# AUTONOMIC NERVOUS SYSTEM

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Lec. 10

# Autonomic Nervous System

- The ***autonomic nervous system(ANS)*** is the portion of the nervous system that **controls** most **visceral functions** of the body**.(unconsciously controlled) .**

➢This system helps to control *arterial pressure*, *gastrointestinal motility*, *gastrointestinal secretion*, *urinary bladder emptying*, *sweating*, *body temperature*, and many other activities.

- One of the most striking characteristics of the *autonomic nervous system* is the **rapidity** and **intensity** with which it can change **visceral functions**.

- For instance, within **3 to 5 seconds** it can **increase** the **heart rate to twice normal**, and within **10 to 15 seconds** the **arterial pressure can be doubled**.

- **Autonomic nervous system is made up of two neurons:**

1) **Preganglionic neurons**

2) **postganglionic neurons**

## ❖**Preganglionic neurons**

- The first neuron has its cell body in the CNS.
- The neurons passing between the CNS and the ganglia are called **preganglionic neurons ; {**The synapse between the two neurons is outside the CNS in a cell cluster called an **autonomic ganglion.}**

❖While the neuron passing between the ganglia and the effector cells are **postganglionic neurons .**

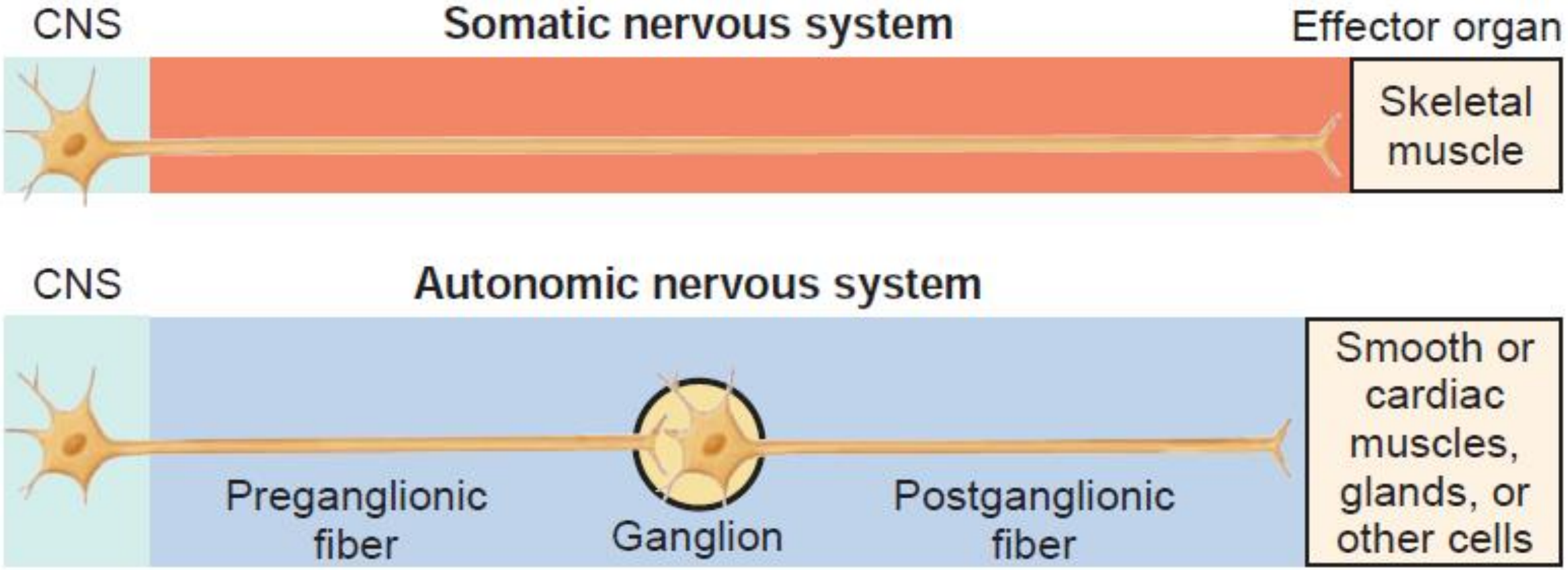



**Figure 6.43** Efferent division of the PNS, including an overall plan of the somatic and autonomic nervous systems.

❖**The efferent pathways of the ANS consist of two neurons that transmit impulses from the CNS to the effector tissue:**

1. The ***preganglionic neuron*** originates in the CNS.

***2. postganglionic neuron***. It is this neuron that innervates the effector tissue.

❑The efferent autonomic **signals** are transmitted to the various organs of the body through **two major subdivisions** called:

1. **sympathetic nervous system** (Adrenergic system)

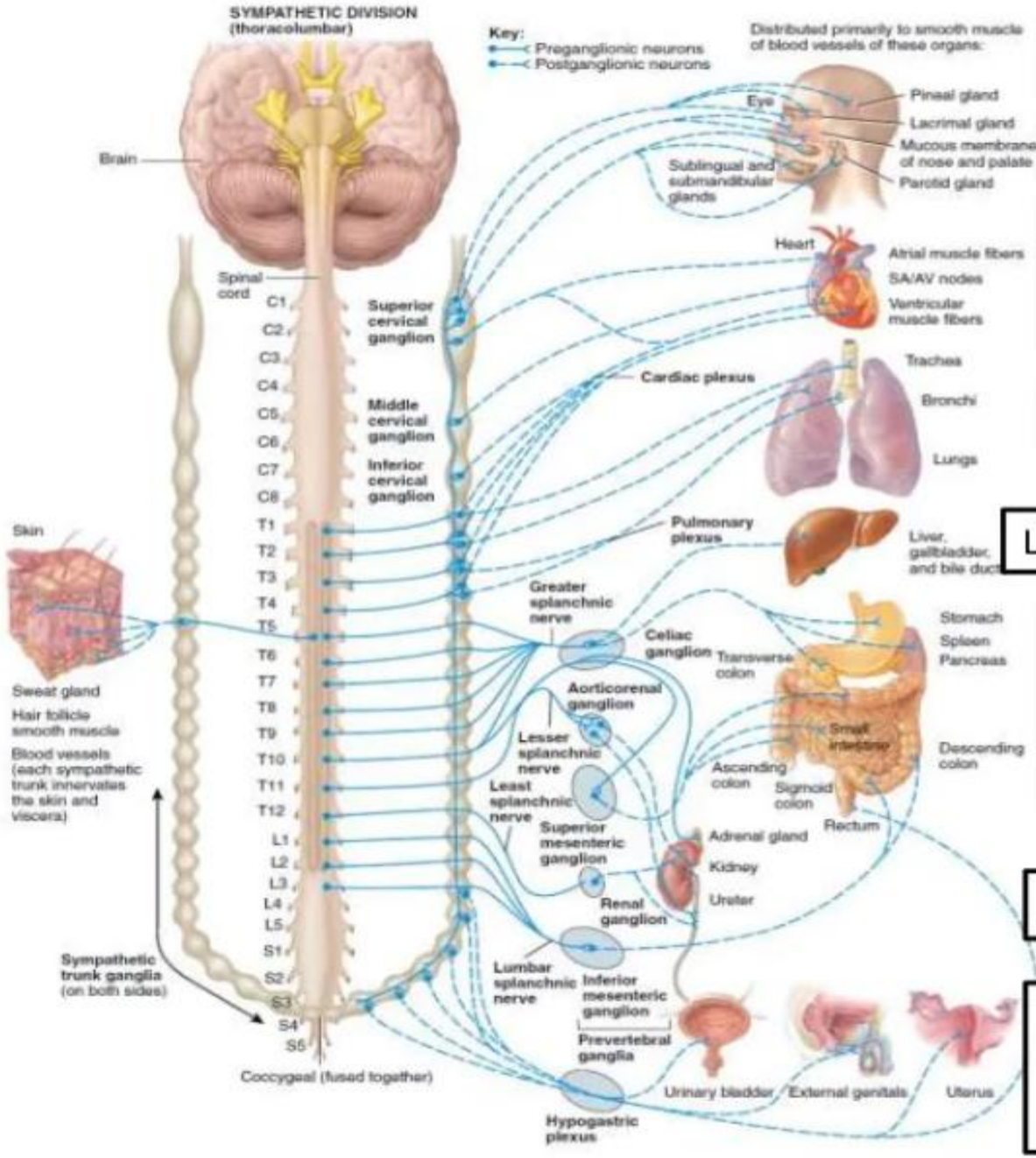
2. **parasympathetic nervous system** (cholinergic system)

❑Each system is **dominant** under certain conditions.

➢The ***sympathetic system*** predominates **during emergency "fight-or-flight"** reactions **and** during **exercise.**

- The overall effect of the sympathetic system under these conditions is to ***prepare the body*** for **strenuous physical activity**.

- The ***parasympathetic system*** predominates during, **resting conditions** (“*rest and digest*”)..
- The overall effect of the *parasympathetic system*, under these conditions, is to **conserve** and **store energy**, and to **regulate basic body functions *such as*** digestion and urination.




Iris muscle: Pupil dilated

Salivary glands: Secretion inhibited

Blood vessels in heart : Vasoconstriction
Heart: Rate and force of contraction increased

Trachea and bronchi: Bronchodilation

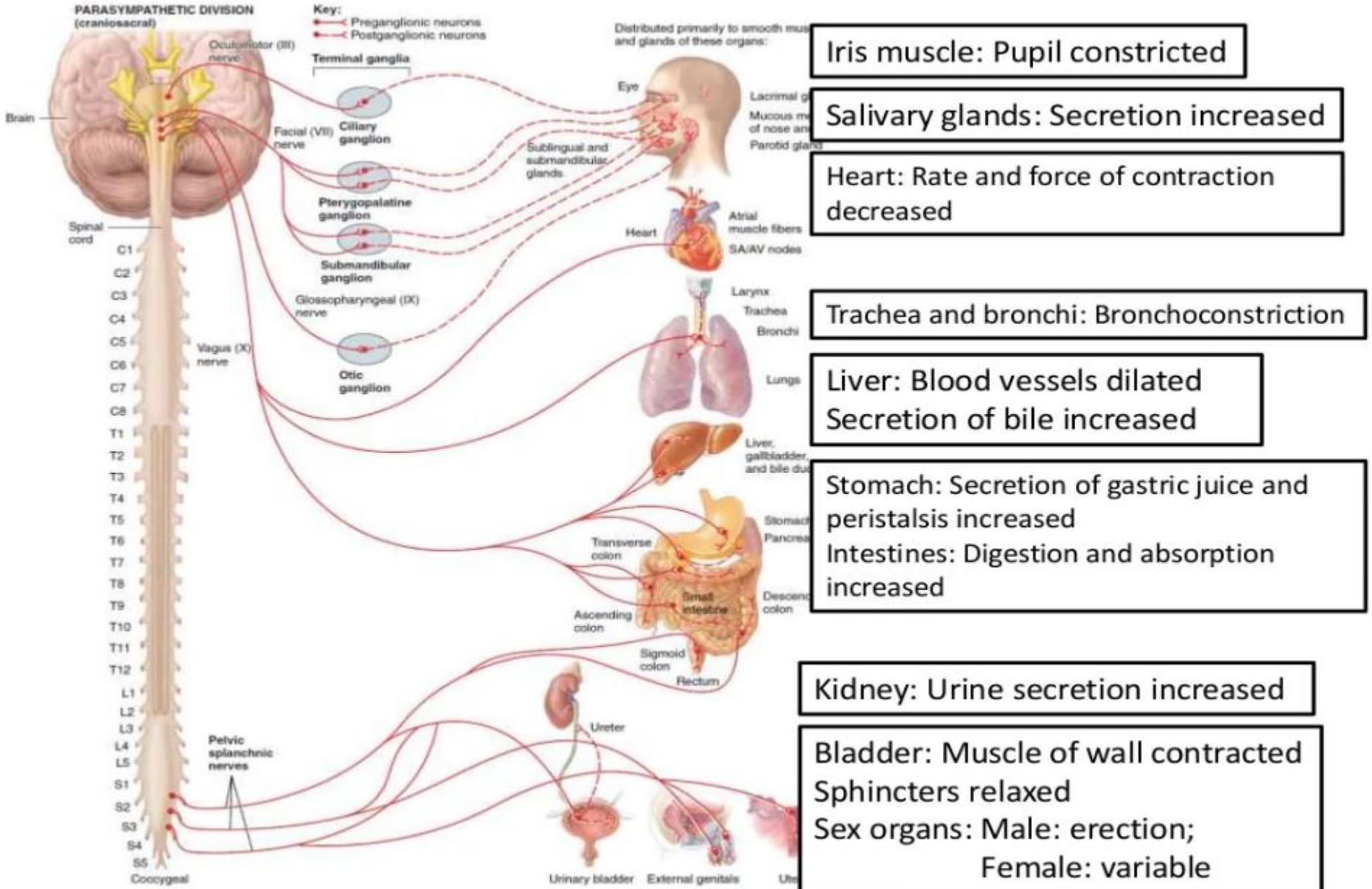
Liver: Glycogen glucose conversion increased

Stomach: Peristalsis reduced
Sphincters closed
Intestines: Peristalsis and tone decreased
Vasoconstriction

Kidney: Urine secretion decreased

Bladder: Smooth muscle wall relaxed
Sphincter closed
Sex organs: Generally Vasoconstriction

***Structure of the sympathetic division of the autonomic nervous system***




Iris muscle: Pupil constricted

Salivary glands: Secretion increased

Heart: Rate and force of contraction decreased

Trachea and bronchi: Bronchoconstriction

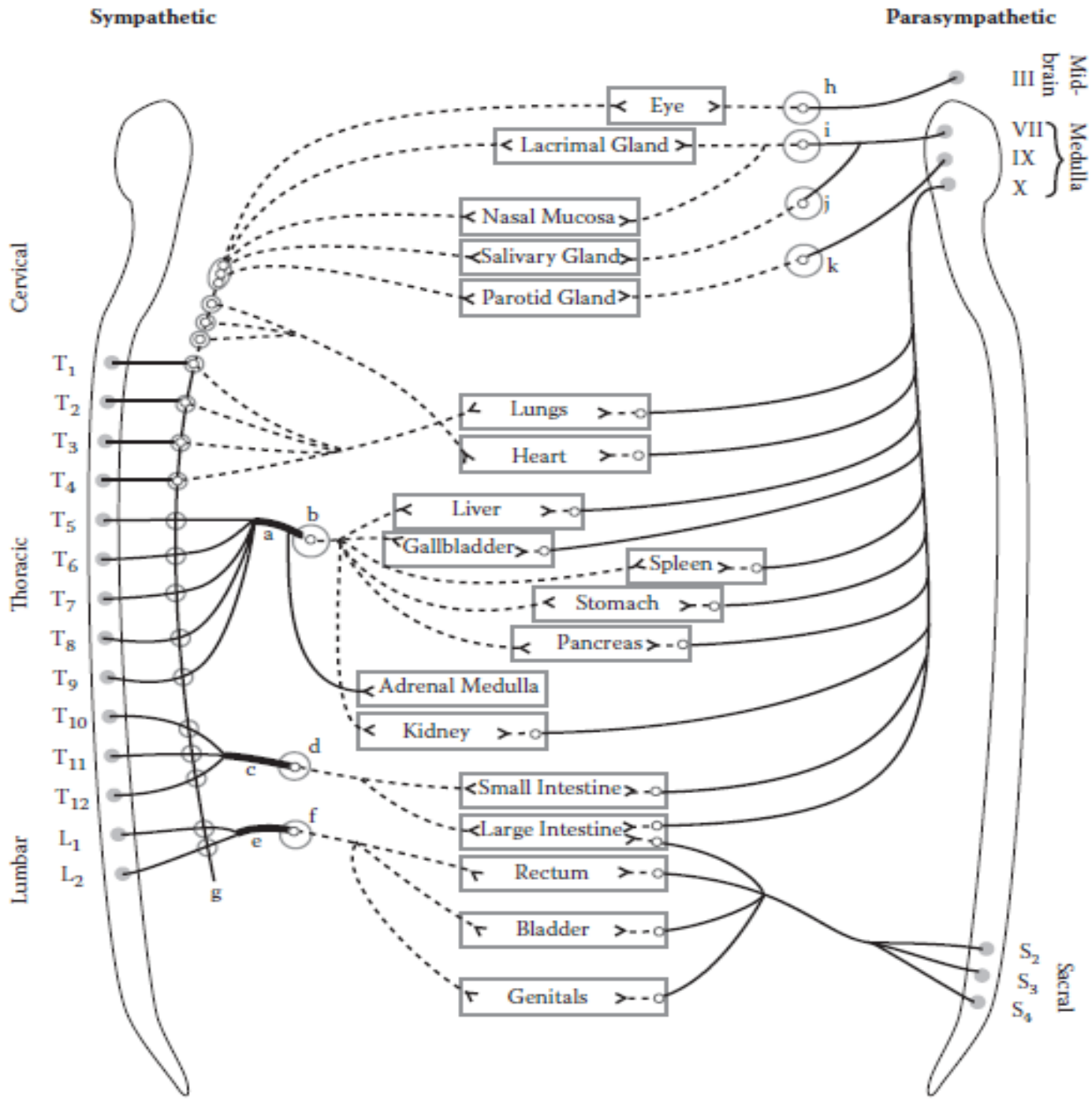
Liver: Blood vessels dilated
Secretion of bile increased

Stomach: Secretion of gastric juice and peristalsis increased
Intestines: Digestion and absorption increased

Kidney: Urine secretion increased

Bladder: Muscle of wall contracted
Sphincters relaxed
Sex organs: Male: erection;
Female: variable

***Structure of the parasympathetic division of the autonomic nervous system***


Sympathetic
Parasympathetic
Cervical
Thoracic
Lumbar
Sacral
Mid-brain
Medulla
III
VII
IX
X
$T_1$
$T_2$
$T_3$
$T_4$
$T_5$
$T_6$
$T_7$
$T_8$
$T_9$
$T_{10}$
$T_{11}$
$T_{12}$
$L_1$
$L_2$
$S_2$
$S_3$
$S_4$
a
b
c
d
e
f
g
h
i
j
k
Eye
Lacrimal Gland
Nasal Mucosa
Salivary Gland
Parotid Gland
Lungs
Heart
Liver
Gallbladder
Spleen
Stomach
Pancreas
Adrenal Medulla
Kidney
Small Intestine
Large Intestine
Rectum
Bladder
Genitals

# Distinguishing features of the sympathetic and parasympathetic systems

| sympathetic | parasympathetic |
| --- | --- |
| Ganglia located in paravertebral sympathetic ganglion chain or in collateral ganglia | Terminal ganglia located near or embedded within target tissue |
| Short cholinergic preganglionic fibers | Short cholinergic postganglionic fibers |
| Ratio of preganglionic fibers to postganglionic fibers is 1:20 | Ratio of preganglionic fibers to postganglionic fibers is 1:3 |
| Predominates during emergency “fight or- flight” reactions and exercise | Predominates during quiet “rest and digest” conditions |

# *Neurotransmission*

❑**The two most common neurotransmitters released by neurons of the ANS are:**

1. ***acetylcholine* (*Ach*)**
2. ***norepinephrine* (*NE*)**

*Neurotransmitters* are synthesized in the **axon** and **stored** in **vesicles** for subsequent release.

- fibers that release **acetylcholine** are referred to as ***cholinergic* fibers**.
- fibers that release **norepinephrine** are referred to as ***adrenergic* fibers.**

❖***Cholinergic* fibers include:**

1. All *preganglionic fibers* of the ANS, **both** *sympathetic* and *parasympathetic systems*.
2. All ***postganglionic fibers*** of the **parasympathetic system**.
3. Some ***sympathetic postganglionic*** fibers like **sweat glands**.

## ❖ ***Adrenergic fibers include:***

1) All **sympathetic postganglionic** that fibers release **norepinephrine**.

2) **Adrenal medulla** are considered **modified** *sympathetic postganglionic neurons*. **BUT**:-

➢ Instead of a ***neurotransmitter***, these cells release ***hormones*** into the blood.

- **20%** of the hormonal output of the **adrenal medulla** is **norepinephrine.**
- The remaining **80%** is ***epinephrine*** (*EPI*).

➢ These two hormones released by the **adrenal medulla** are collectively referred to as the ***catecholamines***.

# *Neurotransmission*

❑**Neurotransmitter**, it **must be rapidly removed** or **inactivated** from the **synapse** or, in this case, the **neuroeffector junction.**

- This is necessary to allow **new signals** to get through and influence **effector tissue** function.

❑**Neurotransmitter activity may be terminated by three mechanisms:**

*1. Enzymatic degradation*

*2. Reuptake into the neuron*

*3. Diffusion away from the synapse*

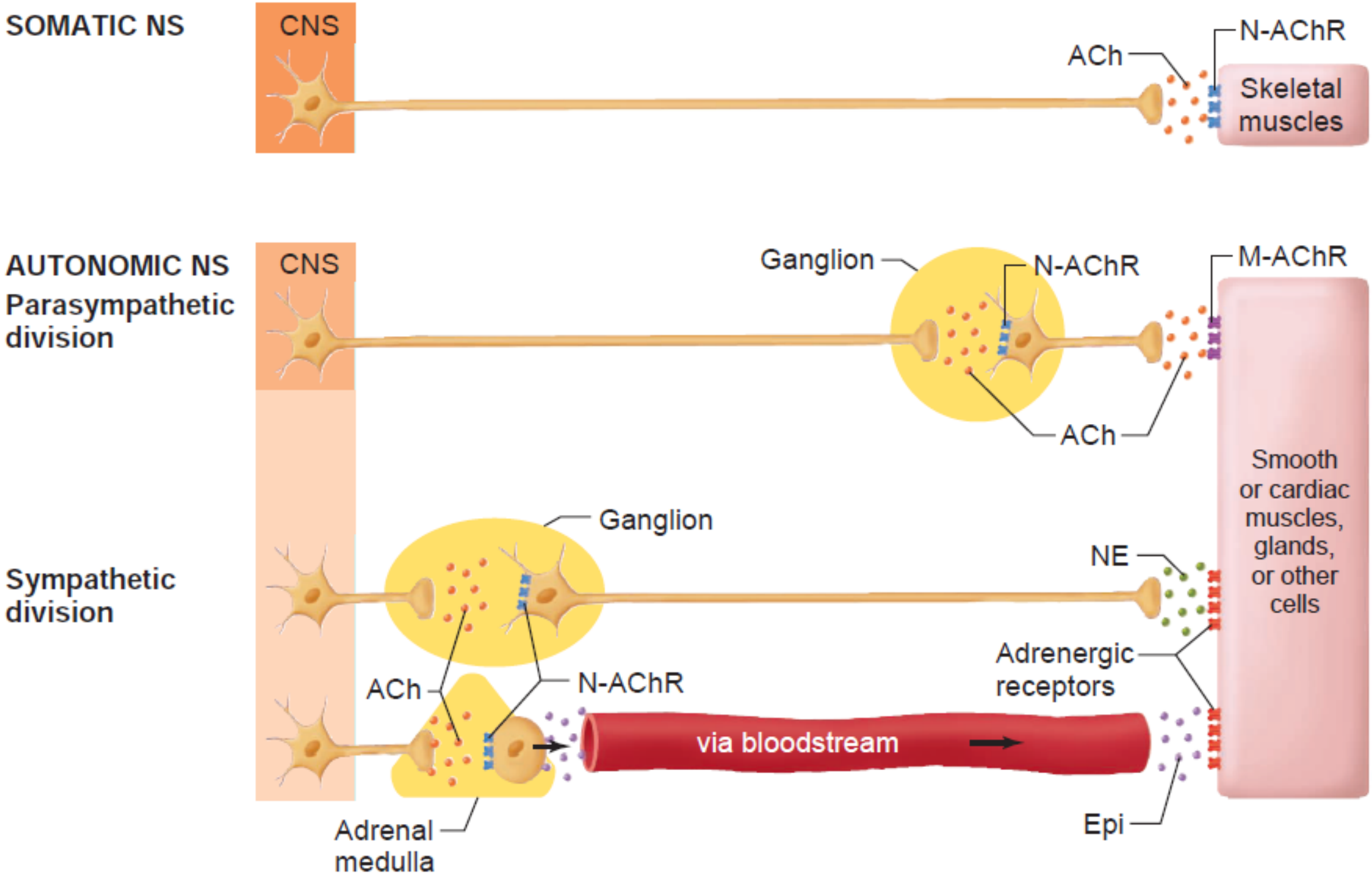
❖**The primary mechanism used by *cholinergic synapses* is *enzymatic degradation***.

- ***Acetylcholinesterase*** hydrolyzes ***acetylcholine*** to its component choline and acetate.
- It is one of the fastest acting enzymes in the body, and acetylcholine removal occurs in **less than** 1 ms.

❖**The most important mechanism for the removal of norepinephrine from the neuroeffector junction is the *reuptake* of this neurotransmitter into the sympathetic postganglionic neuron that released it.**

- **Norepinephrine** may then be **metabolized** intraneuronally by ***monoamine oxidase (MAO).***

❖**The circulating catecholamines**, *epinephrine* and *norepinephrine*, are inactivated by ***catechol-O-methyltransferase (COMT)***.


SOMATIC NS
CNS
ACh
N-AChR
Skeletal muscles
AUTONOMIC NS
Parasympathetic division
CNS
Ganglion
N-AChR
M-AChR
ACh
Smooth or cardiac muscles, glands, or other cells
Sympathetic division
Ganglion
NE
ACh
N-AChR
Adrenergic receptors
via bloodstream
Adrenal medulla
Epi

# Types of ANS receptors

**A. Acetylcholine binds to two types of *cholinergic receptors*:**

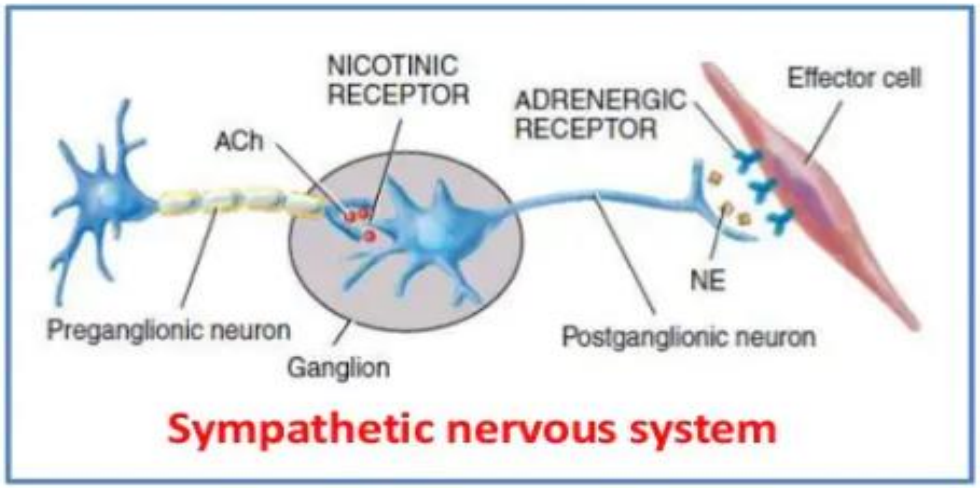
1. *Nicotinic receptors*
2. *Muscarinic receptors*

**B. Adrenergic receptors for norepinephrine and epinephrine:**

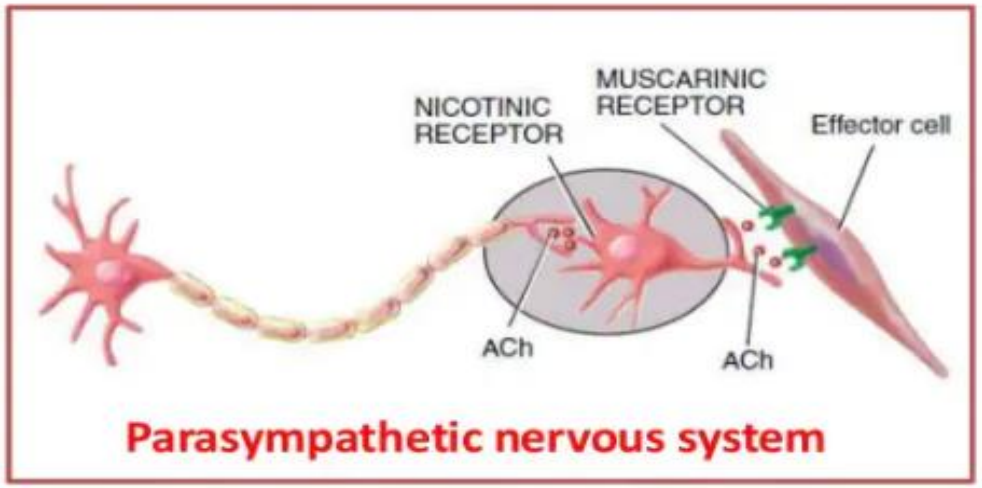
1. Alpha (α)
2. Beta (β)

# ANS Neurotransmitters and Receptors

| ANS | Receptor | Receptor Sub-type |
|---|---|---|
| **Parasympathetic nervous system** | Nicotinic cholinergic receptors | Nn, Nm |
| | Muscarinic cholinergic receptors | M1, M2, M3, M4, M5 |
| **Sympathetic nervous system** | α adrenergic receptor | α1, α2 |
| | β adrenergic receptor | β1, β2, β3 |

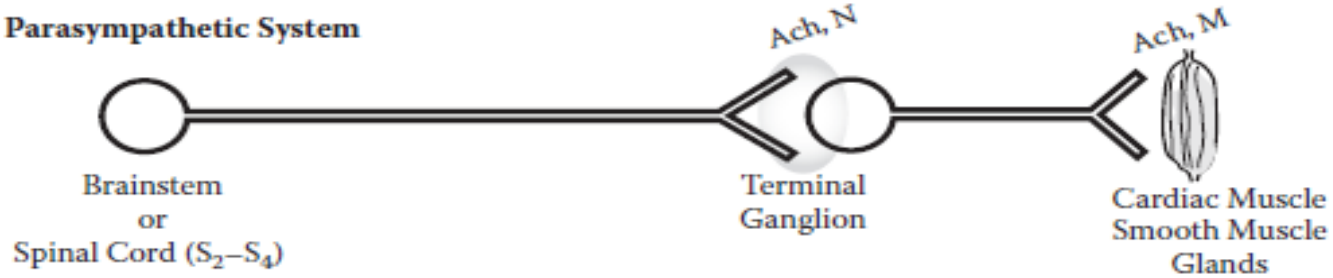


Sympathetic nervous system

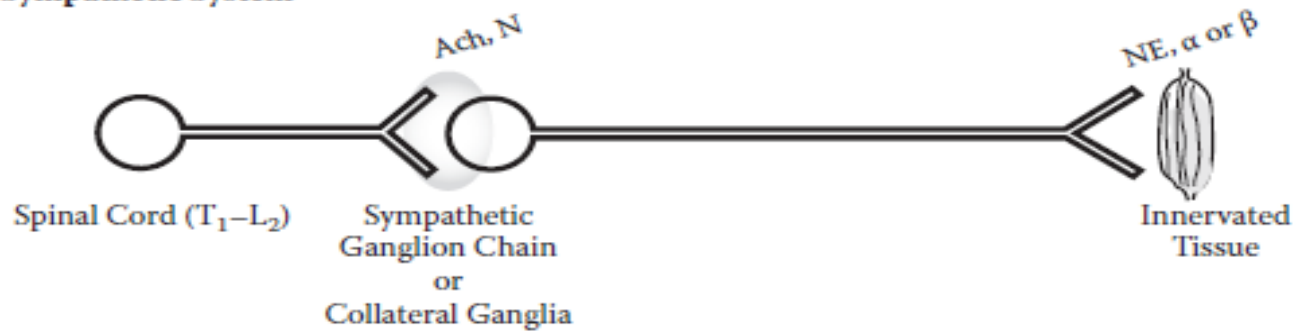


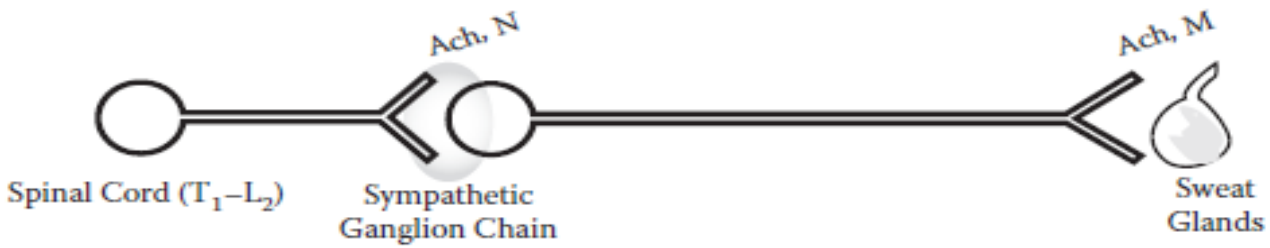
Parasympathetic nervous system

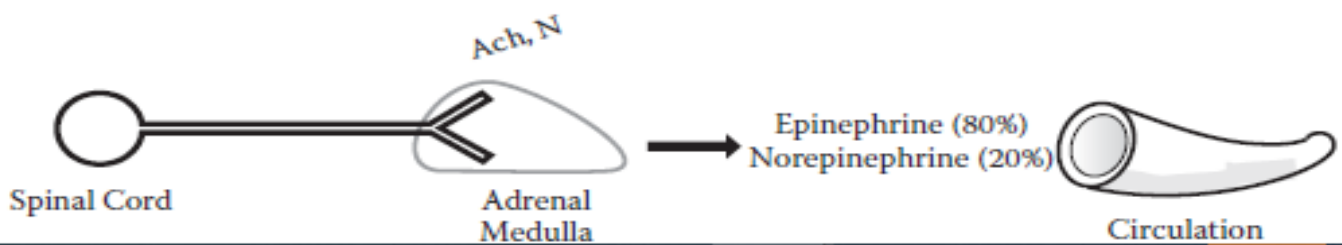
**Parasympathetic System**




**Sympathetic System**



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