ANIMAL PHYSIOLOGY AND PHYSIOLOGICAL CHEMISTRY
PAPER MZO503
PART IV

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COMPARATIVE PHYSIOLOGY
OF
RESPIRATORY SYSTEM

The respiratory system is the organs and other parts of your body involved in breathing, when you exchange oxygen and carbon dioxide.

- Cellular respiration involves the breakdown of organic molecules to produce ATP.
- A sufficient supply of oxygen is required for the aerobic respiratory machinery of Kreb's Cycle and the Electron Transport System to efficiently convert stored organic energy into energy trapped in ATP.
- Carbon dioxide is also generated by cellular metabolism and must be removed from the cell.
- There must be an exchange of gases: carbon dioxide leaving the cell, oxygen entering. Animals have organ systems involved in facilitating this exchange as well as the transport of gases to and from exchange areas.

Types of Cellular Respiration

Anaerobic Respiration

➢Anaerobic means "without air". Therefore, this type of cellular respiration does not use oxygen to produce energy. Sometimes there is not enough oxygen around for some organisms to respire, but they still need the energy to survive.

➢Due to lack of oxygen, they carry out respiration in the absence of oxygen to produce the energy they require, which is referred to as anaerobic respiration. Anaerobic respiration usually occurs in lower plants and microorganisms.

➢In the absence of oxygen, the glucose derived from food is broken down into alcohol and carbon dioxide along with the production of energy.

Glucose → Alcohol + Carbon dioxide + Energy

➢Anaerobic respiration is also used by multi-cellular organisms, like us, as a temporary response to oxygen-less conditions.

➢During heavy or intensive exercise such as running, sprinting, cycling or weight lifting, our body demands high energy.

➢As the supply of oxygen is limited, the muscle cells inside our body resort to anaerobic respiration to fulfill the energy demand.

Glucose → Lactic acid + Energy

➢Anaerobic respiration produces the relatively lesser amount of energy as compared to aerobic respiration as glucose is not completely broken down in the absence of oxygen.

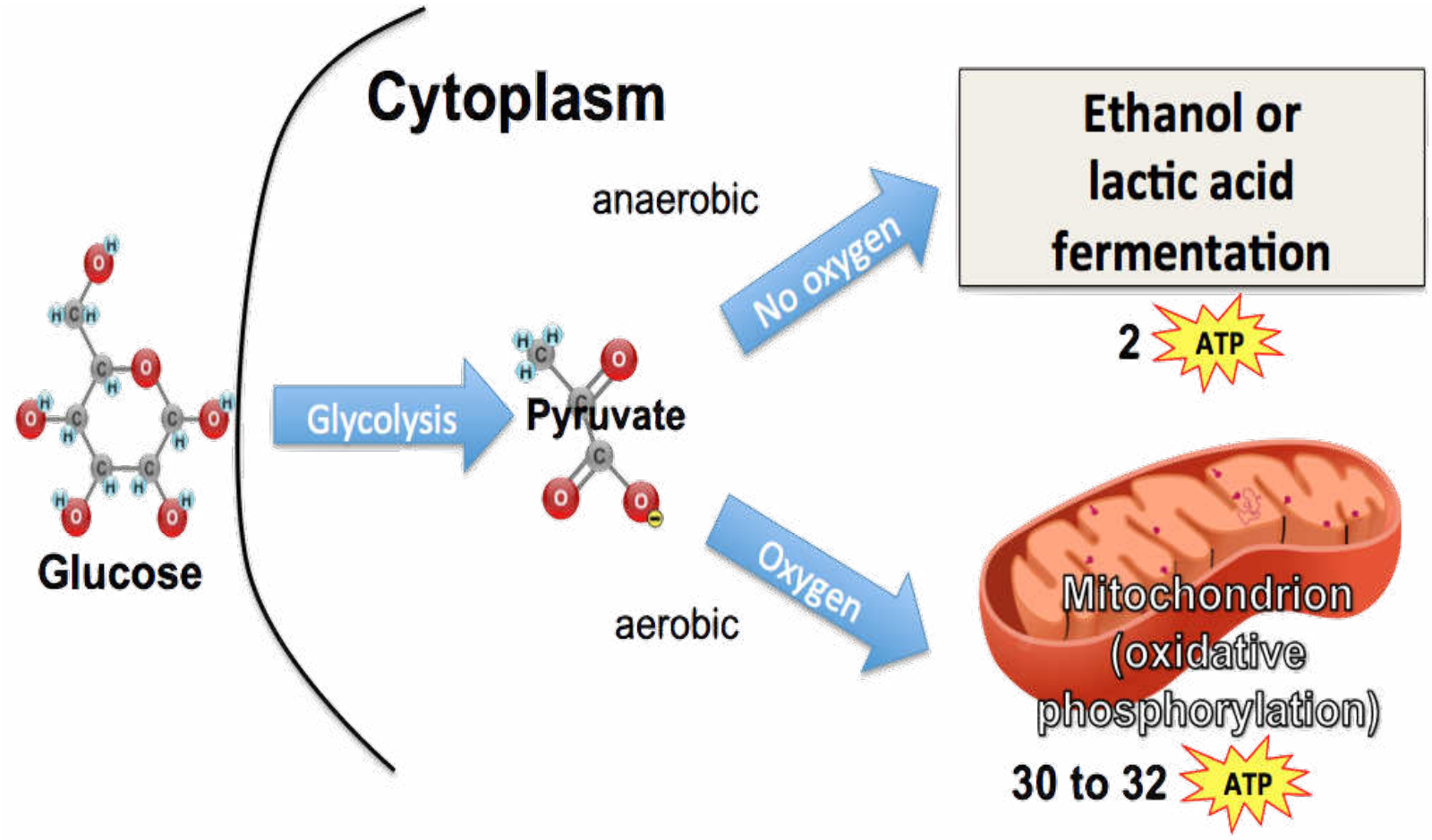


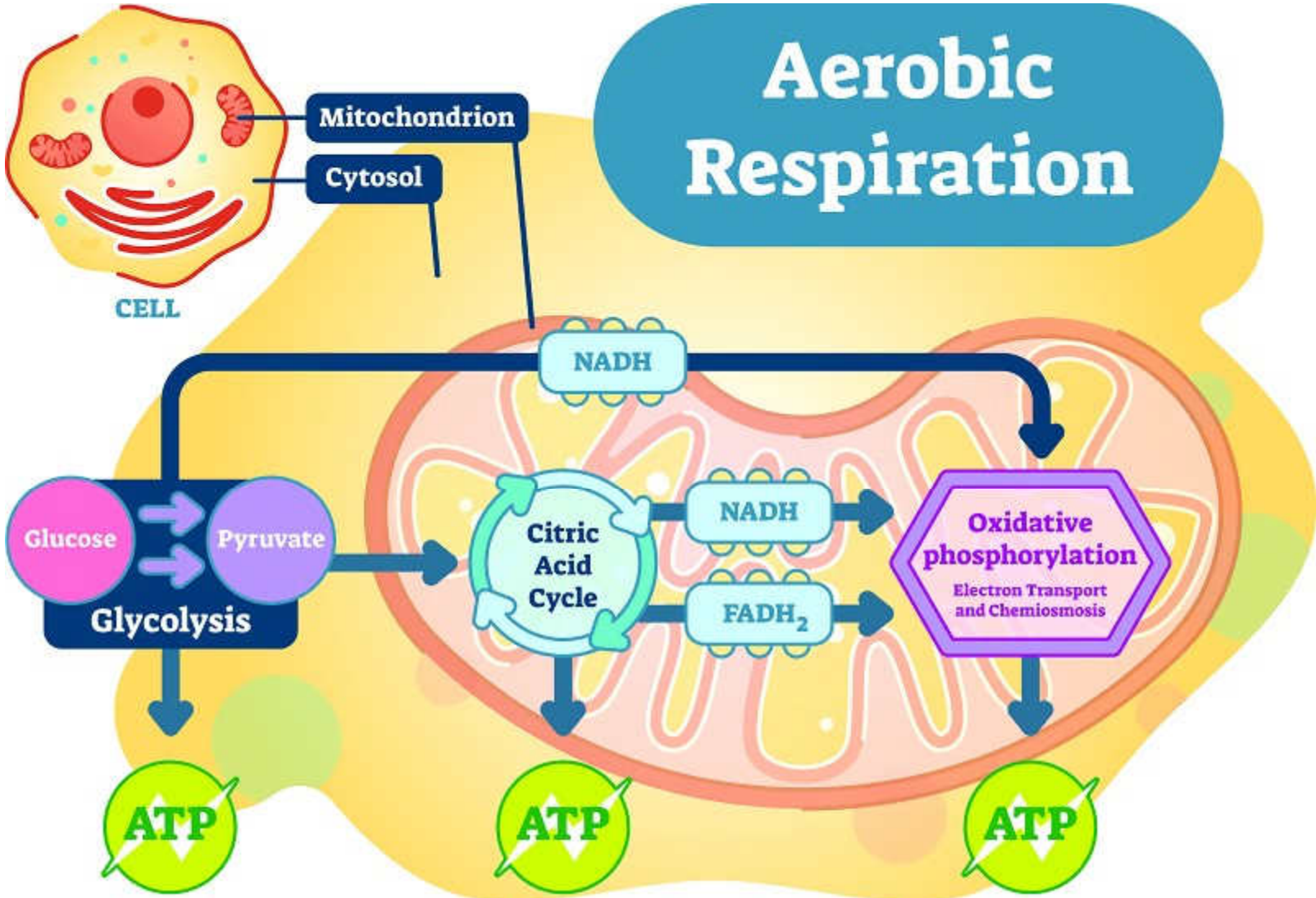
Diagram showing anaerobic respiration

Aerobic Respiration

- Aerobic means “with air”.
- Therefore, aerobic respiration is the process of cellular respiration that uses oxygen to produce energy from food.
- This type of respiration is common in most of the plants and animals including humans, birds, and other mammals.
- While breathing, we inhale air that contains oxygen and we exhale air rich in carbon dioxide. As we breathe in, the oxygen-rich air is transported to all the parts of our body and ultimately to each cell.
- Inside the cell, the food, which contains glucose, is broken down into carbon dioxide and water with the help of oxygen. The process of breaking down the food particles releases energy, which is then utilized by our body.
- The energy released via aerobic respiration helps plants and animals, including us, grow.
- The process can be simply explained with the help of the following equation:

Glucose + Oxygen → Carbon dioxide + Water + Energy

- Aerobic respiration is a continuous process and it happens all the time inside the cells of animals and plants.


Aerobic Respiration
Mitochondrion
Cytosol
CELL
NADH
Glucose
Pyruvate
Glycolysis
Citric Acid Cycle
NADH
FADH2
Oxidative phosphorylation
Electron Transport and Chemiosmosis
ATP
ATP
ATP

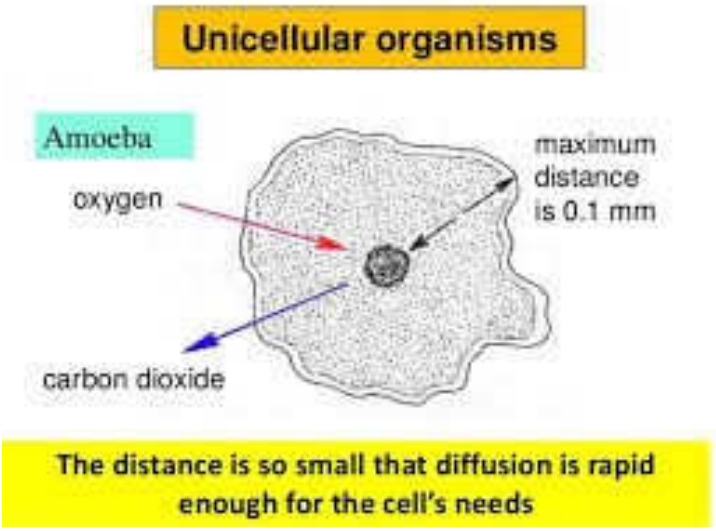
	Anaerobic	Aerobic
Reactants	Glucose	Glucose **and** oxygen
Combustion	Incomplete	Complete
Energy Yield	Low (2 ATP)	High (36 – 38 ATP)
Products	**Animals:** Lactic acid **Yeast:** Ethanol + CO_2	CO_2 and H_2O
Location	Cytoplasm	Cytoplasm **and** mitochondrion
Stages	Glycolysis Fermentation	Glycolysis Link reaction Krebs cycle Electron transport chain

Anaerobic v/s Aerobic Respiration

DIFFERENT METHODS OF RESPIRATION

Respiration via diffusion

- In single-celled organisms, the oxygen and carbon dioxide simply diffuse through the **cell membrane**.
- However, the slow diffusion rate of oxygen relative to carbon dioxide limits the size of single-celled organisms.
- Simple animals that lack specialized exchange surfaces have flattened, tubular, or thin shaped body plans, which are the most efficient for gas exchange.
- However, these simple animals are rather small in size.



Respiration through body surfaces

➢Large animals cannot maintain gas exchange by diffusion across their outer surface. They developed a variety of respiratory surfaces that all increase the surface area for exchange, thus allowing for larger bodies.

➢ A respiratory surface is covered with thin, moist epithelial cells that allow oxygen and carbon dioxide to exchange.

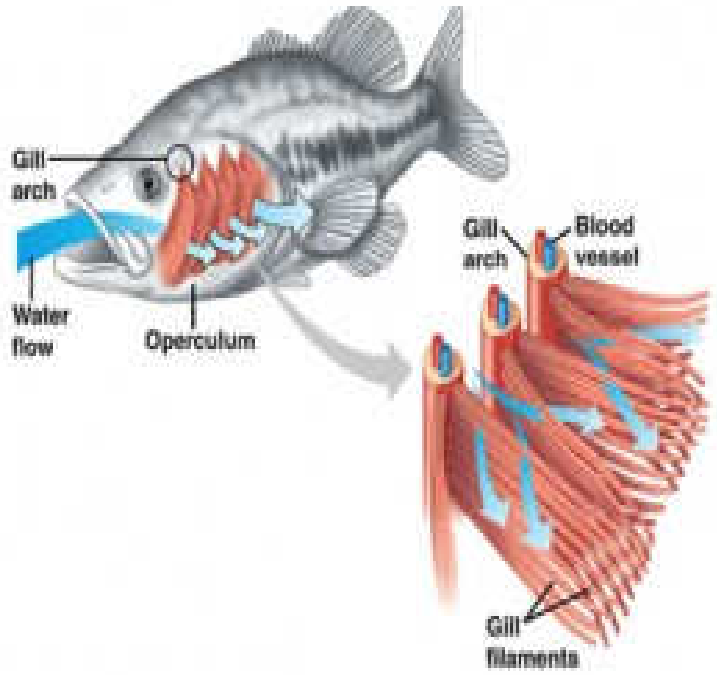
➢Those gases can only cross cell membranes when they are dissolved in water or an aqueous solution, thus respiratory surfaces must be moist.

➢ Flatworms and annelids use their outer surfaces as gas exchange surfaces.

➢Amphibians use their skin as a respiratory surface.

Respiration through Gills

- Gills greatly increase the surface area for gas exchange.
- They occur in a variety of animal groups including arthropods (including some terrestrial crustaceans), annelids, fish, and amphibians
- Gills typically are convoluted outgrowths containing blood vessels covered by a thin epithelial layer.
- Typically gills are organized into a series of plates and may be internal (as in crabs and fish) or external to the body (as in some amphibians).
- Gills are very efficient at removing oxygen from water: there is only 1/20 the amount of oxygen present in water as in the same volume of air.
- Water flows over gills in one direction while blood flows in the opposite direction through gill capillaries. This countercurrent flow maximizes oxygen transfer.

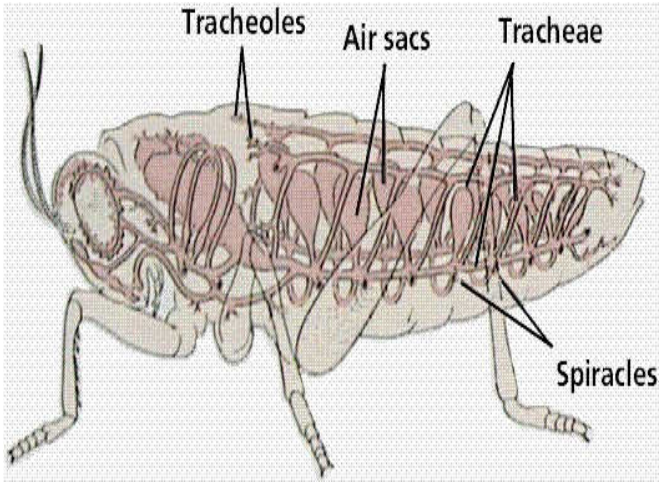


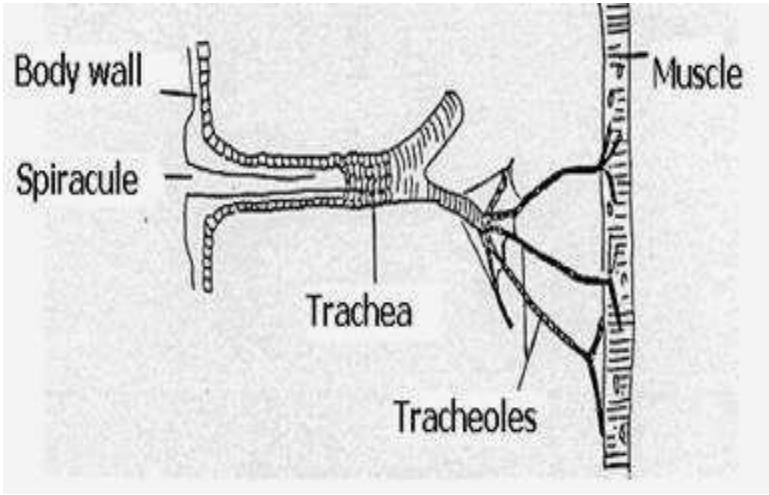
Respiration through Tracheal System

➢Many terrestrial animals have their respiratory surfaces inside the body and connected to the outside by a series of tubes.

➢Tracheae are these tubes that carry air directly to cells for gas exchange. Spiracles are openings at the body surface that lead to tracheae that branch into smaller tubes known as tracheoles.

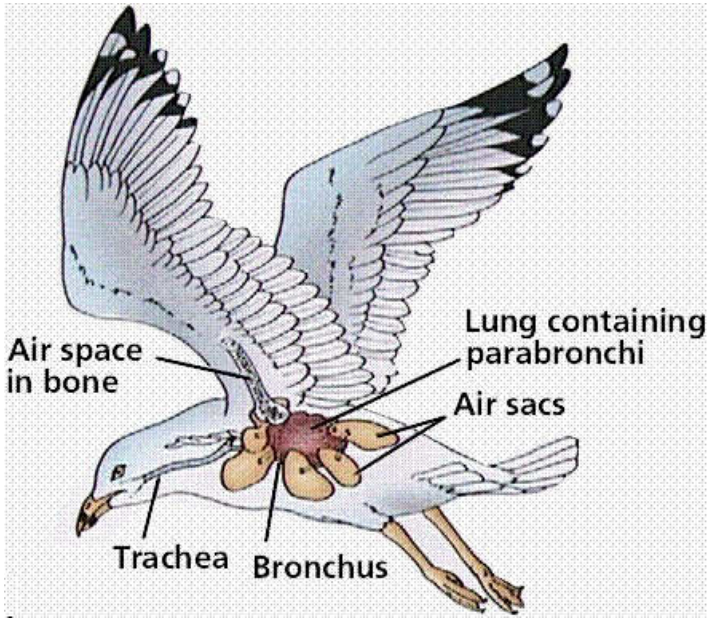
➢Body movements or contractions speed up the rate of diffusion of gases from tracheae into body cells. However, tracheae will not function well in animals whose body is longer than 5 cm.

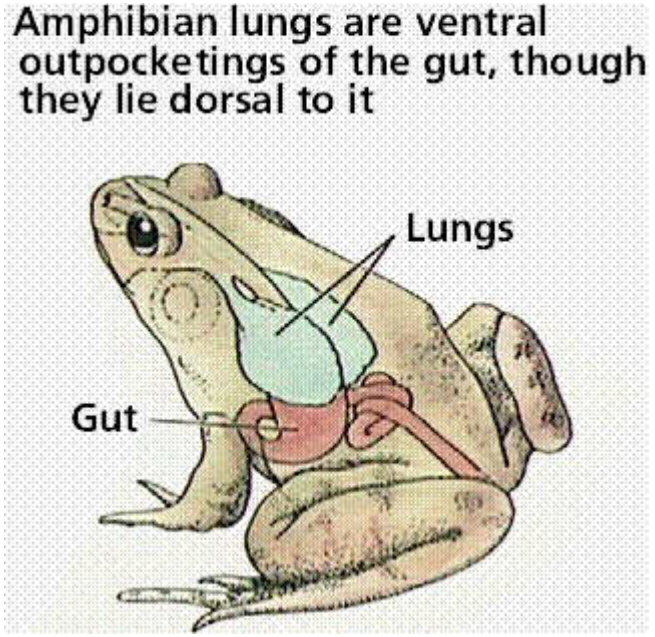




Respiration through Lungs

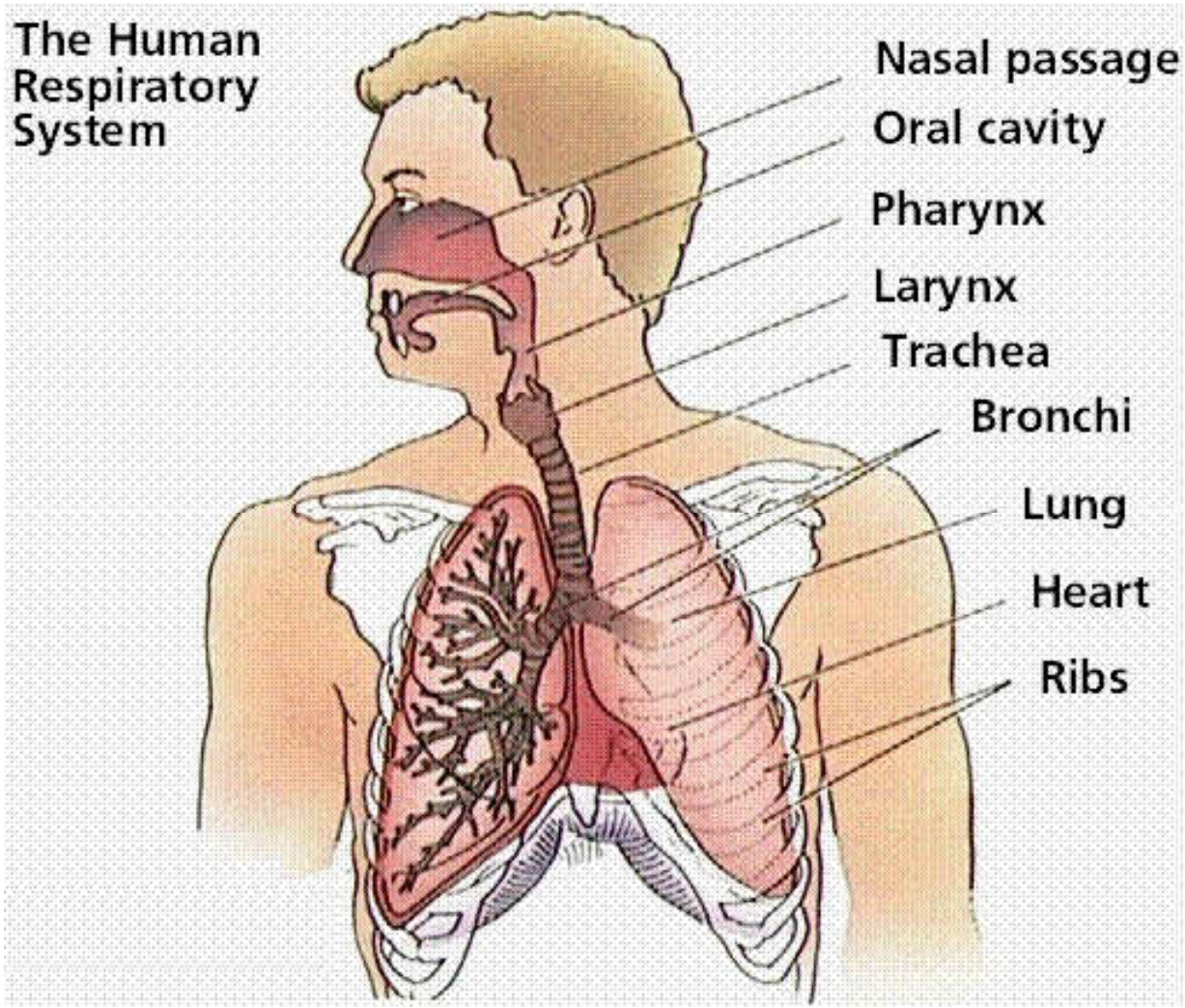
- Lungs are ingrowths of the body wall and connect to the outside by as series of tubes and small openings.
- Lung breathing probably evolved about 400 million years ago.
- Lungs are not entirely the sole property of vertebrates, some terrestrial snails have a gas exchange structures similar to those in frogs.

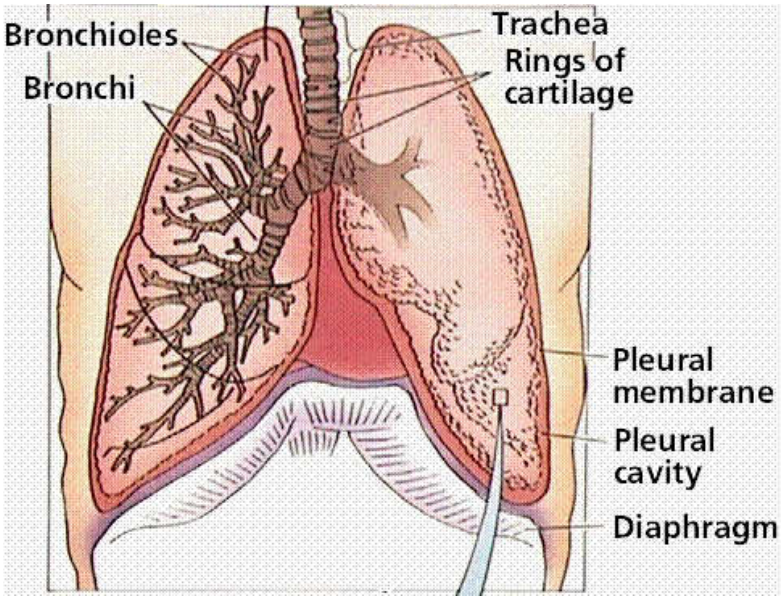


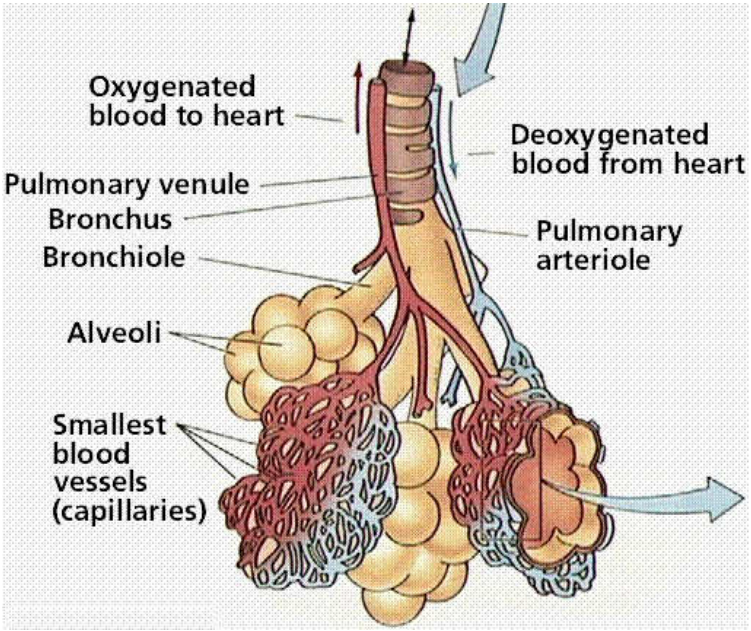


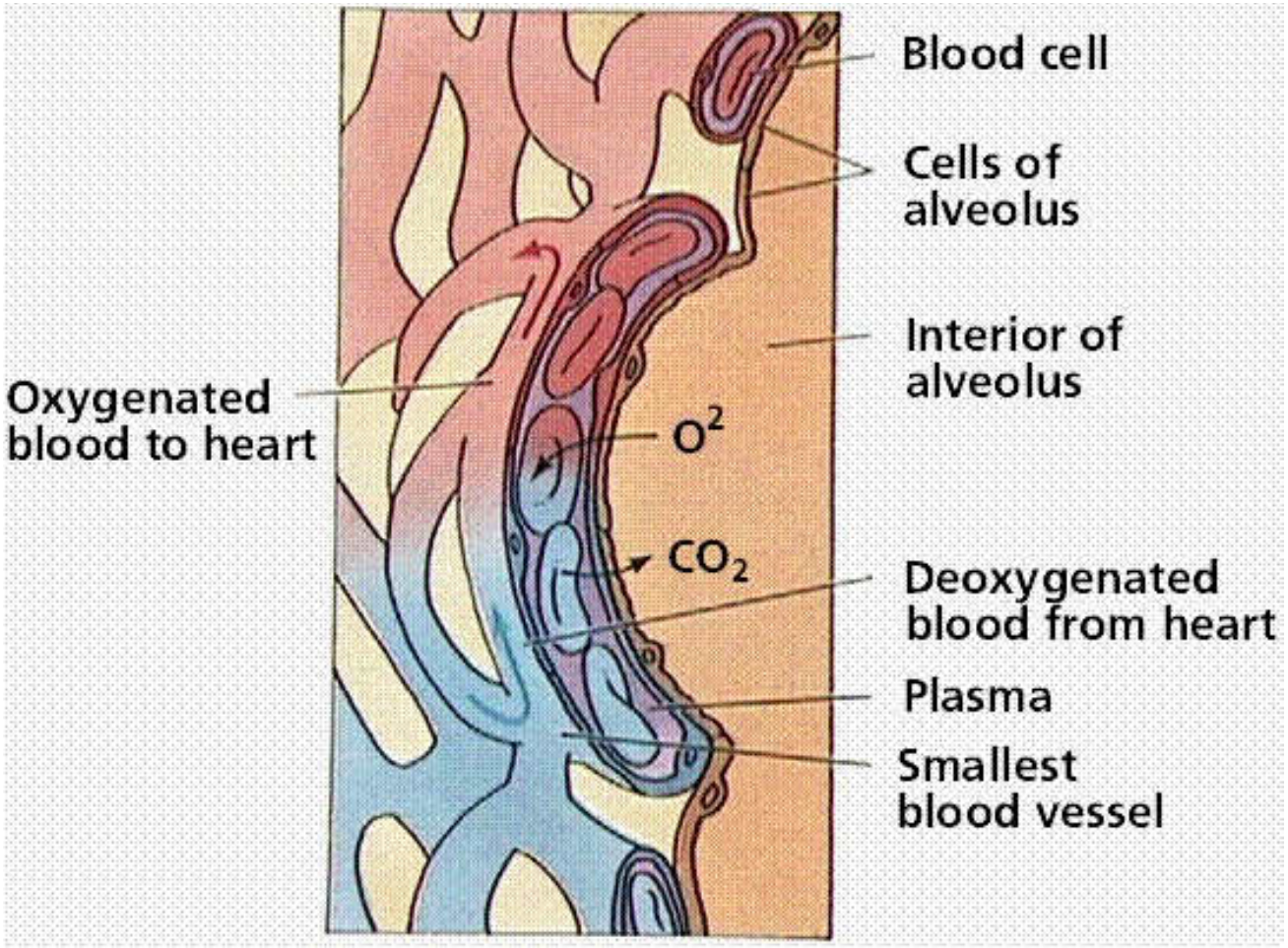
The Human Respiratory System

- This system includes the lungs, pathways connecting them to the outside environment, and structures in the chest involved with moving air in and out of the lungs.
- Air enters the body through the nose, is warmed, filtered, and passed through the nasal cavity.
- Air passes the pharynx (which has the epiglottis that prevents food from entering the trachea).The upper part of the trachea contains the larynx.
- The vocal cords are two bands of tissue that extend across the opening of the larynx.
- After passing the larynx, the air moves into the bronchi that carry air in and out of the lungs.
- The lungs and alveoli and their relationship to the diaphragm and capillaries.
- Bronchi are reinforced to prevent their collapse and are lined with ciliated epithelium and mucus-producing cells.
- Bronchi branch into smaller and smaller tubes known as bronchioles. Bronchioles terminate in grape-like sac clusters known as alveoli.
- Alveoli are surrounded by a network of thin-walled capillaries.
- Only about 0.2 μm separate the alveoli from the capillaries due to the extremely thin walls of both structures.


The Human Respiratory System
Nasal passage
Oral cavity
Pharynx
Larynx
Trachea
Bronchi
Lung
Heart
Ribs


Bronchioles
Bronchi
Trachea
Rings of cartilage
Pleural membrane
Pleural cavity
Diaphragm


Oxygenated blood to heart
Deoxygenated blood from heart
Pulmonary venule
Bronchus
Bronchiole
Pulmonary arteriole
Alveoli
Smallest blood vessels (capillaries)

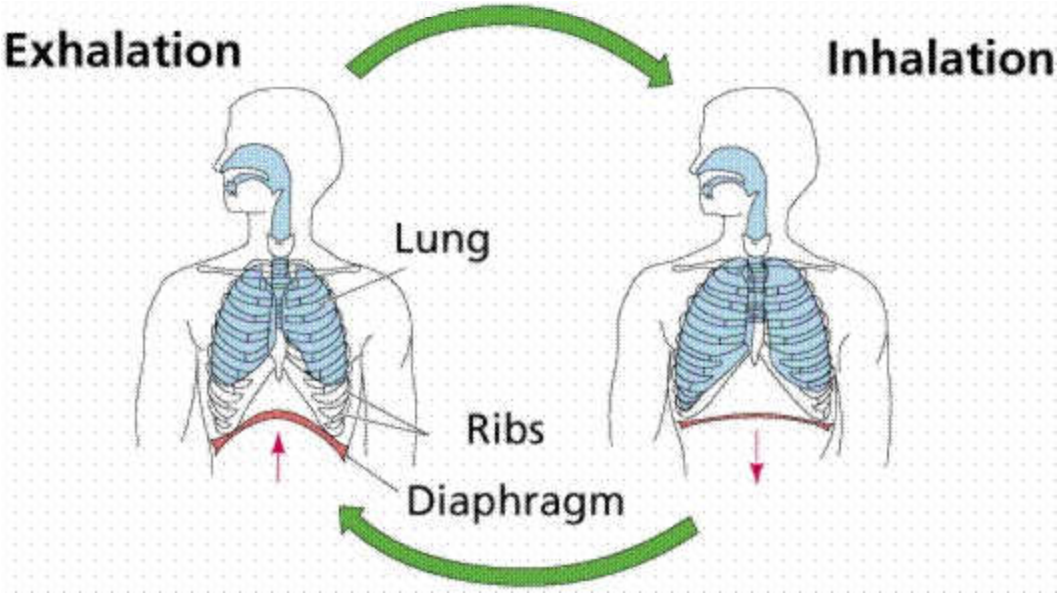


Gas Exchange across capillaries

➢The lungs are large, lobed, paired organs in the chest (also known as the thoracic cavity). Thin sheets of epithelium (pleura) separate the inside of the chest cavity from the outer surface of the lungs. The bottom of the thoracic cavity is formed by the diaphragm.

➢Ventilation is the mechanics of breathing in and out. When you inhale, muscles in the chest wall contract, lifting the ribs and pulling them, outward.

➢The diaphragm at this time moves downward enlarging the chest cavity. Reduced air pressure in the lungs causes air to enter the lungs. Exhaling reverses theses steps.



THANK YOU