Al-Mustaqbal University

Biomedical Engineering Department

Class: 3th

Subject: Systemic Physiology I

Assistant Lecturer : Zainab Sattar Jabbar

1st term – Lect. 5: Respiratory System Physiology

Email: zainab.sattar.jabbar@uomus.edu.iq

Respiration

- **Energy** is essential for sustaining life-supporting cellular activities, such as protein synthesis and active transport across plasma membranes. Body cells need a continuous supply of O2 to support their energy-generating chemical reactions. The CO2 produced during these reactions must be eliminated from the body at the same rate as it is produced to prevent dangerous fluctuations in pH (that is, to maintain acid–base balance) because CO2 generates carbonic acid.

- **Respiration** involves the sum of the processes that accomplish ongoing passive movement of O2 from the atmosphere to the tissues to support cell metabolism and the continual passive movement of metabolically produced CO2 from the tissues to the atmosphere.
- The **Respiratory system** contributes to homeostasis by exchanging O2 and CO2 between the atmosphere and blood. The blood transports O2 and CO2 between the respiratory system and the tissues.

Respiration

- **External Respiration:** the term external respiration refers to the entire sequence of events in exchange of O2 and CO2 between the external environment and tissue cells.

- **Cellular Respiration:** the term cellular respiration refers to the intracellular metabolic processes carried out within the mitochondria, which use O2 and produce CO2 while deriving energy from nutrient molecules.

Breathing process

- **Pulmonary Ventilation:** It includes the movement of oxygen from the air into the alveoli (alveoli) in the lungs (and the movement of carbon dioxide in the opposite direction).

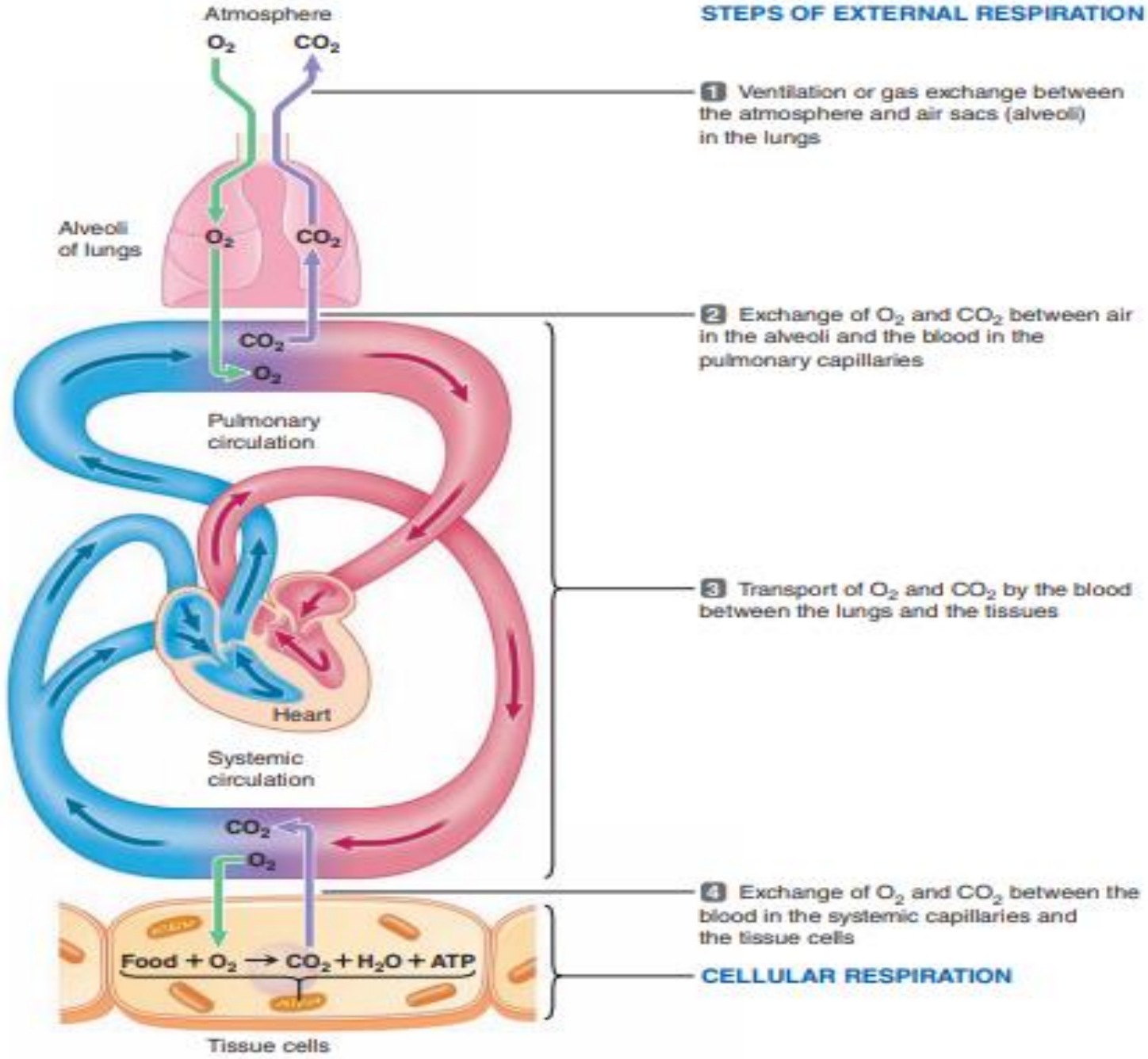
- **Exchange of respiratory gases:** between alveoli and blood.
- Coordination between blood movement and ventilation, which is important in the gas exchange process

- **Transport of O2 and CO2** : making oxygen and carbon dioxide in the blood.

- **Transport of gases :** between capillaries and cells.

- Utilizing oxygen and excreting carbon dioxide into body cells.

STEPS OF EXTERNAL RESPIRATION



1. Ventilation or gas exchange between the atmosphere and air sacs (alveoli) in the lungs
2. Exchange of O_2 and CO_2 between air in the alveoli and the blood in the pulmonary capillaries
3. Transport of O_2 and CO_2 by the blood between the lungs and the tissues
4. Exchange of O_2 and CO_2 between the blood in the systemic capillaries and the tissue cells

CELLULAR RESPIRATION

Respiratory airways

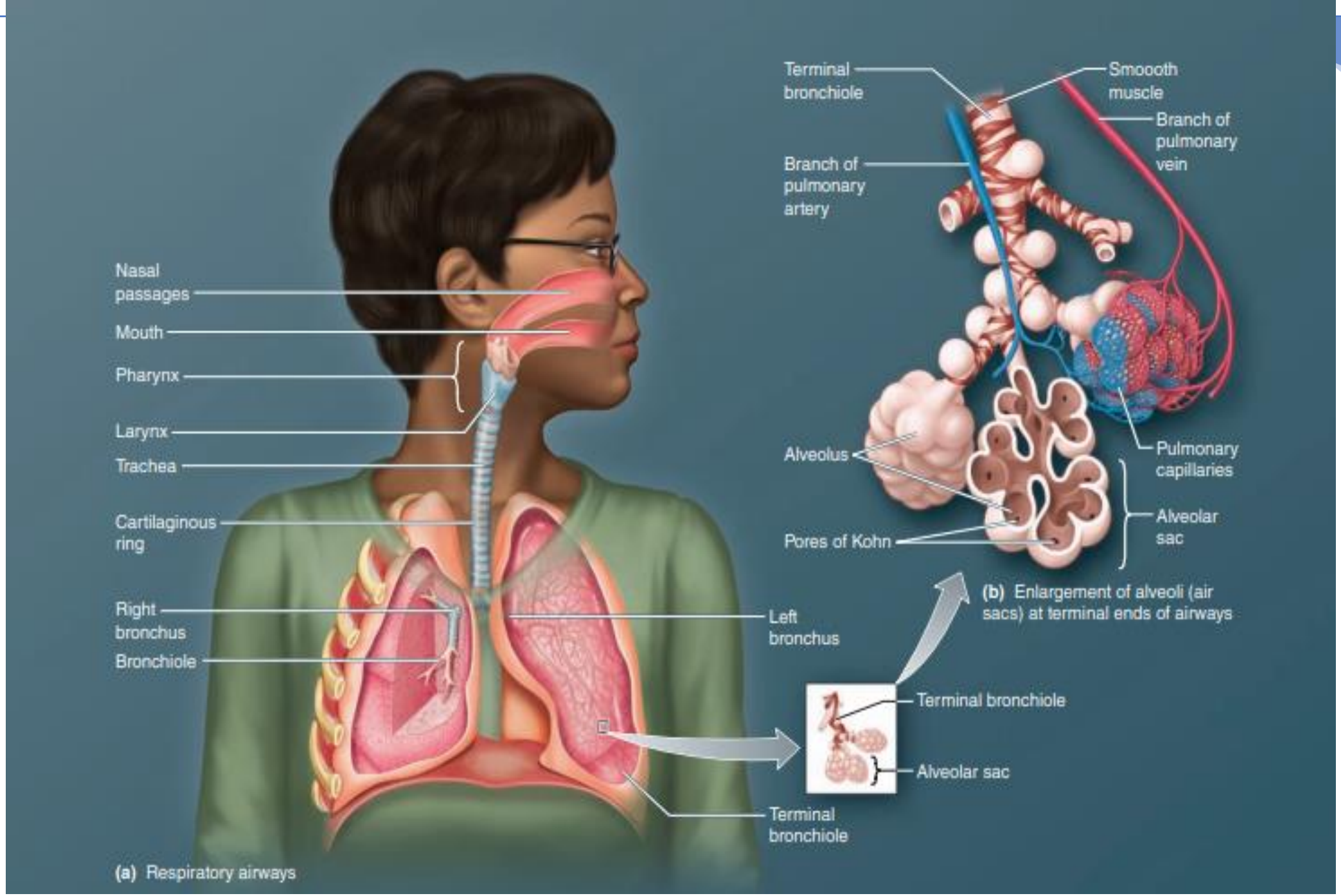
- The **respiratory airways** conduct air between the atmosphere and alveoli.

- The respiratory system includes the respiratory airways leading into the lungs, the lungs themselves, and the respiratory muscles of the thorax (chest) and abdomen involved in producing movement of air through the airways into and out of the lungs.

- The respiratory airways are tubes that carry air between the atmosphere and the air sacs, the latter being the only site where gases can be exchanged between air and blood.

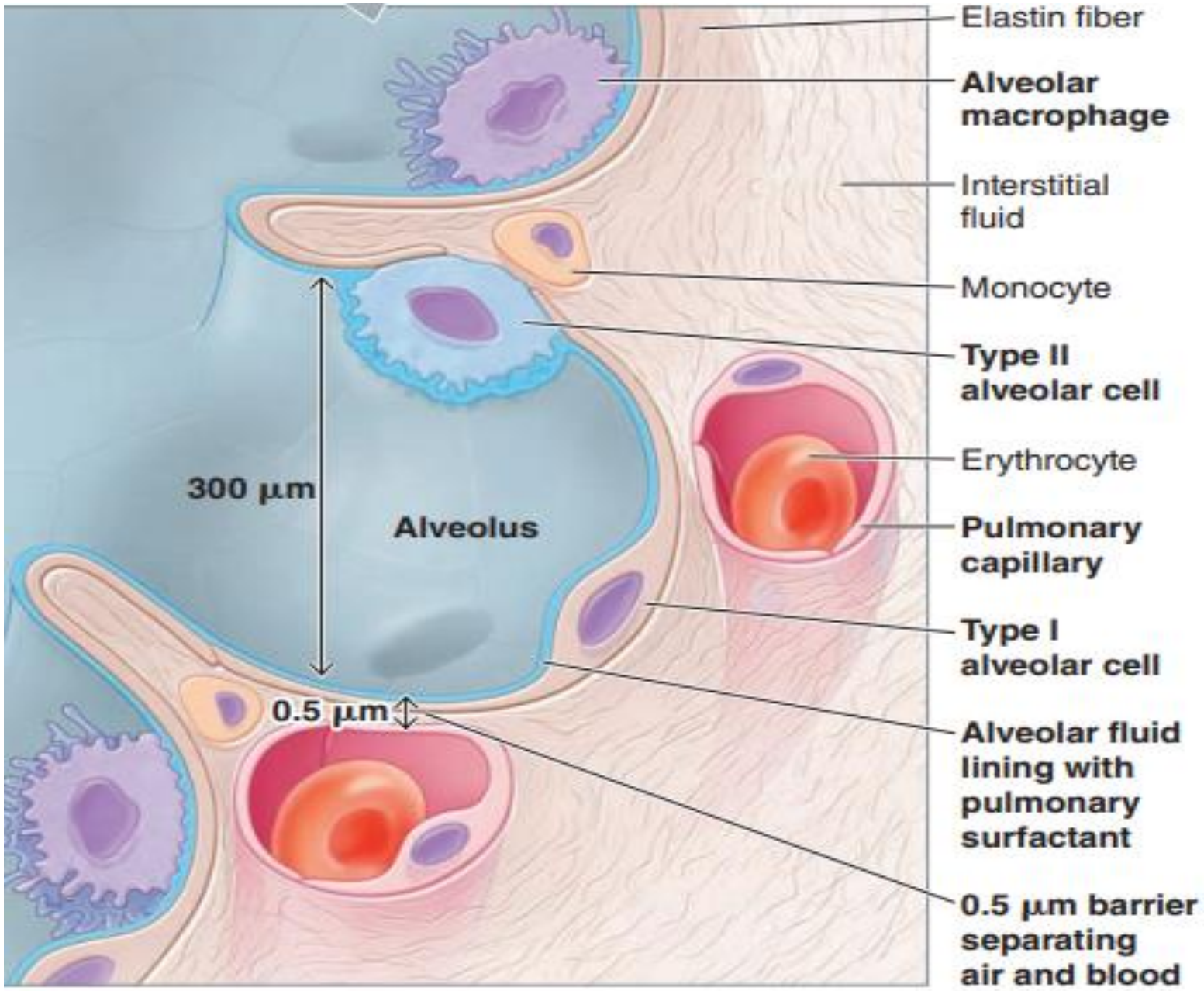
Respiratory airways

- The airways begin with the **nasal passages (nose)**.
- The nasal passages open into the **pharynx** which serves as a common passageway for both the respiratory and digestive systems.
- The **larynx**, or voice box, it is specially prepared to work as a regulating valve for the amount of air entering and exiting during the processes of inhalation and exhalation.
- The **trachea** is a long, U-shaped tube that connects your larynx (voice box) to your lungs.
- Beyond the larynx, the trachea divides into two main branches, the right and left **bronchi**, which enter the right and left lungs, respectively.
- Within each lung the bronchus continues to branch into progressively narrower, shorter, and more numerous airways, like the branching of a tree. The smaller branches are known as **bronchioles**.
- Clustered at the ends of the terminal bronchioles are the **alveoli**, the tiny air sacs where gases are exchanged between air and blood.


Nasal passages
Mouth
Pharynx
Larynx
Trachea
Cartilaginous ring
Right bronchus
Bronchiole
Left bronchus
Terminal bronchiole
(a) Respiratory airways
Terminal bronchiole
Branch of pulmonary artery
Smoooth muscle
Branch of pulmonary vein
Alveolus
Pulmonary capillaries
Alveolar sac
Pores of Kohn
(b) Enlargement of alveoli (air sacs) at terminal ends of airways
Terminal bronchiole
Alveolar sac

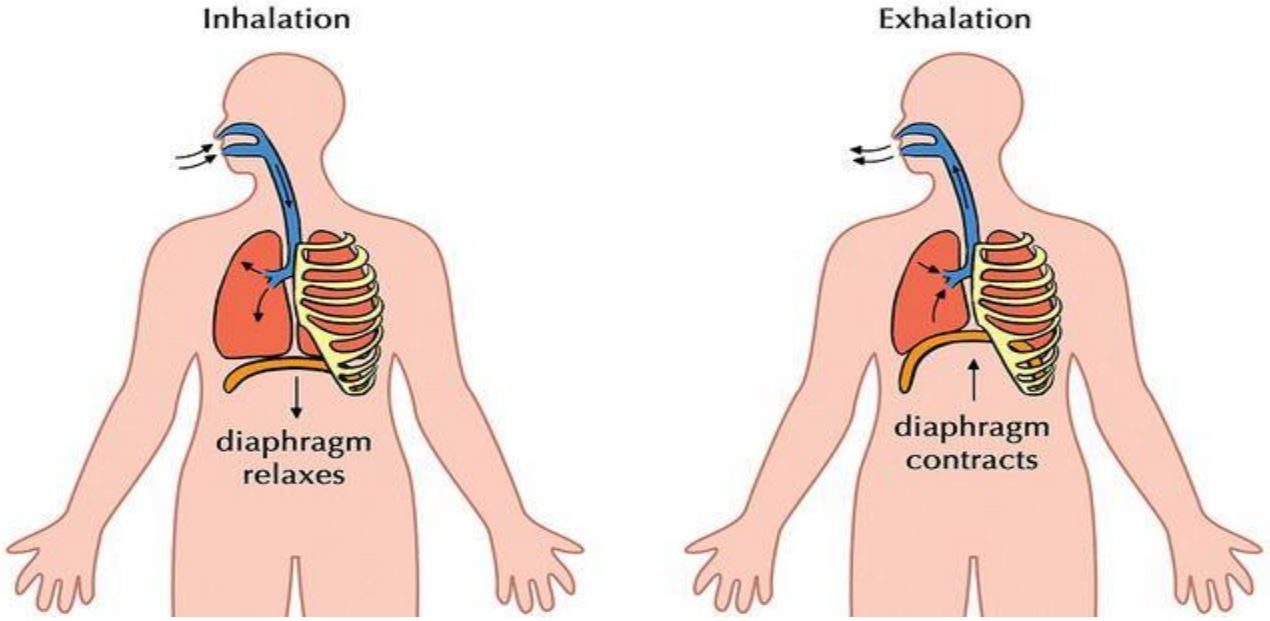
The gas-exchanging alveoli

- The gas-exchanging alveoli are thin-walled air sacs encircled by pulmonary capillaries.
- The alveolar walls consist of a single layer of flattened, **Type I alveolar cells** (wall-forming).
- The other cell called **Type II alveolar cells**. These cells secrete pulmonary surfactant, a phospholipoprotein complex that facilitates lung expansion.
- And the **Alveolar macrophage:** are the first line of defense against invading respiratory pathogens .


Elastin fiber
Alveolar macrophage
Interstitial fluid
Monocyte
Type II alveolar cell
Erythrocyte
Pulmonary capillary
Type I alveolar cell
Alveolar fluid lining with pulmonary surfactant
0.5 µm barrier separating air and blood
300 µm
Alveolus
0.5 µm

Mechanism of respiration

- The air enters through the nostrils, which work to filter, moisturize, and adjust the temperature of the air entering through them. The air passes through the pharynx, larynx, trachea, and bronchioles, which end in finer branches that form at their end pockets called alveolar sinuses.
- The expansion and contraction of the chest in mammals leads to the constant entry and exit of air to and from the lungs, as the change in the size of the rib cage is due to the movements of both the thoracic ribs and the diaphragm.



Mechanism of respiration

- In **inspiration**: the rib cage expands, creating negative pressure (less than atmospheric pressure) in the pleural cavity, which leads to the expansion of the lungs and thus air enters them (the contraction of the diaphragm towards the abdominal side).

- In **expiration** :which represents an attempt to return the rib cage to its normal position by pulling the ribs back and returning the diaphragm to its curved position towards the chest cavity, which leads to a reduction in the size of the chest and thus an increase in pressure or the exit of air from the lungs towards the outside and the main reason for the change in size.

Volume and Capacity of the Lung

- **Tidal volume (Vt or TV):** is the amount of air you move through your lungs each time you inhale and exhale while you're at rest(normal breath).

- **Inspiratory reserve volume (IRV):** the extra volume of air that can be inspired with maximal effort after reaching the end of a normal, quiet inspiration (over TV).

- **Expiratory reserve volume (ERV):** is the volume below the tidal end-expiratory level that can be forcefully expired from the lungs.

- **Residual volume (RV):** is the volume of air remaining in the lungs after maximum forceful expiration.

Volume and Capacity of the Lung

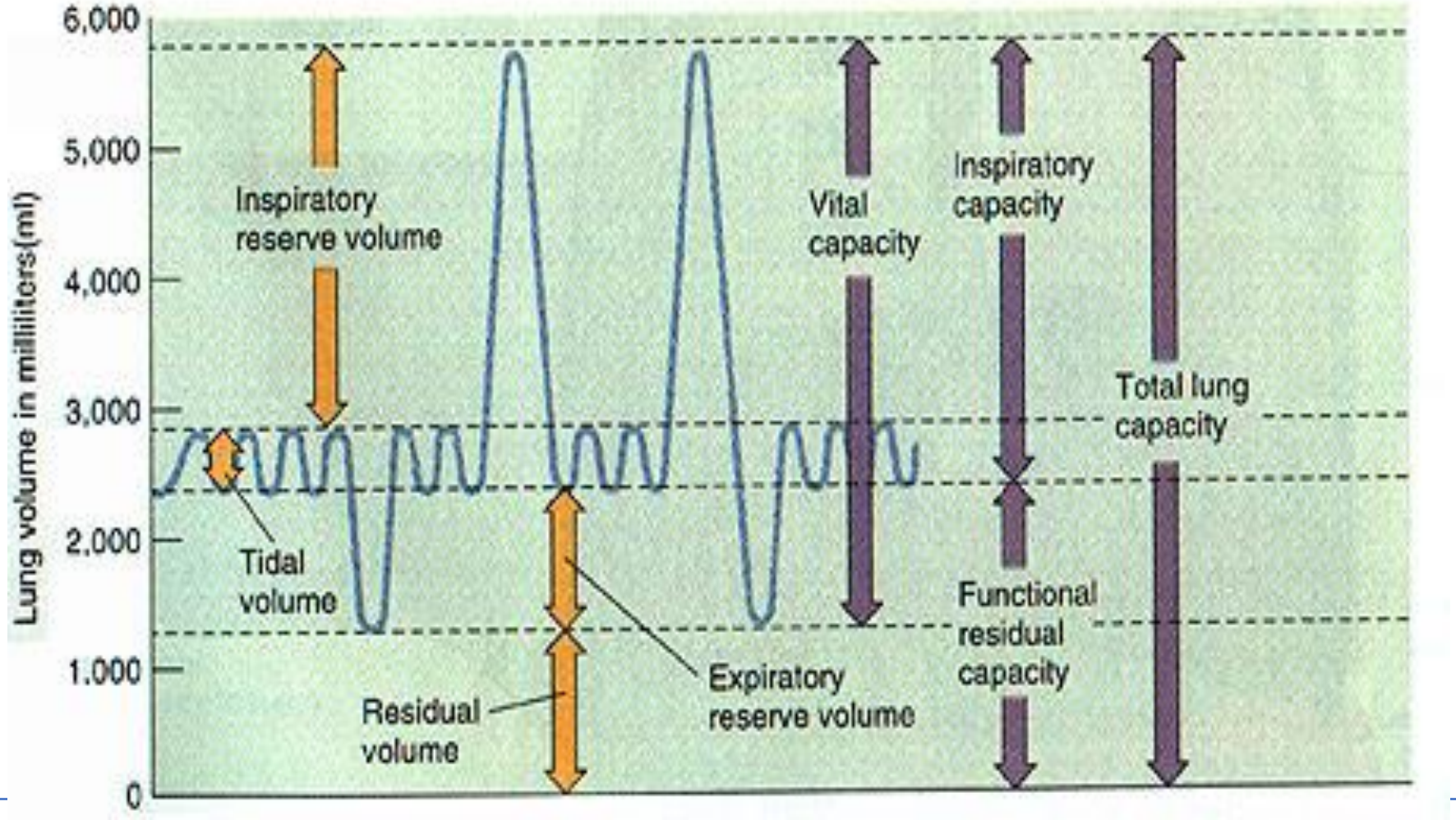
- **Total lung capacity(TLC):** It is the total volume of air (the sum of the four volumes) that the lungs can absorb.

- **Inspiratory capacity(IC):** It is the maximum amount of air that a person takes in after the deepest possible inhalation, and it is the sum of the tidal volume and the inspiratory reserve volume.

- **Functional residual capacity (FRC):** is the volume remaining in the lungs after tidal volume is expired (RV+ERV).

- **Vital capacity**: It expresses the largest amount of air that can enter the lungs at the maximum inhalation or the largest amount of air released at the maximum exhalation.

The volume of vital capacity resulting from the breathing mechanism during inhalation and exhalation



THANK YOU!