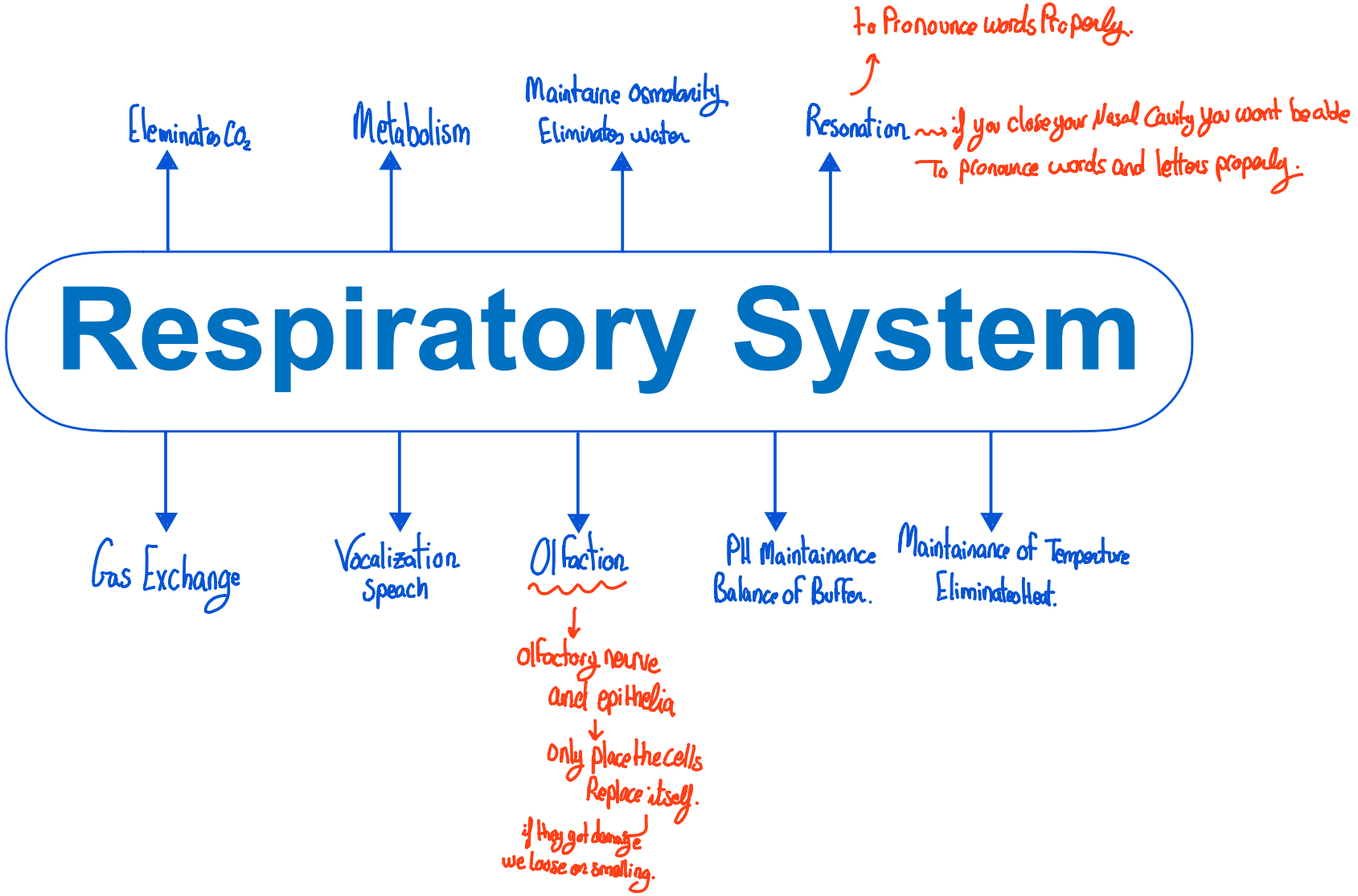


Respiratory System

3 Main Components:

- Consists of the respiratory and conducting zones
- **Respiratory zone:** The Zone where Gas Exchange Happens
  - Site of gas exchange
  - Consists of bronchioles, alveolar ducts, and alveoli

*We only do Gas Exchange in the Alveoli

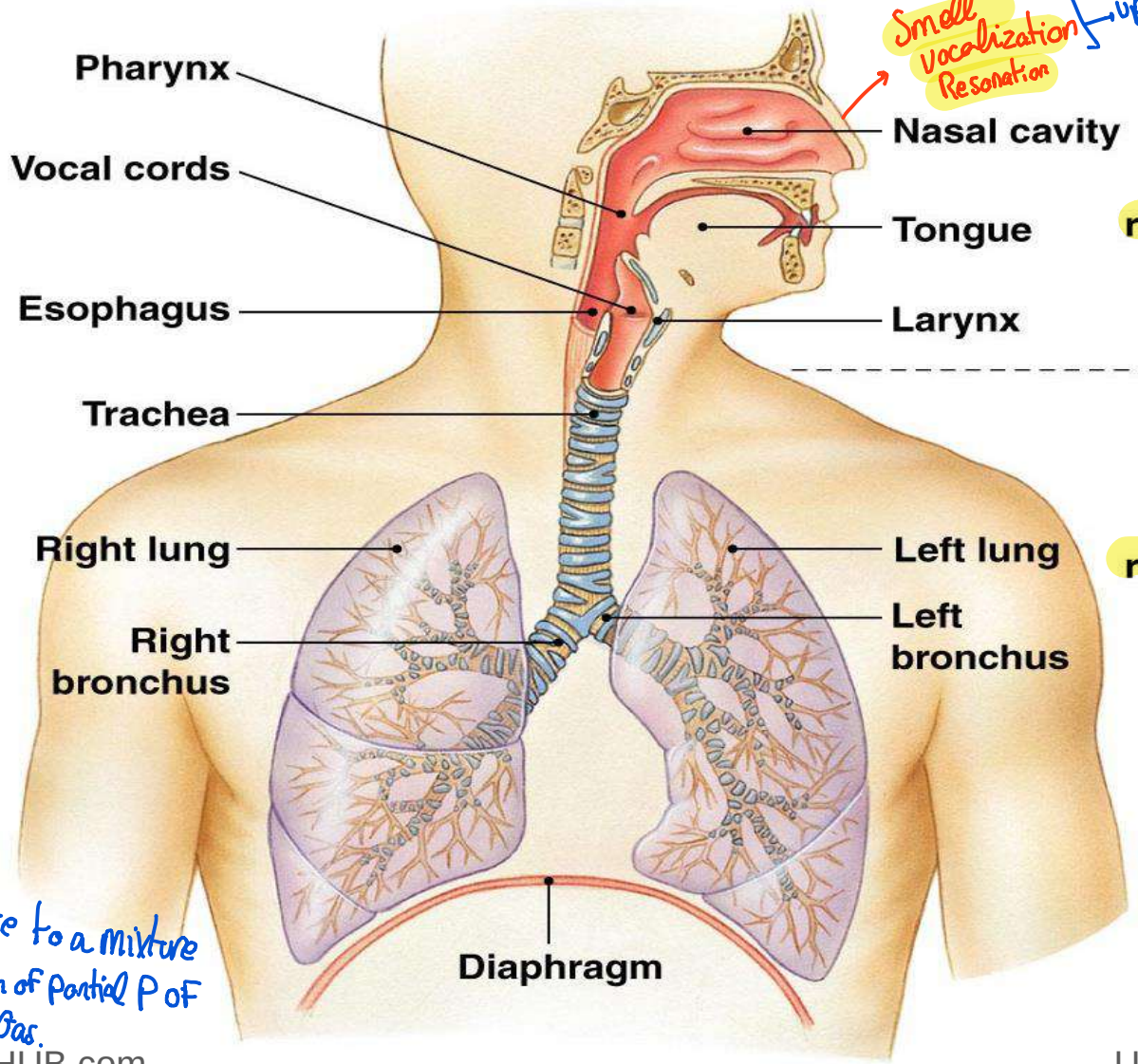
- **Conducting zone:** the Tubes that connects and Brings all Air In and out. // They don't do Gas Exchange but they are Conducting Zone
  - Conduits for air to reach the sites of gas exchange
  - Includes all other respiratory structures (e.g., nose, nasal cavity, pharynx, trachea)

Anatomical dead Zone.
↳ Because we Don't do gas exchange in them

- **Respiratory muscles:** ⇝ they Decrease and Increase Lung's Volume ⟶ So we can Inhale and Exhale.
- Diaphragm, Intercostals, Abdominal and other muscles that promote ventilation

↓
Allowing Air to Get In and out.

Respiratory System

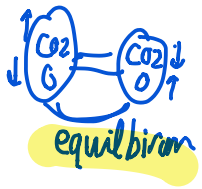


We Have 2 Distinc Area

Smell
Vocalization
Resonation
} Upper Respiratory Tract.

Flu Infected the upper Respiratory Tract

From Trachea and upward.



Total Pressure fo a mixture of Gases → Sum of Partial P of each Gas.

Figure 22.1

*Nasal Cavity ⇝ a) Olfaction
b) Vocalization
c) Resonation
d) it has the muscas which Traps dust Particles
e) Humidification ⇝ the Air which Enters takes up the water Vapor inside the muscas. ← why? → Because if Air Enters Dry it will take up water vapor From the cells inside the lung → So they will get dry → Infection → Damage

⇝ if we Bring a new gas to the mixture? Such as water Vapor.
↳ the O_2 Pressure will decrease and Replaced with water vapor in order to Keep lungs in a Healthy Situation. So the pressure of O_2 that was in the air was 160 mmHg But as it enters it goes to 150 mmHg Because water vapor takes place the 10 mmHg that were lost From O_2 Pressure.

So Humidity is Important..

.Anatomic Dead space is where no gas exchange Happens

What is Physiological Dead space? Dead Alveolies. ⇝ Smokers when they takes up tarr when they Smoke → which Adhere to Alveoli → No gas exchange. (it was physiologicly Active and Became Dead)

Pulmonary Edema → Accumulation of Liquid Substance in the lungs Specifily the Alveols.

~> why do we need O_2? It's the Ultimate OR Final Acceptor → And Required for the Production of ATP
↳ the Final Acceptor in the Electron transport chain

takes e^- and H^+ From H_2O
(Sulfer Can Be used As the Final Acceptor).

Respiration – four distinct processes

taking Air in and out. (Mechanical Ventilation) → Requires muscles (At Quite Breating Digephram and Intercastals → expand and Relax

- **Pulmonary ventilation** – moving air into and out of the lungs

External Respiration → Between lungs and Blood. (Diffusion of Gases Between lungs + Blood)

- **Chemical Respiration** – gas exchange between the lungs and the blood
- **Transport** – transport of oxygen and carbon dioxide between the lungs and tissues (Transport of O_2 + CO_2 in Blood From lungs until it comes into the tissues)
- **Internal respiration** – gas exchange between systemic blood vessels and tissues (Cellular)

(Kreps cycle → Utilization of O_2 + Glucose ↓ to Produce ATP)

Transport → O_2 From lungs diffuse into Blood then to all parts of the Body
↳ CO_2 From tissues → Blood Back to lungs → Out

~> why do we need water? Because All chemical Reactions Require media to Be Performed
↳ Because it's a universal Solvent

Major Functions of the Respiratory System

- To supply the body with oxygen and dispose of carbon dioxide

- **WHAT ELSE?????**

Function of the Nose

- The only externally visible part of the respiratory system that functions by:
  - Providing an airway for respiration
  - Moistening and warming the entering air (Prevent the epithelial cells from getting dry) → Because the Temp Between Body and Incoming Air — that's why we have vessels)
  - Filtering inspired air and cleaning it of foreign matter
  - Serving as a resonating chamber for speech
  - Housing the olfactory receptors → it effects the taste

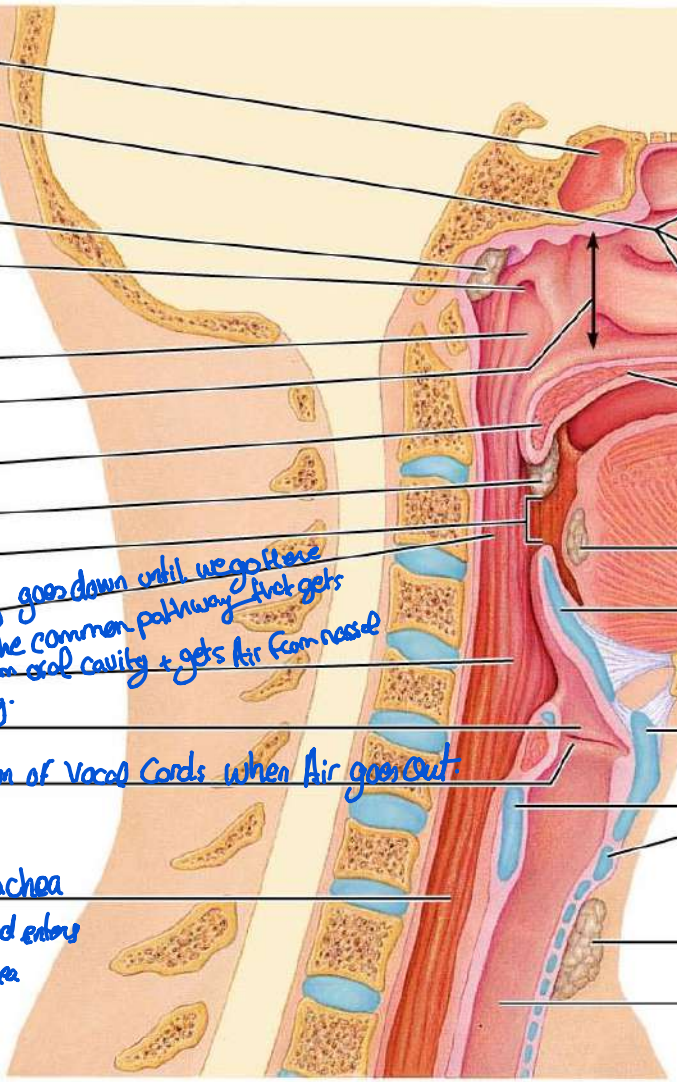
*Mucous → Used for the filtration of Air (Moistirizing) Because Air can Absorb moist → Becomes Dry → Cells will die.

Nasal Cavity

- **Vestibule** – nasal cavity superior to the nares
  - Vibrissae – hairs that filter coarse particles from inspired air
- **Olfactory mucosa**
  - Lines the superior nasal cavity
  - Contains smell receptors
- **Respiratory mucosa**
  - Lines the balance of the nasal cavity
  - Glands secrete mucus containing lysozyme and defensins to help destroy bacteria

Chocking → if Food or Solid enters Before epiglotes Close → Cough → to Remove particles

Nasal Cavity



Sphenoidal sinus
Nasal meatuses (superior, middle, and inferior)
Pharyngeal tonsil
Opening of pharyngotympanic (auditory) tube
Nasopharynx
Posterior nasal aperture
Uvula
Palatine tonsil
Isthmus of the fauces
Oropharynx
Laryngopharynx
Vestibular fold
Vocal fold
Esophagus

Nasal Cavity goes down until we get here which is the common pathway that gets food from oral cavity + gets Air from nasal cavity.

Allow Vibration of Vocal Cords when Air goes out.

Inside the trachea

Close Trachea & if food enters it won't pass through trachea

Frontal sinus
Cribriform plate of ethmoid bone
Nasal conchae (superior, middle and inferior)
Nasal vestibule
Nostril
Hard palate
Soft palate
Tongue
Lingual tonsil
Epiglottis
Hyoid bone
Thyroid cartilage
Cricoid cartilage
Laryngeal cartilages
Thyroid gland
Trachea

Colse the nasopha... so when Food comes in it can't come Back to the nose

Solid

→ if water or Solid comes From oral cavity it will close up the trachea OR Respiratory Syste... ↓ when we swallow we inhibit the Respiration.

Vocal Box ... Cartilage ... Vocal Cords ... Vibrate ... Produce Sounds

(b)

Functions of the Nasal Mucosa

- During inhalation the conchae and nasal mucosa:
  - **Filter, heat, and moisten air**
- During exhalation these structures:
  - Reclaim heat and moisture
  - Minimize heat and moisture loss

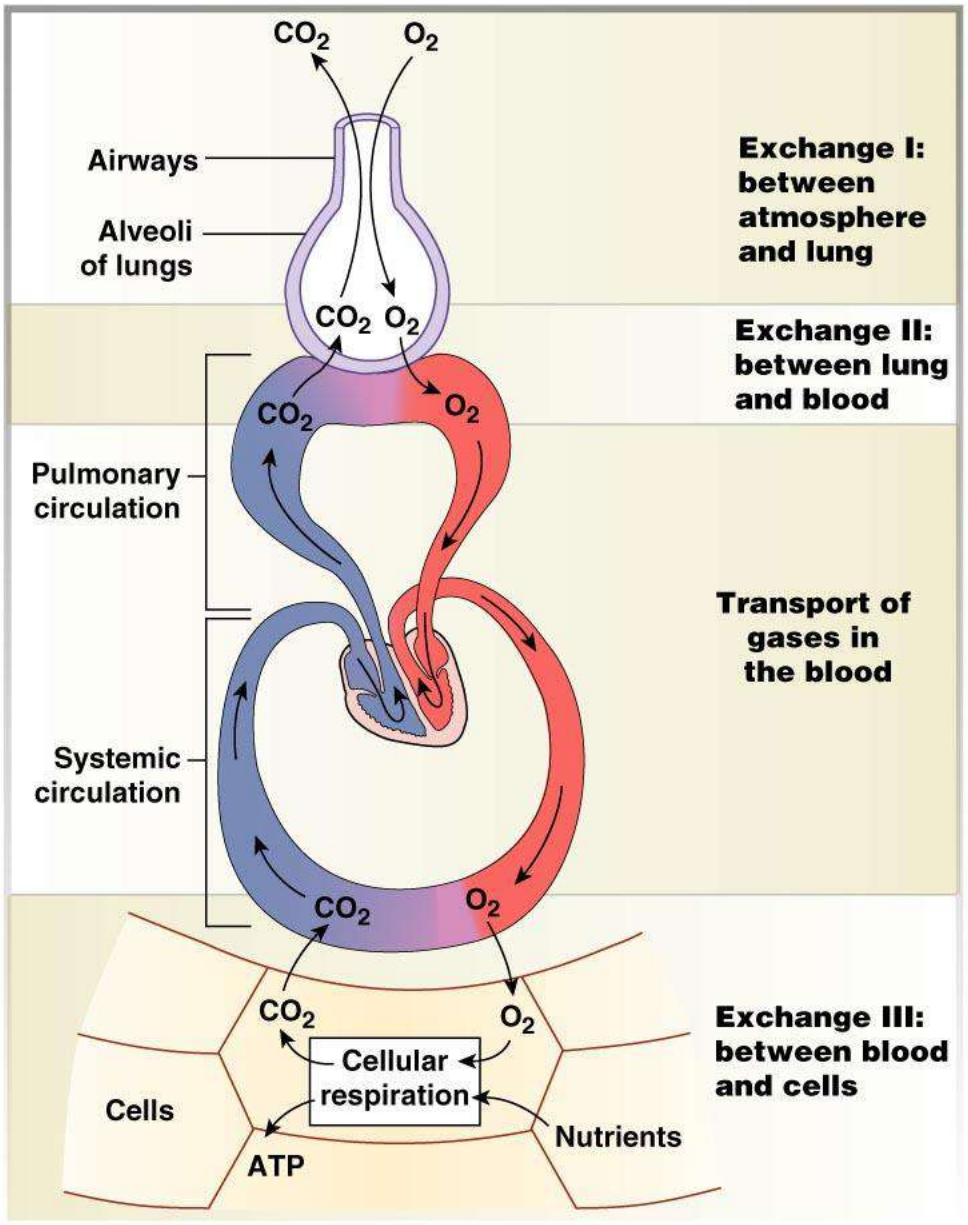


Figure 17-1

* After Nasal Cavity → Pharynx

Common pathway

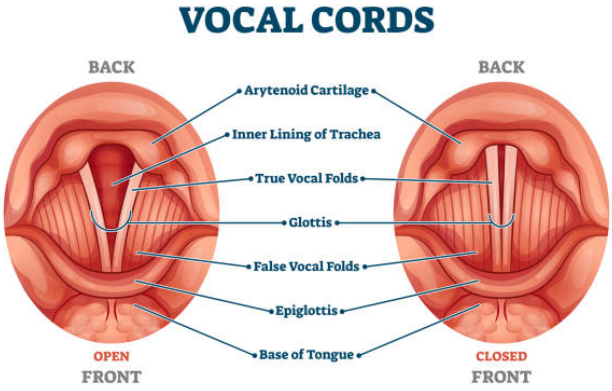
Pharynx → Laryngopharynx

Pharynx → Oropharynx (Common)

Pharynx → Nasopharynx

* Larynx → Cartilages + skeltal muscles → Production of voice (when it goes up and close by the epiglotes. → So food goes Around it then to esophoge

* False Vocal Cords → Attached to the muscles



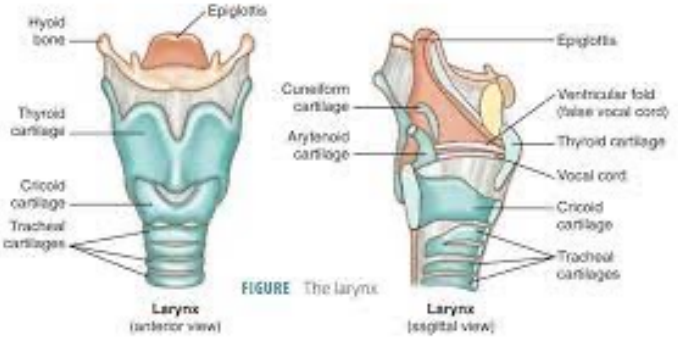


FIGURE The larynx

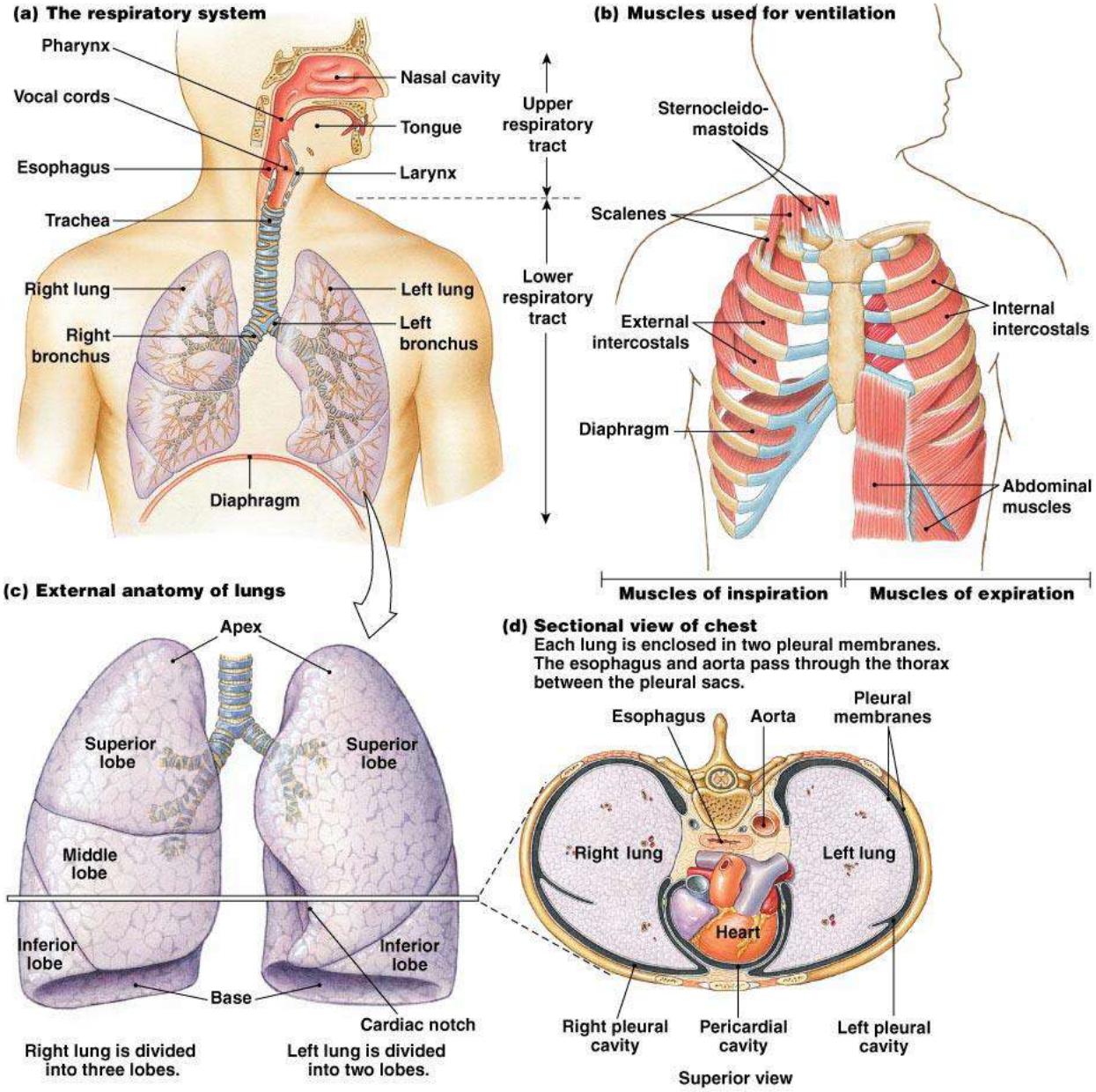


Figure 17.2 Overview (1 of 2)

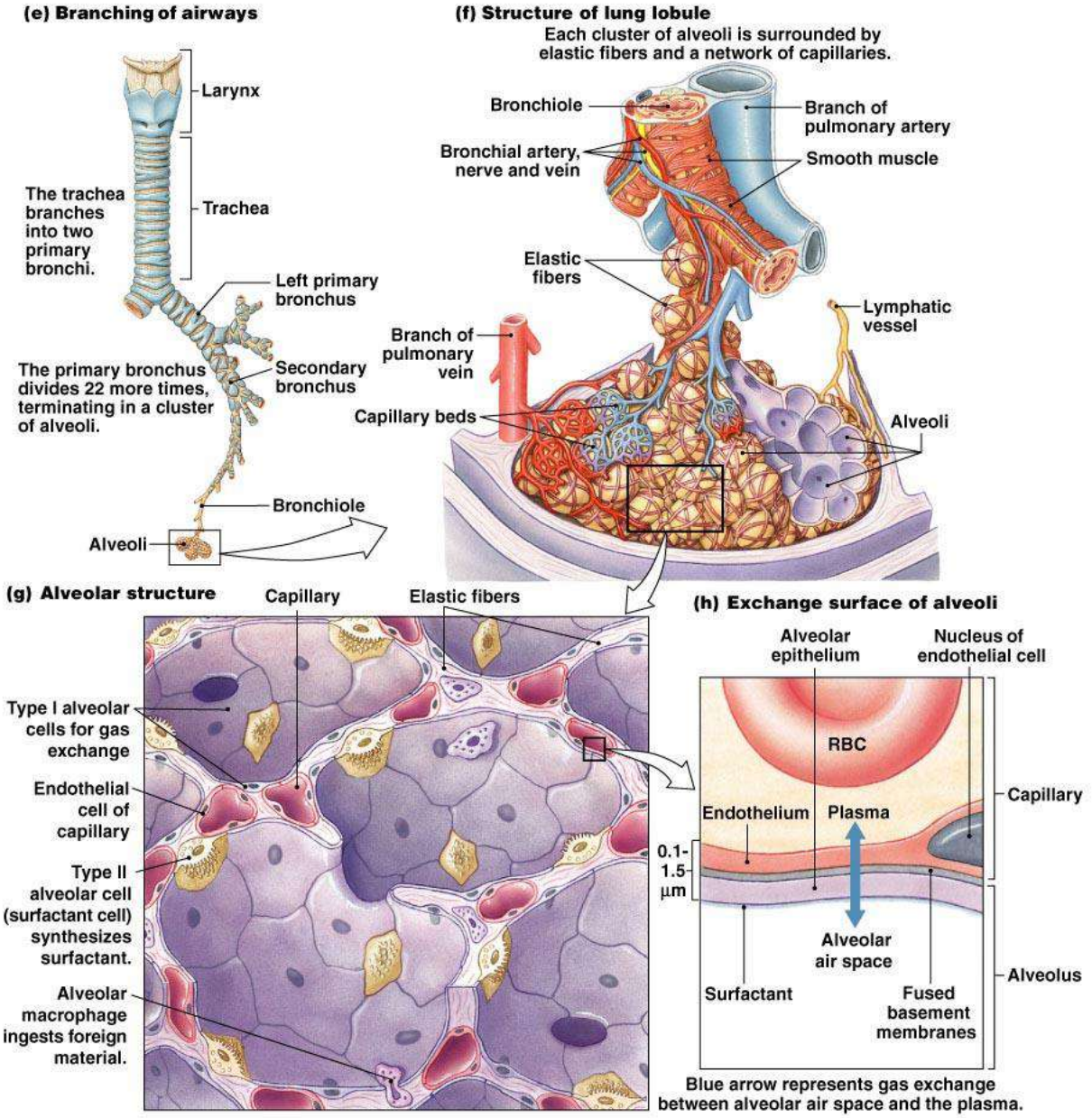


Figure 17.2 Overview (2 of 2)

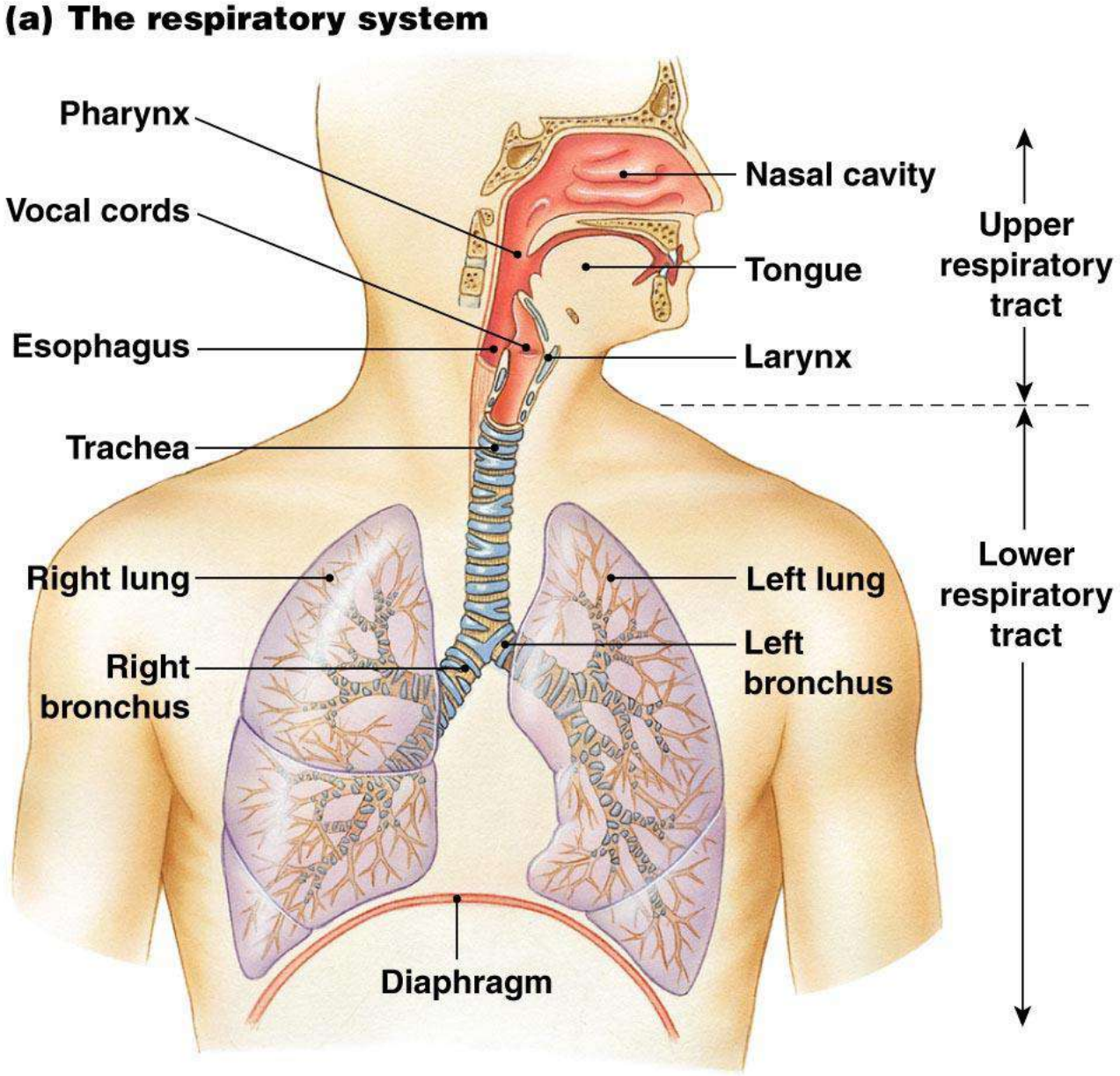


Figure 17.2a

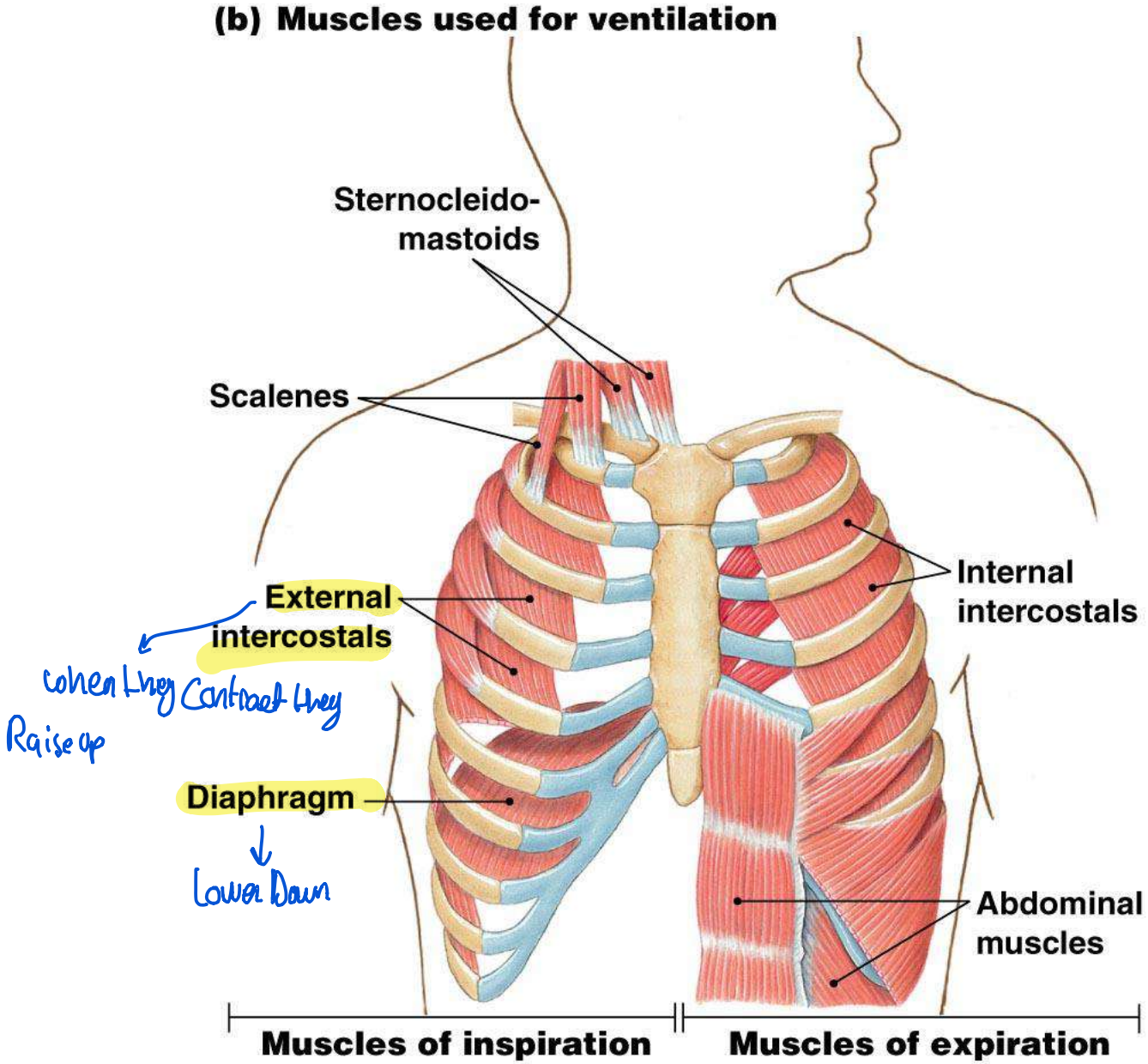


Figure 17.2b

* For Mechanical Respiration Activity

Air Moves In " Gas law → ↑ Volume → Pressure ↓ And the opposit.

. Muscles Are Used In taking Air in (Intake) → Active Respiration 2 muscles Are used:

↳ For Air to Get in we need muscles to expand in the thoracic Cavity.

↓

when Muscles expand → Volume Inc. → Presser ↓ → Allowing Air to Get in.

So we Have 2 muscles to Do that:

1) Diaphragm → lower Down

2) External Intercostals (we use them for Quite Breathing) → Inspiration → Muscles Contract.

↳ Raise Up in Contraction.

* we have other than Normal Quite Breating → Like when walking we will start Breathing Heavily → In this Condition we use the Scalense → Helps In Raising up the thorax Cavity.

↓

Also we Have Sternocliodomastoids → Used for Active Inspiration too

* Normaly For Expiration → Passive Proccess "we Don't use Muscles"

↳ However In Active Respiration → Coughing → Internal intercostals Are Used.

↓

Abdominal Cavity Muscles

↓

the Contraction of them Cause Expiration.

↓

they Contract So they Bring thoracic Cavity lower → ↓ Volume → ↑ Pressure → Air Goes out.

* Pulmonary Ventilation: the Mechanical Process of Respiration → Allow Air to get in by Inspiration + Get out by expiration.

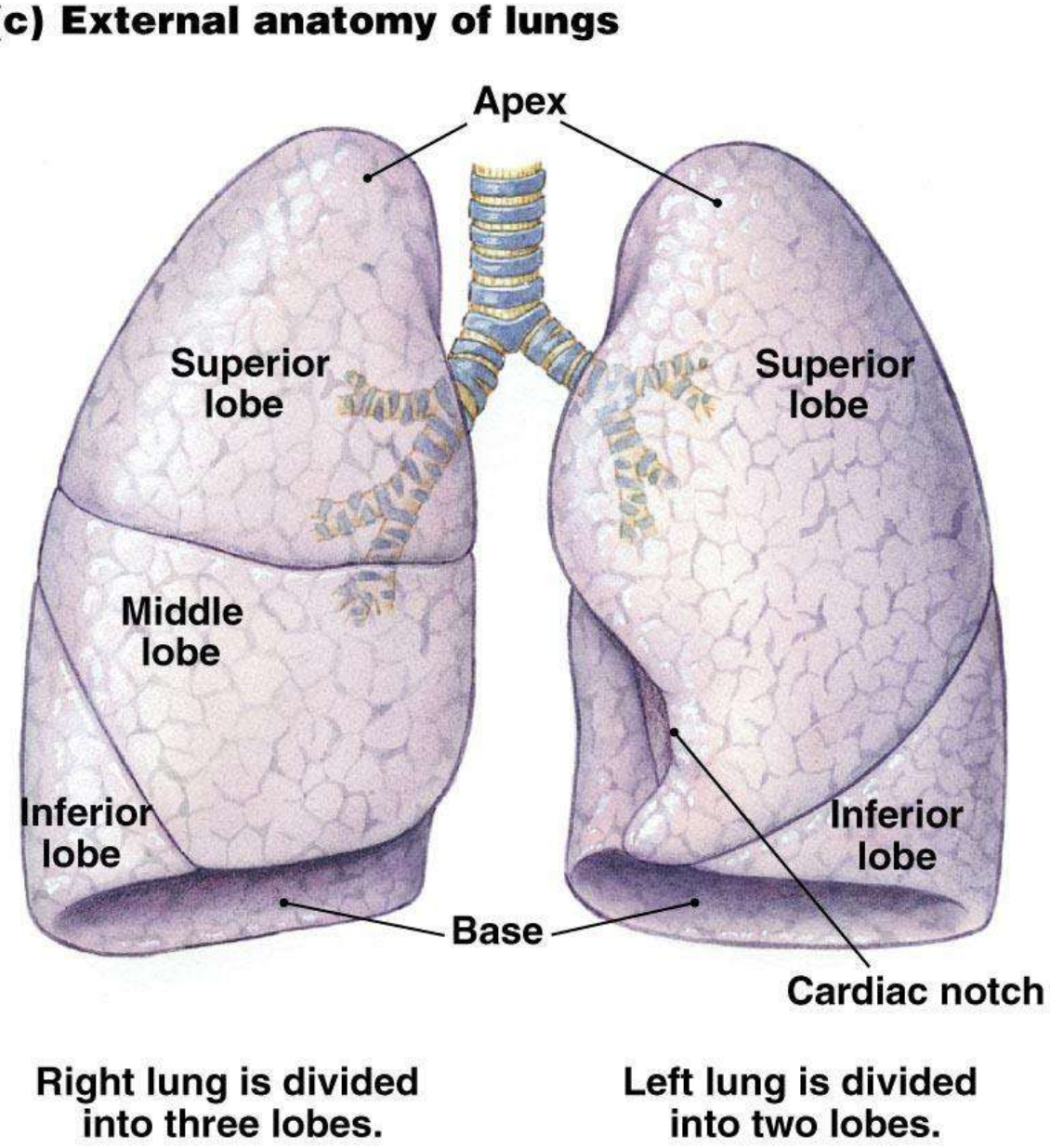
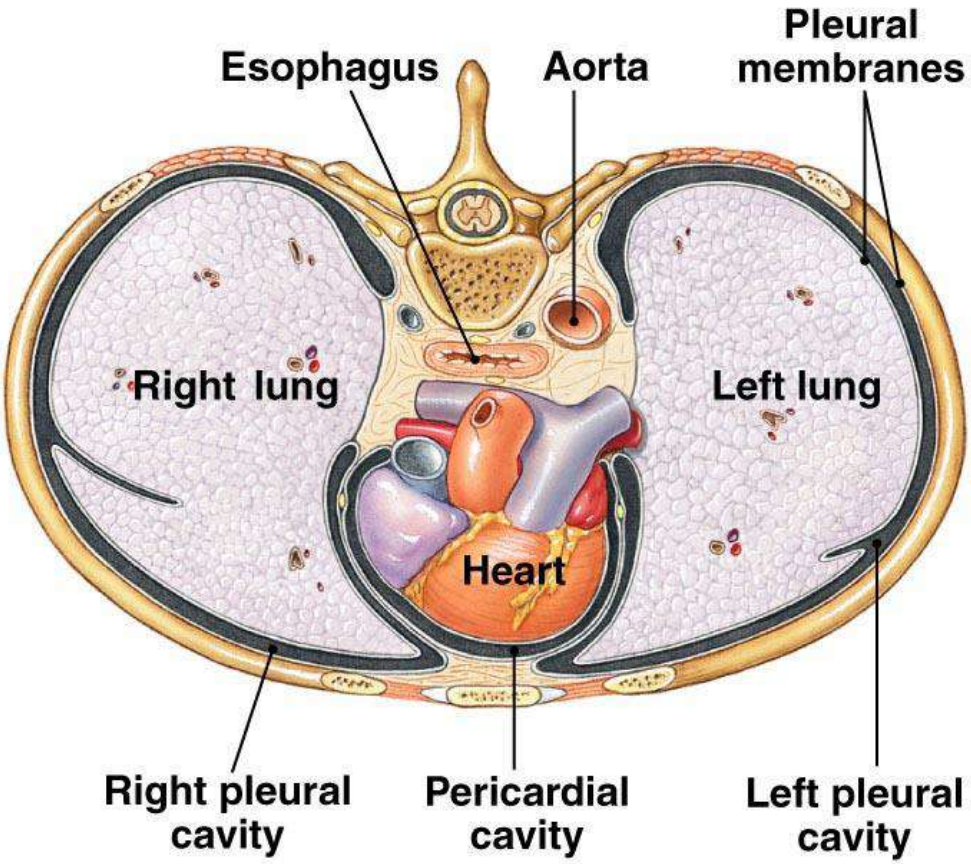


Figure 17.2c

(d) Sectional view of chest
Each lung is enclosed in two pleural membranes. The esophagus and aorta pass through the thorax between the pleural sacs.



Superior view

Figure 17.2d

Trachea

- Flexible and mobile tube extending from the larynx into the mediastinum
- Composed of three layers
  - **Mucosa** – made up of goblet cells and ciliated epithelium
  - **Submucosa** – connective tissue deep to the mucosa
  - **Adventitia** – outermost layer made of C-shaped rings of hyaline cartilage

Goblet Cells.

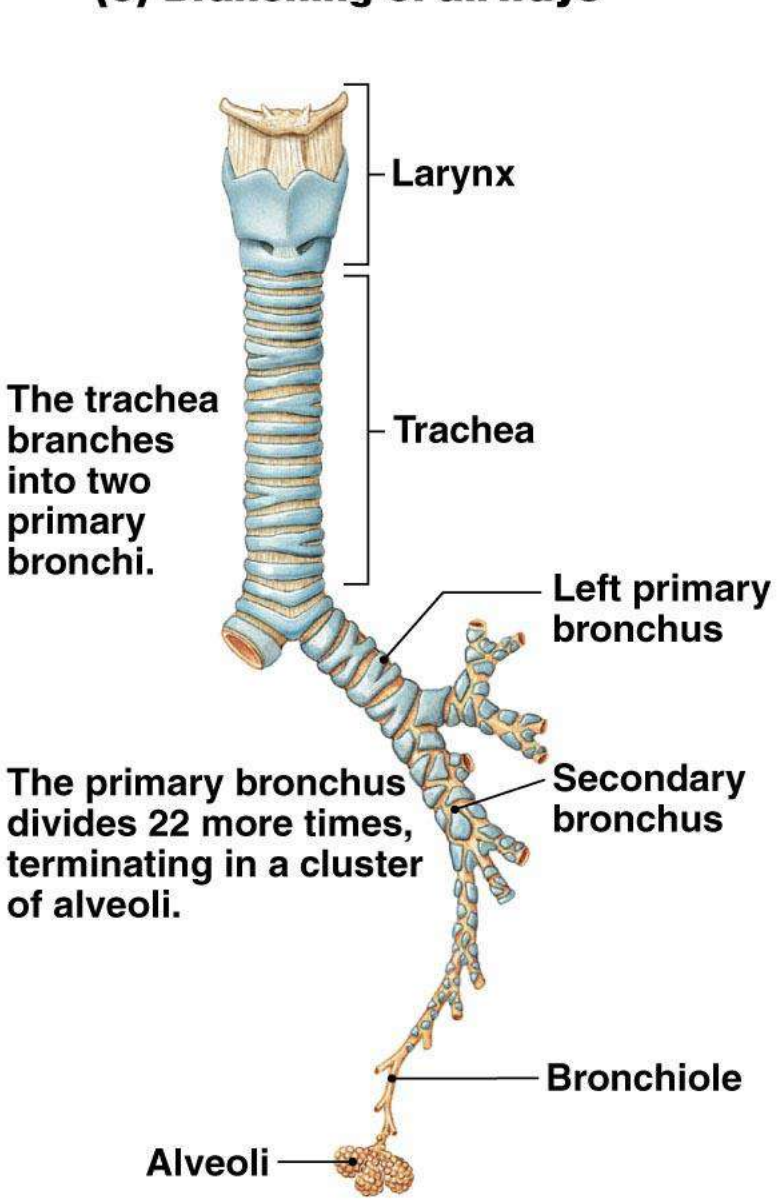
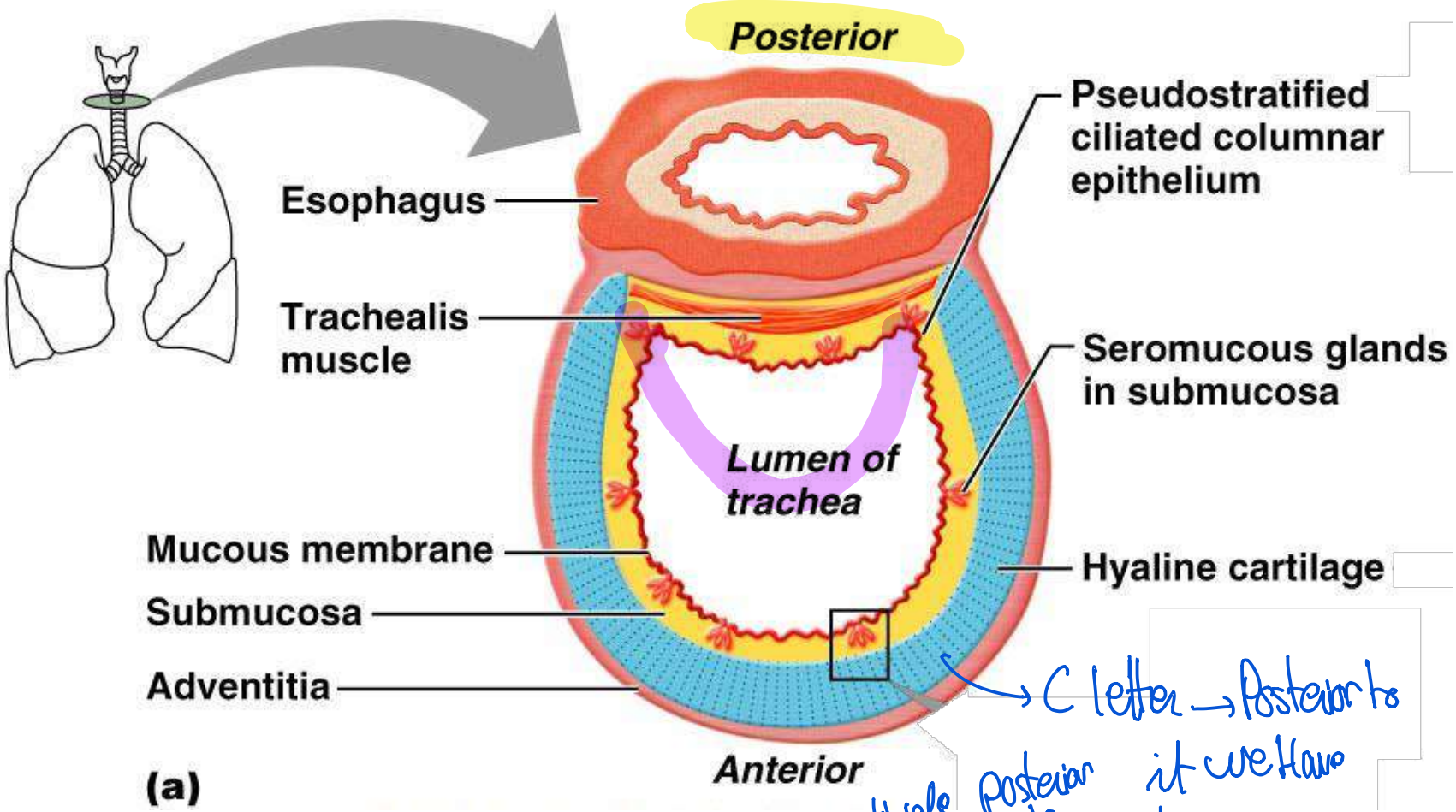


Figure 17.2e

Trachea



End of trachea → smooth muscle → will allow the expand of trachea + allow esophagus to expand

Vestibule

Posterior to it we have esophagus

C letter → Posterior to

Figure 22.6a

the Nasal Cavity, Larynx, Bronchi & Bronchioles → Allow Air to get in But they do not Do gas Exchange — Anatomical Dead Space

Conducting Zone

- **Carina** of the last tracheal cartilage marks the end of the trachea and the beginning of the bronchi
- Air reaching the bronchi is:
  - Warm and cleansed of impurities
  - Saturated with water vapor
- Bronchi subdivide into secondary bronchi, each supplying a lobe of the lungs
- Air passages undergo 23 orders of branching

	Name	Division	Diameter (mm)	How many?	Cross-sectional area (cm^2)
Conducting system	Trachea	0	15–22	1	2.5
	Primary bronchi	1	10–15	2	↓
	Smaller bronchi	2	1–10	4 ↓	↓
		3			
		4			
		5			
		6–11		1×10^4	↓
	Bronchioles	1–23	0.5–1	2×10^4 ↓ 8×10^7	100 ↓ 5×10^3
Exchange surface	Alveoli	24	0.3	$3–6 \times 10^8$	$>1 \times 10^6$

DPG → Diphosphoglycerin.

when Heart Contract it Pumps out Blood and when it's Released Pressure decrease

Conducting Zones

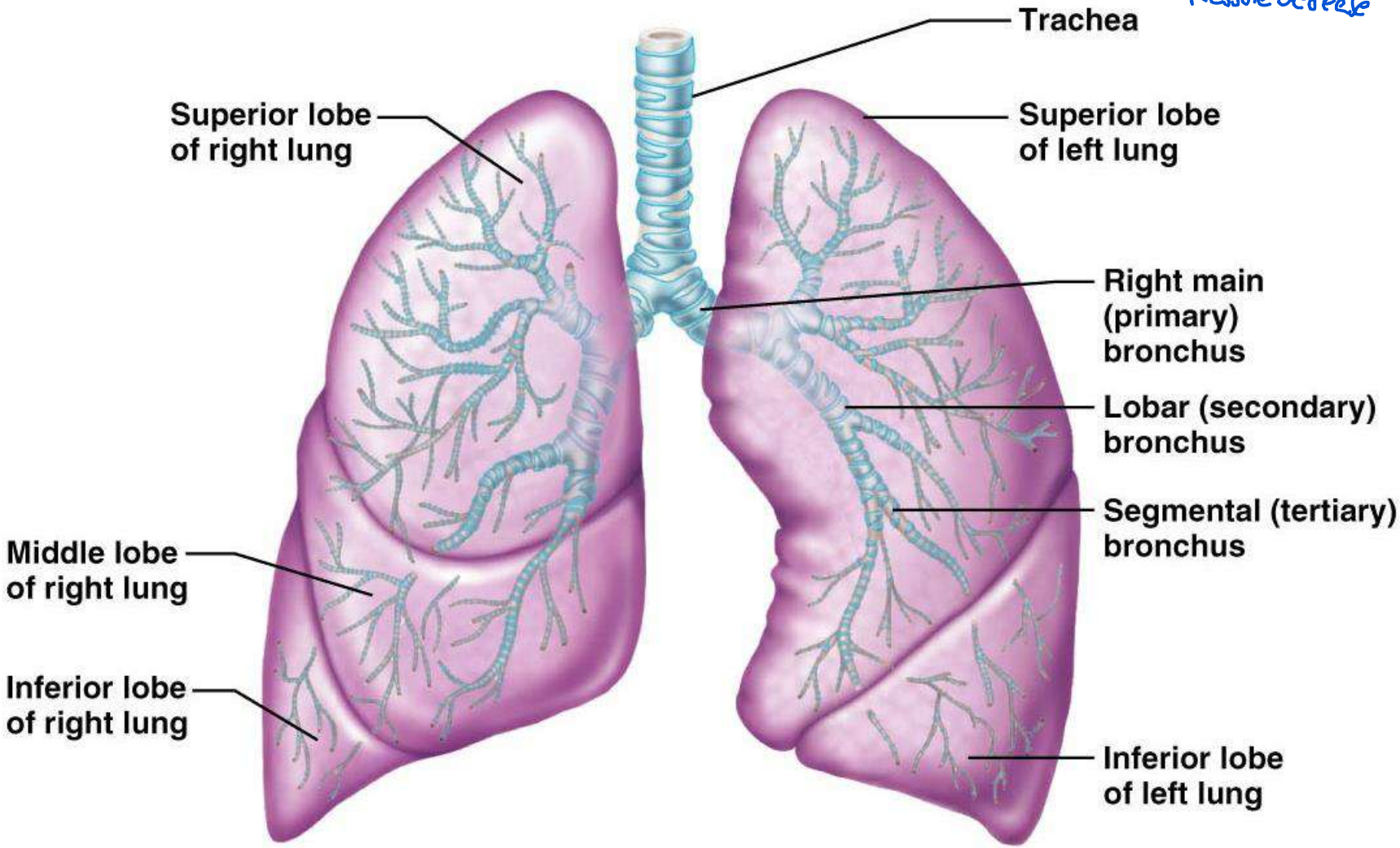


Figure 22.7

Dead Space

- **Anatomic**
- **Physiologic**

Respiratory Zone

- Defined by the presence of alveoli; begins as terminal bronchioles feed into respiratory bronchioles
- Respiratory bronchioles lead to alveolar ducts, then to terminal clusters of alveolar sacs composed of alveoli
- Approximately 300 million alveoli:
  - Account for most of the lungs' volume
  - Provide tremendous surface area for gas exchange

Respiratory Zone

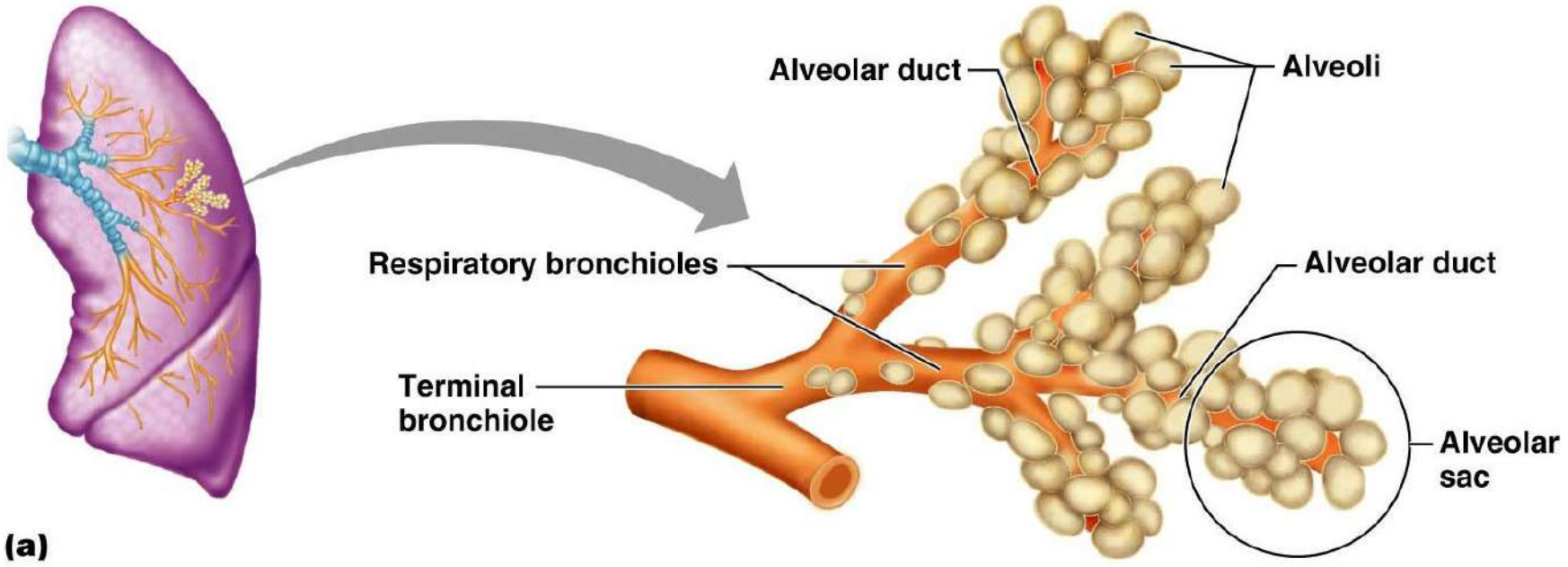


Figure 22.8a

Alveoli

- Surrounded by fine elastic fibers
- Contain open pores that:
  - Connect adjacent alveoli
  - Allow air pressure throughout the lung to be equalized
- House macrophages that keep alveolar surfaces sterile

Alveoli Are Connected to each other So if Air Gets in it will Fill All of the Alveolis.

(f) Structure of lung lobule

Each cluster of alveoli is surrounded by elastic fibers and a network of capillaries.

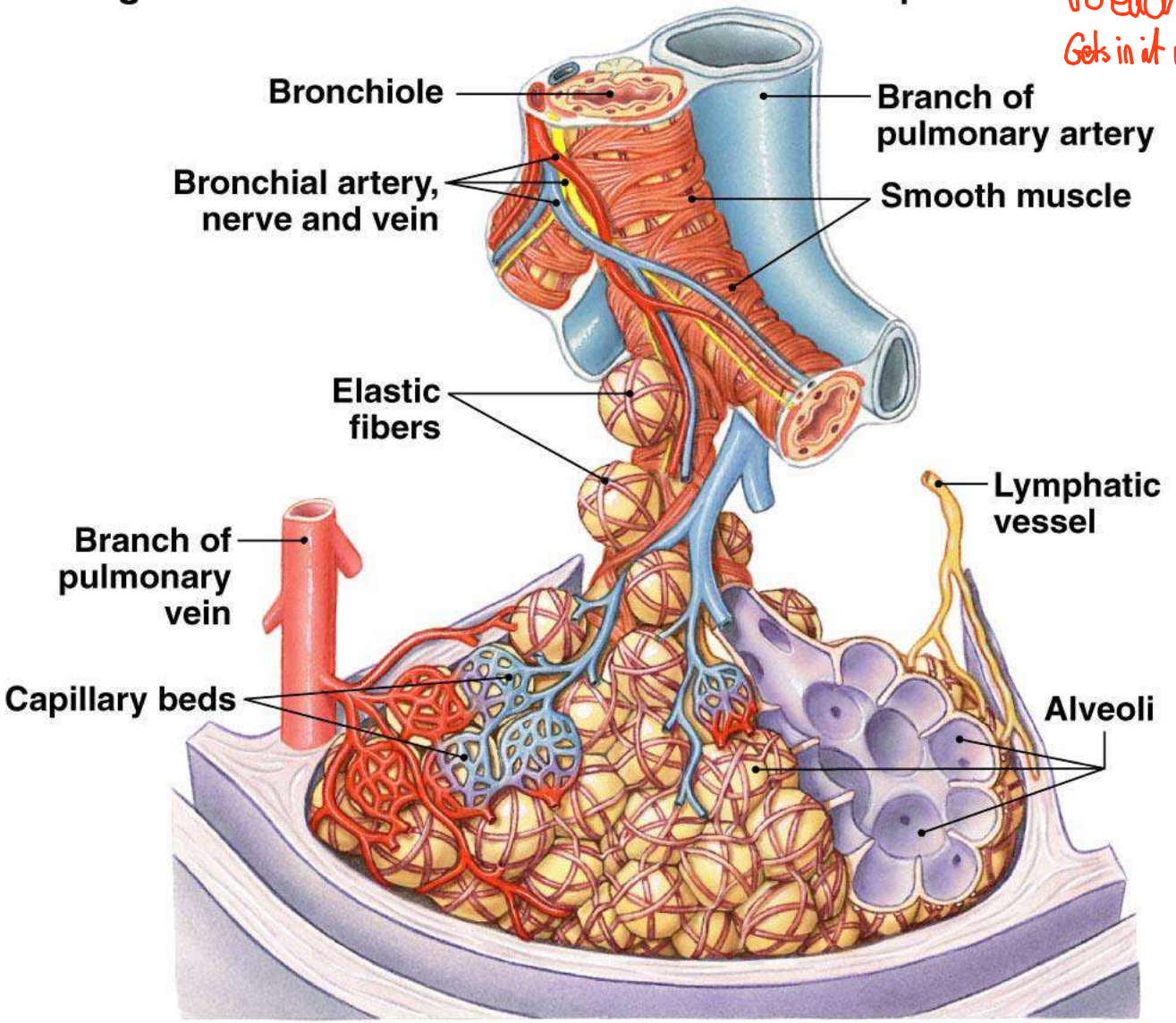
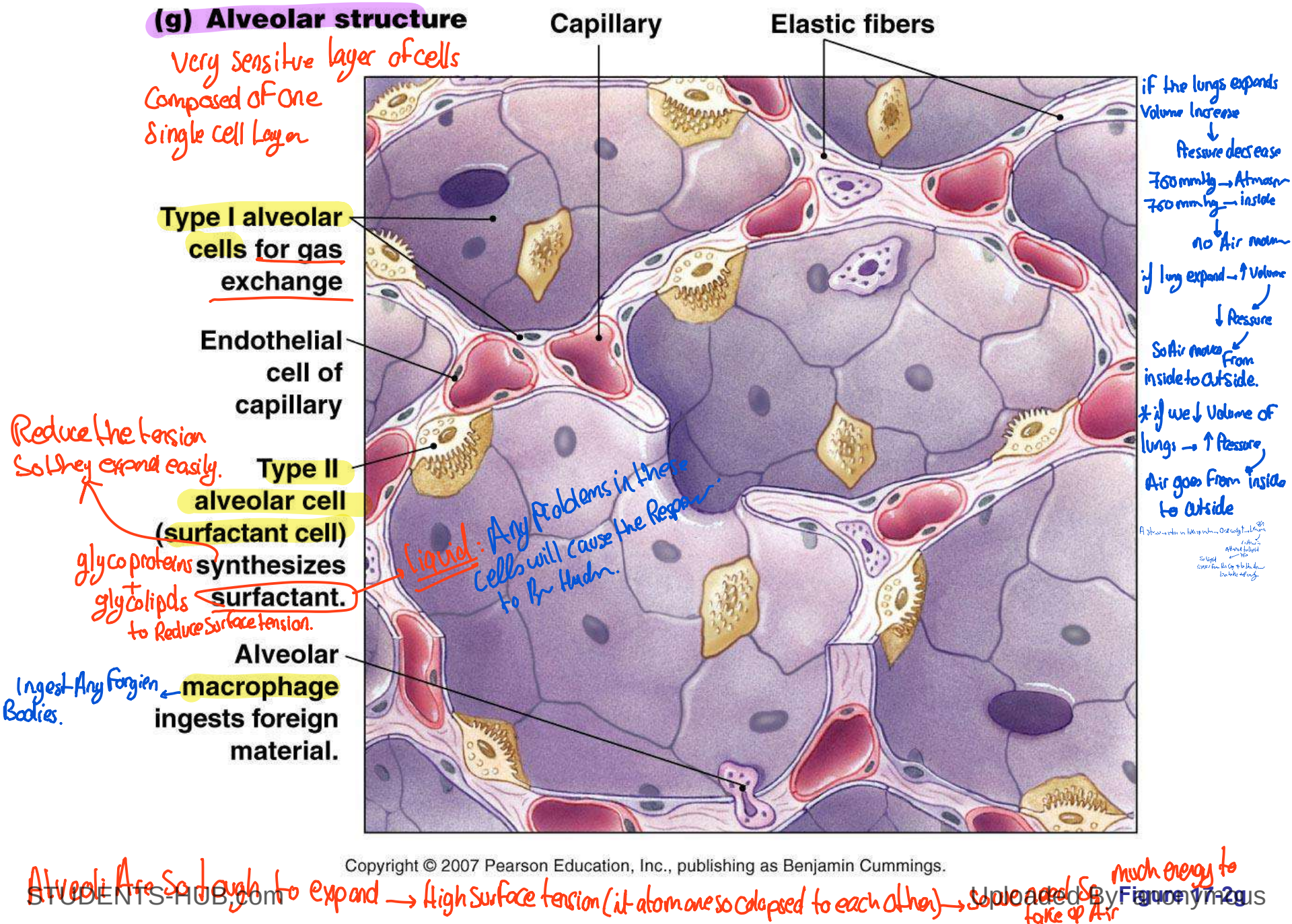


Figure 17.2f



Respiratory Membrane

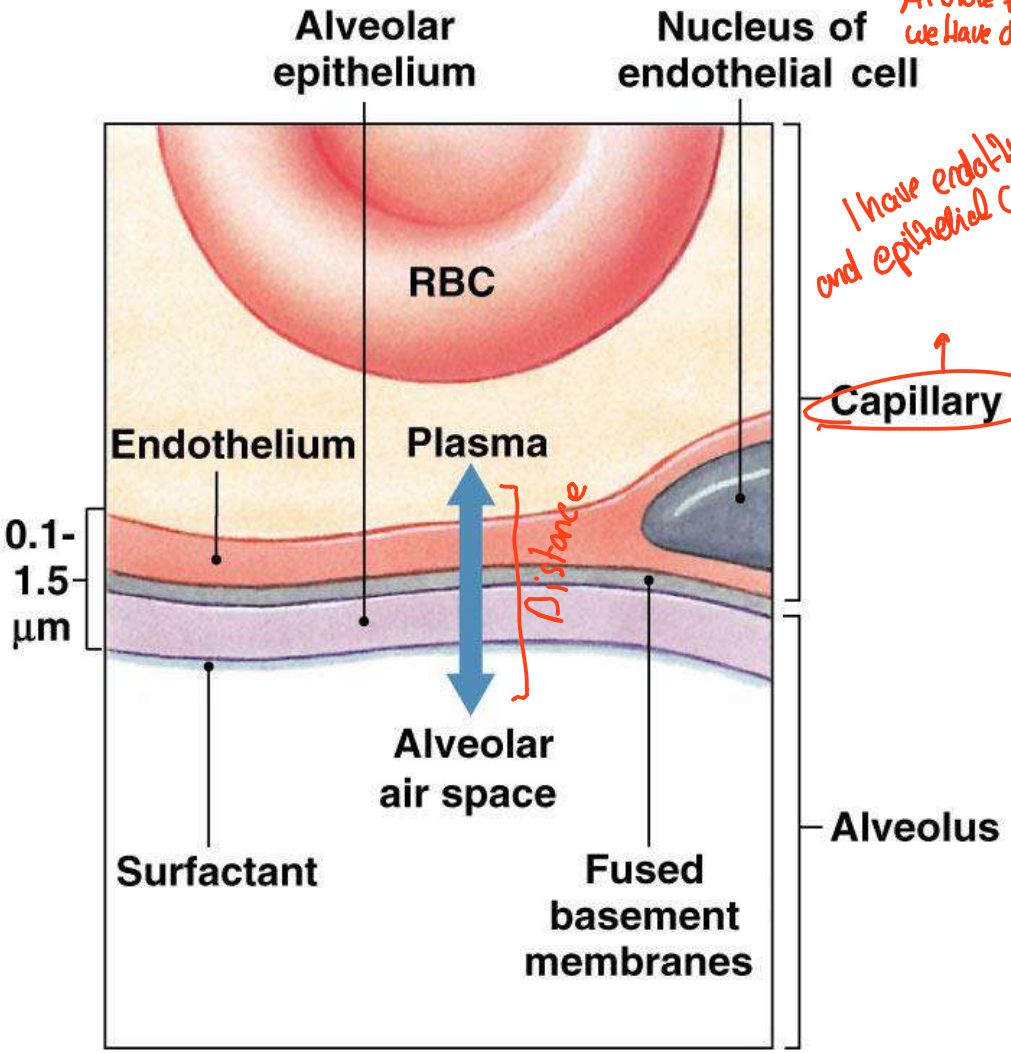
- This air-blood barrier is composed of:
  - **Alveolar and capillary walls**
  - **Their fused basal laminas**
- Alveolar walls:
  - Are a single layer of type I epithelial cells
  - Permit gas exchange by simple diffusion
  - Secrete angiotensin converting enzyme (ACE)

Alveoli → 75 m²

what is the Respiratory distance?
if I'm going to do Exchange of Gases from the Alviole to RBC OR the opposit it means the we have distance that it will Cross

I have endothelium cells and epithelial cells → Surfactant

So for Gas to move From Alvioles to Capillres
↓
diffuse in Surfactant



Blue arrow represents gas exchange between alveolar air space and the plasma.

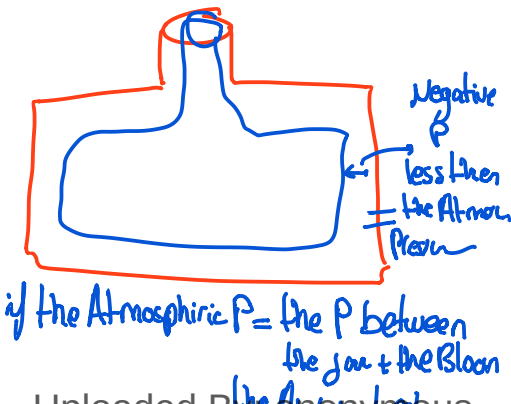
Figure 17.2h

Pleurae

Pleural Cavity → Space/Liquid In between

Parietal + Visceral Pleural membrane

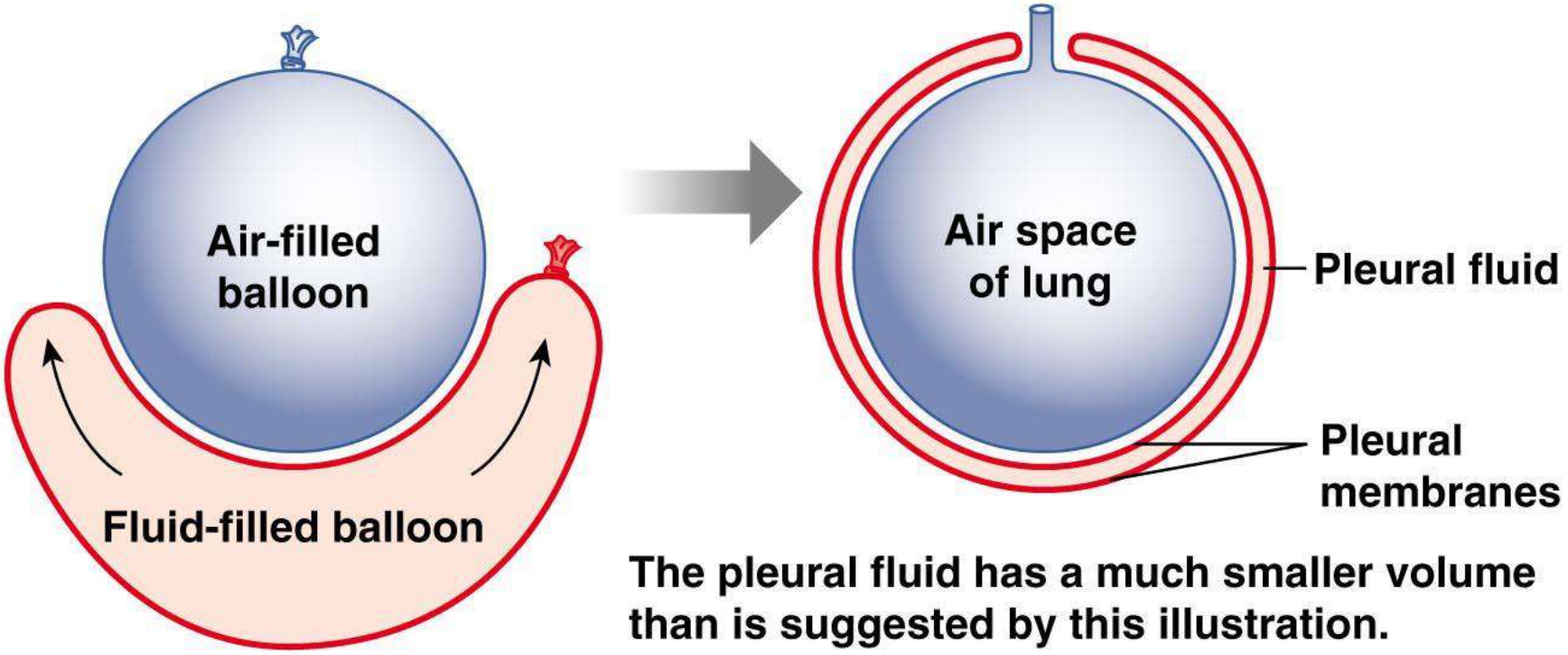
- Thin, double-layered serosa
- **Parietal pleura** → خارجي
  - Covers the thoracic wall and superior face of the diaphragm
  - Continues around heart and between lungs
- **Visceral pleura** → Directly connected to lungs
  - Covers the lungs



Why enhlation is Active and esipration is passive?

enhelation → we need energy + muscles
Exp → we don't need muscles.

The pleural sac forms a double membrane surrounding the lung, similar to a fluid-filled balloon surrounding an air-filled balloon.



The pleural fluid has a much smaller volume than is suggested by this illustration.

TABLE 17-1 Gas Laws

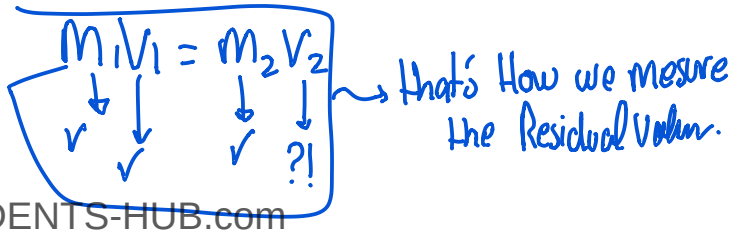
1. The total pressure of a mixture of gases is the sum of the pressures of the individual gases (Dalton's law).
2. Gases, singly or in a mixture, move from areas of higher pressure to areas of lower pressure.
3. If the volume of a container of gas changes, the pressure of the gas will change in an inverse manner (Boyle's law).

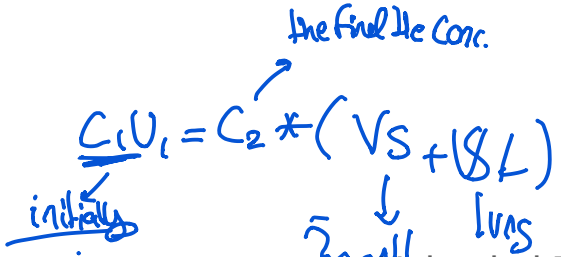
TABLE 17-2 Partial Pressures (P_{gas}) of Atmospheric Gases at 760 mm Hg

GAS AND ITS PERCENTAGE IN AIR	P_{gas} IN DRY, 25° C AIR	P_{gas} IN 25° C AIR, 100% HUMIDITY	P_{gas} IN 37° C AIR, 100% HUMIDITY
Nitrogen (N_2) 78%	593 mm Hg	574 mm Hg	556 mm Hg
Oxygen (O_2) 21%	160 mm Hg	155 mm Hg	150 mm Hg
Carbon dioxide (CO_2) 0.033%	0.25 mm Hg	0.24 mm Hg	0.235 mm Hg
Water vapor	0 mm Hg	24 mm Hg	47 mm Hg

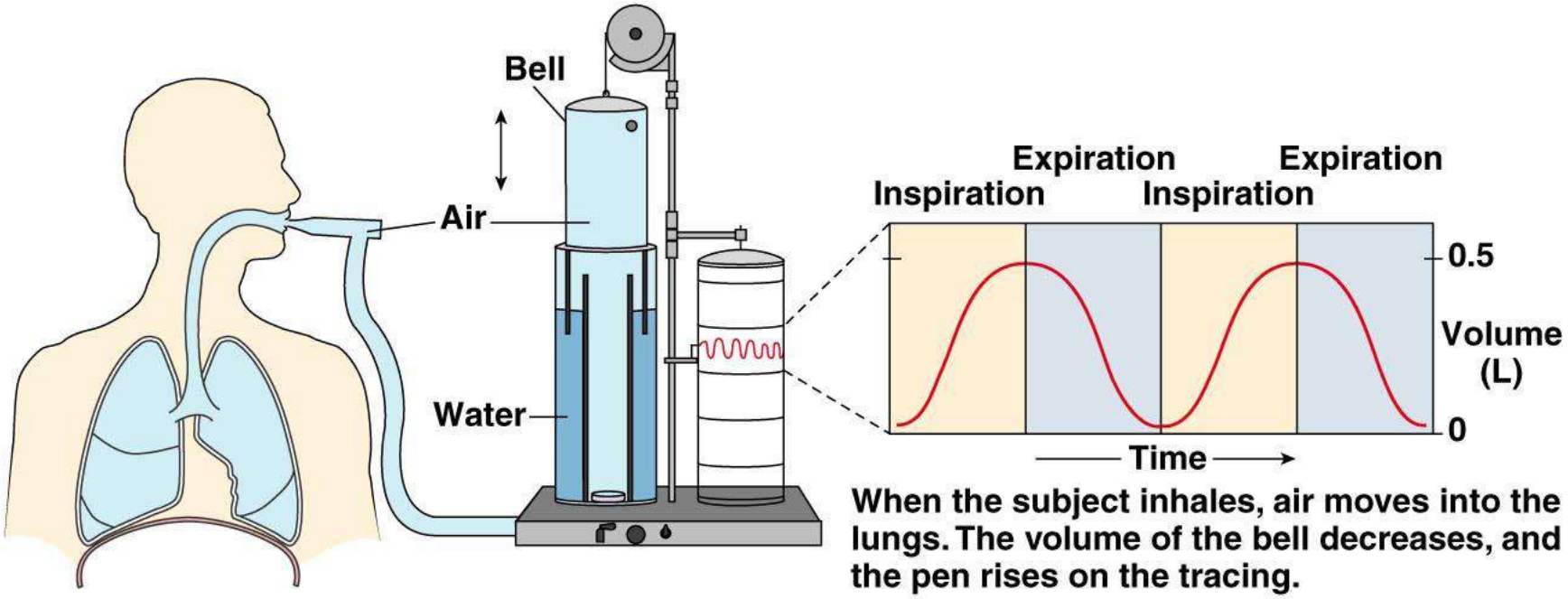
Respiratory Volumes

- **Tidal volume (TV)** – air that moves into and out of the lungs with each breath (approximately 500 ml)
- **Inspiratory reserve volume (IRV)** – air that can be inspired forcibly beyond the tidal volume (2100–3200 ml)
- **Expiratory reserve volume (ERV)** – air that can be evacuated from the lungs after a tidal expiration (1000–1200 ml)
- **Residual volume (RV)** – air left in the lungs after strenuous expiration (1200 ml)





$V_2 = (VS + VL)$



When the subject inhales, air moves into the lungs. The volume of the bell decreases, and the pen rises on the tracing.

Spirometer: Measuring + Reading Breath Moments.

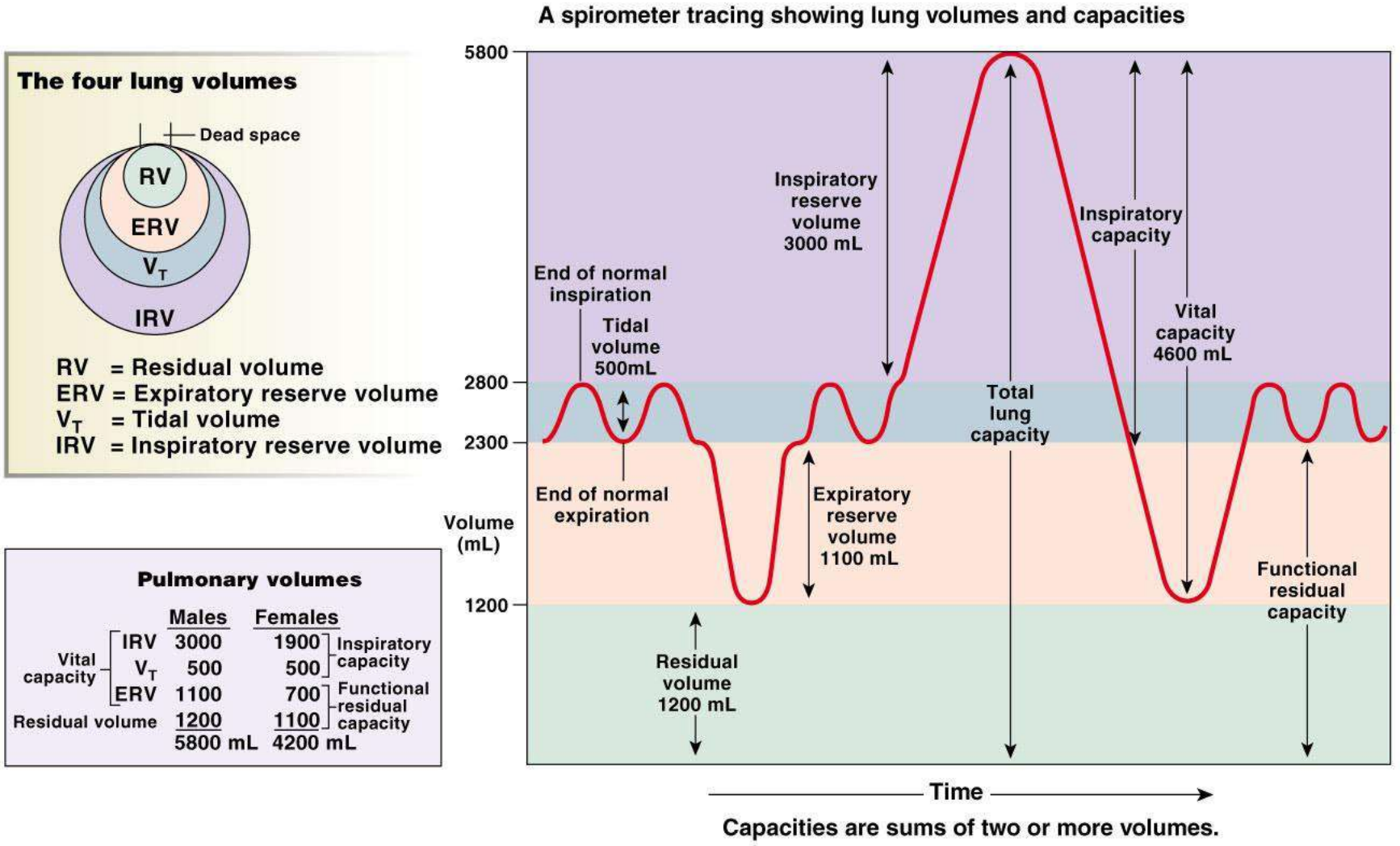


Figure 17.7

* Respiratory Volumes: During Quite Breathing

the Max Volume of Air we take 500 ml But we Have the Potenial to take up to 1L at Running OR doing Activity.

1) Tidal Volume → the Volume of Air we Inhale Normally.

2) Inspiratory Reserve Volume → Air we Inhale Forcibly.

3) Expiratory Reserve Volume (ERV) → the Maximum Air we can Remove from lungs.

4) Residual Volume → the Volume of Air the we still Have In our lungs.

How is it Calculated (Helium dilution Method) → we let the person take up Helium At Known Volume and Conc.

the Air which Enters the Longs (Helium) is Now Mixed with O_2 In there

we measure the Conc./Molarity → Volume

$M_1V_1 = M_2V_2$

total = 100 + RV

RV = total - He Volume.

$VL = Vs \times [(C_1/C_2) - 1]$

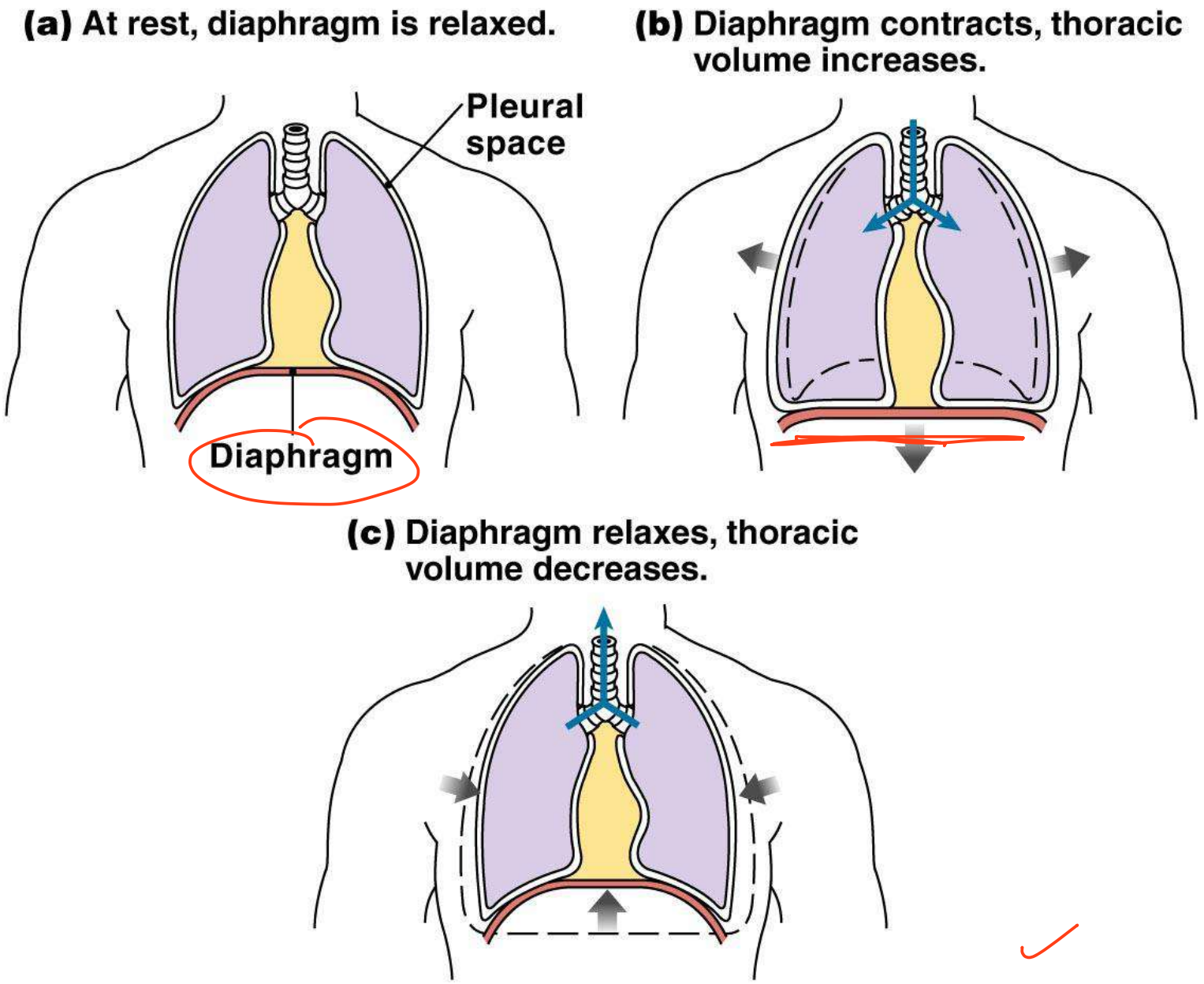


Figure 37-9 Overview

(a) "Pump handle" motion increases anterior-posterior dimension of rib cage.

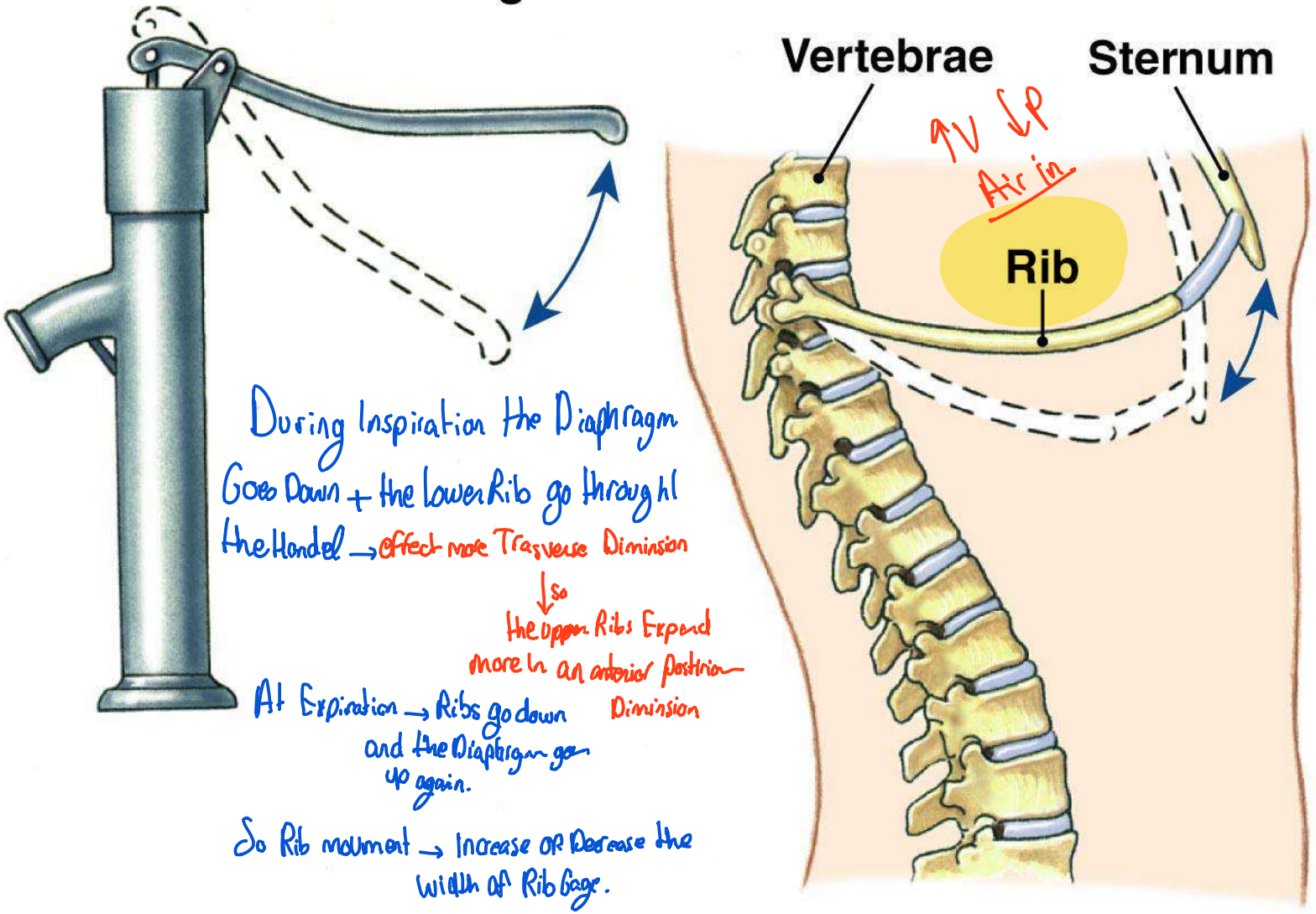


Figure 17-10a

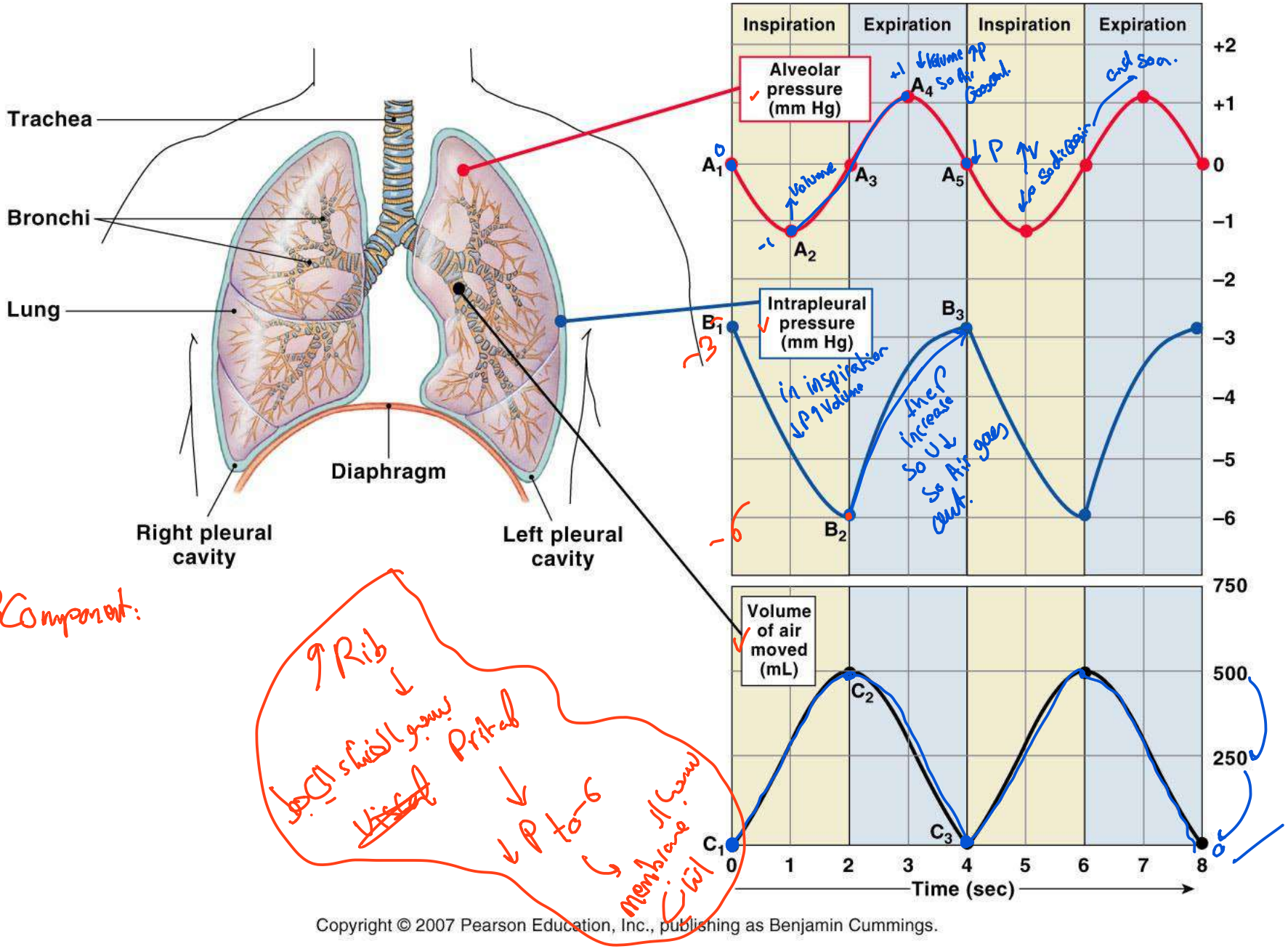


Figure 17.11

Lung Collapse

Caused when lungs Are Injured.

- Caused by equalization of the intrapleural pressure with the intrapulmonary pressure
- Transpulmonary pressure keeps the airways open
  - Transpulmonary pressure – difference between the intrapulmonary and intrapleural pressures ($P_{pul} - P_{ip}$)

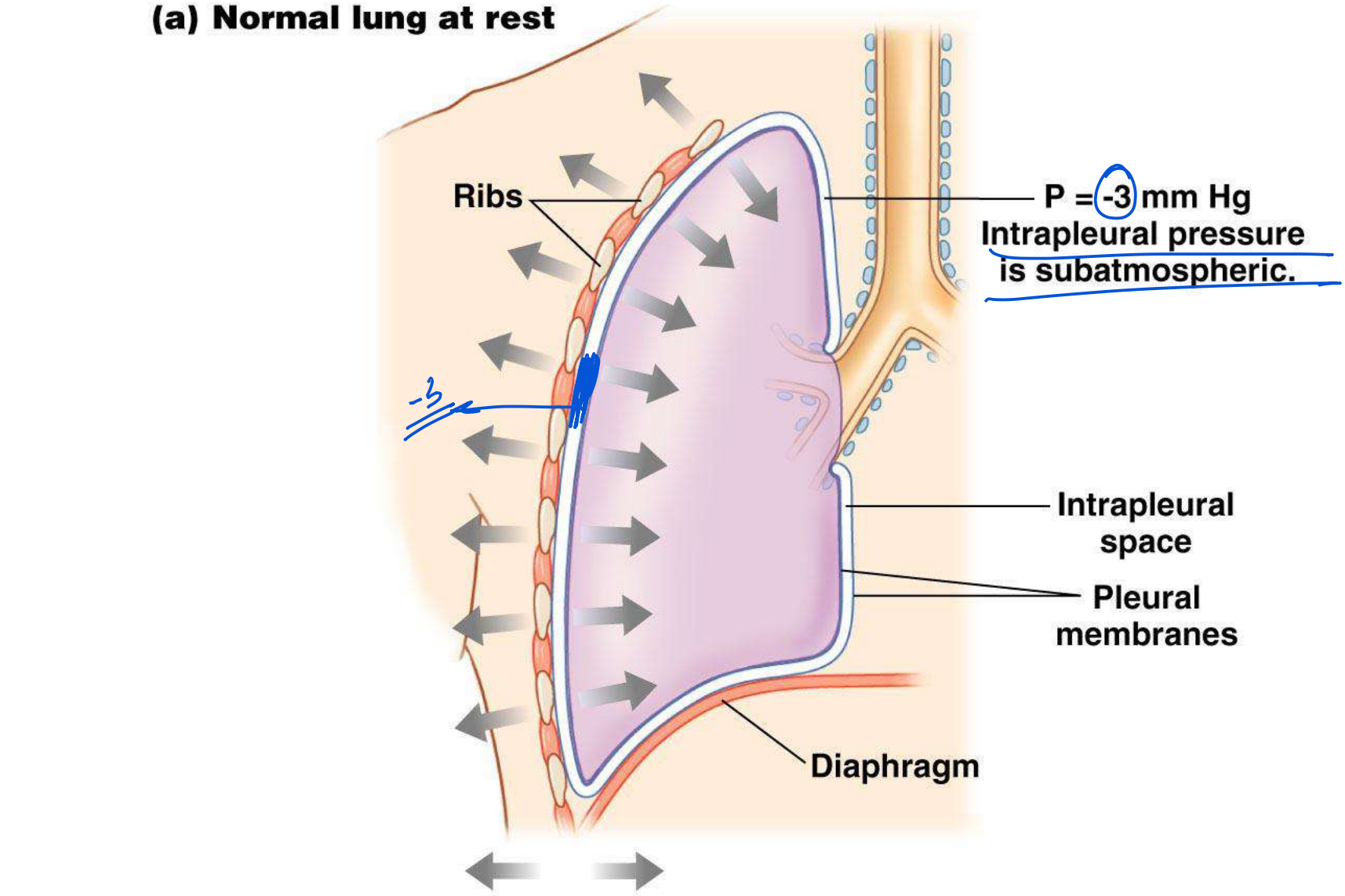


Figure 17-12a

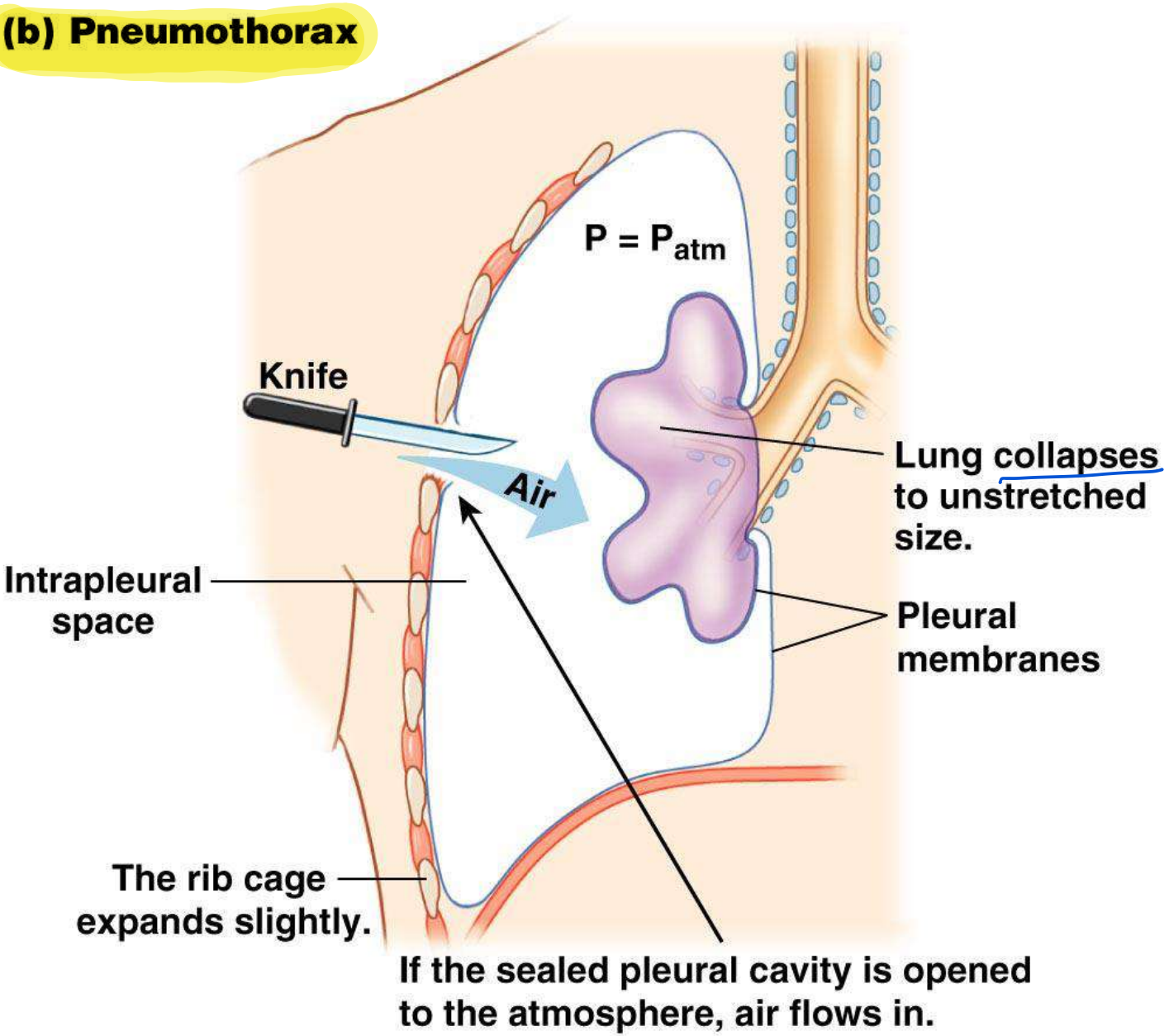


Figure 17-12b

* What is Hypoxia? When Blood level of O_2 falls below 80.

- Hypercapnia → Increase in the CO_2 level in Blood (Normally at Rest → 40 mmHg CO_2 + 98mmHg - 100 O_2)

~→ Hypoventilation: In this case O_2 level will drop and CO_2 level will increase.

↳ So as a Response from our Body it will try to Increase O_2 + ↓ CO_2

1) Increasing Respiratory Rate (More Breathing)

2) ↑ Respiratory Reserve Volume (IRV) + ↑ Expiratory Reserve Volume (ERV) → which increases the Rate + Volume which You take → Hyperventilation.

So Hypoventilation Cause → Hyperventilation.

What tells the Body to take more Air? and Reduce CO_2?

↳ Chemical Receptors Are needed for this Case Because we deal with Chemicals

Integration

↙ Sensation → Motor Action ↘

Everything we Do ~~ is Based on this.

So whenever O_2↓ + CO_2↑ it means that there is Hypoxia - Hypercapinia → which can Be Sensed by the Chemical Receptors.

↓

Those Chemical Receptors Are specific One to CO_2 and the other for O_2.

* Our Body is More Sensitive to CO_2 than O_2

As example: Divers that do Hyperventilation Before Swimming ↑ PO_2 to 120 and Reduce PCO_2 to 20 OR Below

↳ when they dive → O_2 will be consumed Quickly while CO_2 will be produced Slowly

O_2 → 90 → 85 → 80 while CO_2 → 18 → 20 → 25 → 30 → Severe Drop.

So when CO_2 Reaches 40 + O_2 Decrease to below 80 → it will cause Coma → which may lead to death.

Hyperventilation Can Happen Consciously OR unconsciously (By Chemo Receptors)

~→ why are receptors more sensitive to CO_2? Because CO_2 can mess with PH of the body, since it's a part of Buffering System.

→ Normally we have a Ratio to follow (Perfusion - ventillation Ratio) → They have to be equal

. Perfusion → Flow of blood into lungs to meet enough Ventilation →

Circulation (High) → the ventilation is also High to have well oxygenated Blood.

Increase Respiratory Rate → Increase Heart Rate

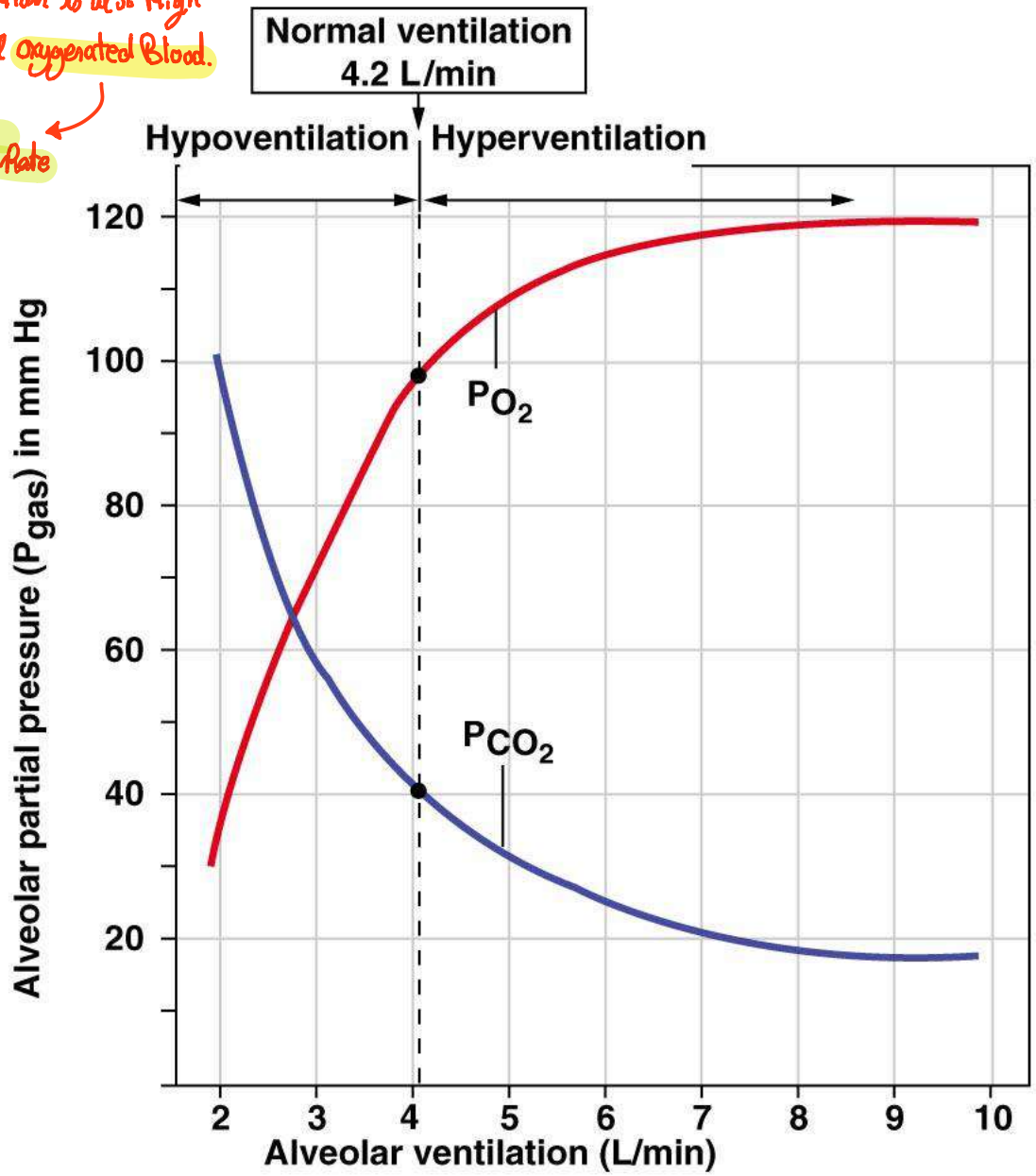


Figure 17-15

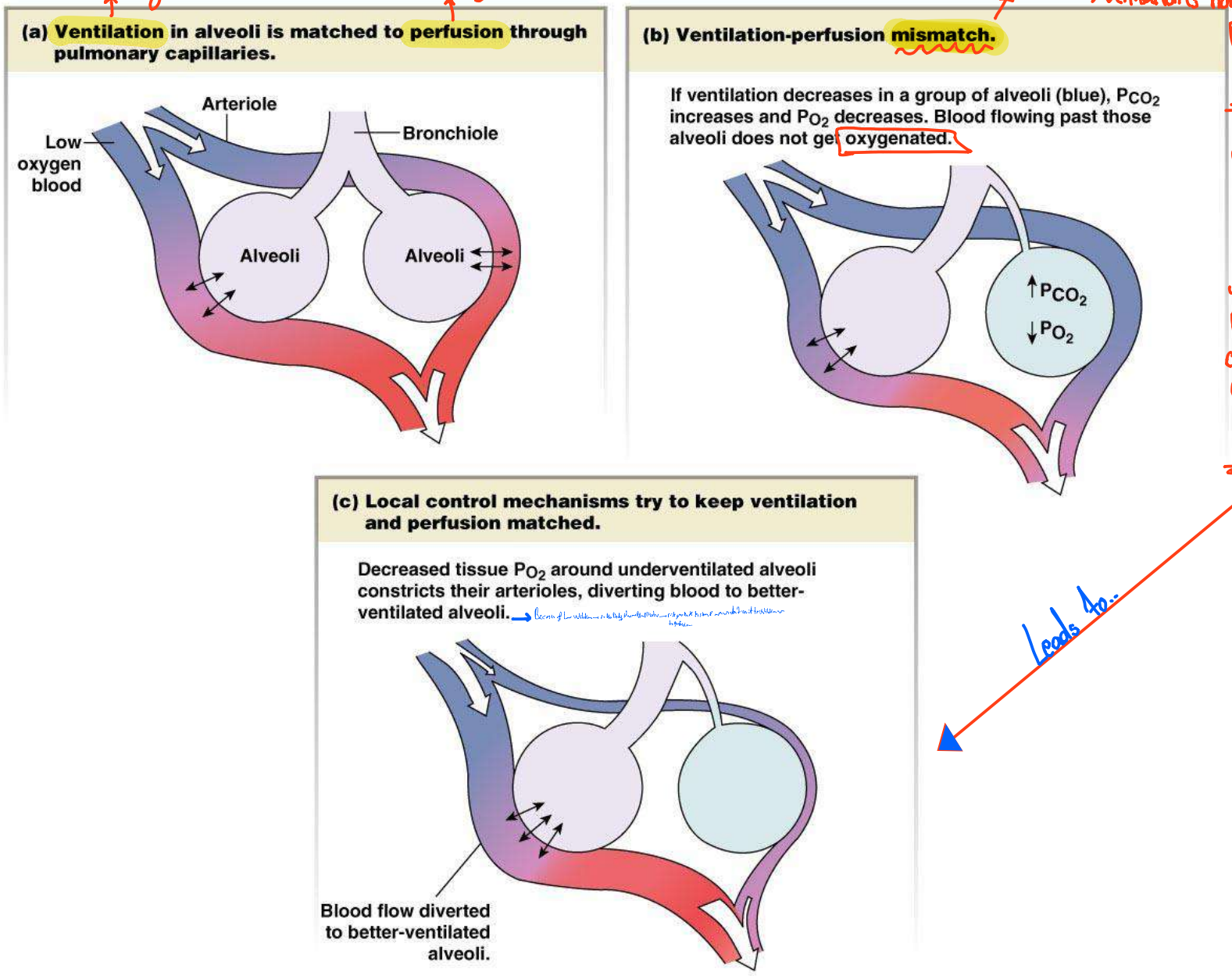
Respiratory Rate Gas Exchange.

Passage of blood into lungs of other Organs.

As for Example Asthma.

↳ Ventilation is not Good while Perfusion is okay.

Perfusion (the amount of Blood which Circulate in lungs = Ratio with gas exchang is okay)



So Blood is not oxygenated

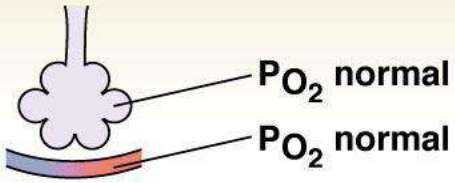
So we need to Decrease the amount of blood entering the lungs

Leads to..

Figure 17-16 Overview

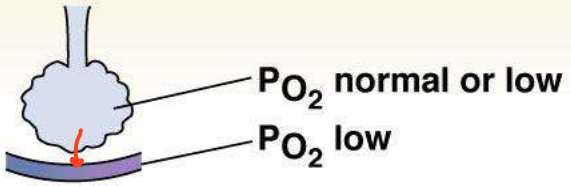
COPD → Chronic obstructive Pulmonary disease.

(a) Normal lung

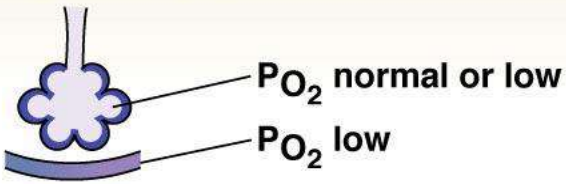


(b) Emphysema: destruction of alveoli reduces surface area for gas exchange.

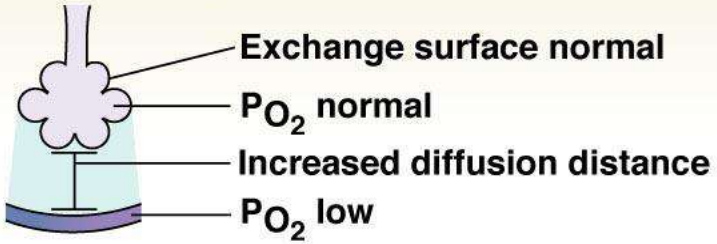
less surface Area (60 m² instead of 75 m²) to take O_2 so blood is not oxygenated well. (even though the O_2 that enters is enough.



(c) Fibrotic lung disease: thickened alveolar membrane slows gas exchange. Loss of lung compliance may decrease alveolar ventilation.



(d) Pulmonary edema: fluid in interstitial space increases diffusion distance. Arterial P_{CO_2} may be normal due to higher CO_2 solubility in water.



(e) Asthma: increased airway resistance decreases airway ventilation.

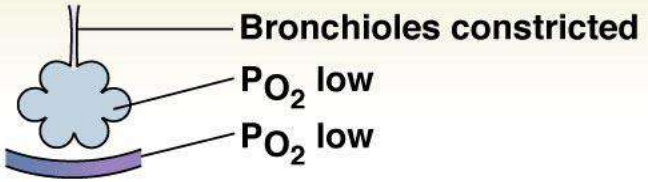


Figure 39-4 Overview

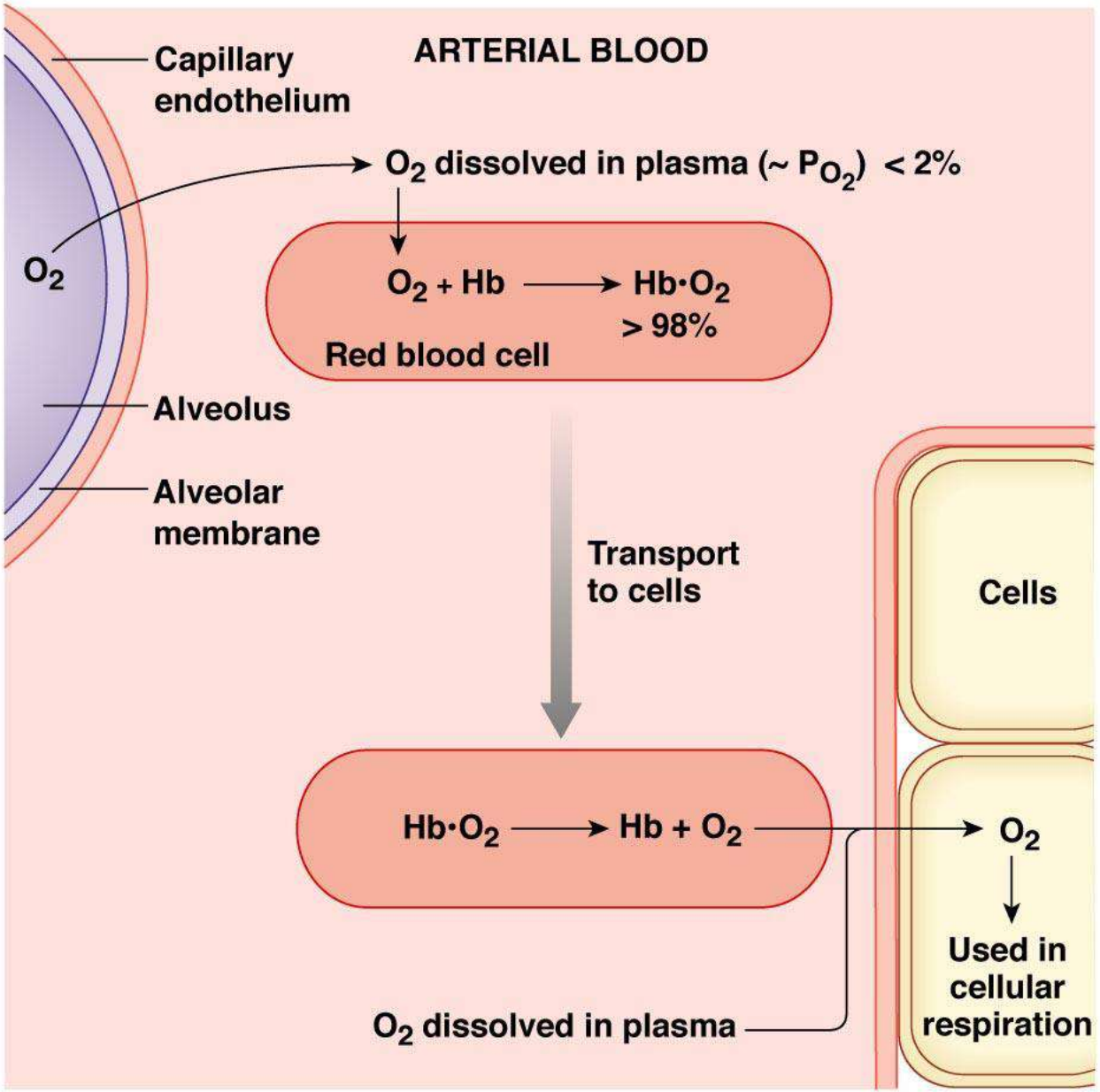


Figure 18.6

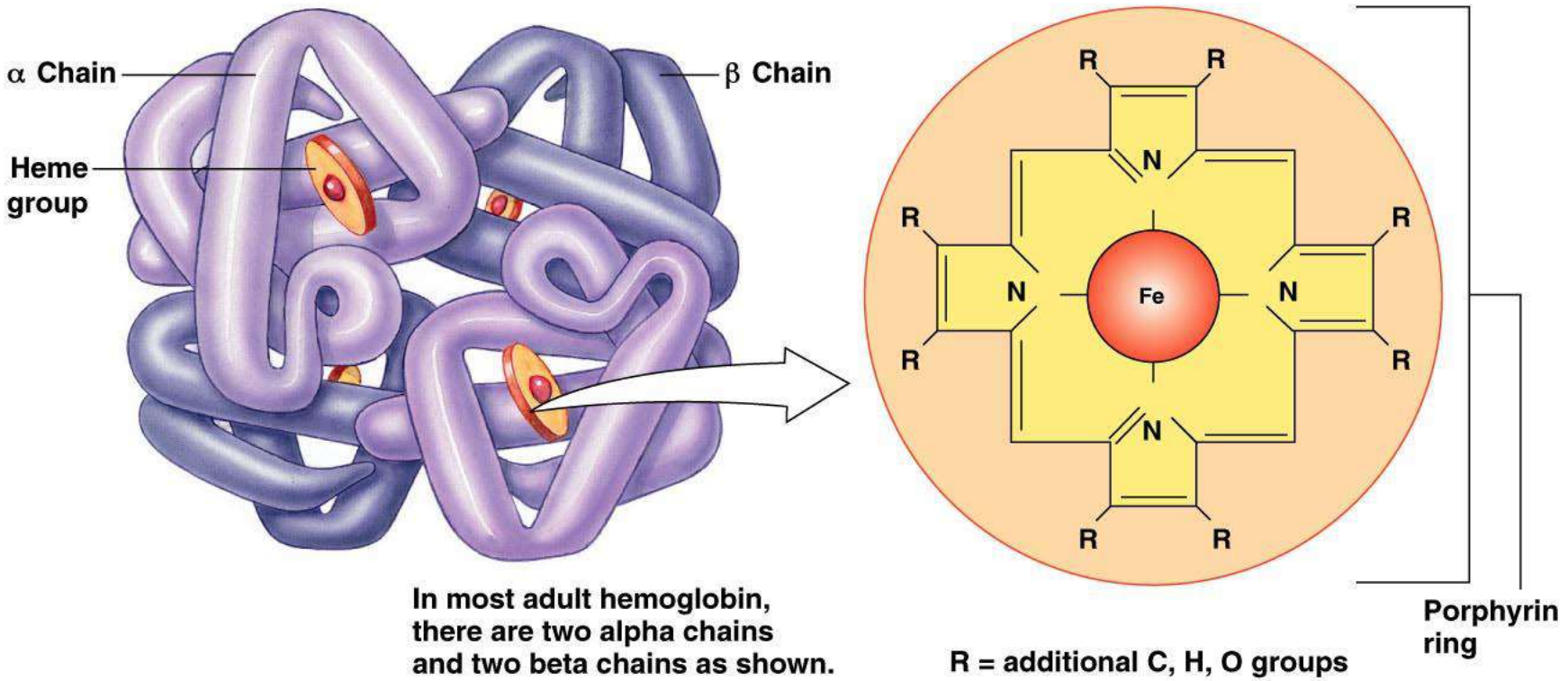


Figure 38-8 Overview

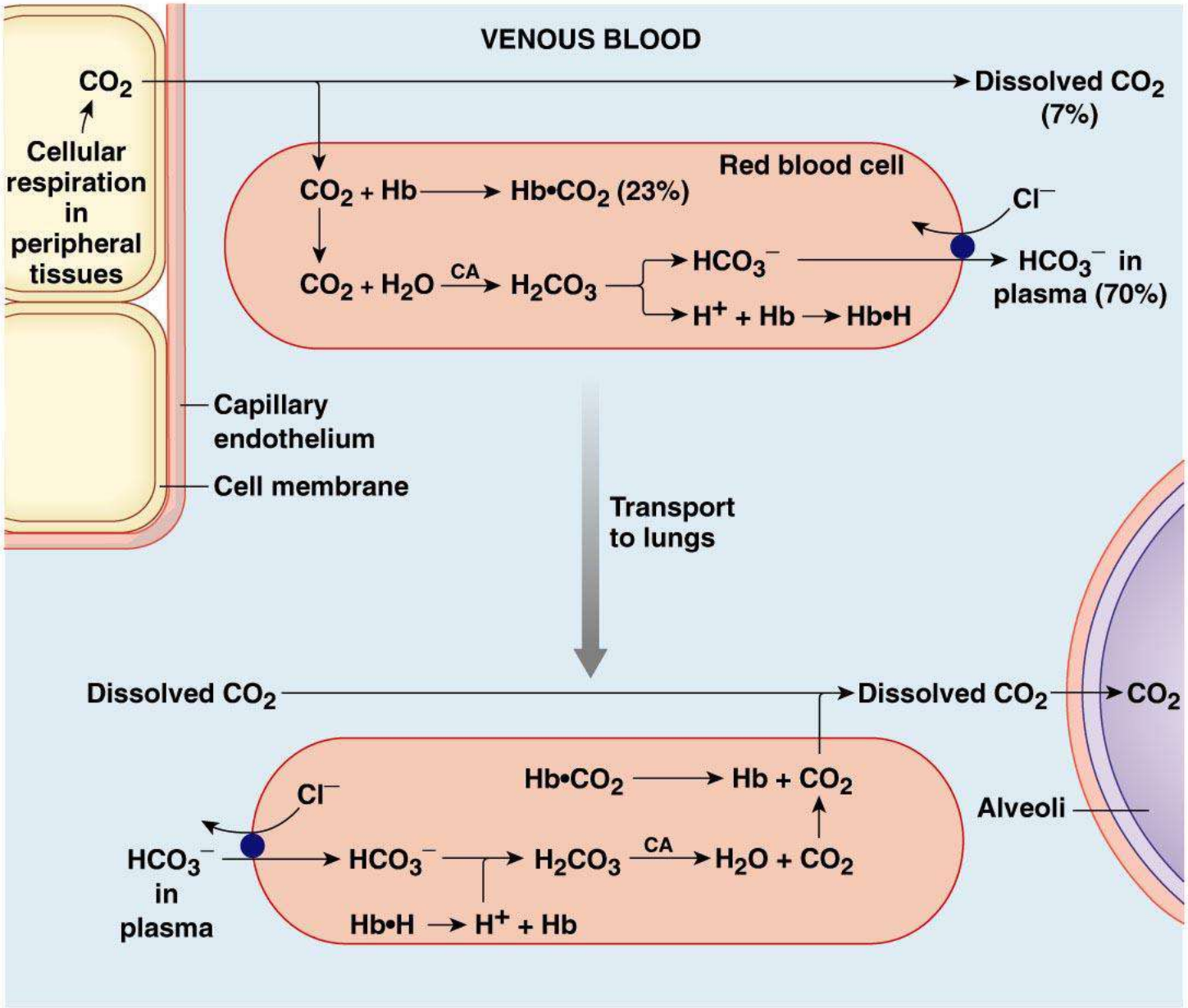


Figure 18.14

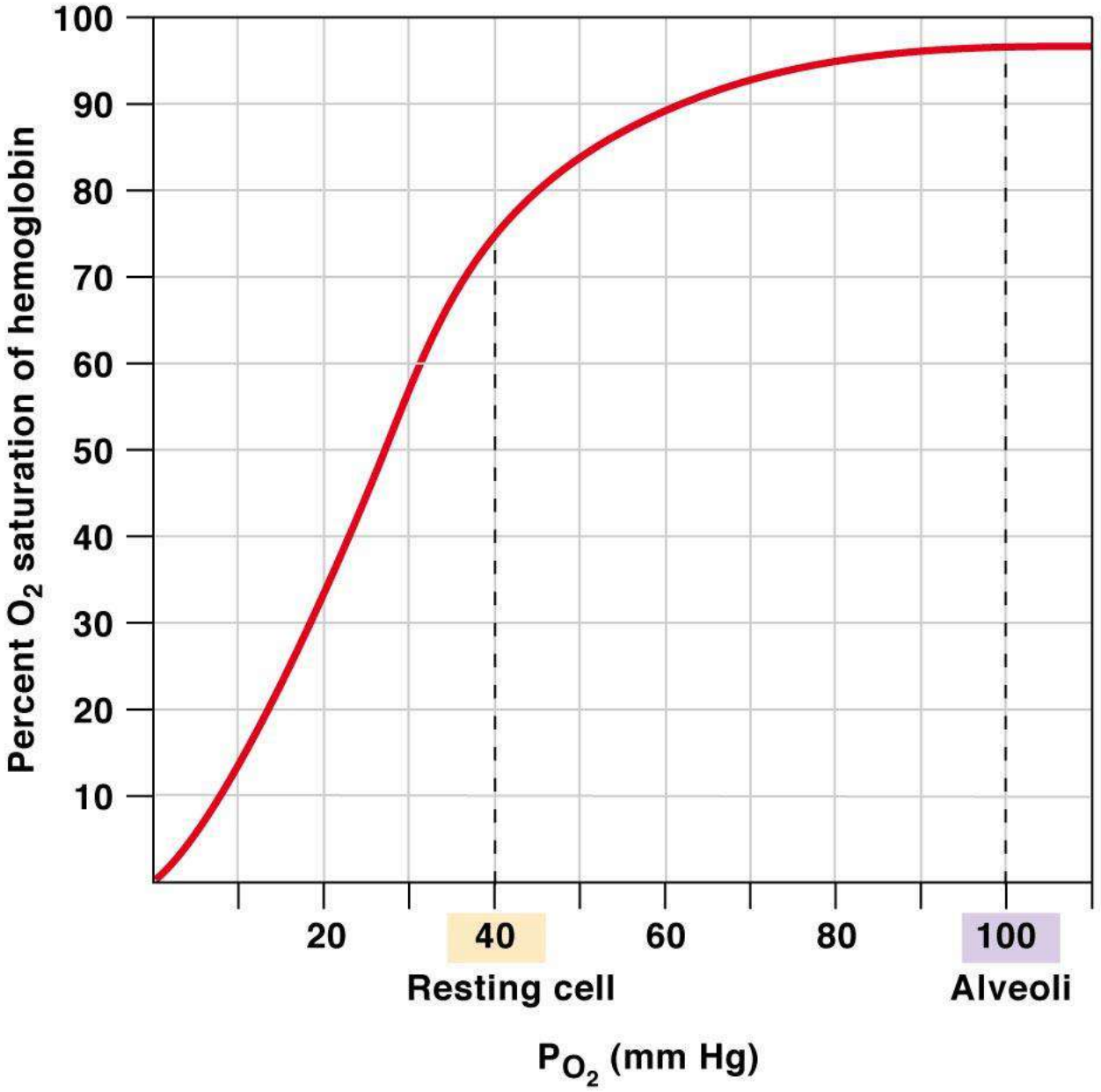


Figure 18.9

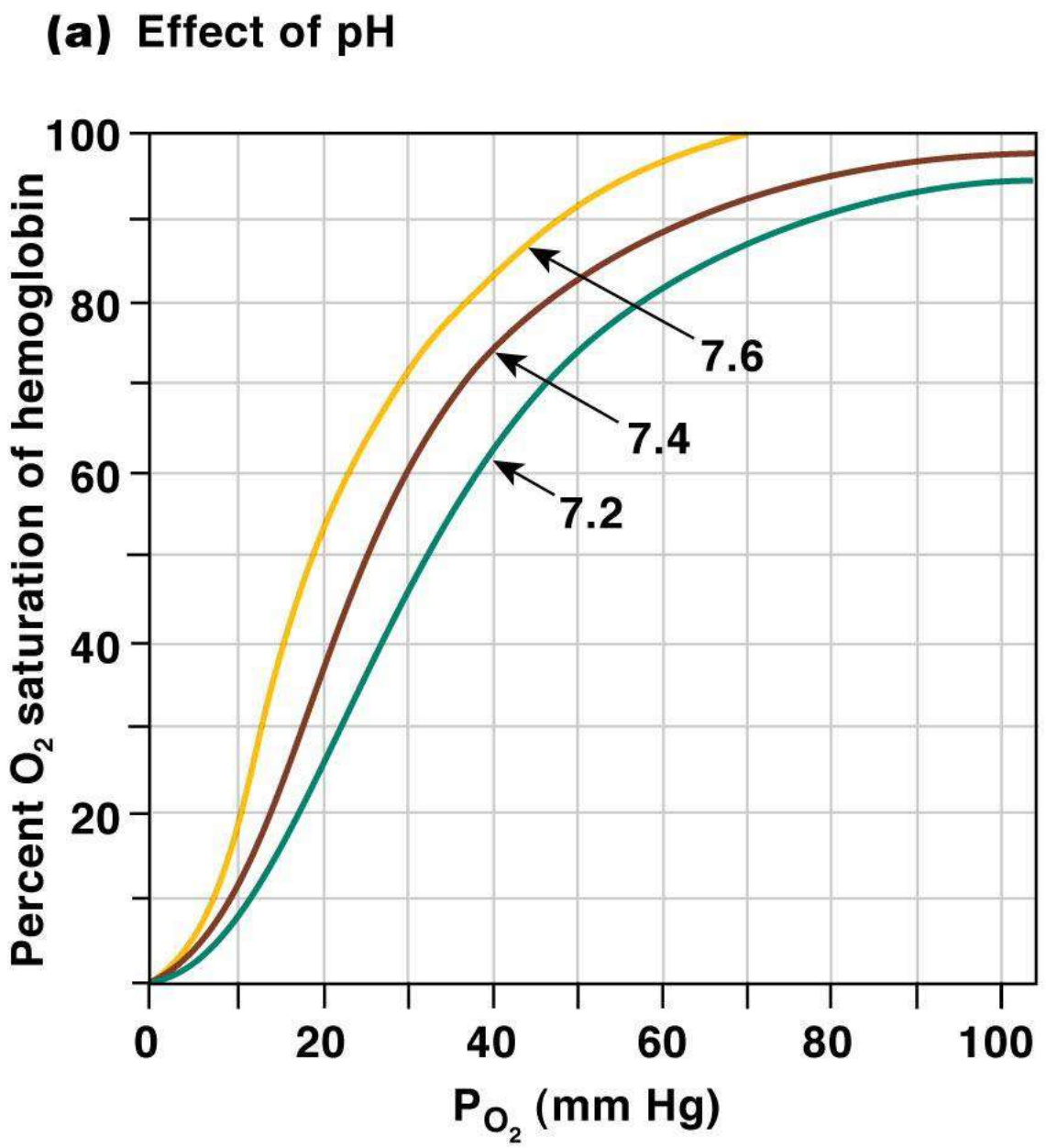


Figure 19-10a

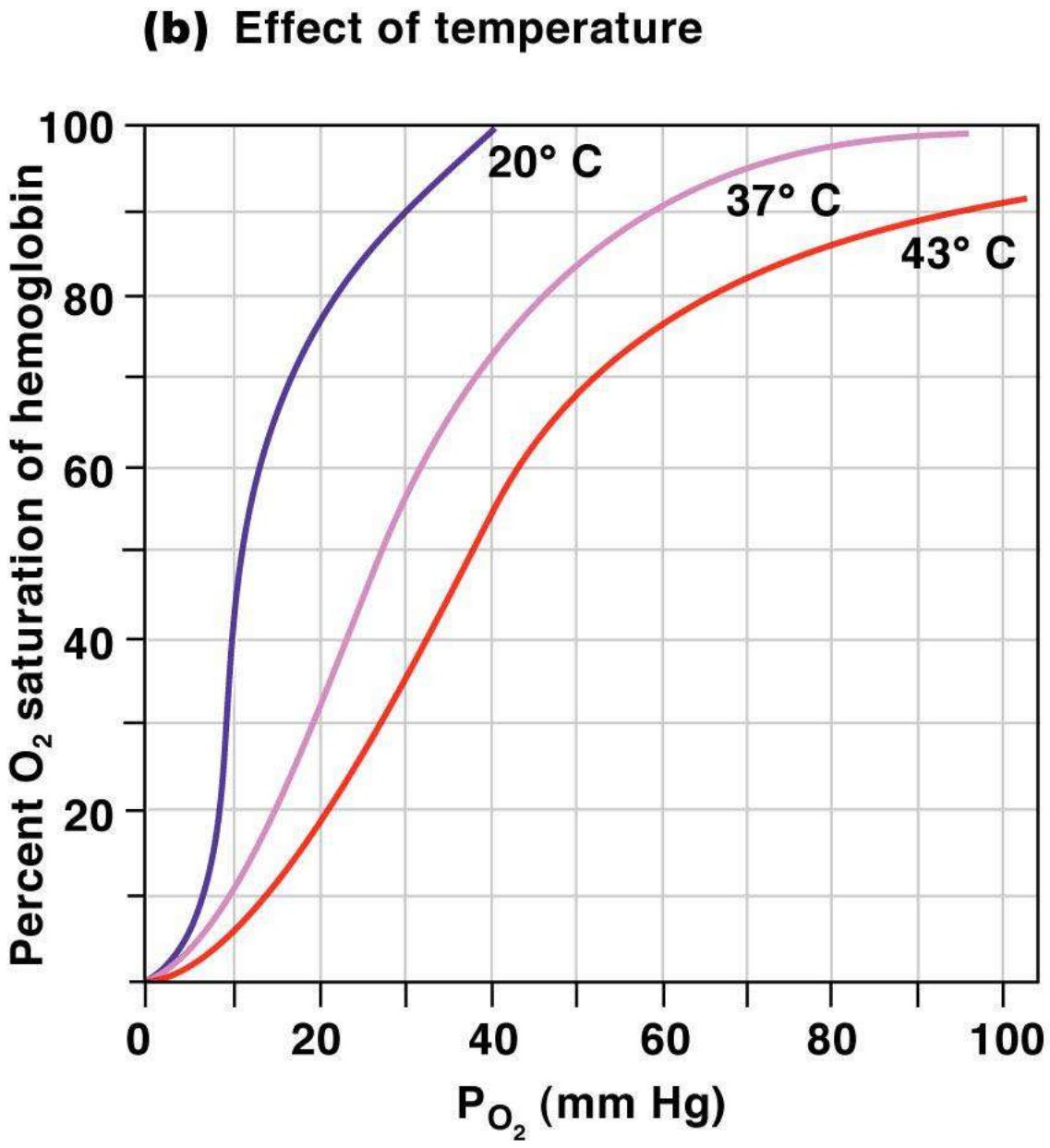


Figure 19-10b

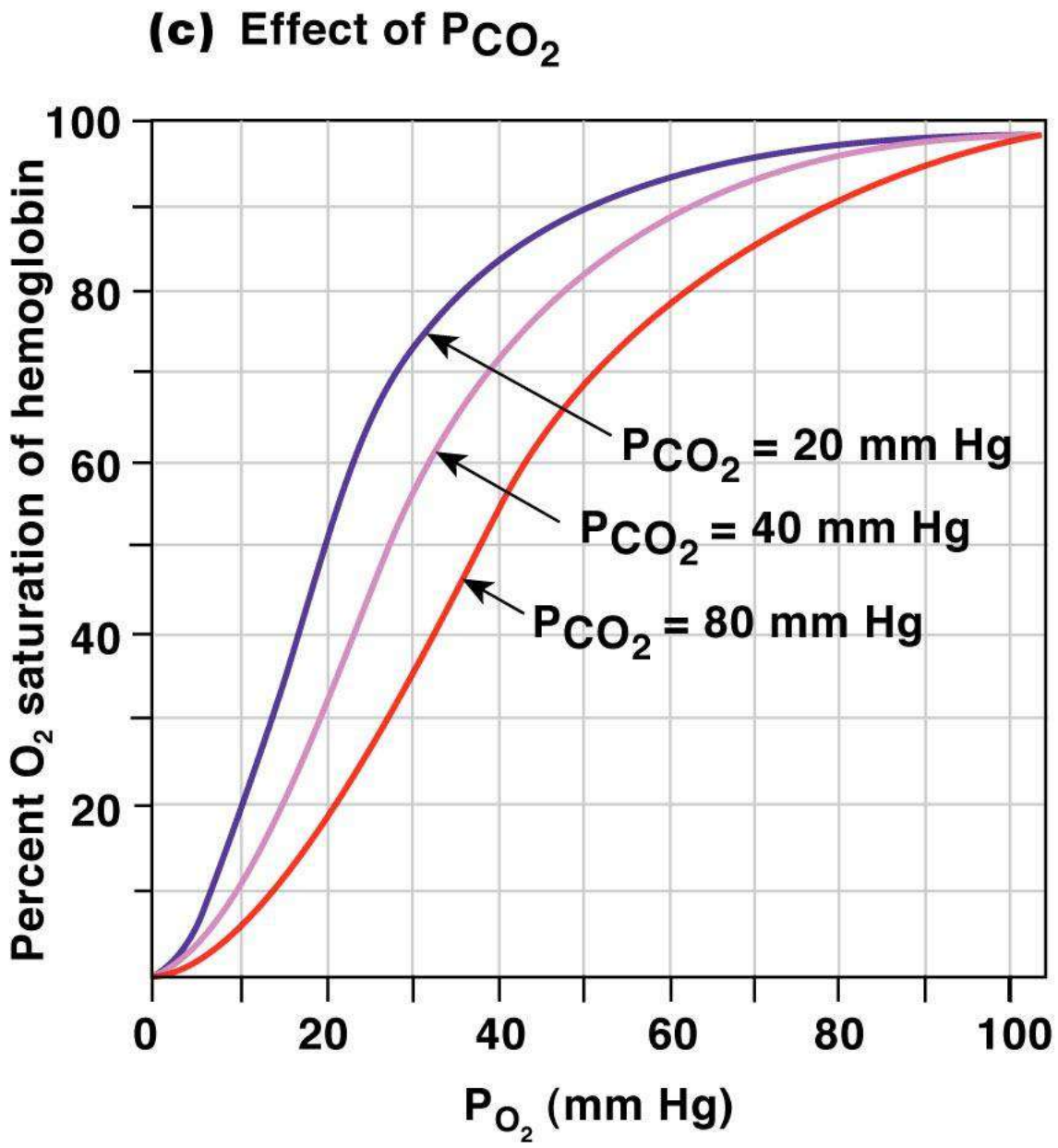


Figure 19-10c

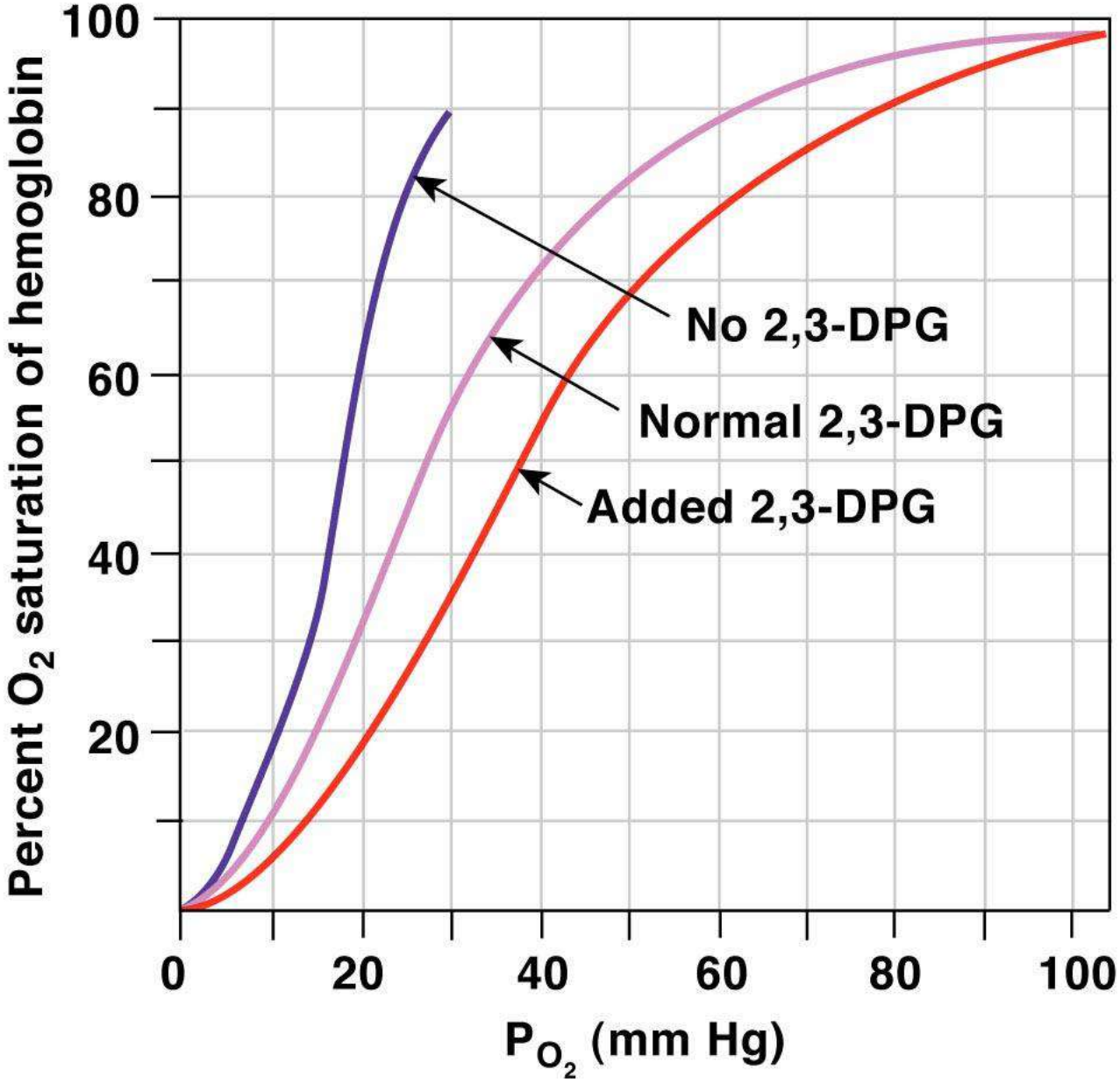


Figure 19-11

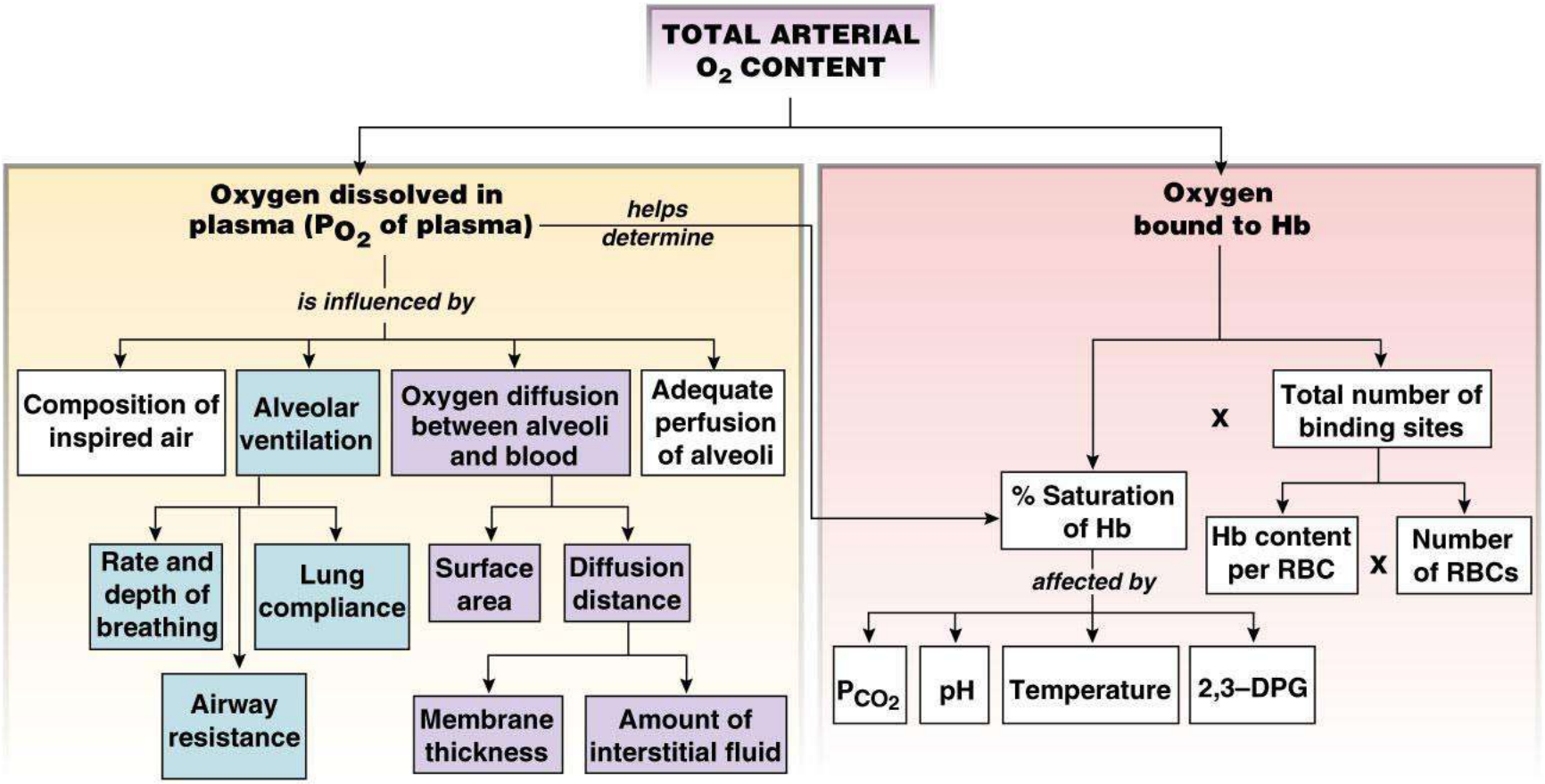


Figure 13.13

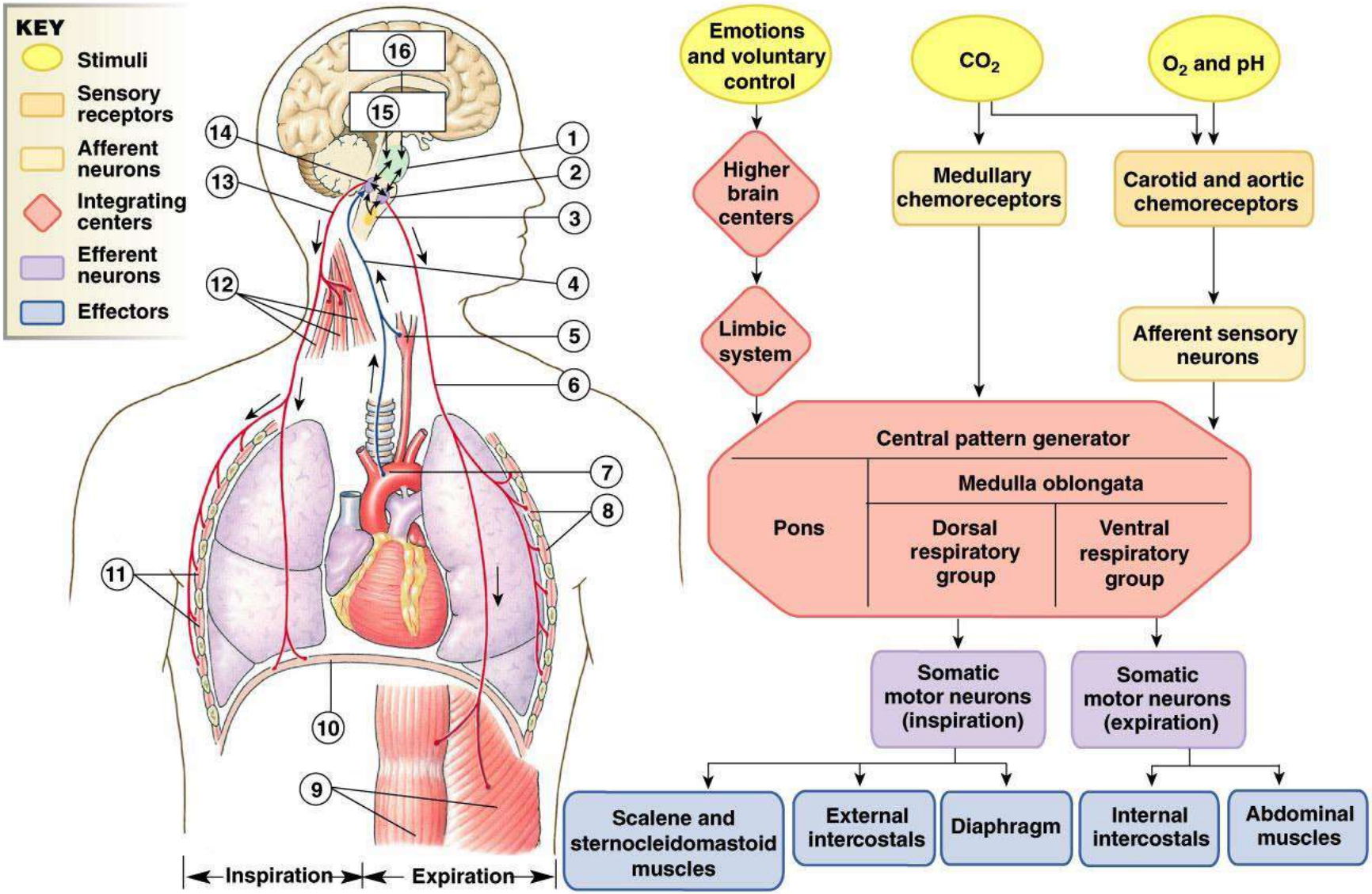


Figure 18.16

Medullary Respiratory Centers

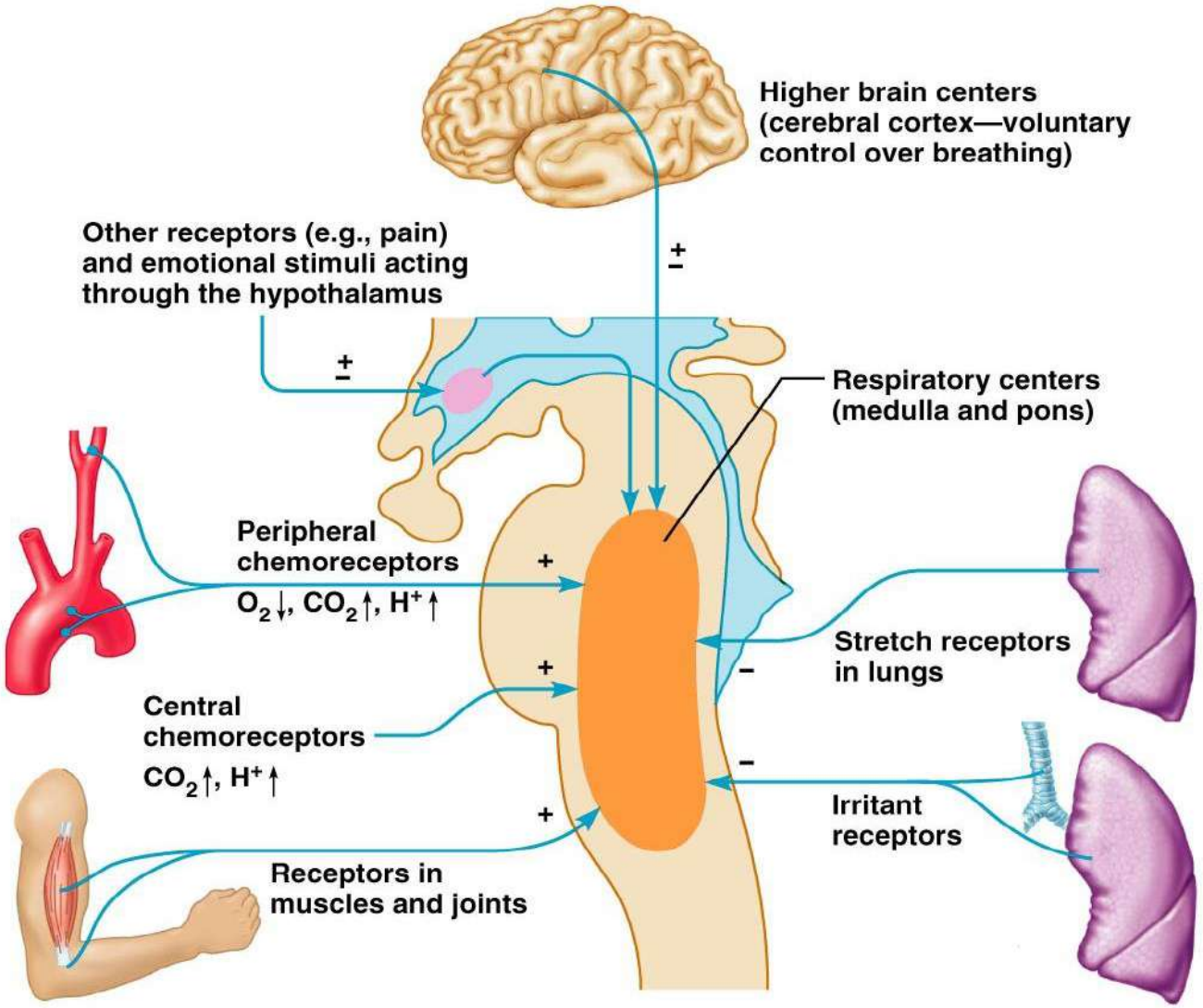


Figure 22.25

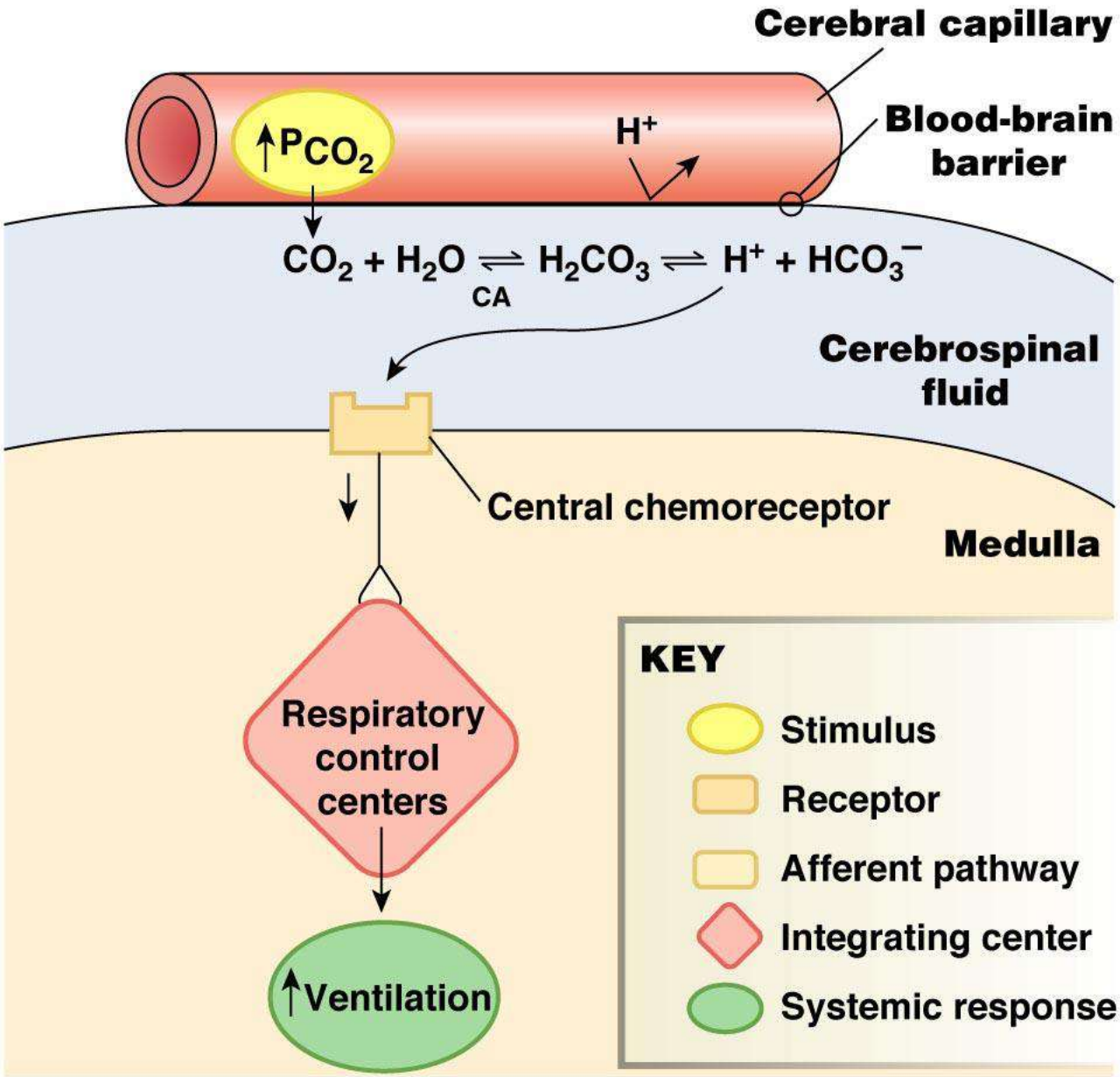


Figure 19.19

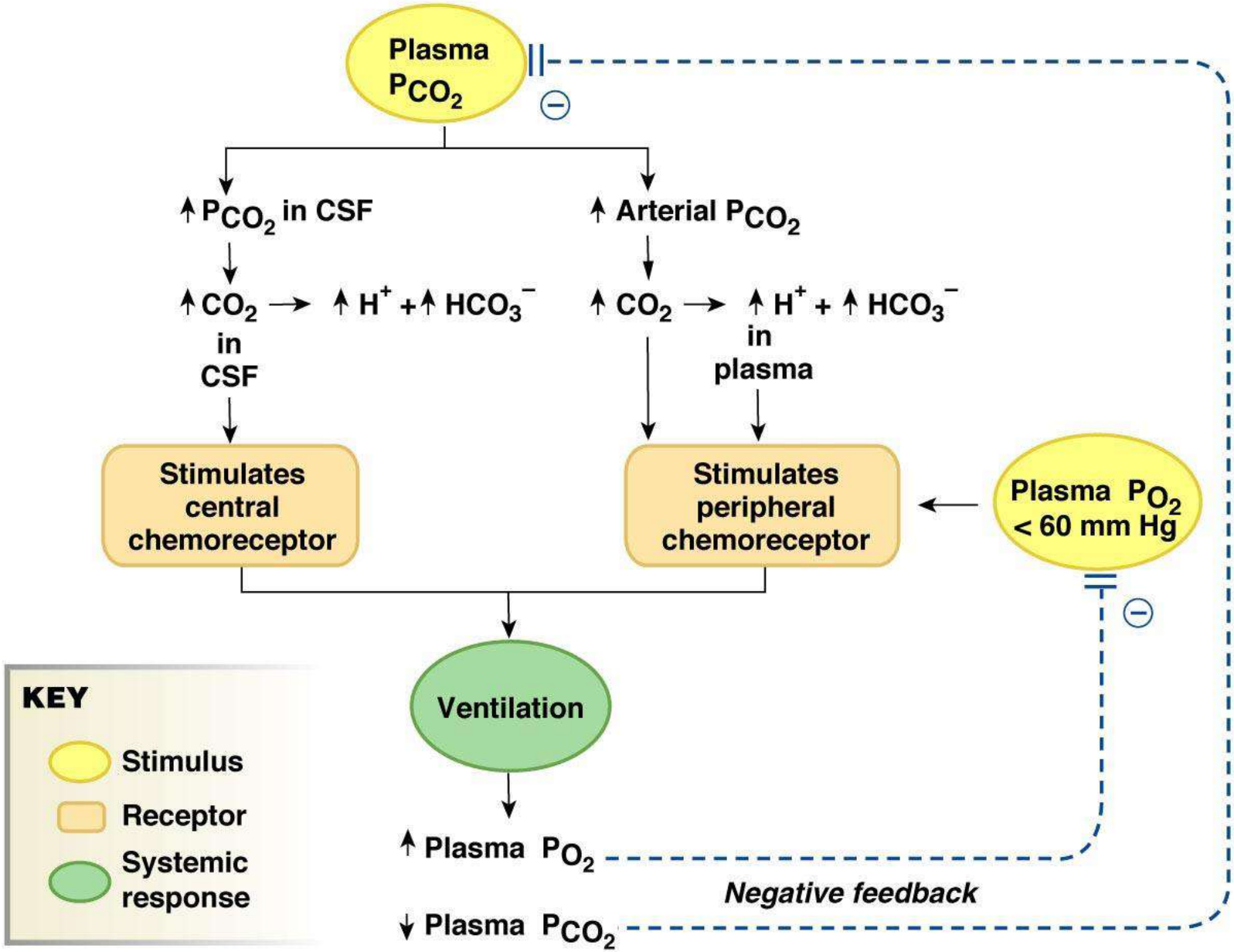


Figure 18.20