The respiratory system consists of long, branching tube that extends from the nasal cavity deep into the lungs. Along its journey the tube branches an incredible 23 times and terminates in delicate sacs called alveoli. The branching and structure of alveoli create an vast surface area within the lung, comparable to the surface area of a tennis court.

The tube is divided into to main segments: conducting and exchange. Each has its own structure and function. The conducting system main tasks is to conduct air into the lungs and clean and warm the air as it passes. The exchange or respiratory airways serve to facilitate gas exchange between the inhaled air and blood.

This lab will examine the structure and function of components in both segments.
The wall of the conducting airway has a similar structure along most of its length. The inner surface of the airway consists of a pseudo stratified epithelium that contains cilia. The epithelium sits atop a thick basement membrane. Beneath the basement membrane is a distinct layer called the lamina propria which contains blood vessels, connective tissue and various types of cells of the immune system. The submucosa sits underneath the lamina propria. Here, one will find in the upper portion of the conducting airway glands and cartilage. The glands secrete a fluid that is rich in glycoprotein which serves in part to moisten the air. The fluid reaches the surface of the epithelium via tubes that extend from the gland through the epithelium.
This magnified image of the epithelium of the conducting airway shows the pseudo stratified structure and its cilia. The cilia beat in a wave-like fashion to conduct material deep in the lung upward through the respiratory tract to be expelled or swallowed. The epithelium also contains goblet cells that secrete mucous. The mucous traps foreign particles allowing the cilia to remove them.
We’ll start our tour of the respiratory tract with the trachea. The trachea connects the larynx above and the two primary bronchi below. The trachea is easily identified by its large C-shaped hyaline cartilage rings. These rings prevent the collapse of the tracheal mucosa during inspiration. The anterior portion of the ring is cartilage, while the posterior gap is closed by the trachealis muscle, which is composed of smooth muscle fibers. Note the presence of glands in the submucosal layer of the trachea.
Two main bronchi branch from the trachea to supply the left and right lung. The main bronchi branch to form secondary bronchi and the branching process continues to form smaller and more numerous bronchi. Bronchi contain a pseudostratified epithelium with similar cellular composition as the trachea. The basement membrane is much thinner than in the trachea, but glands are still found in the submucosa. Bronchi are easily identified by their cartilage plates. When the bronchi enter the lung, the C-shaped cartilages that characterize the trachea and primary bronchi are replaced by irregular plates of cartilage that surround the cylindrical muscular airway tube. Bronchi also contain a layer of smooth muscle that allows the body to regulate the diameter of bronchi.
Bronchioles are conducting airways and have a diameter of 1 millimeter or less. The ciliated, pseudostratified columnar epithelium remains the same as in the previous airways. At this level, the bronchioles are no longer surrounded by cartilage and lack glands which allows one to distinguish histologically bronchioles from bronchi. Bronchioles still display a ring of smooth muscle that can constrict the diameter of bronchioles. The smallest bronchioles are called terminal bronchioles which are the last segment of the conducting airway.
This slide shows a section of lung that contains both bronchi and bronchioles. These intrapulmonary air conduits extend from the intralobular bronchi to the terminal bronchioles and do not participate in gas exchange. Note that bronchi and bronchioles have a similar structure but bronchioles lack cartilage plates that are readily apparent around bronchi. Also note the close juxtaposition of the airways with the pulmonary blood vessels. Observe that the walls of the bronchiole are connected to alveoli. The tension in the wall of the alveoli helps to prevent the bronchiole from collapsing.
The respiratory airways extend from the respiratory bronchioles to the alveoli.
The respiratory bronchioles branch from terminal bronchioles and have a diameter of 0.5 millimeters. They also contain a few alveoli scattered along their walls. The epithelium here remains low cuboidal. Each respiratory bronchiole branches into between 2 and 11 alveolar ducts that still contain smooth muscle fibers in their walls. Along these walls, the alveolar ducts give rise to single alveoli and to numerous alveolar sacs, which are associated with 2 to 4 alveoli. The space at the entrance from the alveolar duct to an alveolar sac is referred to as the atrium.
The surface epithelium of the alveoli contains two developmentally related but functionally distinct cells, known as pneumocytes. The type I pneumocytes form part of the barrier across which gas exchange occurs. They can be identified as thin, squamous cells whose most obvious feature is their flattened nuclei. Type I pneumocytes surround capillaries to form the air-blood barrier.

Type II pneumocytes are larger, cuboidal cells and occur more diffusely than type I cells. They contain 0.2 to 1 micron wide multilamellar bodies that contain a high content of phospholipid that is the precursor to pulmonary surfactant, which lowers the surface tension in the alveoli that would otherwise cause them to collapse.
This electron micrograph shows the two different types of pneumocytes and their arrangement in relation to capillaries and the air space. Note that type I pneumocytes line the lumen of the alveolus and surround the capillaries. Type II pneumocytes are considerably larger and more cuboidal than its type I counterparts. Lamellar bodies are distinct features of this cell; these contain the phospholipid precursors to pulmonary surfactant, which the cell releases onto the surface of the alveoli.
This electron micrograph shows the three layers of the air-blood barrier across which gas exchange occurs. The type I pneumocyte is part of the simple squamous epithelium of the alveolus and the endothelial cell represents the capillary epithelium. The two cells share a fused basement membrane, which allows for the minimization of the barrier across which exchange of gases occur. Oxygen in the air diffuses through the cytoplasm of type I pneumocytes, across the basement membrane and then through the cytoplasm of the endothelial cell to reach the blood. Carbon dioxide in the blood diffuses in the opposite direction.
Within the airspaces of the alveoli are macrophages which serve to remove particulate matter such as dust and pollen. These cells also called dust cells. The macrophages derive from monocytes and also exist in the airspace of within the connective tissue of the lung. Increase numbers of macrophages in the airways are often an indicator of a pathologic condition.