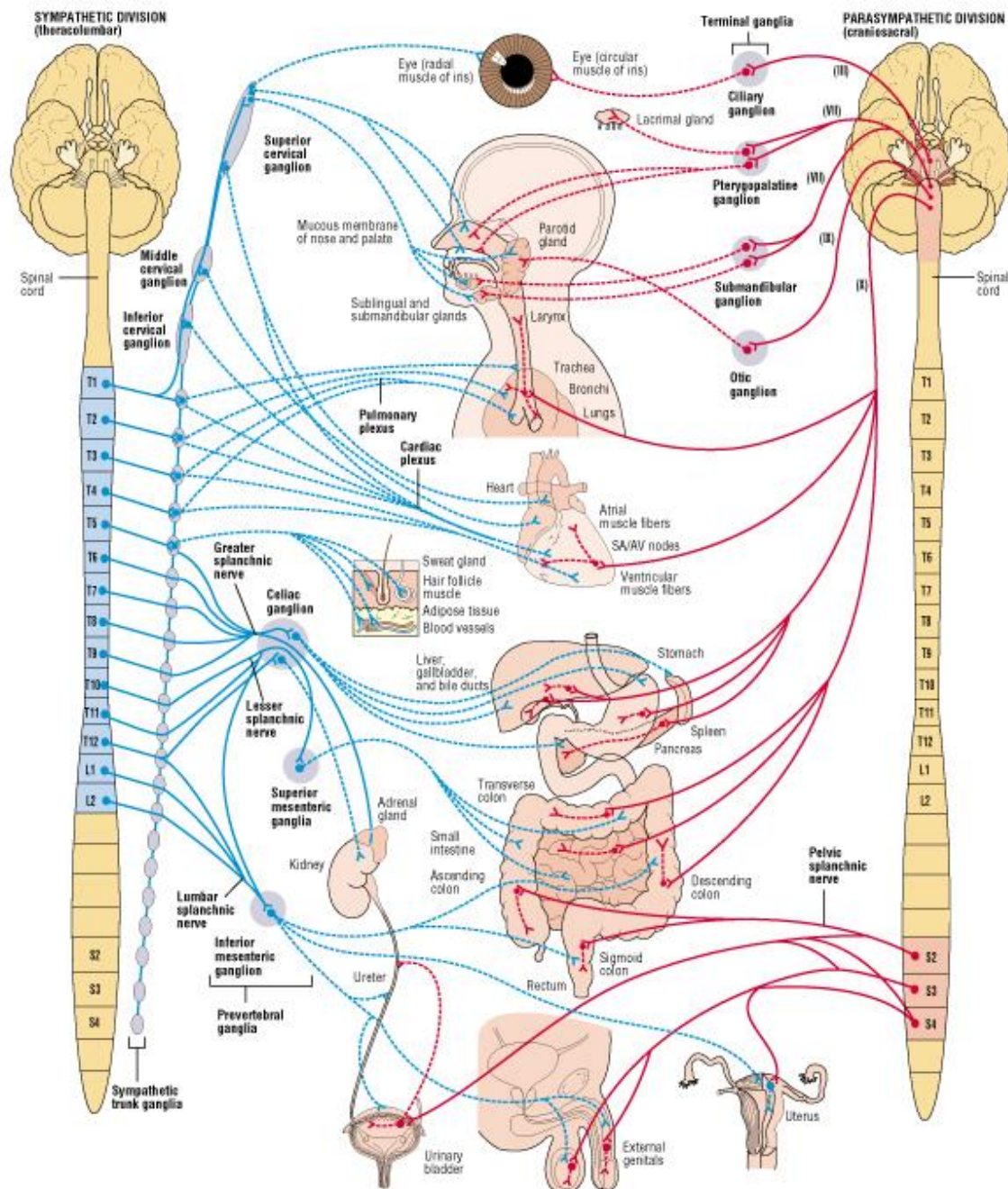


Autonomic Nervous System

Autonomic Nervous System

Ref: **Textbook of Medical Physiology**, Guyton, 14th Ed.:763-773, 13th ed.: 773-784. 12th ed: 729-738, and 11th ed. P748-760.

Fig.17.02



General functions

Control and Adaptation of body systems to
internal and/or external changes

Example of adaptation to external stimuli

Fight and Flight Reaction

- Increase heart rate and force of contraction.
- Widely dilated pupils.
- Pallor (pale of fear) as blood is directed to the skeletal muscle.
- Goose pimples.
- Cold sweat.
- Dry mouth.

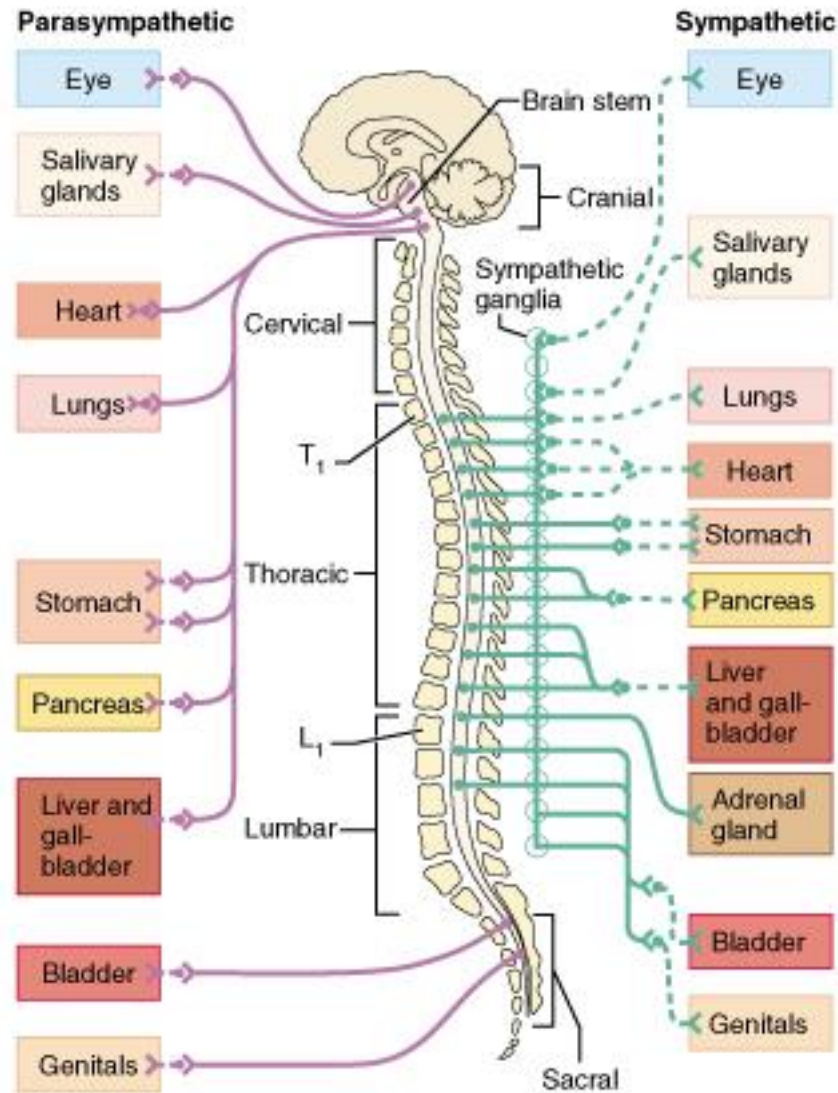
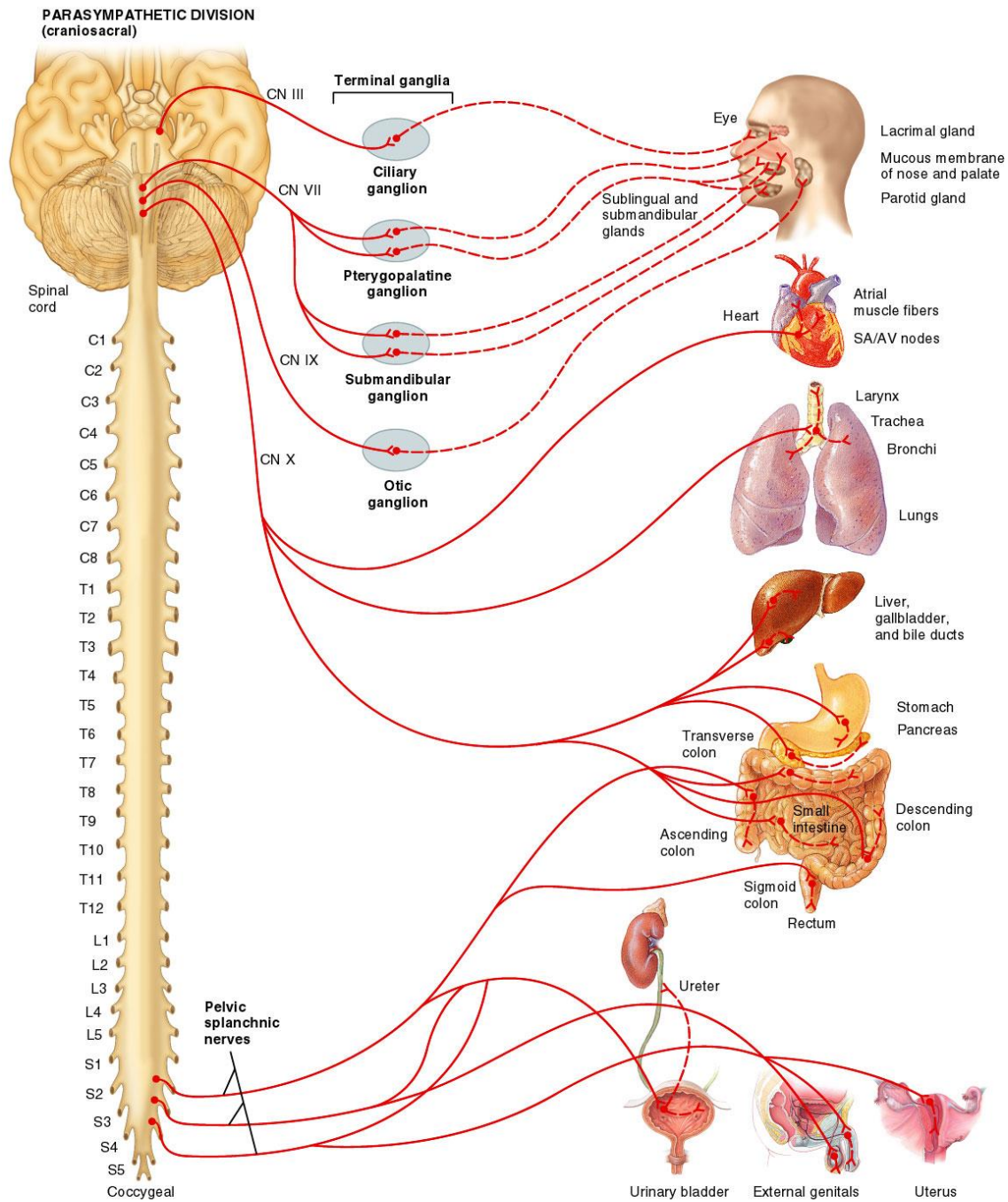


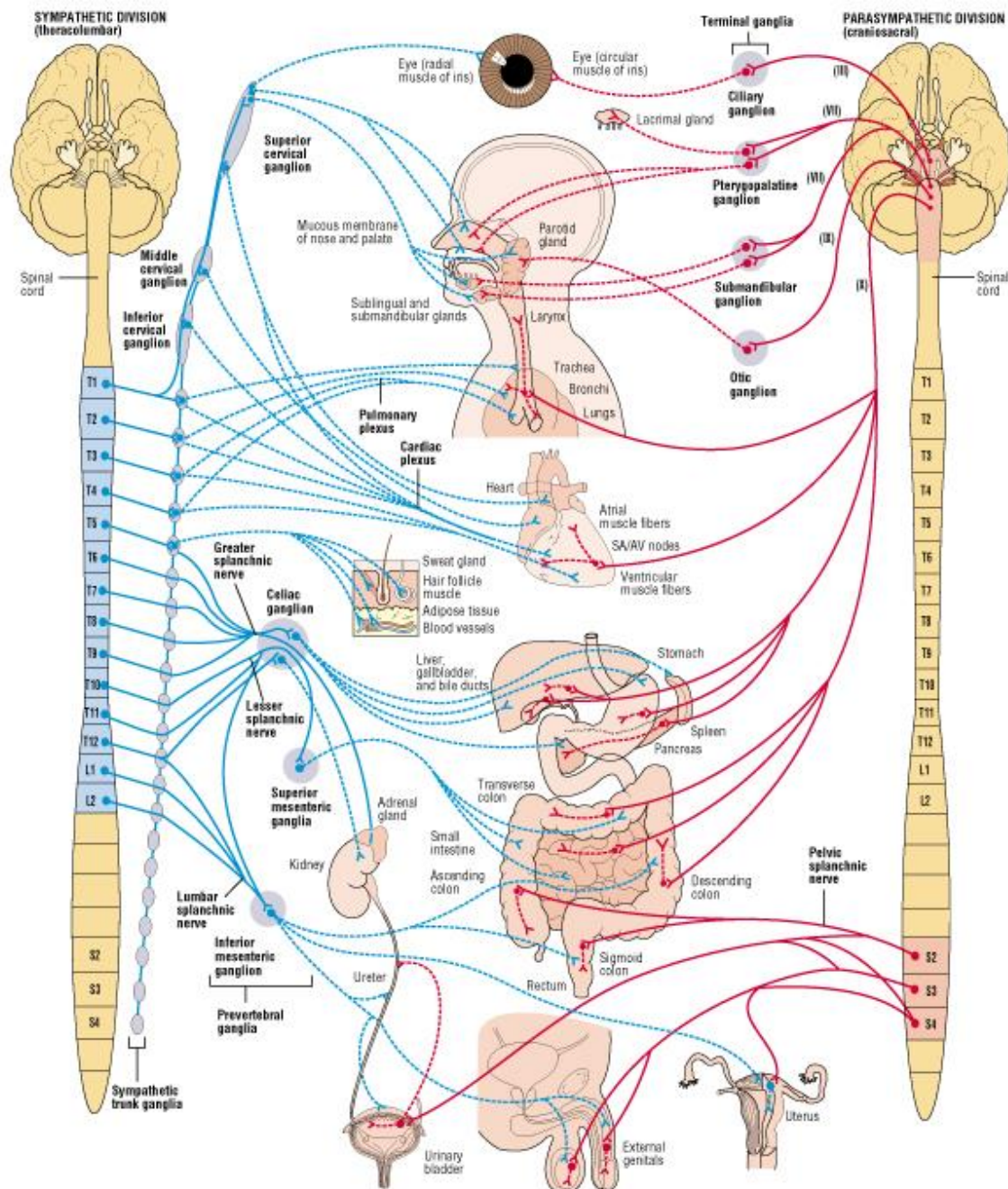
Fig. 17.03



ANS characteristics

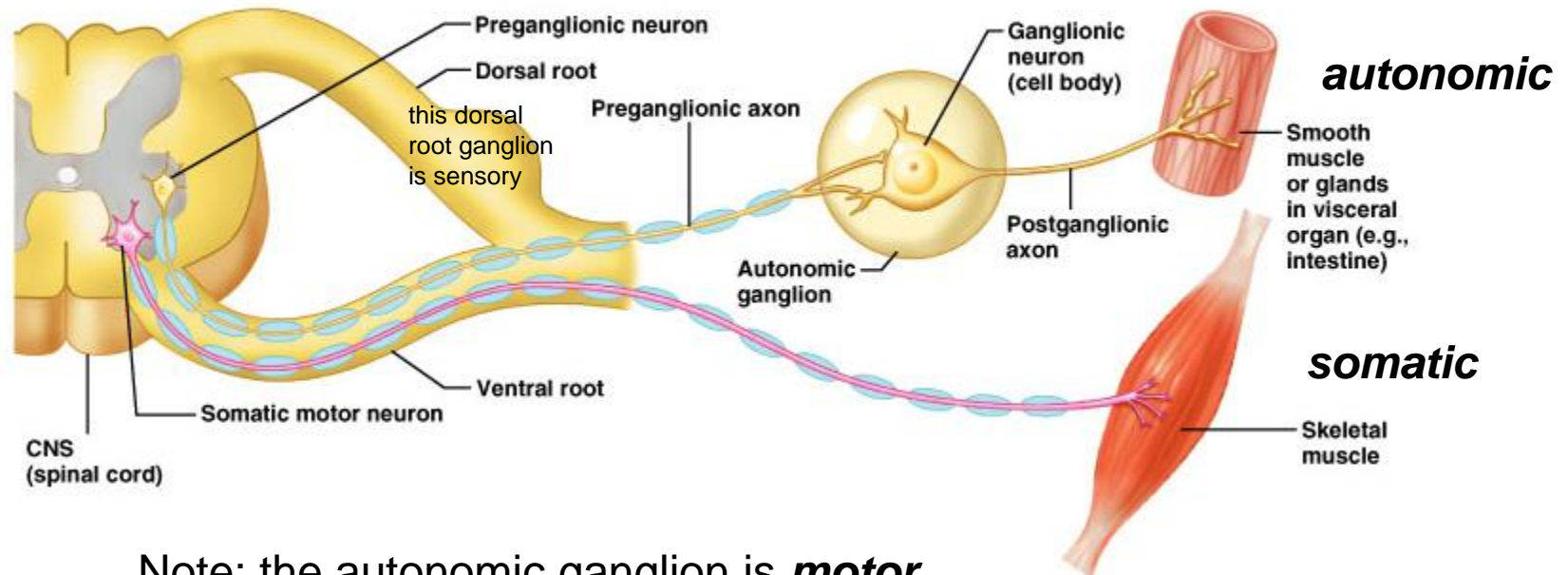
Anatomical characteristics and
Synaptic organization of ANS

Fig.17.02



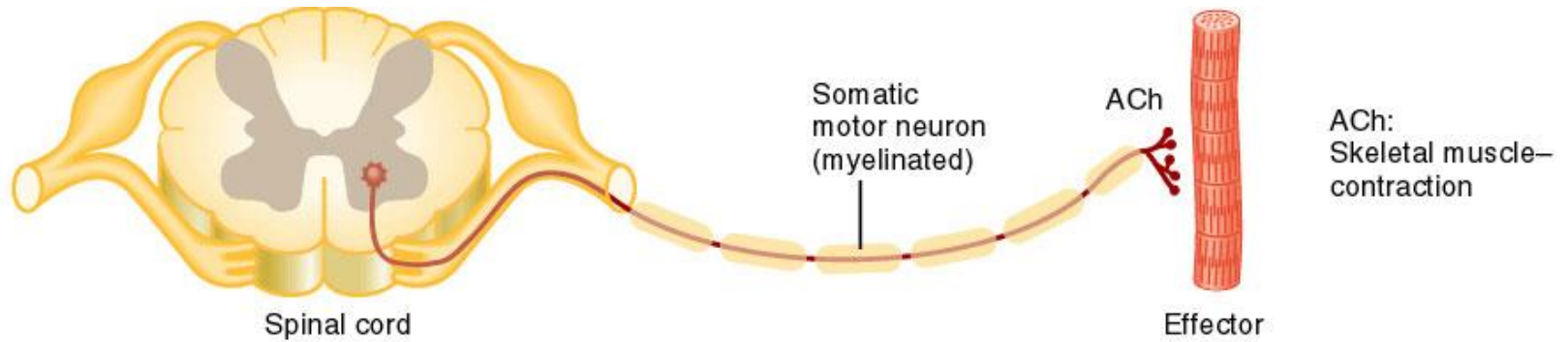
- Axon of 1st (*preganglionic*) neuron leaves CNS to synapse with the 2nd (*ganglionic*) neuron
- Axon of 2nd (*ganglionic*) neuron extends to the organ it serves

Diagram contrasts somatic (lower) and autonomic:

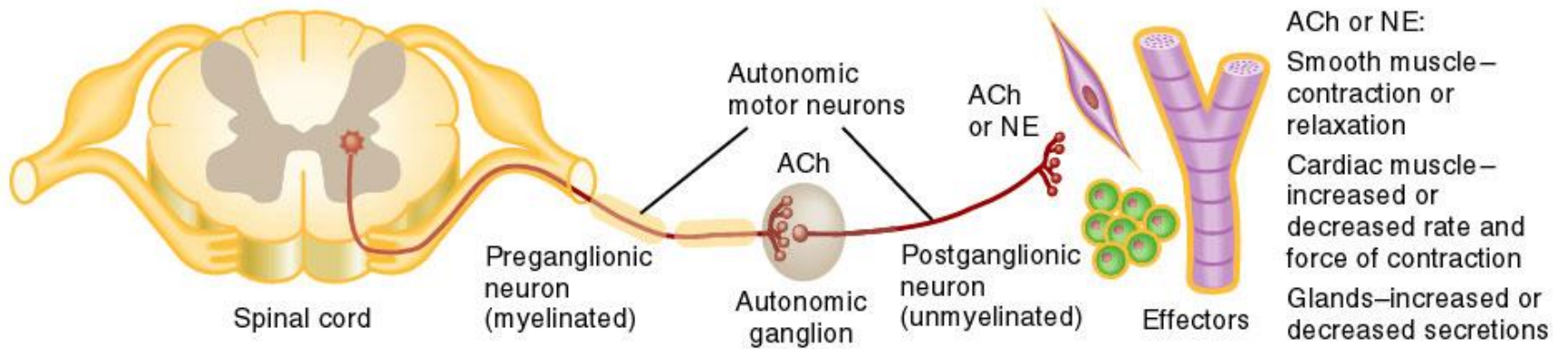


Note: the autonomic ganglion is *motor*

Fig.17.01



(a) Somatic nervous system



(b) Autonomic nervous system

Synaptic organization of ANS

Convergence and Divergence in Sympathetic division

Fig. 17.05

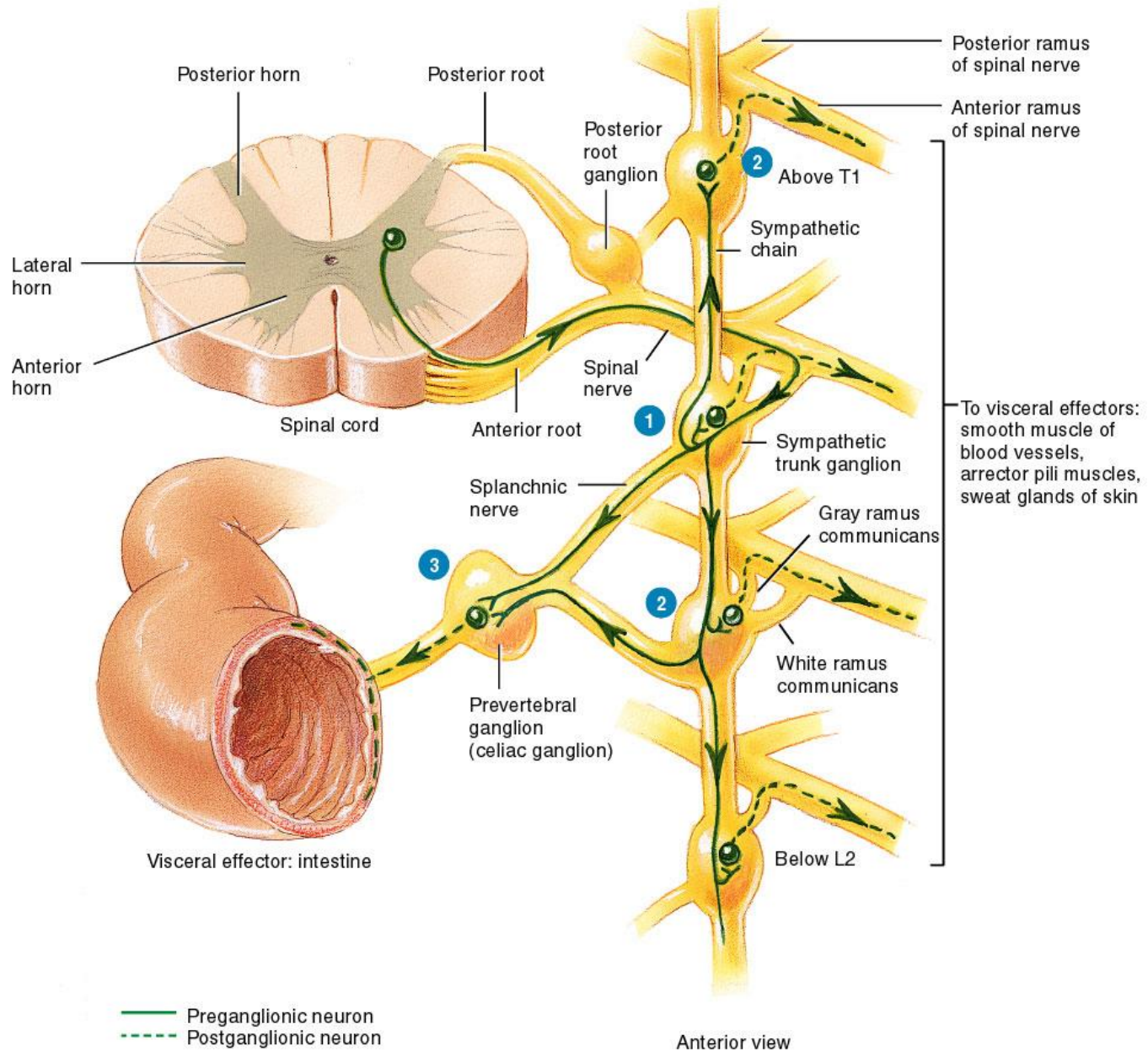
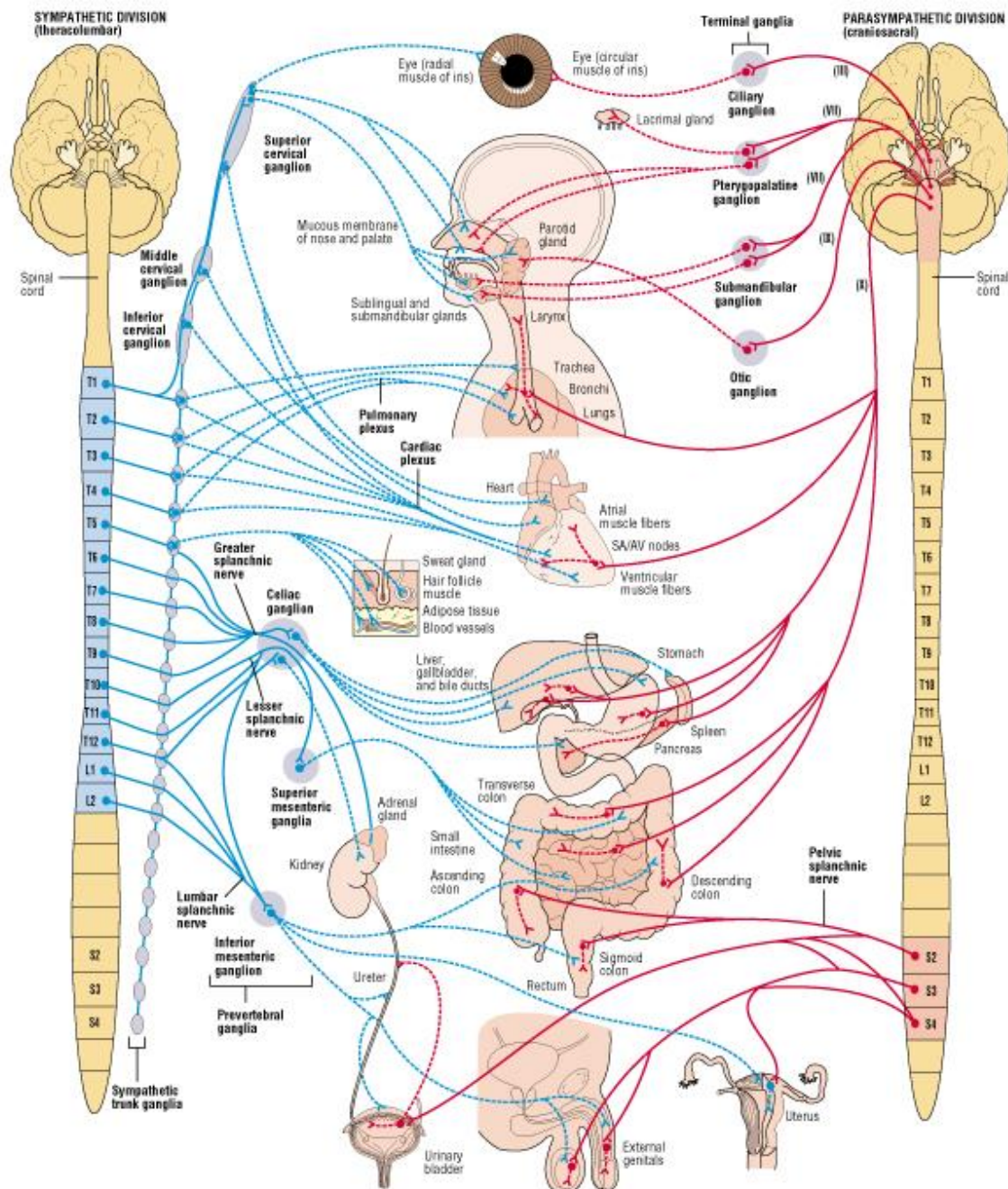
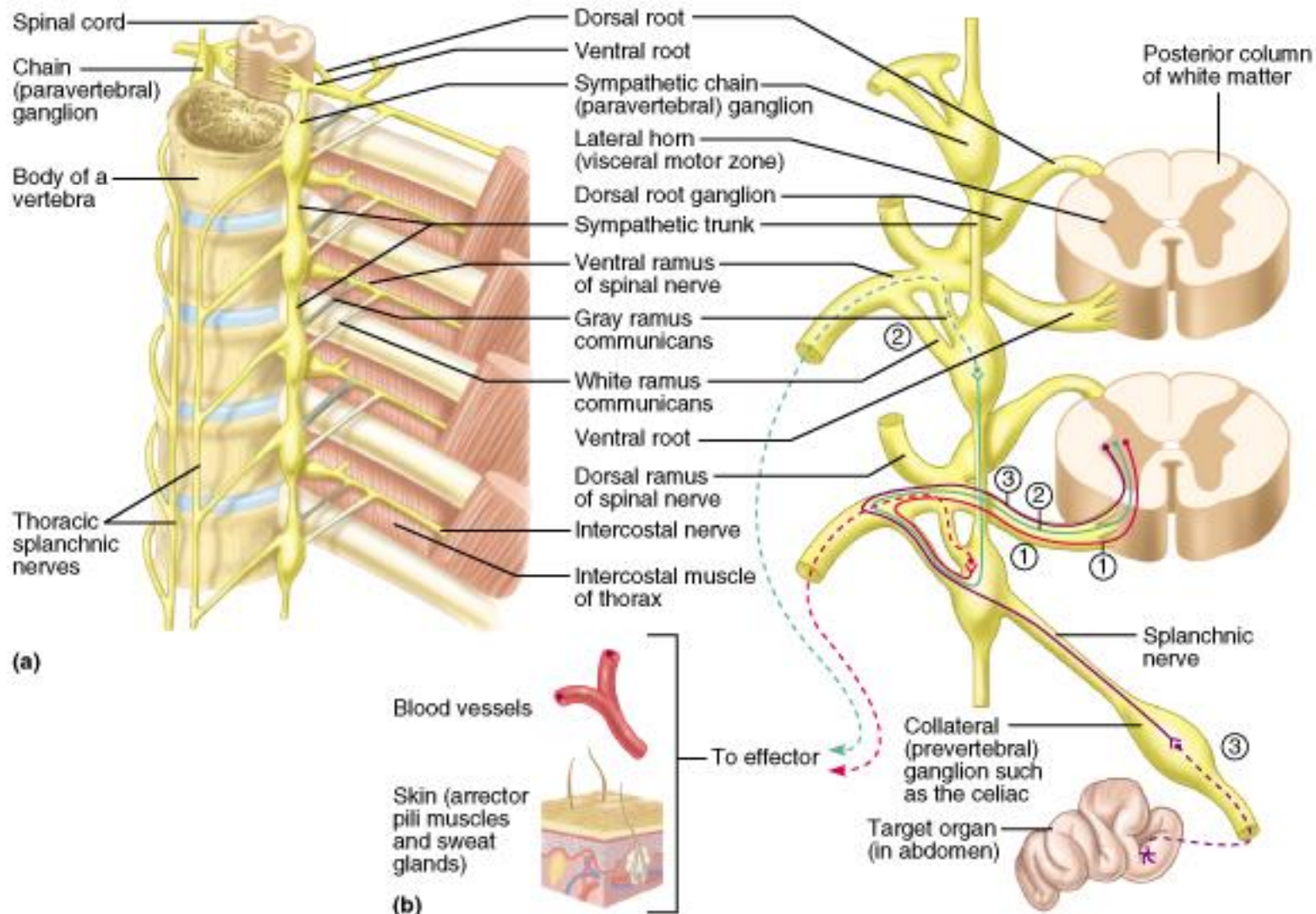


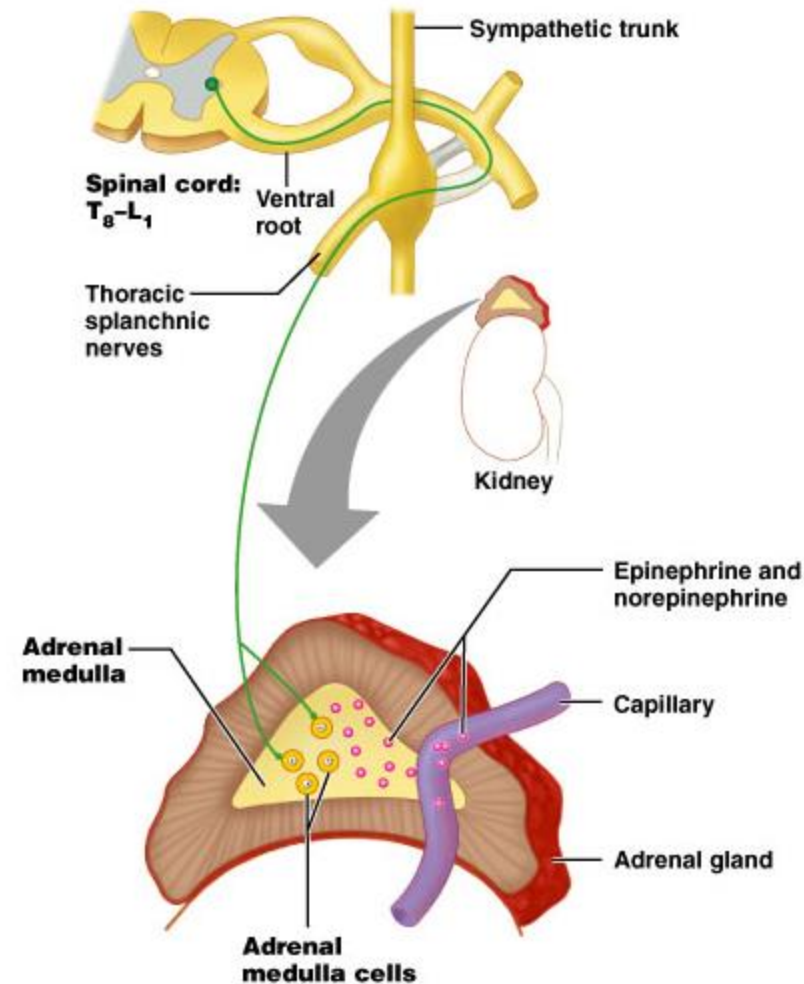
Fig.17.02





Adrenal gland is exception

- Synapse in gland
- Can cause body-wide release of epinephrine



Physiological characteristics of ANS

- High speed of onset:
- Automatic nature:
- Tonic activity:

Effects of **sympathetic** stimulation

- **Blood pressure** (blood vessels supplying skeletal muscle are major players). In addition to that the effect on heart also contributes in regulation of blood pressure.

- **Body temperature** by the sympathetic effects on cutaneous blood vessels and sweat glands.

Effects of **sympathetic** stimulation

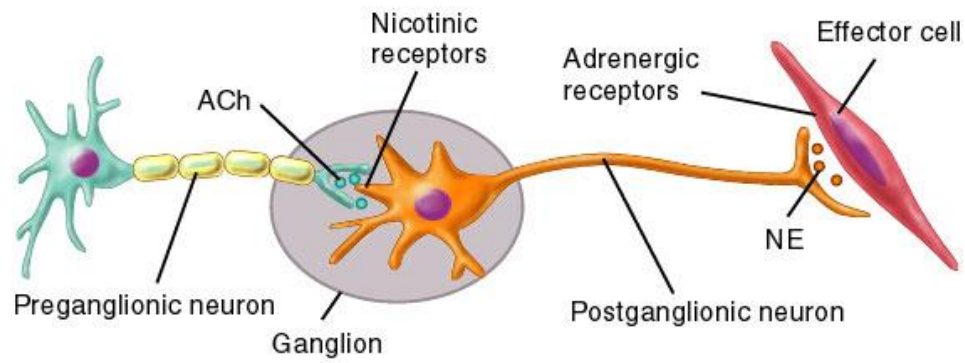
- **Cardiovascular system**: effects on vessels will result in redistribution of blood by enhancing blood flow to skeletal muscle and reducing blood flow to skin and mesentery.
- **Effects on heart**: increasing cardiac output (volume of blood pumped per minute).
- **Respiratory system**: causes relaxation of bronchial muscle which result in bronchodilation.
- **Digestive system**: inhibition of motility and secretion.
- **Metabolic effects**:
 - * Mobilization of glucose.
 - * Increased lipolysis.
 - * Increased metabolic rate.

Effects of **parasympathetic** stimulation

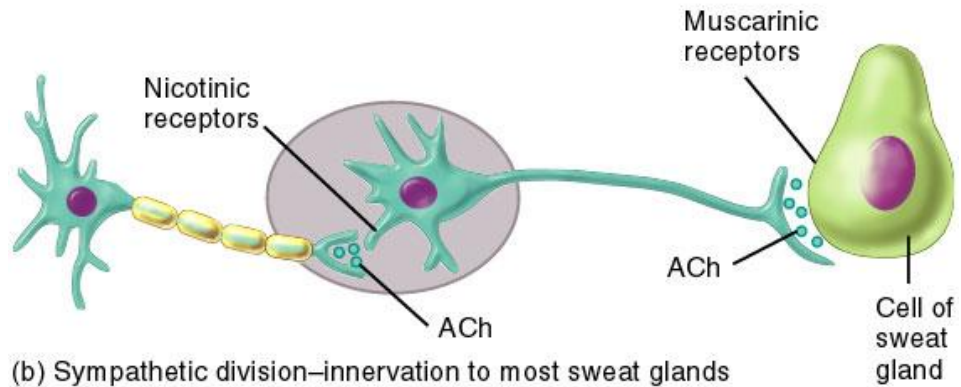
- **Gastrointestinal system**: increases motility and secretory activity.
- **Glands**: increases secretory activity (but remember sweat glands are under sympathetic control).
- **Heart**: decrease rate of contraction (bradycardia).
- **Pupil**: control pupil diameter by papillary light reflex (myosis) (regulates the amount of light falling on retina).
- Accommodation of the **lens** for near vision.
- Voiding the **urinary bladder** (micturation).

**MOLECULAR BASIS OF
PHYSIOLOGICAL ACTIONS OF
THE ANS**

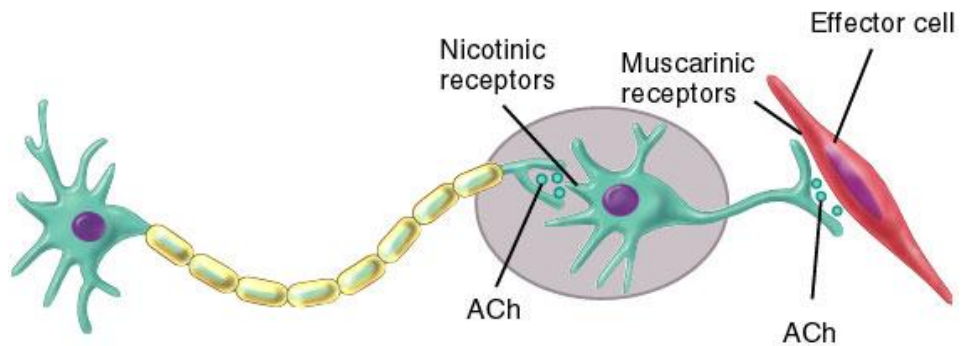
Fig. 17.06



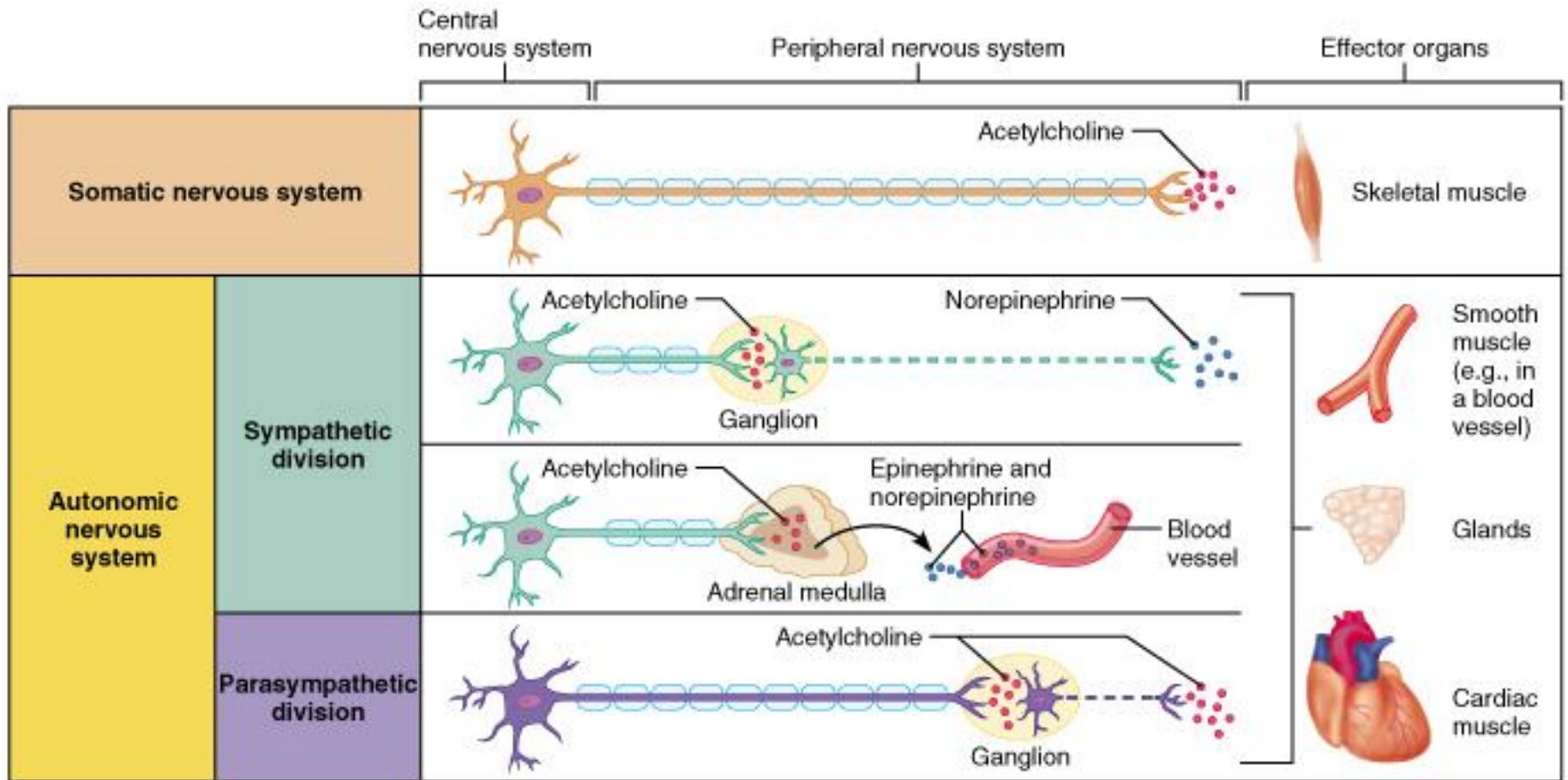
(a) Sympathetic division—innervation to most effector tissues








(b) Sympathetic division—innervation to most sweat glands



(c) Parasympathetic division



Key:

 = Preganglionic axons (sympathetic)
  = Postganglionic axons (sympathetic)
  = Myelination
  = Preganglionic axons (parasympathetic)
  = Postganglionic axons (parasympathetic)

– Neurotransmitters

- At ganglion: preganglionic neurons of both sympathetic and parasympathetic release **acetylcholine (Ach)**.
- Effector organs:
 - parasympathetic fibers release **acetylcholine**
 - Sympathetic: **norepinephrine**.
- An exception for sympathetic nerves to sweat glands, which release **acetylcholine (Ach)**.

Receptors and Signal transduction mechanisms

-At ganglia: sympathetic and parasympathetic have nicotinic receptors at the post synaptic membrane

-on effector cells: Muscarinic receptors.

Receptors and Signal transduction mechanisms

Muscarinic Receptors (M1-M5)

Inhibitory:

-M2 in the heart: G protein \rightarrow K⁺ channel \rightarrow slow the rate of depolarization.

-Other inhibitory receptors:

Gi \rightarrow adenylyl Cyclase \rightarrow reduce cAMP

Receptors and Signal transduction mechanisms

Muscarinic Receptors (M1-M5)

Excitatory Receptors: (M1, M3, M5)

Found on **smooth muscle** and **glands** are coupled Gq protein → phospholipase C.

This enzyme increases production of inositol-1,4,5-trisphosphate (**IP3**)

Activation of Muscarinic Receptors

- Stimulation of secretory activity: salivation, tearing, sweating, nasal and bronchial secretion.
- Increase gastrointestinal tract motility → vomiting and diarrhea.
- Contraction of urinary bladder → urination.
- Slowing of the heart → Bradycardia.

Blocking of Muscarinic Receptors by ATROPIN

- Inhibition of glandular secretions → dry mouth, dry eyes, and dry nasal passages.
- Tachycardia. (increase heart rate).
- Loss of pupillary light reflex.
- Loss of ability to focus the lens for near vision.

Receptors and Signal transduction mechanisms

Adrenergic receptors:

These receptors respond to **catecholamines:** (epinephrine (EP) and norepinephrine (NE)).

Receptors and Signal transduction mechanisms

Alpha receptors:

- **The alpha 1 (α_1)**: Excitatory: PLC \rightarrow IP3

- **Alpha2** receptors: Nerve Adrenergic terminals \rightarrow reduce NE release

Alpha 2 Heteroreceptors: Nonadrenergic -

Gi \rightarrow Adenylyl cyclase \rightarrow decrease cAMP

Receptors and Signal transduction mechanisms

Beta receptors:

- **Beta 1 (β_1) receptors:** found on heart
- **Beta 2 (β_2) receptors:** found on tracheal and bronchial smooth muscle, in the gastrointestinal tract, and on smooth muscles of blood vessels supplying skeletal muscles
Gs \rightarrow Adenylyl cyclase \rightarrow increase cAMP

GOOD LUCK

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