Histology of Respiratory System

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ABSTRACT

The respiratory system consists of the paired lungs and a series of air passages that lead to and from the lungs. Within the lung, the air passages branch into increasingly smaller tubes until the very smallest air spaces, called alveoli, are reached. Three principal functions are performed by this system: air conduction, air filtration, and gas exchange (respiration). The latter occurs in the alveoli. In addition, air passing through the larynx is used to produce speech, and air passing over the olfactory mucosa in the nasal cavities carries stimuli for the sense of smell. The respiratory system also participates to a lesser degree in endocrine functions (hormone production and secretion), as well as regulation of immune responses to inhaled antigens. 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 into the thoracic mesenchyme. The bronchial cartilages, smooth muscle, and the other connective tissue elements are derived from the thoracic mesenchyme. The conducting portion of the respiratory system consists of those air passages that lead to the sites of respiration within the lung where gas exchange takes place. The conducting passages include those located outside as well as within the lungs.

INTRODUCTION

The passages external to the lungs consist of
• Nasal cavities (and, during forced breathing, the oral cavity)
• Nasopharynx and oropharynx
• Larynx
• Trachea
• Paired main (primary) bronchi

Within the lungs, the main bronchi undergo extensive branching to give rise ultimately to the distributing bronchioles. The bronchioles represent the terminal part of the conducting passages. Collectively, the internal bronchi and the bronchioles constitute the bronchial tree.

The respiratory portion is that part of the respiratory tract in which gas exchange occurs. Sequentially, it includes
• Respiratory bronchioles
• Alveolar ducts
• Alveolar sacs
• Alveoli [3].

Blood vessels enter the lung with the bronchi. The arteries branch into smaller vessels as they follow the bronchial tree into the substance of the lung. Capillaries come into intimate contact with the terminal respiratory units, the alveoli. This intimate relationship between the alveolar air spaces and the pulmonary capillaries is the structural basis for gas exchange within the lung parenchyma. The essential features of the lung blood supply [4].

Air passing through the respiratory passages must be conditioned before reaching the terminal respiratory units. Conditioning of the air occurs in the conducting portion of the system and includes warming, moistening, and removal of particulate materials. Mucous and serous secretions play a major role in the conditioning process. These secretions moisten the air and also trap particles that have managed to slip past the special short thick hairs, called vibrissae, in the nasal cavities. Mucus, augmented by these serous secretions, also prevents the dehydration of the underlying epithelium by the moving air. Mucus covers almost the entire luminal surface of the conducting passages and is continuously produced by goblet cells and mucus-secreting glands in the walls...
of the passages. The mucus and other secretions are moved toward the pharynx by means of coordinated sweeping movements of cilia and are then normally swallowed [4].

**Nasal Cavities:**

The nasal cavities are paired chambers separated by a bony and cartilaginous Septum. Each cavity or chamber communicates anteriorly with the external environment through the nares (nostrils) and posteriorly with the nasopharynx through the choanae. The chambers are divided into three regions [3]

- Vestibule
- Respiratory segment
- Olfactory segment

**Explain of vestibule of the nasal cavity:**

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 entrapping large particulate matter before it is carried in the air stream to the rest of the cavity. Sebaceous glands are also present and their secretions assist in the entrapment of particulate matter. Posteriorly, where the vestibule ends, the stratified squamous epithelium becomes thinner and undergoes a transition to the pseudo stratified epithelium that characterizes the respiratory segment. At this site, sebaceous glands are absent [5].

**Describing of respiratory segment of the nasal cavity:**

The respiratory segment constitutes most of the volume of the nasal cavities. It is lined with a ciliated, pseudostratified columnar epithelium. The underlying lamina propria is attached to the periostetum of the adjacent bone.

The medial wall of the respiratory segment, the nasal septum, is smooth, but the lateral walls are thrown into folds by the presence of three shelflike, bony projections called turbinates or conchae. The turbinates play a dual role. They increase surface area as well as cause turbulence in airflow to allow more efficient conditioning of inspired air [5].

The ciliated, pseudostratified columnar epithelium of the respiratory segment is composed of five cell types:

- 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 a Brush cells, a general name for those cells in the respiratory tract that bear short, blunt microvilli
- Small granule cells that resemble basal cells but contain secretory granules
- Basal cells, stem cells from Which the Other cell types arise

The epithelium of the respiratory segment of the nasal cavity is essentially the same as the epithelium lining most of the parts that follow in the conducting system. Because the respiratory epithelium of the trachea is studied and examined in preference to that of the nasal cavity [4].

**The mucosa of the respirntory segment warms, Moistens, filtersins piredari:**

- The lamina propria of the respiratory segment has a rich, vascular network that includes a complex set of capillary loops. The arrangement of the vessels allows the inhaled air to be warmed by blood flowing through the part of the loop closest to the surface. The capillaries that reside near the surface are arranged in rows; the blood flows perpendicular to the airflow, much as one would find in a mechanical heat-exchange system. These same vessels may become engorged and leaky during allergic reactions or viral infections such as the common cold. The lamina propria then becomes distended with fluid, resulting in marked swelling of the mucous membrane with consequent restriction of the air passage, making breathing difficult. The lamina propria also contains mucous glands, many exhibiting serious demilunes. Their secretions supplement that of the goblet cells in the respiratory epithelium.

- By increasing surface area, the turbinates increase the efficiency with which the inspired air is warmed. The turbinates also increase the efficiency of filtration of inspired air through the process of turbulent precipitation. The air stream is broken into eddies by the turbinates. Particulate matter suspended in the air stream is thrown out of the stream and adheres to the mucus-covered wall of the nasal cavity. Particles tripped in this layer of mucus are transported to the pharynx by means of coordinated sweeping movements of cilia and are then swallowed [5].

**Olfactory Segment of the Nasal Cavity:**

The olfactory segment is located on part of the dome of each nasal cavity and, to a variable extent, the contiguous lateral and medial nasal walls. It is lined with a specialized olfactory mucosa. In living tissue, this mucosa is distinguished by its slight yellowish brown color caused by pigment in the olfactory epithelium and the associated olfactory glands. In humans, the total surface area of the olfactory mucosa is only a few square
centimeters; in animals with an acute sense of smell, the total surface area of the olfactory mucosa is considerably more extensive.

**Conclusions:**
1- The serous secretion of the olfactory glands serves as a trap and solvent for odoriferous substances. Constant flow from the glands rids the mucosa of remnants of detected odoriferous substances so that new scents can be continuously detected as they arise.
2- The identifying feature of the olfactory region of the nasal mucosa in a histologic preparation is the presence of the olfactory nerves in combination with olfactory glands in the lamina propria. The nerves are particularly conspicuous because of the relatively large diameter of the individual unmyelinated fibers that they contain.(6)
3- The pharynx connects the nasal and oral cavities to the larynx and esophagus. It serves as a passageway for air and food and acts as a resonating chamber for speech. The pharynx is located posterior to the nasal and oral cavities and is divided regionally into the nasopharynx and oropharynx.
4- Mucosa, composed of a ciliated, pseudostratified epithelium and an elastic, fiber-rich lamina propria
   • Submucosa, composed of a slightly denser connective tissue than the lamina propria
   • Cartilaginous layer, composed of C-shaped hyaline cartilages
   • Adventitia, composed of connective tissue that binds the trachea to adjacent Structures

**REFERENCES**