Trunk

Learning Objectives

After working through the material in this chapter, you should be able to:

- Identify the main structures of the trunk, including bones, joints, special structures, and deep and superficial muscles.
- Identify normal curvatures of the spine, including the cervical, thoracic, and lumbar regions.
- Label and palpate the major surface landmarks of the trunk.
- Draw, label, palpate, and fire the superficial and deep muscles of the trunk.
- Locate the attachments and nerve supply of the muscles of the trunk.
- Identify and demonstrate all actions of the muscles of the trunk.
- Demonstrate resisted range of motion of the trunk.
- Describe the unique functional anatomy and relationships between each muscle of the trunk.
- Identify both the synergists and antagonists involved in each movement of the trunk (flexion, extension, etc.).
- Identify the muscles of breathing and their functions in inhalation and exhalation.
- Identify muscles used in performing four coordinated movements of the trunk: pushing, lifting, bending, and twisting.

OVERVIEW OF THE REGION

The trunk is the body region that includes the thorax (the chest) and the abdomen. It is formed by the ribcage, spine, and the most superior portion of the pelvic girdle. These skeletal structures provide protection for the thoracic organs, primarily the heart, lungs, spleen, and spinal cord, as well as attachments for a complex network of muscles. Layers of strong abdominal muscles protect the abdominal organs.

The trunk is often referred to as the “core” of the body. Many movements are initiated in this region. Forces produced in the lower body must also transfer through the trunk before extending into the arms. We see this type of transfer with movements such as throwing and pushing.

When all of its structures are healthy, balanced, and functionally sound, the trunk is a dynamic, powerful tool that allows us to bend, twist, stand straight, and produce powerful, full-body movements. However, improper development, alignment, and use patterns can easily disrupt this functional equilibrium. Understanding the function of each muscle and its relationship to other structures helps us prevent pathology and enhance performance of work tasks, exercise, sports, and activities of daily living, both for ourselves and for our clients.
SURFACE ANATOMY OF THE TRUNK

Pectoralis major dominates the superior, anterior trunk. Its primary actions are on the shoulder.

The xiphoid process is a tiny diamond-shaped bone at the inferior end of the sternum.

Many muscles attach to the thick superior edge of the ilium, called the iliac crest. It marks the most inferior, lateral portion of the trunk.

The umbilicus is also called the navel.

Rectus abdominis is a paired, superficial muscle that extends from the anterior ribcage to the pubic region.

The linea alba segments the fibers of the rectus abdominis vertically. It runs from the xiphoid process to the pubic bone and marks the midline of the anterior trunk.

The obliquely angled inguinal ligament is the inferior border of the aponeurosis of the external oblique muscle.

7-1A. Anterior view.

7-1B. Anterolateral view.
SURFACE ANATOMY OF THE TRUNK

The lamina groove is a furrow on either side of the spine. It marks the medial edge of the erector spinae group of muscles.

The sacrum is a fused triangular bone inferior to the lumbar spine.

The thoracolumbar aponeurosis extends laterally from the spinous process forming a thin covering for the deep thoracic muscles and a thick covering for the muscles in the lumbar region.

Latissimus dorsi is a broad, flat muscle of the inferior posterior trunk.

7-1C. Posterior view.
SKELETAL STRUCTURES OF THE TRUNK

The slightly mobile sternocostal joints are formed by the articulation of the sternum and ribs. Flexibility here allows the ribcage to expand and contract during breathing.

The true ribs, which are ribs 1–7, articulate via costocartilage directly with the sternum.

The false ribs, which are ribs 8–10, do not articulate directly with the sternum.

The intervertebral joints are formed by adjacent vertebrae and separated by intervertebral disks.

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The pubic symphysis is the midline joint between the two pubic bones.

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7-2A. Bones of the trunk: anterior view.

7-2B. Bones of the trunk: posterior view.
SKELETAL STRUCTURES OF THE TRUNK

There are 12 thoracic vertebrae.

The scapula lies on the posterior trunk and forms a false joint with the posterior ribcage.

There are 5 lumbar vertebrae.

The coccyx, or tailbone, is the most inferior point of the axial skeleton.

7-2C. Bones of the trunk: lateral view.

The cervical curvature is slightly anterior, or lordotic.

The thoracic curvature is slightly posterior, or kyphotic.

The lumbar curvature is slightly anterior, or lordotic.

The sacral curvature is slightly posterior, or kyphotic.

7-2D. Curvatures of the spinal column: lateral view. From this view, the normal curvatures of the spinal column are visible. These characteristic curvatures help maintain erect posture and absorb shock throughout the length of the spinal column. This protects and cushions the axial structures during weight-bearing activities like lifting or walking. Notice that the vertebrae increase in size from superior to inferior to accept more weight.
The costal facet of the transverse process is a point of articulation with the ribs. The superior costal facet of each vertebra articulates with a rib. The spinous process of each thoracic vertebra is an important muscle attachment site. Its flattened structure is unique to the thoracic vertebrae. The kyphotic thoracic curve makes the spinous process very superficial, and its flatter shape prevents damage and discomfort when we lie supine. The vertebral body increases in size from the 1st to the 12th thoracic vertebrae as more weight is transferred through them. Notice the posterolateral orientation of each thoracic transverse process. The lamina is a bridge between the spinous and transverse processes. The lamina is a bridge between the spinous and transverse processes. The vertebral body increases in size from the 1st to the 12th thoracic vertebrae as more weight is transferred through them. Notice the posterolateral orientation of each thoracic transverse process. The lamina is a bridge between the spinous and transverse processes. The lamina is a bridge between the spinous and transverse processes. The vertebral body increases in size from the 1st to the 12th thoracic vertebrae as more weight is transferred through them. Notice the posterolateral orientation of each thoracic transverse process. The lamina is a bridge between the spinous and transverse processes. The vertebral body increases in size from the 1st to the 12th thoracic vertebrae as more weight is transferred through them. Notice the posterolateral orientation of each thoracic transverse process. The lamina is a bridge between the spinous and transverse processes.
SKELETAL STRUCTURES OF THE TRUNK

7-2G. Features of a typical rib. Each rib differs in size, but all share some common features.

7-2H. Lumbar vertebra: lateral view.
SKELETAL STRUCTURES OF THE TRUNK

The lumbar vertebral body is larger and more sturdy than that of the thoracic vertebrae.

Notice the lateral orientation of the transverse process of the lumbar vertebra.

The sacrum articulates with the fifth lumbar vertebra at the lumbosacral articular surface and the superior articular process.

Transverse ridges mark the points of fusion of the five sacral vertebrae.

The anterior sacral foramina provide exit points for the sacral spinal nerves.

The apex of the sacrum marks the most inferior edge of the sacrum at its articulation with the coccyx.

The anterior, or pelvic, surface of the sacrum is concave in shape.
SKELETAL STRUCTURES OF THE TRUNK

The sacral canal is a continuation of the vertebral canal, and houses the most inferior end of the spinal cord.

Spinous tubercles are spinous processes of the fused sacral vertebrae.

The posterior sacral foramina allow for passage of sacral spinal nerves.

The sacral cornu (horn) articulates with the coccygeal cornu and provides soft tissue attachment points.

The coccygeal cornu (horn) articulates with the sacral cornu and provides soft tissue attachment points.

The median sacral crest marks the dorsal midline as well as the fusion of the spinal processes of the sacral vertebrae.

The sacral hiatus is the terminus of the sacral canal.

The posterior sacral foramina allow for passage of sacral spinal nerves.

The intermediate and lateral sacral crests serve as attachment points for muscles and ligaments.

Facet of superior articular process

Ala

The coccygeal cornu (horn) articulates with the sacral cornu and provides soft tissue attachment points.

7-2K. Sacrum: posterior view. The posterior, or dorsal, surface of the sacrum is convex in shape.
Palpating the Anterior Ribs

**Positioning:** client supine.

1. Locate your client’s sternum with the pads of your fingers.
2. Slide your fingertips laterally onto the surfaces of the anterior ribs.

Palpating the Xiphoid Process of the Sternum

**Positioning:** client supine.

1. Locate the inferior edge of your client’s anterior ribcage with your fingertips.
2. Follow the inferior edge medially onto the diamond-shaped xiphoid process.

Palpating the Iliac Crest

**Positioning:** client supine.

1. Locate the lateral surfaces of your client’s trunk with the palms of your hands.
2. Slide your hands inferiorly until the ulnar side of your hand contacts the broad, rounded ridge of the iliac crest.

Palpating the Pubis

**Positioning:** client supine.

1. Place your palm on your client’s abdomen between the navel and pelvis.
2. Slide your hand inferiorly until the ulnar side of your hand contacts the horizontal ridge of the pubis.
**Palpating the Posterior Ribs**

**Positioning:** client prone.
1. Locate the midline of the thoracic region with the pads of your fingers.
2. Slide your fingers laterally onto the surfaces of the posterior ribs.

**Palpating the Spinous Processes**

**Positioning:** client prone.
1. Locate the midline of the posterior trunk with the pads of your fingers.
2. Palpate deeply onto the vertically elongated spinous processes of the thoracic spine or blunt spinous processes of the lumbar spine.

**Palpating the Lamina Groove**

**Positioning:** client prone.
1. Locate the spinous processes with your fingertips.
2. Slide your fingertips slightly lateral and deep into the depression between the spinous and transverse processes of the vertebrae.

**Palpating the Twelfth Rib**

**Positioning:** client prone.
1. Locate the space between the posterior ilium and ribcage with the pads of your fingers.
2. Slide your fingers superiorly and palpate the shortened twelfth rib near the spine.
**Palpating the Transverse Processes**

**Positioning:** client prone.

1. Locate the spinous processes with your fingertips.
2. Slide fingers laterally and deeply past the lamina groove onto the laterally protruding transverse processes.

**Palpating the Posterior Superior Iliac Spine**

**Positioning:** client prone.

1. Locate the iliac crest with your fingertips.
2. Follow the iliac crest posteriorly onto the posterior superior iliac spine; the most prominent projection just lateral to the sacrum.
Palpating the Sacral Spinous Tubercles

**Positioning:** client prone.

1. Locate the lumbar spinous processes with the pads of your fingers.
2. Palpate inferiorly between the right and left ilium onto the dorsal surface of the sacrum, noting the bumpy spinous tubercles as you palpate inferiorly.

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Palpating the Sacral Crests

**Positioning:** client prone.

1. Locate the dorsal surface of the sacrum with your fingertips.
2. Slide your fingertips laterally onto the vertical ridges they form the intermediate and lateral sacral crests.
MUSCLE ATTACHMENT SITES

SUPERIOR

External intercostals
Internal intercostals
Internal intercostals
External intercostals
Subcostales

SUPERIOR

Rectus abdominus

SUBCOSTALES

Intertransversarii

SUBCOSTALES

Diaphragm

MEDIAL

Quadratus lumborum

INTERNAL OBLIQUE

Erector spinae group

INTERNAL OBLIQUE

Rectus abdominus

LATERAL

Subcostales

Diaphragm

INFferior

7-4A. Muscle attachments of the trunk: anterior view.
**MUSCLE ATTACHMENT SITES**

7-4B. Muscle attachments of the trunk: posterior view.

7-4C. Muscle attachments: a thoracic vertebra. Lateral and posterior close-up views of a typical thoracic vertebra reveal the complex relationships between spinal muscles. Several deep, intermediate, and superficial muscles attach to the spinous and transverse processes. Together, they maintain alignment while allowing fine and powerful movements in the trunk.
LIGAMENTS OF THE TRUNK

The anterior longitudinal ligament runs vertically along the spine from cervical to sacral regions.

The ligamentum flavum is a continuous ligament network connecting the anterior surfaces of the pedicles. This network limits flexion and helps the spinal column return to an upright position.

The intertransverse ligaments connect adjacent transverse processes and limit lateral flexion of the spine.

The posterior longitudinal ligament is a narrow vertical band attaching to the intervertebral disks. Also see B and C.

A network of interspinous and supraspinous ligaments connects one spinous process to another and limits spinal flexion.

Together, the supraspinous and interspinous ligaments are a continuation of the nuchal ligament found in the cervical spine.

7-5A. Ligaments of the trunk: Anterior view. Several large ligaments connect the anterior surfaces of the vertebrae.

7-5B. Ligaments of the trunk: lateral view.
LIGAMENTS OF THE TRUNK

The lateral costotransverse ligament helps stabilize the costotransverse and costovertebral joints.

The superior costotransverse ligament helps stabilize the costovertebral joints.

The superficial radiate costal ligament helps stabilize the costotransverse joint.

The rotatores brevis and longus muscles help stabilize vertebrae during movements of the spine.

The posterior longitudinal ligament is deep to the spinal cord and surrounding dura.

The radiate ligament works with the costotransverse ligament to stabilize the costovertebral joint and maintain the position of the rib within the ribcage.

The ligaments unique to the thoracic spine help stabilize the costovertebral joints.

The ligament of the costal tubercle helps stabilize the costotransverse joint.

Levator costae longus helps elevate the ribs during forced inhalation.

The posterior longitudinal ligament is deep to the spinal cord and surrounding dura.

7-5C. Ligaments of the trunk: posterior view. Ligaments unique to the thoracic spine help stabilize the costovertebral joints.

7-5D. Ligaments of the trunk: superior view. From this view, the ligaments that stabilize the costovertebral and costotransverse joints are more visible.
SUPERFICIAL MUSCLES OF THE TRUNK

A. Anterior view. Large, prime movers of the shoulder girdle and trunk dominate the superficial trunk.

B. Posterior view. Spinal muscles are covered by large shoulder muscles and the fascial junction at the thoracolumbar aponeurosis.
INTERMEDIATE MUSCLES OF THE TRUNK

Rhomboids:  
Minor  
Major  

Intercostals  

Longissimus  

Spinalis  

Lumbocostalis  

Thoracolumbar  

aponeuorsis  

7-7. Intermediate muscles of the trunk. A. Anterior view.  
Scapular stabilizers and another layer of protective and prime mover abdominal muscles make up the intermediate layer of the anterior trunk.  
B. Posterior view.  
More global spinal stabilizers and scapular stabilizers make up the intermediate layer of the posterior trunk.
DEEP MUSCLES OF THE TRUNK

7-8. Deep muscles of the trunk. A. Anterior view. Several deep muscles in the trunk move the ribs during breathing and protect underlying organs. B. Posterior view. Deep muscles of the posterior trunk assist with breathing and stabilize the spine.
7-9. *Muscles of breathing.* Several deep and intermediate muscles work together to produce inhalation and forced exhalation.
SPECIAL STRUCTURES OF THE TRUNK

7-10A. Abdominal and thoracic viscera: anterior view.

The bones and muscles of the trunk protect underlying structures vital to life. Organs of the respiratory, cardiovascular, digestive, and other systems are housed in this region.
SPECIAL STRUCTURES OF THE TRUNK

7-10B. Abdominal and thoracic viscera: posterior view. The kidneys are protected partially by the lower ribcage and partially by large muscles of the trunk.
7-10C. Function of the intervertebral disk. As weight is placed through the spine, the intervertebral disk flattens. The central, fluid-containing nucleus pulposus distorts and, together with the surrounding annulus fibrosis, absorbs force, protecting the vertebral bodies. The disk also maintains a gap between vertebrae, allowing passageways for spinal nerves and blood vessels.

7-10D. Lymphatic vessels and lymph nodes of the trunk.
Several large lymph vessels and clusters of nodes reside deep in the trunk. Both the upper and lower limbs drain lymph into this region to be returned to the circulatory system. Deep breathing can stimulate lymphatic flow in the lower vessels, which are close to the diaphragm.
SPECIAL STRUCTURES OF THE TRUNK

The superior vena cava drains blood from the head, neck, and upper extremities.

The inferior vena cava drains the digestive organs, pelvic region, and lower extremities.

The superior mesenteric artery serves the small intestine and parts of the colon.

The iliac veins return blood from the lower extremities.

The subclavian blood vessels are deep to the clavicles and have many branches serving the head, neck, thorax, and upper extremity.

The aorta is the largest artery in the body. It begins at the heart and descends into the abdomen.

The iliac arteries supply blood to the lower extremities.

7-10E. Major blood vessels of the trunk: anterior view.
The aorta and vena cava must pass through the diaphragm muscle (not shown), which separates the thoracic and abdominal cavities.
The hepatic plexus is a large, unpaired group of nerves innervating the liver. The lumbar plexus lies anteriorly in the pelvis and passes in front of the coxal joint. It mainly innervates the anterior thigh. The sacral plexus lies posteriorly in the pelvis and innervates part of the pelvis, the posterior thigh, most of the lower leg, and the entire foot. The splanchnic nerves arise in the thorax but descend to innervate the abdomen. The superior gluteal nerve innervates the gluteus medius and minimus. The inferior gluteal nerve innervates the gluteus maximus muscle. The sciatic nerve originates near the ischium and descends into the lower extremity. **7-10F. Nerves of the trunk: anterior view.** Thoracic, lumbar, and sacral spinal nerves exit the spinal cord and form plexuses, or networks with adjacent blood and lymph vessels. Caution must be used when palpating deep muscles of the abdomen so as not to compress these structures.
7-10G. Nerves of the trunk: posterior view. This view reveals the spinal cord branches at each intervertebral joint forming the 31 pairs of spinal nerves. These spinal nerves have intimate connections with the vertebrae and surrounding muscles such as the intercostals, transverse abdominis, and psoas major.
POSTURE OF THE TRUNK

Assess vertical alignment between the ear canal and acromion process.

Examine the spinal curvatures in the cervical, thoracic, lumbar, and sacral regions.

Assess the horizontal alignment of the pelvis by examining the alignment of the anterior and posterior iliac spines.

Assess vertical alignment between the acromion process of the scapula and greater trochanter of the femur.

Assess the horizontal alignment of the right and left iliac crests.

Check to see if the external occipital protuberance is centered over the sacrum.

Look at the horizontal alignment between the right and left acromion processes.

7-11A. Assessing posture of the trunk: lateral view. Use the lateral view to assess posture in the sagittal plane.

7-11B. Assessing posture of the trunk: posterior view. Use the posterior view to assess posture in the frontal and transverse planes.
**POSTURE OF THE TRUNK**

### Kyphosis

Kyphosis is the clinical term for a pathologic exaggeration of the normal thoracic kyphotic curve. It is commonly seen in clients with significant loss of bone density (osteoporosis).

### Lordosis

Lordosis is an exaggeration of the normal lumbar curve. It is common in people who are overweight, and during the later months of pregnancy.

### Scoliosis

Scoliosis is a pathologic lateral curvature of the spine. It is typically an inherited condition that becomes most noticeable during the adolescent growth spurt.

7-12. **Common postural deviations.** Structural anomalies, muscular imbalances, and poor movement patterns can lead to abnormal or suboptimal posture. Here are several to watch out for when assessing posture. *Kyphosis* is the clinical term for a pathologic exaggeration of the normal thoracic kyphotic curve. It is commonly seen in clients with significant loss of bone density (osteoporosis). *Lordosis* is an exaggeration of the normal lumbar curve. It is common in people who are overweight, and during the later months of pregnancy. *Scoliosis* is a pathologic lateral curvature of the spine. It is typically an inherited condition that becomes most noticeable during the adolescent growth spurt.
MOVEMENTS AVAILABLE: TRUNK

A. Trunk flexion.
B. Trunk extension.
C. Trunk lateral flexion: right.
D. Trunk lateral flexion: left.
E. Trunk rotation: right.
F. Trunk rotation: left.
MOVEMENTS AVAILABLE: BREATHING

A. Inhalation. Expansion of the ribcage decreases air pressure within the thoracic cavity, causing air to rush into the lungs.

B. Exhalation. Compression of the ribcage increases air pressure within the thoracic cavity, causing air to rush out of the lungs.
Performing resisted range of motion (ROM) for the trunk helps establish the health and function of the dynamic stabilizers and prime movers in this region. Evaluating functional strength and endurance helps you to identify balance and potential imbalance between the muscles that move and stabilize the spine and axial skeleton. Notice that you do not assess passive range of motion as this is not practical or safe in this region. Procedures for performing and grading resisted ROM are outlined in Chapter 3.

A. **Resisted trunk flexion.** The green arrow indicates the direction of movement of the client and the red arrow indicates the direction of resistance from the practitioner. Stand at your seated client’s side facing the anterior torso. Place one arm across your client’s upper chest and the other across the client’s upper back. Instruct the client to meet your resistance by curling the trunk as you gently but firmly straighten the trunk. Assess the strength and endurance of the muscles that flex the trunk.

B. **Resisted trunk extension.** Stand at your seated client’s side, facing the anterior torso. Place one arm across your client’s upper chest and the other across the upper back. Instruct your client to meet your resistance by arching the back as you gently but firmly curl their trunk forward. Assess the strength and endurance of the muscles that extend the trunk.

C. **Resisted trunk lateral flexion: right.** Stand in front of your seated client, facing the anterior torso. Place one hand on your client’s right lateral shoulder and the other on the side of the left hip. Instruct your client to meet your resistance by tipping the right shoulder toward the right hip as you gently but firmly tip the left shoulder toward the left hip. Assess the strength and endurance of the muscles that laterally flex the trunk to the right.

D. **Resisted trunk lateral flexion: left.** Stand in front of your seated client, facing the anterior torso. Place one hand on your client’s left lateral shoulder and the other on the side of the right hip. Instruct your client to meet your resistance by tipping the left shoulder toward the left hip as you gently but firmly tip the right shoulder toward the right hip. Assess the strength and endurance of the muscles that laterally flex the trunk to the left. (continues)
E. Resisted trunk rotation: right. Stand in front of your seated client, facing them. Place one hand on the front of your client’s left shoulder and the other on the back of the right. Instruct your client to meet your resistance by turning the upper body to the right as you gently but firmly turn the upper body to the left. Assess the strength and endurance of the muscles that rotate the trunk to the right.

F. Resisted trunk rotation: left. Stand in front of your seated client, facing them. Place one hand on the front of your client’s right shoulder and the other on the back of the left. Instruct your client to meet your resistance by turning the upper body to the left as you gently but firmly turn the upper body to the right. Assess the strength and endurance of the muscles that rotate the trunk to the left.

A. Resisted inhalation: upper ribcage. Stand to the side of your supine client, facing them. Place both your hands on the anterior chest. Instruct your client to meet your resistance by breathing deeply into the chest as you gently but firmly press your hands posteriorly and inferiorly. Assess the strength and endurance of the muscles of inhalation.

B. Resisted inhalation: lower ribcage. Stand to the side of your supine client, facing them. Place one hand on each side of the lower ribcage. Instruct your client to meet your resistance by breathing deeply into the abdomen and sides as you gently but firmly compress the ribcage medially. Assess the strength and endurance of the muscles of inhalation.
Rectus Abdominis • *rekˈtəs ab dərˈmə nəs* • Latin “rectus” straight “abdominus” of the abdomen

**Attachments**
O: Pubis, crest, and symphysis
I: Ribs 5–7, costal cartilage, and xiphoid process of sternum

**Actions**
- Flexes the vertebral column (bilateral action)
- Laterally flexes the vertebral column (unilateral action)

**Innervation**
- T5–T12
- Ventral rami

**Functional Anatomy**
Rectus abdominis is the most anterior abdominal muscle. It connects the sternum and ribcage to the pubis, and its right and left sides are separated by the vertical linea alba. The fibers of rectus abdominis are also segmented horizontally; each side is divided into five paired sections by a horizontal line of connective tissue. The resulting segments are commonly referred to as a “six pack,” since other muscles typically obscure the most superior and inferior segments. Segmentation of rectus abdominis allows for graded movement in the trunk. Sequential contraction of segment pairs creates a rounding effect during trunk flexion.

Besides graded flexion, the rectus abdominis muscles can act unilaterally to assist in lateral flexion. This capacity becomes important during walking. The right rectus abdominis fires with its corresponding right erector spinae muscles to stabilize the trunk as weight is accepted onto the right leg. As weight is shifted onto the left leg, the left rectus abdominis and erector spinae muscles are activated to stabilize the trunk. This unilateral stabilization can be viewed on the student CD included with this text.

Rectus abdominis is also important in maintaining upright posture. It counterbalances the posterior erector spinae muscles, keeping the anterior pelvis fixed superiorly. Weakness in rectus abdominis allows the anterior portion of the pelvis to tip inferiorly (imagine the pelvis as a bowl of water spilling out the front), creating an *anterior pelvic tilt*. This excessively increases the spine’s natural lumbar lordosis and can be a cause of low back pain.

**Palpating Rectus Abdominis**

**Positioning:** client supine.

1. Standing at the client’s side, face the abdomen and locate the inferior edge of the anterior ribcage with the palms of both your hands.
2. Slide your hands inferiorly, into the space between the xiphoid process and the anterior pelvis.
3. Locate the segmented fibers of rectus abdominis on either side of the linea alba.
4. Client gently raises both shoulders off of the table to ensure proper location.
External Oblique • *eks ter'nal o blek* • Latin “*extern*” *outward* “*obliquus*” *slanting*

**Attachments**

O: Ribs 5–12, external surfaces  
I: Ilium, anterior crest, inguinal ligament, and linea alba

**Actions**

- Flexes the vertebral column (bilateral action)  
- Laterally flexes the vertebral column (unilateral action)  
- Rotates the vertebral column toward opposite side (unilateral action)  
- Compresses and supports abdominal organs

**Innervation**

- T7–T12

**Functional Anatomy**

The external oblique lies superficial to the internal oblique and lateral to rectus abdominis. It is a thick, strong, prime mover. Its fibers run at an oblique angle from the lateral ribs anteriorly and inferiorly to the ilium, inguinal ligament, and linea alba. The origin of external oblique interdigitates with the costal attachments of serratus anterior (see Chapter 4).

External oblique functions with internal oblique and transverse abdominis to compress and protect the abdominal contents during forced exhalation. When the right and left sides of the external and internal obliques work together, the trunk flexes at the waist. During rotation, the right external oblique teams up with the left internal oblique to turn the trunk to the left. The left external oblique works with the right internal oblique to turn the trunk to the right. During flexion and rotation, these muscles rely on the deep transversospinalis muscles to maintain vertebral alignment. The external and internal obliques are active when we swing an axe, throw overhand, or push with one hand.

**Palpating External Oblique**

**Positioning:** client supine.

1. Standing at the client’s side, face the abdomen and locate the inferior edge of the anterolateral ribcage with the palm of your hand.  
2. Slide hand inferiorly into the space between the iliac crest and inferior edge of ribcage.  
3. Locate the sloping fibers of external oblique as it angles anteriorly and inferiorly from the lateral ribcage toward the linea alba.  
4. Client gently lifts the shoulder of the same side to ensure proper location.
Attachments
O: Thoracolumbar aponeurosis, iliac crest, and lateral inguinal ligament
I: ribs 10–12, internal surfaces, medial pectineal line of pubis, and linea alba

Actions
• Flexes the vertebral column (bilateral action)
• Laterally flexes the vertebral column (unilateral action)
• Rotates the vertebral column toward same side (unilateral action)
• Compresses and supports abdominal organs

Innervation
• T7–T12, L1
• Iliohypogastric, ilioinguinal, and ventral rami nerves

Functional Anatomy
The internal oblique lies superficial to transverse abdominis, deep to the external oblique, and lateral to rectus abdominis. It is a thick, strong, prime mover muscle. Its fibers run at an oblique angle from the linea alba inferiorly to the ilium and posteriorly to the thoracolumbar aponeurosis.

Internal oblique, external oblique, and transverse abdominis work together to compress and protect the abdominal contents. They are active during forced exhalation. When the right and left sides of the internal and external obliques work together, the trunk flexes, bending the body at the waist. For rotation, the right internal oblique teams up with the left external oblique to turn the trunk to the right. The left internal oblique works with the right external oblique to turn the trunk to the left. These strong trunk rotators rely on the deep transversospinalis muscles to maintain vertebral alignment during movement. The internal and external obliques are responsible for strong rotation and flexion such as in swinging an axe, throwing overhand, and pushing with one hand.

Palpating Internal Oblique
Positioning: client supine.
1. Standing at the client’s side, face the abdomen and locate the inferior edge of the anterolateral ribcage with the palm of your hand.
2. Slide your hand inferiorly, into the space between the iliac crest and inferior edge of ribcage.
3. Locate the sloping fibers of internal oblique as it angles inferiorly and posteriorly from the linea alba toward the lateral iliac crest.
4. Client gently turns the trunk to the same side to ensure proper location.
Transverse Abdominis

Palpating Transverse Abdominis

Positioning: client supine.
1. Standing at the client’s side, face the abdomen and locate the most lateral edge of the iliac crest with the palms of both your hands, one on each side.
2. Slide your hands superiorly into the space between the iliac crest and inferior edge of ribcage.
3. Locate the horizontal fibers of transverse abdominis with your palms as it wraps around the waist.
4. Client gently exhales while “hissing like a snake” to ensure proper location.

Attachments
O: Ribs 7–12, costal cartilages, thoracolumbar fascia, internal iliac crest, and lateral inguinal ligament
I: Linea alba and crest and pectineal line of pubis

Actions
• Compresses and supports abdominal organs
• Assists with exhalation

Innervation
• T7–T12, L1
• Lower intercostal, iliohypogastric, and ilioinguinal nerves

Functional Anatomy
Transverse abdominis is the deepest of the abdominal muscles. Its fibers run horizontally and wrap around the waist from the vertebral column to the linea alba. Transverse abdominis is unique in that it has no true action. Instead, it is defined by its function of increasing intra-abdominal pressure. Transverse abdominis joins the internal and external oblique muscles at the abdominal fascia, a sturdy sheath of connective tissue terminating anteriorly at the linea alba and lying superficial to rectus abdominis.

Contraction of transverse abdominis compresses the organs and contents of the abdominal cavity. The resulting increase in pressure within the abdominal cavity serves three functions. First, it assists with expulsion of air during forced exhalation. Second, it assists with expulsion of abdominal contents such as urine and feces, or stomach contents during vomiting. Third, and most importantly to human movement, it supports and stabilizes the lumbar spine. This last function earns transverse abdominis the nickname of “anatomical weightbelt.” A strong, functional transverse abdominis will serve the same purpose as the thick belts worn to prevent injury when lifting heavy objects.
Diaphragm  •  di’ə främ  •  Greek “dia” through “phragma” partition

Attachments
O: Ribs 7–12, inner surfaces and costal cartilages, xiphoid process of sternum, and bodies of L1–L2
I: Central tendon

Actions
• Expands thoracic cavity during inhalation

Innervation
• C3–C5
• Phrenic nerve

Functional Anatomy
The diaphragm is a dome-shaped muscle that forms a seal around the inferior ribcage and separates the thoracic and abdominal cavities. It has several openings for blood vessels, nerves, and structures of the digestive system. The muscle fibers of the diaphragm converge in the center to form the central tendon. This tendon forms the most superior, medial area of the dome.

The diaphragm is the primary muscle of breathing. As it contracts, the central tendon is pulled inferiorly toward the abdominal cavity. This flattens the dome, increasing the volume of the thoracic cavity and decreasing its internal air pressure. Decreased air pressure within the cavity prompts environmental air to flow inward to equalize air pressure (inhalation). This mechanism fills the lungs with air. As the diaphragm relaxes, resuming its domed shape, the space within the thoracic cavity decreases. Increased pressure within the thoracic cavity prompts air to flow out of the lungs to equalize air pressure (exhalation). Contraction and relaxation of the diaphragm drives breathing when the body is relaxed. Other muscles such as the intercostals, subcostales, and serratus posterior muscles are activated to increase the depth of breathing.

Palpating the Diaphragm
Positioning: client supine.
1. Standing at the client’s side, face the abdomen and locate the inferior edge of the anterolateral ribcage with your fingertips or pad of your thumb.
2. Instruct your client to take several deep breaths while you are palpating this muscle.
3. Locate the fibers of the diaphragm by gently sliding posteriorly and deeply and following the inner surface of the ribcage.
4. Client inhales to ensure proper location.
Palpating External Intercostals

**Positioning:** client supine.

1. Standing at the client’s side, face the abdomen and locate the anterior surface of a rib with the pad of one of your fingers.
2. Slide your finger into the space between this rib and the one immediately superior or inferior.
3. Locate the angled fibers of the external intercostal between the edges of the two ribs.
4. Client forcefully inhales through pursed lips to ensure proper location.

**Attachments**
- O: Rib, lower border
- I: Rib below, upper border

**Actions**
- Elevate ribs during inhalation

**Innervation**
- Intercostal nerves

**Functional Anatomy**

The external intercostals lie between the ribs, superficial to the internal intercostals. Their fibers run at an oblique angle from lateral to medial, like those of the external oblique muscles. The external and internal intercostal muscles help maintain the shape and integrity of the ribcage.

The functional role of the intercostals is controversial. It is clear that they are involved in breathing. Mechanically, the muscles fibers tend to pull the inferior attachment toward the superior attachment, elevating the ribs. This action would assist with inhalation as the ribcage elevates, increasing the space within the thoracic cavity. Activation of the internal and external intercostals seems more significant during activities that require forceful inhalation or exhalation, such as sucking on a straw or blowing out a candle.
Internal Intercostals • in ter’nal in ter kos’tal • Latin “intern” inward “inter” between “costal” rib

Attachments
O: Rib, inner surface and costal cartilage
I: Rib below, upper borders

Actions
• Depress the ribs during exhalation

Innervation
• Intercostal nerves

Functional Anatomy
The internal intercostals lie between the ribs, deep to the external intercostals. Their fibers run at an oblique angle from medial to lateral, like those of the internal oblique muscles. The internal and external intercostals help maintain the shape and integrity of the ribcage.

As with the external intercostals, there is some controversy about the function of the internal intercostals. It is clear that they are involved in respiration, but it is not clear whether they assist with inhalation, exhalation, or both. Mechanically, the muscle fibers are able to pull their superior attachments toward their inferior attachments to depress the ribs. This action would assist with exhalation as the ribcage depresses, decreasing the space within the thoracic cavity. This ability seems to be more prevalent in the posterior fibers. Anteriorly, the intercostals pull the inferior attachment up toward the superior one. This action assists with inhalation as the ribcage elevates, increasing the space within the thoracic cavity. Activation of the intercostals seems to be more significant during forced breathing activities such as sucking on a straw or blowing out a candle.

Palpating Internal Intercostals

Positioning: client supine.

1. Standing at the client’s side, face their abdomen and locate the anterior surface of a rib with the pad of one of your fingers.
2. Slide your finger into the space between this rib and the one immediately superior or inferior.
3. Locate the angled fibers of internal oblique between the edges of the two ribs.
4. Client exhales and “hisses like a snake” to ensure proper location.
Palpating Iliocostalis

Positioning: client prone.

1. Standing at the client’s side, face the spine and locate the thoracic spinous processes with the fingertips of both your hands.
2. Slide your fingertips laterally, past the lamina groove onto the erector spinae muscles.
3. Strum laterally across the erector spinae muscles with the fingertips of both your hands toward the ribs to find iliocostalis.
4. Client gently lifts the head and extends the trunk to ensure proper location.

Attachments

O: sacrum, posterior aspect, medial lip of ilium, and posterior surface of ribs 1–12
I: L1–L3, transverse processes, posterior surface of ribs 1–6, and transverse processes of C4–C7

Actions

• Extends the vertebral column (bilateral action)
• Laterally flexes the vertebral column (unilateral action)

Innervation

• Spinal nerves

Functional Anatomy

The iliocostalis is part of the erector spinae (erect = upright and spine = spine) group of muscles. The longissimus and spinalis are also part of this group. These muscles connect the sacrum, ilium, vertebral column, and cranium. They provide broader stabilization and movement than the deeper transversospinalis group. Together, the erector spinae and transversospinalis groups maintain upright posture of the spine against gravity.

Iliocostalis is the most lateral of the three pairs of erector spinae muscles. Its segments extend superiorly and laterally, like the branches of a tree, from the posterior sacrum and ilium to the posterior ribs and transverse processes in the lumbar and cervical spine. These branches give it leverage to extend and strongly laterally flex the vertebral column. Iliocostalis also may contribute to pulling the ribs down during forced exhalation.
Attachments
O: Thoracolumbar aponeurosis, transverse processes of L5–T1, and articular processes of C4–C7
I: T1–T12, transverse processes, posterior surface of ribs 3–12, transverse processes of C2–C6, and mastoid process of the temporal bone

Actions
• Extends the vertebral column (bilateral action)
• Laterally flexes the vertebral column (unilateral action)
• Rotates the head and neck toward same side (unilateral action of cervical portion)

Innervation
• Spinal nerves

Functional Anatomy
The longissimus is part of the erector spinae group of muscles. The iliocostalis and spinalis are also part of this group, which connects, stabilizes, and allows for broad movements of the sacrum, ilium, vertebral column, and skull. The erector spinae also work with the transversospinalis group to maintain upright posture in the spine against gravity.

Each longissimus lies medial to iliocostalis and lateral to spinalis. This muscle spans the entire axial skeleton and connects the sacrum and cranium: it extends from the sacrum and ilium to the transverse processes of the vertebrae and the mastoid process of the temporal bone. The fibers of longissimus are more vertical than iliocostalis; thus, it is a strong extender and weak lateral flexor of the spine. It also stabilizes and rotates the head and neck by pulling the mastoid process posteriorly and inferiorly toward the spine.

Palpating Longissimus
Positioning: client prone.
1. Standing at the client’s side, face the spine and locate the thoracic spinous processes with fingertips of both your hands.
2. Slide your fingertips laterally, past the lamina groove onto the erector spinae muscles.
3. Strum back and forth across the erector spinae muscles with fingertips of both your hands to differentiate the vertical fibers of longissimus in the center from the lateral, oblique fibers of iliocostalis.
4. Client gently lifts the head and extends the trunk to ensure proper location.
Palpating Spinalis

Positioning: client prone.

1. Standing at the client’s side, face the spine and locate the thoracic spinous processes with the fingertips of both your hands.

2. Slide your fingertips laterally, past the lamina groove onto the erector spinae muscles.

3. Strum back and forth across the erector spinae muscles with the fingertips of both your hands locating the most medial edge formed by spinalis.

4. Client gently lifts the head and extends the trunk to ensure proper location.

Attachments

O: L2–T11, spinous processes, ligamentum nuchae, and spinous processes of T2–C7

I: T1–T8, spinous processes, spinous processes of C2–C4, and between the superior and inferior nuchal lines of the occiput

Actions

• Extends the vertebral column (bilateral action)
• Rotates head and neck toward opposite side (unilateral action)

Innervation

• Spinal nerves

Functional Anatomy

The spinalis is part of the erector spinae group of muscles, which also includes iliocostalis and longissimus. These muscles connect the sacrum, ilium, vertebral column, and cranium, and provide broad stabilization and movement. The erector spinae and transversospinalis group together maintain upright posture in the spine against gravity.

Spinalis is the most medial of the three pairs of erector spinae muscles. It extends from the spinous processes of the lower thoracic and upper lumbar vertebrae to the spinous processes of the upper thoracic and lower cervical vertebrae. Its vertical fibers make it stronger in extension than rotation. In the cervical spine, spinalis joins the semispinalis muscle of the transversospinal group before attaching to the occiput.
Attachments
O: Iliac crest, posterior and iliolumbar ligament
I: L1–L4, transverse processes and inferior border of 12th rib

Actions
• Extends the vertebral column (bilateral action)
• Laterally flexes the vertebral column (unilateral action)
• Depresses/fixes the last rib during inhalation.

Innervation
• T12–L3
• Lumbar plexus

Functional Anatomy
The quadratus lumborum is a deep, multifunctional muscle of the spine. It connects the ilium to the lateral lumbar spine and twelfth rib. The fibers of each quadratus lumborum run slightly diagonal from the rib and spine inferiorly and laterally toward the posterior ilia. Quadratus lumborum lies deep to the erector spinae muscles and posterior to the psoas major, helping form the posterior abdominal wall.

Functionally, the quadratus lumborum muscles position the spine relative to the pelvis when the lower body is fixed. They maintain upright posture, creating fine lateral movements as well as extension when coordinating with the erector spinae muscles. When we stand, the paired quadratus lumborum muscles work with the gluteus medius muscles to position the body over the lower extremities.

During walking, the quadratus lumborum and gluteus medius help stabilize the pelvis as the weight of the body shifts onto one foot, then the other. These muscles prevent the pelvis from shifting laterally and maintain movement in the sagittal plane. Also, quadratus lumborum raises the iliac crest toward the ribcage as weight shifts to the other foot. This action allows the leg to swing forward without the foot hitting the ground.

Quadratus lumborum also assists with breathing. During inhalation, it tethers the 12th rib inferiorly, allowing the ribcage to fully expand. Dysfunction in quadratus lumborum can occur from labored breathing, weakness in gluteus medius, and imbalances in postural muscles such as the erector spinae, abdominals, and psoas.
**Quadratus Lumborum (continued)**

**Palpating Quadratus Lumborum**

**Positioning:** client prone.

1. Standing at the client’s side, face the spine and locate the lumbar spinous processes with fingertips of both your hands.
2. Slide your fingertips laterally, past the lamina groove and the erector spinae muscles.
3. Palpate deeply between the twelfth rib and ilium to find the angled fibers of quadratus lumborum.
4. Client gently elevates the hip superiorly to ensure proper location.

**Positioning:** client sidelying with top arm forward or overhead.

1. Standing at the client’s side, face the spine and locate the iliac crest of their up-facing hip with your fingertips or elbow.
2. Slide your fingers or elbow superiorly toward the ribcage and laterally to the erector spinae.
3. Palpate deeply between the twelfth rib and ilium to find the angled fibers of quadratus lumborum.
4. Client gently elevates the hip superiorly to ensure proper location.
Serratus Posterior Superior

Attachments
O: C7–T3, spinous processes and ligamentum nuchae
I: Ribs 2–5, posterior surfaces

Actions
• Elevates ribs during inhalation

Innervation
• Intercostal nerves 2–5

Functional Anatomy
Serratus posterior superior is deep to the rhomboids and trapezius muscles (see Chapter 4). It connects the spine at C7 through T3 to the 2nd through 5th ribs on the posterior ribcage. The descending angle of its fibers allows this muscle to elevate the upper ribs during forced inhalation.

Palpating Serratus Posterior Superior

Positioning: client prone.
1. Standing at the client’s side, face the spine and locate the spinous process of C7–T3 with your fingertips.
2. Slide your fingertips laterally and slightly inferiorly toward the ribs.
3. Locate the inferiorly angled fibers of serratus posterior along the posterior surfaces of ribs 2–12.
4. Client inhales forcefully through pursed lips to ensure proper location.
Serratus Posterior Inferior

**Attachments**
- **O:** T11–L3, spinous processes
- **I:** Ribs 9–12, posterior surfaces

**Actions**
- Depresses ribs during exhalation

**Innervation**
- Intercostal nerves

**Functional Anatomy**
Serratus posterior inferior lies deep to latissimus dorsi (see Chapter 4) and superficial to the erector spinae muscles. It connects the spine at T11 through L3 to the 9th through 12th ribs on the posterior ribcage. The ascending angle of its fibers allows this muscle to depress these ribs. There is some controversy as to this muscle’s role in breathing. Most agree that the depression of the lower ribs by serratus posterior inferior assists with forced exhalation.

### Palpating Serratus Posterior Inferior

**Positioning:** client prone.
1. Standing at the client’s side, face the spine and locate the spinous process of T11–L3 with your fingertips.
2. Slide your fingertips laterally and slightly superiorly toward the ribs.
3. Locate the superiorly angled fibers of serratus posterior inferior along the posterior surface of the lower ribs.
4. Client exhales and “hisses like a snake” to ensure proper location.
Attachments
O: T10–C7, transverse processes and C6–C4 articular processes
I: T4–C2, spinous processes and occiput between superior and inferior nuchal lines

Actions
• Extends the vertebral column (bilateral action)
• Rotates the head and vertebral column toward opposite side (unilateral action)

Innervation
• Spinal nerves

Functional Anatomy
The semispinalis muscles are part of the transversospinalis (transverse across and spinalis the spine) group of muscles. They work with the rotatores and multifidi to stabilize and steer the individual vertebrae as the spinal column moves. But unlike rotatores and multifidi, semispinalis is not present in the lumbar region.

Semispinalis is the most superficial of the transversospinalis muscles. Its fibers connect the transverse process of one vertebra to the spinous process of the vertebra five or six above. Its fiber direction is the most vertical of the transversospinalis muscles; this characteristic gives it the best leverage for extension. All of the transversospinalis muscles rotate the vertebral column to the opposite side by pulling the spinous processes inferiorly toward the transverse processes.

Palpating Semispinalis
Positioning: client prone.
1. Sitting at the client’s head, place both your hands palm up under client’s head, and find external occipital protuberance with your fingertips.
2. Slide your fingertips inferiorly and laterally into the suboccipital region and lamina groove.
3. Follow the vertical muscle fibers inferiorly within the lamina groove as the client tucks their chin to slack superficial structures.
4. Client gently resists tipping the head back to ensure proper location.
Palpating Multifidi

Positioning: client prone.

1. Standing at the client’s side, face the spine and locate the lumbar spinous processes with fingertips of both your hands.
2. Slide your fingertips laterally and deeply toward the transverse processes or sacrum and into the lamina groove.
3. Locate the multifidi with your fingertips between the spinous processes and transverse processes or sacrum directly below.
4. Client gently lifts the head and one shoulder off the table to ensure proper location.

Attachments

O: L5–C4, transverse processes, posterior sacrum, and posterior iliac spine
I: L5–C2, spinous process 2–4 vertebrae above

Actions

• Extends the vertebral column (bilateral action)
• Rotates vertebra toward opposite side (unilateral action)

Innervation

• Spinal nerves

Functional Anatomy

The multifidi are part of the transversospinalis group of muscles. Together with the rotatores and semispinalis muscles, they form a network connecting the transverse and spinous processes of different vertebrae. They also stabilize and steer the vertebrae as the spinal column moves.

The multifidi lie deep to the semispinalis and superficial to the rotatores. They are present in all segments of the spine. Their fibers connect the transverse process of one vertebra to the spinous process of the vertebrae three or four above. The multifidi lie slightly more vertically than the rotatores, allowing them better leverage to extend the vertebral column. All of the transversospinalis muscles rotate the vertebral column to the opposite side. This is accomplished by pulling the spinous processes toward the transverse processes immediately inferior.
Rotatores • *rotato'rez • Latin “rotato’rez" *rotators*

**Attachments**
O: L5–C1, transverse processes
I: Vertebra above, spinous process

**Actions**
• Extends the vertebral column (bilateral action)
• Rotates vertebra toward opposite side (unilateral action)

**Innervation**
• Spinal nerves

**Functional Anatomy**
The rotatores are part of the transversospinalis group of muscles. The multifidi and semispinalis muscles are also part of this group. The deep, small muscles of the transversospinalis group form a network connecting the transverse and spinous processes of different vertebrae. They work together to stabilize and steer the individual vertebrae as the spinal column moves.

The rotatores are the deepest muscles of the transversospinalis group. They’re present in all segments of the spine, but most developed in the thoracic spine. Each muscle has two parts: the first connects the transverse process of one vertebra to the spinous process of the vertebra immediately superior, and the second connects the transverse process to the spinous process of the vertebra that is two vertebrae superior. Rotator’s nearly horizontal fiber direction gives it good leverage for rotation, but less for extension. The multifidi and semispinalis muscles are more vertically oriented. All of the transversospinalis muscles rotate the vertebral column to the opposite side. This is accomplished by pulling the spinous processes toward the transverse processes immediately inferior.

**Palpating Rotatores**
**Positioning:** client prone.
1. Standing at the client’s side facing the spine, locate the spinous processes with your fingertips. Use both hands.
2. Slide your fingertips laterally and deeply toward the transverse processes and into the lamina groove.
3. Locate rotatores with your fingertips between the spinous processes and transverse processes directly inferior.
4. Client resists slight trunk rotation to ensure proper location.
Palpating Interspinalis

Positioning: client prone over pillow.

1. Standing at the client’s side, face the spine and locate the spinous processes with your fingertips.
2. Slide your fingertips between one spinous process and the one below; your client remains relaxed.
3. Locate the vertical fibers of interspinalis centrally between the two spinous processes (one on the right and one on the left of midline).
4. Client gently extends the trunk to ensure proper location.

Interspinalis • in’ter spi na’lez • Latin “inter” between “spinalis” of the spine

Attachments
O: L5-T12, spinous processes and T3-C2, spinous processes
I: Vertebra above, spinous process

Actions
• Extends the vertebral column (bilateral action)

Innervation
• Spinal nerves

Functional Anatomy

The interspinalis are small, deep muscles that connect the spinous process of one vertebra to the spinous process of the vertebra immediately superior. They work in pairs, one on each side of the interspinous ligament. Their main function is to monitor and maintain front-to-back posture when the body is upright against gravity. Their muscle fibers are on the posterior, medial vertebral column and run vertically. This position allows them to contract isometrically and maintain the spine upright in the sagittal plane.

The interspinalis muscles are not present throughout the thoracic spine. There is less mobility in this region of the spine due to the stabilizing action of the ribcage and thus less need for stabilizing muscles like the interspinalis.
Intertransversarii

- *Inter* - between
- *Transversus* - across
- *Versus* - turn
- *Much* - much

**Attachments**
- **O:** L5–C1, transverse processes
- **I:** Vertebrae above, transverse processes

**Actions**
- Laterally flexes the vertebral column (unilateral action)

**Innervation**
- Spinal nerves

**Functional Anatomy**

The intertransversarii are small, deep muscles that connect the transverse process of one vertebra to the transverse process of the vertebra immediately superior. So as you might guess, their muscle fibers are laterally oriented on the vertebral column, and run vertically. This position allows them to contract isometrically and maintain the spine upright in the frontal plane. Indeed, their main function is to maintain side-to-side posture against gravity when the body is upright.

The intertransversarii of the thoracic spine are indistinguishable from the intercostal muscles between the ribs. There is less call for lateral stabilization by the intertransversarii as the ribcage limits movement in this region.

**Palpating Intertransversarii**

The intertransversarii muscles are very small and too deep to palpate.
### TABLE 7-1. OTHER MUSCLES INVOLVED IN BREATHING

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Levator costarum</strong></td>
<td>C7–T11 Transverse Processes</td>
<td>Ribs 1–12, angle of rib below</td>
<td>Elevates rib during forced inhalation</td>
</tr>
<tr>
<td><strong>Subcostales</strong></td>
<td>Ribs 10–12, near angle</td>
<td>Ribs 8–10, near angle</td>
<td>Depresses ribs 8–10 during forced exhalation</td>
</tr>
<tr>
<td><strong>Transversus Thoracis</strong></td>
<td>Xiphoid process and sternum</td>
<td>Ribs 2–6, costal cartilage</td>
<td>Depresses ribs 2–6 during forced exhalation</td>
</tr>
</tbody>
</table>

![Image of skeletal structures showing muscle locations and actions](image.png)
### SYNERGISTS/ANTAGONISTS: TRUNK

<table>
<thead>
<tr>
<th>Trunk Motion</th>
<th>Muscles Involved</th>
<th>Trunk Motion</th>
<th>Muscles Involved</th>
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</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>Rectus Abdominis</td>
<td>Extension</td>
<td>Iliocostalis</td>
</tr>
<tr>
<td></td>
<td>External oblique</td>
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<td>Longissimus</td>
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<tr>
<td></td>
<td>Internal oblique</td>
<td></td>
<td>Spinalis</td>
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<td></td>
<td></td>
<td></td>
<td>Quadratus lumborum</td>
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<td>Semispinalis</td>
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<td>Rotatores</td>
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<td>Multifidi</td>
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<td></td>
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<td></td>
<td>Interpinalis</td>
</tr>
<tr>
<td>Lateral Flexion (Right)</td>
<td>Right rectus abdominis</td>
<td>Lateral Flexion (Left)</td>
<td>Left rectus abdominis</td>
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<tr>
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<td></td>
<td>Right internal oblique</td>
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<td>Left internal oblique</td>
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<td></td>
<td>Right iliocostalis</td>
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<td>Left iliocostalis</td>
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<td>Right longissimus</td>
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<td>Left longissimus</td>
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<td></td>
<td>Right quadratus Lumborum</td>
<td></td>
<td>Left quadratus lumborum</td>
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<tr>
<td></td>
<td>Right intertransversarii</td>
<td></td>
<td>Left intertransversarii</td>
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<tr>
<td>Rotation (Right)</td>
<td>Right external oblique</td>
<td>Rotation (Left)</td>
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<td>Left internal oblique</td>
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<td>Right internal oblique</td>
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<td>Right semispinalis</td>
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<td>Left multifidi</td>
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<td>Right multifidi</td>
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<tr>
<td></td>
<td>Left rotatores</td>
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<td>Right rotatores</td>
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</table>
## SYNERGISTS/ANTAGONISTS: BREATHING

<table>
<thead>
<tr>
<th>Thoracic Motion</th>
<th>Muscles Involved</th>
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<th>Muscles Involved</th>
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</thead>
<tbody>
<tr>
<td>Inhalation</td>
<td>Diaphragm</td>
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<td>Internal intercostals</td>
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<tr>
<td></td>
<td>External intercostals</td>
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<td>Serratus posterior inferior</td>
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<tr>
<td></td>
<td>Serratus posterior superior</td>
<td></td>
<td>Transverse abdominus</td>
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<td>Levator costarum</td>
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<td>Internal oblique</td>
</tr>
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<td></td>
<td>Quadratus lumborum</td>
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<td></td>
<td>Scalenes (see Ch 6)</td>
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<td>Rectus abdominus</td>
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<td></td>
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<tr>
<td></td>
<td>Serratus anterior (see Ch 4)</td>
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<td>Transverse thoracis</td>
</tr>
</tbody>
</table>

**Trunk**

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Pushing. The abdominal muscles are capable of powerful forward movements of the trunk. The arms and trunk flexors work together when pushing anteriorly and overhead such as with this throwing motion.

Bending. The lateral flexors of the trunk are active when bending toward one side of the body. Deep stabilizers, such as the quadratus lumborum and erector spinae muscles, maintain posture while the abdominals power the movement of bending to the side.

Lifting. Maintaining erect posture and re-establishing this posture after bending is a primary function of the trunk extensors. The erector spinae group is a main contributor to this function, particularly when carrying or moving loads in the front of the body.

Twisting. Rotational movements such as throwing require coordination of the deep spinal stabilizers and superficial prime movers of rotation. The rotatores and multifidi muscles maintain spinal alignment while the obliques turn the body and generate force in the trunk.
SUMMARY

• The bones of the trunk include the thoracic and lumbar vertebrae, sacrum, and coccyx, the 12 ribs, the sternum, and the paired ilium, ischium, and pubis.

• The ribcage contains anterior costosternal joints and posterior costovertebral joints while the spinal column consists of overlapping intervertebral joints.

• The spinal column has four curved divisions: the lordotic cervical spine, kyphotic thoracic spine, lordotic lumbar spine, and kyphotic sacral region.

• Each spinal division has unique bony and soft tissue features that regulate mobility and function.

• Deep muscles such as the rotatores and multifidi stabilize spinal segments while large superficial muscles like the obliques and erector spinae powerfully move the trunk.

• Complex networks of nerves branch from the spinal cord and form plexuses in the trunk. Trunk bones and muscles are nourished and drained by circulatory and lymphatic vessels.

• Movements available in the trunk include flexion, extension, lateral flexion, and rotation.

• The motions responsible for inhalation and exhalation occur in the trunk and are controlled mainly by the diaphragm, intercostals, and abdominals.

• Coordinated movement of the trunk muscles creates smooth, efficient motions such as pushing, lifting, bending, and twisting.

FOR REVIEW

Multiple Choice

1. Lordotic curvatures are normally found in the:
   A. cervical and thoracic spine
   B. cervical and lumbar spine
   C. thoracic and lumbar spine
   D. cervical and sacral regions

2. Kyphotic curvatures are normally found in the:
   A. cervical and thoracic spine
   B. cervical and lumbar spine
   C. thoracic and sacral regions
   D. lumbar and sacral regions

3. The floating ribs are named for lack of attachment to the:
   A. sternum
   B. costocartilage
   C. vertebral body
   D. transverse processes

4. Organs that are protected by the ribcage include the:
   A. heart, liver, and small intestine
   B. small intestine, spleen, and liver
   C. colon, stomach, and spleen
   D. heart, spleen, and lungs

5. An enlargement at the end of the thoracic duct that collects lymph from lumbar lymphatic trunks is called the:
   A. right lymphatic duct
   B. chyle cistern
   C. abdominal aorta
   D. intestinal lymphatic trunk

6. Large vessels that return blood from the arms, legs, and head to the heart are the:
   A. aorta and chyle cistern
   B. renal vein and artery
   C. inferior vena cava and superior vena cava
   D. aorta and inferior vena cava

7. The gelatinous center of the intervertebral disk absorbs force and is called the:
   A. vertebral body
   B. transverse process
   C. anulus fibrosus
   D. nucleus pulposus

8. The spinal cord branches to form ____ distinct pairs of spinal nerves.
   A. 31
   B. 21
   C. 51
   D. 10

9. The muscle primarily responsible for relaxed breathing is the:
   A. rectus abdominis
   B. transverse abdominis
   C. derratus posterior superior
   D. diaphragm

10. A muscle that has no true action or movement, but functions to compress and support the abdominal organs, is the:
    A. rectus abdominis
    B. transverse abdominis
    C. serratus posterior superior
    D. diaphragm
Matching

Different muscle attachments are listed below. Match the correct muscle with its attachment.

11. _____ T1–T8, spinous processes, spinous processes of C2–C4, and between the superior and inferior nuchal lines of the occiput
12. _____ Ribs 5–12, external surfaces
13. _____ Ribs 7–12, inner surfaces and costal cartilages, xiphoid process of sternum, and bodies of L1–L2
14. _____ L5–C2, spinous process 2–4 vertebrae above
15. _____ Linea alba and crest and pectineal line of pubis
16. _____ Ribs 2–5, posterior surfaces
17. _____ Thoracolumbar fascia, iliac crest, and lateral inguinal ligament
18. _____ Vertebrae above, transverse processes
19. _____ Vertebra above, spinous process
20. _____ Thoracolumbar aponeurosis, transverse processes of L5–T1, and articular processes of C4–C7

A. Serratus posterior superior
B. Intertransversarii
C. Spinalis
D. Multifidi
E. Longissimus
F. Transverse abdominis
G. Rotatores
H. Diaphragm
I. Internal oblique
J. External oblique

Different muscle actions are listed below. Match the correct muscle with its action. Answers may be used more than once.

21. _____ Right internal oblique
22. _____ Left intertransversarii
23. _____ Rectus abdominis
24. _____ Diaphragm
25. _____ Right external oblique
26. _____ Transverse abdominis
27. _____ Serratus posterior inferior
28. _____ Left rotatores
29. _____ Right quadratus lumborum
30. _____ Longissimus

A. Trunk flexion
B. Trunk extension
C. Trunk right lateral flexion
D. Trunk left lateral flexion
E. Trunk right rotation
F. Trunk left rotation
G. Inhalation
H. Exhalation

Short Answer

31. Compare and contrast the structures of the thoracic and lumbar vertebrae. What do they have in common and what is different about them? Briefly explain the purpose or cause of their differences.

32. Draw or explain the structures of the ribcage. Include all bones, articulations, and muscles. Describe how this structure is able to expand and contract to create breathing.

33. Make a list of all the muscles of the trunk that attach to the spine. Briefly describe the function of each.
Try This!

**Activity 1:** Find a partner. Study the person’s standing posture from the side. Write down what you observe about their postural alignment. Repeat this process, this time looking from the back. If you notice any deviations, use your knowledge of muscle functions and relationships to determine which muscles might be out of balance. See if you can figure out which muscles are tight. Switch partners and repeat the process. Compare your findings.

**Activity 2:** Find a partner and have him or her perform one of the skills identified in the Putting It in Motion segment. Identify the specific actions of the trunk that make up this skill. Write them down. Use the synergist list to identify which muscles work together to create this movement. Make sure you put the actions in the correct sequence. See if you can discover which muscles are stabilizing or steering the joints into position and which are responsible for powering the movement.

**Suggestions:** Switch partners and perform a different skill from Putting It in Motion. Repeat the steps above. Confirm your findings with the Putting It in Motion segment on the student CD included with your textbook. To further your understanding, practice this activity with skills not identified in Putting It in Motion.

**Activity 3:** Make your own diaphragm model! First, cut the bottom end off of a plastic bottle (a 2-liter bottle works well). Next, cut a piece of exercise band large enough to cover the newly opened end of the bottle. Tape the band to the bottle securely so that it seals that end. Be sure there are no gaps. Finally, place a small balloon inside the top end of the bottle so it sits inside and seals the top of the bottle. Now you can pull down on the center of the bottom seal. What happens to the balloon? What happens when you push up on the bottom seal? How is this like the action of the diaphragm and the lungs?

**Suggested Readings**


