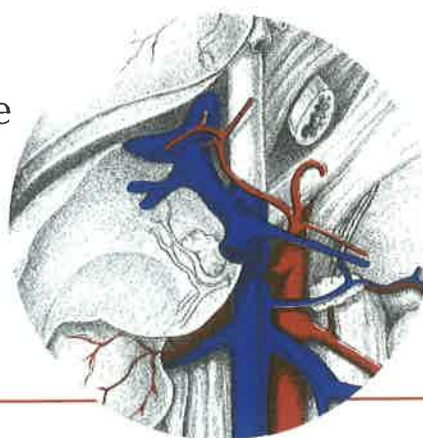


## c h a p t e r f i v e

THE RESPIRATORY  
SYSTEM

The **respiratory system** brings oxygen into the bloodstream, which transports it to all body cells. It also removes the waste product carbon dioxide from the blood and channels it outside the body. The process of oxygen delivery and carbon dioxide removal from the blood is called **gas exchange**. It is a vital function, due to the oxygen demand by cells for supporting metabolism and the toxic results of a buildup of carbon dioxide.

The first step in bringing oxygen into the blood occurs during inhalation, or **inspiration**, which is initiated by expansion of the thoracic cavity as a result of respiratory muscle contraction. The most important respiratory muscle is the **diaphragm**, which separates the thoracic and abdominopelvic cavities in mammals. During inspiration, air moves from the outside environment to the air sacs within the lungs, which are known as alveoli. Exhaling air results when the respiratory muscles relax, and is called **expiration**. Together, inspiration and expiration are known as **ventilation**.

The second step of respiration begins when fresh air has filled the lungs. The air molecules diffuse between the alveoli and the surrounding capillaries. Due to pressure differences, oxygen moves out of the alveoli and into the capillaries, and carbon dioxide moves in the opposite direction. This process is known as **external respiration**.

The third step of respiration is called **internal respiration**. It occurs when oxygen carried in the bloodstream diffuses into surrounding body cells, and carbon dioxide moves from the cells into the bloodstream.

The final step of respiration occurs when the body exhales, or expires, pushing air containing carbon dioxide out of the lungs and body.

The respiratory system consists of organs that support the activities of ventilation and external respiration. It includes a series of chambers and tubes that carry air to and from the lungs and the alveoli within the lungs where external respiration takes place.

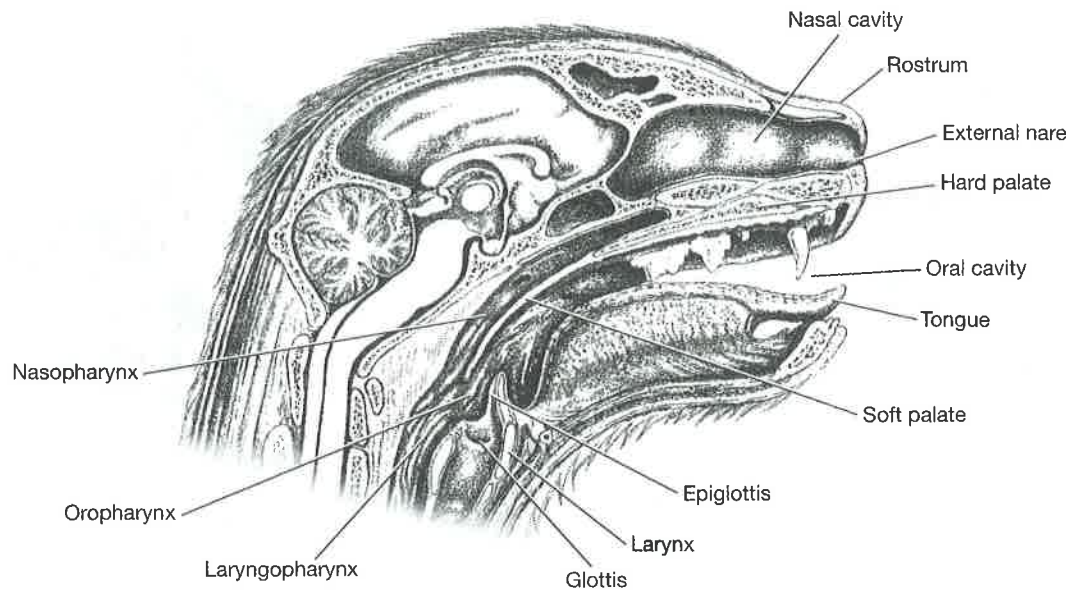
In this chapter you will study the organs and associated structures of the respiratory system. For convenience of discussion, they have been divided into cranial respiratory structures, which are located cranial to the thoracic cavity, and caudal respiratory structures, which lie within the thoracic cavity.

CRANIAL RESPIRATORY  
STRUCTURES

The respiratory organs that are located cranial to the thoracic cavity include the nose, pharynx, larynx, and trachea. With your cat on its dorsal side, identify the following cranial structures:

*Nose*

The nose, or **rostrum**, is the initial warming chamber for incoming air (Figure 5.1). Its internal chamber, the **nasal cavity**, lies between the nostrils, called the **external nares**, and the openings to the throat called the **internal nares**, or **choanae**. Also, it is located cranial to the palate. The nasal cavity is divided by a vertical partition



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**Figure 5.1** – Nose and pharynx (midsagittal section of head).

dividing the nasal cavity into right and left **nasal chambers**, or **nasal fossae**. The partition is composed of the vomer, the perpendicular plate of the ethmoid bone, and cartilage. The nasal fossae include channels that warm and moisten inspired air as it passes through, called **nasal meati**. The two meati within each nasal fossa are formed by the turbinate bones.

### *Pharynx*

You observed the pharynx during your dissection of the digestive system. Recall that it includes three sections, the **nasopharynx**, **oropharynx**, and **laryngopharynx** (Figure 5.1). The nasopharynx receives air that exits the choanae. From this upper chamber, air moves into the oropharynx, then the laryngopharynx. From here, air moves into the larynx.

### *Larynx*

The larynx is a box-like structure composed of five cartilages that create a small chamber between the laryngopharynx and the trachea (Figures 5.1 and 5.2). The larynx houses the vocal cords, which produce sound when exhaled air is channeled through. To observe the larynx in your specimen, clear away any remaining tissue in the upper throat area. Notice the thyroid cartilage and identify the following parts:

**GLOTTIS**: the opening between the laryngopharynx and the larynx.

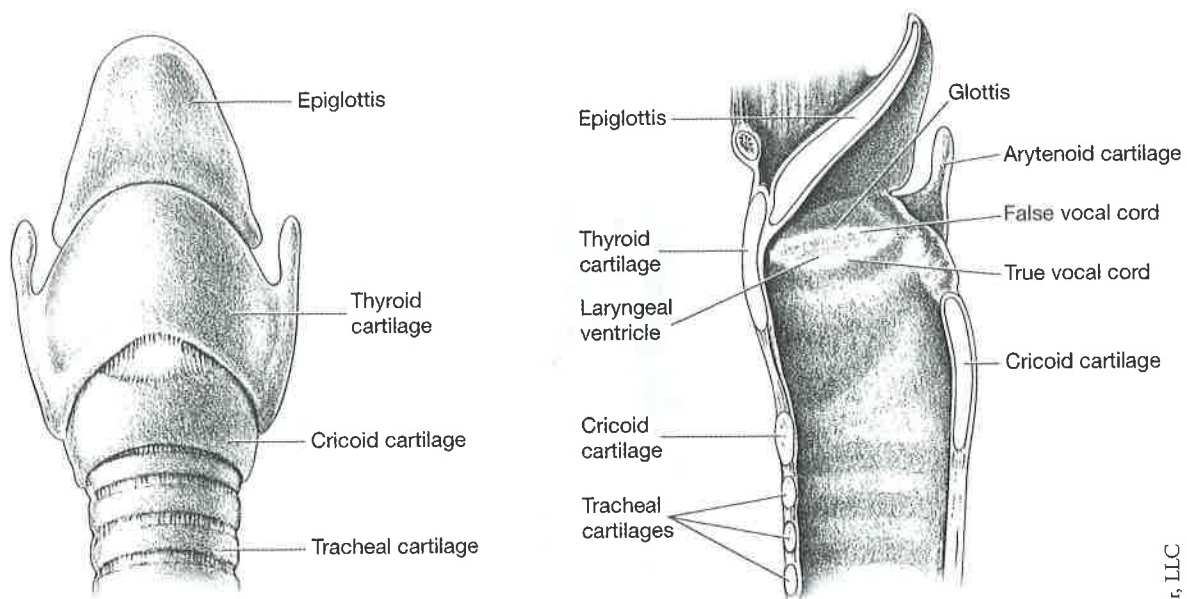
**EPIGLOTTIS**: a thin, leaf-shaped single cartilage located cranial to the glottis. During swallowing, it covers the glottis as pharyngeal muscles elevate the larynx to contact it, creating a lid that prevents the passage of food and water into the larynx. The epiglottis is attached to the large thyroid cartilage at its base.

**THYROID CARTILAGE**: the most prominent of the laryngeal cartilages, it is a single cartilage that forms most of the ventral wall of the larynx. It is larger in males than in females, and *in human males it is commonly referred to as the “adam’s apple”*.

**CRICOID CARTILAGE**: located caudal to the thyroid cartilage, it is an unpaired ring-like cartilage that forms the caudal walls of the larynx. It is attached to the first ring of tracheal cartilage.

**ARYTENOID CARTILAGES**: located dorsal to the thyroid cartilage at the margin of the glottis, these small, paired cartilages serve as the point of origin of the vocal cords.

**VOCAL CORDS**: to observe these, carefully cut open the larynx along the midventral line. The pair of whitish, lateral folds that extend from the arytenoids to the thyroid cartilage



**Figure 5.2** – Larynx (ventral and sectioned lateral views).

on the dorsal side are known as the **true vocal cords**, and the pair of lateral folds on the ventral side are known as **false vocal cords**. Sound production in cats is the result of exhaled air movement across the true vocal cords, while purring is likely caused by the vibration of the glottis.

*The human larynx also includes the cuneiform and corniculate cartilages in the posterior side of the larynx.*

### *Trachea*

The trachea is a tubular air passageway extending from the larynx to the level of the 5th thoracic vertebra, where it divides. It is located ventral to the esophagus, and its walls are formed by smooth muscle and connective tissue encircled by a series of incomplete horizontal rings of cartilage. The openings in the cartilage rings face the esophagus. Locate the cranial portion of the trachea in the neck region of your cat, and notice the rings of cartilage that support its walls and keep them patent, or open (Figures 5.2 and 5.3).

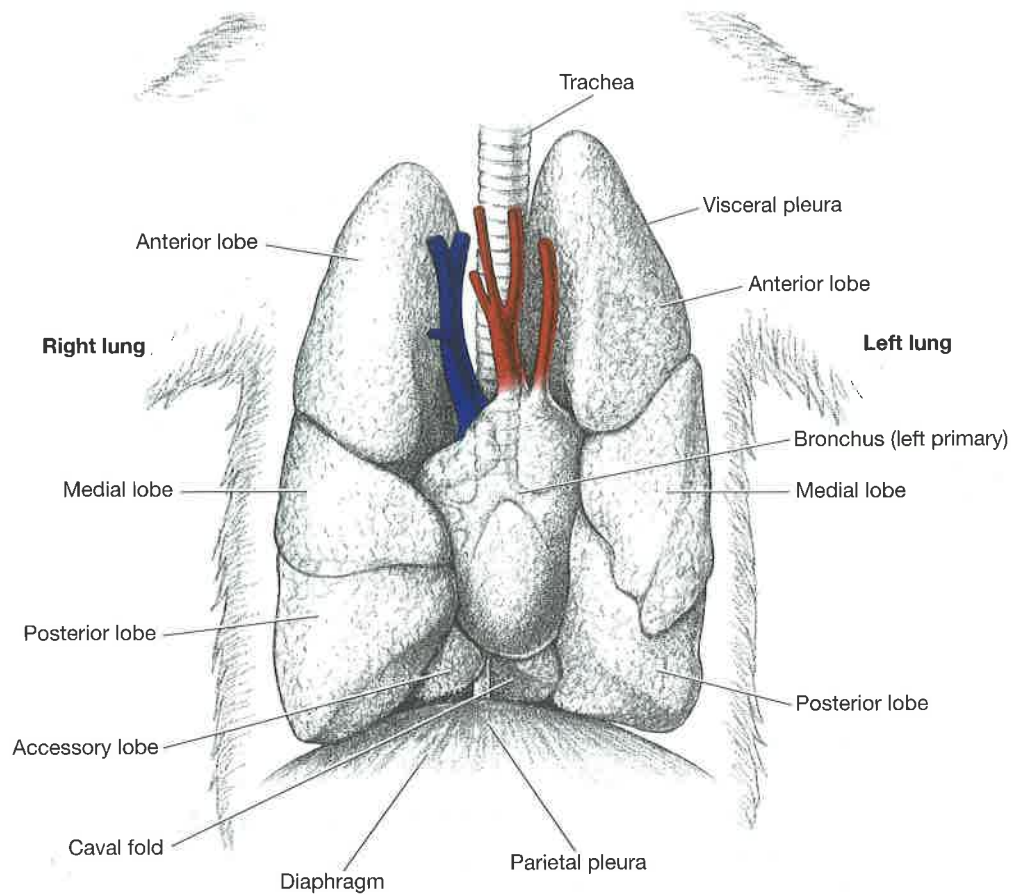
## CAUDAL RESPIRATORY STRUCTURES

The remainder of the respiratory organs are located within the thoracic cavity. To examine them, spread apart the walls of the thorax to observe the thoracic cavity. The respiratory organs within the thoracic cavity are the bronchial tubes and the lungs. Identify these organs, their features, and the structures associated with them.

### *Bronchi*

The trachea terminates in the thoracic cavity dorsal to the heart by dividing into the **right** and **left primary bronchi**, which lead to the lungs (Figure 5.3). Both bronchi include a wall structure similar to the trachea, containing incomplete rings of cartilage. Locate the primary bronchi by gently pushing aside the heart and the cranial lobe of each lung. Once within a lung, the primary bronchus divides into **secondary (lobar) bronchi**, which conduct air to and from individual lobes of the lung. Secondary bronchi branch further to





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**Figure 5.3** – Caudal respiratory structures

form smaller, **tertiary (segmental) bronchi**, which divide into yet smaller, microscopic **bronchioles**. When combined together, the bronchial branches are referred to as the **bronchial tree**, due to their resemblance to the extensive branching of a tree. The bronchioles terminate directly in **alveolar ducts**, which contain **alveoli**. The microscopic alveoli are the site of gas exchange with the capillaries surrounding them. At this stage of the

dissection procedure, the secondary bronchi and its numerous branches cannot be seen. However, you should be able to observe the primary bronchi by reflecting the lungs medially and picking away tissue surrounding them. The bronchi appear as whitish, shiny tubes.

### *Pleurae*

The pleurae are serous membranes associated with the lungs (Figure 5.3). Two layers of pleura are associated with each lung: the **parietal pleura**, which lines the inner walls of the thoracic cavity; and the **visceral pleura**, which covers the surface of each lung. The space between the pleurae of each lung is called the **pleural cavity**, which in the living cat contains fluid that prevents friction between the two membranes during ventilation. The parietal pleura includes a fold that attaches to the visceral pleura of each lung, called the **pulmonary ligament**. Identify these membranes and compare them with the peritoneal membranes of the abdominal cavity. Their surface appears shiny because of the secretions the cells produce to reduce friction.

### *Lungs*

The lungs are large, multi-lobed structures located lateral, cranial, and caudal to the heart, which lies in the center of the thoracic cavity (Figure 5.3). The lungs are spongy when you squeeze them slightly, which demonstrates their structural composition of many air-filled alveoli. The left lung of the cat includes three lobes: **anterior**, **medial**, and **posterior**. The right lung is divided similarly, except the posterior lobe is subdivided to include an **accessory lobe**. The accessory lobe is tucked into a membrane-enclosed space, called the **caval fold**. The exterior surface of each lung includes a cranial tapering, called the **apex**, and a caudal, concave portion touching the diaphragm called the base. The **mediastinal sur-**

**face** faces the mediastinum, and the **costal surface** faces the ribcage laterally. The various connections to the lungs include the primary bronchi and blood vessels carrying blood to and from the heart. Combined with the pulmonary ligament, they form the **root** of each lung. Do not cut the root at this time. Located ventral to the root are a pair of white strands, the **phrenic nerves**, which can be observed in the central part of the mediastinum on each side of the pericardial cavity and the heart. These nerves extend to the diaphragm, which they innervate. *The human lungs are similar, except in the number of lobes. The human left lung is divided into two lobes—superior and inferior—and the right lung is divided into three lobes—superior, middle, and inferior.*