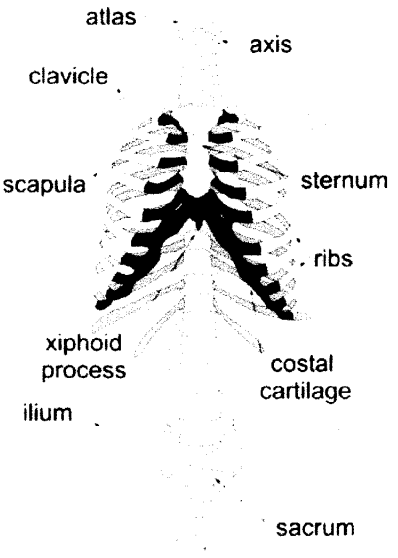
Chapter 8:
Breathing for Singing

Unless otherwise cited, anatomical images used in the print version of Chapters Eight through Eleven are either original creations of the author or taken from the 1918 Edition of *Gray's Anatomy*, which is now in the public domain. Readers are strongly urged to refer to the accompanying CD-ROM, which presents high-resolution color drawings and photos of the anatomical structures under discussion.

The respiratory system—or pulmonary system—is the power source and actuator of the vocal instrument. In this capacity, the lungs serve a function similar to the bellows of a pipe organ or the air bladder of bagpipes; in essence, they function as a storage depot for air. This is not, of course, the primary biological function of the respiratory system, which must perpetually oxygenate the blood and cleanse it of excess carbon dioxide to maintain life.



Axial Skeleton

Figure 8-1. Axial Skeleton

Respiratory Anatomy

The respiratory system is housed within the *axial skeleton*. This portion of the human skeleton consists of the spine and thorax (ribcage). The remainder of the skeleton, including the skull, pelvis, arms and legs is called the *appendicular* skeleton. Posture is largely a function of the relative positions and balance between these skeletal regions. As such, the appendicular skeleton will become more important later in this Chapter when breathing methods are discussed.

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Spine

Discussion of the respiratory framework must begin with the spine itself, which consists of twenty-four individual segments called *vertebrae*. Stacked together to form a gentle "S" curve in the anterior/posterior plane, the vertebrae gradually become narrower and thinner from the bottom to the top of the spinal column. The bottom five are called the *lumbar vertebrae*. These are the largest and thickest bones in the spine and are responsible for carrying most of the weight of the upper body. Curvature in this region acts as a shock absorber, helping to prevent injury during heavy lifting. *Thoracic vertebrae* make up the next twelve segments of the spine. These bones are somewhat smaller than the lumbar vertebrae and possess flat areas called *facets* for the attachment and articulation of the ribs.

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The seven *cervical vertebrae* complete the top of the spine. The topmost cervical vertebra is called the *atlas* and is specially shaped to fit snugly into the base of the skull and carry the weight of the head. The second cervical vertebra, called the *axis*, features a projection from its anterior segment called the *dens* or *odontoid* process

that inserts into the atlas. Together, these two vertebrae provide a pivot around which the skull can be tilted and rotated.

All of the vertebrae—except the atlas—have a small projection from their posterior called a *spinous process* that serves as an attachment point for muscles of the back. In the lumbar region, these projections are robust and somewhat stubby, extending at nearly a right angle to the spine. In the thoracic region, the spinous processes are longer and extend obliquely away from the spine. The spinous process of the seventh cervical vertebrae is particularly large and can be easily seen or felt in most people, especially while bending over. This provides a landmark for the division between the cervical and thoracic regions and can be useful in establishing correct posture. Two *transverse processes* also extend laterally from each vertebra.

At the base of the spine, five *sacral* vertebrae are found, which are fused together to form the *sacrum*. An additional five, very small vertebrae, which are also fused together, extend beyond the sacrum to form the *coccyx* or tailbone. The sacrum joins with a group of bones called the *ilium*, *pubis* and *ischium* to create the *pelvis*, a very strong structure that serves as the attachment points for the lower extremities and as a girdle for the contents of the abdomen.

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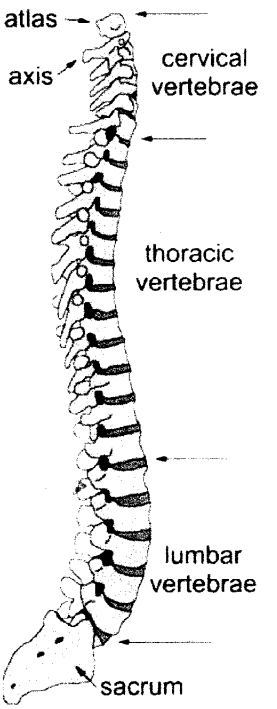

Spinal Column (lateral aspect)

Figure 8-2. Spine

Knowledge of the structure, shape and attachments of the spine has significant pedagogical consequences. It must be remembered that the spine has a natural, s-shaped curve. While this curve should not be exaggerated, as seen in severe cases of *lordosis* (swayback), it should also not be artificially removed and straightened. At least one prominent text on singing technique instructs that correct posture can be established by leaning against a wall with the knees bent and the feet placed several inches forward. The singer then presses the small of his back into the wall, making it as straight as possible. Finally, he is to stand up while maintaining the same vertebral posture—and sing (McKinney, 1994). While this technique might be somewhat beneficial for the correction of lordosis, the impact on normal bodies is contrived and unnatural.

When the entire skeleton is considered, another significant pedagogical implication becomes clear. The central pivot-point for bending forward and back is not at the waist but at the joint between the pelvis and the hips. Many singers and teachers use breathing exercises that include bending over to increase awareness of abdominal motion during respiration. If the instruction or intent is to bend from the waist, this exercise compresses the abdominal area and may actually inhibit free breathing. If, however, the singer bends forward from the hips, the spine and abdomen are lengthened and released, making the exercise much more effective.

Inspiratory muscles (primary)

We now know that the thorax must be made larger to induce inhalation. We also know that muscles are capable of only one motion: contraction. How is it, then, that something is made larger through contracting—isn't this a paradoxical contradiction?

The most important muscle of inhalation is the *diaphragm*. This is the second largest muscle in the human body—in most people, only the *gluteus maximus* muscles are larger. Shaped like a dome or parachute with two small humps, the diaphragm bisects the body, separating the contents of the thorax from the abdomen. In this location, it serves as the floor to the thorax. Once again with the help of the pleurae, motion of the diaphragm is transferred directly to the lungs. On contraction, the diaphragm lowers and becomes somewhat flatter. It therefore increases the volume capacity of the thorax (and therefore, lungs) much like withdrawing the plunger of a syringe.

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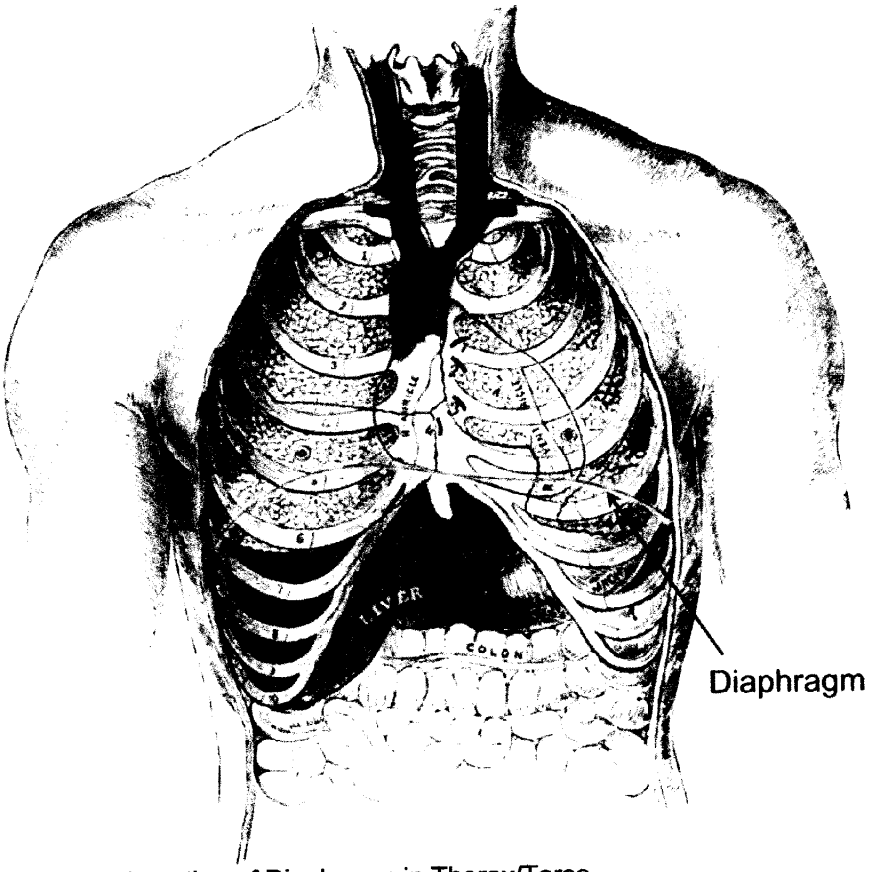

Figure 8-5. Location of Diaphragm in Thorax/Torso

Many people have misconceptions about the location and size of the diaphragm. Since it lies deep within the abdominal/thoracic cavity and cannot be directly felt, it is often believed to be smaller in diameter and lower in placement than is correct. Often these misconceptions arise from the best intentions of voice teachers or choir directors who teach breathing by placing a hand on the tummy and telling the student to "breathe from the diaphragm." The student naturally assumes the outward movement of the abdominal wall is the actual diaphragm. Even well educated singers often believe the diaphragm lies lower in the torso than it actually does. CD Example 8/7 pre-

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now be at a diagonal angle to your body in about the same orientation as the external intercostals.

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As can be seen in CD Example 8/13, the external intercostals cover a substantial surface area within the thorax. Viewing the thorax in horizontal cross section with the spine in the 12:00 position (as on the face of a clock), external intercostals extend throughout the regions between 12:00 and 4:00 on the right side and 8:00 through 12:00 on the left.

The external intercostals, and indeed almost all the remaining respiratory muscles, are strongly voluntary. Most people are quickly able to learn their direct control independent of the breathing process simply by deliberately expanding the circumference of the rib cage.

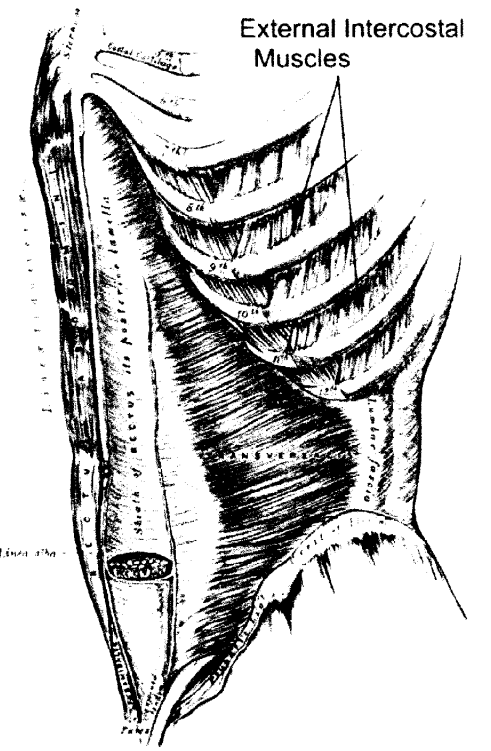
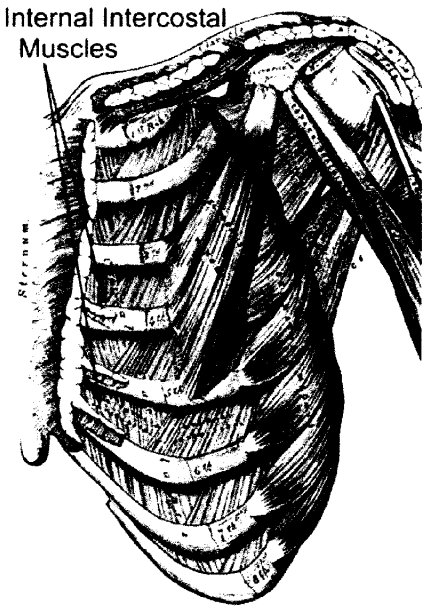


Figure 8-7. External Intercostal Muscles

Expiratory Muscles (primary)

During everyday living, expiration is generally a passive activity. Ordinary people—those who are not trained as pulmonary athletes the way singers are—inhale by gently contracting the diaphragm while simultaneously lifting the entire thorax. This technique is often called *clavicular* breathing, since it is accompanied by a lifting of the clavicles and shoulders. In this breath, the natural elastic recoil of the lungs and the weight of gravity pressing down upon the thorax are sufficient to generate respiratory force. As physical exertion increases, however, additional means are required to induce and control the expulsion of air from the lungs. This is particularly true in breathing for singing. Six different sets of muscles can be considered primary for exhalation; not all, however, are used by every singer or for every variation in breathing technique.



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The *internal intercostal* muscles are found on the inside of the ribcage underneath the external intercostals. Their fibers run obliquely away from the midline of the body, crisscrossing their external neighbors and thereby acting as direct antagonists. You can also use your hand to approximate the orientation of the internal intercostals in the body; this time, however, cross your right hand over and place it on the left side of your rib-

cage with the fingers pointing down toward your hip. Your fingers will now point in the general direction of the internal intercostals.

Each internal intercostal muscle originates from the lower rib and inserts into the rib above it. Upon contraction, the higher rib is pulled down and inward toward the lower rib, depressing the ribcage and decreasing its circumference. This, as we know, induces exhalation.

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Compared with the external intercostals, the internal muscles lie in a more anterior orientation within the thorax. If their location is again compared with the face of a clock, they occupy the space between approximately 2:00 to 5:00 in the right hemisphere and 7:00 to 10:00 in the left.

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Internal Intercostals are voluntary muscles whose control can be learned through the deliberate squeezing of the thorax. In most singing pedagogies, however, their contraction is delayed as long as possible, only becoming significant at the ends of very long or extremely loud phrases. This is because a strong initial contraction in these muscles will over-pressurize the breath, leading to a pressed, strident sound quality.

For many singers, the more important muscles for expiration are found in the abdomen. Five significant pairs of muscles are located in this region: the *external oblique*, *internal oblique*, *rectus*, and *transverse abdominis* (or abdominal) muscles, which are found in the anterior abdomen; and the *quadratus lumborum*, which lies in the posterior. These muscles all contribute to expiration either by depressing the thorax, or by compressing the abdominal viscera and thrusting it upward against the underside of the diaphragm to help deflate the lungs.

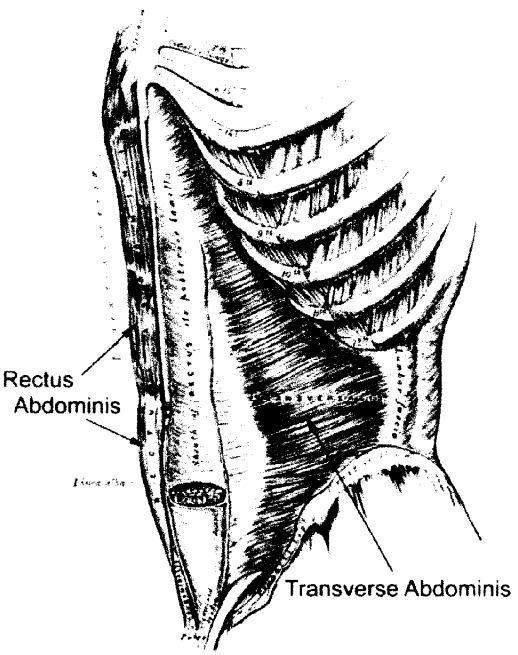

Figure 8-9. Rectus and Transverse Abdominals

The four sets of anterior abdominal muscles form a complex, interlaced structure of great strength and flexibility. At its center lies the paired *rectus abdominis*. These long muscles have fibers that run longitudinally (in the rectus orientation as discussed in the previous Chapter), originating from tendons attached to the pubic bones and inserting into the cartilaginous portions of the fifth through seventh ribs and the xiphoid process at the base of the sternum. Each rectus is divided into four sections, called bellies, which can be contracted simultaneously or independently—the classic example of independent contraction is seen in the middle-eastern "belly dancer." When the rectus is contracted, the rib cage is pulled toward the pelvis, arching the back forward. Many people use exercises such as sit-ups, crunches and leg-lifts to strengthen the rectus. Carried to the extreme, these exercises result in the "ripped" abdomen or "six-pack" sometimes associated with body builders. Strenuous exercise of the rectus probably has little positive effect for singers beyond the im-

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provement of physical appearance. Since its action is to shorten the distance from the pubis to the thorax, contraction of the rectus does little to compress the viscera when appropriate singing posture is maintained.

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Surrounding the rectus muscles is a tendinous sheath formed by the division of the *abdominal aponeurosis*, which extends from the sternum to the pubis. The remaining anterior abdominal muscles all attach at some point to the aponeurosis at the lateral edges of the paired rectus.

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The three remaining pairs of anterior abdominals encircle the lower torso from the spine to the rectus. Beginning with the outermost layer, we find the *external oblique abdominis* muscles. Like the external intercostals, these muscles have oblique fibers that run downward toward the midline of the body. They originate in the exterior thorax, attaching to ribs five through twelve, and insert into the iliac crest of the pelvis and the abdominal aponeurosis adjacent to the rectus muscles. Because they cover the largest surface area of any of the abdominal muscles, the external obliques are particularly important expiratory muscles for singers.

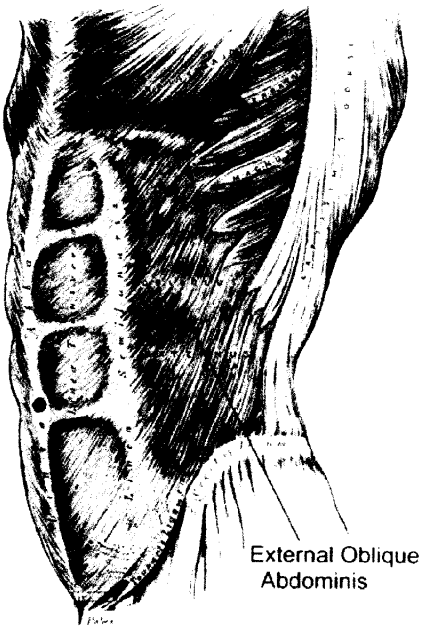

Figure 8-10. External Oblique

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Continuing more deeply into the torso, we find the *internal oblique abdominis* muscles, whose fibers run approximately perpendicular to those of the external obliques. They originate from the iliac crest and the *inguinal* ligament—a ligament that runs from the pubic bone to the iliac crest, also called the groin ligament—and insert into the aponeurosis and the thorax at ribs nine through twelve. The deepest layer of abdominal muscle is the *transverse*, whose fibers run horizontally from the rectus muscles to the spine. Like the internal obliques, the transverse muscles have attachments to the inguinal ligament, the iliac crest and the aponeurosis; at the top, however, they are located in the interior of the thorax where they attach to ribs six through twelve and interlace with portions of the diaphragm.

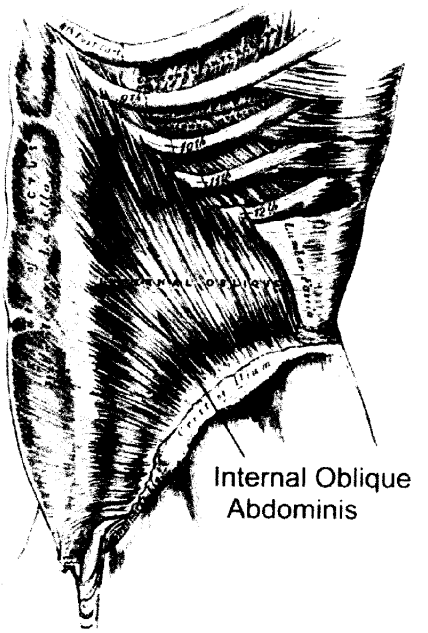

Figure 8-11. Internal Oblique

According to Zemlin, the expiratory functions of the various abdominal muscles are not uniform:

> "Because of their attachments and courses, the abdominal muscles probably do not all contribute to expiratory activity to the same degree. On mechanical grounds, the oblique muscles are probably the more effective in depressing