MEDICAL EDUCATION RESOURCE

Larynx

Larynx – Introduction

- The **larynx** (voice box) is a **part of the respiratory system** located in the anterior midline of the neck.
- It serves as a **passage for air**, a **sphincter** at the inlet of the lower respiratory tract, and is the **organ of phonation**.
- It lies opposite **C3 to C6 vertebrae** in adults; slightly higher (C1–C4) in children and females.
- **Length:** 44 mm in males, 36 mm in females.
- **Pubertal change:** The male larynx enlarges rapidly, forming the **Adam's apple** and producing a **deeper voice**.
- **Internal diameter:** 3 mm in infants, 12 mm in adults.

Constitution of Larynx

The larynx consists of:

- **Framework:** 9 cartilages (3 unpaired + 3 paired).
- **Connections:** Joints, ligaments, and membranes linking the cartilages.
- **Muscles:** Intrinsic and extrinsic muscles that move the cartilages.

- **Lining:** Entire cavity covered by **mucous membrane**.

Dissection Steps

1. Identify **sternothyroid** and **thyrohyoid** muscles.
2. Locate **thyrohyoid membrane**, pierced by **superior laryngeal vessels** and **internal laryngeal nerve**.
3. Note **cricothyroid muscle** externally — the only intrinsic muscle visible from outside.
4. Observe the **cricothyroid joint** between the **inferior horn of thyroid cartilage** and **cricoid cartilage**.
5. Identify **epiglottis**, **thyroepiglottic** and **hyoepiglottic ligaments**.
6. Expose **posterior cricoarytenoid**, **transverse arytenoid**, and **oblique arytenoid** muscles.
7. Recognize that **recurrent laryngeal nerve** enters the larynx deep to **inferior constrictor muscle**.

Cartilages of Larynx

Total 9 Cartilages:

- **Unpaired (3):**
    1. **Thyroid cartilage** – shield-shaped, forms laryngeal prominence.
    2. **Cricoid cartilage** – ring-shaped, complete circular cartilage at base of larynx.

3. **Epiglottis** – leaf-shaped, acts as a lid over the glottis during swallowing.

- **Paired (3):**

1. **Arytenoid** – pyramid-shaped, attached to vocal cords; control movements for phonation.

2. **Corniculate** – small conical nodules on the apices of arytenoids.

3. **Cuneiform** – small rod-like cartilages within aryepiglottic folds.

Key Points:

- **Hyaline cartilage:** Thyroid, cricoid, and base of arytenoids; may ossify after age 25.
- **Elastic cartilage:** Epiglottis, corniculate, cuneiform, and processes of arytenoid; do not ossify.

Laryngeal Joints

1. **Cricothyroid Joint**
    - **Type:** Synovial joint.
    - **Between:** Inferior cornu of thyroid cartilage and side of cricoid cartilage.
    - **Movements:**
        - Rotation around a transverse axis ? *tension and relaxation of vocal cords.*
        - Slight gliding movements also occur.

- **Function:** Adjusts pitch by stretching or relaxing vocal cords.

2. **Cricoarytenoid Joint**
   - **Type:** Synovial joint.
   - **Between:** Base of arytenoid cartilage and upper border of cricoid lamina.
   - **Movements:**
     - Rotation around a vertical axis ? *adduction and abduction of vocal cords.*
     - Gliding movements in all directions.
   - **Function:** Controls opening and closing of the glottis.

Laryngeal Ligaments and Membranes

A. Extrinsic Ligaments

1. **Thyrohyoid membrane** – between thyroid cartilage and hyoid bone; pierced by **internal laryngeal nerve** and **superior laryngeal vessels**.
2. **Hyoepiglottic ligament** – connects upper end of epiglottis to hyoid bone.
3. **Cricotracheal ligament** – connects lower border of cricoid cartilage to first tracheal ring.

B. Intrinsic Ligaments

- Formed by **fibroelastic membrane of larynx** divided by the sinus into two parts:
  1. **Quadrate membrane (upper part):**

- Extends from arytenoid cartilage to epiglottis.
- Upper border ? **aryepiglottic fold.**
- Lower border ? **vestibular fold.**

2. **Conus elasticus (lower part):**
    - Extends upward and medially from arch of cricoid cartilage.
    - Anterior thickened part ? **cricothyroid ligament.**
    - Upper free border ? **vocal fold (true vocal cord).**

Cavity of Larynx

1. **Extent:** From the **laryngeal inlet** to the **lower border of cricoid cartilage.**
2. **Laryngeal inlet:**
    - Opens upward and backward into the **laryngopharynx.**
    - **Boundaries:**
        - Anterior – epiglottis
        - Posterior – interarytenoid fold
        - Lateral – aryepiglottic folds
3. **Subdivisions of cavity:**

- **Vestibule (supraglottis):** Above vestibular folds.
- **Sinus or ventricle:** Between vestibular and vocal folds.
- **Infraglottic cavity:** Below the vocal folds.

4. **Rima glottidis (glottic chink):**
   - Opening between vocal folds; narrowest part of the larynx.
   - Divided into:
     - *Intermembranous part (3/5)* – between vocal folds.
     - *Intercartilaginous part (2/5)* – between arytenoid cartilages.
   - **Length:** ~23 mm in males; 17 mm in females.
5. **Saccule of the larynx:**
   - Upward extension of the ventricle; lined with mucous glands that **lubricate vocal cords** ("oil can of the larynx").

Mucous Membrane of the Larynx

- **Lining epithelium:**
  - **Stratified squamous epithelium:** Over epiglottis (anterior surface), upper part of aryepiglottic folds, and vocal folds.
  - **Ciliated columnar epithelium:** Remainder of laryngeal cavity.

- **Attachment:** Loosely attached except over **vocal cords** and **posterior surface of epiglottis**, where it is tightly adherent.
- **Mucous glands:**
    - Absent over vocal cords.
    - Abundant over epiglottis, vestibular folds, and near cuneiform cartilages.

Clinical Anatomy

- **Foreign body aspiration:** Most foreign bodies lodge in the **glottis** — the narrowest part of airway.
- **Laryngitis:** Inflammation of mucosa ? **hoarseness** of voice.
- **Laryngeal oedema:** Can obstruct airway; may result from infection or allergy.
- **Singer's / Teacher's nodules:** Small nodules at junction of anterior one-third and posterior two-thirds of vocal cords due to overuse.
- **Piriform fossa:** Lies between quadrate membrane and thyroid cartilage; pierced by **internal laryngeal nerve** — accidental injury can cause loss of sensation in upper larynx.
- **Referred ear pain:** Laryngeal tumours can cause ear pain via **auricular branch of vagus nerve.**
- **Foreign bodies:**
    - Large ? may cause suffocation by blocking the inlet.

- Small ? may lodge in ventricle and trigger **reflex glottic closure.**

- **Smuggler's fossa:** Piriform fossa historically used to hide small objects like gems.

- **Laryngoscopy:**

  - *Indirect laryngoscopy:* Mirror examination.

  - *Fibreoptic laryngoscopy:* Under local anaesthesia for visualization.

  - *Microlaryngoscopy:* Under microscope to excise vocal cord lesions.

Intrinsic Muscles of the Larynx

Nerve supply

- All intrinsic muscles are supplied by the **recurrent laryngeal nerve**, **except** the **cricothyroid**, which is supplied by the **external laryngeal nerve**.

Muscles Acting on the Vocal Cords

FUNCTION	MUSCLES INVOLVED	KEY ACTIONS
Abductor	**Posterior cricoarytenoid**	Opens the rima glottidis by rotating the arytenoid cartilage laterally; called the **"safety muscle of larynx."**
Adductors	**Lateral cricoarytenoid**, **Transverse arytenoid**, **Oblique arytenoid**	Close the glottis by bringing vocal cords together for phonation and cough reflex.

FUNCTION	MUSCLES INVOLVED	KEY ACTIONS
Tensors	**Cricothyroid**	Rocks thyroid cartilage forward and downward, tightening and elongating the vocal cords to raise pitch.
Relaxors	**Thyroarytenoid**, **Vocalis**	Pull arytenoid cartilage forward, shortening and relaxing the cords to lower pitch.

Muscles Acting on the Laryngeal Inlet

FUNCTION	MUSCLES INVOLVED	DESCRIPTION
Close inlet	**Aryepiglottic**, **Oblique arytenoid**	Approximate arytenoids and pull epiglottis backward to close the laryngeal inlet during swallowing.
Open inlet	**Thyroepiglottic**	Widens inlet by pulling epiglottis forward after swallowing.

Muscles Elevating or Depressing the Larynx

MOVEMENT	MUSCLES
Elevation	Thyrohyoid, mylohyoid
Depression	Sternothyroid, sternohyoid

Clinical Anatomy

- **Foreign body reflex:** Entry of a foreign body into the larynx elicits **violent cough**; loss of internal laryngeal nerve function abolishes this reflex ? foreign bodies may enter silently.
- **External laryngeal nerve injury:** Causes **weakness of phonation** due to paralysis of cricothyroid ? inability to tense the vocal cords (monotone voice).
- **Unilateral recurrent laryngeal nerve injury:** Vocal cord on the affected side lies **paramedian**; phonation possible but **voice hoarse**, and cough is weak.
- **Bilateral recurrent laryngeal nerve injury:** Both cords fixed in **cadaveric position** (half-open) ? **aphonia** and **respiratory difficulty**.
- **Carcinoma of glottis:** Spreads slowly because the **vocal cords lack lymphatics** — hence best prognosis.
- **Supraglottic or subglottic carcinoma:** Spread occurs via lymphatics to **deep cervical nodes** along superior and inferior thyroid vessels.

Movements of Vocal Folds

Movements of the vocal folds determine the **shape and size of the rima glottidis** (the space between them):

1. **Quiet Breathing (Rest):**
    - Intermembranous part ? *triangular*
    - Intercartilaginous part ? *quadrangular*
    - Glottis partially open.
2. **Phonation (Speech):**

- Vocal folds are **adducted**, reducing the glottis to a narrow slit (*chink*).
- Air passing through produces sound vibrations.

3. **Forced Inspiration:**
   - Both parts of rima are **triangular**.
   - Glottis becomes **lozenge- or diamond-shaped** due to full abduction of vocal folds.
4. **Whispering:**
   - Intermembranous part is **closed**, but intercartilaginous part remains **open**.
   - Results in a **funnel-shaped glottis**.

Infant’s Larynx

- **Shape:** Short and **funnel-shaped**.
- **Size:** About **one-third** that of an adult.
- **Lumen:** Very narrow ? prone to obstruction.
- **Position:** Higher in neck — opposite **C1–C4** vertebrae (compared to C3–C6 in adults).
- **Epiglottis:** At level of **C2**, reaches **C1** during elevation, enabling **simultaneous suckling and breathing**.
- **Cartilages:** Soft and pliable; thyroid cartilage short and broad.
- **Vocal cords:** 4–4.5 mm long (shorter than in adults).

- **Mucosa:** Lax, especially in supraglottic and subglottic areas — oedema may cause **respiratory distress**.
- **Clinical Note:** Extreme care is needed during **anaesthesia** in infants due to narrow airway

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Mechanism of Speech

Speech production involves **four coordinated components**:

1. **Expired Air (Energy Source):**
   - Expelled air from lungs and larynx generates voice.
   - **Loudness** depends on the **force of expiration**.
2. **Vibrators (Sound Generators):**
   - Vocal cords vibrate as air passes through.
   - **Pitch** depends on the **rate of vibration** — controlled by cord tension and length.
   - **Vowels** are produced mainly by these vibrations.
3. **Resonators (Quality Modifiers):**
   - Air columns between vocal cords, mouth, and nasal cavity amplify and modify tone.
   - Quality of voice depends on resonating chambers — explains why voices sound distinct.

4. **Articulators (Speech Formers):**
    - Include **palate, tongue, teeth, and lips.**
    - They shape airflow into distinct sounds.
    - **Vowels** – from vocal cord vibration.
    - **Consonants** – by modifying or obstructing airflow via articulators.

Examples:

- **Labial sounds:** Pa, Pha, Ba, Bha, Ma
- **Labiodental:** Ta, Tha, Da, Dha, Na
- **Lingual:** Cha, Ja, Jha
- **Palatal:** Ka, Kha, Ga, Gha

Clinicoanatomical Problem

A patient presents with **severe infection of the larynx** and **high fever**, followed by **inability to speak or breathe**.

Question:
Which muscles are likely paralyzed, causing extreme difficulty in breathing?

Answer:

- The infection has affected the **branches of the recurrent laryngeal nerve** supplying the **posterior cricoarytenoid muscles**.

- These are the **only abductors of the vocal cords**.
- When they are paralyzed, the **vocal cords remain adducted**, leading to **airway obstruction** and **severe respiratory distress**.
- **Treatment:** If infection does not resolve promptly, **tracheostomy** may be necessary to restore breathing.

Summary of Laryngeal Muscle Actions

- **Abduction of vocal cords:** Posterior cricoarytenoid
- **Adduction of vocal cords:** Lateral cricoarytenoid, transverse arytenoid, oblique arytenoid
- **Opening of laryngeal inlet:** Thyroepiglottic
- **Closing of laryngeal inlet:** Aryepiglottic
- **Tensing of vocal cords:** Cricothyroid
- **Relaxing of vocal cords:** Thyroarytenoid

Clinicoanatomical Problem 1: Recurrent Laryngeal Nerve Injury

Case:
A thyroidectomy patient complains of a **hoarse voice** and **weak cough** post-surgery.

Explanation:

- The **recurrent laryngeal nerve** (branch of vagus) may have been injured.

- It supplies **all intrinsic muscles** of the larynx except **cricothyroid**.
- Paralysis leads to the **vocal cord resting in a paramedian position**, causing **hoarseness**.
- Bilateral injury results in **airway obstruction** requiring **tracheostomy**.

Clinicoanatomical Problem 2: External Laryngeal Nerve Injury

Case:
A singer experiences **monotone voice** after ligation of the **superior thyroid artery** during surgery.

Explanation:

- The **external laryngeal nerve**, which runs with the **superior thyroid artery**, supplies **cricothyroid**.
- Its injury prevents **tensing of vocal cords**, resulting in **loss of pitch modulation** and a **monotone voice**.

Clinicoanatomical Problem 3: Laryngeal Oedema

Case:
A child with upper respiratory infection suddenly develops **stridor and difficulty breathing**.

Explanation:

- Due to the **narrow lumen** and **loose submucosa** in the **subglottic region**, oedema can **quickly occlude the airway**.
- This is an emergency requiring **tracheostomy or intubation**.

Clinicoanatomical Problem 4: Laryngeal Papilloma

Case:
A young child develops **recurrent hoarseness and voice loss**.

Explanation:

- Caused by **Human Papillomavirus (HPV)** infection forming **benign papillomas** on the vocal cords.
- The lesion interferes with vibration and may cause **airway obstruction** if large.
- Treated by **microlaryngoscopic removal**.

Clinicoanatomical Problem 5: Carcinoma of the Larynx

Case:
An elderly man with long-term smoking presents with **persistent hoarseness** and **referred ear pain**.

Explanation:

- Commonly arises from **glottic region**.
- The **auricular branch of vagus nerve** conveys referred pain to the **ear**.
- **Early hoarseness** is an initial symptom; later, tumour may cause **airway compromise** or **lymph node spread**.

Clinicoanatomical Problem 6: Foreign Body in Larynx

Case:
A fishbone accidentally enters the throat and the patient feels **sharp pain and choking sensation**.

Explanation:

- Fishbones can lodge in the **vallecula** or **piriform fossa**.
- The **internal laryngeal nerve** supplies mucosa of the larynx above the vocal cords; irritation causes **violent cough**.
- Removal is done under **laryngoscopic guidance**.

Frequently Asked Questions

1. What are the functions of the larynx?

- Acts as an **air passage**.
- **Protects lower respiratory tract** during swallowing.
- **Produces voice (phonation)**.
- Helps in **cough reflex** and **respiratory control**.

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2. What are the cartilages of the larynx?

- **Unpaired:** Thyroid, Cricoid, Epiglottis.
- **Paired:** Arytenoid, Corniculate, Cuneiform.

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3. Which are the synovial joints of the larynx?

- **Cricothyroid joint** and **cricoarytenoid joint**.

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4. Which intrinsic muscle is visible from the exterior of the larynx?

- **Cricothyroid muscle.**

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5. Which muscle is the only abductor of the vocal cords?

- **Posterior cricoarytenoid** — also known as the **safety muscle of the larynx**.

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6. Which muscle is supplied by the external laryngeal nerve?

- **Cricothyroid** (all others are by recurrent laryngeal nerve).

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7. What is the narrowest part of the larynx in adults and children?

- **Adults:** Rima glottidis.
- **Children:** Below vocal cords (subglottic region).

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8. What type of epithelium lines the vocal cords?

- **Stratified squamous epithelium.**

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9. What is the extent of the larynx in adults?

- From **C3 to C6 vertebrae**.

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10. Which structure pierces the thyrohyoid membrane?

- **Internal laryngeal nerve** and **superior laryngeal vessels.**

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11. What is the function of the cricothyroid joint?

- Allows **rotation and gliding**, adjusting **tension of vocal cords** (modulating pitch).

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12. Which muscle acts as a tensor of the vocal cords?

- **Cricothyroid.**

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13. Which muscle acts as a relaxer of vocal cords?

- **Thyroarytenoid (including vocalis).**

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14. What is the rima glottidis?

- The **opening between the two vocal folds**, the narrowest part of the larynx.

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15. What happens in whispering?

- **Intermembranous part** of glottis is closed, **intercartilaginous part** remains open.

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16. What causes hoarseness of voice?

- **Laryngitis**, **vocal cord nodules**, or **recurrent laryngeal nerve paralysis**.

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17. Why is the larynx called the “sphincter of the air passage”?

- It **closes during swallowing** to prevent aspiration into the trachea.

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18. Why does carcinoma of the glottis spread slowly?

- Because the **vocal cords lack lymphatic drainage**, delaying metastasis.

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19. What is the shape of the infant larynx?

- **Short and funnel-shaped**, lying higher (C1–C4) than in adults.

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20. Which nerve carries sensation above and below the vocal cords?

- **Above cords:** Internal laryngeal nerve.
- **Below cords:** Recurrent laryngeal nerve.

Multiple Choice Questions

1. Which histological type of cartilage forms the **epiglottis**?
a. Fibrous
b. Elastic
c. Hyaline
d. Fibroelastic
? Answer: b. Elastic

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2. Which is the **only abductor muscle** of the vocal cords?
a. Lateral cricoarytenoid
b. Thyroarytenoid
c. Posterior cricoarytenoid
d. Thyroepiglottic
? Answer: c. Posterior cricoarytenoid

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3. The **recurrent laryngeal nerve** supplies all intrinsic muscles **except**:
a. Posterior cricoarytenoid
b. Oblique arytenoid
c. Lateral cricoarytenoid
d. Cricothyroid
? Answer: d. Cricothyroid

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4. The **angle** between the anterior borders of thyroid laminae in adult males is approximately:

a. 90°

b. 100°

c. 80°

d. 120°

? Answer: a. 90°

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5. Which of the following muscles is **not inserted** into the posterior border of the thyroid cartilage?

a. Palatopharyngeus

b. Salpingopharyngeus

c. Stylopharyngeus

d. Levator veli palatini

? Answer: d. Levator veli palatini

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6. Which muscle is **not attached** to the cricoid cartilage?

a. Cricothyroid

b. Oblique arytenoid

c. Lateral cricoarytenoid

d. Posterior cricoarytenoid

? Answer: b. Oblique arytenoid

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7. Which muscle is called the **“safety muscle” of the larynx**?

a. Lateral cricoarytenoid

b. Posterior cricoarytenoid

c. Oblique arytenoid

d. Transverse arytenoid

? Answer: b. Posterior cricoarytenoid

Short Notes / Structured Questions Commonly Asked:

1. Describe the **intrinsic muscles of the larynx** and their **clinical significance**.

2. Mention the **structures attached** to various parts of the **thyroid cartilage**.
3. Write short notes on:
    - Rima glottidis
    - Epiglottis
    - Cricoid cartilage
    - Vocal folds
    - Pyriform fossa

Additional Viva-Style Objective Points

- What is the **angle** of thyroid laminae in females? ? About **120°**.
- Name the **muscles attached** to the posterior border of thyroid cartilage. ? **Palatopharyngeus**, **Stylopharyngeus**, and **Salpingopharyngeus**.
- Which muscle **opens** the laryngeal inlet? ? **Thyroepiglottic**.
- Which muscles **close** the laryngeal inlet? ? **Aryepiglottic** and **Oblique arytenoid**.
- What is the **epithelium** over the vocal cords? ? **Stratified squamous epithelium**.
- Which nerve provides **sensation above and below** the vocal cords?
    - Above ? **Internal laryngeal nerve**
    - Below ? **Recurrent laryngeal nerve**

Viva Voce – Larynx

1. What are the paired and unpaired cartilages of the larynx?

- *Paired:* Arytenoid, Corniculate, Cuneiform
- *Unpaired:* Thyroid, Cricoid, Epiglottis

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2. Which laryngeal joint allows change in pitch of voice?

- **Cricothyroid joint** (tenses the vocal cords)

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3. Which muscle is supplied by the external laryngeal nerve?

- **Cricothyroid**

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4. Which muscle is the only abductor of the vocal cords?

- **Posterior cricoarytenoid**

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5. What is the “safety muscle” of the larynx? Why is it called so?

- Posterior cricoarytenoid ? keeps airway open by abducting vocal cords.

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6. What happens when the recurrent laryngeal nerve is injured?

- **Unilateral injury:** Hoarseness
- **Bilateral injury:** Airway obstruction (cords fixed in paramedian position)

7. What is the narrowest part of the larynx in adults?

- **Rima glottidis**

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8. What is the narrowest part of the larynx in children?

- **Subglottic region**

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9. What type of epithelium lines the vocal cords?

- **Stratified squamous epithelium**

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10. What structures can be seen in indirect laryngoscopy?

- Epiglottis
- Aryepiglottic folds
- Valleculla
- Piriform fossa
- Vestibular folds
- Vocal folds

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11. Which nerves supply sensation above and below the vocal cords?

- Above ? **Internal laryngeal nerve**
- Below ? **Recurrent laryngeal nerve**

12. What forms the inlet of the larynx?

- Anterior ? Epiglottis
- Lateral ? Aryepiglottic folds
- Posterior ? Interarytenoid notch

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13. What happens to the vocal cords during phonation?

- They are **adducted**.

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14. What is the position of vocal cords in forced inspiration?

- **Fully abducted**, rima glottidis becomes diamond-shaped.

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15. What are the intrinsic muscles that close the laryngeal inlet?

- **Aryepiglottic**
- **Oblique arytenoid**

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16. What are the intrinsic muscles that open the laryngeal inlet?

- **Thyroepiglottic muscle**

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17. What structures pierce the thyrohyoid membrane?

- **Internal laryngeal nerve**

- **Superior laryngeal vessels**

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18. Why is glottic cancer detected early?

- Changes **voice early** due to involvement of vocal cords.

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19. Why is subglottic cancer detected late?

- Few symptoms initially; region has **poor lymphatic drainage**, so spread is slow.

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20. What is the position of the larynx in infants?

- Higher (C1–C4), funnel-shaped, narrow lumen.