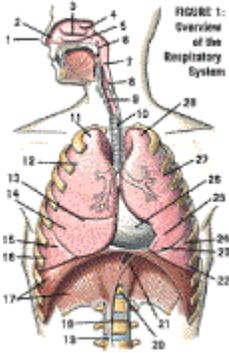


TECHNIQUE

ANATOMY



“I’m an artist, not a scientist!”

Some people really HATE the idea that something they love, like singing, could be associated with something they don’t, like science. Sometimes, singers don’t even want to take lessons because they want to feel spontaneous and natural.

Until they lose their voices.

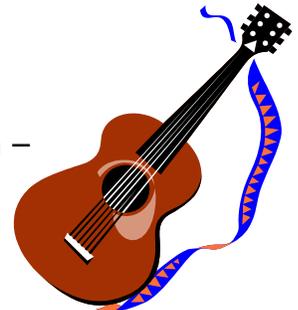
Then they want to know everything.

It’s true; you don’t need to know anatomy to be able to sing. And some teachers stay away from discussing actual anatomy, if they can, and prefer to talk in metaphors: “think of a beam of light coming out of the top of your head” or “ imagine flying”. But metaphors are inexact. Eventually, even ‘natural’ singers run into some specific problem that requires them to learn something about their own anatomy.

They’re still artists, just smarter artists.

Remember that sounds are audible vibrations. Think of a guitar.

The sound is created when a power source – your finger – sets a medium – a string – in motion. Then the resonator – the body of the guitar - shapes and reflects the sound so that it has a characteristic sound. Without the body of the guitar, the string might sound more like a harp.



When you sing, your breath (the power source) starts the vibration of the cords (the medium). Then the sound travels up your throat and out your mouth (or sometimes your nose, like for mm’s and nn’s). The area from the cords up is called the vocal tract (the resonator).

So, I will examine the anatomy of singing in these three parts:

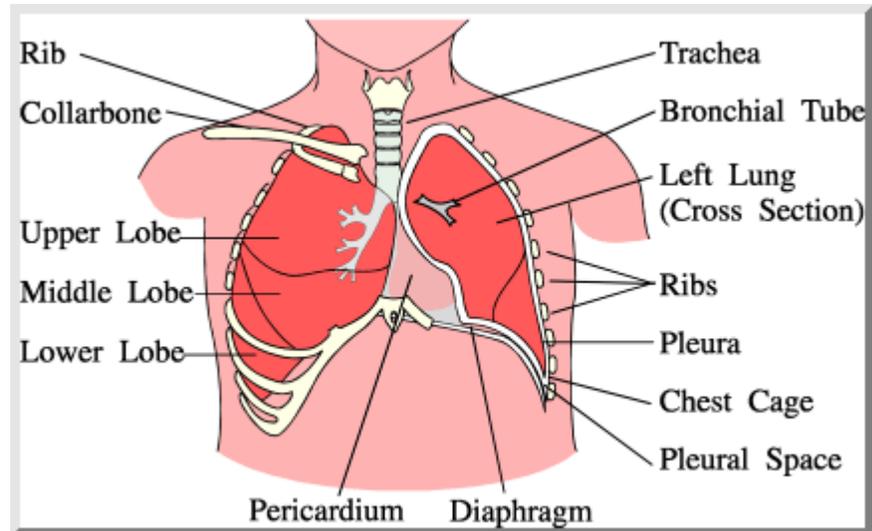
- 1) breathing mechanism – p2-8**
- 2) vocal cords – p9-11**
- 3) vocal tract – p12 - 14**

ANATOMY

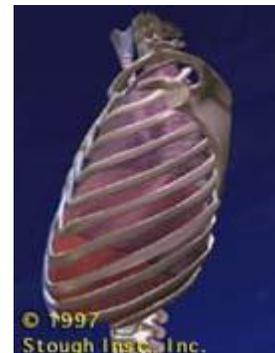
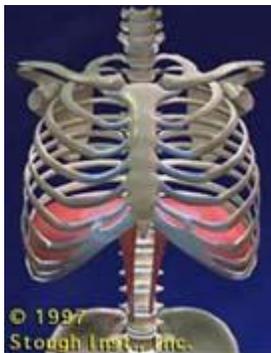
BREATHING

Here's a look at the rough anatomy. Notice how high up the lungs sit, how they are completely enclosed within the rib cage.

So why do voice teachers talk so much about 'breathing low', when there's no lung down low?



Because of the **DIAPHRAGM**. Take a look.



At maximum inhale

At maximum exhale

Max inhale, sideview

Max exhale, sideview

The difference in position between max inhale and max exhale can be up to 10 centimeters, depending on the vigorousness of the breath.

The diaphragm is a thin, dome-shaped flap of muscles that lies under your lungs and on top of your abdominal contents - stomach, liver, spleen, kidneys, intestines, etc. It is attached to your lungs. On the inhale, it pushes downward, stretching the lungs down and sucking air into them. On the exhale, it rises up again, and pushes the air out of the lungs. [Take a look.](#)

When the diaphragm is lowered, during inhale, it pushes the abdominal contents (tummy, guts, etc.) downward, out of the way. Teachers see many singers who hold their lower abdominal muscles stiff, and so the tummy and guts can't be lowered or expanded properly.

The **abdominal muscles** are important muscles for breathing, too. They need to be able to relax quickly, to make room, but also contract quickly smoothly, with strength and control in order to assist in the energized exhales that are so crucial in singing.

Singing teachers who concentrate their advice on 'low breathing' or *diaphragmatic breathing* may be addressing a problem with low-toned abs, or stiff abs. Low-toned or lazy abdominals can reduce energy in the entire body, making the singer seem unenthused. Stiff abs can reduce the breath size and force motion upwards into the shoulders. As a result, the singer may seem nervous and ungrounded.

Exercises:

- 1) **To feel the abdominal muscles' role in the exhale**, hold one hand on your abs while you blow up a balloon. Feel how they move.
- 2) **To visualize the downward movement of the abdominal contents**, measure your waist, twice, once after a complete inhale, once after a complete exhale. Be sure to keep good posture.
- 3) **To isolate the feeling of diaphragmatic breathing**, lie on the floor on your back. Relax and try to breath regularly; then begin to concentrate your breathing motion to just those lower areas, the diaphragm and abdomen. You may need to consciously restrict your rib movement for the exercise.

THE BIG THREE

Of course, a singer's breathing involves more than just low breathing. For study, it's helpful to divide the breathing areas into three theoretical areas:

- 1) Diaphragmatic (low, including abdominal motion)
- 2) Intercostal (middle, rib motion)
- 3) Clavicular (high, collar bone and shoulder lifting)

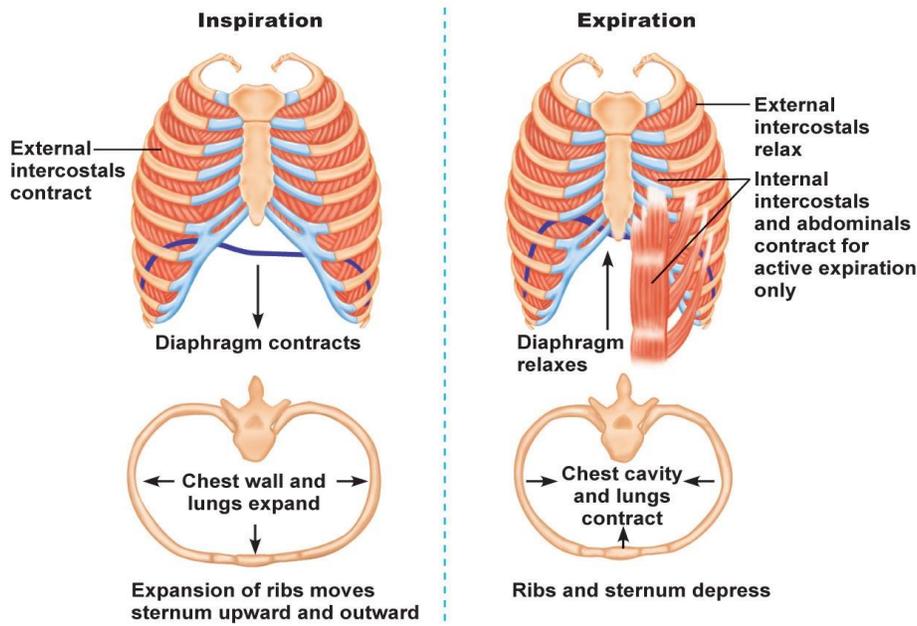
Exercises:

- 1) **To feel the full torso muscles**, just cough. (Coughing isn't good for the cords, so only do it once or twice.) Feel how the cough muscle attaches at the base to your pubic bone and curves around your torso all the way up to your collar bones.
- 2) **To feel the full range of your breathing musculature**, run up and down some stairs until you're quite winded, then stop, and feel which muscles are now automatically working hard. This is an excellent piece to use in every warm-up, as it activates your autonomic responses – "your breath breathes you". Your singing becomes more real and present moment, because your body systems are awake and coordinating with each other.



INTERCOSTAL, or MIDDLE BREATHING

During a normal breath, the ribs expand to give the lungs room to fill outward, just as the abdominal contents moved to allow the lungs to expand downward.



The rib muscles, or intercostals, are layered - internal and external layers wrapping around the torso. With focused exercise these layers can become very strong, flexible and well coordinated. Inexperienced singers, however, usually start out with intercostals that are relatively weak and less flexible. They don't expand very far, so these singers never get a really good-sized breath, and the layers don't balance together well, so the singers have trouble controlling breath pressure over long phrases. They may collapse very quickly, so their tone and volume are uneven. Imagine a bagpipe, after the player stops pushing the air through. The sound just sort of dies away.

Exercises:

- 1) To exercise the rib muscles,** hold your hands about an inch out from the sides of your ribs at rest position. As you inhale, consciously expand your ribs outward until you touch your hands. Hum a mid-range note for as long as you can without collapsing your ribs. Be sure to keep your shoulders relaxed and low. Shake out any excess tension after the exercise.
- 2) To measure the movement of your ribs,** use a measuring tape and measure the area around your torso just below your breasts. Compare the measurement when you are fully inhaled with the measurement when you are fully exhaled.

More breathing exercises are here.

CLAVICULAR, or HIGH BREATHING ☹

Singers who aren't tap dancing shouldn't need to use clavicular breathing at all. The lifting of the collar bones only adds a tiny bit of space, only necessary during heavily aerobic activities. However, performance nerves can cause stiff abs and high, shallow breathing. So voice teachers ask singers to "breathe low - and keep those shoulders down!" Like any advice, it's easy to skew it: if one ONLY breathes low, or holds shoulders down stiffly, that compounds the problem.

Does Breath Really Matter That Much?

In many of the mellower pop styles, it isn't necessary to get a very *big* breath, is it? The musical phrases are shorter, the style is somewhat lazy sounding relative to classical singing, and since there's a microphone, a singer doesn't have to project very far. But even these folks need the muscular tone of good middle breathing. Without it, their voices would sound tinny, weak, and unfocused, and/or they'd have difficulty negotiating the pitch variation of a normal melody.

More importantly, though, breath is a major factor in a singer's emotional content and communicative power. Even the most unnatural styles of singing rely to a large degree on empathic connection, that is, how much our sound resembles the sound of a human in a real situation. A wailing cry, an urgent whisper, a long call, an angry bark, a sexy crooning – these sounds communicate immediately, before and beyond actual lyrics.

When we hear someone out of breath, as humans we want to know why – is it danger, or opportunity? When we hear an unsteady or randomly shaking tone, we want to know if it's fear, injury or weakness.

Tips on the Inhale

- Inhalers are best practiced from the bottom up: first release the abs outward, then expand the ribs around, then gently open the throat.
- Inhalers are good moments to lift the soft palette and relax the jaw, often accomplished by imagining smelling a rose or warm bread.
- For more precise onsets, use slower inhalers, mouth in the shape of the onset vowel.
- The inhale is the thought, identifying a target; the size of the inhale depends on the size of the thought/feeling, and how far away the target of communication is.
- When learning a new song, mark the start of your inhale in the music. It's more important than the lyrics.

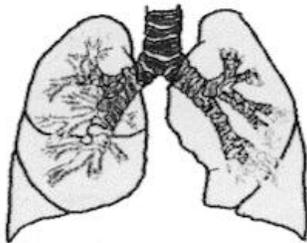


PUSHING, RELEASING, and CONTROLLING THE EXHALE

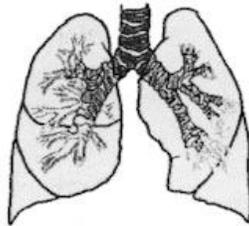
You can assess a singer's breathing efficiency by asking him or her to sing one medium-loud, sustained, mid-range note on any open vowel. A note that is properly supported by breath will be strong, resonant, and on-pitch, from the onset to the finish.

Imagine three breath-mechanism positions:

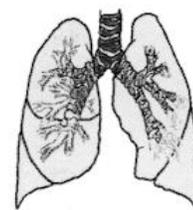
- 1) Maximum inhale
- 2) Rest position (A theoretical middle position you pass through, on the way to max inhale or max exhale)
- 3) Maximum exhale



1. Max inhale
Positive air pressure



2. Rest
Zero air pressure



3. Max exhale
Negative air pressure

Imagine yourself in a maximum inhale position (1), just about to exhale. There is *positive* air pressure in the lungs, meaning the air is just waiting to get out. If you just **release** your muscles, just let go, the exhale will be fairly strong, for a moment. Then, when your lungs and diaphragm get to middle – rest – position (2), the power will fade. The released exhale doesn't last very long. Once there is *zero* air pressure in the lungs, your lungs are like empty balloons.

You could, if you wanted, continue using your abdominal and rib muscles to keep **pushing** out, all the way to maximum exhale (3). This would be like squeezing the balloon flat, or like wringing out a sponge. This is the **releasing+pushing** technique of exhale, but it makes for a very uneven sound, and difficulty controlling pitch.

Rather than just releasing the start of the exhale, experienced singers use the rib and abdominal muscles to **control** the exhale. The abdominal muscles activate from the start of the note, just as they do when you are blowing up a balloon. The rib muscles engage, balancing and coordinating with the abs, to prevent the air from escaping all at once. As they get closer to the middle - rest - position, the musculature continues to **control** the exhale so that it does not slow, as before.

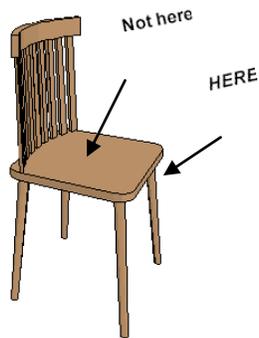
Classical singers rarely push the exhaled sound past the rest position. Pop and jazz singers often move well into the negative pressure position. In both cases, the evenly controlled, strongly supported exhale helps the resonance by making the sound waves more uniform in size and shape. They can then establish better sympathetic vibrations, which the listener hears as a richness of overtones.

POSTURE

Looking at this picture, you can see very quickly that this hunched over position would make it impossible to get a full breath on the inhale, or sustain an even resonant tone on the exhale. And this posture would also constrict fluidity of movement. So, not only would it sound bad, it would look bad, too.... unless you are portraying a character who is down-trodden, in which case this is exactly right and the sound you produce will be very effective.



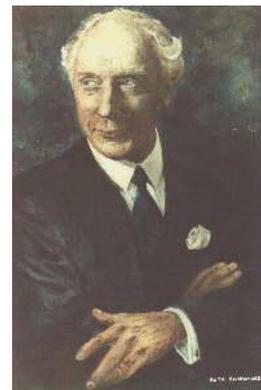
There is no one perfect posture for singing. Posture is a form of communication itself; it telegraphs status and condition, and can be an important part of character. Many students, in searching for some reliable 'correct' position, may develop a habitual pose or stance that limits their emotional range and accumulates extraneous tension. Beware of excess tension in the legs, buttocks and lower back, as it will prevent the ribs and abs from fully expanding on the inhale.



Here are a few basic rules that most good singers observe:

- 1) Do some kind of physical warm-up.
- 2) Keep your weight from settling on the heels.
- 3) Let your knees bend slightly.
- 4) Keep your pelvis and hips loose.
- 5) If you must sit, then use the chair edge.
- 6) Don't cross legs; keep feet flat on the floor.
- 7) Keep neck long, shoulders relaxed.

Many high-level singers study a body-alignment method called **Alexander Technique**. This technique has proven equally useful for singers, instrumentalists, actors, dancers, and athletes, because it focuses on maintaining optimal coordination of various muscle and structural elements. Typically, Alexander work addresses the habitual tension of the head and neck and their relationship to the spine and the rest of the body during performance. You can find a certified Alexander instructor from NASTAT ([North American Society Of Teachers of Alexander Technique](#)) or ATI ([Alexander Technique International](#)).



Frederick Mathias Alexander

Some singers resist body work, and even resent other singers who use their bodies as part of the performance, as though it were cheating. It almost is, and absolutely worth it. Audiences are proven over and over to be more swayed by visual stimuli than by aural -- even people who swear [they are aural only](#). Your body is speaking already, so let it say what you want it to.

Common breathing problems

1. **Clavicular breathing** – phrases
2. **Weak abdominals** – abs fail to engage on exhale; sound may be weak in volume, may lack resonance or 'spin', may sound lazy, with pitch difficulty especially in the higher ranges, and weak note releases.
3. **Stiff abdominals** – inhale is incomplete and shallow; sound can be tinny, lacking in rich overtones. Frequently accompanied by excess tension in spine, pelvis, legs, shoulders, neck, and head.
4. **Over-active abs** – forced, huffing exhale; onsets are harsh, often off-pitch. Stresses the vocal cords and leads to injury or hoarseness.
5. **Withholding the breath** – over-engaged ribs literally withhold the exhale; sound may be low volume, lacking in overtones, vibrato and expressive richness, with difficulties with coloratura (rapid pitch movement).
6. **Collapsing the breath** – ribs fail to engage; sound may be breathy, inconsistent, or may be 'pressed', or squeezed out on the last bit of breath.
7. **Extraneous head/neck tension** – may come from poor posture, or from trying to rush the inhale; sound may be thin and uneven, range limited; often with noisy inhales.
8. **Late inhales** – inhale is incomplete or rushed; onsets lack precision.

Breathiness of tone is a 'sometimes' problem. When the vocal cords do not connect fully, the tone is breathy. In very young singers, breathiness is a normal part of development. In mature singers, it may be a stylistic choice (like Enya or Celtic Woman), or it may indicate a problem in balancing the breath energy with the vocal cord engagement. See more about this in the Vocal Cord section below.

When a singer has a successful balance of breath energy with vocal cord energy, he or she is said to have mastered the *appoggio*. It may take many years for even a good natural singer to master the appoggio, so don't be discouraged if it is difficult. Also, appoggio techniques will differ across musical genres and aesthetics, so a master in one style may be a beginner in another.

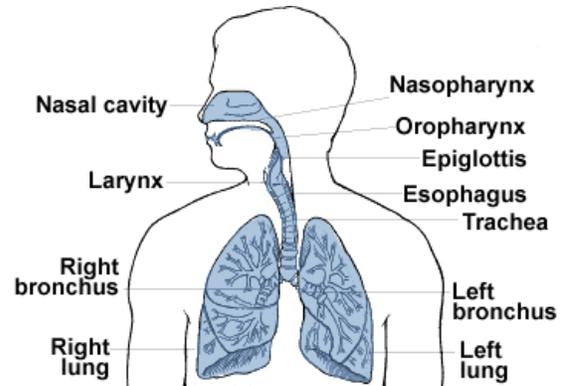
When you begin, you will need to be extremely conscious of **each** breath. This is appropriate; breath management is an acquired skill that must eventually become habit. It may seem tedious to be so demanding, to really stop yourself EVERY time you sing with lazy breathing, even when the sound you produce isn't that bad. However, the more rigorous you are early on, the faster you'll learn the habit.

ANATOMY

VOICE BOX

I view the anatomy of the larynx (aka voice box) like this: you don't have to know about chemistry to build a fire. But you do if you want to be a professional pyrotechnician.

On the following pages, you'll see several anatomical drawings of the larynx, and the text of an excellent article from The Singing Voice website, describing the function of the voicebox during phonation.



Great stuff, very confusing. It's a good idea to become familiar with these concepts, eventually, but don't try to understand the details all at once.

Start instead with a good sense-memory of what it feels like to make sound. Practice now - just make a few different noises: hums, coughs, growls, words, sirens, like that. Now, as an exercise, make up a theory about how you think it works. Don't worry if you're wrong; just make a theory that accurately describes how it feels to you.

You can be as specific as you want, or as metaphorical as you want. Maybe it feels like an engine revving up or revving down as you change pitch. Maybe it feels like air is squeezing through various sized holes.

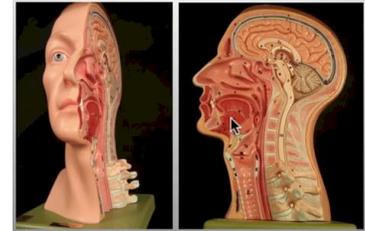
Why do this?

Because these empirical observations you make are as valuable to you as the real descriptions will be, maybe more so. The truth is, when you sing an A, you don't tell your vocal chords to get long and thin and slap together 440 times every second. I don't know anyone who can do anything 440 times a second, on purpose. But knowing that it happens, and how it happens, can give you respect for the physical complexity of a form of expression that comes very naturally to many people: vocalization.

If you are like most singers, you'll take the greatest degree of interest in the science of singing when you are in trouble. And your focus will be primarily the condition, care, and maintenance of the vocal chords. For a sheet on vocal health and hygiene, go [here](#).

What's a larynx? *In the simplest terms: your throat separates into esophagus (for food and drink, to the back) and trachea (for air, to the front). The larynx sits at the gate to the airway. Food and drink shouldn't touch it. The vocal cords themselves are a couple of folds of soft tissue, hung on a couple of ligaments, which are controlled by muscles in the throat.*

Here's a lovely video [anatomy walk-thru](#), with strobe lights and scoping of healthy and hoarse voices from Dr. Robert Bastian.



And below is a brief description of the actual cords function, from Mark D. Williams of [The Singing Voice](#):

Vocal Anatomy -

The larynx, or voicebox, is composed of two major cartilages, the ring-shaped **cricoid** at the top of the trachea, and the **thyroid**, also known as the Adam's apple. The larynx hangs from a U-shaped bone called the **hyoid bone** to which the base of the tongue is attached.

Located at the back of the thyroid on each side are two sets of "**horns**," the upper, or superior horns, and the lower, or inferior horns. The upper horns attach to the hyoid bone. The lower horns attach to the cricoid cartilage allowing the thyroid "a rocking articulation."

On the top edge of the cricoid are two small cartilages know as the arytenoids to which are attached the vocal ligaments and the internal muscles of the larynx. These muscles open and close the vocal folds during breathing and phonation and help to adjust dynamics and pitch.

Another cartilage that deserves mention is the **epiglottis**, a leaf-shaped cartilage that is attached to both the thyroid and the arytenoids and serves as a "lid" to the trachea during swallowing.

The muscles of the larynx are named for the cartilages to which they attach. The one with which singers are primarily concerned is the **thyroarytenoid** muscle or **vocalis**. The vocalis forms the body of each vocal fold. When it contracts the vocal folds shorten and thicken, thus lowering pitch. In addition to shortening the vocal folds, contraction of the vocalis can also keep the glottis closed longer and increase loudness.

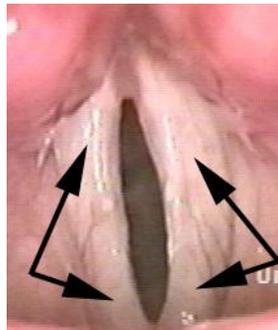
When the **cricothyroid** muscle contracts it causes the thyroid cartilage to rock forward slightly. This in turn causes the vocal folds to stretch and thin, thus raising pitch.

The muscles that close the vocal folds for phonation are the lateral **cricoarytenoids** and the **interarytenoids**. When the lateral **cricoarytenoids** contract, they bring the vocal processes of the **arytenoid** cartilages together closing most of the glottis. For complete closure the **interarytenoids** must also contract to close the posterior portion of the glottis. Failure of the interarytenoids to contract allows air to escape resulting in a breathy tone.

The posterior cricoarytenoid muscle is responsible for opening the vocal folds for inhalation. It acts in opposition to the lateral cricoarytenoids and also can control pitch and loudness by acting as a check on the vocalis and cricothyroid muscles.



Cords separate during breath



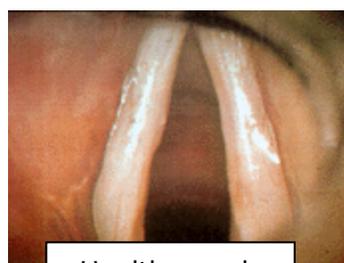
The stages of each beat.
When singing an A, this happens 440 times every second.

On a guitar, the initial vibration of the string depends first on the strength of the actuator - the finger that plucks. But then the character of the string's vibration depends on how tight it's strung, how thick the string is and what it's made of - that is - its **shape** and **density**.

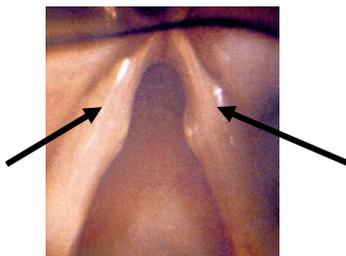
The same goes for the vocal cords. The muscles around them can make them shorten and thicken, or lengthen and thin out. They can make them curve, or increase or decrease the pressure of each beat. They can make them touch only on their edges, or make their movement wide. But they must have the movement of *air* to do it.

As an exercise, blow air through your lips, as though you are a horse, or a motor boat. (Bbbbbbbbbb) Now try to do it without breath. It can't be done because the muscles aren't fast enough to do it without riding on the current of air. They need the air to get a bounce. Just like your cords. The air is like the wind in a sail, and unless you can catch that wind, you can't move. Much vocal cord damage is caused by overworking the cords, or parts of the cords, and this is very often linked to breathing problems.

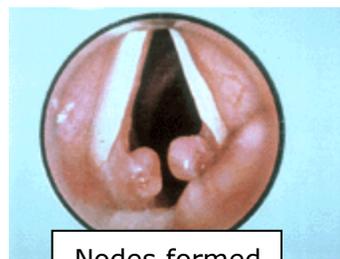
If the cords meet unevenly, they may eventually form bumps. Like calluses, these raised parts become the focus of more pressure, and if unattended, may turn into nodes. The voice becomes habitually hoarse, with loss of control over pitch and tone.



Healthy cords



Bumps beginning



Nodes formed

Singers with vocal injuries may need to take a period of silence, or have voice therapy to correct the sound production technique, or have surgery to remove the nodules, with voice therapy afterward to learn how to sing properly so the nodes do not form again. This is risky, since there is no guarantee the singer's original sound quality will return. Singers who've had this type of injury include: Julie Andrews, Elton John, Adele, John Mayer, Keith Urban, Paul Stanley, Steve Tyler, Roger Daltry, Lionel Richie, Denyce Graves, and more.

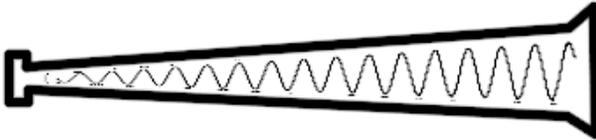
However, singers who practice scrupulous vocal hygiene, resisting the pressures to over book and overplay, are much less likely to ever need these treatments. See the [vocal hygiene](#) handout for more.

ANATOMY

Vocal Tract

The vocal tract is the area between the vocal cords and the outside world.

If the vibration is the raw ingredient, then the vocal tract is where things get cooking, and as at the best parties, everything happens in the kitchen.



*A cone increases the amplitude, (loudness)
i.e. Mechanical amplification*



*Surface reflections create more overlapping
waveforms – harmonics - resonance*

The vocal tract, like the body of a guitar or the cavities of a horn, determines the shape of the waves that move through it. The shape, texture, density and size of the resonating chamber all work to guide and reflect the initial sound wave, and help or hinder any secondary waves. The vocal tract creates the character, color, and weight of the voice.

The human voice is considered the most versatile musical instrument of all, primarily because of the elasticity of the various cavities you see at left. If a trumpet could reshape itself midway through a note into a trombone shape, or a French horn could soften itself into wood, those instruments might begin to have some of the flexibility of the human voice. Even if you don't feel your voice is doing what you want it to, the potential is there.

So Cool

This video of "Better Man Than He" by a band called Sivo, shows a [singer in a magnetic resonance imaging machine\(MRI\)](#). These incredibly complex shifts are managed through several different areas of the brain handling language, motor function, auditory and social awareness.

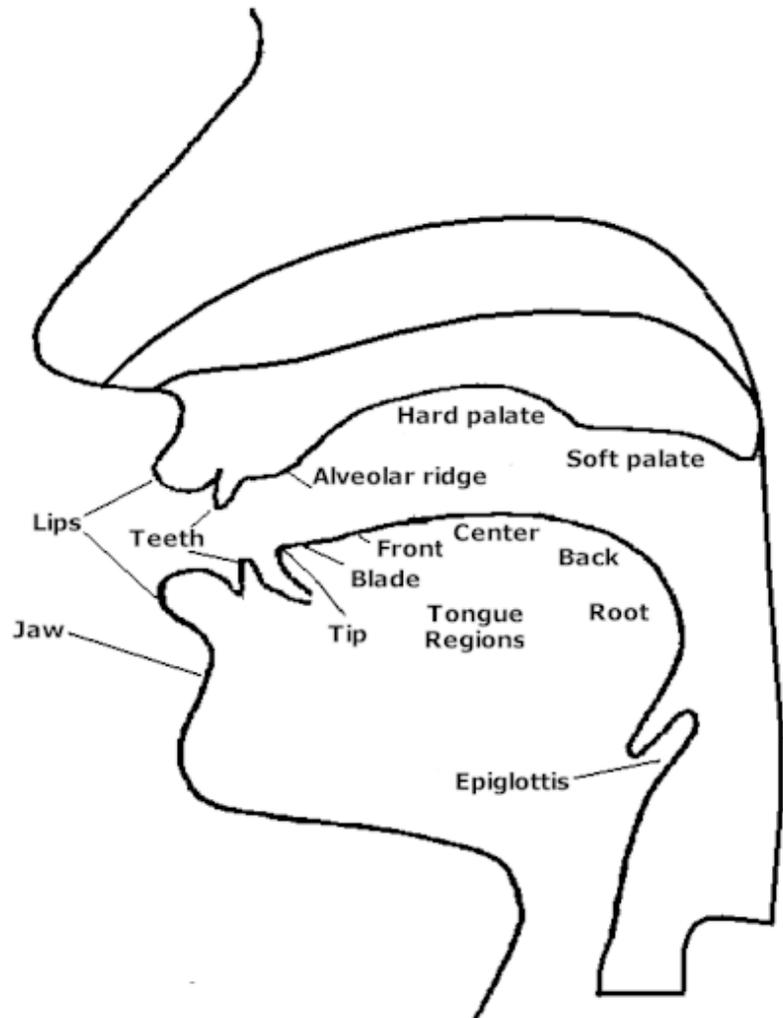


To Metaphor or Not to Metaphor

The vocal tract, unlike the larynx, is mostly visible to the student singer using a mirror. Therefore, naming and isolating the various parts of the vocal tract anatomy is somewhat more useful here than for the cords themselves.

For example, a singer should be able to flex and relax his tongue independently from his lips and jaw, and with some practice with a mirror, should be able to drop and lift the soft palate at will.

However, the student singer can't carry a mirror around for every gig, so we need memorable metaphors, too. Metaphors are shorthand for remembering the feeling of correct function, usually because they allow us to access the memory of a familiar natural function, in order to shift shapes in the resonance cavities.



“Like smelling a rose” is a reference to a slow inhale, with a slightly lifted soft palate and relaxed tongue. But saying “smell the rose” or “smell warm bread” is almost always quicker, more effective, more pleasant, and more memorable.

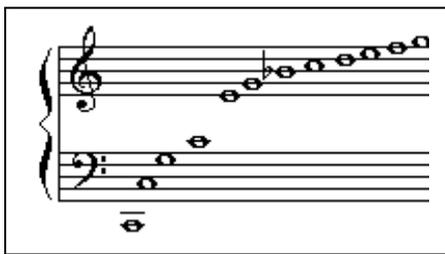
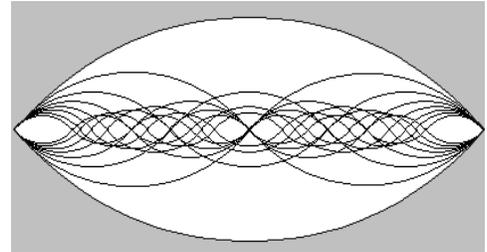
However, for resonance shifts that are faster than either anatomical accuracy or metaphor, students should explore **mimicry** and **acting exercises**. “Raise and stiffen the back of tongue” works a little; but “make a sound like Kermit the Frog” works a lot. If it seems wrong to use pop culture as a basis for resonance training, remember that resonance preferences themselves are in large part culturally defined.

There are some sounds that are perceived similarly across cultures and generations: e.g. a lullaby in 1870’s Hawaii is not too unlike a lullaby in NYC today. However, most of vocal taste is time/genre specific. The ideal vocal sounds of 1920’s Italian opera bear very little resemblance to the ideal sounds of 1970’s Broadway or 2010’s pop.

What is Resonance?

The vocal tract is all about shifting the sound resonance, but what IS resonance?

For the technical answers, we go back to some middle school science. If you pluck a string on a harp, or hit a note on a piano, the vibrations of that note will set off sympathetic vibrations with the other strings. But it also sets off sympathetic vibrations with *itself*, most strongly with the tone of half its own length (an octave higher), then more lightly with smaller a smaller segments.



These other notes, or harmonics, have a fixed tonal relationship with the original note, and together are called the Overtone Series. The staff at left shows the first eleven overtones of the series, which theoretically continues upward infinitely, each note ringing more quietly than the last. The resulting blend of overtones can be shown on a [spectrograph](#), emphasizing some formants over others.

But I've never met a singer who used this information to sing better.

We describe the resonance of a voice using words for color, timbre, weight, ring, etc. A sound is warm, round and golden, or maybe it's bright and biting. It could be dry and grating, or sincere and honest. The resonance – the specific shape of which overtone are emphasized more than other - is what creates this sense of character. Have a listen to these voices, and describe the difference in resonance profile in your own words:

[Leontyne Price](#) compared to [Lucia Popp](#)
[Blossom Dearie](#) compared to [Sarah Vaughan](#)
[Eddie Vedder](#) compared to [Billy Corgan](#)
[Trace Adkins](#) compared to [Vince Gill](#)
[Donna Murphy](#) compared to [Bernadette Peters](#)
[Jessie J](#) compared to [Beyonce](#)
[Josh Groban](#) compared to [Michael Buble](#)
And just this one [just for fun](#)

We create resonance shifts through experimentation and mimicry, and we are not limited to one particular genre ideal. Fans of particular genres of music will exaggerate the value of their favorite resonance profile, and deride other profile types (Oh! Those terrible Balkan throat singers!), but don't be cowed. Include sounds that might be 'ugly'. And use a voice recorder – sounds from the inside are very different from what an audience hears.

For more resonance exercises, go [here](#).