

### Gas Exchange

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### Introduction

respiration, i.e carrying on gas exchange with the water.

The movement of oxygen from the external media to the cells is by way of diffusion in opposite direction  $CO_2$  moves the same way.



### Solubility of gases

## physiological process.

# Effect of pressure and temperature

water depends on the pressure is doubled, twice as much gas will be dissolved.

#### Diversity Second Constants partial pressure of that gas in atmosphere is in equilibrium with the solution.

### Gas diffusion

#### Staring Life espiratory organ of animals gas diffuse between the environment and the organism

The rate of diffusion of a gas is inverse by proportional to the square root of its molecular weight.

 $Diffusion rate \alpha = -$ 

Diffusion time  $(t) = \frac{R^2}{t^2} = \frac{Square\ root\ of\ average\ diffusion\ distance}{average\ length}$ 

### **Respiration and Gas Exchange**

breathing ) is defined as the transport of oxygen from the outside air to the cells within tissues

cellular respiration : the metabolic process by which an organism obtains energy by reacting oxygen with glucose to give water , carbon dioxide and ATP (energy)

### **Solutions of respiration**

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Buccal pumping

Aquatic respiration is the process whereby an aquatic animal obtains oxygen from water.

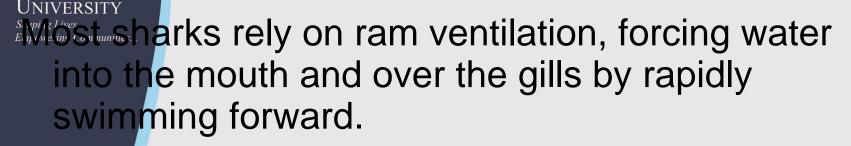
Buccal pumping is a method of respiration in which the animal moves the floor of the mouth in a rhythmic manner that is externally apparent.

### Cartilaginous fish respiration

that open directly to the outside of the body, though some more primitive sharks have six or seven pairs.

Water enters through the mouth of the animal, into the pharynx, over the gills and exits through the gill slits.

A smaller opening, the spiracle, lies in front of the first gill slit



(ram ventilation The production of respiratory flow in some fish in which the mouth is opened during swimming, such that water flows through the mouth and across the gills.

## same called gills

The great majority of bony fish species have five pairs of gills.

From each gill arch arise two rows of filaments

The gill arch along with the filaments is called a gill

Each gill is composed of many filaments that are each covered in many lamellae



blood capillaries, which have blood flowing in the opposite direction to the water.

This is called "counter current" mechanism and helps in the maximum exchange

The counter current exchange system gives fish 80-90% efficiency in acquiring oxygen

## size of the gill filaments and gill lamellae.

### The total gill area increases with the increase in body weight during the growth of the fish.

The teleostean gill is capable of diffusing 60-80% of oxygen from water to blood at the gills.

#### Centurion UNIVERSITY Compared and and exhalation of water in the buccal cavity causes purification of blood.

### **Double pump system**

and opercular function in co-ordination with each other, to propel water through the gills. These 2 pumps are operated by a set of muscles resulting in contraction or expansion of the buccal and opercular cavities.

The process can be described as below

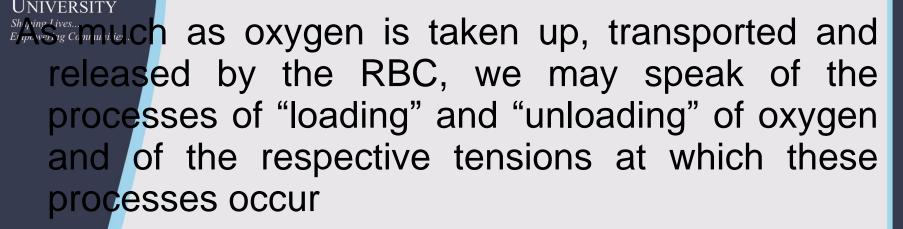
The mouth is opened and the buccal cavity is enlarged by lateral expansion of its walls. increased. But the opercular opening remains closed

When the operculum is closed, the gills must extract as much oxygen as possible.

#### Fish blood as a gas carrier

abbreviated Hb or Hgb) has the iron -containing oxygen -transport and Hg is the metalloprotein in the red blood cells of all vertebrates (except the fish family Channichthyidae) and the tissues of some invertebrates

- Haemoglobin is a large protein with four polypeptide chains and four haemo groups.
- Each haeme group is enfolded in one of 2 or 4 chains of amino acid units that collectively constitute the protein part of the molecule called globin.



The oxygen dissociation curve describes the equilibrium of oxygen with hb.



### Ventilation of gills

in the gill by taking water into the mantle cavity, and by ejecting the water by jet propulsion

### **Counter Flow Mechanism**

steam of blood running within the gill flow in opposite direction to each other and this will help for effective removal of oxygen and this called counter current flow

### **Ram Ventilation**

in a high speed. There are no visible breathing movements and water flows continuously over the gills; this is called ram ventilation

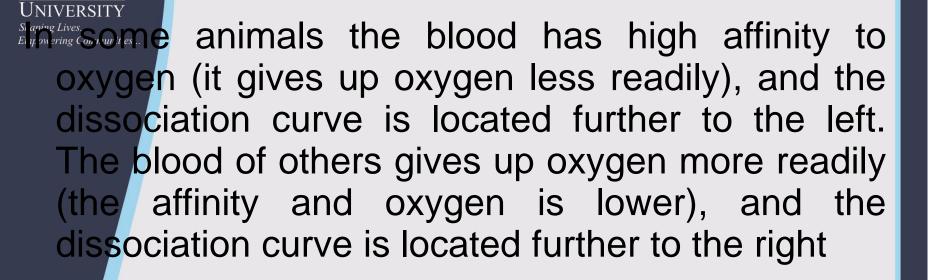
### Oxygen dissociation curve

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combines with oxygen concentration the hemoglobin (Hb) combines with oxygen to form oxyhemoglobin(HbO<sub>2</sub>)

The hemoglobin is saturated according to the given O<sub>2</sub> concentration

Thus by plotting the oxyhemoglobin for a given oxygen concentration, a curve oxygen hemoglobin dissociation curve is obtained. This curve will be of normally in sigmoid shape.



# Carbon dioxide transported in the blood

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A small percentage of the  $CO_2$  that is in the blood is dissolved molecular  $CO_2$ .

A larger amount of CO<sub>2</sub> reacts with –NH<sub>2</sub> groups of hemoglobin and other proteins to form carbamino compounds

However, most of the  $CO_2$  that is transported in the blood is in the form of bicarbonate (HCO<sub>3</sub><sup>-</sup>)

### water is catalyzed by the enzyme carbonic anhydrase

- Mackerel is a fish of high seas that never encounters low levels of oxygen and lives under uniform but low carbon dioxide tensions
- Factors that influence oxygen consumption include activity, age, reproductive state, nutrition, disease and intrinsic regulatory mechanisms (nervous and hormonal control)

# Accessory respiratory organs in fishes

haryngeal epithelium

Skin External gills Labyrinthiform organs Opercular lungs Air bladder/ swim bladder A special part of alimentary canal