Gas exchange

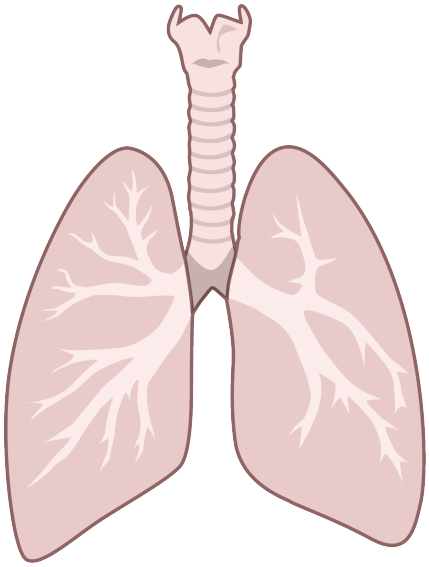
A-Level Biology

The gas exchange system

Your body needs to take in oxygen and get rid of carbon dioxide. This swap happens in the **gas exchange** 气体交换 system. Air follows this path into the body:

- down the **trachea** 气管 (the windpipe),
- into two **bronchi** 支气管 (one to each lung),
- into many smaller **bronchioles** 细支气管,
- and finally into tiny air sacs called **alveoli** 肺泡, deep in the **lungs** 肺.

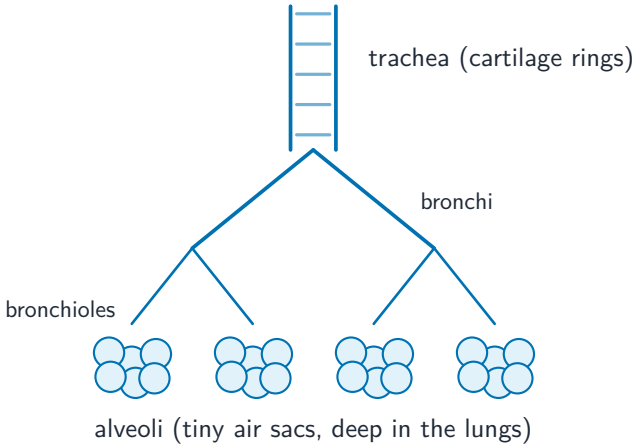
Each alveolus is wrapped in a network of **capillaries** 毛细血管, so air and blood are brought very close together.



The human lungs, where gas exchange takes place across millions of alveoli

Image: Courtesy of NIAID

Ryan Kissinger, Public domain (commons.wikimedia.org)

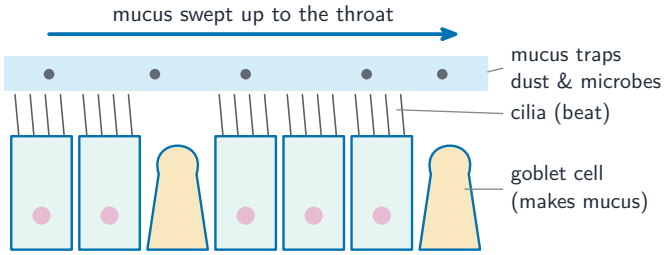


Air passes down the trachea 气管, *into the bronchi* 支气管 *and bronchioles* 细支气管, *to the alveoli* 肺泡

The tissues of the airways and what they do

Tissue	Where it is	Function
cartilage 软骨	C-shaped rings in the trachea and bronchi	holds the airway open so it cannot collapse when you breathe in
ciliated epithelium 纤毛上皮	lining the trachea and bronchi	tiny hairs called **cilia** 纤毛 beat to sweep **mucus** 黏液 up towards the throat, away from the lungs
goblet cells 杯状细胞 and **mucous glands** 黏液腺	in the lining of the airways	make the mucus, which traps dust and **microbes** 微生物 that you breathe in
smooth muscle 平滑肌	in the walls of bronchi and bronchioles	contracts to make the airway narrower
elastic fibres 弹性纤维	in the airway and alveolus walls	stretch when you breathe in, then spring back to help push air out
squamous epithelium 扁平上皮	the very thin, flat lining of the alveoli	gives a very short distance for gases to cross

The cilia, goblet cells and mucous glands work together to keep the lungs clean and healthy: the mucus traps dirt and microbes, and the cilia carry it away to be swallowed.



Goblet cells 杯状细胞 *make mucus* 黏液 *that traps dust and microbes; the cilia* 纤毛 *sweep it up to the throat*

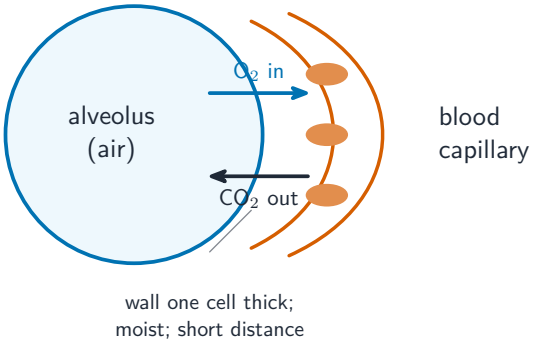
Gas exchange in the alveoli

The alveoli are excellent surfaces for exchanging gases, because they have:

- a very large total surface area (millions of tiny sacs),
- very thin walls —the squamous epithelium of the alveolus and the capillary wall are each only one cell thick, so the distance to cross is tiny,
- a rich blood supply from the capillary network,
- a moist lining, so gases dissolve before crossing.

Gases move by **diffusion** 扩散 down their **concentration gradients** 浓度梯度:

- **oxygen** 氧气 is at a high concentration in the alveolar air and a low concentration in the blood, so it diffuses from the air into the blood.
- **carbon dioxide** 二氧化碳 is at a high concentration in the blood and a low concentration in the alveolar air, so it diffuses from the blood into the air to be breathed out.



Across the thin, moist wall, oxygen 氧气 *diffuses into the blood and carbon dioxide* 二氧化碳 *diffuses out*

Under the microscope, real lung tissue looks like a fine pink lace. The many open spaces are the alveoli, and the thin pink lines between them are the walls where gas exchange happens:

Real lung tissue 肺组织 *stained for the microscope: the open spaces are alveoli* 肺泡 *and the thin pink walls are where gases cross; a small airway sits in the centre*

Breathing keeps fresh air in the alveoli, and the flowing blood keeps carrying gases away. Both of these keep the concentration gradients steep, so gas exchange stays fast.