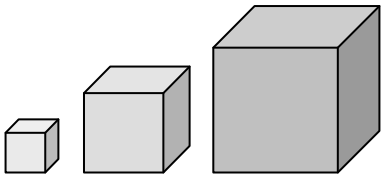
Biology Top-Up
Exchange Mechanisms

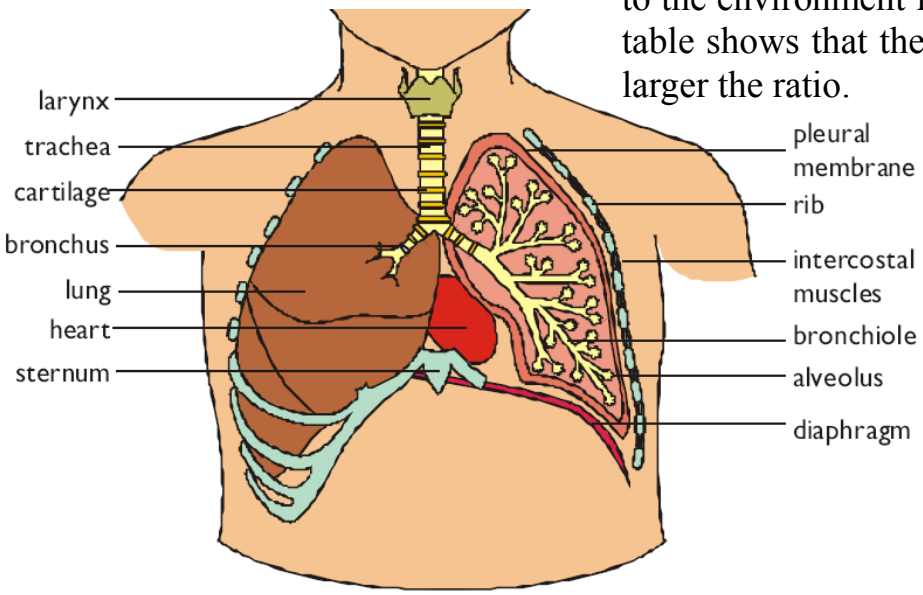


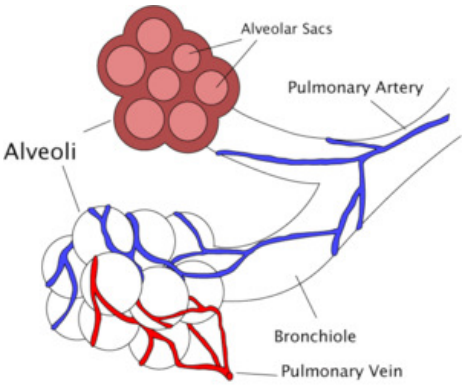
Side length	1	2	3
Surface area	6	24	54
Volume	1	8	27
SA: vol ratio	6:1	3:1	2:1

Surface area: volume ratio

Organisms need to exchange heat, useful substances and waste with their environment. Larger organisms need to use more oxygen and nutrients (and get rid of more waste and excess heat) than smaller organisms. The size means that simple processes such as diffusion are no longer efficient.

The surface area: volume ratio is a measure of how much of an organism's surface is exposed to the environment for each unit of volume - the table shows that the smaller an organism is, the larger the ratio.





Multicellular organisms have had to evolve a complex gas exchange system to increase the surface area that is in contact with the environment. In mammals, the lungs perform this function.

The trachea (airway) divides to form the bronchi. These then divide further into the bronchioles before terminating in air sacs called alveoli. It is the alveoli where gas exchange takes place, so they adapted to do this efficiently.

- Diffusion takes place quickest over short distances: the walls of the alveoli are made of a single layer of flattened cells
- The larger the concentration gradient, the faster diffusion will occur - a constant flow of blood maintains this gradient (high O_2 concentration in the lungs, low in the blood; high CO_2 concentration in the blood, low in the lungs)
- Epithelial cells are permeable to dissolved gases and provide a large surface area for diffusion to take place

Ventilation (breathing) uses two sets of muscles: the diaphragm and intercostal muscles. When they contract, the ribs move upwards and outwards and the diaphragm flattens. This *increases* the volume of the thorax, *decreasing* the pressure, so air moves into the lungs. The opposite happens when you exhale.