

Co and Benjamin
Laboratory Manual in Animal Histology
2nd Ed

Laboratory Manual in Animal Histology (Biology 134)



**Department of Biology
College of Arts and Sciences
University of the Philippines Manila**

**Elisa L. Co, Ph.D.
Kimberly S. Beltran-Benjamin, M.Sc.**

EXERCISE 9: THE RESPIRATORY SYSTEM

Introduction

The respiratory system is responsible for the rapid and continuous supply of oxygen to man. The exchange of gases between man and the external environment occurs via the respiratory system.

Objectives

At the end of the exercise, the students should be able to:

1. differentiate the histological features of the conducting portion from the respiratory portion of the respiratory system; and,
2. identify the different structures and cells associated with the organs and correlate their functions.

I. The two main portions of the respiratory system.

A. The conducting portion – a series of rigid tubular organs that convey oxygen to the lungs and carbon dioxide to the opposite direction.

1. Nose – pyramid-like hollow organ for the entry and exit of gases. It is soft but flexible and consists of two parts:

- ❖ Vestibule – large chamber behind the anterior nares.
- ❖ Mucosa – thick stratified squamous epithelium which is keratinized and with long stiff hairs, sebaceous and sweat glands.

The respiratory epithelium is lined with pseudostratified columnar epithelium associated with numerous goblet cells. This olfactory epithelium is the organ of scent and composed of three cell types:

a. Sustentacular cells – tall cells with tapered basal cytoplasm and central ovoid nucleus. The broad apical cytoplasm bears many long striated borders. These are the most numerous cell type and function for the support of the other cells.

b. Olfactory cells - fusiform cells with round nuclei below the level of Sustentacular nuclei. They are interspersed evenly among the Sustentacular cells. At the apical ends of these bipolar neurons are bulbous structures called olfactory vesicles formed by a cluster of short fine dendrites from which 6-8 olfactory hairs or cilia arise. These long and non-motile cilia are the actual receptors of scent. The basal ends of these sensory cells thinned out to form long axons which fused into a bundle of fila olfactoria in the lumen of the organ. This communicates with olfactory bulb of the brain via cribriform plate of the ethmoid bone.

c. Basal cells – short, pyramidal cells with round nuclei between the two cell types. They are believed to serve as the stem cells to replace the supporting cells.

Lamina Propria – thick layer of connective tissue fibers and cells associated with serous Bowman's glands. The watery secretion of this gland form a film of solvent for odoriferous substances.

Venous sinuses – large oval structures filled with blood. They are thin-walled vessels that are cavernous and erectile tissue.

Glands - maybe serous, mucous, or mixed glands.

2. Larynx – a short tube between the pharynx and trachea. It is commonly known as the voice-box by virtue of its function in phonation.

a. Mucosa – there are three types depending upon the location:

- ❖ **Stratified squamous nonkeratinized epithelium**- in the exposed surfaces.
- ❖ **Pseudostratified ciliated columnar epithelium** – below the vocal cords.
- ❖ **Stratified ciliated columnar epithelium**- between the two aforementioned types.

b. Lamina Propria – mainly elastic fibers with sero-mucous glands and diffused lymphatic tissue and lymph nodules.

c. Vocal Folds – pairs of apposed mucous membranes which project into the lumen.

d. False Vocal Cords – the upper pair composed of stratified squamous epithelium and lamina propria of loose connective tissue.

e. True Vocal Cords - lower pair of folds with the same epithelium as the false vocal cord. Its lamina propria, however, is dense connective tissue with striated muscles.

f. Cartilaginous walls - supporting elements that maintain the patency of the larynx. Thyroid, cricoids, and arytenoids are the large hyaline cartilages while the smaller ones are of the elastic type. **What are they called?**

3. Trachea - thin-walled yet pliable tube supported by cartilages. In the upper thorax, this tube readily bifurcate into two smaller tubes or bronchi which enter the lungs. The lumen of this organ appears D-shaped in transverse section.

a. Mucosa - lined by pseudostratified ciliated columnar epithelium with thick basement membrane.

- ❖ **Columnar cells** – constitute the majority of the cells, they have long cilia that beat upward towards the pharynx. Note the dense line just below the cilia, **what is it called?**
- ❖ **Goblet cells** - interspersed among the columnar cells and appear light and dilated. Their nuclei are flattened and located at the base and usually indistinct.
- ❖ **Basal Cells** – somewhat pyramidal in shape and have round nuclei at the base.

b. Lamina Propria – mainly reticular fibers with numerous lymphocytes. It contains muco-serous glands.

c. Submucosa – is loose connective tissue with abundant tracheal glands of the mixed type. Blood and lymphatic capillaries are numerous.

d. Adventitia - composed of a series of oval-shaped rings of hyaline cartilages. These stain metachromatically and are so large. Between the end of these cartilages are bands of circular smooth muscles with fibroelastic connective tissue.

4. Bronchi - paired tubes that divide repeatedly inside the lungs. The two main branches are called primary bronchi, the right and left bronchi. They have the same histological features as the trachea but exhibit gradual reduction in the size and number of components during the course of repeated subdivisions.

a. Intrapulmonary bronchus – has folded mucosa and appears to have a wavy luminal outline. The hyaline cartilages are beginning to be smaller and occur as irregular plates of cartilages. Bundles of smooth muscles are disposed in open spiral around the bronchus. They are mingled with elastic fibers such that contraction of the muscles leads to the folding of the mucosa.

b. Terminal Bronchus – has a diameter of about 0.5 mm. The smallest branch of the series of bronchi lined with ciliated columnar epithelium with few and small cartilages.

5. Bronchioles – large, oval structures with wavy or folded lumen. These are characterized by the absence of cartilages, glands and lymph nodes.

- ❖ **Mucosa** – simple ciliated columnar epithelium with few goblet cells that disappear completely towards the smallest branch. The smooth muscles become more prominent as they form a complete layer around the mucosa.

a. Terminal Bronchiole – lined with simple cuboidal epithelium and patches of ciliated cells. Has a small diameter with round or wavy outline.

❖ **Clara cells** – large, dome-shaped cells associated with the cuboidal cells.

b. Respiratory Bronchiole – a short tube (1-4 mm long) continuous with the terminal bronchiole and leading to one or two smaller tubes, the alveolar ducts. This appears as parallel layers with alternating thick and thin walls.

❖ **Mucosa** – simple squamous epithelium lined the walls of the organ. This appears like concavity or C-shaped wall supported by elastic fibers with bundles of smooth muscles. The latter constitute the protruding ends or “knobs” of the thin walls. Closer examination of these walls reveals that they actually form the other half of the alveoli which lie side by side with these tubes.

6. Alveolar Duct – appears as long, thick tube continuous with the respiratory bronchiole.

❖ **Mucosa** – thin layer of simple squamous epithelium that appears like a lacy “hallway”. In longitudinal sections, it resembles a “doorless rooms”. The two layers seem to be composed of concaves that face each other. On the distal side of the hallway are three to four alveolar sacs.

1. **Alveolar Sac** – a cluster of 3-5 alveoli that open into a common atrium. It is continuous with the alveolar duct.
2. **Alveoli** – small polyhedral bodies that appear like a delicate lacework. Under HPO, focus on one alveolus and identify the cells that composed it.

Type I Cell or Squamous alveolar cell- flat and thin cell that surround the air space inside. The nucleus is large and basophilic, hence, much visible than its cytoplasm.

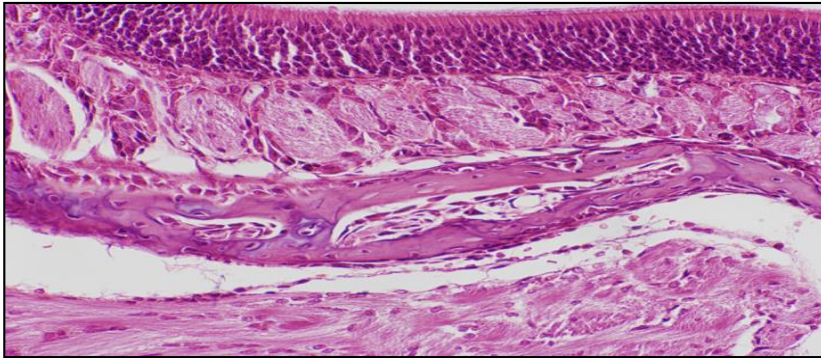
Type II Cell – large cell with “frothy” cytoplasm and dense nucleus. This may occur singly or in group of two to three at the corners of the alveoli.

What is the function of this cell?

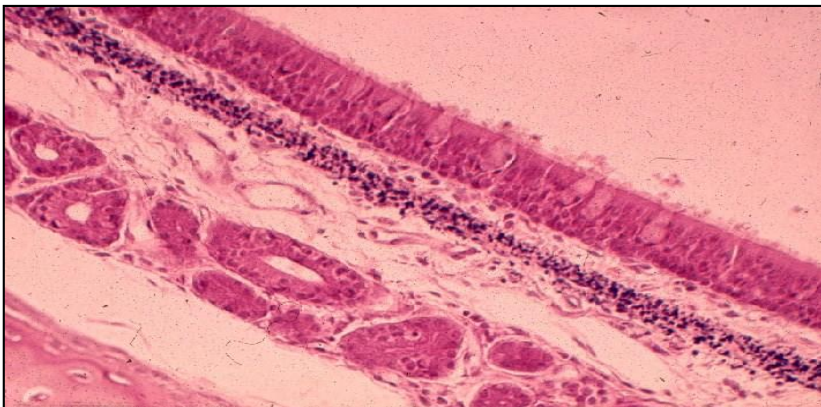
Dust Cell - very large cell that appear light and found between the alveolar walls or within the alveoli.

Capillary cell – endothelial cell lining the capillary. It is closely apposed with the walls of the alveoli. This can be identified by the presence of blood cells inside its lumen.

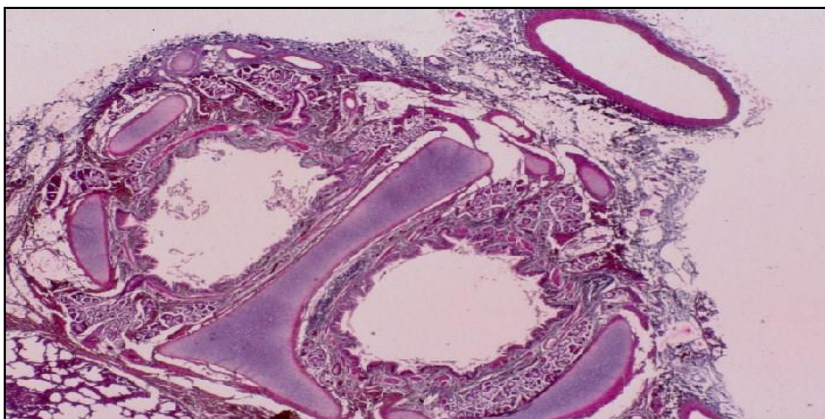
Illustrations



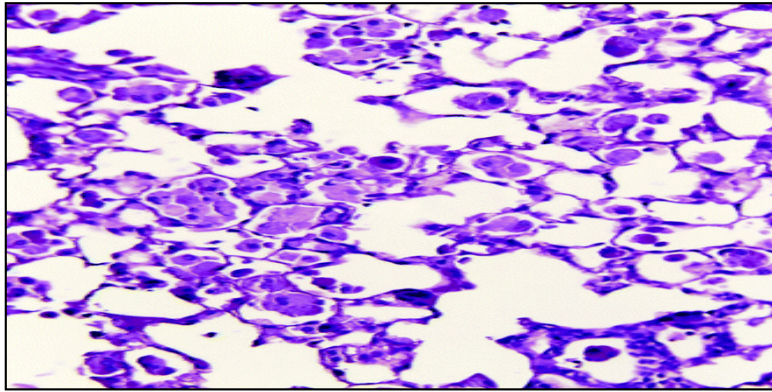
Olfactory epithelium



Trachea



Bronchus



Lungs showing the alveoli



Larynx

Guide Questions

1. What structural features distinguish the following pair of organs?

a. Larynx from trachea

b. Bronchus from bronchiole

c. Alveolar duct from alveolar sac

2. What is the blood-air-barrier? Give the structural basis and functional significance of this to human.

3. Draw and label the following cells:

a. Olfactory Cell

b. Clara cells

c. Pneomocyte Type I

d. Pneomocyte Type II

e. Dust cell