The respiratory system carries out nonrespiratory functions.

- It provides a route for water loss and heat elimination.
- It enhances venous return.
- It contributes to the maintenance of normal acid-base balance.
- It enables various kinds of vocalizations.
- It defends against inhaled foreign matter.
- It modifies, activates, and inactivates materials passing through the circulatory system.
Total lung capacity at maximum inflation

Variation in lung with normal, quiet breathing

Minimal lung volume (residual volume) at maximum deflation

Volume of lungs at end of normal inspiration (average 2,200 ml)

Volume of lungs at end of normal inspiration (average 2,200 ml)

Difference between end-expiratory and end-inspiratory volume equals tidal volume (average 500 ml)
Recording paper advancing with time
Spirogram

Floating drum
Air
Water
Expired air
Inspired air
TV = Tidal volume (500ml)
IRV = Inspiratory reserve volume (3,000 ml)
IC = Inspiratory capacity (3,500 ml)
ERV = Expiratory reserve volume (1,000 ml)
RV = Residual volume (1,200 ml)
FRC = Functional residual capacity (2,200 ml)
VC = Vital capacity (4,500 ml)
TLC = Total lung capacity (5,700 ml)
Pulmonary volumes

Spirometry:
-Volumes: - T.V = 500 ml
    - IRV= 3000 ml
    - ERV= 1000 ml
    - R.V = 1200 ml

Capacities:
    - IC = T.V+IRV 3500 ml
    - FRC = ERV + RV 2200 ml
    - V.C = IRV + TV + ERV 4500 ml
    - TLC 5700 ml
Determination of FRC:

**Helium dilution method:**
1- a spirometer is filled with air that is mixed with a known concentration of helium.

2- the person expires normally then begins breathing from the spirometer.

3- helium becomes diluted by the FRC.

\[
FRC = (\text{CiHe} - 1) \times \text{Vi spir.}
\]

\[
\text{Cf He}
\]

\[
RV = FRC - \text{ERV}.
\]
Airway dead-space volume (150 ml)

Fresh air from inspiration

After inspiration, before expiration

“Old” alveolar air that has exchanged $O_2$ and $CO_2$ with the blood

Fresh atmospheric air that has not exchanged $O_2$ and $CO_2$ with the blood

The numbers in the figure represent ml of air.
During expiration

The numbers in the figure represent ml of air.
During inspiration

500 ml fresh air enter from atmosphere

350 ml fresh air reach alveoli

150 ml fresh air remain in dead space

500 ml enter alveoli

150 ml “old” air from dead space (left from preceding expiration)

350 ml fresh air from atmosphere

150 ml “old” alveolar air that has exchanged $O_2$ and $CO_2$ with the blood

Fresh atmospheric air that has not exchanged $O_2$ and $CO_2$ with the blood

The numbers in the figure represent ml of air.

Fig. 12-18c, p. 382
• **Dead space**: not used for gas exchange.

• **Measurement**: 

1- deep breath of \( O_2 \).
2- Expiration into nitrogen meter.

3- first portion recorded by the meter comes from D.S the \([N2]\) increases until a plateau is reached

D.S occupies 150 in a normal adult.
Physiol. D.S = alv. D.S + anatomical dead space
• Minute respiratory volume:

→ Total volume of new air moved into respiratory passages each minute

→ \( MRV = TV \times \text{freq.} \)

→ Normal = 500 \( \times \) 12 = 6L/min

→ (1.5 L/min fatal). (high value like 200 L/min is fatal).
• Alveolar ventilation:
  rate at which new air reaches these areas (respir. spaces).
  \((TV - D.S)^* \text{ freq.} = 4.2 \text{L/min}\)
# Table 12-2

<table>
<thead>
<tr>
<th>Breathing Pattern</th>
<th>Tidal Volume (ml/breath)</th>
<th>Respiratory Rate (breaths/min)</th>
<th>Dead Space Volume (ml)</th>
<th>Pulmonary Ventilation (ml/min)*</th>
<th>Alveolar Ventilation (ml/min)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet breathing at rest</td>
<td>500</td>
<td>12</td>
<td>150</td>
<td>6,000</td>
<td>4,200</td>
</tr>
<tr>
<td>Deep, slow breathing</td>
<td>1,200</td>
<td>5</td>
<td>150</td>
<td>6,000</td>
<td>5,250</td>
</tr>
<tr>
<td>Shallow, rapid breathing</td>
<td>150</td>
<td>40</td>
<td>150</td>
<td>6,000</td>
<td>0</td>
</tr>
</tbody>
</table>

*Equals tidal volume × respiratory rate.

**Equals (tidal volume − dead space volume) × respiratory rate.
Respiratory passageway:

1. Main resistance to the airflow present in Large bronchioles and bronchi

2. Sympathetic system dilate bronchioles

3. Parasympathetic system constrict bronchioles

4. Irritation of membrane passageways cause constriction as (smoking, dust, Infection)
• 5- Histamine and slow reactive substance of anaphylaxis secrete locally by the lungs
• By mast cells during allergic reaction as in Asthma. These cause bronchiolar constriction
• 6- Atropine relax respiratory passageway.