

# **A Review of the Breathing Mechanism for Singing:**

## **Part I: Anatomy**

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Breathing is important for singing. In fact, many argue that a properly coordinated breathing mechanism is one of, if not the most important components of a vocal technique. As my former teacher, Dr. Robert Harrison, is fond of saying, “No air, no sound.” It is our responsibility as teachers of singing to help students learn to coordinate the muscles and organs of the breathing mechanism in such a way as to produce the most efficient and vibrant sound. Part I of this series will focus on the anatomy of the breathing mechanism. It will review the major organs, muscles, and bones and discuss how they interact with each other for both passive and active breathing. Part II will examine the singer’s breath in greater detail and discuss various ways the system can be used for singing, including a description of *appoggio*.

### **The Lungs and Lower Airway**

The lungs are made of a porous, spongy material that is somewhat elastic in nature (its elasticity is an important part of exhalation, but more on that later). The lungs attach to the ribs via the pleural sacs, two thin pieces of membrane that cause the lungs to adhere to the ribs. Because of this connection, any change in

the volume of the rib cage causes a similar change in the volume of the lungs. As the volume of the lungs increase, a vacuum is created, causing air to rush in and fill the lungs. This is called inhalation. As the volume of the lungs decreases, air within the lungs is pushed out. This is called exhalation.

Expelled air from the lungs passes through the trachea, past the vocal folds, into the back of the throat and out the mouth or nose. The trachea is a tube made of flexible cartilaginous rings. The bottom of the trachea splits into two branches, one for the left lung and one for the right lung. If inverted, the trachea forms the trunk of a tree with two main branches: the left and right lungs. The larynx sits at the top of the trachea. Its primary, biological function is to act as a valve to keep food and liquids from falling into the lungs. It is the body's last line of defense against aspiration.

### **Muscles and Bones**

The lungs are housed inside the ribcage, which protects the lungs and other vital organs of the upper thorax. The ribcage is formed of twelve pairs of ribs, all of which originate at the vertebrae of the thoracic (middle and upper) spine. The top seven pairs of ribs wrap around and connect directly into the sternum, a flat bone in the front of the chest commonly called the breastbone. These seven ribs have very little flexibility and move very little in the breathing process. Ribs 8, 9, and 10 also attach to the sternum but in a more indirect

manner. This allows them a fair amount of flexibility. Ribs 11 and 12 do not connect to the sternum. Since the front portion of these ribs “floats” unattached, they are often called the floating ribs. They have a substantial amount of flexibility.

Because the lungs attach directly to the ribcage via the pleural sacs, movement of the ribcage directly influences the volume of the lungs. If the ribcage expands, the volume of the lungs increases and air is inhaled. If the ribcage collapses, the volume of the lungs decreases and air is exhaled. Neither the lungs nor the ribcage are muscles and are, therefore, unable to move on their own. Instead, they must rely on some of the muscles of the chest and thorax to produce movement.

The muscles responsible for moving the lungs can be divided into two groups: muscles of inhalation and muscles of exhalation. The chief muscle of inhalation is the diaphragm. Responsible for sixty to eighty percent of inhalation, the diaphragm receives more attention than any other breathing muscle. It is a dome-shaped muscle that attaches to the base of the sternum, the lower ribs, and the lower spine. When the diaphragm contracts, it flattens several inches. Because the top of the diaphragm attaches to the bottom of the lungs, this contraction pulls the lungs downward, increasing their volume and drawing in air, just as pulling the plunger of a syringe draws in medicine.

Contraction of the diaphragm presses downward on the organs of the lower abdomen. These organs, called viscera, are displaced downward and outward, causing the lower abdominal expansion associated with correct breathing for singing. Many people falsely assume the expansion of the lower abdomen is caused by the inflation of the lungs. While it is true that the lungs have more than likely inflated, the lungs' position within the rib cage makes it impossible for them to directly affect the abdomen. Rather, the abdomen protrudes as a result of the diaphragm's descent and subsequent displacement of the abdominal viscera, not the expansion of the lungs directly.

The second muscle of inhalation is the external intercostal, which runs between the pairs or ribs. When it contracts, it pulls the ribcage up and out, expanding the lungs and causing inhalation. Singers most often feel this expansion as a widening around the lower portion of the ribcage, particularly on the sides.

The muscles of exhalation include the internal intercostal muscles and the abdominal muscles. The internal intercostal muscles work opposite to the external intercostal muscles. They also run in between the ribs but, when they contract, they pull the ribcage down and in and cause exhalation. Typically, singers only use the internal intercostals at the ends of very long or extremely

loud phrases. The powerful contraction of these muscles can easily overblow the vocal mechanism and result in a strident, pressed, or pushed sound.

A more appropriate way to manage exhalation is to use the muscles of the abdominal wall. The rectus abdominis (“six-pack” muscle) connects the sternum to the pelvis. When contracted, the rectus abdominis flexes the ribcage downward toward the pelvis. While this action is important to stabilize the thorax during large motions (such as moving a piano), it can collapse the ribcage and limit a singer’s ability to take a deep breath. For the singing process, this muscle is generally passive.

The internal and external oblique abdominis run diagonally on the sides of the abdomen, connecting the ribcage and the pelvis. When these two muscles contract they stabilize the pelvis and spine and also compress the abdominal viscera (organs of the lower abdomen). The innermost abdominal muscle is the transversus abdominis, which wraps around the body much like a corset. When this muscle contracts, it stabilizes the pelvis, elongates the torso, and compresses the abdomen. At the base of the abdomen are the muscles of the pelvic floor. These muscles act like a hammock for the abdominal viscera. They help stabilize the pelvis, and help the transversus abdominis to compress the abdominal viscera.

When the abdominal muscles contract, they press inward and upward on the abdominal viscera, which in turn presses inward and upward on the diaphragm. This reduces the volume of the ribcage and lungs and causes exhalation. The inward and upward pressure of the muscles of exhalation counters the downward and outward pressure of the muscles of inhalation. This “antagonism” between the muscle of inhalation and the muscles of exhalation gives singers the ability to control the precise amount of air pressure and air flow that reaches the vocal folds.

### **The Breathing Process**

Typically, the breathing process occurs unconsciously and requires very little muscular control or activity. Passive breathing (as this is called) occurs in three stages. The process begins with inhalation. During this phase, the diaphragm contracts slightly (approximately 1.5cm) expanding the lungs. The diaphragm mildly pushes the abdominal viscera out of the way which results in a slight expansion in the upper stomach area. Normally, the external intercostals remain relatively inactive during passive breathing but might become more involved as exertion increases or when more air is needed (e.g. yawning and sighing). Sometimes, the muscles of the upper chest assist with passive breathing by raising the collar bones and sternum. While this is not necessarily a problem

for passive breathing, it is extraordinarily inefficient and not of particular use in the singing process.

The second phase of passive breathing is exhalation. During passive exhalation, the diaphragm relaxes and, because of their elastic nature (recall that the lungs are made of somewhat elastic tissue), the lungs shrink back to their at-rest shape. As the lungs shrink, air is expelled from them through the vocal tract and out of the body. The abdominal viscera and the ribcage also return to their at-rest positions. Little if any muscular involvement is required in passive exhalation.

The final phase of passive respiration is a brief recovery. If one were to quietly observe his breath, he would notice a slight pause after each exhalation. This pause allows the muscles of respiration a moment of rest.

Breathing for singing involves much more conscious control and occurs in four phases. Like passive breathing, the first phase is inhalation. When one breathes to sing, the diaphragm contracts more deeply than it does in passive breathing, typically around three inches. Additionally, the external intercostal muscles contract to lift and expand the ribcage. The combination of these muscles' actions expands the thorax and lungs in all directions. Singers sometimes refer to this as a 360° breath and is a hallmark of a good singing technique

The second phase of breathing for an active breath cycle is suspension. The larynx, from a biological viewpoint, serves two purposes: to keep food and liquid out of the lungs and to pressurize the thorax. During intense physical activity (such as heavy lifting) the body will attempt to exhale against the tightly closed vocal folds, pressurizing and stabilizing the torso. While this is a necessary response for intense physical activity, it does not allow for a freely produced sound. The suspension phase seeks to counteract the larynx's natural desire to control air pressure within the lungs. During the suspension phase, the glottis (space between the vocal folds) remains open and free while the muscles of inhalation maintain the rib cage's expanded position. Air is neither inhaled nor exhaled. This opens the vocal tract and prepares the singer for the next phase.

During exhalation, the muscles of exhalation contract, compressing the abdominal viscera. The viscera is pressed upward against the bottom of the diaphragm, which in turn presses upward on the lungs, decreasing their volume and expelling air. Singers work to maintain rib expansion for the duration of the sung phrase. The external intercostals, in particular, resist the temptation to relax and allow the rib cage to collapse as the singer exhales. This temptation is greatest among inexperienced singers who rely on the weight of the rib cage to expel air. This type of exhalation allows very little control over air pressure and



causes the rib cage and sternum to come out of alignment. With proper training, singers learn to balance the muscles of inhalation and exhalation to control air pressure and flow to the vocal folds.

The final phase of active breathing is one of brief recovery. Though some repertoire does not allow a singer a chance to rest between phrases, it is ideal to find moments when the breathing system can pause and reset itself. This does not mean that a singer should allow the sternum and chest to fall. Instead, a singer should maintain his/her noble posture throughout the singing process and find moments when the body can return to passive breathing.

### **Conclusion**

The explanation of the breathing process provided here is only the basis of the incredibly intricate and complicated muscular coordination required of professional singers. The exact balance of each of these muscle groups will vary from person to person, body type to body type, and teacher to teacher. Though the end result is often a similar muscular coordination there are, indeed, “many roads to Rome.” The second portion of this article series will focus on some of the broad categories used to classify some of the varying ways singers coordinate the muscles of the breathing system.