6-4 GAS EXCHANGE

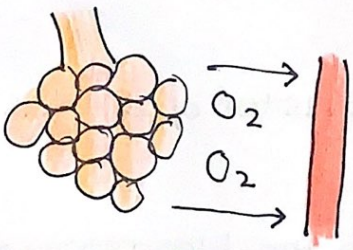
Physiological respiration involves the transport of oxygen to cells within the tissues, where energy production occurs.

The processes involved:

- Ventilation: the exchange of gas between the atmosphere and lungs to maintain a concentration gradient.
- Gas exchange: exchange of O_2 and CO_2 between alveoli and bloodstream via passive diffusion.
- cell respiration: the release of ATP from organic compounds (aerobic respiration).

VENTILATION

- Oxygen is consumed by cells during cellular respiration which means that it is constantly being removed from the alveoli into the blood stream.

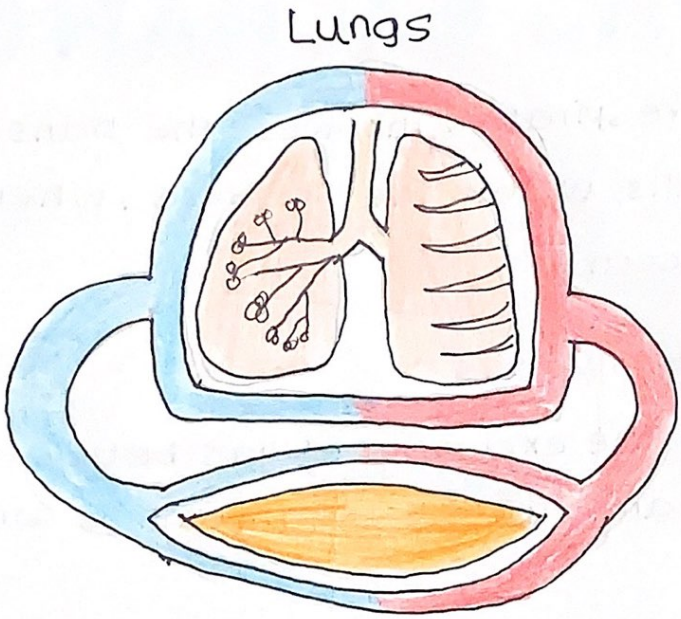


oxygen levels ↑ in alveoli diffuse into the blood

- carbon dioxide is produced as a waste product and is constantly released.

CO_2 levels ↓ diffuse from the blood.

Ventilation system



RESPIRATORY SYSTEM

air enters through nose/mouth → pharynx ↓ trachea → bronchi → lungs → bronchioles ↓ alveoli

→ the right lung is composed of 3 lobes

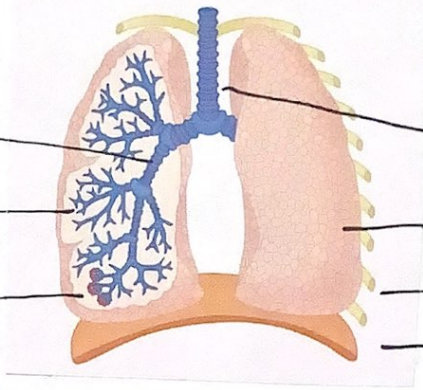
→ left lung is composed of 2 lobes - due to position of heart.

→ inside the lung, bronchi divide into bronchioles which increase the surface area.

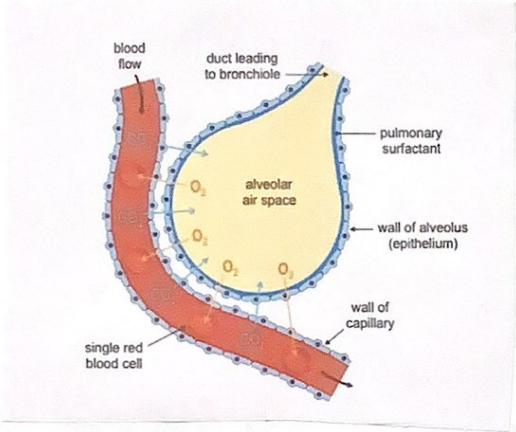
→ each bronchiole terminates with a cluster of air sacs called alveoli.

→ in the alveoli, the gas exchange with the bloodstream occurs.

Respiratory system



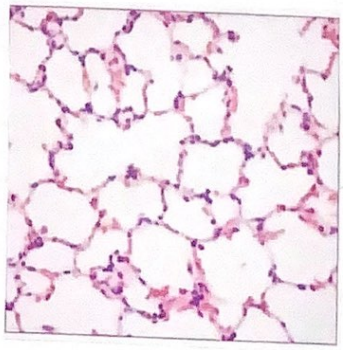
STRUCTURE OF ALVEOLUS



- thin epithelial layer
  → to minimize diffusion distances for gases.
- rich capillary network
  → to increase the capacity for gas exchange with blood.
- roughly spherical in shape
  → to maximise the available surface area for gas exchange.
- pulmonary surfactant (layer of fluid)
  → dissolved gases are better able to diffuse into the blood stream.

PNEUMOCYTES

→ Type 1 and Type 2 pneumocytes



→ Alveolar air spaces (low magnification)

Type I pneumocytes:

→ involved in process of gas exchange between alveoli & the capillaries.

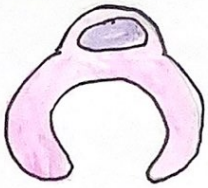
- squamous and thin (~0.15 μm)

→ to minimize diffusion distance for gases.

- connected by occluding junctions

→ prevents leakage of tissue fluid into the alveolar air space.

→ amitotic and unable to replicate.



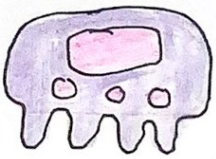
Type 2 pneumocytes:

- secretion of pulmonary surfactant

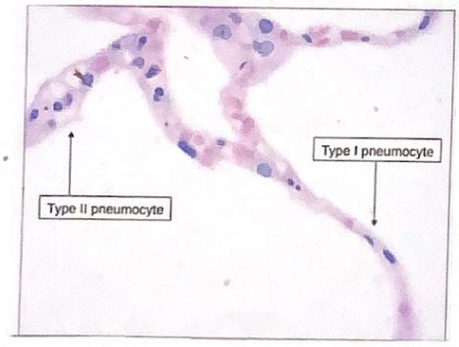
→ reduces the surface tension in alveoli

- cuboidal and granulated

→ for storing surfactant components



→ can differentiate into type I cells when required



The moist lining helps with gas exchange but also creates a tendency for the alveoli to collapse and resist inflation.

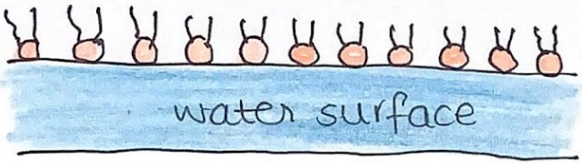
Surface Tension:

→ elastic force created by a fluid surface that minimizes the surface area via cohesion of liquid molecules.

Pulmonary surfactant reducing surface tension in alveoli:

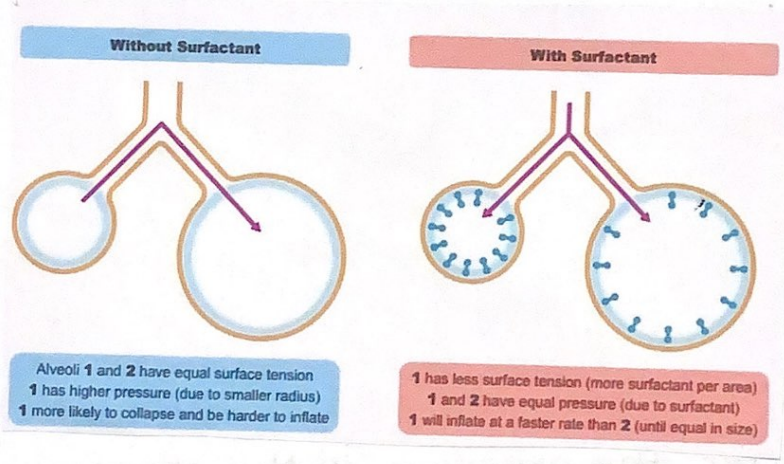
→ form a monolayer on the surface of the moisture lining.

→ the hydrophilic heads face the water and the hydrophobic tails face the air.



→ this reduces the surface tension and prevents the water from causing the sides of the alveoli to adhere when air is exhaled.

→ This helps to prevent the collapsing of the lung.



BREATHING MECHANISM

Breathing: active movement of respiratory muscles that enables the passage of air into and out of the lungs.

→ contraction of these muscles change the volume of the thoracic cavity (chest).

Principle of breathing (Boyle's law)

→ Pressure is inversely proportional to volume.

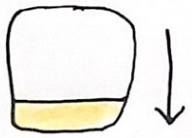
- volume of thoracic cavity

→ increases → pressure in the thoracic cavity decreases.

→ decreases → pressure in the thoracic cavity increases.

→ Gases will move from a region of high pressure to a region of low pressure.

- pressure in the chest ↓ atmospheric pressure ↑ air moves into the lungs (inspiration)
- pressure in the chest ↑ atmospheric pressure ↓ air moves out of the lungs (expiration).



chest pressure

atmospheric pressure

chest pressure

atmospheric pressure

Respiratory muscles

They contract to change the volume of the thoracic cavity and alter the pressure in the chest.

→ muscles that ↑ volume of the chest cause inspiration.

→ muscles that ↓ volume of the chest cause expiration.

RESPIRATORY MUSCLES

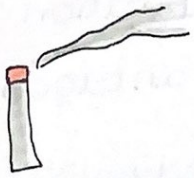
Inspiration and Expiration are controlled by 2 sets of antagonist muscle groups.

Antagonist - working oppositely - when the inspiratory muscles contract, the expiratory muscles relax and vice versa.

Inhalation	Exhalation
• muscles responsible: diaphragm & external intercostal + accessory muscles.	• muscles responsible: abdominal muscles and internal intercoastals + accessory muscles.
• diaphragm muscles: contract and flatten volume of thoracic cavity: increases.	• diaphragm muscles: relax and curve upwards volume of thoracic cavity: decreases.
• External intercoastals: contract ribs - upwards & outwards	• Inter intercoastals: contract ribs - inwards and downward
• Additional muscle groups: help pull the rib up and out. (eg: pectolaris minor)	• Additional muscle groups: help pull the rib downwards. (eg: quadratas lumborum)
	• Abdominal muscles: contract and push the diaphragm upwards during forced exhalation.

LUNG DISORDERS

Lung Cancer

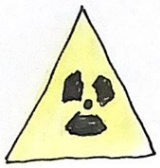


→ causes: . smoking causes 87% of the cases.
- tobacco
- passive smoking 3% of cases.
- air pollution probably causes 5% of lung cancers.
- radon gas

→ radioactive gas that leaks out of certain rocks such as granite.

→ abses tos, silica and some other solids can cause lung cancer if the particles are inhaled.

Symptoms:



→ difficulty breathing
→ persistent coughing
→ coughing blood
→ chest pain
→ loss of apetite
→ weight loss
→ general fatigue.