ANATOMY OF INTERCOSTAL SPACES

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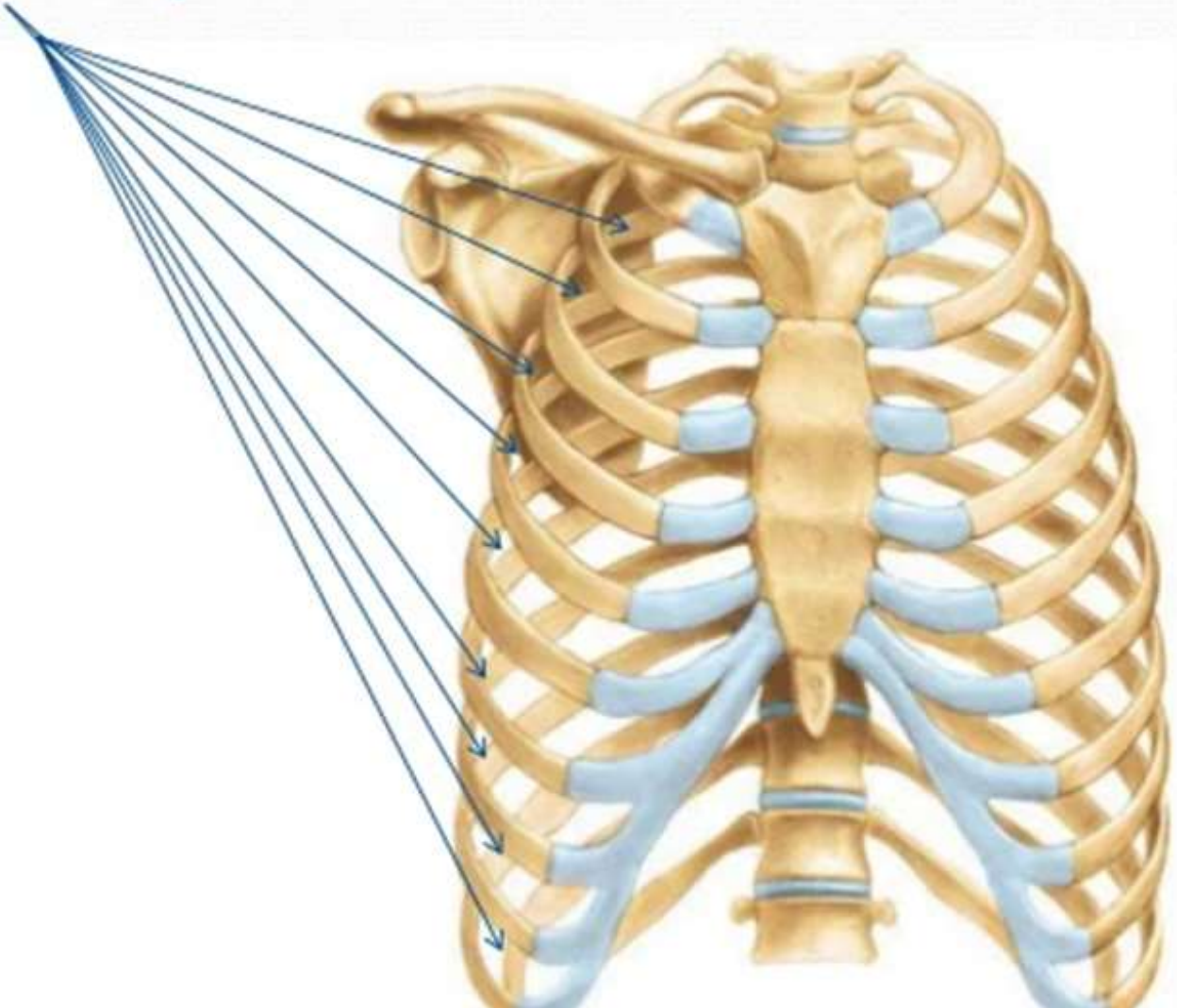
INTERCOSTAL SPACE

- The **Intercostal space** (ICS) is the space between the two adjacent **ribs**.
- There are 11 intercostal spaces on each side, each intercostal space is numbered for the rib superior to it.
- Every space consists of:
  - **Intercostal muscles** .
  - Neurovascular bundle.

Intercostal spaces



Importance of intercostals

- Help in breathing .
- Chest lead placement for ECG.
- Play import ant role in auscultation .
- Approachable way to percardial and pleural cavity.
- Prevent the internal tissue and organ from bulging out.
- Medium for internal organ of thoracic cavity during surgery.
- Prevent blowing in and out of air to maintain intrathoracic pressure .

INTERCOSTAL SPACE

- **In each space**, the vein is the most superior structure and is thus highest in the costal groove.
- The nervovascular bundle is in such a an order that vein is at the top, then the artery and then the nerve and they are generally not guarded by the groove.
  - *For that reason, the nerve is the structure which is in most danger when objects perforate the upper part of an intercostal space.*
- Small collateral branches of the major **intercostal nerves** and vessels are often found above the inferior rib below.
  - (Mnemonic: VAN).

INTERCOSTAL SPACE

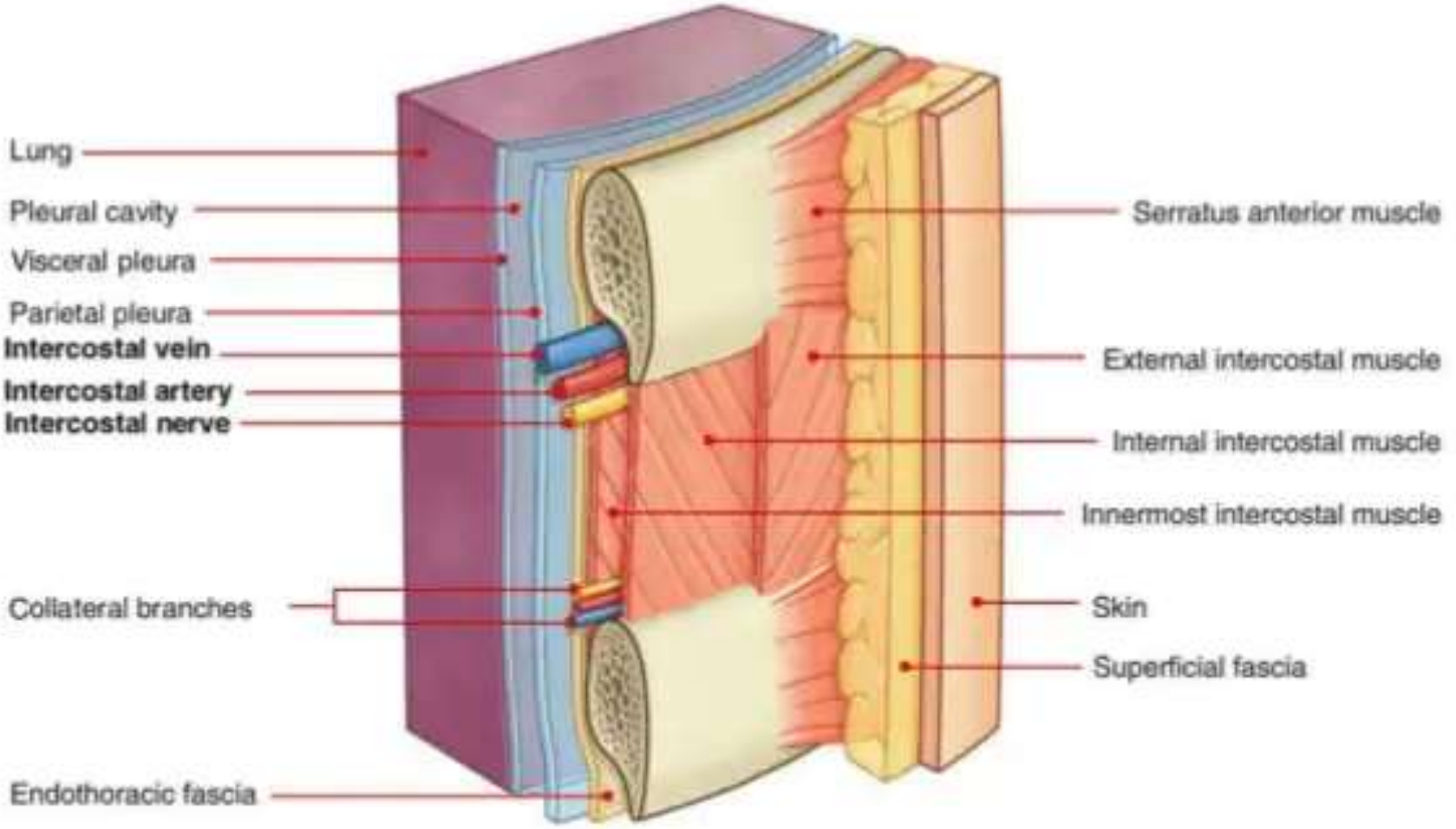
- Deep to the intercostal spaces and **ribs**, and separating such structures from the underlying **pleura**, is a layer of **loose connective tissue**, know as **endothoracic fascia**, which consists of variable amounts of fat.
- Superficial to the spaces are deep **fascia**, superfcial fascia, and skin.
    - Muscles related to the upper limbs and back overlap the spaces.

INTERCOSTAL SPACE

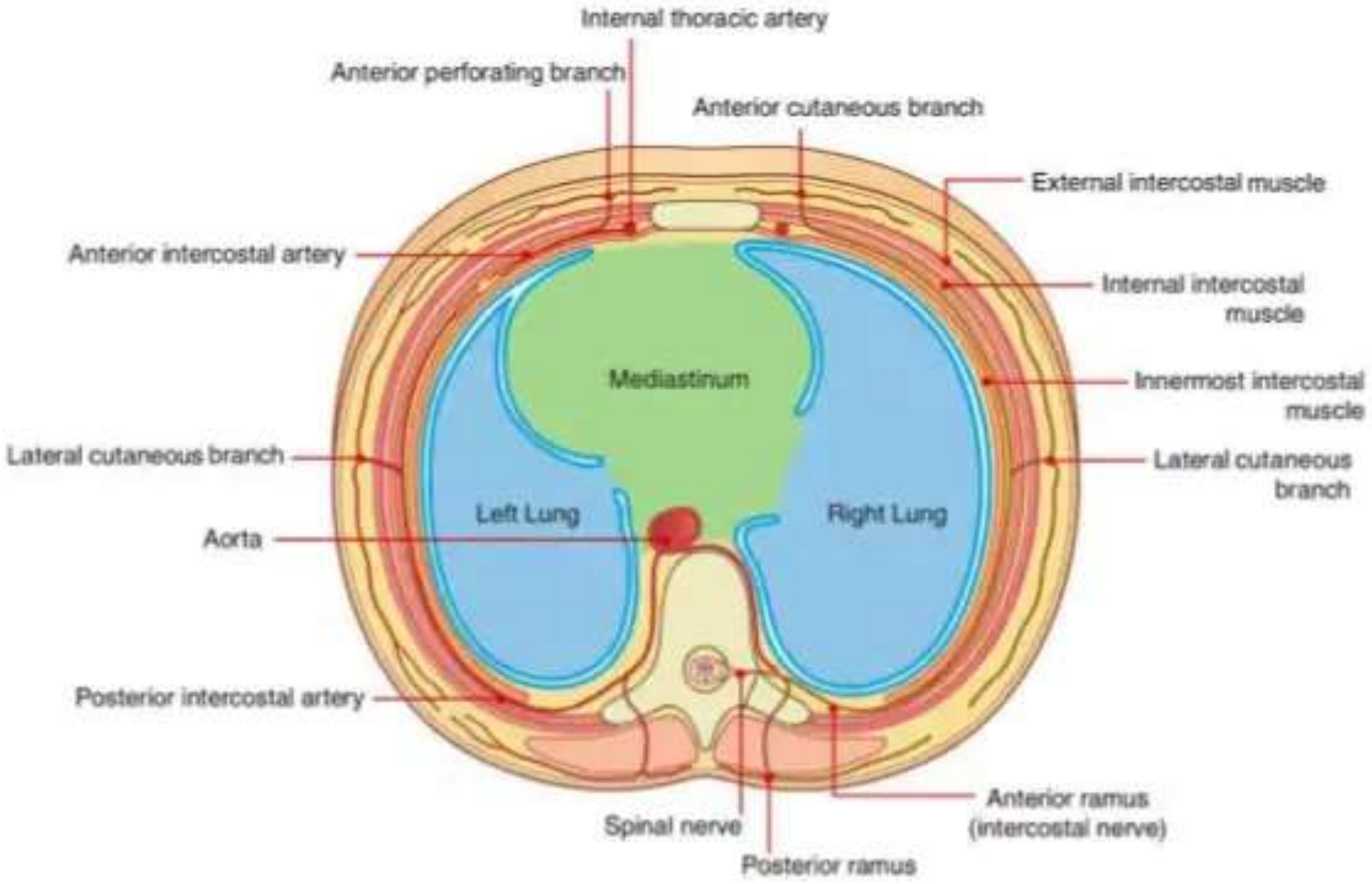
- **TYPICAL INTERCOSTAL SPACE:**
  - 3^{rd}, 4^{th}, 5^{th} & 6th spaces are typical intercostal spaces.
- **ATYPICAL INTERCOSTAL SPACE:**
  - 1^{st} , 2^{nd} and 7^{th} to 12^{th} are atypical intercostal spaces.

This diffentiation depends upon the blood supply and nerve supply of the intercostal spaces.

Intercostal Spaces: Anterolateral View



TRANSVERSE SECTION



CONTENTS OF A TYPICAL INTERCOSTAL SPACE

1. INTERCOSTAL MUSCLES
2. INTERCOSTAL NERVES
3. INTERCOSTAL ARTERIES
4. INTERCOSTAL VEINS
5. INTERCOSTAL LYMPH VESSELS

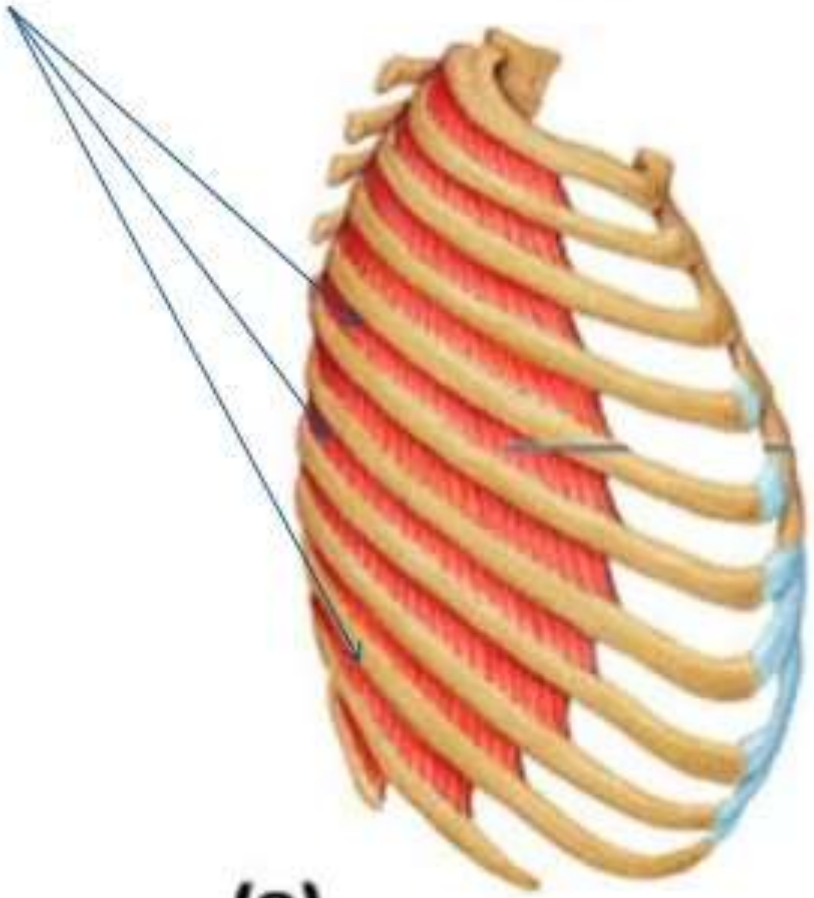
CONTENTS OF A TYPICAL INTERCOSTAL SPACE

- **INTERCOSTAL MUSCLES**
  1. External intercostal,
  2. Internal intercostal and
  3. Innermost intercostal (intercostalis intimus).

External intercostal muscle

- External intercostals (11 pairs) these outermost muscles pass from the lower border of the upper rib to the upper border of the lower rib downword and forward. They extend anteriorly towards the costochondral junction becoming gradually more fibrous, and merge into the external(anterior) intercostal membrane.

External intercostal muscle



(a)

Action

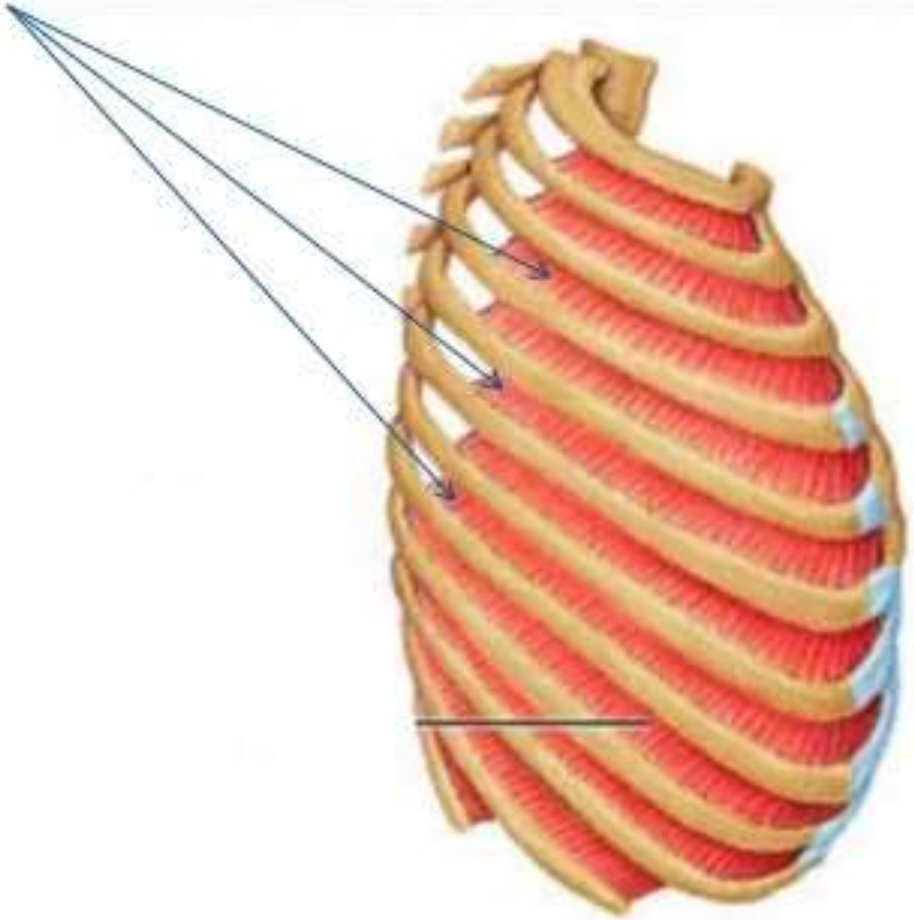
- During inspiration these muscle contract and pull up the ribs to increase surface area for lungs to inspire.

Anteroposterior Expansion

Internal intercostal muscle

- Internal intercostals (11 pairs) run intermediately , and with the fibres directed downward and backward running at right angles, to the external intercostals. They extend from the sternum, laterally around to the angle of the rib, where they become fibrous and merge to form the internal (posterior) intercostal membrane.

Internal intercostal muscle



Action

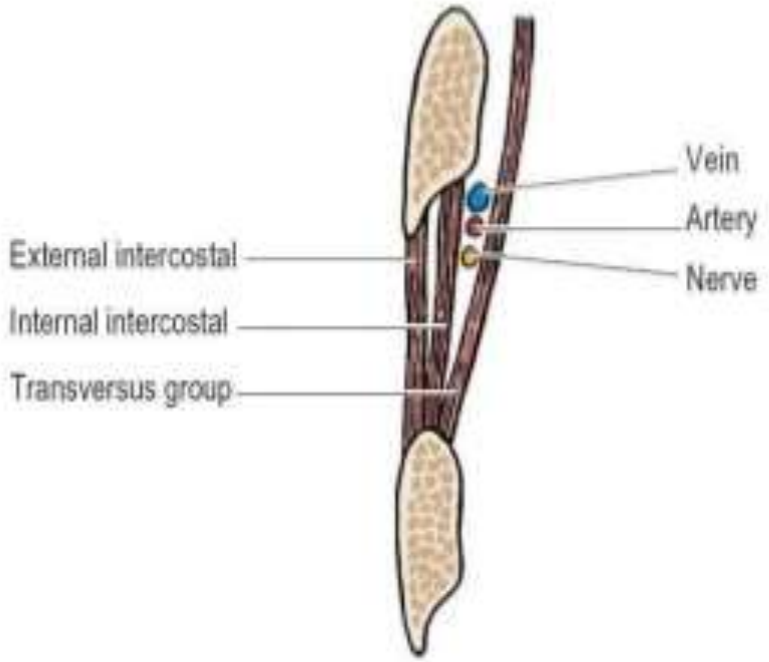
- During expiration these muscle contract to pull down (closed) the ribs to decrease surface area for lungs to expire.

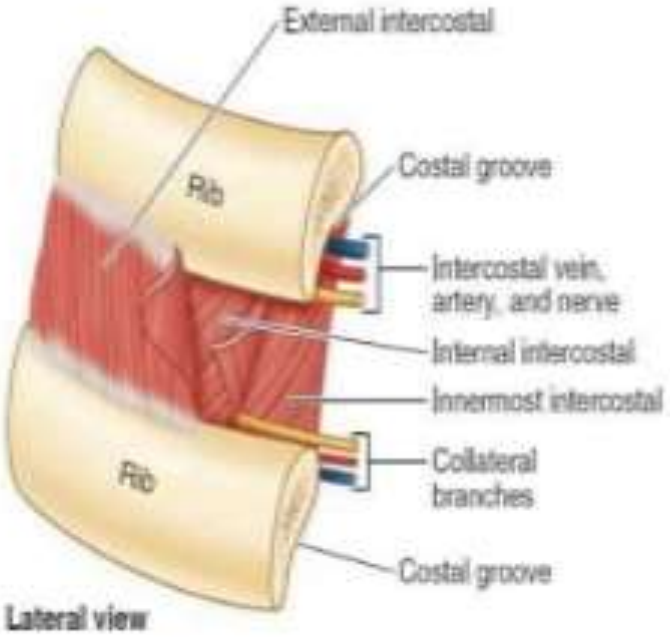
Anteroposterior contraction

Innermost intercostal muscle

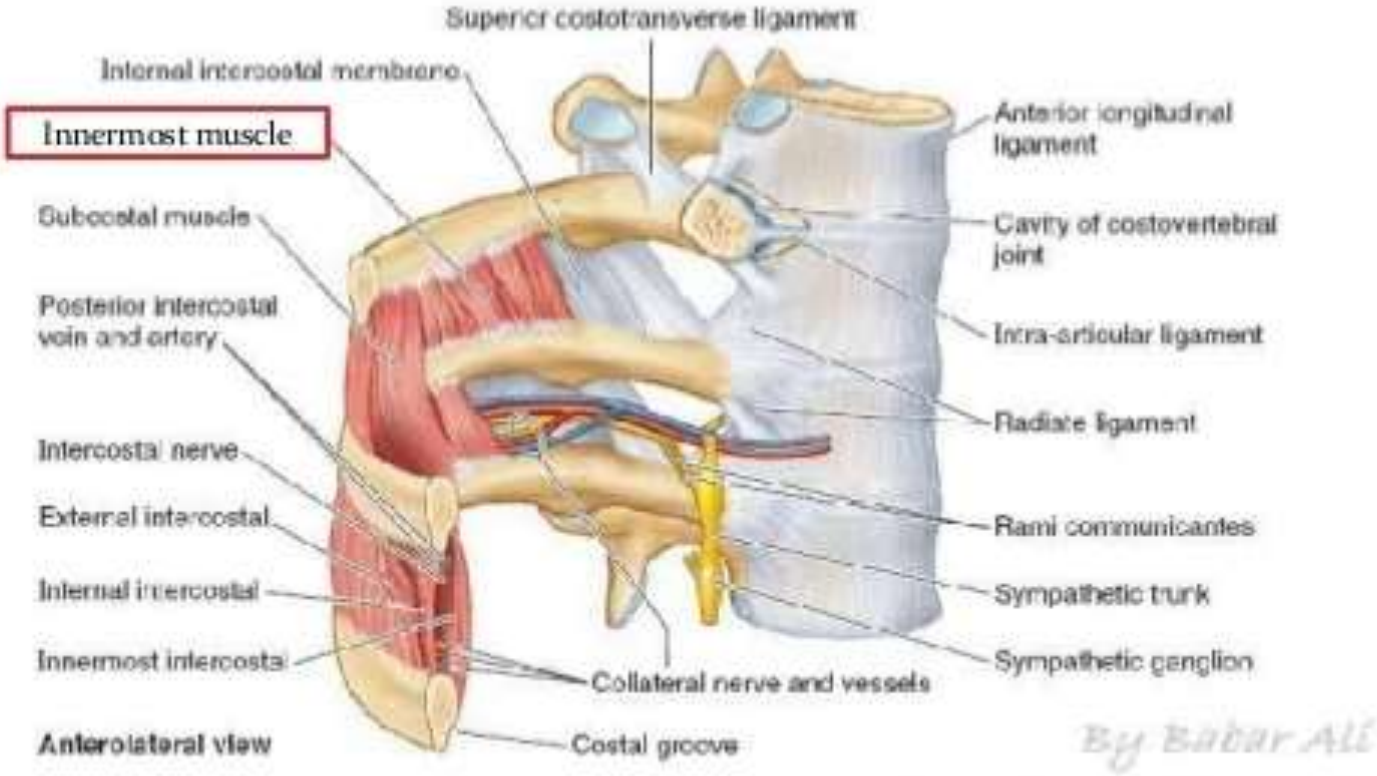
- Innermost intercostal – largely incomplete and consist of numerous slips of muscle tissue. They are individually named as the transversus thoracis (anteriorly), intracostal (laterally) and subcostalis (posteriorly) muscles. These are bound together by a continuous sheet of fascia. The innermost muscles are also separated from the parietal pleura by a further layer of fascia, the endothoracic fascia.

Innermost muscle





Innermost muscle



Schematic overview

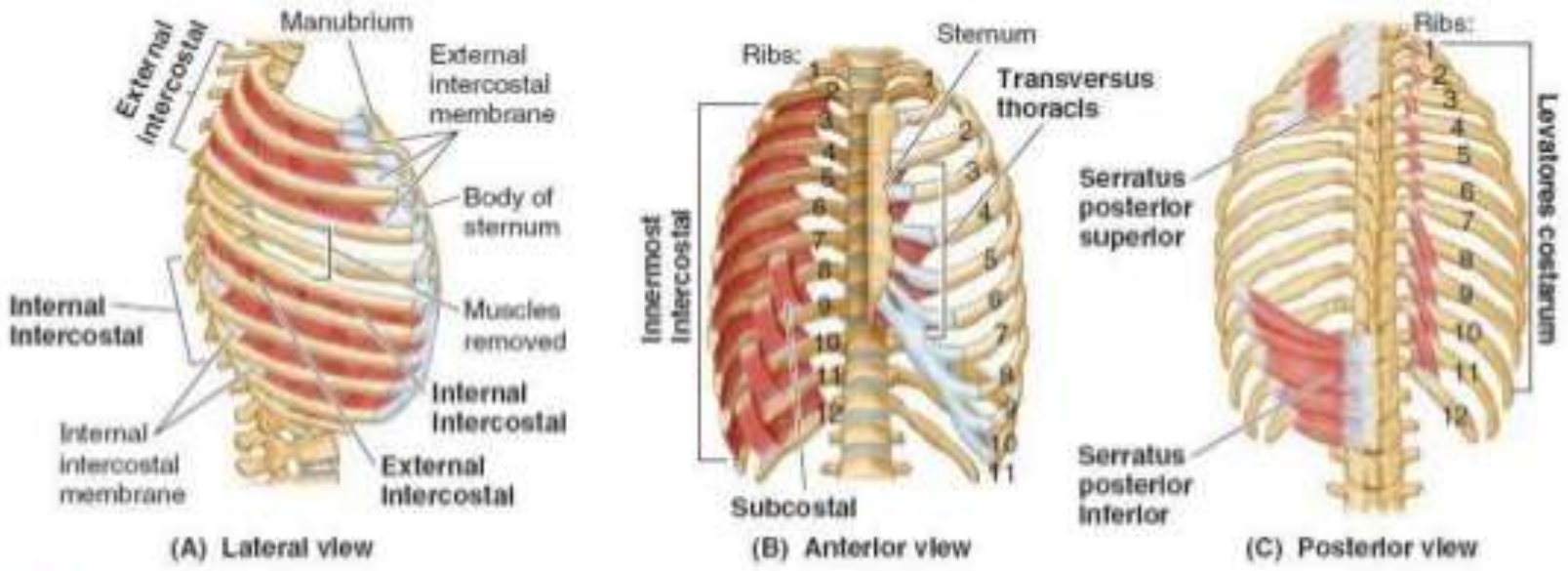


FIGURE **Muscles of thoracic wall. A.** External and internal intercostal muscles. **B.** Innermost intercostals, subcostal, and transversus thoracis muscles. **C.** Serratus posterior superior and inferior and levatores costarum muscles.

INTERCOSTAL NERVES

- The 12 pairs of thoracic **spinal nerves** innervates the thoracic wall. When they leave, the intervertebral foramina they split into anterior and posterior rami.
- The anterior primary rami of upper 11 thoracic spinal nerves (T1-T11) are named intercostal nerves as they course via the intercostal spaces.
- The anterior primary ramus of the 12th thoracic spinal nerve runs in the **abdominal wall** inferior to the 12th rib, therefore it is known as **subcostal nerve**.

Distinct features

The intercostal nerves

- They are segmental in character unlike the anterior primary rami from other regions of **spinal cord**.
- In the posterior part of intercostal space, the intercostal nerve is located between the **pleura** and posterior intercostal membrane.
- In greater part of intercostal space, it is located between the internal intercostal and intercostalisintimus muscles.

Classification of intercostal nerves

- 1. Typical intercostal nerves
  - (3rd, 4th, 5th, and 6th).
  - The typical intercostal nerves are those which remain confined to their own intercostal spaces.

- 2. Atypical intercostal nerves
  - (1st, 2nd, 7th, 8th, 9th, 10th, and 11th).
  - The atypical spinal nerves extend beyond the thoracic wall and partly or entirely supply the other regions

Special features of some atypical intercostal nerves

- **First intercostal nerve:**
- The first intercostal nerve joins the brachial plexus through a branch.
  - Equivalent to the lateral cutaneous branches of remaining intercostal nerves.
- Another exception with the first intercostal nerve is that there is no anterior cutaneous branch.
- It is also very small as compared to the remaining nerves.

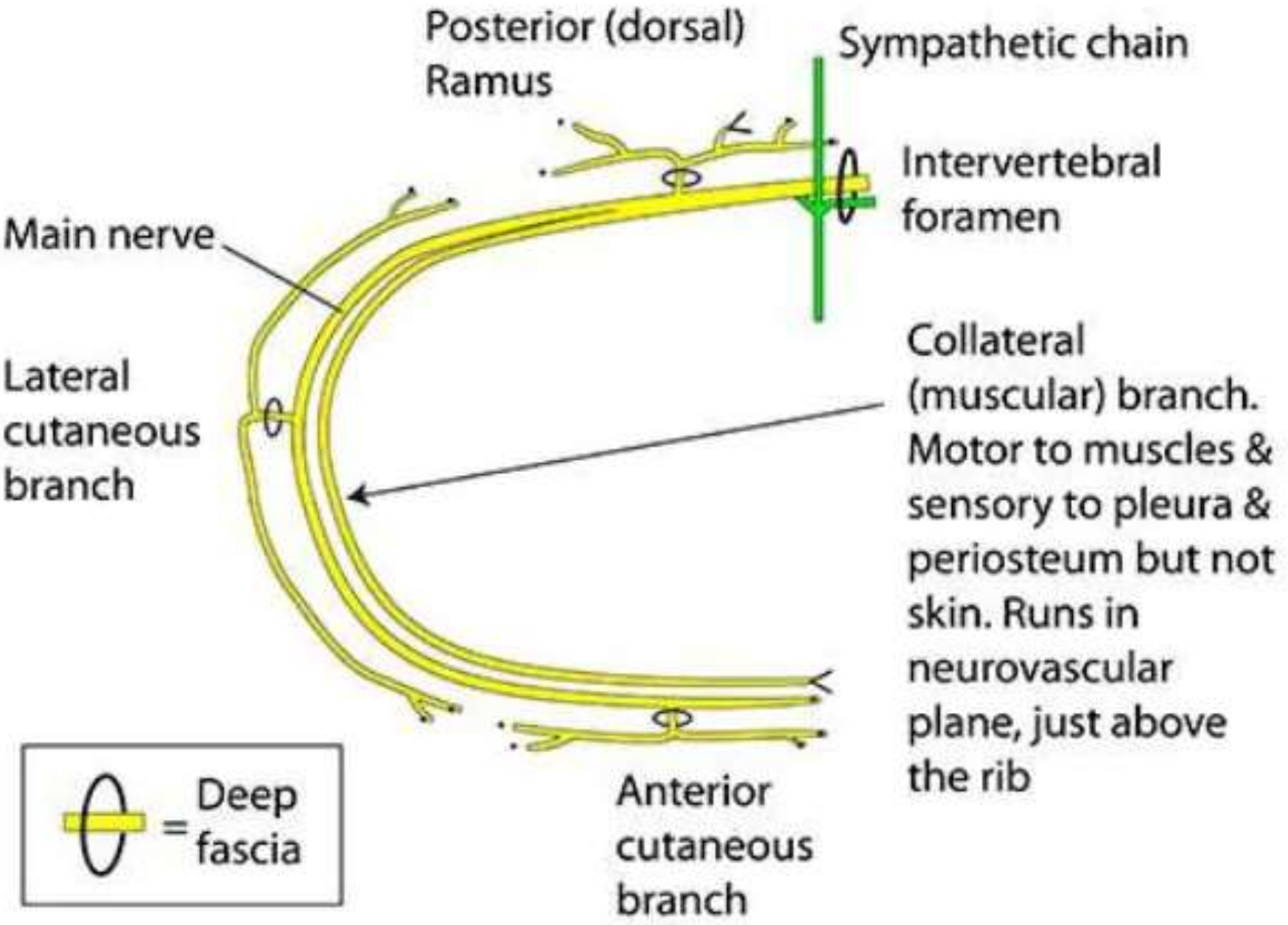
Special features of some atypical intercostal nerves

- **Second intercostal nerve:**
- It joins the medial cutaneuos nerve of the arm by a branch called the intercostobrachial nerve.
  - This branch is equivalent to the lateral cutaneuos branch of the remaining nerves. In this way the second intercostal nerve supplies not only the second intercostal space, but also the skin of the armpit and the upper medial side of the arm.

Special features of some atypical intercostal nerves

- **The 7^{th} to 11^{th} intercostal nerves:**
- After giving rise to lateral cutaneous branches (lower five **intercostal nerves**) cross the costal margin posteriorly into the neurovascular plane of the abdominal wall, which they supply.
- They now become the thoracoabdominal nerves of the anterior abdominal wall.
- Their anterior cutaneous branches pierce the rectus sheath, becoming cutaneous close to the median plane.

TYPICAL INTERCOSTAL NERVE



Arterial supply of the thoracic wall

- The arterial supply to the thoracic wall derives from:

1. Thoracic aorta, through the posterior intercostal and subcostal arteries.
2. Subclavian artery, through the internal thoracic and supreme intercostal arteries.
3. Axillary artery, through the superior and lateral thoracic arteries.

- With the exception of the 10th and 11th intercostal spaces, each intercostal space is supplied by three arteries:
  - A large posterior intercostal artery (and its collateral branch)
  - A small pair of anterior intercostal arteries.

INTERCOSTAL ARTERIES

- The thoracic wall has rich blood supply. It is provided by the posterior and anterior **intercostal arteries**.
- Each intercostal space contains one posterior and two **anterior intercostal arteries** (upper and lower).
- **Posterior Intercostal Arteries:**

- Usually one posterior intercostal artery in each intercostal space
  - The 1st & 2nd arteries descend to reach their spaces.
  - The 3rd & 4th arteries ascend to reach their spaces.

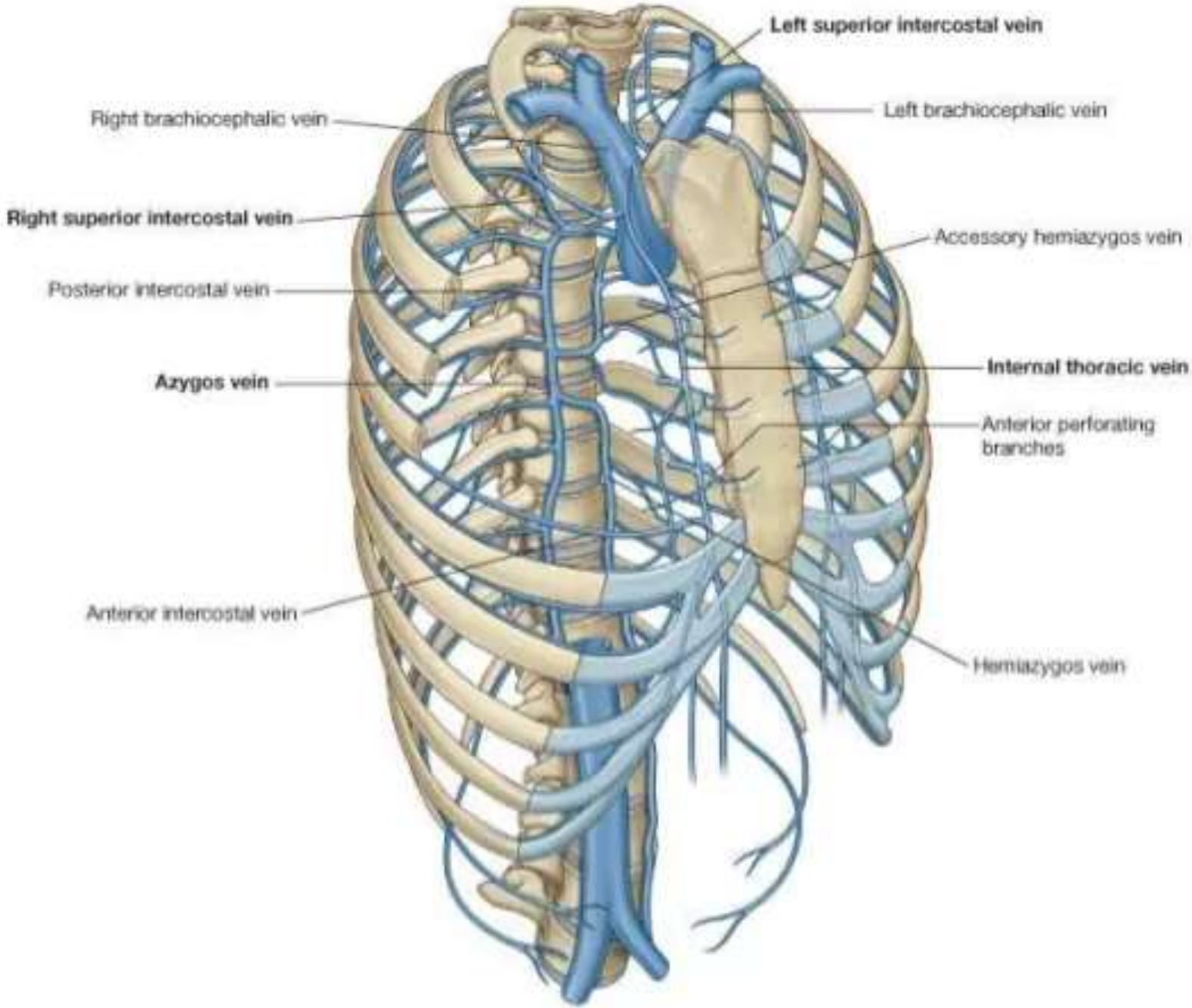
- **Anterior Intercostal Arteries:**

- Usually two anterior intercostal arteries in each of upper 9 intercostal space.
  - No antrior intercostal artery in last two(10 & 11) intercostal spaces.

INTERCOSTAL VEINS

- The number of **intercostal vein** corresponds to the number of intercostal arteries, i.e.,
  - Each intercostal space contains:
    - Two anterior **intercostal veins** and
    - One posterior intercostal vein.
- Their tributaries correspond to the branches of the arteries

The **intercostal veins**

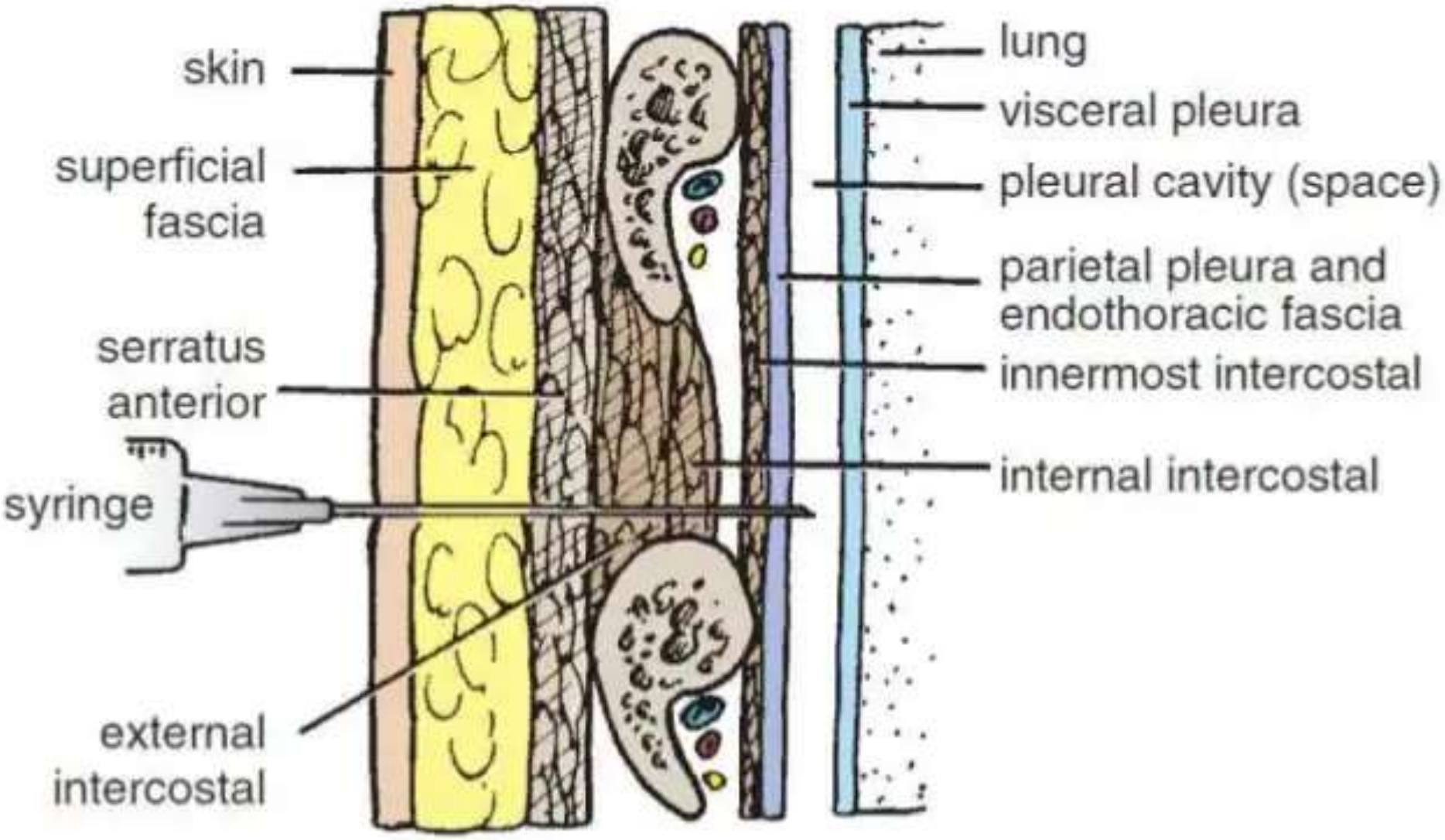


Plane of **neurovascular bundle** in the **intercostal space**

- The neurovascular bundle being composed of **intercostal nerve**and vessels is located between the internal intercostal and **innermost intercostal muscles**, i.e., between the intermediate and deepest layers of muscles.
- They may be ordered in the following sequence from above downwards:
- Intercostal Vein. V
- Intercostal Artery. A
- Intercostal Nerve. N

Sites Of Eruption Of Cold Abscess On The Body Wall

- Pus from the tuberculous thoracic vertebra/vertebrae (Pott's disease) tends to track along the neurovascular plane of the space and might point at 3 sites of development of cutaneous branches of the thoracic spinal nerve, viz.
- Just lateral to the **sternum**.
- In the midaxillary line.
- Lateral to the erector spinae muscle.

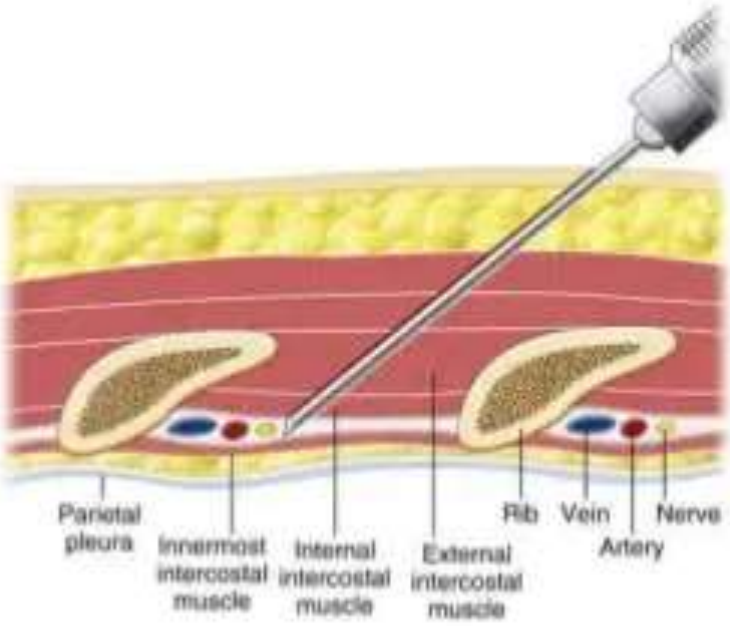

skin
superficial fascia
serratus anterior
syringe
external intercostal
lung
visceral pleura
pleural cavity (space)
parietal pleura and endothoracic fascia
innermost intercostal
internal intercostal

Herpes Zoster

- In herpes zoster (**shingles**) involving the thoracic spinal ganglia, the cutaneous vesicles appear in the dermatomal area of distribution of intercostal nerve. It's an incredibly debilitating state.

Intercostal Nerve Block

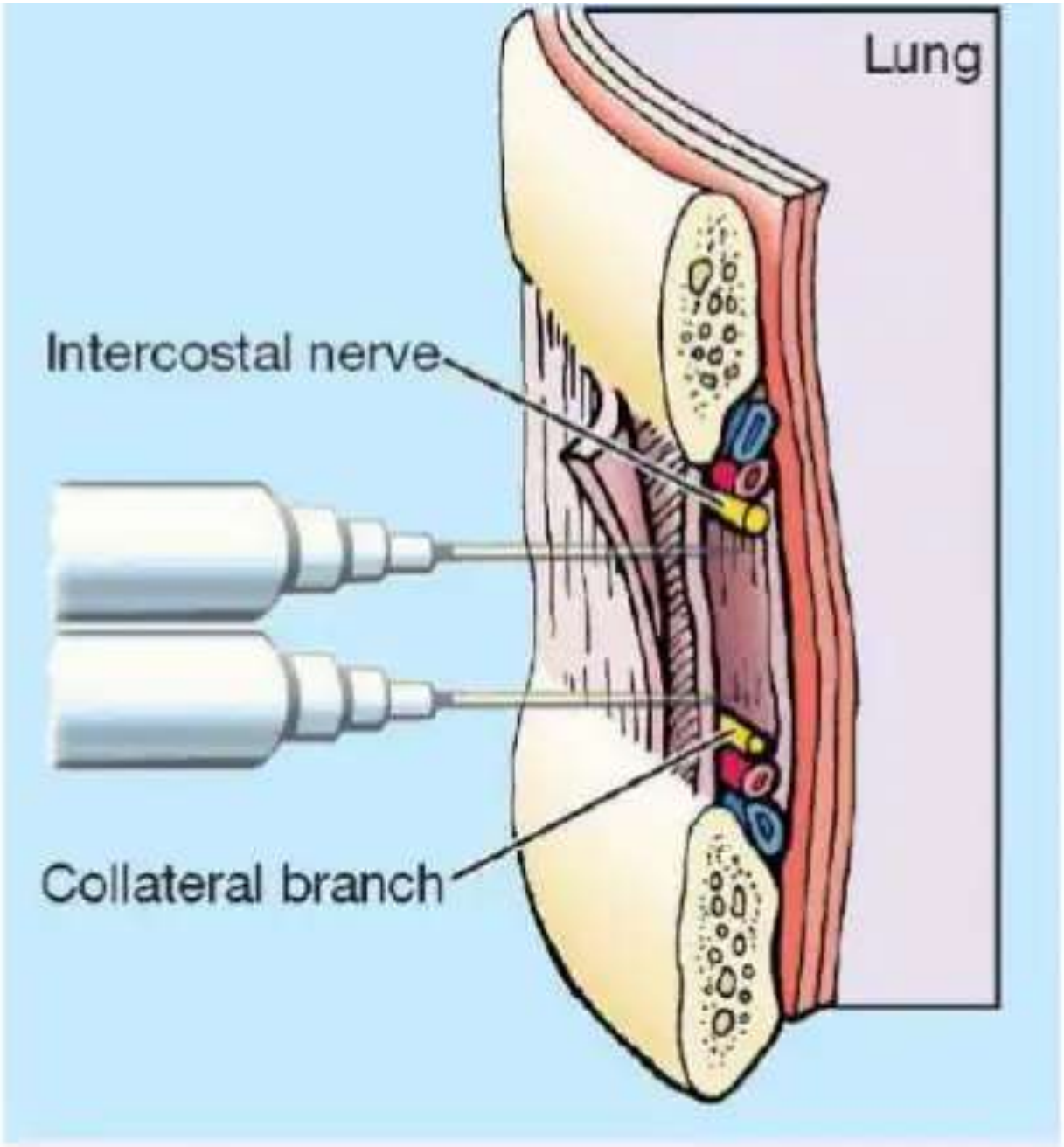
- Intercostal nerve block is given to make local anesthesia in one or more intercostal spaces by injecting the anesthetic agent around the nerve trunk near its origin, i.e., just lateral to the vertebra.



Intercostal Nerve Block

Local anesthesia of an intercostal space is produced by injecting a local anesthetic agent around the intercostal nerves. This procedure, an intercostal nerve block, involves infiltration of the anesthetic around the intercostal nerve and its collateral branches. Because any particular area of skin usually receives innervation from two adjacent nerves, considerable overlapping of contiguous dermatomes occurs.

Therefore, complete loss of sensation usually does not occur unless two or more intercostal nerves in adjacent intercostal spaces are anesthetized.



Intercostal nerve block.

Thoracotomy

- The traditional thoracotomy (postero- lateral) is performed along the 6th rib.
- The neurovascular bundle is shielded from injury by lifting the periosteum of the rib.
- Considering the position of neurovascular bundle in the intercostal space, it is safe to add the needle, a little above the upper border of the rib below.

Thoracotomy, Intercostal Space Incisions

The surgical creation of an opening through the thoracic wall to enter a pleural cavity is called a thoracotomy. An anterior thoracotomy may involve making H-shaped cuts through the perichondrium of one or more costal cartilages and then shelling out segments of costal cartilage to gain entrance to the thoracic cavity.

The posterolateral aspects of the fifth to seventh intercostal spaces are important sites for posterior thoracotomy incisions. In general, a lateral approach is most satisfactory for entry through the thoracic cage . With the patient lying on the contralateral side, the upper limb is fully abducted, placing the forearm beside the patient's head. This elevates and laterally rotates the inferior angle of scapula, allowing access as high as the fourth intercostal space.

CORONARY HEART DISEASE AND THE INTERCOSTOBRACHIAL NERVE

In coronary heart disease pain is often referred along the intercostobrachial nerve to the medial side of the arm.

HEART SOUNDS

The heart makes two sounds: lu¯b, and du˘ p. The **first** sound is produced by the contraction of the ventricles and the closure of the tricuspid and the mitral valves.
The **second**, shorter sound is produced by the sharp closure of the aortic and the pulmonary valves.
The **tricuspid valve is best heard over the right** half of the lower end of the body of the sternum.
The **mitral valve is best heard over the apex beat** (i.e., at the level of the fifth left intercostal space, approximately 3.5 in. [9 cm] from the midline).
The **pulmonary valve is best heard over the medial** end of the second left intercostal space.
The **aortic valve is best heard over the medial end** of the second right intercostal space.