

1. In the lung/capillary bed model, the primary engineering concepts that occur in each unit are:
 - a. Conductive mixing in the trachea and bronchi, where air is transported from the environment to the alveoli. (Anatomical dead space)
 - i. The selection of this unit is because mixing is necessary to achieve a homogenous composition of air in the lung. The volume of the trachea and bronchi is estimated to be around 150 mL.
 - b. Convective mixing in the bronchioles and alveolar ducts, where air is distributed to the alveoli.
 - i. The selection of this unit is because convective mixing enhances gas exchange efficiency. The volume of the bronchioles and alveolar ducts is estimated to be around 25 mL.
 - c. Diffusive gas transport in the alveoli, where gas exchange occurs between the air and the blood.
 - i. The selection of this unit is because diffusion is the main mechanism for gas exchange in the lung. The volume of the alveoli is estimated to be around 300 mL.
 - d. Convective blood-flow in the capillary bed, where blood is distributed to the alveolar walls for gas exchange.
 - i. The selection of this unit is because convective mixing enhances gas exchange efficiency. The volume of the capillary bed is estimated to be around 40 mL.
2. The major chemical components that must be tracked in the lung model include oxygen gas (O_2), carbon dioxide (CO_2), water (H_2O), and nitrogen gas (N_2). Oxygen is critical for aerobic respiration and maintaining tissue homeostasis while carbon dioxide is a waste product of metabolism that must be removed from the body. Water is produced because of aerobic respiration and must be removed to maintain gas exchange efficiency. Nitrogen is an inert gas that makes up most of the air we breathe, and its partial pressure must be accounted for in the lung model.