Western

UNIVERSITY · CANADA

Tutorial 16
Sections 009/010

TA: Greydon Gilmore
Physiology 2130
Feb 4th, 2020

Western

Your TA reminding you…

- **3rd Peerwise assignment** (1.5%)
  - Post 2 MC questions: due Feb 12th @ midnight
  - Answer 5 MC questions: due Feb 14th @ midnight
- **3rd Quiz** (1%)
  - Opens: Feb 24th @ 4pm
  - Closes: Feb 25th @ 4pm
- **3rd Midterm** (15%)
  - When: Feb 28th @ 6pm-7pm

Today

- Group work activity
- Learning Catalytics Question
- Respiratory Physiology

Group Work

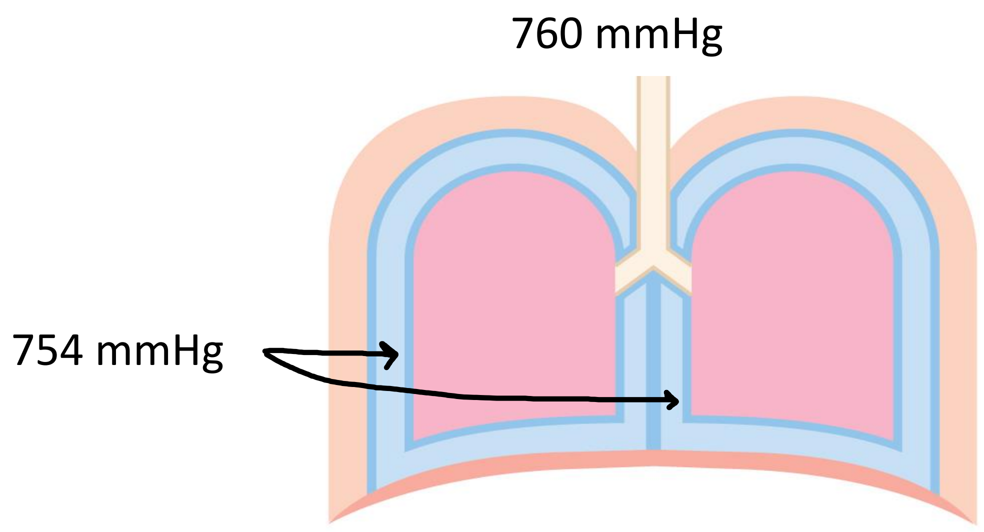
You have 1.5 minutes to answer each question—discuss as a group and come to a consensus.

- Write your team name on the top of the paper along with your group #
- As a group you have 90 seconds to discuss and write down your answer on your paper
- There are 5 questions

Question 1

Based on what you learned in class, what is the state of this person's lungs in the above scenario?

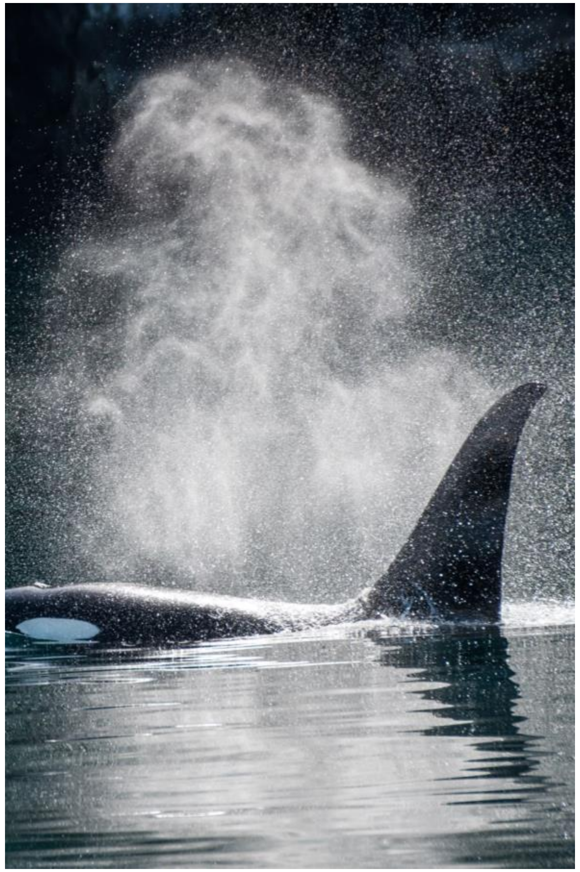
A. This person is inhaling
B. This person is exhaling
C. This person has a pneumothorax
D. This person is not breathing



Atmospheric pressure is 760 mmHg, intrapleural pressure is 754 mmHg. At rest, the intrapleural pressure is 757 mmHg. When you breath in, the volume gets larger and the pressure gets lower (Boyle's law). Thus, this person has to be breathing inward, since the intrapleural pressure lower than at rest.

Question 2

Air is moving through your lungs but not a single muscle involved in breathing is contracting. Why?



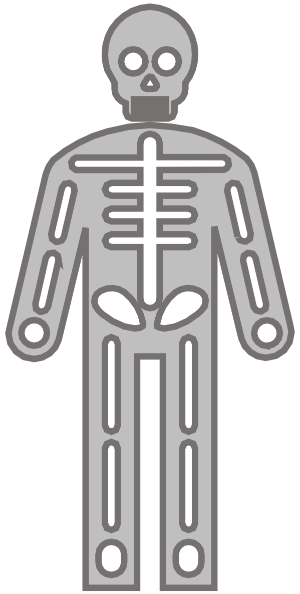
A. you are inhaling at rest
B. you are exhaling at rest
C. you are inhaling while swimming hard
D. you are exhaling while swimming hard

When exhaling (passively) the diaphragm and external intercostal muscles relax. Swimming hard would be active breathing.

Question 3

Dorothy has a genetic condition that causes her to not produce pulmonary surfactant. What is true about Dorothy's lungs?

A. Dorothy has low surface tension in her lungs
B. Dorothy has excellent lung compliance
C. Dorothy has poor gas exchange into her blood
D. Dorothy has too much elastin in her lungs



Pulmonary surfactant reduces surface tension, without it tension would be higher. Compliance would decrease due to the increase in surface tension. The decrease in compliance would result in poor gas exchange.

Question 4

What is true about the visceral pleura?

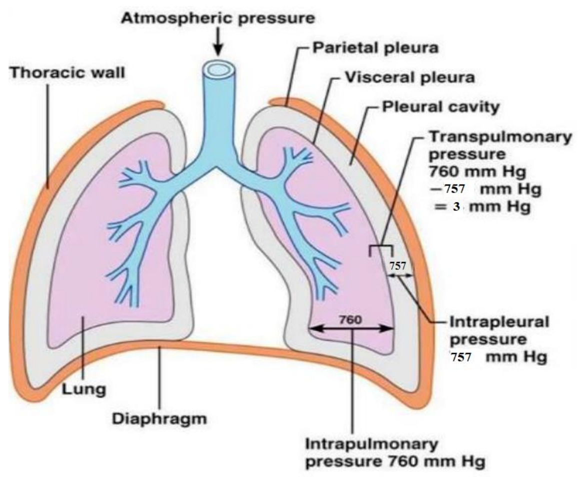
A. On one side is the lung and the other side is fluid

B. A hole in this membrane would cause a pneumothorax, as long as the chest wall was also punctured

C. This membrane directly contacts/covers the diaphragm

D. One membrane surrounds both lungs forming one compartment in the thoracic cavity

A hole in the visceral pleura OR parietal pleura would cause pneumothorax.
Visceral pleura is next to the lung and pleural cavity.



Question 5

Four roommates are running. They each breathe 700 mL per breath. Based on this information alone, who likely has the best gas exchange?

A. They all have the same gas exchange
B. Matt, because he is the heaviest runner
C. Kate, because she breathes the slowest
D. Tim, because he is the lightest runner

Hint is how you calculate anatomical dead space (weight * Resp rate.). With lower resp rate the dead space would be less, meaning the alveolar ventilation would be higher! $V_A = V_E - V_D$

Western

Practice Calculations

Patrick Mahomes has finished his season. In a post-game physical, his lung function test shows he has a resting tidal volume of 600 mL and breathes at 15 breaths/min. He weighs 104 kg (230 pounds).

A. What is his pulmonary ventilation per minute?
B. What is his alveolar ventilation per minute?
C. How much anatomical dead space does he have in his lungs?

Practice Calculations

Patrick Mahomes has finished his season. In a post-game physical, his lung function test shows he has a resting tidal volume of 600 mL and breathes at 15 breaths/min. He weighs 104 kg (230 pounds).

A. What is his pulmonary ventilation per minute?

$V_E = V_T$ x RR = 600 mL x 15 breaths/min = 9000 mL/min or 9 L/min

B. What is his alveolar ventilation per minute?

$V_E = V_A + V_D$

9 L/min = ? + (230 mL * 15 breaths/min)

9 L/min = ? + (3.45 L/min)

9L/min – 3.45 L/min = V_A

V_A = 5.55 L/min

C. How much anatomical dead space does he have in his lungs?

Since he weighs 230 pounds, he has 230 mL of dead space in one breath.

Western

Learning Catalytic Question

Respiratory System: Anatomy

Chapter 9: Dr. Beye

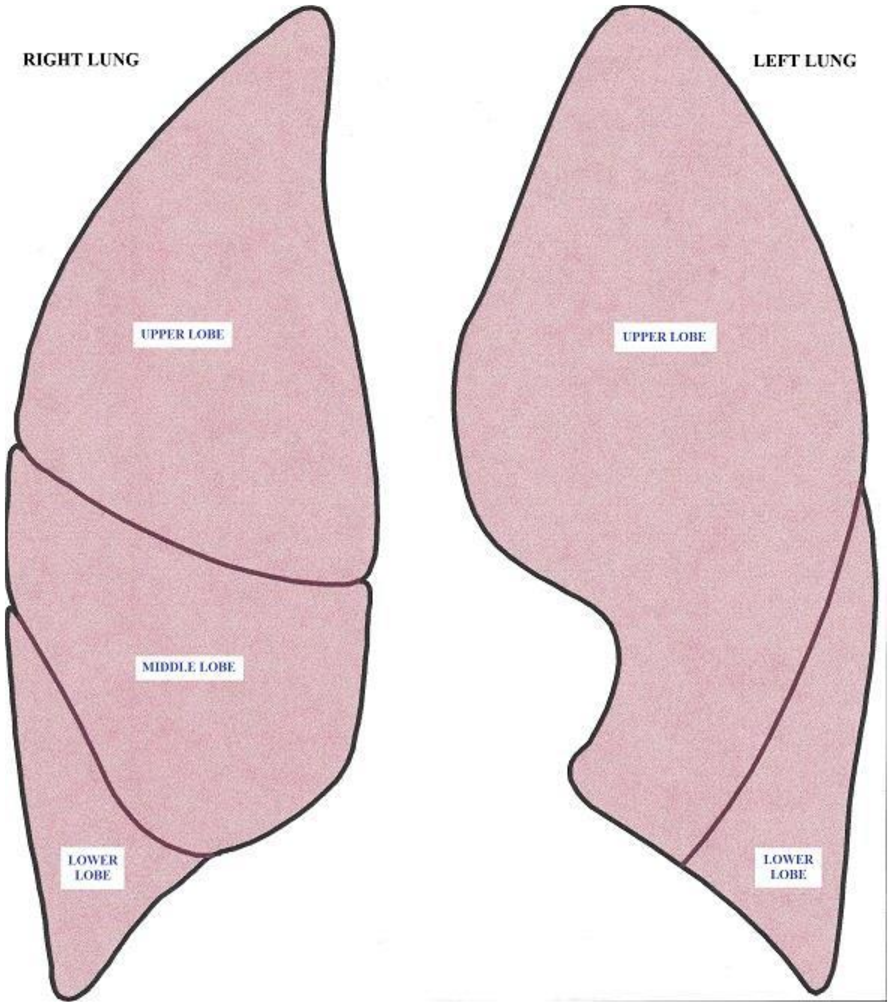
Western

Functions of Respiratory System

1. Provides oxygen
2. Removes carbon dioxide
3. Regulates blood pH
4. Speech
5. Microbial defense
6. Chemical messenger concentrations
7. Traps and dissolves small blood clots

Lung Anatomy

Right Lung
3 Lobes



Left Lung
2 Lobes

Why? The heart sits on the left side of thoracic cavity

Lung Anatomy

Muscles

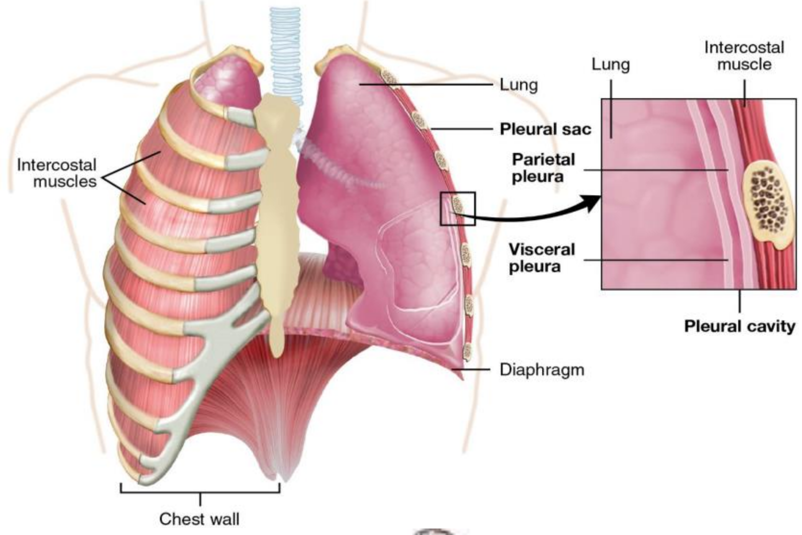
- Intercostal muscles (between ribs)
- Diaphragm (bottom)

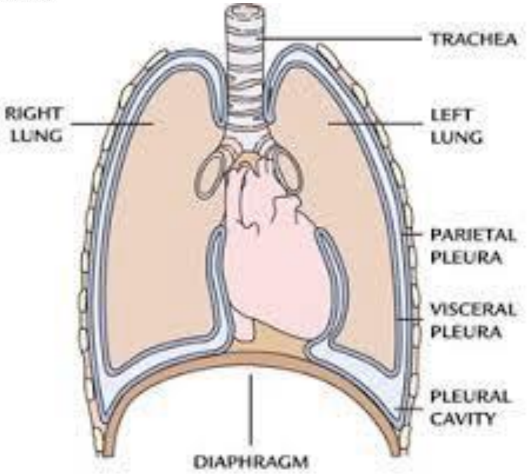
Pleural Layers

- Visceral pleura (against lungs)
- Intrapleural space/cavity
- Parietal pleura (against chest wall)

Visceral = Very close

Parietal = Pretty close

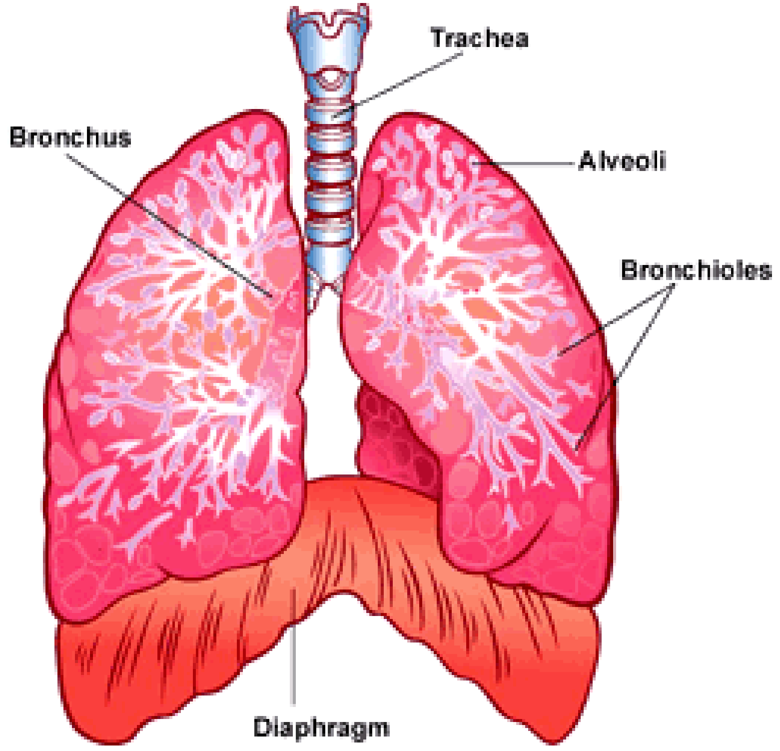




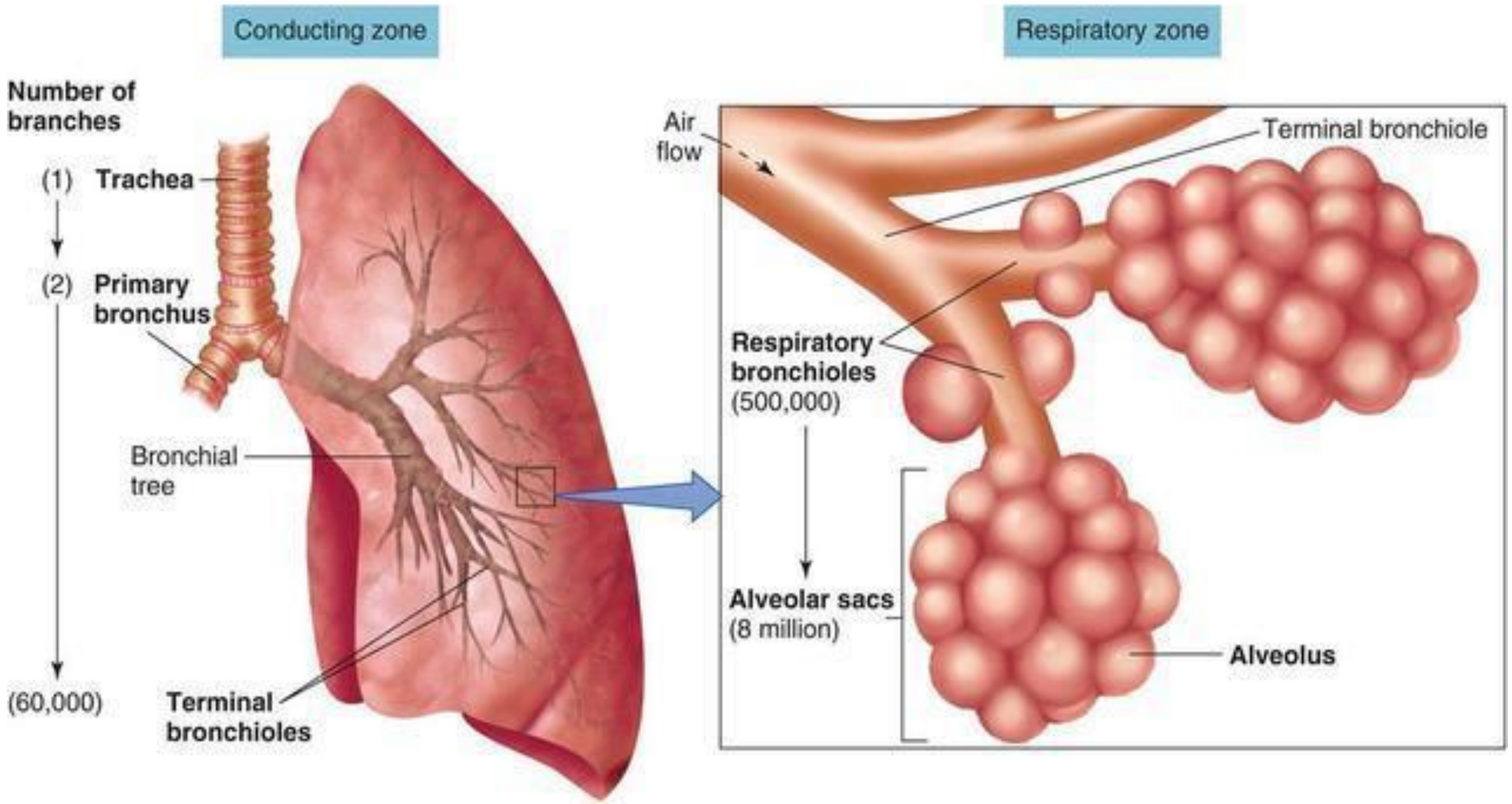
Lung Anatomy

Respiratory tract can be divided into two sections:

1. Conducting Zone
2. Respiratory Zone



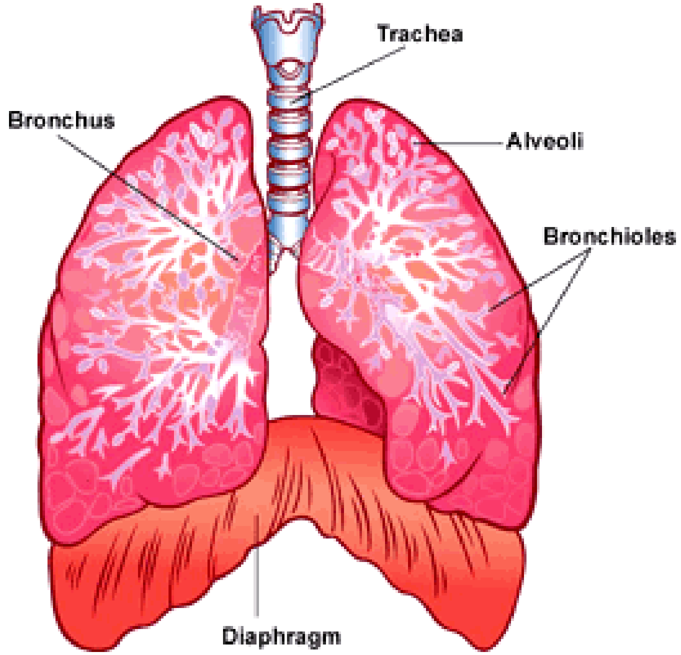
Zones of Respiratory Tract



Conducting Zone

Trachea → Primary Bronchus (Left and Right) → 2^0 Bronchi → 3^0 Bronchi → Bronchioles → Terminal Bronchioles

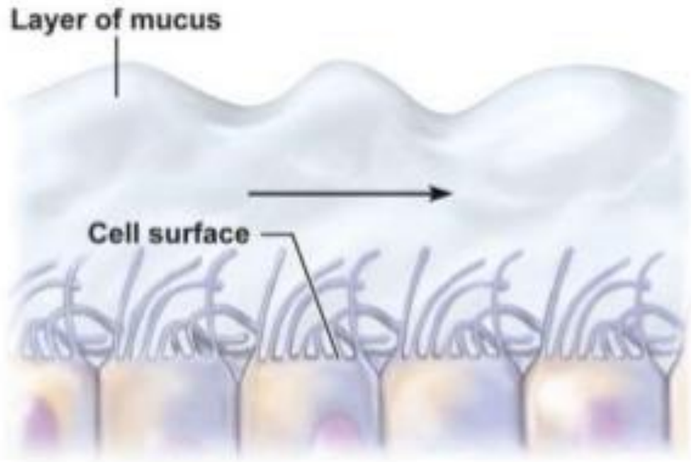
"Conducting zone terminates at terminal bronchioles"



Conducting Zone

Functions

- Transport air to lungs
- Filter, warm and moisten air
- Microbial defense:
  - Bronchial epithelial cells are ciliated
  - Cilia sweeps mucus with trapped micro-organisms towards the trachea
  - Smoking reduces function of cilia



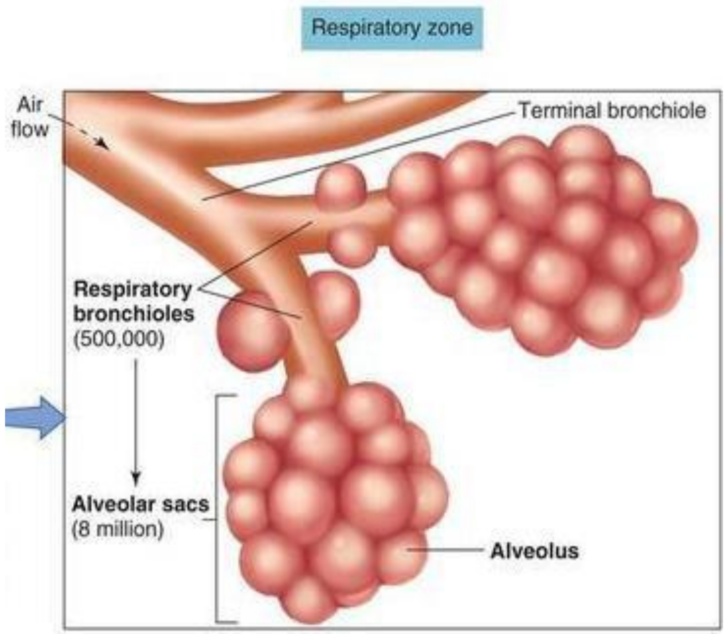
(b) Traveling wave created by the activity of many cilia acting together propels mucus across cell surfaces.

Western

Respiratory Zone

Respiratory Bronchioles → Alveolar Ducts → Alveolar Sacs → Alveoli

"Respiratory zone begins at respiratory bronchioles"



The walls of the alveoli are composed of two types of cells, type I and II. The function of type II is to _______.

A. Secrete surfactant
B. Trap dust and other debris
C. Replace mucus in the alveoli
D. Protect the lungs from bacterial invasion

The walls of the alveoli are composed of two types of cells, type I and II. The function of type II is to _______.

A. Secrete surfactant
B. Trap dust and other debris
C. Replace mucus in the alveoli
D. Protect the lungs from bacterial invasion

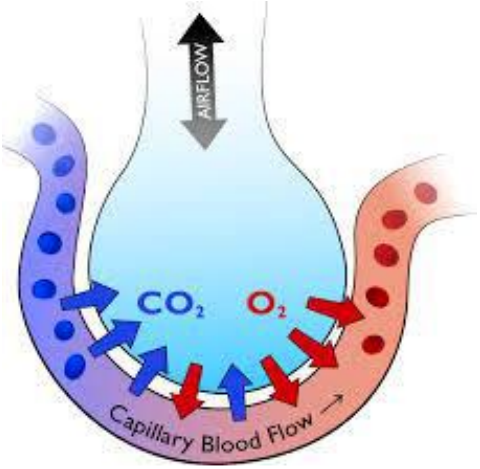
Respiratory Zone

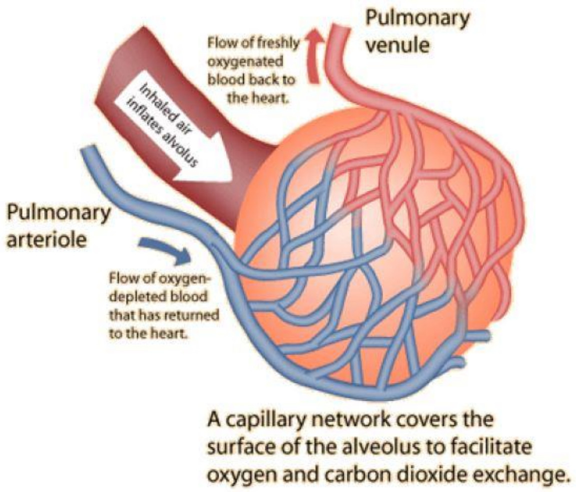
Function

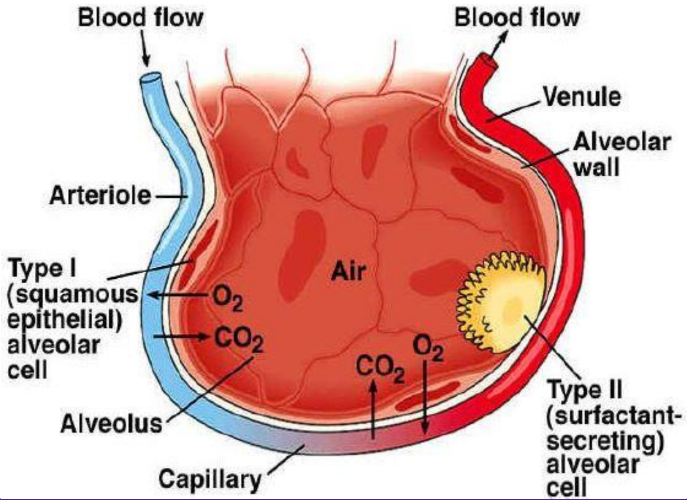
- Gas exchange in the alveoli at the blood gas barrier
  - CO^2 leaves blood supply into air
  - O^2 leaves air into blood supply

Cells

- Type 1 cell: flat and thin cells that form alveolar wall and allow for easy gas exchange between alveoli and capillary
- Type 2 cell: secrete surfactant
- Macrophages: destroy microorganisms







Mechanisms of Breathing

Chapter 9: Dr. Beye

Western

Ventilation Calculations

- Tidal Volume: Amount of air entering lungs in one breath during normal inhalation
- Respiratory Rate: # of breaths per minute
- Pulmonary Ventilation (V_E): Amount of air entering lungs (both zones) per minute

$$V_E = \text{Tidal Volume} \times \text{Respiratory Rate}$$

- Anatomical Dead Space Ventilation (V_D): Amount of air not involved in gas exchange (Anatomical dead space = 1 mL/pound)

$$V_D = \text{Weight} \times \text{Respiratory Rate}$$

- Alveolar Ventilation (V_A): Amount of air entering only the respiratory zone per minute

$$V_A = V_E - V_D$$

Ventilation Calculations

Example: For a 150 lb individual with respiratory rate of 30 breaths/min and tidal volume of 200 mL/breath

V_E = Tidal Volume x Respiratory Rate

= 200 x 30

= 6000 mL/min

V_D = Weight x Respiratory Rate

= 150 x 30

= 4500 mL/min

$V_A = V_E – V_D$

= 6000 – 4500

= 1500 mL/min

By changing your pattern of breathing, you can alter how much air is actually available for gas exchange (V_A)

Complete the following statement using the choices below. Air moves out of the lungs when the pressure inside the lungs is…

A. Less than the pressure in the atmosphere.
B. Greater than the pressure in the atmosphere.
C. Equal to the pressure in the atmosphere.
D. Greater than the intra-alveolar pressure.

Complete the following statement using the choices below. Air moves out of the lungs when the pressure inside the lungs is…

A. Less than the pressure in the atmosphere.

B. Greater than the pressure in the atmosphere.

C. Equal to the pressure in the atmosphere.

D. Greater than the intra-alveolar pressure.

Pressure

- Gases move down a pressure gradient
  - For air to move into and out of our lungs, there must be a pressure gradient
- Atmospheric pressure: 760 mmHg
- Intrapulmonary pressure: 760 mmHg
- Since atmosphere pressure is fixed, intrapulmonary pressure must change to create a pressure gradient during respiration
- Boyle's Law:

$P = 1/V$ (Change volume of thoracic cavity to alter pressure)

Inhalation

Diaphragm and external intercostal muscles contract (Diaphragm moves down and intercostals pull ribcage up and out)

⬇

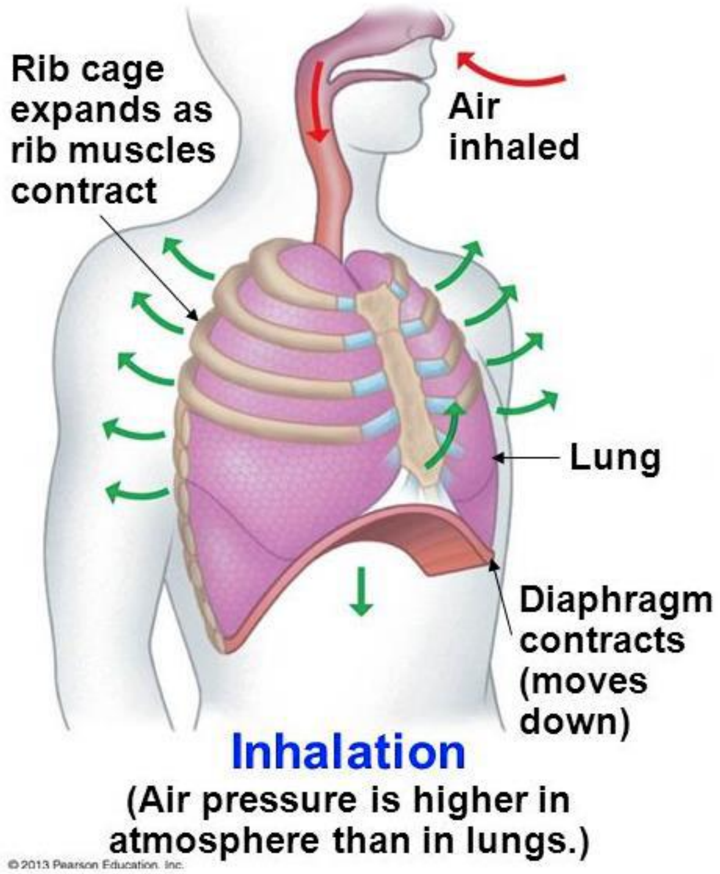
Thoracic cavity expands (Increase volume)

⬇

Decrease intrapulmonary pressure by Boyle’s law (<760 mmHg)

⬇

Air moves in



Exhalation (Passive)

Diaphragm and external intercostal muscles relax (Diaphragm moves up and ribcage gets smaller)

⬇

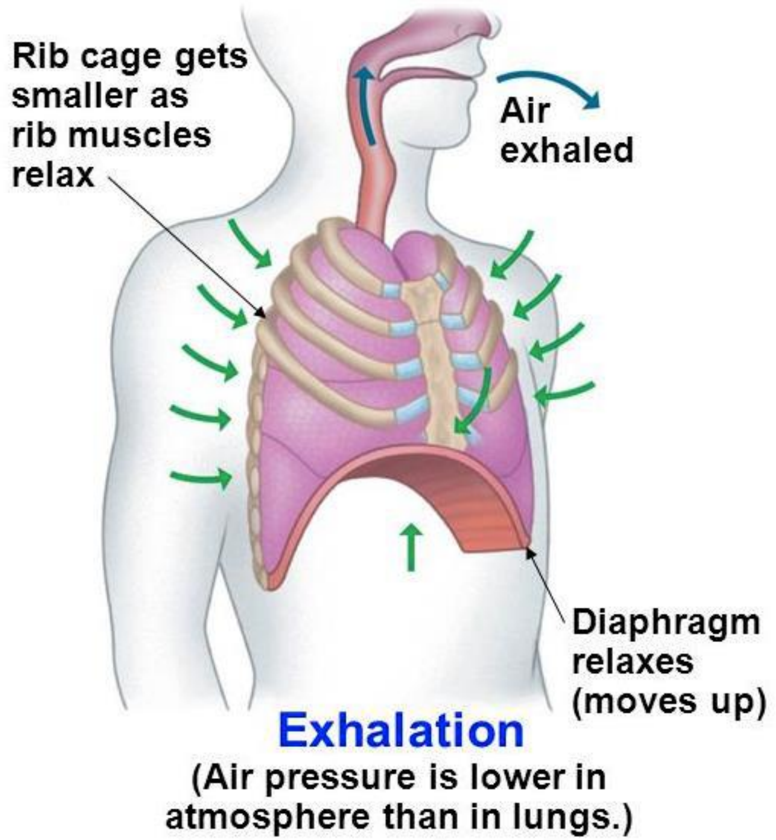
Thoracic cavity decreases in volume

⬇

Increase intrapulmonary pressure by Boyle's law (>760 mmHg)

⬇

Air moves out



Exhalation (Active - Exercise)

Diaphragm and external intercostal muscles relax

Internal intercostals, obliques and rectus abdominus contract

⬇

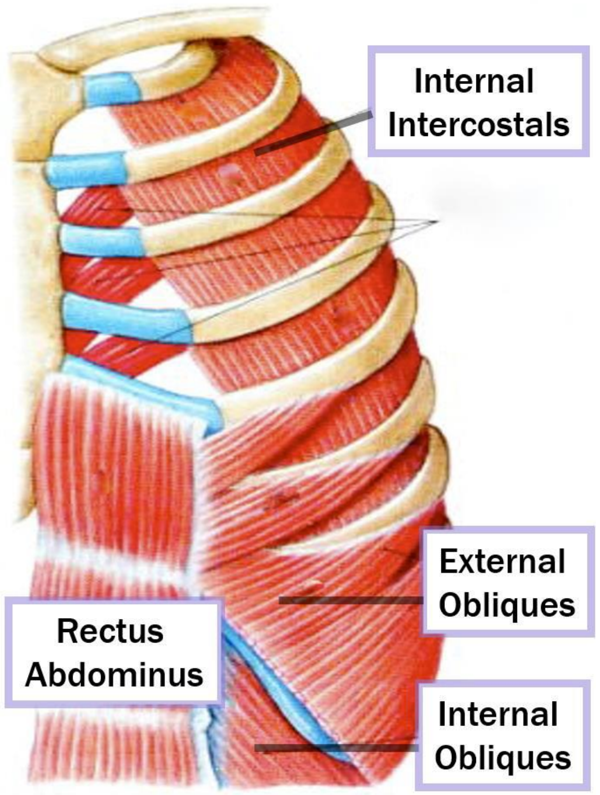
Thoracic cavity decreases in volume

⬇

Increase intrapulmonary pressure by Boyle's law (>760 mmHg)

⬇

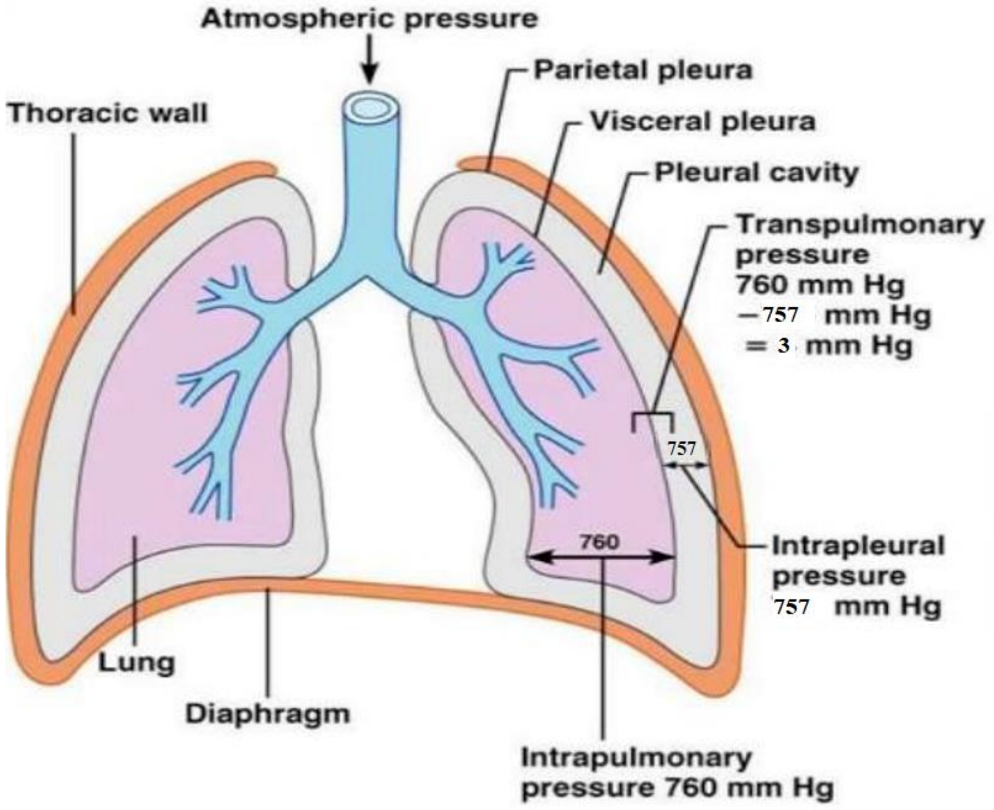
Air moves out



Western

Intrapleural and Transpulmonary Pressure

- Intrapleural Pressure: Pressure in intrapleural space; 757 mmHg
  - Prevents lung from collapsing at the end of expiration
  - Allows for easy expansion of the lung
- Transpulmonary Pressure: Pressure across the lung; +3 mmHg
  - Intrapulmonary Pressure (760) – Intrapleural Pressure (757)



Pneumothorax

Spontaneous hole in visceral pleura or puncture hole in parietal pleura

⬇

Air rushes into intrapleural space

⬇

Transpulmonary pressure becomes 0 mmHg

⬇

Lung collapses in and chest wall springs out

Next Tutorial (Feb 11th)

- More respiratory physiology!

What Questions Do You Have?

You can ask in the **Owl forums** as well!

Also anonymously ask questions in the **online dropbox**!!

Western