MUSCLES OF EXPIRATION

Remember that the first expiratory force is the elasticity of the lungs themselves. This force is responsible for most of the act of exhalation.

The muscles of expiration are involved in:

- increasing the expiratory reserve volume
- accentuating the force of exhalation (e.g., when blowing up a balloon)
- accelerating the rate of exhalation.

These muscles assist in reducing the volume of the lungs. To do this, they either drop the ribs, raise up the base of the lungs, or do both at the same time. (For more detail, see pages 146-149).

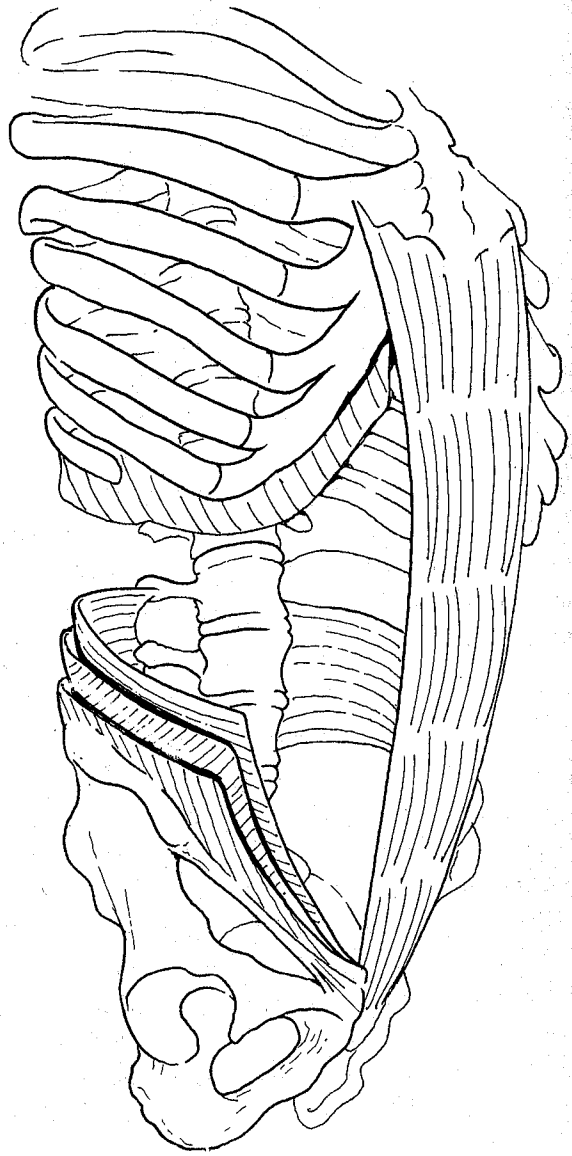
Abdominal muscles

These muscles support and surround the abdomen. There are four of them on the left and on the right:

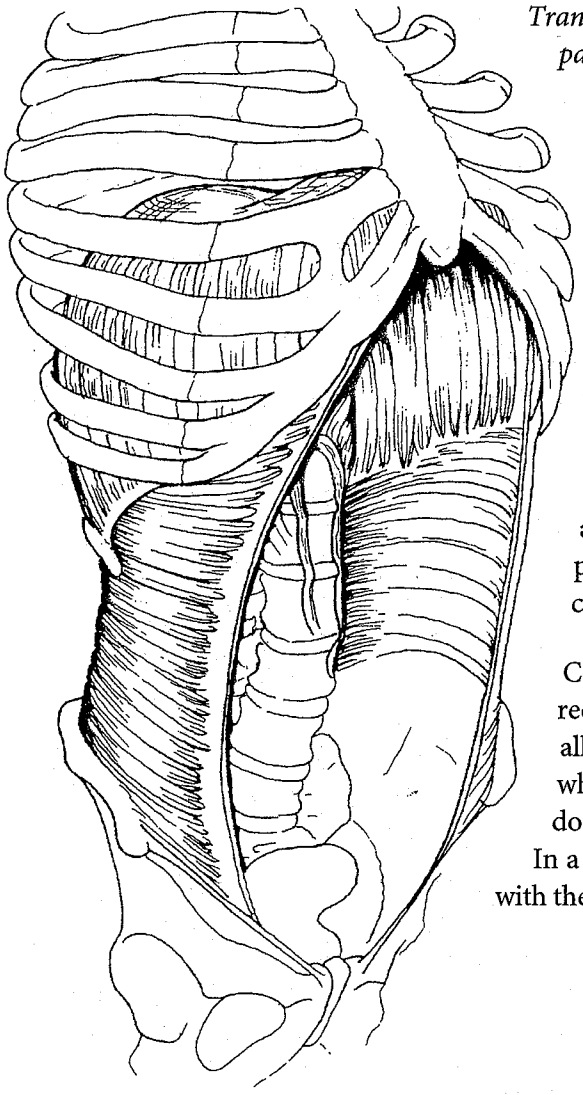
- the *rectus abdominis* in the front
- three layers of large muscles that lay on top of each other on the sides.

Relative to the abdomen, the abdominal muscles *mobilize the organs* in a number of ways. They can lift them up and thus participate in expiration. This is their "visceral" action.

Relative to the skeleton, the abdominal muscles *move the spine, pelvis, and especially the ribs* in an expiratory direction. This is their "skeletal" action.



From: B. Calais-Germain. Anatomy of Breathing, Eastland Press, 2006.

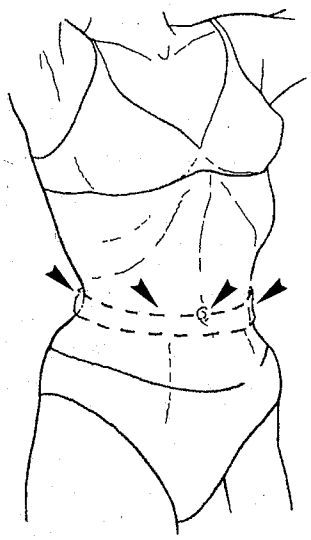


Transversus abdominis: partner of the diaphragm

This muscle attaches at the top to the deep surface of the lower rib cage. At the back, it is attached via a fibrous sheet to the lumbar vertebrae at the bottom, to the iliac crest, and the inguinal ligament.

These muscle fibers surround the sides of the abdomen like a belt, then change into a large fibrous area in the front. This is the anterior aponeurosis of the transversus abdominis. The right and left aponeuroses unite in the middle anterior portion via a region of crisscrossing fibers called *linea alba*.

Contraction of the transversus abdominis reduces the diameter of the abdomen. Of all the abdominal muscles, this is the one whose action is the most visceral. Its action does not really affect the skeleton, however. In a lot of movements, it acts in combination with the diaphragm (see pages 148 and 149).



This is the muscle that helps you "narrow your waist." This action is greatest at the level of the costoiliac region where its fibers are the biggest. It is not good for the muscle to be the dominant participant here, because it exerts a strong pressure on the lower part of the abdomen. That is why it is often necessary to coordinate its action with other abdominal muscles.

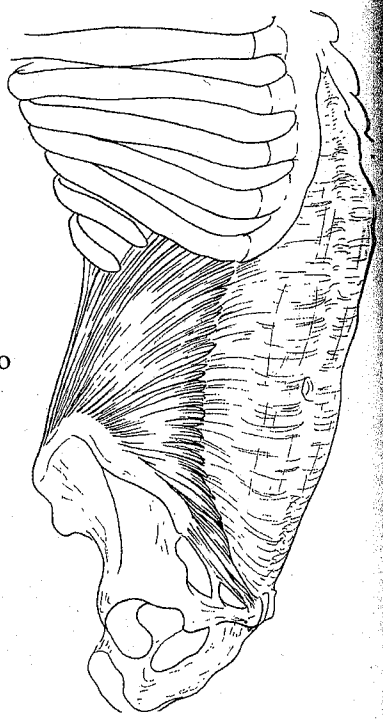
Obliques: two crisscrossing layers

Internal oblique

This muscle attaches at the top to the lower rib cage and at the bottom to the iliac crest and the inguinal ligament.

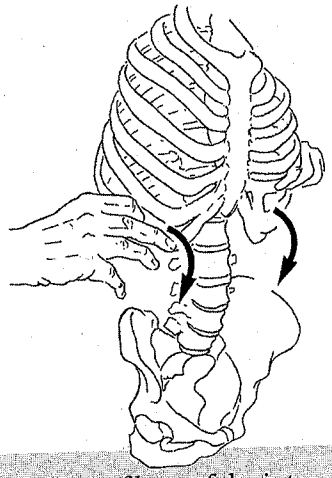
Its fibers travel from the back to the front across the sides of the waist and then change to a broad fibrous area anteriorly, called the anterior aponeurosis of the internal oblique.

At the bottom, the fibers of the internal oblique run parallel to the inguinal ligament to the pubic crest. They converge with some of the fibers of the transversus abdominis along the groin.



Among other actions, the internal oblique participates in expiration in the following ways:

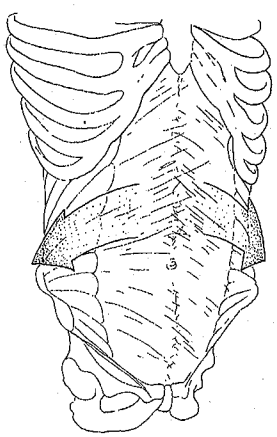
- It participates in costal expiration by lowering the ribs.



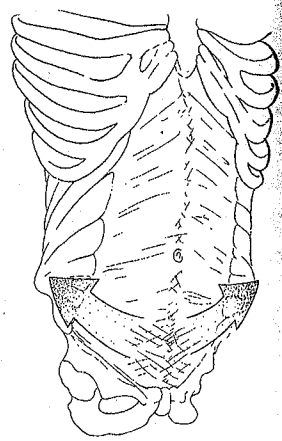
The lower fibers of the internal oblique (mostly), transverse abdominis, and rectus abdominis form the "lower" abdominal muscles. After the muscles of the pelvic floor, these muscle fibers are the ones that begin the contraction of the abdomen in the rising abdominal expiration (see page 149).

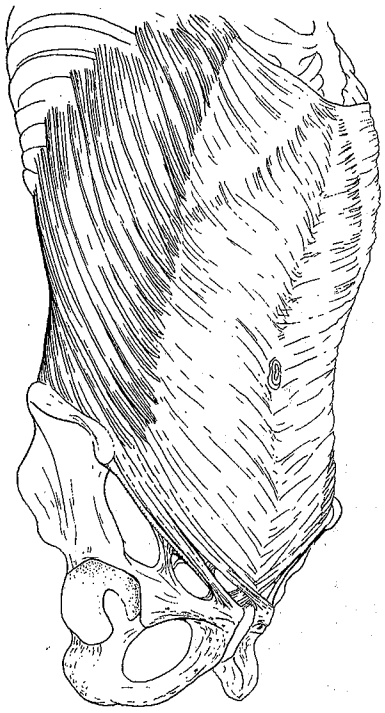
- It reduces the diameter of the abdomen.

— If it works in conjunction with the transversus abdominis, this action occurs primarily at the waist.



— If it works in conjunction with the inferior fibers of the transversus abdominis and the rectus abdominis, this action occurs primarily at the bottom of the abdomen.





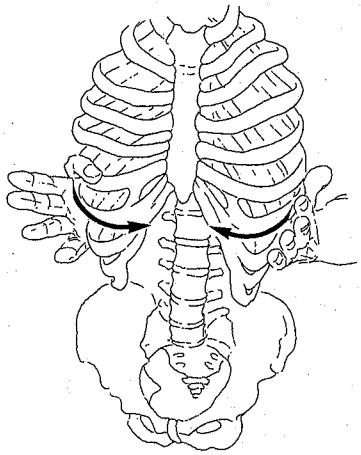
External oblique

This muscle attaches at the top to the outside of the lower rib cage and at the bottom to the iliac crest and the inguinal ligament.

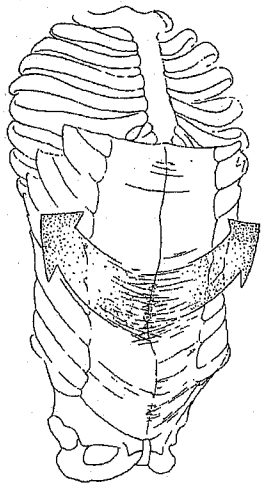
The muscle fibers travel from the back to the front across the sides of the trunk and then change to a broad fibrous area called the anterior aponeurosis of the external oblique.

Among many other actions, the external oblique participates in expiration in the following ways:

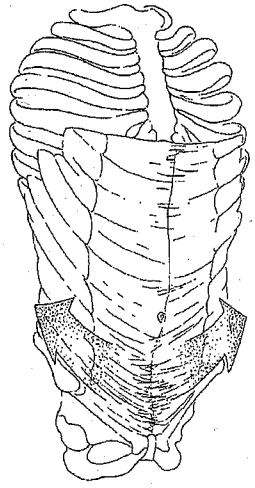
- It participates in costal expiration by lowering the ribs.

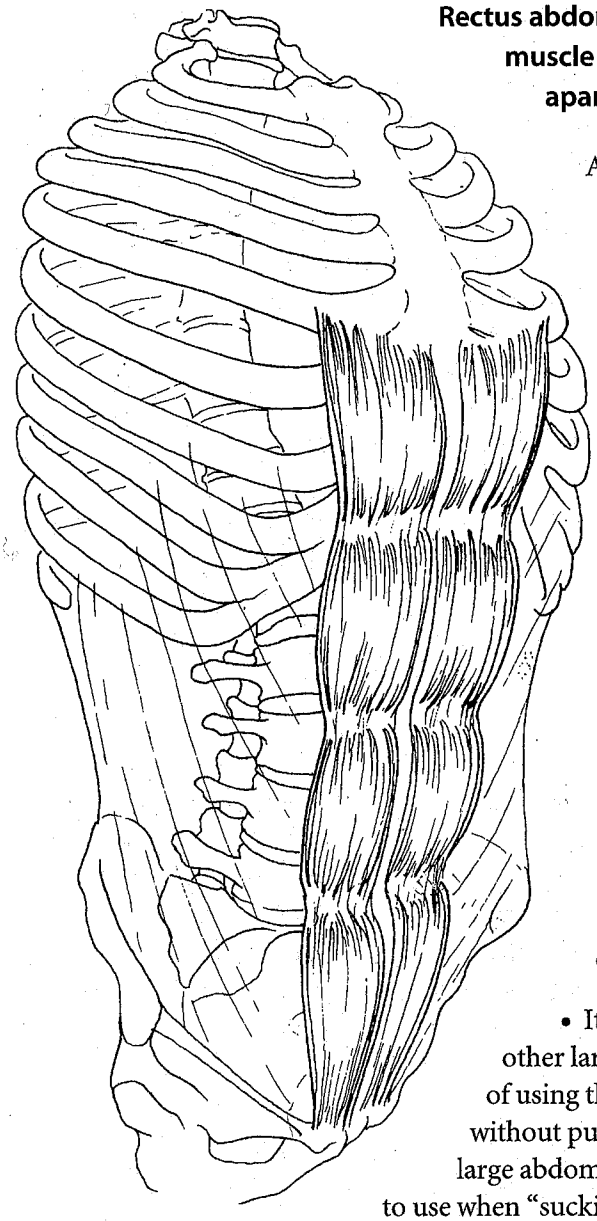


- It reduces the diameter of the abdomen, when working in conjunction with the transversus abdominis. In this case, the action occurs primarily at the waist.



- It pulls in the lowest part of the abdomen (via its lowest fibers) when working in conjunction with the rectus abdominis and the lower fibers of the transverse abdominis.





Rectus abdominis: the only abdominal muscle that does not pull apart the linea alba

At the top, this muscle attaches to the sternum and the costal cartilage of ribs 5-7, and at the bottom to the pubic crest.

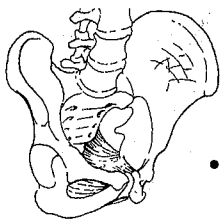
Its muscle fibers run downward lengthwise at the front of the abdomen. They are interrupted and alternated by aponeurotic areas, which give the muscle its characteristic square shapes.

Among other actions, the rectus abdominis participates in expiration in the following ways:

- It participates in anterior costal expiration by dropping the sternum.
- It participates in intensive expirations by raising the pubic bone (an action used sometimes for totally closing the anterior abdomen).
- It completes the rectus sheath of the other large abdominal muscles. The advantage of using the rectus abdominis is that it pulls without pulling the abdomen apart, as do the other large abdominal muscles. This is a good muscle to use when "sucking in the stomach" during expiration (think of doing this action "from the front").

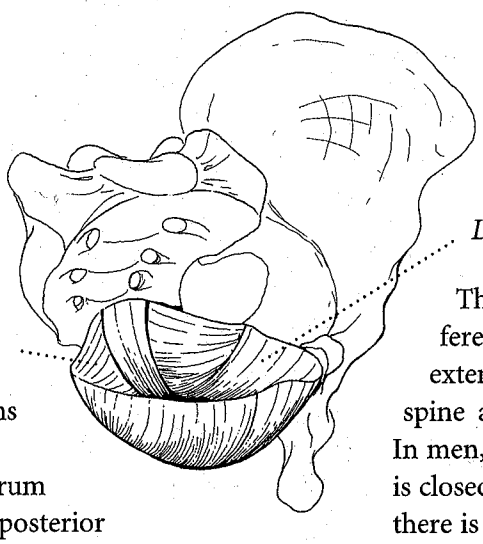
The rectus abdominis always participates at the beginning of each exhalation by using its lowest fibers (in conjunction with those of the other abdominal muscles) to hold and suck in the lowest, most anterior portion of the abdomen.

Pelvic floor: the foundation of breathing



All the muscles at the bottom of the pelvis are called the pelvic floor. They form the lowest portion of the trunk. The pelvic floor consists of two layers:

- a superficial layer at the bottom (not shown in detail here, because it does not play an important role in breathing)
- a deep layer located above it in the lesser pelvis. This layer contains the levator ani and the ischiococcygeus muscles. This deep layer has the shape and size of a bowl.



Levator ani

This muscle attaches to the circumference of the lesser pelvis, along a line extending from the pubis to the ischial spine and the midsection of the sacrum. In men, the anterior portion of this muscle is closed: this is the *scrotal floor*. In women, there is an indentation at this area, the *urogenital groove*, which extends into the vulva.

Ischiococcygeus

This muscle runs from the ischial spine to the sacrum and coccyx. Its posterior extent completes the bowl shape.

How are these muscles involved in breathing?

They do not play a dynamic part in expiration: since their surface is very small, they cannot cause a big movement with every contraction. Nor can they lift the big abdominal mass with the efficiency of the muscles discussed in previous pages, as some would suggest.

Still, this area of the pelvic floor is the base of the abdominal cavity, for which it serves as:

- a contractile foundation that must be able to *adapt its tonicity* so that it is neither too high nor too low in order to withstand the deep pushing action it endures during inhalation and exhalation
- a foundation that will initiate the successive "rising" muscle contractions of the abdominal cavity in connection with certain expiratory actions (see page 149).

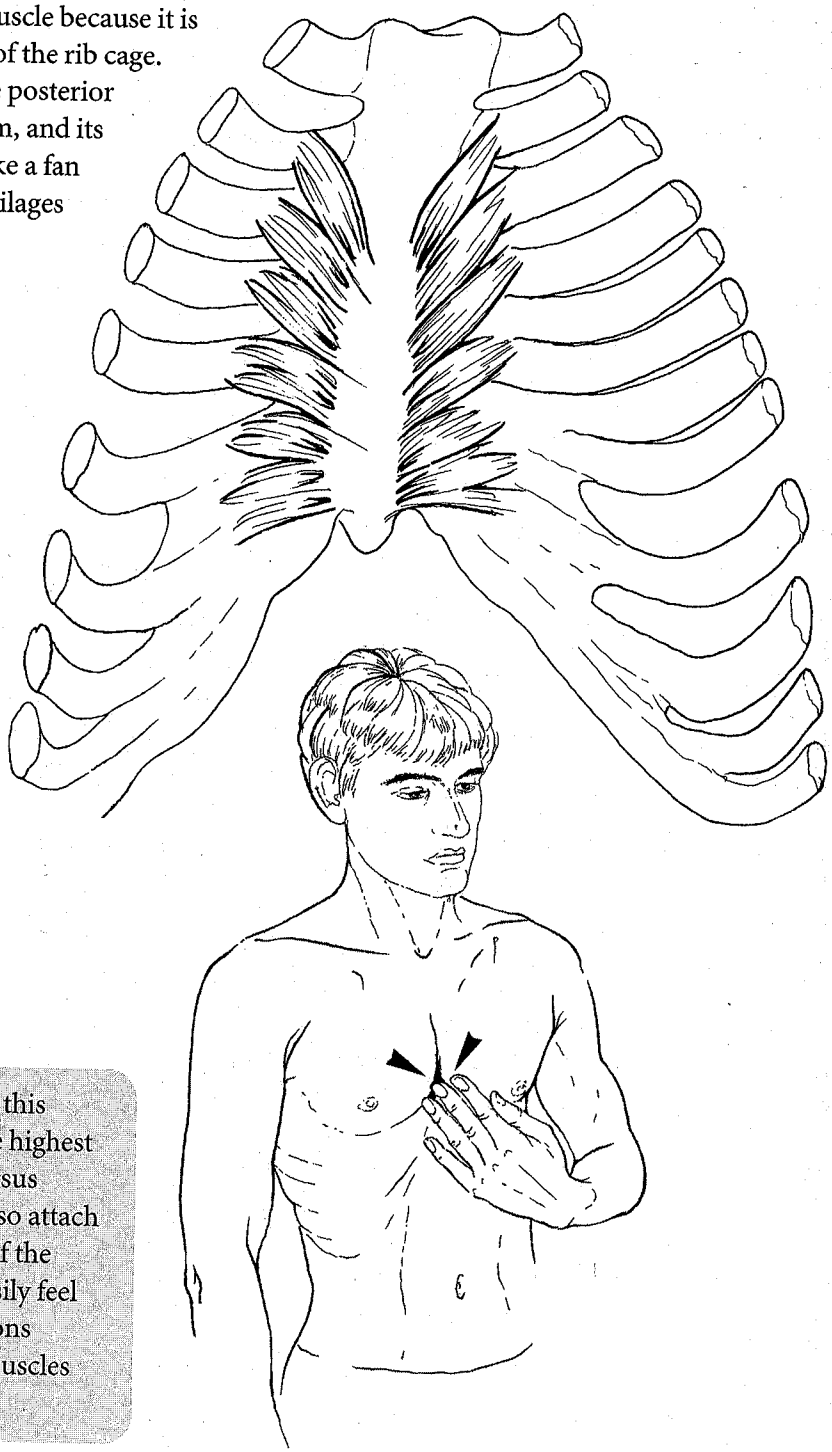
Expiratory muscles that move the ribs

Transversus thoracis at the inside of the rib cage

This is an unusual muscle because it is located at the inside of the rib cage. It originates from the posterior surface of the sternum, and its fibers are arranged like a fan and insert on the cartilages of ribs 2 through 7.

When contracting, it lowers the costal cartilages and moves them backward, thus closing the region around the sternum.

This is a muscle of expiration which sits very anterior, yet its contraction occurs in the depth of the rib cage. It is easy to feel this movement when coughing.

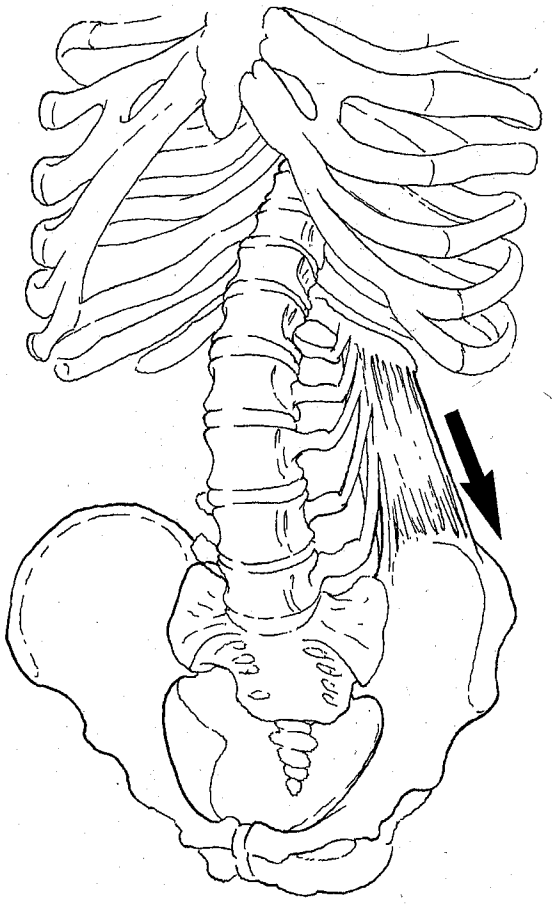


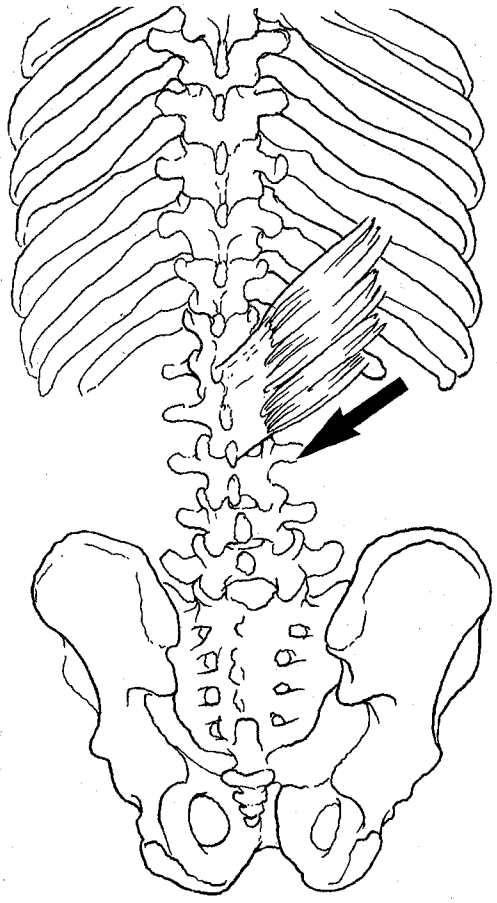
The lowest fibers of this muscle extend to the highest fibers of the transversus abdominis, which also attach to the deep surface of the rib cage. You can easily feel successive contractions between these two muscles (see page 211).

Quadratus lumborum

This muscle originates from the iliac crest and inserts on rib 12 and the transverse processes of the lumbar vertebrae.

Contraction of this muscle lowers rib 12, and thus it participates in expiration.





Serratus posterior inferior

This muscle runs from the higher lumbar vertebrae (L1-L2) and lower thoracic vertebrae (T10-12) to ribs 9-12.

Contraction of this muscle lowers these ribs, and thus it participates in expiration.

These two muscles work in posterior breathing. If you make these muscles work in costal expiration, the resulting exhalation will be felt as a movement in the back of the waist. An example is breathing with a "rounded belly" (see page 215).

Respiratory muscles with variable actions

Intercostals — inspiratory muscles

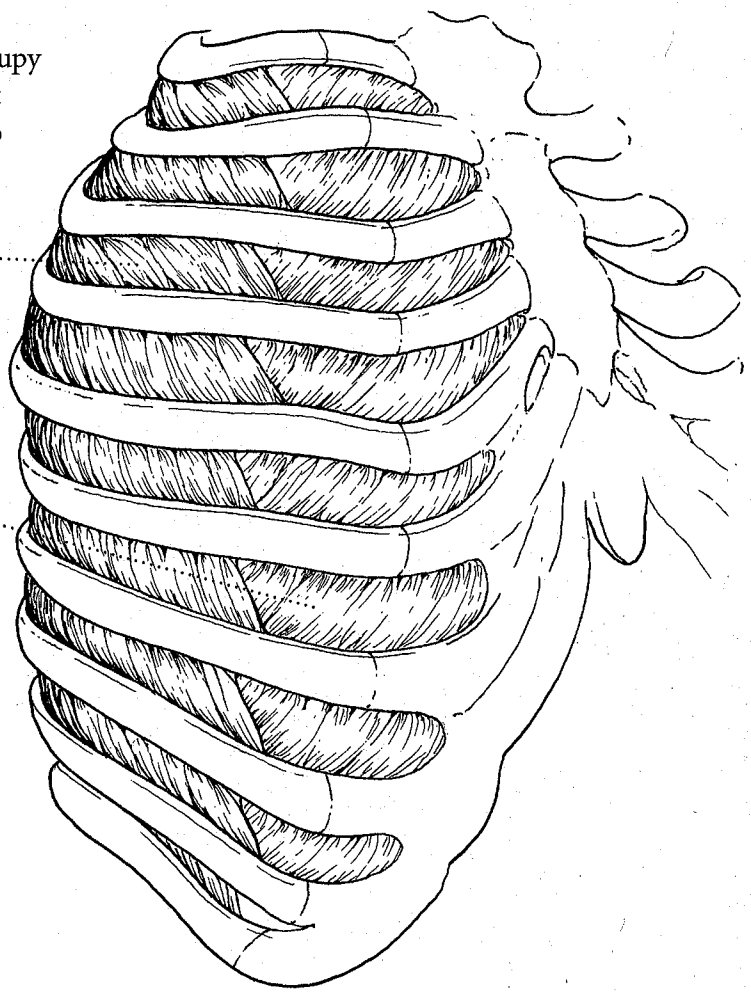
The intercostal muscles occupy the spaces between adjacent ribs and are arranged in two crisscrossing layers.

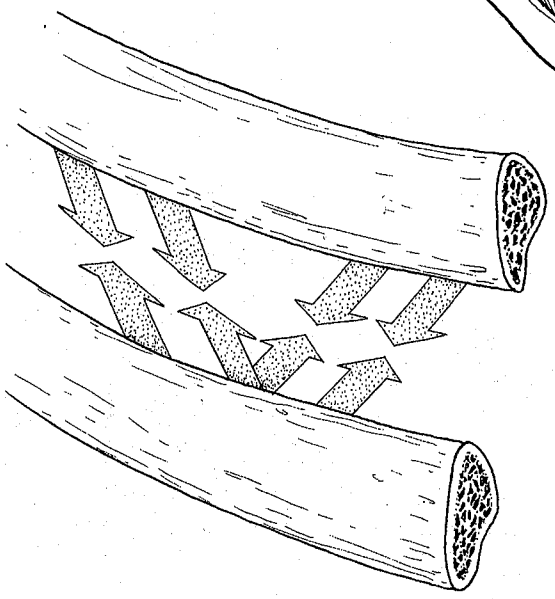
External intercostals

These have fibers that run obliquely downward and forward.

Internal intercostals

These have fibers that run obliquely downward and backward.

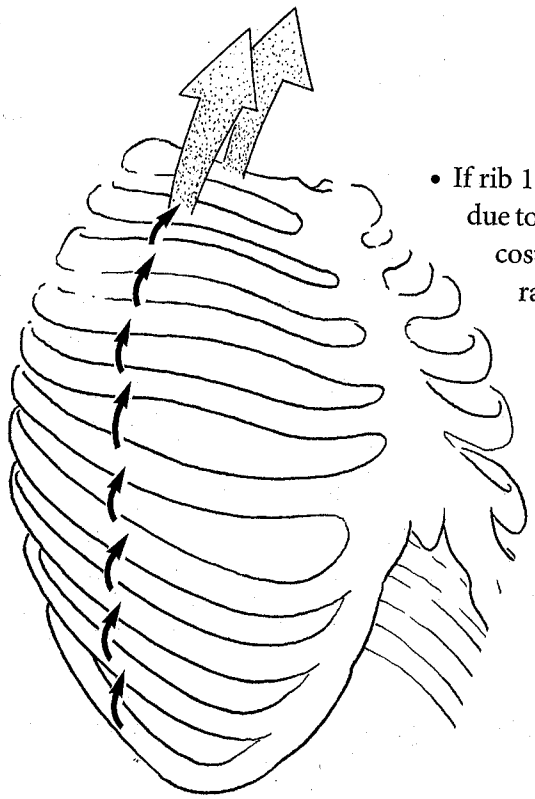




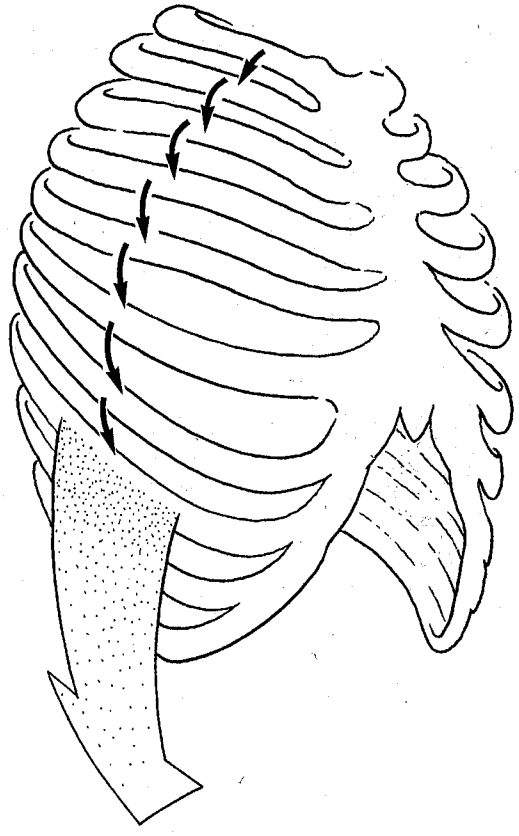
The first contractile action of the intercostals is to bring the intercostal spaces closer together and to make the ribs slightly glide on each other.

For this reason, they are *global expiratory muscles.*

This action, however, can change totally, depending on where the ribs are fixed.



- If rib 1 is fixed or if it is already raised (as shown here, due to the action of the scalenes), the entire set of intercostals will move the ribs closer to the top, that is, raise them. This is an inspiratory function.



- If, on the other hand, rib 12 is fixed or already lowered (as shown here, due to the action of the external oblique), the entire set of intercostals will move the ribs closer to the bottom. This is an expiratory function.

We can therefore see that these muscles generally work in static contraction; the set of muscles forms a layer, connecting the ribs to each other. Thus, a movement occurring at one rib will be followed by movement in the neighboring ribs, or even by the entire rib cage.

From: B. Calais-Germain. Anatomy of Breathing, Eastland Press, 2006.