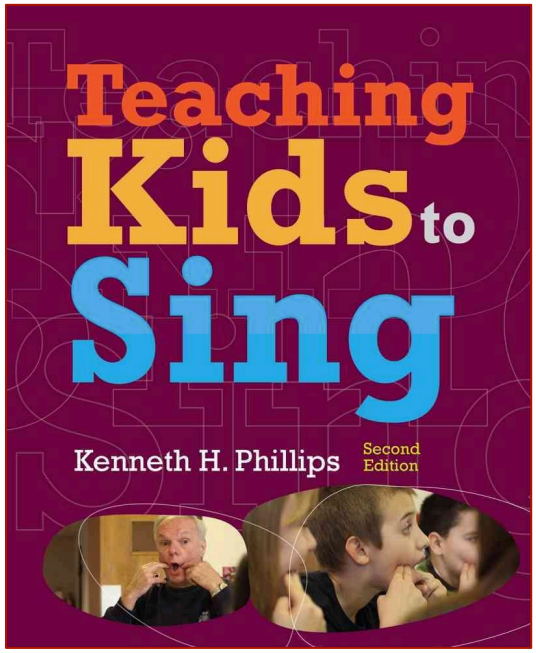
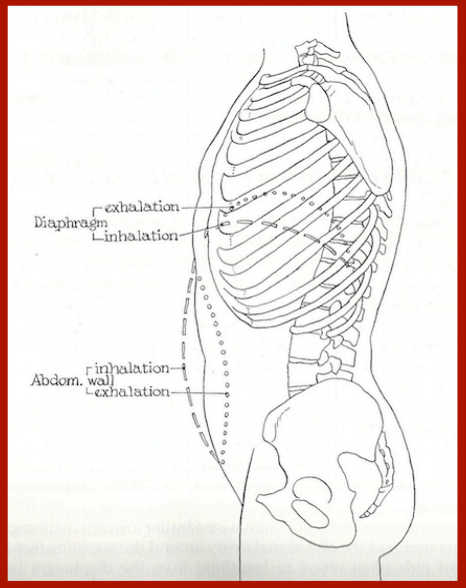
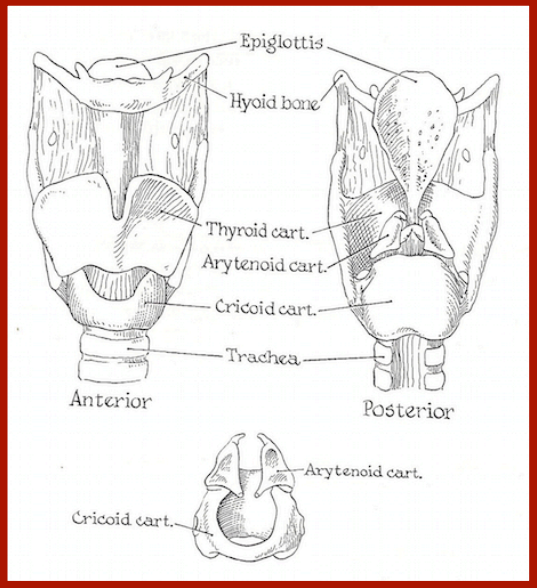






Source: Phillips, *TKTS*, p. 145/157.

The Art of Choral Techniques

In-class Review of *Teaching Kids to Sing*: **Chapter 6 Vocal Physiology: Breathing and Laryngeal Mechanics**

Main Sources for Images:

Phillips, Kenneth. *Teaching Kids to Sing* ***(TKTS)***, 2nd ed. U.S.: Schirmer CENGAGE Learning, 2014.

Doscher, Barbara. *The Functional Unity of the Singing Voice* ***(FUSV)***, 2nd ed. Metuchen, NJ: Scarecrow Press, 1994.

Alderson, Richard. *Complete Handbook of Voice Training* ***(CHVT)***. West Nyack, NY: Parker, Publishing, 1979.

Chapter 6: Breathing and the Laryngal Mechanism

- Two phases: Inhalation (Inspiration) and Exhalation (expiration)
- Bimodal breathing motion:
  - Use intercostals (muscles between ribs) to lift and lower chest for fast breathing cycle, or
  - Contract (lower) the diaphragm upon inhalation, slowly relaxing it (elastic recoil) upon exhalation.
- Know three major muscles groups and how they function and interact:
  - Abdominals
  - Diaphragmatic
  - Costal

Preferred: Diaphragmatic

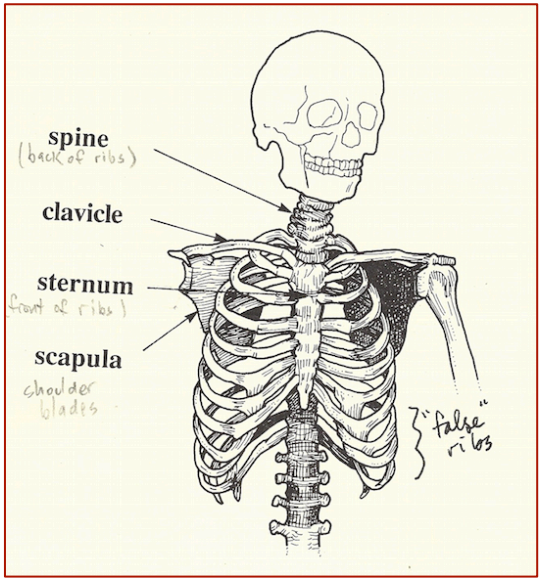
- Use combination of abdominal, diaphragmatic, and costal muscles.
- Must be controlled and managed.
- Not as natural and must be practiced to become habitual.
- Avoid high, clavicular breathing and teach children to take “full” and “deep” breaths. [Expand downward and outward; invite air into lungs (no gasping or sucking)

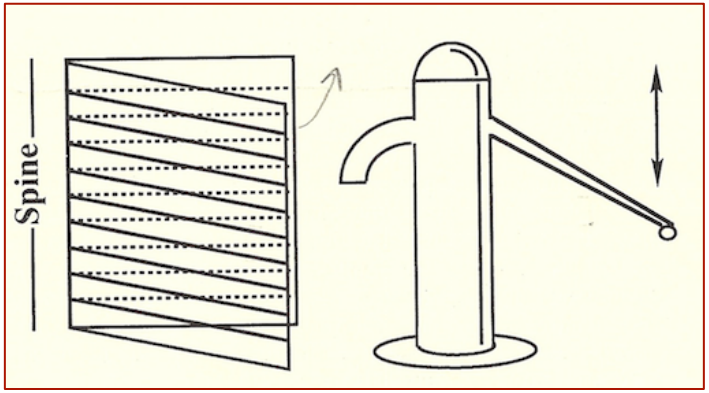
Inhalation/Exhalation Cycle

- **Inhalation:** diaphragm descends (contracts); lower ribs expand outward w/enlargement of body around waistline permitted by relaxed abdominal muscles.
- **Exhalation:** diaphragm ascends (relaxes) – also known as "elastic recoil" – and lower ribs contract inward; corresponding contraction of body around waistline as abdominals contract

Breathing Physiology: Lungs and Ribs

- Lungs are organs (not muscles!)
- Lungs are acted upon by surrounding muscles
- Interconnection of ribs (costae) with spine, pelvis, costal cartilages, etc.
- Upper ribs connect with breastbone (sternum) via costal muscles
- Ribs move forward and upward w/ sternum in a pump-handle fashion.
- Clavicles (or collarbones) are attached to top of sternum and to shoulder blades

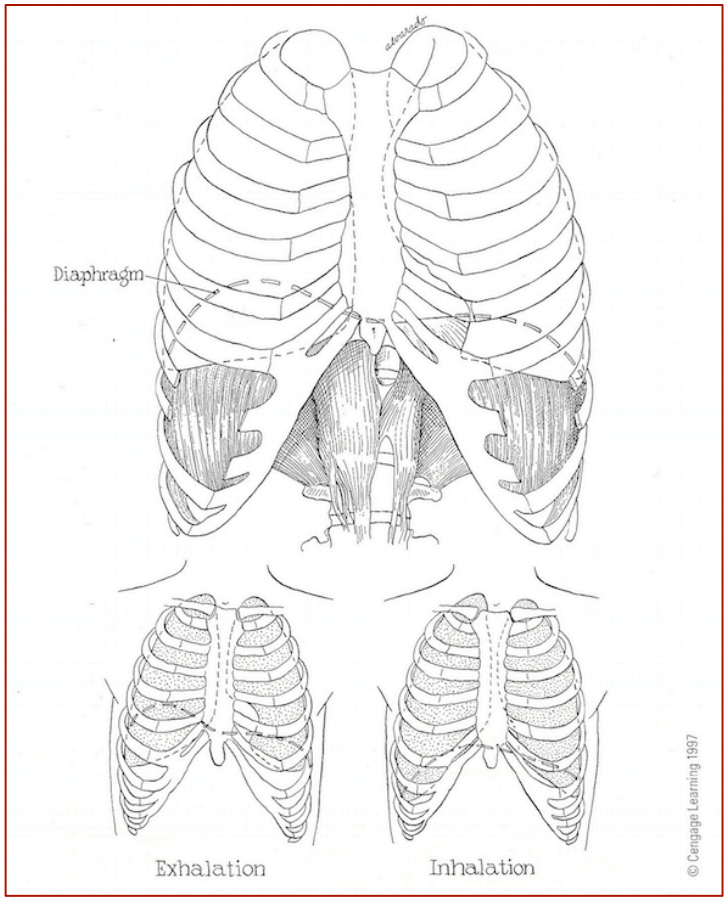




Source: Doscher, *FUSV*, p. 6/7.

Breathing Physiology: Diphragm

- Major muscle of inhalation.
- Double-domed shape.
- Separates thoraic cavity from abdominal cavity.
- Thin and attaches to the lumbar (back) vertebrae,costal (rib) margin, and lower end of sternum.
- Action of diaphragm during breathing motion.



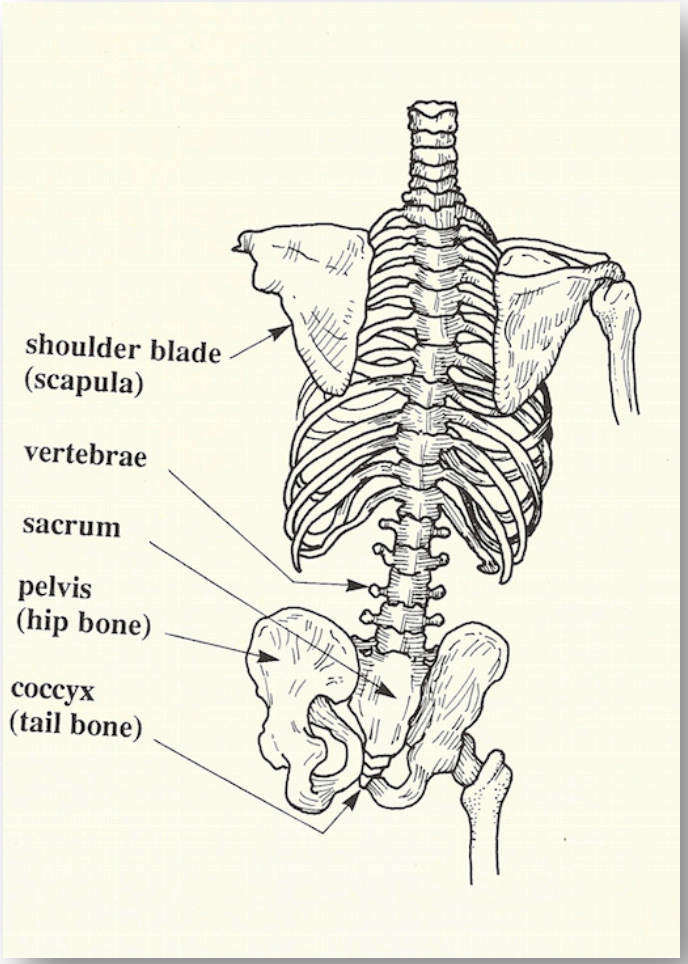
Source: Phillips, *TKTS*, p. 147.

Quiet Breathing vs. Breathing for Singing

- Diaphragm is involuntary (acts on its own); don't try to control it.
- Breathing from diaphragm is natural, but tendency to breathe from upper chest (clavicular breathing) w/o diaphragmatic descent is common.
- Deep breathing is conducive to good health (e.g., yoga) and various forms of meditation.

Diagram of Spine and Adjoining Skeletal Structures (posterior view)

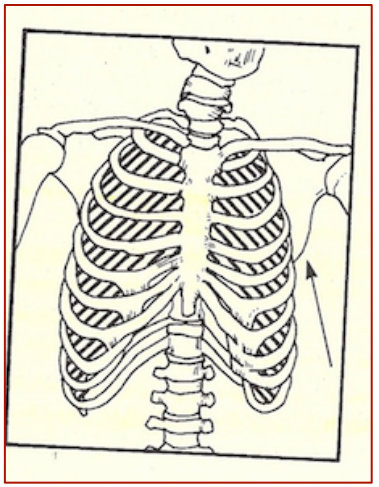
Keep this skeletal image in mind as we discuss the musculature that brings it all together!

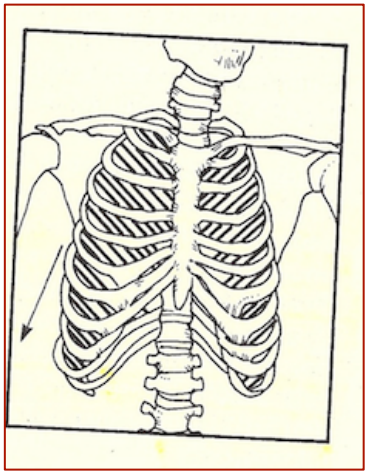


Source: Doscher, *FUSV*, p. 2.

Intercostal Muscles

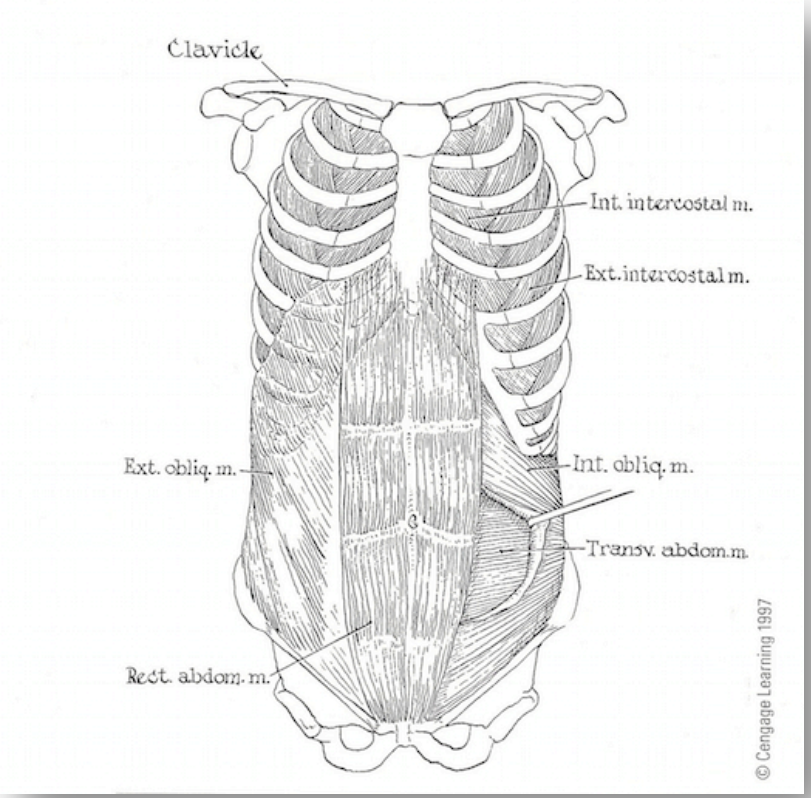
- **External Intercostals**: located between ribs and slanted diagonally downward from the backbone.
  - Help with inhalation.
  - Contraction brings rib cage upward to allow for expansion of thoracic cavity and, acting together with the diaphragm, serve as two basic muscles sources for inhalation.
- **Internal Intercostals:** located between ribs beneath external intercostals
  - Pull ribs inward and downward, contracting thoracic cage to produce exhalation.





Source: Doscher, *FUSV,* p. 12.

Intercostals and Abdominals



Source: Phillips, *TKTS,* p. 148 .

Breath Management
(Need for Support and Control)

- **Quiet breathing:** forces are passive.
- Breathing for singing requires "control" and "management."
- **Exhalation**: support and control of forced *[elongated]* expiration
- **Inhalation:** must be more active to increase diaphragmatic descent and rib expansion
- *[Natural expansion of normal breathing process!]*

Creating Breath Energy

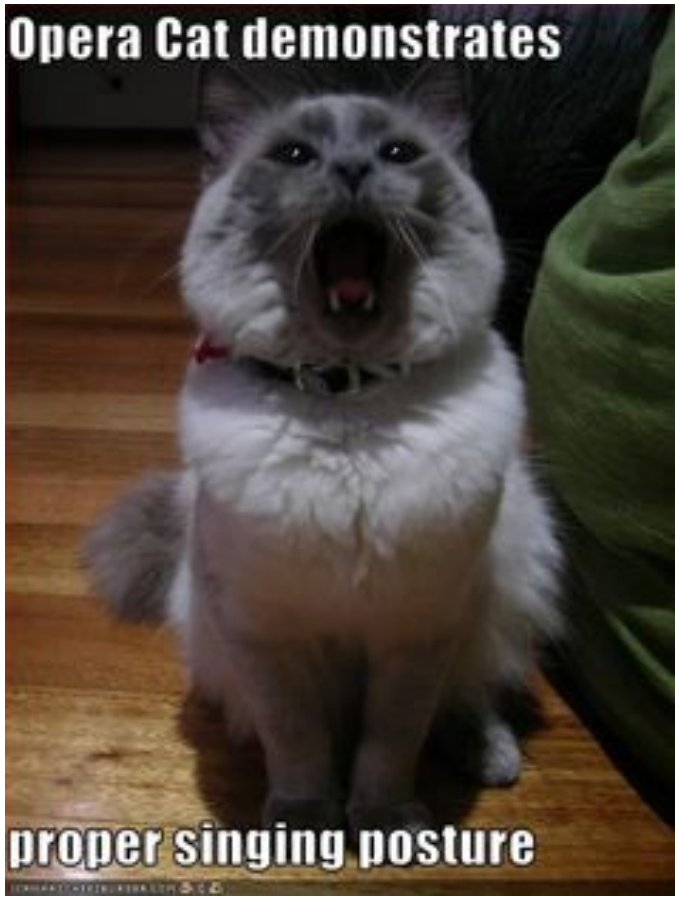
- **Objective:** produce energized air column; the power behind the act of singing
- **Origin:** contraction of abdominals and muscles in lower back
- **Inhalation:** abdominals relax, allowing lungs to be infused deeply with air
- **Exhalation:** abdominals contract upward and inward against the abdominal viscera and diaphragm, creating internal pressure and energized air column that is constant and balanced
- Expansion of waistline vs. elevated sternum/extended rib cage
- "Expand to breathe, not breathe to expand"

Breath Control

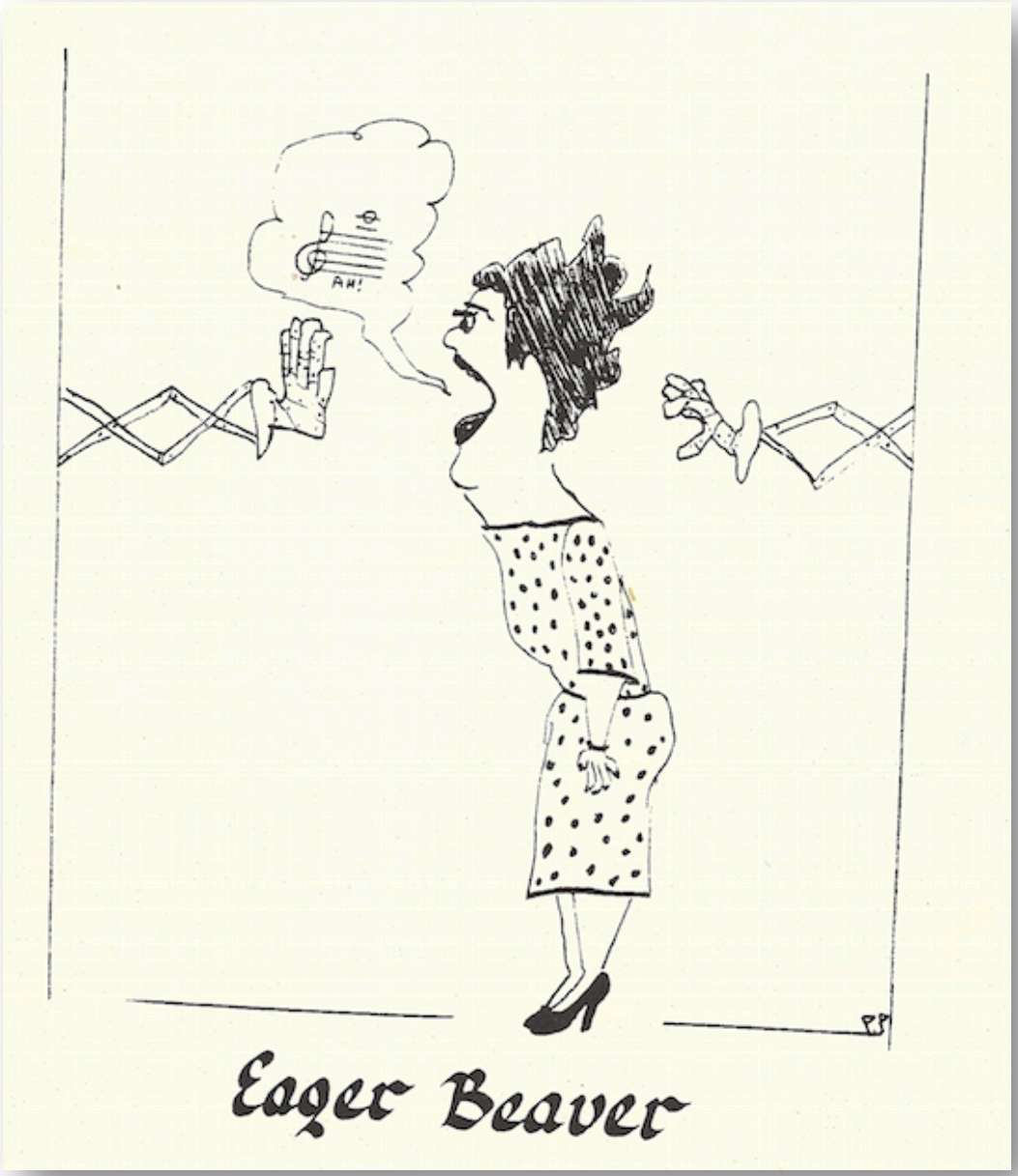
- Slow emission of energized air column
- Major muscle of control is diaphragm; as it relaxes, slowly counteracts internal pressure created by abdominal contraction
- "Balanced resistance" *[antagonism]* between abdominals and slowly relaxing diaphragm is aided by intercostals, which continue to hold ribs out during exhalation.
- By maintaining a smooth application of abdominals up and against diaphragm, a steady stream of pressurized breath creates constant subglottal pressure against the folds. Result: steady pitch.

Posture is Important!

- Remember: diaphragm is an involuntary muscle and must be acted upon during exhalation.
- By maintaining full, upright posture for singing, lower rib line does not collapse, which allows for slow, upward relaxation of the diaphragm.
- Outward expansion of rib cage keeps diaphragm from relaxing too quickly through muscular antagonism.
- This indirect control of the diaphragm is crucial for good breath management.

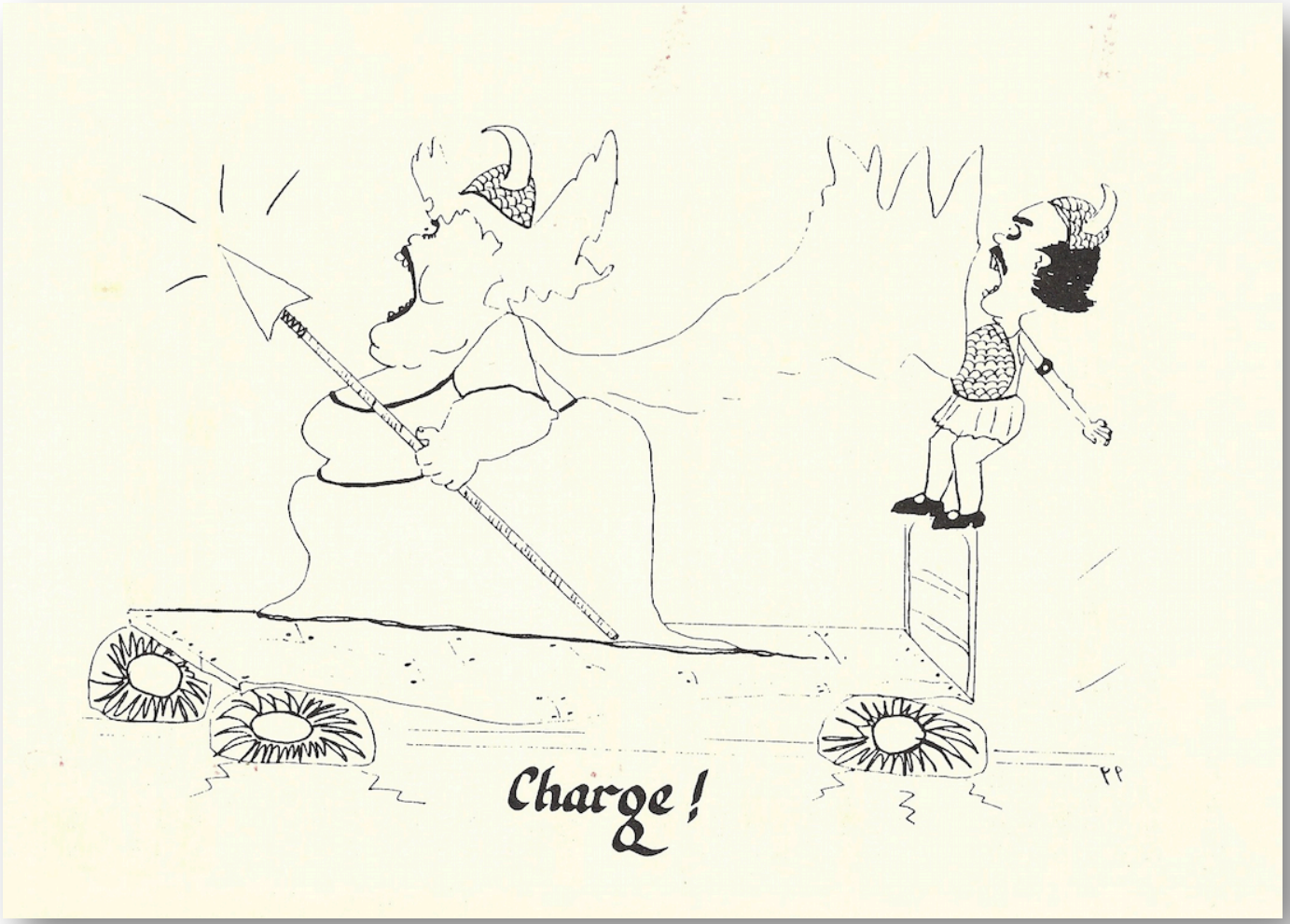


Source: Doscher, *FUSV*, p. 70.



Source: Doscher, *FUSV*, p. 77.

Source: Doscher, *FUSV*, p. 78.



Source: Doscher, *FUSV*, p. 82.

Appoggio

- The amount of air (vital capacity) is less important than how the air column is energized and controlled: it is not how much air is used, but how the air is managed *[in relation to phonation and resonance]* that matters most.

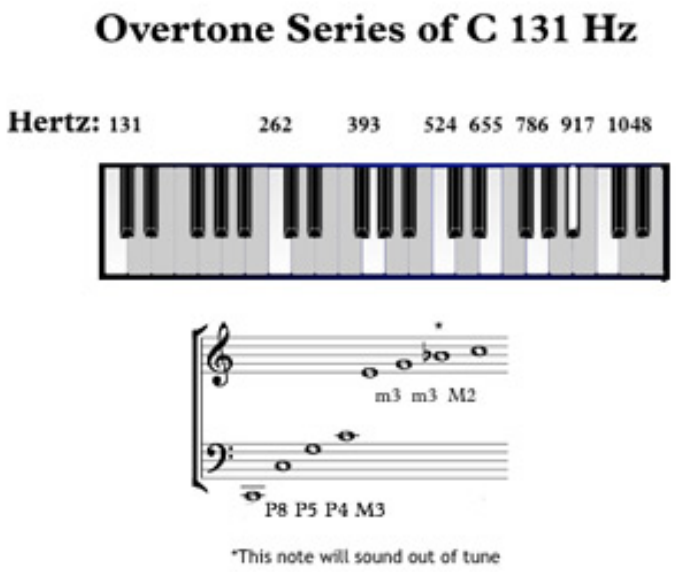
- Favorite description: *In "appoggio" technique, the sternum must initially find a moderately high position; this position is then retained throughout the inspiration-expiration cycle. Shoulder are relaxed, but the sternum never slumps. Because the ribs are attached to the sternum, sternal posture in part determines diaphragmatic position. If the sternum lowers, the ribs cannot maintain an expanded position, and the diaphragm must ascend more rapidly. Both the epigastric and umbilical regions should be stabilized so that a feeling of internal-external muscular balance is present. This sensation directly influences the diaphragm.* [Miller, 1986, p. 24]

“Larry” the Larynx (not “lar-nix”)

- Act of phonation centers on larynx, which sits on top of the trachea (wind pipe) to provide passageway for respiration and to create sound
- Sensitive and delicate area protects vocal folds (or “cords,” but never “chords”)
- Can move up (clearing throat or swallowing) or down (yawning)
- When phonating maintain “at rest” position and avoid raising it or pressing it lower than normal

Vocal Folds, Fundamental Pitch, and Overtones

- Two "sound generators" alternately close and open from air passing between them in exhalation
- Vibrations generate energy in the form of complex sounds waves, which travel through air and are perceived as sound in the form of both pitch and quality
- Rate of vibration expressed in "cycles per second" (cps) or "hertz" (Hz)
- In addition to this fundamental pitch, "overtones" or higher-frequency pitches are also produced that add resonance



Vowel Formants

- In the voice, overtones are called "formants," or frequency "regions" that are not fixed frequencies, as are the overtones produced by musical instruments.
- Each region is a width of frequencies, which permits different voices to blend on any vowel as long as the vowel is shaped in the vocal tract within the range of variation. *[This is why vowel unification is so important to achieve "blend" of ensemble.]*

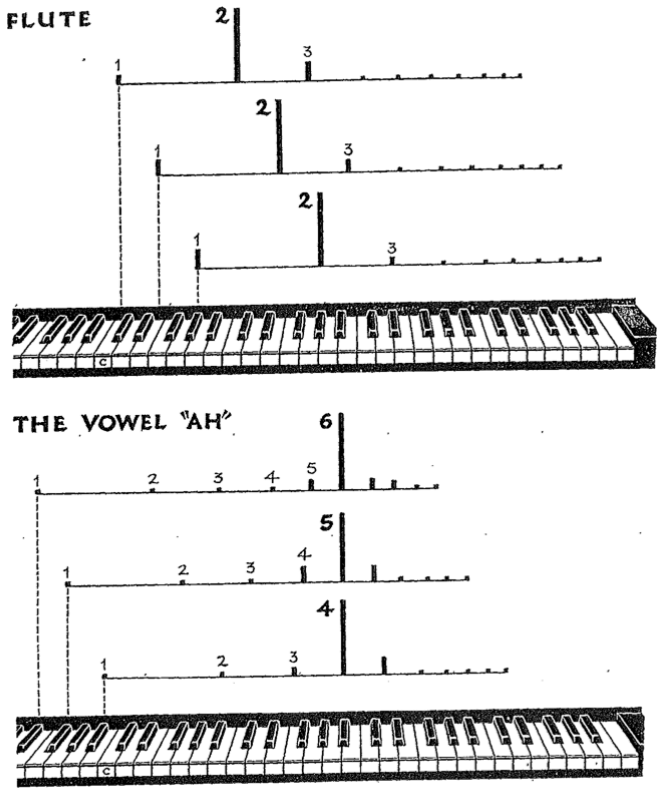
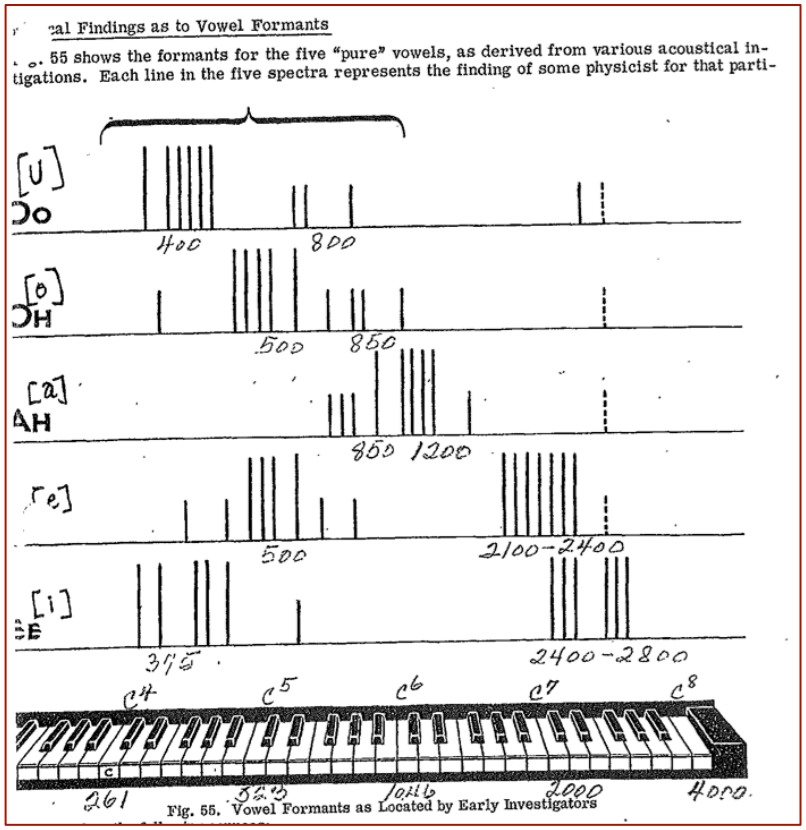
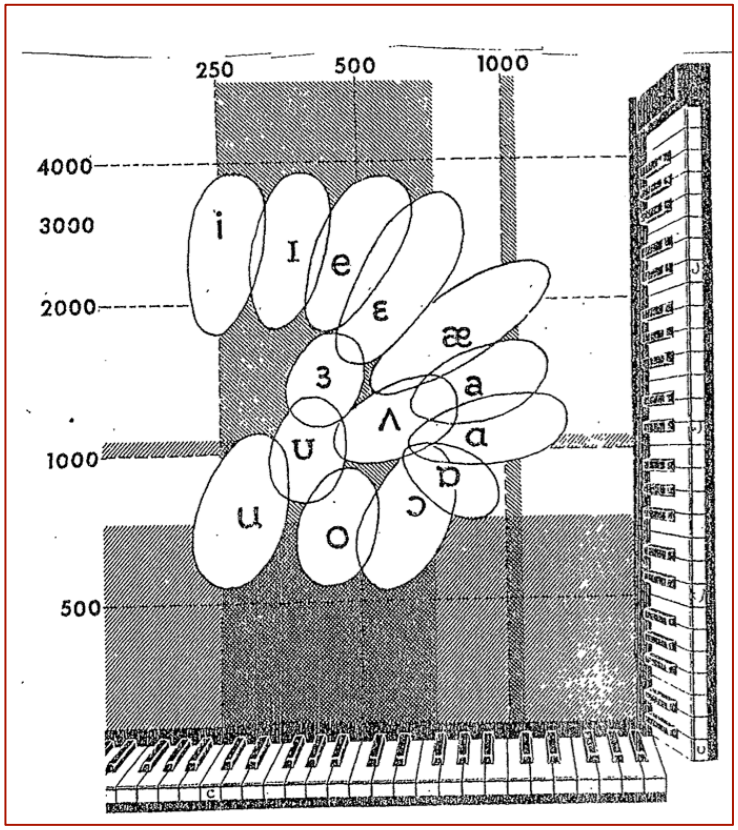


Fig. 54. Spectra of Flute and Vocal Tones
From Dayton C. Miller, *The Science of Musical Sounds*., Copyright, 1916 by the Macmillan Company and used with their permission, p. 256.

Vowels Have Pitch! (Acoustics)

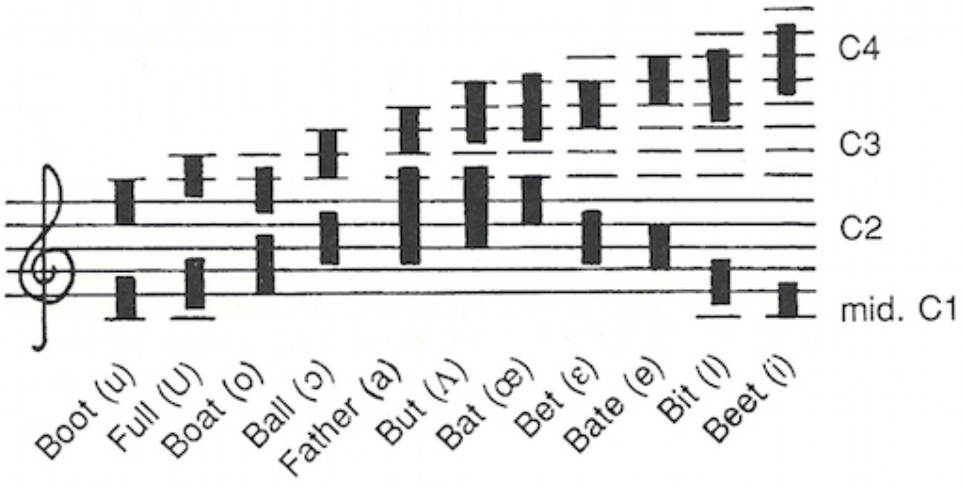




Spectral Analysis showing the formants of five "pure" vowels

The Importance of Tuning Formants

- In choral situations, too much variation in vowel production causes the formant frequencies to "beat" against each other resulting in poor intonation.
- The fundamental frequency generates the most energy and is heard as pitch. Overtones and formants progressively decrease in energy the higher they become.

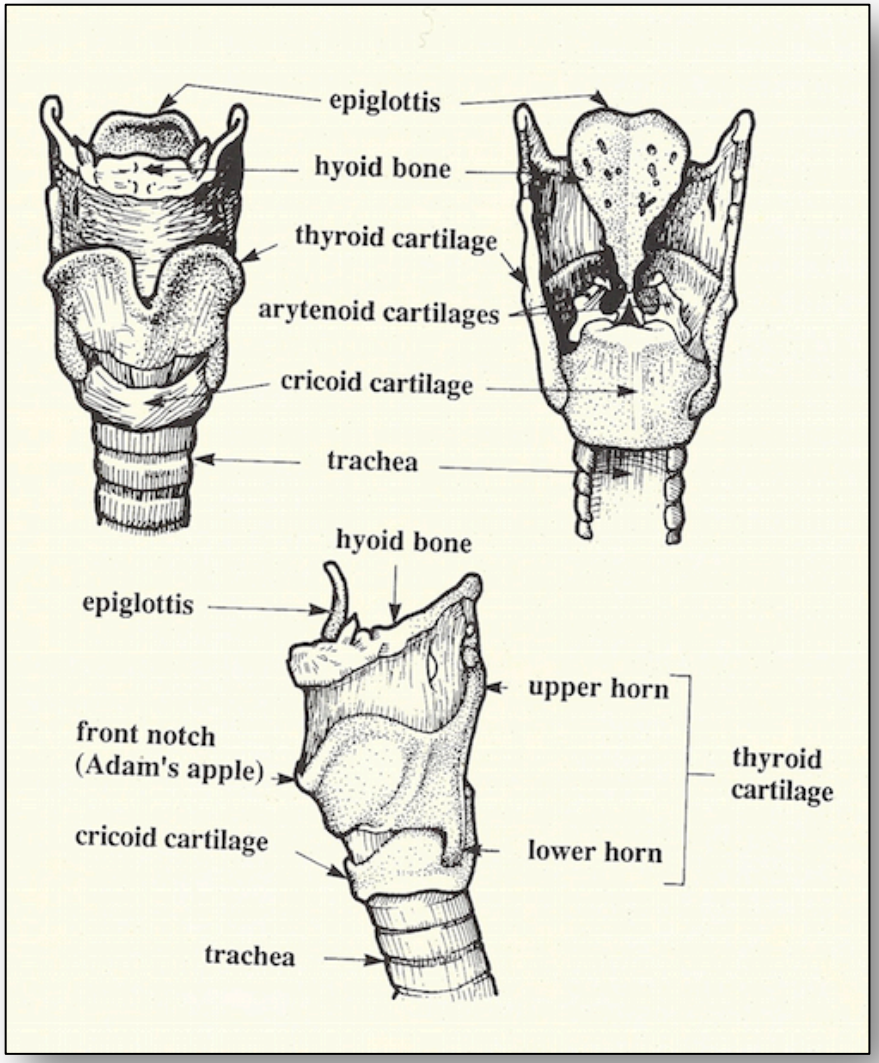


Source: Phillips, *TKTS,* p. 169.

Laryngeal Physiology

- You must have a rudimentary knowledge of basic-sound producing actions of the larynx, the various cartilages, ligaments, and muscles, and how they all interact to produce sound. *[The mechanic (teacher) must know the engine (voice)!]*
- *You should be familiar with the following:*
  - *4 cartilages*
  - *1 bone*
  - *5 intrinsic muscles* *(be able to recognize connections/functions)*
  - *9 extrinsic muscles* *(be able to recognize connections/functions)*

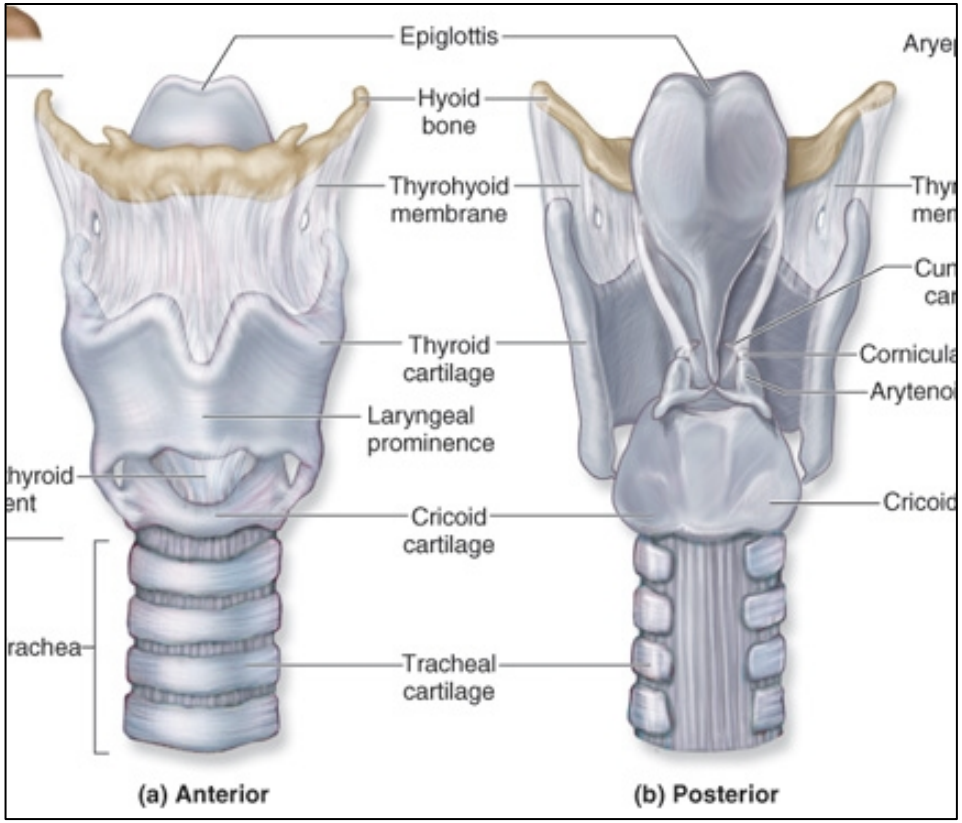
Cartilages of the Larynx



Source: Doscher, *FUSV*, p. 32.

Thyroid and Cricoid Cartilages

- **(1) Thyroid:** largest; shape and size protects other parts from damage; front is "notch" or "Adam's apple"; attached to cricoid; hinge-like interaction between thyroid and cricoid allows rocking movement.
- **(2) Cricoid:** forms a ring that sits on and is attached to top of trachea; surrounded by thyroid (front); wider and taller (rear), so it looks like a signet ring.



Arytenoid Cartilages and Epiglottis

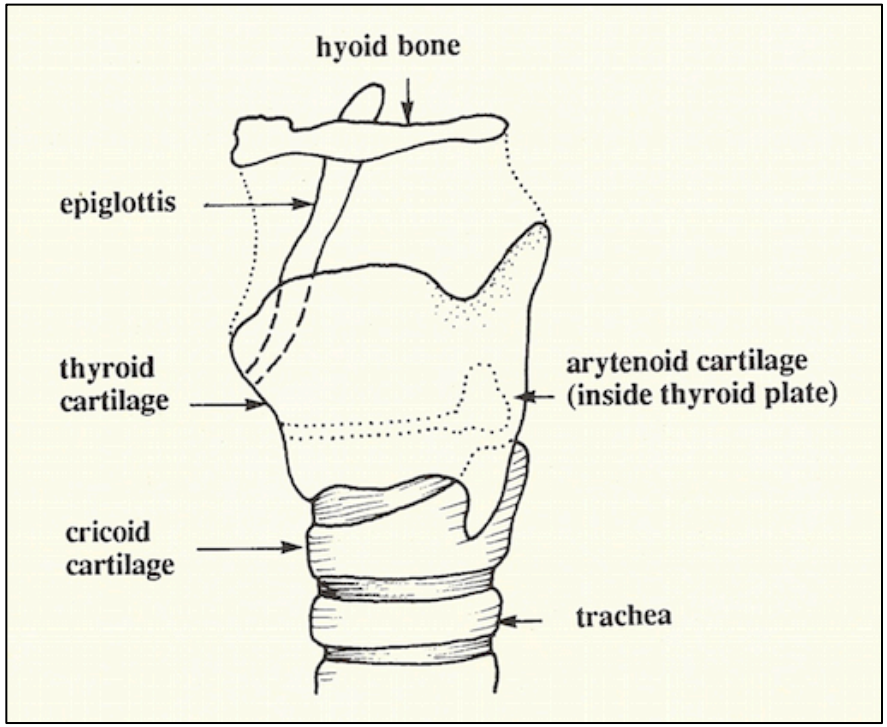
- **(3) Arytenoid Cartilages:** pyramidal in shape and located posteriorly on the top of the cricoid; both rotate and slide from side to side or forward and backward on the cricoid; posterior ends of vocal folds are attached to them.

- **(4) Epiglottis:** cartilage closes off larynx during swallowing; resembles tongue of a shoe; attached at lower end to inside of thyroid and upper end by a ligament to the hyoid bone.

Source: Doscher, *FUSV*, p. 32.

The Hyoid Bone

- Only bone of the larynx; located at the top of the laryngeal structure and attached to the thyroid cartilage by a membrane and the superior cornu
- Only bone in the entire skeletal structure not attached to another bone of the skeletal system.
- Positioning regulator for larynx, along with many other muscles, allowing larynx to move upward or downward to accommodate yawning, swallowing, throat clearing, etc.



Source: Doscher, *FUSV*, p. 54.

Intrinsic Muscles of the Larynx

- Either govern pitch production or open/close vocal folds. Two important sets for pitch:
- **(1) Cricothyroid (CT):** attached to anterior base of cricoid and extend upward to thyroid; primarily pitch-control muscles, lengthening and tensing vocal folds to cause pitch to rise. When contracted, front of cricoid rises and rear portion tilts backward, causing vocal folds to become thinner and increase in tension. Produces upper (CT) register.
- **(2) Thyroarytenoid (TA):** located within vocal folds; attached anteiorly to thyroid notch and posteriorly to arytenoids. Contraction causes folds to shorten and thicken, thus lowering pitch. Reverses the action of cricothyroid and produces lower (TA) register.

Intrinsic Muscles of the Larynx

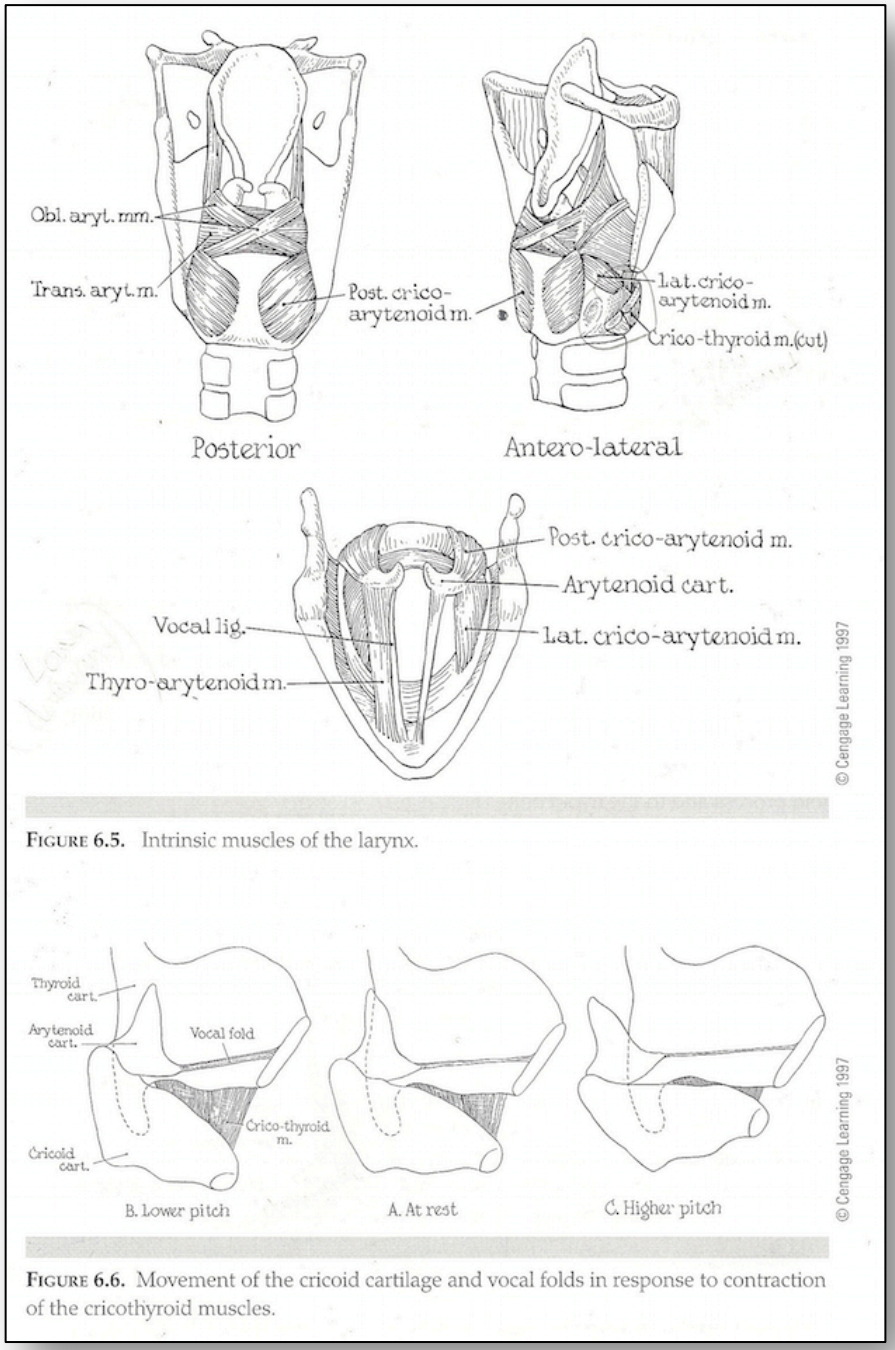


FIGURE 6.5. Intrinsic muscles of the larynx.

FIGURE 6.6. Movement of the cricoid cartilage and vocal folds in response to contraction of the cricothyroid muscles.

Source: Phillips, *TKTS*, p. 159.

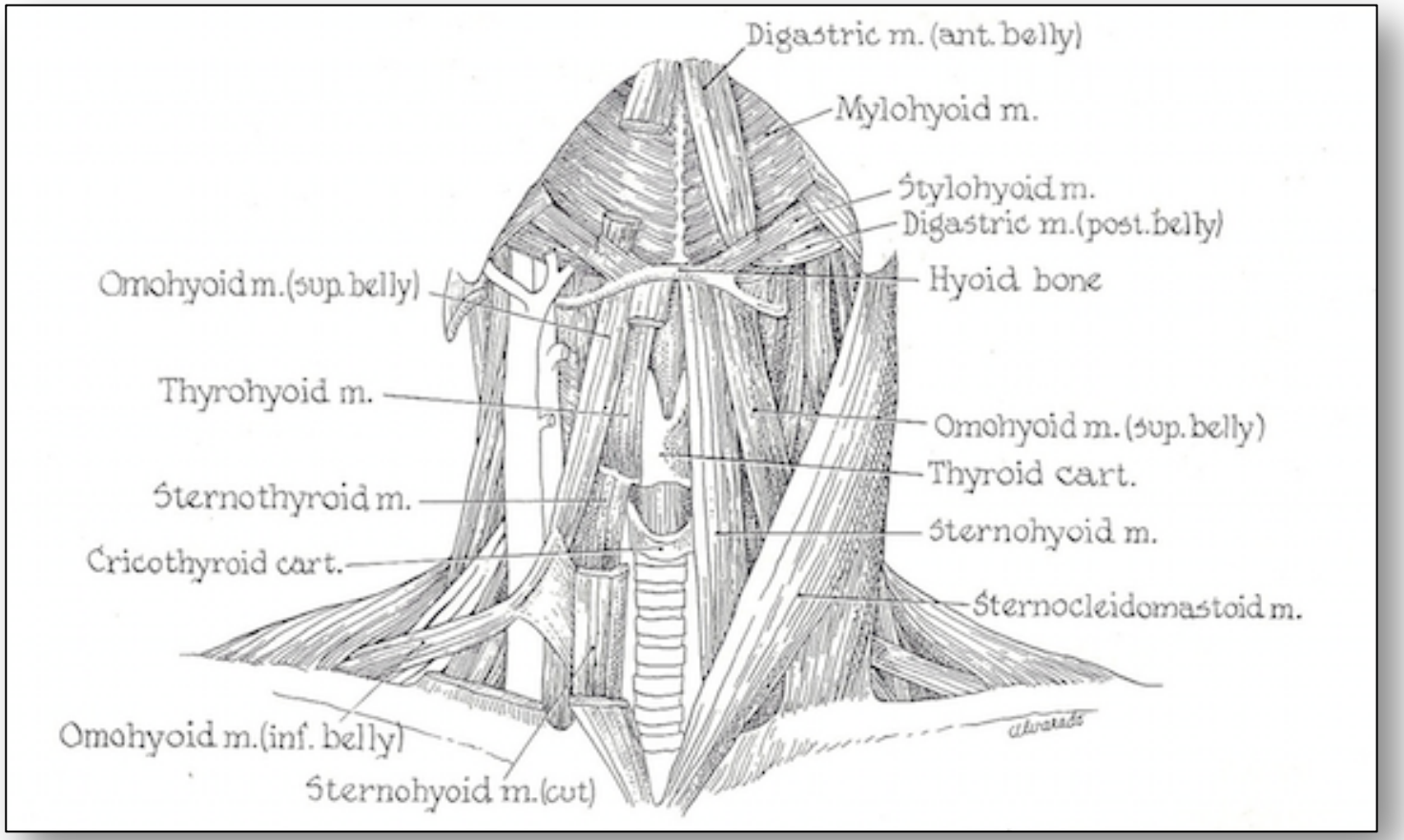
Intrinsic Muscles (cont'd)

- **(3) Lateral Cricoarytenoids:** attached from the cricoid arch and extend laterally, attaching to the aryntenoid cartilages. Upon contraction, hold the vocal folds together (adduction).
- **(4) Interarytenoids:** attach between arytenoids and, upon contraction, hold the vocal folds together. Aided by cricothyroid and lateral cricoarytenoids.
- **(5) Posterior Cricoarytenoids:** attach to back of cricoid and extend upward to arytenoids. Contraction moves vocal folds apart (abduction) for normal respiration. Opening between two vocal folds in this position is called the glottis.

Extrinsic Muscles of the Larynx

- Located outside the larynx itself, but are attached between it and some other part of the anatomy.
- Swallowing muscles, when contracted, govern movement of the larynx and should NOT be used directly in singing; source of much vocal tract tension.
- Important to relax these muscles *[and DEACTIVATE those above the hyoid bone called "false elevators"]*.

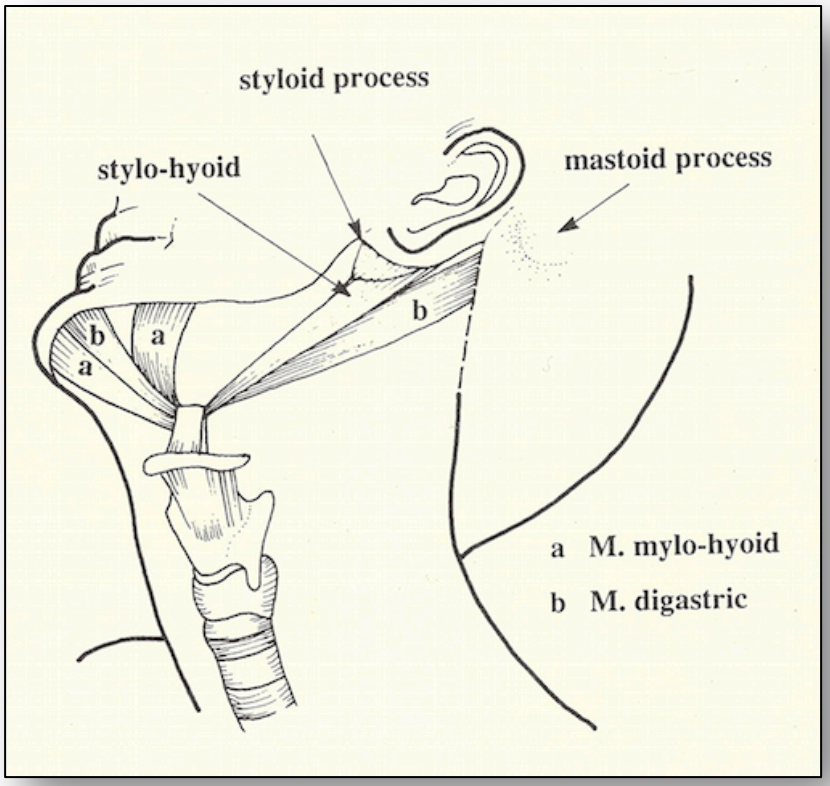
Extrinsic Muscles: Suspensory Network



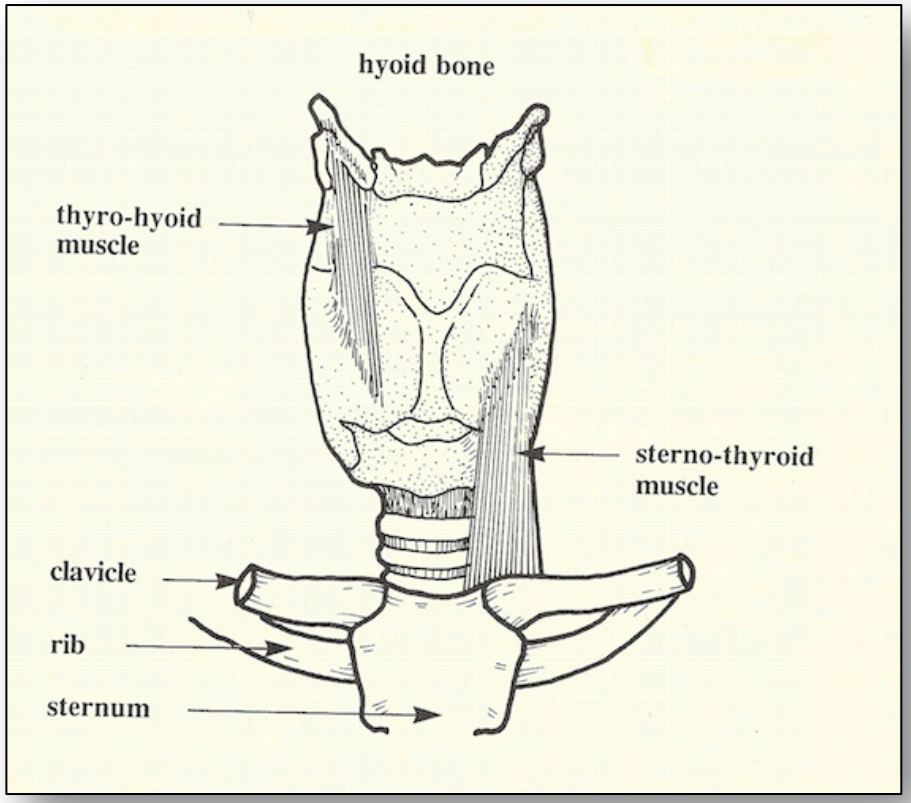
Source: Phillips, *TKTS*, p. 160.

False Elevators & Antagonistic Extrinsic Muscles

Source: Doscher, *FUSV*, pp. 46-47.



False Elevators to be DEACTIVATED



Primary antagonists: Sterno-thyroid depressor and the thyro-hyoid elevator

The Vocal Folds

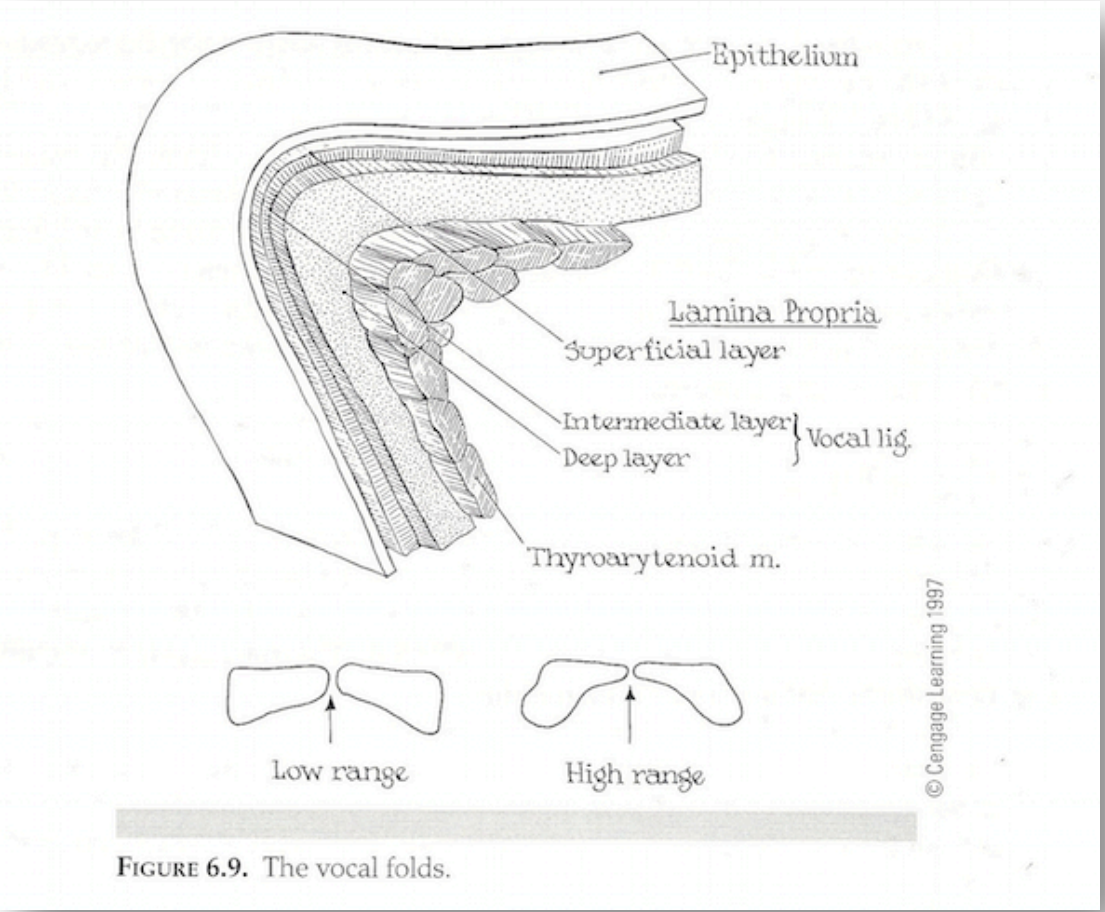


FIGURE 6.9. The vocal folds.

Source: Phillips, *TKTS*, p. 162 .

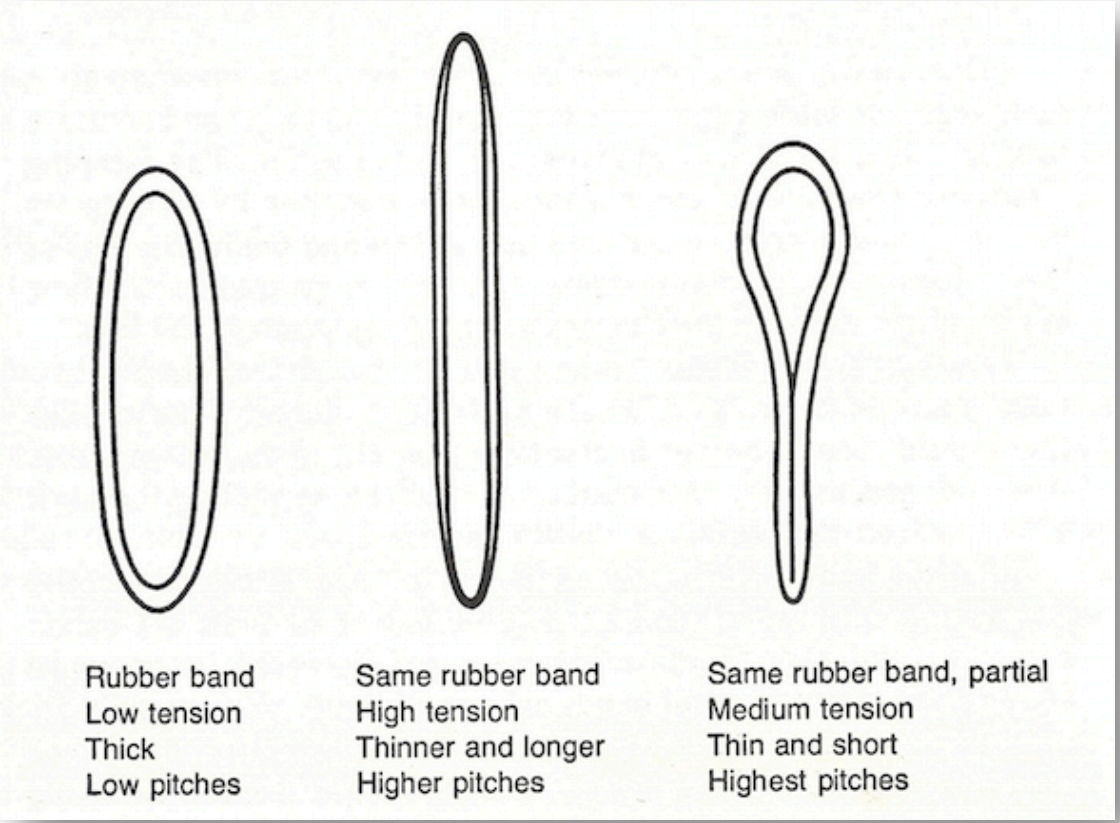
The Vocal Folds: Action

- Two vocal folds are source of vibrations for sound.
- Pyramidal in shape, quite small, capable of rapid changes of thickness, length, and tension.
- When brought together for phonation, pressure of expired air forces them apart; almost immediately the mechanical properties of the folds and air passing between them draws them back together (Bernoulli effect).

The Vocal Folds: Pitch

- When inner portions vibrate, upper voice (CT) is produced.
- As folds shorten with contraction of TA muscles, vibrations spread laterally to include more of the fold; pitch is lowered.
- When full width of folds is set into vibration, the lower, or chest voice, is produced.
- Bringing folds together at beginning is called the "stroke of the glottis," which is preferred to "shock of glottis" (hard glottal attack).

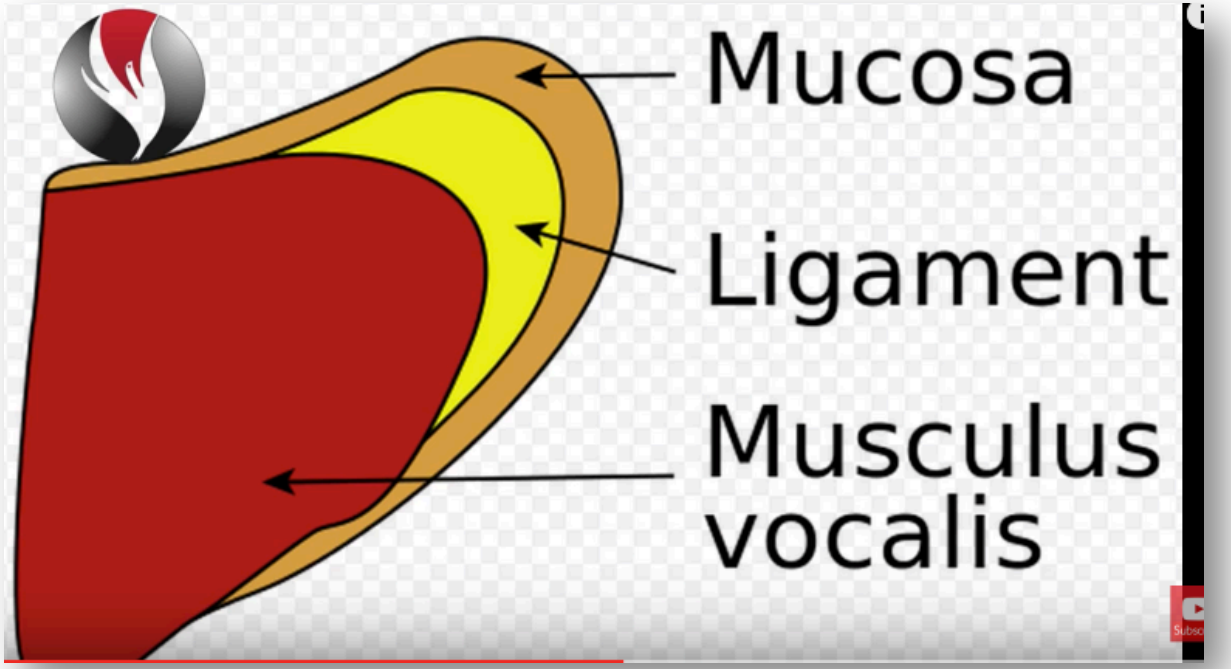
Rubber Band Analogy



Source: Alderson, *CHVT*, p. 63.

Video: Singing Basics: How do Vocal Cords Work?

- https://youtu.be/P2pLJfWUjc8



Source: powertosing.com