

**M U N I**  
**M E D**

# **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/ $\alpha$ - or $\beta$ -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

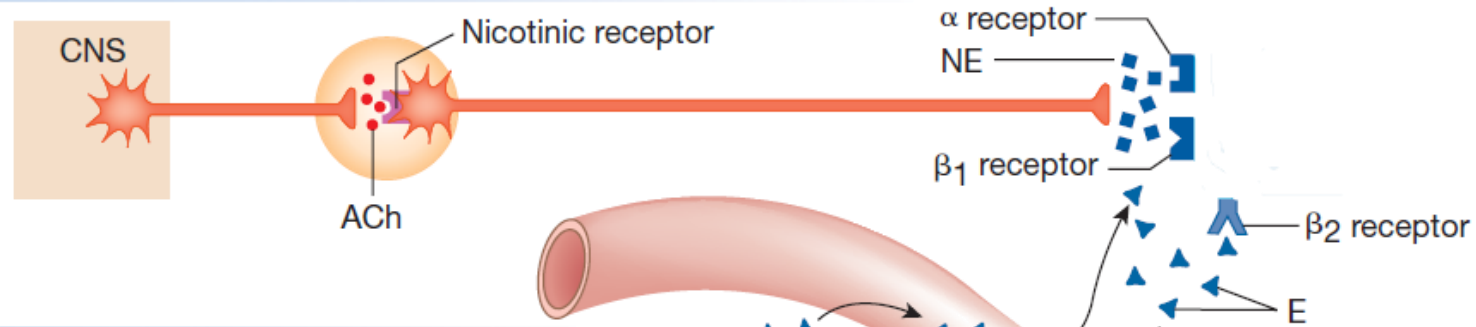
# Autonomic nervous system

## AUTONOMIC PATHWAYS

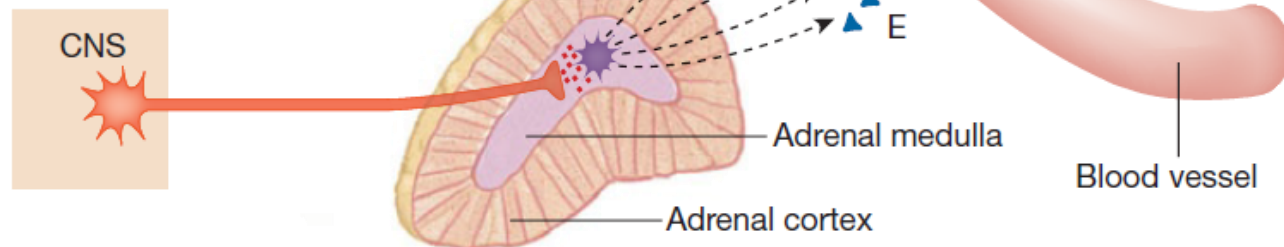
### (a) Parasympathetic Pathway



### (b) Sympathetic Pathway



### (c) Adrenal Sympathetic Pathway



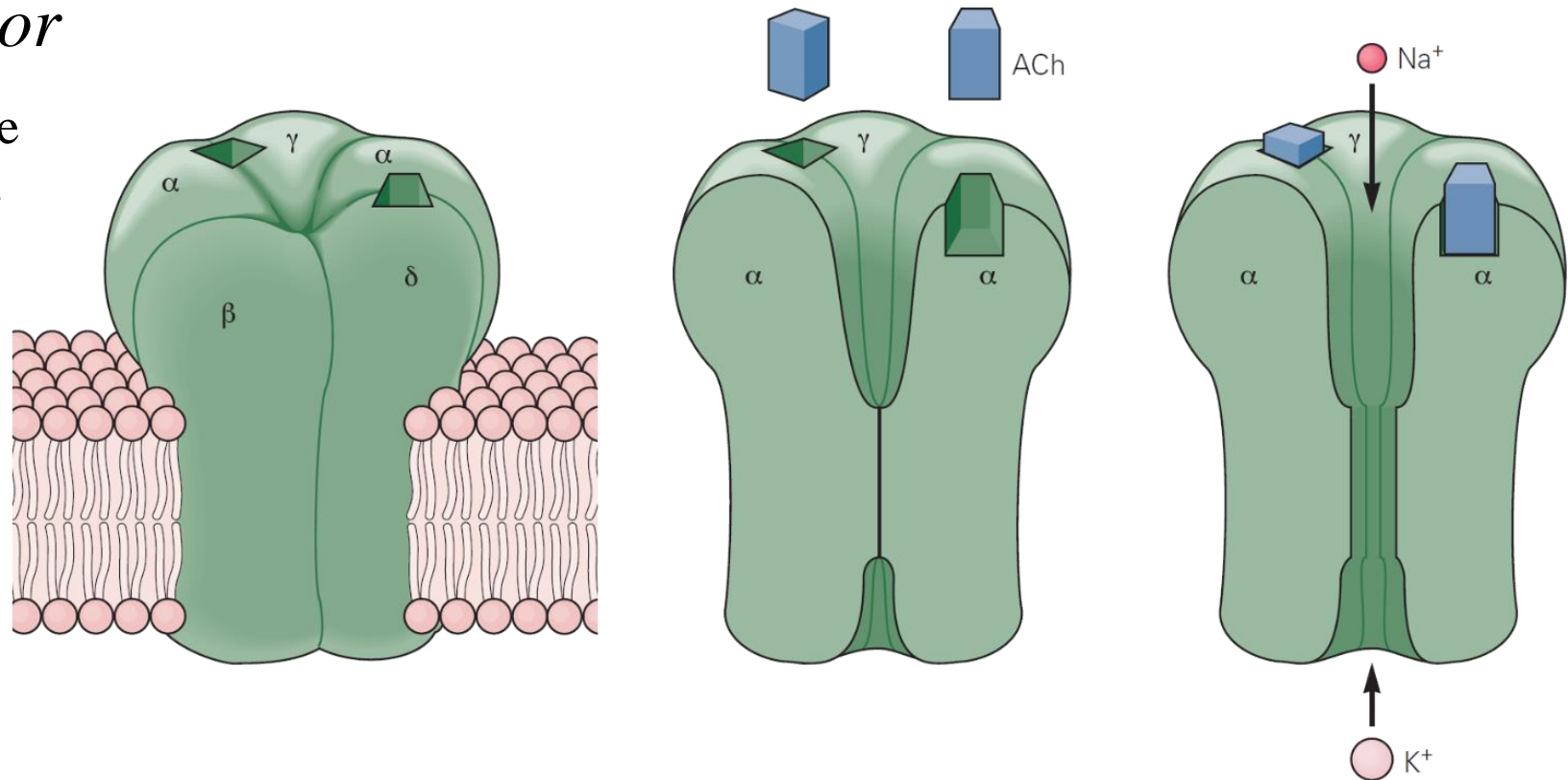
# Autonomic nervous system

## Preganglionic fibers

– SNS, PNS

– *Nicotinic receptor*

- N<sub>N</sub> type and N<sub>M</sub> type
- Excitatory receptors



# Autonomic nervous system

## Postganglionic fibers

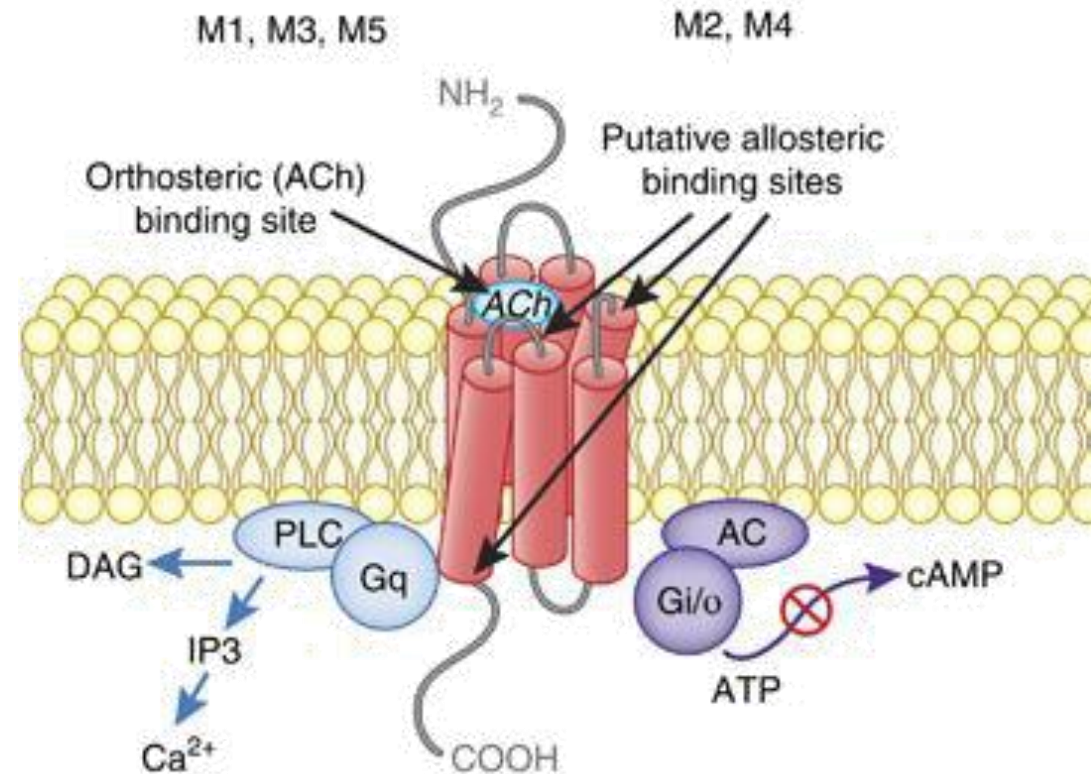
– PNS

– *Muscarinic receptor*

– G-protein coupled

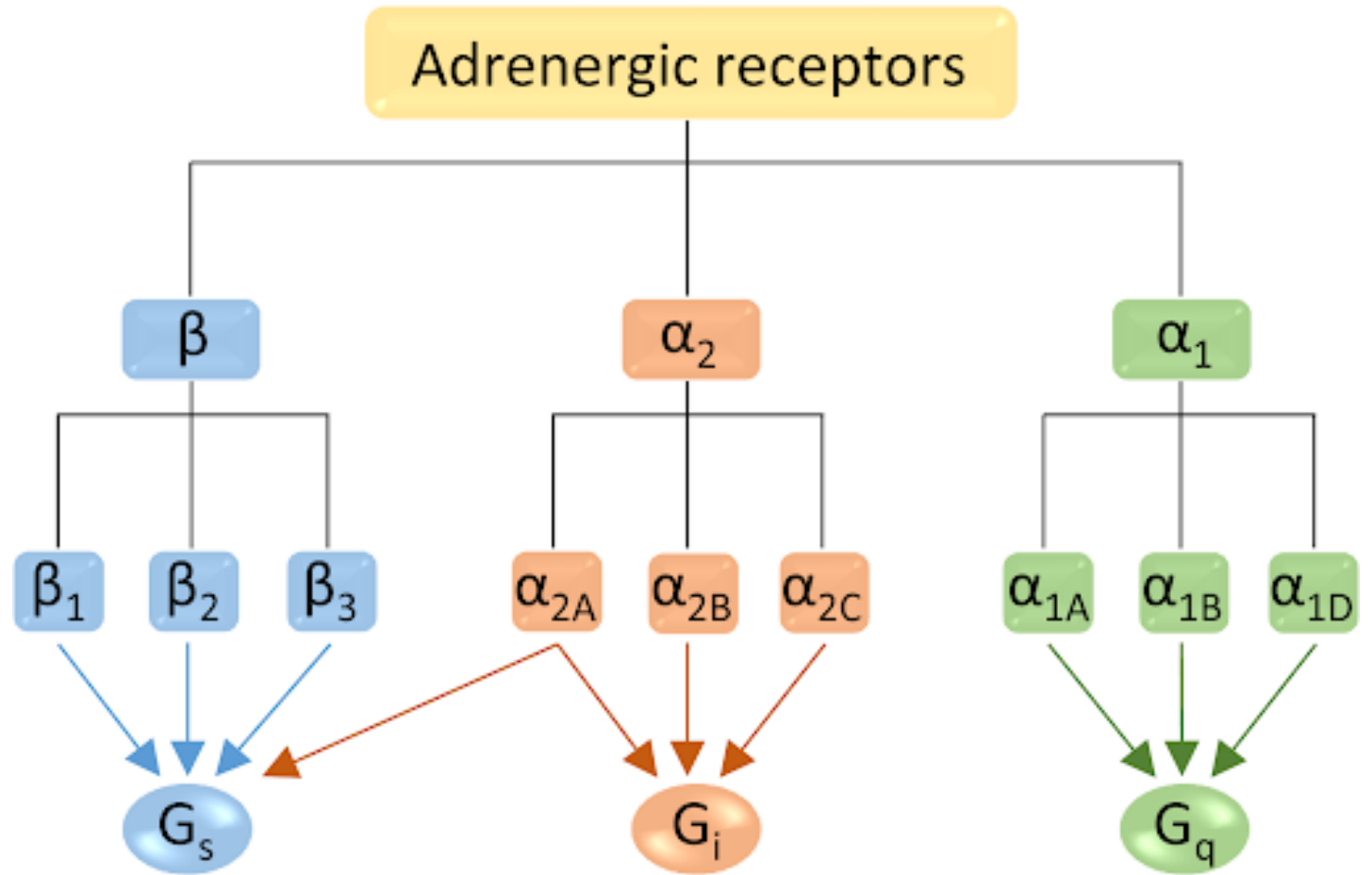
– Excitatory receptors ( $M_1$ ,  $M_3$ ,  $M_5$ )

– Inhibitory receptors ( $M_2$ ,  $M_4$ )



# Autonomic nervous system

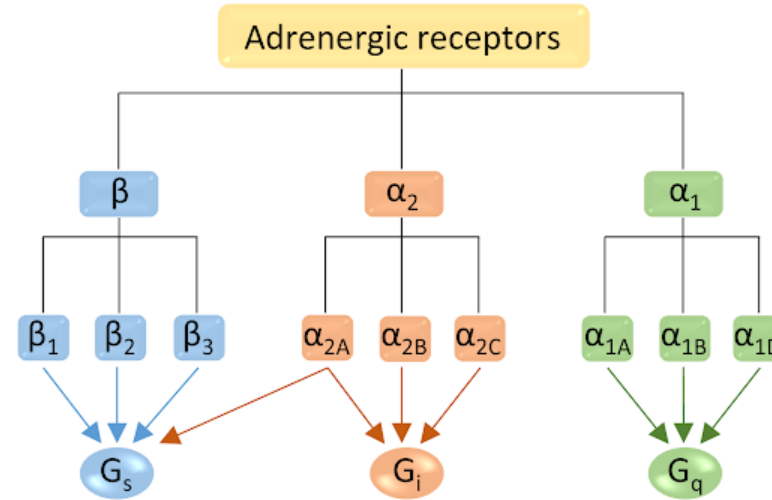
- Postganglionic fibers
- SNS
- *Adrenergic receptor*
  - G-protein coupled



# Autonomic nervous system

## *Adrenergic receptor*

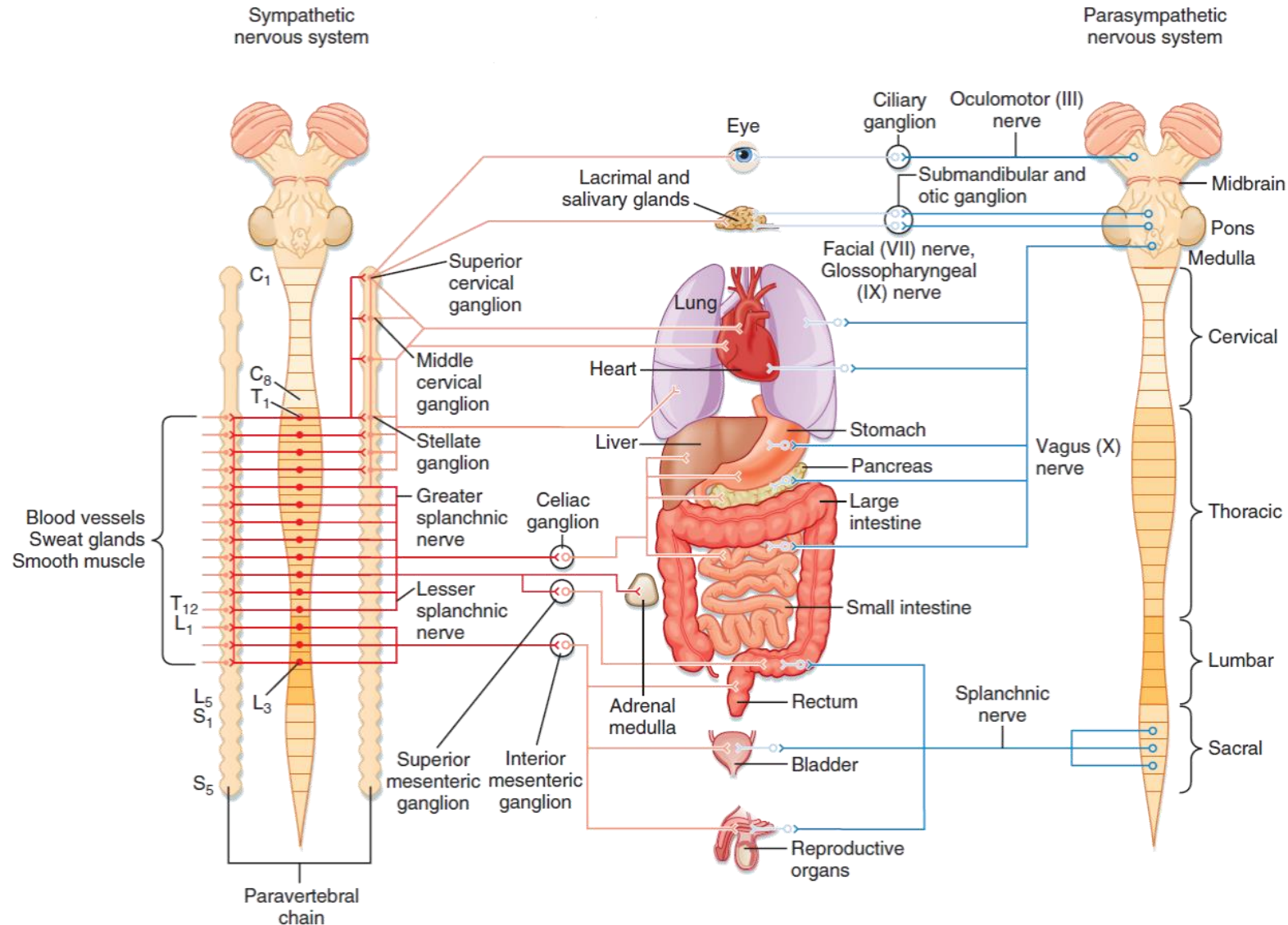
- G-protein coupled
- Type  $\alpha$  – Excitatory receptors
- Type  $\beta$  – Inhibitory receptors



Receptor Type	Primary Mechanism of Action	Examples of Tissue Distribution	Examples of Action
$\alpha_1$	$\uparrow$ IP3 and $Ca^{++}$ , DAG	Sympathetic postsynaptic nerve terminals	Increase vascular smooth muscle contraction
$\alpha_2$	$\downarrow$ cAMP	Sympathetic presynaptic nerve terminals, beta cell of pancreatic islets	Inhibit norepinephrine release, inhibit insulin release
$\beta_1$	$\uparrow$ cAMP	Heart	Increase cardiac output
$\beta_2$	$\uparrow$ cAMP	Liver; smooth muscle of vasculature, bronchioles, and uterus	Increase hepatic glucose output; decrease contraction of blood vessels, bronchioles, and uterus
$\beta_3$	$\uparrow$ cAMP	Liver, adipose tissue	Increase hepatic glucose output, increase lipolysis

# Autonomic nervous system

FIGHT OR FLIGHT



REST OR DIGEST



# Brain control of ANS

## Autonomic centers—brain stem and hypothalamus

### 1. Medulla

- Vasomotor center
- Respiratory center
- Swallowing, coughing, and vomiting centers

### 2. Pons

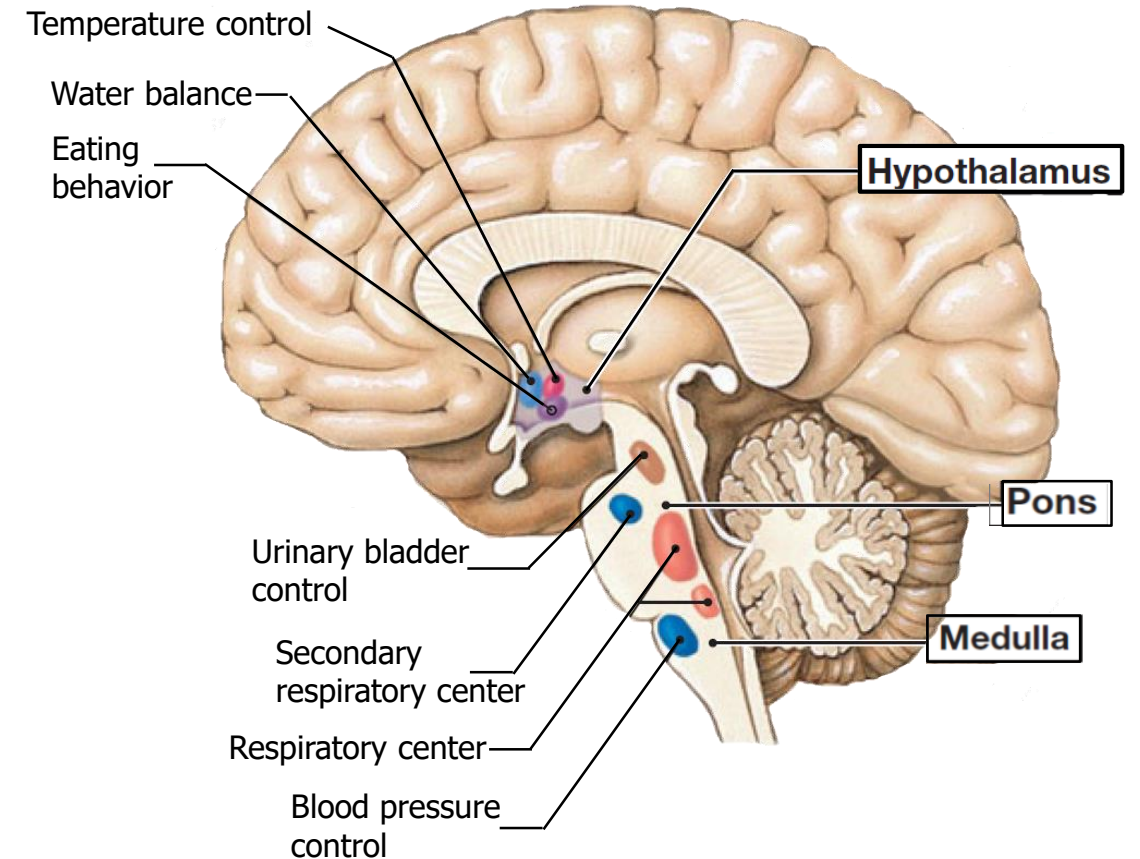
- Pneumotaxic center

### 3. Midbrain

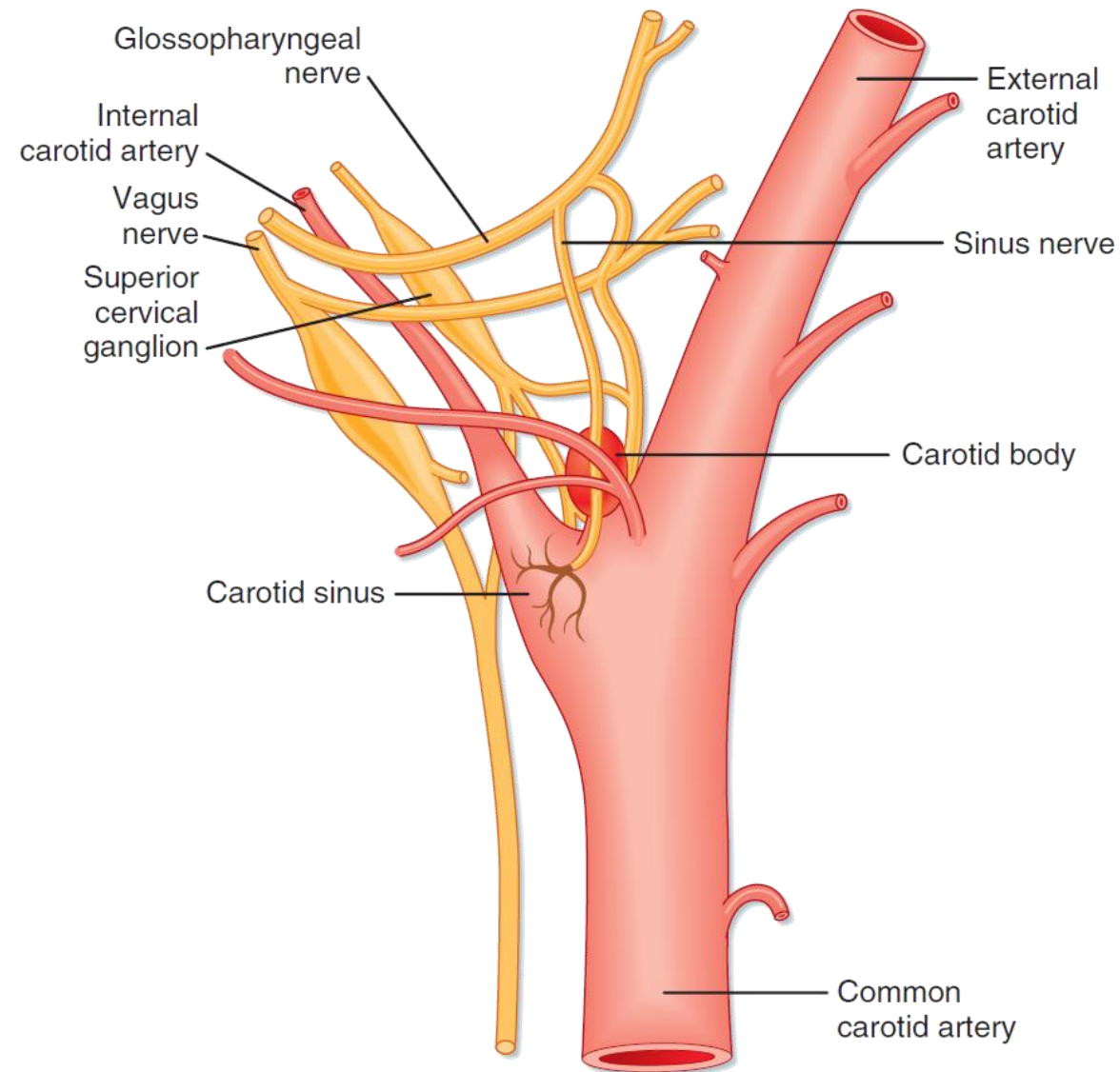
- Micturition center

### 4. Hypothalamus

- Temperature regulation center
- Thirst and food intake regulatory centers

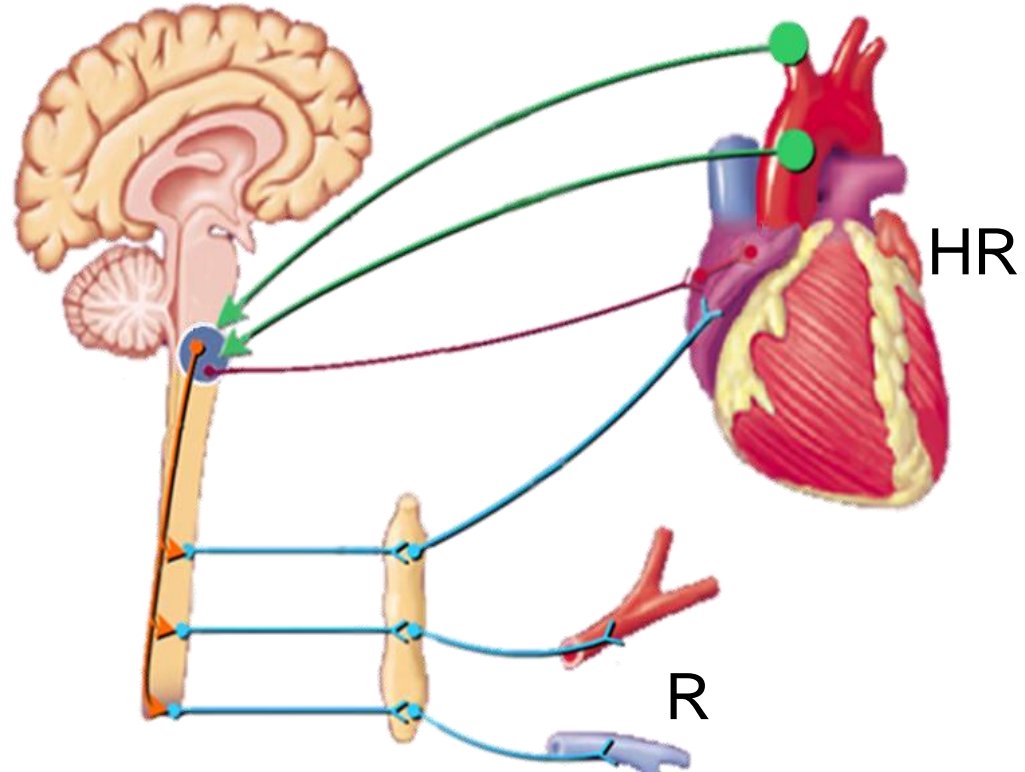


# Baroreceptor vs. Chemoreceptor

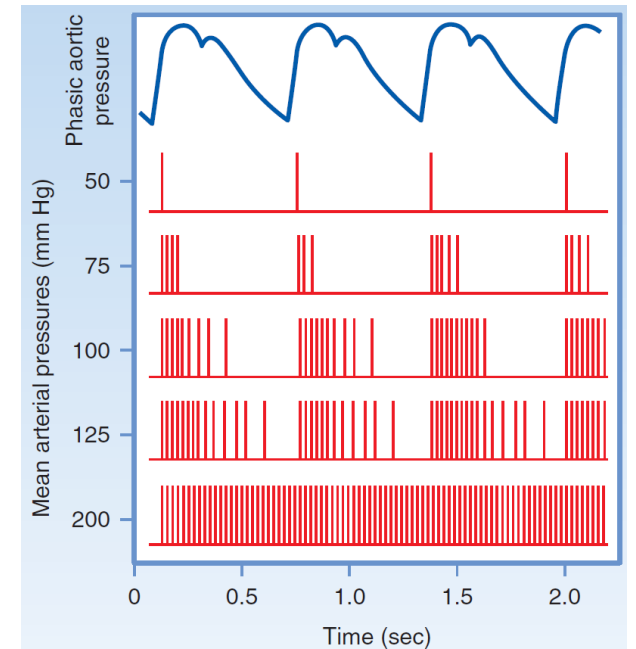


# Baroreflex I

- Aferent pathway
- Parasympathetic pathway
- Sympathetic pathway

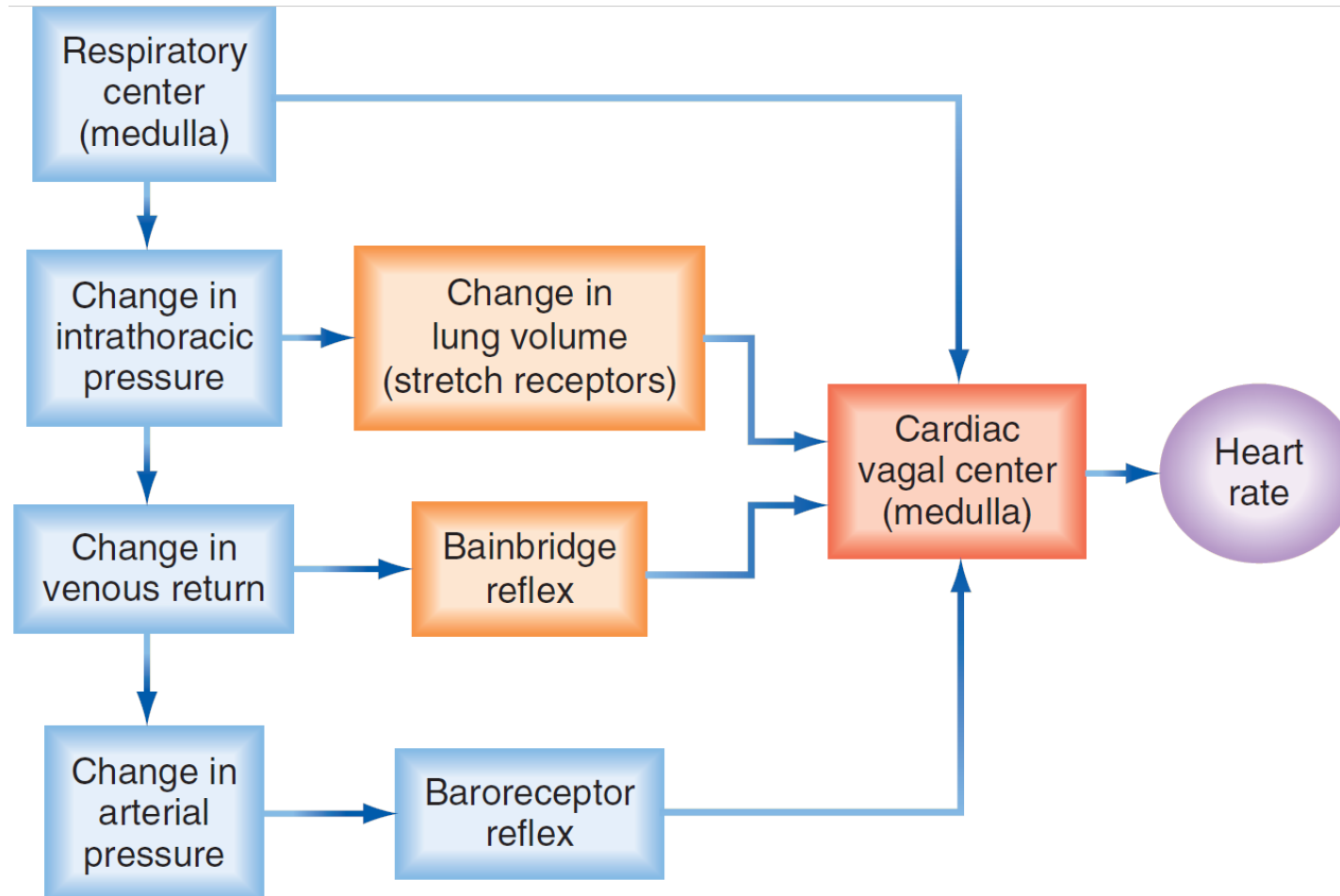


- Inotropic
  - Chronotropic
  - Dromotropic
  - Batmotropic
- } effect



$$BP = HR \times SV \times R$$

# Sinus respiratory arytmie



# Something more...

## – Oculocardial reflex

- Pressure on the eyebulbes 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

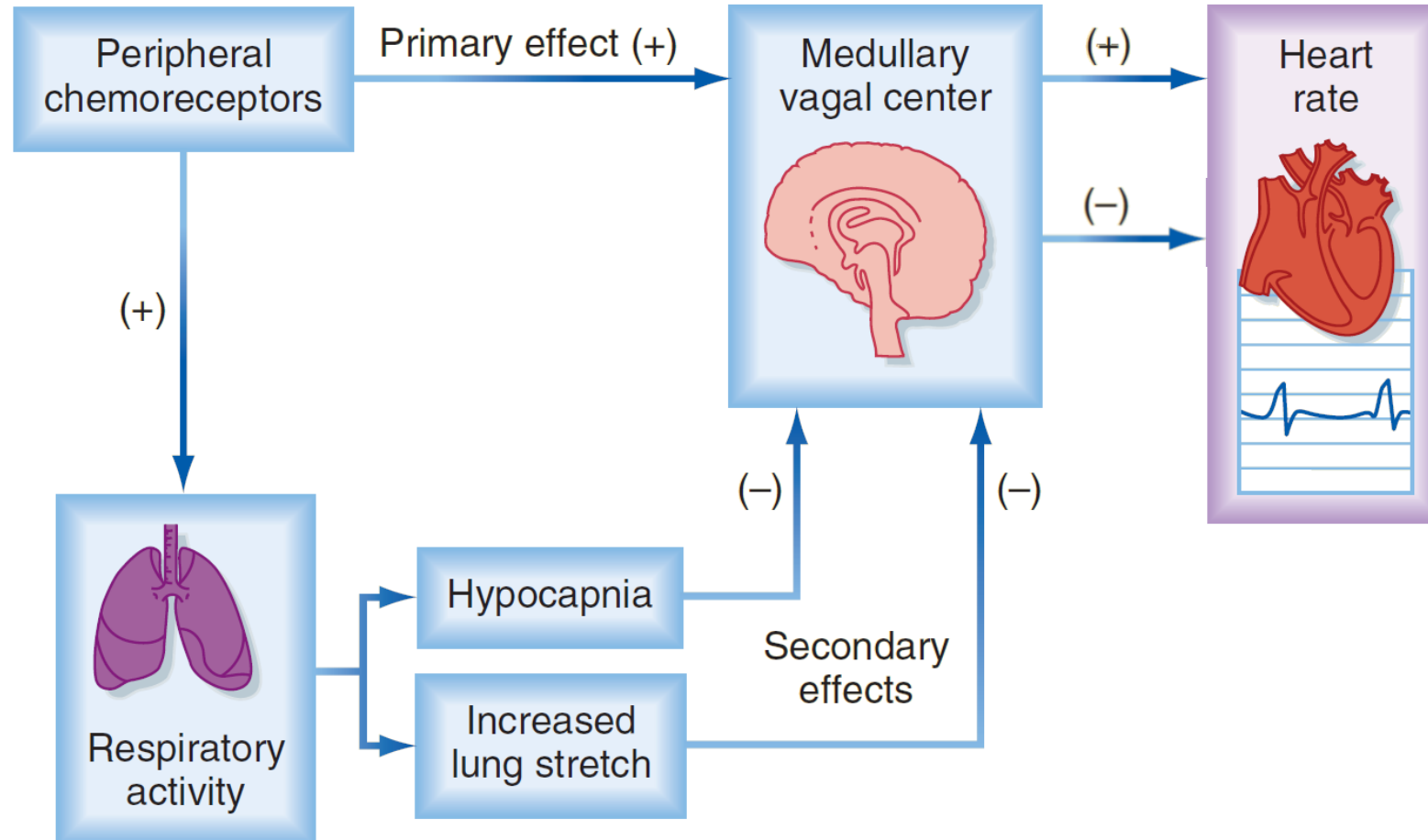
## – Diving reflex

- Cold water on the face causes respiratory arrest, peripheral vasoconstriction and bradycardia

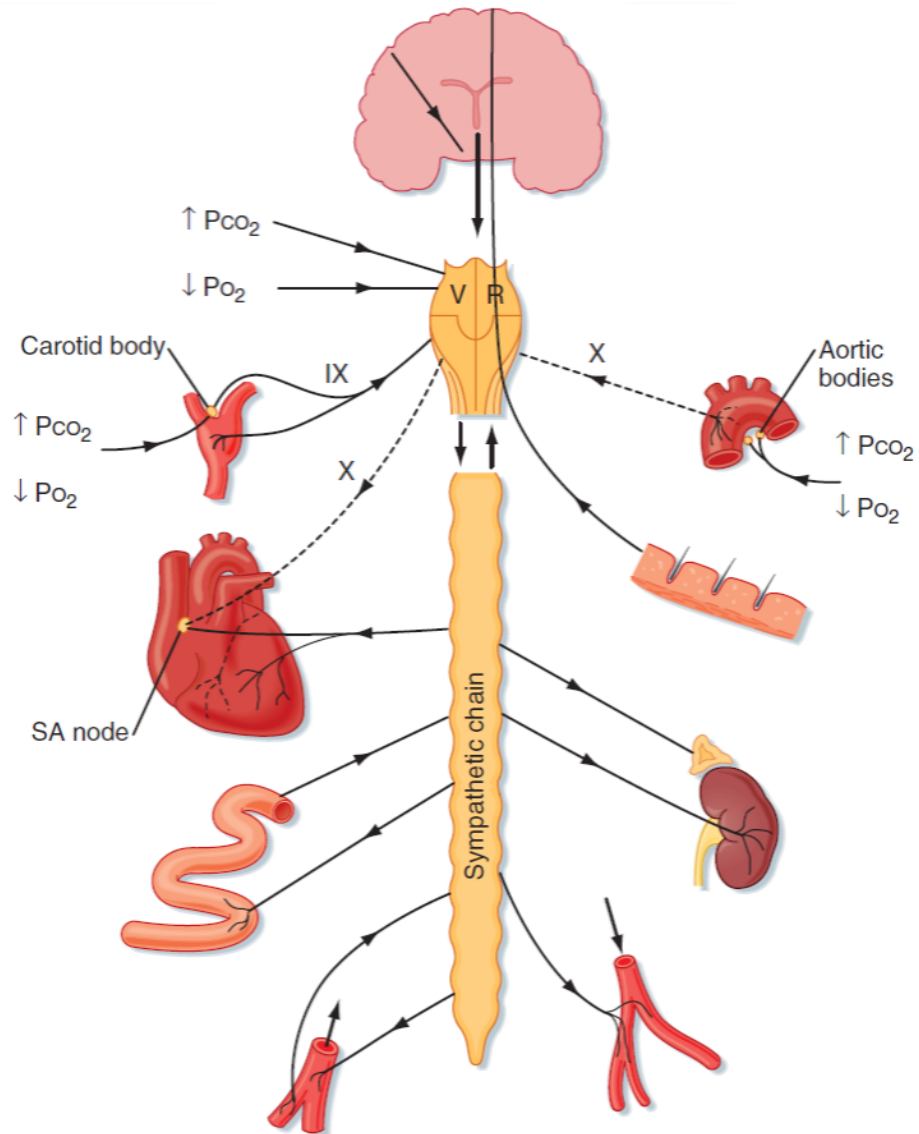
## – Coronary chemoreflex (Bezoldov-Hirtov-Jarisch reflex)

- 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)

# Chemoreflex



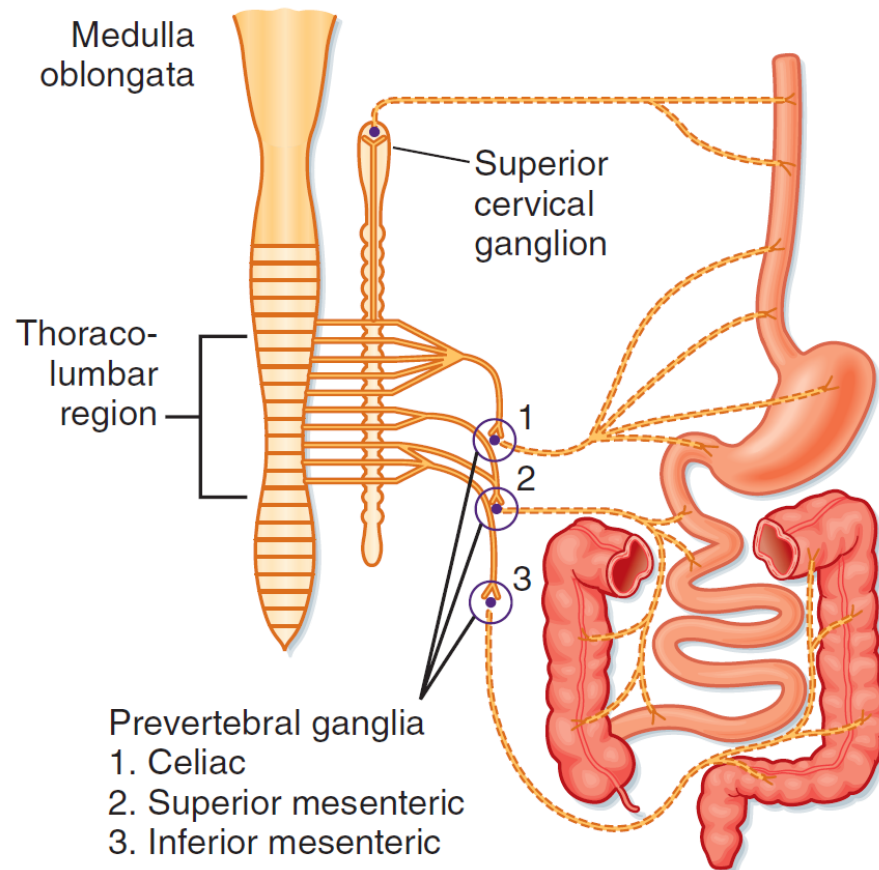
# ANS and blood vessels



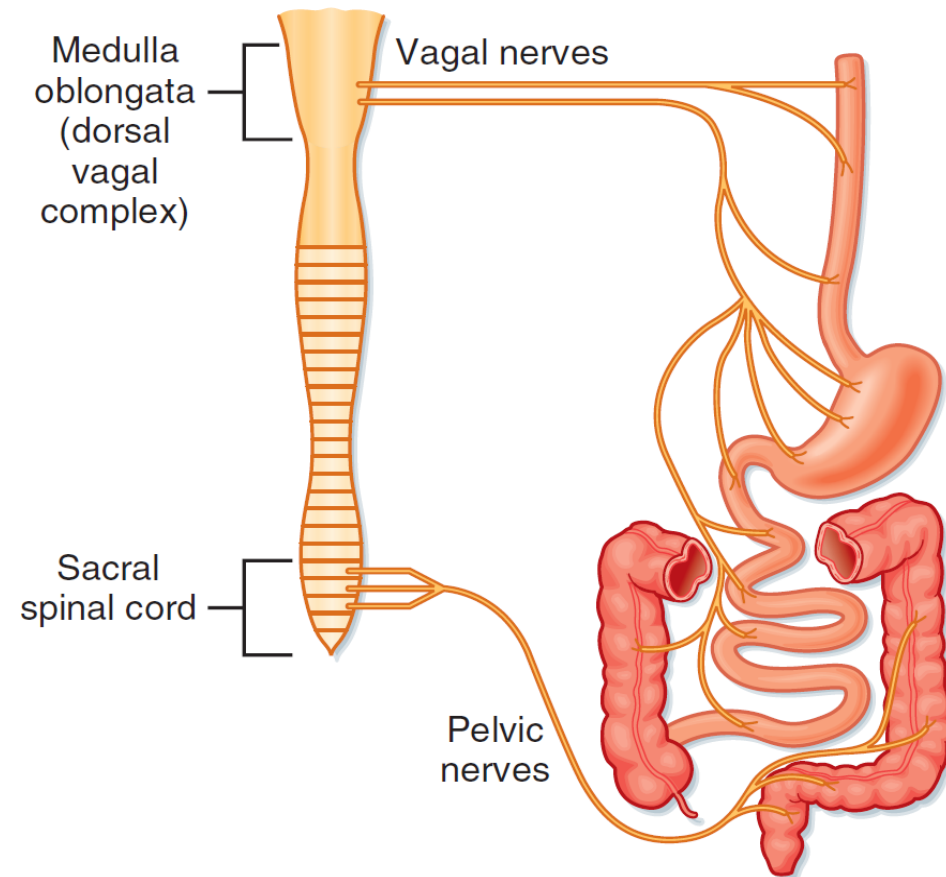
EFFECTORS	RECEPTORS	ADRENERGIC REACTION
CORONARY A.	$\alpha, \beta_2$	C, D
SKIN A.	$\alpha$	C
SKELETAL MUSCLE	$\alpha, \beta_2$	C, D
BRAIN A.	$\alpha$	C
LUNGS A.	$\alpha, \beta_2$	C, D
ABDOMENAL A.	$\alpha, \beta_2$	C, D
VEINS	$\alpha, \beta_2$	C, D

# GIT and ANS

## SNS

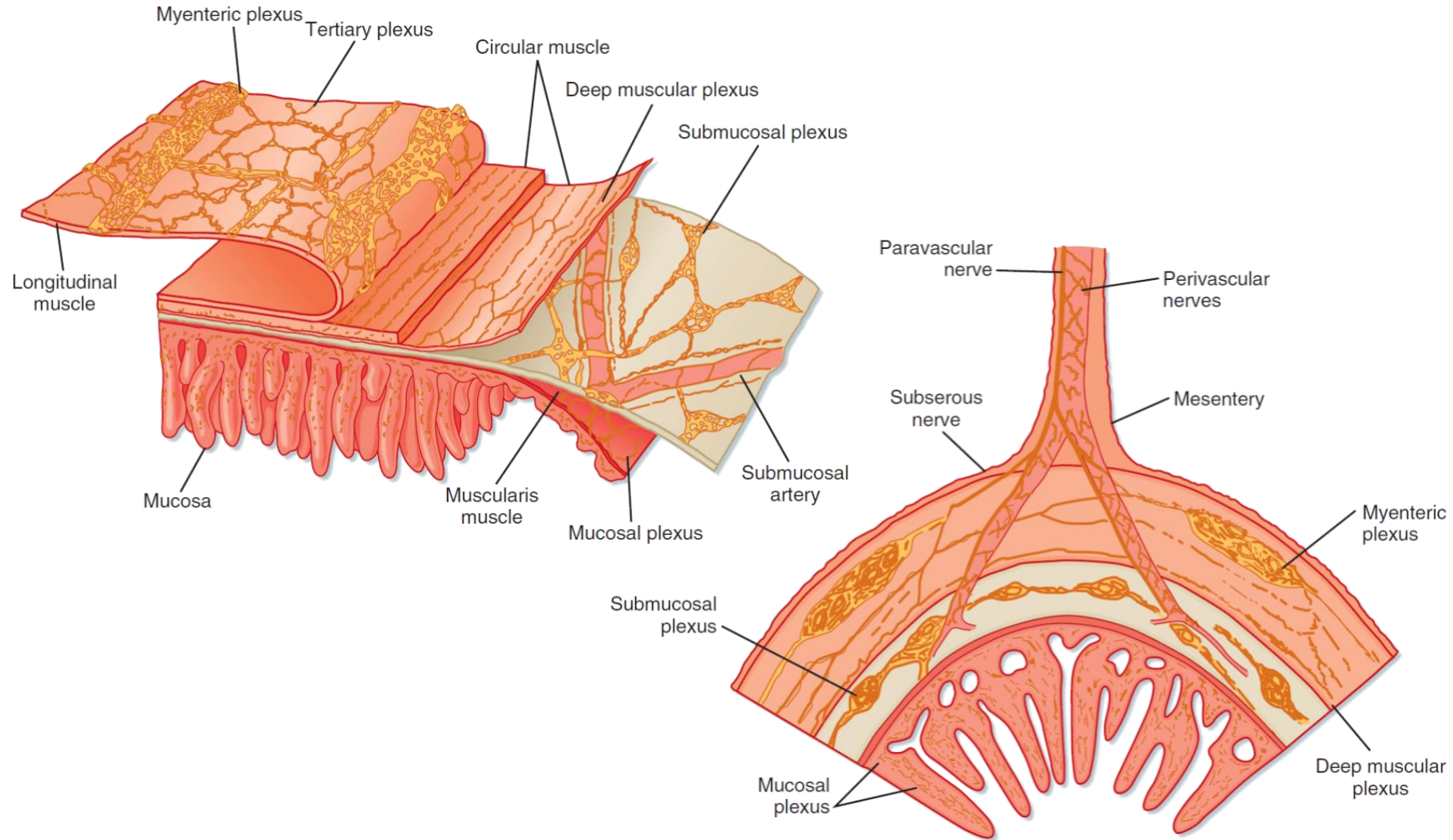


## PNS





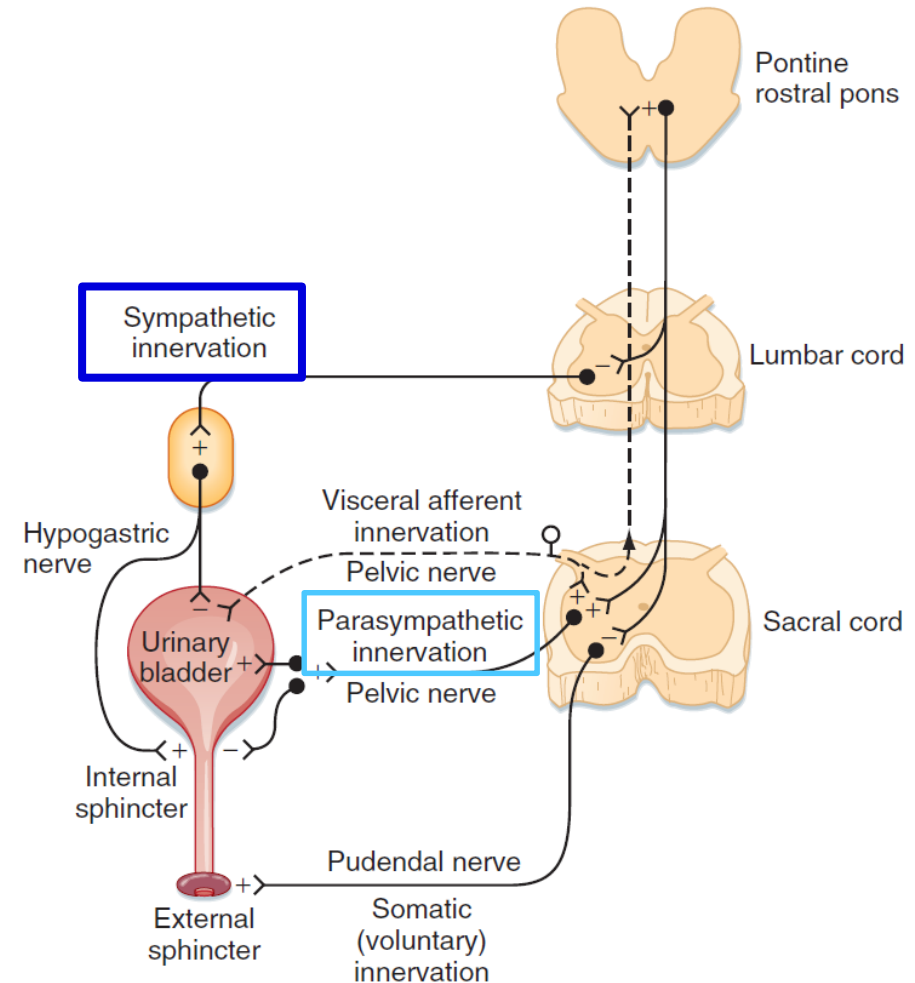
# GIT - Enteric Nervous System



# ANS and urinary bladder

SNS	
DETRUSOR	RELAXATION
SPHINCTER	CONTRACTION

PSN	
DETRUSOR	CONTRACTION
SPHINCTER	RELAXATION



# 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 sparing 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 sparing 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

**Thank you for your attention**