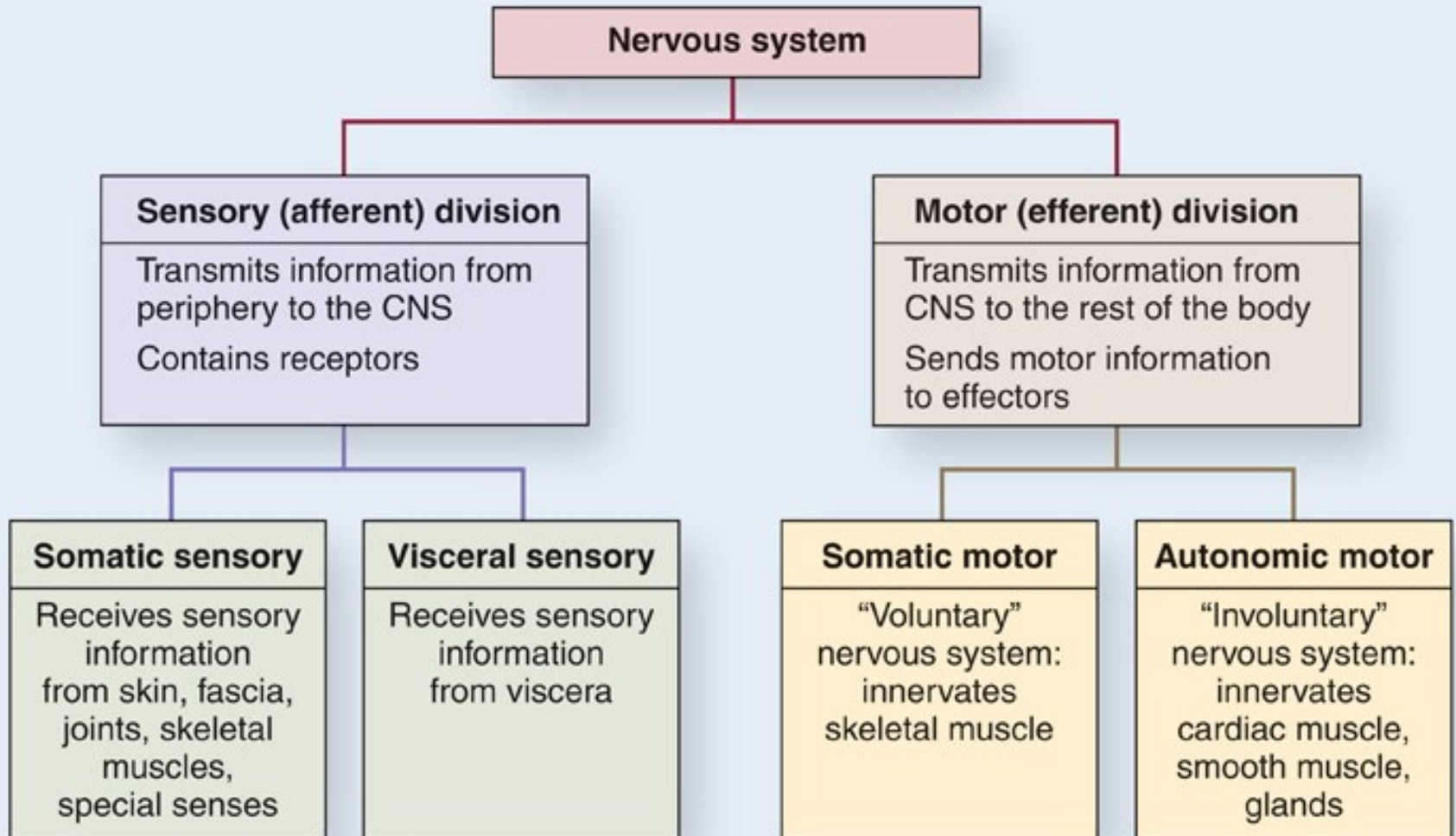


# **AUTONOMIC NERVOUS SYSTEM**

## Functional Organization of the Nervous System



## THE NERVOUS SYSTEM

### Central Nervous System

Brain

Spinal cord

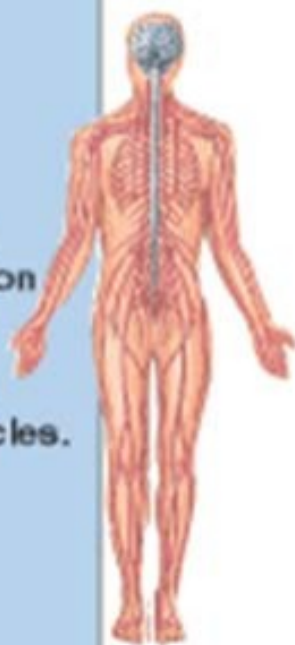
### Peripheral Nervous System

**Autonomic division**  
Regulates internal environment. Carries information from the CNS to organs, blood vessels and glands.

**Somatic division**  
Carries information to the CNS from the senses and from the CNS to the skeletal muscles.

**Sympathetic**  
(Arouses the body)

**Parasympathetic**  
(Calms after arousal)



# AUTONOMIC NERVOUS SYSTEM

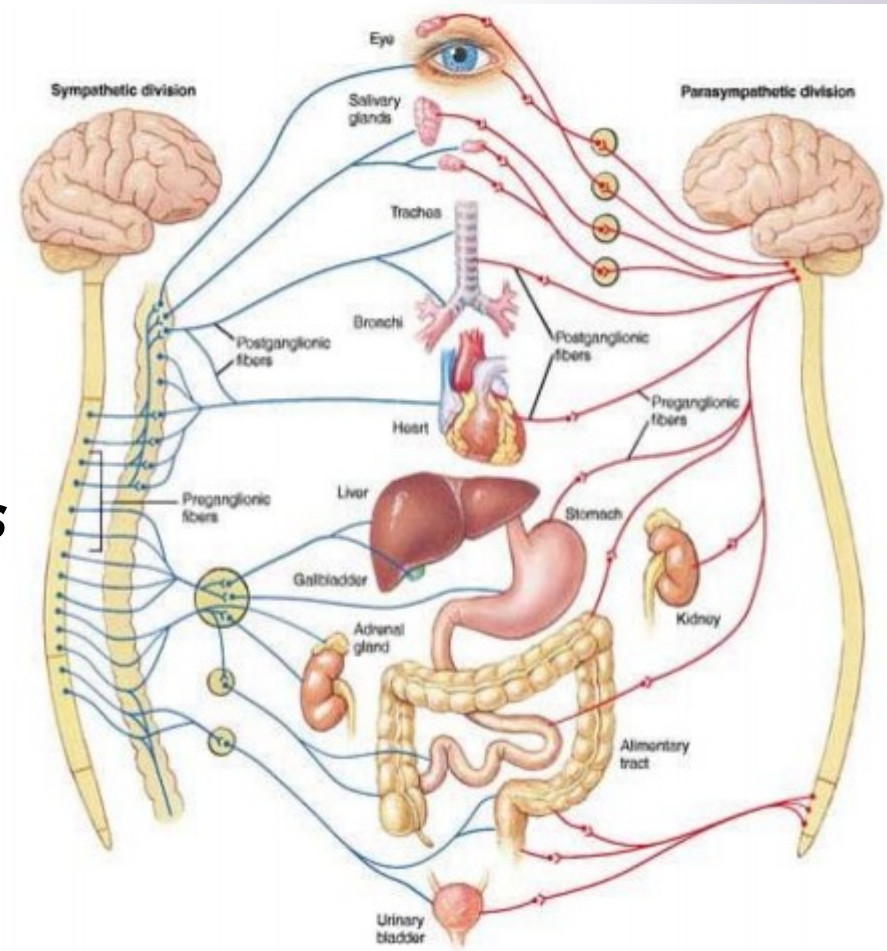
Functions:

*Contraction and relaxation of smooth muscles*

*Function of all exocrine glands*

*Heart rate*

*Some metabolic processes*

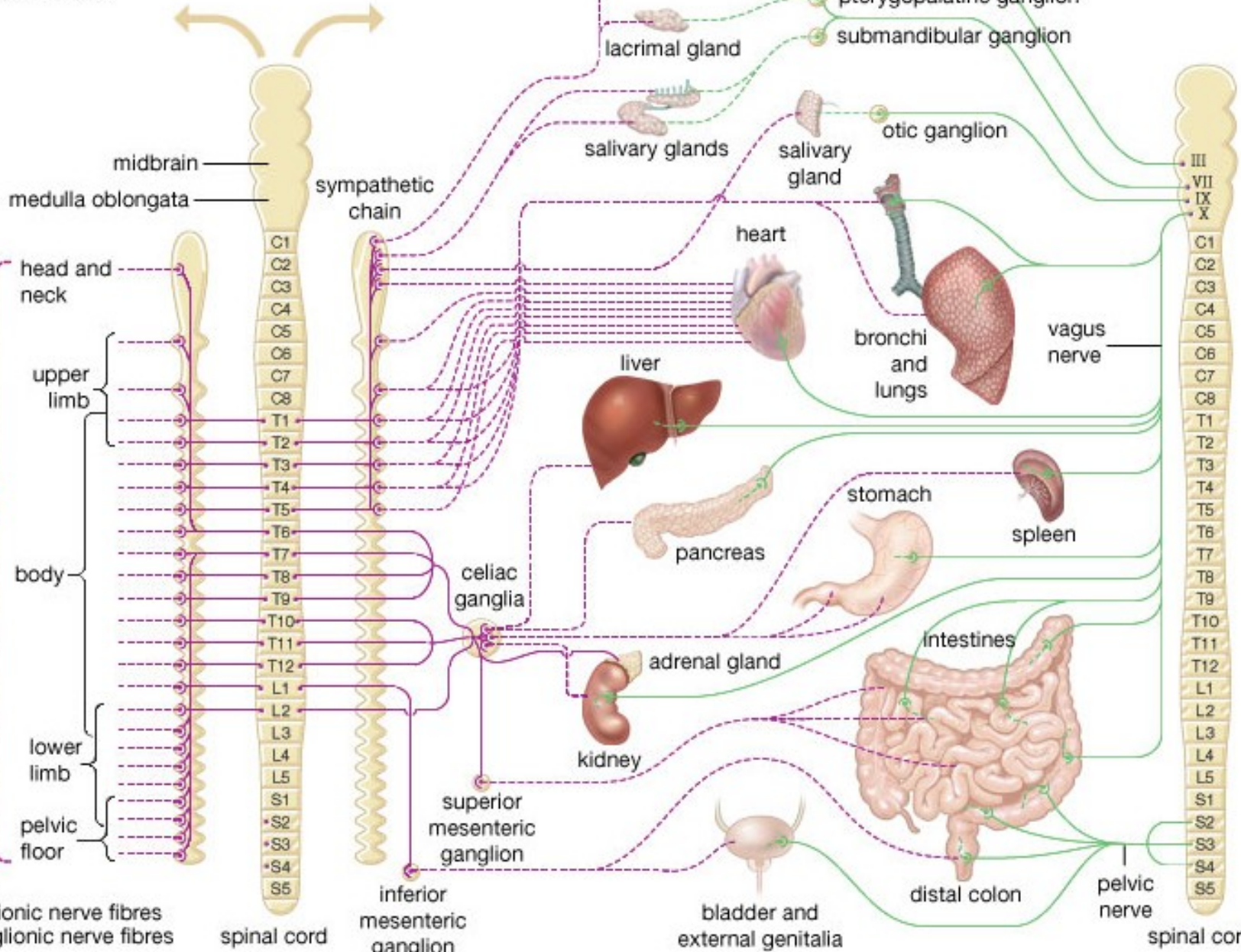
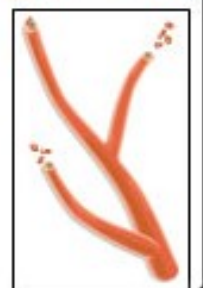
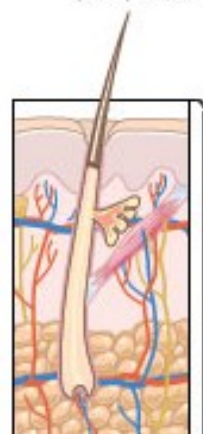


# Sympathetic nervous system

# Parasympathetic nervous system

sympathetic outflow to smooth muscle of hair follicles, sweat glands, and peripheral blood vessels

sympathetic outflow to organs of the head and trunk



head and neck

upper limb

body

lower limb

pelvic floor

midbrain  
medulla oblongata

sympathetic chain

celiac ganglia

superior mesenteric ganglion

inferior mesenteric ganglion

heart

liver

pancreas

kidney

salivary gland

bronchi and lungs

stomach

intestines

distal colon

bladder and external genitalia

vagus nerve

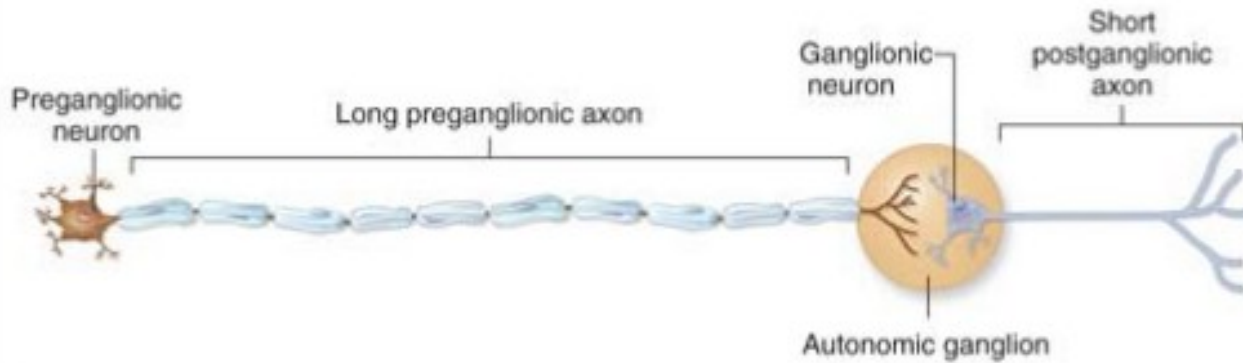
spleen

pelvic nerve

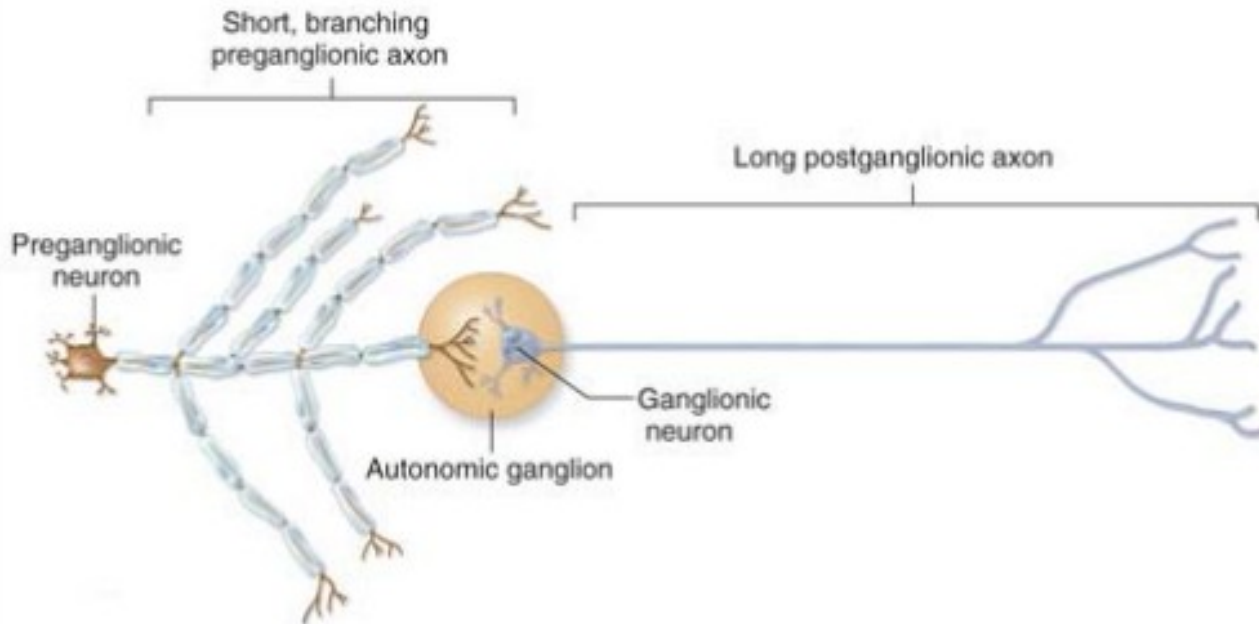
spinal cord

spinal cord

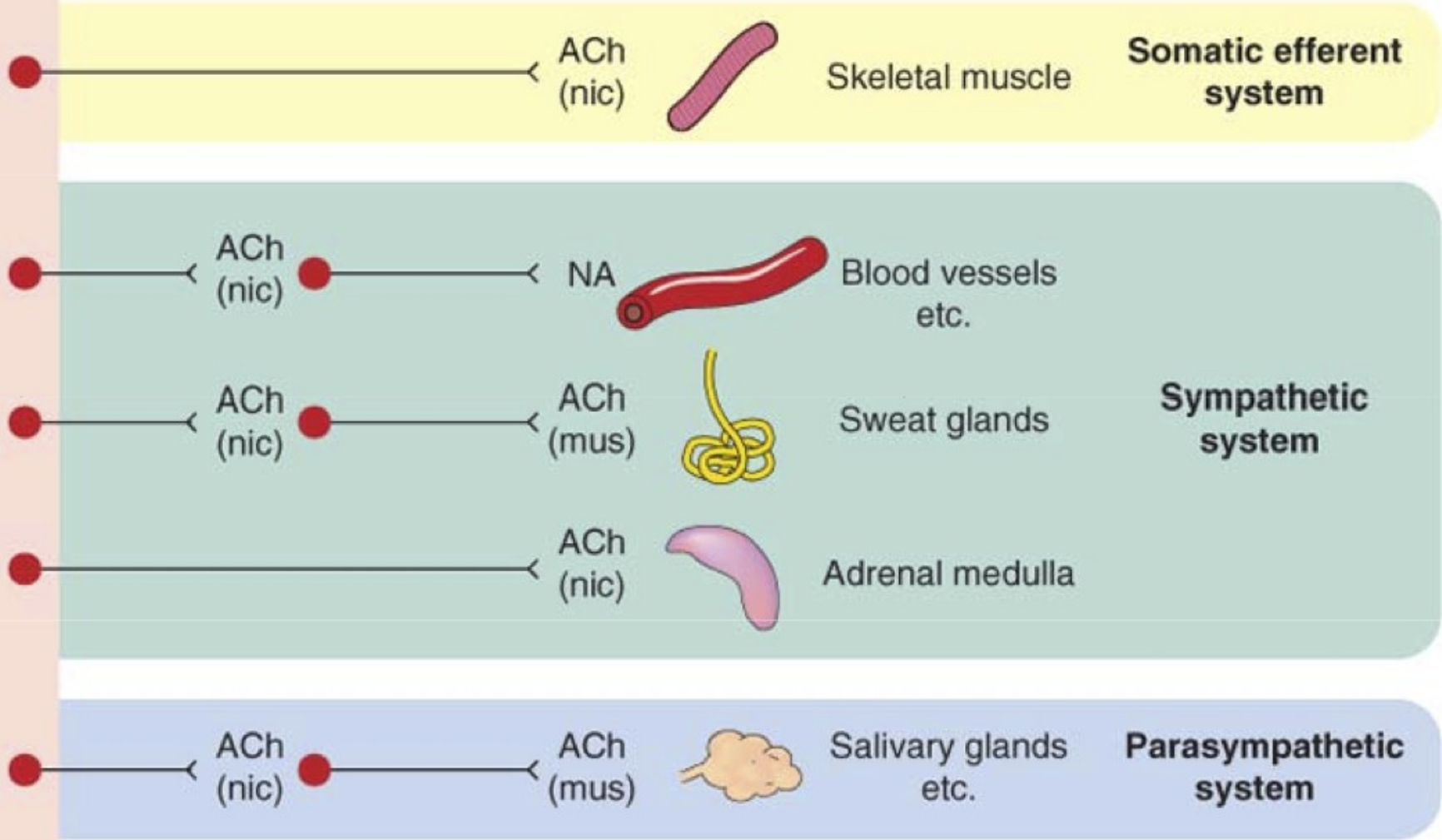
## Parasympathetic Division



## Sympathetic Division



**CENTRAL NERVOUS SYSTEM**



# AUTONOMIC NERVOUS SYSTEM

## □ sympathetic NS

- ncl. intermediolateralis in T1 - L2 segments of spinal cord = *thoracolumbar system*
- paravertebral ganglia (tr. sympathicus) and prevertebral ganglia
- neurotransmitters
  - pregangl. - acetylcholine
  - postgangl. - norepinephrin (ex. sweat glands and piloerector muscle)

## □ parasympathetic NS

- parasympathetic nuclei of CN III, VII, IX, X
- segments S2 - S4 = *craniosacral system*
- ganglia near the target organ
- neurotransmitter acetylcholine



## **Sympathetic system**

**Catabolic reaction (activities that are mobilized during emergency and stress situations, “fight, fright and flight” responses)**

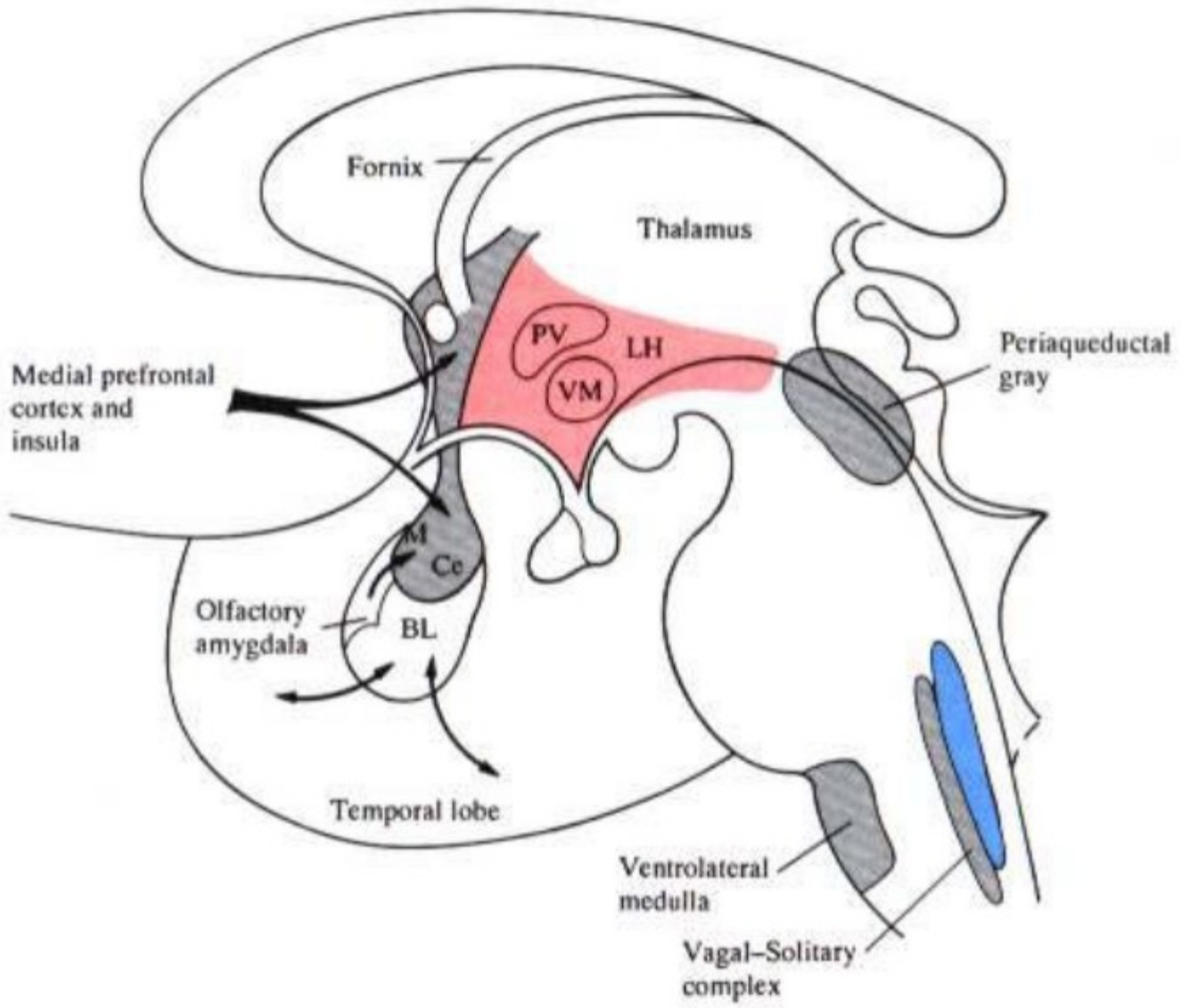
## **Parasympathetic system**

**Anabolic reactions (activities associated with conservation and restoration of body resources, “rest and digest” responses)**

# FUNCTIONS OF THE AUTONOMIC NERVOUS SYSTEM

<u>SYMPATHETIC RESPONSE</u>	<u>ORGAN</u>	<u>PARASYMPATHETIC RESPONSE</u>
Increase rate	HEART	Decrease rate (to normal)
Dilate	BRONCHIOLES (Smooth muscle)	Constrict (to normal)
Pupils dilate	IRIS	Pupils constrict (to normal)
Decrease secretion	SALIVARY GLANDS	Increase secretion (to normal)
Decrease peristalsis	STOMACH & INTESTINES (Smooth muscle)	Increase peristalsis for normal digestion
Decrease secretion	STOMACH & INTESTINES (Glands)	Increase secretion for normal digestion
Contracts to prevent defecation	INTERNAL ANAL SPHINCTER	Relaxes to permit defecation
Relaxes to prevent urination	URINARY BLADDER	Contracts for normal urination

<b>Feature</b>	<b>Parasympathetic Division</b>	<b>Sympathetic Division</b>
<i>Function</i>	Conserves energy and replenishes energy stores; maintains homeostasis; “ <i>rest-and-digest</i> ” division	Prepares body to cope with emergencies and intensive muscle activity; “ <i>fight-or-flight</i> ” division
<i>Location of Preganglionic Neuron Cell Bodies</i>	Brainstem and lateral gray regions in S2–S4 regions of spinal cord (craniosacral)	Lateral horns in T1–L2 regions of spinal cord (thoracolumbar)
<i>Location of Ganglionic Neuron Cell Bodies</i>	Terminal or intramural ganglion	Sympathetic trunk (paravertebral) ganglion or prevertebral ganglion
<i>Divergence of Axons</i>	Few (1 axon innervates < 4 ganglionic cell bodies)	Extensive (1 axon innervates > 20 ganglionic cell bodies)
<i>Length of Preganglionic Axon</i>	Long	Short
<i>Length of Postganglionic Axon</i>	Short	Long
<i>Location of Ganglia</i>	Terminal ganglia located close to the target organ; intramural ganglia located in wall of the target organ	Sympathetic trunk (paravertebral) ganglia located on either side of vertebral column; prevertebral (collateral) ganglia located anterior to vertebral column and descending aorta
<i>Rami Communicantes</i>	None	White rami attach to T1–L2 spinal nerves; gray rami attach to <i>all</i> spinal nerves



# Modulation of ANS

## ❑ from brain cortex

- tr. corticoreticularis → tr. reticulospinalis → preganglionic neurons

## ❑ from hypothalamus

- tr. hypothalamotegmentalis
- tr. mammillotegmentalis

## ❑ from hypothalamus and limbic forebrain

- FLD → dorsolateral tegmentum

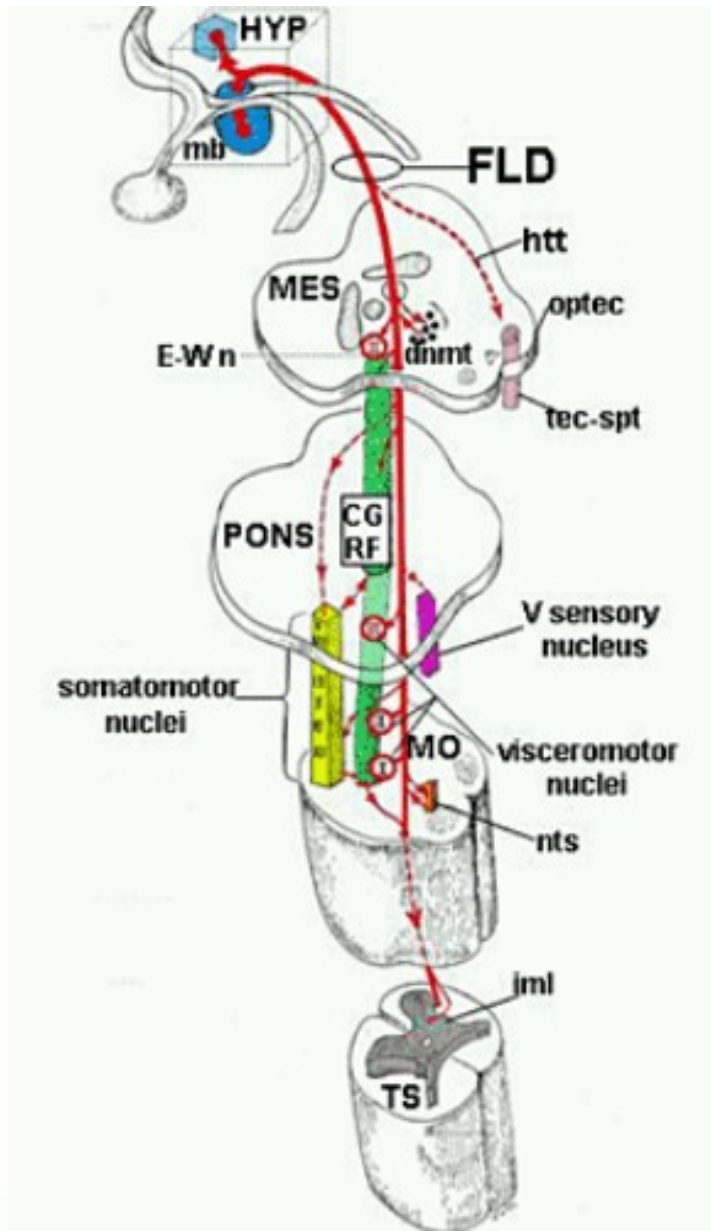
## ❑ CC - from amygdalar complex

- → hypothalamus
- → PAG – coordination of somatic and autonomic response to behavior and defensive reaction → preganglionic neurons of S and PS divisions

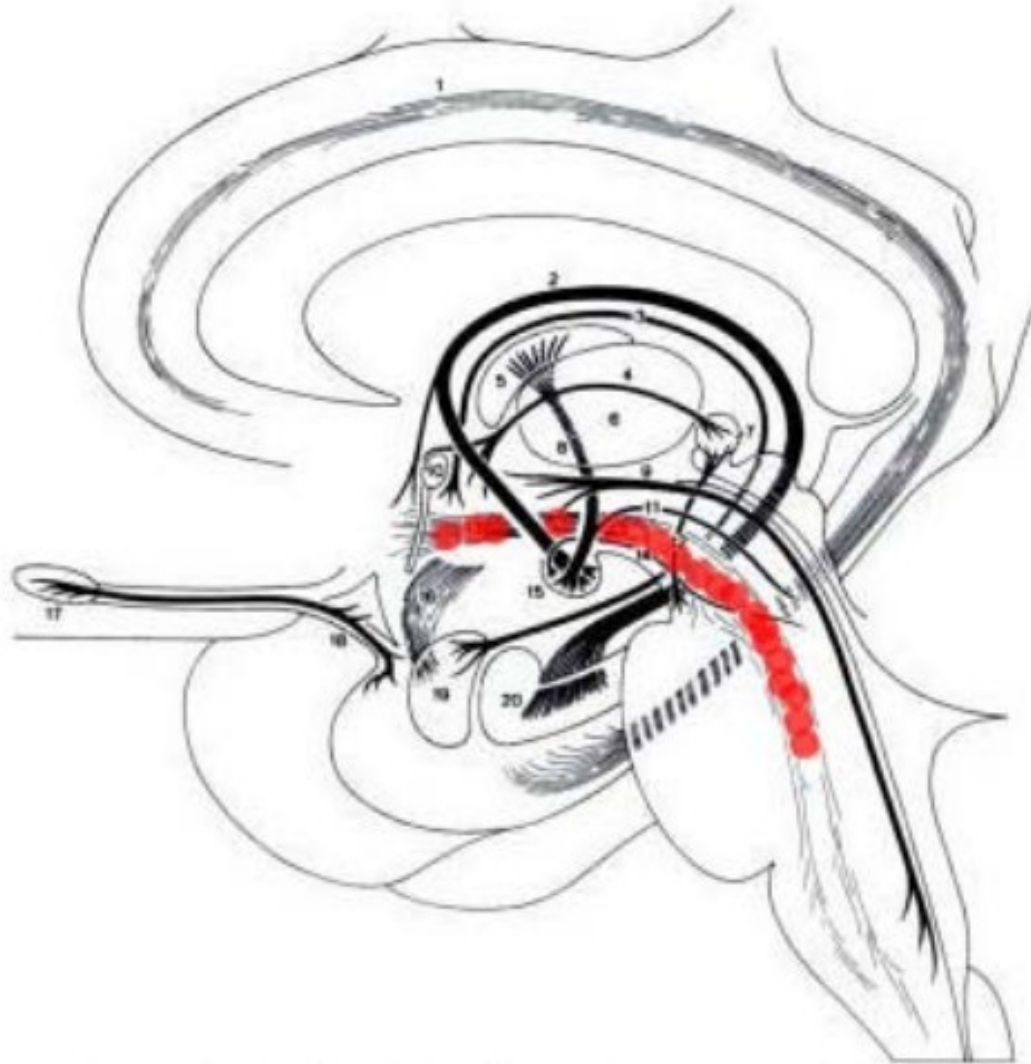
# Descendent modulatory pathways

- ❑ fasciculus longitudinalis dorsalis (FLD)
- ❑ fasciculus telencephalicus medialis (medial forebrain bundle MFB)
- ❑ tr. mammillotegmentalis

# Fasciculus longitudinalis dorsalis

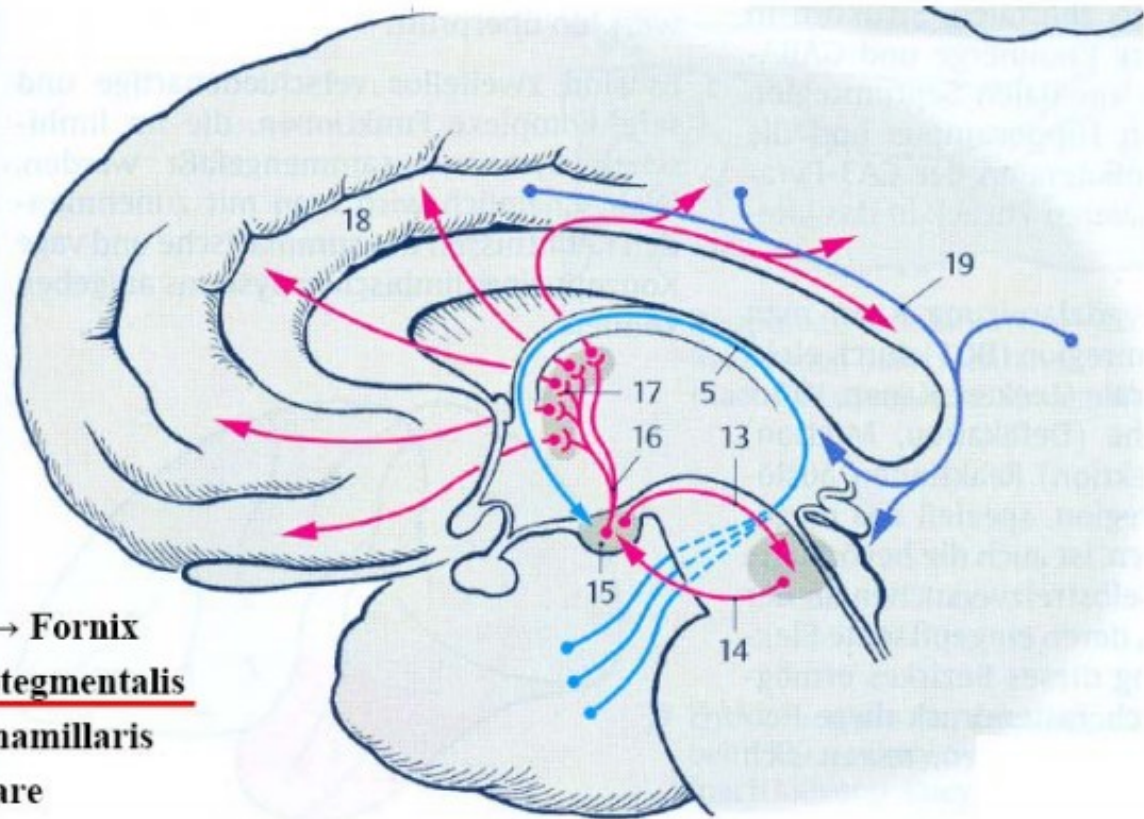


# Fasciculus telencephalicus medialis





# Tractus mamillo-tegmentalis



5 Hippocampus → Fornix

13 Fascic. mamillo-tegmentalis

14 Pedunc. corp. mamillaris

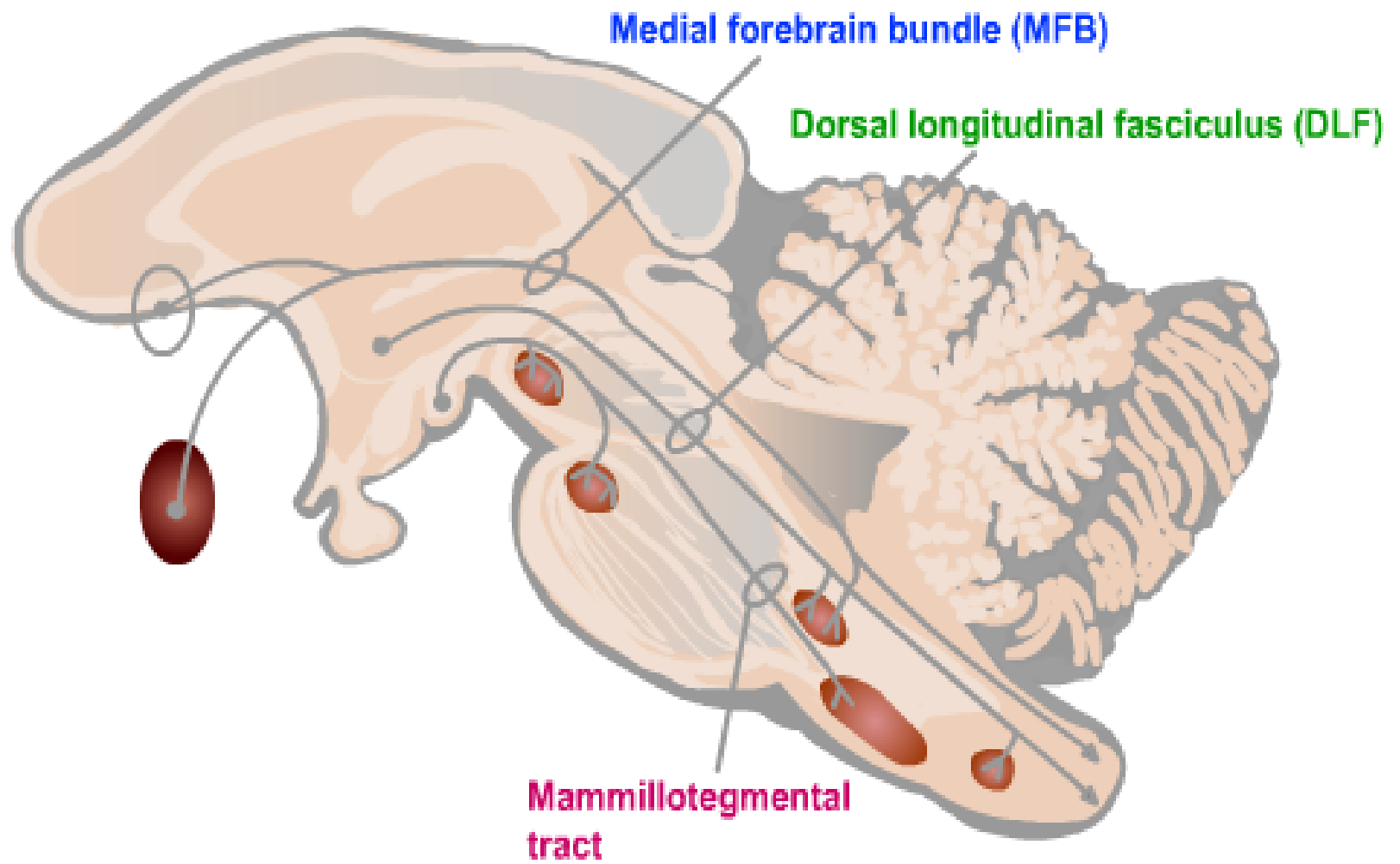
15 Corpus mamillare

16 Fascic. mamillothalamicus

17 Nc. ant. thalami

18 Gyrus cinguli

19 Cingulum → Hippocampus



# Hypothalamus

## Nuclei of the anterior part

- ncl. paraventricularis
- stimulation of parasympathetic system

## Stimulation of the anterior part of hypothalamus

- miosis
- decrease in heart rate and blood pressure
- dilation of cutaneous arteries
- increase in peristalsis and secretion in the GIT

# Hypothalamus

## Nuclei of the posterior part

- ncl. mammillaris and hypothalamicus post.
- stimulation of sympathetic system

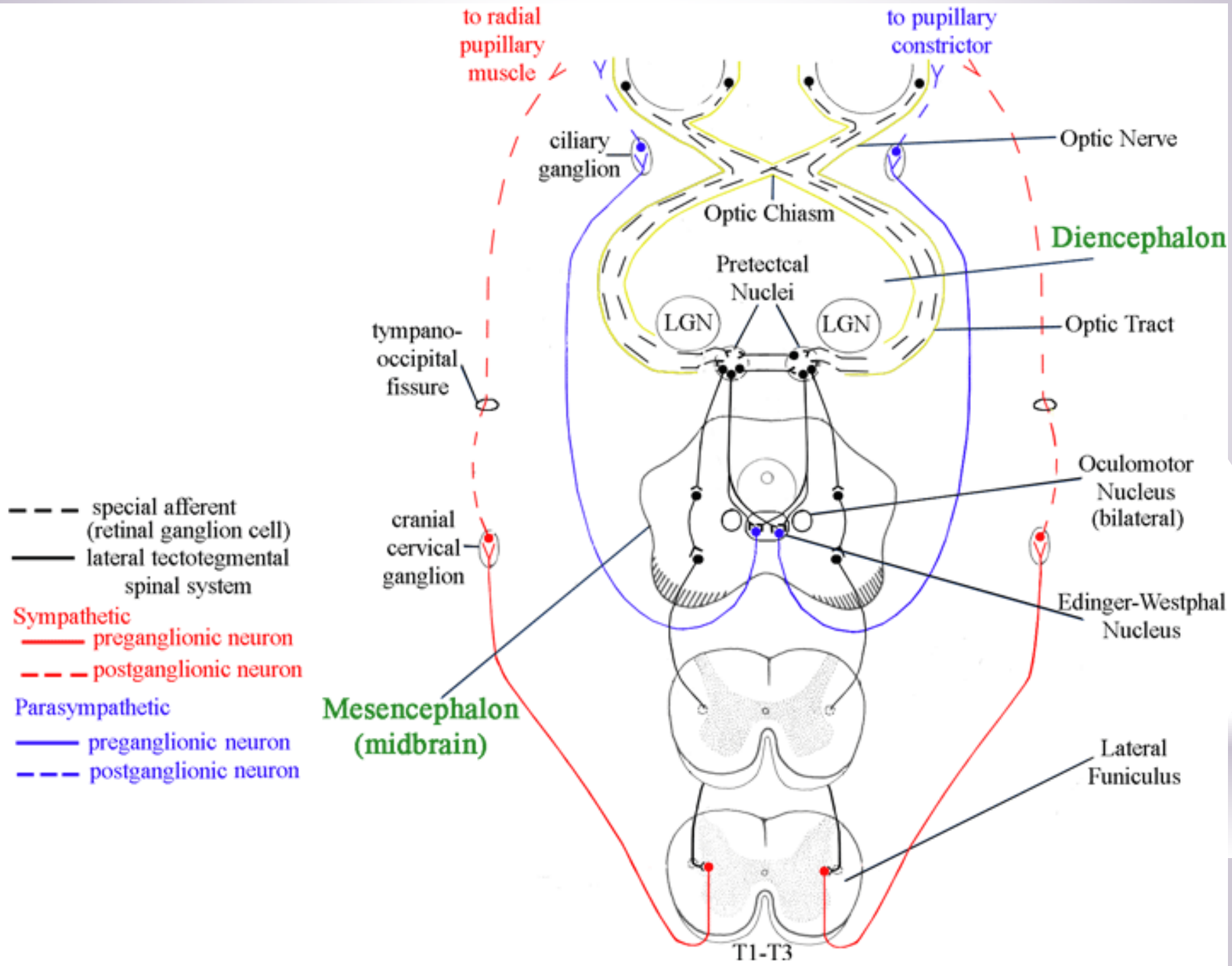
## Stimulation of the posterior part of hypothalamus

- mydriasis
- increase in heart rate and blood pressure
- constriction of cutaneous arteries
- decrease in peristalsis and secretion in the GIT
- erection of hairs

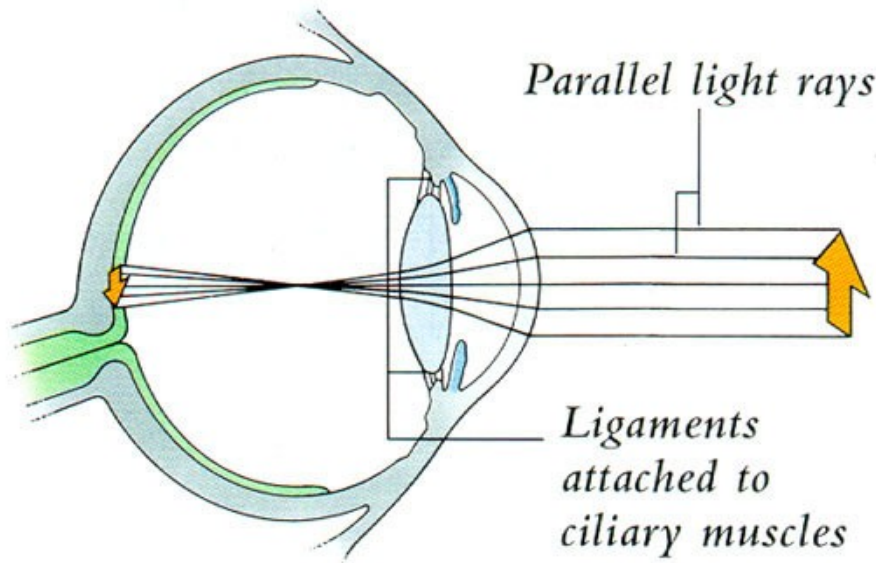
# PUPILARY LIGHT REFLEX

- ❑ a reflex that controls the diameter of the pupil, in response to the intensity of light (luminance) that falls on the retina of the eye
- ❑ **mydriasis:** dilation of the pupil
- ❑ **miosis:** constriction of the pupil



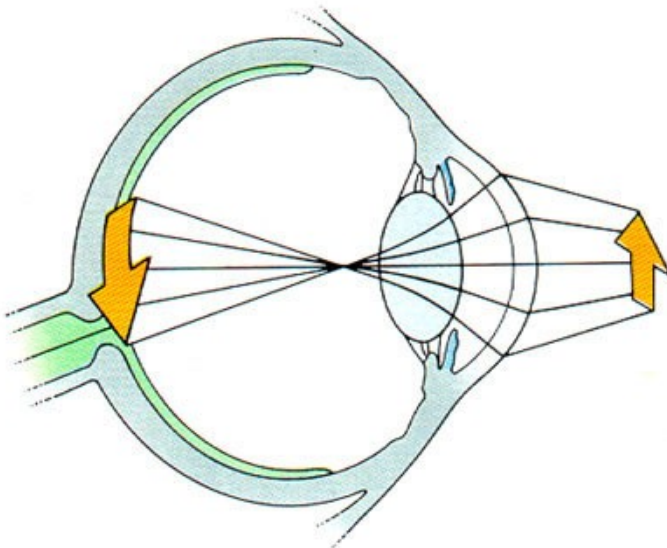


# ACCOMMODATION



## **Distant objects**

To focus on objects in the distance, the ciliary muscles relax and the lens flattens and thins. Light rays are slightly refracted (bent) by the lens.

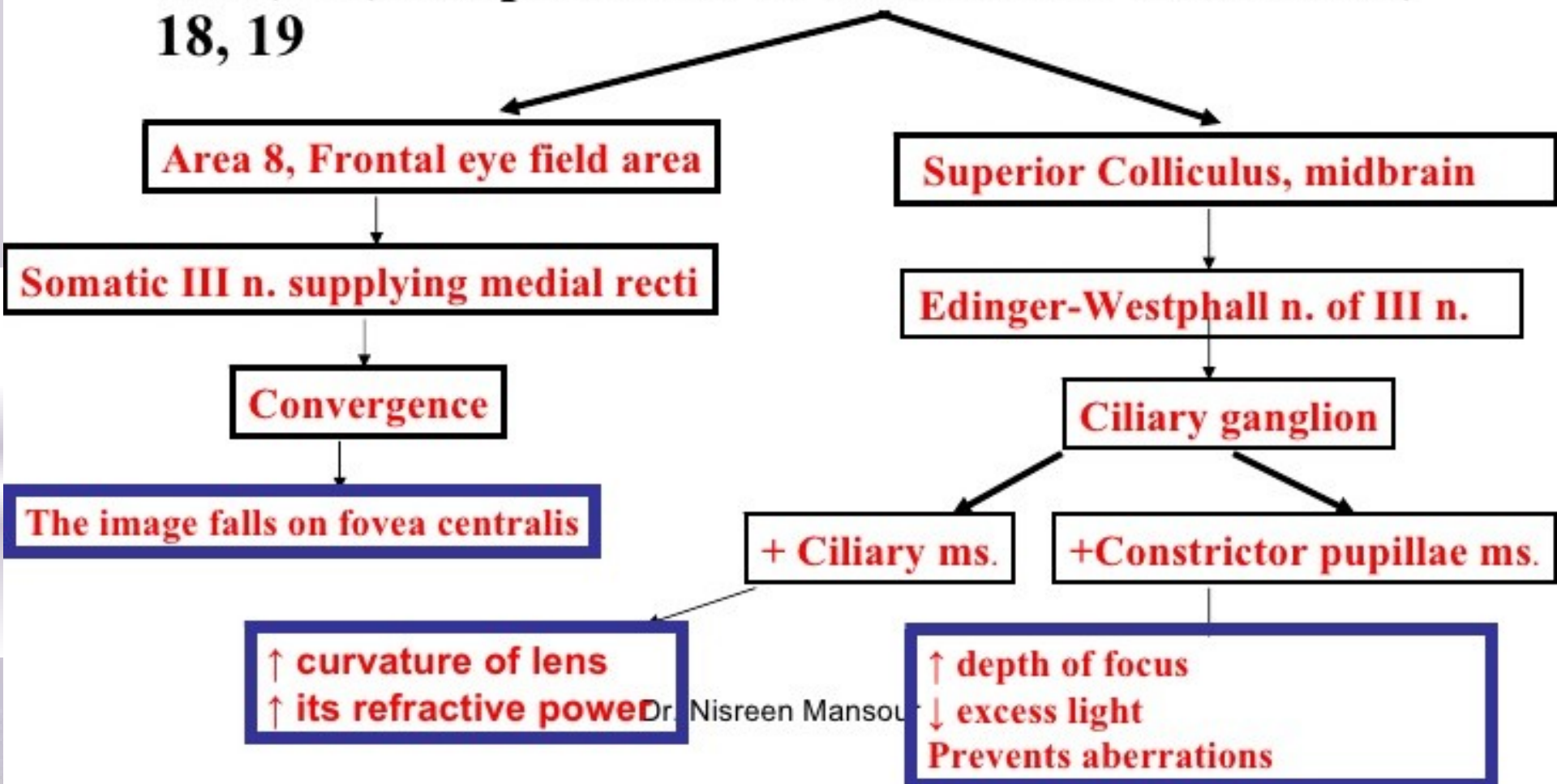


## **Nearby objects**

To view objects that are nearby, the ciliary muscles contract and the lens becomes more rounded. The point at which the image of a close object becomes blurred is called the near point of vision; it occurs when the lens reaches its maximum curvature.

# • Pathway of Accommodation reflex:

Blurred retinal image → retinal nervous elements → optic nerve → optic chiasma → optic tract → LGB (thalamus) → optic radiation → primary visual area; 17; occipital lobe & association visual area; 18, 19





Illustrations were copied from:

**Neuroscience Online, the Open-Access Neuroscience  
Electronic Textbook**

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[University of Texas Medical School at Houston](#)