Regulation of Respiration

- Where does the rhythmical activity originate?
- How is it generated?
- How is the rate and depth of respiration controlled?

Basic Rhythm of Breathing

What is the origin of this rhythmicity?
Regulation of Respiration

**Sensors**
- Stretch receptors
- Chemoreceptors

**Vagus N.**
- Centers

**Phrenic N.**
- Intercostal N.

**Effectors**
- Respiratory muscles

- Medulla
- Pons
- Cortex
Regulation of Respiration

1. Respiratory centers
   - Spinal cord
   - Medulla  Automatic respiratory rhythm
     DRG (dorsal respiratory group), VRG (ventral ~)
   - Pons  Pneumotaxic center PBKF (NPBM-KF)
   - Cortex  Voluntary control

Regulation of Respiration

2. Respiratory reflex
   - Pulmonary stretch reflex (Hering-Breuer reflex)
     Inflation reflex:  Deflation reflex:
   - Regulation by chemical factors
     - Peripheral chemoreceptors
       Carotid bodies  PO₂, PCO₂, pH
       Aortic bodies
     - Central chemoreceptors
       pH (c.s.f.)  PCO₂
       Ventral surface of the medulla
   - Effects of CO₂, O₂ on breathing
CO2--generated H+ in the brain is normally the primary regulator of ventilation:

<table>
<thead>
<tr>
<th>CO2 level</th>
<th>Breath-Holding, Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>After quiet breathing</td>
<td>Normal</td>
</tr>
<tr>
<td>After hyperventilating</td>
<td>Low</td>
</tr>
<tr>
<td>After breathing into a plastic bag</td>
<td>High</td>
</tr>
</tbody>
</table>

Decreased arterial PO2 increase ventilation only as an emergency mechanism.

TABLE 1. Influence of Chemical Factors on Respiration

<table>
<thead>
<tr>
<th>Chemical Factor</th>
<th>Effect on the Peripheral Chemoreceptors</th>
<th>Effect on the Central Chemoreceptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>↑PO2 in the Arterial Blood</td>
<td>Stimulates only when the arterial PO2 has fallen to the point of being life-threatening (&lt;60mmHg); an emergency mechanism</td>
<td>Directly depresses the central chemoreceptors and the respiratory center itself when &lt;60mmHg</td>
</tr>
<tr>
<td>↑PCO2 in the Arterial Blood (↑H+ in the Brain ECF)</td>
<td>Weakly stimulates</td>
<td>Strongly stimulates; is the dominant control of ventilation (Levels &gt;70-80mmHg directly depress the respiratory center and central chemoreceptors)</td>
</tr>
<tr>
<td>↑H+ in the Arterial Blood</td>
<td>Stimulates; important in acid-base balance</td>
<td>Does not affect; cannot penetrate the blood-brain barrier</td>
</tr>
</tbody>
</table>