

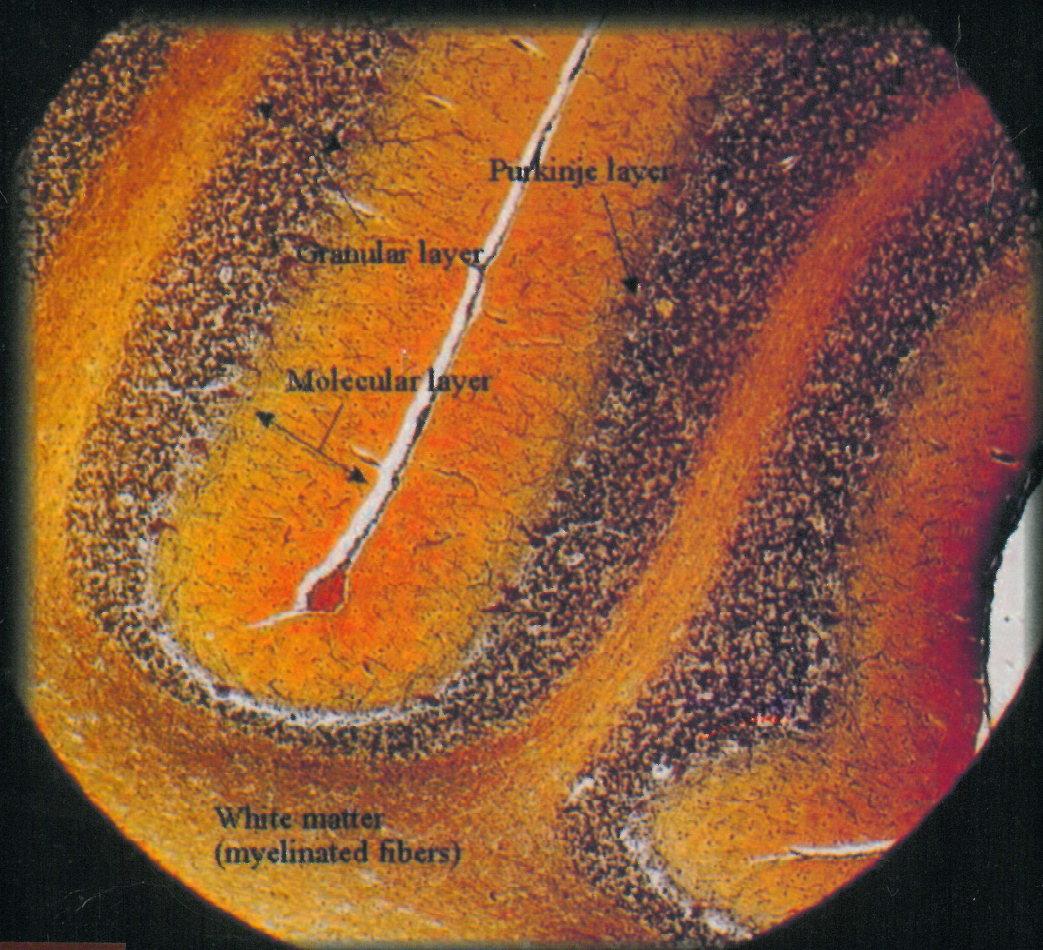
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E. Ivanov, MD, PhD

MANUAL

Microscopic Anatomy of Internal Organs Practical Exercises



Under the editorial guidance of E. Ivanov, MD, PhD, Chairman at the
Department of Anatomy, Histology, Cytology and Biology

Pleven 2011

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SYLLABUS

Date	Topic	Instructor signature
	1. Digestive system I – oral cavity, pharynx, oesophagus	
	2. Digestive system II – stomach, small and large intestine	
	3. Digestive system III – liver, pancreas	
	4. Seminar digestive system	
	5. Respiratory system I – nasal cavity, larynx	
	6. Respiratory system II – trachea, lungs	
	7. Cardiovascular system – heart, structure of the blood vessels	
	8. Lymphatic organs – thymus, lymph nodes, spleen, tonsils	
	9. Seminar – respiratory, cardiovascular system and lymphatic organs	
	10. Urinary system – kidney, ureter, urinary bladder	
	11. Male reproductive system	
	12. Female reproductive system	
	13. Endocrine system	
	14. Seminar – urinary, male and female reproductive system, endocrine glands	
	15. Nerve system and sensory organs	

Topic 4. RESPIRATORY SYSTEM I – NOSE, LARYNX

The organs of the respiratory system can be divided into those that conduct air from outside the body to the interior of the lungs and form the *conducting portion* of the system and those that are sites of gaseous exchange – *respiratory portion*. The **conducting portion** consists of the *nose, pharynx, larynx, trachea and bronchi*. The **respiratory portion** consists of small *respiratory bronchioles, the alveolar ducts, the alveolar sacs and the alveoli* (Fig.1).

Three principal **functions** are performed by this system: **air conduction, air filtration,** and **gas exchange (respiration)**. The nasal cavities **carry stimuli for the sense of smell**. The respiratory system also participates to a lesser degree in **endocrine** function, as well as **regulation of immune responses to inhaled antigens**.

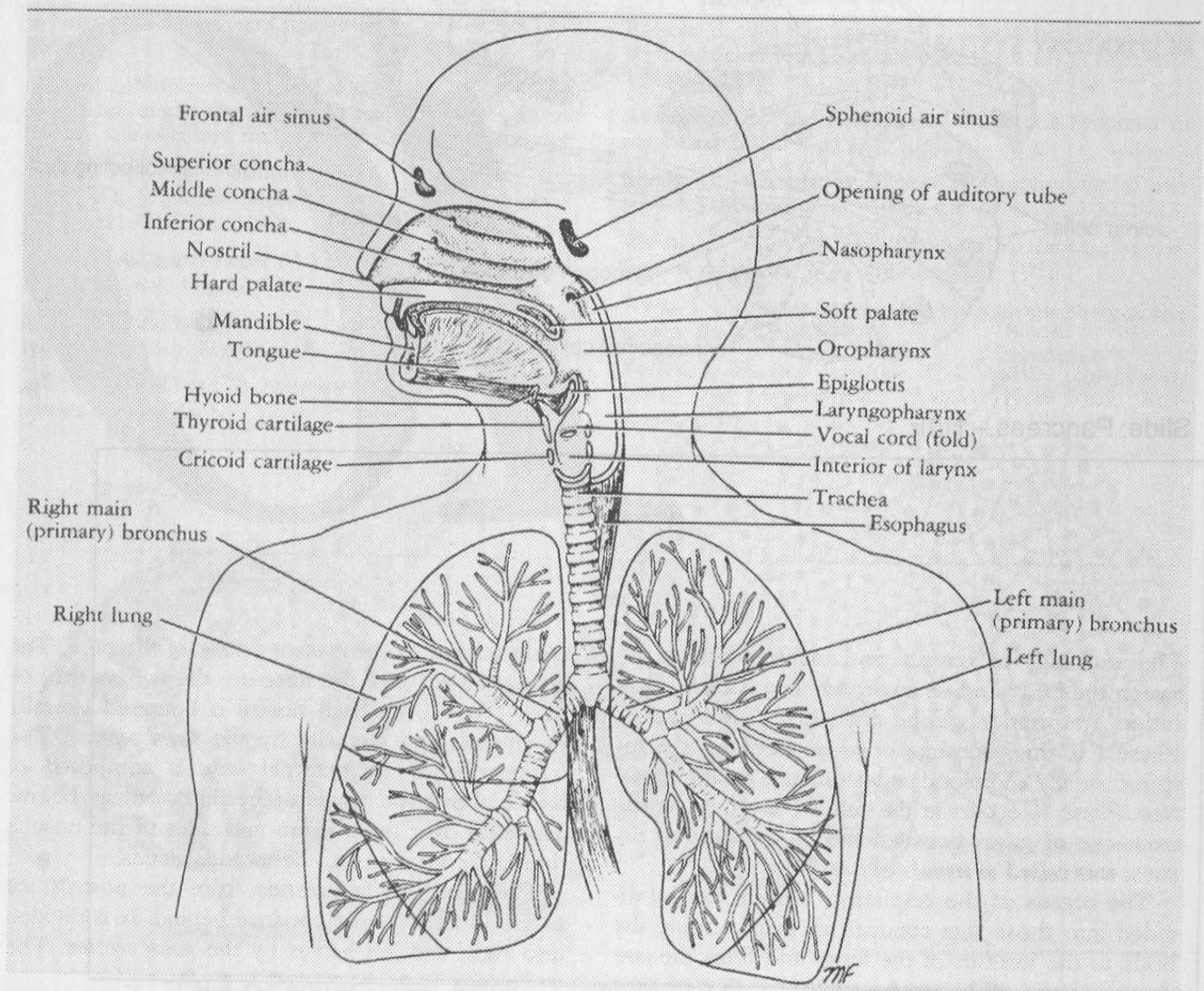


Fig.1. Illustration of the respiratory system

The lungs develop in the embryo as a ventral evagination of the foregut; thus the epithelium of the respiratory system is of endodermal origin. This initial respiratory diverticulum grows in to

the thoracic mesenchyme. The bronchial cartilages, smooth muscle, and the other connective tissue elements are derived from the thoracic mesenchyme.

NOSE (nasus or rhinos) consists of the external nose and nasal cavity (Fig.1).

The **external nose (nasus externus)** has a free tip and is attached to the forehead by the *root*. The external orifices of the nose are the two **nostrils (nares)**. The frame work of the external nose is composed of bones above and plates of hyaline cartilage below. The skin over the dorsum and sides of the nose is thin and contains many sebaceous glands.

The **nasal cavity (cavitas nasi)** extends from the nostrils in front to the **choanae** behind. It is divided into right and left halves by the **nasal septum (septum nasi)**– made of bone posteriorly and hyaline cartilage anteriorly.

The lateral wall of the nasal cavity is marked by three projections called **superior, middle and inferior conchae**. The area below each concha is referred as **meatus (meatus nasi superior, medius et inferior)**.

The chambers are divided into three regions:

- Vestibule – the wider portion, just behind the nares
- Respiratory segment
- Olfactory segment

The **vestibule** communicates anteriorly with the external environment. It is lined with stratified squamous epithelium, a continuation of the skin of the face and contains a variable number of stiff hairs, *vibrissae* that filter out large particulate matter before it is carried in air stream to the rest of the cavity. Sebaceous glands are also present and their secretion assists in the entrapment of particulate matter. The posterior part of the vestibule is lined with nonkeratinized stratified squamous epithelium, continuous posteriorly with pseudostratified ciliated columnar epithelium and goblet cells.

The remaining portion of the nasal cavities is lined with mucous membrane of two types – respiratory and olfactory. **Respiratory mucous membrane** lines the lower part of the nasal cavity. Its function is to warm, moisten and clean the inspired air. A layer of ciliated, pseudostratified columnar epithelium with goblet cells rests on a basal lamina. The underlying lamina propria contains mucous glands, many exhibiting serous demilunes. The ciliated pseudostratified columnar epithelium of this segment is composed of five cell types:

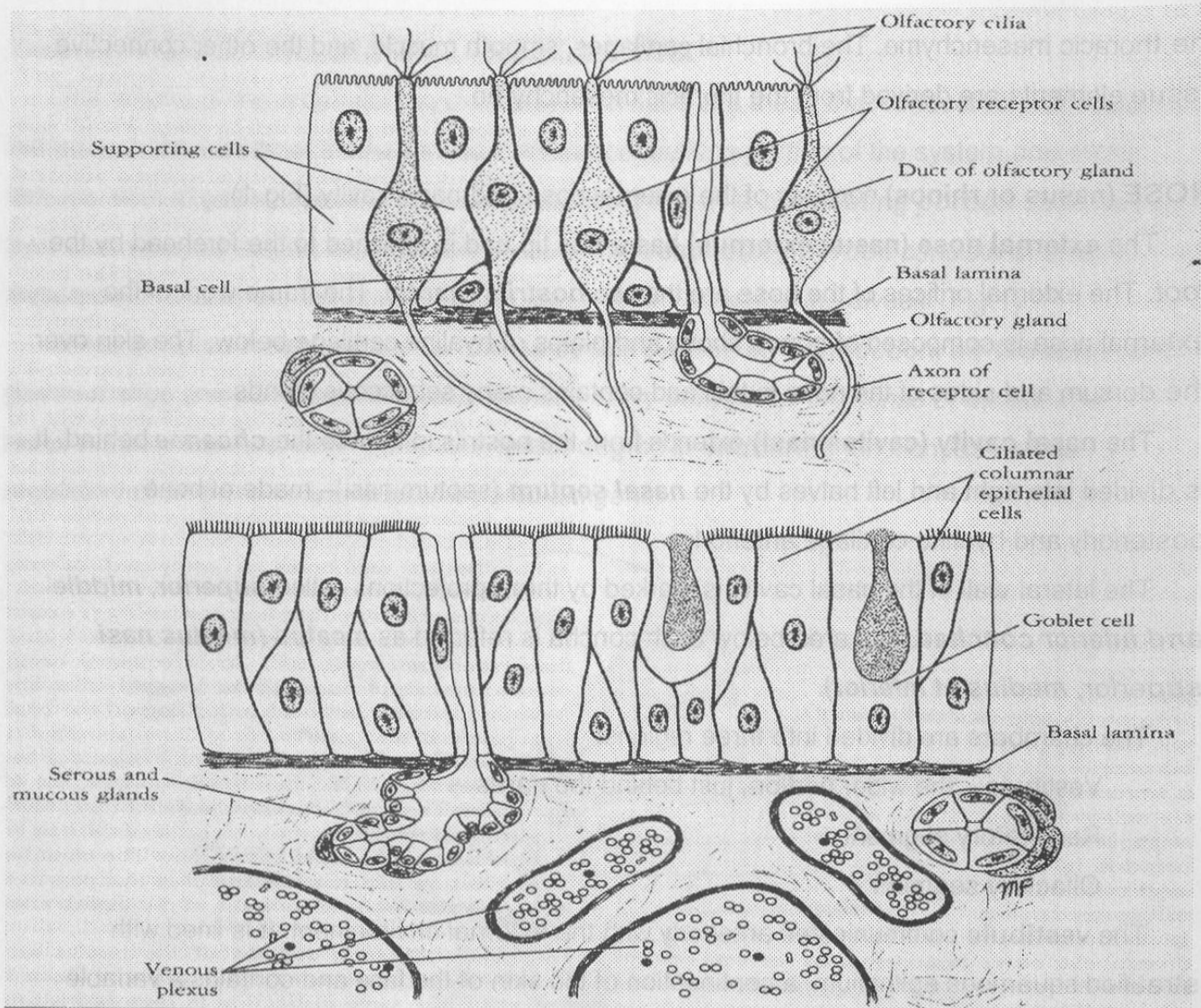


Fig.2. Olfactory epithelium (up) comparing with respiratory epithelium

- **Ciliated cells**, tall columnar cells with cilia that project into the mucus covering the surface of the epithelium
- **Goblet cells** that synthesize and secrete mucus
- **Brush cells** (microvillous cells), a general name for those cells in the respiratory tract that bear short, blunt microvilli. They are columnar cells specialized for transduction of general sensation.
- **Small granule cells** that resemble basal cells but contain secretory granules
- **Basal cells**, stem cells from which the other cell types arise

The inspired air is warmed by a plexus of veins in the lamina propria. Moisture is added by evaporation of the secretions poured onto the surface of the mucous membrane by the glands and goblet cells. Inspired dust particles are removed from the air by the moist, sticky surface of the mucous membrane. The contaminated mucus is moved backward continuously by the ciliary action of the columnar ciliated epithelium covering the surface.

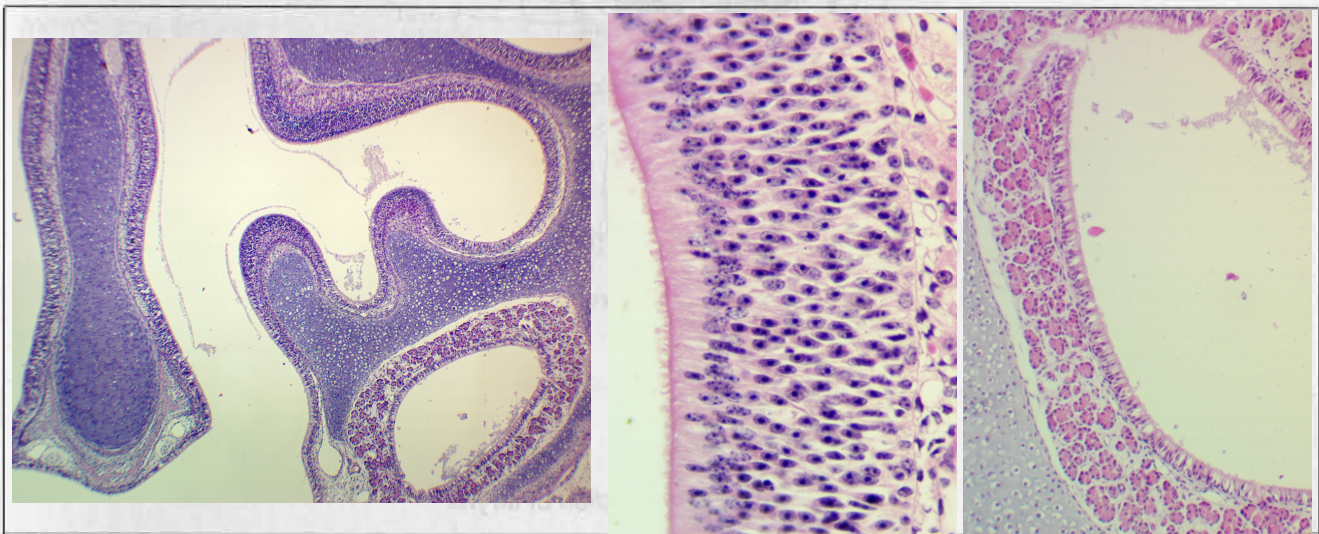
The lamina propria of the respiratory segment has a rich, vascular network that includes a complex set of capillary loops.

Olfactory epithelium lines the upper surface of the superior concha and the area of the lateral wall above it (spheno-ethmoidal recessus), corresponding area of the nasal septum and the roof. Like the epithelium of the respiratory segment, is also pseudostratified, but it contains very different cell types (Fig.2):

- a) **Olfactory cells - bipolar neurons** that span the thickness of the epithelium
- b) **Supporting or sustentacular cells** - columnar cells that provide mechanical and metabolic support to the olfactory cells
- c) **Basal cells** - stem cells from which new olfactory cells and supporting cells differentiate
- d) **Brush cells** - the same cell type that occurs in the respiratory epithelium

The olfactory glands (Bowman's glands), are branched tubuloalveolar serous glands that deliver their proteinaceous secretions via ducts onto the olfactory surface.

Slide: Nasal cavity (cavitas nasi) – H&E



x40

x400

x100

Paranasal sinuses

Paranasal sinuses are air-filled spaces in the bones of the walls of the nasal cavity. The sinuses communicate with the nasal cavity via narrow openings into the respiratory mucosa.

The sinuses are named for the bone which they are found, i.e. the ethmoidal, frontal, sphenoid, and maxillary. The mucosal surface of the sinuses is a thin, ciliated, pseudo-stratified columnar epithelium with numerous goblet cells. The **maxillary, frontal** and **the anterior part of the ethmoidal** sinuses are drained into the *middle meatus* of the nose; the **sphenoid** and the **posterior part of the ethmoidal** sinuses open above the *superior concha*.

The paranasal sinuses are lined with mucous membrane continuous with that lining the nasal cavity. The membrane is covered with pseudostratified ciliated columnar epithelium and contains goblet cells. The mucous formed in sinuses is moved to the nasal cavities by the action of the cilia.

LARYNX

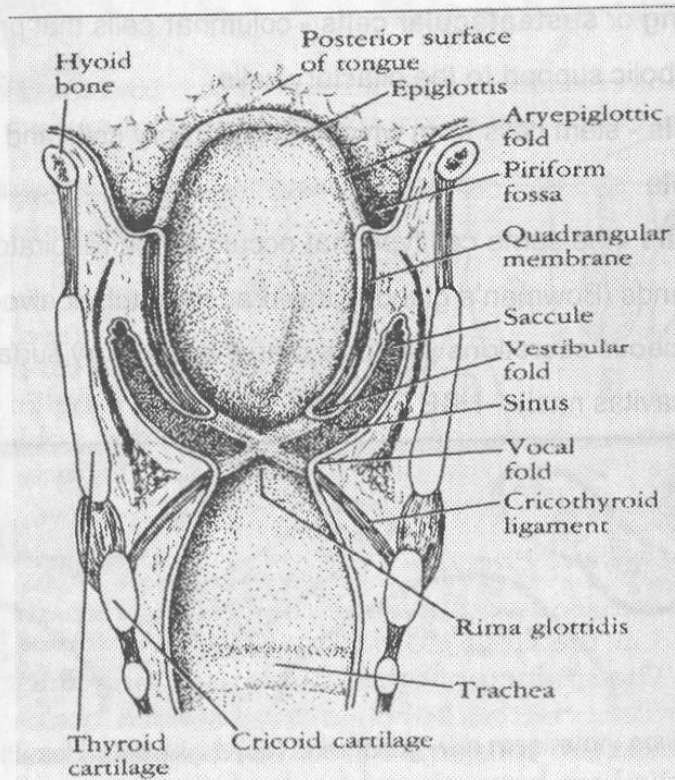


Fig.3. Longitudinal section of larynx

The passageway for air between the oropharynx and trachea is the **larynx**.

The larynx is formed by irregularly shaped plates of hyaline - *thyroid cartilage*, *cricoid cartilage*, *arytenoid cartilages* and elastic cartilage - *epiglottis*. The larynx serves as the organ for speech (phonation).

The cartilages are connected by membranes and ligaments and moved by skeletal muscles.

The larynx is lined with mucous membrane. Under the mucous membrane on each side are the *vocal ligaments* which connect the arytenoid to the thyroid cartilage. The ligaments are composed of bundles of elastic fibers, with a few collagen fibers, and produce ridges, or folds - **vocal folds (*plica vocalis*)**, or *vocal cords*. The luminal surface of vocal cords is covered with

stratified squamous epithelium as is most of the epiglottis. The gap between the vocal folds is called the *rima glottidis*. The vocal folds can be moved by skeletal muscles acting on the arytenoid cartilages (the vocal muscles). Voice sounds are produced by causing a strong stream of air to pass up through the rima glottidis from the trachea and bronchi.

Ventricular (vestibular) folds located above the vocal folds are the “false vocal cords”. These folds do not have the intrinsic muscular investment of the true vocal cords.

The stratified squamous and pseudostratified columnar ciliated epithelium line the larynx. The cilia beat upward toward the pharynx moving the mucus and adherent particles to the laryngeal part where they are swallowed. The lamina propria contains many serous and mucous glands that pour their secretions onto the free surface. Lymph nodules are scattered throughout the lamina propria. Over the vocal folds, where there is a considerable amount of wear and tear because of vibration, the surface is covered with stratified nonkeratinized epithelium. The same epithelium covers the anterior surface of the epiglottis.

Above the vocal folds, the lumen of the larynx expands to the *sinus*. Extending superiorly from the sinus on each side is the *laryngeal sacculle*, a blind-ended tube lined with mucous membrane containing many goblet cells – the mucus runs inferiorly and lubricates the vibrating vocal folds.

Histologically the wall of larynx has all the elements of those the respiratory tract, mucous membrane with pseudostratified ciliated columnar epithelium, cartilage plates, glands, lymphoid follicles. The distinguishing feature of the laryngeal wall is presence of the skeletal muscles between the cartilages.

Slide: Larynx -H&E

