RESPIRATORY SYSTEM (VERTEBRATES)

I.INTRODUCTION:

vertebrates consume oxygen for oxidation of nutrients present within the cells. This oxygen needs to be replenished and the waste byproducts like heat and carbon dioxide produced during oxidation metabolism must be removed in order to survive. The sequence of events that result in exchange of oxygen and carbon dioxide between an organism and its environment is known as **respiration**. This is done primarily by the respiratory system.

The gas exchange between the environment and blood via the respiratory surface is referred to as **external respiration**. The utilization of oxygen for oxidation of nutrients within the cells and tissues may be termed as **internal respiration.**

II. SALIENT FEATURES OF RESPIRATORY:

SYSTEM OF VERTEBRATES:

Respiration is the sequence of events that result in exchange of oxygen and carbon dioxide between the environment and organism. External respiration refers to gas exchange between the environment and blood via a respiratory surface. Respiratory organs are of two types:

(A) those that have respiratory surface turned out forming an evagination called **gills**,

(B) those that have respiratory surface turned in forming an invagination called **lungs**. Our own lungs are a good example of such invagination.

The organs of respiration in vertebrates (the gills or lungs and in some cases the skin) help in ventilation/breathing i.e. active movement of the respiratory medium (water or air) across the respiratory surface.

III.RESPIRATION BY GILLS:

Gills are the main respiratory organs in fishes and some aquatic amphibians.

They are composed of numerous gill filaments or gill lamellae, which are thin-walled extensions of the epithelial surface. Each gill contains a vascular network. Blood is brought extremely close to the respiratory surface, thus facilitating ready exchange of gases.

III.1. General Gill Structure:

Gills are enclosed in a gill cavity. This provides protection for the fragile organ and also permits the water to run over the gills in an efficient manner.

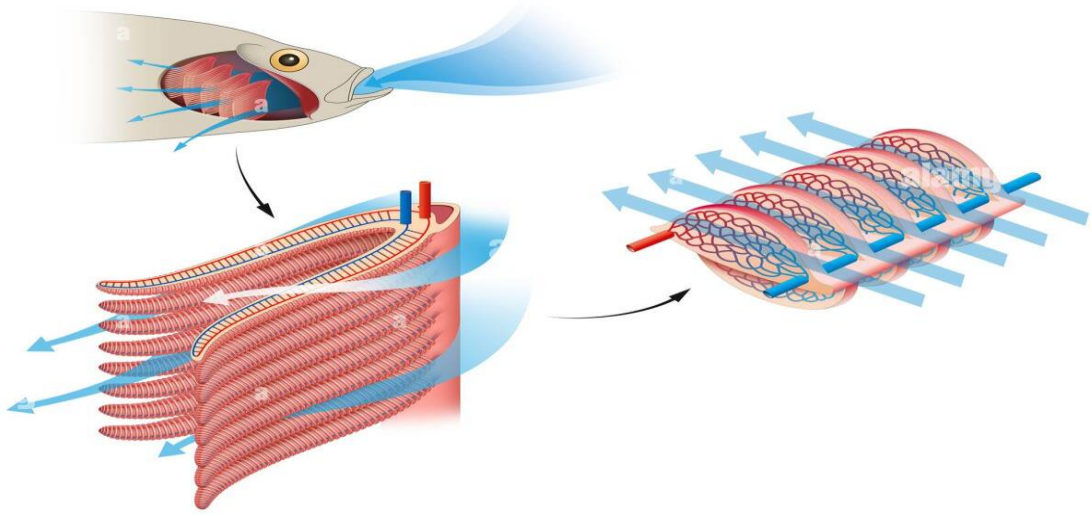

Figure 01: Structure of Gills in Fishes.

III.2. Respiratory System of Fishes:

Ventilation or breathing in fishes is unidirectional. Water enters the mouth and pharynx and is expelled through external gill slits in Elasmobronchii and through operculum in teleosts.

Gas exchange takes place in gill lamellae as water flows between them in one direction and blood within them in the other direction. This is called countercurrent flow. This type of flow has an important consequence. It permits the fish gills to have the highest possible oxygen levels.

IV.RESPIRATION BY LUNGS:

One of the most important changes in vertebrate evolution was the transition from water breathing to air breathing. In terrestrial animals the main respiratory organ is the lung. Vertebrate lungs are elastic bags designed for air breathing (Fig 2). The volume of lungs expands when air is inhaled and shrinks/contracts when air is exhaled. Embryologically, lungs develop from outpocketing of endoderm from the pharynx. The diverticulum divides into two halves, the lung buds, which are destined to give rise to the bronchi, and the lungs proper. The original unpaired duct, which connects the lungs to the pharynx, serves to carry air back and forth and is known, in most cases, as windpipe or trachea. Generally, the trachea branches into two bronchi, one to each lung. In some species, each bronchus branches into successively smaller bronchioles that eventually supply air to the respiratory surfaces within the lung. In snakes which have slender bodies one lung may be reduced in size; or may be absent.

The trachea and bronchi bring the air we breathe to the lungs. Each bronchus is shaped like a tree, with lots of smaller and smaller branches. They may branch to varying degrees, depending upon the species. The smallest branches are called bronchioles and at the end of these are air sacs (alveoli).

They are about 600 million alveoli (large surface area provided with ample capillary network) in the lungs in humans. These are covered with capillaries, and here the exchange of gases takes place.

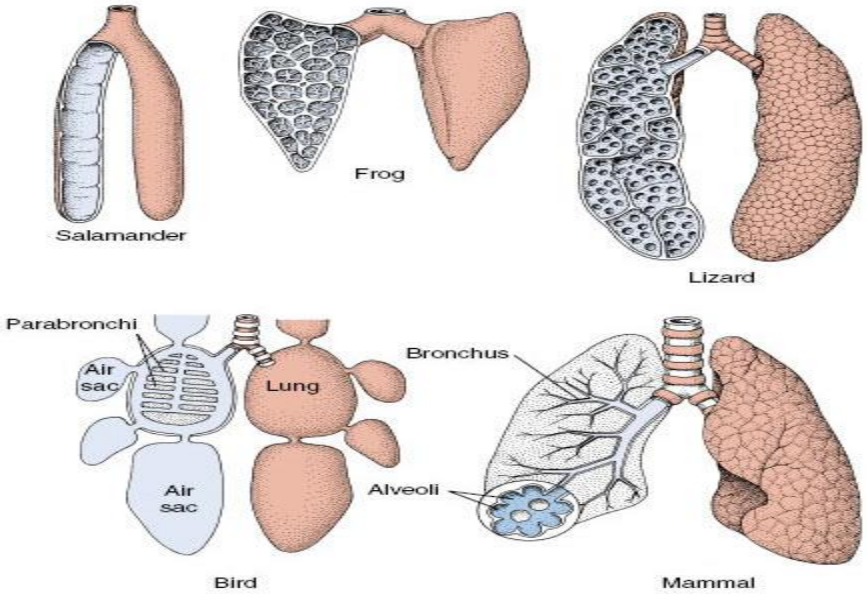

Figure 02: Lungs in terrestrial vertebrates.

IV.1.Respiratory System in Mammals:

Mammals have a pair of lungs enclosed in a thoracic cavity. The bony framework of the thoracic cavity is formed of thoracic vertebrae, ribs and sternum. The lungs of the mammals are multi-chambered and usually divided into lobes. Usually the right side has more lobes than the left side. Humans have three right and two left lobes.

Figure 3 shows the respiratory organs of humans. The air from outside enters through the external nostrils and nasal passages into pharynx. From the pharynx it passes through the glottis into trachea. The trachea is a long tube that traverses the neck and lies ventral to gullet. The anterior part of the trachea is enlarged to form the voice box or larynx. The vocal chords are located inside the larynx and the vibrations of the vocal chords results in the production of the sound. The trachea bifurcates into two primary bronchi. Each primary bronchus enters into lungs and branches into secondary and tertiary bronchi, and finally into bronchioles. Terminal

bronchioles lead into thin walled delicate alveolar ducts, the walls of which are evaginated to form clusters of alveoli. The lungs are protected and cushioned by the pleura. The pleura is made of two thin layers of tissue:

a) the inner layer (visceral pleura) which wraps around the lungs and is stuck so tightly to the lungs that it cannot be peeled off,

b) the outer layer (parietal pleura) which lines the inside of the chest wall. The pleura prevent the lungs from separating from the rib cage.

The very thin space between the layers is called the pleural cavity. A liquid, called pleural fluid, lubricates the pleural cavity so that the two layers of pleural tissue can slide against each other as the lungs inflate and deflate during respiration.

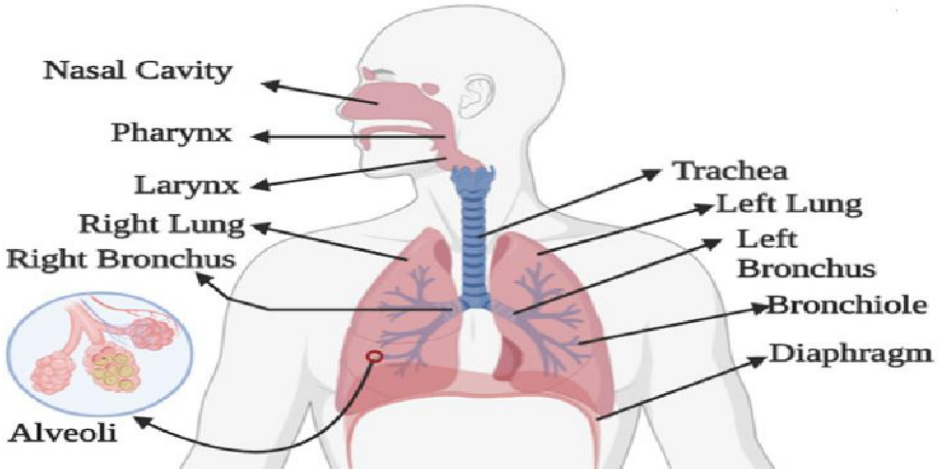

Figure 03: The respiratory system of humans

In mammals buccal cavity plays no role in respiration, and the diaphragm and ribs play an important part. You can see in Figure 4, that during inhalation the rib muscles (external intercostal muscles extend between the ribs) and diaphragm contracts causing the raising of the ribs and flattening of the diaphragm increasing the size of the thoracic cavity. The pressure decreases and the air enters into lungs. The entire process constitutes **inspiration**.

Expiration is a passive process, brought about by the relaxation of the intercostals muscles and the diaphragm. The thoracic cavity is brought to its normal size and as a result the air is forced out.

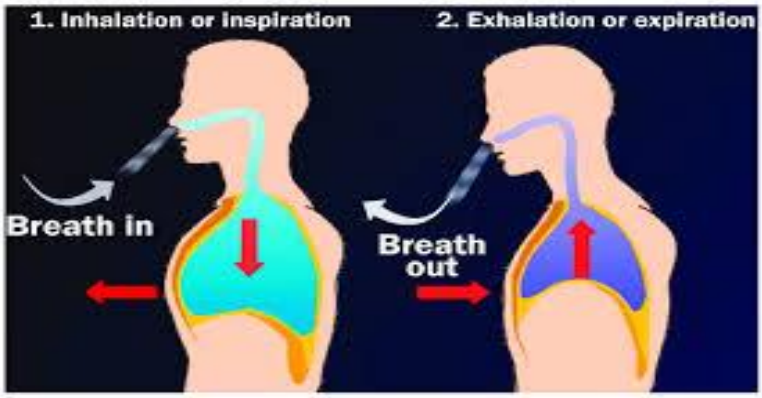

Figure 04: Process of Inhalation and exhalation.