

Physiology of the Voice

Fundamentals of Vocal Care
A Wake County PLC Project

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Presentation Information

- *The following presentation was assembled through the research and contributions of vocal experts from numerous sources, including the [Duke Voice Care Center](#), the [UNC Vocal Wellness Clinic](#) and many other print resources*
- *Wake County high school choral directors were able to contribute to and request that specific information be included in this project*
- *Key terms are in **YELLOW***

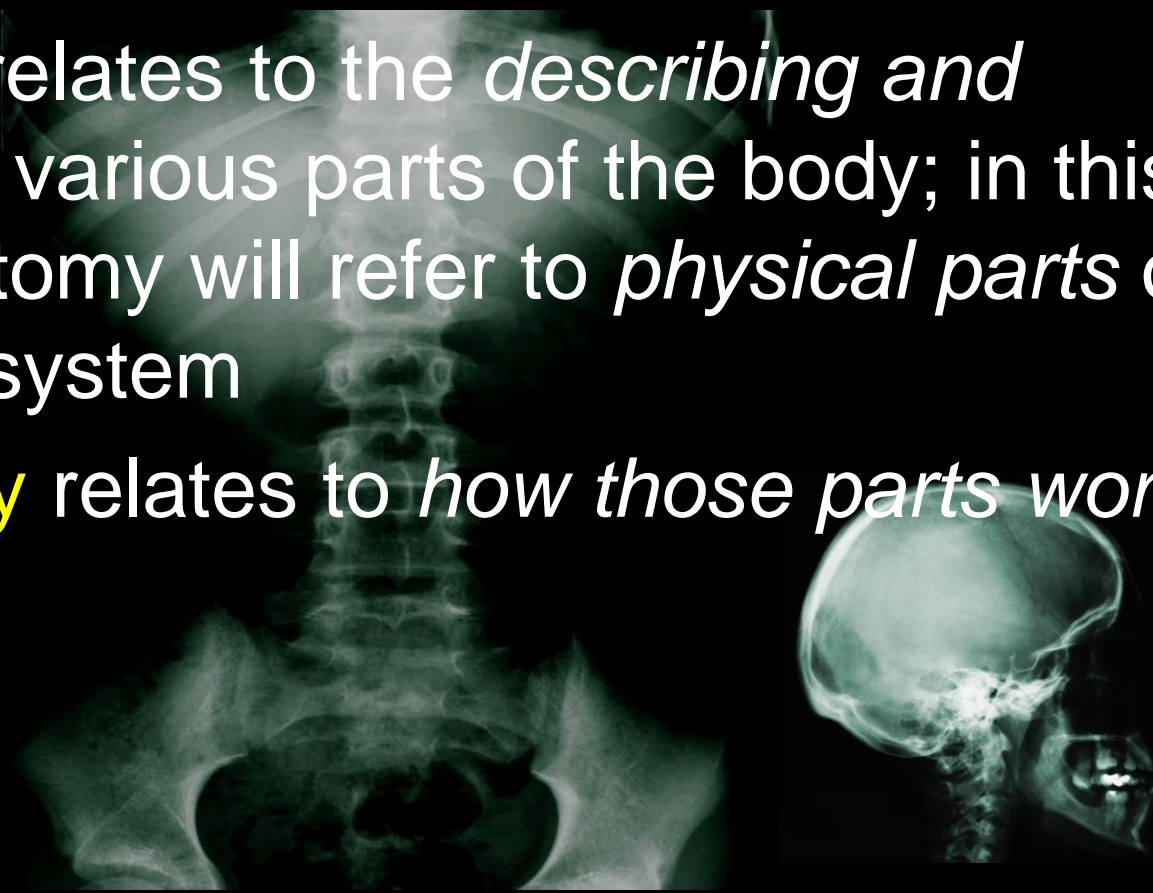
Purpose

- The purpose of this project is to help students and teachers of choral music get a better understanding of the following:
 - Anatomy and physiology of the voice
 - Exploration of vocal damage
 - Tips for vocal health



Anatomy and Physiology

- **Anatomy** relates to the *describing and naming* of various parts of the body; in this case, anatomy will refer to *physical parts* of the vocal system
- **Physiology** relates to *how those parts work*



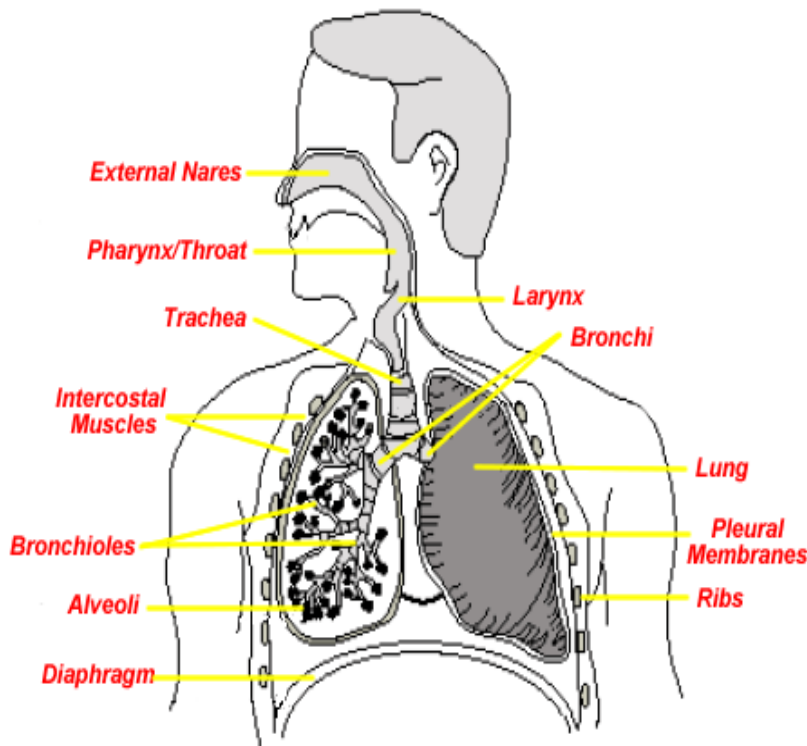
Anatomy:

Physical parts of the vocal system

- Creating sound requires numerous muscles, bones and organs of the body
- Three main anatomical aspects:
 - **Actuators:** Lungs/diaphragm/intercostal muscles; these organs deal with breathing/“air management”
 - **Vibrator:** Voice box (**larynx**); this deals with the creation of pitch in the form of a sound wave
 - **Resonators:** Throat (**pharynx**), mouth/lips/teeth, nose; these deal with the modification of sound into tones of varying “colors” (called **timbre**)

Actuators: Breathing Process

Respiratory System



Note location of
actuators

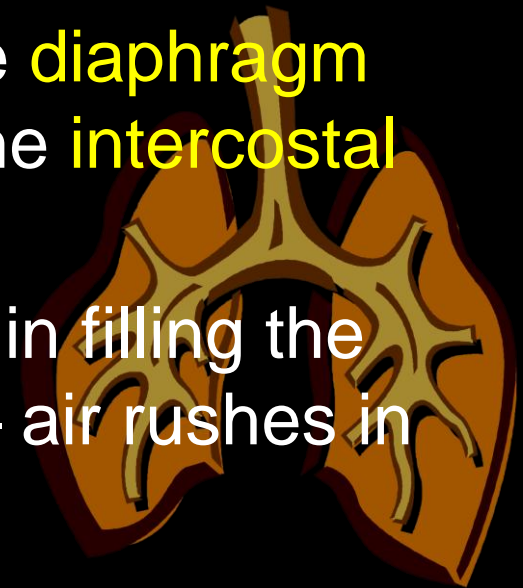
-- Intercostal
Muscles

-- Diaphragm

-- Lungs

Respiration: The Breathing Process

- **Actuators** are “organs” used in the breathing process; **respiration**, however, refers to the actual process of breathing
- When breathing in (**inhalation**), the **diaphragm** descends, pulling the ribs apart (the **intercostal muscles** help with this as well)
- As the ribs move apart, air rushes in filling the lungs (think of a bellows for a fire— air rushes in and fills the cavity)



Respiration, cont'd

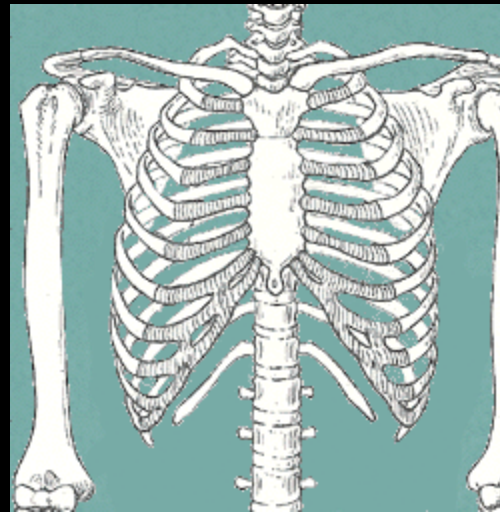
- When breathing out (**exhalation**), the diaphragm and intercostals relax which makes the lungs force air back out (again, much like a bellows being squeezed together)



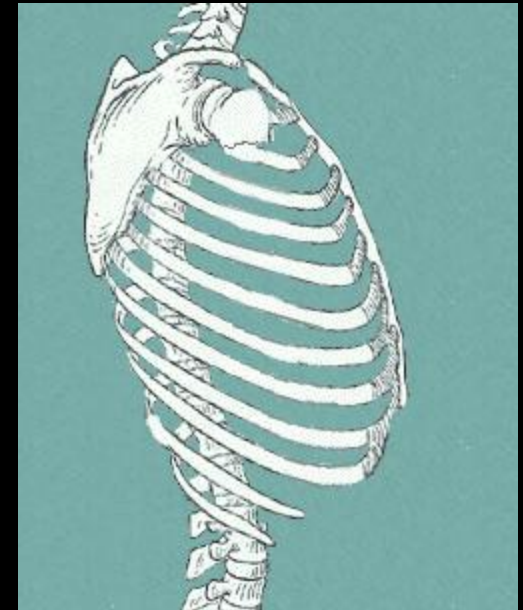
Respiration: Demonstration



Movement of diaphragm



Movement of ribs/lungs

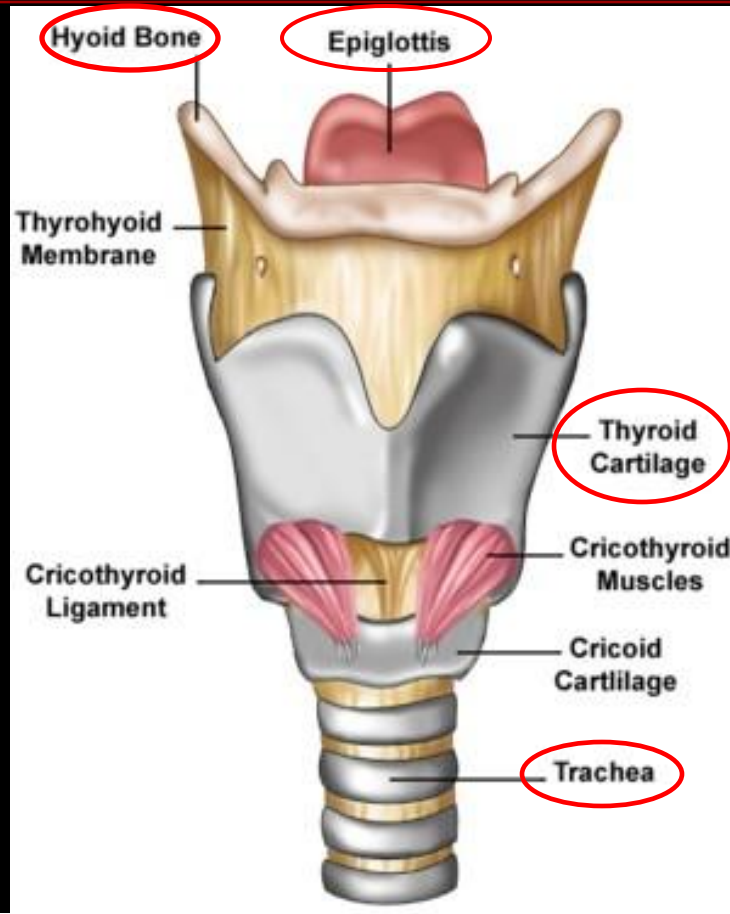


Vibrator (also known as “Oscillator”)

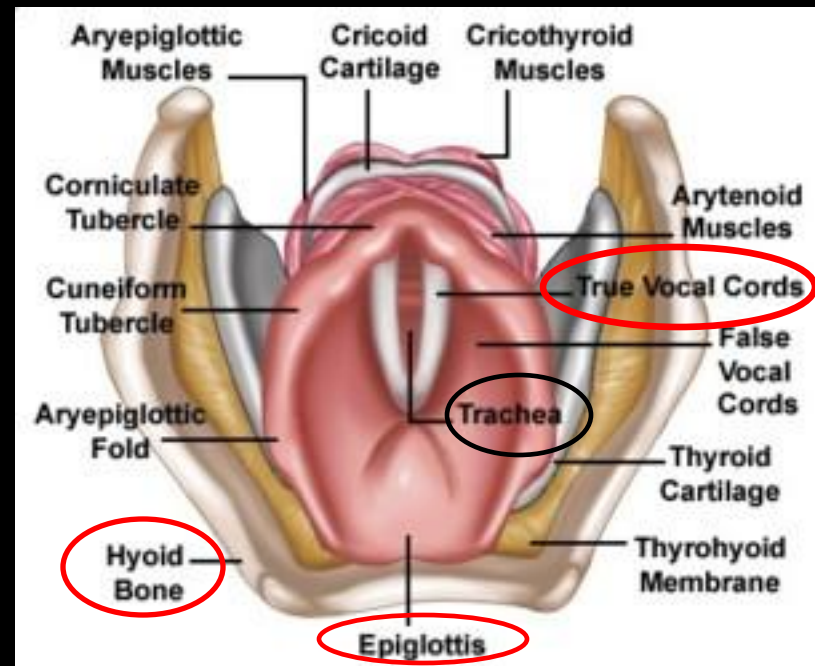
- **Larynx** is the formal name for **voice box** (also, some call it the “Adam’s Apple”)
- The **larynx** contains the **vocal cords** (also known as **vocal folds**)
- The **epiglottis** closes off the airway when swallowing so food does not go down the wind pipe (**trachea**)
- The **thyroid cartilage** houses the larynx and protrudes in the neck (easily visible on many men as “Adam’s Apple”)

The Larynx; Please note the following:

Hyoid Bone, Epiglottis, Thyroid Cartilage, Trachea, True Vocal Cords

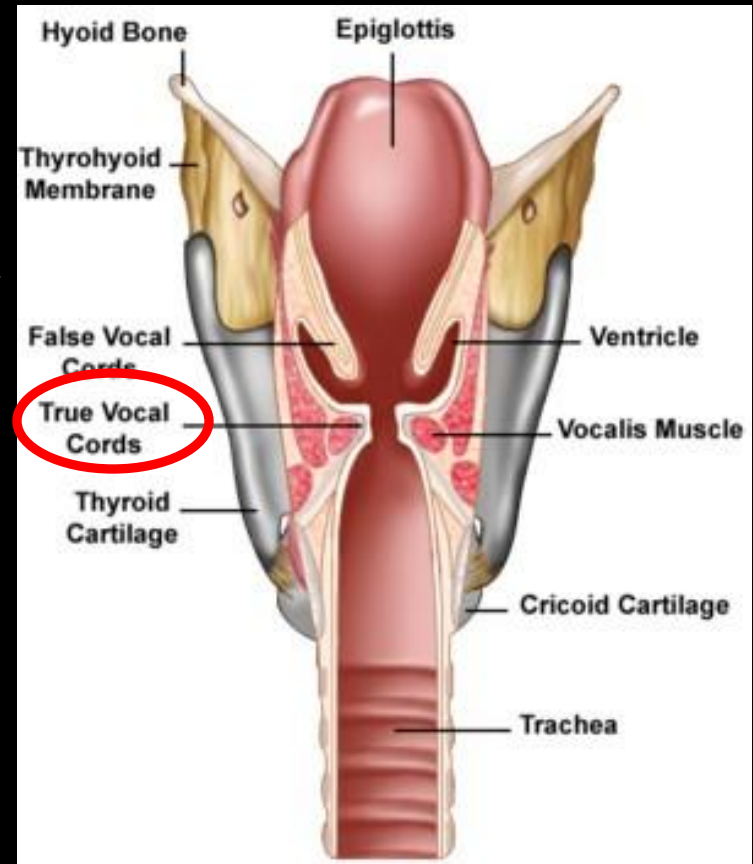


Left: Larynx as looking directly ahead at the throat; Right: Larynx as looking down the throat.



Larynx: Cross section

- If we cut the front view of the larynx in half, we would see: →
- Notice the location of the **true vocal cords**



How the larynx works (how the voice is produced):

- During the respiration process of exhalation, air rushes up the **trachea** and into the **larynx** (voice box) where it rushes past the **vocal cords** and causes them to vibrate; when singing, the tighter we stretch the cords, the higher the pitch (like two rubber band being plucked)

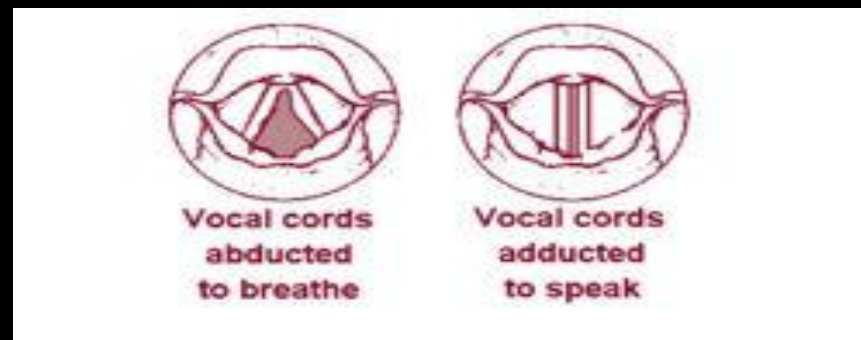


Inside the larynx: What happens

- The vocal cords **adduct** (come together) during **phonation** (creating of sound)
- The more the cords are tightened, the higher the pitch
- The cords vibrate against each other hundreds of times per second; the number of times they vibrate is known as **frequency** and this is measured in **Hertz (Hz)**
- Just like a piano, when a string is hit by a key, it vibrates a certain number of times (like A above middle C vibrates at 440 times a second- or 440 Hz); the vocal cords do the same (when singing an A above middle C, they vibrate 440 times a second--- 440 Hz)

Abduction vs. Adduction

- **Abduction** is the vocal cords being spread apart (this occurs while breathing); think “abduct” means to take away
- **Adduction** is the vocal cords coming together (this occurs while speaking or singing); think “add” = putting together)



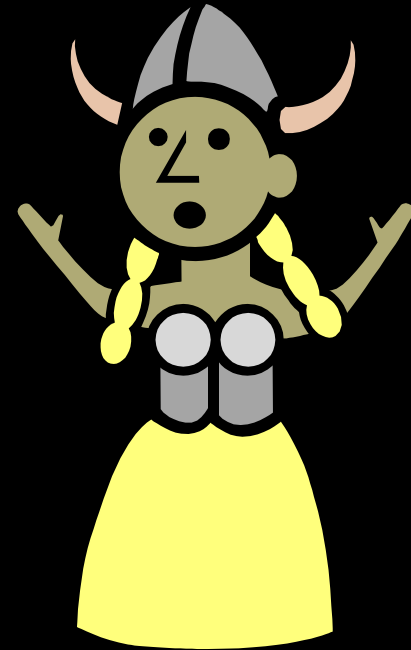
What it looks like:

- The following link shows a video of the inside of a larynx (top-down view)
- Notice the vocal cords **adducting** (coming together) when pitch is created; it is not really possible to see the vibrations taking place (several hundred times a second)

[Video of larynx producing sound](#)

Low vs. high pitch

- Notice in the following video the changes in the larynx when the singer moves from a moderately low pitch to a higher one:
- Also, notice the **trachea** (wind pipe) below the larynx



Click on the opera diva above!

Note: It may be necessary to turn up the volume to hear clearly

More on the cords...

- The **vocal folds** (synonym for vocal cords) are made of layers of delicate tissue (mucous membranes); little blood flow occurs in the cords, thus, the white appearance
- Under normal talking or singing, they can withstand quite a bit of use; however, loud/forceful **phonation** can cause injury (either suddenly or over time)
- Vocal folds cannot be replaced, though they can be surgically corrected for lesions or growths

Vocal Injury

- It is fairly easy to injure the vocal cords!
- Forceful singing, yelling, screaming, loud talking can cause the vocal cords to hit very hard and result in injury to the cords (these are forms of **vocal abuse**)
- Excessive amounts of **phonating** (singing/talking) can also lead to injury (**vocal overuse**)
- **Nodules, polyps, laryngitis** and **hemorrhage** of the cords are possible effects of such vocal abuse
- *Smoking also has dramatic effects on the larynx!*

Vocal Injury: PLEASE READ

Please note, the following slides describe the most common vocal injuries. It is important to understand these “illnesses” as such understanding may help us take better care of our voices. Videos of patients with the injuries are featured on each slide; some of the videos are quite graphic because of the nature of the injury. It is possible to get a clear understanding of what the injury looks like without watching the entire video (most are 10-20 seconds). These videos are not intended to “gross you out” but to make you aware of the extreme consequences of vocal abuse, including effects of smoking.

Nodules

- **Nodules** (also called “**nodes**”): A common injury that is essentially a small growth found on both of the cords (nodules are much like a callus on the hand or foot); Nodules keep the cords from fully closing, resulting in a harsh/breathy voice

Note: 5 yr. old patient;

(clicking on small video will enlarge to full screen— true of all videos in this presentation)

[Video of Nodules](#)

Polyps

- **Polyps** are like nodules in that they are also a growth on the cords that keep the cords from closing, but are more like a soft lesion than a hard callus
- Polyps may be on either just one cord or both (typically on just one side); both abusive phonation and smoking are common reasons for polyps

Note: Middle-aged adult-- smoker for 30 years; polyp is easiest to see at end of video

[Video of polyp](#)

Hemorrhage

- A **hemorrhage** is where a blood vessel “explodes” due to excessive pressure



Laryngitis

- **Laryngitis** is the inflammation of the vocal cords
- It may be the result of reactions to allergies, bacterial or fungal infections, or the result of vocal overuse
- With laryngitis, the vocal cords often swell too much to correctly close, resulting in the lack of phonation

In this video, notice the extra mucous, redness and irritation associated with the illness and the inability of the cords to close (and thus, the inability to phonate)

[Laryngitis Video](#)

Causes of vocal injury or illness

The following list is not inclusive of all things that can cause vocal issues, but rather a general list of “frequent offenders”

- **Vocal abuse:** (can result in nodules, polyps, hemorrhaging, general irritation and laryngitis)
 - Yelling, screaming, hollering (especially cheerleading— a common source of adolescent vocal problems)
 - Forceful singing
 - Throat clearing and coughing
 - Loud talking (especially in loud settings like sporting events, restaurants, parties, etc.)
 - Whispering! This can put great strain on the larynx

Causes of vocal injury/illness

- **Vocal overuse** (can have the same effects as vocal abuse by the general “wear and tear” of the vocal cords)
 - Singing for too long (this can especially occur during long rehearsals like choral festivals)
 - Talking for too long (cell phones!, sleepovers, reunions, etc.); low-pitched talking can be especially detrimental
 - Habitual throat clearing

Treatment

- For treatment of nodules, polyps, laryngitis, hemorrhaging: **A DOCTOR should be consulted!**
- In general, total **vocal rest** (NO talking, singing or whispering for an extended period) is the first line of defense, and in some cases, can help cure some of the above conditions; increased hydration may also be beneficial; in general, resting the voice is important whenever it feels strained or if the sound is not normal
- Surgery may be required in some cases

Acid Reflux as irritant

- **Reflux** (backflow of stomach acid) can cause significant irritation, burning or swelling on vocal cords/larynx; Two types:
 - **“GERD”**: Gastroesophageal reflux disorder— is when acid backflows into **esophagus** (food pipe)
 - Symptoms: Heartburn, regurgitation; occurs while laying down
 - **“LPR”**: Laryngopharyngeal reflux— is when acid backflows into larynx/pharynx
 - Symptoms: Too much mucous in throat, need to clear throat often, sour taste in mouth, hoarse voice, feeling of a “lump” in the throat

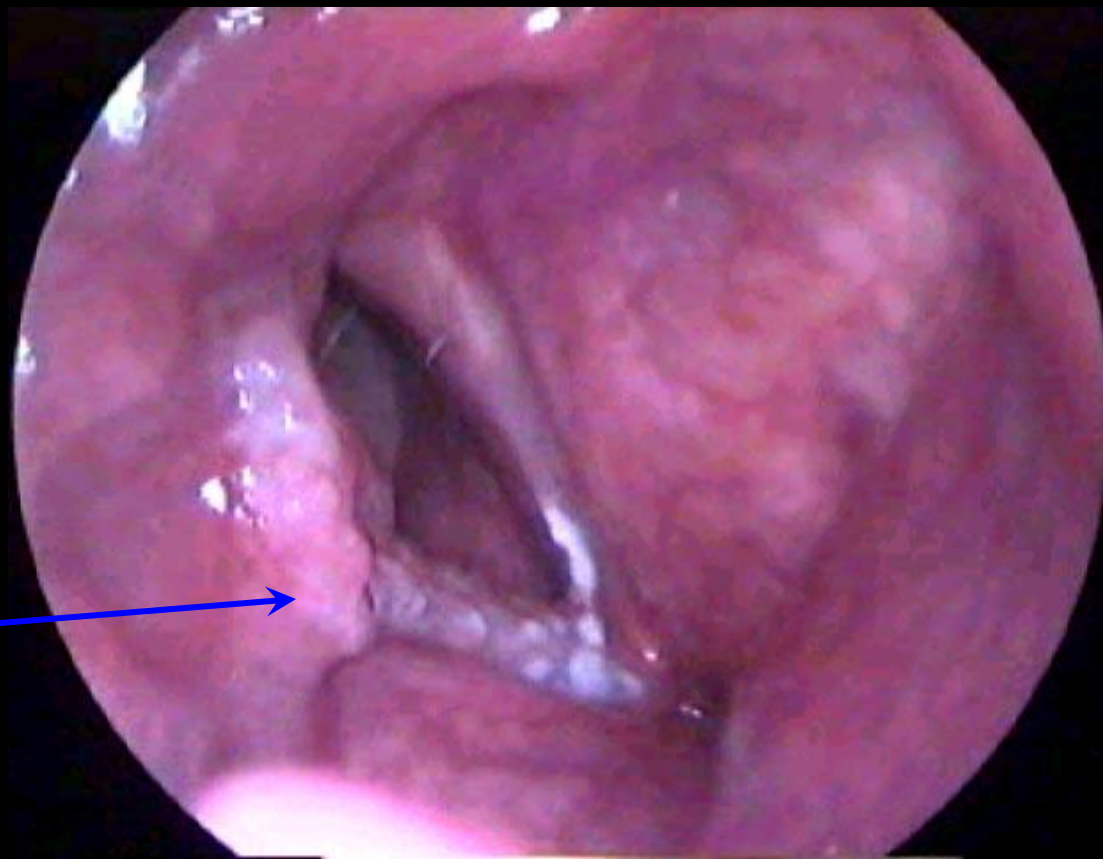
More on Reflux

- Reflux is best treated by a doctor
- Preventing reflux from occurring is the best medicine; the following can help to do so:
 - Diet: **avoid** very spicy foods, alcohol/caffeine (both rob body of moisture), highly acidic foods (citrus fruits and tomatoes), carbonated drinks, chocolate, dairy products, fatty foods
 - Eat at least 3 hours before going to bed
 - Exercise/lose weight (if overweight)

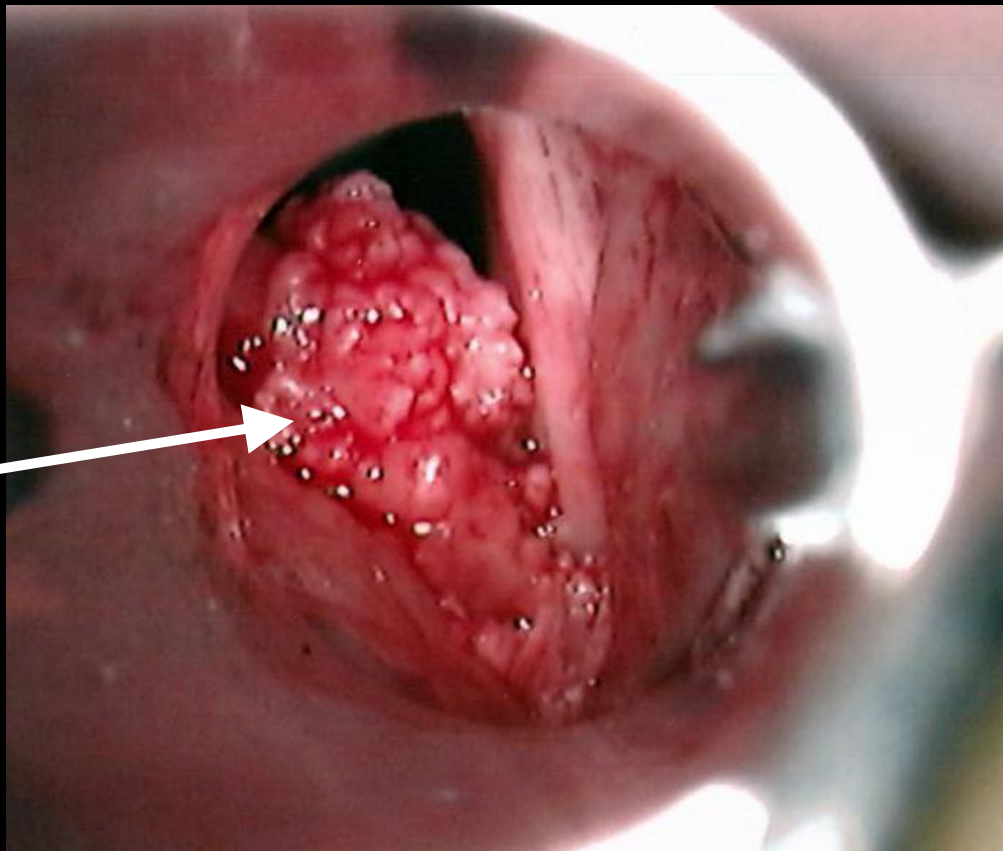
CANCER

- Fortunately, cancer of the larynx is **not** dependent on vocal overuse or abuse
- However, smoking presents a very real danger to singers (as evident by the cancer patients presented in the following pictures— **of whom are all smokers**)
- **The cancer pictures are quite graphic**, but it is important to understand the possible consequences of smoking; *please be willing to look at these 3 examples with a perceptive mind*

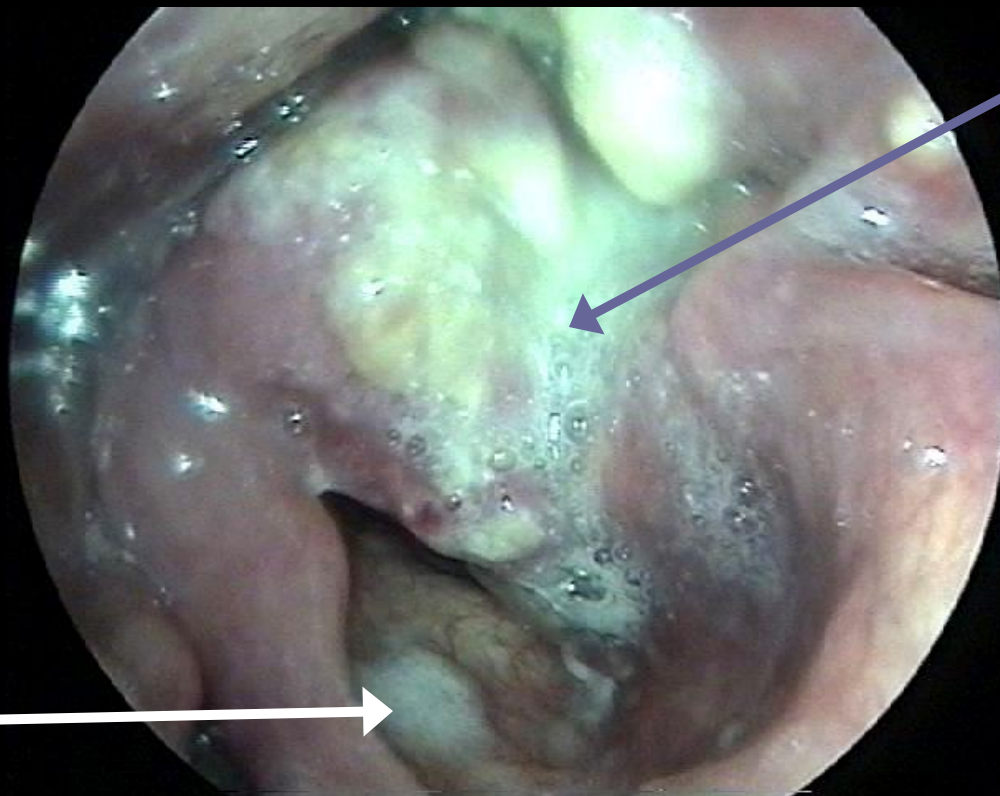
Cancer Picture 1



Cancer Picture 2



Cancer Picture 3



Please don't smoke.

Keys to vocal health

- The larynx (voice box) is very much a finely tuned musical instrument and should be taken care of like a fine violin (plus, the voice box can NEVER be replaced!)
- **Hydration** is key! Water is the best fluid for the body. Try to drink at least 64 oz. a day (about ½ gallon)!; the vocal cords need constant lubrication while singing



More on hydration...



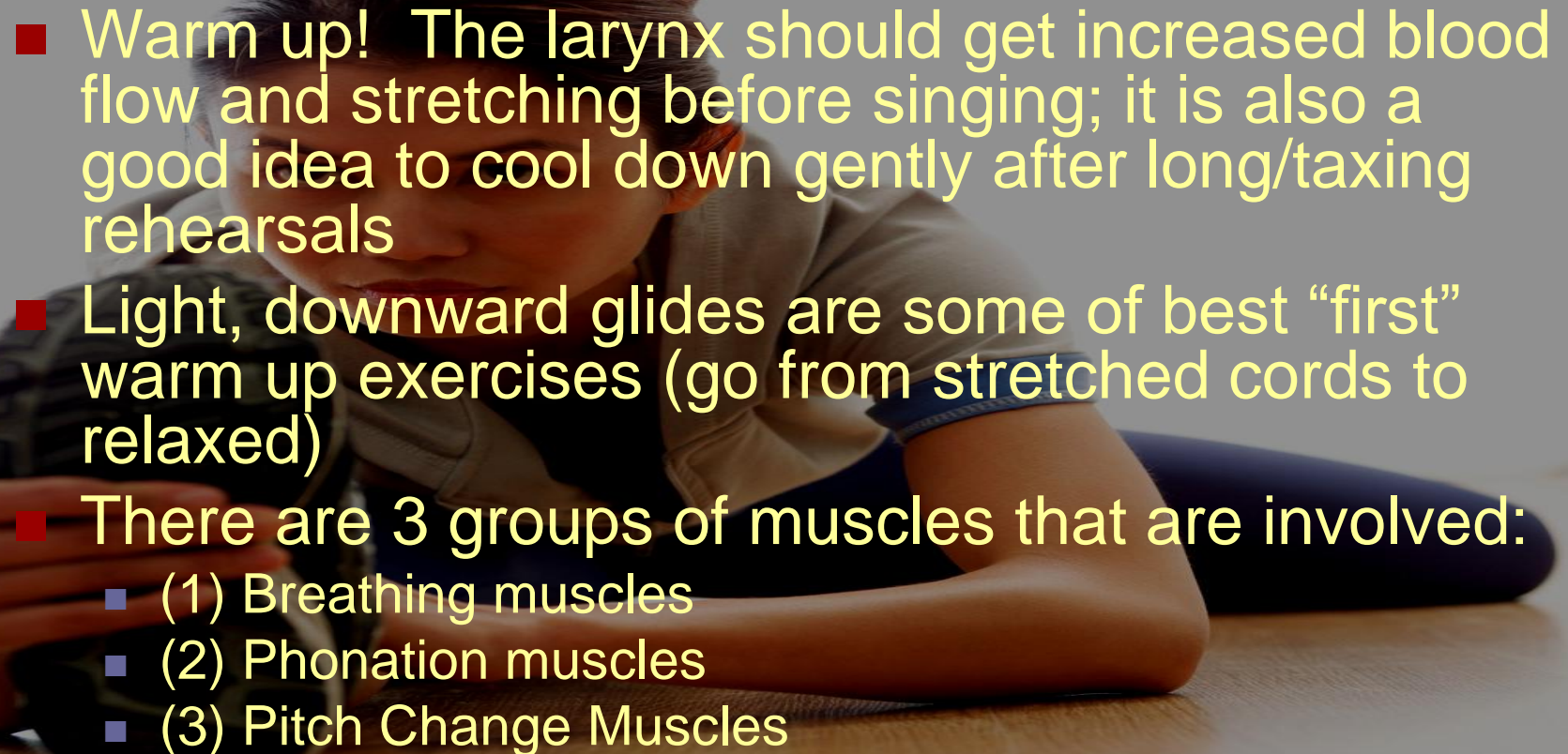
- The body should produce about 1 liter of mucous a day! However, it needs lots of water to do so; in order to keep the mucous “thin”, much water is needed
- Foods like grapes, melons, cucumbers have a lot of water and are quite beneficial
- Alcohol, caffeine, smoking and antihistamines all dry the body/vocal cords
- A humidifier in dry areas or your bedroom may also be beneficial

Vocal health



- Try not to sing forcefully or for long periods of time; let your choral director know if you are experiencing vocal fatigue
- Try to avoid singing **hard glottal attacks** (where the voice is initiated quickly with force— as on words like “Go”); this can be helped by beginning the breath/airflow before the pitch is phonated— especially on vowels

Vocal health

- 
- Warm up! The larynx should get increased blood flow and stretching before singing; it is also a good idea to cool down gently after long/taxing rehearsals
 - Light, downward glides are some of best “first” warm up exercises (go from stretched cords to relaxed)
 - There are 3 groups of muscles that are involved:
 - (1) Breathing muscles
 - (2) Phonation muscles
 - (3) Pitch Change Muscles

Bodily Health: Exercise is key component!

- Exercise: Frequent exercise can help promote a strong circulatory system, efficient lungs and good immunity toward sickness
- Try to get 8 hours of sleep!
- Don't grunt when lifting weights! It creates dramatic pressure against the cords



Vocal health cont'd...



- When talking on the phone, hold the phone with your hand, not with your shoulder as the position can put a lot of strain on the larynx and neck muscles
- The singing voice should last for hours without much discomfort; if hoarseness, discomfort or lack of range/phonation occur, it is an indication of a problem with the voice, or an issue with singing technique

More on vocal health...



- Smoking can cause dramatic changes to the tissues in and around the vocal cords and is the primary cause of laryngeal cancer; It robs the vocal cords of full flexibility because of its drying effects. **Singers should not be smokers.**

Summary

- The voice is a wonderful instrument; man has made nothing like it! Singing is a great privilege and the vocal cords should be treated with care and protection
- The tips in this presentation can help you maintain your voice for years to come, but in the event of any vocal problem, the advise of a doctor/laryngologist is the most important action you can take

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