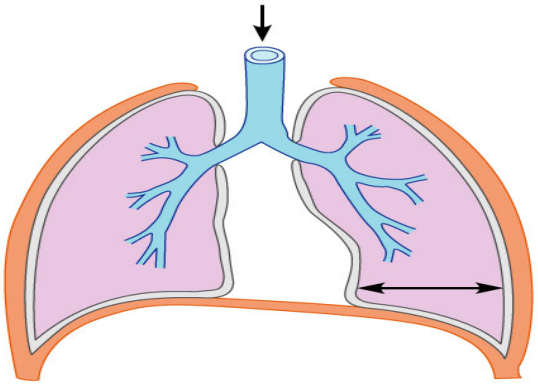
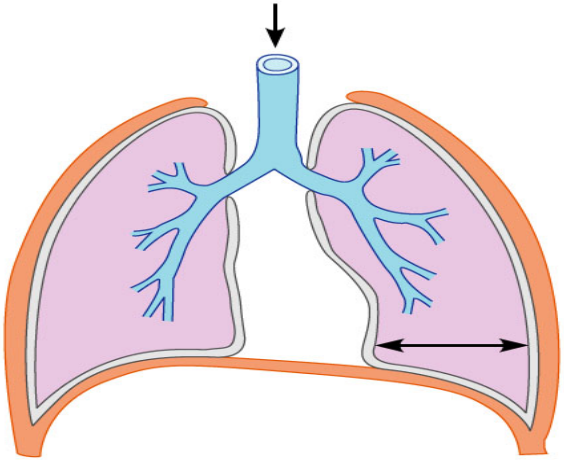
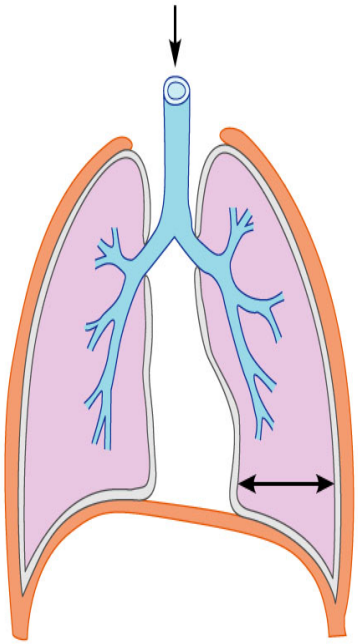
4 Chest Vol.

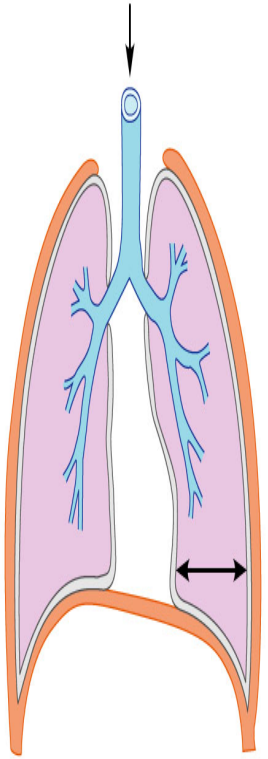


normal inhale → ↑ vol.



forced inhale →↑ ↑ vol.





normal exhale → ↓ vol.

forced exhale → ↓↓ vol.

Inspiratory Muscles

1) normal inhale: ↑ chest vol.

- muscle contractions

a) diaphragm → diaphragm down

b) external intercostals → open rib cage

2) forced inhale: ↑↑ chest vol.

- muscle contractions

a) diaphragm (see above)

b) ext. intercostals (see above)

c) neck (scalenes & sternocleidomastoid)

→ rib cage up

d) chest (pectoralis minor)

→ open rib cage

Expiratory Muscles

1) normal exhale: ↓ chest vol.

- muscle relaxations

a) diaphragm → diaphragm up

b) external intercostals → rib cage in

c) neck (scalenes & sternocleidomastoid) → rib cage down

d) chest (pectoralis minor) → rib cage in

2) forced exhale: ↓↓ chest vol.

- muscle contractions

a) int. intercostals → rib cage in

b) abdominal muscles → rib cage in

Lung Vol. Δ

a) lung vol. decrease

- lung pulls away from thoracic cavity

- lung collapsing forces

1) recoil: lung material elasticity

2) surface tension: alveolar fluid shrinks alveoli

b) lung vol. increase

- lung pulled outwards by thoracic cavity

- lung expanding forces

1) chest wall changes (inspiratory)

2) transpulmonary pressure

Note: review 4 forces

Spirometry

Spirometry: meas. breathing capacity

Pulmonary Function Tests:

1) **pulmonary volumes & capacities**
   - **track losses over course of disease**
2) **minute ventilation**
   - **vol. airflow in 1 min.**
   - **= (avg. vol/breath) x (breath rate)**
   - **normal = TV x 12**
     = (0.5 l/breath)x(12 breath per min)
     = 6 l / min
3) **FVC & FEV_1**
   - **focus on exhale as inhale vol. hard to meas.**

Resp. Tissue Prop.

Lung Tissue Prop.

a) compliance or distensibility
   - tendency to expand w/ pressure
   - reduced w/ diseases eg pulmonary fibrosis “scars”

b) elasticity
   - tendency to return to orig. size after distention
   - resists compliance / distention

Alveolar Prop.

a) surface tension
   - tendency to maintain bubble (alveolar) shape
   - resists distention (review La Place’s Law)

b) lung surfactant
   - breaks up surface tension; prevent alvolar collapse
   - alveolar cells II @ 8 mo.; prob. premature babies

Law of Partial Pressures

Dalton: Law of Partial Pressure of Gasses

$$P_{total} = P_1 + P_2 + P_3..... + P_n*$$

***n = # gases**

earth atmosphere, "air"

$$P_{sea\ level} = P_{N2} + P_{O2} + P_{CO2} + P_{H20}$$

$$100\% = 78.6\% + 20.9\% + 0.04\% + 0.46\%$$

$$760\ mm\ Hg = 597 + 159 + 0.3 + 3.7$$

lung atmosphere, "lung air"

$$P_{alveoli} = P_{N2} + P_{02} + P_{CO2} + P_{H20}$$

$$100\% = 74.9\% + 13.7\% + 5.2\% + 6.2\%$$

$$760\ mm\ Hg = 569 + 104 + 40 + 47$$

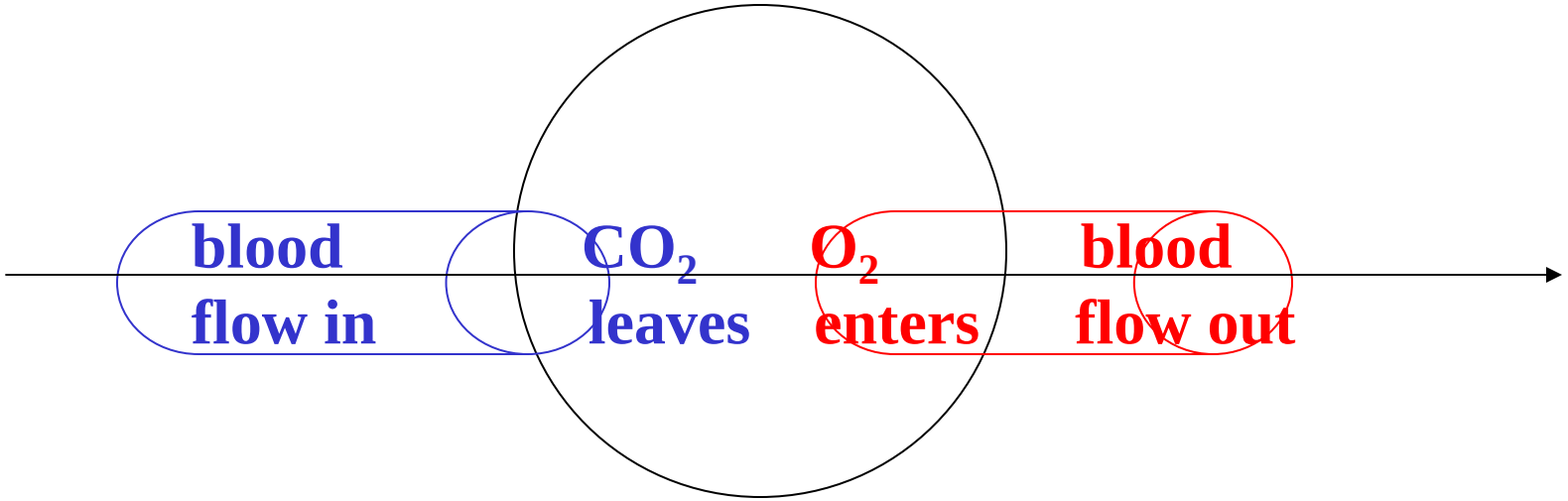
Alveolus notes

1) **alveolar features:**
   - **surfactant: lubricates alveolar walls**
   - **macrophages: ingest alveolar foreign bodies**
   - **capillary: gas exchange partner**

2) **alveolar gas exchange**
   - **@ interface between 2 permeable membranes (alveolus and capillary walls)**
   - **with normal breathing**
     a) **oxygen leaves alveolus, enters capillary**
     b) **carbon dioxide leaves capillary, enters alveolus**

Alveolar Gas Exchange

alveolus: inhale: ↓CO_2, ↑O_2
exhale: ↑CO_2, ↓O_2



pul. arterioles	pul. cap.	pul. venules
↑CO_2, ↓O_2	gas exch.	↓CO_2, ↑O_2

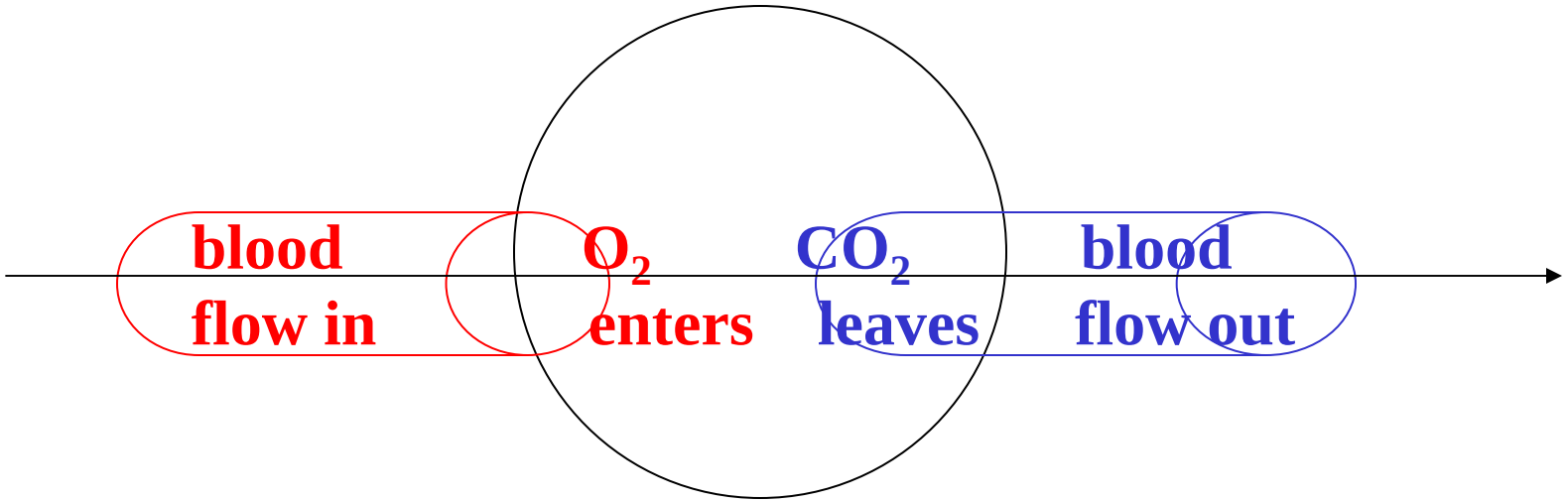
Tissue notes

1) **tissue features:**
   - **power metabolism:**
     "aerobic respiration"
     glucose + $O_2 \rightarrow CO_2 + H_20$ + cell energy (ATP)
   - **tissues depend on systemic capillaries to bring in new O_2 and take away old CO_2**
   - **capillary: gas exchange partner**

2) **tissue gas exchange**
   - **@ interface between 2 permeable membranes (tissue cell and capillary walls)**
   - **with normal breathing & proper circulation**
     a) **O_2 leaves capillary, enters tissue cells**
     b) **CO_2 enters capillary, leaves tissue cells**

Tissue Gas Exchange

tissues: ↑CO_2, ↓O_2



sys. arterioles	sys. cap.	sys. venules
↓CO_2, ↑O_2	gas exch.	↑CO_2, ↓O_2

Gas Diffusion Factors

1) partial pressure of gases in atmosphere (Dalton)
2) conc. gases dissolved in blood (Henry)
3) amount alveolar surfaces avail.
   (obstructive & restrictive diseases)
4) diffusion distance between
   alveoli & pul. capillary
   & between tissues & sys. capillary
5) amount of vasculature avail.
   (circulation, CV disease)
6) amount RBC avail.
   (Hb = gas carrier, anemias)