system

Adrenergic receptor

- G-protein coupled
  - Type α –Excitatory receptors
  - Type β – Inhibitory receptors



Receptor Type	Primary Mechanism of Action	Examples of Tissue Distribution	Examples of Action
α_1	↑ IP3 and Ca^{++}, DAG	Sympathetic postsynaptic nerve terminals	Increase vascular smooth muscle contraction
α_2	↓ cAMP	Sympathetic presynaptic nerve terminals, beta cell of pancreatic islets	Inhibit norepinephrine release, inhibit insulin release
β_1	↑ cAMP	Heart	Increase cardiac output
β_2	↑ cAMP	Liver; smooth muscle of vasculature, bronchioles, and uterus	Increase hepatic glucose output; decrease contraction of blood vessels, bronchioles, and uterus
β_3	↑ cAMP	Liver, adipose tissue	Increase hepatic glucose output, increase lipolysis

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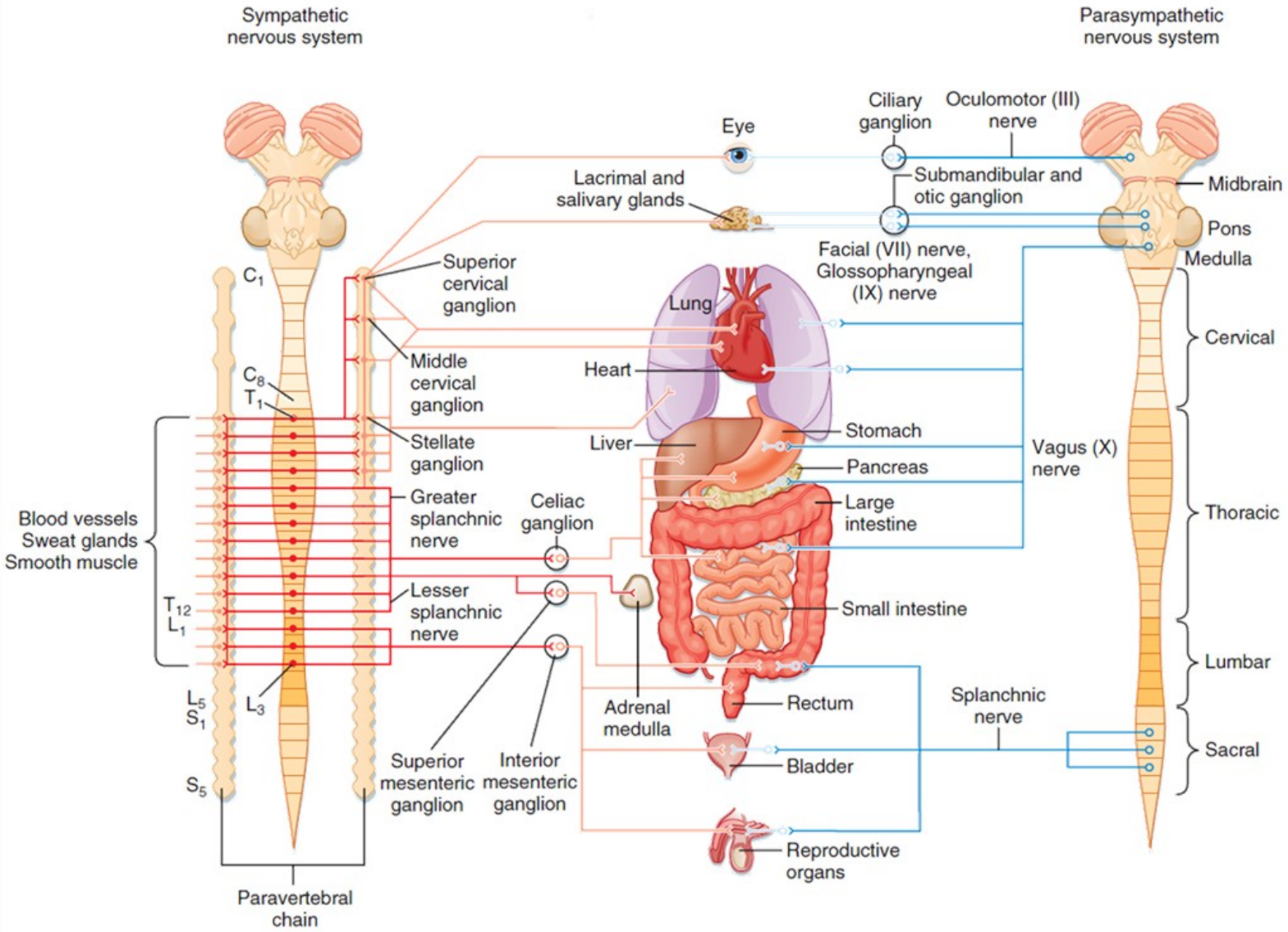
Autonomic nervous system

FIGHT OR FLIGHT



REST OR DIGEST

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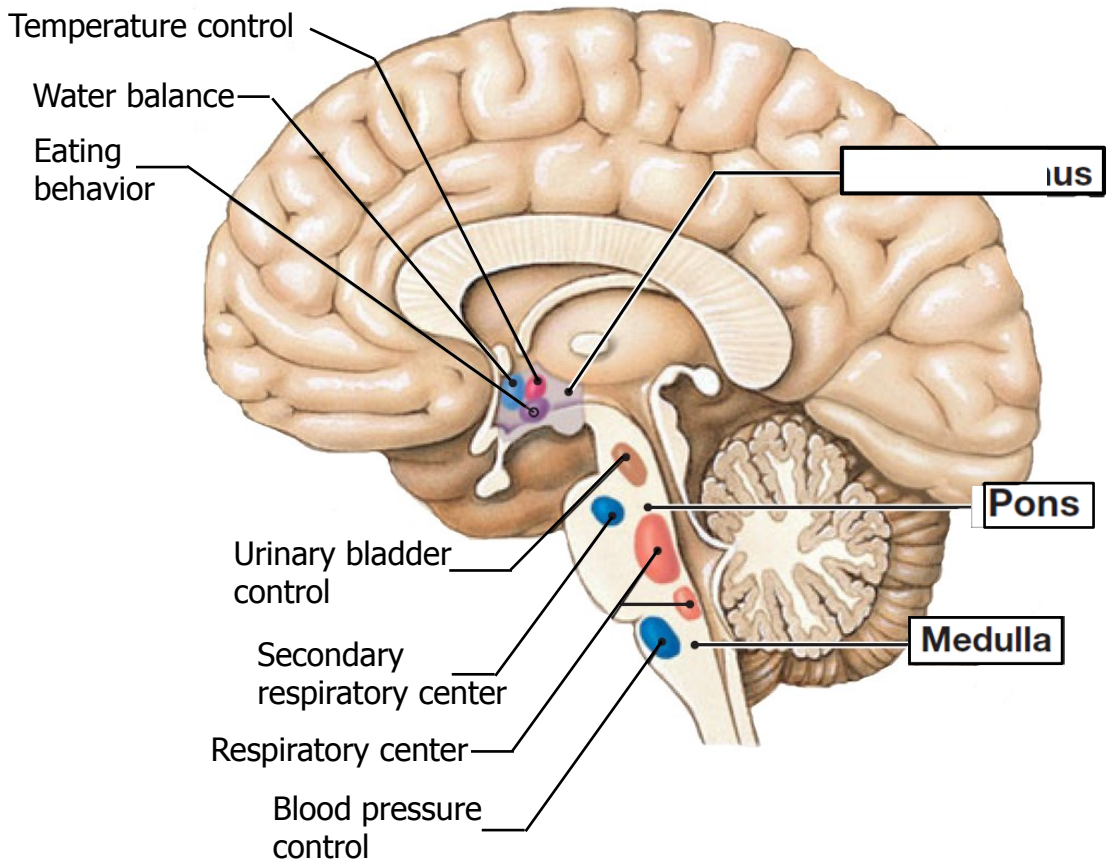
Brain control of ANS

Autonomic centers—brain stem and hypothalamus

1. **Medulla**
   - Vasomotor center
   - Respiratory center
   - Swallowing, coughing, and vomiting centers
2. **Pons**
   - Pneumotaxic center
3. **Midbrain**
   - Micturition center
4. **Hypothalamus**
   - Temperature regulation center
   - Thirst and food intake regulatory centers



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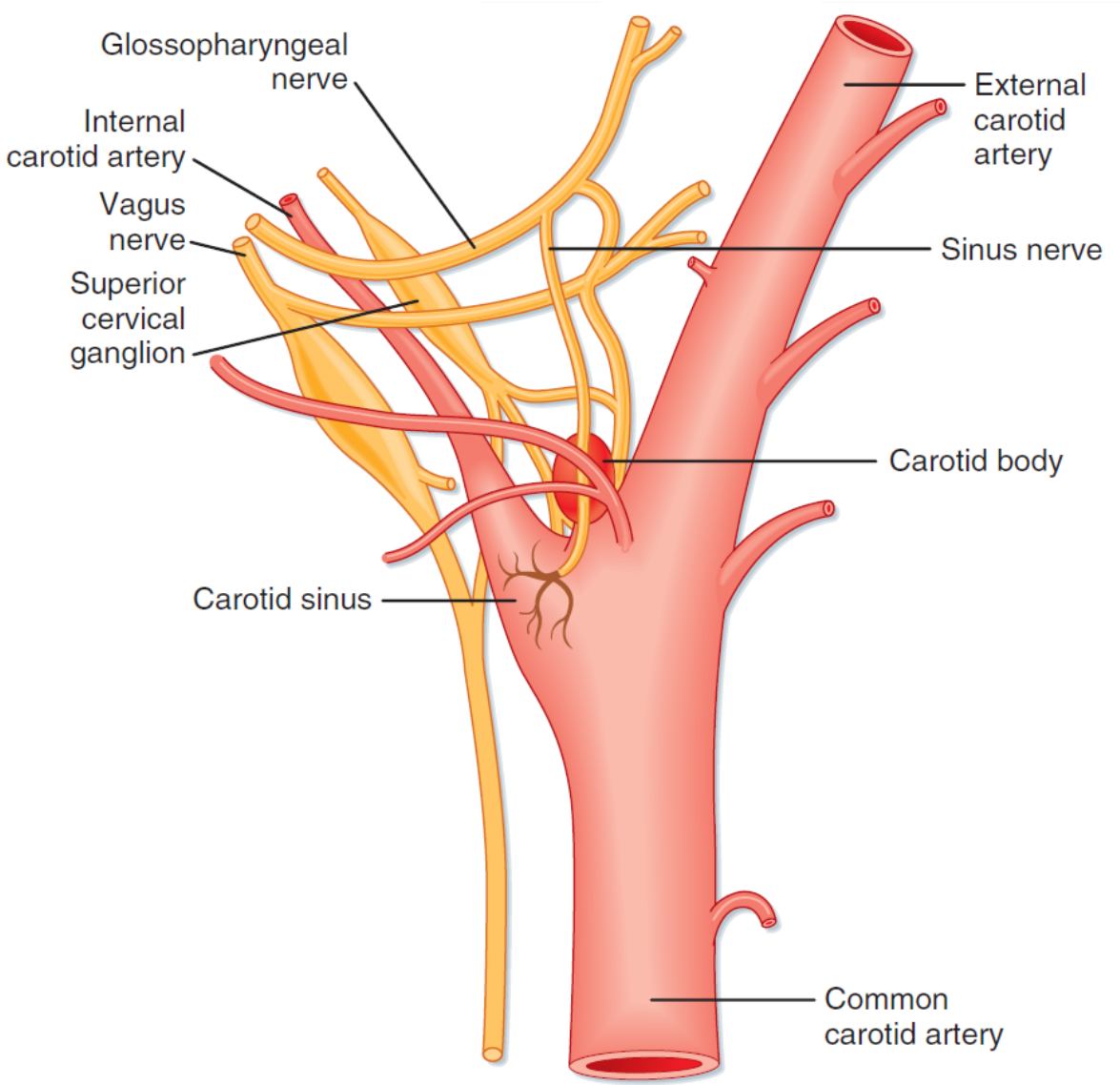
Baroreceptor vs. Chemoreceptor



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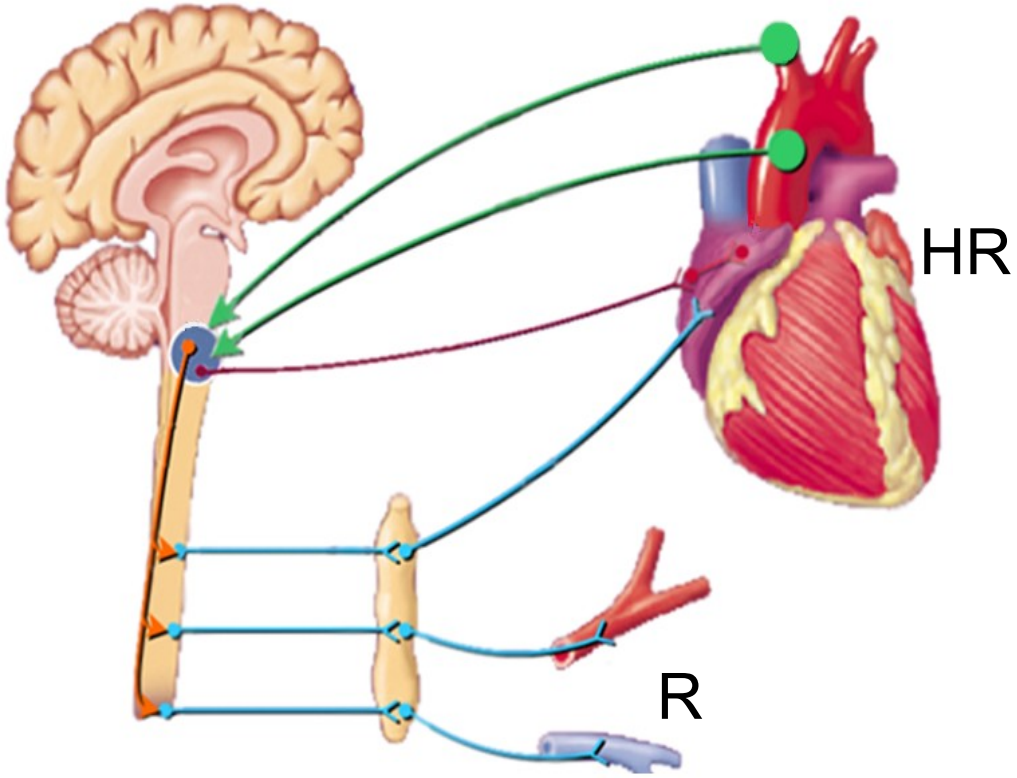
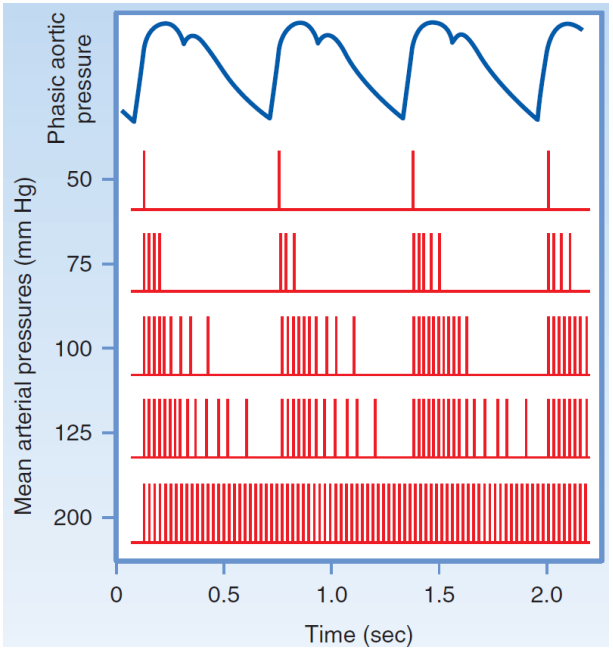
Baroreflex I

Aferent pathway
Parasympathetic pathway
Sympathetic pathway





- Inotropic
- Chronotropic
- Dromotropic
- Batmotropic

} effect

BP=HR x SV x R

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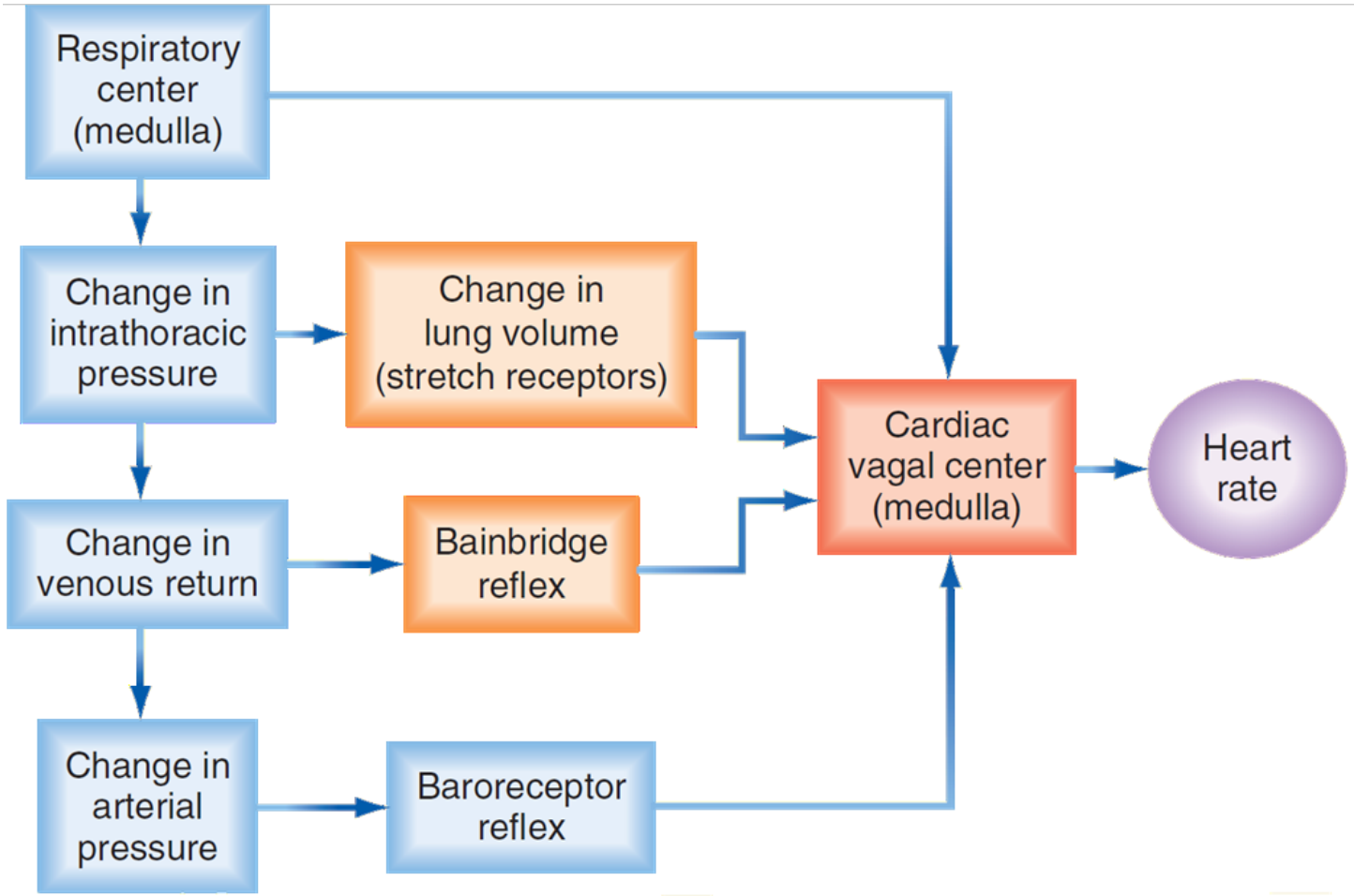
Sinus respiratory arrhythmia



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Something more…

- Oculocardial reflex
  - Pressure on the eye bulbes decreases heart rate (activation of the vagus)
  - It is used to suppress or stop tachycardia
- Low pressure baroreflex
  - greater expansion of the left ventricle stimulates baroreceptors –vagus→medulla - inhibition of SNS – vasodilation, bradycardia – decrease of BP
- Diving reflex
  - Cold water on the face causes respiratory arrest, peripheral vasoconstriction and bradycardia
- Coronary chemoreflex (Bezoldov-Hirtov-Jarisch reflex)
  - Substances applied to the left coronary artery (veratridine, capsaicin, some contrast agents, substances produced by ischemic tissue) induce apnea and then hyperpnea, hypotension, bradycardia (vagal afferentation)

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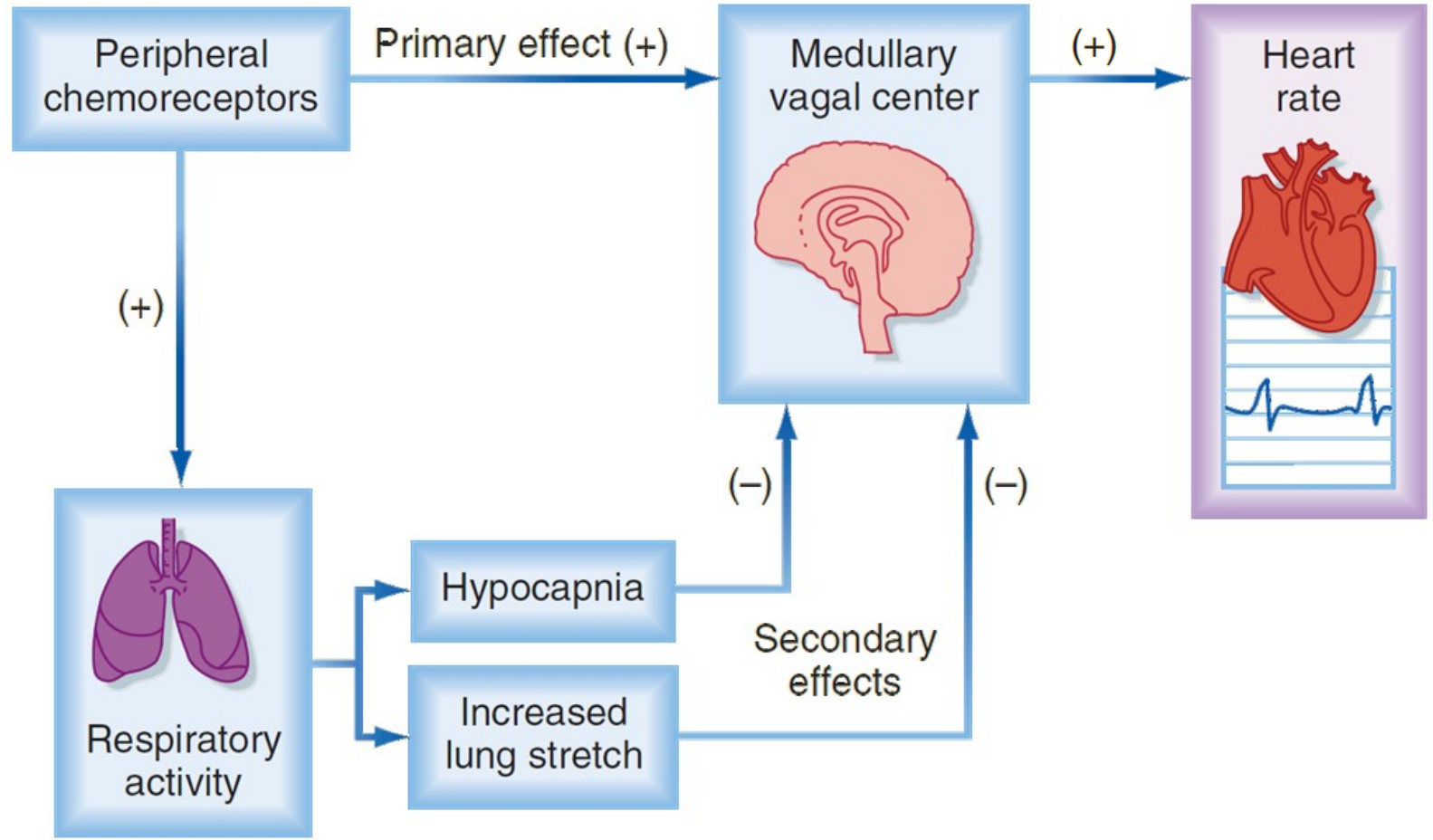
Chemoreflex



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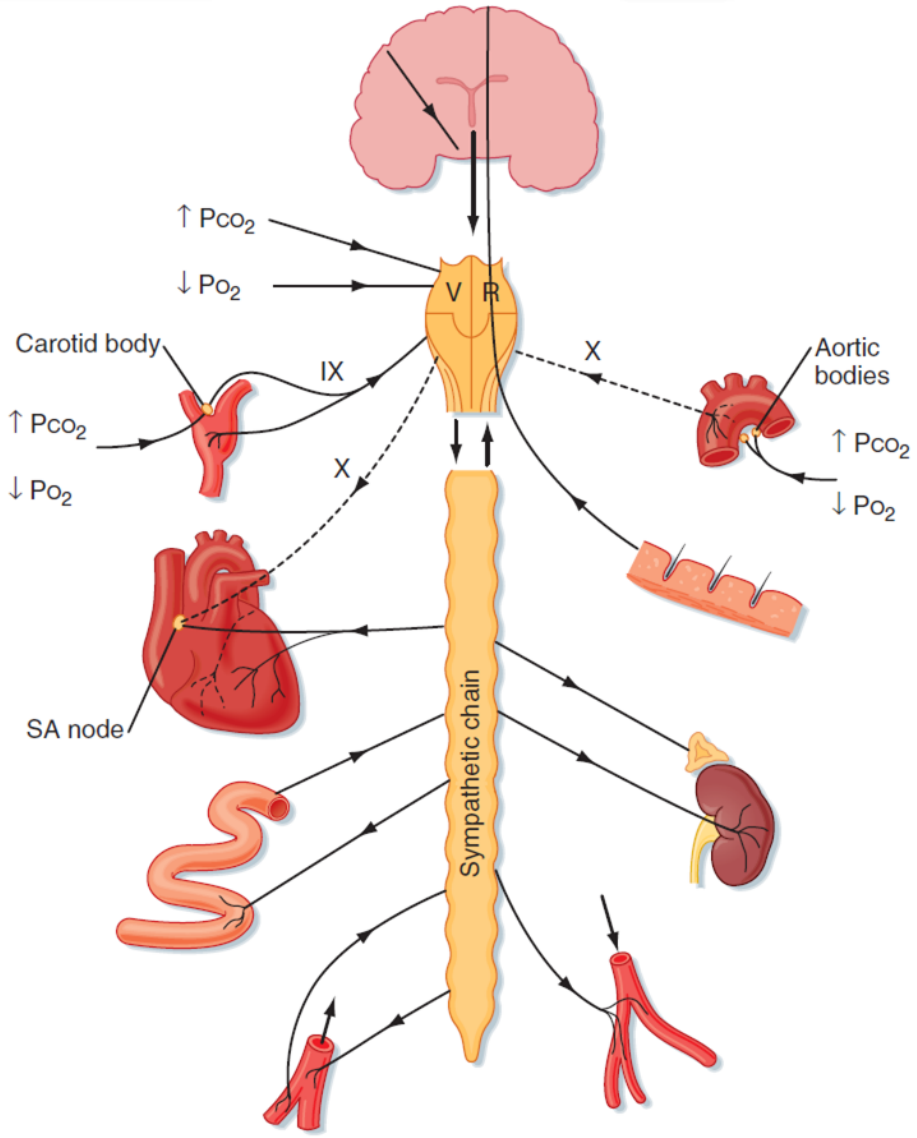
ANS and blood vessels



EFECTORS	RECEPTORS	ADRENERGIC REACTION
CORONARY A.	α, β_2	C, D
SKIN A.	α	C
SKELETAL MUSCLE	α, β_2	C, D
BRAIN A.	α	C
LUNGS A.	α, β_2	C, D
ABDOMENAL A.	α, β_2	C, D
VEINS	α, β_2	C, D

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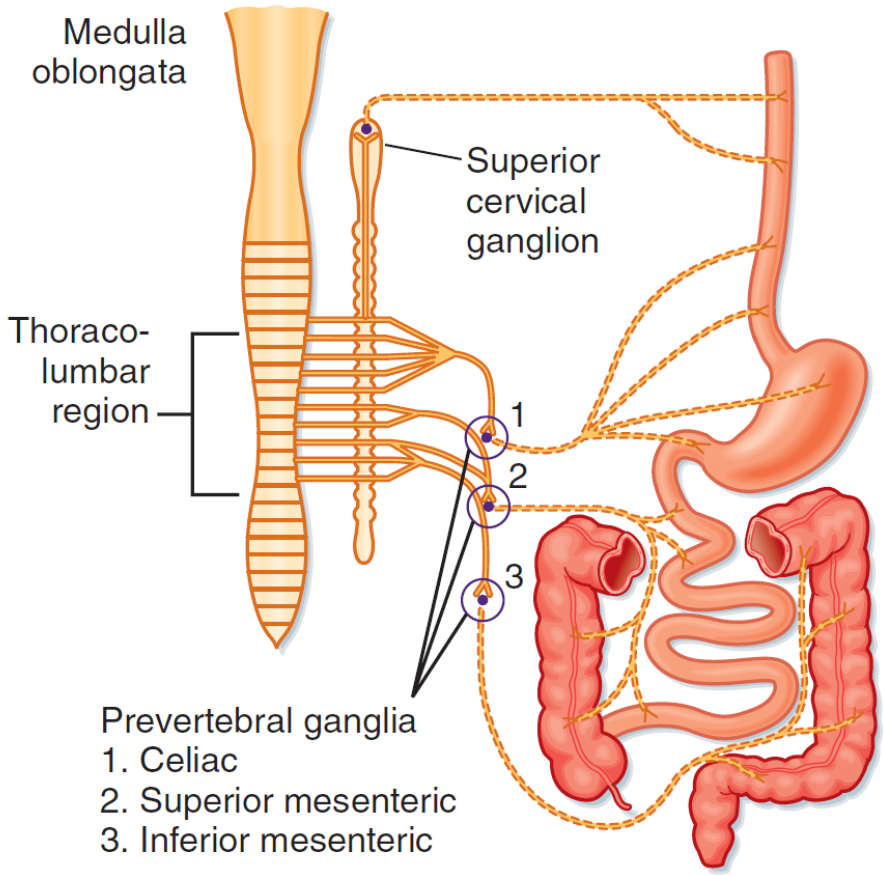
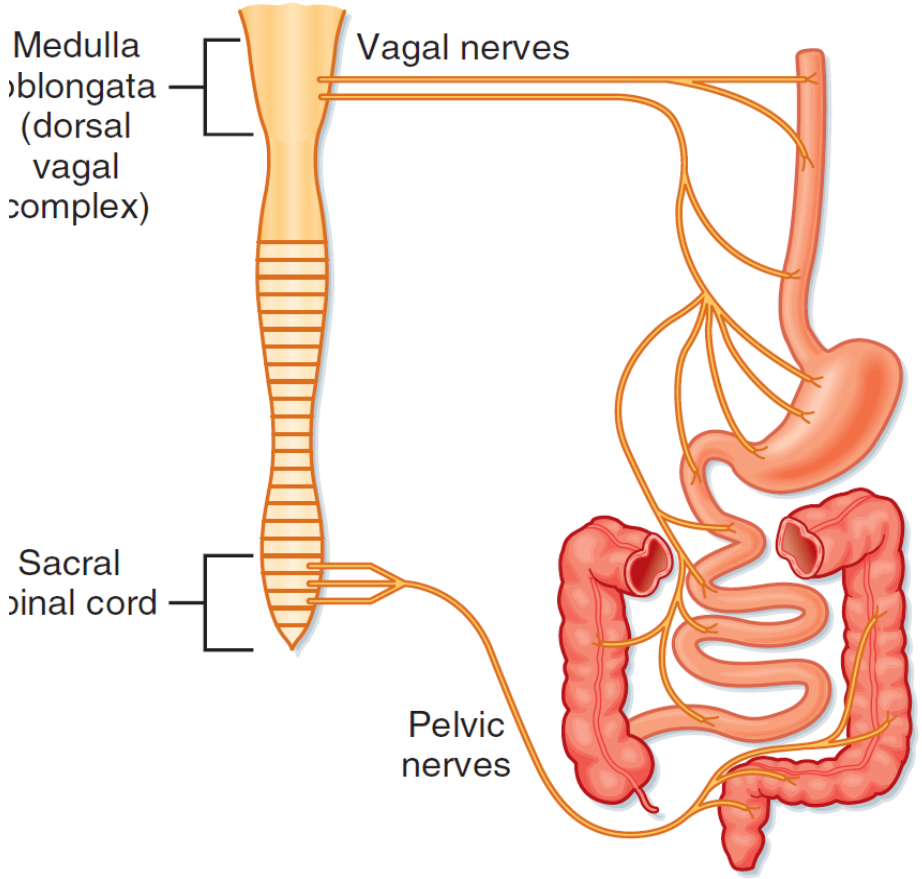
GIT and ANS

SNS



PNS



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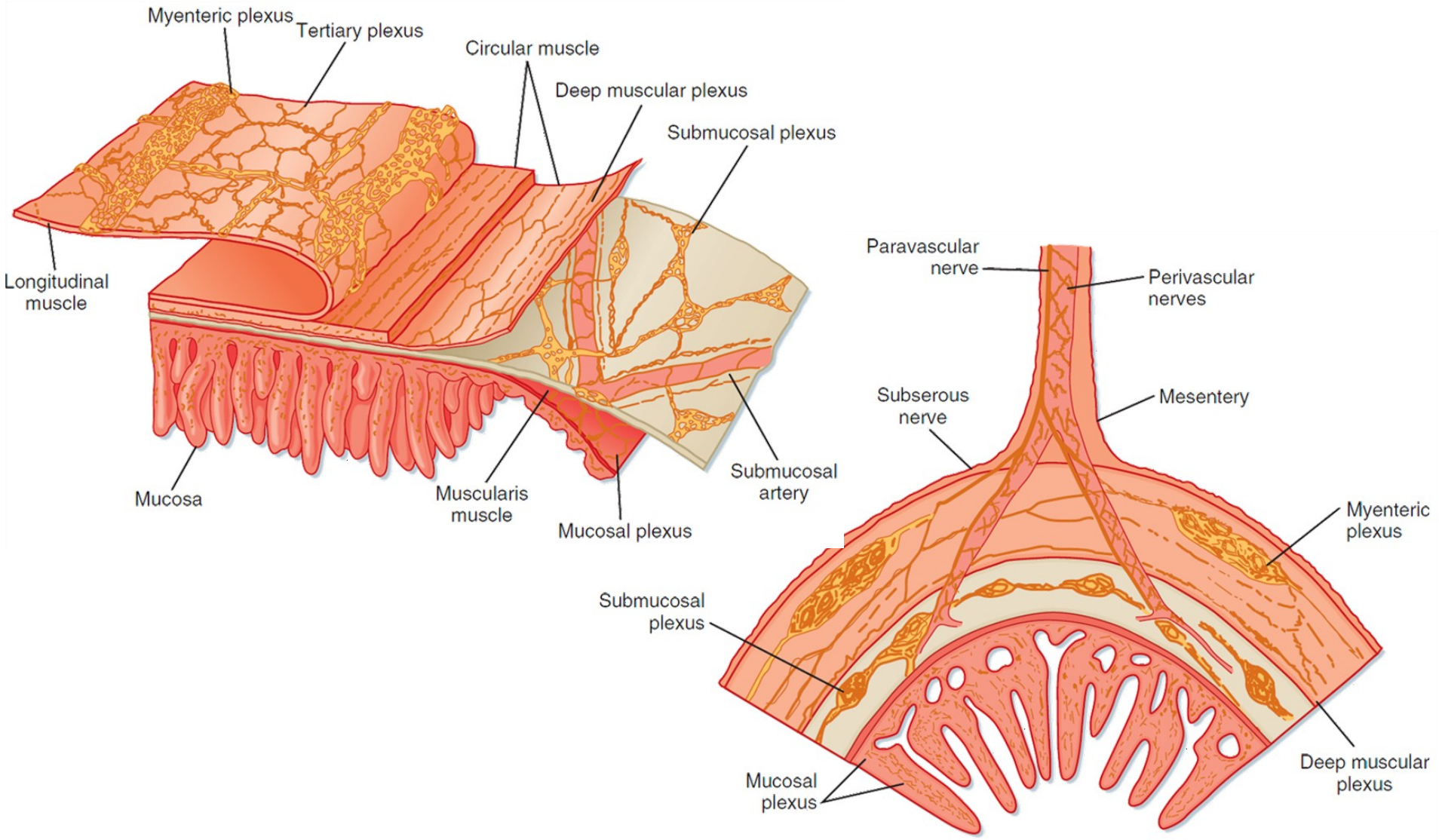
GIT - Enteric Nervous System



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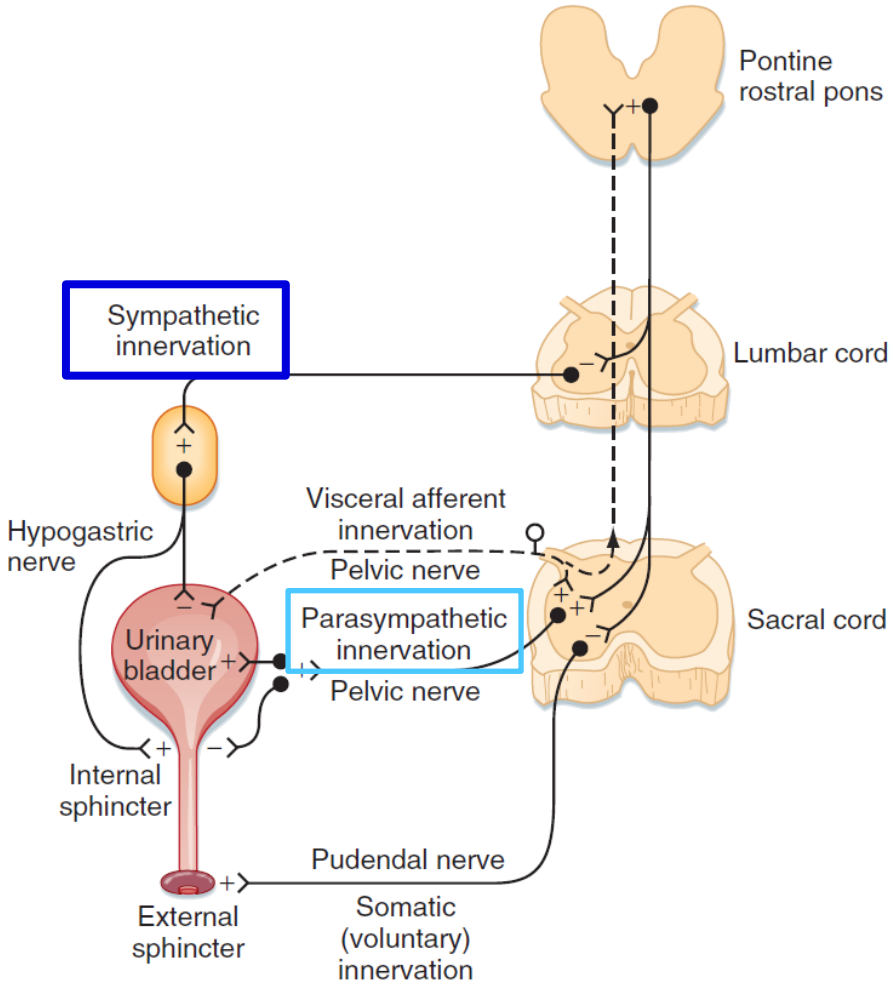
ANS and urinary bladder

SNS	
DETRUSOR	RELAXATION
SPHINCTER	CONTRACTION

PSN	
DETRUSOR	CONTRACTION
SPHINCTER	RELAXATION



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Neurogenic bladder

NAME	COMMENTS
Uninhibited bladder	Lesion: above the pontine micturition center Signs: reduced awareness of bladder fullness, incontinence may occur
Upper motor neuron bladder (Detrusor-sphincter dyssynergia)	Lesion: between the pontine micturition center and sacral cord Signs: detrusor is usually spastic, simultaneous detrusor and urinary sphincter contractions increase pressures in the bladder, can lead to vesicoureteral reflux that and renal damage
Mixed type A bladder	Lesion: sacral cord lesion at the detrusor nucleus with sparring of the pudendal nucleus Signs: the detrusor muscle is flaccid, bladder is large, external urinary sphincter is spastic, incontinence uncommon
Mixed type B bladder	Lesion: sacral cord lesion at the pudendal nucleus with sparring of the detrusor nucleus Signs: the bladder is spastic and the external urinary sphincter is flaccid, incontinence is common
Lower motor neuron bladder	Lesion: sacral cord or sacral root while the thoracic sympathetic outflow to the lower urinary tract is preserved Signs: bladder is large and hypotonic, incontinence uncommon

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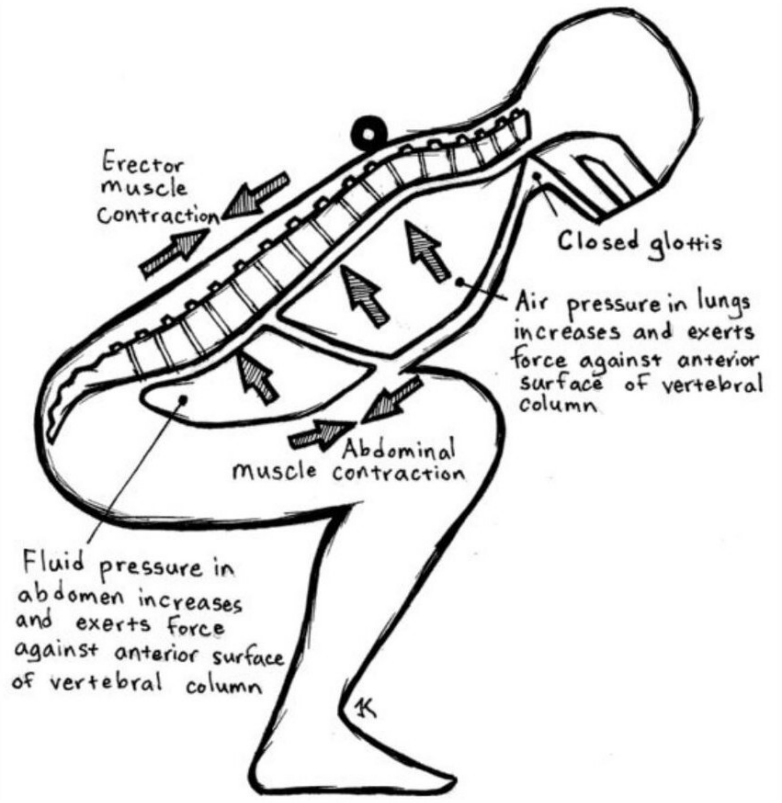
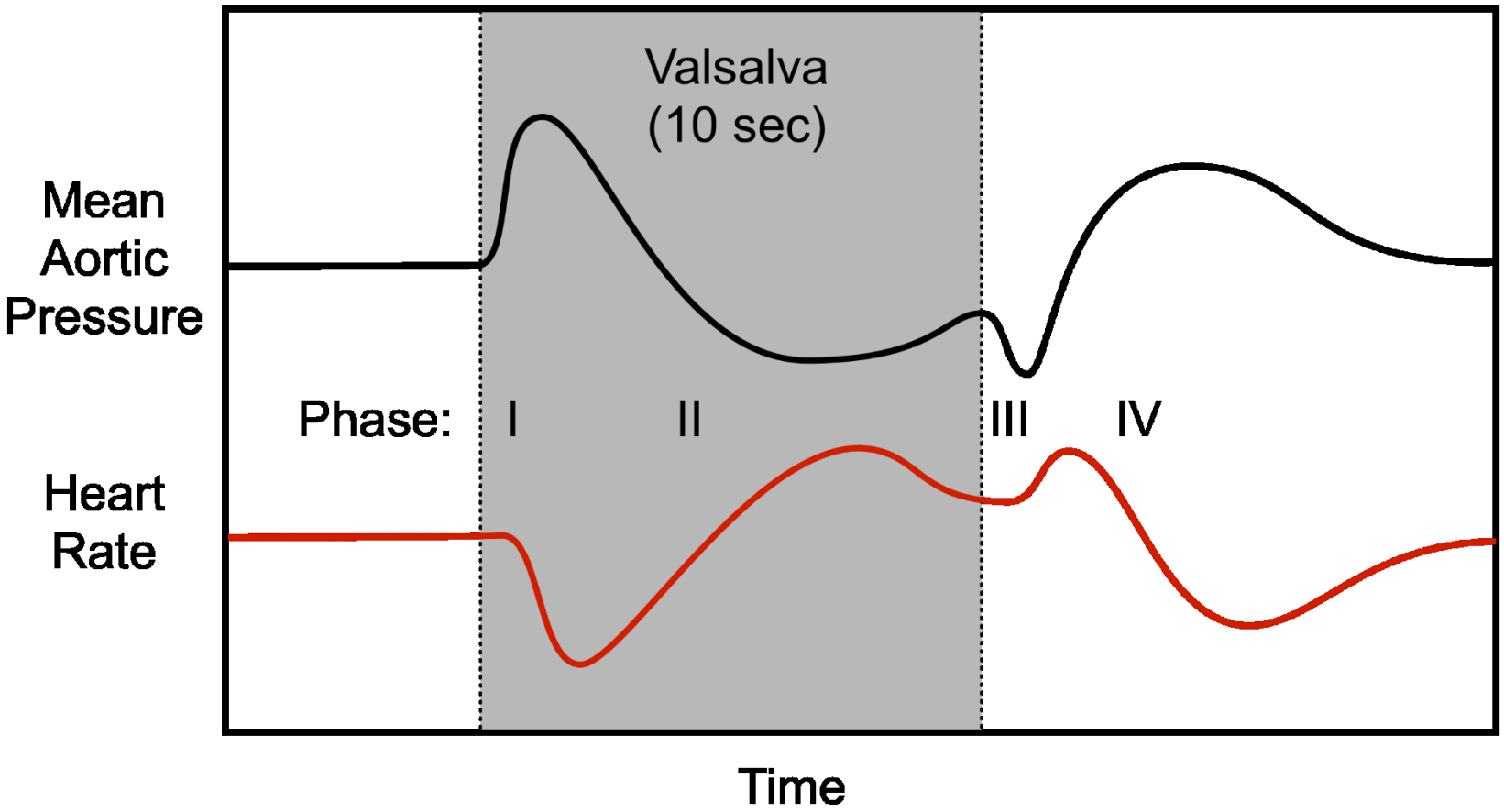
Valsalva maneuver





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- A 36-year-old female began to have problems at the age of 18 years after she developed a severe case of mononucleosis. She began to experience palpitations, sweating, irritable bowel syndrome, and was diagnosed with anxiety. Her symptoms continued throughout subsequent years, and she continued to feel light-headed upon standing as well as noticing excessive palpitations. She had a few syncopal events, but she generally has enough warning to sit down and protect herself.
- She cannot exercise much because of her very poor stamina. She has no other autonomic symptoms except for the irritable bowel, which is diarrhea predominant. She has a history of migraines, which have been fairly well controlled. She reports her sleep quality is quite good, but still she is exhausted at the end of the working day and oftentimes needs a nap before dinner.
- The examination was normal.
- Hematologic, endocrine, routine chemistry, and neuroimmunology panel were normal except for lower vitamin D levels. Plasma catecholamines were normal as were the 24-hour urinary sodium output and urine volume.
- The echocardiogram was normal.
- Autonomic reflex screen: marked tachycardia on tilt, but was otherwise normal.
- Exercise study: normal hemodynamic profile but profound deconditionin

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Thank you for your attention

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