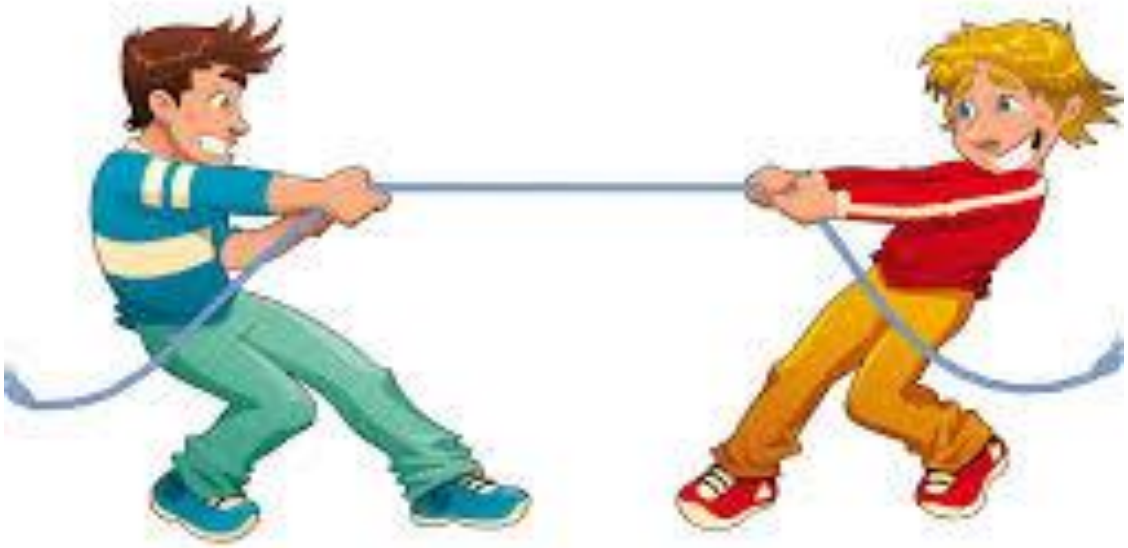

بسم الله الرحمن الرحيم



AUTONOMIC NERVOUS SYSTEM

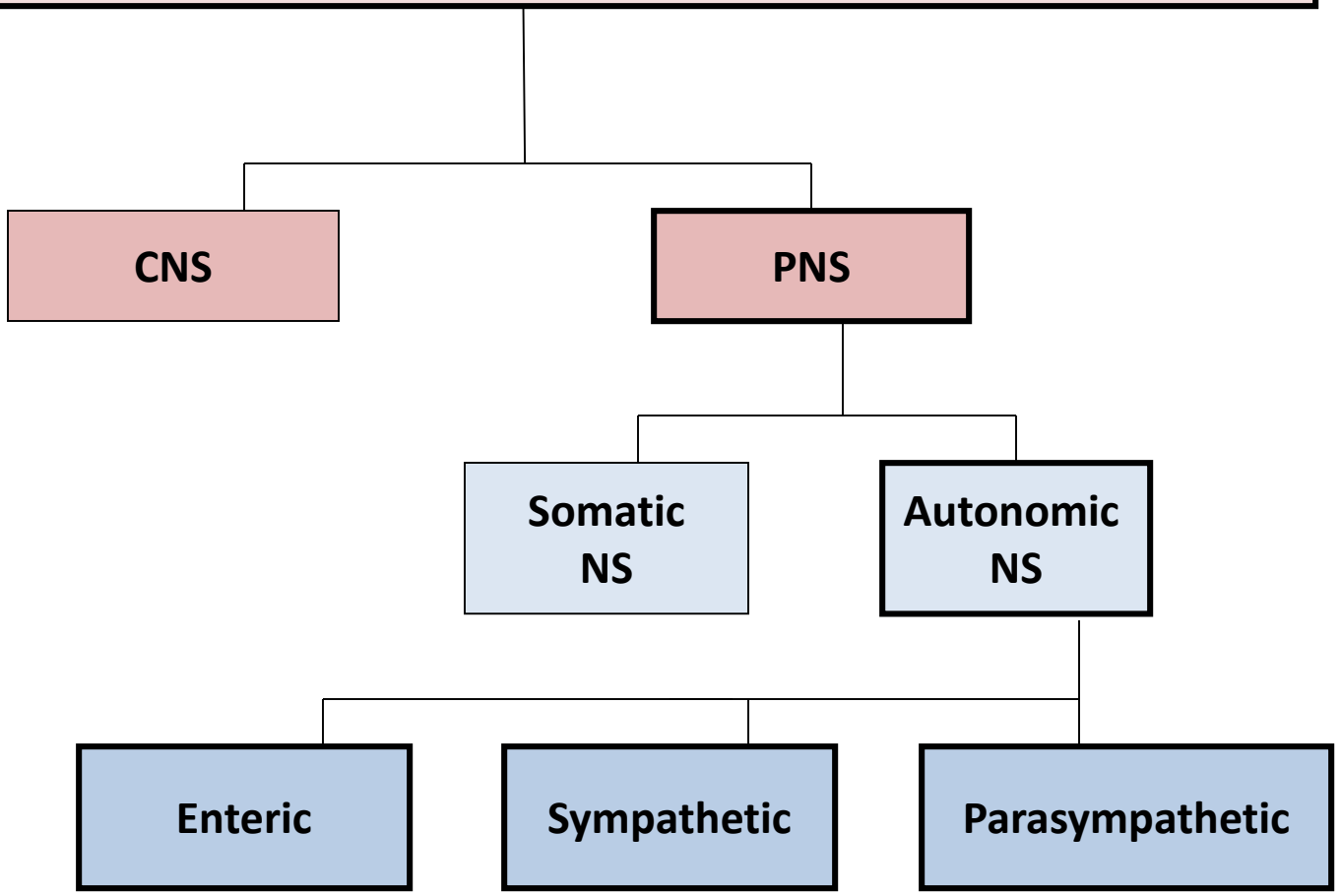
First Year

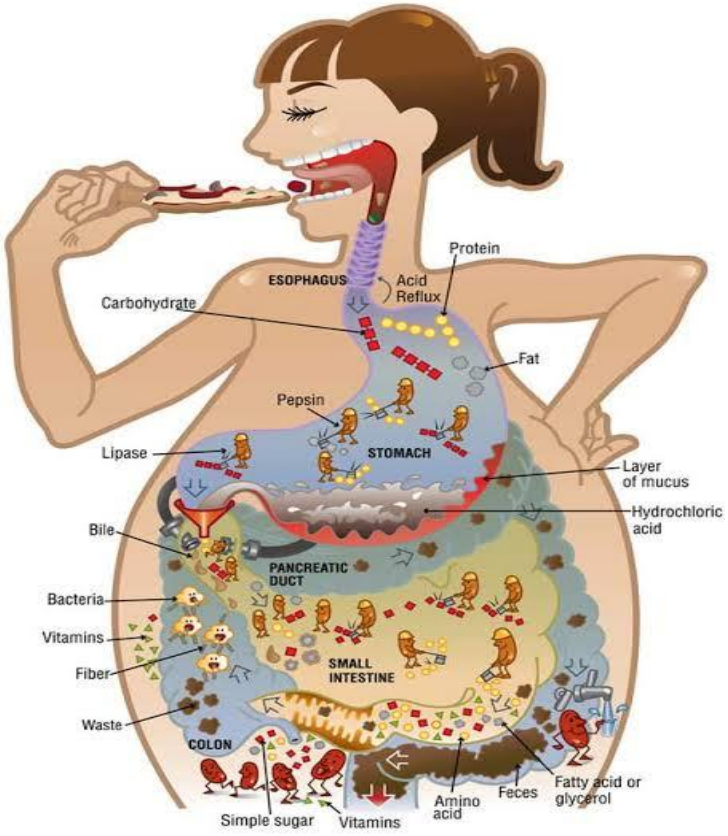
Dr Zubia Shah

Learning Objectives

- Discuss the organization of autonomic nervous system.
- Describe autonomic ganglia.
- Compare and contrast the sympathetic and parasympathetic systems.
- Describe enteric nervous system.
- Classify Autonomic Receptors.
- Describe the types of autonomic receptors.

Nervous System




Protein
ESOPHAGUS
Acid Reflux
Carbohydrate
Fat
Pepsin
Lipase
STOMACH
Layer of mucus
Hydrochloric acid
Bile
PANCREATIC DUCT
Bacteria
Vitamins
Fiber
SMALL INTESTINE
Waste
COLON
Fatty acid or glycerol
Feces
Amino acid
Simple sugar
Vitamins

Introduction

The portion of the nervous system that controls most visceral functions of the body

helps control

Blood Pressure,

Gastrointestinal motility,

Gastrointestinal secretion,

Urinary bladder emptying,

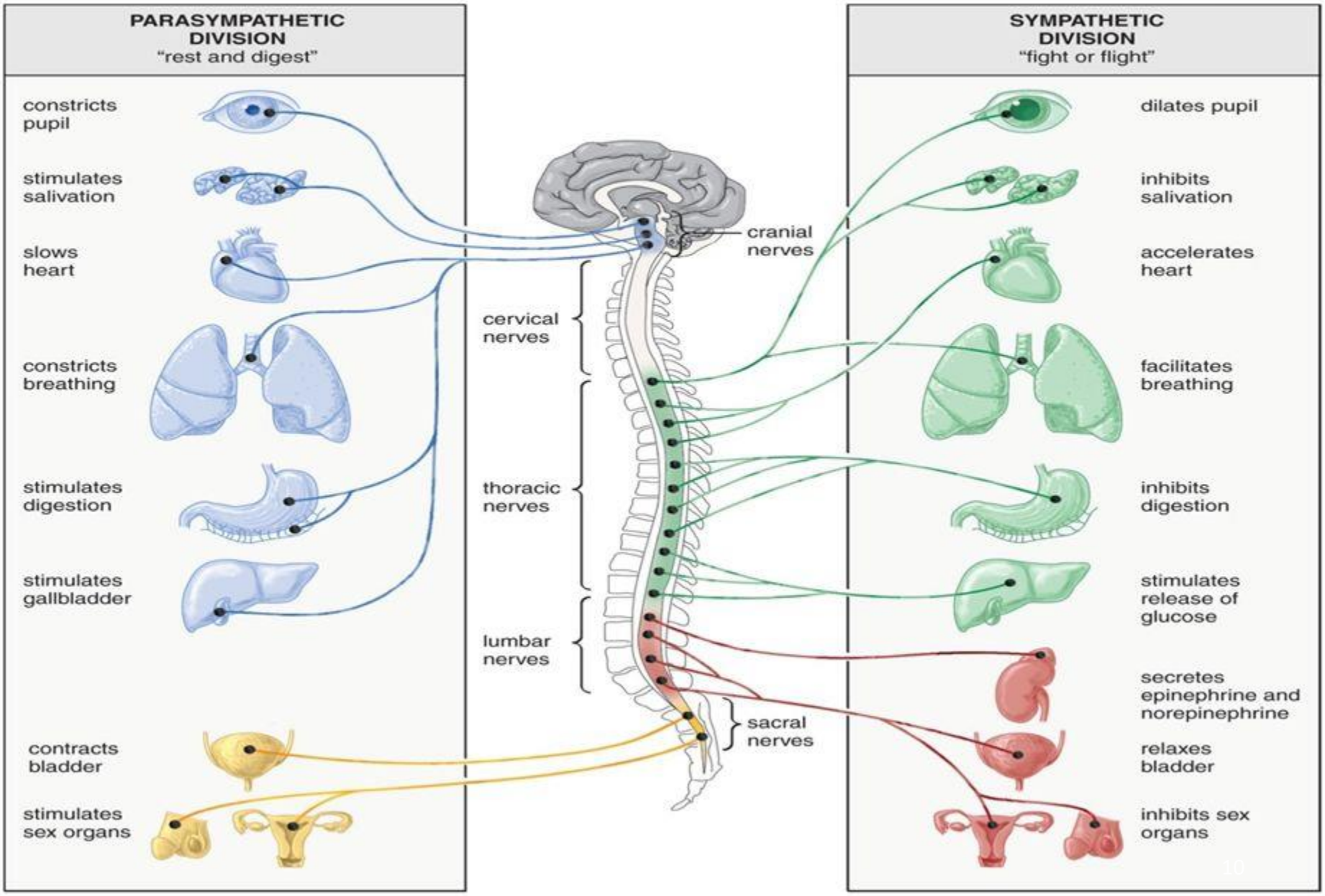
Sweating,

Body temperature…

Functions of Autonomic Nervous System

- Arterial pressure
- Gastrointestinal motility & secretion
- Urinary bladder emptying
- Sweating
- Body temperature
- Pupillary dilation and constriction

The Autonomic Nervous System



Organization of ANS

- Activated mainly by centers located in **spinal cord, brainstem and hypothalamus**

- Higher signals from cerebral cortex and limbic cortex can influence it as well

- Operates through **visceral reflexes**

Autonomic Centers

- Medulla

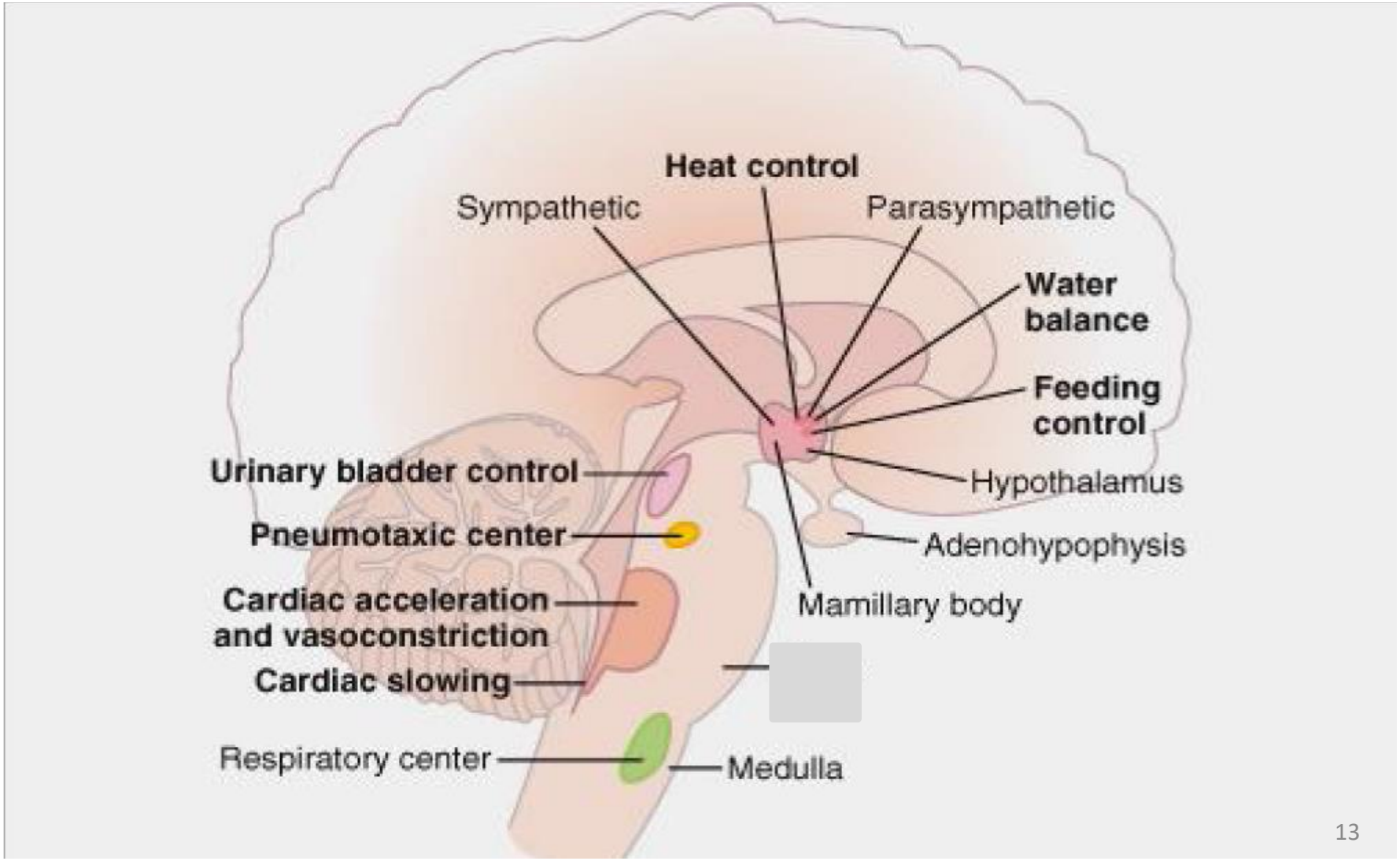
  Vasomotor center

  Respiratory center

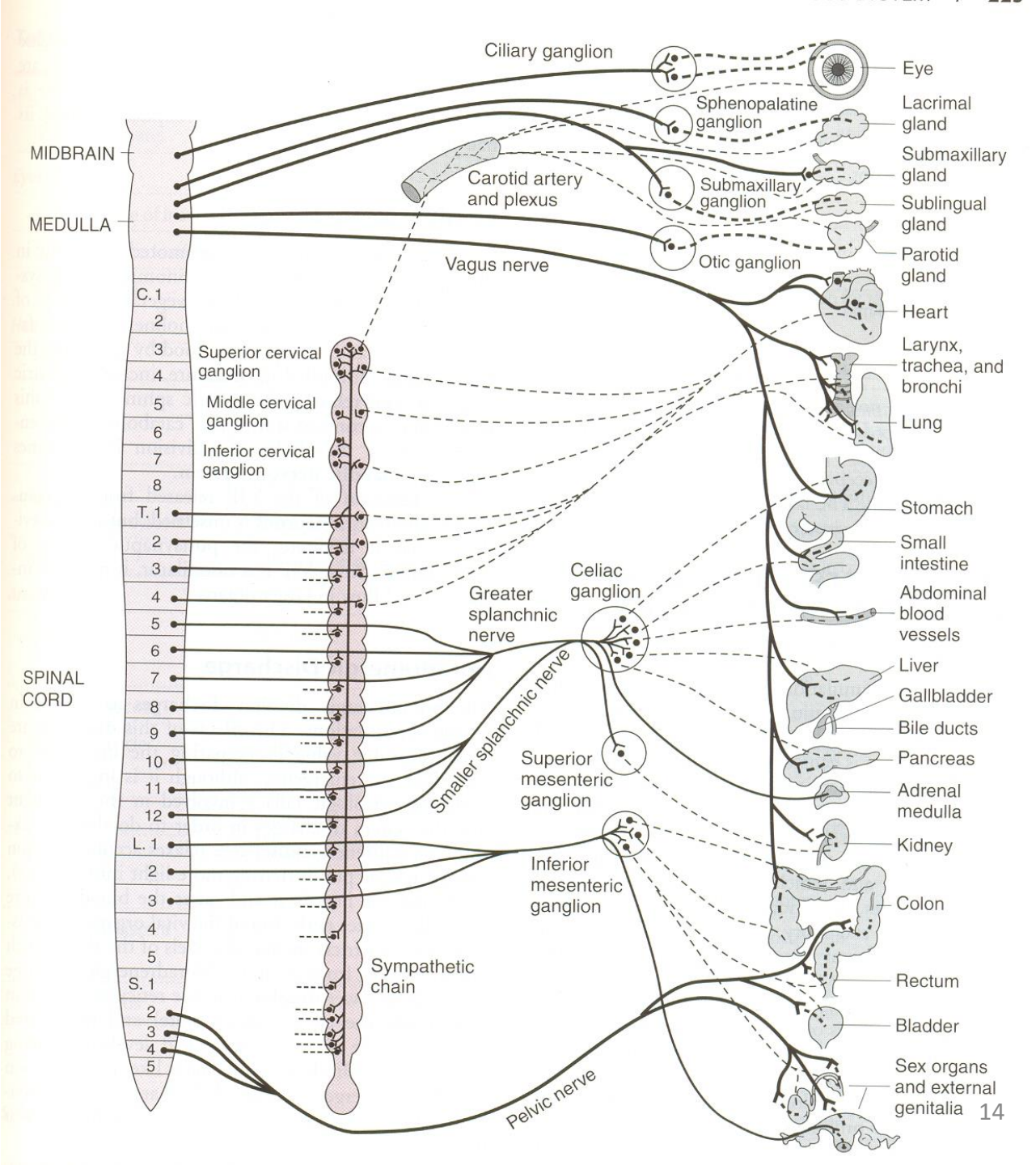
  Swallowing, coughing and vomiting centers

- Pons → Pneumotaxic center
- Midbrain → Micturition Center
- Hypothalamus → Temperature, thirst and food intake regulatory centers

Control Centres in Brain and Spinal Cord



Organization of Autonomic NS



Autonomic Ganglia

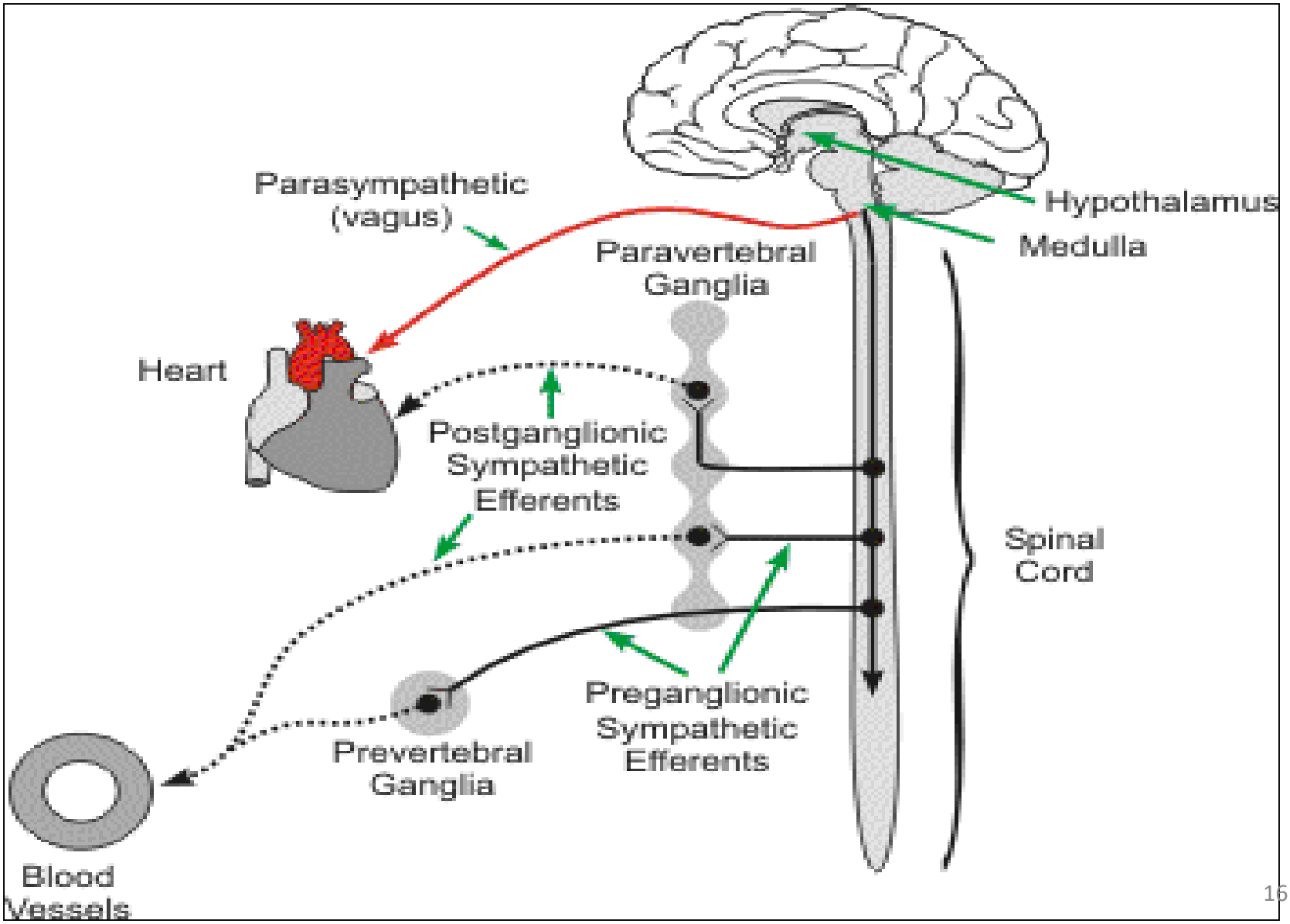
The site where preganglionic nerve fibres synapse on postganglionic neurons

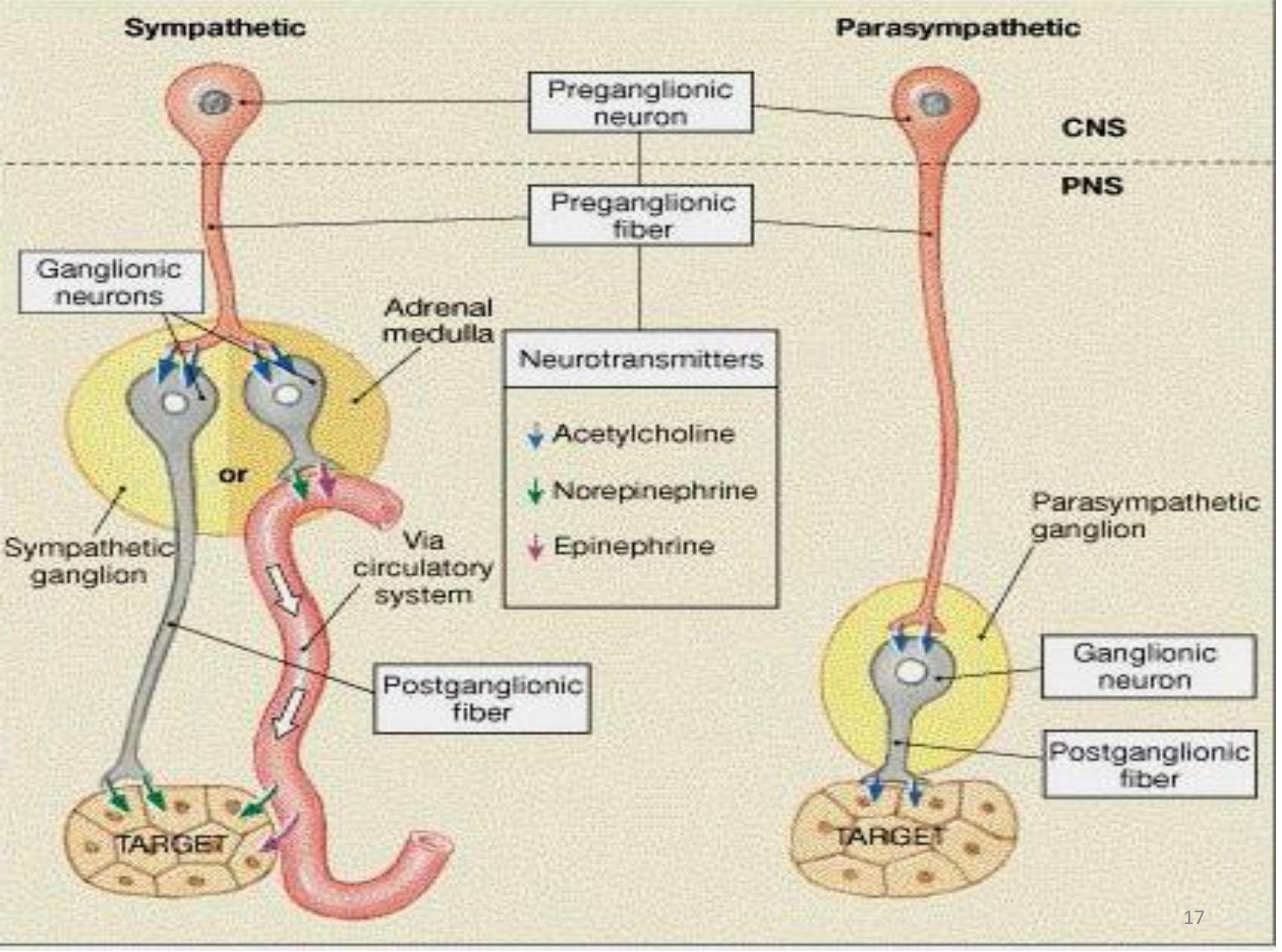
Preganglionic fibres Type B small, Myelinated

Postganglionic fibres Type C small, Unmyelinated

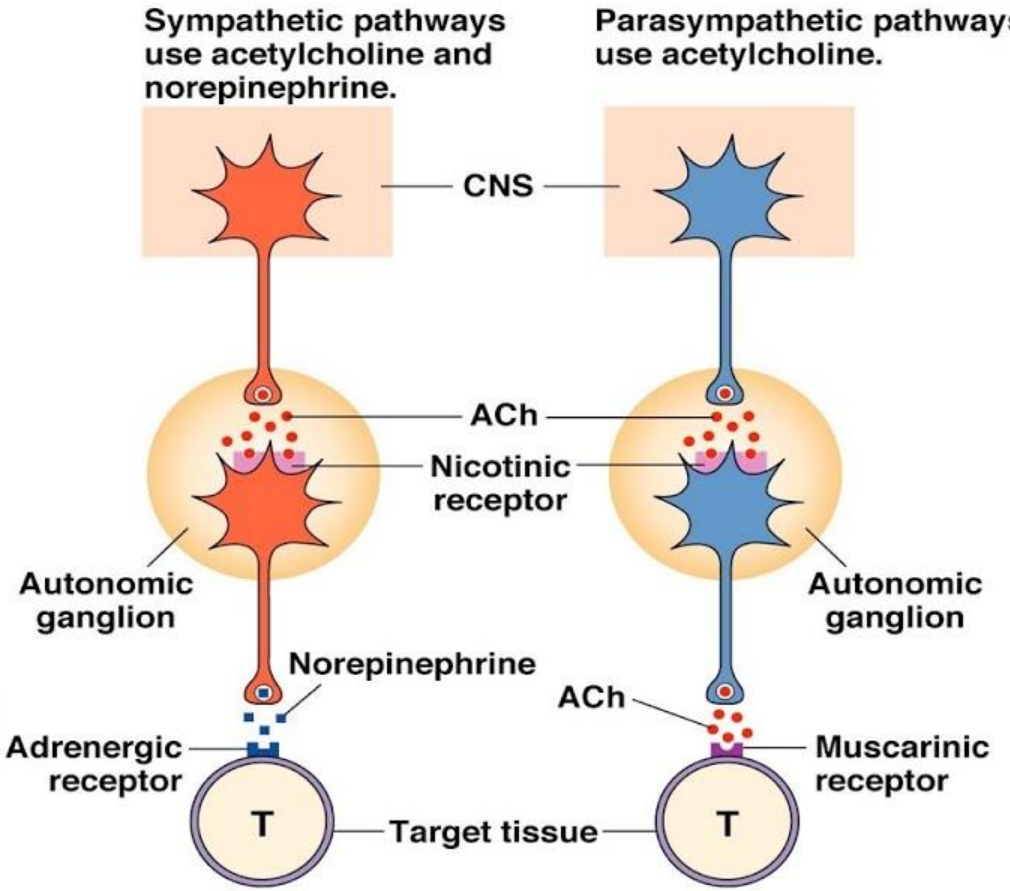
Small interneurons and collateral branches in ganglia which serve as a relay station

Autonomic Ganglia




Sympathetic
Parasympathetic
Preganglionic neuron
CNS
PNS
Preganglionic fiber
Ganglionic neurons
Adrenal medulla
Neurotransmitters
Acetylcholine
Norepinephrine
Epinephrine
or
Sympathetic ganglion
Via circulatory system
Postganglionic fiber
TARGET
Parasympathetic ganglion
Ganglionic neuron
Postganglionic fiber
TARGET

The Autonomic Nervous System



Physiologic Anatomy of SNS

Sympathetic chains of ganglia

interconnected with the spinal nerves on the side

Prevertebral ganglia

(the celiac and hypogastric)

Nerves

Sympathetic nerve fibers originate in

T-1 and L-2 → sympathetic chain → tissues and organs that are stimulated by them

Special Nature of the Sympathetic Nerve Endings in Adrenal Medulla

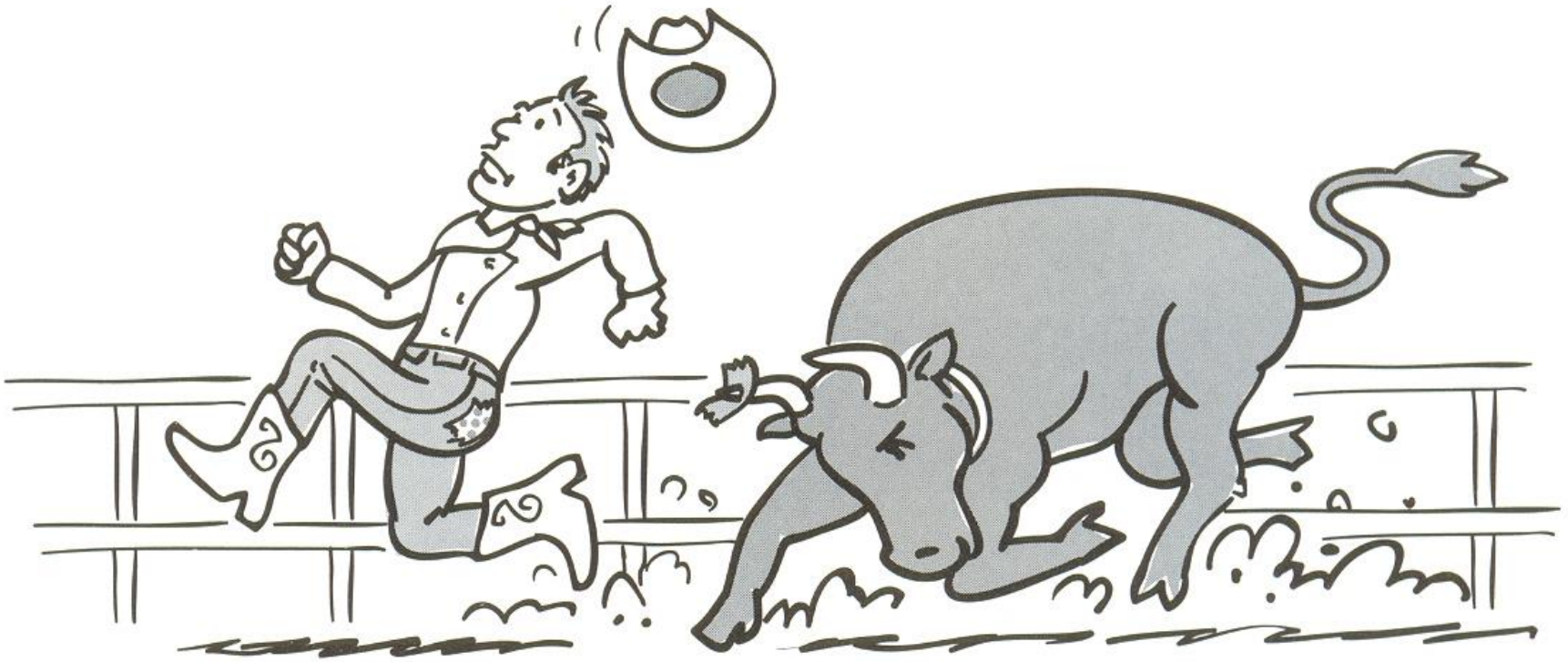
Preganglionic sympathetic nerve fibers pass **without synapsing** from the **intermediolateral horn** cells of the spinal cord

→ **sympathetic chains**

→ **splanchnic** nerves → **adrenal medullae**

There they end directly on modified neuronal cells → **Epinephrine** and **Norepinephrine** into the blood stream

Sympathetic functions



The Fight or Flight Response

1. Increased Blood Pressure
2. Increased Heart Rate
3. Increased Force of Cardiac Contraction
4. Increased Heart conduction velocity
5. Increased depth and rate of Respiration
6. Shift of blood flow to skeletal muscles & heart
7. Liver Glycogen → Glucose
8. Mobilization of FFA from adipose tissue
9. Contraction of Spleen capsule (haematocrit)

Fight and Flight….

10. Dilation of Pupil (Mydriasis)
11. Widening of Palpebral fissure
12. Piloerection
13. Inhibition of GI motility, secretion, contraction of sphincters
14. Sweating

(cold sweat as skin vessels are constricted)

15. Increased metabolism
16. Increased mental activity
17. Increased muscle Strength

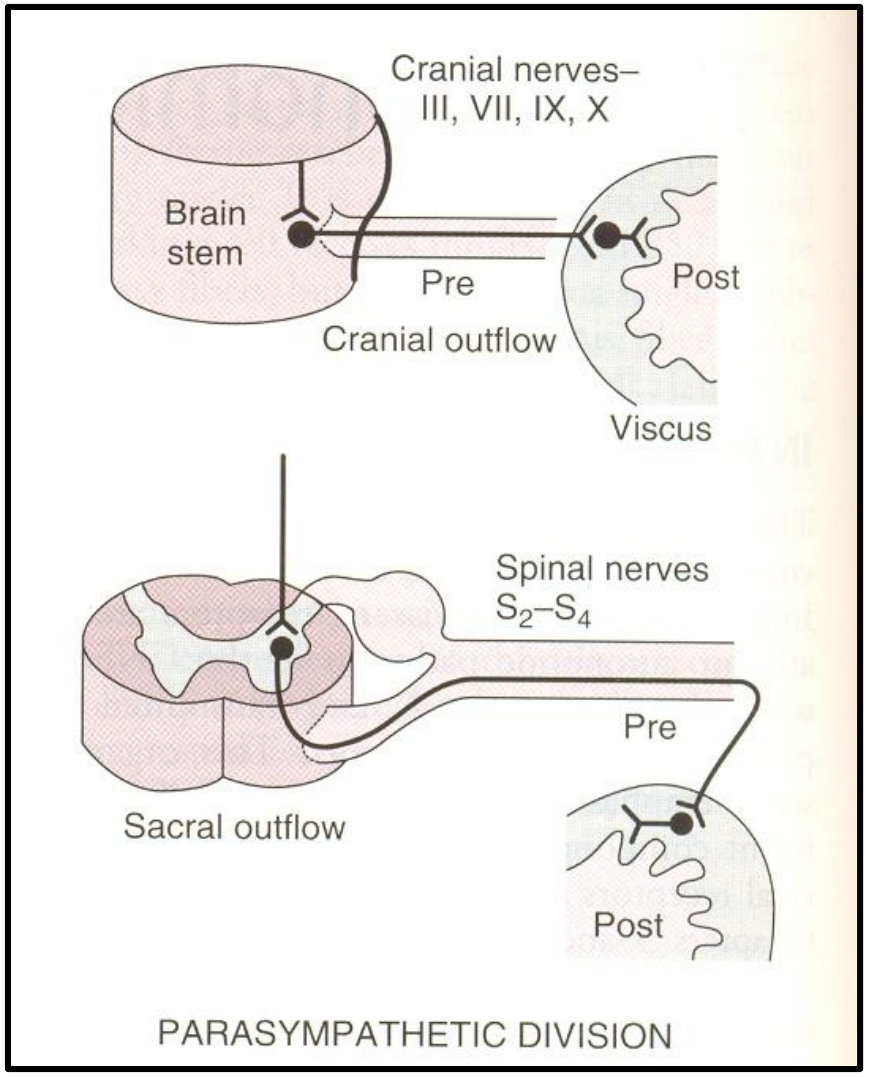
MCQ

The Alarm reaction causes an increase in

A. Defecation
B. Digestion
C. Pupil size
D. Sphincter relaxation
E. Urination

Parasympathetic system

Parasympathetic Division



Physiologic Anatomy of the PNS

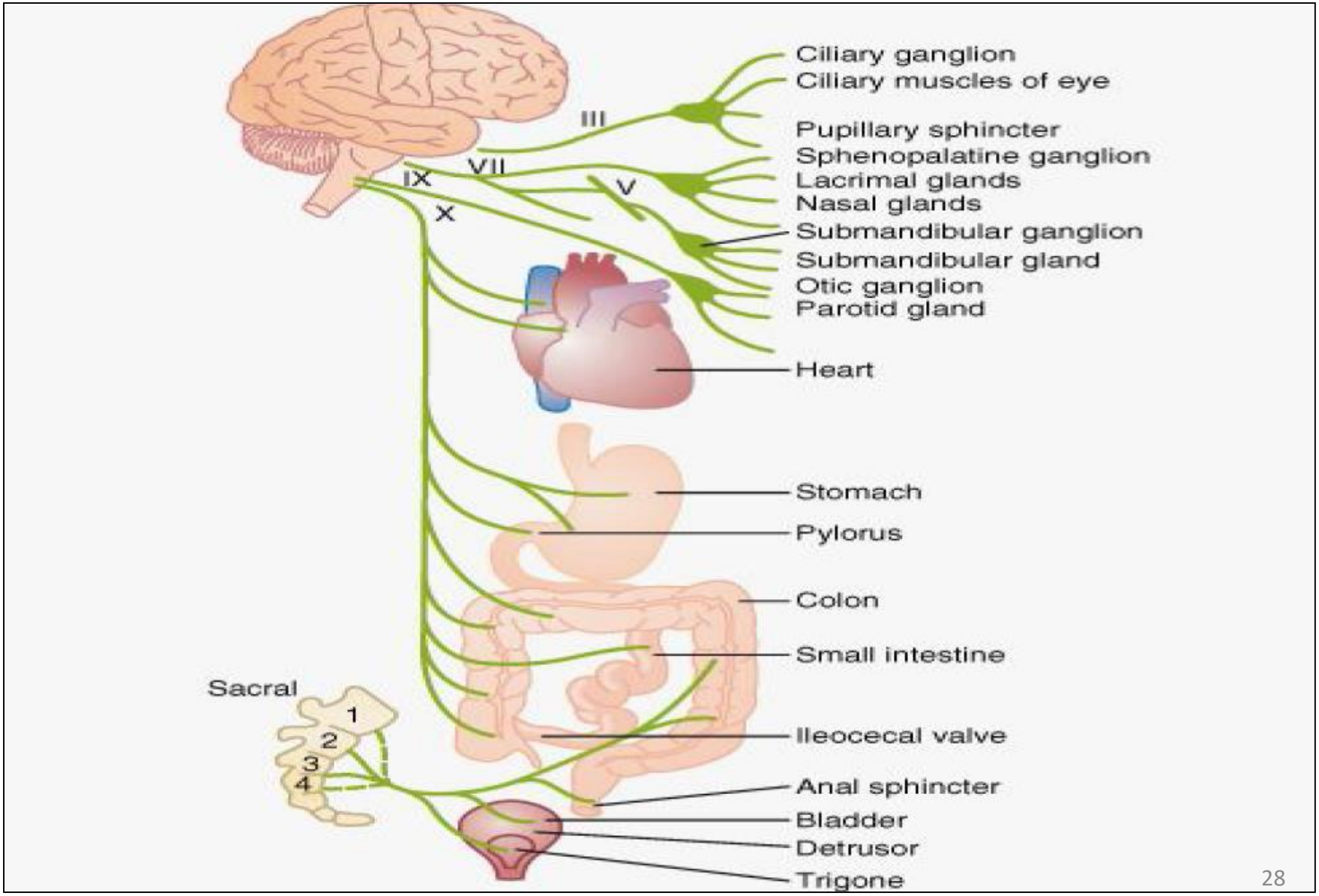
Cranial nerves III, VII, IX, and X;

S2 and S3(S2-S4)

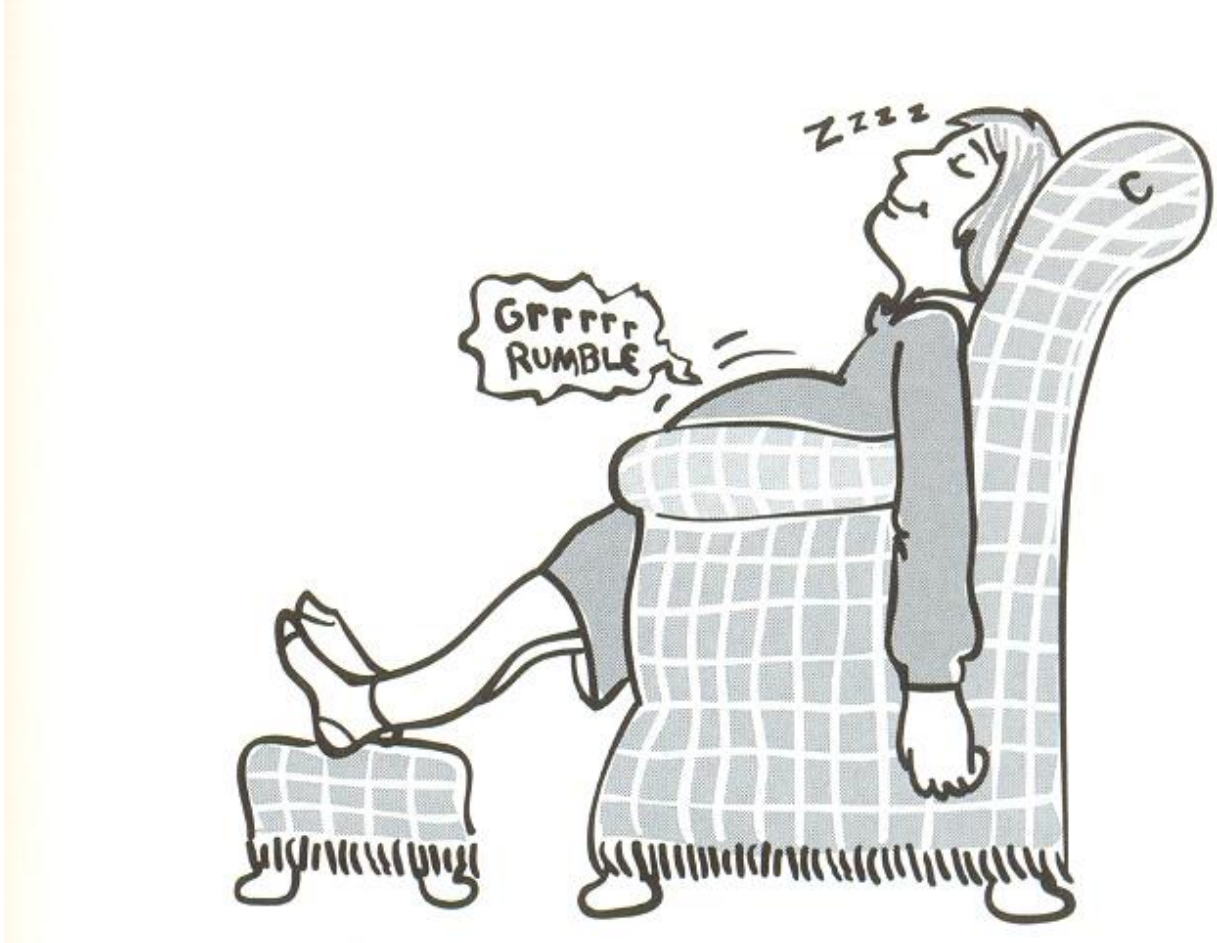
Vagus nerves carry about **75%** to entire thoracic and abdominal regions of the body

to the heart, lungs, esophagus, stomach, small intestine, proximal half of the colon, liver, gallbladder, pancreas, kidneys and ureters

Parasympathetic Nervous System



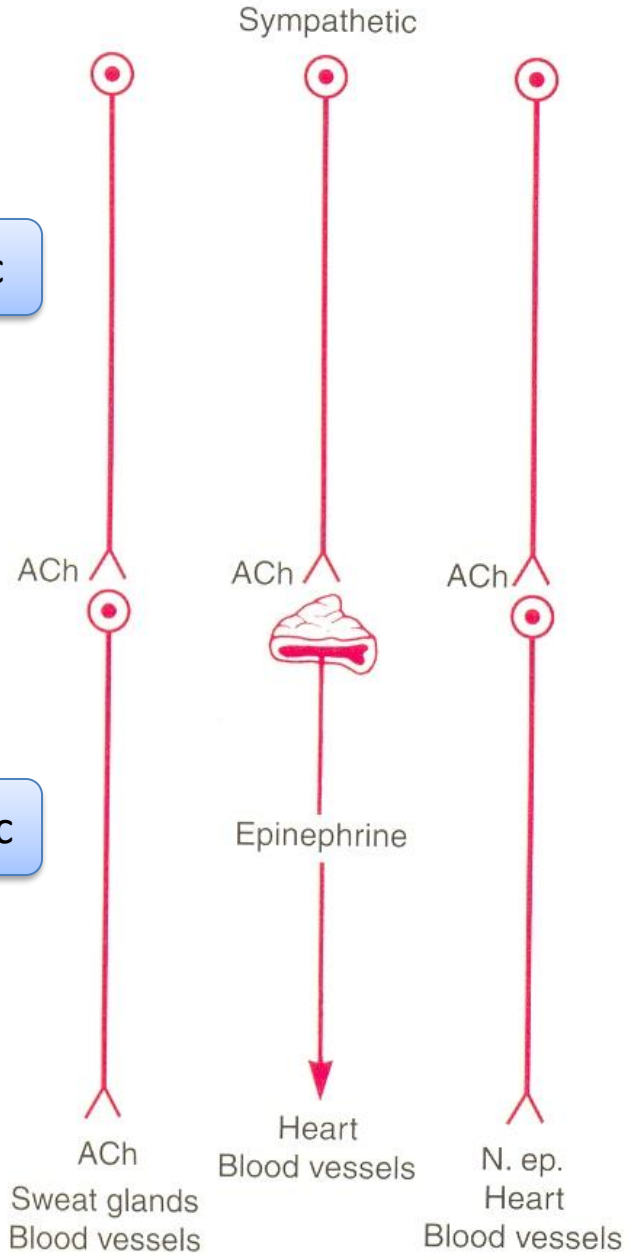
Parasympathetic functions

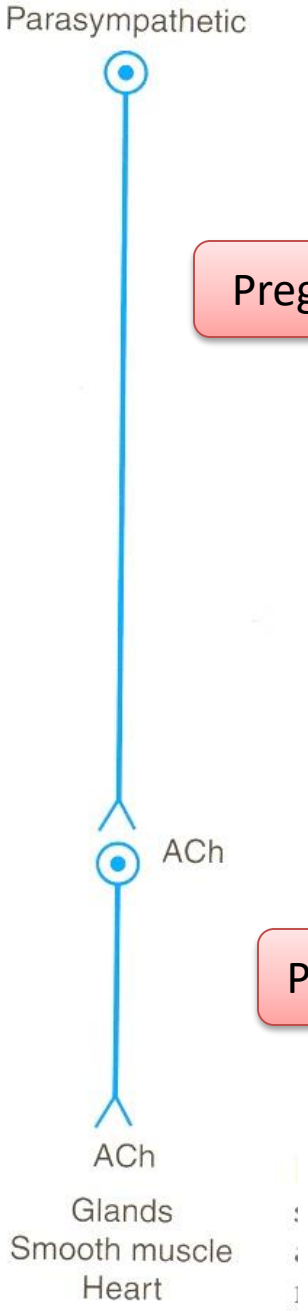


Nerve Fibers in Autonomic Nervous System

Preganglionic

Postganglionic

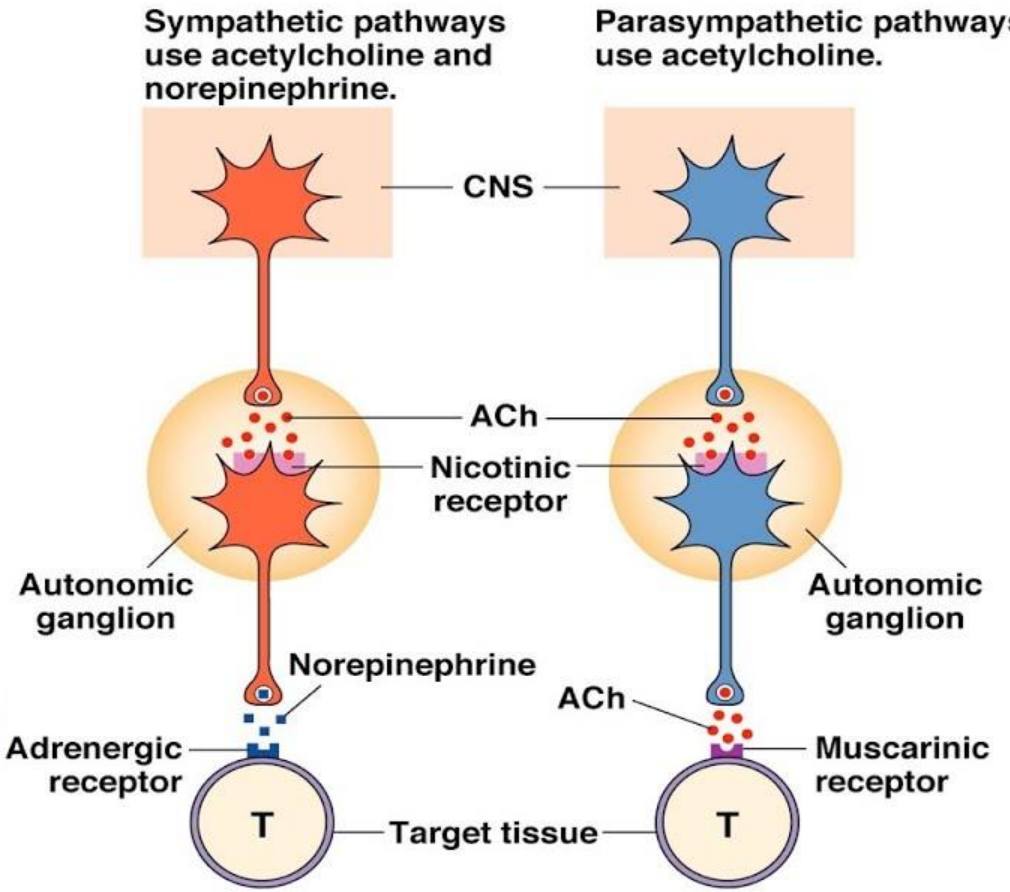


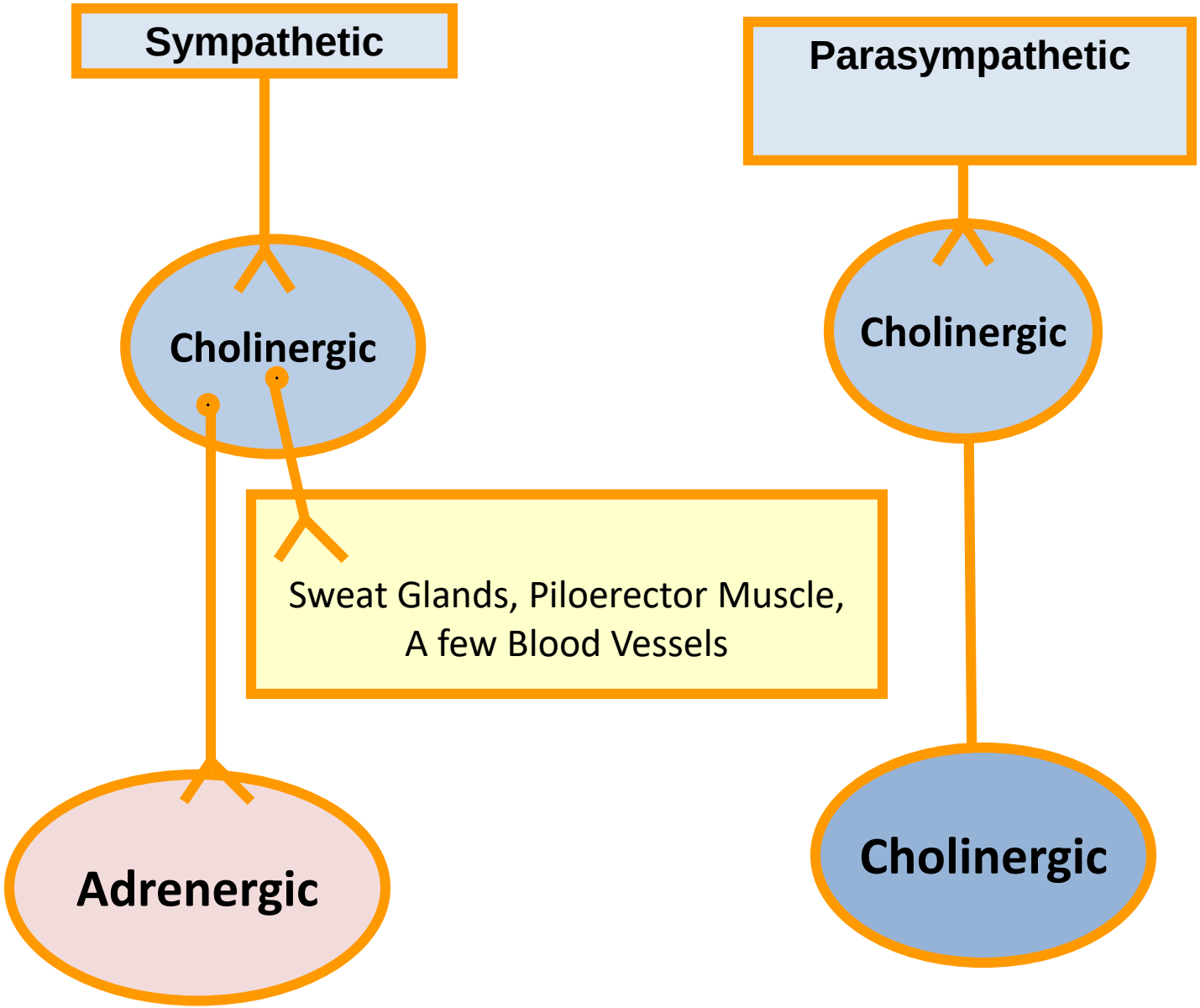


Preganglionic

Postganglionic

The Autonomic Nervous System




Sympathetic
Parasympathetic
Cholinergic
Cholinergic
Sweat Glands, Piloerector Muscle,
A few Blood Vessels
Adrenergic
Cholinergic

Acetylcholine is called a **Parasympathetic transmitter**

Norepinephrine is called a **Sympathetic transmitter**

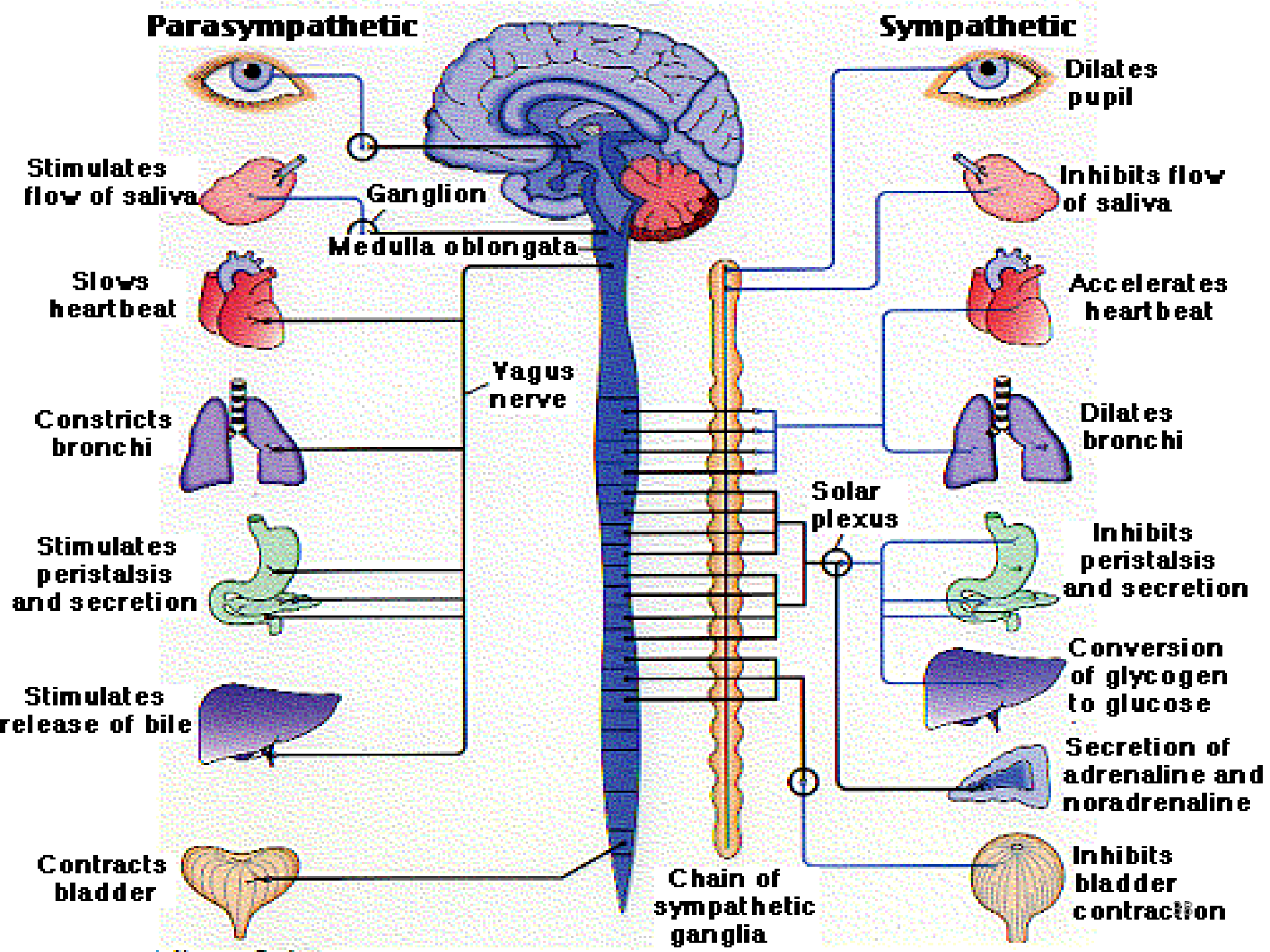
Autonomic Nervous System

Parasympathetic – "Rest and Digest"

Sympathetic – "Fight or Flight"

Sympathetic Vs Parasympathetic

Sympathetic	Parasympathetic
Thoracolumbar outflow	**Craniosacral outflow**
Quick response	**Slow response**
Fight or flight	**Rest and digest**
Diverts blood away from GI tract and skin	**increases blood flow to the GI tract**
Bronchiolar dilatation	**Bronchiolar constriction**
Increases heart rate & myocardial contractility	**Decreases the heart rate and contraction**
Dilates pupils	**constriction of the pupil**
Constricts the intestinal & urinary sphincters	**Relaxes the intestinal & urinary sphincters**
Inhibits salivary gland secretion	**stimulates salivary gland secretion,**
Inhibits **peristalsis**	**accelerates peristalsis**
Stimulates orgasm	**stimulating sexual arousal**


Parasympathetic
Sympathetic
Dilates pupil
Stimulates flow of saliva
Ganglion
Medulla oblongata
Inhibits flow of saliva
Slows heartbeat
Accelerates heartbeat
Vagus nerve
Constricts bronchi
Dilates bronchi
Solar plexus
Stimulates peristalsis and secretion
Inhibits peristalsis and secretion
Conversion of glycogen to glucose
Stimulates release of bile
Secretion of adrenaline and noradrenaline
Contracts bladder
Chain of sympathetic ganglia
Inhibits bladder contraction

Autonomic Functions

- Opposite
  - Excitatory/Inhibitory
- Parasympathetic
  - Localized
- Sympathetic
  - Diffuse

Enteric Nervous System

GIT has **intrinsic set of nerves** known as

intestinal enteric nervous system

- **autonomous functions** - coordination of reflexes
- innervation from the **autonomic nervous system**
- **operate independently** of the brain and the spinal cord
- **Neurogastroenterology**

Enteric…

Second brain

- Functions even when Vagus is cut
  - **30** neurotransmitters
- More than **90% of the body's serotonin** lies in the gut; about **50% of the body's dopamine**
  - Has support cells like those forming blood brain barrier

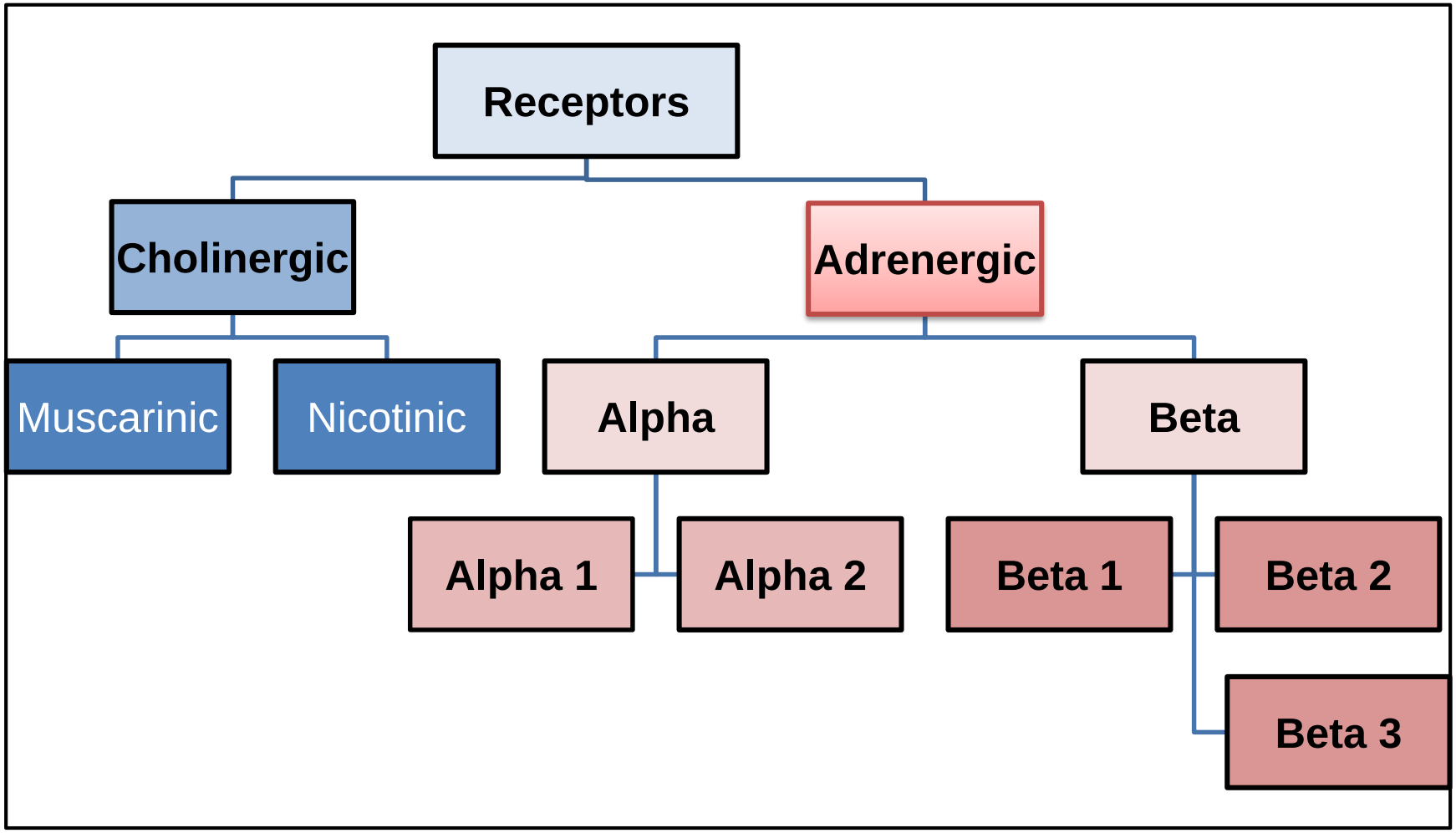
Adrenal Medullae And Sympathetic Nervous System

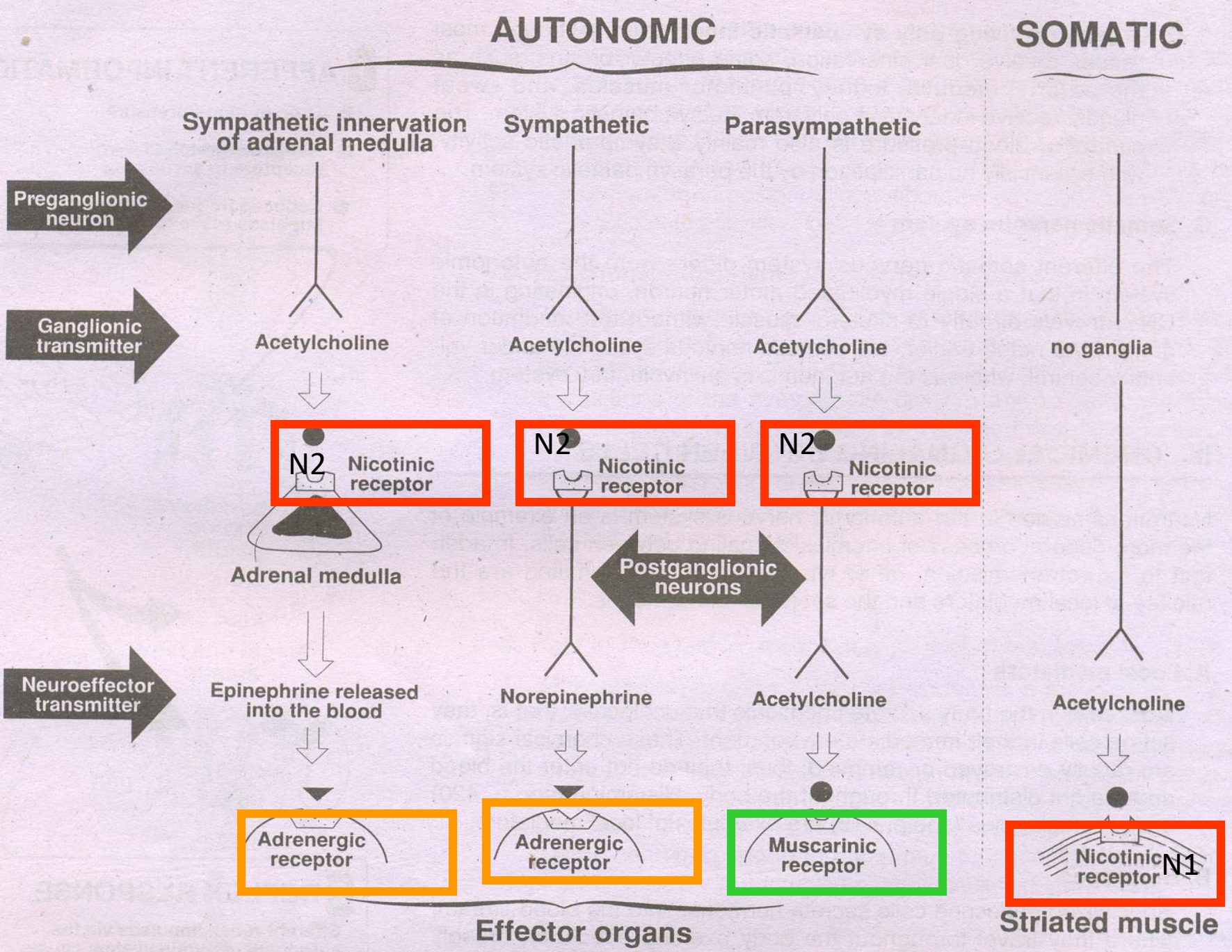
- **Epinephrine** and **norepinephrine** stimulate organs in 2 ways

Directly by the sympathetic nerves and

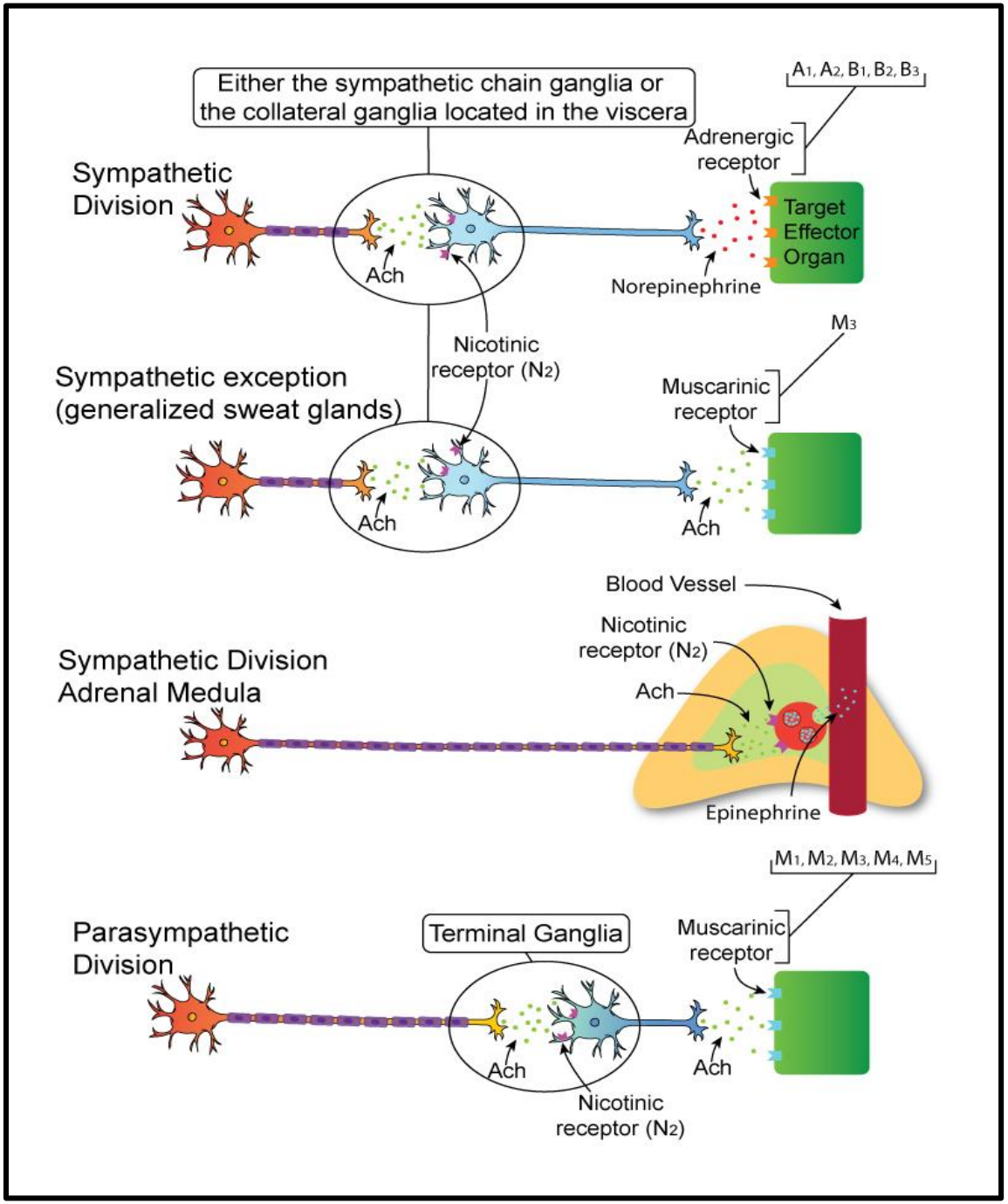
Indirectly by the adrenal medullary hormones

Autonomic Receptors




AUTONOMIC
SOMATIC
Sympathetic innervation of adrenal medulla
Sympathetic
Parasympathetic
Preganglionic neuron
Ganglionic transmitter
Acetylcholine
Acetylcholine
Acetylcholine
no ganglia
N2
Nicotinic receptor
N2
Nicotinic receptor
N2
Nicotinic receptor
Adrenal medulla
Postganglionic neurons
Neuroeffector transmitter
Epinephrine released into the blood
Norepinephrine
Acetylcholine
Acetylcholine
Adrenergic receptor
Adrenergic receptor
Muscarinic receptor
Nicotinic receptor
N1
Effector organs
Striated muscle

Autonomic Receptors



Function
of the autonomic nerves is determined
by the
Type of Receptor

Nicotinic Receptors

- **Ionotropic -** permeable to Na+, K+ and Ca++
- Stimulated by **Nicotine** and **Acetylcholine**
- Nicotinic AChR →

  Muscle end plates

  Autonomic ganglia

Muscarinic Receptors

- **Metabotropic –** Second messenger mediated (G Proteins)

- **stimulated** by **Muscarine** and **Acetylcholine**

- found in both **CNS** and **PNS**, in **heart**, **lungs**, **upper GI tract** and **sweat glands**

Muscarinic and Nicotinic Receptors

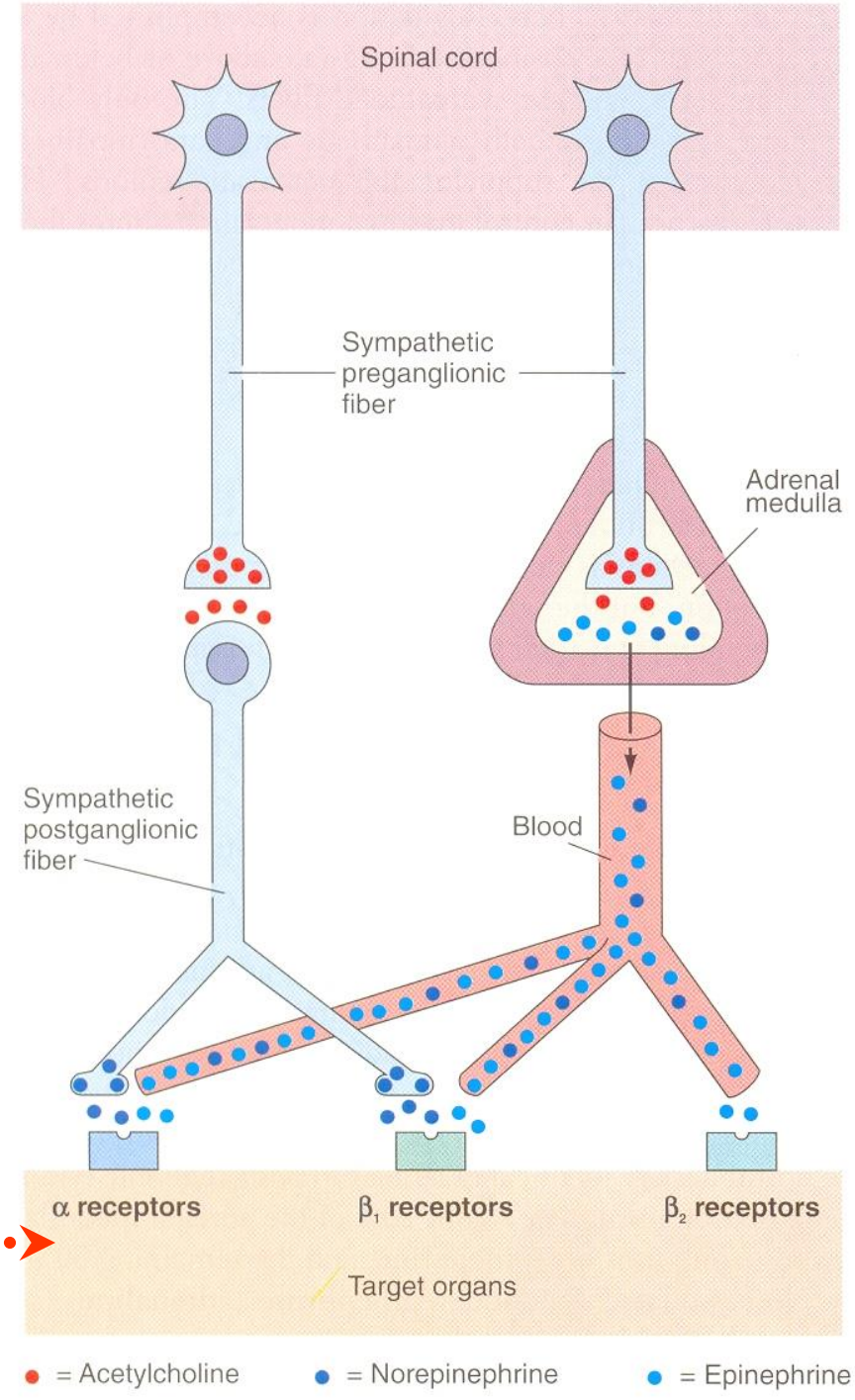
Acetylcholine activates 2 types of receptors

1. **Muscarinic** → muscarine
2. **Nicotinic receptors** → nicotine

Muscarinic receptors → on all **effector cells** stimulated by the **postganglionic cholinergic** neurons

Nicotinic receptors → in **Autonomic ganglia** at **synapses** between the pre and postganglionic neurons of both the sympathetic and parasympathetic systems

Adrenergic Receptors



Adrenergic Receptors—Alpha and Beta Receptors

2 major types of adrenergic receptors,

Alpha receptors (alpha1 and alpha2)and

Beta receptors (beta1 and beta2)

Norepinephrine and epinephrine → into the blood by the adrenal medullae

Norepinephrine excites **mainly alpha receptors, beta receptors** to a lesser extent
Epinephrine excites **both types** of receptors approximately equally

Differences between functions of epinephrine and norepinephrine

	epinephrine	norepinephrine
Type	*Hormone*	*Neurotransmitter + Hormone*
Amount secreted by Adrenal medulla	*80 %*	*20 %*
Binding with receptors	*Both α and β (more effect on β receptors)*	*Mainly α* *(and β1 ?)*
Cardiac stimulation	*More*	*Less*
Vasoconstriction	*Weak*	*Strong*
Effect on tissue metabolism	*More (5-10 times)*	*Less*
Glycogenolysis	*More*	*Less*

Adrenergic Receptors and Function

Alpha Receptor	Beta Receptor
Vasoconstriction	Vasodilation (β_2)
Iris dilation	Cardioacceleration (β_1)
Intestinal relaxation	Increased myocardial strength (β_1)
Intestinal sphincter contraction	Intestinal relaxation (β_2)
	Uterus relaxation (β_2)
Pilomotor contraction	Bronchodilation (β_2)
Bladder sphincter contraction	Calorigenesis (β_2)
	Glycogenolysis (β_2)
	Lipolysis (β_1)
	Bladder wall relaxation (β_2)

Value of Dual Autonomic Supply

1. Safety factor

2. Stimulation of structures not innervated by sympathetic nerves e.g., metabolic rate of all cells

3. Heart

References

- Guyton and Hall Textbook of Medical Physiology
- Ganong's Review of Medical Physiology
- Human Physiology From cells to Systems by Lauralee Sherwood
- BRS Physiology

ANY QUESTIONS?

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thank
you