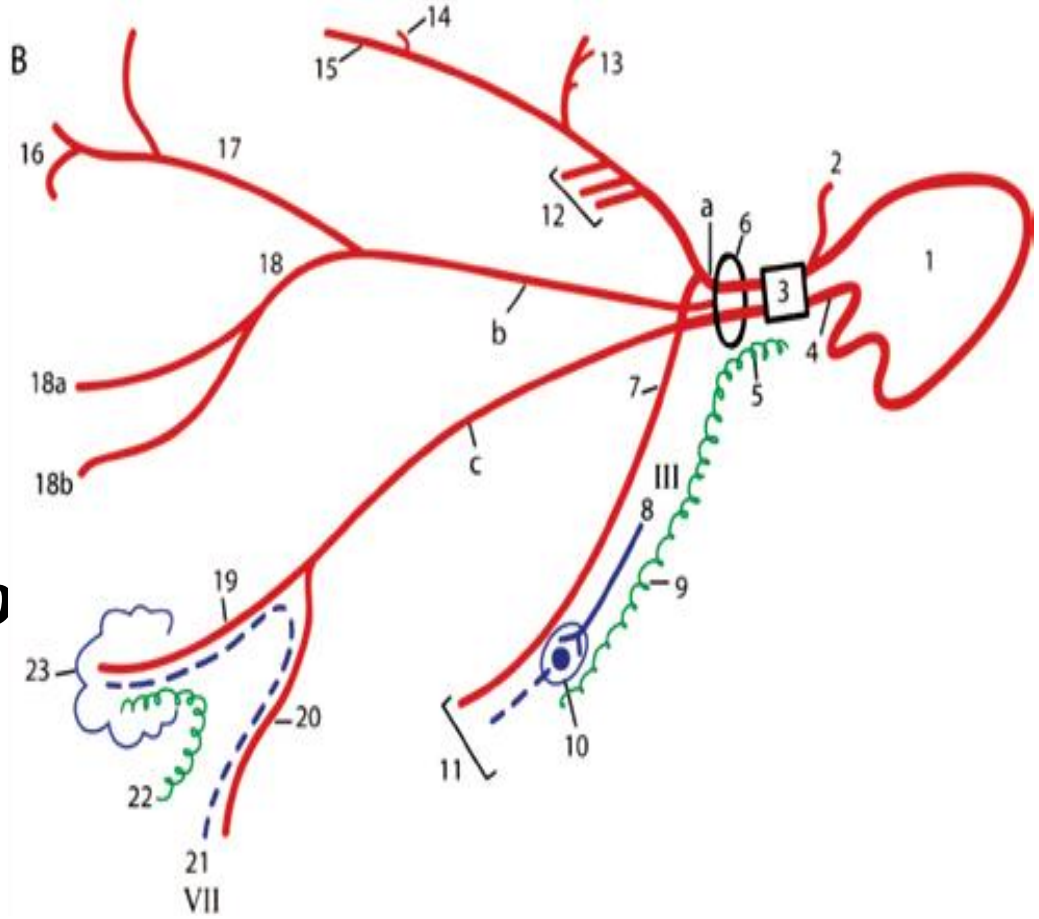
# NERVOUS SYSTEM

## (MORPHOFUNCTIONAL CLASSIFICATION )

| | VEGETATIVE (AUTONOMIC) | SOMATIC (ANIMAL) |
|---|---|---|
| *Functional differences* | | |
| Region of supply: | smooth muscles, glands | striated muscles |
| Action : | slow | fast |
| Duration: | permanent | during the action of excitant |
| Functions: | metabolism, growth, homeostasis | motion |
| *Structural differences* | | |
| | *has not segmental structure<br>*ascending part does not form visible nerves<br>*vegetative nerves form plexuses around blood vessels | *has segmental structure<br>*ascending & descending fibers form visible nerves |

# Common principles of nerve-supply of different organs

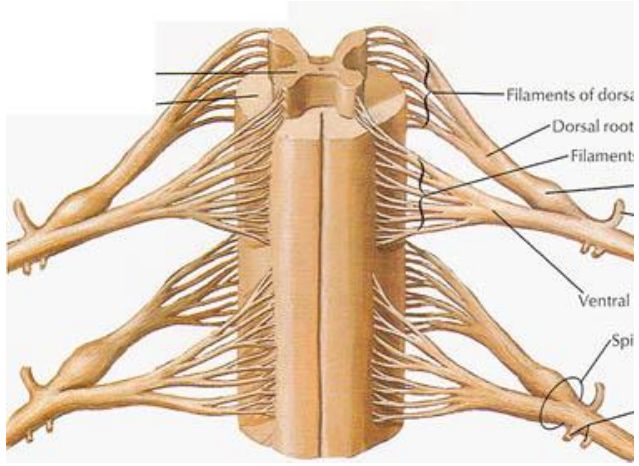
1. **The skin and mucous** membrane get *afferent sensory nervous fibers and efferent vegetative* (to its glands and vessels)
2. **The striated muscles** need *efferent motor somatic fibers and efferent vegetative* (to the blood vessels)
3. **The smooth muscles** get *efferent moto vegetative fibers*
4. The lacrimal, mucous and salivary **glands** have *sensory and efferent vegetative innervation*




*Scheme of the ophthalmic nerve*

# General characteristics of the somatic and vegetative nerves

## Functional components of the spinal nerves




**All spinal nerves are mixed: they contain ascending sensory, descending motor fibers.**

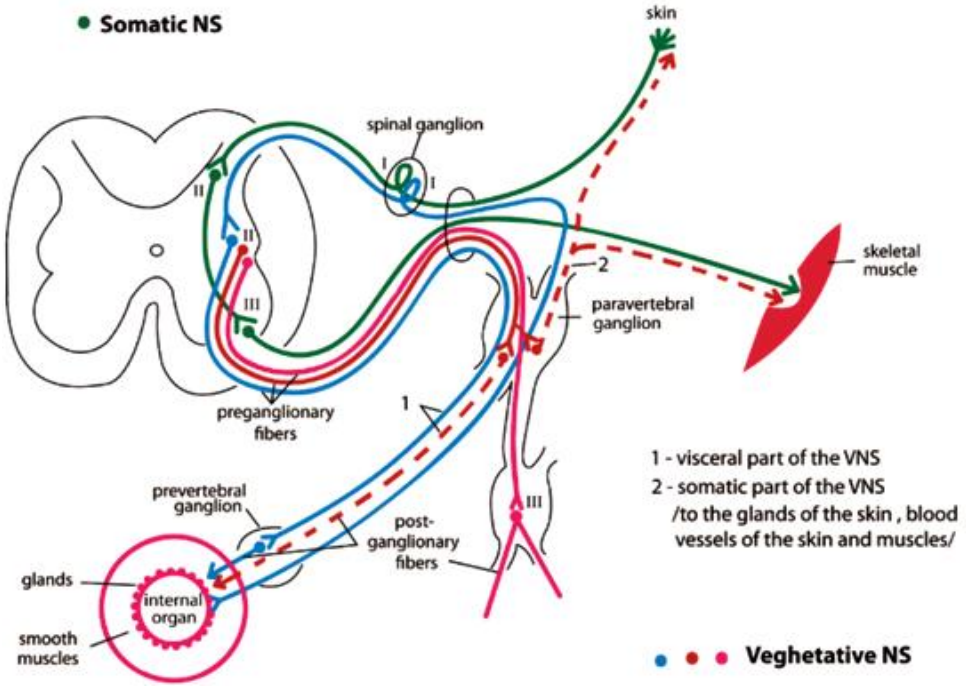
**Anterior roots of some spinal nerves contain vegetative fibers: C8, Th 1-12, L1-2 (sympathetic), S2-4 (parasympathetic)**

## Functional components of the cranial nerves

**Some of the cranial nerves are exclusively or largely afferent (I, II, and VIII), others are largely efferent (III, IV, VI, XI, and XII), and still others are mixed, that is, contain both afferent and efferent fibers (V, VII, IX, and X).**

**The efferent fibers of the cranial nerves arise within the brain from groups of nerve cells termed *motor nuclei*.**

**The afferent fibers arise outside the brain from groups of nerve cells, generally in a *sensory ganglion* along the course of the nerve. The central processes of these nerve cells then enter the brain, where they end in groups of nerve cells termed *sensory nuclei*.**

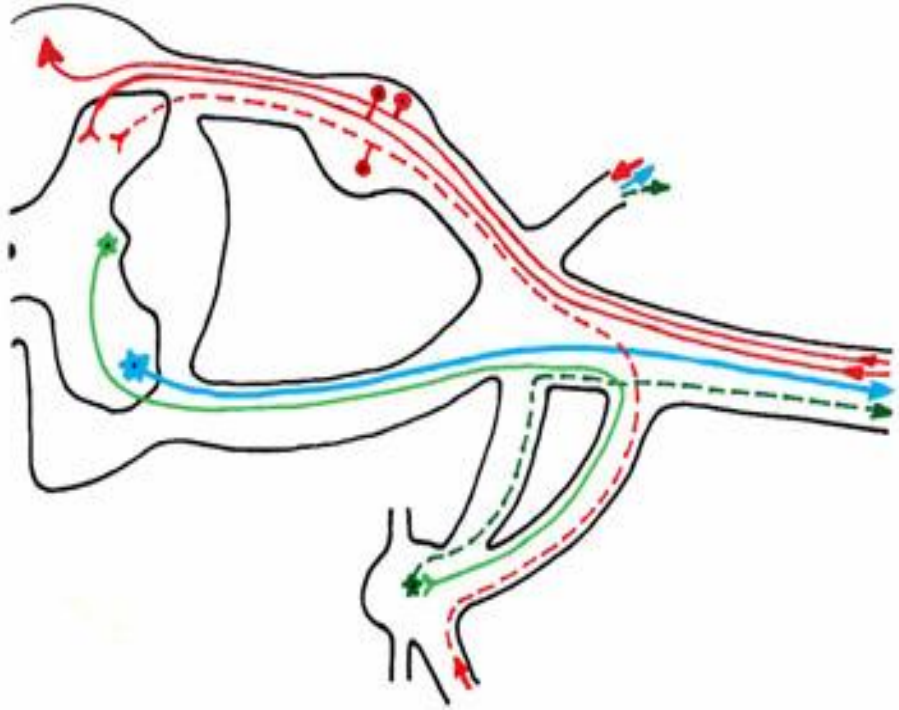


# Fibers in peripheral nerves

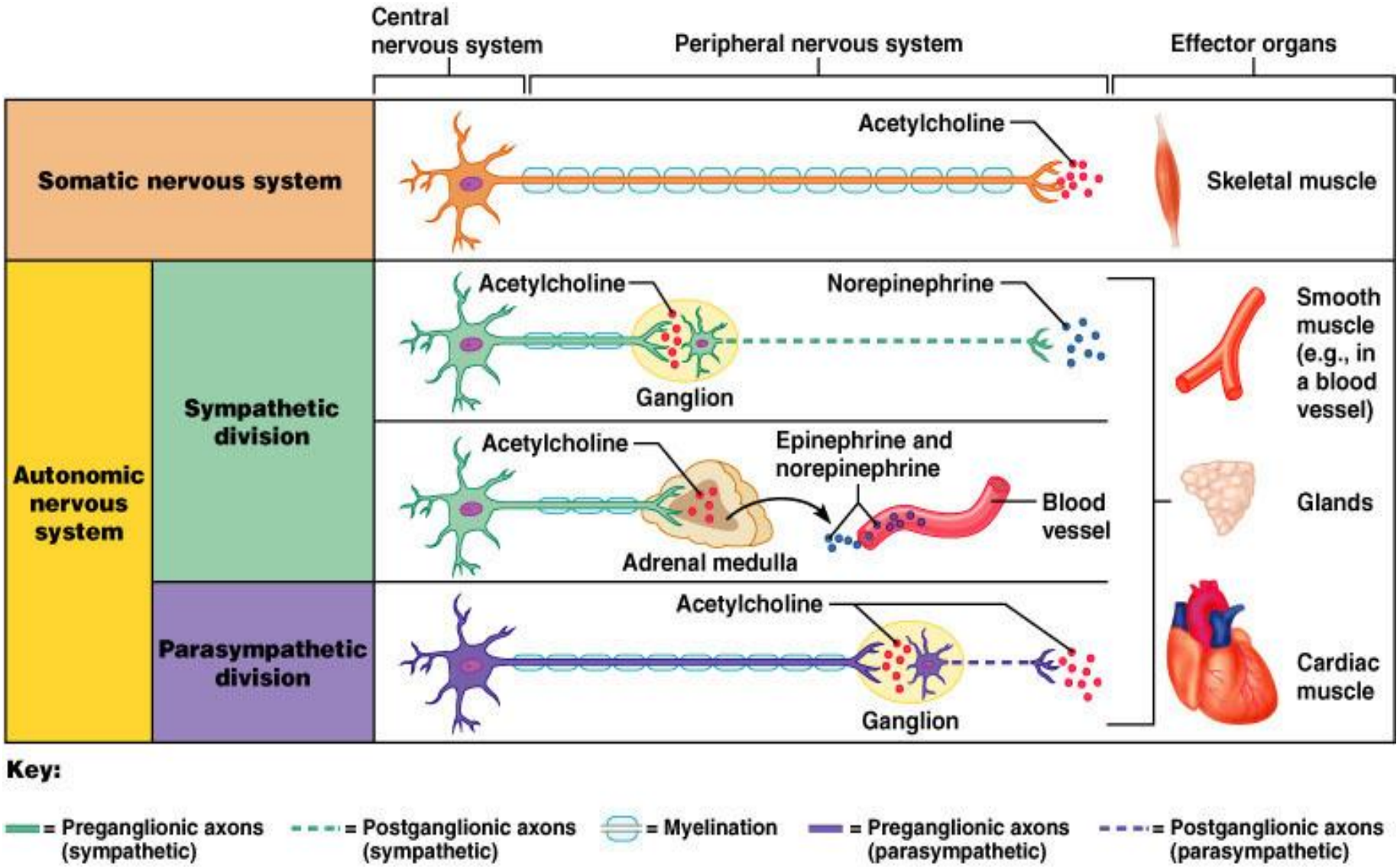
- **Spinal nerves**
- **Cranial nerves**

**Both groups of nerves contain afferent and efferent fibers**

- ***Afferent***
  - ***- Somatic sensitivity fibers***
  - ***- Viscerosensitivity fibers***
- ***Efferent***
  - ***- Somatic motor fibers***
  - ***- Autonomous (motor) fibers***



# Comparison of Somatic and Autonomic Systems



## White Rami

Connecting the spinal nerves to each sympathetic trunk are rami communicantes.

Preganglionic axons are myelinated.

The white ramus has a whitish appearance

Carry preganglionic sympathetic axons from the C8–L2 spinal nerves to the sympathetic trunk.

Associated only with the C8–L2 spinal nerves.

## Gray Rami

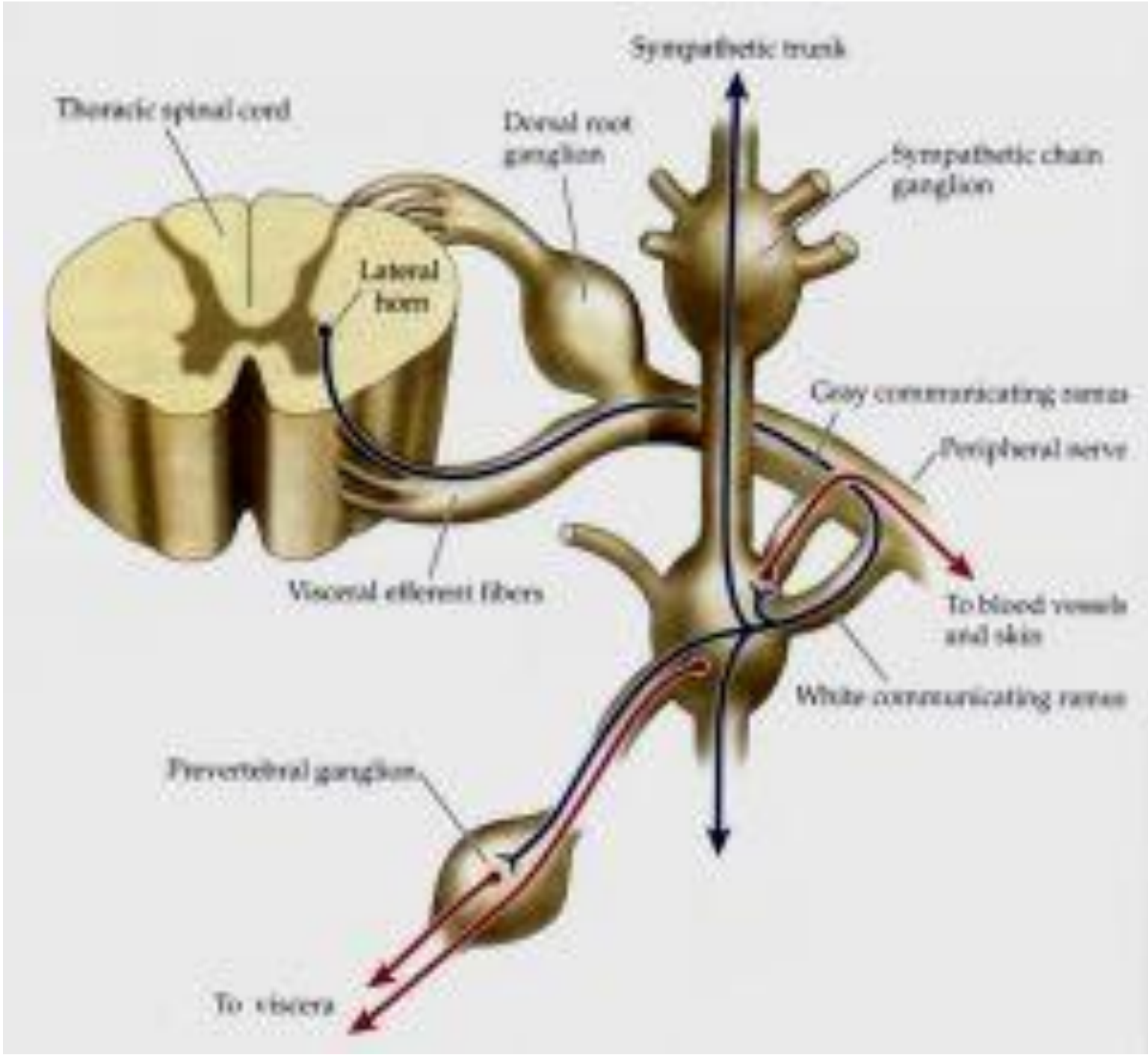
Carry postganglionic sympathetic axons from the sympathetic trunk to the spinal nerve.

Axons are unmyelinated.

Gray rami have a grayish appearance

Connect to all spinal nerves.

Sympathetic information that starts in the thoracolumbar region can be dispersed to all parts of the body.



# Structural differences of the sympathetic and parasympathetic nervous systems

## Sympathetic nervous system:

1.All neurons forming this system originate from C8 to L2 segment of spinal cord. So it is called ***thoracolumbar*** outflow.

2.Pre-ganglionic fibers are short, relay either in paravertebral or ***prevertebral ganglia***

3.Post-ganglionic fibers are long nerve endings are adrenergic in nature except in sweat gland

4.Nerve endings are adrenergic in nature

5.Effect is widely diffused and directed towards mobilization of resources and expenditure of energy during emergency and emotional crisis

6.It supplies visceral blood vessels, skin. Afferents from viscera and specific area of skin reach the same spinal segment to go to the cerebrum. Since pain is better appreciated from the skin, it appears to be coming from skin rather than the viscera. This is the basis of referred pain.

## Parasympathetic nervous system:

1. All neurons forming this system originate from brain (Ill, VII, IX, X cranial nerves) and S2—S4 segment of spinal cord. So it is called ***craniosacral*** outflow.

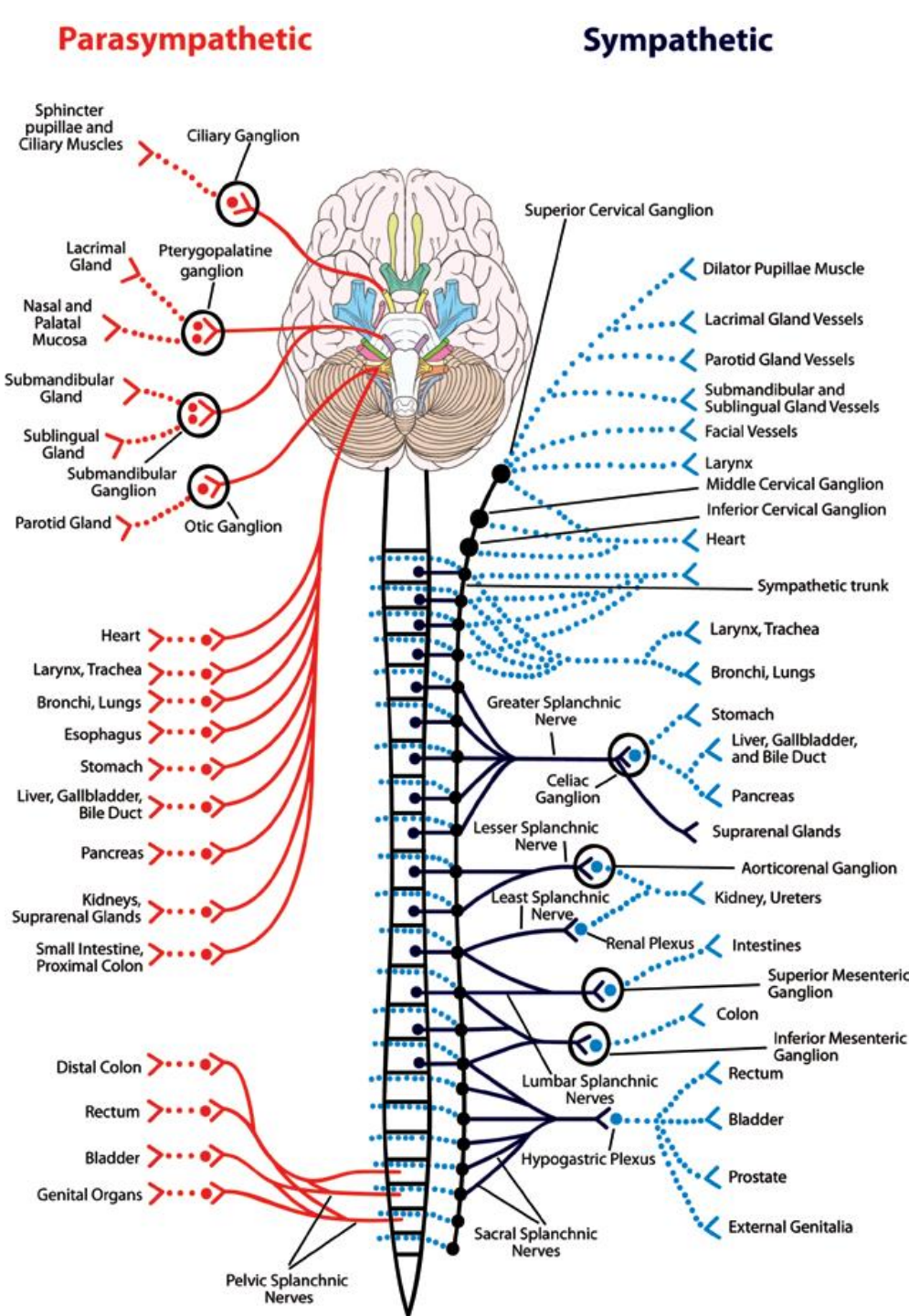
2. Pre-ganglionic fibers are very long reaching up to ***terminal ganglia*** mostly on viscera.

3. Postganglionic fibers are short

4. Nerve endings are cholinergic in nature

5. Effect is discrete, isolated, directed towards conservation and restoration of the resources of energy

6. It only supplies viscera. Parasympathetic system has no effect on skin



# Differences between Sympathetic & Parasympathetic divisions of the VNS

## Target Tissues

### *Sympathetic*

- **Organs of head, neck, trunk, & external genitalia**
- **Adrenal medulla**
- **Sweat glands in skin**
- **Errector muscles of hair**
- **All vascular smooth muscle**

### *Parasympathetic*

- **Organs of head, neck, trunk, & external genitalia**

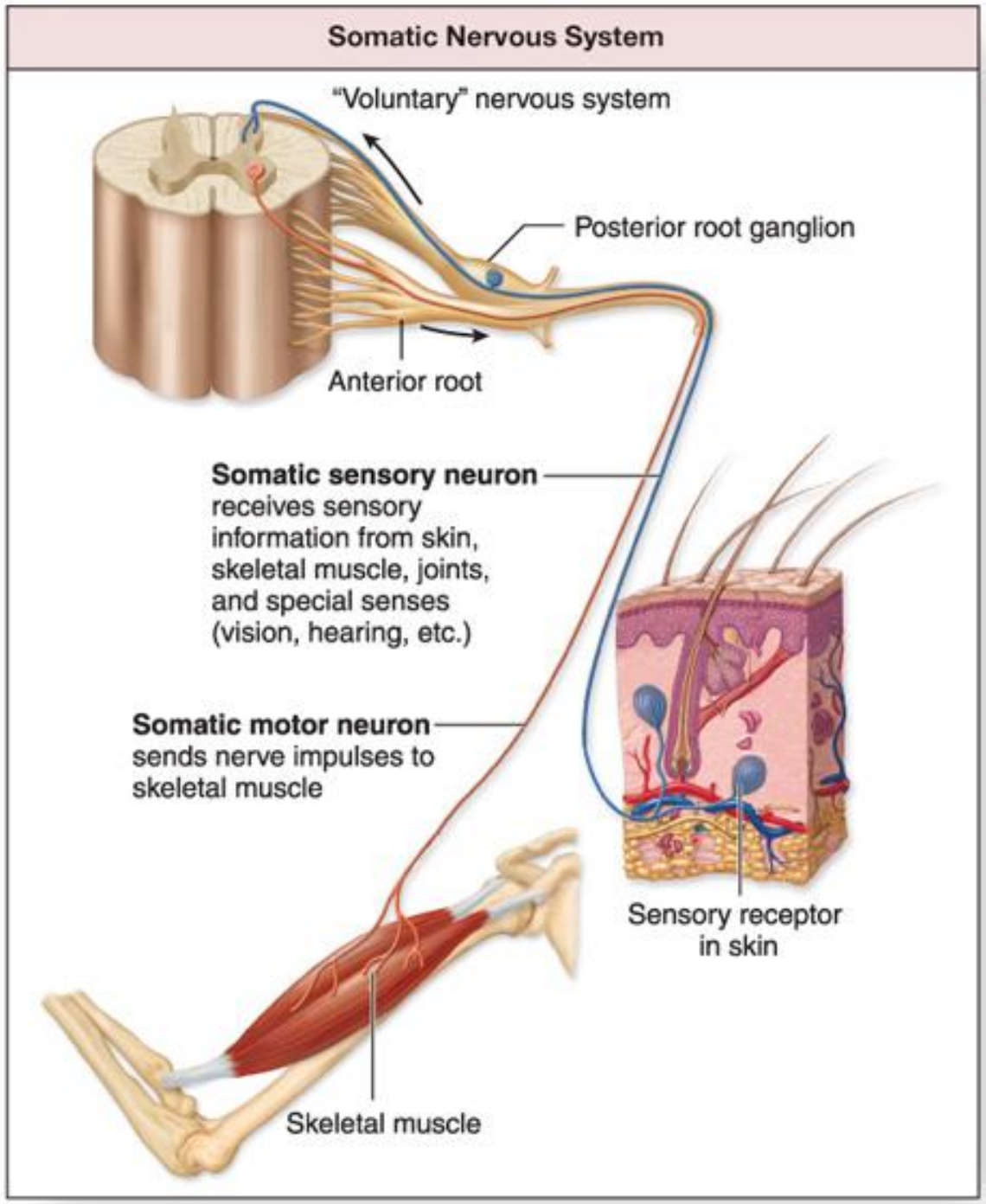
**» Sympathetic system is distributed to essentially all tissues (because of vascular smooth muscle)**
**The sympathetic division *exerts long-lasting, diffuse effects***

**» Parasympathetic system never reaches limbs or body wall (except for external genitalia)**
**The parasympathetic division *exerts short-lived, highly localized control***

# Connection between the Autonomic and Somatic nervous systems

- The morphological and functional unit of both system is a ***neuron***
- The main functional unit is a ***reflex arch***
- The autonomic nervous fibers go within cranial nerves and spinal nerves





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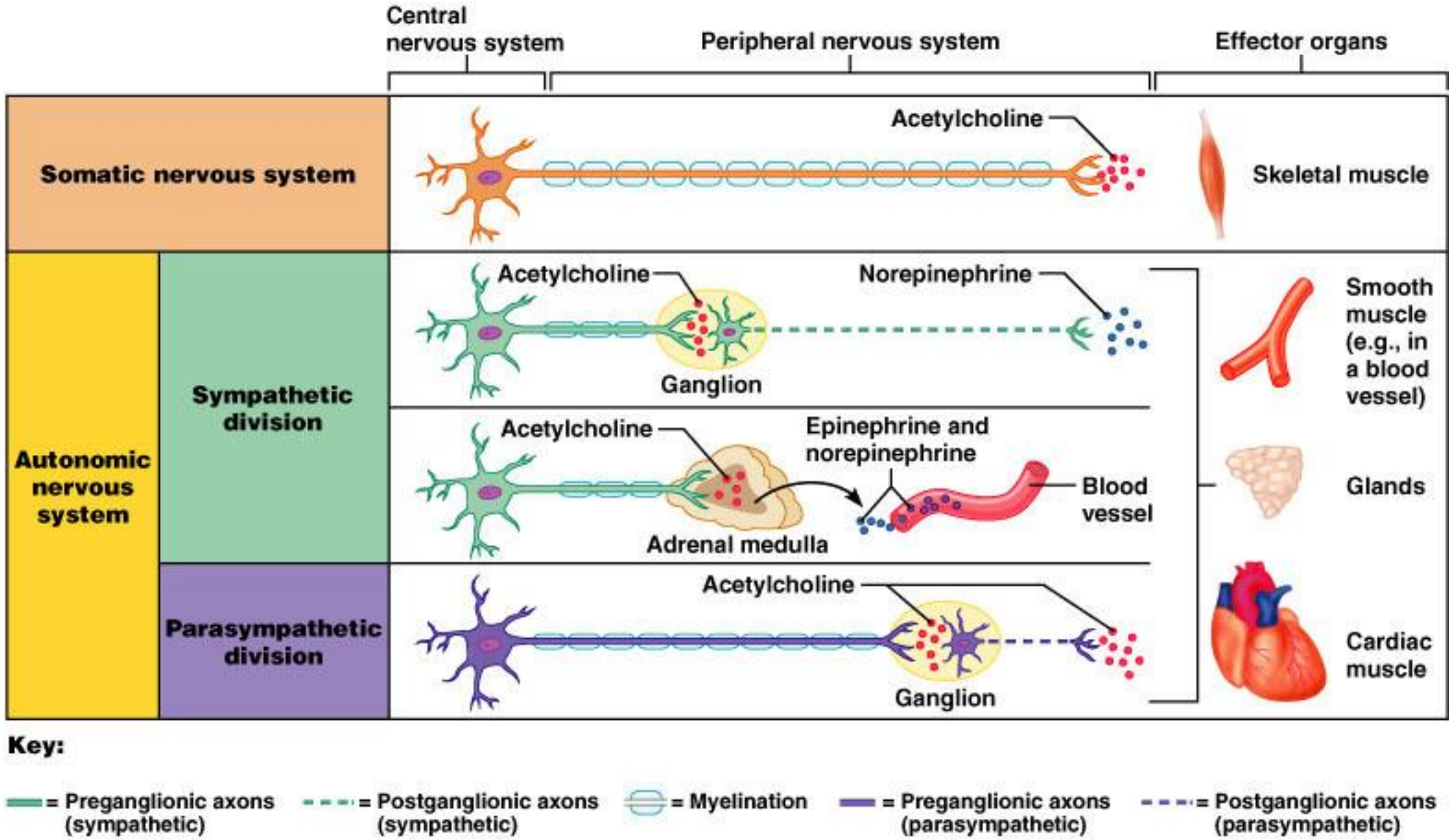
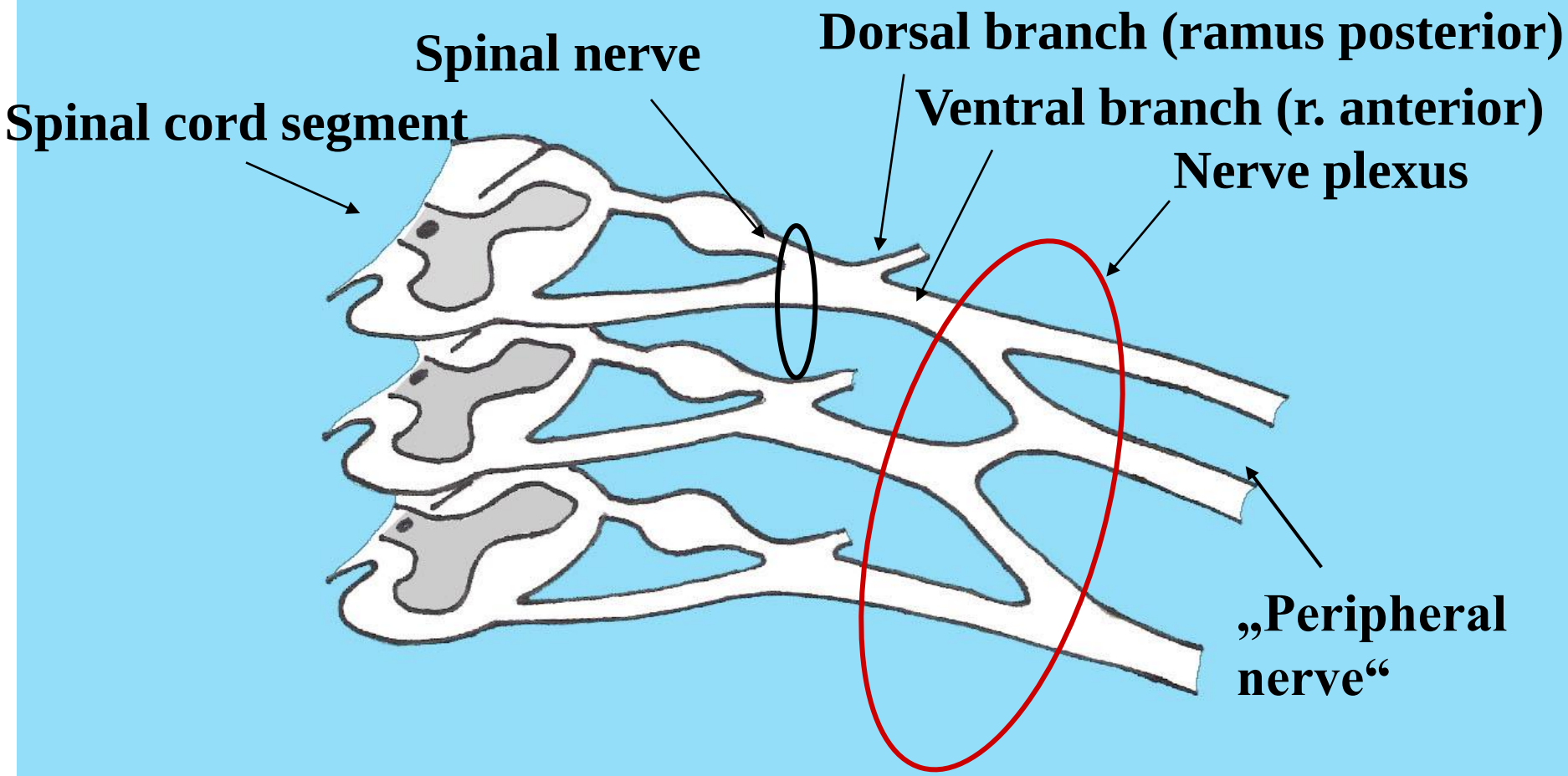
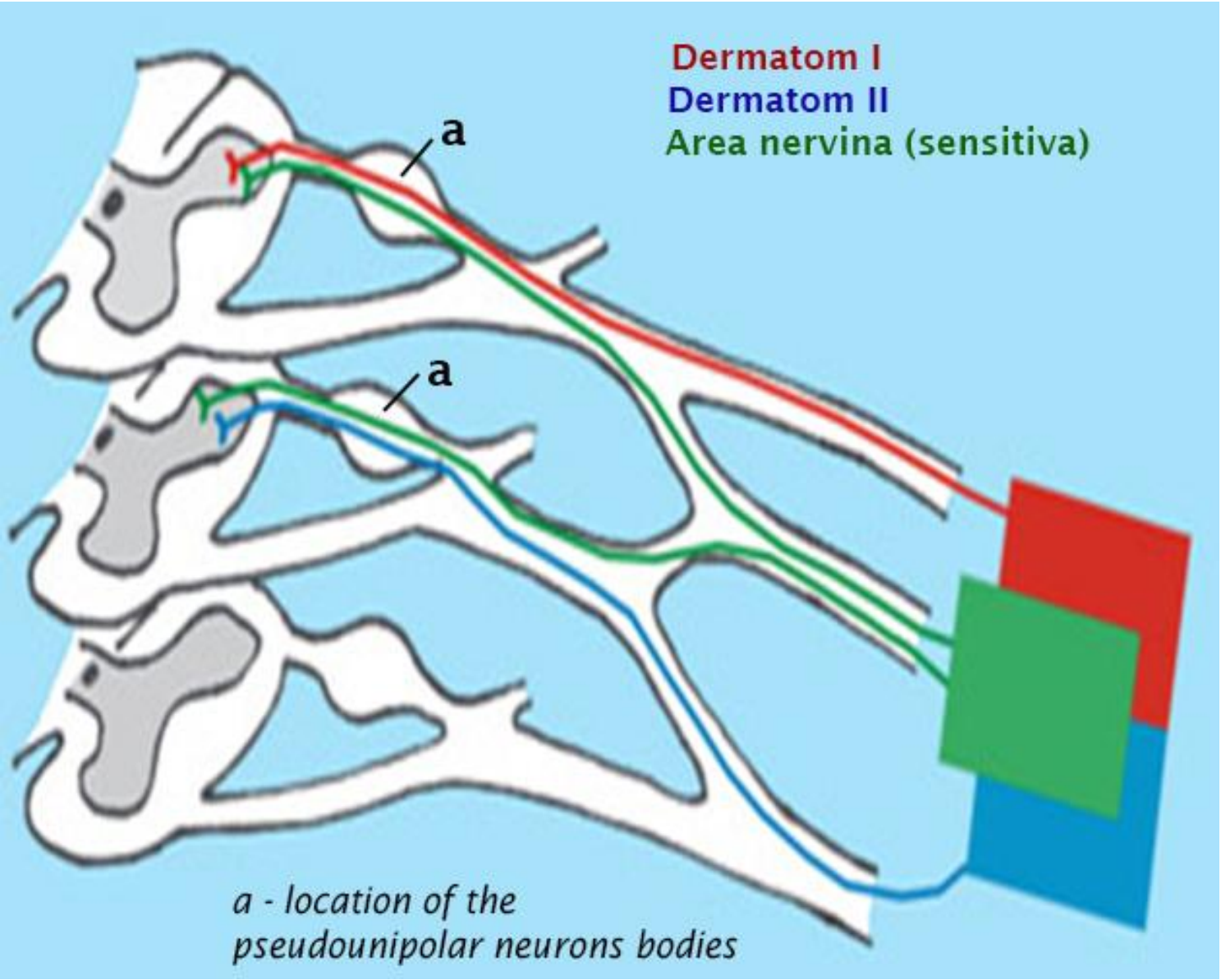





Nerve plexus is allways formed only by ventral branches of spinal nerves!

# Some important concepts of somatic organs innervation




**Difference between *dermatom* and *area nervina* (sensitiva)**

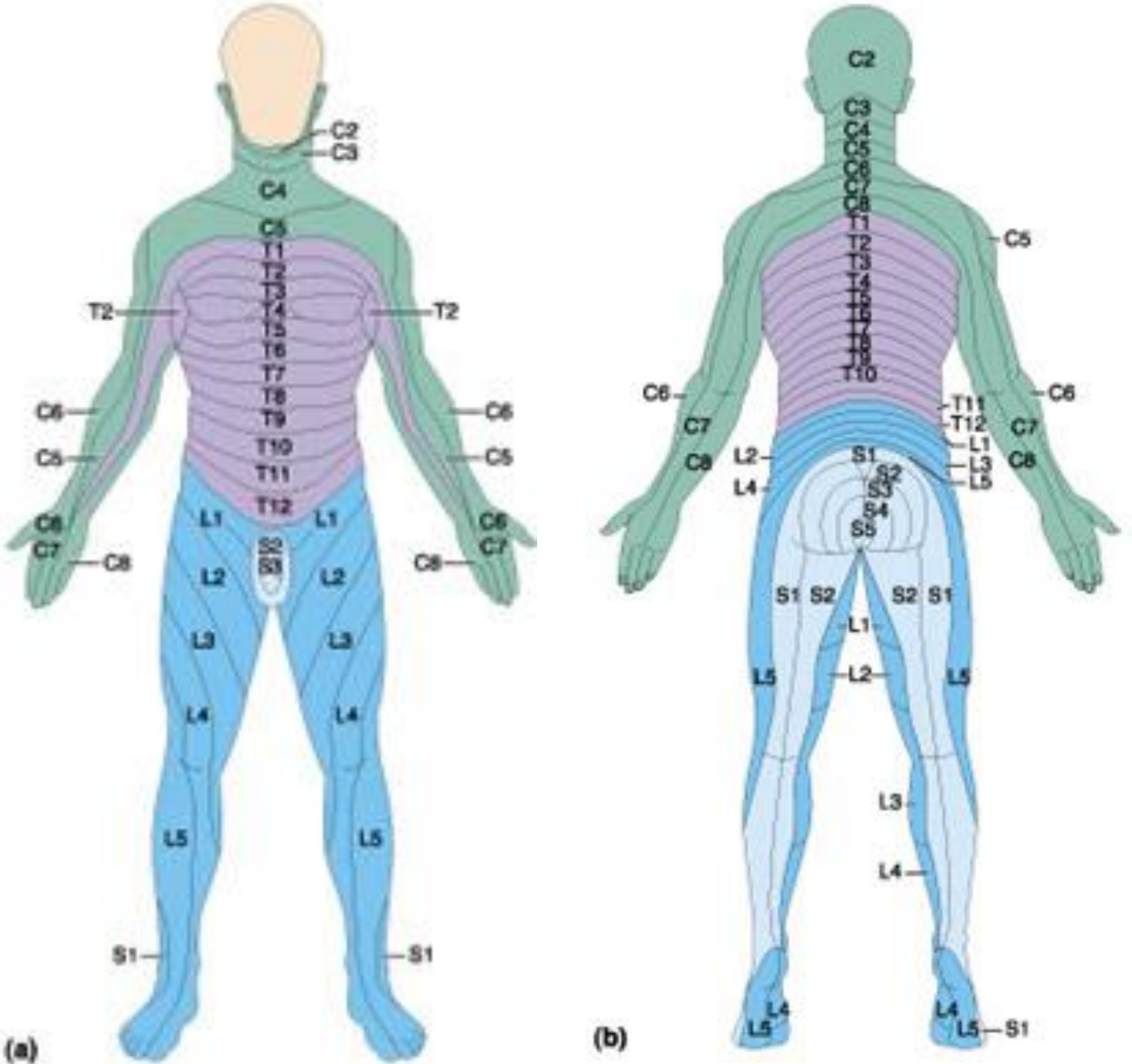
- ***Area radicularis sensitiva*** – a part of the body, from which the sensory information is led by one dorsal root of spinal nerve (or one cranial nerve)

- ***It consists of DERMATOM (skin area and internal organs and muscles area)***, innervated by the same dorsal root.

- ***Area nervina*** – part of the body innervated by one peripheral nerve. Some nerves form nervous plexus and here, as a peripheral nerve we mean the nerve distally to the plexus from which it arises.

- ***Dermatomes extend over the limbs***
- ***Dermatoms form longitudinal strips on the surface of the body.***
- ***Twisted orientation reflects twisting of limb during development***
- ***Nerves generally innervate skin over muscles that they innervate***
- ***It's important to know these dermatome regions especially physical therapists and nurses.***

# Dermatomes /sensory skin segments from spine/



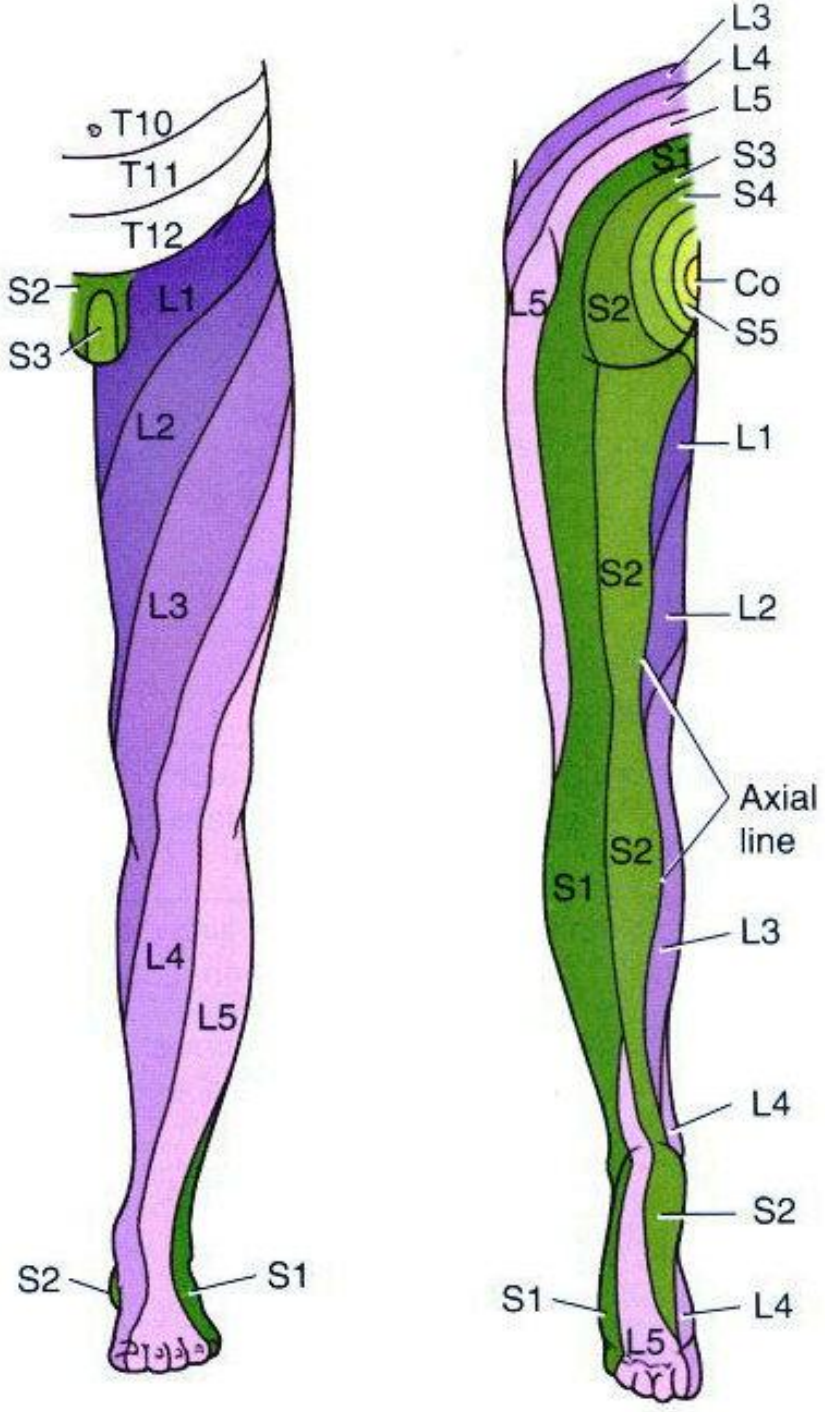
## Nervous Organization of the Limbs

The innervation from the limbs comes from spinal nerves:
C5 – T1 for the arms
L2 – S2 for the legs

Nerves form **plexus** of which in the:
***Upper limb***: anterior division supply the flexors and the posterior division supply to the extensors
***Lower limb:*** posterior division supply the flexors and the anterior division supply the extensors

***Segmental Innervation***

Muscles are generally supplied by two adjacent segments of the spinal cord.
Muscles with the same action share the same nerve supply.
Opposing muscles are usually supplied by nerves two segments above or below.



# Sensory Segmental Supply

**Each segmental spinal nerve supplies sensation to a strip of skin.**

**These do generally overlap – so when a single dermatome is lost it is not generally noticed.**

**T12 – lower abdomen**

**L1 – suprapubic region**

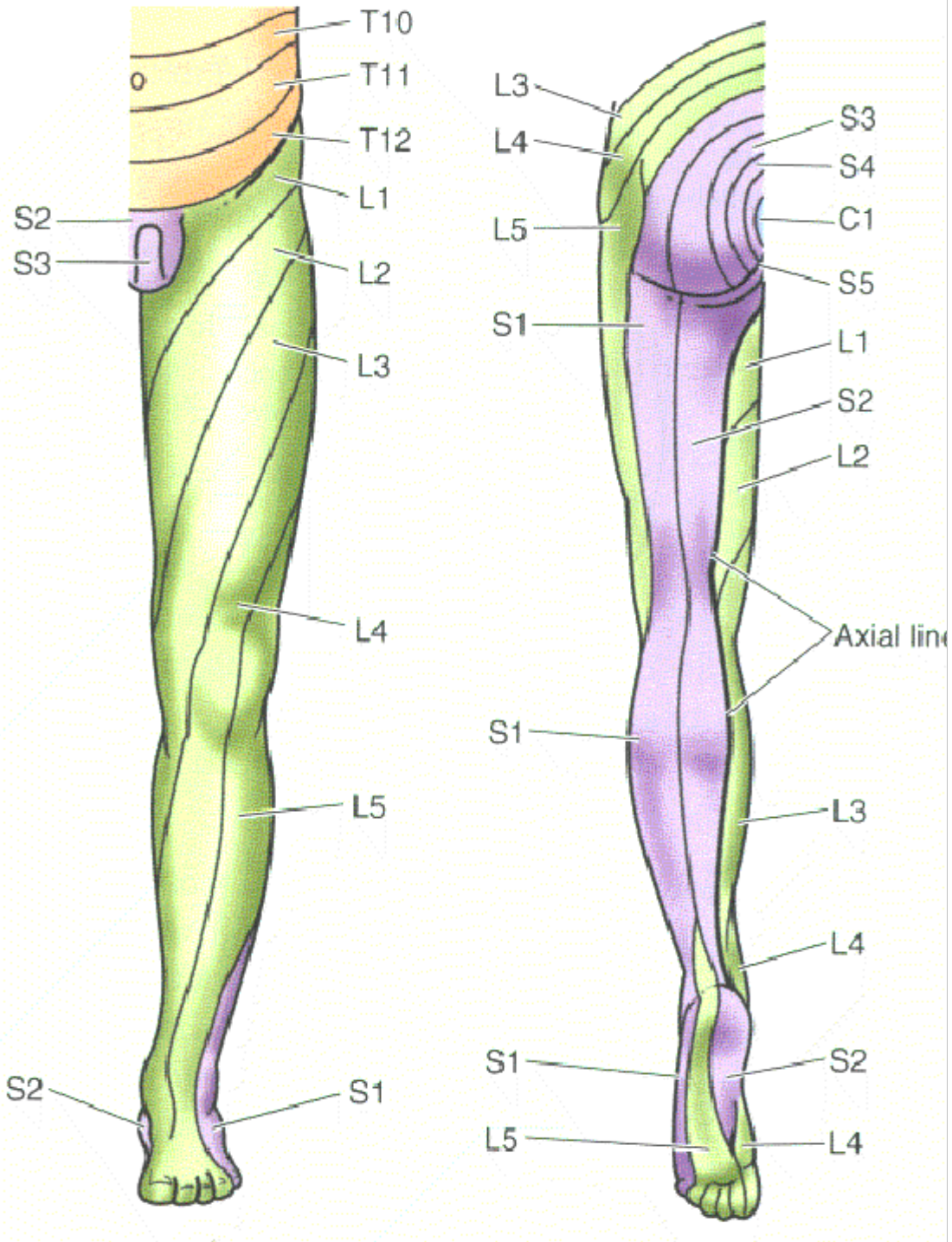
**L3 – front of the thigh (L3 to knee)**

**L4 – front of leg (L4 to floor)**

**L5 – dorsum of great toe**

**S1 – lateral aspect of foot**

**S2-S4 – perineum and perianal region**

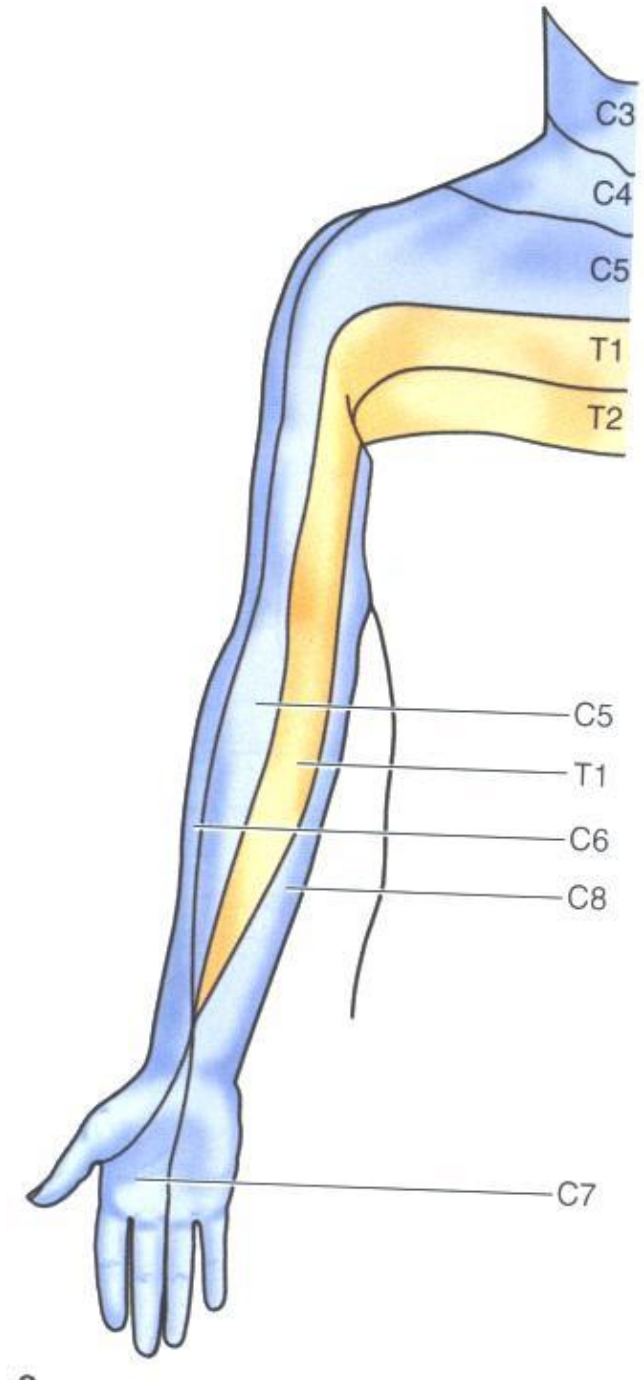


# Muscles innervated by 2 nerves

**Flexor digitorum profundus:** **Anterior interosseus & Ulnar nerves**

**Flexor pollicis brevis:** **Ulnar (Deep head) & Median (Superficial head)**

**Adductor magnus:** **Obturator & Tibial portion of Sciatic**




## Segmental Reflexes:

- ❖Either stretch reflexes or deep tendon reflexes and are monosynaptic
- ❖Two main reflex arches in the upper limb:
  - ➢Biceps jerk (C6)
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- ❖Two main reflexes in the lower limb:
  - ➢Knee jerk (L3)
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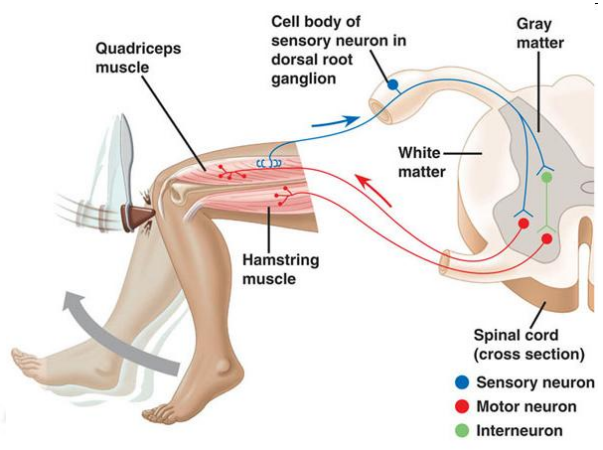
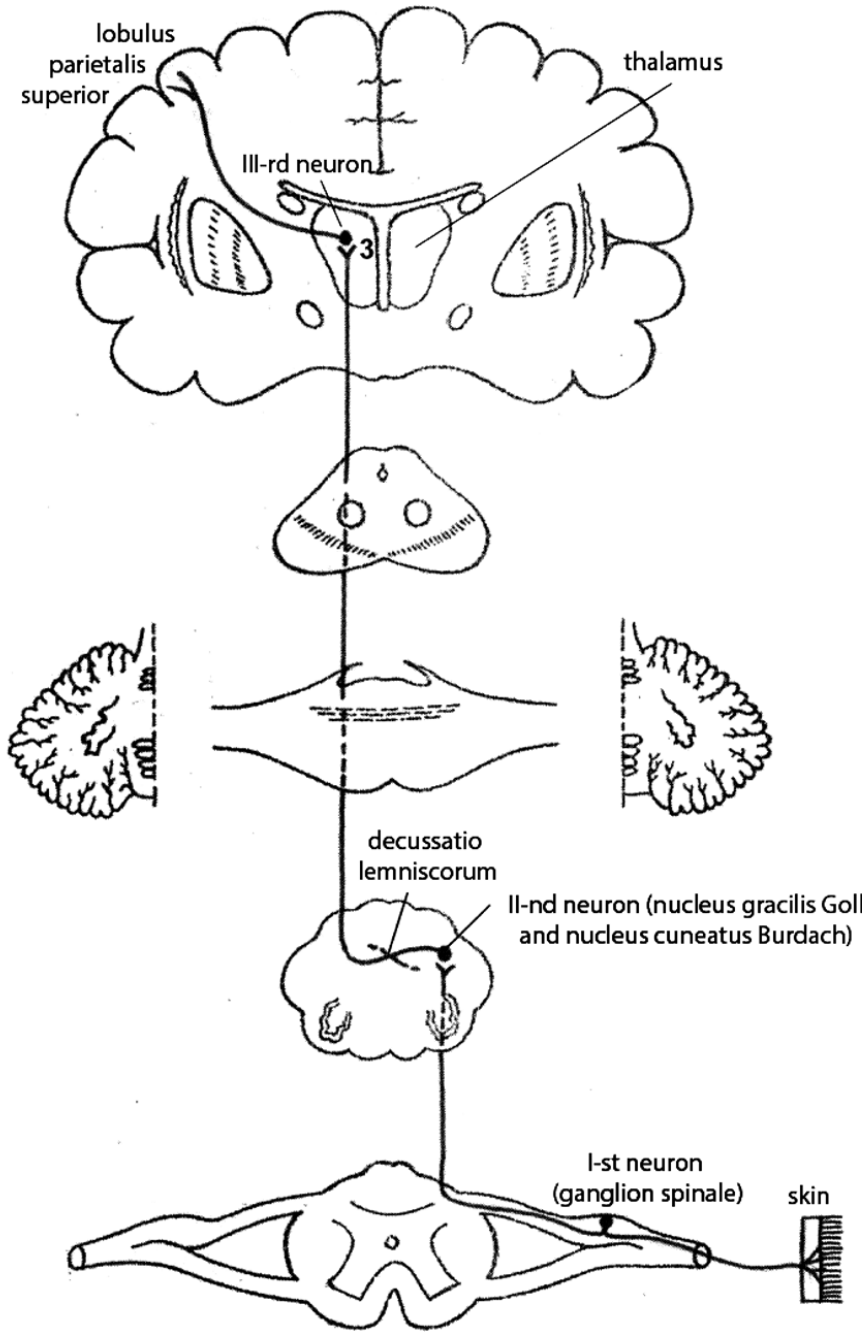


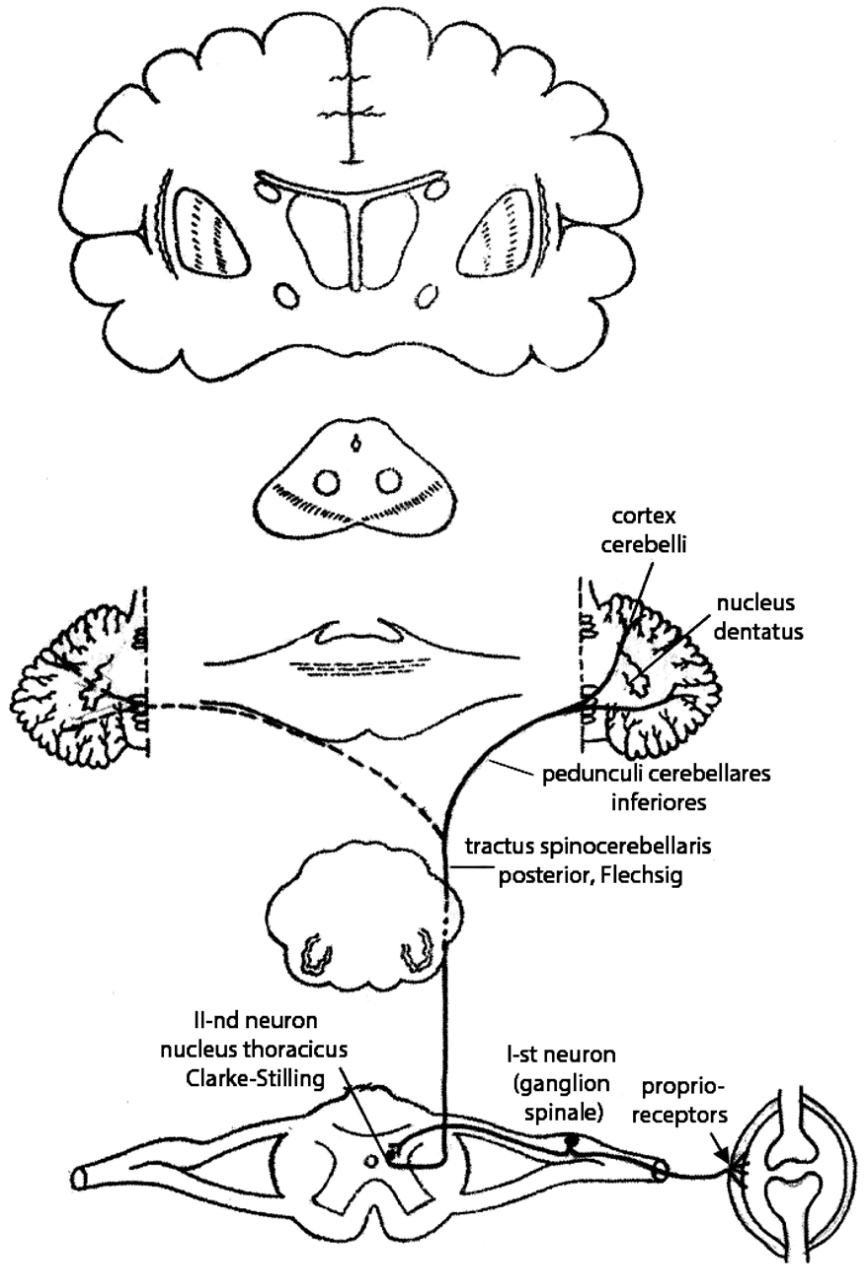

# Sensory pathways

- **Sensory systems allow us to detect, analyze and respond to our environment**

**"Ascending pathways"**

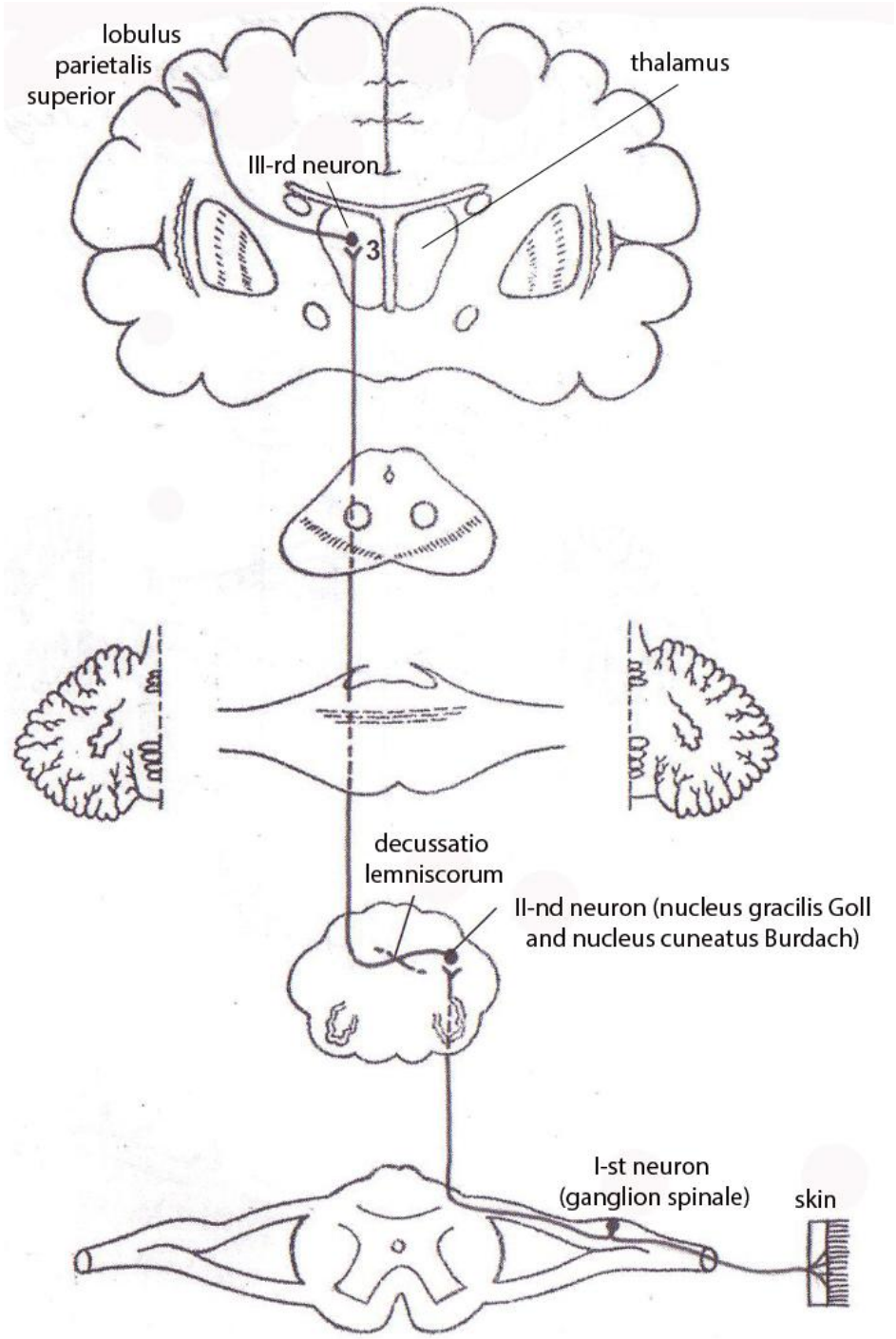
- **Carry information from sensory receptors to the brain**
- **Conscious: reach cerebral cortex**
- **Unconscious: do not reach cerebral cortex**
- **Sensations from body reach the opposite side of the brain**



# Sensory pathways: 3 neurons

- 1st: enters spinal cord from periphery
- 2nd: crosses over (decussates), ascends in spinal cord to thalamus
- 3rd: projects to somatosensory cortex



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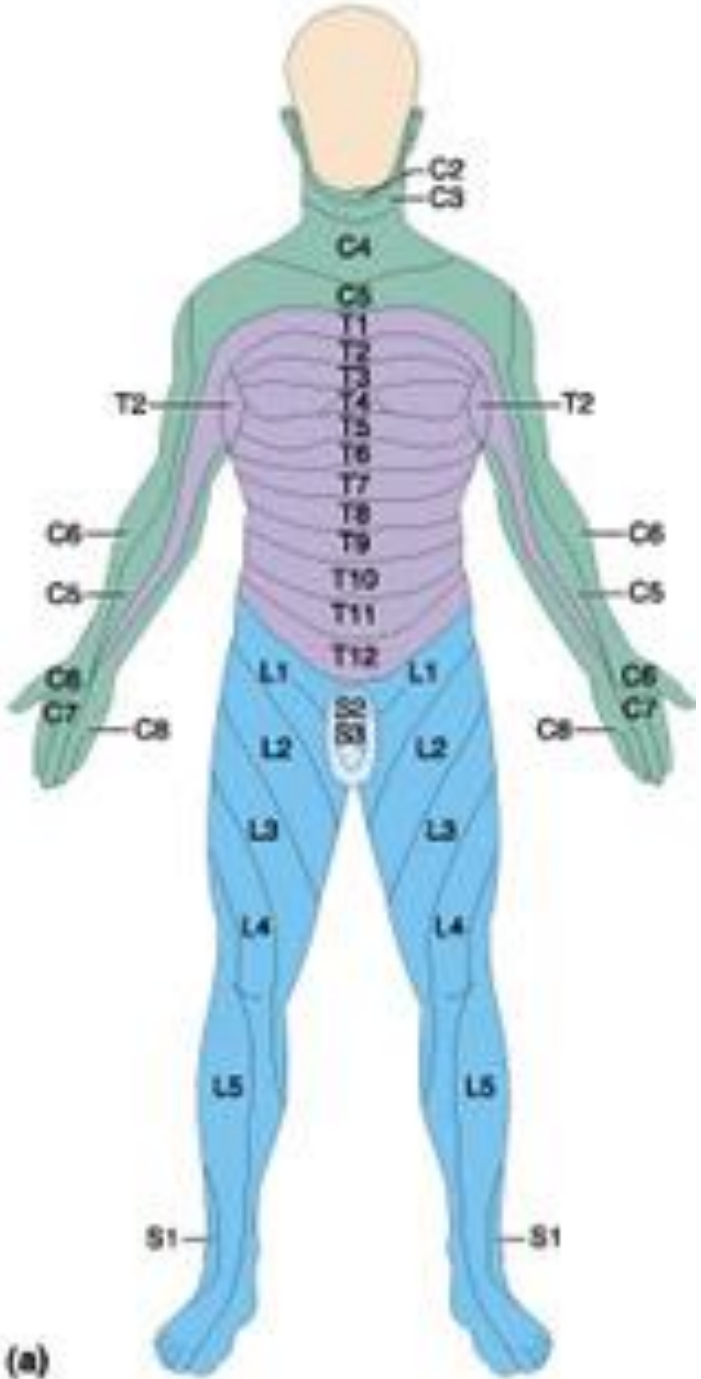


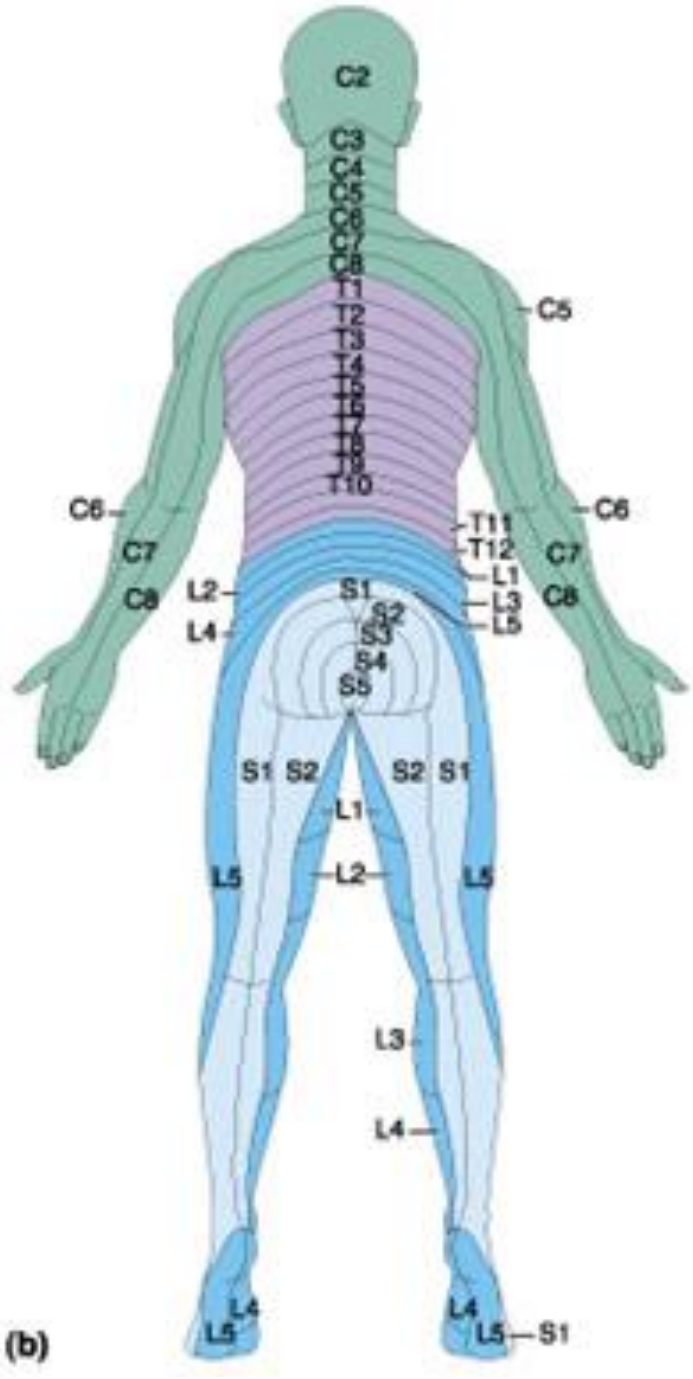

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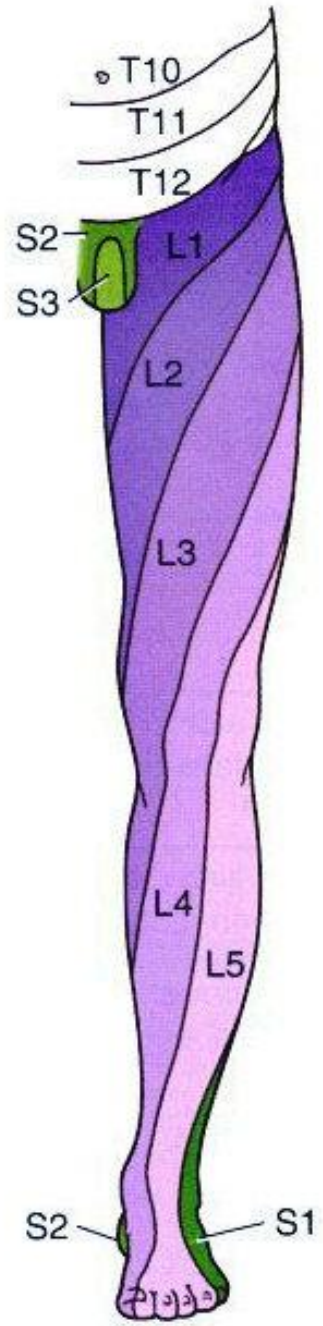


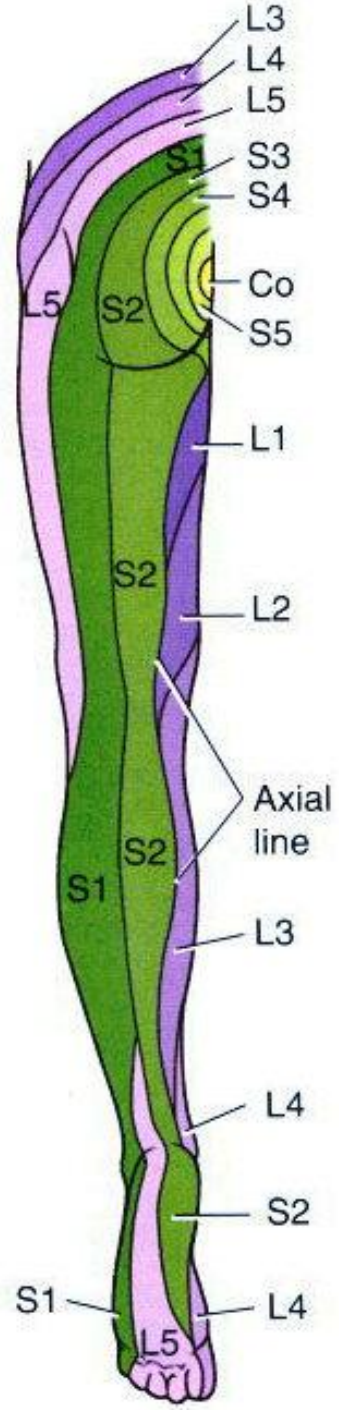

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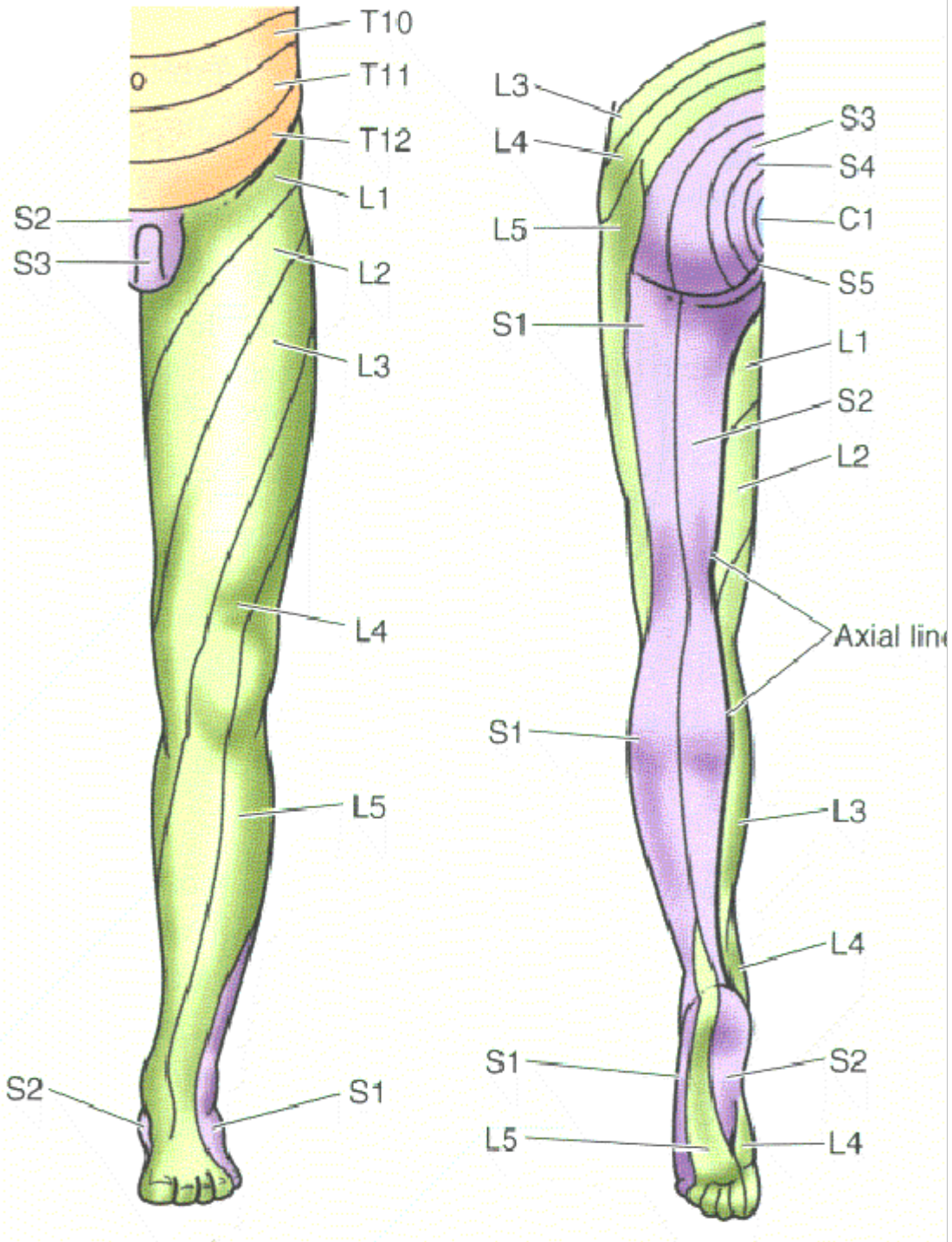

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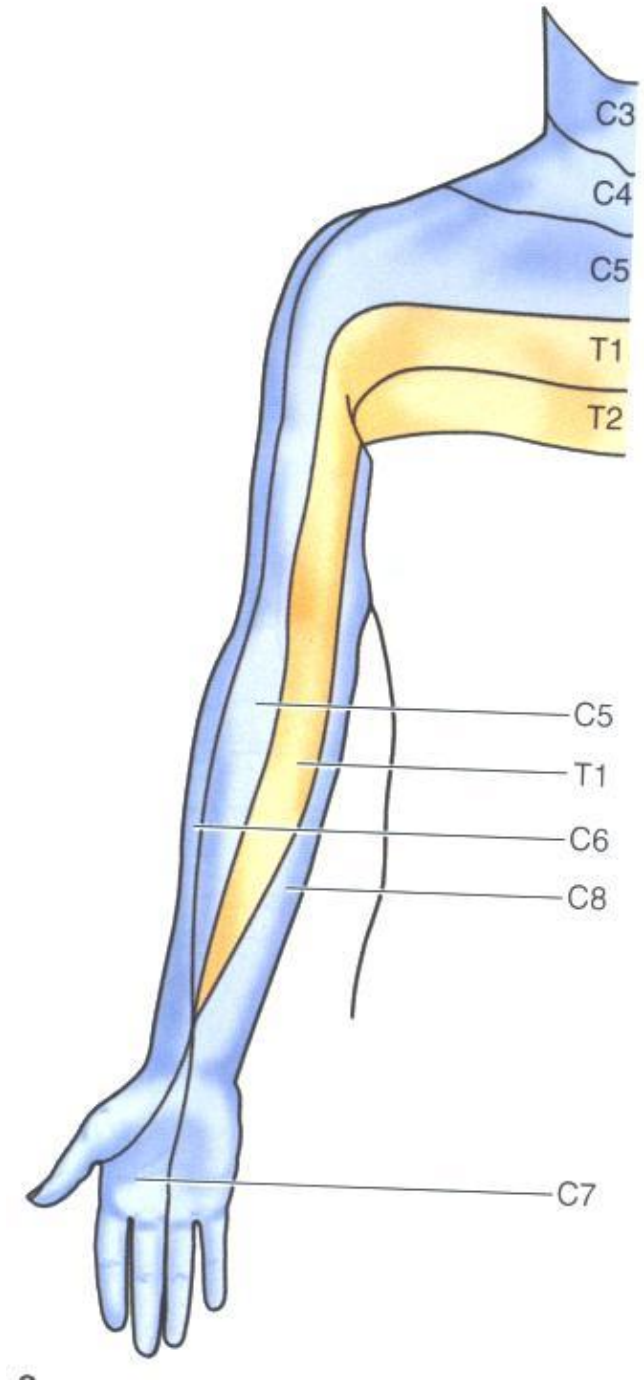
# Visceral Sensations

- Visceral sensations such as heartburn, nausea, hunger and fullness of bladder & bowel tend to be somewhat poorly localized due to poor representation of viscera in cortex
- Viscera including brain/spinal cord are insensitive to *ordinary* mechanical/thermal stimuli
- Pain is caused by excessive stretch, violent/spasmodic contractions or ischemia
- Pain is often felt in a cutaneous or somatic area; this is called ***referred pain***

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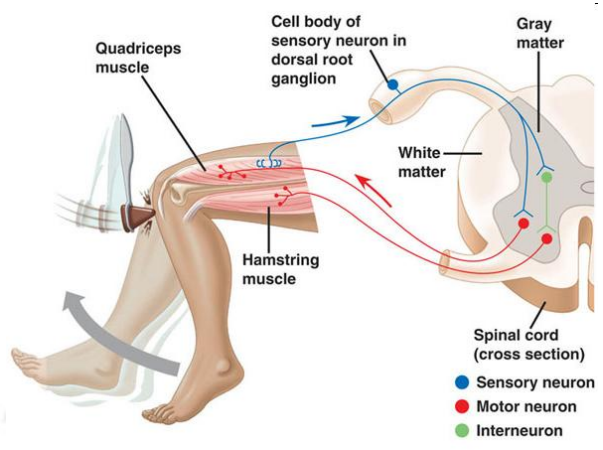
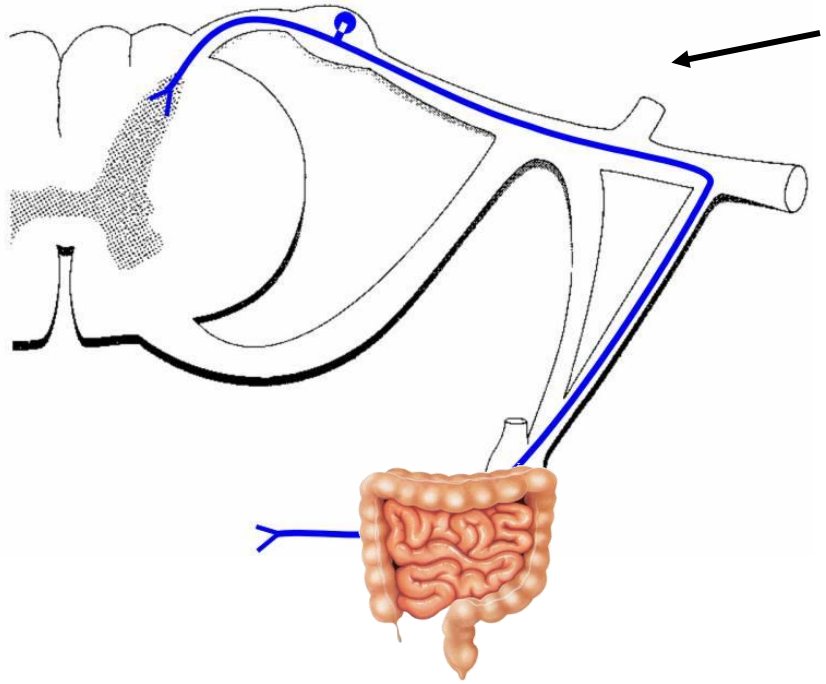



# Visceral Afferents and Referred Pain




Visceral sensory nerves
[GVA]

- run with sympathetic nerves
- cell bodies in dorsal root ganglion
- nerve ending in viscera

## Afferent innervation of the viscera

**Somatic sensation:**

- conscious, sharp, well-localized
- touch, pain, temperature, pressure, proprioception

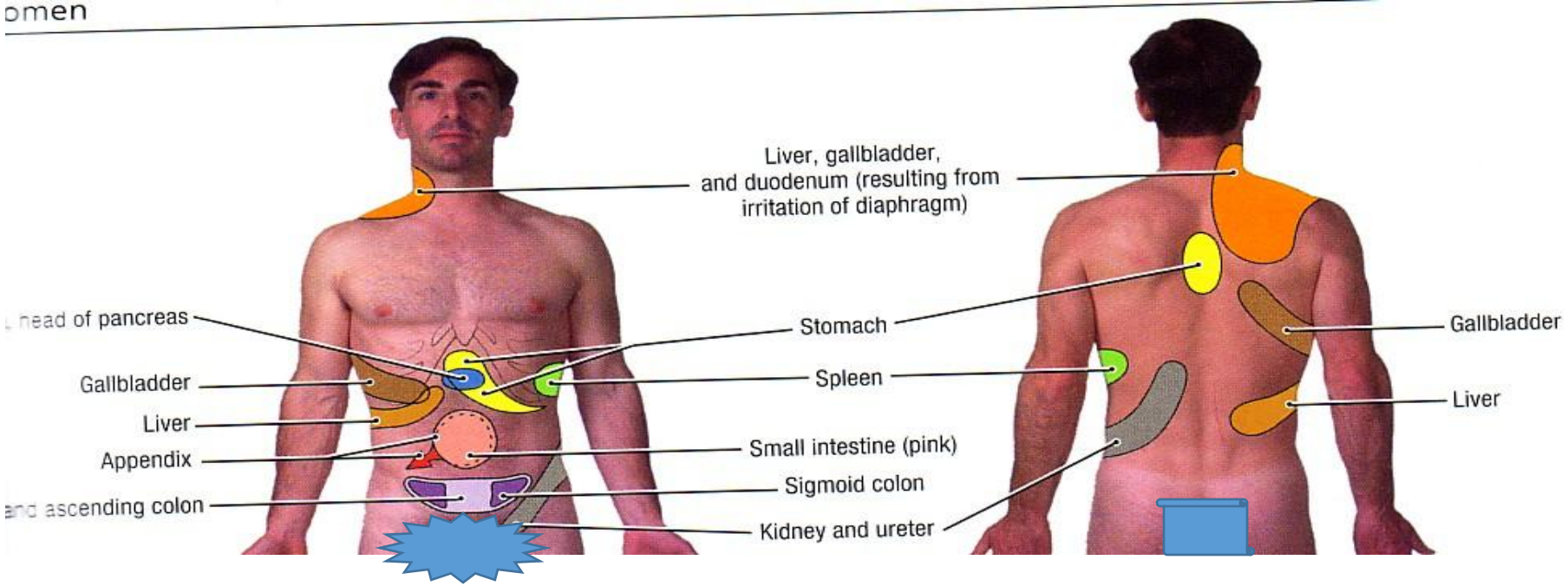
**Visceral sensation:**

- often unconscious; if conscious: dull, poorly-localized
- distension, blood gas, blood pressure, cramping, irritants

**Nociceptors are special receptors that respond only to noxious stimuli and generate nerve impulses which the brain interprets as "pain".**

**Nociceptor sensitization is well developed in all viscera.**

**Large numbers of silent/sleeping nociceptors, awakened by inflammation.**




Pain arising from the organs, called visceral pain.

It varies from sever to dull pain.

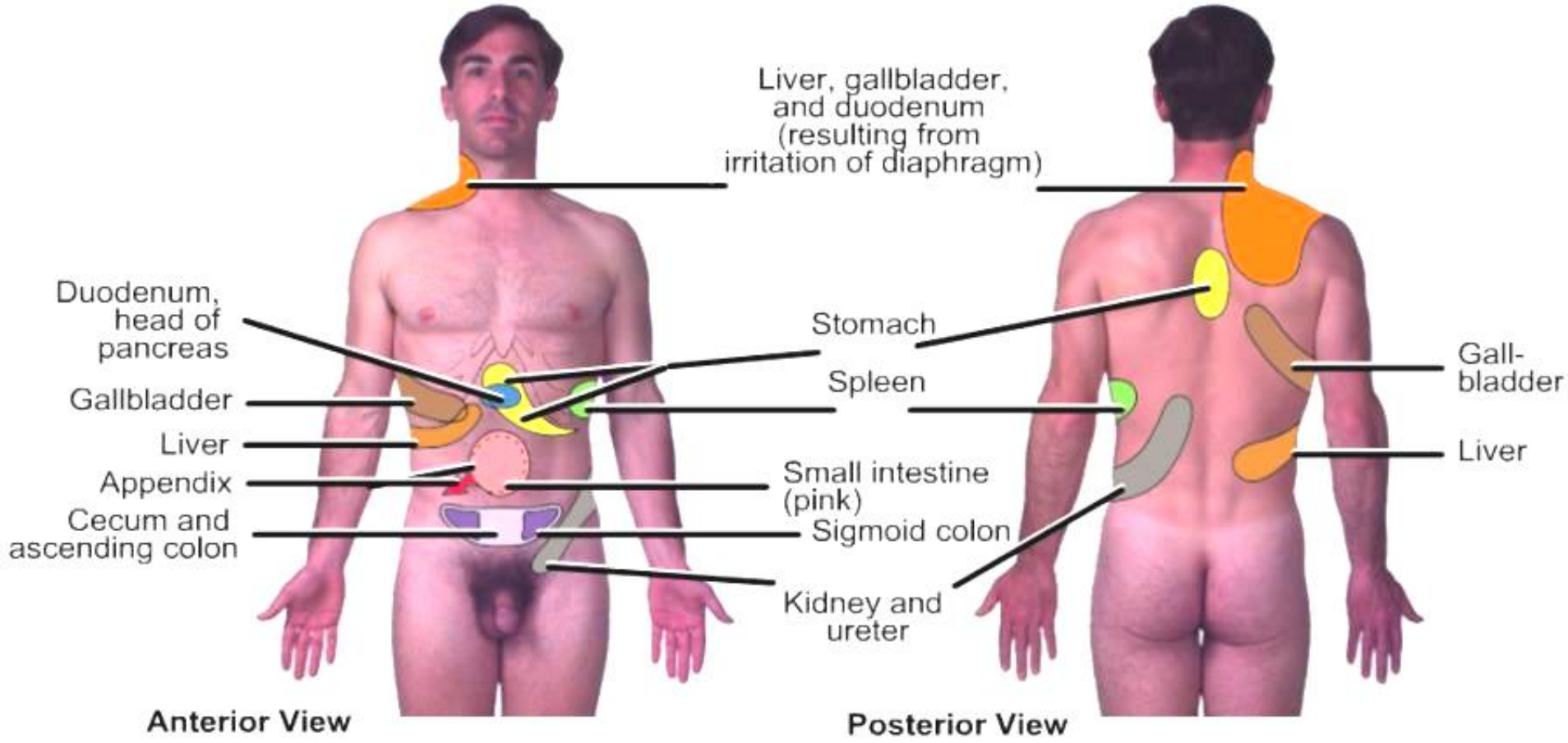
It is poorly localized pain.

It radiates to the part of the body supplied by somatic sensory fibers associated with the same ganglion and spinal cord segment.

Pain is interpreted by the brain as thought the irritation occurred from the area of skin supplied by the same segment

# Referred Pain

- **Pain stimuli arising from the viscera are perceived as somatic in origin**
- **This may be due to the fact that visceral pain afferents travel along the same pathways as somatic pain fibers**



# Innervation of the viscera

## Organs Innervated by Sympathetic NS

• Structures innervated by each spinal nerve
– sweat glands, errector pili mm., blood vessels to skin & skeletal mm.

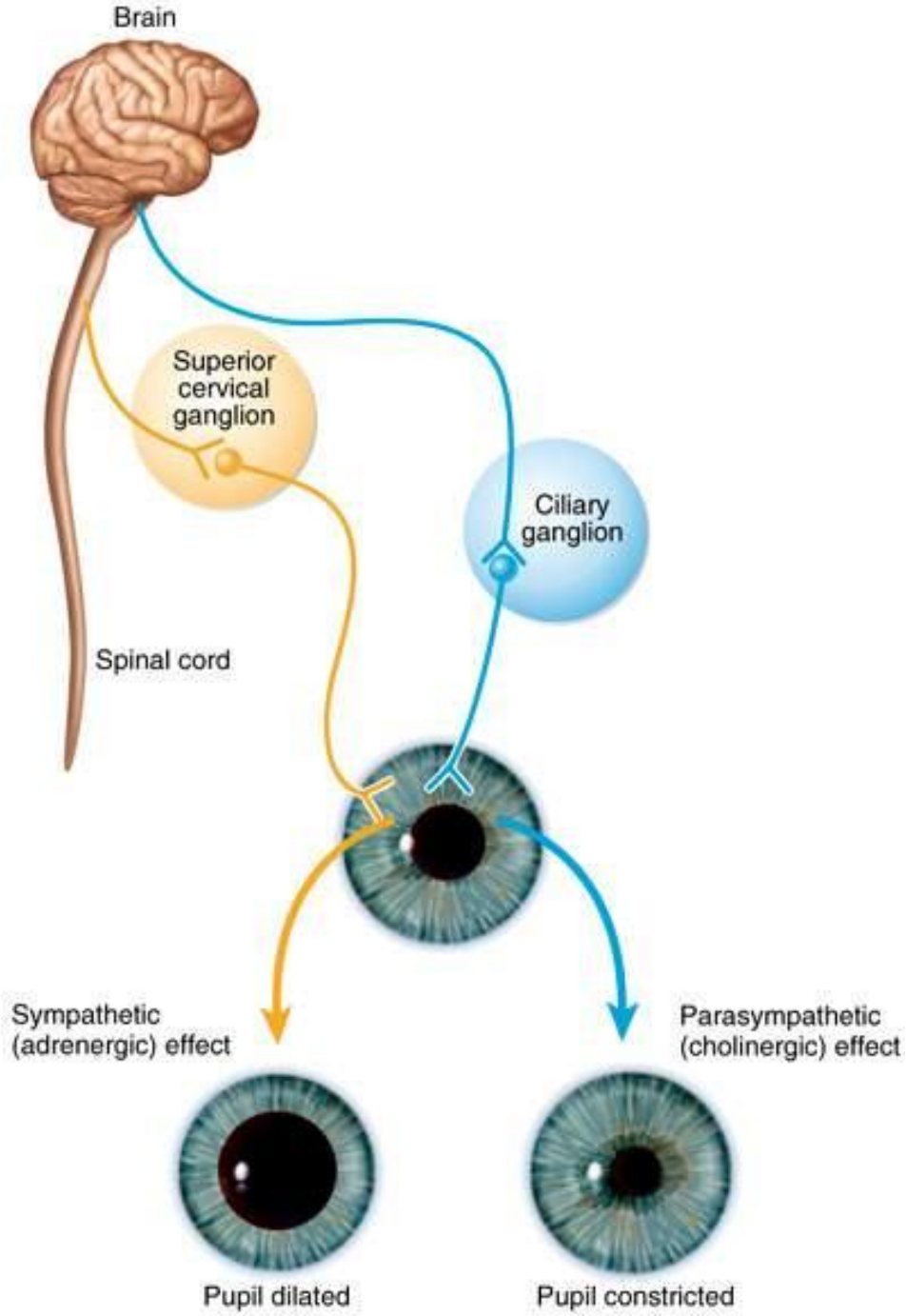
• Thoracic & cranial plexuses supply:
– heart, lungs, esophagus & thoracic blood vessels
– plexus around carotid artery to head structures

• Splanchnic nerves to prevertebral ganglia supply:
– GI tract from stomach to rectum, urinary & reproductive organs

# Dual Innervation

- Most of viscera receive nerve fibers from both parasympathetic and sympathetic divisions
- Both divisions do not normally innervate an organ equally
- Antagonistic effects
  - oppose each other
  - exerted through dual innervation of same effector
    - heart rate decreases (parasympathetic)
    - heart rate increases (sympathetic)
  - exerted because each division innervates different cells
    - pupillary dilator muscle (sympathetic) dilates pupil
    - constrictor pupillae (parasympathetic) constricts pupil





# Cooperative Effects of the SNS and PSNS

- **Cooperative effects seen when 2 divisions act on different effectors to produce a unified effect**
  - ***parasympathetics increase* salivary serous cell secretion**
  - ***sympathetics increase* salivary mucous cell secretion**
- **<u>ANS cooperation is best seen in control of the external genitalia</u>**
  - ***Parasympathetic fibers cause vasodilation and are responsible for erection of the penis and clitoris***
  - ***Sympathetic fibers cause ejaculation of semen in males and reflex peristalsis in females***

# Unique Roles of the Sympathetic Division

- It regulates many functions ***not subject to parasympathetic influence***
- These include the activity of the ***adrenal medulla, sweat glands, erector pili muscles, kidneys, and most blood vessels***

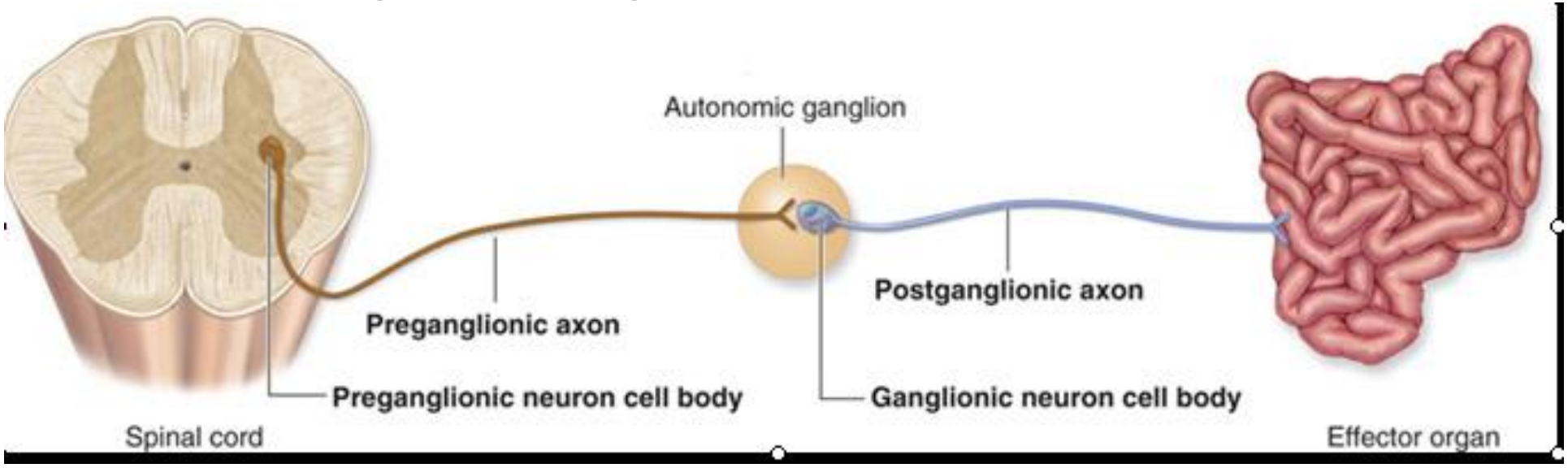
# Autonomic or Visceral Reflexes

- **Autonomic reflexes occur over autonomic reflex arches. Components of that reflex arch:**

**– sensory receptor**
**– sensory neuron**
**– integrating center**
**– pre & postganglionic motor neurons**
**– visceral effectors**

- **Unconscious sensations and responses cause**

**– change blood pressure, digestive functions etc**
**– filling & emptying of bladder or defecation**



# Metasympathetic nervous system

- **It is known that many organs, extracted from the body, continue to perform their functions. For example, peristaltic and absorbtion, etc.**

- **This relative functional independence is explained by the presence of *metasympathetic part of the autonomic nervous system* in the walls of these organs, which has its own neurogenic rhythm, a complete set of links for reflex activity: receiving, associating and effector part.**

- **This system contains proper *mechano-*, *chemo-*, *thermo-*, *osmoreceptors* - capable to send information about state of organ to its internal network and to transmit signals to the CNS.**

- **Metasympathetic innervation is characteristic for internal organs, but not all.**

- **All links of these system are localized only in the intramural ganglia.**

- **Metasympathetic part doesn't have a proper central apparatus and its connection to the central nervous system is mediated by sympathetic and parasympathetic neurons, forming synaptic contacts on the bodies and processes of metasympathetic interneurons and effector neurons.**

# Neural innervation of intestine

- **Autonomic nervous system**
  - Extrinsic set of nerves
    - Parasympathetic
    - Sympathetic

- **Enteric nervous system (ENS)**
  - Intrinsic set of nerves
  - ~$10^8$ neurons - similar to spinal cord $\Rightarrow$ "brain of gut"
  - Neurons extending from esophagus to anus
  - 2 plexuses
    - ***Myenteric plexus***
    - ***Submucosal plexus***

***Myenteric plexus (Auerbach)***

- **Located between the longitudinal and circular layers of muscle in the tunica muscularis**
- **Controls tonic and rhythmic contractions**
- **Exerts control primarily over digestive tract motility**

***Submucosal plexus (Meissner)***

- **Buried in the submucosa**
- **Senses the environment within the lumen**
- **Regulates GI blood flow**
- **Controls epithelial cell function (local intestinal secretion and absorption)**
- **May be sparse or missing in some parts of GI tract**

# Intrinsic Nervous System

- **3 types of neurons in enteric system**

1. ***Sensory neurons*** (5 types)
   - Chemoreceptors sensitive to acid, glucose and amino acids have been demonstrated which, in essence, allows "tasting" of lumenal contents. Sensory receptors in muscle respond to stretch and tension
2. ***Motor neurons***
   - Control GI motility and secretion, and possibly absorption

3. ***Interneurons***
   - Largely responsible for integrating information from sensory neurons and providing it to motor neurons

# Interaction of the autonomic and somatic parts of the NS

**Activities of the autonomic and somatic nervous system are closely related, although in response to stimulation of visceral afferent fibers somatic and autonomic systems are involved in varying degrees.**

**Reflexes in this case are classified into viscero-visceral, and viscero-somatic and viscero-sensory, somato-visceral, viscero-dermal and dermo-visceral.**

**When *viscero-visceral* reflexes occur internal organ can respond in two ways: either inhibition or enhancement functions.**

- ✓ **- Mechanical stimulation of the mesentery causes slowing of the heart rate.**
- ✓ **- Stimulation of digestive tract receptors is accompanied by a weakening of sphincter pupillae muscle tone.**
- ✓ **- Stimulation of the carotid and aortic reflex zones involves a change in intensity of respiration, blood pressure, heart rate.**

## Viscero-somatic reflexes

**Viscero-somatic reflex also occurs during stimulation of the internal organs and, in addition to visceral causes physical reactions: a change in current activity of skeletal muscles.**

**-Disturbance of general motor activity of the body during stimulation of sensory endings of the carotid sinus area.**

**-Contractions of abdominal wall muscles during stimulation of the receptors of the digestive tract.**

## Viscero-sensory reflexes

**Viscero-sensory reflex is carried through the same pathway like the viscero-somatic, but to provide it must be long-lasting and profound action.**

**Reaction occurs not only in the internal organs and somatic muscles, but in addition to this somatic sensitivity becomes changed.**

**Area of high perception corresponds to the site segment, which receives impulses from annoying visceral organ.**

## Somato-visceral reflexes

**Somato-visceral or dermo-visceral reflex is expressed in the fact that the stimulation of certain areas of the body surface provide vascular response and changes in the functions of visceral organs.**

**This phenomenon gave rise to direction of clinical medicine - *reflexology.***

# Centers regulating visceral functions

Coordination of activities of all three parts of the autonomic nervous system is implemented by

***segmental*** and ***suprasegmental centers*** with the participation of the cerebral cortex.

***Segmental centers*** **due to the characteristics of their organizations are truly autonomous. They are located** ***in the spinal cord and brain stem*****.**

## *Spinal centers*

C7-Th1,2 – spinociliary center /the second neuron – superior cervical ganglion/;
Th1-5 – centers of heart and bronchi activity;
Th- L2 – centers supplying blood vessels and sweat glands;
S2-4 – centers of urination, defecation, erection, etc

***Brain stem centers*** **- these parasympathetic nuclei located** ***in the medulla oblongata, pons, midbrain.***
***These are centers of*** reflexes: sucking, chewing, swallowing, sneezing, coughing, vomiting, saliva production, lacrimation, inhibition of cardiac activity, secretion of gastric glands, etc. These effects are transmitted to the executive structures through the fibers of the vagus, glossopharyngeal, facial and oculomotor nerves.

***Suprasegmental centers* in the brain *are presented by limbic-reticular level mainly.***

***These integrative apparatus of the brain provide a holistic form of behavior, adaptation to changing conditions of internal and external environment.***

***These centers are responsible for regulation of mental health, somatic and visceral functions***

# Levels of ANS Control

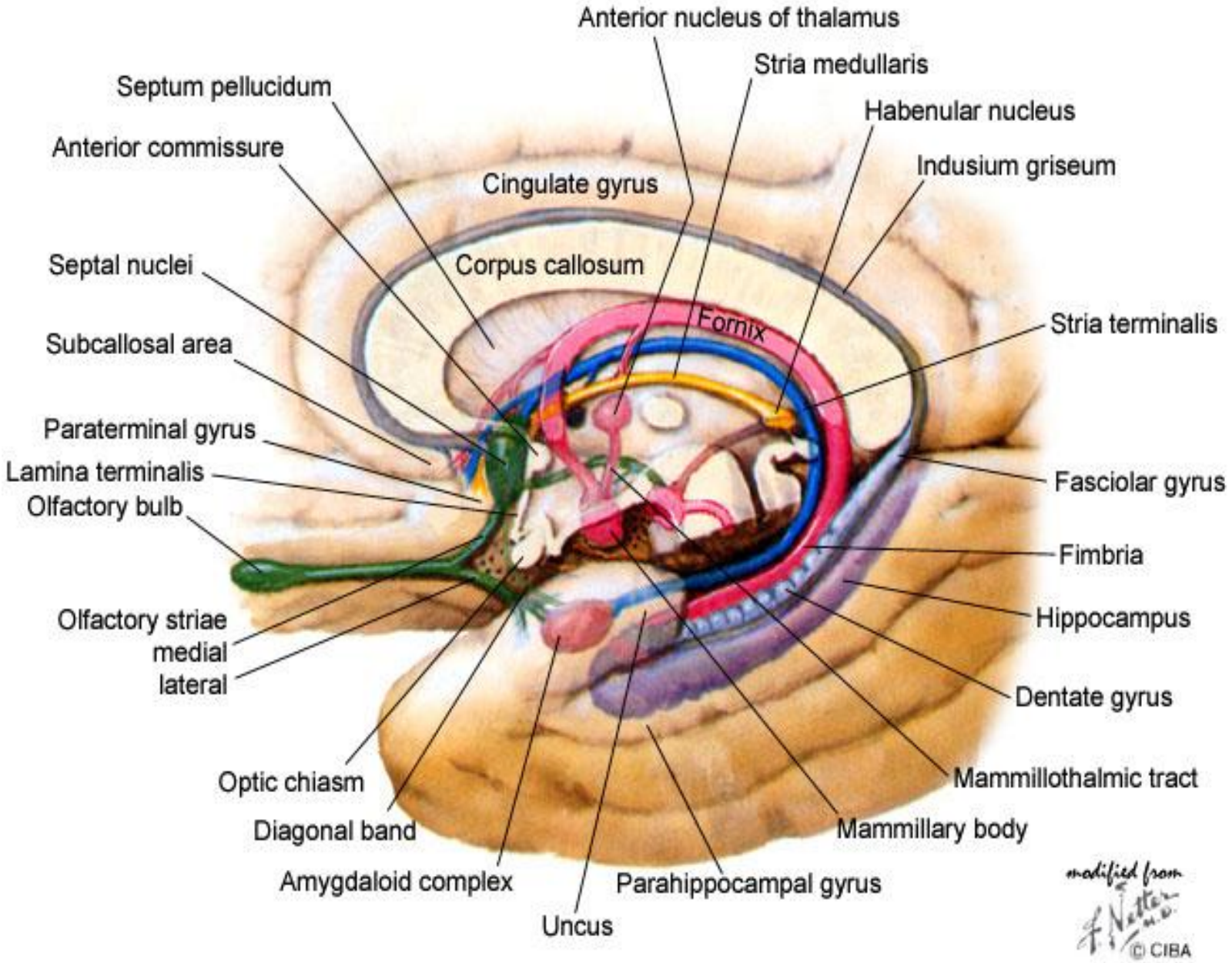
***The hypothalamus* is the main integration center of ANS activity:**
***Anterior – it is associated with parasympathetic function***
***Middle – endocrine – trophy***
***Posterior – has mainly sympathetic influence***

***Subconscious cerebral input via limbic lobe connections influences hypothalamic function***

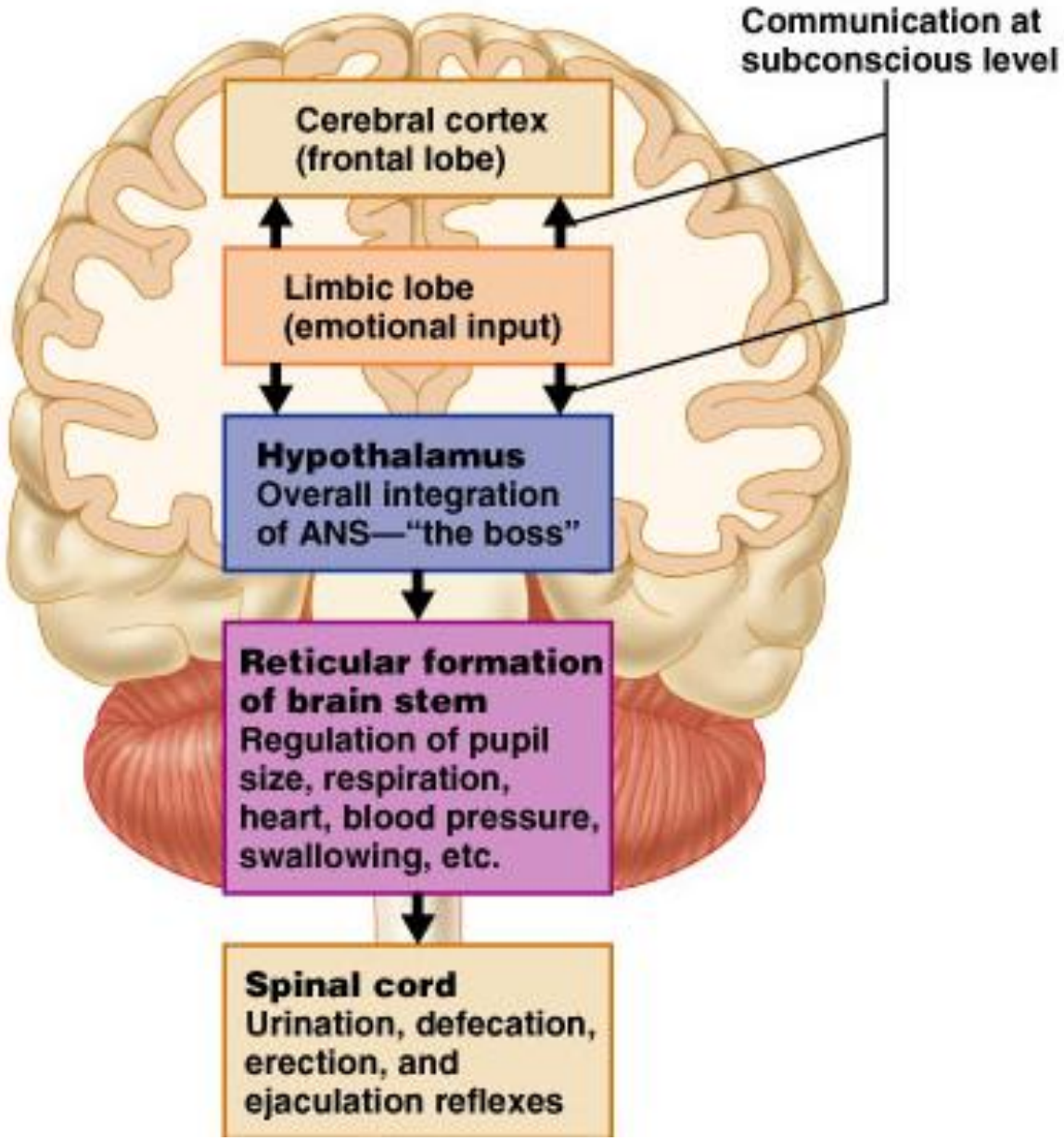
***Other controls come from the cerebral cortex, the reticular formation, and the spinal cord.***

# The limbic system (LS)

- **Bulbus olphactorius, tractus olphactorius, trigonum olphactorii, substantia perforata anterior**
- **Septum pellucidum**
- **Gyrus cinguli**
- **Gyrus hypocampalis**
- **Orbital part of frontal lobe**
- **Corpus amygdaloideum**
- **The pole of temporal lobes**



# Central control of the Autonomic NS




***Amygdala:*** **main limbic region for emotions**

**-Stimulates sympathetic activity, especially previously learned fear-related behavior**

**-Can be voluntary when decide to recall frightful experience - cerebral cortex acts through amygdala**

**-Some people can regulate some autonomic activities by gaining extraordinary control over their emotions**

***Hypothalamus:*** **main integration center**

***Reticular formation:*** **most direct influence over autonomic function**

# Functions of the LS

- Emotional reactions
- The reception of afferent impulses from internal organs
- It is a memory substratum; it preserves information about previous genetically inherited experience
- It provides motivation to thirstiness, hunger, sexual desire
- It regulates the state of sleepiness and liveliness
- It indirectly regulates the function of internal organs

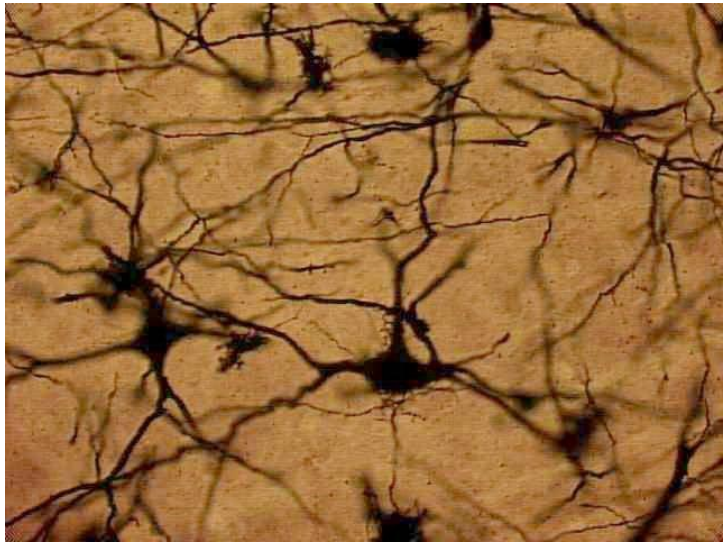
# The symptoms of its lesion

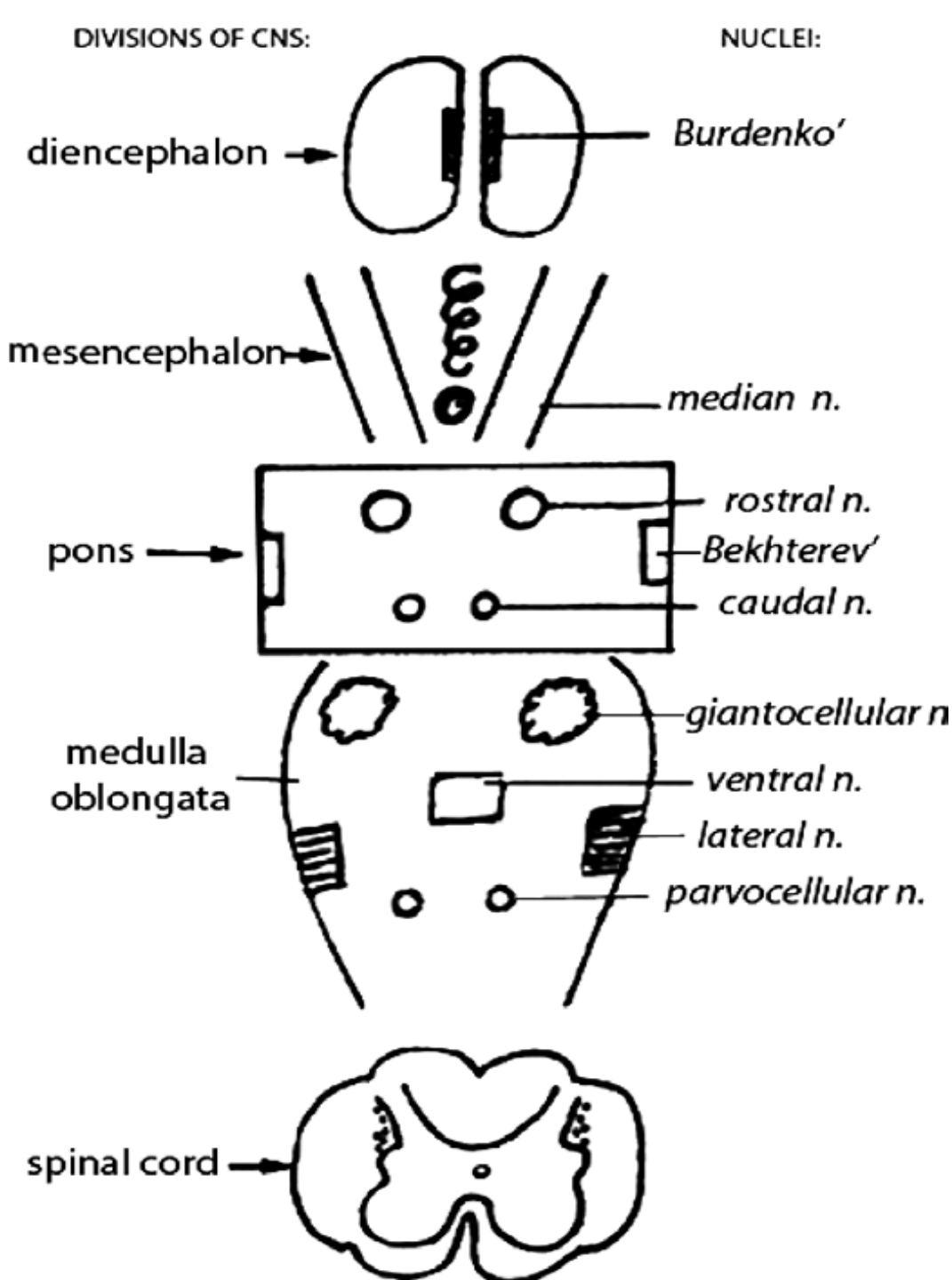
- Emotional disturbances (euphoria and depression)
- Changes of eating (anorexia or bulimia)
- Sleeping disorders (insomnia, lethargy)
- Sexual disturbances (hypersexuality and hyposexuality)
- Memory disorders (especially on current events)
- The irritation of some structures leads to aggression

# Reticular formation

- **It is a tonus motor of the brain, which works constantly in the brain stem. It consists of great number of cells, the axons of which are going in different directions and create a reticule.**

- **In spite of the other cells of nervous system the cells of reticular formation accept pain, light, temperature and humeral impulses and send them to the brain cortex.**





# Functions of the reticular formation

*Sends impulses to the cerebral cortex to keep it conscious and alert

*Filters out repetitive and weak stimuli

*Helps control coarse motor movements

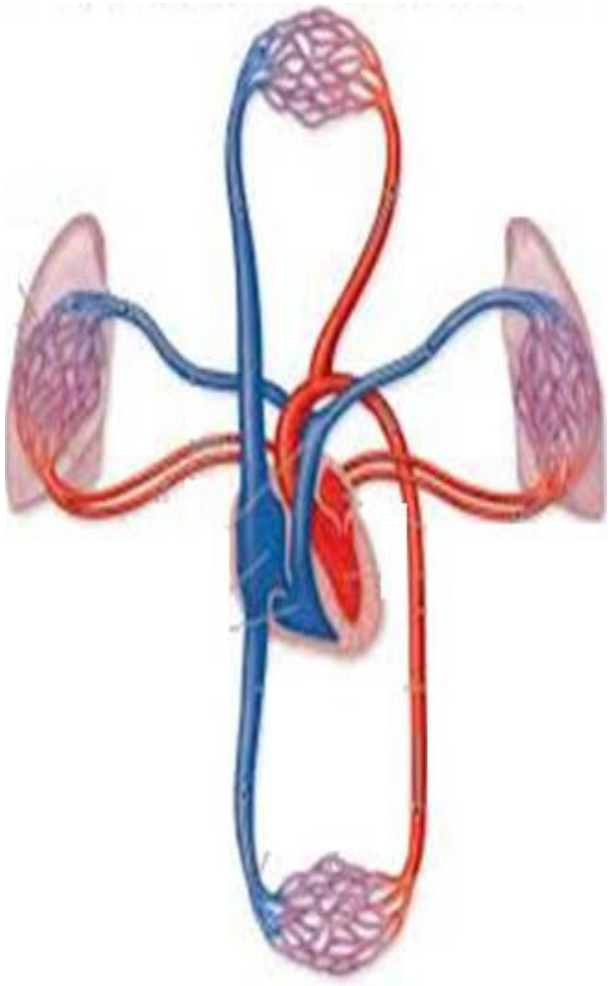
*Autonomic centers regulate visceral motor functions – e.g., vasomotor, cardiac, and respiratory centers

# The symptoms of its lesion

- The low activity of RF – the patient is unconscious
- Decreased activity of RF – sleepiness
- The lower parts of RF have general and long – lasting influence on consciousness and behavior, the upper ones have short – lasting and specific influence

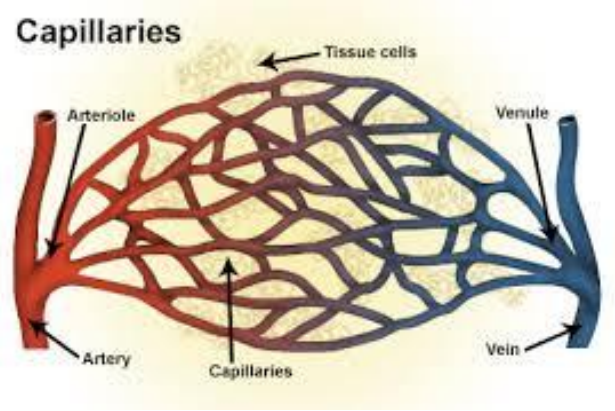
# General laws of the structure, course and branching of blood vessels

- **In 1881, P.F. Lesgaft formulated the "General Law of Angiology," which stated that**
- **"Vascular trunks are located on the concave side of the body and limbs; they divide according to the division of the skeleton, supply branches to the organs surrounding them, and in the circumference of the moving parts form bypass networks lying in the plane of motion ".**
- **The blood vessels are divided by function and structure into *conducting vessels* (*arteries and veins*) and *feeding vessels* (*capillaries*).**
- **Their main function of blood vessels is: to *carry blood ensuring metabolism*.**



**There are 3 types of blood vessels:**

- **Arteries – are vessels by which blood is carried from the heart.**
- **Capillaries – are the thinnest feeding vessels connecting the arterioles and venules that perform the exchange function.**
- **Veins - are vessels through which blood flows from the organs to the heart.**



# VASCULAR PATTERNS

1. ***Blood vessels are located in well-protected places*** **(especially arteries):** ***many arteries run in the musculoskeletal or intermuscular canals and grooves.***

2. **Blood vessels** ***follow the shortest path***

3. ***Most arteries pass together with the veins, nerves and lymphatic vessels forming with them neurovascular bundles***

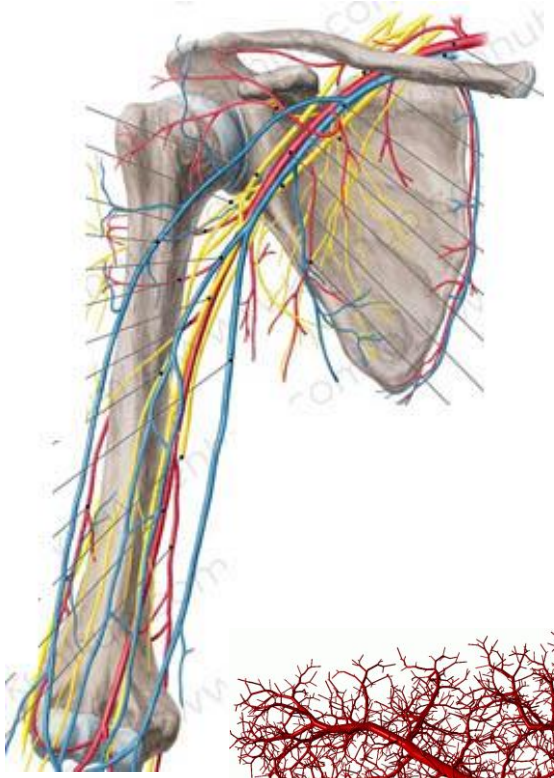
4. ***In the moving parts*** ***of the body and in the moving organs, the arteries are anastomosed, forming vascular arches and networks*****.**

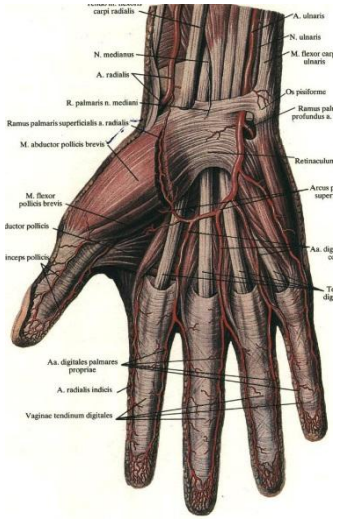
5. ***There are 2 veins per 1 artery*****, therefore there are superficial and deep venous lines.**

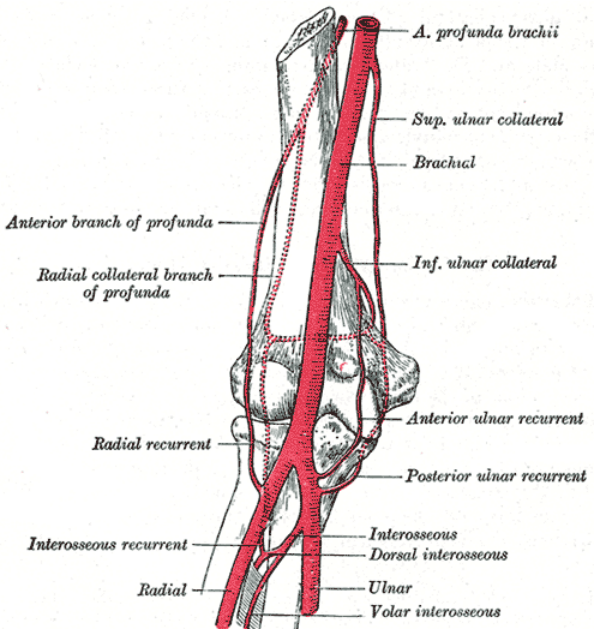
6. ***The lumen of the arteries never collapses*** **due to the elastic frame, the lumen of the veins subsides.**

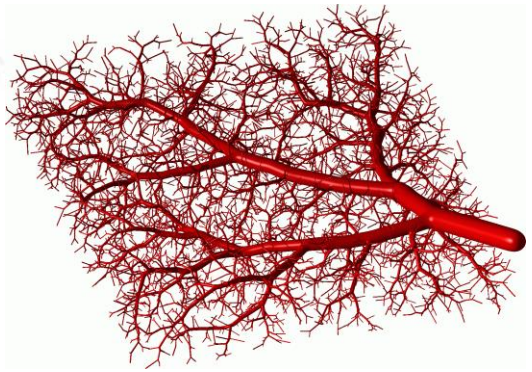
7. **The** ***type of branching*** **of the arteries within individual organs** ***depends on the characteristics of the development, structure and function***

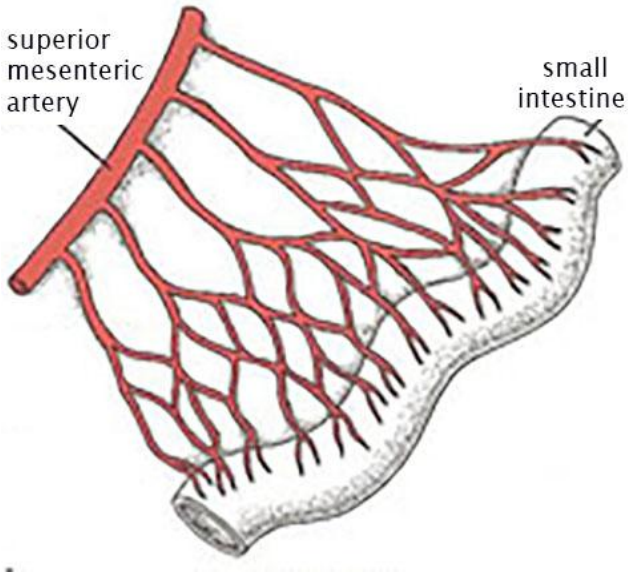
8. **There are four types of arterial branching:** ***loose*** **(the vessel eventually branches into many small ones),** ***magistral*****,** ***dichotomous*** **(vessels split into 2 identical) and** ***terminal*** **(there are no anastomoses between the arteries).**







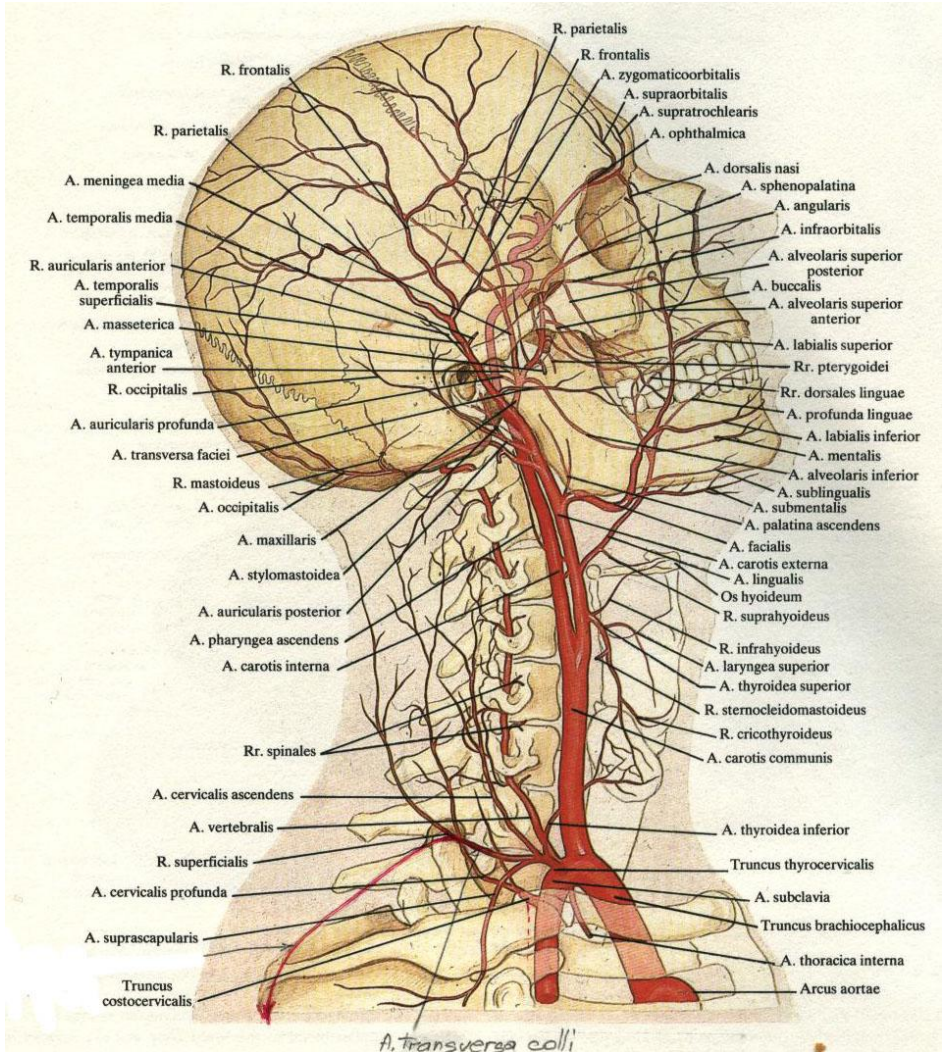


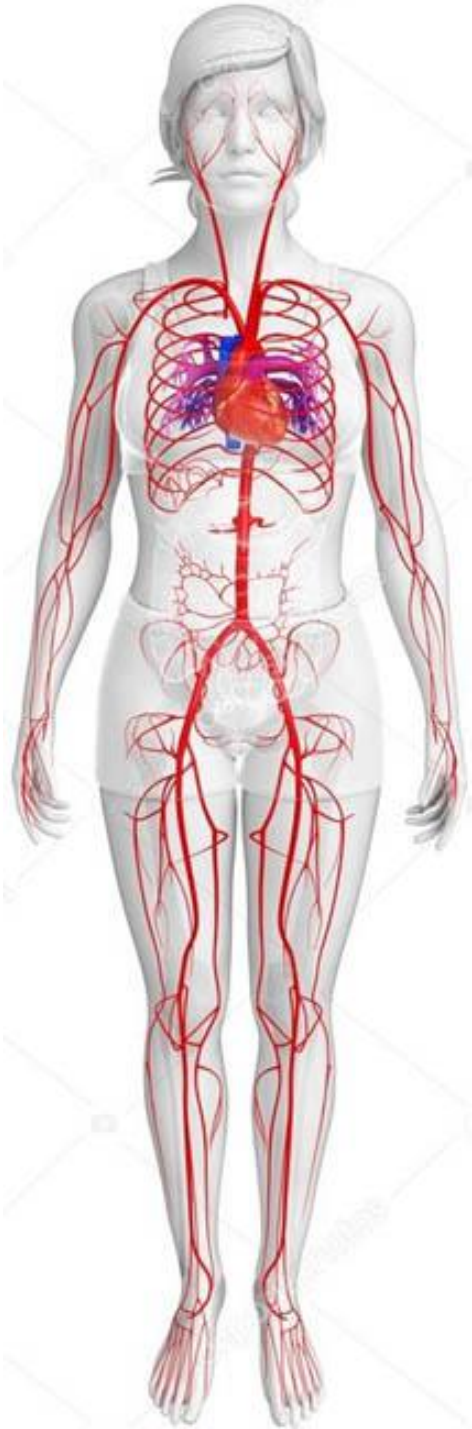
# Specific regional vascular pattern

- ***Each half of the head*** is supplied with a single arterial highway, which is divided according to the divisions of the bone skeleton:

the common carotid artery gives the external carotid artery, supplying mainly the facial section, and the internal carotid artery, which branches in the cranial cavity.

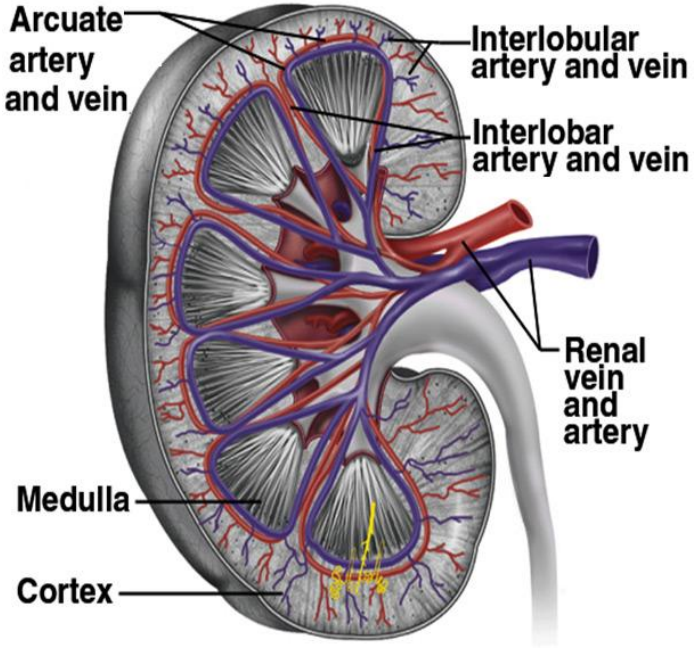
- ***On the upper limb,*** the arterial highway includes the subclavian, axillary, and brachial arteries; reaching the forearm, it is divided into the ulnar and radial arteries, which in turn are divided according to the number of bone rays.
- ***The common iliac artery*** is divided into the internal iliac, which supplies mainly the pelvis, and the external iliac, continuing to the free lower limb. Here the arterial highway passes to the knee joint, at the level of which it is divided into two vessels, the anterior and posterior tibial arteries, and on the foot,



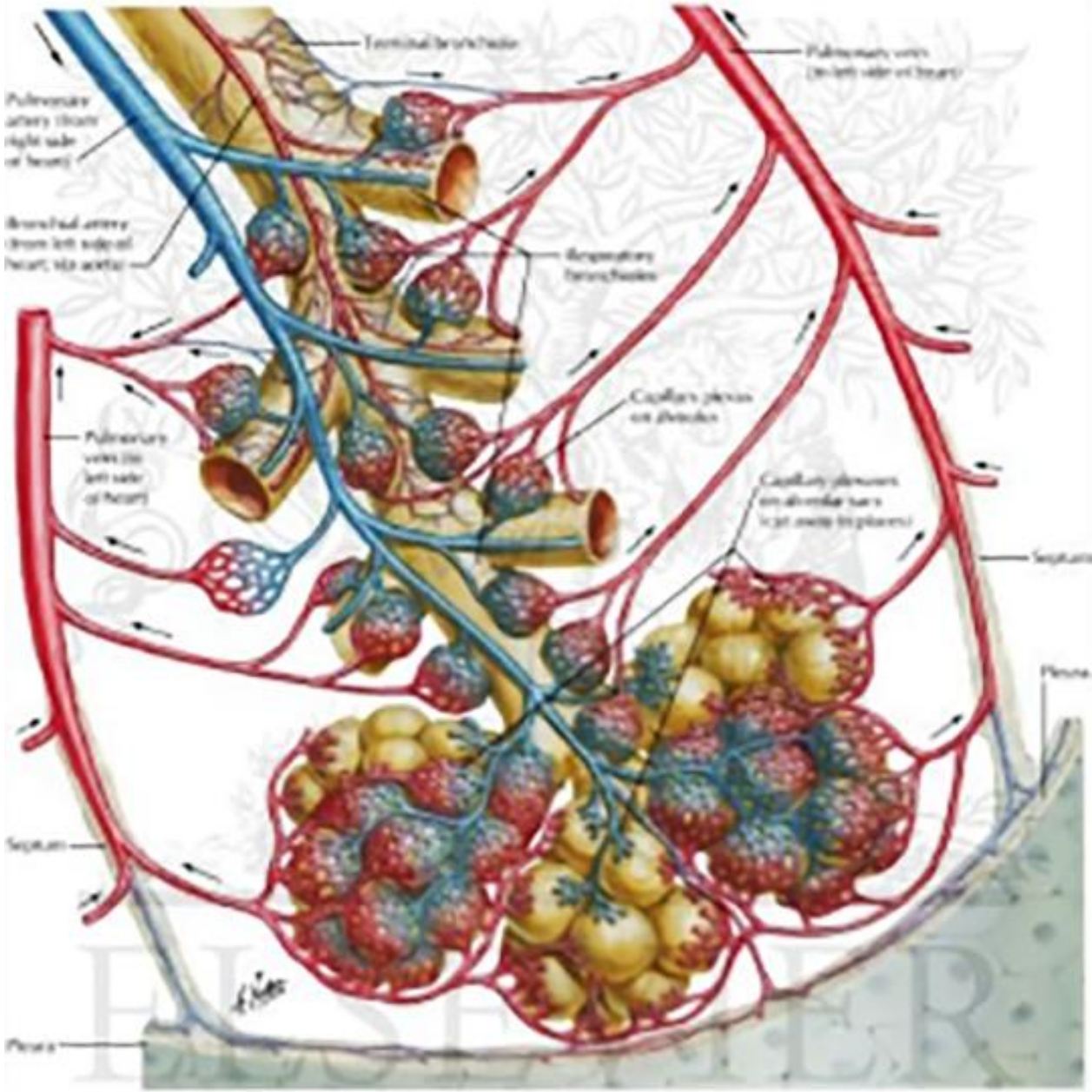
# Intraorganic vascular pattern

- **The structure of the *intraorganic arterial bed depends on the development, structure and function of the organ*. According to the angiogenetic law of V.Shpaltegolts, the nature of the blood supply to the organs is determined by their insertion in the embryonic period.**
- **Thus, *parenchymal organs usually have 1-2 major sources of blood supply, which in the substance of an organ break up into lobar, segmental, subsegmental and lobular vessels*.**
- **The hollow *organs of the gastrointestinal tract receive blood from arcade anastomoses in the form of numerous arteries circling the organ*.**
- **Vascular plexuses are formed in the membranes of the cavitary organs: submucosal, intermuscular, subserous.**
- **In the hollow organs of the urogenital system, as a rule, there are several main arteries, oriented along the axis of the organ. Branches**
- **In the *pia mater of the brain and spinal cord a dense anastomotic network* is formed.**
- **In the substance of *the brain vessels penetrate radially*.**
- ***In the muscles and bones*, numerous sources of blood supply, anastomosing between themselves, form a looped structure, and *in the skin - networks and plexuses*.**
- **Venous vessels, basically, repeat the course of arterial, but they can form independent plexuses and trunks**



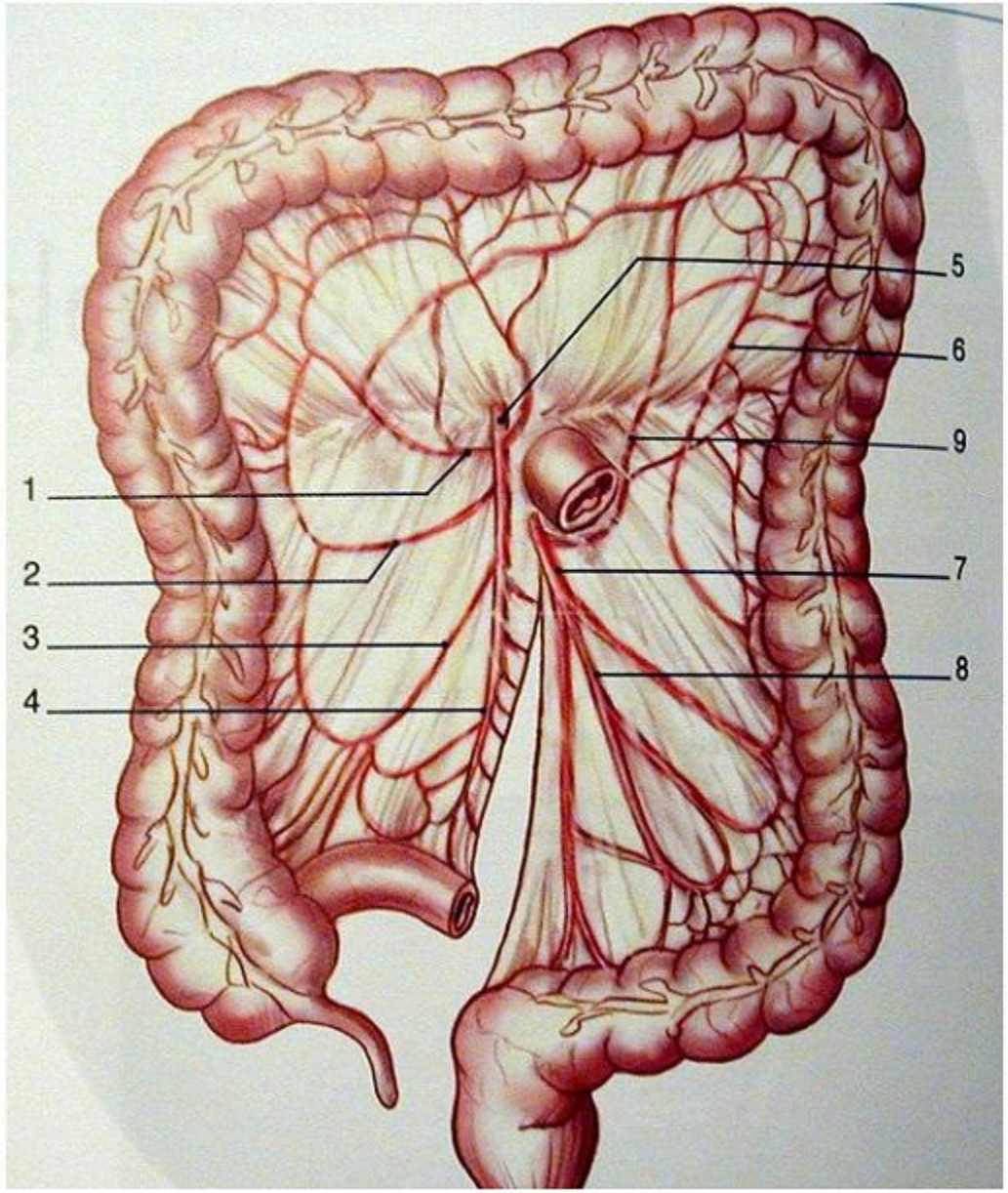
# Vascularization of the lungs

- **Blood to be oxygenated is carried by the *pulmonary arteries*, whereas the tissue of the bronchial tree and alveoli is nourished by the *bronchial arteries*.**
  **The branches of the pulmonary arteries within the lungs accompany the bronchi and end in capillary networks in the alveoli.**
  **The pulmonary veins collect oxygenated blood from the lung and deoxygenated blood from the bronchi and visceral pleura.**
  **Pulmonary veins are intersegmental in location. Usually four pulmonary veins enter the left atrium.**



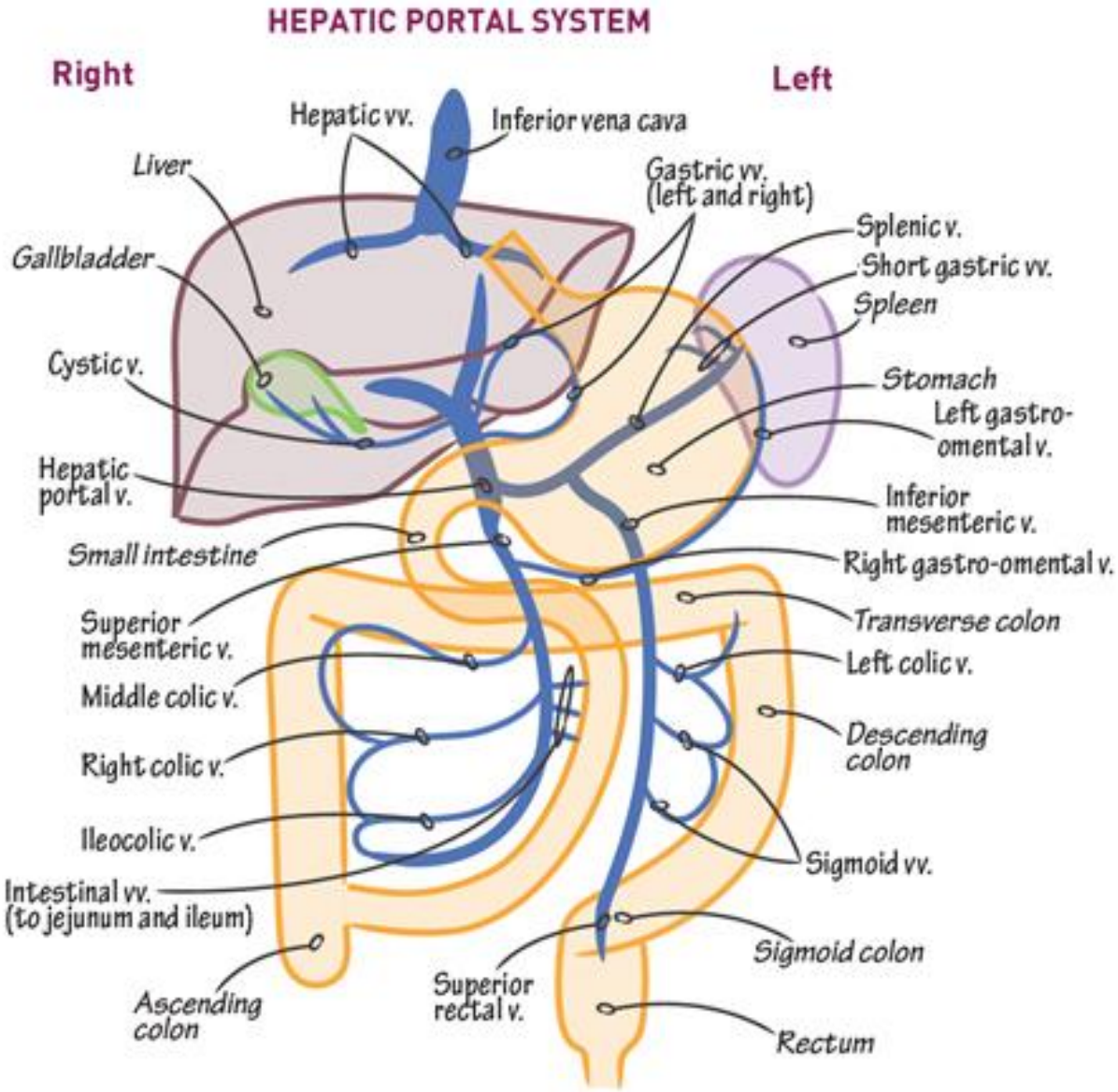
# Vascularization of the alimentary canal

- The alimentary canal is not only one of the vital organs in the body, but also one of the largest.
- Because of this and because of its many diverse functions, it requires a circulatory system capable of responding to its many functional requirements. As such, the circulation of the alimentary canal, particularly the splanchnic circulation, which is its major component, has a number of special characteristics.
- ***The splanchnic circulation is the portion of the systemic circulation that supplies the gastrointestinal tract (i.e., the abdominal portion of the digestive tract) plus the spleen. It is the largest regional circulation supplied by the aorta, receiving more than a quarter of the left ventricular output at rest regardless of whether the subject is fasted or fed.***
- The physiological role of the splanchnic circulation is to supply the oxygen and nutrients required to support the activities of the digestive tract (motility, secretion, digestion, and absorption). Along with the lymphatic circulation, it ensures also the transfer of absorbed nutrients and water to the rest of the body.



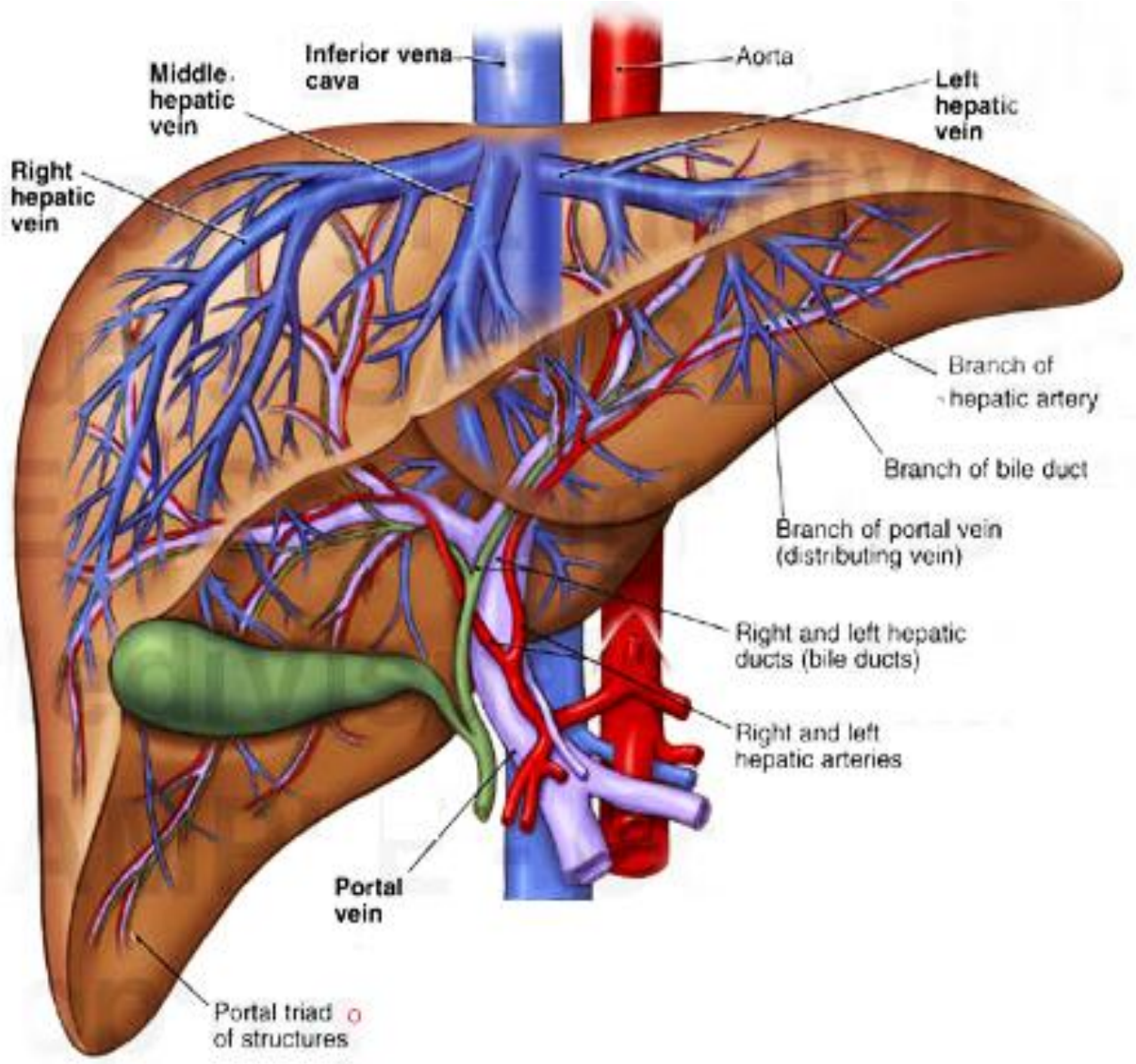
# Peculiarities of venous drainage of the GIT

- Blood from the digestive system is rich in absorbed nutrients derived from intestinal digestion including sugars, fatty acids and amino acids which are produced in digestion of carbohydrates, fats and protein respectively.
- Along with this many bacteria, toxins and potentially hazardous substances also get absorbed.
- All these are first taken to the liver where excess sugars are stored as glycogen in liver, fatty acids are used to generate cholesterol and transported for utilisation, amino acids are converted into various critical proteins like albumin. The liver also extracts and detoxifies harmful substances before they can enter the general circulation and protects other organs from being damaged by these poisons. The liver is the filter and metabolic powerhouse of the body and hence is the first portal for blood from the digestive tract.
- Venous blood is curried to the liver by system of the portal vein.



# Vascularization of the liver

- **The liver is unique among organs in that it receives blood via two distinct circulatory routes: *systemic circulation* and *hepatic portal circulation.* Each of these routes provides blood of differing compositions that allow the liver to perform its unique and vital digestive and metabolic functions.**
- **Right and left hepatic arteries arteries further branch off into many smaller arteries and arterioles and, finally, capillaries to provide oxygen and nutrients to all of the tissues of the liver and gallbladder.**
- **The hepatic portal vein provides the liver's tissues with deoxygenated blood that has passed through the tissues of the stomach, pancreas, spleen, and intestines. This blood is rich in dissolved nutrients absorbed from digested food, as well as any toxins or medications consumed by the body. Before this material can reach the other tissues of the body, it passes through the hepatic portal vein and enters the liver, wherein it is divided among many specialized capillaries, known as sinusoids. In the sinusoid, the deoxygenated blood is processed by hepatocytes, which can absorb or release nutrients as needed and metabolize dangerous chemicals before they can affect the rest of the body.**



# Good luck