BLOCK RRS-209

Respiratory - Renal System

Lecture

Respiratory System

Ass. Prof. Dr. Safaa Said

Department of Histology &Cell Biology

Assuit University

Learning objectives

After this lecture, students should be able to:

Know the different classifications of the respiratory tract: - Conducting and respiratory portions.

- Correlate functions of the conducting & respiratory portions with histological structure.

- Discriminate the type of the lining epithelium of the respiratory system

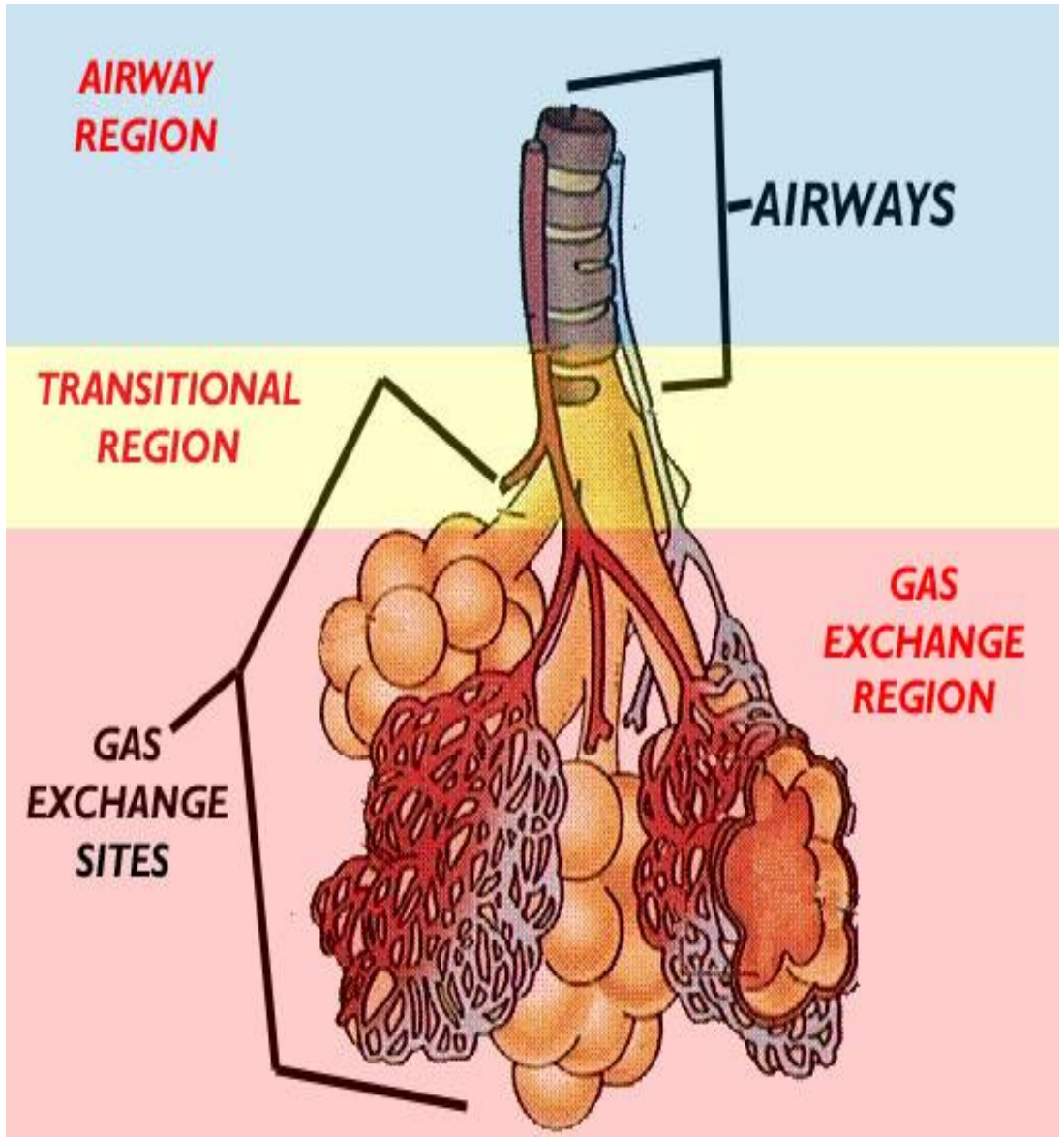
- Compare between the histological structure of the trachea, bronchi, bronchioles, alveoli and discriminate the type of their lining epithelium.
- Describe the histological structure of Clara (club) cell and identify its function

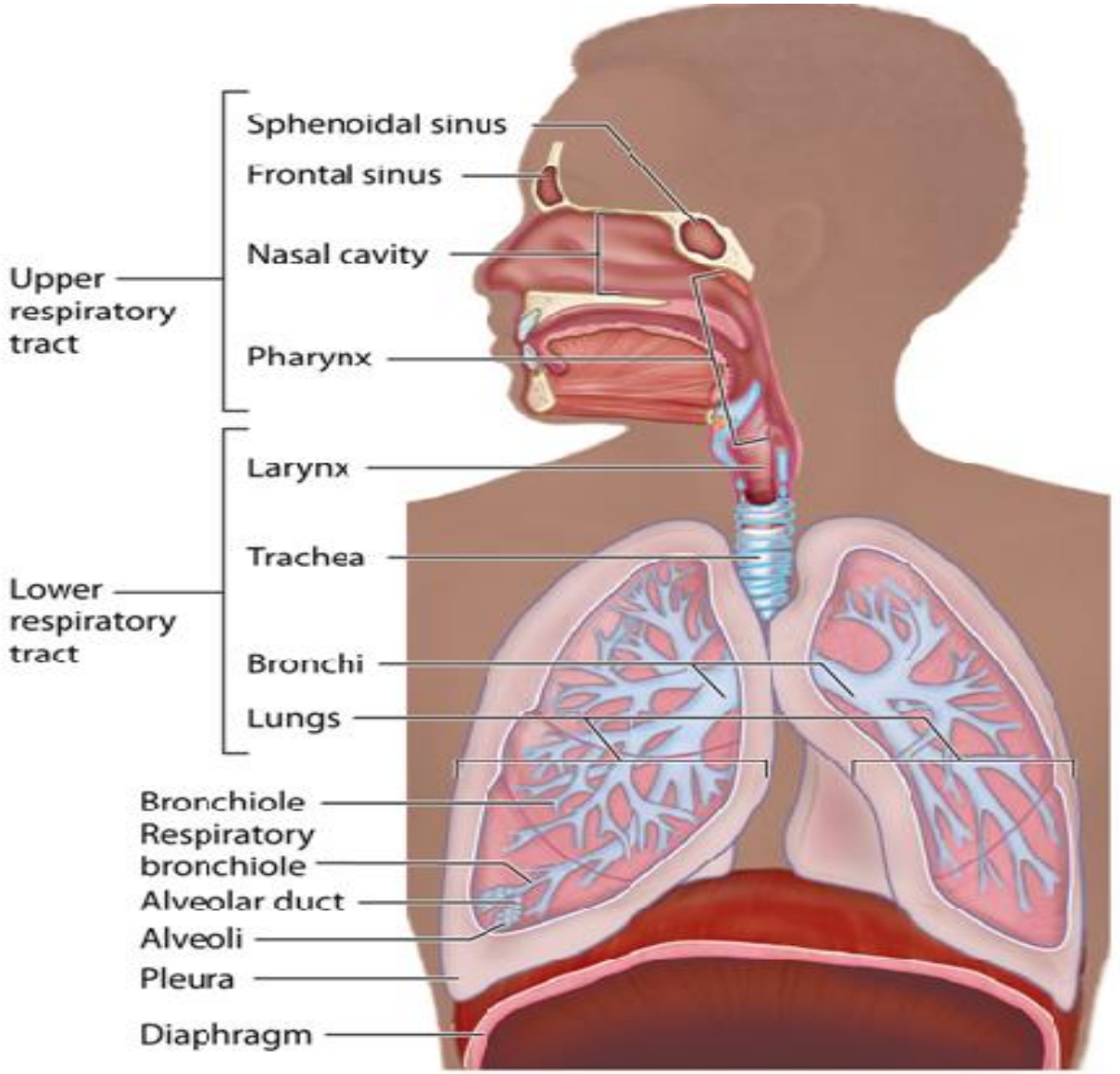
Conducting & respiratory portions of the Respiratory tract

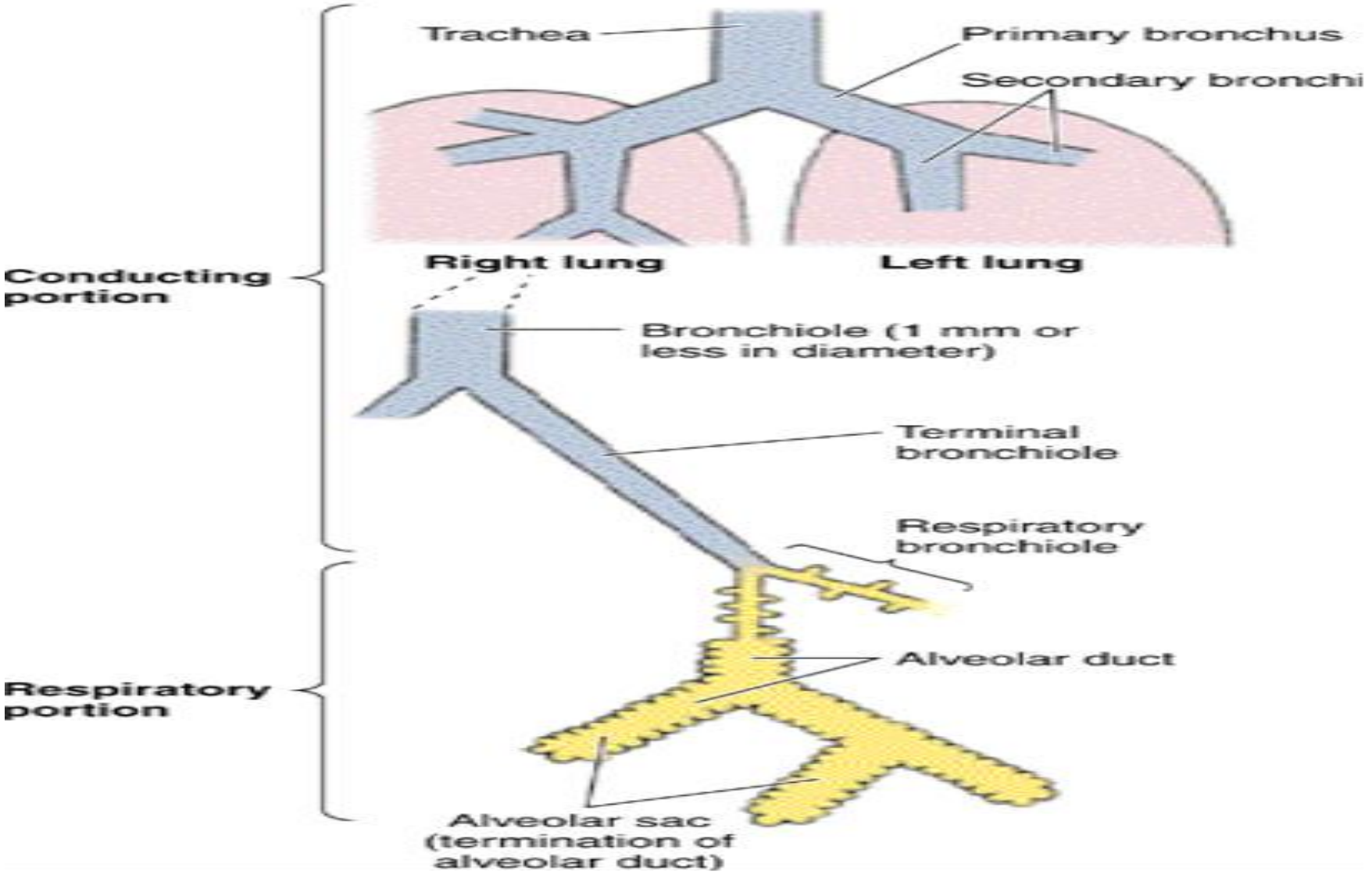
- **The conducting portion**: {does not participate in gas exchange} consists of nasal cavity, paranasal sinuses, nasopharynx, larynx, trachea, bronchi and bronchioles that further divide into terminal bronchioles.

The respiratory portion: (Lung parenchyma), participates in gas exchange consists of respiratory bronchioles, alveolar ducts, alveolar sacs and alveoli.

	Conducting portion	Respiratory portion
Functions	**Warm, humidify and filter air.** {The activity of the cilia and the mucous secretion of goblet cells make up the "mucociliary escalator", which is important in removing the inhaled particles}.	**Gas exchange.** {The lungs are the only place in our body where blood capillaries come into direct contact with the outside air, as a result of the fusion of the type I alveolar cells with the pulmonary capillary endothelium}.

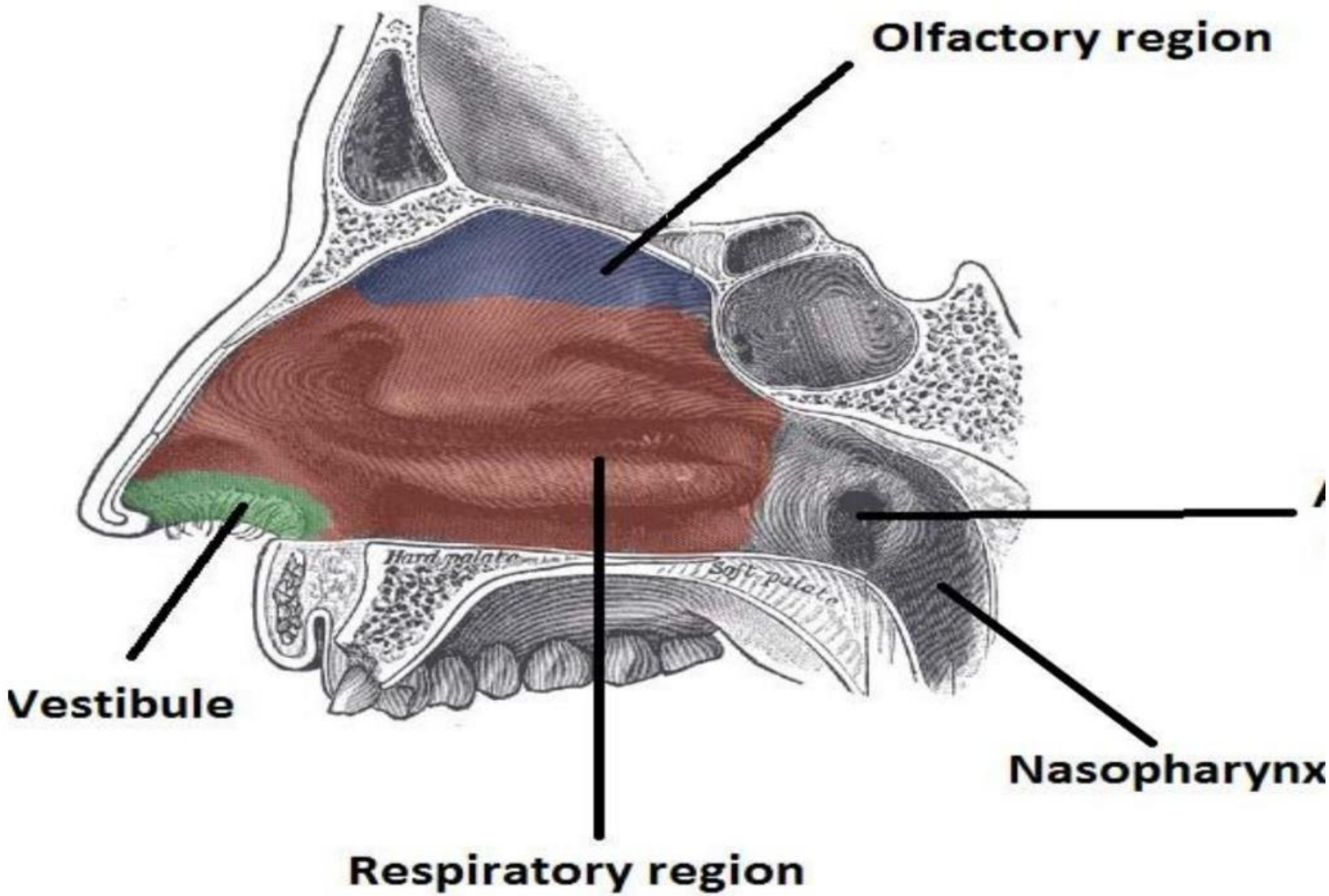

AIRWAY REGION
AIRWAYS
TRANSITIONAL REGION
GAS EXCHANGE REGION
GAS EXCHANGE SITES

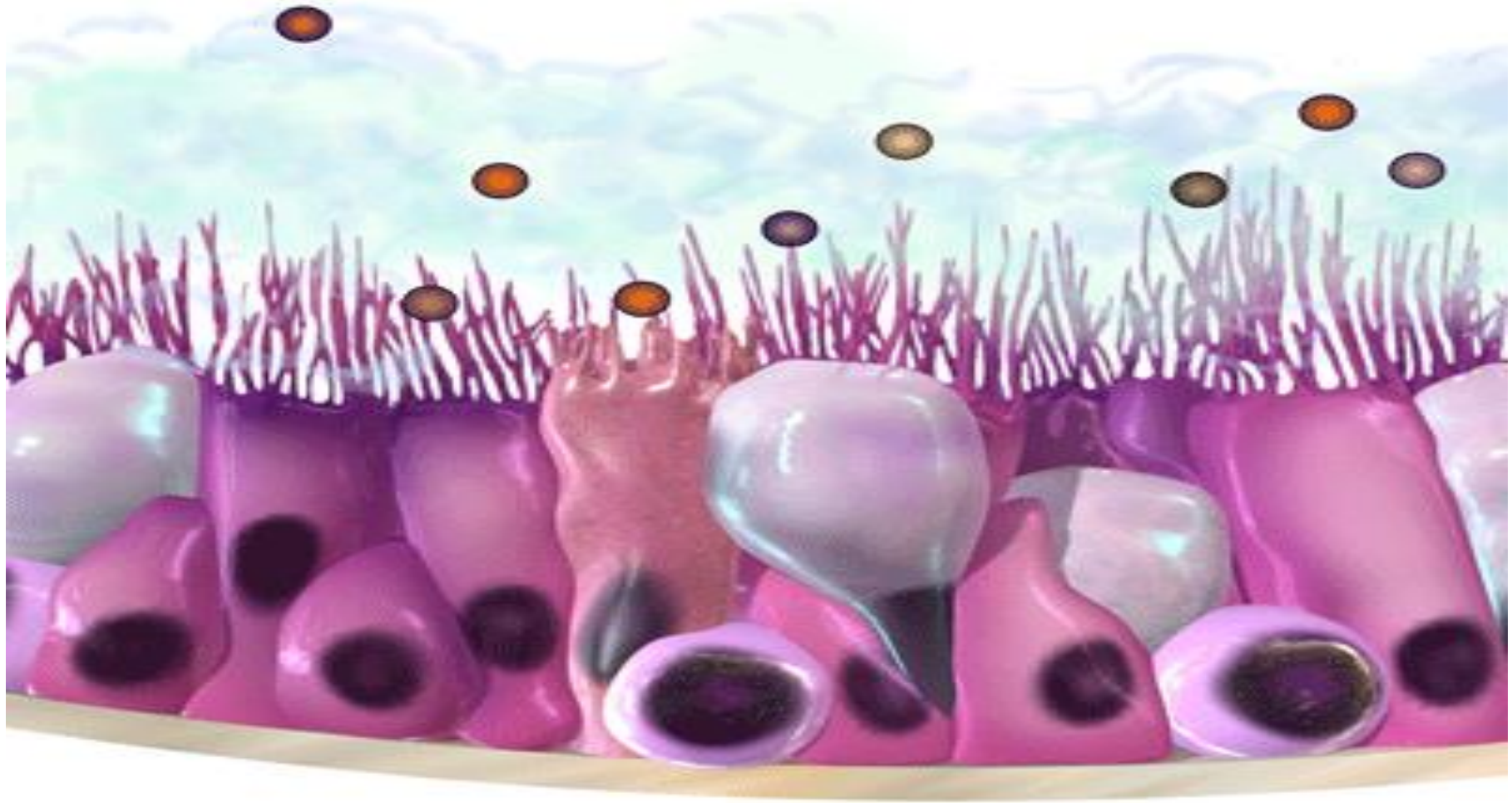

Upper respiratory tract
Sphenoidal sinus
Frontal sinus
Nasal cavity
Pharynx
Lower respiratory tract
Larynx
Trachea
Bronchi
Lungs
Bronchiole
Respiratory bronchiole
Alveolar duct
Alveoli
Pleura
Diaphragm


Trachea
Primary bronchus
Secondary bronchi
Right lung
Left lung
Conducting portion
Bronchiole (1 mm or less in diameter)
Terminal bronchiole
Respiratory bronchiole
Alveolar duct
Respiratory portion
Alveolar sac (termination of alveolar duct)

Nasal Cavity

- The nose moistens, warms inhaled air & preventing particulate matter from entering the airways. It is playing an important role in the sense of smell.
- • The left and right nasal cavities each have two components: the external dilated vestibule and the internal nasal cavity.
- Air enters the nose through the anterior nares (nostrils), passing the 3 anterior nasal hairs (vibrissae); these trap and prevent inhalation of larger foreign particles.
- The epithelial lining changes shortly after entering the nose from keratinized to respiratory epithelium.
- • Olfactory epithelium, possess receptors that bind specific odorants, is found in the upper regions of the nasal airway above the superior conchae and is specialized for the detection of smell


Olfactory region
Hard palate
Soft palate
Vestibule
Respiratory region
Nasopharynx



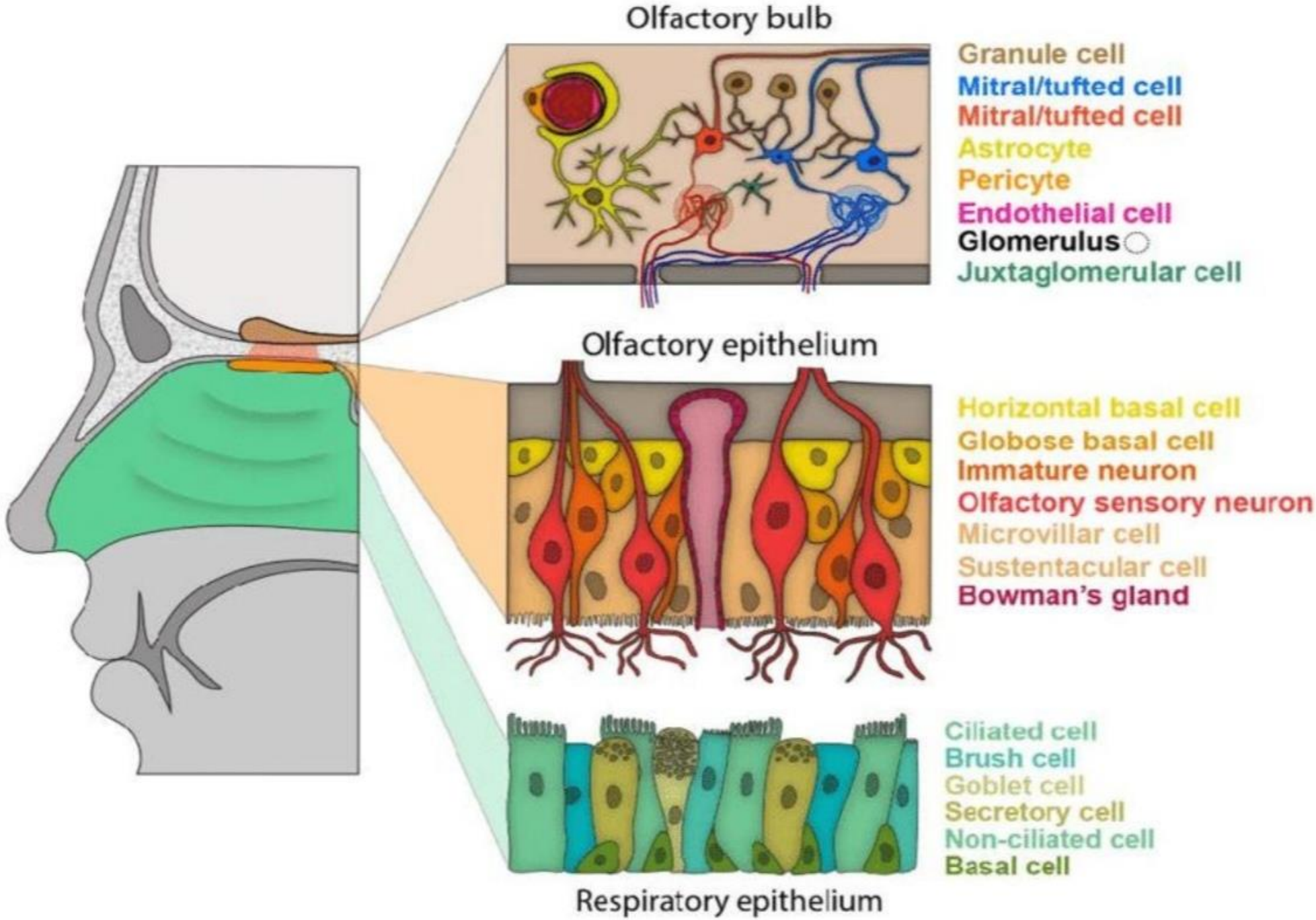
1- NASAL CAVITY

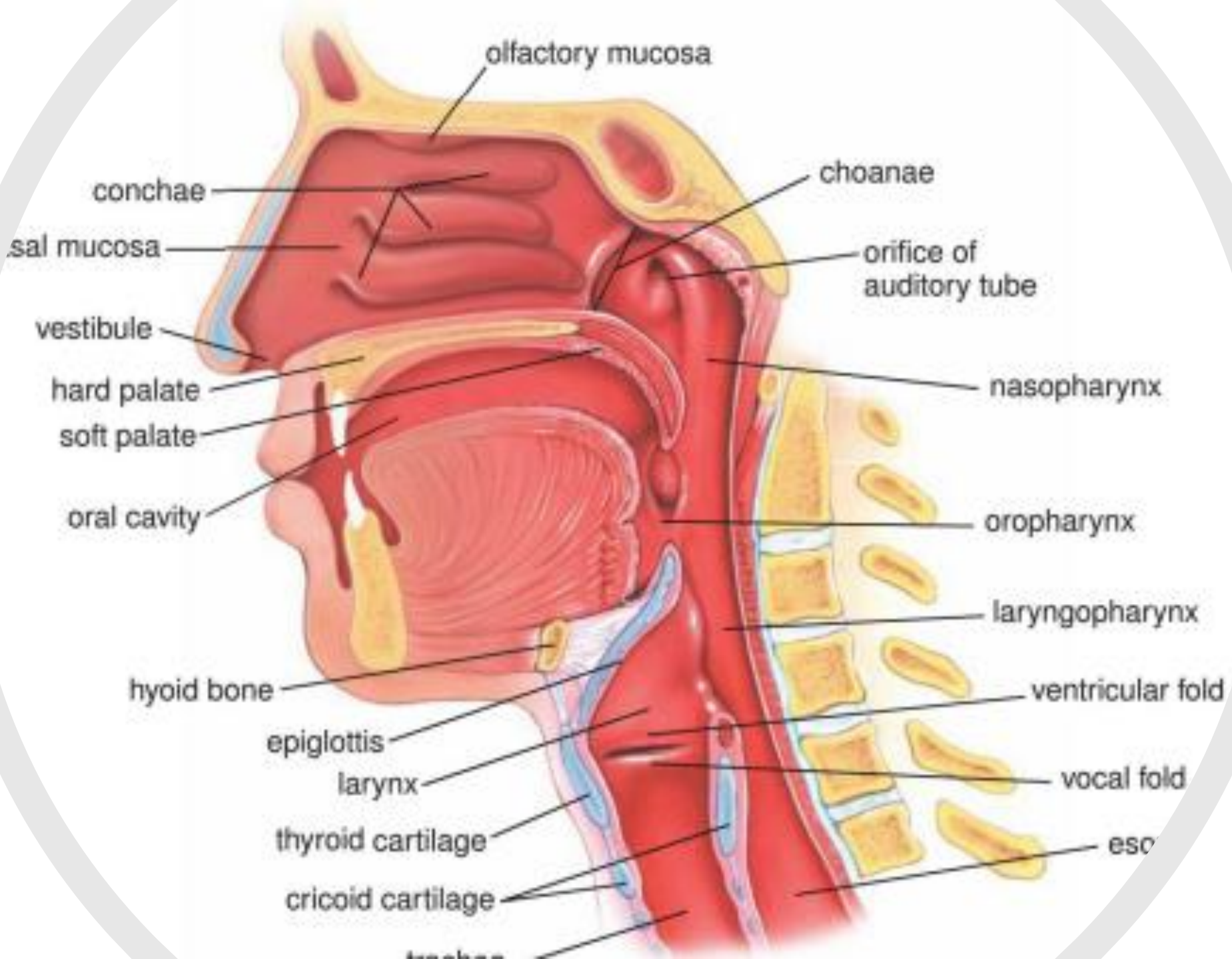
- **Anterior portion of the nasal cavity (vestibule):**

The vestibule is lined with skin and has vibrissae; short stiff hairs that prevent larger particles from entering the nasal cavity. The dermis contains numerous sebaceous and sweat glands.

- **Posterior portion of the nasal cavity:**

- Except for the vestibule and olfactory region, the nasal cavity is lined by pseudostratified ciliated columnar epithelium, frequently called respiratory epithelium.


Olfactory bulb
Granule cell
Mitral/tufted cell
Mitral/tufted cell
Astrocyte
Pericyte
Endothelial cell
Glomerulus
Juxtaglomerular cell
Olfactory epithelium
Horizontal basal cell
Globose basal cell
Immature neuron
Olfactory sensory neuron
Microvillar cell
Sustentacular cell
Bowman's gland
Ciliated cell
Brush cell
Goblet cell
Secretory cell
Non-ciliated cell
Basal cell
Respiratory epithelium


olfactory mucosa
conchae
sal mucosa
vestibule
hard palate
soft palate
oral cavity
hyoid bone
epiglottis
larynx
thyroid cartilage
cricoid cartilage
choanae
orifice of
auditory tube
nasopharynx
oropharynx
laryngopharynx
ventricular fold
vocal fold
esc

- The subepithelial C.T. (Lamina propria) is richly vascularized. It has many seromucous glands and abundant lymphoid elements, including occasional lymphoid nodules.
- Olfactory region of the nasal cavity:
- Site: it is located in the roof of the nasal cavity, the superior aspect of the nasal septum and the superior conchae.
- Olfactory epithelium:
- It is yellow in the living person (due to the presence of pigment in the epithelium) and responsible for perception of odours.
- Olfactory epithelium is composed of 3 types of cells: olfactory, sustentacular and basal cells.

Olfactory epithelium:

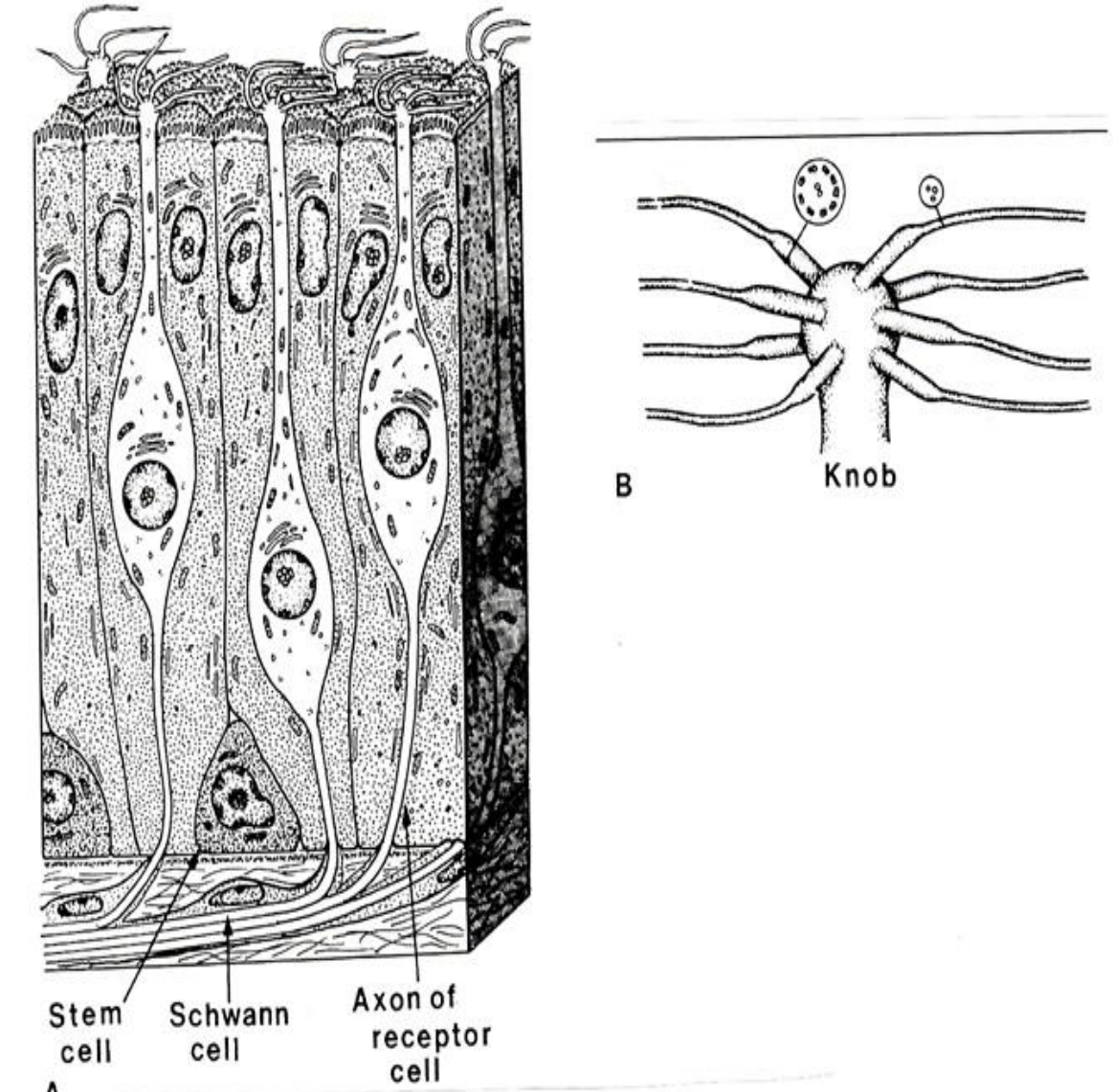
•Supporting cells:

- **LM:They are tall columnar cells with fine yellowish granules in their cytoplasm that responsible for the yellowish color of the mucosa.**
- **The nucleus is oval and situated at the superficial portion of cytoplasm.**
- **Their free cell surface presents microvilli that covered with a thin film of serous fluid produced from the Bowman´s glands.**
- **They joined with adjacent olfactory cells by junctional complexes to prevent separation of the cells and access of secretion.**
- **They have a supporting and nourishment function for olfactory cells.**

• b. Olfactory (chemoreceptor) cells

- They are bipolar neurons which lie in-between the supporting cells.
- They have oval or rounded cell body contain spherical nucleus, apical dendrite and basal unmyelinated axons directed to the olfactory bulb.
- The nucleus is roundish and present in the widest part of the body.
- The cytoplasm is more electron lucent than that of the other types of cells, and contains moderate RER, and moderate supra-nuclear Golgi.
- Most of organelles are close to the nucleus. The apical dendrite is modified to form a roundish olfactory vesicle projecting above the surface of sustentacular cells.

- Long, non motile (lacking the dynein) olfactory cilia (6-8 cilia) extend from the olfactory vesicles which act as receptors.
- They are stimulated by odoriferous substance dissolved in serous secretions bathing olfactory cilia.
- The axon of olfactory cells penetrates the basal lamina and join together to form bundles of nerve fibers.
- The nerve fibers penetrate the cribriform plate of ethmoid in the roof of the nasal cavity to synapse



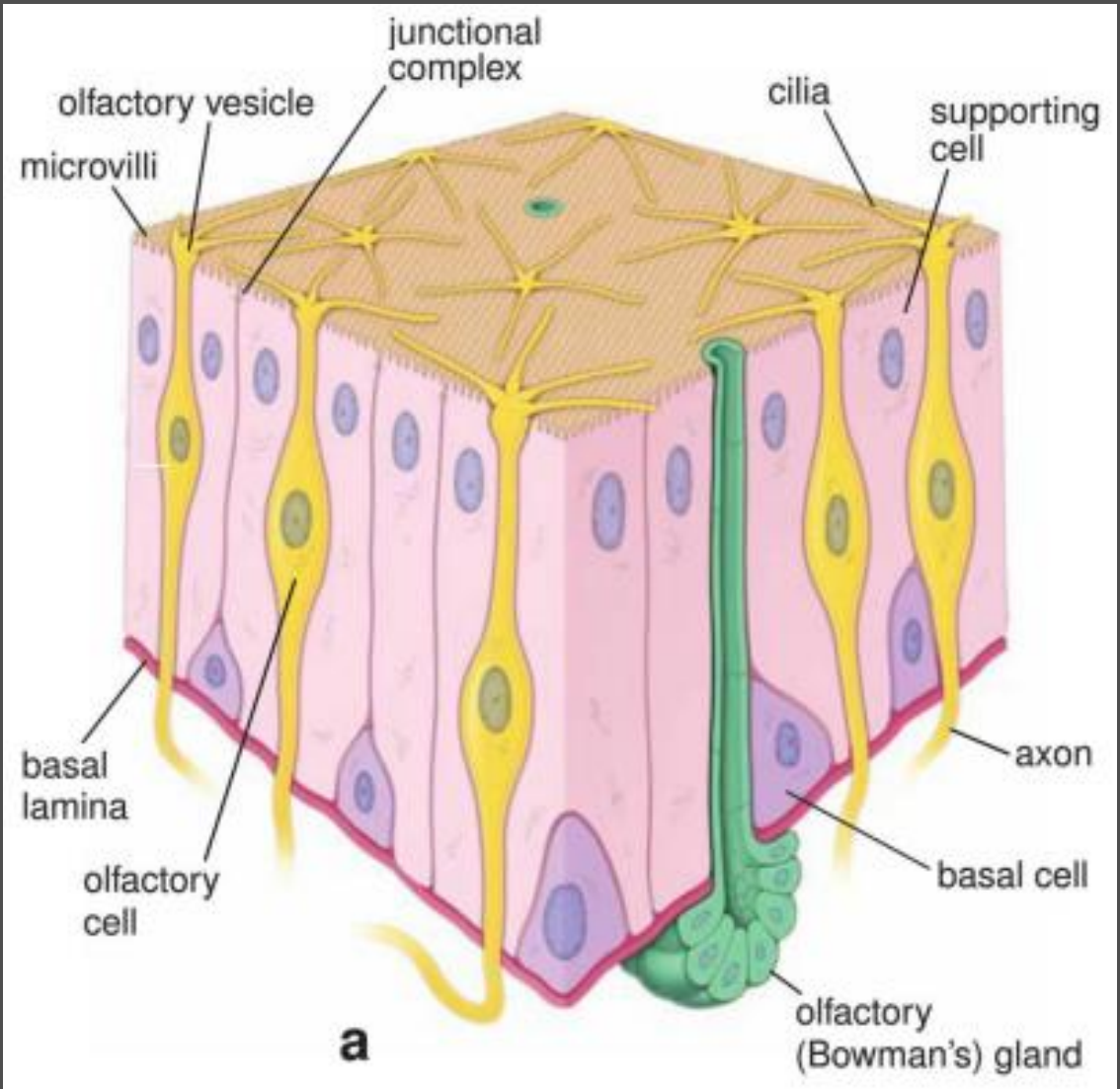
Olfactory mucosa showing the 3 cell types.
A: basal cells, B: supporting cells, C: olfactory cell

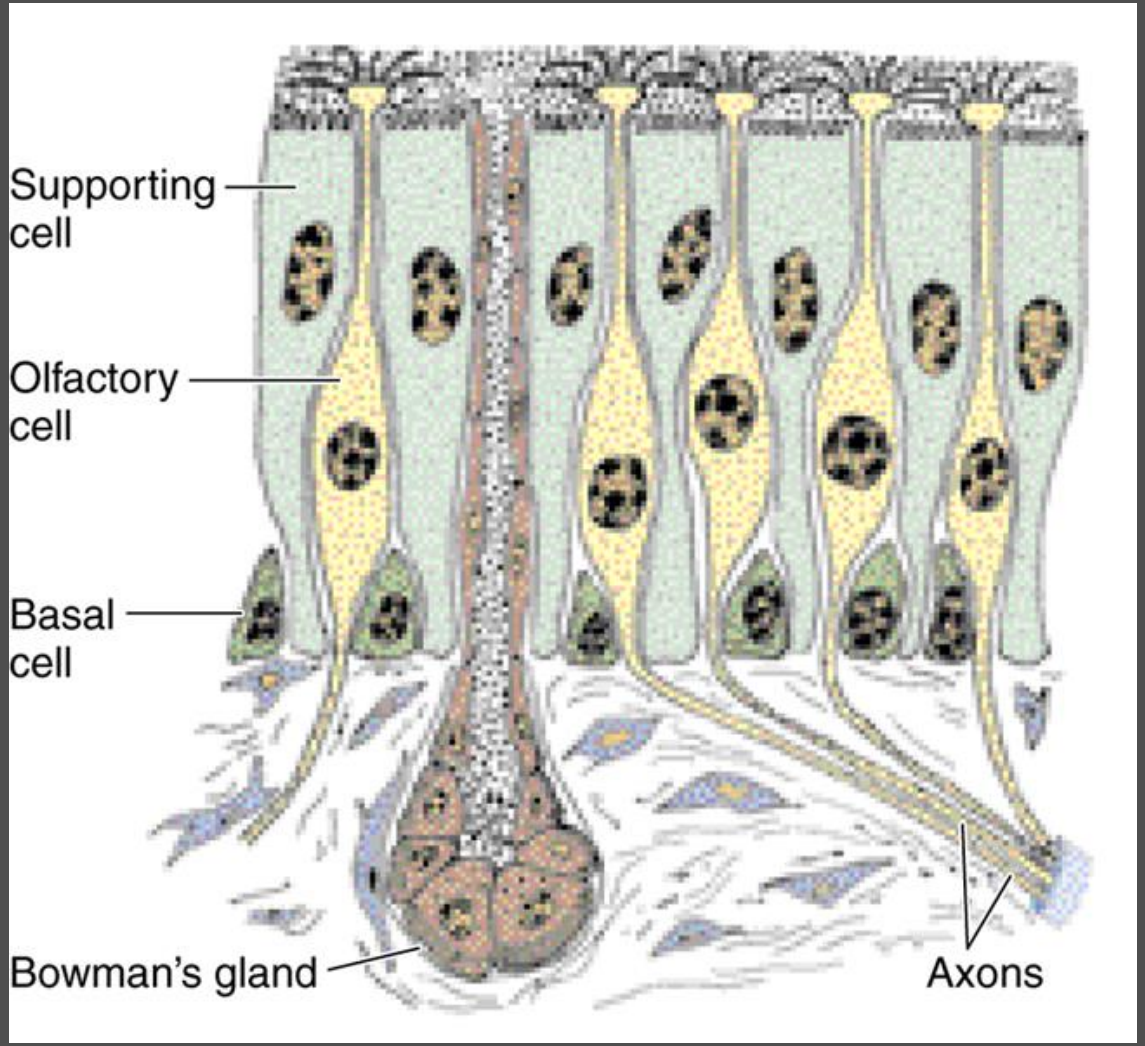
c. Basal (reserve or stem) cells

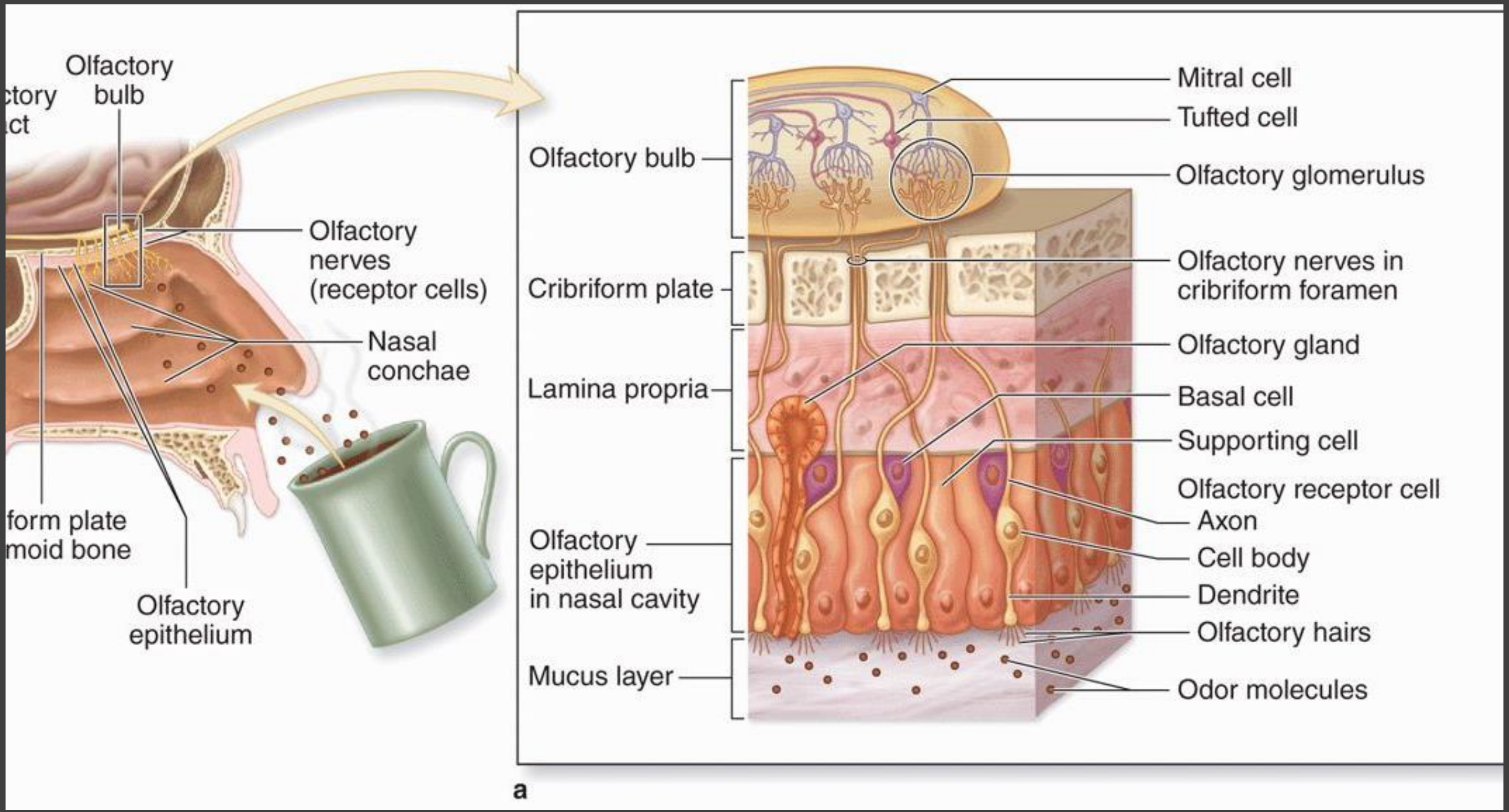
- They are small rounded cells located close to the basal lamina.
- Their nuclei are small darkly stained frequently invaginated.
- It lie on the basement membrane forming a single layer at the base of the epithelium.
- The cytoplasm contains few organelles, a feature consistent with their role as reserve cell.
- They can be differentiated to form olfactory or sustentacular cells (during prenatal life).
- The neurons are not replaced at postnatal life.

• b. Lamina propria:

- ► Formed of dense fibro-elastic connective tissue that contains serous glands (Bowman´s glands).
- Their secretion covers the olfactory cilia to clear them and thus allow perception of new odorous substances.

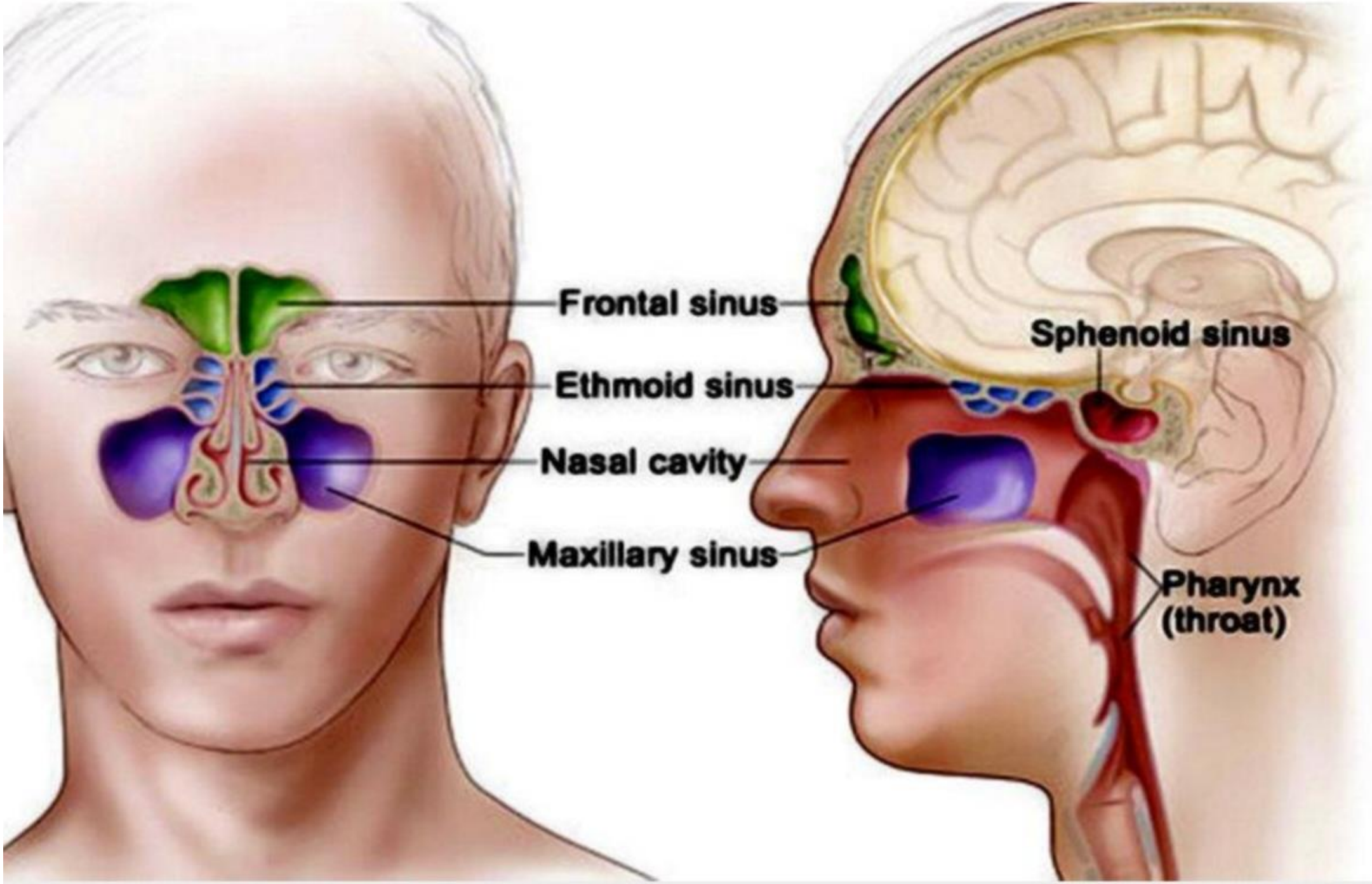

junctional complex
olfactory vesicle
cilia
supporting cell
microvilli
basal lamina
olfactory cell
axon
basal cell
olfactory (Bowman's) gland
a


Supporting cell
Olfactory cell
Basal cell
Bowman's gland
Axons


Olfactory bulb
Olfactory nerves (receptor cells)
Nasal conchae
form plate
moid bone
Olfactory epithelium
Olfactory bulb
Cribriform plate
Lamina propria
Olfactory epithelium in nasal cavity
Mucus layer
Mitral cell
Tufted cell
Olfactory glomerulus
Olfactory nerves in cribriform foramen
Olfactory gland
Basal cell
Supporting cell
Olfactory receptor cell
Axon
Cell body
Dendrite
Olfactory hairs
Odor molecules
a

PARANASAL SINUSES

- **Ethmoid, sphenoid, frontal and maxillary bones of the skull contain large paranasal sinuses which communicate with the nasal cavity.**
- **They are lined with a thin mucous membrane, the epithelium of which is pseudostratified columnar ciliated epithelium with goblet cells.**
- **The cilia sweep the mucous layer toward the nasal cavity.**


Frontal sinus
Ethmoid sinus
Nasal cavity
Maxillary sinus
Sphenoid sinus
Pharynx
(throat)

3- NASOPHARYNX

- The nasopharynx is the area behind the nose and above the soft palate.
- Its nasal side is lined by a respiratory epithelium.
- Its oral surface is lined with stratified squamous epithelium.
- It is protected from the regurgitation of food during swallowing by the soft palate rising upwards and closing it off from the rest of the pharynx.

- The lamina propria of the posterior aspect of the nasopharynx contains the pharyngeal tonsils.

- The pharyngeal tonsil (a collection of lymphoid tissue commonly known as the adenoids) is found in the posterior wall and roof of the nasopharynx.
- The eustachian tube, a conduit with the middle ear, enters at the level of the floor of the nose on the lateral walls. This explains the common concurrence of throat and middle ear infections.

4- LARYNX

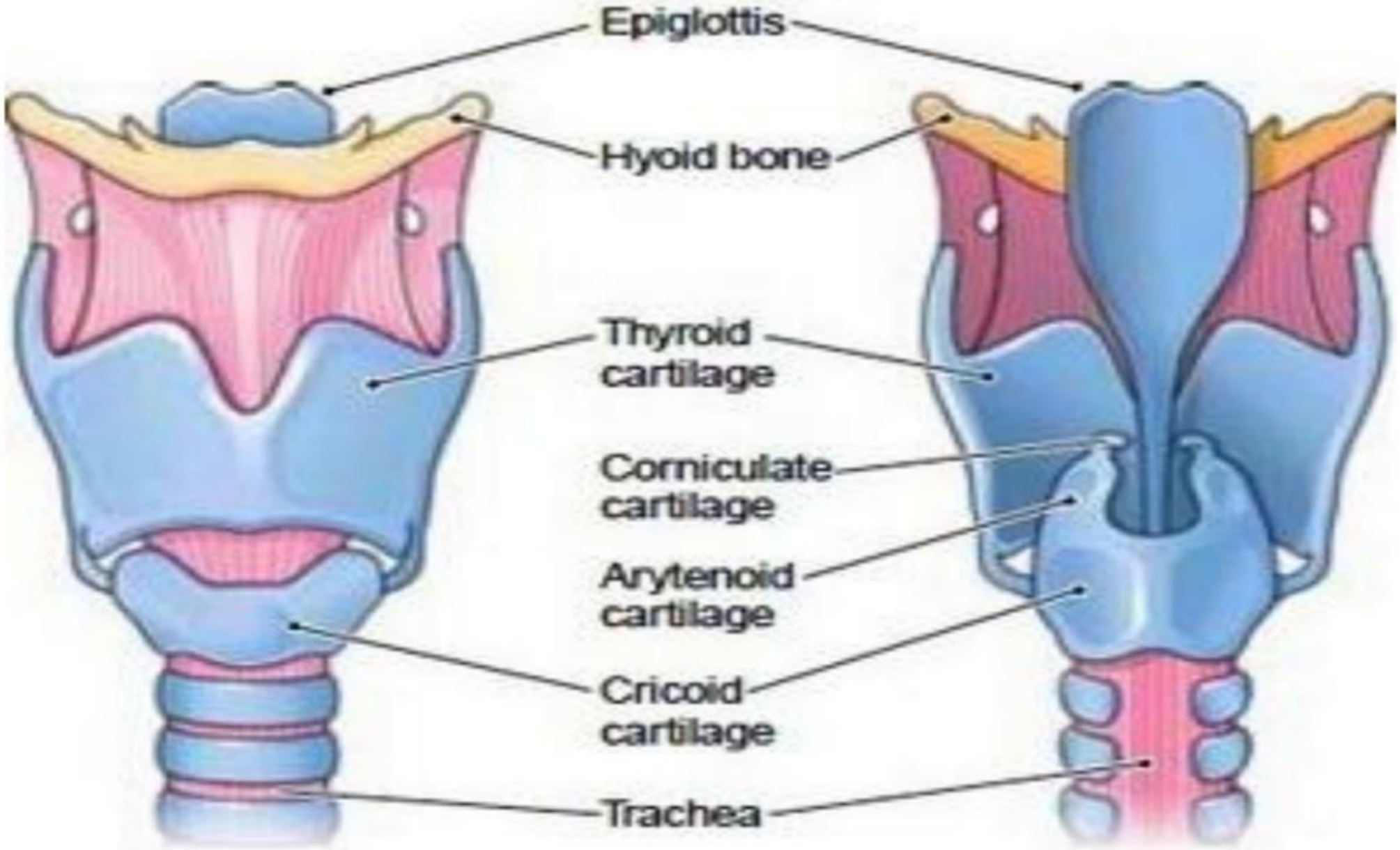
- **It is a musculocartilaginous structure situated between the pharynx and the trachea, acts as an airway sphincter during swallowing and contains the vocal cords which are responsible for sound (vocalization).**
- **The laryngeal wall is composed of a mucosa, cartilages and striated muscle fibers in C.T. sheath.**
- **Its wall is reinforced by cartilages (thyroid, cricoids, epiglottis, and paired corniculate and cuneiform arytenoids) with ligaments and muscles that regulate the size of the laryngeal inlet.**

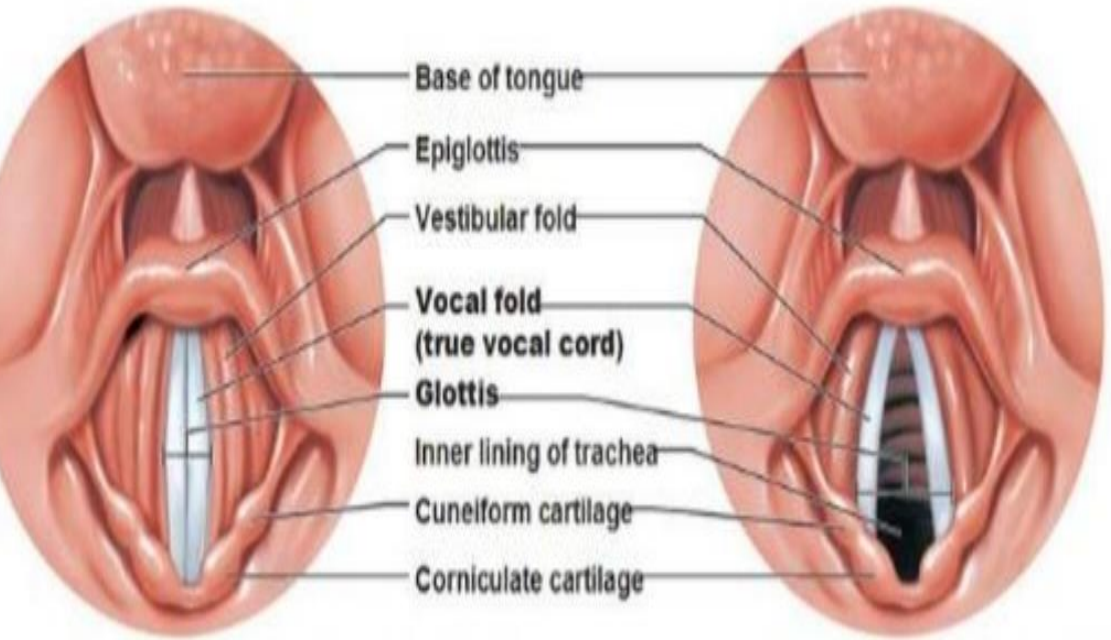
- The thyroid, cricoid and lower parts of arytenoids are hyaline cartilages.

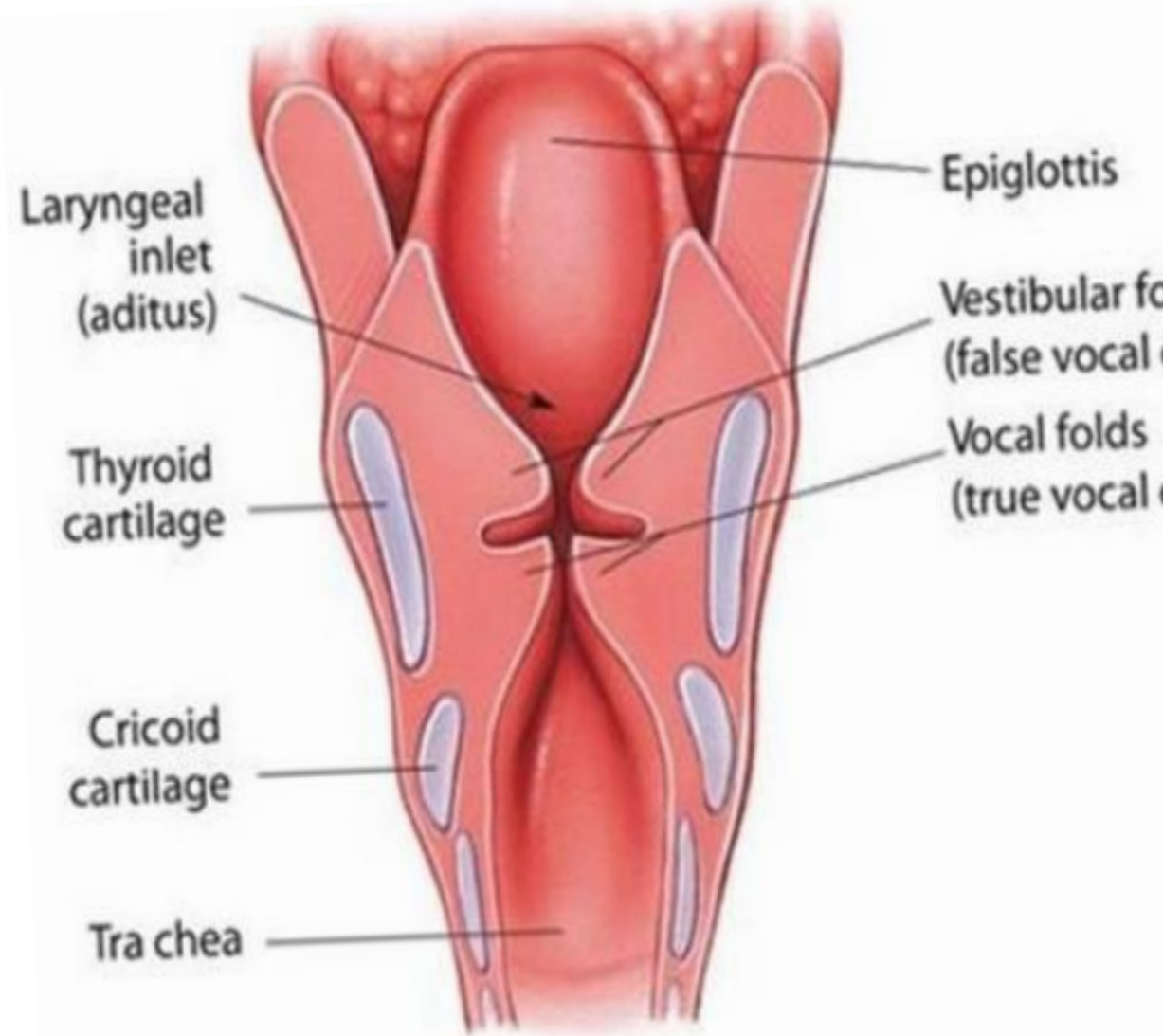
- The epiglottis, corniculate, cuneiform and vocal processes of arytenoids are elastic cartilages

- The epiglottis is an elastic flap of cartilage, which lies behind the tongue and forms the entrance to the larynx. It serves to prevent swallowed food or fluid from entering that passage.

- The mucosa of the anterior surface of epiglottis & vocal cords is nonkeratinized stratified squamous epithelium while the rest of the larynx is lined with


Epiglottis
Hyoid bone
Thyroid cartilage
Corniculate cartilage
Arytenoid cartilage
Cricoid cartilage
Trachea

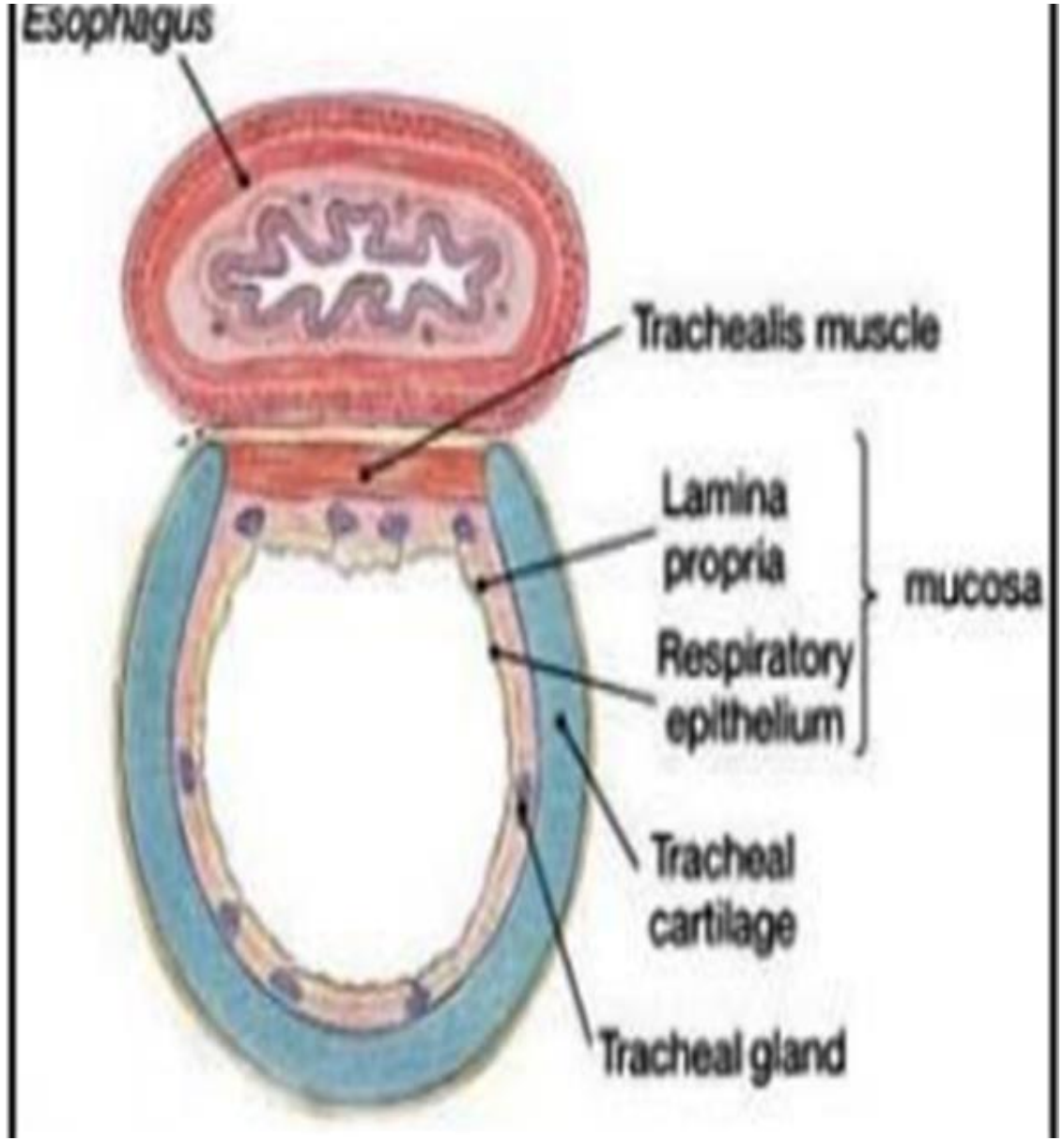

Base of tongue
Epiglottis
Vestibular fold
Vocal fold
(true vocal cord)
Glottis
Inner lining of trachea
Cuneiform cartilage
Corniculate cartilage

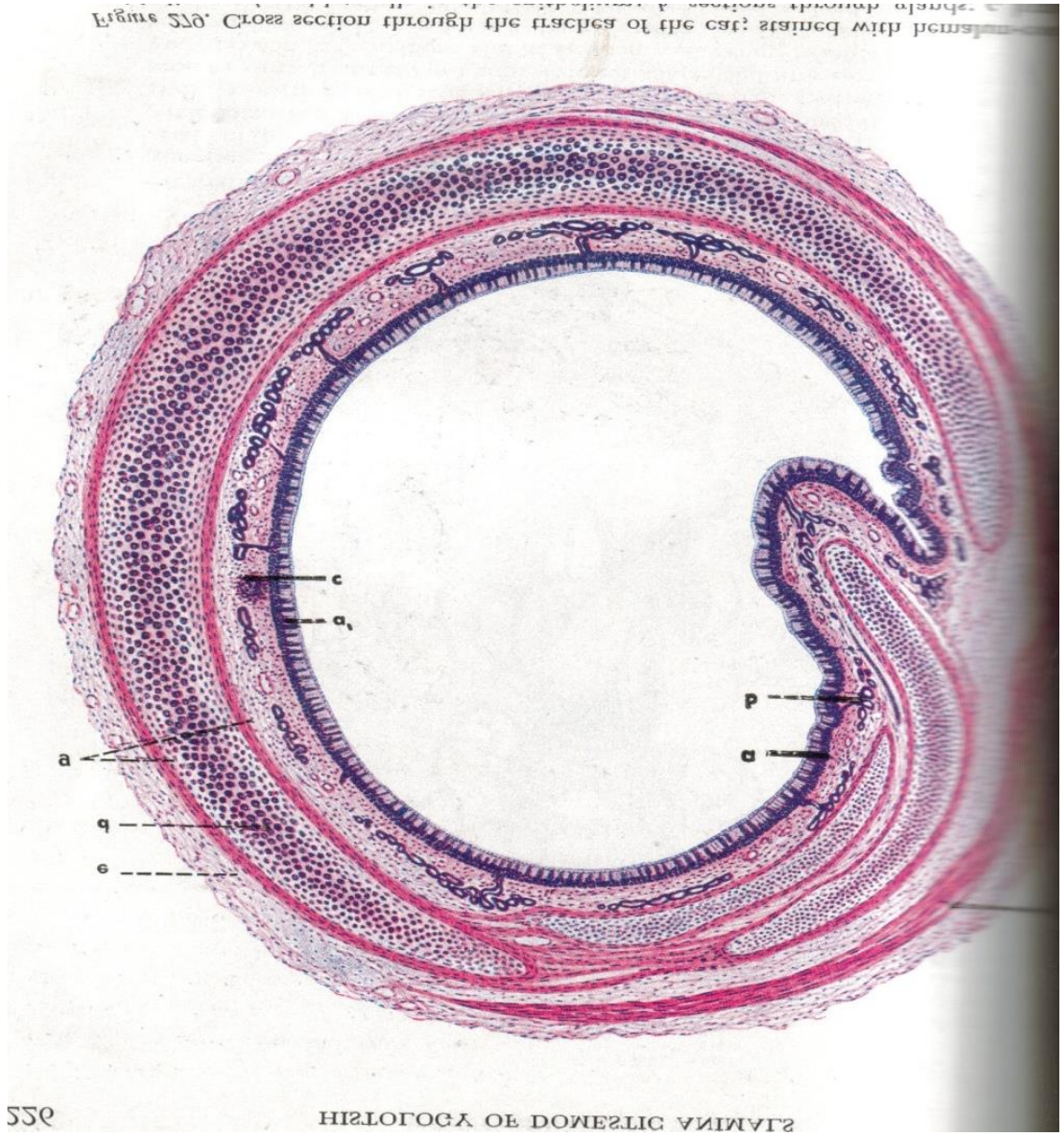

Laryngeal
inlet
(aditus)
Thyroid
cartilage
Cricoid
cartilage
Tra chea
Epiglottis
Vestibular fo
(false vocal
Vocal folds
(true vocal
Posterior view

Trachea

The tracheais a tube lies between the larynx and main bronchi of the lungs. It has a series of20 C-shaped hyaline cartilagerings that keep the tracheal lumen open with aband of smooth muscle(trachealis muscle) over the cartilage-deficient areaposteriorly(i.e. against the esophagus)

The trachea is lined withrespiratory epithelium, which acts as an escalator, wafting particulate matter in the mucus upwards, away from the lower airways.The elastic fibersin the lamina propria prevent excessive distention of the lumen.The lamina propria containsnumerous seromucous (mixed) glands.


Esophagus
Trachealis muscle
Lamina propria
Respiratory epithelium
mucosa
Tracheal cartilage
Tracheal gland


c
a
a
b
c
d
d

- The wall of the trachea consists of 3 definable layers:

- **1. Mucosa:**

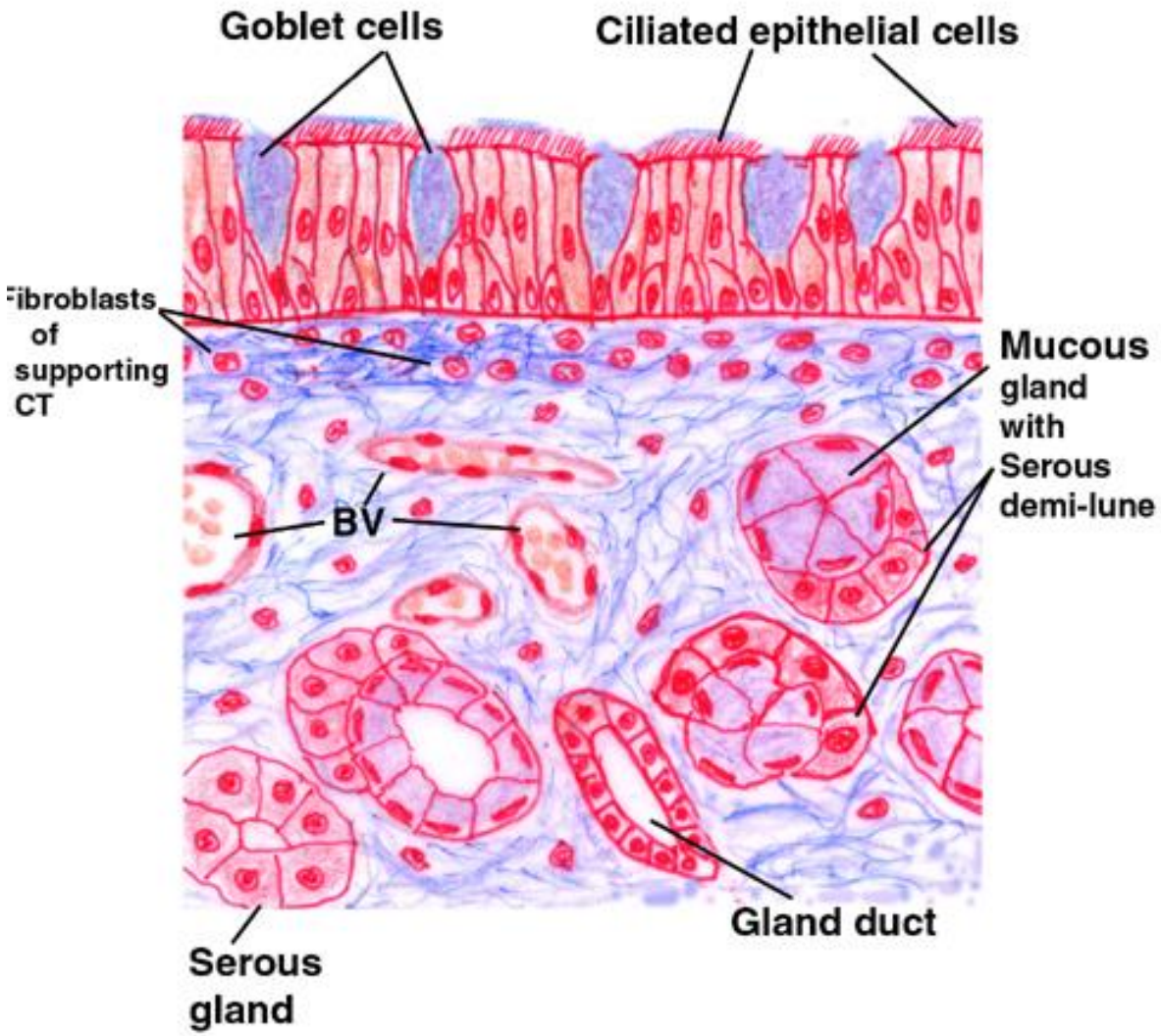
A- Epithelium: **Respiratory epithelium** (pseudostratified columnar ciliated with goblet cells). **six types of cells** could be recognized: ciliated columnar cells, goblet cells, basal cells, brush cells, serous cells and kulchitsky (K) or small granule cells.

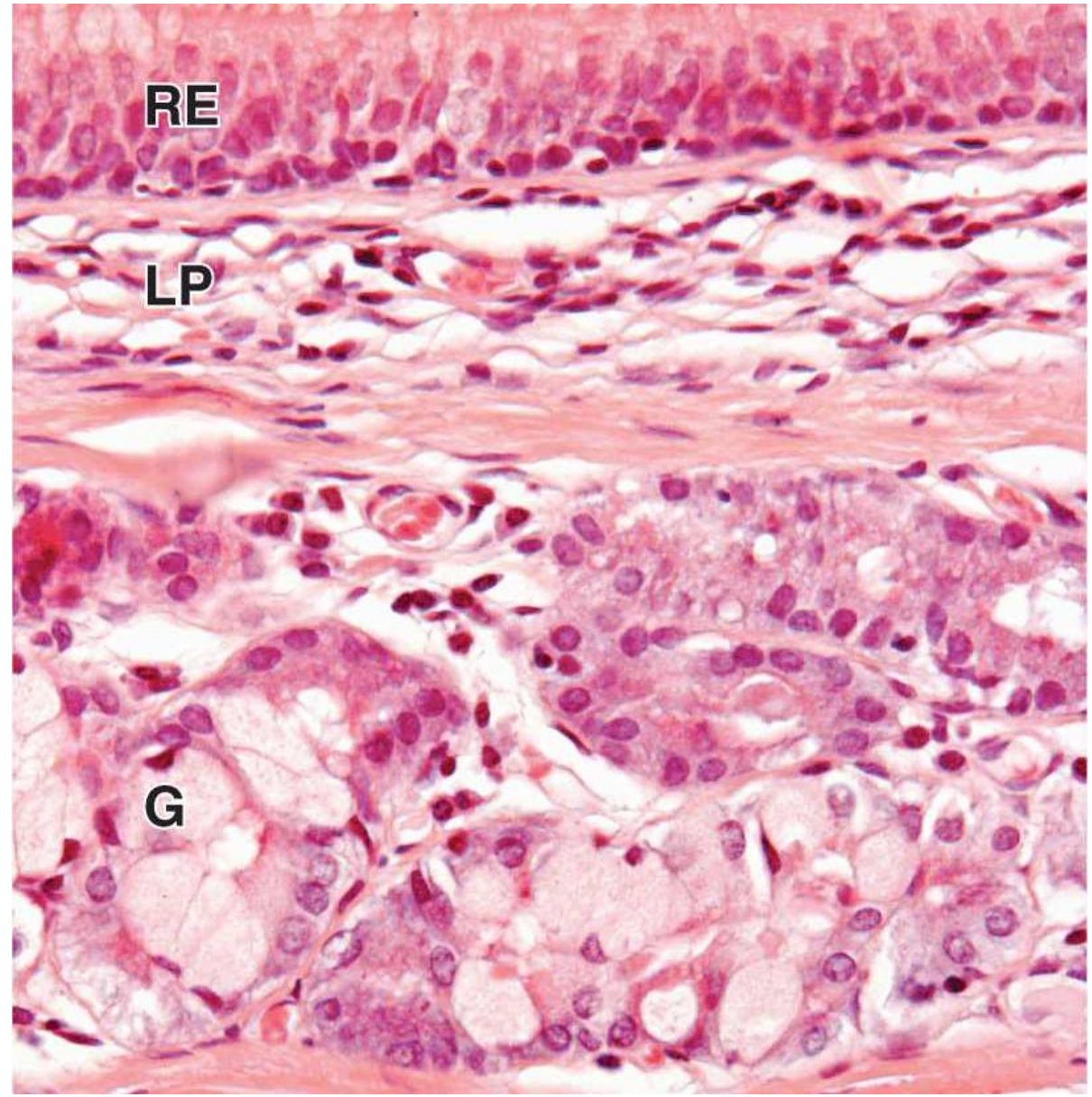
B- The lamina propria: **Loose fibroelastic CT** rich in elastic fibers, lymphocytes, and lymphatic nodules.

C. Lamina elastic interna: The elastic fibers are condensed to form an **elastic membrane** separating the lamina propria from the submucosa. It is responsible for **elastic recoil of the trachea after expiration**.

- **2. Sub-mucosa:** CT layer which contains **mixed glands**. Their **ducts** pass through the elastic membrane to open onto the surface.
-

- **3- Fibro-cartilagenous layer:** Fibroelastic CT containing **20 C-shaped hyaline cartilaginous rings** located anteriorly and laterally, but incomplete posteriorly. **Posteriorly**, the wall of the trachea contains a thick band of transversely arranged bundles **of smooth muscles.**


Goblet cells
Ciliated epithelial cells
Fibroblasts of supporting CT
Mucous gland with Serous demi-lune
BV
Gland duct
Serous gland


RE
LP
G

Respiratory epithelium

- **It is characteristically pseudostratified columnar ciliated with goblet cells.**
- **• This epithelium has five major cell types:**

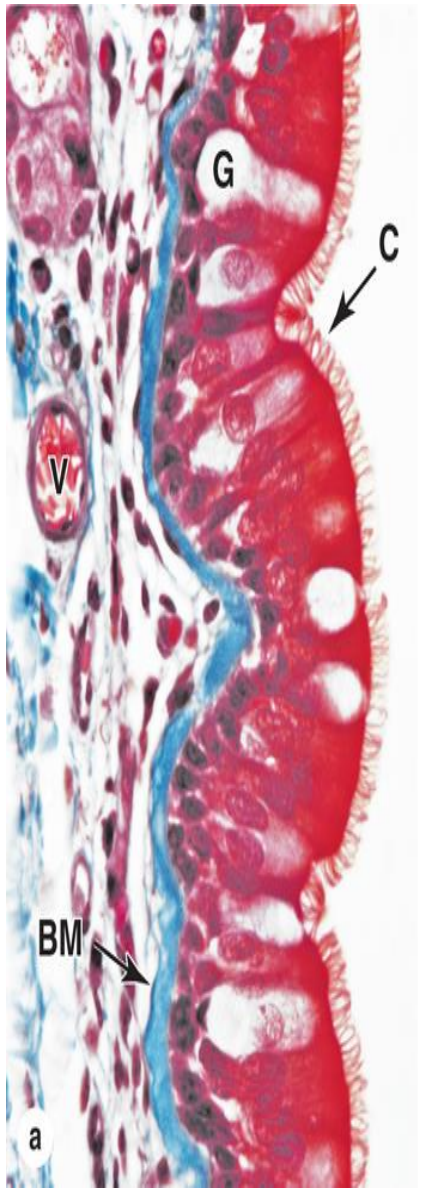
1- Ciliated columnar cells.

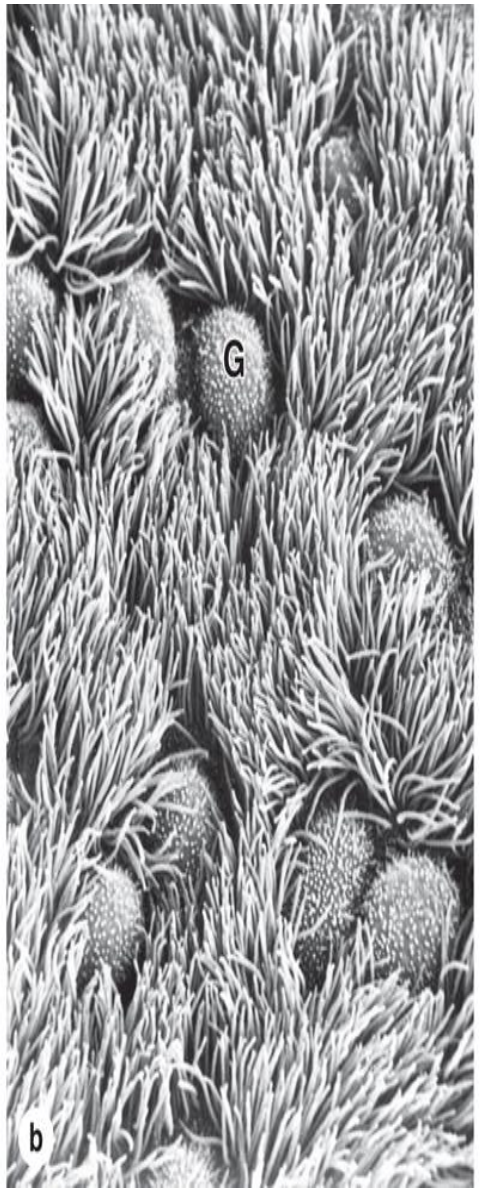
2- Goblet cells.

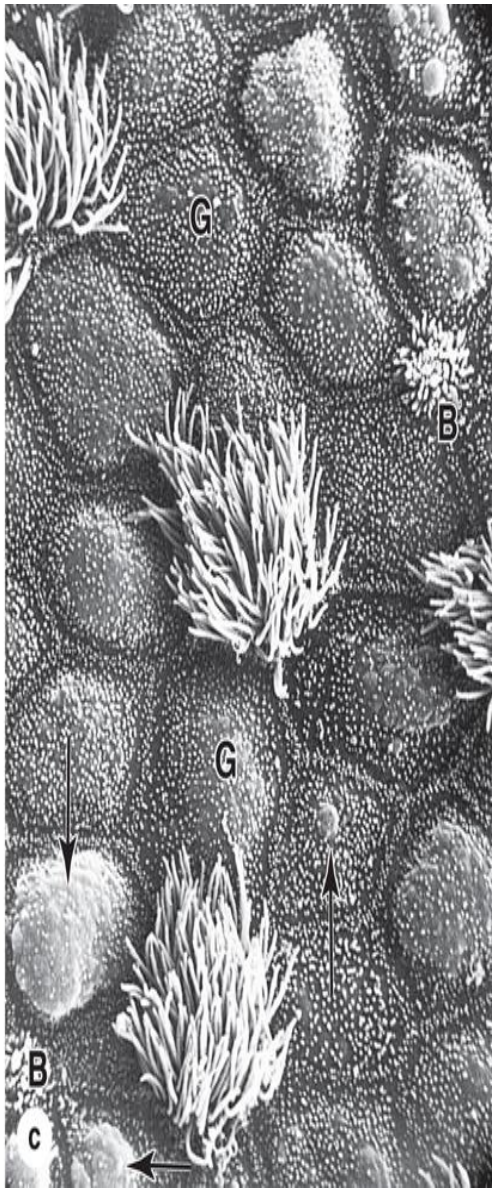
3- Basal cells.

4- Brush cells.

5- Pulmonary neuroendocrine cells





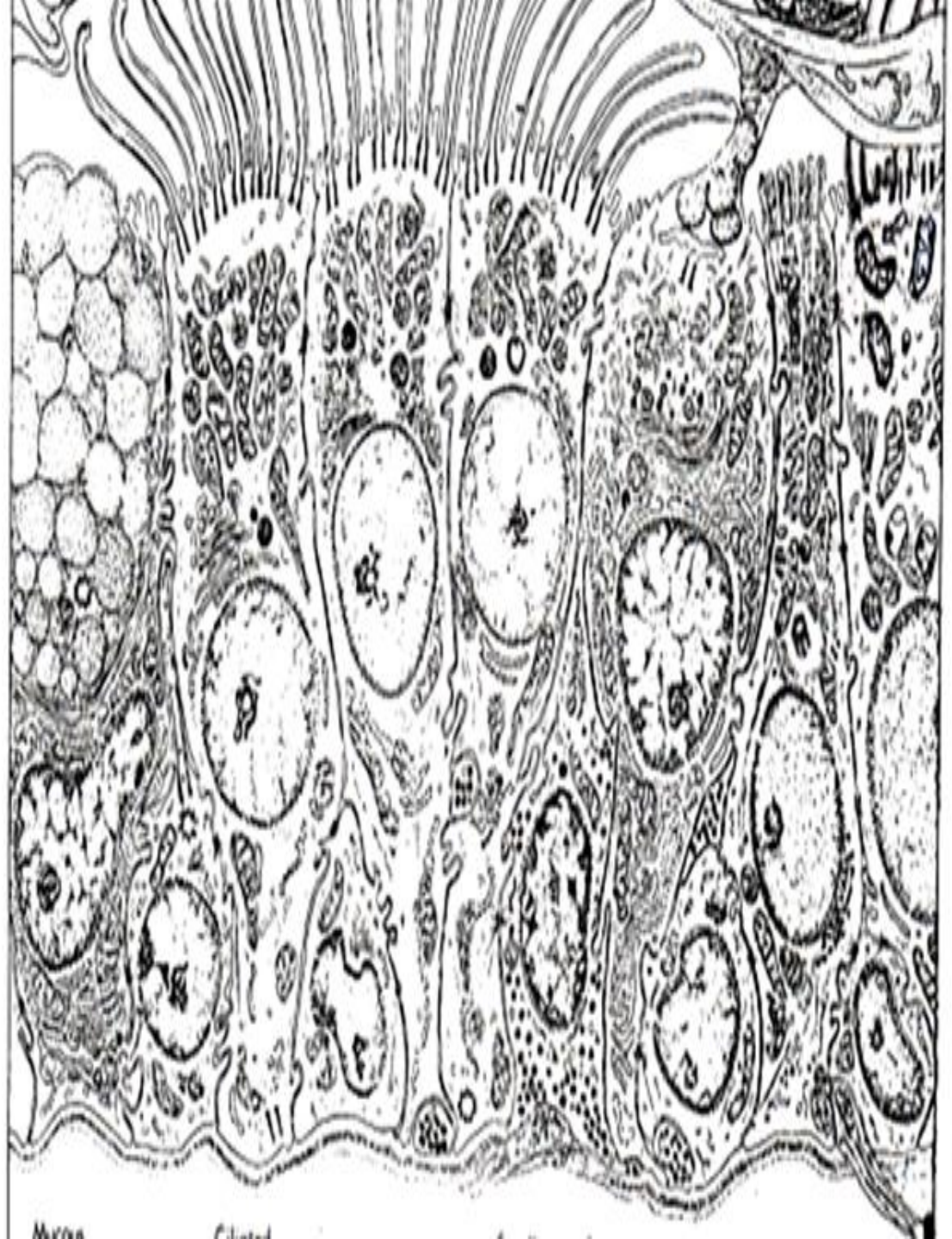


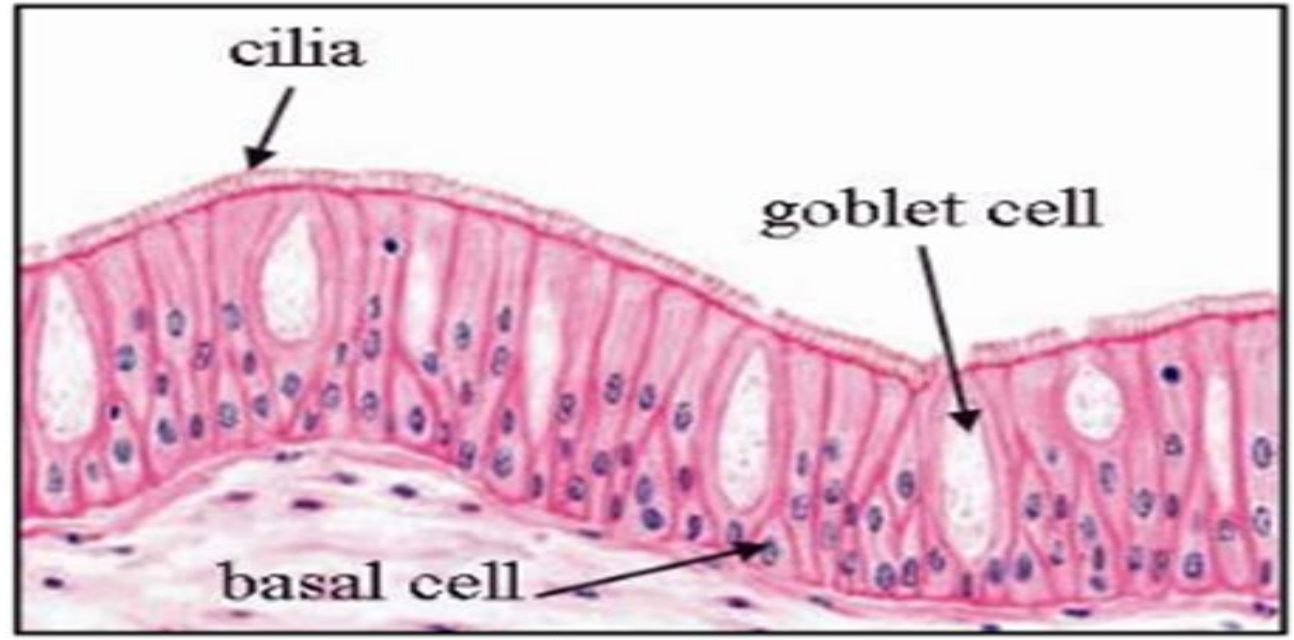
Respiratory System

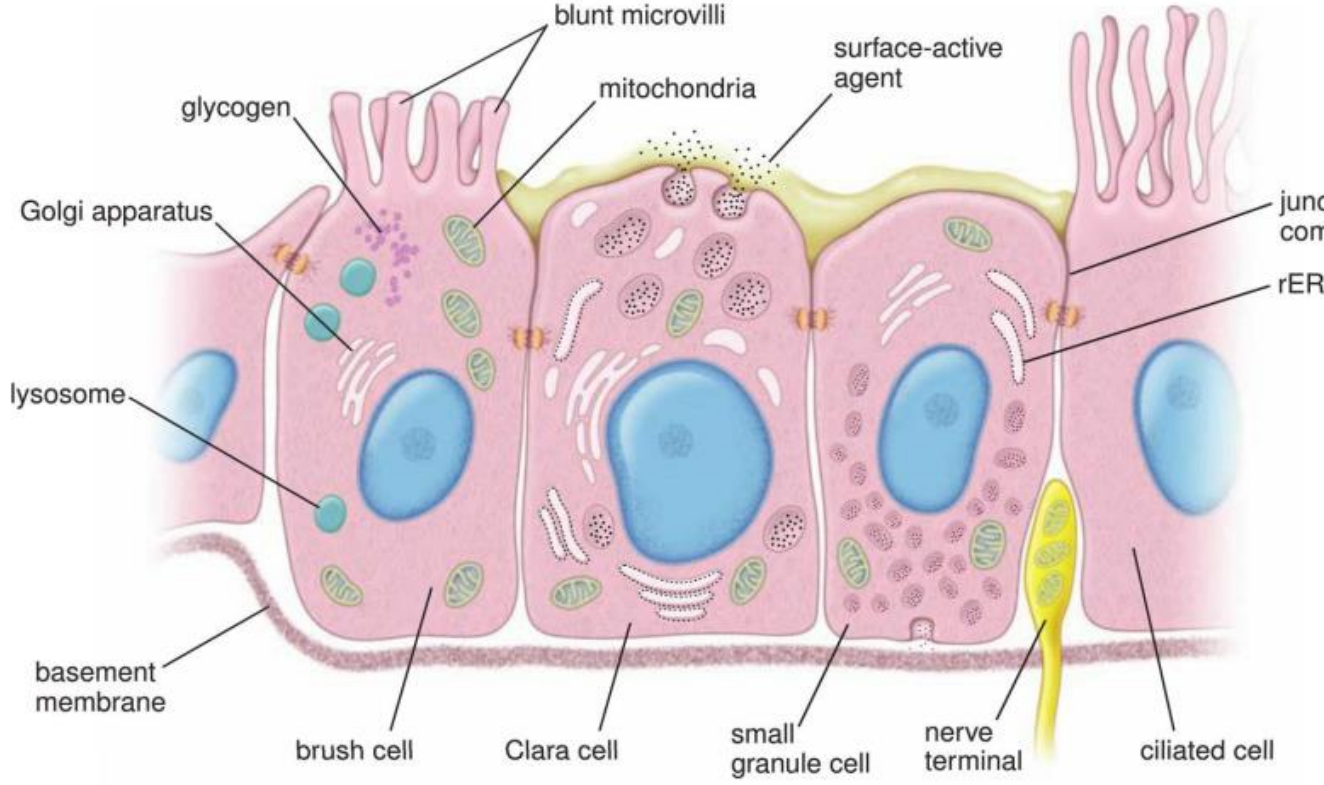
- **Ciliated columnar cells and Goblet cells The beating motion of the cilia and the mucous secretion of the goblet cells make up the "mucociliary escalator" which is important in removing the inhaled particles. This is an**

Pulmonary neurendocrine cells (PNECs) or Kulchitsky (K) or small granule cells

- They are argentaffinlike cells, resemble the enteroendocrine cells of GIT.
- They have neuro-endocrine function, secrete peptides and endocrine factors that may play role in sensing low tissue oxygen and inducing lung growth and repair.
- PNEC hyperplasia lead to small cell lung cancer, is thought to be induced by nicotine.




cilia
goblet cell
basal cell

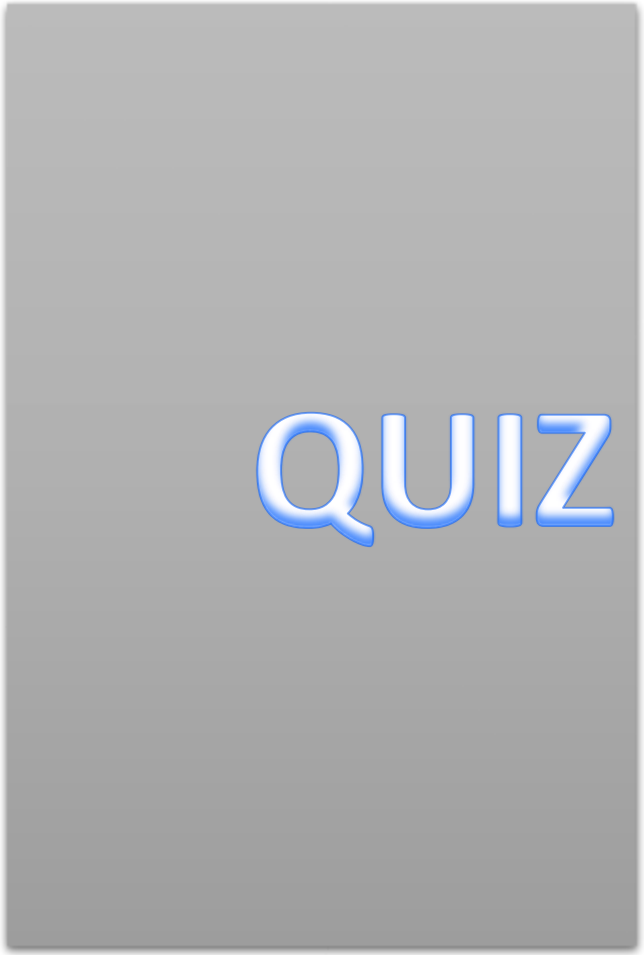

blunt microvilli
surface-active agent
mitochondria
glycogen
Golgi apparatus
lysosome
basement membrane
brush cell
Clara cell
small granule cell
nerve terminal
ciliated cell


I love Histology!

REFERENCES:

JUNQUEIRA'S BASIC HISTOLOGY (TEXT AND ATLAS) (2018) 15 TH EDITION.

ELSEVIER'S INTEGRATED HISTOLOGY (2007) 1ST EDITION.



Choose the correct answer

1- T.S. of the trachea reveals:

a. Multiple plates of cartilage.

b. No cartilage.

c. C-shaped elastic cartilage rings.

d. Compact bone.

e. C-shaped hyaline cartilage rings.

2- The smooth muscle fibers of the trachea are present:

a. In the submucosa.

b. Between the cartilage ends.

c. In the mucosa.

d. Over the cartilage-deficient area anteriorly.

e. Around the lumen