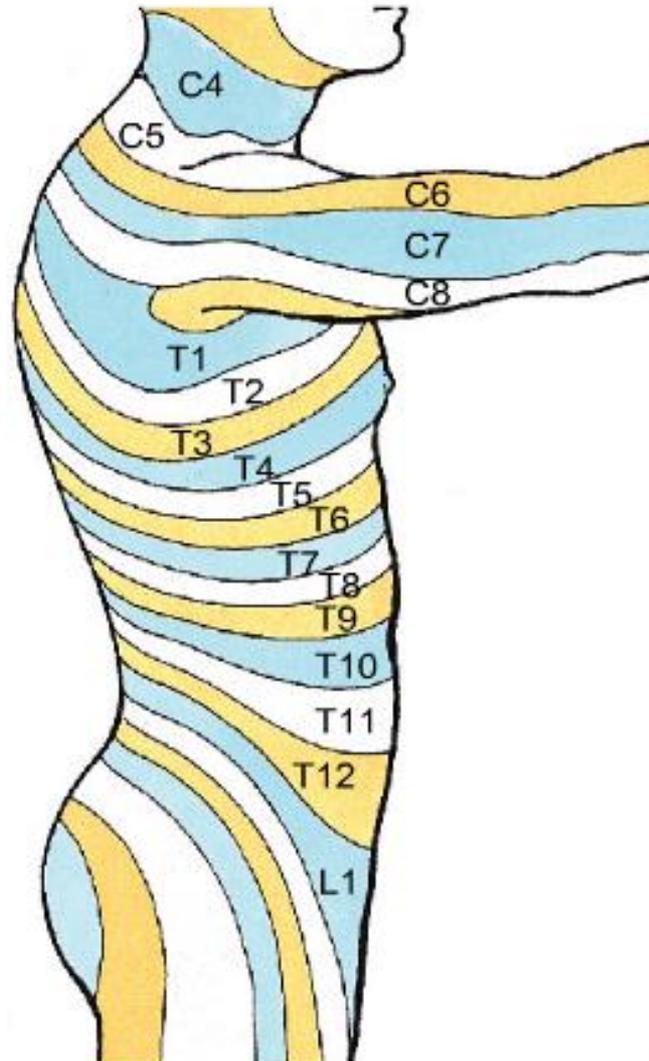


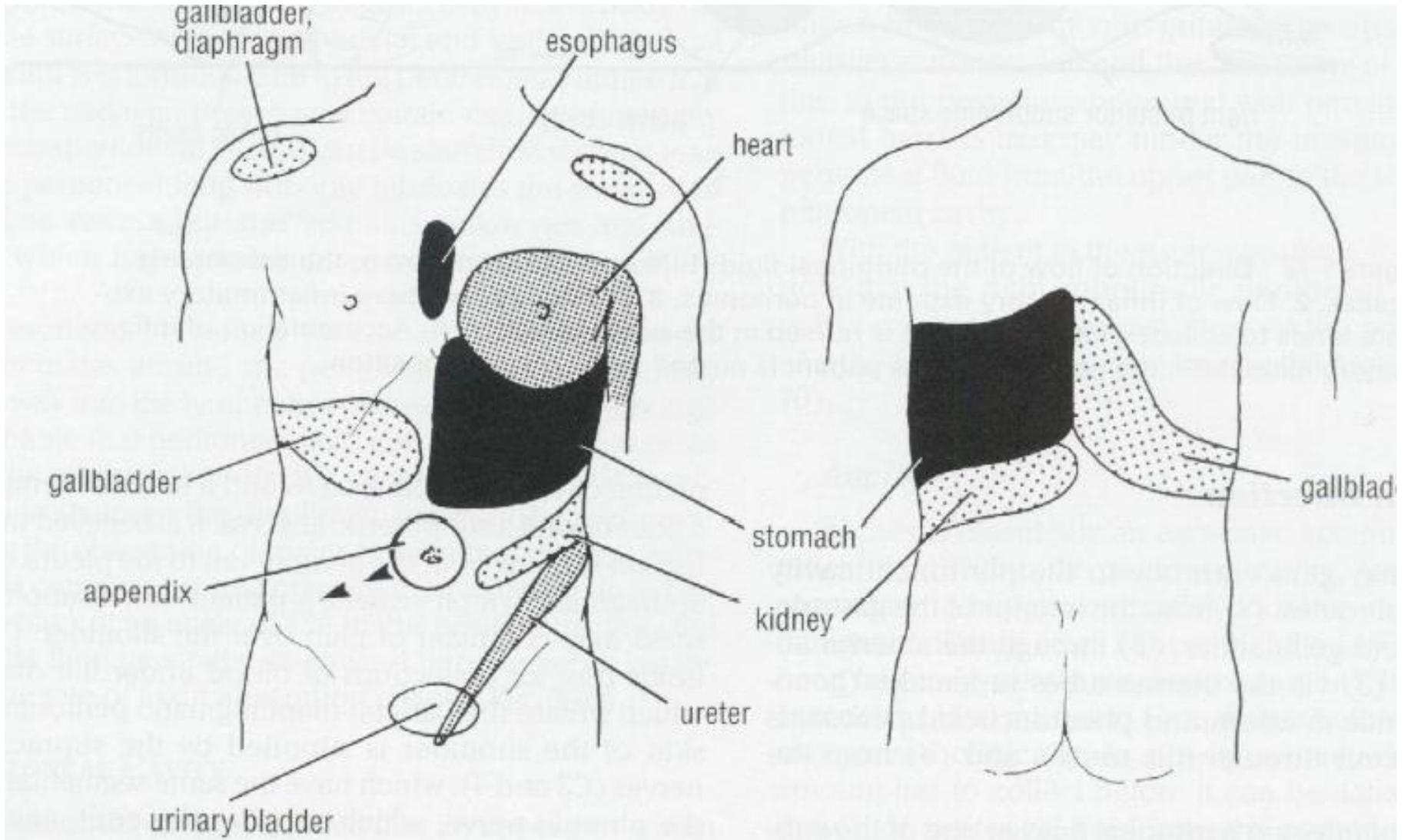
# visceral referred pain

- Left. Anterior view. Right. Posterior view.
- Pain arising from a viscus (organ) varies from dull to severe but is poorly localized. It radiates to the part of the body other than site of pain. The pain is interpreted by the brain as though the irritation occurred in the area of skin supplied by the dorsal roots of the affected segments. This is called visceral referred pain.

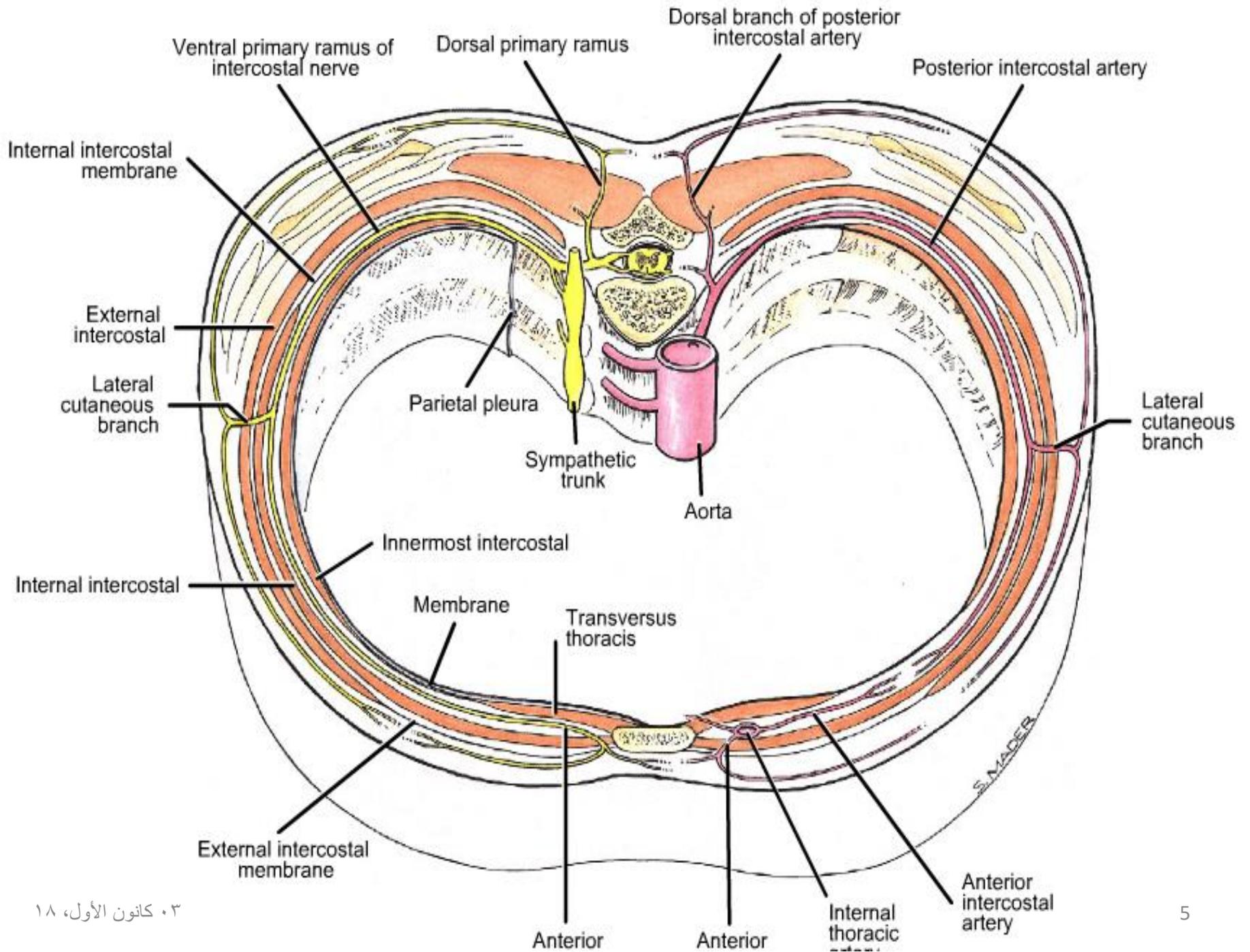
- **Greater splanchnic nerves: visceral branches (*afferent fibers(sensory)*);** of the sympathetic ganglia at T5-T9 that communicates with the spinal nerves at the corresponding segment of the spinal cord white and gray rami communicants, so holds sensory enervation to dorsal root of that segment (from the viscera) and interpreted by the CNS to pain to skin supplied by the corresponding spinal nerve (dermatome).
- **Lesser splanchnic nerves: visceral branches of the sympathetic ganglia at T10-T11**
- **Least splanchnic nerves: visceral branches of the sympathetic ganglia at T12**

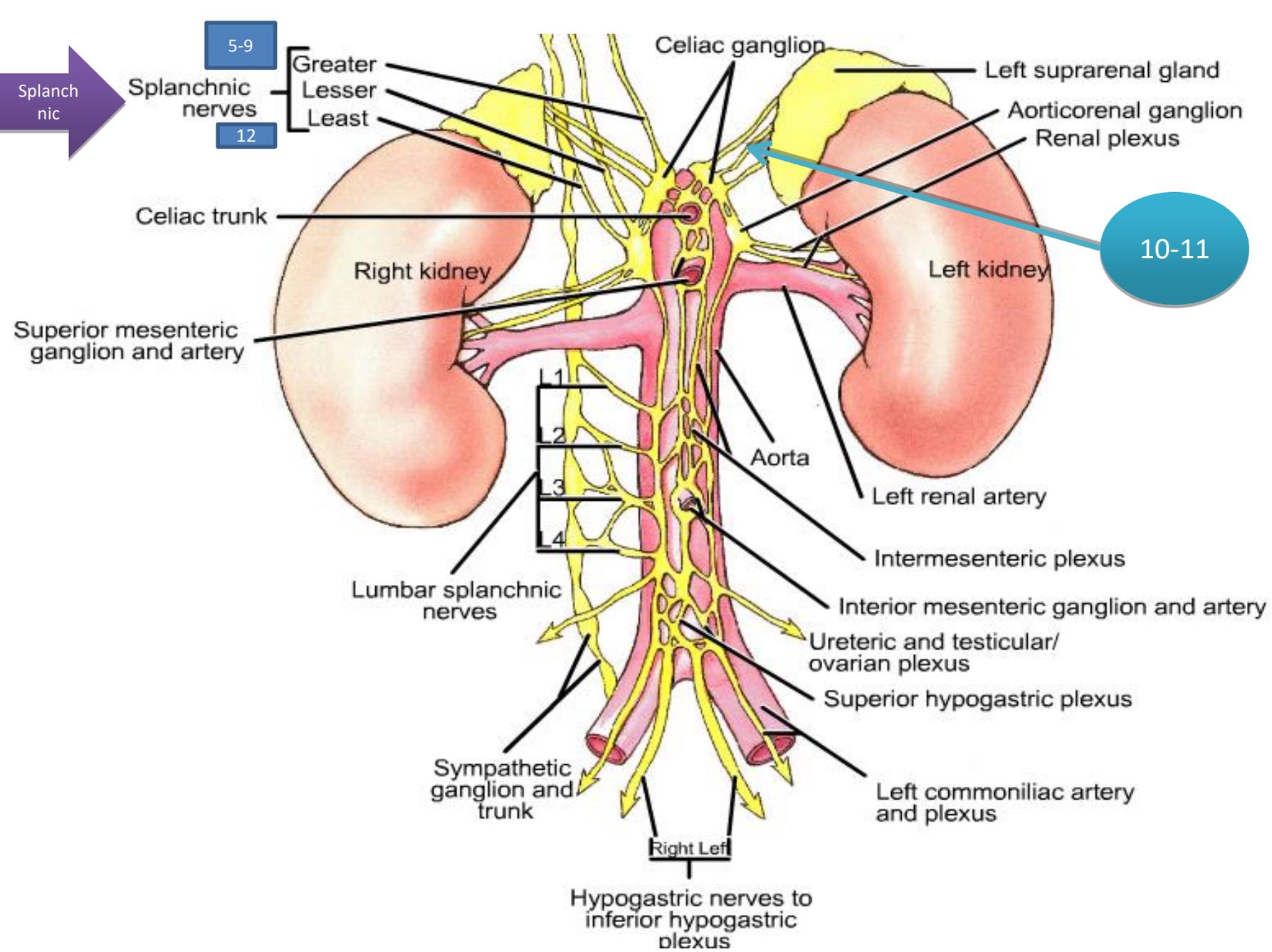
# Dermatome

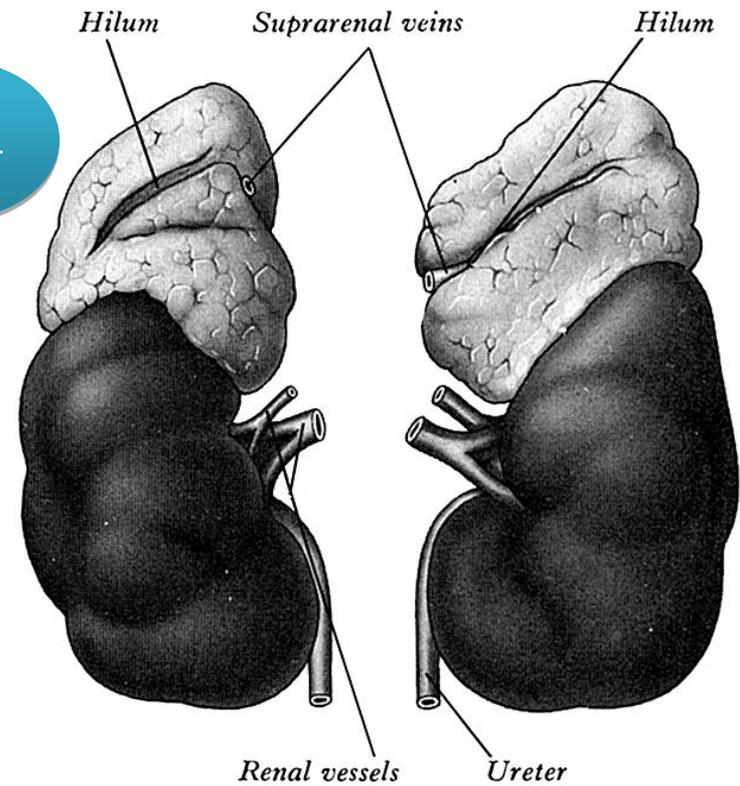
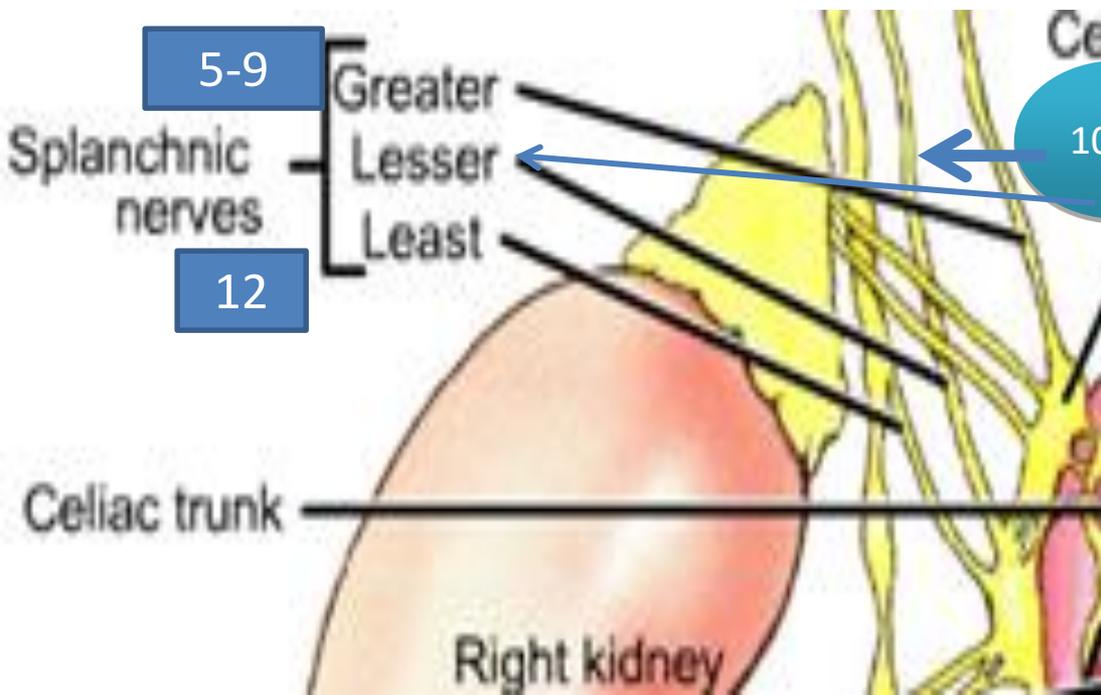




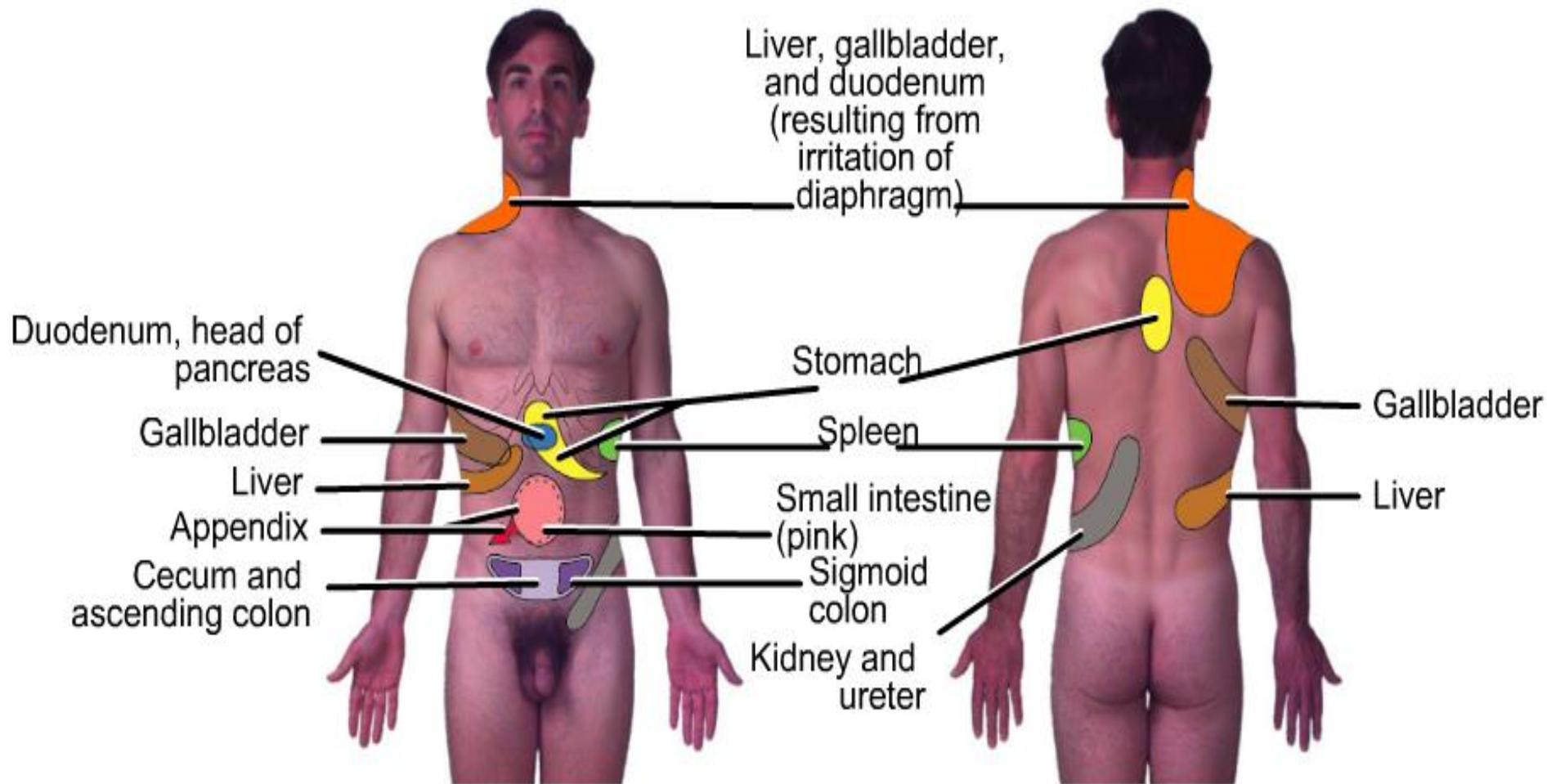
**Figure 5-71** Some important skin areas involved in referred visceral pain

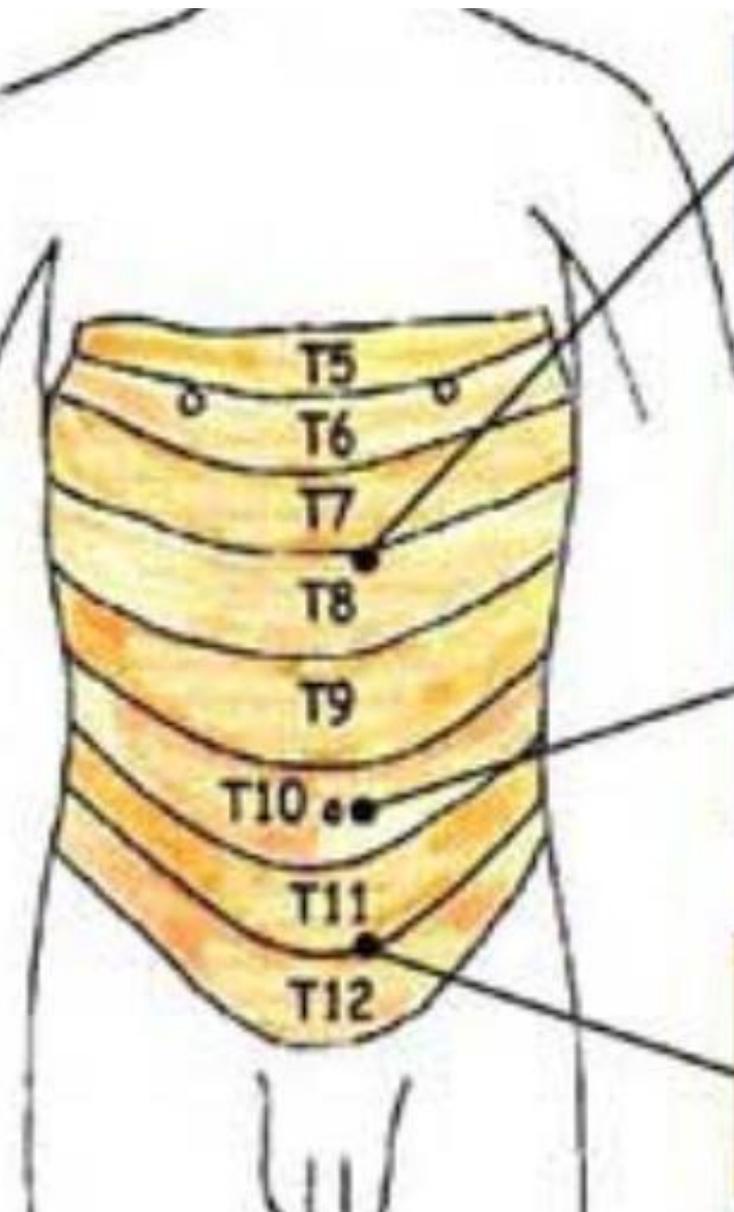






The greater splanchnic nerve is formed by fibers from the **5<sup>th</sup> to 10<sup>th</sup>** thoracic ganglia, and the lesser splanchnic nerve receives fibers from the **10<sup>th</sup> and 11<sup>th</sup>** thoracic ganglia. Both nerves contain preganglionic and visceral afferent fibers(sensory);





Foregut pain referred to epigastrium via greater splanchnic nerves (T5-9)

Midgut pain referred to peri-umbilical region via lesser splanchnic nerves (T10,11). Only when the parietal peritoneum (somatic) over the appendix becomes inflamed does the pain localise into the right iliac fossa

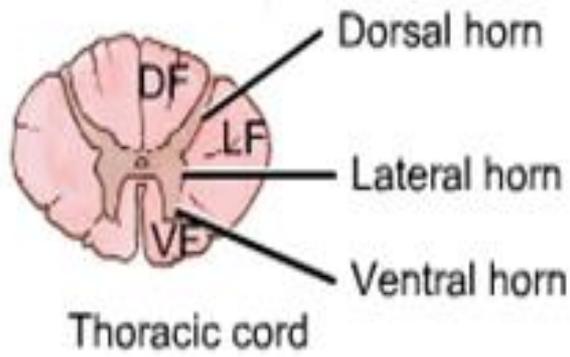
Hindgut pain referred to suprapubic region via least splanchnic nerves (T12)

- The renal pelvis and ureter sends their afferent fibers into spinal cord segment T11-12, L1-2, colicky pain referred to skin in an area supplied by these segment of the spinal cord (flank, lion, and groins). If the defect is in lower parts the pain referred to the testis or the tip of the penis (male) and labium majors (female).some may be through (L1-2) to the front of thigh if severe spread to CNS cause nausea and vomiting.

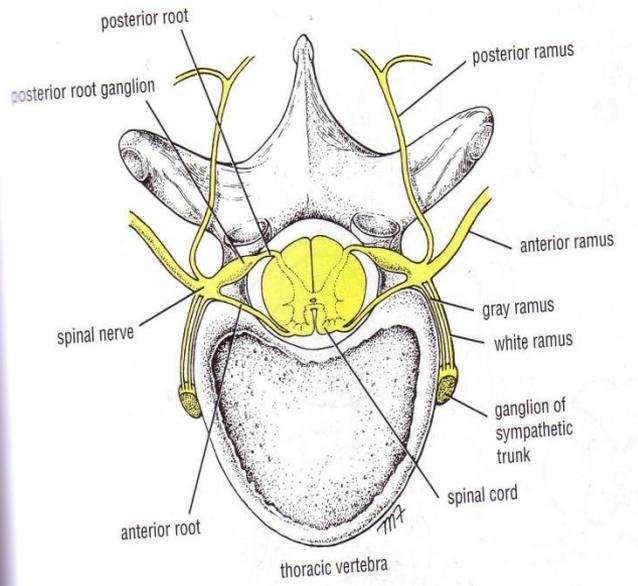
- ***This supply is autonomic, and has both efferent (sympathetic and parasympathetic) and afferent components. Parasympathetic fibres reach the heart through vagal branches, the sympathetic from the branches of the sympathetic trunk .***

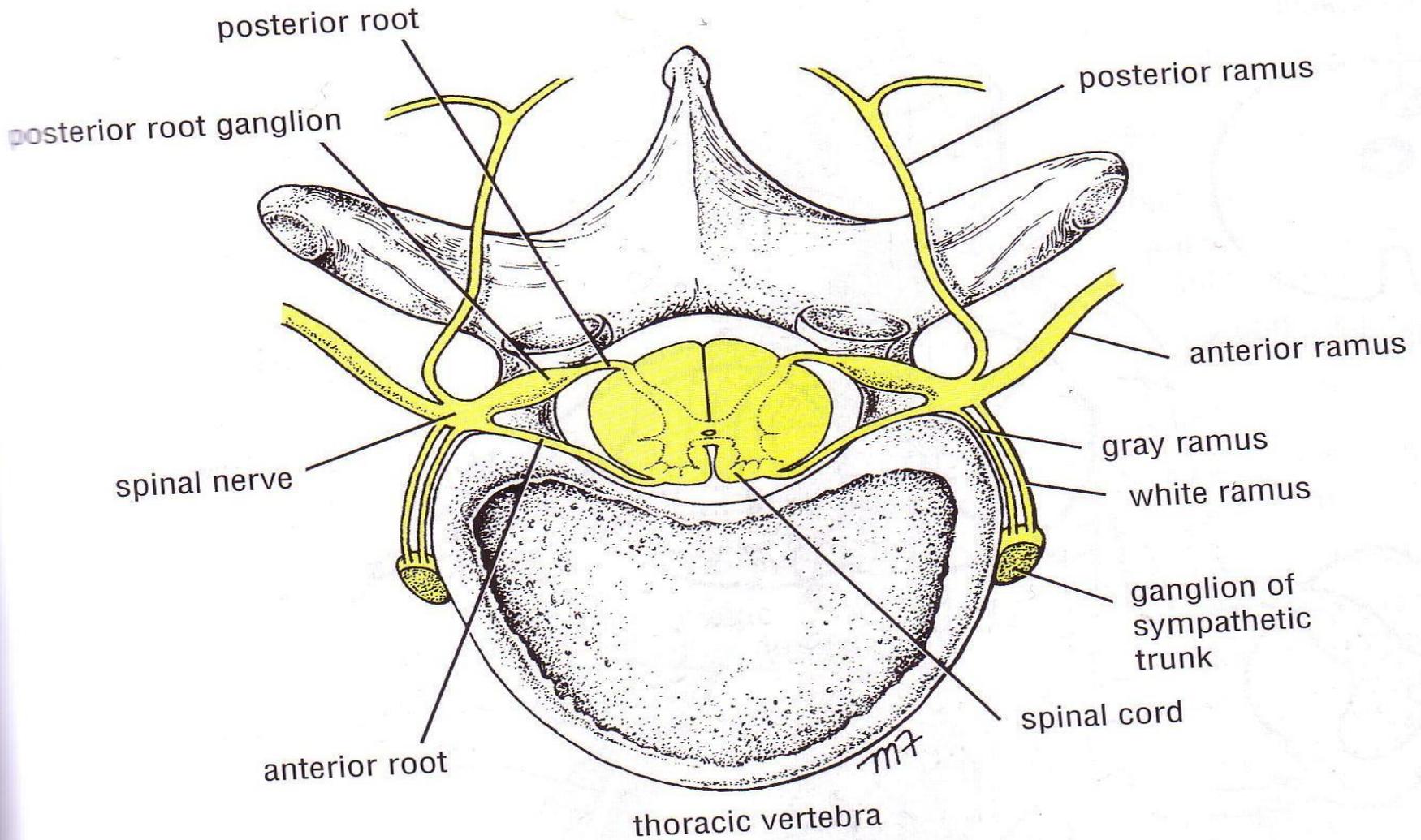
- ***Vagal preganglionic fibres proceed from origins within the brainstem, particularly the medulla, including the nucleus ambiguus, the reticular nuclei and possibly the dorsal vagal nucleus to the R and L vagal branches to the cardiac plexus.***

- **Sympathetic preganglionic neurons are in the upper five or six segments of the intermedio lateral column of the thoracic spinal cord.**



- **These fibres end in the cervical and the third and fourth thoracic sympathetic ganglia, from all of which postganglionic fibres proceed bilaterally to the heart.**





**Figure**  
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 trun

## Association between spinal cord ,spinal nerves & sympathetic

# Referred pain from liver and diaphragm

Is the feeling of pain at a location other than the site of origin of the stimulus, but in an area supplied by the same or adjacent segments of the spinal cord. Both somatic and visceral structures can produce referred pain.

For example, it's unlikely but possible that your shoulder pain is a sign of something insidious happening in your **liver, gall bladder, stomach, spleen, lungs, or pericardial sac** (the connective tissue bag containing the heart). Conditions as diverse as liver abscesses, gallstones, gastric ulcers, splenic rupture, pneumonia, and pericarditis can all cause shoulder pain

To understand referred pain from any structure you should have some information about the nerve supply of that structure (regarding the type of innervation and the root origin of the nerve fibers supplying the structure) and also some information about the cutaneous nerves (nerves supplying the skin) having the same root origin as that of the nerves supplying the structure or containing some of the spinal roots that are common to both.

- For example, regarding referred pain from diaphragm, we should know that the only motor nerve supply of the diaphragm is by the phrenic nerves (C3, C4, and C5) and we should also not forget that supraclavicular nerves have root origins of C3 and C4.
- But first, let's go through a brief description of each of liver and diaphragm and have some information on the nerve supply of both structures

## Introduction

- The liver is the most massive of the viscera, occupying a substantial portion of the abdominal cavity. It is essential to life, since it carries out a multiplicity of metabolic activities necessary for homeostasis, alimentation (التغذية) and defense.

## Innervation:

- The hepatic nerves arise from the hepatic plexus containing sympathetic and parasympathetic (vagal) fibres. They enter at the porta hepatis and largely accompany blood vessels and bile ducts; very few run amongst the liver cells and their terminations are uncertain. Both myelinated and non-myelinated fibres reach the liver from nerves in its various peritoneal folds.

# Clinical Anatomy of the Liver

On account of its large size, fixed position, and friability, the liver is sometimes ruptured; haemorrhage may be severe, because the hepatic veins lie in rigid canals and are unable to contract. The organ may be torn by a broken rib, perforating the diaphragm.

Clinical evidence suggests that the bloodstreams of the superior mesenteric and splenic veins remain largely separate in the portal vein, passing respectively along the right and left portal branches to the right and left physiological (vascular) lobes;

thus malignant or infective emboli may be more pronounced in the right lobe if the primary disease is in the territory drained by the superior mesenteric vein, or in the left if it is in the splenic or inferior mesenteric territory. Vascular hepatic segmentation is a vital factor in partial hepatectomy.

## ***Anatomy of the diaphragm***

*The diaphragm is a curved musculofibrous sheet that separates the thoracic from the abdominal cavity, its mainly convex upper surface facing the former, and its concave inferior surface directed towards the latter. Its muscle fibres arise from the highly oblique circumference of the thoracic outlet, the attachments being low posteriorly and laterally, but high anteriorly.*

- The muscular origin of the diaphragm is from the lower 6 ribs bilaterally, the posterior xiphoid process, and from the external and internal arcuate ligaments.*

# Nerve Supply

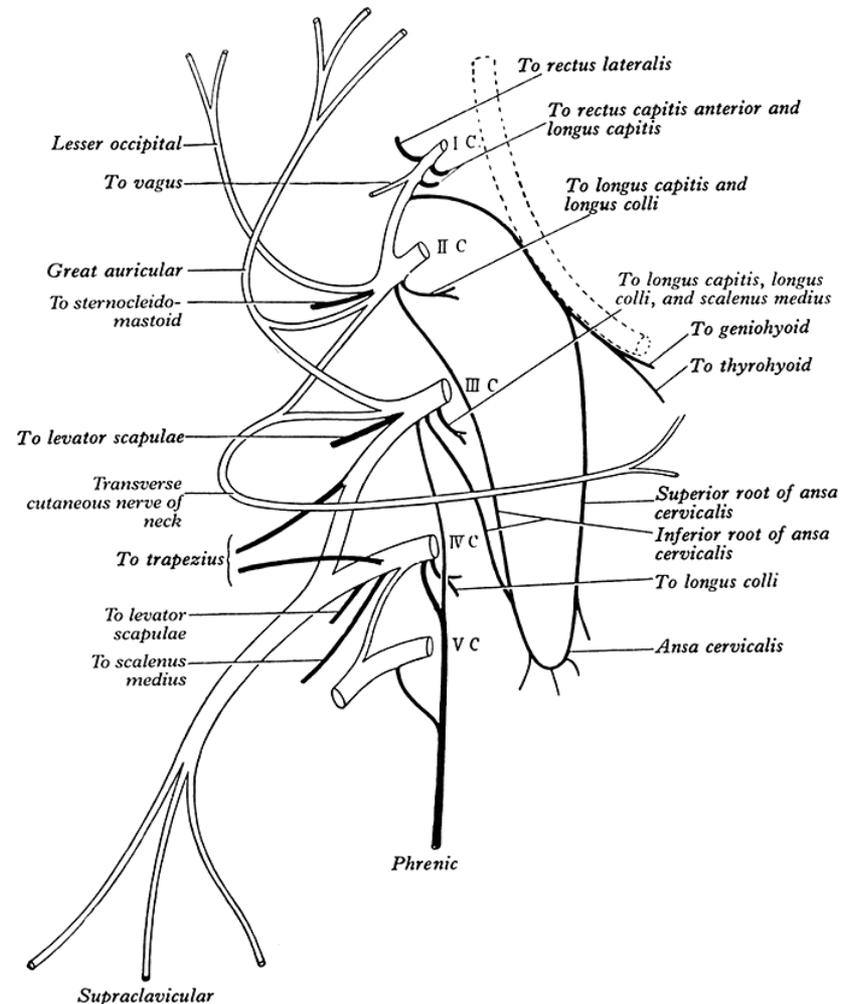
The diaphragm receives its motor supply via the phrenic nerves, which emerge from spinal cord levels **C3, C4, and C5** (medical students remember these spinal cord levels using the mnemonic, "C3, 4, 5 keeps the diaphragm alive"). Sensory fibres are distributed to the peripheral part of the muscle by the lower six or seven intercostal nerves.

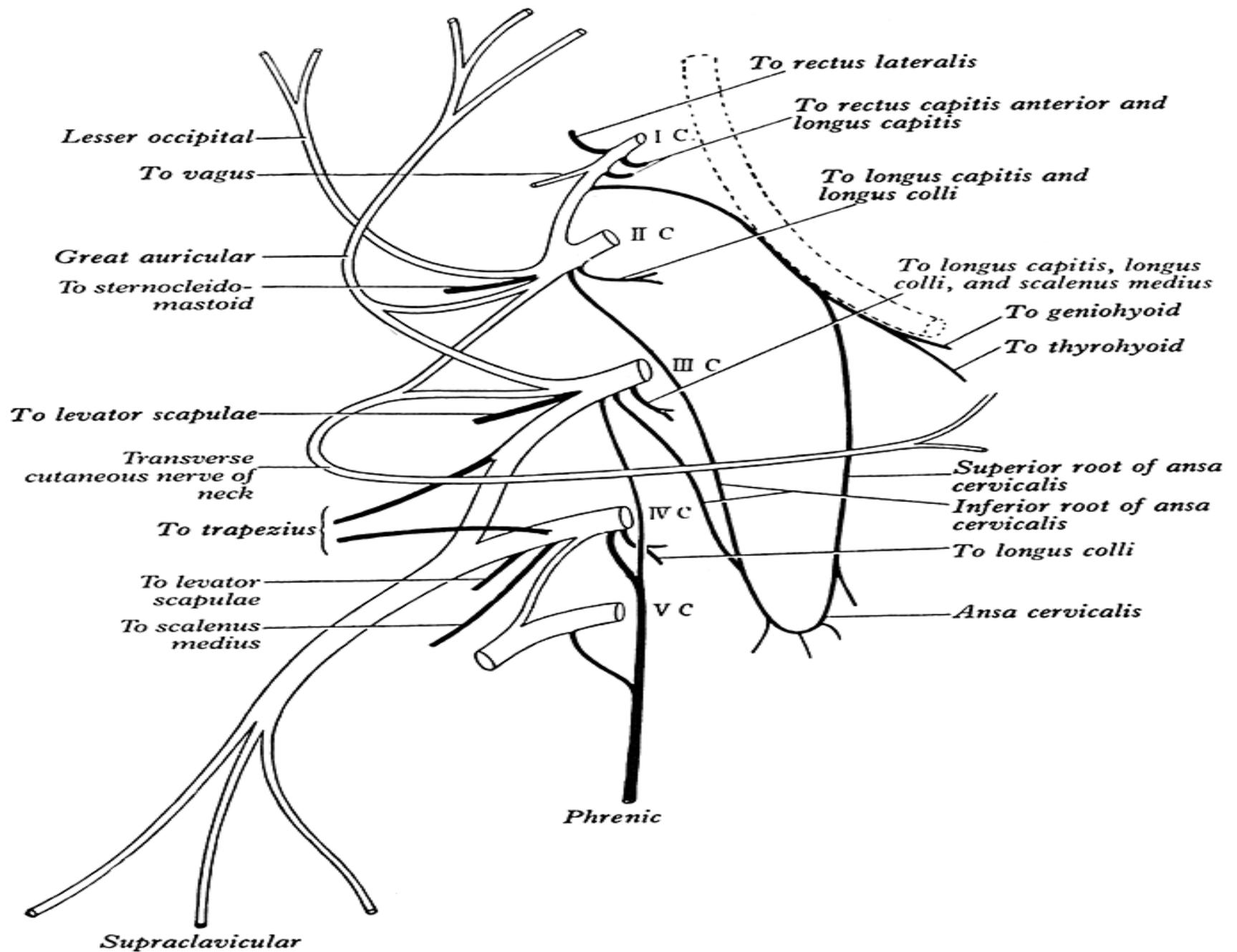
- It has been suggested that the motor innervation of the crural fibres comes from intercostal nerves, but Shehata (1966) has confirmed that the phrenic nerves are the source of supply.

The right crus of the diaphragm, whose fibres divide to the right and left of the oesophageal opening, is innervated by both right and left phrenic nerves. Although the crural fibres are not innervated separately from the rest of the diaphragm, there is some evidence that this part of the diaphragm contracts slightly before the costal part and this may be functionally significant. Because of common nerve root origins in the neck, diaphragmatic pain is frequently felt at the tip of the scapula

# The Phrenic Nerve

- This is the sole motor supply to the diaphragm, and also contains widespread sensory fibres. It arises chiefly from the fourth cervical ramus but also has contributions from the third and fifth.





## *Its course:*

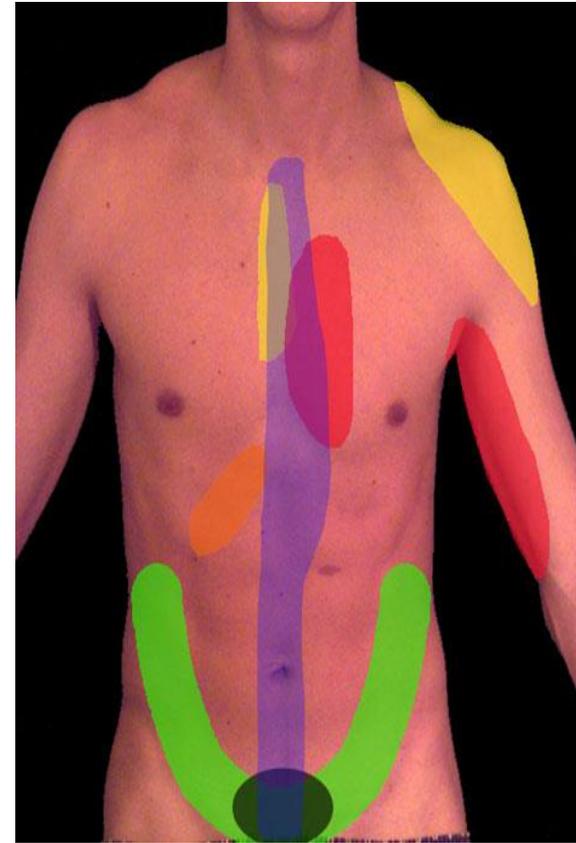
Formed at the upper part of the lateral border of the scalenus anterior, it descends almost vertically across it behind the prevertebral fascia. It descends posterior to the sternocleidomastoid, the inferior belly of omohyoid (near its intermediate tendon), the internal jugular vein, transverse cervical and suprascapular arteries and, on the left, the thoracic duct. It then runs anterior to the subclavian artery, posterior to the subclavian vein and enters the thorax by crossing medially in front of the internal thoracic artery, after which it descends anterior to the pulmonary hilum, between the fibrous pericardium and mediastinal pleura, to the diaphragm, accompanied by the pericardiophrenic vessels. The right and left phrenic nerves differ in their intrathoracic relations.

## *Supraclavicular Nerves*

These arise by a common trunk from the third and fourth cervical ventral rami and emerge from the posterior border of the sternocleidomastoid, to descend under the platysma and the deep cervical fascia; they divide into medial, intermediate and lateral (posterior) branches, which diverge to pierce the deep fascia a little above the clavicle.

# Referred pain from diaphragm

Most of the time there isn't any sensation to convey from the diaphragm, at least at the conscious level. But if a nearby organ gets sick, it may irritate the diaphragm, and the sensory fibers of one of the phrenic nerves are flooded with pain signals that travel to the spinal cord (at C3-C5). It turns out that C3 and C4 don't just keep the diaphragm alive; neurons at these two spinal cord levels also receive sensation from the shoulders (via the **supraclavicular nerves**). So when pain neurons at C3 and C4 sound the alarm, the brain assumes (quite reasonably) that the shoulder is to blame. Usually that's a good assumption, but sometimes it's wrong.



- The central connections of cardiac preganglionic neurons, parasympathetic and sympathetic (Reticular formation of the brainstem Hypothalamus and Cerebral cortex . The existence and behavior of these integrating influences can be deduced in terms of their function but the precise locations of connecting pathways in the spinal cord, brainstem, and cerebrum are uncertain.

- Nearing the heart, the autonomic nerves form a mixed cardiac plexus , usually described in terms of a superficial component found inferior to the aortic arch and between it and the pulmonary trunk, and a deep part between the aortic arch and tracheal bifurcation. These plexuses contain ganglion cells, with further ganglion cells found in the heart along the distribution of branches of the plexus .

- The branches of these cells are considered largely, if not exclusively, postganglionic and parasympathetic in nature.

- **Cholinergic and adrenergic fibres, arising in or passing through the cardiac plexus, are distributed most profusely to the sinus and atrioventricular nodes, with a much less dense supply to the atrial and ventricular myocardium. Adrenergic fibres supply the coronary arteries and cardiac veins.**

- **Rich plexuses of nerves containing cholinesterase, adrenergic transmitters, and other peptides such as neuropeptide Y (NY) are found in the subendocardial regions of all chambers and in the leaflets of the valves. Complex endorgans have also been discovered in the subendocardium of the left atrium .**

- Ganglion cells, the source of vagal postganglionic fibres, are confined to the atrial tissues in man, with a preponderance adjacent to the sinus node. Some ganglion cells in the atrium have now been shown to contain adrenergic transmitters, and they also contain small, intensely-fluorescent chromaffin cells .

## *Cardiac Pain*

Pain originating in the heart as the result of acute myocardial ischemia is assumed to be caused by oxygen deficiency and the accumulation of metabolites, which stimulate the sensory nerve endings in the myocardium. The afferent nerve fibers ascend to the central nervous system through the cardiac branches of the sympathetic trunk and enter the spinal cord through the posterior roots of the upper four thoracic nerves. The nature of the pain varies considerably, from a severe crushing pain to nothing more than a mild discomfort.

The pain is not felt *in* the heart, but is referred to the skin areas supplied by the corresponding spinal nerves. The skin

The pain is not felt *in* the heart, but is referred to the skin areas supplied by the corresponding spinal nerves. The skin

areas supplied by the upper four intercostal nerves and by the intercostobrachial nerve (T2) are therefore affected. The intercostobrachial nerve communicates with the medial cutaneous nerve of the arm and is distributed to skin on the medial side of the upper part of the arm. A certain amount of spread of nervous information must occur within the central nervous system, for the pain is sometimes felt in the neck and the jaw.

Myocardial infarction involving the inferior wall or diaphragmatic surface of the heart often gives rise to discomfort in the epigastrium. One must assume that the afferent pain fibers from the heart ascend in the sympathetic nerves and enter the spinal cord in the posterior roots of the seventh, eighth, and ninth thoracic spinal nerves and give rise to referred pain in the T7, T8, and T9 thoracic dermatomes in the epigastrium.

Because the heart and the thoracic part of the esophagus probably have similar afferent pain pathways, it is not surprising that painful acute esophagitis can mimic the pain of myocardial infarction.

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