

# Thorax

# 1

## INTRODUCTION

The thorax is that portion of the trunk inferior to the neck (superior thoracic aperture) and superior to the diaphragm, to which the pectoral girdle and upper limbs are attached.

## THORACIC WALL

The bones of the thoracic wall are the ribs and sternum. Ribs 3–9 possess characteristics common to the majority of ribs and so are considered “typical,” whereas ribs 1–2 and 10–12 have specializations or are lacking typical characteristics and so are considered “atypical.”

### Bones of the thoracic wall

Bone	Characteristic	Significance
Typical ribs (3–9)	Head	Bears 2 facets that articulate with vertebra of same number and the vertebra superior to it
	Neck	Joins head with body of rib
	Tubercle	<ul style="list-style-type: none"> <li>Articulates with transverse process of vertebra of same number</li> <li>Located at junction of neck and body</li> </ul>
	Body	<ul style="list-style-type: none"> <li>Bears pronounced angle</li> <li>Inferior internal border has costal groove for intercostal neurovascular elements</li> </ul>
Atypical ribs (1–2, 10–12)	<ul style="list-style-type: none"> <li>1st and 2nd ribs—heads</li> <li>Ribs 10–12 sternal attachments</li> </ul>	<ul style="list-style-type: none"> <li>The heads of the first 2 ribs only attach to one vertebral body, unlike typical ribs that attach to two</li> <li>The 1st and 2nd ribs have additional tubercles for muscle attachments</li> </ul>

(continued)

## 2 CLINICAL ANATOMY FOR YOUR POCKET

### Bones of the thoracic wall *(continued)*

Bone	Characteristic	Significance
		<ul style="list-style-type: none"> <li>Ribs 10–12 attach indirectly (rib 10) or not at all to the sternum (ribs 11–12, the floating ribs)</li> </ul>
Thoracic vertebrae (12)	Body	Supports weight
	Spinous process	Serve for muscle attachments
	Transverse process	
	Laminae and pedicles	Form <b>vertebral arch</b> that encloses spinal cord
	Vertebral foramen	<ul style="list-style-type: none"> <li>Formed from vertebral arch and posterior aspect of vertebral body</li> <li>Encloses spinal cord</li> <li>Successive vertebral foramen form vertebral canal</li> </ul>
	Vertebral notches—superior and inferior	Inferior and superior notches of adjacent vertebrae form intervertebral foramen that permits passage of spinal nerves between the vertebral canal and periphery
	Articulating processes—superior (2) and inferior (2)	Form zygapophyseal joints with articulating processes on adjacent vertebrae
Sternum	Manubrium	<ul style="list-style-type: none"> <li>Superior part of sternum</li> <li>Superior border bears jugular notch</li> <li>Clavicular notches (2) are found on each side of the jugular notch for articulation with the clavicles</li> </ul>
	Sternal angle	<ul style="list-style-type: none"> <li>Landmark for the 2nd ribs' costal cartilage articulation with the sternum</li> <li>Marks articulation between manubrium and body</li> </ul>
	Body	Bears costal notches along lateral border for articulation with costal cartilages
	Xiphoid process	<ul style="list-style-type: none"> <li>Most inferior part of sternum</li> <li>Landmark for central tendon of diaphragm, superior margin of liver, and inferior border of heart</li> </ul>

### Additional Concept

#### True, False, and Floating Ribs

Ribs 1–7 are considered “true” ribs, as they attach to the sternum via their individual costal cartilages; ribs 8–10 are considered “false” ribs, as they attach indirectly to the sternum via the costal cartilages of more superior ribs; ribs 11–12 are considered “floating” ribs, as they do not connect to the sternum.

### Clinical Significance

#### Rib Fracture

Fracture of the upper ribs may injure the lungs and of lower ribs may damage the liver or spleen or may tear the diaphragm. All rib fractures are painful owing to the broken pieces moving during respiration, coughing, sneezing, or laughing.

#### Sternal Puncture

A wide-bore needle may be used to harvest bone marrow from the sternum for transplantation or biopsy.

### Muscles of the thoracic wall

(Figures 1-2 and 1-4)

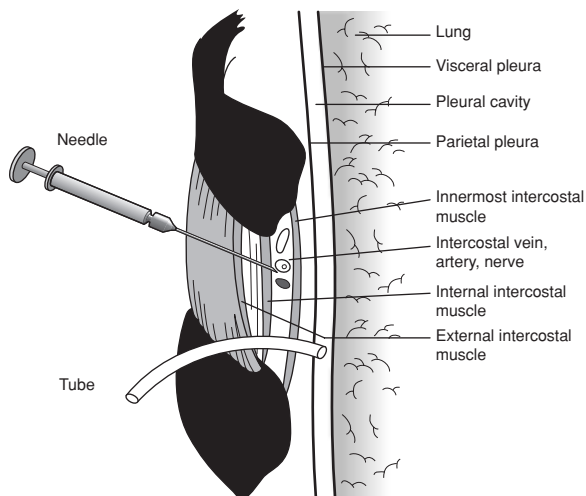
Muscle	Proximal attachment	Distal Attachment	Innervation	Main Actions
External intercostal	Inferior aspect of ribs	Superior aspect of ribs	Intercostal nerves	Elevate ribs
Internal intercostal				Depress and elevate ribs
Innermost intercostal				
Transverse thoracic	Posterior inferior aspect of sternum	Posterior aspect of costal cartilages 2–6		Depress ribs
Subcostal	Deep aspect of lower ribs, near angles	Superior aspect of 2–3 ribs below proximal attachment		Depress and elevate ribs

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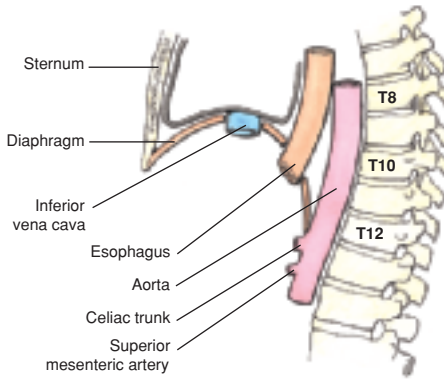
#### 4 CLINICAL ANATOMY FOR YOUR POCKET

##### Muscles of the thoracic wall (continued)

Muscle	Proximal attachment	Distal Attachment	Innervation	Main Actions
Diaphragm	Sternum, inferior 6 ribs and their costal cartilages, medial & lateral arcuate ligaments, and 1st 3 lumbar vertebrae	Central tendon of the diaphragm	Motor: phrenic; sensory: phrenic and intercostal nerves	Increases the volume of the thorax to cause inspiration
Levator costarum	T7–T11 transverse processes	Subjacent ribs between tubercle and angle	C8–T11 posterior rami	Elevate ribs
Serratus posterior superior	Nuchal ligament, C7–T3 spinous processes	2nd–4th ribs superior borders	2nd–5th intercostals	
Serratus posterior inferior	T11–L2 spinous processes	8th–12th ribs inferior borders, near angles	9th–11th intercostals and subcostal	Depress ribs



**FIGURE 1-1.** Thoracocentesis. An intercostal nerve block (needle in image) produces anesthesia of an intercostal space by introduction of an anesthetic agent around the intercostal nerve and its collaterals. The tube in the diagram indicates the position for thoracocentesis. (From Dudek RW, Louis TM. *High-Yield Gross Anatomy*. 3rd ed. Baltimore: Lippincott Williams & Wilkins; 2008:56.)



**FIGURE 1-2.** Holes in diaphragm. There are three large apertures in the diaphragm for major structures to pass to and from the thorax into the abdomen. The caval opening for the inferior vena cava (IVC), most anterior, is at the T8 level and to the right of the midline; the esophageal hiatus, intermediate, is at T10 and to the left of the midline; the aortic hiatus for the aorta passes posterior to the vertebral attachment of the diaphragm in the midline at T12. (From Moore KL, Dalley AF. *Clinically Oriented Anatomy*. 5th ed. Baltimore: Lippincott Williams & Wilkins; 2006:329.)

### Additional Concept

#### Diaphragm

The **diaphragm** has three openings that permit passage of structures between the thorax and abdomen. These openings are found at T8—caval foramen, T10—esophageal hiatus, and T12—aortic hiatus.

### Clinical Significance

#### Phrenic Nerve Injury

Phrenic nerve injury results in hemiparalysis of the diaphragm and paradoxical movement during inspiration. Instead of descending during inspiration, the paralyzed half ascends in response to increased intra-abdominal pressure.

## 6 CLINICAL ANATOMY FOR YOUR POCKET

### Nerves of the thoracic wall

(Figures 1-1 and 1-4)

Nerve	Origin	Structures Innervated
Intercostals	Anterior rami of T1–T11	Intercostal muscles and parietal pleura
Subcostal	Anterior rami of T12	Abdominal wall musculature and parietal pleura
Rami communicantes	Connect intercostals and subcostal nerves to sympathetic trunk	<ul style="list-style-type: none"> <li>• White—convey presynaptic sympathetic fibers from spinal nerve to sympathetic chain and visceral afferents to spinal nerves</li> <li>• Gray—convey postsynaptic sympathetic fibers from the sympathetic chain to spinal nerve</li> </ul>
Sympathetic trunk	Sympathetic chain ganglia (paravertebral ganglia)	Composed of sympathetic ganglia containing postsynaptic sympathetic cell bodies connected by ascending and descending fibers
Thoracic splanchnics	Sympathetic chain: <ul style="list-style-type: none"> <li>• Greater—T5–T9</li> <li>• Lesser—T10–T11</li> <li>• Least—T12</li> </ul>	Convey presynaptic sympathetic fibers to the prevertebral ganglia of the abdomen; convey visceral afferents to the sympathetic chain

### Arterial supply of the thoracic wall

(Figures 1-1 and 1-4)

Artery	Origin	Description
Internal thoracic	Subclavian	Gives rise to anterior intercostals and musculophrenic
Anterior intercostals	Internal thoracic (1–6) and musculophrenic (7–9)	Supplies intercostal muscles and parietal pleura
Posterior intercostals	Supreme intercostal (1–2) and thoracic aorta	
Subcostal	Thoracic aorta	Supplies anterolateral abdominal musculature

## Additional Concept

### Venous Drainage

Venous drainage of the thoracic wall generally parallels arterial supply. However, the posterior intercostal veins drain to the azygos system, which is discussed with the posterior mediastinum.

### Joints of the thoracic wall

Joint	Type	Articulation	Structure
1st sternocostal	Cartilaginous	1st costal cartilage with manubrium	Joint strengthened by sternocostal radiate ligaments
2nd–7th sternocostal	Synovial	2nd–7th costal cartilages with sternum	
Sternoclavicular	Synovial	Sternal end of clavicle with manubrium and 1st costal cartilage	<ul style="list-style-type: none"> <li>• Divided into two compartments by articular disc</li> <li>• Joint strengthened by anterior and posterior sternoclavicular and costoclavicular ligaments</li> </ul>
Manubriosternal	Cartilaginous	Manubrium with body of sternum	Joint often fuses in older people
Xiphisternal		Xiphoid process with body of sternum	
Interchondral	<ul style="list-style-type: none"> <li>• 6th–9th: synovial</li> <li>• 9th–10th: fibrous</li> </ul>	Costal cartilages of adjacent ribs 6–10	Strengthened by interchondral ligaments
Costochondral	Cartilaginous	Costal cartilage with end of rib	<ul style="list-style-type: none"> <li>• Bound together by periosteum</li> <li>• Little if any movement permitted</li> </ul>
Intervertebral	Symphysis	Adjacent vertebral bodies	Strengthened by anterior and posterior longitudinal ligaments and the anular ligament

(continued)

## 8 CLINICAL ANATOMY FOR YOUR POCKET

### Joints of the thoracic wall *(continued)*

Joint	Type	Articulation	Structure
Costovertebral	Synovial	Head of ribs with vertebral bodies at same level and the vertebral body superior to it	<ul style="list-style-type: none"> <li>• Strengthened by radiate and intra-articular ligaments</li> <li>• 1st, 11th, 12th, and sometimes 10th ribs articulate only with vertebral body of same level</li> </ul>
Costotransverse		Tubercle of rib with transverse process of vertebral body at same level	<ul style="list-style-type: none"> <li>• Strengthened by lateral and superior costotransverse ligaments</li> <li>• 11th and 12th ribs do not participate in costotransverse joints</li> </ul>

## BREAST

The breast extends from the sternum to the midaxillary line and from ribs 2–6. It rests on the pectoral fascia and the fascia over serratus anterior.

### Structure of the breast

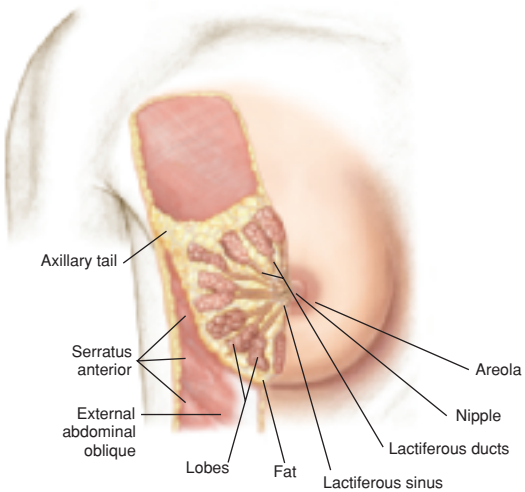
(Figure 1-3)

Structure	Description	Significance
Mammary glands	<ul style="list-style-type: none"> <li>• Modified sweat glands</li> <li>• Arranged in 15–20 lobules</li> </ul>	<ul style="list-style-type: none"> <li>• Accessory reproductive organs in the female</li> <li>• Contained within the breast</li> </ul>
Areola	<ul style="list-style-type: none"> <li>• The skin around the nipple</li> <li>• Studded with sebaceous glands that form elevations</li> </ul>	<ul style="list-style-type: none"> <li>• Turns a darker color during pregnancy</li> <li>• Stimulation from the suckling infant triggers ejection and production of milk—the let-down reflex</li> </ul>
Nipple	<ul style="list-style-type: none"> <li>• Round, raised area of skin in the center of the areola</li> <li>• Surrounded by circularly arranged smooth muscle fibers that cause erection on stimulation</li> </ul>	Stimulation from the suckling infant triggers erection of the nipple and the ejection and production of milk

*(continued)*

**Structure of the breast** (continued)

Structure	Description	Significance
Suspensory ligaments	Connective tissue supports that extend from the dermis to the pectoral fascia	<ul style="list-style-type: none"> <li>• Provide support for the breast</li> <li>• If invaded by carcinoma, the ligaments shorten and produce skin dimpling and nipple inversion</li> </ul>
Lactiferous duct	15–20 total, open onto the nipple	Drain the mammary glandular tissue
Lactiferous sinus	Expansion of lactiferous duct near the nipple	Function as a milk reservoir during lactation
Axillary process	Extension of breast tissue into the axilla	High percentage of breast tumors occurs here



**FIGURE 1-3.** Breast, anterior view. (From Tank PW, Gest TR. *LWW Atlas of Anatomy*. Baltimore: Lippincott Williams & Wilkins; 2009:39.)

**Additional Concept**

The size and shape of the adult female breast is due to its contained fat, which forms the bulk of the breast tissue.