Ministry of Higher Education
& Scientific Research
Al-Muthanna University
Faculty of Pharmacy

وزارة التعليم العالي والبحث العلمي
جامعة المثنى
كلية الصيدلة

First stage

Faculty of Pharmacy

Al-Muthanna University

Second semester of 2023-2024 academic years

Theory Histology

Respiratory System

Lec. (2)

Lecturer Ahmed Adeeb Mohamed Al-Tamimi

The respiratory system subdivided into two principal portions :-

A- ***Conducting portion*** **:** consisting of the nasal cavity , nasopharynx , larynx , trachea , bronchi , bronchioles , and terminal bronchioles **.**

B- The main function of conducting portion :

1- To provide a conduit through which air travel to and from the lungs and to conduction the inspired air, condition of the air before reaching the terminal respiratory units includes , warming , moistening , and removal of particulate materials . These structure components, cilia, glands, goblet cells, blood vessels.

2- To ensure an uninterrupted supply of air.

- The conducting portion has many structural components to condition the air, and other to keep air passages always opened.

Structure components to keep air passages always opened.

- **Smooth muscles fibers** which decrease diameter of tract and regulate air flow.
- **Cartilage** mainly hyaline cartilage which give support to the wall to prevent collapse and rigidity.
- **Elastic fiber** provide flexibility, extensibility to conducting .

C- ***Respiratory portion*****:** consisting of respiratory bronchioles, alveolar ducts, alveolar sac and alveoli.

- Most of the conducting portion is lined with ciliated pseudostratified columnar epithelium is known as **respiratory epithelium**.

Typical respiratory epithelium consists of 5 cell types .

1- ***Ciliated columnar cells*****:** Each cell has about 300 cilia on its apical surface, beneath the cilia , basal bodies , and numerous small mitochondria that supply ATP for ciliary beating for pushes the foreign particles and mucus secretion to the pharynx .

2- ***Goblet cells***: the abundant cells in the respiratory epithelium, the apical portion contain the mucous droplets, which play major role with secretion of glands in the conditioning process, these secretion moisten the air and prevents the dehydration of the underlying epithelium by the moving air.

3- ***Brush cells***: which are columnar cells, have numerous microvilli on their apical surface and have afferent nerve endings on their basal surfaces and are considered to be chemosensory receptors.

4- ***Basal (short) cells***: are small rounded cells that lie on the basal lamina but do not extend to the luminal surface of the epithelium. These cells considered as generative stem cells that undergo mitosis and differentiate into the other cell types

5- ***Small granule cell***: which resembles a basal cell except that it possess numerous granules with dense cores, and these cells diffuse in neuroendocrine system.

Nasal Cavity:

It is consists of two structures, **the external vestibule** and **the internal nasal fossae.**

A. ***Vestibule*** **:** It is the most anterior and dilated portion of the nasal cavity lined with ***stratified squamous epithelium*** , a continuation of the skin of the face . Posteriorly, where the vestibules ends, the ***stratified squamous epithelium*** becomes transition into ***typical respiratory epithelium*** before entering the nasal fossa.

B. ***Nasal fossae*****:** The nasal fossae lie within the skull are two cavernous chambers separated by the osseous nasal septum. Extending from each lateral wall are three conchae.

The nasal fossae divided into two segments:-

1- ***Respiratory Segment*** **:** The middle and inferior projection conchae are covered with respiratory epithelium

2- ***Olfactory Segment*** **:** The superior conchae are covered with olfactory epithelium

It is a pseudostratified columnar epithelium composed of 3 types of cells:

1- ***Supporting cells*****:** Columnar cells, have broad, cylindrical apexes and narrower bases and have oval nucleus near the apical part and on their free surfaces are microvilli, the supporting cells to the adjacent olfactory cells, It is contain a light yellow pigment that responsible for the color of the olfactory mucosa, and these cells provide mechanical and metabolic support to the olfactory cells.

2- ***Basal cells (stem cells)*** **:** are small & spherical or cone shaped & form a single layer at the base of the epithelium , but don't reach the surface , they have oval centrally located nucleus these cells differentiate to supporting and olfactory cells.

3- ***Olfactory cells*****:** Bipolar neurons distinguished from supporting cells by the position of their nuclei, which lie below the nuclei of the supporting cells . Their apexes posses elevated & dilated area (olfactory vesicles) from which arise 6 to 8 cilia . These cilia are very long & nonmotile and respond to odoriferous substances increase the receptor surface. The afferent axons of these cells unite in small bundles and synapse with neurons of the brain (olfactory lobe).

The lamina propria possesses serous glands the ***glands of Bowman*** produces a fluid environment via ducts around the cilia , that may be ***clear the cilia*** , ***facilitating the access of new odoriferous substances*** **.**

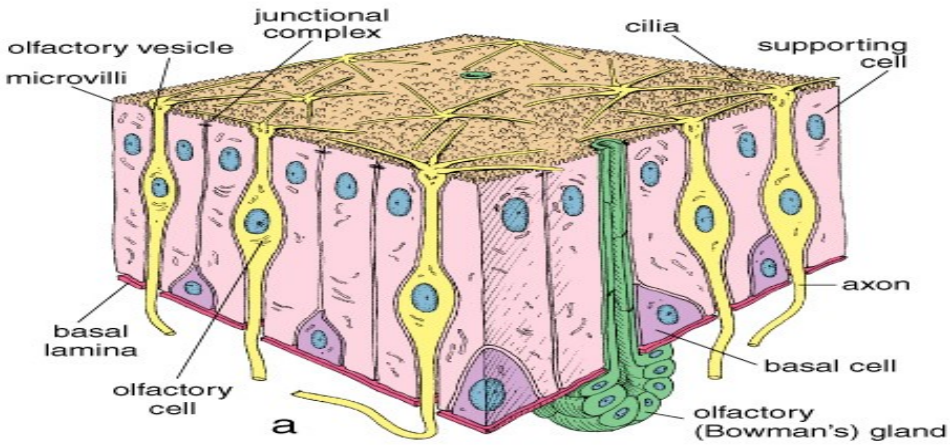


Figure 18.3a. **Diagram of the olfactory mucosa of the nasal cavity.**

Larynx **:** The larynx is an irregular tube that connects the pharynx to the trachea and within the lamina propria lie number of *laryngeal cartilages* .

3- The larger cartilages (thyroid, cricoids and most of the arytenoids) are hyaline cartilages.

4- The small cartilages (epiglottis, cuneiform, corniculate and the tips of the arytenoids) are elastic cartilages.

- *The epiglottis* which projects from rim of the larynx extends into the pharynx and has both a lingual & a laryngeal surface .

The entire lingual surface and the apical portion of the laryngeal surface are covered with ***stratified squamous epithelium*** .

Toward the base of the epiglottis on the laryngeal surface, the epithelium undergoes a transition into ***ciliated pseudostratified columnar epithelium*.**

Trachea :

It is a short air tube about 2.5 cm in diameter and about 10 cm long .

***The wall of trachea is composed of 4 layers* :**

A- ***Mucosa* :** It's lining with typical respiratory epithelium.

lamina propria is composed of **loose C.T**. layers& numerous ***seromucus glands*** that produce a more fluid mucus and rich with **elastic fibers** .

B- ***Submucosa* :** Dense irregular C.T. houses mucous & seromucus glands, rich lymphatic elements & blood vessels & composed of 16-20 C-shaped hyaline cartilages, that keep the tracheal lumen open . The open ends of these cartilage rings are located on the posterior surface of the trachea A fibroelastic ligament & bundle of smooth muscle(***trachealis muscle***) bind to the perichondrium & bridge the open ends of these C-shaped cartilages. The ligament prevents over distension of the lumen and the muscle allows regulation of the lumen**.**

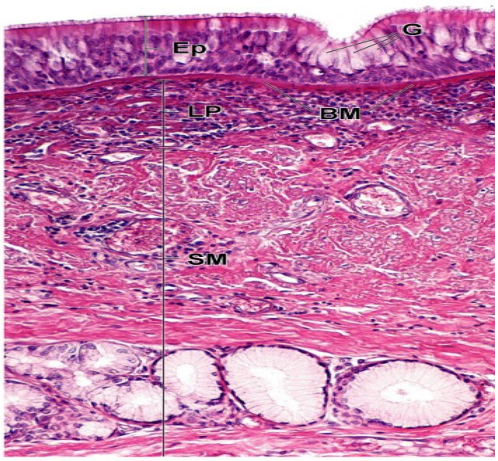


Figure 18.8. **Photomicrograph of tracheal epithelium.** *G*, goblet cells; *BM*, basement membrane; *LP*, lamina propria; *SM*, submucosa.

C- ***Adventitia* :** Dense C.T. that binds trachea to adjacent structures in neck & mediastinum & contains the largest blood vessels & nerve, large lymphatic vessels .

BRONCHEAL TREE

primary bronchi

The trachea divided in two primary bronchi, that enter the lungs at the hilum, primary bronchi resemble the trachea in histological structure except that the cartilage is a complete ring and the diameter is smaller.

Secondary* (lobar) *bronchi

The secondary bronchi are completely surrounded by lung tissue and divide forming tertiary (segmental) bronchi.

The bronchi are lined by ***respiratory epithelium*** with ***goblet cells***. the height of the cells decrease as the bronchi decrease in diameter .

the lamina propria contain a *smooth muscle* layer which becomes more prominent near the respiratory zone, while the amount of cartilage diminishes.

The lamina propria is relatively *loose C.T.*, rich in elastic fibers & mucous & serous glands & numerous lymphocytes, lymphatic nodules.

The C-ring cartilage of trachea are replaced by irregularly shaped hyaline cartilage plates distributed in a linear array around the entire circumference of the wall, giving the bronchi a circular or cylindrical shape, these cartilage plates become smaller as the bronchial diameter diminishes, when the diameter of bronchi decrease, the cartilage plates disappear from conducting passage ways .

Dense C.T. collagenous Connects the perichondrial of the cartilage plates .

Bronchioles *:*

The bronchioles represent the terminal portion of the conducting passage ways , its intralobular airways with diameter of 5 mm or less , have ***neither cartilage*** , ***nor glands*** in their mucosa , the large bronchioles are lined by ***ciliated pseudostratified columnar*** with scattered **goblet cells** lines the lumen , but this decrease in height & complexity to become ***ciliated simple columnar epithelium or cuboidal epithelium*** in the smaller terminal bronchioles . The lumen shows mucosal folds caused by the contractions of the surrounding smooth muscle .

Terminal Bronchioles :

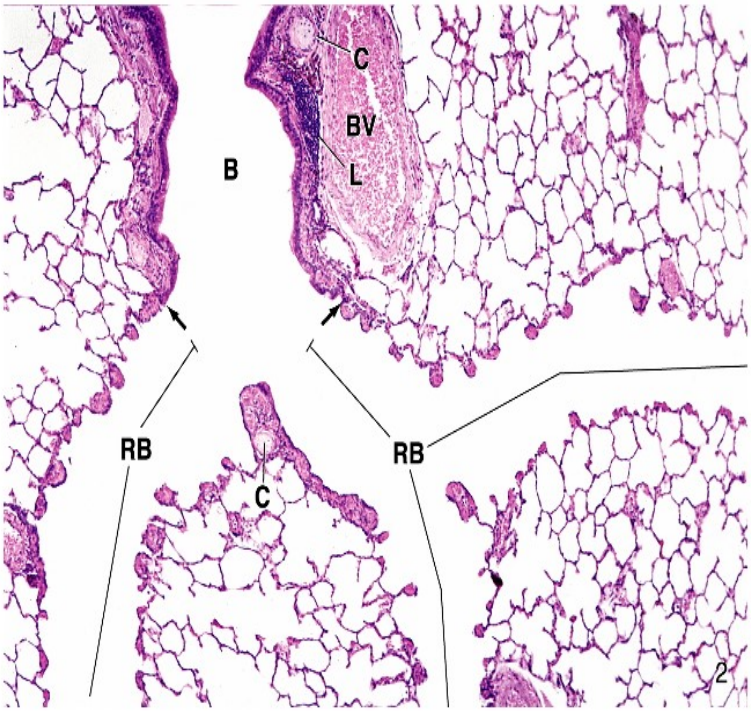
The terminal bronchioles are usually less than 0.5 mm in diameter. The lumen is lined by ***ciliated simple columnar or simple cuboidal epithelium*** (some ciliated) interspersed with ***Clara cells*** but are **not present the goblet cells**. **Clara cells** increase in number as the ciliated cells decrease along the length of the bronchiole. occasional **brush cells** & **small granule cells** are also present . **Clara cells** are non-ciliated cells that have a characteristic rounded or dome-shaped apical surface projection . They have a well – developed rER, Golgi apparatus, secretory granules, and numerous cisternae of SER in the apical cytoplasm. Clara cells secrete a ***surface – active agent***, a lipoprotein, that ***prevent luminal adhesion*** should the wall of the airway collapse on itself & ***protect*** the bronchiolar lining against oxidative pollutants & inflammation.

The bronchiole exhibit specialized regions called ***neuroepithelial bodies*** these formed by groups of 80 – 100 cells, the probably *functions* for these bodies as ***chemoreceptors*** that react to changes in gas composition within the airway and also seen in the ***reparative process*** of airway epithelial cell renewal after injury.

The lamina propria is composed a thick layer of smooth muscle & elastic fibers .

Respiratory bronchioles

The terminal bronchiole subdivided into two or more respiratory bronchioles, that serve as regions of transition between the conducting & respiratory portions of the respiratory system. The respiratory bronchioles mucosa is structurally identical to that of the terminal except that their walls are interrupted by numerous **sac like alveoli** where gas exchange occurs.



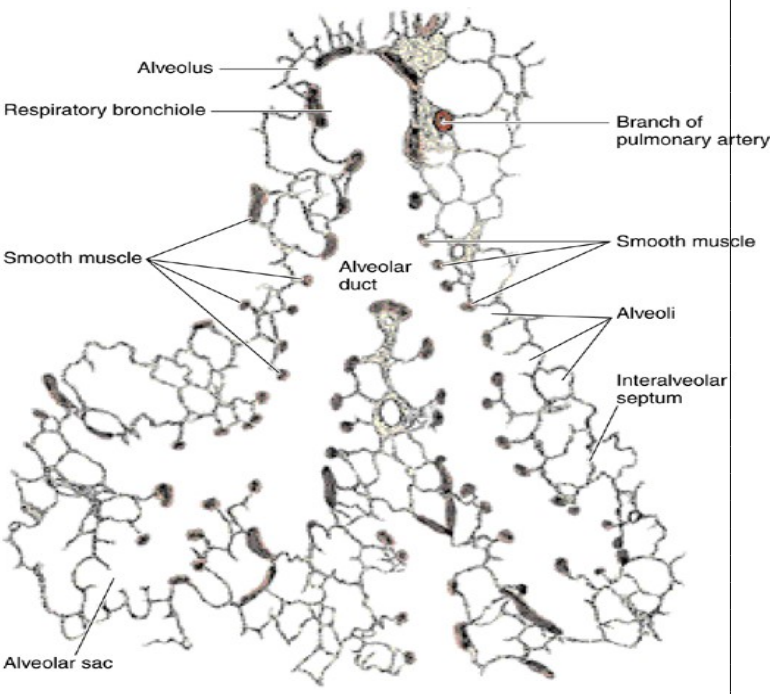
Portions of the respiratory bronchioles are lined with ***ciliated cuboidal epithelial cells*** and

Clara cells, occasional ***brush cells*** and dense core ***granule cells*** are also present, but at the rim of the alveolar openings the bronchiolar epithelium becomes continuous with the squamous alveolar lining cells (type I alveolar cells) .

Distally along these bronchioles, the alveoli increase greatly in number .

Smooth muscle & elastic C.T. lie beneath the epithelium of respiratory bronchioles .

Alveolar ducts



Alveolar ducts are elongate straight tubes lined by ***simple squamous epithelium*** (squamous alveolar cells) that have almost ***no walls***, only alveoli as their peripheral boundary. In ***the laminae propria*** surrounding the rim of the alveoli is a network of smooth muscle cells , these sphincter like smooth muscle bundle appear as ***knobs*** between adjacent alveoli , the smooth muscle disappears at the distal ends of alveoli ducts . A rich matrix of elastic fibers & reticular fibers provides the only support of the duct and its alveoli . Alveolar ducts open into ***atria*** that communicate with ***alveolar sacs*** , two or more of which arise from each atrium . Elastic & reticular fibers form a complex network encircling the openings of **atria** , **alveolar sacs** & **alveoli** .

- **The elastic fibers** enable the alveoli to expand with inspiration and to contract passively with expiration .
- **The reticular fibers** serve as a support that prevents over distention & damage to the delicate capillaries & thin alveolar septa .

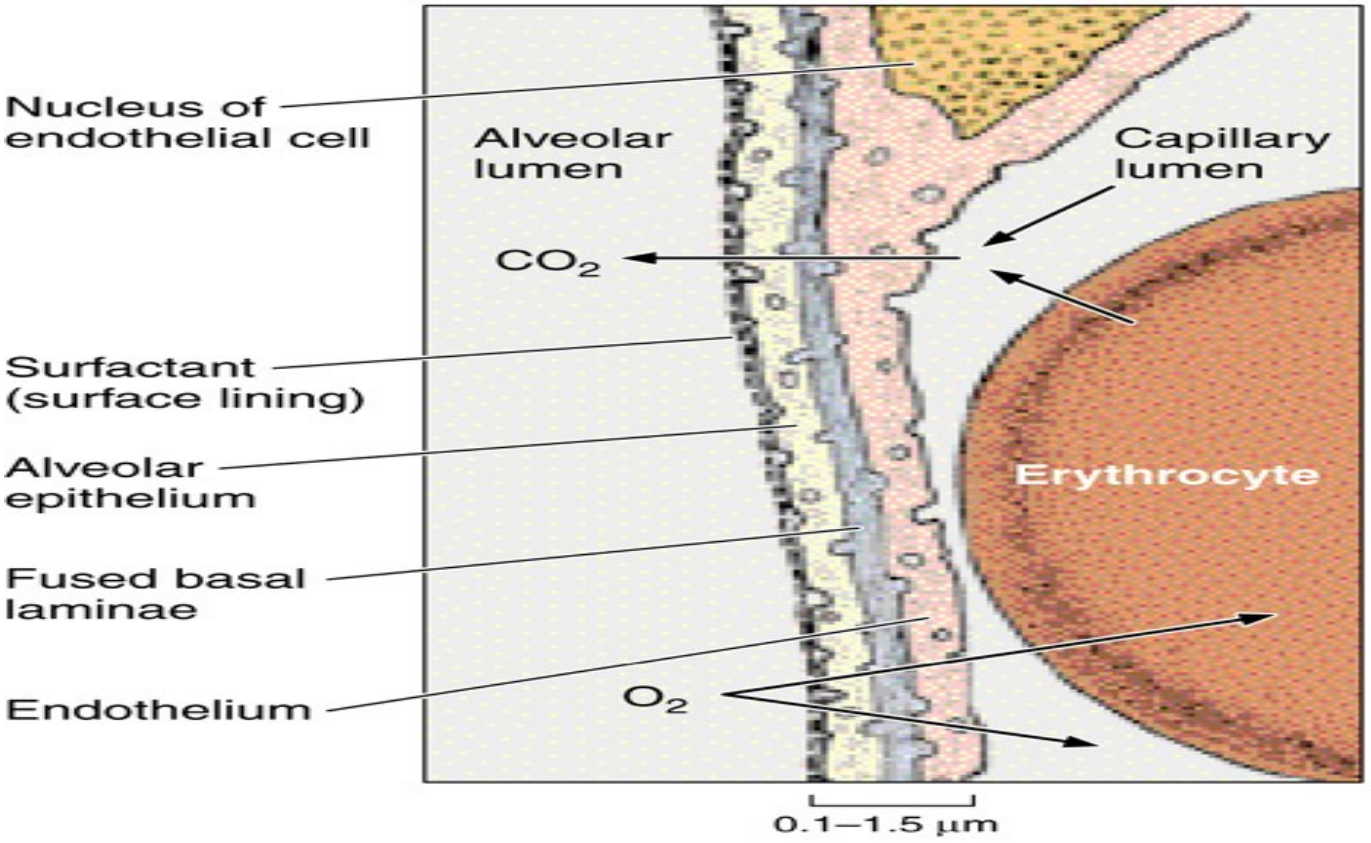
Alveoli

The alveoli are saclike evaginations (about 200 µm in diameter) of the *respiratory bronchioles , alveolar ducts , and alveolar sacs* . Alveoli are responsible for the spongy structure of the lungs . Structurally alveoli resemble small pockets that are open one side . within these CUP like structures , O_2 & CO_2 are exchange between the air and the blood .

- The wall lies between two neighboring alveoli called an ***interalveolar septum*** which consists of two ***thin squamous epithelial layers*** between which lie pulmonary capillaries, elastic & reticular fibers & C.T. matrix & cells .
- The air in the alveoli is separated from capillary blood by three components as ***blood-air barrier*** :-

- The surface lining & cytoplasm of the alveolar cells .
- The fused basal laminae of the closely apposed alveolar & endothelial cells
- The cytoplasm of the endothelial cells.

The total thickness of these layers varies from 0.1 to 1.5 µm.



The cells in the interaliveolar septum

- ***Capillary endothelial cells*** which are *continuous & not fenestrated*.
- ***Type I cell*** , or ***squamous alveolar cells*** or ***type I pneumocytes*** which line the alveolar surfaces & make up 97 % of the alveolar surface which form an ***effective barrier*** between the air space & the septa wall that **prevent** the leakage of tissue fluid into the alveolar air space and provide a ***barrier of minimal thickness that is readily permeable to gases.***
- ***Type II cells*** or ***Type II alveolar cells*** or ***Type II Pneumocytes*** or ***septal cells***, they form only 3% of the alveolar surface are *secretory cells* , these *cuboidal cells* & divided by **mitosis** to replace their own population, also *providing* an extra alveolar coating, ***surfactant***, which serves several major **functions** *primarily aids in reducing the surface tension of the alveolar cells , activity participates in the clearance of foreign materials , surfactant proteins help organize the surfactant layer and modulate alveolar immune responses.*
- ***Alveolar macrophages***

Also called ***dust cells*** are found in the interior of the interalveolar septum & are often seen on the surface of the alveolus.

Alveolar pores

The interalveolar septum contains pores, 10 – 15 μm in diameter that connect neighboring alveoli. These pores equalize air pressure in the alveoli & promote the collateral circulation of air when a bronchiole is obstructed.

Pleura

It is the serous membrane covering the lung which consists of two layers, parietal & visceral, that are continuous in the region of the hilum. Both membranes are composed of ***mesothelial cells***.