## **External Respiration**

#### Introduction

Inspiration: Process of which air is taken into the body.

Expiration: Process in which air is given out from the body.

Therefore, breathing is simply rhythmic inspirations and expirations 1-14 times a minute. Automatic process with control centers in the brain. [Reflex Action]



### **Associated Structures**

#### Lungs

It is the organ in man dedicated to the exchange of gases between man and the environment. In the human, there is two lungs present in the chest cavity.

#### Air Passages

The air passages leading to the lungs [alveoli] are:

Nasal Passages  $\rightarrow$  Pharynx  $\rightarrow$  Larynx [voice box]  $\rightarrow$ Trachea  $\rightarrow$  Bronchi  $\rightarrow$  Bronchioles

\*Note: Air passes to the trachea through an opening called the glottis.



\*Note: Trachea supported by C-shaped rings of cartilage to ensure it is always open. This cartilage also found in bronchus and bronchial tubes.

Within lungs, bronchial tubes divide repeatedly to give smaller and smaller tubes. Smallest tubes are bronchioles; and each bronchiole ends in a cluster of air-sacs or alveoli.



Alveolar walls very thin, moist and well supplied with blood capillaries. Gaseous exchange takes place through the walls of alveoli. There are thousands of alveoli found in the lung, and this provides a very large surface area for gaseous exchange to take place.  $\rightarrow$  greater efficiency

## Air Entry

Air enters the body through the nose [nostril] and mouth. Nose breathing better than oral breathing.

Advantages of breathing through nose:

- Dust and foreign particles trapped by hair in nostrils and mucus on mucous membrane.
  - → Epithelium lining bronchi and trachea bears gland cells which secretes mucus that helps to trap dust and bacteria. The epithelium cells also bear cilia, which help to sweep dust particles up bronchi and trachea into pharynx which is then swallowed into oesophagus.
- Warmed and moistened before it enters the lungs. This is because from the nostrils to the nasal passage is lined with moist mucous membrane.
- Harmful chemicals detected by sensory cells in mucous membrane.

### **Other Related Structures**

Ribs:

- Chest wall supported by ribs
- 4 In front attached to sternum, which is the chest bone
- Behind attached to vertebra column, which obviously is the backbone
- There are 12 pairs of ribs, of which only the first ten are attached to the sternum



Intercostal Muscles:

External intercostal and internal intercostal muscles are found between ribs. When one set of muscle contracts, the set relaxes. When the ribs move up and down, they change volume of thoracic cavity.

Diaphragm:

Thorax separated from abdomen by the diaphragm, a thin sheet of tissue. When diaphragm muscles contract, diaphragm flattens downwards. When diaphragm muscles relax, diaphragm arches upwards. These actions change volume of thoracic cavity.



### Negative Pressure Breathing:



#### Inspiration

Principle of inspiration:

- Thoracic cavity expands
- Lungs expand to fill up enlarged space
- Expansion of lungs means air pressure in lungs lower than lower than atmospheric pressure
- 4 Air rushes into lungs

#### **Breathing Movements**

- External intercostal muscles contract
- Internal intercostal muscles relax
- Ribs swing upwards and outwards
- Sternum moved up and further away from backbone

These movements increase dorso-ventral diameter and breadth of thorax. The diaphragm contracts and flattens  $\rightarrow$  enlarges thoracic.

As a result, volume of thorax increases and air pressure decreases and hence, the air rushes into lungs.

## Expiration

Principle:

- Thoracic cavity contracts [lungs contract].
- Contraction of lungs means air pressure in lungs higher than atmospheric pressure
- Air rushes out lungs.

## **Breathing Movements**

- External intercostal muscle relax
- Internal intercostal muscles contract
- Ribs lower
- Sternum returns to original position, nearer backbone
- Diaphragm relaxes and arches upwards

These movements decreases thoracic cavity, and thus the volume of thorax will decrease. Air pressure increases, which causes the air rushes out of lungs.

## Gaseous Exchange

The equation for gaseous exchange: Hb +  $4O_2 \leftrightarrow$  HbO<sub>8.</sub> Note that this reaction is reversible. Gaseous exchange also depends on amount of oxygen present in surroundings.

CO<sub>2</sub> is transported in blood in three forms:

- Dissolved CO<sub>2</sub> in the plasma [5-7%]
- Bound to the amino groups of haemoglobin [15-20%]
- 4 As bicarbonate ions in the plasma [70-80%]

 $\begin{array}{c} \mathsf{CA} \\ \mathsf{H}_2\mathsf{O} + \mathsf{CO}_2 \overleftarrow{\longleftrightarrow} \mathsf{H}_2\mathsf{CO}_3 \overleftarrow{\longleftrightarrow} \mathsf{H}^+ + \mathsf{HCO}_3 \end{array}$ 

When carbon dioxide concentration is low [like in the alveoli], carbonic anhydrase [CA] catalyses reaction in which hydrogen carbonates converted to carbon dioxide and water.

Carbon dioxide is then diffused out of blood into alveolar cavities.

- → Water evaporates from walls of alveoli
- ➔ Heat also escapes from blood into alveolar air

## Comparing Inspired Air and Expired Air

| Inspired Air         | Expired Air       |
|----------------------|-------------------|
| 21% oxygen           | 16% oxygen        |
| 0.03% carbon dioxide | 4% carbon dioxide |

| 78% nitrogen                    | 78% nitrogen                         |
|---------------------------------|--------------------------------------|
| Water Vapour variable           | Water vapour saturated               |
| Temperature variable            | Temperature about 37 degrees Celsius |
| Dust particles might be present | Dust particles little or none        |

## **Smoking and Associated Health Hazards**

Cigarettes contain a large number of toxins and smoking poses a serious health risk.



## Risks include:

Chronic diseases like stroke, blindness, gum infection, aortic rupture, heart diseases, pneumonia, hardening of the arteries, reduced fertility, and even hip fractures.

Chronic lung diseases and asthma are also risks that cigarettes can possibly pose.

## Carbon Monoxide Poisoning

Carbon monoxide is a colourless and odourless gas. It bonds irreversibly with haemoglobin to form carbinohaemoglobin [carboxyhaemoglobin]. Oxygen transport will be thus reduced and can result in a serious risk of fetal underdevelopment and deformity if smoking while pregnant.

## Chronic Bronchitis

Chronic Bronchitis is the inflammation of the epithelium of airways [bronchi, trachea] by the toxins in tobacco smoke. This results in hyper-production of mucus by gland cells that accumulate and obstruct the bronchial pathway. Consequently, the cilia become paralyzed and cannot remove the large amounts of mucus which clogs up the airway, making breathing difficult. Symptoms include



persistent coughing with green or yellowish mucus to clear airway; wheezing and breathlessness.

## Lung Cancer

Cigarettes contain close to 50 carcinogens, including tar and lead. Many studies have shown strong associations between cigarette smoking and lung cancer. In US, smokers account for 90% of all lung cancer cases.

### **Relating Vertebrate Respiratory and Circulatory Systems**



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