

# **CIE Biology GCSE**

## 11: Gas exchange in humans

### Notes

## Human respiratory system

### Key structures:

- **Lungs** - The lungs are the main organs in the respiratory system, containing the surfaces where gas exchange takes place.
- **Ribs and intercostal muscles** - Intercostal muscles are found between the ribs. Internal and external intercostal muscles work antagonistically in pairs to expand and contract the rib cage during breathing. The ribs also protect the lungs and heart from physical damage.
- **Larynx** - contains the vocal cords.
- **Trachea** - connects the throat to the bronchi. C-shaped cartilage rings are present to provide structural strength, keeping the trachea open so that air can pass through it.
- **Bronchi** - hollow tubes composed of cartilage rings that carry air from the trachea to the lungs. The bronchi splits into two tubes to enter the left and right lung, before branching further inside the lungs.
- **Bronchioles** - Smaller tubes which branch off from the bronchi in the lungs, leading to the alveoli.
- **Alveoli** - Where gas exchange occurs; comprised of tiny air sacs with a capillary network. Oxygen from the air diffuses into the capillaries, whilst waste carbon dioxide diffuses out. Waste gases are then breathed out.

### Ventilation:

Ventilation is the act of moving air into and out of the lungs to allow **gas exchange** to occur.

- **Breathing in** - **internal** intercostal muscles **relax** whilst the **external** intercostal muscles **contract**, pulling the ribs **up and out** while the **diaphragm flattens**, pushing the abdominal muscles downwards. The volume in the **thorax** (chest cavity) **increases**, so air enters the lungs. Air **diffuses** into the lungs, rather than being 'sucked' in. This is because when the volume of the chest increases, there is a lower concentration of air inside the lungs compared to outside, thus air diffuses in.
- **Breathing out** - volume of thorax **decreases**, increasing pressure so that air is forced out. This is **passive** (does not require muscle contraction) except when forcibly breathing out, where the internal intercostal muscles contract.

The majority of air in the atmosphere is composed of **nitrogen, oxygen and carbon dioxide**. Inhaled air is made up of **more oxygen** than exhaled air, as oxygen is absorbed into the blood in the alveoli instead of being exhaled. Oxygen is used in cells for **respiration**, and **carbon dioxide is produced** as a waste product. This carbon dioxide is released from the blood at the alveoli

and diffuses out into the lungs, before being exhaled, thus there is **more carbon dioxide in exhaled air**. Exhaled air also contains **more water vapour** than inhaled air.

When exercise is carried out, muscles **increase the rate of respiration** to **produce energy** for muscle contraction. **Aerobic respiration** requires oxygen; thus, a greater amount of oxygen is demanded. In addition, a greater amount of **carbon dioxide** is produced as a waste substance, which **diffuses into the blood**. This increase in carbon dioxide in the blood is **detected by the brain**, which causes the **rate of breathing to speed up**, allowing gas exchange to happen more rapidly, expelling the carbon dioxide whilst taking in more oxygen. The **heart rate is also increased** to pump substances around the body more quickly in the blood.

#### **Adaptations of exchange surfaces:**

- **Large surface area** - allows more efficient diffusion. The alveoli allow the lungs to have a huge surface area of 80-100 square meters.
- **Thin surface** - this means that there is a short diffusion distance, thus exchange can occur more rapidly.
- **Good blood supply** - Maintains concentration gradient by carrying away substances which have diffused across already.
- **Good ventilation with air** - this means that waste gases can diffuse out of the blood into the air in the lungs whilst oxygen diffuses into the blood.
- **Moist** - Allows gases to dissolve before diffusing across the membrane.

The lungs are also adapted to protect from foreign pathogens and particles. **Goblet cells**, found in the **trachea and bronchi**, are adapted to **secrete mucus** into the respiratory tract. Foreign pathogens and particles stick to this mucus, which is then **moved upwards** towards the throat by **cilia** (hair-like projections from some cells). Mucus is then swallowed, and pathogens are destroyed in the acidic conditions in the stomach.