

Al-Mustaqbal University

College of Engineering and Engineering Technologies

Biomedical Engineering Department

Subject: *Systemic Physiology I*

Respiratory System Physiology

Class : 3th

Lecture: 5

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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.

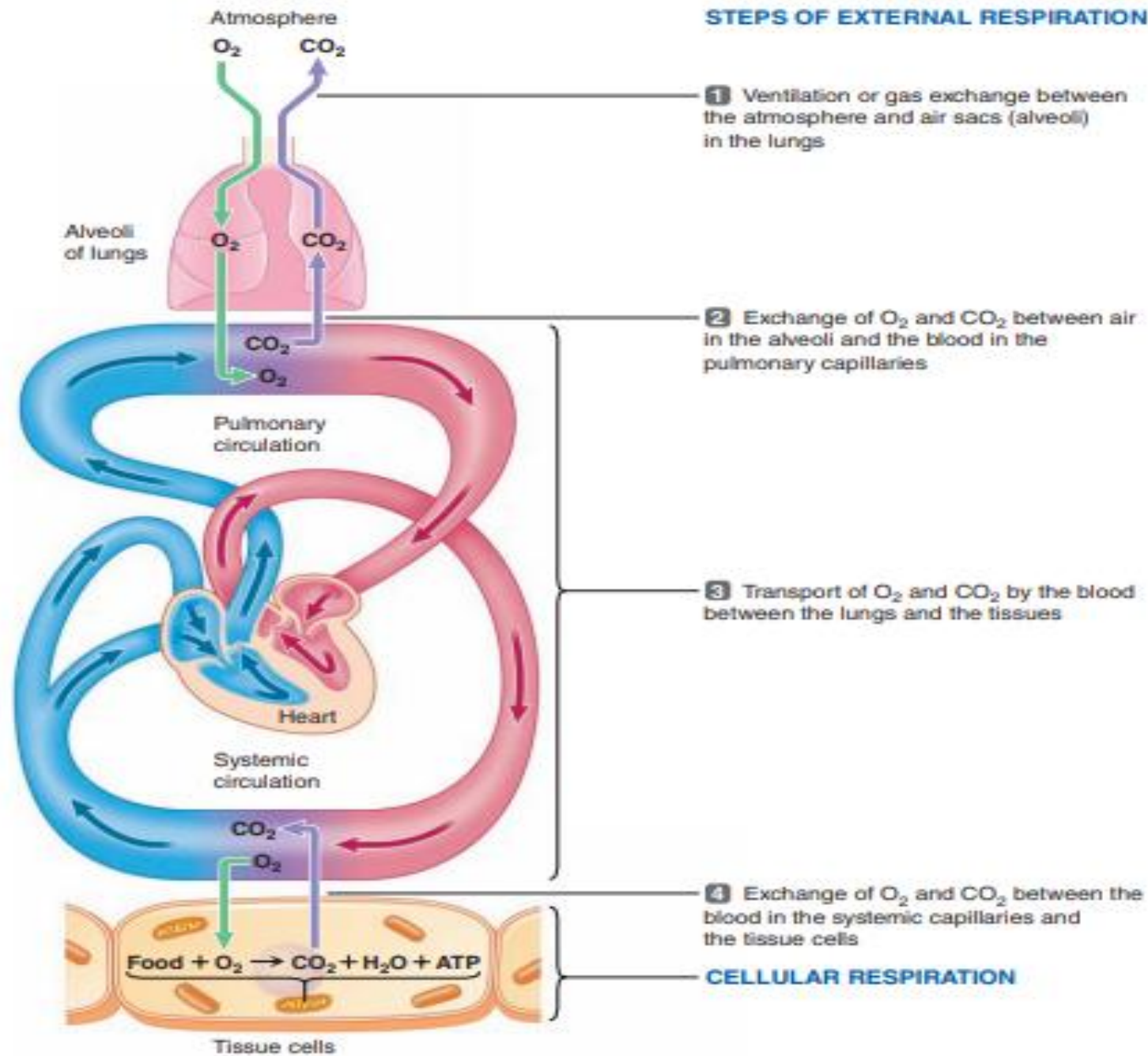
Respiration

- **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



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

(a) Respiratory airways

Terminal bronchiole

Branch of pulmonary artery

Smooth muscle

Branch of pulmonary vein

Alveolus

Pores of Kohn

Pulmonary capillaries

Alveolar sac

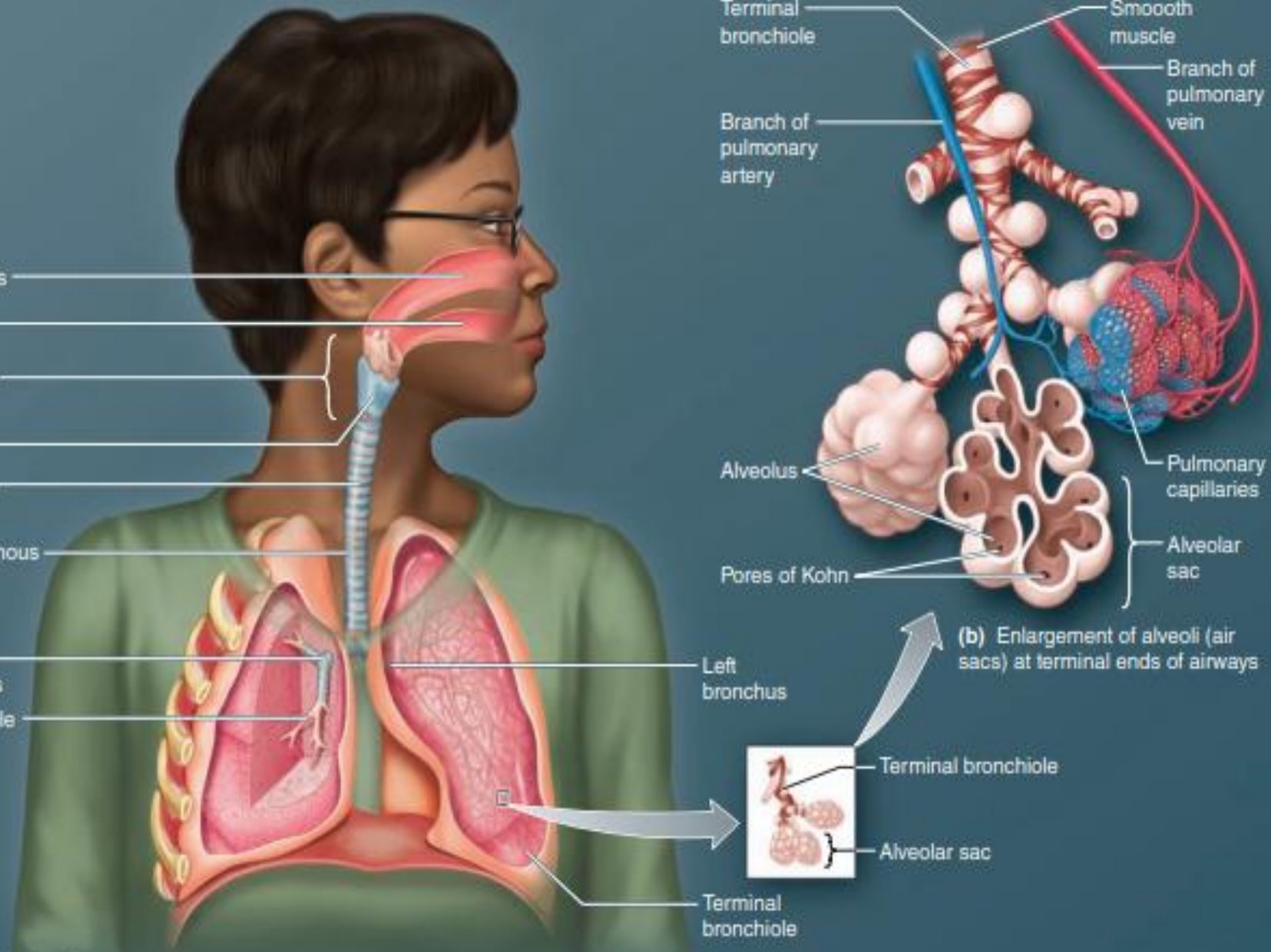
(b) Enlargement of alveoli (air sacs) at terminal ends of airways

Left bronchus

Terminal bronchiole

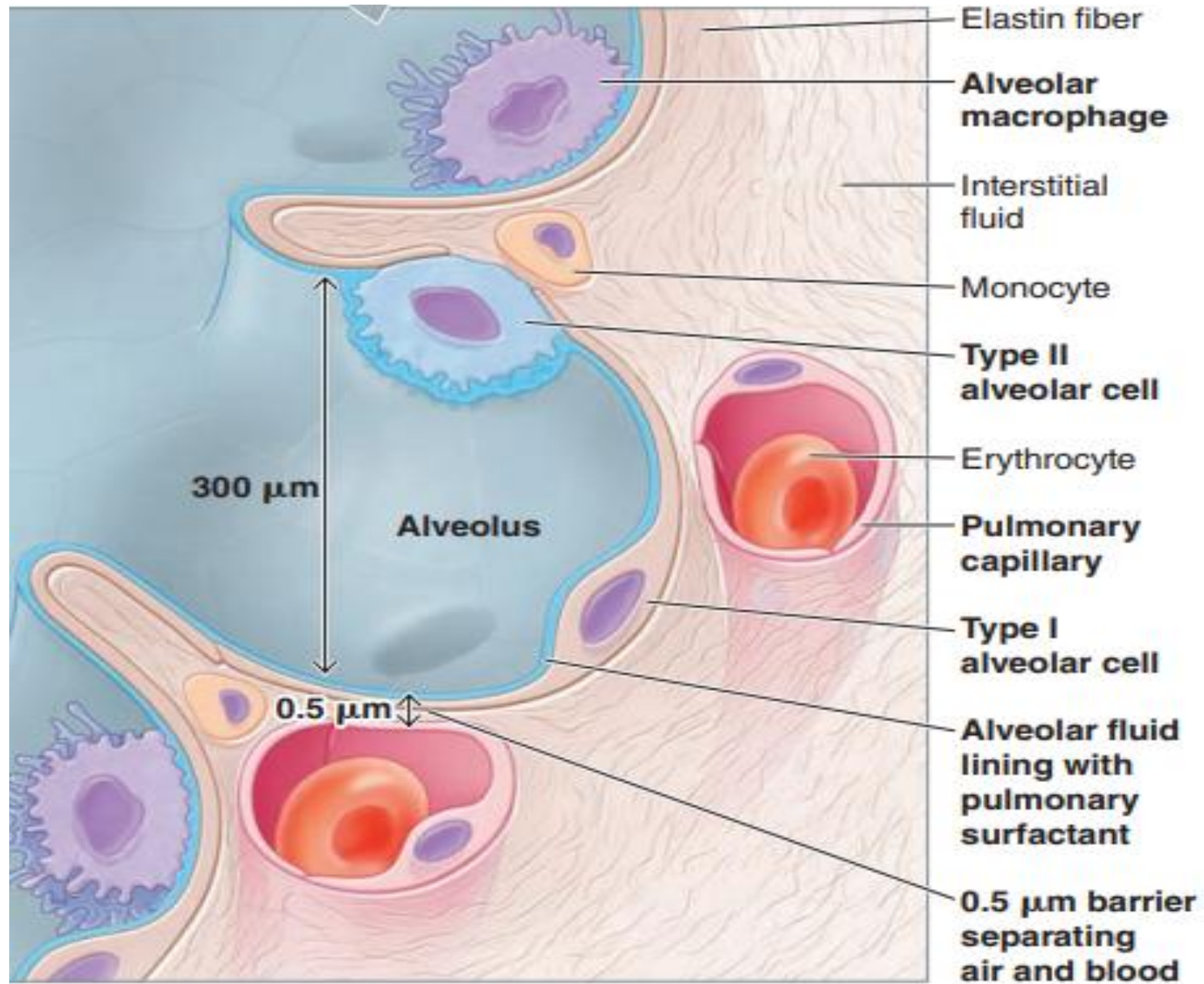
Alveolar sac

Terminal bronchiole



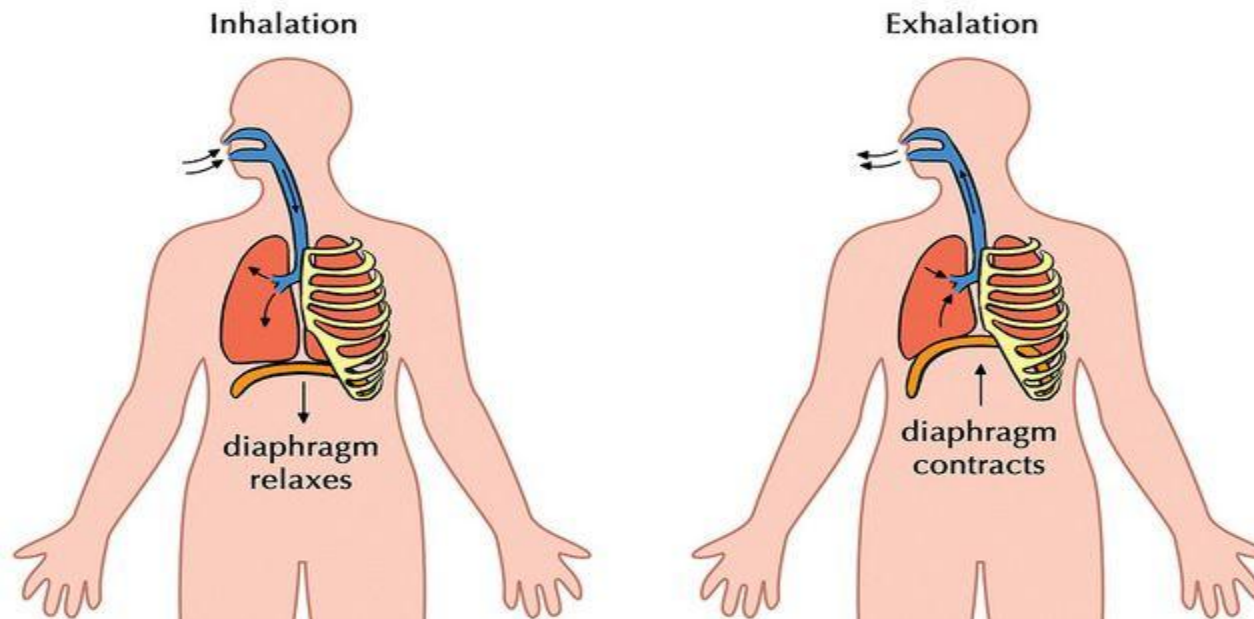
The gas-exchanging alveoli

- 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 .



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.

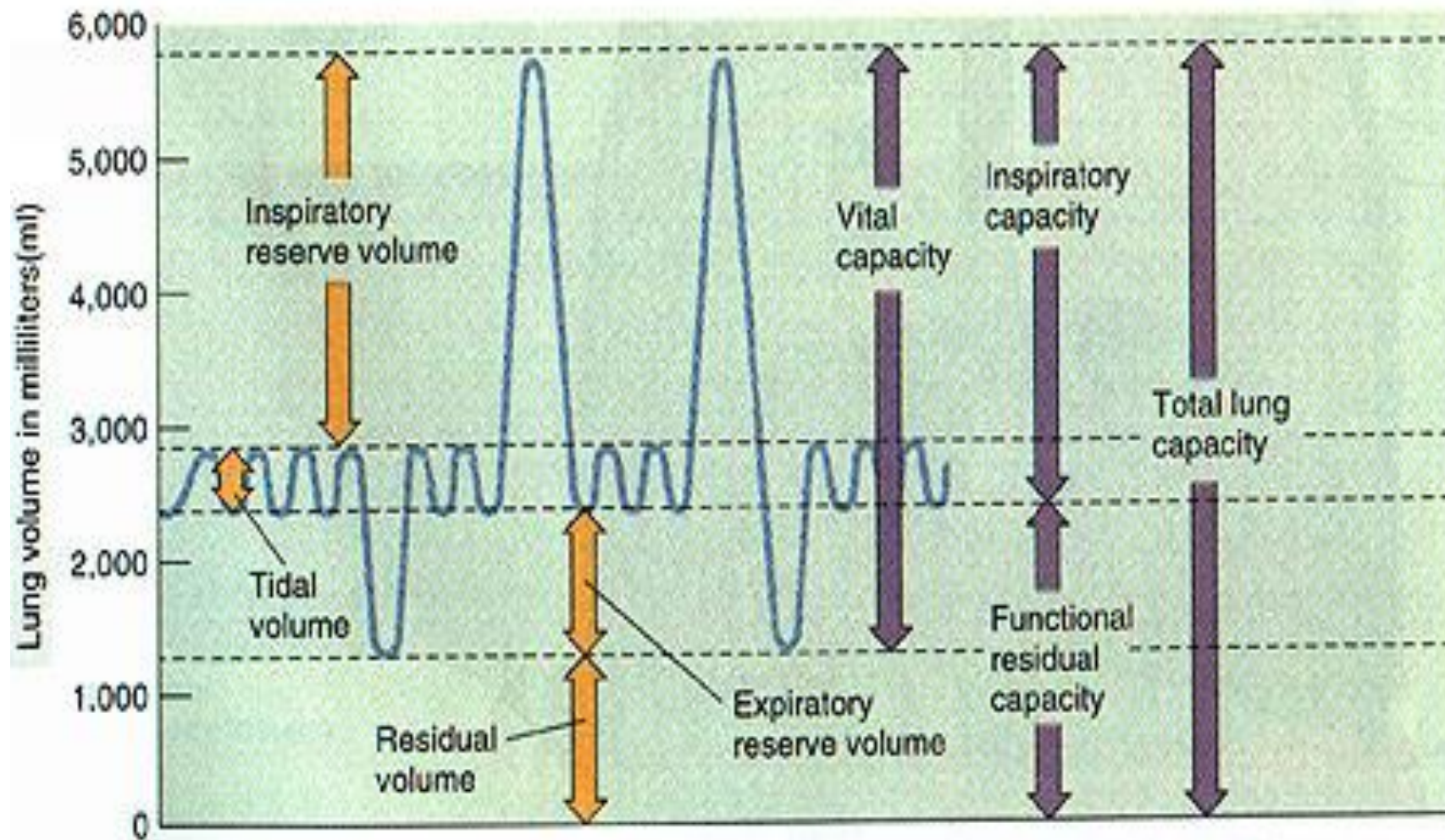
Volume and Capacity of the Lung

- **Tidal volume (V_t 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



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THANK YOU