Muscles of the Trunk and Abdominal Wall
Lecture Objectives

• List the muscles involved in respiration within the chest (respiratory and non-respiratory).
• List the abdominal wall muscles.
• Describe the attachments of the above mentioned muscles and their nerve supply.
• Discuss the chest and the abdominal wall muscles and their functions and enervation.
• Describe the rectus sheath and the aponeurosis contents.
• Define the inguinal region and inguinal ligament.
• Describe the inguinal canal.
Muscles of the Thorax that Assist in Breathing
Muscles of the Thorax that Assist in Breathing

• Respiratory muscles alter the size of the thoracic cavity which affects the pressure in the lungs, and that determines whether we inhale or exhale.

• The diaphragm is the most important respiratory muscle.

• Other important respiratory muscles include the external and internal intercostal muscles.

• There are also a number of accessory muscles useful in forced breathing.
Muscles Used in Breathing

- Breathing requires a change in size of the thorax
- During inspiration, thoracic cavity increases in size
  - external intercostal lift the ribs
  - diaphragm contracts & dome is flattened
- During expiration, thoracic cavity decreases in size
  - internal intercostal mm used in forced expiration
- Diaphragm is innervated by phrenic nerve (C3-C5) but intercostals innervated by thoracic spinal nerves (T2-T12)
Intercostal Spaces

- Between successive ribs
- Contain the intercostal mm.
  - External, internal, and innermost intercostal mm.
- Neurovascular bundle run superficial to the innermost intercostal m.
  - Arranged from superior to inferior as vein, artery, and nerve
Intercostal Muscles

- Nerve supply: intercostal nerves
  - Three layers
    - External intercostal
      - Orientation
      - Anterior (external) intercostal membrane
      - Helps in inspiration
    - Internal intercostal
      - Orientation
      - Posterior (internal) intercostal membrane
      - Helps in expiration
    - Innermost intercostal
      - Cross more than one intercostal spaces
      - Attached to the endothoracic fascia internally
        - Attached to parietal pleura
      - Divided into three parts
      - Works with the internal intercostal
Accessory Muscles of Respiration

- Transversus thoracis
  - Help in expiration
- Pectoralis major, pectoralis minor, serratus anterior, scalene mm.
  - May help in inspiration
Accessory Muscles of Respiration

• **Levator costarum**
  - Between the transverse processes and the ribs
  - Nerve supply: posterior rami of thoracic spinal nerves
  - Help in inspiration

• **Serratus posterior superior m.**
  - Deep to rhomboids
  - Nerve supply: 1-4 intercostal nerves
  - Help in inspiration

• **Serratus posterior inferior m.**
  - Deep to latissimus dorsi
  - Nerve supply: last 4 intercostal nerves
  - Help in expiration
<table>
<thead>
<tr>
<th>Muscle</th>
<th>Superior Attachment</th>
<th>Interior Attachment</th>
<th>Innervation</th>
<th>Main Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serratus posterior</td>
<td>Nuchal ligament, spinous processes of C7 to T3 vertebrae</td>
<td>Superior borders of 2nd to 4th ribs</td>
<td>2nd to 5th intercostal nerves</td>
<td>Proprioception (elevate ribs)</td>
</tr>
<tr>
<td>superior</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serratus posterior</td>
<td>Spinosus processes of T11 to L2 vertebrae</td>
<td>Inferior borders of 8th to 12th ribs near their angles</td>
<td>Anterior rami to T9 to T12 thoracic spinal nerves</td>
<td>Proprioception (depress ribs)</td>
</tr>
<tr>
<td>inferior</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Levator costarum</td>
<td>Transverse processes of T7–11</td>
<td>Subjacent ribs between tubercle and angle</td>
<td>Posterior primary rami of C8–T11 nerves</td>
<td>Elevate ribs</td>
</tr>
<tr>
<td>External intercostal</td>
<td></td>
<td>Superior border of ribs below</td>
<td></td>
<td>Elevate ribs during forced inspiration</td>
</tr>
<tr>
<td>Internal intercostal</td>
<td></td>
<td></td>
<td></td>
<td>Interosseous part: depresses ribs</td>
</tr>
<tr>
<td>Innermost intercostal</td>
<td></td>
<td></td>
<td></td>
<td>During active (forced) respiration</td>
</tr>
<tr>
<td>Subcostal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transversus thoracis</td>
<td>Posterior surface of lower sternum</td>
<td>Internal surface of costal cartilages 2–6</td>
<td></td>
<td>Weakly depress ribs; Proprioceptive?</td>
</tr>
</tbody>
</table>

All intercostal muscles keep intercostal spaces rigid, thereby preventing them from bulging out during expiration and from being drawn in during inspiration. The role of individual intercostal muscles and accessory muscles of respiration in moving the ribs is difficult to interpret despite many electromyographic studies.

Action traditionally assigned based on attachments; appear to be largely proprioceptive in function.
Abdominal Wall

• Parts
  • Anterolateral wall
    • Parts
      • Anterior wall
      • Left & right lateral walls
    • Boundaries
      • Superiorly – costal margin
      • Inferiorly – iliac crest, inguinal lig., pubic symphysis
    • Content
      • Musculoaponeurotic wall
  • Posterior wall
Anterolateral Abdominal Wall: Content

- Skin
  - Umbilicus
- Superficial fascia
  - Superficial fatty (fascia of Camper)
  - Deep membranous (Scarpa’s fascia)
- Deep fascia
- Muscles
- Fascia transversalis (endoabdominal fascia)
- Extraperitoneal fat
- Parietal peritoneum
Fascia of abdominal wall

• Superficial fascia
  • Superficial fatty (fascia of Camper)
    • Continuous with the rest of the superficial fascia
  • Deep membranous (Scarpa’s fascia)
    • Disappears laterally & superiorly
    • Continuous with the fascia lata on the lower limb
    • Form a tubular sheath at the penis
    • At perineum (Colles’ fascia) attached to the pubic arch (anteriorly) & the perineal body & membrane (posteriorly)
Fascia of abdominal wall

- Deep fascia
  - Covers the muscles
- Fascia transversalis
  - Lines transversalis m., diaphragm, & iliacus m.
  - Anterior wall of femoral sheath
  - Replace the posterior wall of the rectus sheath below the arcuate line
  - Form part of the posterior wall of the inguinal canal
Muscles of the Abdomen

(a) Anterior superficial view
(b) Anterior deep view
Muscles of the Abdomen

- The anterolateral abdominal wall includes the external oblique, internal oblique, and transversus abdominis muscles.
  - The muscle fascicles of each layer extend in a different direction, conferring considerable protection to the abdominal viscera.
  - The muscles of the anterior abdominal wall flex and rotate the vertebral column.
  - Contraction of the abdominal muscles when the vertebral column is fixed decreases the volume of the abdominal and thoracic cavities and increases the intra-abdominal pressure which aids in defecation, urination and child birth.

- The aponeuroses of these 3 muscles form the **rectus sheaths** which enclose the **rectus abdominis muscles**.
  - The sheaths form the **linea alba**, a connective tissue band extending from the xiphoid process to the pubic symphysis.
Muscles of Anterolateral Abdominal Wall

- External oblique m.
  - Inguinal ligament
- Internal oblique m.
  - Cremaster m.
- Neurovascular plane
- Transversus abdominis m.
Muscles of Anterolateral Abdominal Wall

- Conjoint tendon
  - Lower medial part of the internal oblique & transversus mm.
  - Attached to the pubic crest & pectineal line
  - Part of the posterior wall of the inguinal canal
Muscles of anterolateral abdominal wall

- Rectus abdominis m.
  - Tendinous intersections
    - 1\textsuperscript{st} – at xiphoid process
    - 3\textsuperscript{rd} – at umbilicus
    - 2\textsuperscript{nd} – in between
  - Attached firmly to the anterior wall of the rectus sheath (but not to the posterior wall)

- Pyramidalis m.
  - Absent in 20%
<table>
<thead>
<tr>
<th>Name of Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Nerve Supply</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>External oblique</td>
<td>Lower eight ribs</td>
<td>Xiphoid process, linea alba, pubic crest, pubic tubercle, iliac crest</td>
<td>Lower six thoracic nerves and iliohypogastric and ilioinguinal nerves (L1)</td>
<td>Supports abdominal contents; compresses abdominal contents; assists in flexing and rotation of trunk; assists in forced expiration, micturition, defecation, parturition, and vomiting</td>
</tr>
<tr>
<td>Internal oblique</td>
<td>Lumbar fascia, iliac crest, lateral two thirds of inguinal ligament</td>
<td>Lower three ribs and costal cartilages, xiphoid process, linea alba, symphysis pubis</td>
<td>Lower six thoracic nerves and iliohypogastric and ilioinguinal nerves (L1)</td>
<td>As above</td>
</tr>
<tr>
<td>Transversus</td>
<td>Lower six costal cartilages, lumbar fascia, iliac crest, lateral third of inguinal ligament</td>
<td>Xiphoid process linea alba, symphysis pubis</td>
<td>Lower six thoracic nerves and iliohypogastric and ilioinguinal nerves (L1)</td>
<td>Compresses abdominal contents</td>
</tr>
<tr>
<td>Rectus abdominis</td>
<td>Symphysis pubis and pubic crest</td>
<td>Fifth, sixth, and seventh costal cartilages and xiphoid process</td>
<td>Lower six thoracic nerves</td>
<td>Compresses abdominal contents and flexes vertebral column; accessory muscle of expiration</td>
</tr>
<tr>
<td>Pyramidalis</td>
<td>Anterior surface of pubis</td>
<td>Linea alba</td>
<td>Twelfth thoracic nerve</td>
<td>Tenses the linea alba</td>
</tr>
</tbody>
</table>

Rectus Sheath

- Aponeuroses of the lateral abdominal mm.
  - Anterior wall
  - Posterior wall
- Enclose the rectus abdominis m. & pyramidalis m.
Rectus Sheath

- **Content**
  - **Muscles**
    - rectus abdominis m.
    - pyramidalis m.
  - **Blood vessels**
    - Superior and inferior epigastric vessels
  - **Nerves** (abdominal part of T7-T12)
  - **Lymphatic vessels**
Rectus Sheath

- Associated lines
  - Linea alba
  - Linea semilunaris
    - From 9th rib to pubic tubercle
  - Arcuate line
    - At level of ASIS
Rectus Sheath: Walls

- **Anterior wall**
  - Above costal margin
    - Ext. oblique
  - Above arcuate line
    - Ext. oblique & anterior layer of Int. oblique
  - Below Arcuate line
    - Aponeurosis of all mm.

- **Posterior wall**
  - Above costal margin
    - Replaced by thoracic wall
  - Above arcuate line
    - Posterior layer of Int. oblique & transversus
  - Below arcuate line
    - Replaced by fascia transversalis
Inguinal Ligament

- Lower border of external oblique’s aponeurosis
- Attachment of fascia lata
- Between ASIS and pubic tubercle
- Lower limb neurovascular bundle (femoral sheath) passes deep to it
- Continue medially as the lacunar ligament
  - Femoral ring (medial part)
  - Continue with the pectineal ligament
Inguinal Canal

- Oblique canal in the lower border of the anterior abdominal wall
- Above the inguinal ligament
- 4 cm long
- In males: connection between testes and abdomen (spermatic cord)
- In female: between uterus and labia majora (round ligament)
Inguinal Canal

- **Deep inguinal ring**
  - Lateral opening to the abdomen through the transversalis fascia
  - Oval in shape
  - Relations
    - Inguinal ligament
    - Inferior epigastric artery
    - Internal spermatic fascia

- **Superficial inguinal ring**
  - Medial opening in the ext. oblique aponeurosis
  - Triangular in shape
  - External spermatic fascia
Inguinal Canal: Walls

• Anterior wall
  • External oblique aponeurosis

• Posterior wall
  • Conjoint tendon (medially)
  • Transversalis fascia (laterally)

• Roof
  • Fibers from int. oblique & transversus mm.

• Floor
  • Inguinal ligament
Posterior Abdominal Wall

- Lumber vertebrae & their IVD
- Muscles
- Somatic & autonomic nerves
- Aorta, IVC, & their branches
- Lymphatics
Muscles of Posterior Abdominal Wall

- **Psoas major**
  - Thick, long muscle
  - Lateral to vertebral column
  - Medial arcuate lig.
    - Thickening of psoas fascia
  - Lumber plexus runs posterior and through it

- **Quadratus lumborum**
  - Posteriolateral to psoas major
  - Lateral arcuate lig.
    - Thickening of lumbar fascia
  - Posterior to the lumber plexus

- **Iliacus**
  - Lateral to psoas major
  - Iliopsoas m.

- **Transversus abdominis**

- **Diaphragm**
<table>
<thead>
<tr>
<th>Muscle</th>
<th>Superior Attachment</th>
<th>Inferior Attachment</th>
<th>Innervation</th>
<th>Main Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psoas major</td>
<td>Transverse processes of lumbar vertebrae; sides of bodies of T12–L5 vertebrae and intervening intervertebral discs</td>
<td>By a strong tendon to lesser trochanter of femur</td>
<td>Anterior rami of lumbar nerves L1, L2, L3</td>
<td>Acting inferiorly with iliacus, it flexes thigh; acting superiorly it flexes vertebral column laterally; it is used to balance the trunk; when sitting it acts inferiorly with iliacus to flex trunk</td>
</tr>
<tr>
<td>Iliacus</td>
<td>Superior two thirds of iliac fossa, ala of sacrum, and anterior sacroiliac ligaments</td>
<td>Lesser trochanter of femur and shaft inferior to it, and to psoas major tendon</td>
<td>Femoral nerve (L2–L4)</td>
<td>Flexes thigh and stabilizes hip joint; acts with psoas major</td>
</tr>
<tr>
<td>Quadratus lumborum</td>
<td>Medial half of inferior border of 12th ribs and tips of lumbar transverse processes</td>
<td>Iliolumbar ligament and internal lip of iliac crest</td>
<td>Anterior branches of T12 and L1–L4 nerves</td>
<td>Extends and laterally flexes vertebral column; fixes 12th rib during inspiration</td>
</tr>
</tbody>
</table>
Vertebral Column

Muscles
Extrinsic Back Muscles

- **Superficial layer**
  - Axioappendicular mm.
  - Trapezius m.
  - Latissimus dorsi m.
  - Levator scapulae m.
  - Rhomboids mm.

- **Intermediate layer**
  - Respiratory muscles
  - Serratus posterior superior m.
    - Deep to rhomboids
    - Nerve supply: 1-4 intercostal nerves
  - Serratus posterior inferior m.
    - Deep to latissimus dorsi
    - Nerve supply: last 4 intercostal nerves
<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Nerve Supply</th>
<th>Nerve Roots(^a)</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trapezius</td>
<td>Occipital bone, ligamentum nuchae, spine of seventh cervical vertebrae, spines of all thoracic vertebrae</td>
<td>Upper fibers into lateral third of clavicle; middle and lower fibers into acromion and spine of scapula</td>
<td>Spinal part of accessory nerve (motor) and C3 and 4 (sensory)</td>
<td>XI cranial nerve (spinal part)</td>
<td>Upper fibers elevate the scapula; middle fibers pull scapula medially; lower fibers pull medial border of scapula downward</td>
</tr>
<tr>
<td>Latissimus dorsi</td>
<td>Iliac crest, lumbar fascia, spines of lower six thoracic vertebrae, lower three or four ribs, and inferior angle of scapula</td>
<td>Floor of bicipital groove of humerus</td>
<td>Thoracodorsal nerve</td>
<td>C6, 7, 8,</td>
<td>Extends, adducts, and medially rotates the arm</td>
</tr>
<tr>
<td>Levator scapulae</td>
<td>Transverse processes of first four cervical vertebrae</td>
<td>Medial border of scapula</td>
<td>C3 and 4 and dorsal scapular nerve</td>
<td>C3, 4, 5</td>
<td>Raises medial border of scapula</td>
</tr>
<tr>
<td>Rhomboid minor</td>
<td>Ligamentum nuchae and spines of seventh cervical and first thoracic vertebrae</td>
<td>Medial border of scapula</td>
<td>Dorsal scapular nerve</td>
<td>C4, 5</td>
<td>Raises medial border of scapula upward and medially</td>
</tr>
<tr>
<td>Rhomboid major</td>
<td>Second to fifth thoracic spines</td>
<td>Medial border of scapula</td>
<td>Dorsal scapular nerve</td>
<td>C4, 5</td>
<td>Raises medial border of scapula upward and medially</td>
</tr>
</tbody>
</table>

\(^a\)The predominant nerve root supply is indicated by boldface type.

<table>
<thead>
<tr>
<th>Name of Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Nerve Supply</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serratus posterior</td>
<td>Lower cervical and upper thoracic</td>
<td>Upper ribs</td>
<td>Intercostal</td>
<td>Raises ribs and therefore inspiratory</td>
</tr>
<tr>
<td>superior</td>
<td>spines</td>
<td></td>
<td>nerves</td>
<td>muscles</td>
</tr>
<tr>
<td>Serratus posterior</td>
<td>Upper lumbar and lower thoracic</td>
<td>Lower ribs</td>
<td>Intercostal</td>
<td>Depresses ribs and therefore expiratory</td>
</tr>
<tr>
<td>inferior</td>
<td>spines</td>
<td></td>
<td>nerves</td>
<td>muscles</td>
</tr>
</tbody>
</table>

Intrinsic (Deep) Back Muscles

- Nerve supply: posterior rami of spinal nerves
- Control movements of vertebral column and maintain posture
- Three layers
  - Superficial
  - Intermediate
  - Deep
Intrinsic (Deep) Back Muscles

• Superficial layer
  • Splenius mm.
    • Splenius cervicis m.
    • Splenius capitis m.
  ➢ extend the head and neck, and laterally flex and rotate the head

![Diagram of back muscles with labeled SPLenius cervicis and other anatomic landmarks.](image-url)
<table>
<thead>
<tr>
<th>Muscle</th>
<th>Proximal Attachment</th>
<th>Distal Attachment</th>
<th>Nerve Supply</th>
<th>Main Action(s)</th>
</tr>
</thead>
</table>
| Splenius  | Nuchal ligament and spinous processes of C7–T3 or T4 vertebrae | *Splenius capitis*: fibers run superolaterally to mastoid process of temporal bone and lateral third of superior nuchal line of occipital bone  
*Splenius cervicis*: tubercles of transverse processes of C1–C3 or C4 vertebrae | Posterior rami of spinal nerves | *Acting alone*: laterally flex neck and rotate head to side of active muscles  
*Acting together*: extend head and neck |
Intrinsic (Deep) Back Muscles

- Intermediate layer
  - Errector spinae mm.
    - Iliocostalis (lateral column)
    - Longissimus (intermediate column)
    - Spinalis (medial column)
  - Run longitudinally
  - Major extensor of the vertebral column
<table>
<thead>
<tr>
<th>Muscle</th>
<th>Proximal Attachment</th>
<th>Distal Attachment</th>
<th>Nerve Supply</th>
<th>Main Action(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Erector spinae</strong>&lt;br&gt;iliocostalis&lt;br&gt;longissimus&lt;br&gt;spinalis</td>
<td>Arises by a broad tendon from posterior part of iliac crest, posterior surface of sacrum, sacroiliac ligaments, sacral and inferior lumbar spinous processes, and supraspinous ligament</td>
<td><em>iliocostalis</em>: lumberum, thoracis, cervicis; fibers run superiorly to angles of lower ribs and cervical transverse processes&lt;br&gt;<em>longissimus</em>: thoracis, cervicis, capitis; fibers run superiorly to ribs between tubercles and angles to transverse processes in thoracic and cervical regions, and to mastoid process of temporal bone&lt;br&gt;<em>spinalis</em>: thoracis, cervicis, capitis; fibers run superiorly to spinous processes in the upper thoracic region and to cranium</td>
<td>Posterior rami of spinal nerves</td>
<td>Acting bilaterally: extend vertebral column and head; as back is flexed, control movement via eccentric contraction&lt;br&gt;Acting unilaterally: laterally flex vertebral column</td>
</tr>
</tbody>
</table>
Intrinsic (Deep) Back Muscles

• Deep layer
  • Transversospinalis muscle group
    ➢ Run from transverse process to spine of vertebrae above
    ➢ Help rotate and extend vertebrae
  • Semispinalis
    • Semispinalis capitis, thoracis, and cervicis
  • Multifidus
  • Rotators
• Deepest mm.: Interspinales, intertransversarii, levators costarum
### Table 4.6: Deep Layers of Intrinsic Back Muscles

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Proximal Attachment</th>
<th>Distal Attachment</th>
<th>Nerve Supply</th>
<th>Main Action(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep layer</td>
<td>Transverse processes</td>
<td>Spineous processes of more superior vertebrae</td>
<td>Posterior rami of spinal nerves</td>
<td>Extension</td>
</tr>
<tr>
<td></td>
<td>Semispinalis</td>
<td>Semispinalis: arises from transverse processes of C4–T12 vertebrae</td>
<td>Semispinalis: thoracic, cervico, capitis; fibers run superomedially to occipital bone and spineous processes in thoracic and cervical regions, spanning 4–6 segments</td>
<td>Semispinalis: extends head and thoracic and cervical regions of vertebral column and rotates them contralaterally</td>
</tr>
<tr>
<td></td>
<td>Multifidus</td>
<td>Multifidus: arises from posterior sacrum, posterior superior iliac spine of ilium, anterior spinous of erector spinae, sacroiliac ligaments, mammillary processes of lumbar vertebrae, transverse processes of T1–T3, articular processes of C4–C7</td>
<td>Posterior rami of spinal nerves*</td>
<td>Multifidus: stabilizes vertebrae during local movements of vertebral column</td>
</tr>
<tr>
<td></td>
<td>Rotatores</td>
<td>Rotatores: arise from transverse processes of vertebrae, best developed in thoracic region</td>
<td></td>
<td>Rotatores: stabilize vertebrae and assist with local extension and rotatory movements of vertebral column; may function as organs of proprioception</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minor deep layer</th>
<th>Superior surfaces of spineous processes of cervical and lumbar vertebrae</th>
<th>Inferior surfaces of spineous processes of vertebra superior to vertebra of proximal attachment</th>
<th>Posterior rami of spinal nerves</th>
<th>Aid in extension and rotation of vertebral column</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interspinales</td>
<td>Transverse processes of cervical and lumbar vertebrae</td>
<td>Transverse processes of adjacent vertebrae</td>
<td>Posterior and anterior rami of spinal nerves*</td>
<td>Aid in lateral flexion of vertebral column; acting bilaterally, stabilize vertebral column</td>
</tr>
<tr>
<td>Intertransverseri</td>
<td>Tips of transverse processes of C7 and T1–T11 vertebrae</td>
<td>Pass inferolaterally and insert on rib between tubercle and angle</td>
<td>Posterior rami of C8–T11 spinal nerves</td>
<td>Elevate ribs, assisting respiration; assist with lateral flexion of vertebral column</td>
</tr>
</tbody>
</table>

*Most back muscles are innervated by posterior rami of spinal nerves, but a few are innervated by anterior rami. Anterior intertransverse muscles of the cervical region are supplied by anterior rami.