Main role of the respiratory system:

I. RESPIRATORY SYSTEM ANATOMY

A. Conducting Zone:

roles:

The control of air flow in the conducting zone is mediated by the autonomic nervous system. The sympathetic and parasympathetic systems have contrasting effects on air flow:

_________________________ leads to bronchodilation and inhibits mucous production.

_________________________ leads to bronchoconstriction and stimulates mucous production.

Clinical Application: ASTHMA

What are some stimuli that cause asthma and why do they affect some people and not others?

What is the effect of an asthma attack on airflow through the respiratory system?

Why does a $\beta_2$-adrenergic agonist make it easier to breathe in just a few moments?
B. Respiratory Zone:

Type I alveolar cells:

clinical connection: surface tension

Type II alveolar cells:

clinical application: infant respiratory distress syndrome (IRDS) = severe difficulty breathing due to an increase in surface tension in the lung

Why would premature infants be at higher risk for IRDS?

What treatment could be used to help relieve the symptoms of IRDS?

How long would this treatment be necessary?
C. Thoracic Cavity

diaphragm

intercostal muscles

other muscles
- scalenes
- pectoralis minor
- sternocleidomastoid

-abdominal muscles

role of muscles in respiration:

II. RESPIRATION =

1. External respiration
   a. Ventilation
   b. Gas exchange

2. Internal respiration =
III. PULMONARY PRESSURES

Two important things we need to breathe:
1) a way to move air into the lungs
2) a way to keep the lungs from collapsing when we exhale

1. Intrapulmonary Pressure =
   a. Air pressure gradients:
   b. Boyle's Law

   c. Mechanics of Inspiration
      goal:
      needs:
      mechanics:

   d. Mechanics of Expiration
      goal:
      needs:
      mechanics:

Question: How do you think the mechanics described above change during exercise?
III. PULMONARY PRESSURES (cont.)

2. Intrapleural Pressure

**goal:**

**needs:**

**mechanics:**

a. Parietal pleura

b. Visceral pleura
c. Intrapleural space

---

**Net Effect of Intrapleural Pressure**

---

**Clinical Application:** What happens if something punctures the pleura?

What would happen to intrapleural pressure?

What would happen to the lung on the injured side?

What would happen to the lung on the UNinjured side?

What would happen to the chest wall on the injured side?

What is this medical condition called?
IV. PULMONARY COMPLIANCE & ELASTICITY

1. Pulmonary compliance:

2. Elasticity:
**Clinical Application: Pneumonia**

What is the role of the conductive zone?

What happens if _________________ reach the alveoli?

Why is _________________ a big problem in the lungs?

If _________________ & _________________ decrease, what must happen?

What mechanism is used to accomplish this?

If _________________ increases, what happens to O₂ demand in those cells?

How will those needs be met?

Why can this be fatal?
V. PARTIAL PRESSURES AND GAS EXCHANGE

1. Pressure \( (P) = \)

2. Partial Pressure \( (P_{gas}) = \)

3. Dalton's Law \( (P_{atm}) : \)

At sea level, atmospheric pressure is 760 mmHg. If inspired air is approximately 21% oxygen, 0.04% carbon dioxide and 78% nitrogen, calculate the partial pressure of each gas listed.

Partial pressure = % gas x atmospheric pressure:

\[ P_{O2} \text{ of inspired air is } \quad \underline{__________} \]

\[ P_{CO2} \text{ of inspired air is } \quad \underline{__________} \]

\[ P_{N2} \text{ of inspired air is } \quad \underline{__________} \]

Note: \( P_{atm} = P_{N2} + P_{O2} + P_{CO2} + P_{H2O} + P_{misc} = 760 \text{ mmHg (at sea level)} \)

4. Effect of the conducting zone on inspired air
VI. GAS EXCHANGE

A. Air entering lungs from outside air has \( P_{O_2} \) of ________ and \( P_{CO_2} \) of ________.

B. As air moves through the conducting zone the values change to a \( P_{O_2} \) of ________ and a \( P_{CO_2} \) of ________.

This change occurs for two reasons:

1. 

2. 

C. Blood entering lungs (pulmonary artery) has a \( P_{O_2} \) of ________ and a \( P_{CO_2} \) of ________.

These partial pressures are the result of ________________________________.

D. As the blood travels through the ________________ capillaries, the partial pressures in blood change to a \( P_{O_2} \) of ________ and a \( P_{CO_2} \) of ________.

E. Blood travels back to the left side of the heart and then proceeds to the capillaries out in the body. Blood entering the capillaries still has a \( P_{O_2} \) of ________ and a \( P_{CO_2} \) of ________.

F. Gas exchange occurs within the tissues where \( O_2 \) diffuses into the cell and \( CO_2 \) diffuses into the blood. The blood entering a venule will have a \( P_{O_2} \) of ________ and a \( P_{CO_2} \) of ________.

G. Blood then heads to the right side of the heart where it will be sent back to the lungs where the cycle will repeat as gas exchange takes place with the alveolar air.
Functional Applications:

Effect of Altitude

Is it physically more difficult to ventilate the lungs at higher altitudes? Why or why not?

What effect does high altitude have on breathing?

Effect of deep water diving

How is deep water diving breathing different than breathing at high altitude?

Effects of depth on blood gases:

Nitrogen narcosis:

Decompression sickness:
VII. RESPIRATORY ACID-BASE BALANCE

Relationship between CO₂ and pH:

\[ \text{H}_2\text{O} + \text{CO}_2 \leftrightarrow \text{H}_2\text{CO}_3 \leftrightarrow \text{H}^+ + \text{HCO}_3^- \]

When H₂O and CO₂ mix, they form carbonic acid which dissociates into hydrogen ions and bicarbonate.

★ Respiration is normally adjusted to keep pace with the ____________________.

respiratory terminology

- eupnea
- hyperpnea
- hyperventilation
- hypopnea
- hypoventilation

Acid-Base imbalances:

A. Respiratory acidosis

B. Respiratory alkalosis

Clinical Application: Why does breathing into a paper bag help someone having an anxiety attack?
VIII. REGULATION OF RESPIRATION BY CHEMORECEPTORS

A. Central receptors:

B. Peripheral receptors

Question: Why isn’t \( P_{O_2} \) an important contributor to control of respiration?

Clinical Application: the effect of carbon monoxide

IX. REGULATION OF BREATHING

There are 3 locations that help control breathing:

1. Medulla oblongata:

2. Pons:
   a. pneumotaxic center
   b. apneustic center

3. Cerebral cortex:
X. LUNG VOLUMES AND CAPACITIES

Spirometry is used to measure lung volumes and capacities and is useful in diagnosing pulmonary diseases.

1. Tidal Volume (TV): volume of air entering or leaving lungs during one breath.

2. Residual Volume (RV): The amount of air remaining in the lungs after maximum expiration.

3. Vital Capacity (VC): The max. amount of air that can be exhaled after max. inspiration.
   \[ VC = IRV + TV + ERV \]

4. Inspiratory Reserve Volume (IRV): The max. amount that can enter the lungs beyond TV.
5. Expiratory Reserve Volume (ERV): The max. amount of air that can be exhaled beyond TV.
6. Inspiratory Capacity (IC): The amount of air that can be inhaled after exhaling the TV.
7. Functional Residual Capacity (FRC): Amount of air in the lungs after exhalation of the TV.
8. Total Lung Capacity (TLC): Total air in lungs after maximal inspirational effort.

Other measurements:

- Minute Ventilation (VE) = TV x Respiratory Rate
- Alveolar Minute Ventilation (VA) = ( ______________ ) x Respiratory Rate
- Forced Expiratory Volume in 1 second (FEV₁) =

Relative FEV₁ (FEV₁ %)
XI. PULMONARY DISORDERS

1. Restrictive disorders

2. Obstructive disorders