For

Critical Care Nursing Students

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What's RESPIRATION?
The "big picture" of respiration

External respiration
- Ventilation
- Pulmonary gas exchange

Transport by blood
- Plasma
- Hemoglobin (RBCs)

Internal respiration
- Systemic tissue gas exchange
- Cellular respiration
UPPER RESPIRATORY TRACT
PARANASAL SINUSES
FIGURE U13–3 The mucociliary blanket is an important respiratory defense mechanism. Mucus is secreted by surface goblet cells. About 100 ml of mucus is normally secreted each day by the submucosal glands. Mucus covers the epithelial lining of the tracheobronchial tree in two layers—the watery solution layer close to the mucosal surface and the thicker gel layer. The cilia (hair-like projections) beat in an upward direction toward the upper airway. Particulate matter is trapped on the mucous layer and moved upward by the cilia. Debris-laden mucus is then either swallowed or expectorated as sputum.
Respiratory Muscles

MUSCLES OF INSPIRATION
- Sternoleidomastoid
- Scalenes
- External intercostals
- Diaphragm

MUSCLES OF EXPIRATION
- Internal intercostals
- External oblique
- Internal oblique
- Diaphragm

Trachea
Lung
Diaphragm
Bony Structure

- Ribs
- Sternum
- Cartilage
NORMAL INSPIRATION

NORMAL EXPIRATION

**FIGURE U13-7** Normal inspiration and expiration.
Lung Volumes & Capacities
Alveolocapillary Membrane
AIR ENTERS THE LUNGS

PO₂ 159 mm Hg
PCO₂ 0.3 mm Hg
PN₂ 597 mm Hg
PH₂O 3.7 mm Hg

MIXES WITH DEAD SPACE AIR AND IS HUMIDIFIED

PAO₂ 104 mm Hg
PACO₂ 40 mm Hg
PH₂O 47 mm Hg
PH₂N₂ 596 mm Hg

ALVEOLAR UNIT

CO₂

PULMONARY CAPILLARY

O₂

PvO₂ 40 mm Hg
PvCO₂ 45 mm Hg

DESATURATED BLOOD

OXYGENATED BLOOD

CO₂

SYSTEMIC CAPILLARY

O₂

TISSUE

FIGURE U13-8 Partial pressures of gases during normal respiration.
FIGURE U13–6 The ultrastructure of the respiratory membrane, where oxygen is exchanged.
V/Q Ratio Mismatching

Shunting

Dead Space
Gas Transportation

O2: - Plasma(S)
    - HbO2

CO2: - Plasma(S)
    - HbCO2
    - Co3H
CENTRAL CHEMORECEPTORS

CHEMICAL CONTROL OF BREATHING

PERIPHERAL CHEMORECEPTORS
Control of Breathing

Other receptors (e.g., pain) and emotional stimuli acting through the hypothalamus

Higher brain centers (cerebral cortex—voluntary control over breathing)

Peripheral chemoreceptors
- $O_2$ ↓, $CO_2$ ↑, $H^+$ ↑

Central chemoreceptors
- $CO_2$ ↑, $H^+$ ↑

Respiratory centers (medulla and pons)

Stretch receptors in lungs

Irritant receptors

Receptors in muscles and joints