Exercise 10
Respiratory System

Objectives

After completing the laboratory exercise of the respiratory system, you should be able to:

- Identify – typical respiratory epithelium and olfactory epithelium in microscopic preparations.
- Identify – the microscopic appearance of the trachea in mammals and distinguish it from bronchi and bronchioles.
- Identify – the cell types found in the airways and the gas exchange regions of the respiratory system.

Introduction

The respiratory system includes all those structures involved in inhalation of air, gas exchange, and exhalation of CO\(_2\). It also includes the anatomic and histologic structures associated with the chemoreceptor sense of smell. In this exercise we'll examine the histologic features of the nose, the epiglottis and the larynx, the trachea, bronchi, and the lungs.

Nose

The nose is the first place where you'll encounter typical respiratory epithelium, usually abbreviated as "TRE." This term refers to a sheet of ciliated pseudostratified columnar epithelium with goblet cells scattered throughout. You'll find TRE throughout the length of the air passages of the respiratory tract. In the nose it lines most of the cavity, except for the chemosensory area. In the deeper part of the system it disappears before you get to the very end of the smallest airways. But, it's the characteristic lining epithelium for the bulk of the respiratory system.

The nasal septum divides the nasal cavity into two parallel sections. Both respiratory and olfactory epithelium are found on it. Towards the dorsal part of nasal cavity you'll find spiralling bony plates (the nasal turbinates) covered with a high pseudostratified columnar epithelium. This is the portion of the nasal cavity specialized for chemoreception.

The olfactory epithelium contains cells that are really neurons, as well as some supporting and glial elements. These olfactory cells have long modified cilia that extend into the lumen of the nose, and which bear on their surfaces receptor sites for the chemical materials that are perceived as "scent." Binding of these materials to the membrane of the olfactory cell causes a change in its charge characteristics, and a signal is sent back down its axon via the first cranial nerve to the olfactory lobe of the brain. You will see the beginning of the first cranial nerve in the lamina propria under the olfactory epithelium; there are bundles of nerve fibers visible. In the lamina propria, under the olfactory region, there are numerous olfactory glands.

List of slides – Nose

- R-1 Nasal mucosa
- R-2 Nasal epithelium
- R-3 Olfactory epithelium
- R-4 Olfactory epithelium
- R-5 Nasal septum

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**Epiglottis and Larynx**

The entry into the lower part of the respiratory system is guarded by the epiglottis. This is a flap of elastic cartilage, as you can easily see, and it's covered on all sides by epithelium.

Note the glands in the lamina propria of the epiglottis. Glands are found throughout most of the airways, and their secretions help to trap dust and debris that's inhaled. The beating of the ciliated cells of the TRE then brings it back up to the pharynx where it is swallowed or spit out. The **larynx**, is the cartilaginous box into which the epiglottis opens. Skeletal muscles are attached to the outer parts of the cartilage. Here the transition from the stratified squamous epithelium of the oral cavity to the respiratory epithelium on the inner portion of the epiglottis is easily seen.

**List of slides – Epiglottis and Larynx**

- R-6 Epiglottis
- R-7A Larynx, sag.
- R-7B Larynx, frontal
- R-7C Larynx, frontal

**Trachea**

The larynx opens at its lower end into the **trachea**. The tracheal rings are composed of hyaline cartilage, not the elastic cartilage of the epiglottis. The respiratory epithelium can be seen in some of the slides from the trachea. Notice the cilia. There are a few glands and blood vessels present in the lamina propria.

**List of slides – Trachea**

- R-8 Trachea, l.s.
- R-9 Trachea, l.s.
- R-10 Trachea, monkey, c.s.
- R-11 Trachea, monkey, c.s. and t.s.
- R-12 Trachea, human
- R-13 Trachea, turtle
- R-14 Trachea, guinea pig
- R-15 Trachea, cat
- R-16 Trachea, chick

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**Bronchi**

The trachea bifurcates and sends primary branches or **bronchi** to each side of the chest to supply air to the lungs. The structure of the bronchi is similar to that of the trachea in that it is a flexible tube with stiffening walls of hyaline cartilage. Once the bronchi are inside the tissue of the lungs, the ring shaped cartilage support gives way to cartilage plates.

There is also a considerable amount of smooth muscle in the walls of bronchi, which increases in proportion as the bronchi get smaller and the cartilaginous plates decrease in size. In cross section, the bronchi are plicated -- i.e., the wall is pleated in cross section. This is caused by the puckering of the resilient wall. When the lungs are inflated, the bronchi can expand a bit, and the elasticity of the intercartilage areas is great enough that they return to the plicated state when the lung deflates. At the same time, the stiffness of the wall is high enough that the airway remains patent at all times. As with the trachea, large bronchi have glands in the lamina propria.

**List of slides – Bronchi**

- R-17 Bronchus
- R-18 Bronchus
Lungs

We have looked so far only at the airways and now it’s time to see where the actual gas exchange occurs. The gas exchange areas in the respiratory system are the alveolar ducts, alveolar sacs and individual alveoli.

As the intrapulmonary bronchi branch and become smaller, the height of the epithelial cells and the amount of cartilage decreases. In bronchioles, the epithelium is pseudostratified columnar ciliated epithelium with occasional goblet cells. The smooth muscle surrounding the lumen is prominent. Glands and cartilage plates are no longer present. The terminal bronchioles exhibit a wavy mucosal lining and columnar ciliated epithelium. Goblet cells are absent but, still present are a thin lamina propria, a layer of smooth muscle and adventitia.

The respiratory bronchioles are directly connected to the alveolar ducts and alveoli. In these bronchioles, the epithelium is cuboidal and may be ciliated. A minimal amount of CT supports the band of smooth muscle, the elastic fibers of the lamina propria and the blood vessels. Individual alveoli appear in the wall of the respiratory bronchioles as small outpockets. The epithelium and smooth muscle in the distal respiratory bronchioles appear as small, intermittent areas between the openings of the numerous alveoli.

The terminal portion of each respiratory bronchiole branches into several alveolar ducts. In your sections only one of these alveolar ducts can be seen. The walls of the alveolar ducts are formed by a series of alveoli situated adjacent to each other. A cluster of alveoli that open into an alveolar duct is called an alveolar sac. The alveoli form the parenchyma of the lung, giving it the appearance of fine lace.

The hardest structure to identify in your sections will be the alveolar ducts but this is because they are really a "place," not a "thing" and hard to visualize. If you can imagine a tube whose wall is composed of halved soap bubbles, look for places where the smooth muscle fibers at the "seams" between bubbles are prominent, and where such "seams" are lined up. This will be the most reliable way to identify the alveolar ducts. The alveoli are lined by extremely thin, simple squamous alveolar cells (Type 1 pneumocytes).

Two more cell types remain to be described. One is the septal cell or great alveolar cell, sometimes also referred to as a Type 2 pneumocyte. These are found in the walls of the alveoli, often between two adjacent ones. They are low cuboidal type cells, which stick out a bit from the flattened septal epithelium. You may also notice a large number of free cells in the lumen of the alveoli. These are macrophages, which are mobile phagocytic scavengers.

In sections of the lung, pulmonary arterioles can be seen near the walls of the various bronchi, bronchioles and other areas of the lung. Small bronchial veins can be seen in the walls of the larger bronchi. The visceral pleura can be seen in the outside, adhering closely to the lungs. It is composed of a thin layer of pleural CT and pleural mesothelium.

List of slides - Lungs

| R-19 | Lung |
| R-20 | Lung, rabbit |
| R-21 | Lung, human |
| R-22 | Lung, human, t.s. |
| R-23 | Lung, human, phagocytosis |
| R-24 | Lung, human, phagocytosis |
| R-25 | Lung, monkey, t.s. |
| R-26 | Lung, elastic fibers |

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List of slides – Comparative Section – Lungs

| R-28 | Lung, rabbit |
| R-29 | Lung, frog |
| R-30 | Lung, bird |
| R-31 | Lung, turtle |
| R-32 | Gill, dogfish |
| R-33 | Gill, perch |
Gills are gas exchange organs present in some amphibians and fishes. Look for similarities between gills and lungs.

List of slides – Pathology of respiratory system

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