

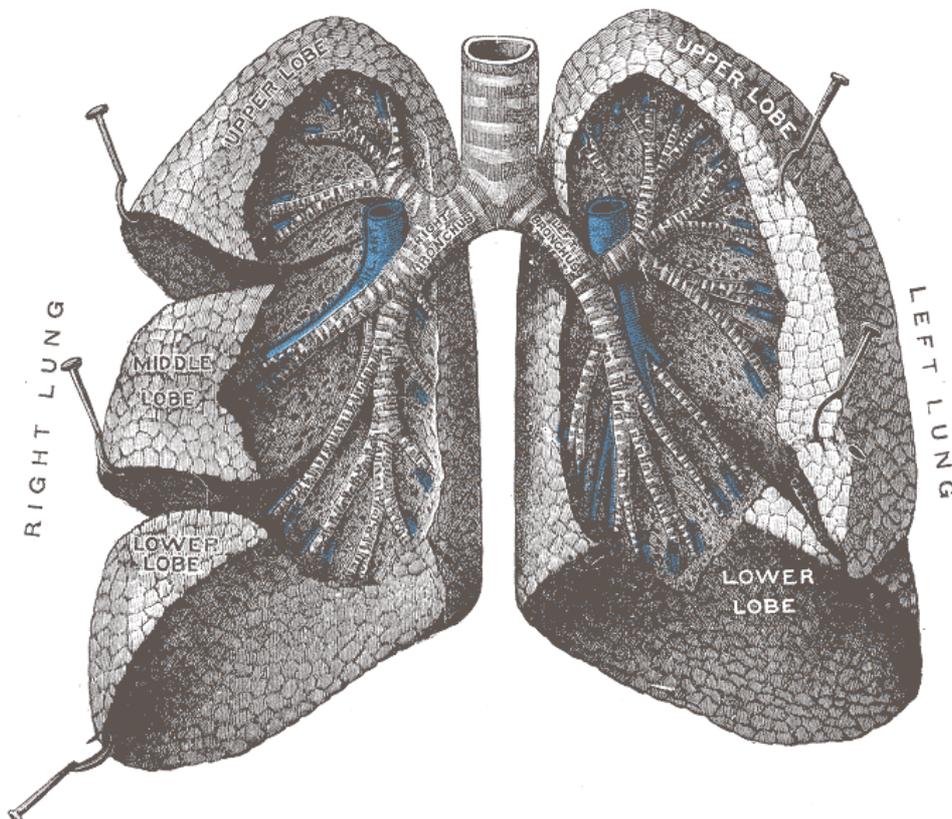
1 ANATOMY OF THE RESPIRATORY SYSTEM

The main function of the lungs is to provide oxygen to the cells of the body and to remove carbon dioxide in the process of gas exchange. While a unicellular organism can exchange oxygen and carbon dioxide directly with the external environment, this is not possible with a complex multicellular organism, so that a more sophisticated gas exchange system has been developed. In the human, this has been divided into two subsystems – the lungs and pulmonary circulation which form the external respiratory system, and the cells, which form the internal respiratory system. The lung is also responsible for a number of other functions within the human body including metabolism of some compounds, filtering of toxic material and acting as a reservoir for blood.

1.1 Topography of the Lungs

The lungs are paired cone shaped organs lying within the thoracic cavity and separated from each other by the mediastinum – this is the space within the thoracic cavity extending from the sternum to the vertebral column between the lungs and containing the heart, oesophagus and great vessels (aorta and vena cava). The lungs are separated from the abdominal cavity by the diaphragm immediately beneath which on the right hand side is the liver. Thus, the right lung is somewhat shorter than the left lung. The left lung is, however, narrower than the right lung due to a depression in its surface to accommodate the heart – this is known as the cardiac notch. The right lung is composed of three lobes, the upper, middle and lower lobes. The left lung has just two lobes, the upper and the lower lobes (Figure 1.1).

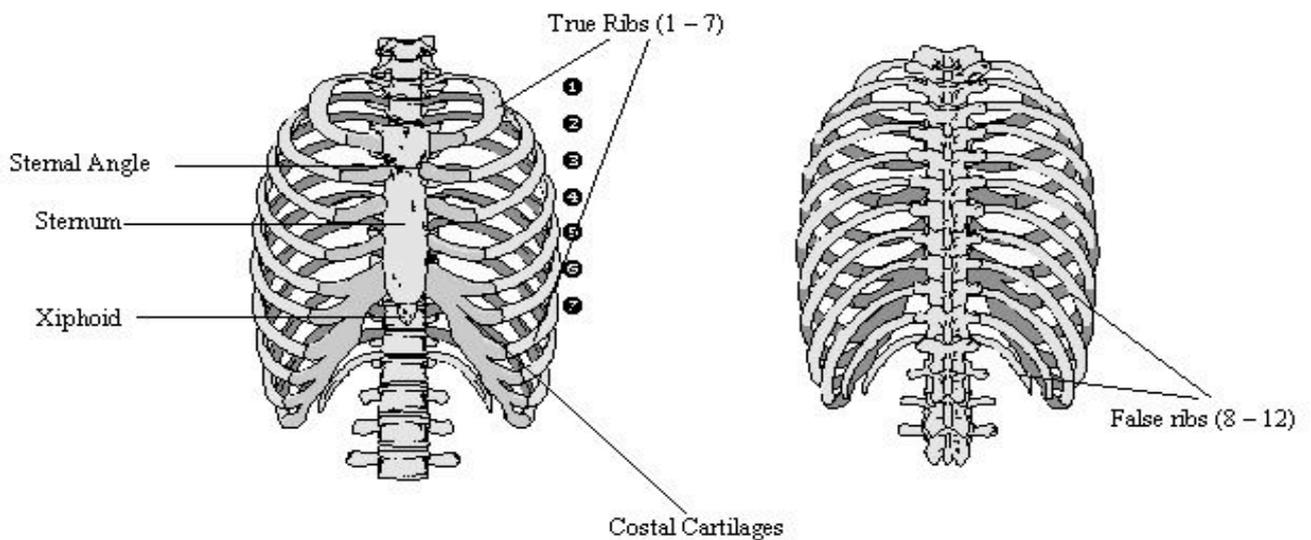
Figure 1.1 Topography of the lungs



The air supply for each lung is provided by the left and right primary bronchi. These are first branches of the trachea, the bifurcation of which is known as the carina.

The thorax is a closed compartment composed of 12 pairs of ribs and their cartilage, 12 thoracic vertebrae and the sternum (Figure 1.2). The sternum is composed of the manubrium, the body and the xiphoid process, the latter being cartilaginous and attached to the lower most region of the sternum. The joints between all the ribs and the vertebrae are synovial joints (i.e. containing fluid) which helps to reduce friction between them during respiration.

Figure 1.2 Diagram of the anterior and posterior views of the rib cage



1.2 Pleural Membranes

The lungs are surrounded by two membranes known as the pleural membranes. The parietal pleura (outer membrane) is attached to the inner wall of the thoracic cavity whilst the visceral pleura (inner membrane) is directly attached to the outer surface of the lungs themselves. The distance between the two membranes is very small and the pleural space is the potential space. This space is very important in the transmission of pressure changes during respiration. Indeed, disorders such as a pneumothorax or haemothorax are associated with either air or blood within the pleural space and results in ventilation being compromised.

1.3 Respiratory Tract

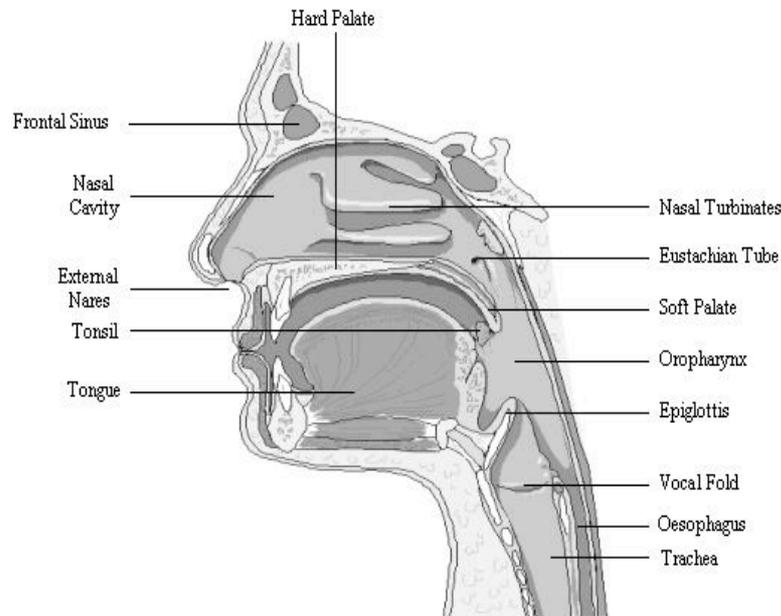
The respiratory tract is divided into two components: the upper respiratory tract and the lower respiratory tract.

1.3.1 Upper Respiratory Tract

The upper respiratory tract consists of the mouth, nasal cavity, paranasal sinuses, pharynx and larynx (Figure 1.3). The first part of the respiratory tract, the nose, is subdivided into two nasal cavities by the nasal septum. This and the paranasal sinuses are lined by the respiratory mucosa composed of specialised epithelial cells, the function of which is to filter particulate matter and to adjust the temperature and the humidity of the inspired air. These features reflect the protective functions of the nasal

mucosa, processes which begin in the nasal cavities and continue throughout the respiratory tract.

Figure 1.3 Cross-section through the upper respiratory tract



From the nasal cavity the air is conducted to the pharynx, a funnel shaped tube that extends from the nose to the level of the larynx. Similar to the nasal cavity it is lined with specialised respiratory epithelium and is involved in the conduction of air further down the respiratory tract. The pharynx is the only part of the respiratory tract that has a dual function for both the passage of air and of food, the role of the epiglottis being crucial in the regulation of breathing and swallowing.

The larynx is a specialised organ that provides a protective sphincter at the inlet of the air passages and is also responsible for vocalisation. The framework of the larynx is composed of different cartilages (including the epiglottis) that are connected by membranes and ligaments and moved by muscles. It is also lined with respiratory mucosa. Closely attached to the thyroid cartilages and to the upper region of the trachea is the thyroid gland which is responsible for secreting hormones involved in the regulation of tissue metabolism. Enlargement of the thyroid gland (goitre) due to a variety of causes including hyperthyroidism, may produce dysphagia and difficulty breathing due to tracheal compression. This produces a characteristic flow volume curve.

1.3.2 Mucociliary Escalator

The functions of the upper respiratory tract are to conduct air from the atmosphere further down to the tracheobronchial tree, to adjust the temperature and humidity of the inspired air and to defend the lungs from foreign bodies entering the respiratory tract. The entrance to each nasal cavity, the nasal vestibule, is lined by skin which has short, coarse hairs called vibrissae whose role is to filter large particles from the inhaled air and prevent them from entering the upper respiratory tract. Smaller particulate matter including dust and bacteria in inspired air is trapped in a thin layer of surface mucus secreted by specialised goblet cells within the respiratory epithelium. This forms part of the 'mucociliary escalator', which is the primary mechanical defence mechanism within the lungs. The respiratory epithelial cells are lined with hair like projections on the apical surface known as 'cilia', which beat in metachronal waves i.e. all in the same