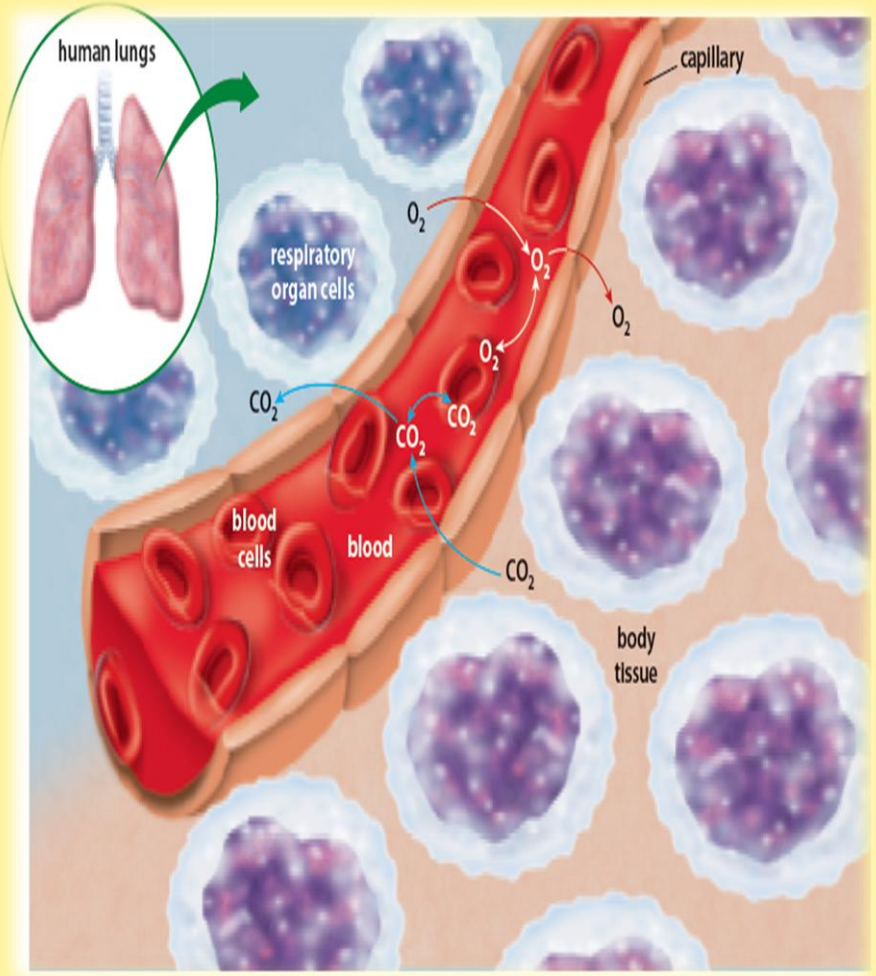
The Function of Respiration

- The main function of the **respiratory system** is to ensure that oxygen is brought into the body and made available to each cell that needs it, and that carbon dioxide can leave each cell and be removed from the body.
- **Respiration** is the general term that is used to describe this overall process.

Respiration and Gas Exchange

- There are several stages in human respiration, and each stage has specialized structures to facilitate it.



The 1st Stage: Breathing

- The first stage in respiration, ***breathing***, *involves* two basic processes: **inspiration** (breathing in, or inhaling) and **expiration** (breathing out, or exhaling).

The 2nd Stage: External Respiration

- The second stage of respiration, ***external respiration***, is the exchange of oxygen and carbon dioxide between the inspired air inside the lungs and the blood.
- This stage of the respiratory process performs the vital function of **gas exchange**.
- **Gas exchange** is the delivery of oxygen from the lungs to the blood, and the elimination of carbon dioxide from the blood to the lungs.

The 3rd Stage: Internal Respiration

- The third stage, called ***internal respiration***, is the exchange of oxygen and carbon dioxide between the blood and the body's tissue cells.

The 4th Stage: Cellular Respiration

- The fourth and final stage in human respiration is ***cellular respiration***.
- Cellular respiration is the series of energy-releasing chemical reactions that take place within the cells.
- It is the sole means of providing energy for all cellular activities.

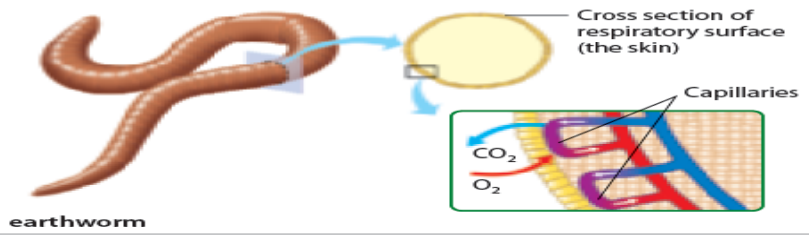
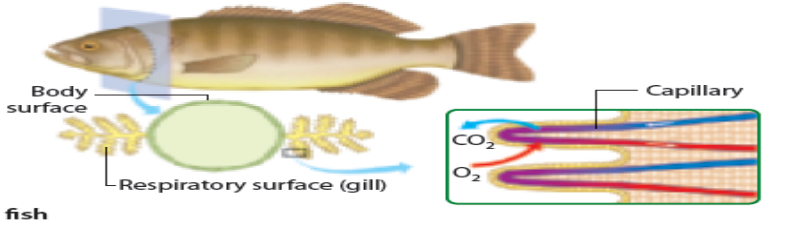
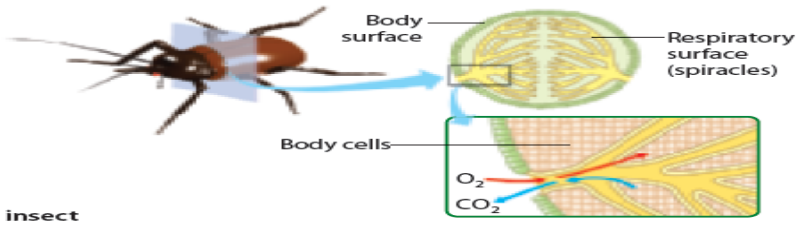
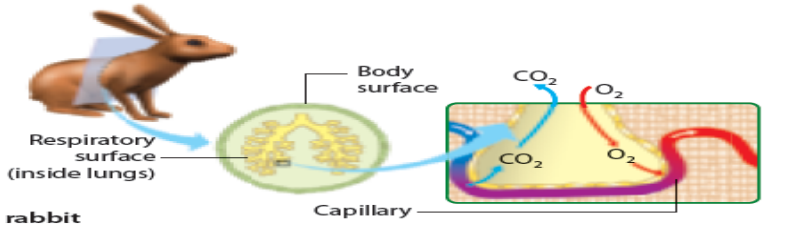
Respiratory Surfaces

- There are two main requirements for respiration.

1. The area of an animal's body where gases are exchanged with the environment, called its respiratory surface, must be large enough for the exchange of oxygen and carbon dioxide to occur quickly enough to meet the body's needs.
2. Respiration must take place in a moist environment, so that the oxygen and carbon dioxide are dissolved in water.

- To increase the efficiency of respiration, all organisms use **ventilation**.
- **Ventilation** is the process of moving an oxygen-containing medium (water or air) over the respiratory surface (such as the gills, trachea, or lungs).

Types of Respiratory Surfaces in Animals

Description of Respiratory Surface	Example
Outer Skin Some animals, like the earthworm, do not have specialized gas exchange organs. They use their entire outer skin as a respiratory surface. Oxygen diffuses into a network of thin-walled capillaries just below the skin, and carbon dioxide diffuses out. Animals that breathe through their skin usually have a high ratio of respiratory surface to body volume. They must live in damp places or in water to keep their respiratory surface (their skin surface) moist. Some amphibians are also "skin breathers."	
Gills Fish and many aquatic invertebrates, such as clams, mussels, crayfish, and crabs, exchange gases through gills. Gills are extensions or folds in the body surface that increase the surface area through which gases are exchanged. Oxygen from the water diffuses across the gill surfaces into capillaries, and carbon dioxide diffuses out into the external environment. Since aquatic animals are surrounded by water, they have no problem keeping their respiratory surfaces moist.	
Tracheal System Insects exchange gases through a tracheal system, which is an internal system of branching respiratory tubes called *tracheae*. The tracheae connect body cells directly to the environment outside the insect's body by even smaller tubes called *spiracles*. Oxygen enters the body through the spiracles and diffuses into the tracheae. Carbon dioxide then diffuses out of the body in the opposite direction. Since gas is exchanged directly with the body cells, the insect's circulatory system is not involved in transporting oxygen.	
Lungs Due to their larger size and higher activity levels, most land animals require much more oxygen than could be delivered by gills or a tracheal system. Mammals, birds, reptiles, and most amphibians exchange gases through an internal respiratory system consisting of a trachea (or windpipe) that branches into lungs. The lungs are sacs lined with a moist epithelium. Folds in the lining of the lungs increase the surface area for diffusion. Oxygen diffuses across the epithelium into the capillaries, and carbon dioxide diffuses in the opposite direction into the external environment.	

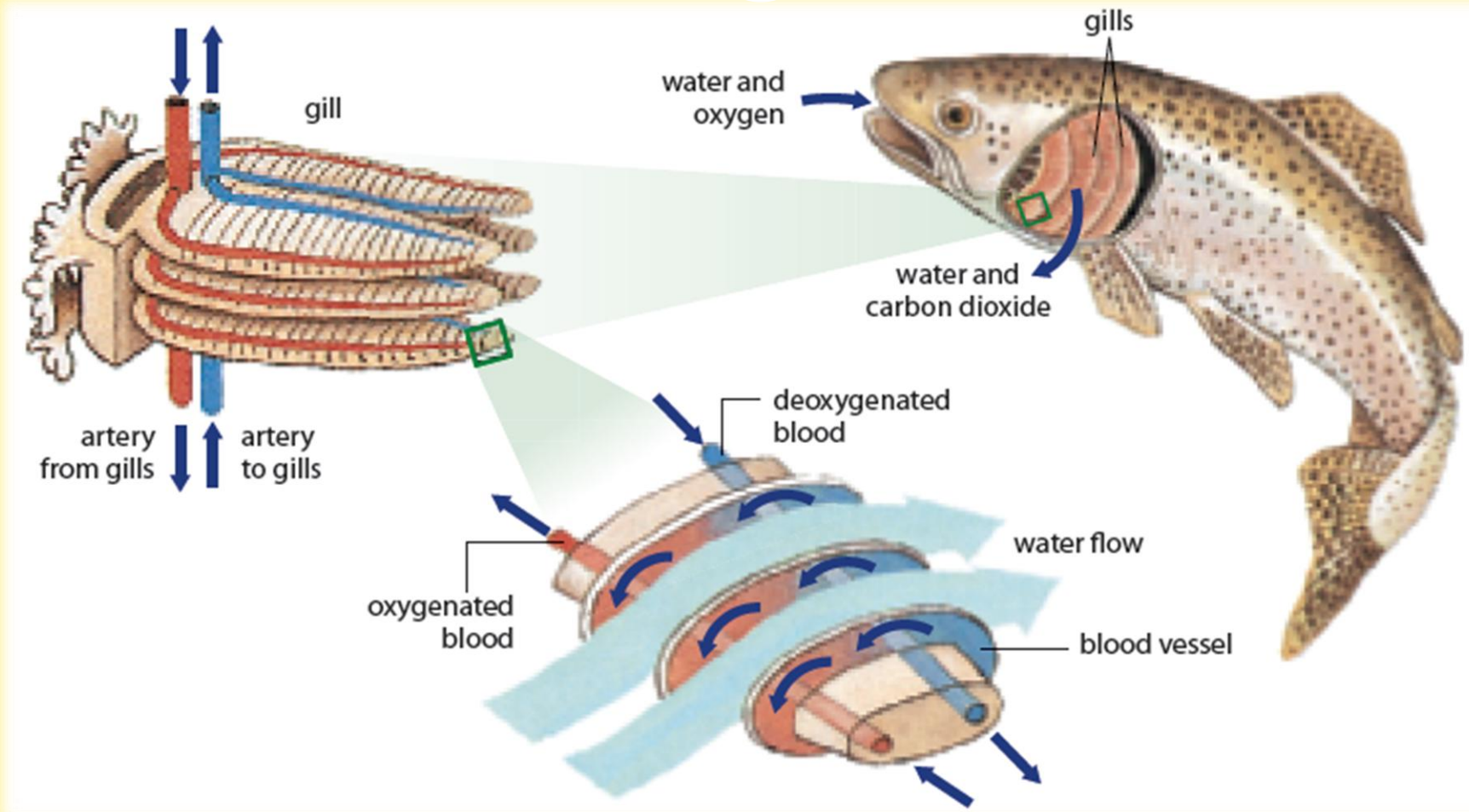
Gas Exchange in Aquatic Environments

- Aquatic environments contain oxygen in the form of dissolved gas.
- Many aquatic organisms, such as fish, lobsters, clams, and molluscs take in oxygen through gills.
- Gills are physical adaptations that enable organisms to carry out gas exchange in aquatic environments.

Gas Exchange in Fish

- A fish exchanges gases by taking water into its mouth and ventilating (or pumping) it over the gills.
- Another adaptation used by fish is a counter-current exchange mechanism.
- Oxygen diffuses along a gradient, called a **diffusion gradient**, meaning that the oxygen molecules move from a region of high concentration to a region of low concentration.
- Because blood and water flow in opposite directions, the diffusion gradient of the oxygen is kept high.

Counter–current Gas Exchange in Fish



Gas Exchange on Land

- Air-breathing vertebrates such as reptiles, birds, and mammals rely on lungs for gas exchange.

The Mechanics of Breathing

- Two sets of structures - the muscular diaphragm and the rib muscles - control the air pressure inside the lungs.
- Changes in air pressure cause air to move into and out of the lungs.
- The **diaphragm** is a dome-shaped layer of muscle that separates the region of the lungs (the thoracic cavity) from the region of the stomach and liver (the abdominal cavity).
- The rib muscles, or **intercostal muscles**, are found between the ribs and along the inside surface of the rib cage.

A Look at Inhalation and Exhalation