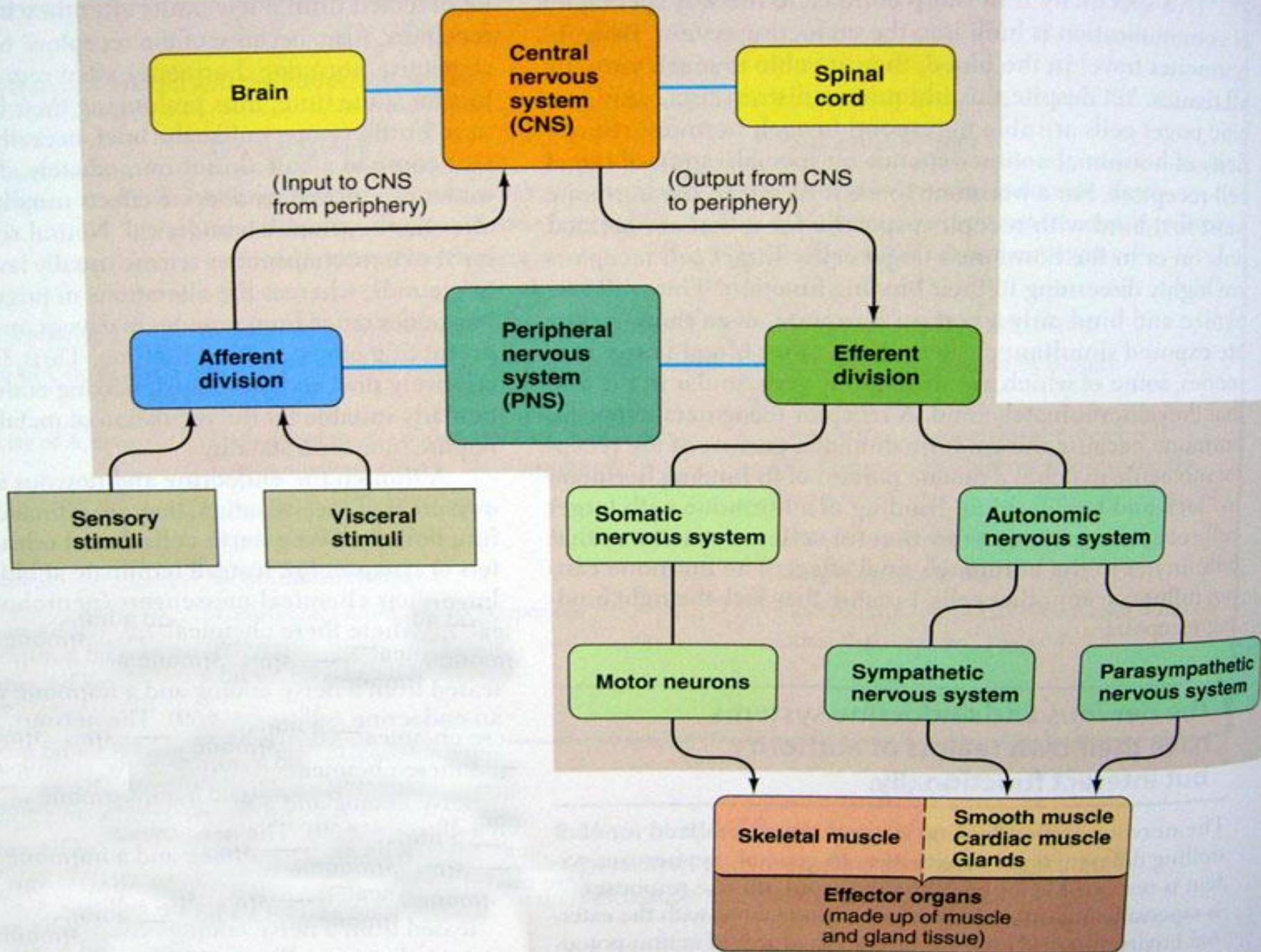


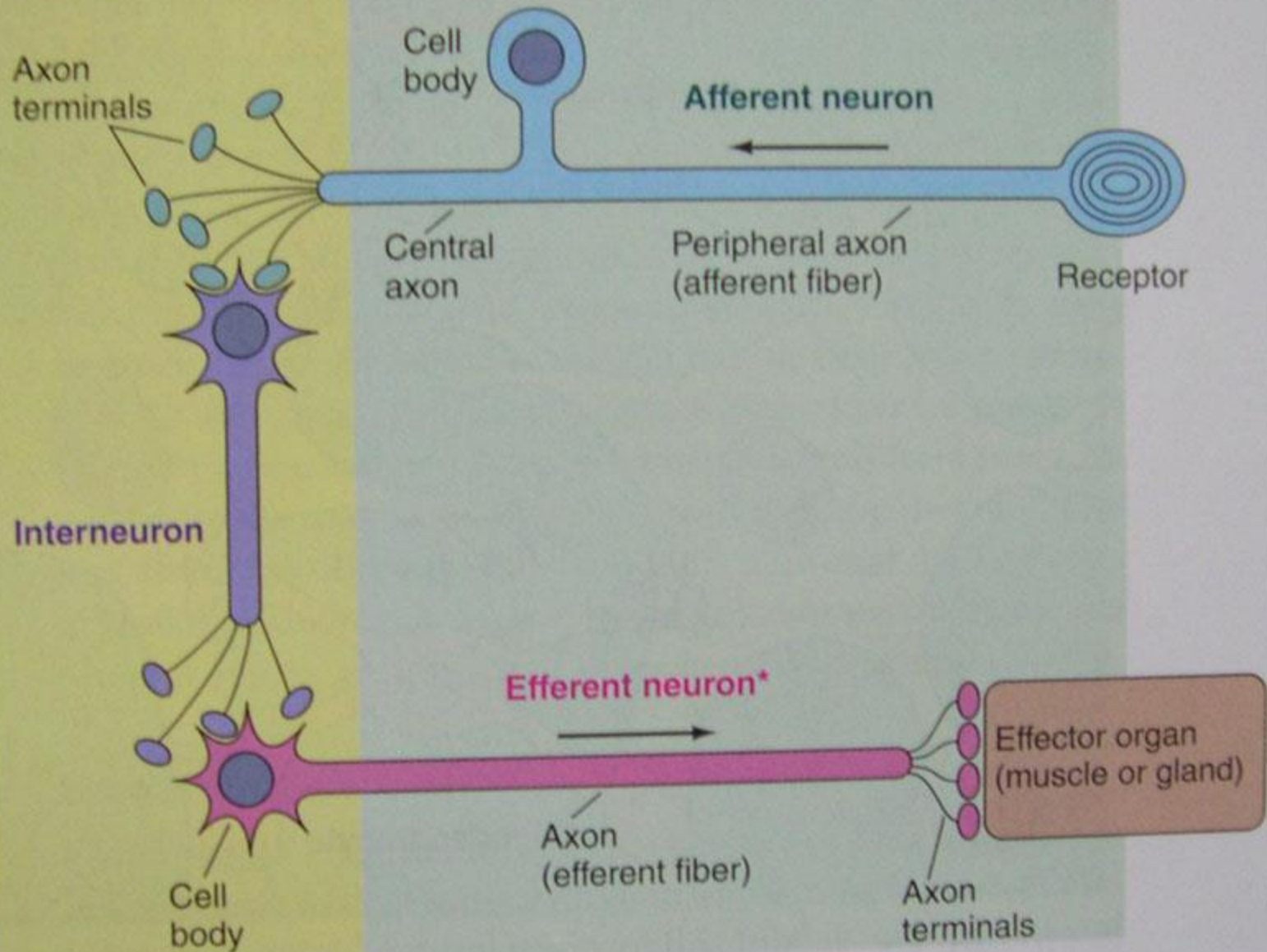
SISTEM SARAF OTONOM

dr. Juni Chudri, MARS, AIFO-K



Central nervous system
(spinal cord)

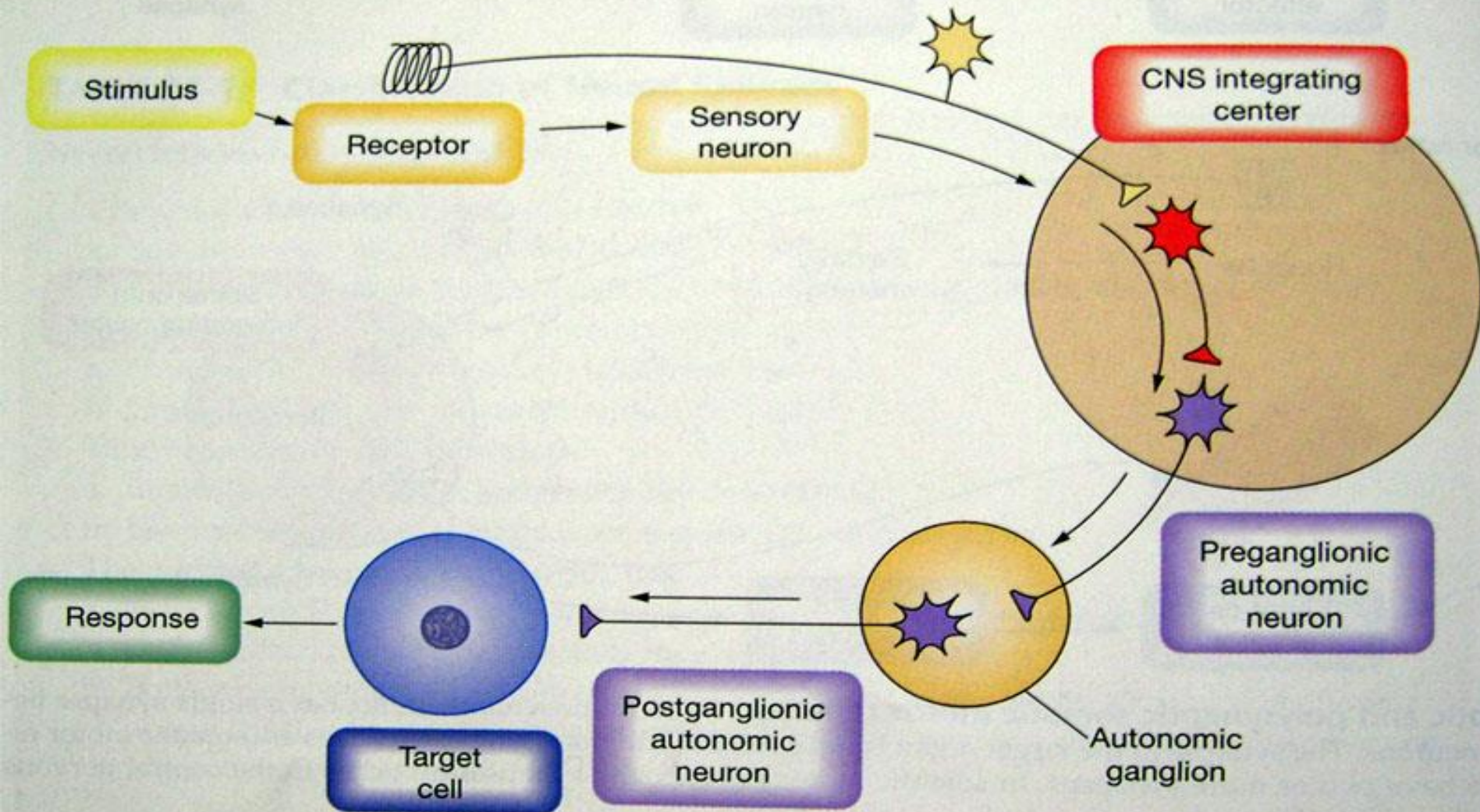
Peripheral nervous system



Sistem saraf otonom

- ◉ Sistem saraf vegetatif / involunter
- ◉ Fungsi :
 - > Mempertahankan homeostasis
 - > Mengkoordinasikan respons tubuh
 - > Berperan dalam sistem reproduksi
- ◉ Bekerja berdasarkan refleks

Refleks Otonom



SSO

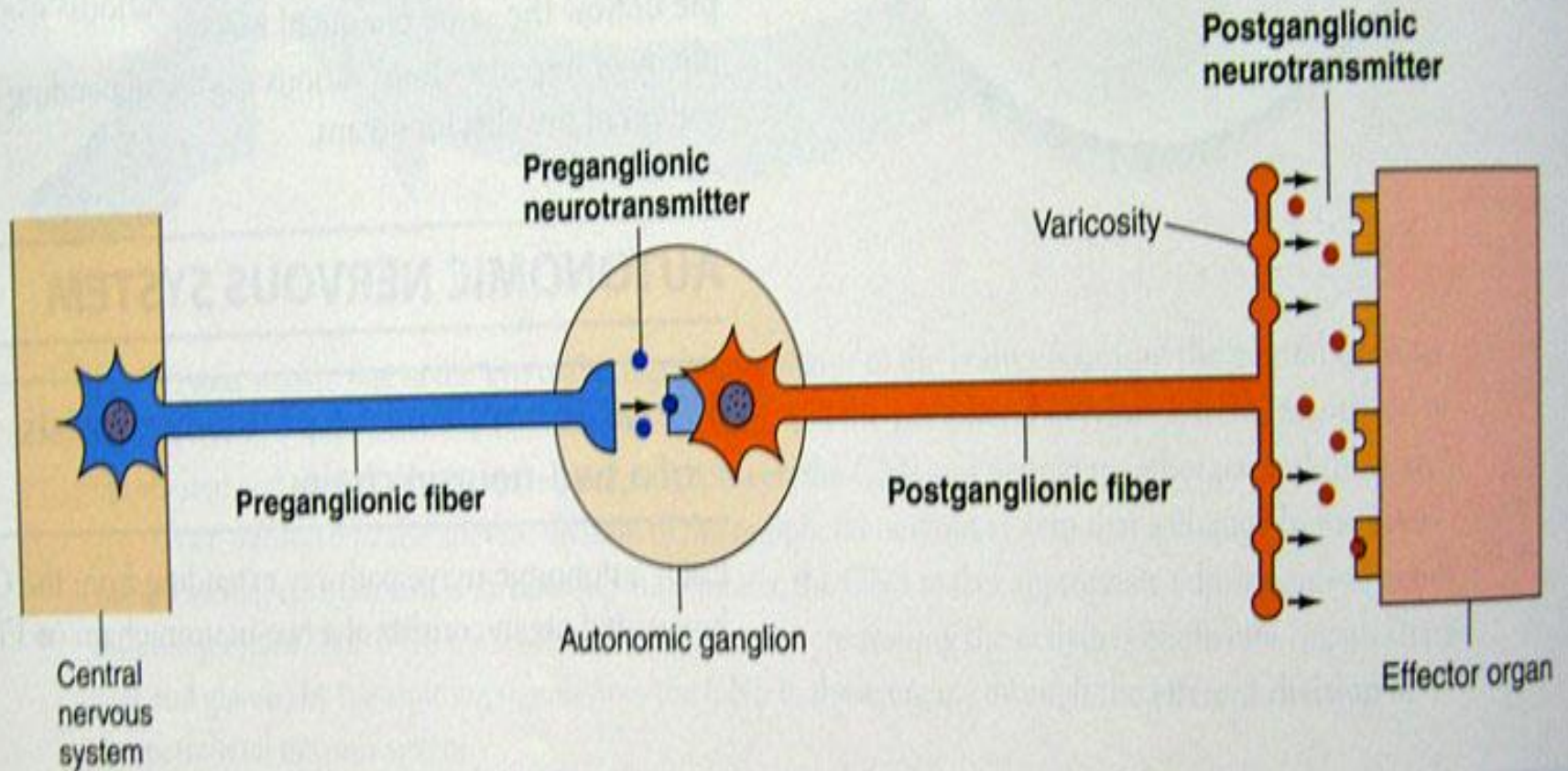
- ⦿ Input dapat berasal dari :
 - > Korteks serebri
 - > Reseptor
- ⦿ Serabut aferen masuk Medulla Spinalis melalui radiks dorsalis & membentuk sinaps di *Intermediolateral horn*

SSO

- ◎ Pusat SSO :
 - > Hipotalamus
 - > Batang otak
 - > Medulla spinalis
- ◎ Serabut eferen terdiri dari 2 rantai :
 - > Preganglion
 - > Postganglion
- ◎ Mempunyai ganglion otonom

Preganglion

Postganglion



SSO

- ◉ Eferen SSO :

- > Simpatis
- > Parasimpatis

- ◉ Neurotransmitter :

- > Asetilkolin
- > Norepinefrin / epinefrin

- ◉ Asetil koA dan kolin → Asetilkolin

- ◉ Tirosin → Norepinefrin → Epinefrin

SSO

◉ Reseptor neurotransmitter :

> Asetil kolin :

- Nikotinik
- Muskarinik

> Norepinefrin / epinefrin :

- Alfa : alfa1, alfa2
- Beta : beta1, beta2

SSO

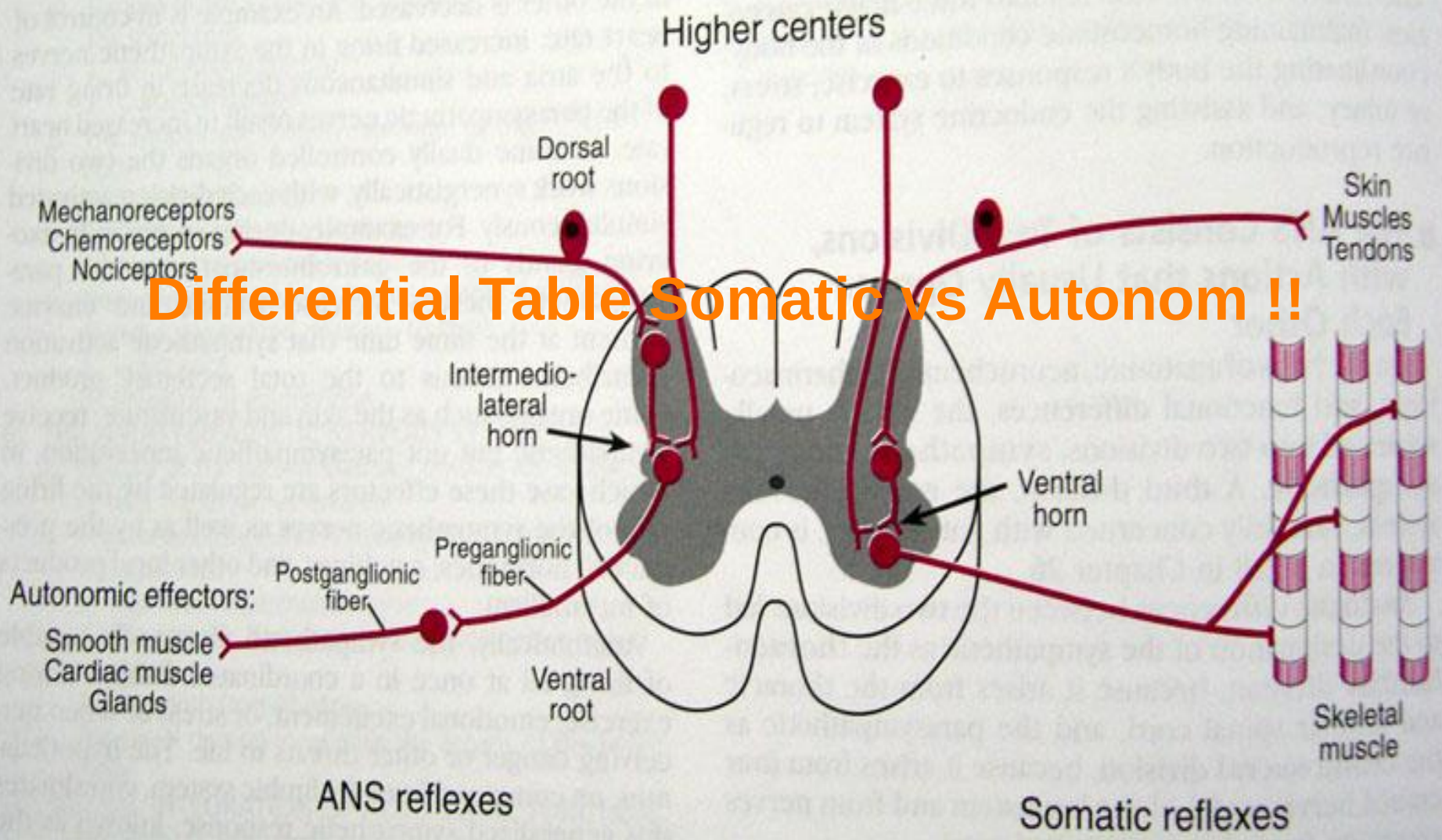
● Efektor SSO :

- > Otot polos
- > Otot jantung
- > Kelenjar

Otonom

Somatik

Differential Table Somatic vs Autonom !!



▲ TABLE 7-6

Comparison of the Autonomic Nervous System and the Somatic Nervous System

Feature	Autonomic Nervous System	Somatic Nervous System
Site of Origin	Brain or lateral horn of spinal cord	Ventral horn of spinal cord for most; those supplying muscles in head originate in brain
Number of Neurons from Origin in CNS to Effector Organ	Two-neuron chain (preganglionic and postganglionic)	Single neuron (motor neuron)
Organs Innervated	Cardiac muscle, smooth muscle, exocrine and some endocrine glands	Skeletal muscle
Type of Innervation	Most effector organs dually innervated by the two antagonistic branches of this system (sympathetic and parasympathetic)	Effector organs innervated only by motor neurons
Neurotransmitter at Effector Organs	May be acetylcholine (parasympathetic terminals) or norepinephrine (sympathetic terminals)	Only acetylcholine
Effects on Effector Organs	Either stimulation or inhibition (antagonistic actions of two branches)	Stimulation only (inhibition possible only centrally through IPSPs on cell body of motor neuron)
Types of Control	Under involuntary control; may be voluntarily controlled with biofeedback techniques and training	Subject to voluntary control; much activity subconsciously coordinated
Higher Centers Involved in Control	Spinal cord, medulla, hypothalamus, prefrontal association cortex	Spinal cord, motor cortex, basal nuclei, cerebellum, brain stem

Sistem simpatis

- Berasal dari :
 - Thorakolumbal
 - T1 – T12
 - L1 – L3
- Preganglion berakhir pada :
 - > Trunkus simpatikus
 - > Ganglion kolateral
 - > **Medulla adrenal**

Sistem simpatis

- ◉ Serabut preganglion :

- > Pendek
- > Kolinergik

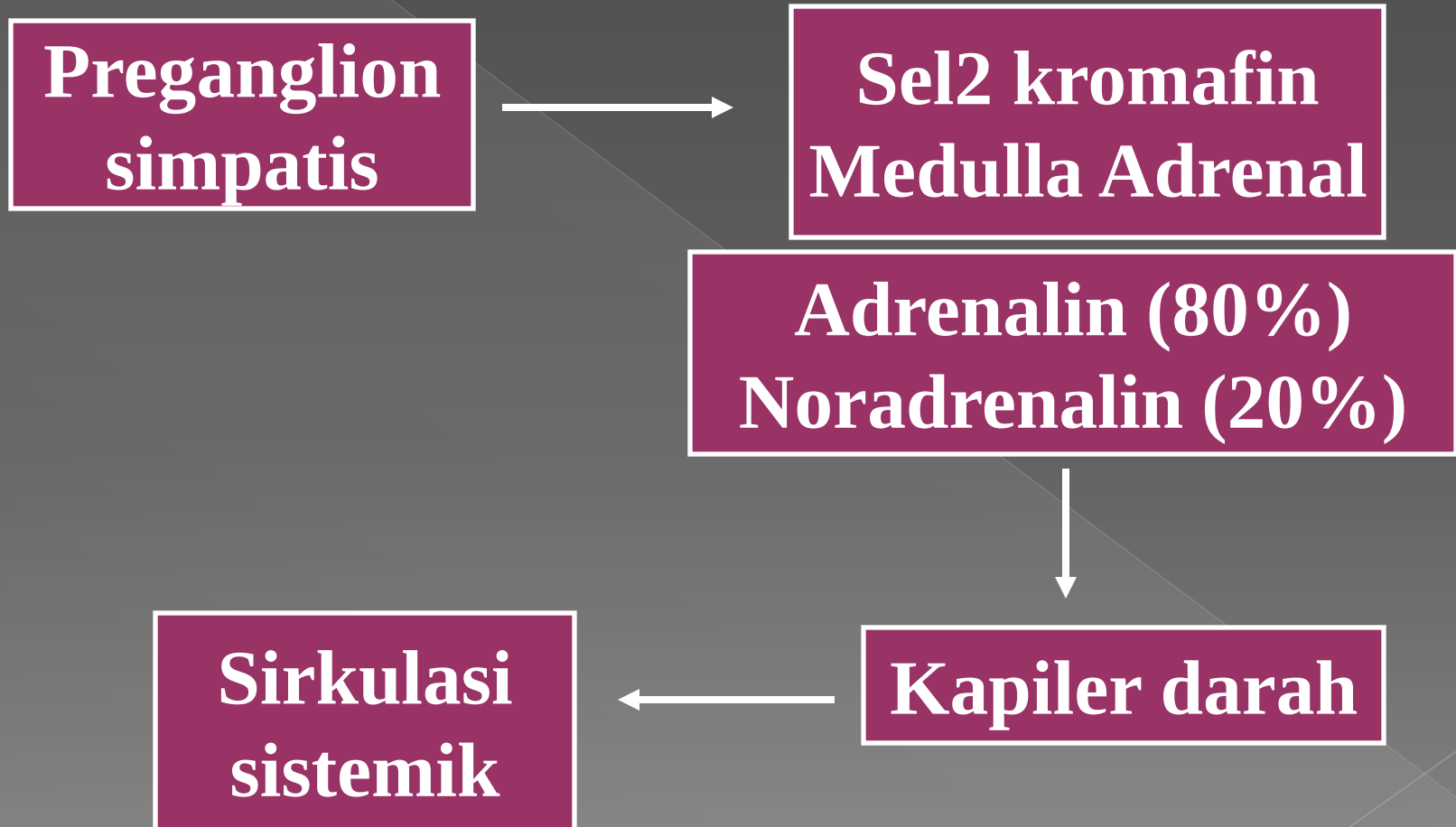
- ◉ Serabut postganglion :

- > Panjang
- > Adrenergik (sebagian besar)
- > Cholinergik (kel. Keringat, M. pilloerector, Pembuluh darah kulit)

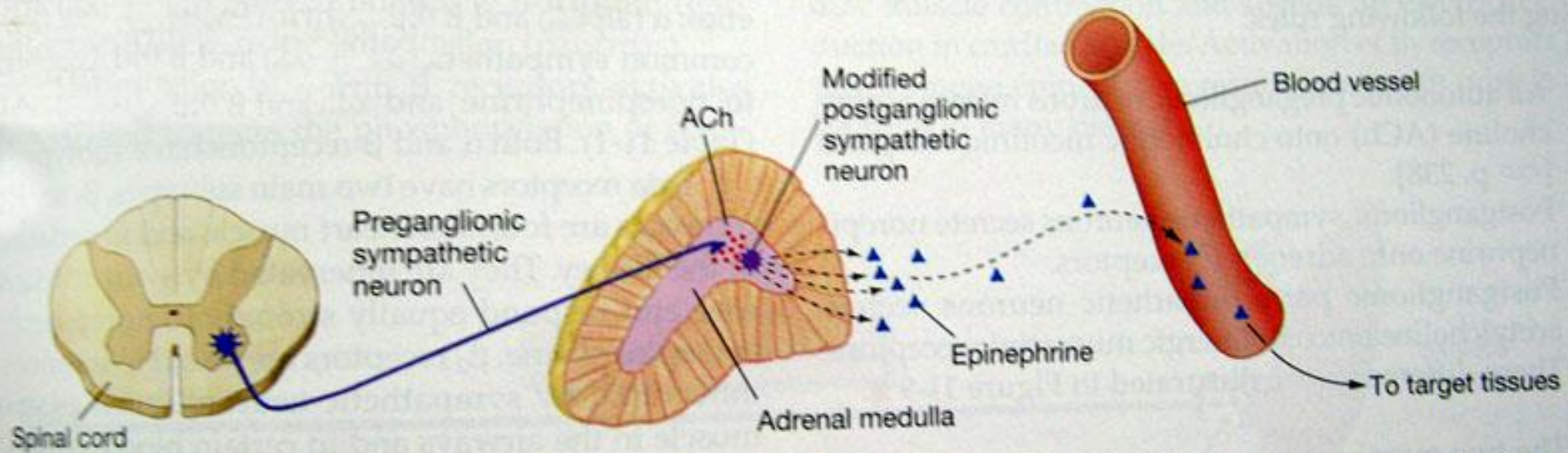
Sistem simpatis

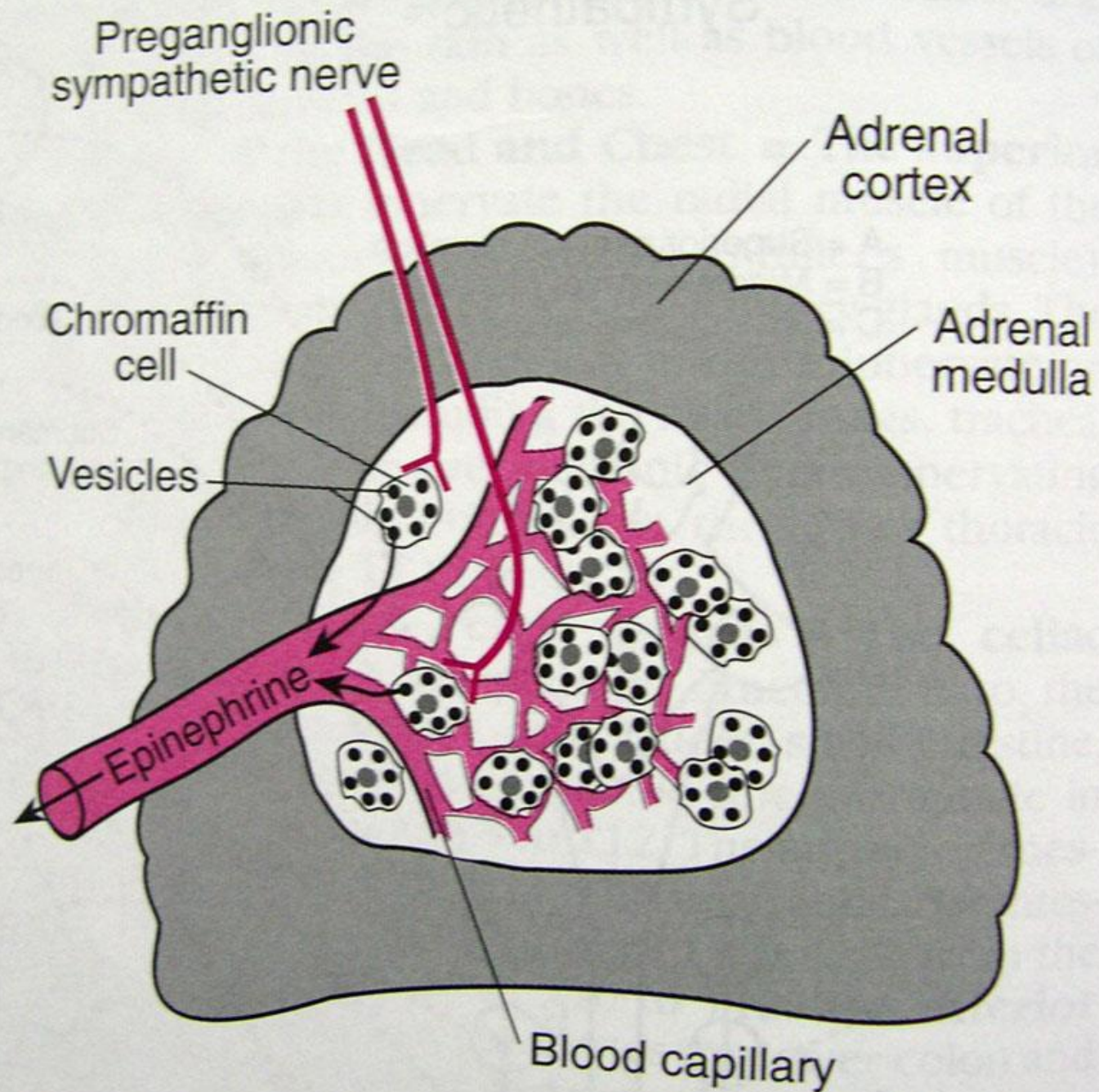
- Respon yang timbul meliputi daerah yang luas.
???

Medulla Adrenal



Medulla Adrenal



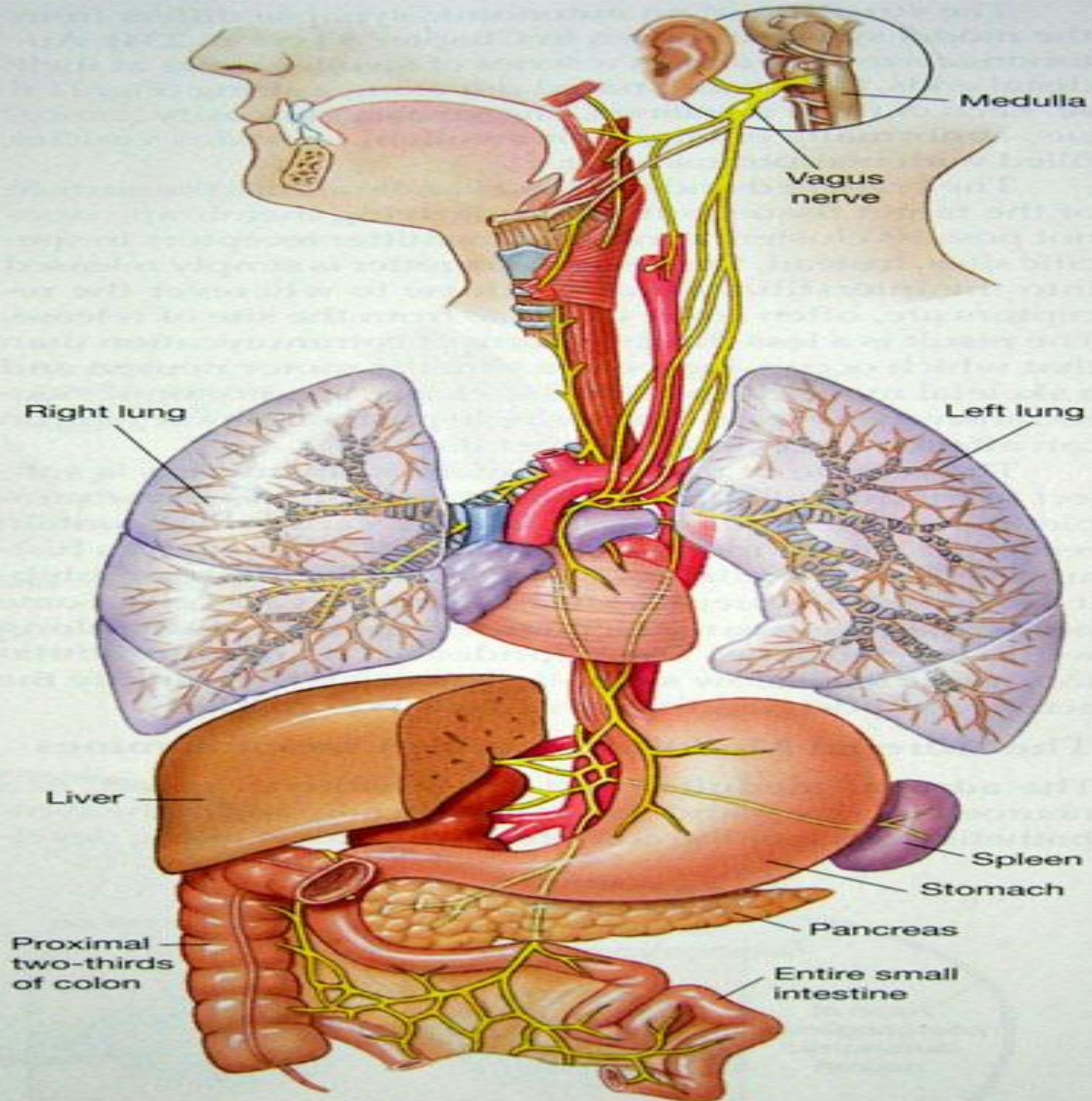


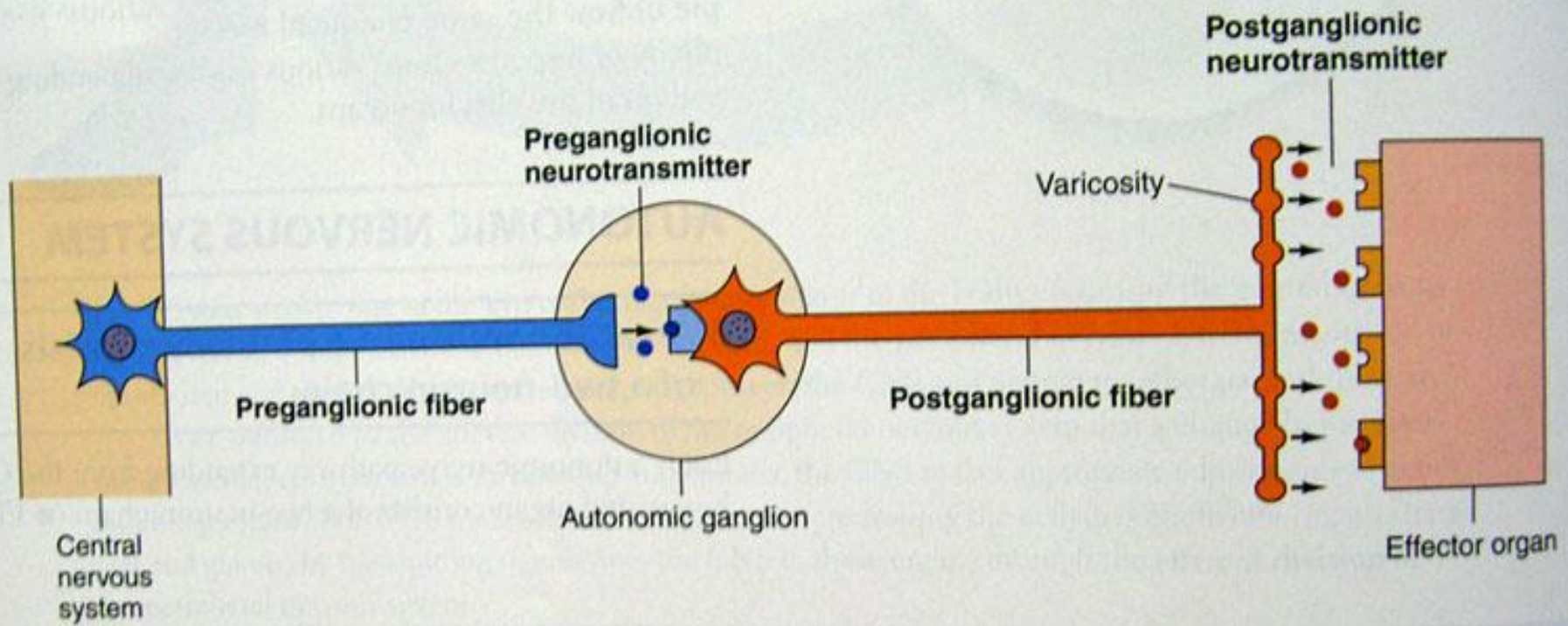
Sistem Parasimpatis

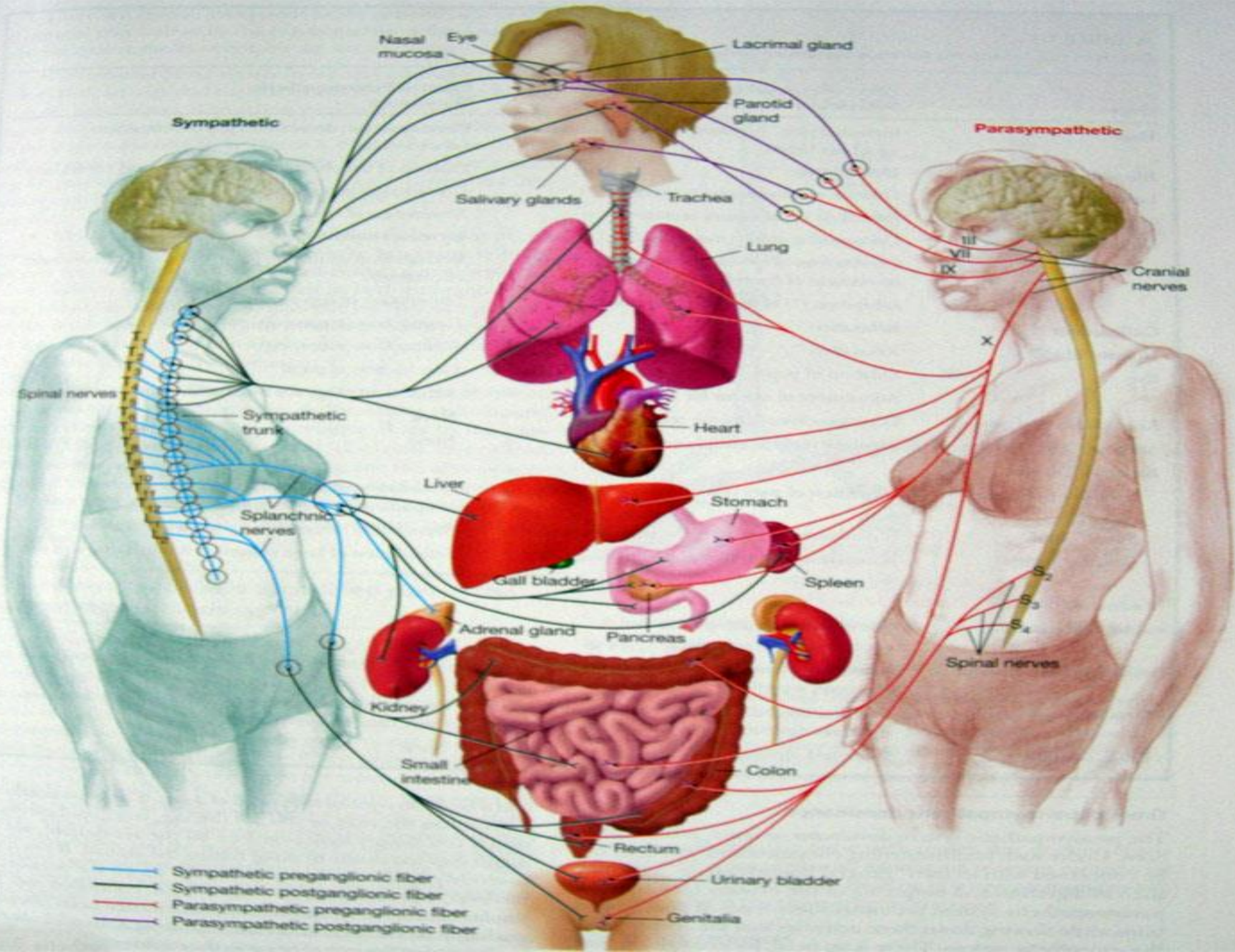
- Berasal dari :
 - Kraniosakral
 - N III, VII, IX, X
 - S2 – S4
- Serabut preganglion :
 - > Panjang
 - > Kolinergik

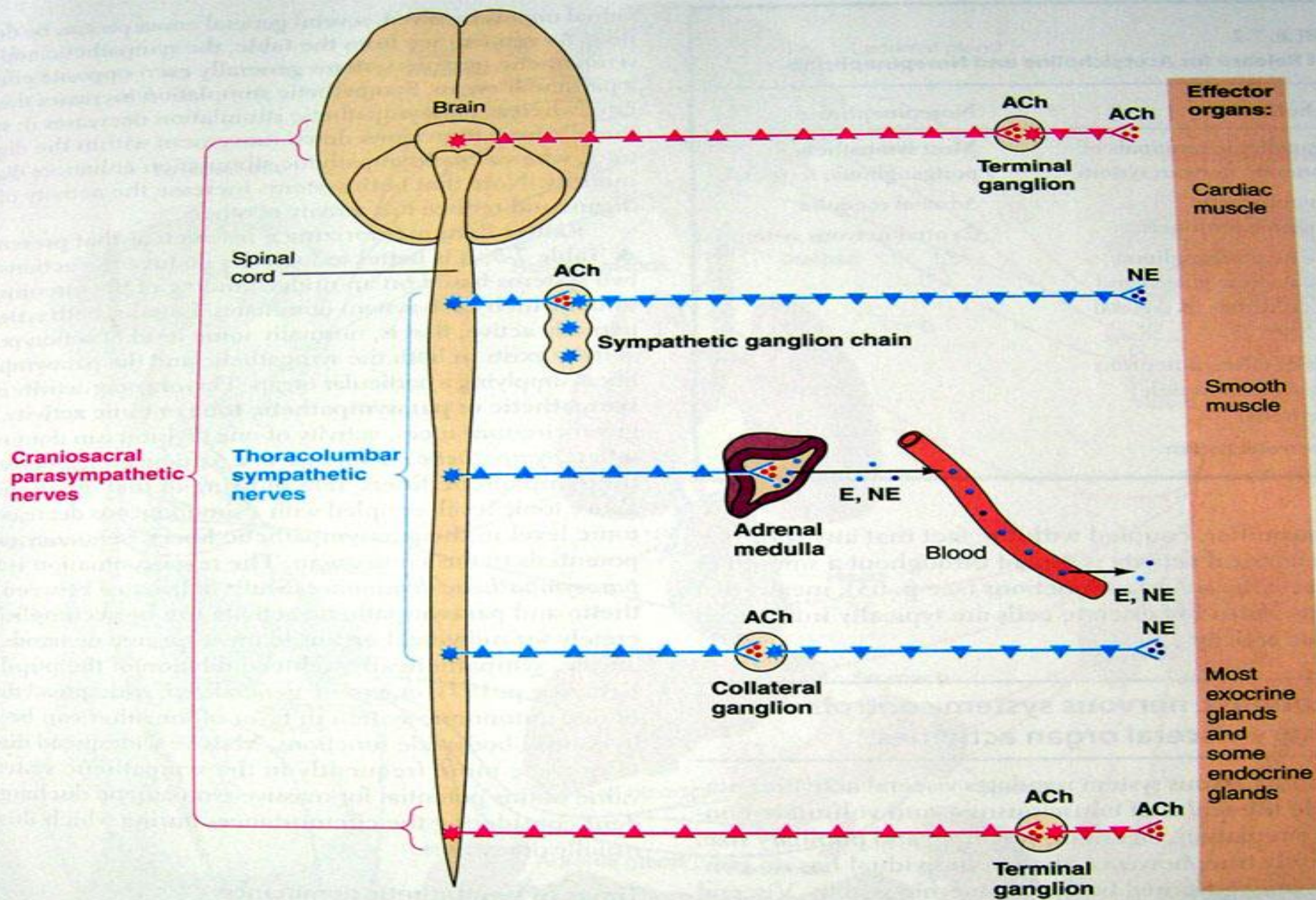
Sistem Parasimpatis

- ◉ Preganglion berakhir pada ganglion terminalis
- ◉ Serabut postganglionnya sangat pendek dan kolinergik
- ◉ Responnya jarang melibatkan daerah yang luas









— = Sympathetic system
 — = Parasympathetic system

★ = Preganglionic fiber
 ▲ = Postganglionic fiber

ACh • = Acetylcholine
 NE • = Norepinephrine
 E • = Epinephrine

★ = Cell body
 ★ = Cell body
 — = Axon

▲ **TABLE 7-4**

Location of Nicotinic and Muscarinic Cholinergic Receptors

Type of Receptor	Site of Receptor	Respond to Acetylcholine Released from:
Nicotinic Receptors	All autonomic ganglia	Sympathetic and parasympathetic preganglionic fibers
	Motor end plates of skeletal muscle fibers	Motor neurons
	Some CNS cell bodies and dendrites	Some CNS presynaptic terminals
Muscarinic Receptors	Effector cells (cardiac muscle, smooth muscle, glands)	Parasympathetic postganglionic fibers
	Some CNS cell bodies and dendrites	Some CNS presynaptic terminals

Location & Effects of stimulation of adrenergic receptors

◉ Alpha 1 :

- > Arterioles & veins : constriction (epi & norepinephrine)
- > Glands : decreased secretion
- > Eye : constriction of radial muscle
- > Intestine : decreased motility

Location & Effects of stimulation of adrenergic receptors

◉ Alpha 2 :

- > CNS postsynaptic terminals :
decreased of sympathetic outflow
from brain
- > CNS presynaptic terminals :
norepinephrine release
- > Beta islet cells of pancreas :
decreased secretion

Location & Effects of stimulation of adrenergic receptors

◉ Beta 1 :

> Heart :

- Increased heart rate
- Increased contractility
- Increased conduction velocity
- Increased automaticity

> Kidney :

- Increased renin secretion

Location & Effects of stimulation of adrenergic receptors

● Beta 2 :

- > Trachea & bronchioles : dilatation
- > Pregnant / non pregnant uterus : relaxation
- > Arterioles (no Beta 2 receptors in skin or brain) : dilatation (epinephrine)

AKTIFITAS SSO

- Sistem simpatis dan parasimpatis secara terus menerus memberikan signal ke target organ



Tonus Simpatis / Parasimpatis

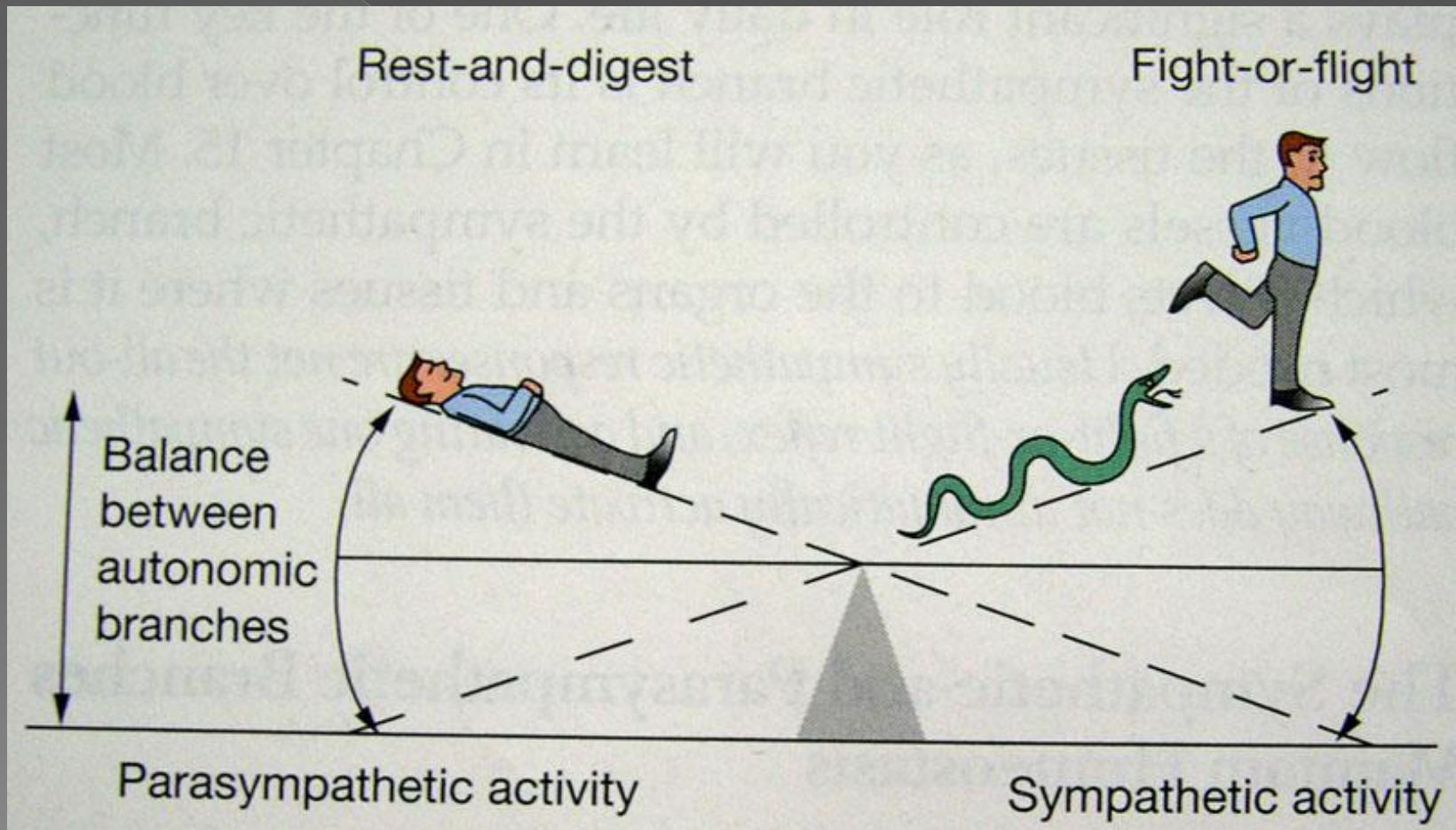
AKTIFITAS SSO

- Sebagian besar organ mendapat persarafan ganda (*dual innervation*) dari sistem simpatik dan parasimpatik

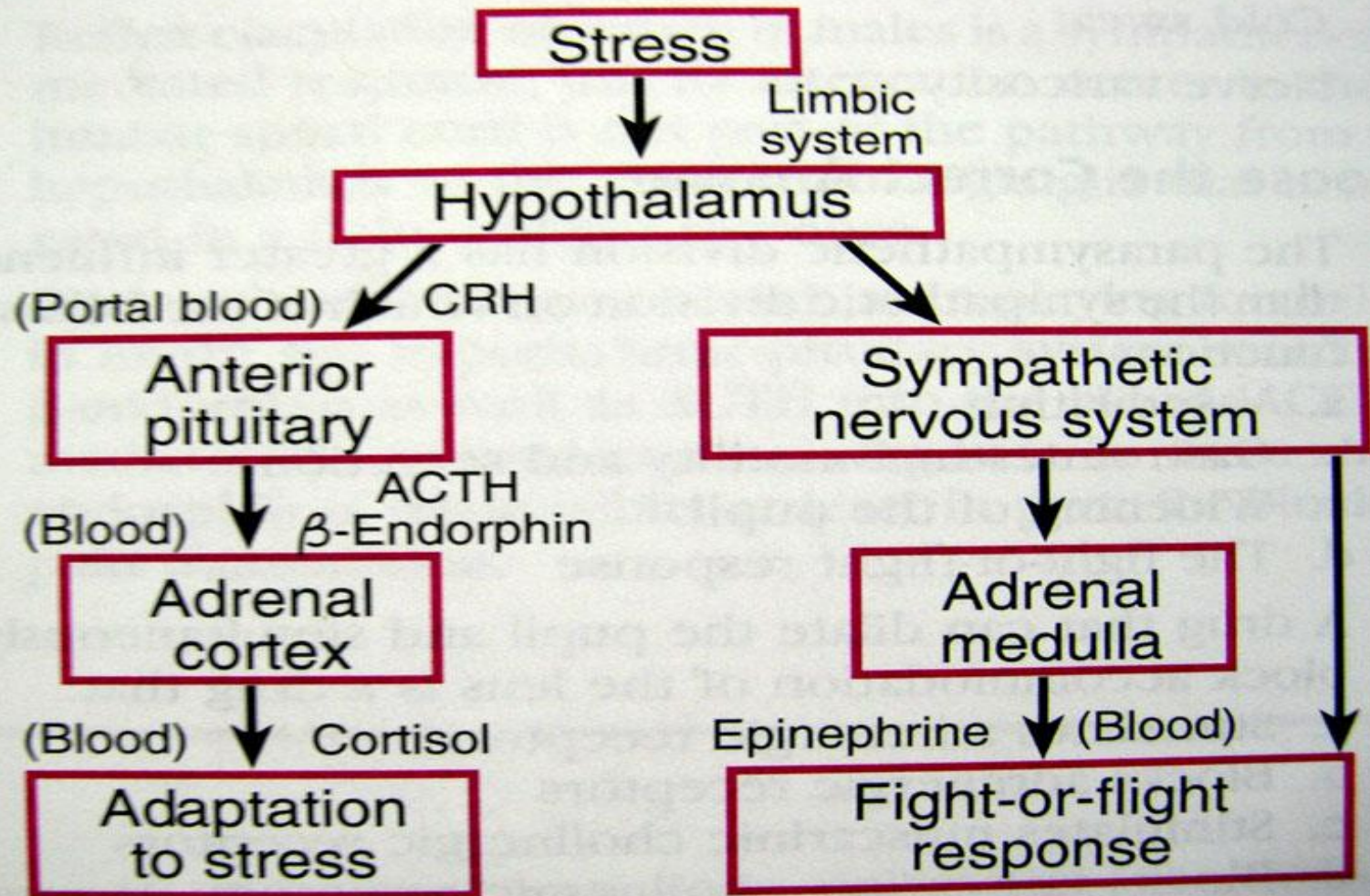
ORGAN	TYPE OF SYMPATHETIC RECEPTOR	EFFECT OF SYMPATHETIC STIMULATION	EFFECT OF PARASYMPATHETIC STIMULATION
<i>Heart</i>	β_1	Increased rate, increased force of contraction (of whole heart)	Decreased rate, decreased force of contraction (of atria only)
<i>Blood vessels</i>	α (most organs)	Constriction	Dilation of vessels supplying the penis and clitoris only
	β_2 (heart and skeletal-muscle vessels)	Dilation	
	*Cholinergic (skeletal-muscle vessels)	Dilation	
<i>Lungs</i>	β_2 (airways)	Dilation of bronchioles (airways)	Constriction of bronchioles
	? (gland cells)	Inhibition (?) of mucus secretion	Stimulation of mucus secretion
<i>Digestive tract</i>	α, β_2 (organs)	Decreased motility (movement)	Increased motility
	α (sphincters)	Contraction of sphincters (to prevent forward movement of contents)	Relaxation of sphincters (to permit forward movement of contents)
	? (gland cells)	Inhibition (?) of digestive secretions	Stimulation of digestive secretions
<i>Gallbladder</i>	?	Relaxation	Contraction (emptying)
<i>Urinary bladder</i>	β_2	Relaxation	Contraction (emptying)
<i>Eye</i>	α (iris)	Dilation of pupil	Constriction of pupil
	β_2 (ciliary muscle)	Adjustment of eye for far vision	Adjustment of eye for near vision
<i>Liver (glycogen stores)</i>	β_2	Glycogenolysis (glucose released)	None
<i>Adipose cells (fat stores)</i>	β_2	Lipolysis (fatty acids released)	None

ORGAN	TYPE OF SYMPATHETIC RECEPTOR	EFFECT OF SYMPATHETIC STIMULATION	EFFECT OF PARASYMPATHETIC STIMULATION
Exocrine glands			
Exocrine pancreas	α	Inhibition of pancreatic exocrine secretion	Stimulation of pancreatic exocrine secretion (important for digestion)
Sweat glands	α , cholinergic	Stimulation of secretion by sweat glands	None
Salivary glands	α	Stimulation of small volume of thick saliva rich in mucus	Stimulation of large volume of watery saliva rich in enzymes
Endocrine glands			
Adrenal medulla	Cholinergic	Stimulation of epinephrine and norepinephrine secretion	None
Endocrine pancreas	α	Inhibition of insulin secretion; stimulation of glucagon secretion	Stimulation of insulin and glucagon secretion
Genitals	α	Ejaculation and orgasmic contractions (males); orgasmic contractions (females)	Erection (caused by dilation of blood vessels in penis [male] and clitoris [female])
Brain activity	?	Increased alertness	None

GAMBAR KESEIMBANGAN SSO



STRESS RESPONSE



ALARM REACTION

- ⦿ Peningkatan tekanan arteri
- ⦿ Aliran darah :
 - otot : meningkat
 - organ : menurun
- ⦿ Peningkatan metabolisme tubuh
- ⦿ Kadar gula darah meningkat
- ⦿ Glikolisis meningkat
- ⦿ Kekuatan otot meningkat
- ⦿ Aktivitas mental / kewaspadaan meningkat

REFLEKS OTONOM

- ◉ Refleks otonom KV
 - > Baroreceptor reflex
- ◉ Refleks otonom GI
 - > Refleks defekasi
- ◉ Refleks otonom sistem perkemihan
 - > Refleks miksi

PENGARUH OBAT TERHADAP SSO

○ Obat pada efektor adrenergik / noradrenergik :

- Epinefrin
- Metoksamin
- Fenilefrin
- Isoproterenol
- Albuterol
- Efedrin
- Tiramin
- Amfetamin

PENGARUH OBAT TERHADAP SSO

- Obat yang menghambat aktivitas adrenergik / noradrenergik :
 - Reserpin
 - Guanetidin
 - Fenoksibenzamin
 - Fentolamin
 - Propanolol
 - Metaprolol

PENGARUH OBAT TERHADAP SSO

○ Obat pada efektor kolinergik :

- Pilocarpin
- Metakolin
- Neostigmin
- Piridostigmin
- Ambenonium

PENGARUH OBAT TERHADAP SSO

- Obat yang menghambat aktivitas kolinergik :
 - Atropin dan obat sejenisnya

THANK YOU

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Medical Faculty of Trisakti University
Jakarta