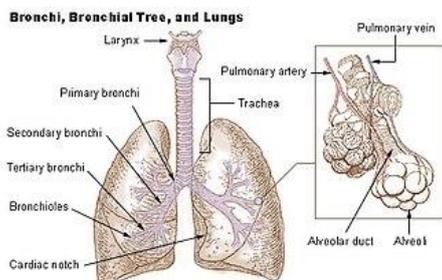


Gas Exchange

A. LUNGS

- The lungs are a pair of spongy, air-filled organs located on either side of the chest (thorax). The trachea (windpipe) conducts inhaled air into the lungs through its tubular branches, called bronchi. The bronchi then divide into smaller and smaller branches (bronchioles), finally becoming microscopic.



- Gas Exchange Surface**
The exchange of gases occurs between the alveoli and blood in the capillaries that supply the lungs. Capillaries cover 70% of the outside of alveoli, providing a large surface area for gases to diffuse across. The total surface area of the alveoli is around 70 square metres.
- Alveolus**
A pulmonary alveolus also known as an air sac or air space is one of millions of hollow, distensible cup-shaped cavities in the lungs where oxygen is exchanged for carbon dioxide.

B. TRACHEA, BRONCHI, AND BRONCHIOLES

- Trachea**
The long tube that connects your larynx (voice box) to your bronchi. The function is to carry air in and out of the lungs. Because it's a stiff, flexible tube, it provides a reliable pathway for oxygen to enter the body
- Bronchus**
Two large tubes that carry air from your windpipe to your lungs. The function is to carry air to and from the lungs. The bronchi also help moisturize the air and screen out foreign particles. The airways are lined with cells that create mucus

- Bronchiole**
Air passages inside the lungs that branch off like tree limbs from the bronchi. The bronchi carry air into lungs. At the end of the bronchi, the bronchioles carry air to small sacs in lungs called alveoli. The alveoli perform the body's gas exchange

- Cartilage**
a flexible connective tissue that keeps joint motion fluid by coating the surfaces of the bones in our joints and by cushioning bones against impact. It is not as rigid as bone, but is stiffer and less flexible than muscle tissue

C. WARMING AND CLEANING THE AIR

- When you inhale through your nose or mouth, air travels down the pharynx (back of the throat), passes through your larynx (voice box) and into your trachea (windpipe)
- The trachea is divided into 2 air passages called bronchial tubes. One bronchial tube leads to the left lung, the other to the right lung. For the lungs to perform their best, the airways need to be open during inhalation and exhalation and need to be free from inflammation (swelling) and abnormal amounts of mucus.
- The right lung has 3 sections called lobes and is a little larger than the left lung, which has 2 lobes. The bronchial tubes divide into smaller air passages called bronchi, and then into bronchioles. The bronchioles end in tiny air sacs called alveoli, where oxygen is transferred from the inhaled air to the blood.
- After absorbing oxygen, the blood leaves the lungs and is carried to the heart. The blood then is pumped through the body to provide oxygen to the cells of tissues and organs. When cells use oxygen, carbon dioxide (CO₂) is produced and transferred to the blood. The blood carries the CO₂ back to your lungs and it is removed when you exhale
- The respiratory system prevents harmful substances from entering the lungs by using
 - Small hairs in your nose act as an air-cleaning system and help filter out large particles
 - Mucus produced in the trachea and bronchial tubes to keep air passages moist and aid in intercepting dust, bacteria and other substances

- The sweeping motion of cilia (small hairs in the trachea) to keep air passages clean. If substances such as cigarette smoke are inhaled, the cilia stop functioning properly
- Healthy lungs are spongy, pinkish-gray tissue. Lungs that have become polluted with harmful carcinogens (substances that cause cancer) or carbon particles appear to have blacked spots on the surface. Healthy lungs are elastic so they can expand when you exhale. In contrast, a disease like emphysema causes the lungs to lose their elasticity
- When a person's lung can no longer expand properly or transfer oxygen to the blood, that person has difficulty breathing and tires easily

D. ALVEOLI

- Alveoli are tiny balloon-shaped structures. They are the smallest structures in the respiratory system
- The alveoli are arranged in clusters throughout the lungs. They sit at the ends of the branches of your respiratory tree. This is the term used to describe the tree-like structure of passageways that brings air into the lungs
- The walls of the alveoli are very thin. This lets oxygen and CO₂ pass easily between the alveoli and capillaries, which are very small blood vessels
- Cells of the Alveoli
The alveoli are made up of two different types of cells. Each type has different functions
 1. Type I Pneumocytes
These are the cells responsible for the exchange of oxygen and CO₂
 2. Type II Pneumocytes
These cells perform two important functions. They produce surfactant, which helps keep the balloon shape from collapsing. They can also turn into type I cells in order to repair damage
- Alveoli are lined by a fluid called surfactant. This fluid maintains the shape of the air sac and helps keep it open so that oxygen and CO₂ can pass
- At this point, the oxygen molecules move through a single layer of lung cells in the alveolus, then through a single cell layer in a capillary to enter the bloodstream

- CO₂ is a byproduct of the process in cells that uses oxygen to produce energy. As oxygen moves out of the alveolus, CO₂ molecules pass into it. They are then breathed out of the body through the nose or mouth
- Oxygen can pass from the alveoli to the capillaries because the concentration of oxygen is lower in the capillaries than in alveoli
- Similarly, CO₂ moves the other way because the concentration of carbon dioxide is lower in the alveoli than in the capillaries.
- Diaphragm is the muscle that controls breathing
- When inhale, the diaphragm contracts. This creates negative pressure in the chest, causing the alveoli to expand and pull in air. When exhale, your diaphragm relaxes. This causes the alveoli to recoil or spring back, pushing out air

E. DISEASES

- Asthma
The airway is narrow and makes too much mucus
- Bronchiectasis
Inflammation and infection make the bronchial walls thicker
- Chronic obstructive pulmonary disease (COPD)
This long-term condition gets worse over time. It includes bronchitis and emphysema
- Pneumonia
An infection causes inflammation in the alveoli. They might fill up with fluid or pus
- Tuberculosis
A bacterium causes this dangerous infection. It usually affects your lungs but might also involve kidney, spine, or brain
- Lung cancer
Cells in the lung change and grow into a tumor. This often happens because of smoking or other chemicals that someone breathed in

F. EXERCISE

Pathogens enter the body in a variety of ways, including through the gas exchange system. The

body has several defence mechanisms against the entry of pathogens and their spread throughout the body.

Fig. 2.1 is an electron micrograph of a cross section of the lining of a bronchiole



Fig. 2.1

- (a) (i) Name tissue X and cell Y
- (ii) With reference to the structures visible in Fig. 2.1, state three ways in which the lining of the trachea, bronchus and bronchioles provides protection against the entry of bacterial pathogens

Fig. 2.2 shows part of the immune response to the first infection by a bacterial pathogen that has entered the body through the lining of a bronchiole. J and K are stages in the immune response

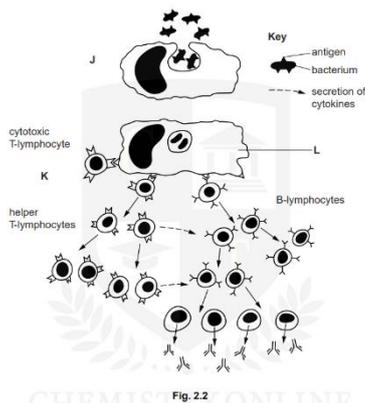


Fig. 2.2

- (b) (i) State what is happening at stage J.
- (ii) Explain the role of cell L at stage K in the immune response

- (c) With reference to Fig. 2.2, explain how the response to a second infection by this bacterial pathogen differs from the first
- (d) There are various ways in which the effectiveness of immune responses can be reduced. Suggest how each of the following reduces the effectiveness of an immune response.
 - (i) The number of T-lymphocytes is reduced in person with HIV/AIDS
 - (ii) Some pathogens are covered in cell surface membranes from their host
 - (iii) B-lymphocytes do not mature properly and do not recognise any antigens

Solutions

- (a) (i) X – ciliated epithelium
Y – red blood cell
- (ii) – Cilia beat to move mucus up the bronchiole
– Mucus as a barrier to entry into epithelial cells
– Mucus traps, pathogens accept in context of goblet cells capillary, brings, phagocytes to engulf bacteria
- (b) (i) J – phagocytosis
(ii) – Digestion of bacteria
– To destroy bacteria
– Recognition of appropriate B/T cells
- (c) – Increases chances of encountering pathogens more quickly
– Faster production of B lymphocytes
– Greater concentration of antibodies in blood or greater numbers of plasma cells
- (d) (i) weak immune response
(ii) pathogen not recognised as non-self
(iii) no antibodies produced