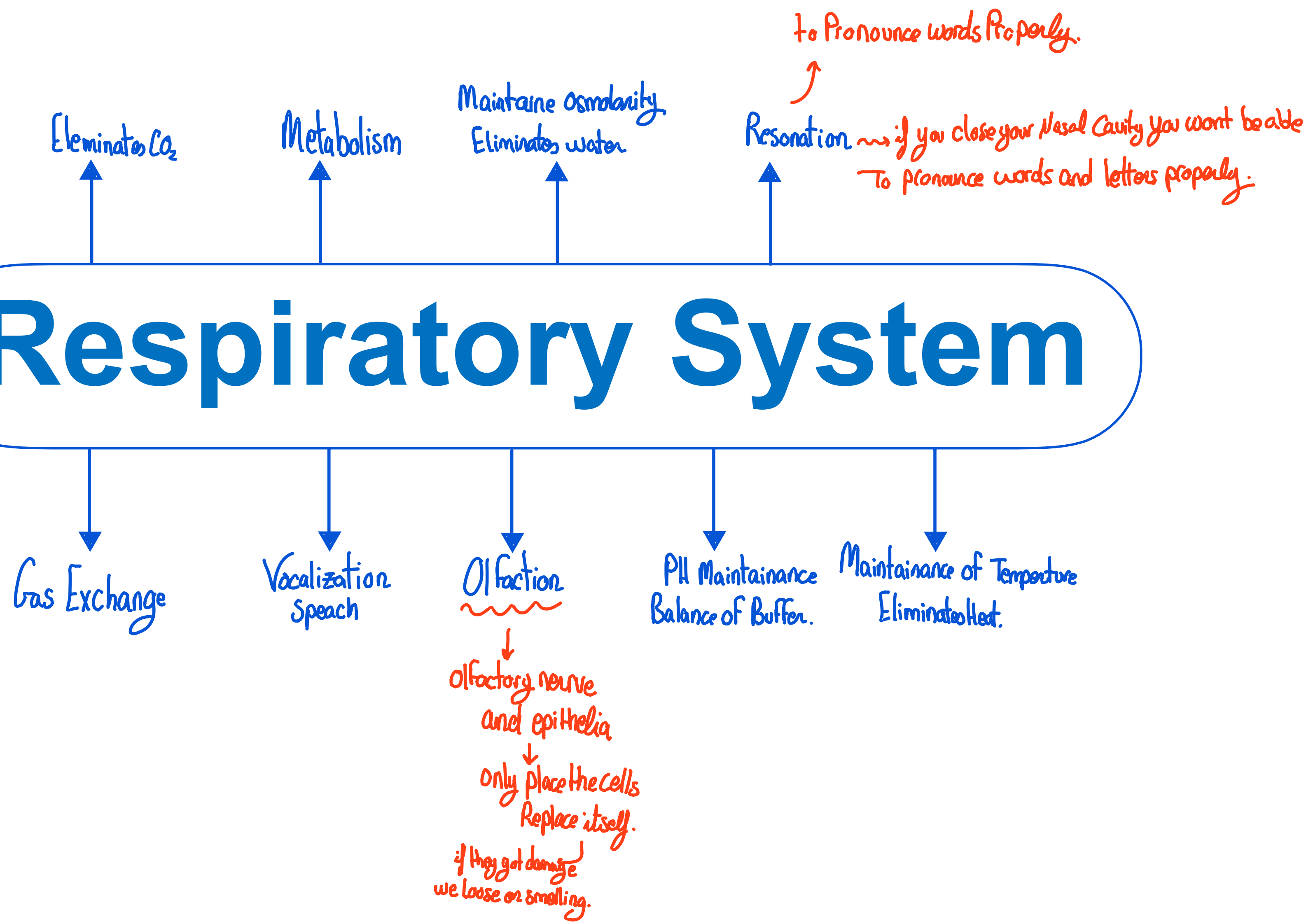
#Anatomy



Respiratory System
Eleminates CO_2
Metabolism
Maintaine Osmolarity
Eliminates water
Resonation
to Pronounce words Properly.
if you close your Nasal Cavity you wont be able To pronounce words and letters properly.
Gas Exchange
Vocalization
Speach
Olfaction
olfactory nerve
and epithelia
only place the cells
Replace itself.
if they got damage
we loose on smelling.
PH Maintainance
Balance of Buffer.
Maintainance of Temperture
Eliminates Heat.

Respiratory System

3 Main Components:

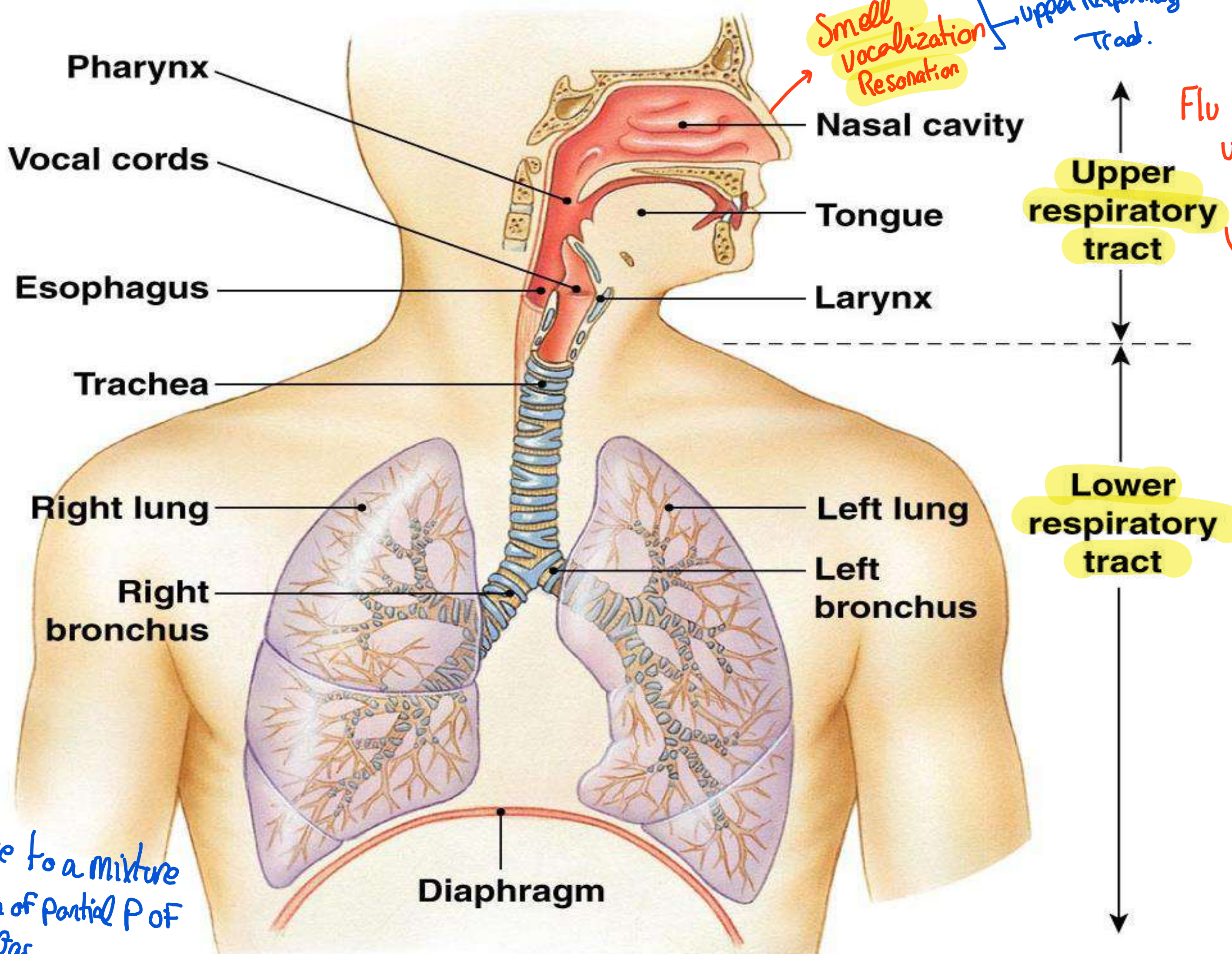
- Consists of the respiratory and conducting zones
- **Respiratory zone:** The Zone where Gas Exchange Happens
  - Site of gas exchange *We only do Gas Exchange in the Alveoli
  - Consists of bronchioles, alveolar ducts, and alveoli
- **Conducting zone:** the Tubes that connects and Brings all Air In 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 Enhale and Exhale. ↓ Allowing Air to Get In and out.
- Diaphragm, Intercostals, Abdominal and other muscles that promote ventilation

Respiratory System

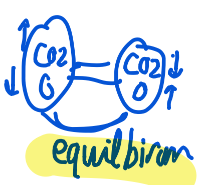
We Have 2 Distinc Area



Smell
vocalization
Resonation
→ upper Respiratory Tract.

Flu Infected the upper Respiratory Tract

From Trachea and upward.



Total Pressure to a Mixture of Gases → Sum of Partial P of each Gas.

igure 22.1

*Nasal Cavity → a) Olfaction
b) Voclization
c) Resonation
d) it has the muscos which Traps dust Particles
e) Humidification → the Air which Enters takes up the water Vapor inside the muscos. → 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 → So Humidity is Important.

→ 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.

. 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 Adheres to Alveoli → No gas exchange. (it was physiologcly Active and Became Dead)

Pulmonary Edema → Accumilation 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) → Requirs muscles (At Quite Breating Diaphragm and InterCostals → 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 untile it comes into the tissues)

Cellular

– **Internal respiration** – gas exchange between systemic blood vessels and tissues (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
  - (Prevent the epithelial cells from getting dry) Moistening and warming the entering air → Because the Temp Between Body and Incoming Air → thats 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 (Mostirizing) Because Air can Absorb moist → Becomes Dry → Cells will die.

Nasal Cavity

Important Because Air pass trough it → So it can be filtrated mostirized + warmed up

- **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 epiglottis Close → Cough → to Remove particles

Nasal Cavity

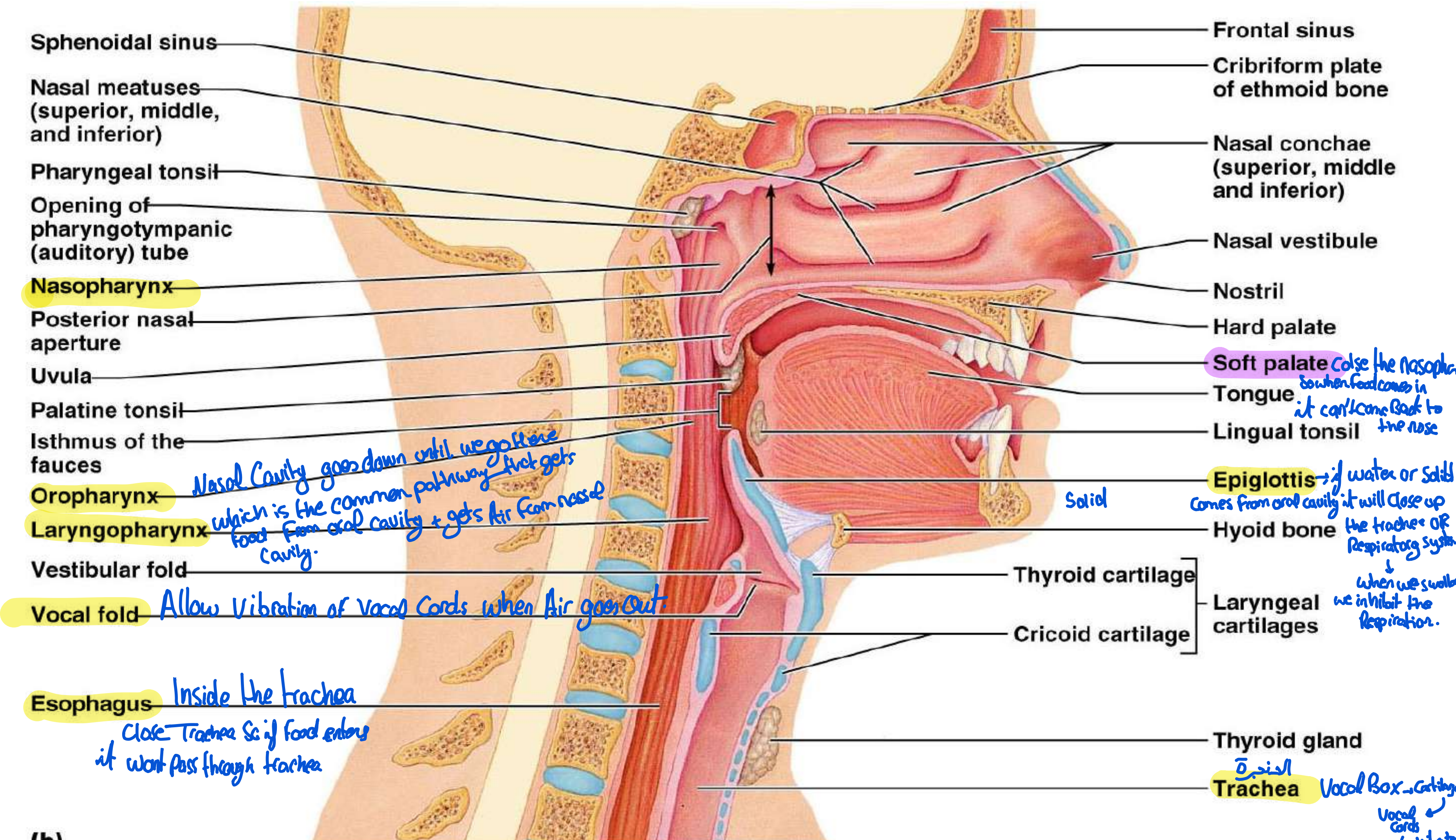
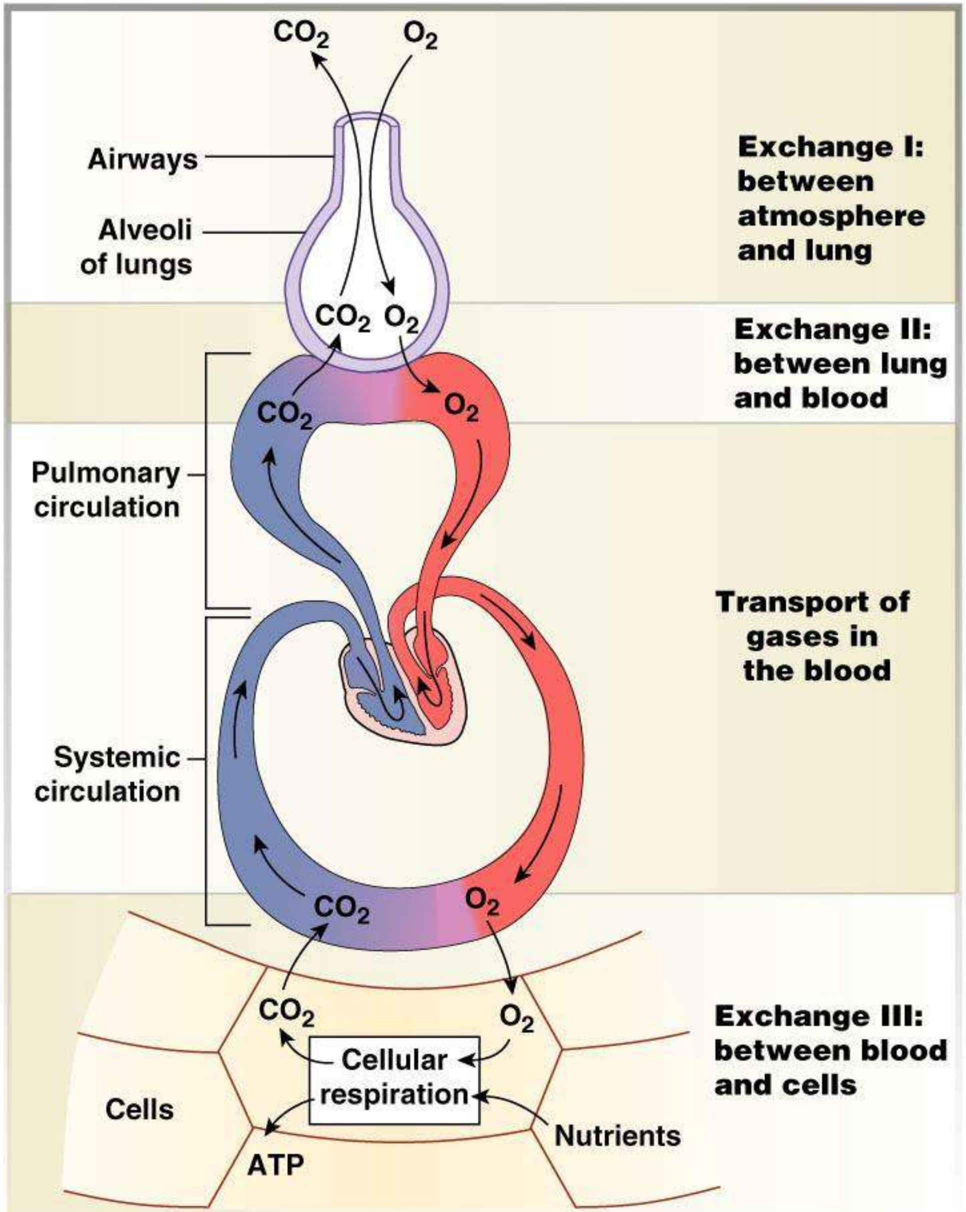


Figure 22.3b

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



CO_2
O_2
Airways
Alveoli of lungs
CO_2 O_2
Exchange I: between atmosphere and lung
Exchange II: between lung and blood
CO_2
O_2
Pulmonary circulation
Transport of gases in the blood
Systemic circulation
CO_2
O_2
CO_2
O_2
Cellular respiration
Cells
ATP
Nutrients
Exchange III: between blood and cells

Figure 17-1

Common pathway

* After Nasal Cavity → Pharynx

→ Nasopharnx

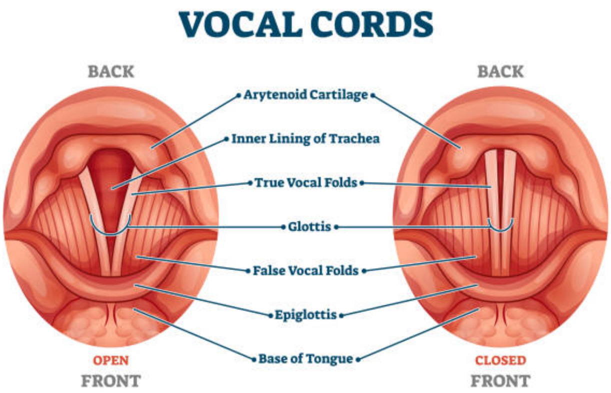
→ Oropharynx (Common)

→ Laryngopharynx

by the epiglotes.

* larynx → Cartilages + skeltal musle → Production of voice (when it goes up and close) → So food goes Around it then to esophages

* False Vocal Cords → Attached to the muscles



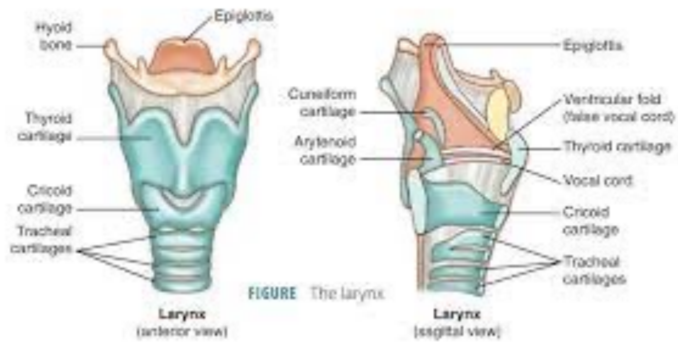


FIGURE The larynx

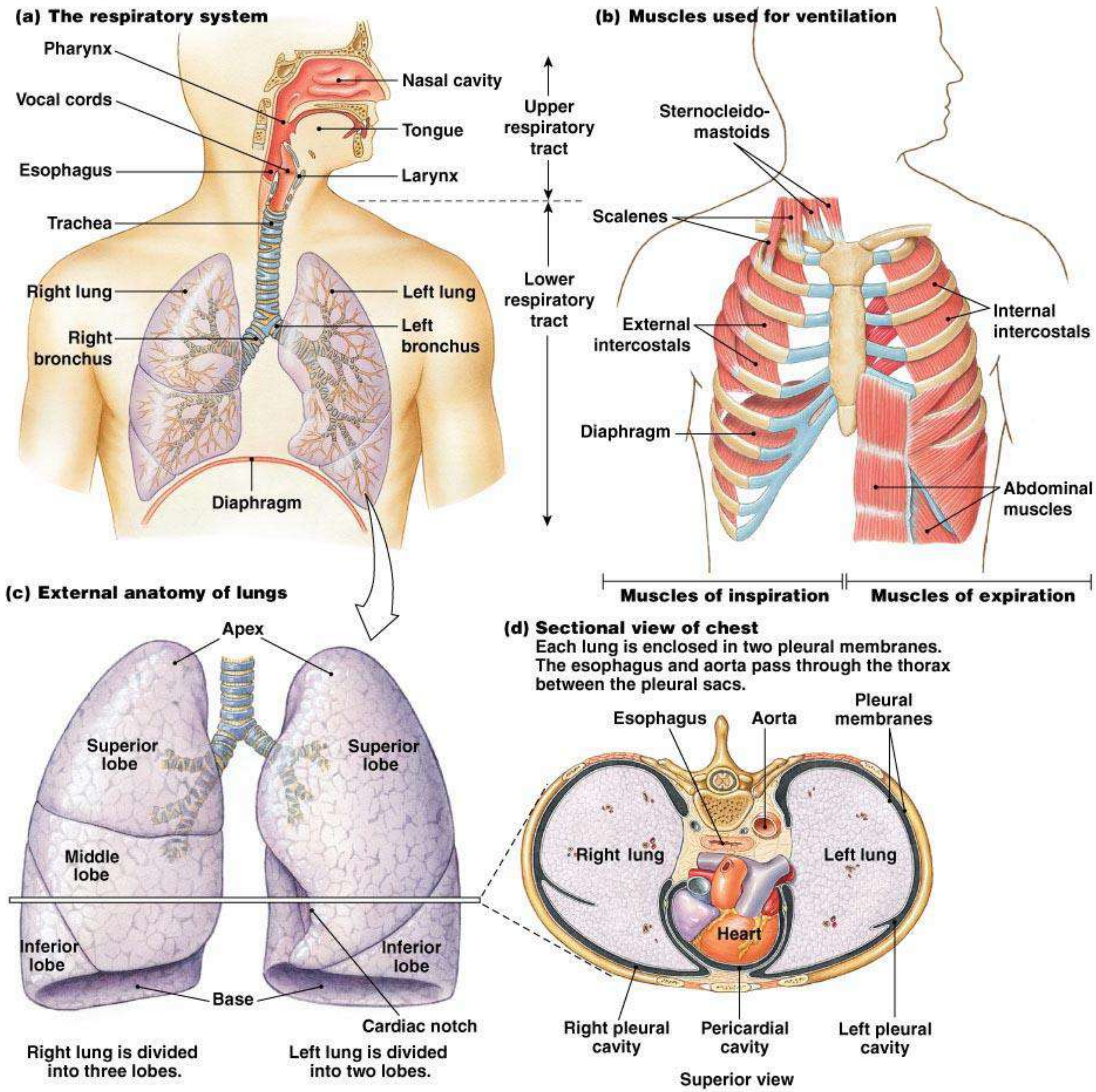


Figure 17-2 – Overview (1 of 2)

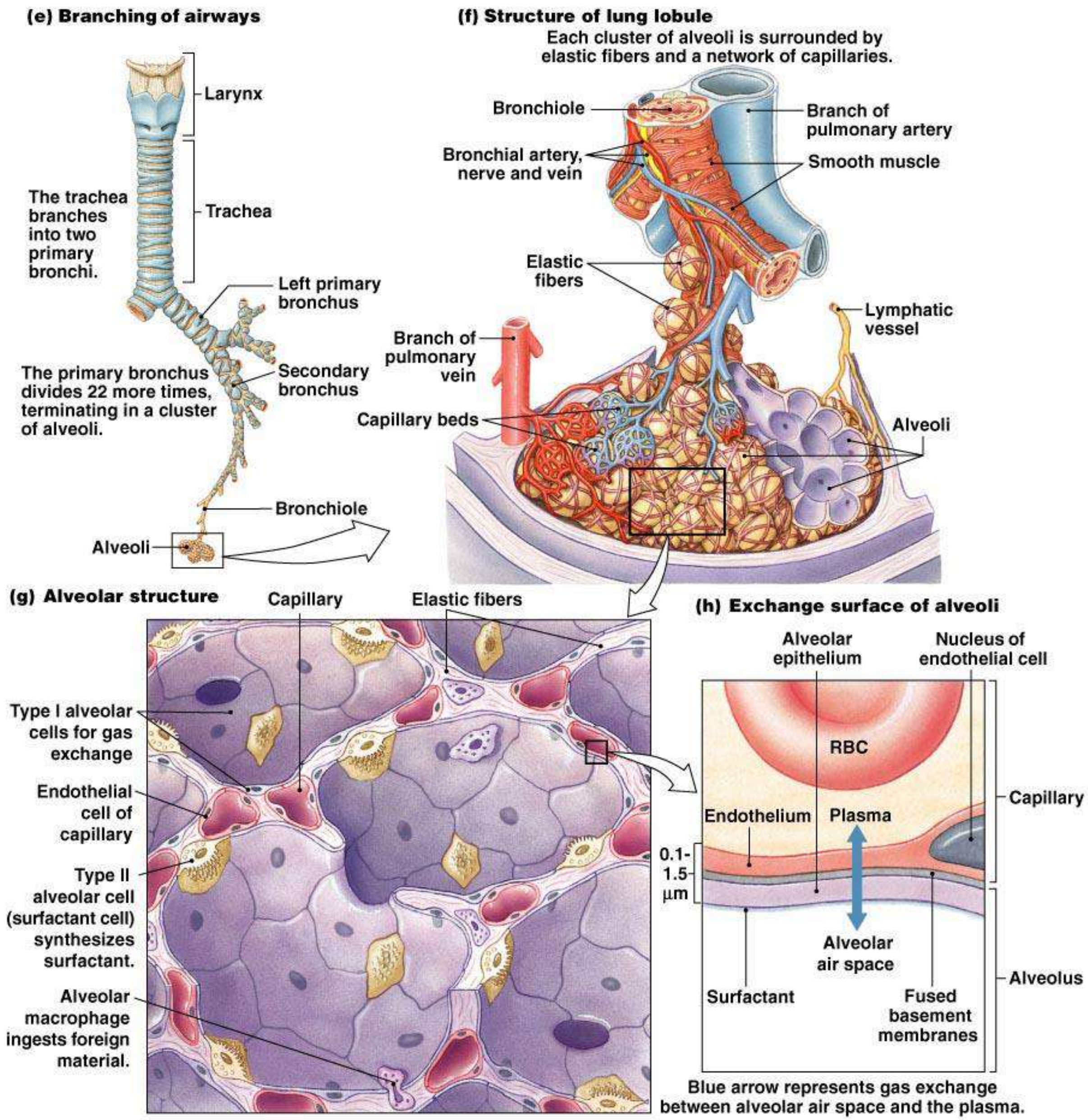


Figure 17-2 – Overview (2 of 2)

(a) The respiratory system

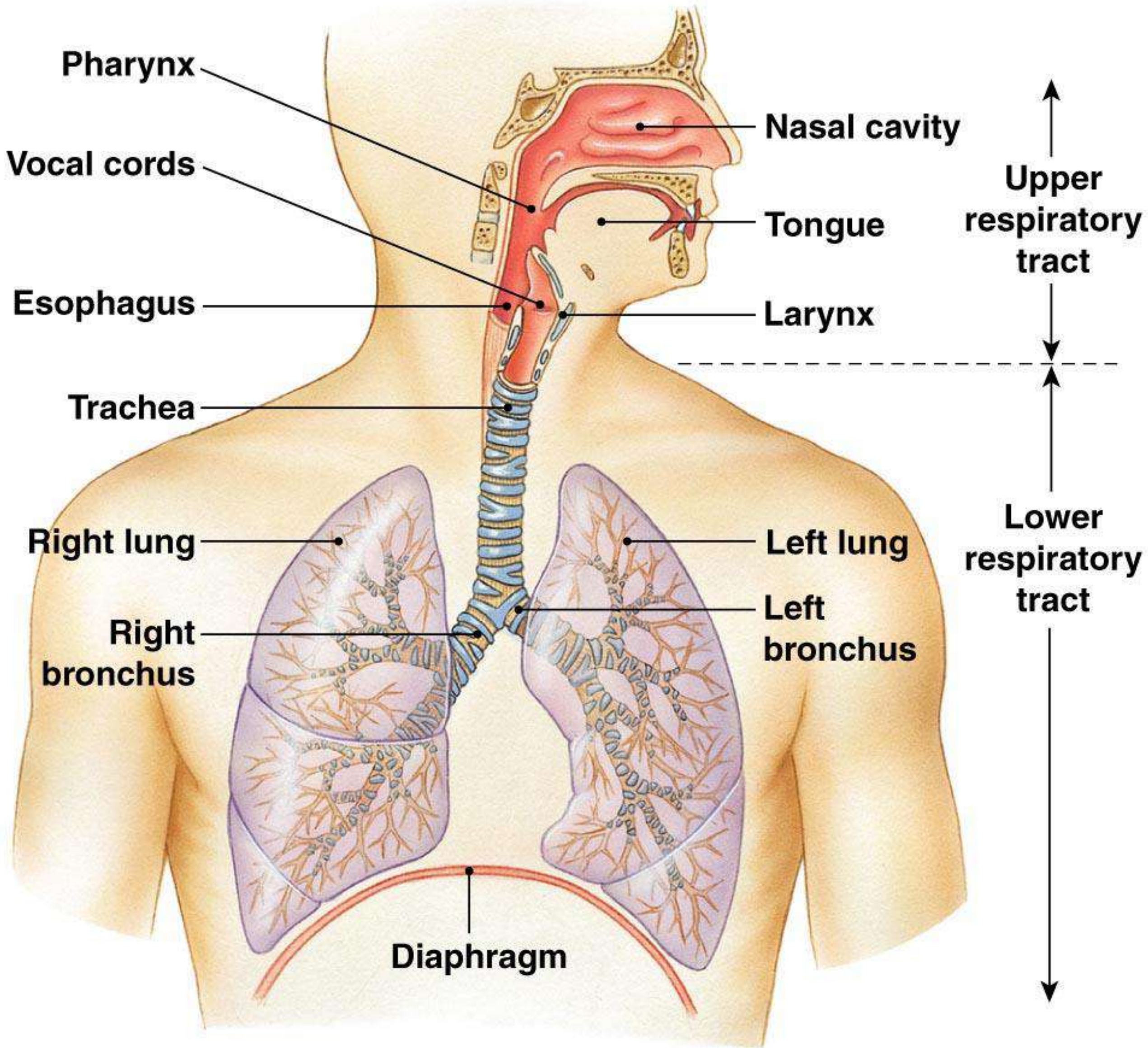


Figure 17-2a

(b) Muscles used for ventilation

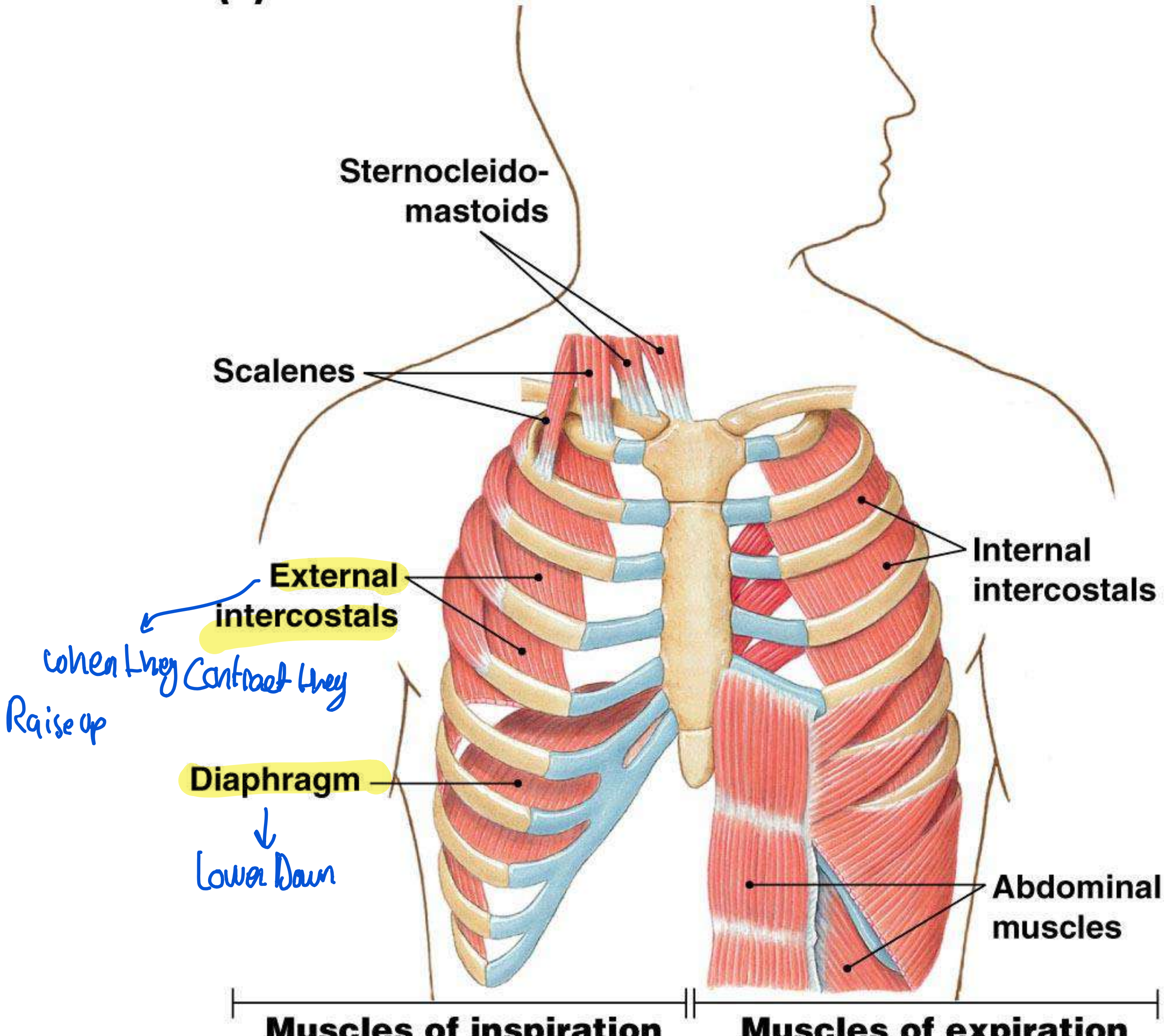


Figure 17-2b

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

* 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 Sternocliedomastoids → Used for Active Inspiration too

* Normaly For Expiration → Passive Process "we Don't use Muscles"
↳ However In Active Respiration → Coughing → Internal intercostals Are Used.

↓

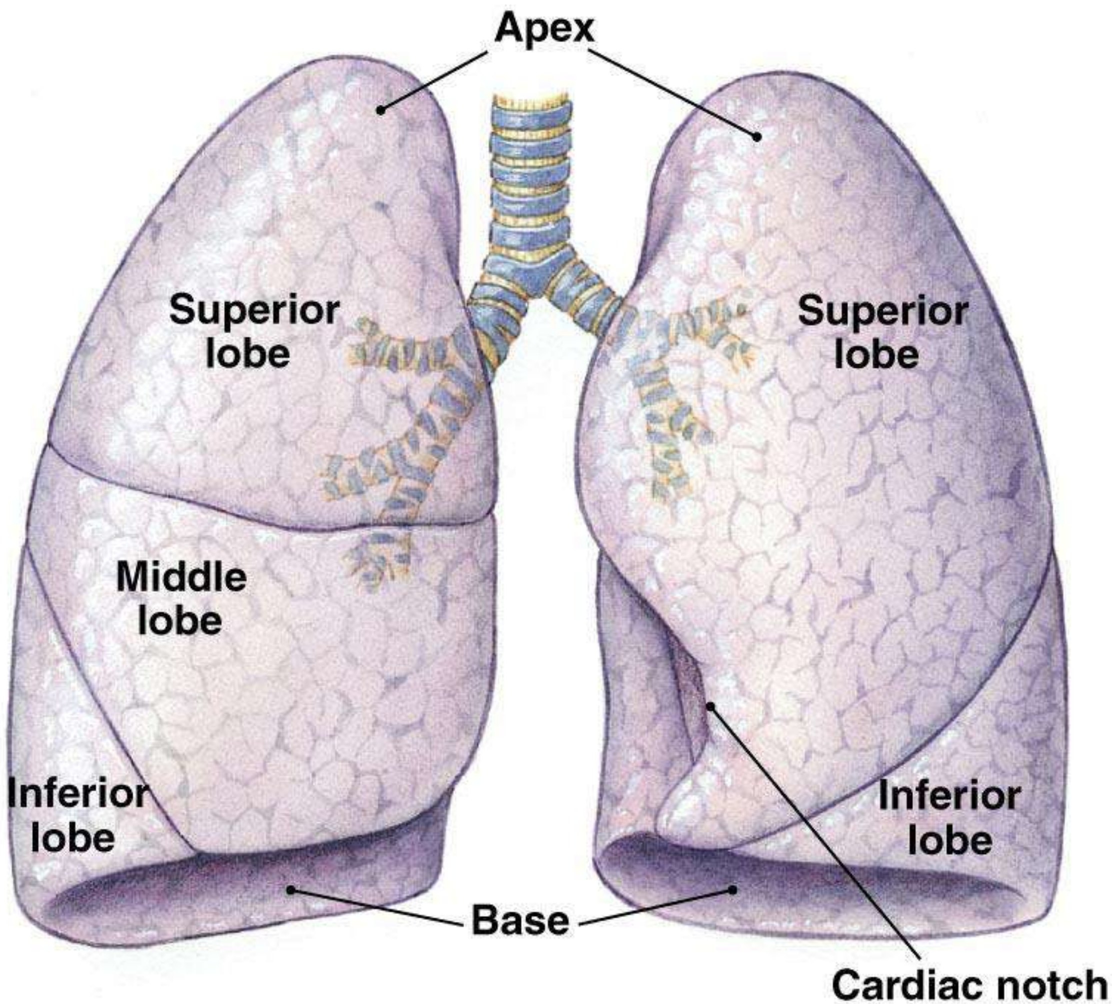
they Contract So they Bring thoracic Cavity lower → ↓ Volume → ↑ Pressure → Air Goes out.

Abdominal Cavity Muscles

↓

the Contraction of them Cause Expiration.

(c) External anatomy of lungs



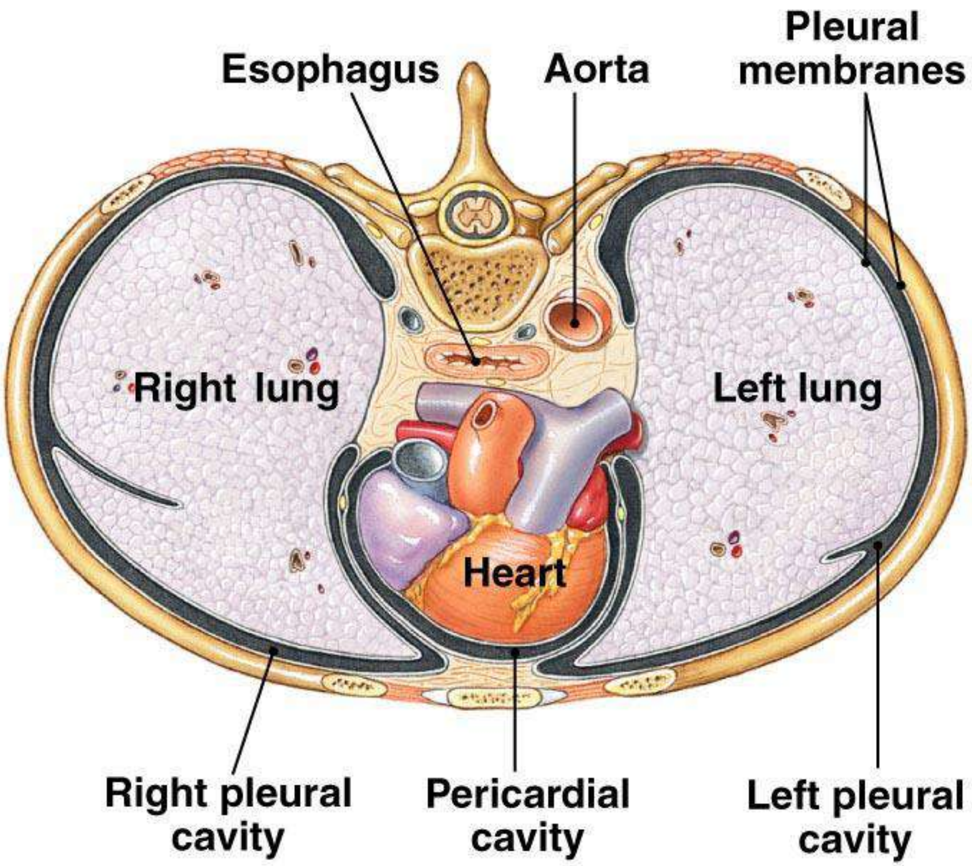
Right lung is divided into three lobes.

Left lung is divided into two lobes.

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

Gobalt Cells.

(e) Branching of airways

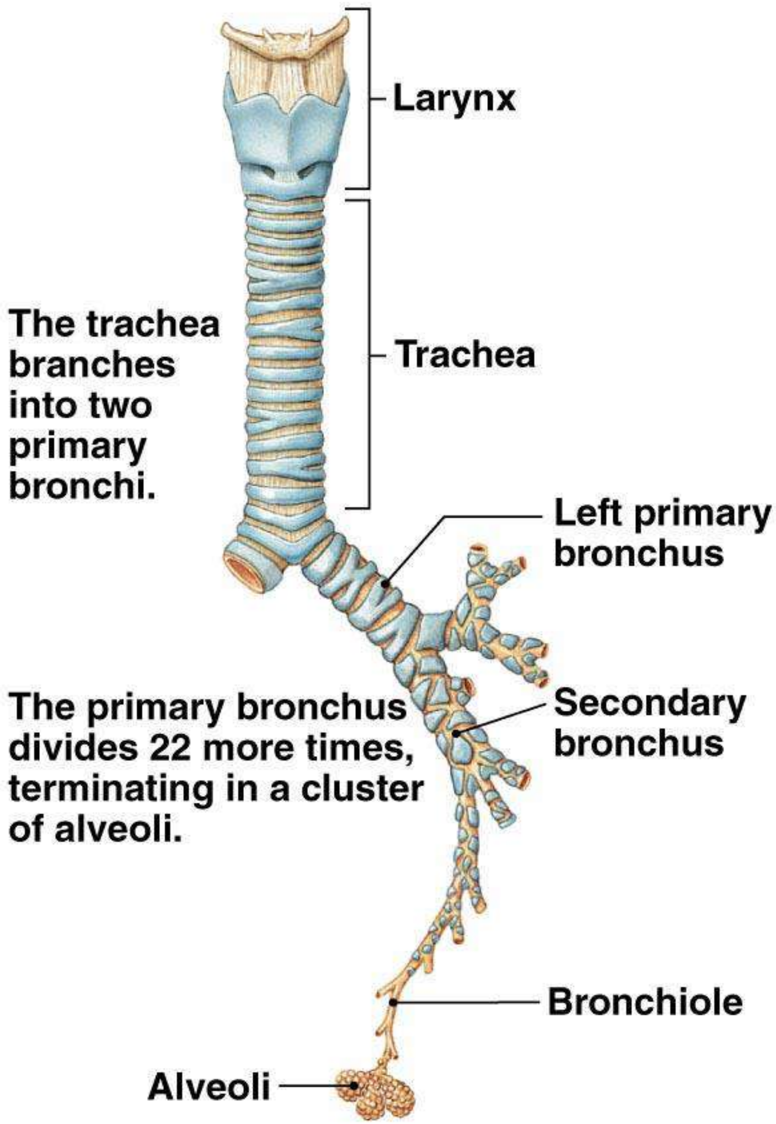


Figure 17-2e

Trachea

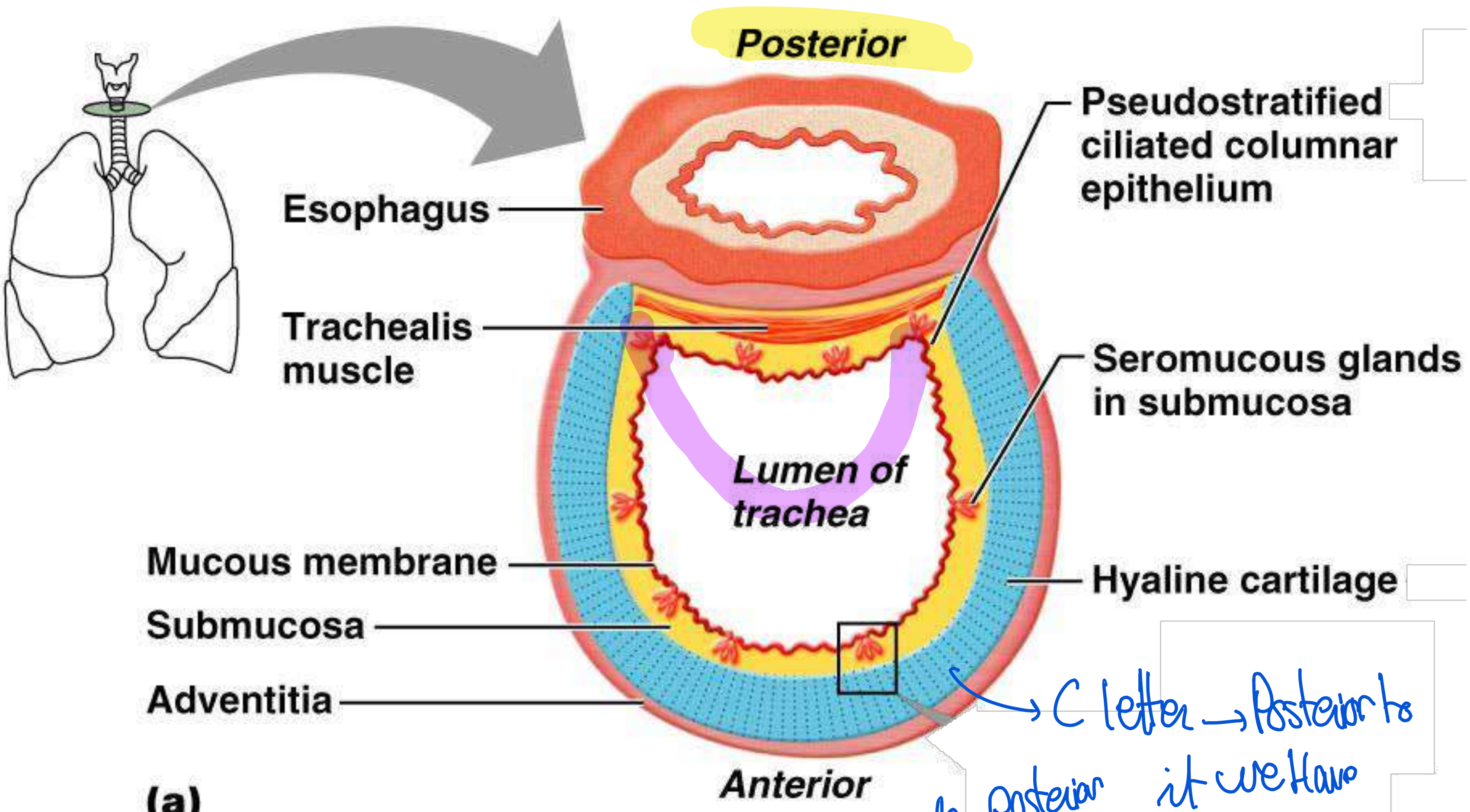


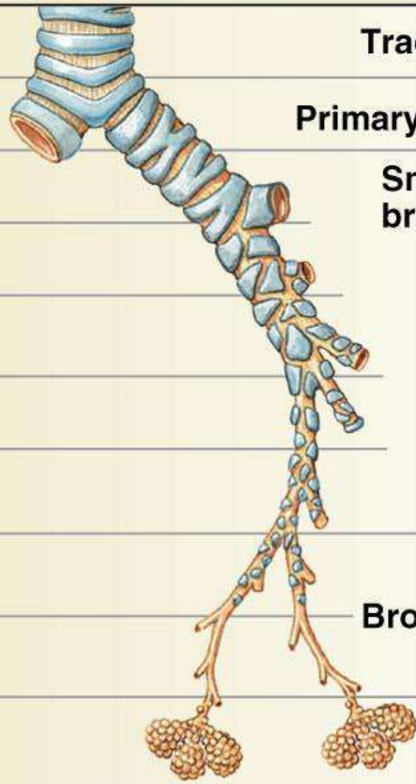
Figure 22.6a

C letter → Posterior to vertebrate, posterior to colom ← it, if we Have esophagus

end of trachea → smooth muscle → will allow the expand of trachea + allow esophagus to expand the Nasal Cavity, Larynx, Bronchlies + Bronchiols → Allow Air to get in But they do not Do gas Exchange — Antomical 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 → Diphosphoglycan.

Figure 17-4

Conducting Zones

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

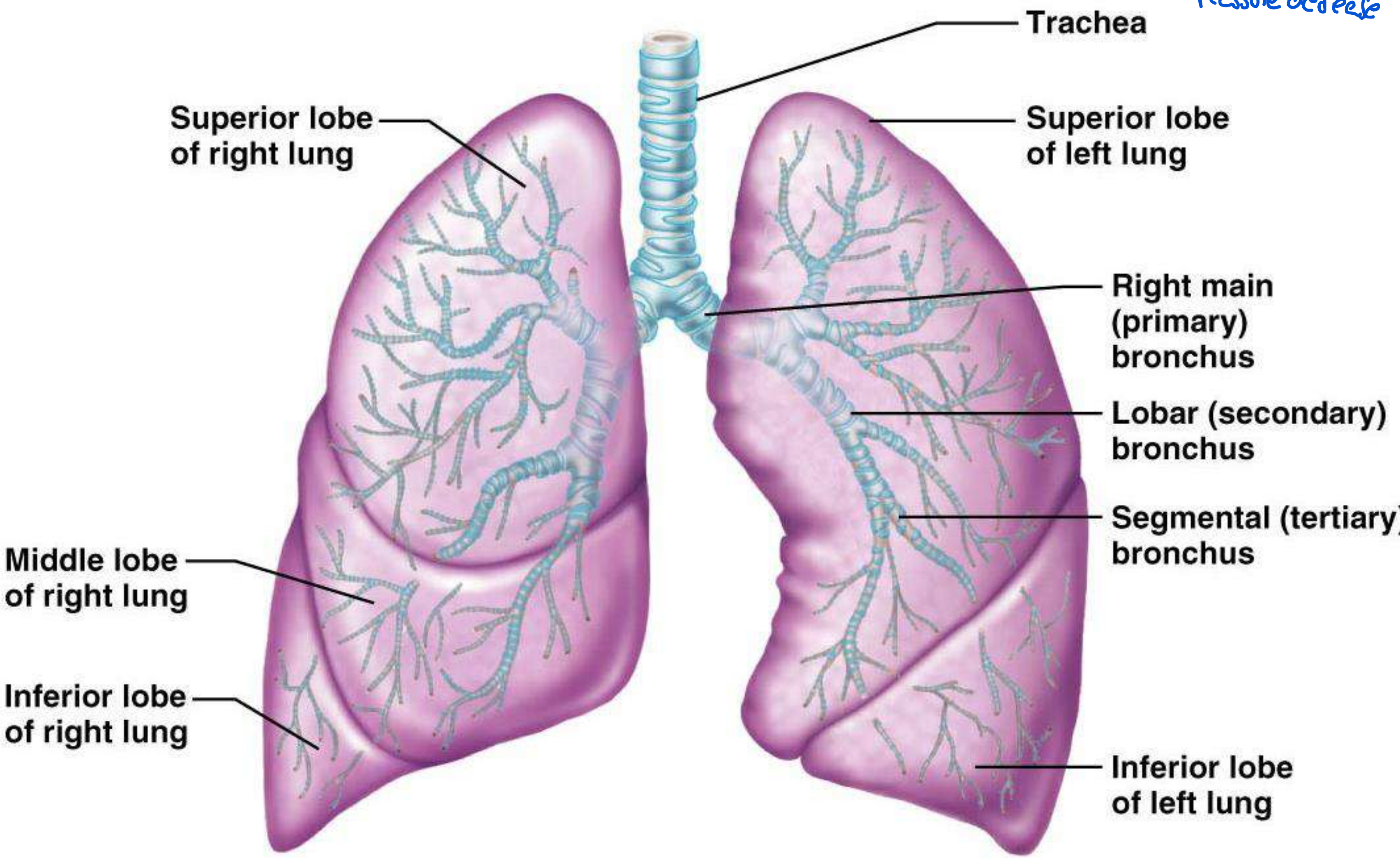


Figure 22.7

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

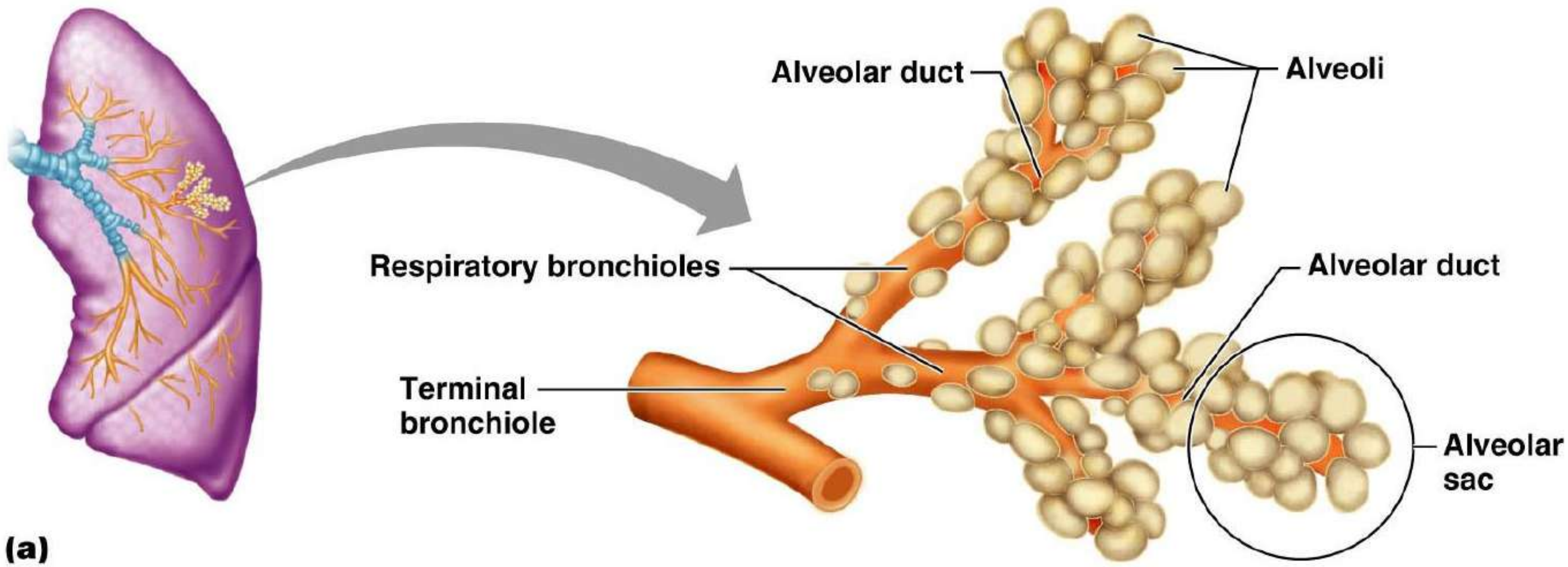


Figure 22.8a

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

(f) Structure of lung lobule

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

Aluiden Are Connected to each other So if Air Gets in it will fill All of the Alvedis.

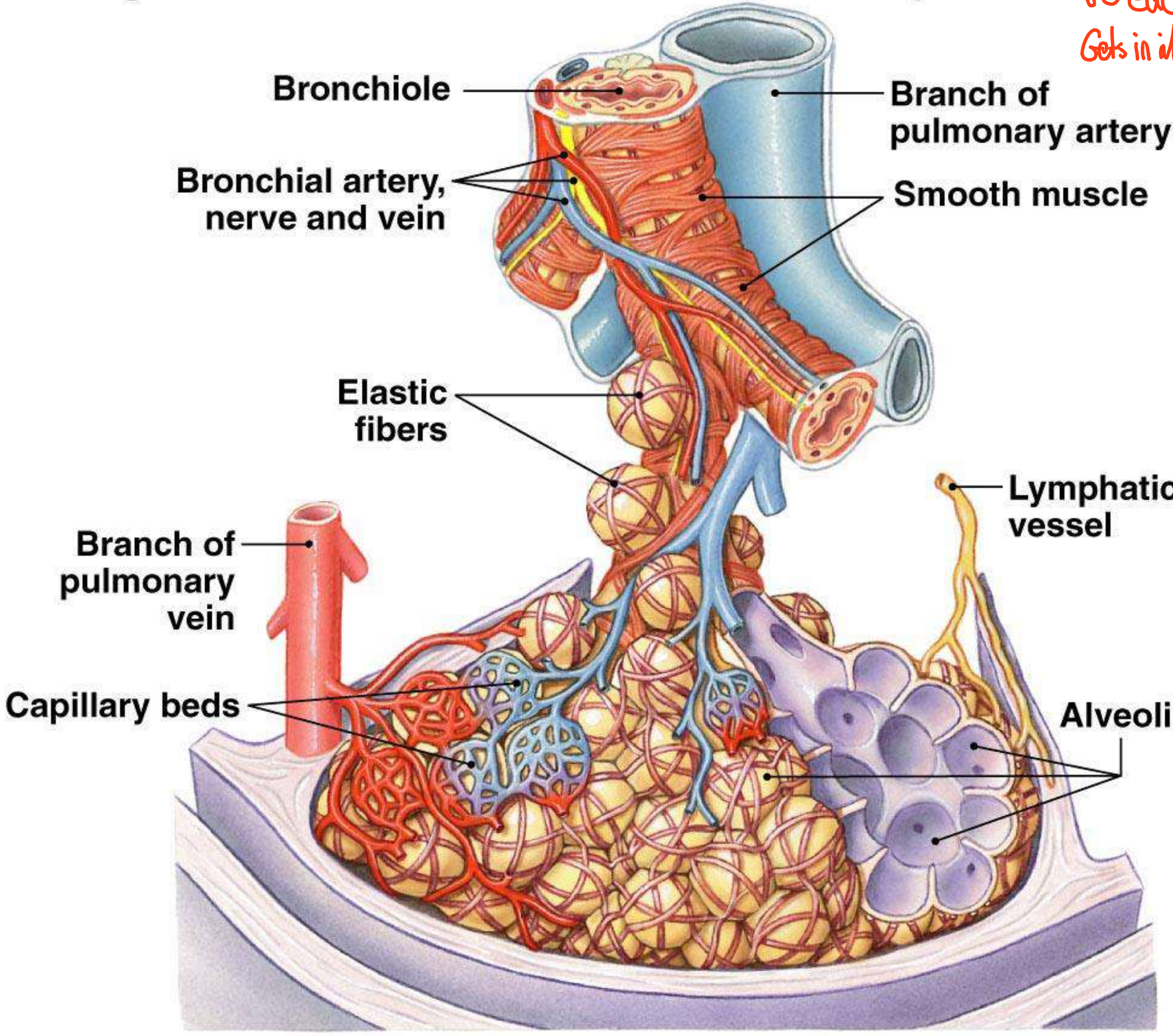


Figure 17-2f

(g) Alveolar structure

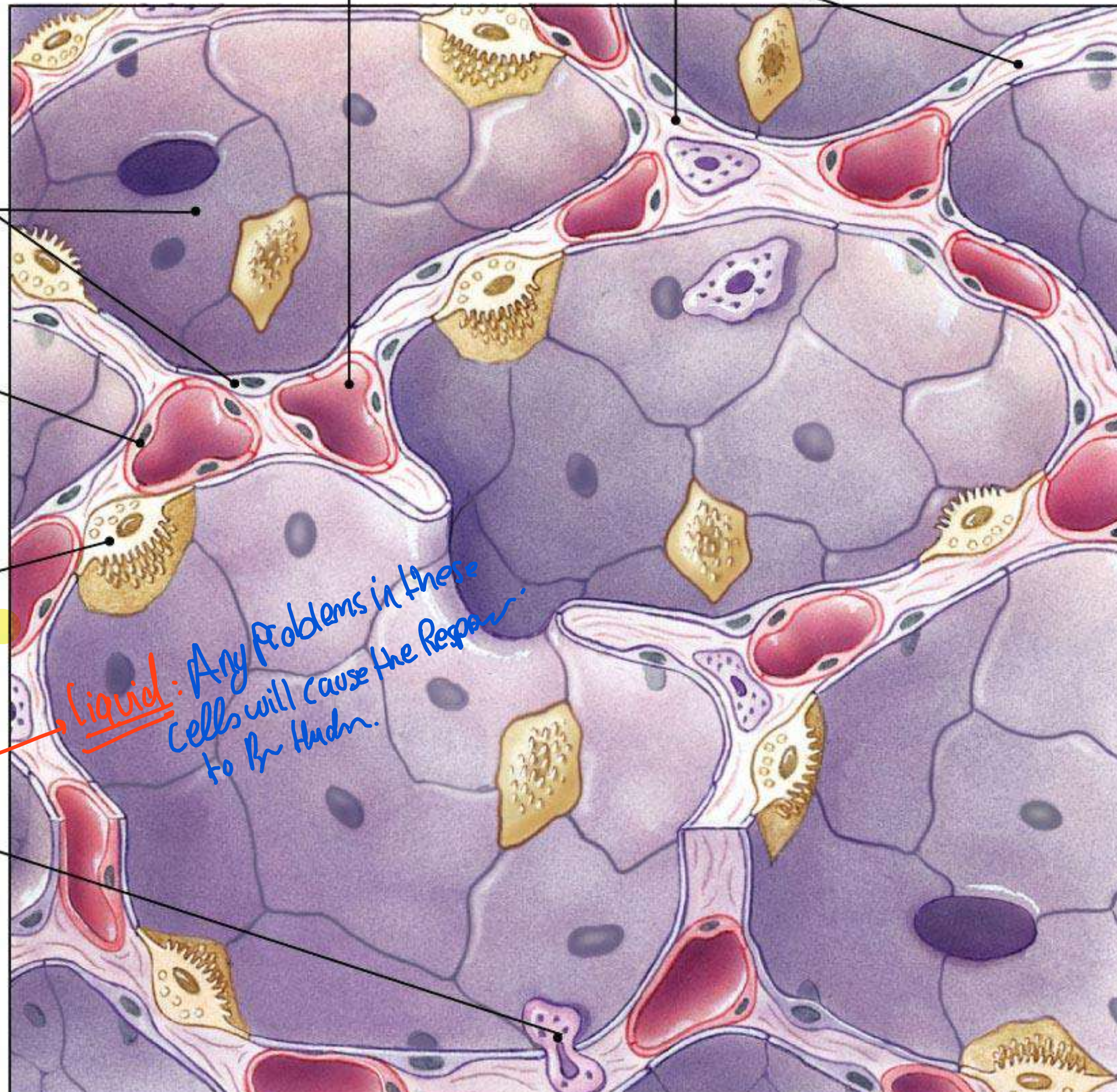


Figure 17-2g

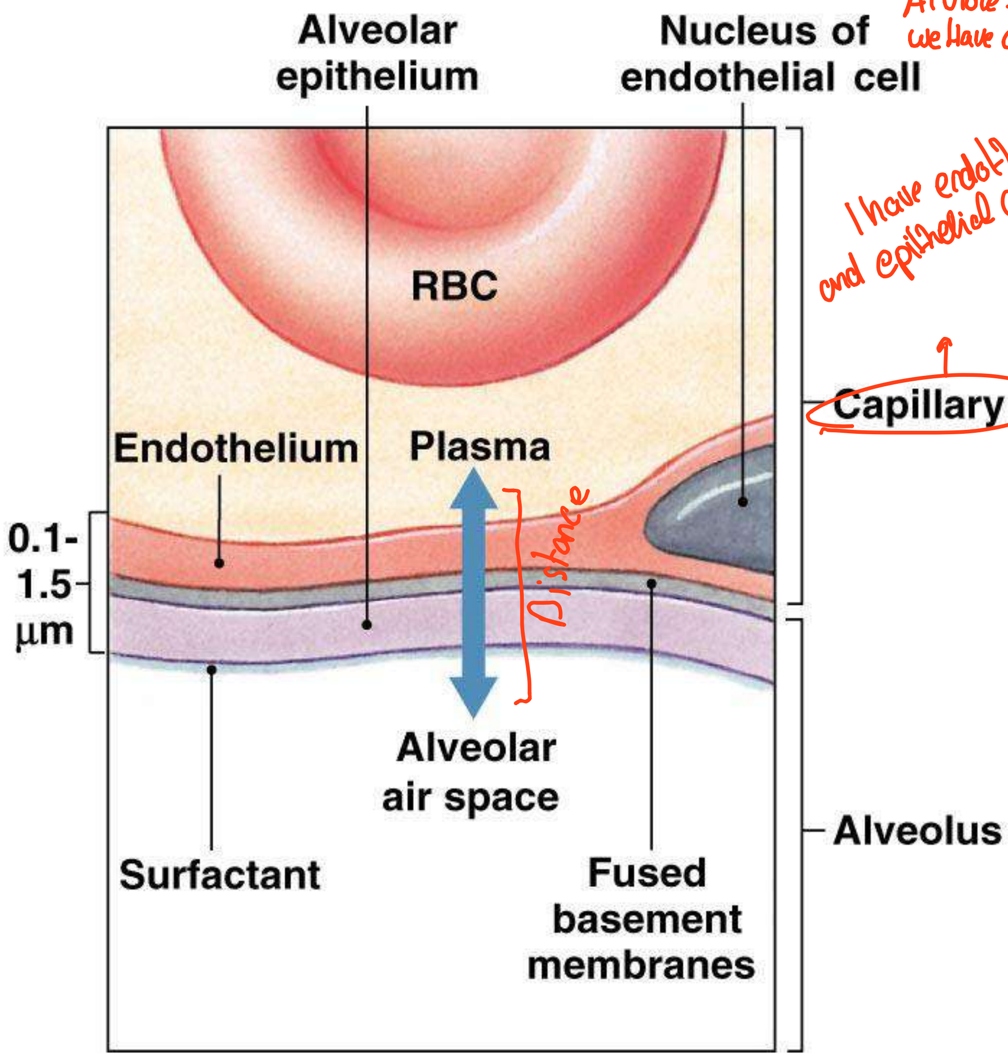
Respiratory Membrane

- 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

(h) Exchange surface of alveoli

What is the Respiratory distance?
if I'm going to do Exchange of Gases From the Alvicle to RBC OR the opposit it means that we Have distance that it will Cross



I have endothelium cells and epithelial cells + Surfactant

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

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

Figure 17-2h

Pleurae

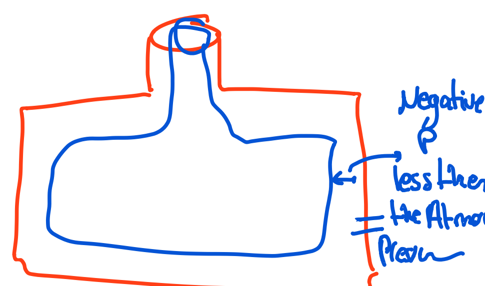
Pleural Cavity → Space/Liquid in between

Parietal + Visceral Plural membran

- 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



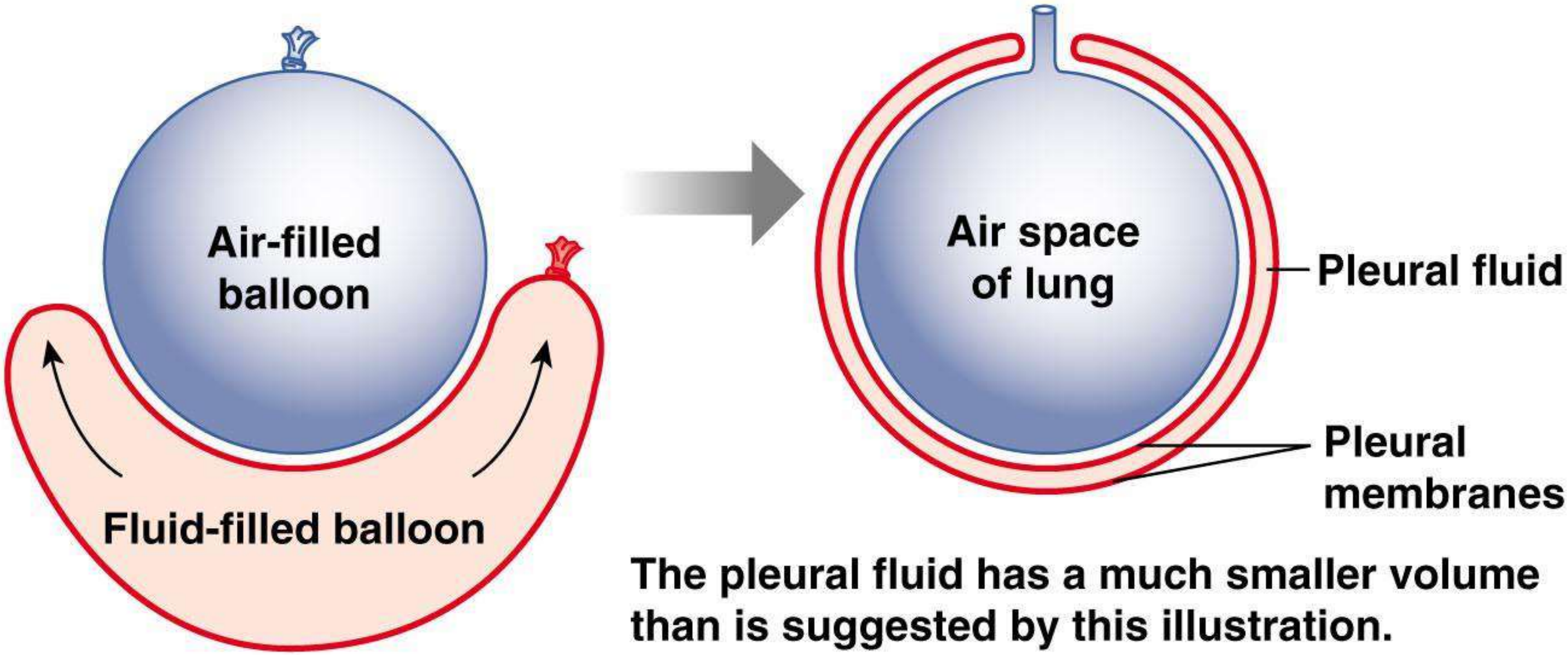
if the Atmosphiric P = the P between the Jar + the Bloon the Air wont enter.

Why enhlation is Active and exinatin is passive?

enhelation → we need energy + muscles

expn → we don't use the muscl.

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.

Figure 17-3

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

Table 17-2

Respiratory Volumes

500 – 750 ml →

- **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) (to Prevent lungs From Colapssing)

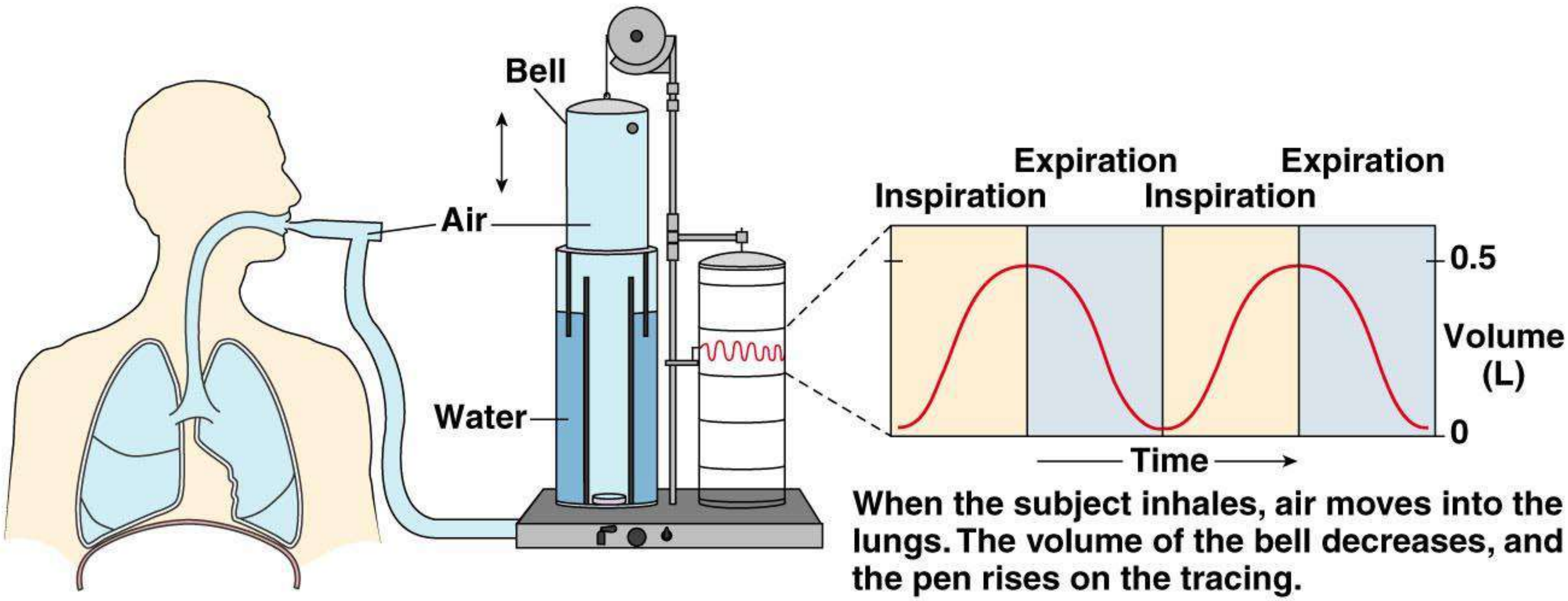
$M_1V_1 = M_2V_2$ → that's How we mesure the Residual Volum.

the final He Conc.

$C_1V_1 = C_2 * (V_S + V_L)$

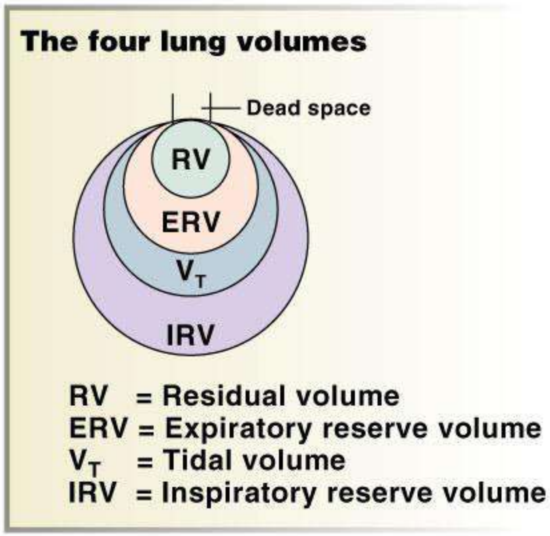
initially

$V_2 = (VS + VL)$



Spirometer: Measuring + Reading Breath Movements.

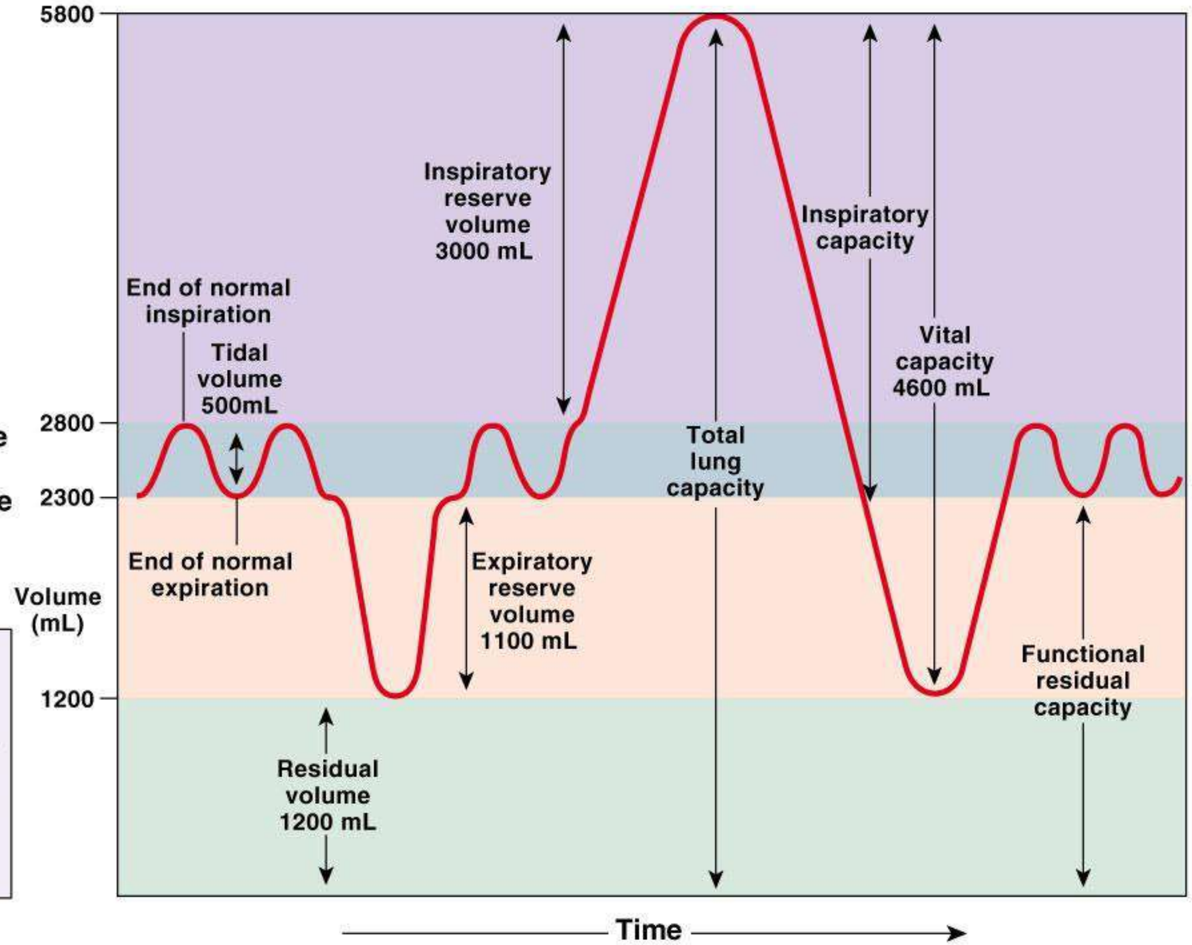
Figure 17-6



Pulmonary volumes

		Males	Females	
Vital capacity	IRV	3000	1900	Inspiratory capacity
	V_T	500	500	
	ERV	1100	700	Functional residual capacity
Residual volume		1200	1100	
		5800 mL	4200 mL	

A spirometer tracing showing lung volumes and capacities



Capacities are sums of two or more volumes.

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 lungs (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.

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

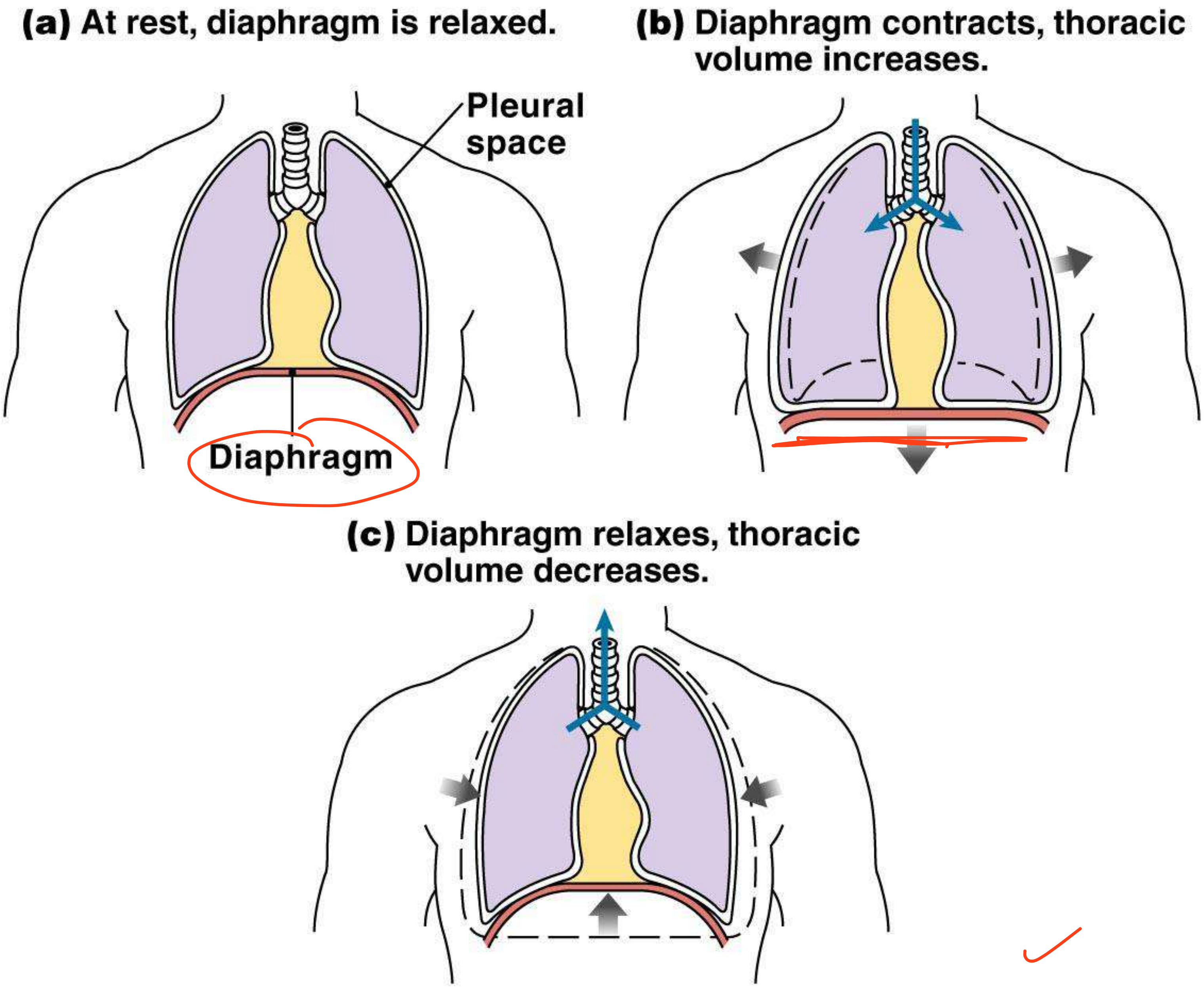
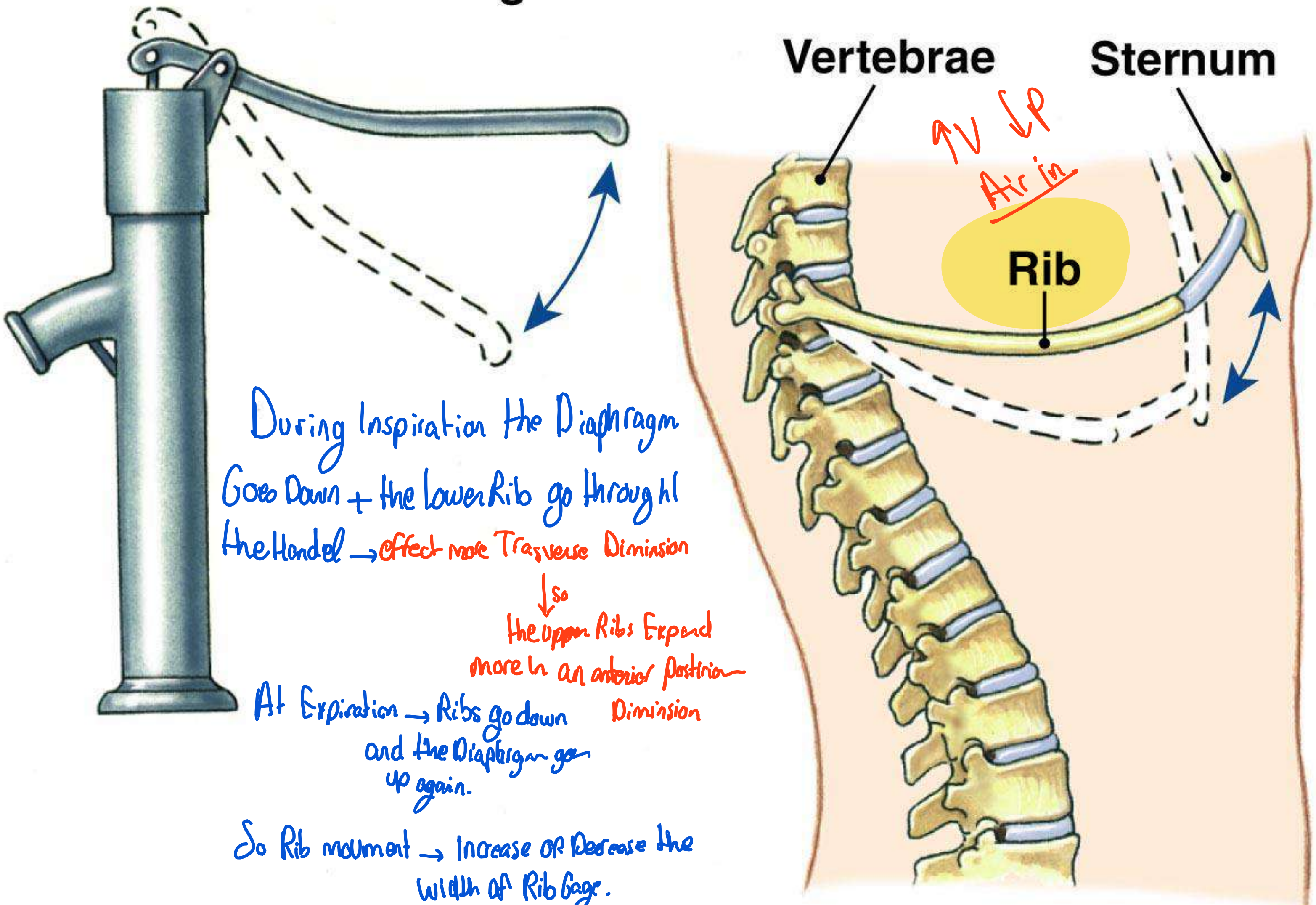


Figure 17-9 - Overview

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



During Inspiration the Diaphragm Goes Down + the lower Rib go through the Handel → effect more Trasverse Diminsion ↓ so the upper Ribs Expand more in an anterior Postrior Diminsion

At Expiration → Ribs go down and the Diaphrgm goes up again.

So Rib movment → Increase OR Decrease the width of Rib Cage.

Figure 17-10a

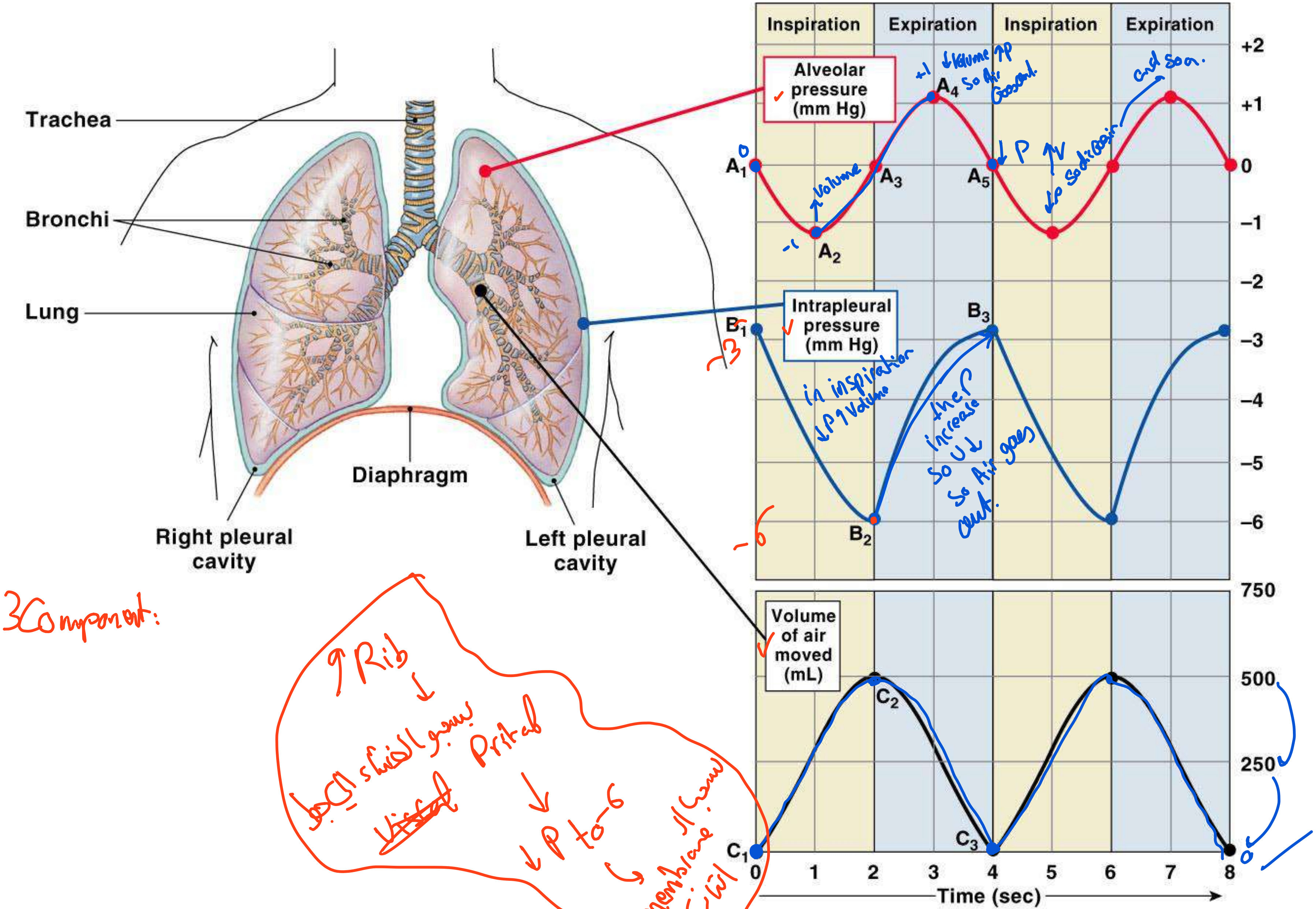

Trachea
Bronchi
Lung
Diaphragm
Right pleural cavity
Left pleural cavity
Inspiration
Expiration
Inspiration
Expiration
Alveolar pressure (mm Hg)
Intrapleural pressure (mm Hg)
Volume of air moved (mL)
A1
A2
A3
A4
A5
B1
B2
B3
C1
C2
C3
+2
+1
0
–1
–2
–3
–4
–5
–6
750
500
250
0
1
2
3
4
5
6
7
8
Time (sec)

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 ($P_{pul} - P_{ip}$)

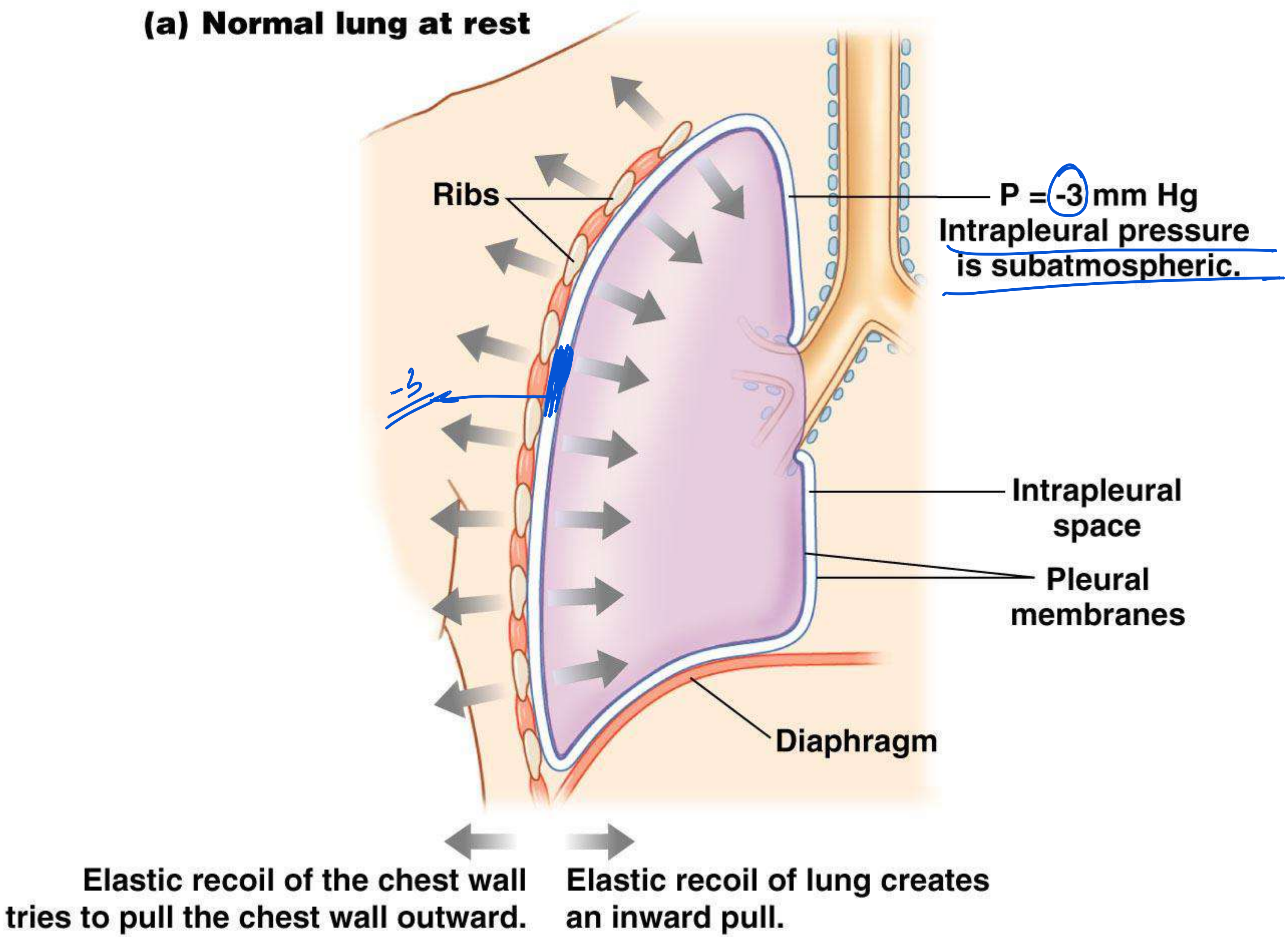


Figure 17-12a

(b) Pneumothorax

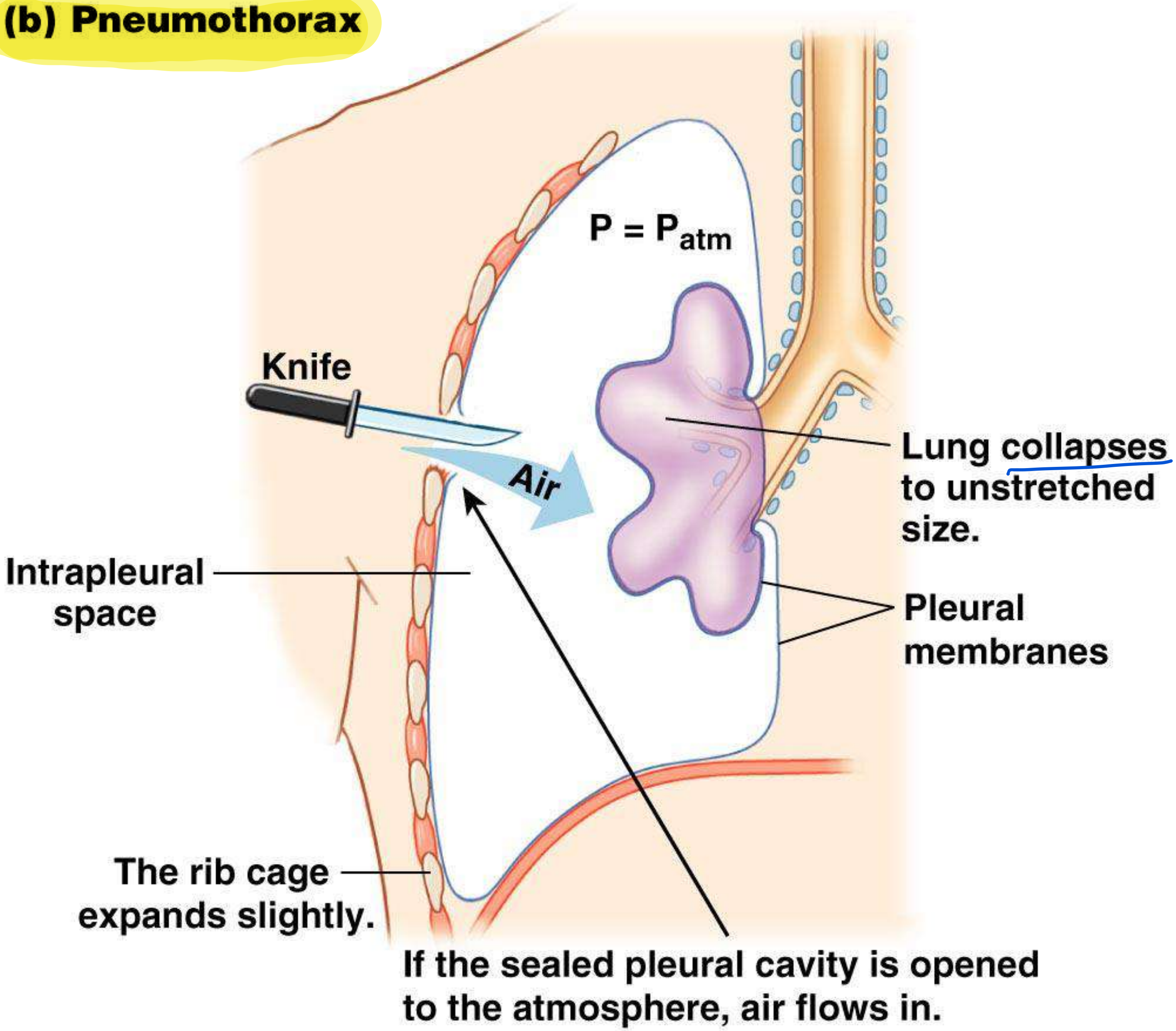


Figure 17-12b

* 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 + 98 mmHg - 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 → تروية.

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

Increase Respiratory Rate ← Increase Heart Rate

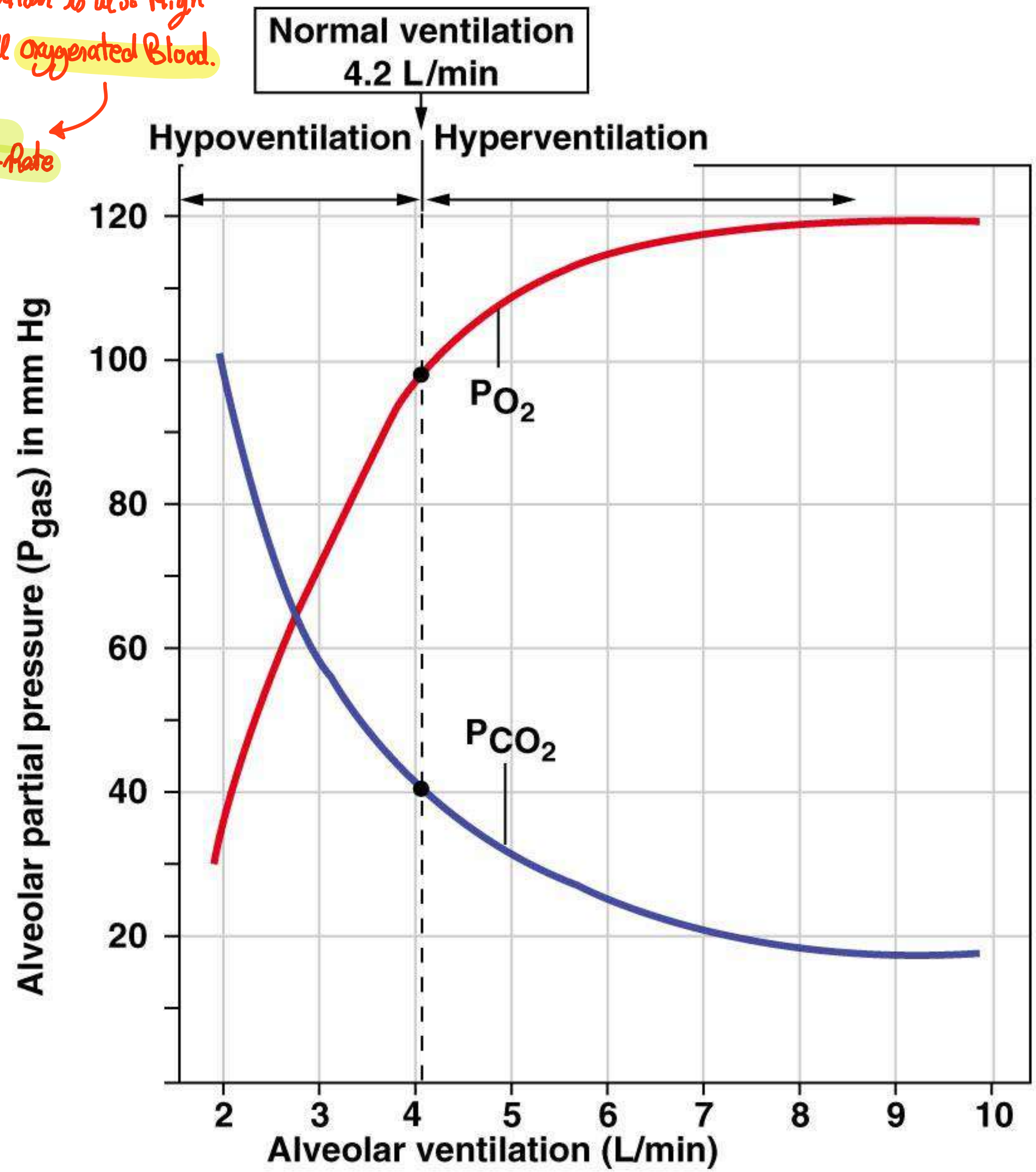


Figure 17-15

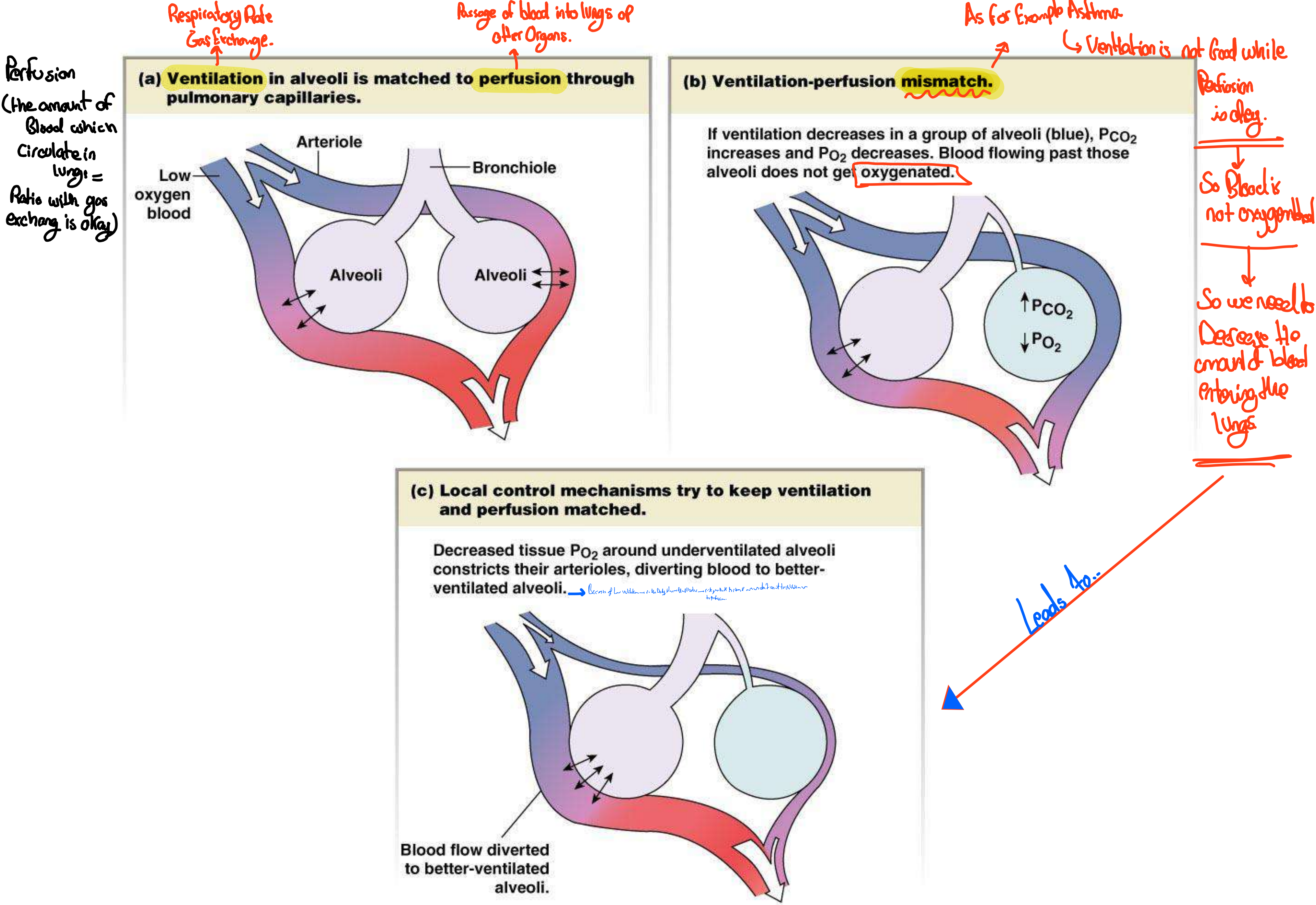


Figure 17-16 - Overview

COPD → Chronic obstructive Pulmonary disease.

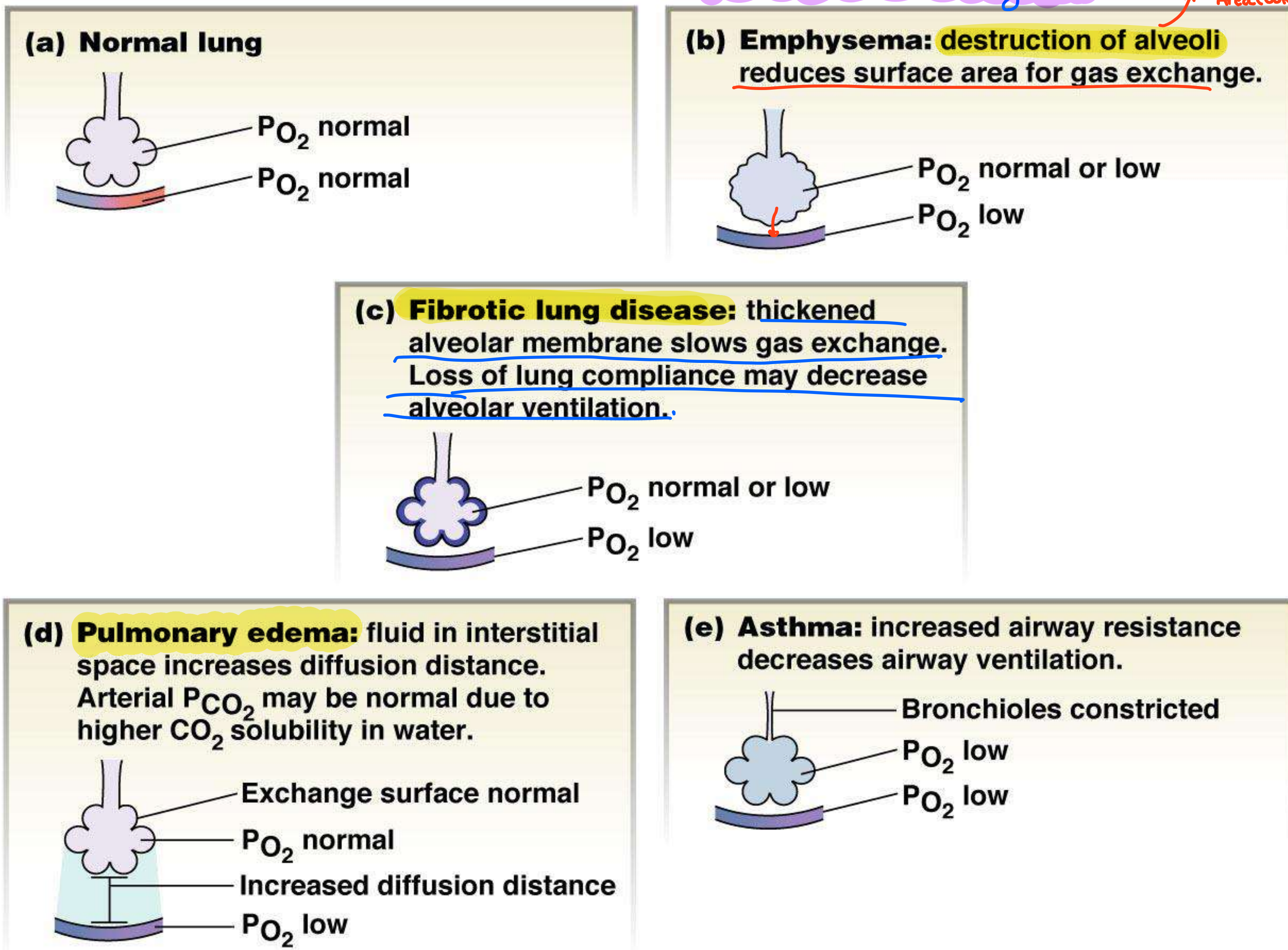


Figure 18-4 - Overview

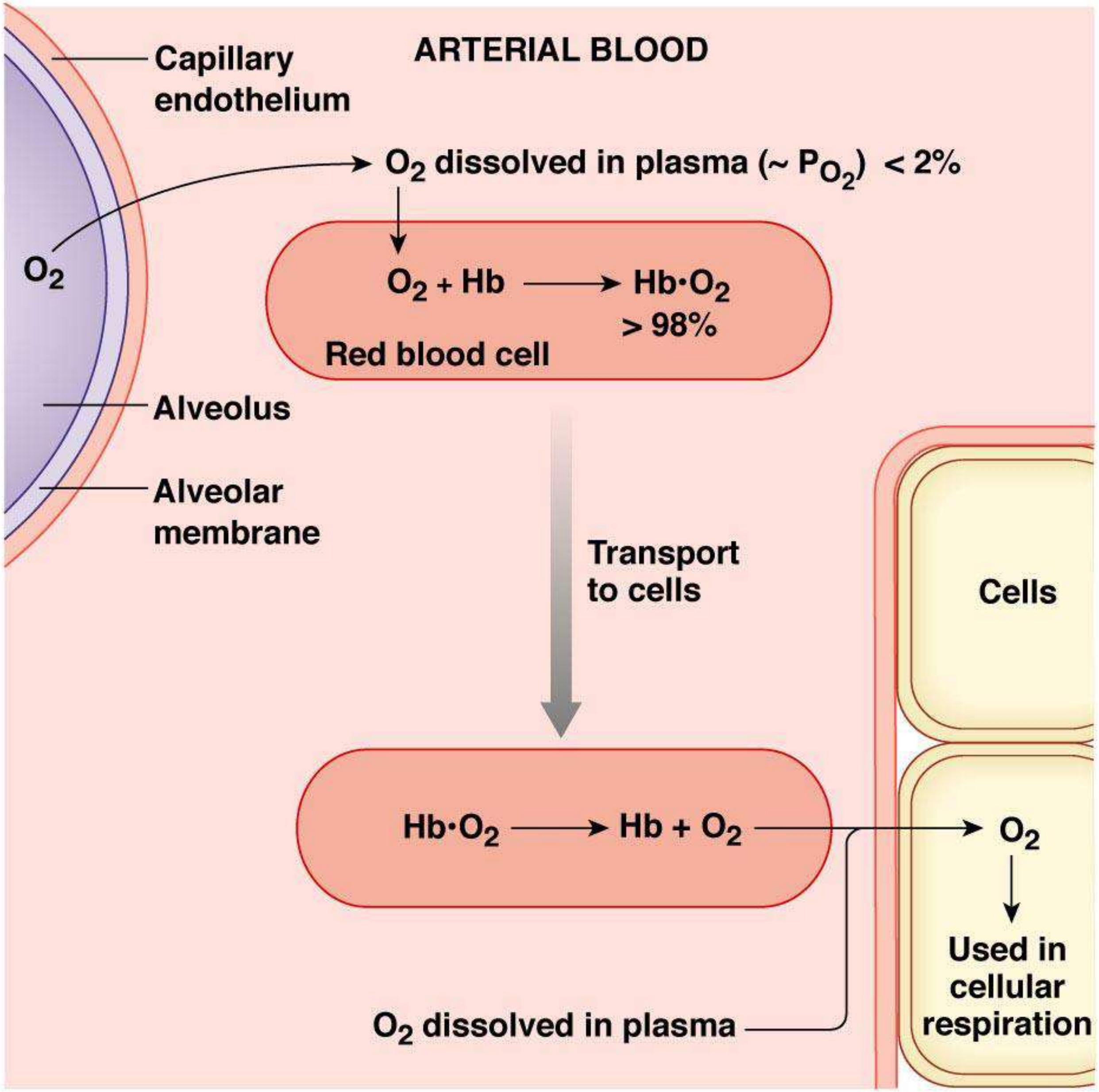
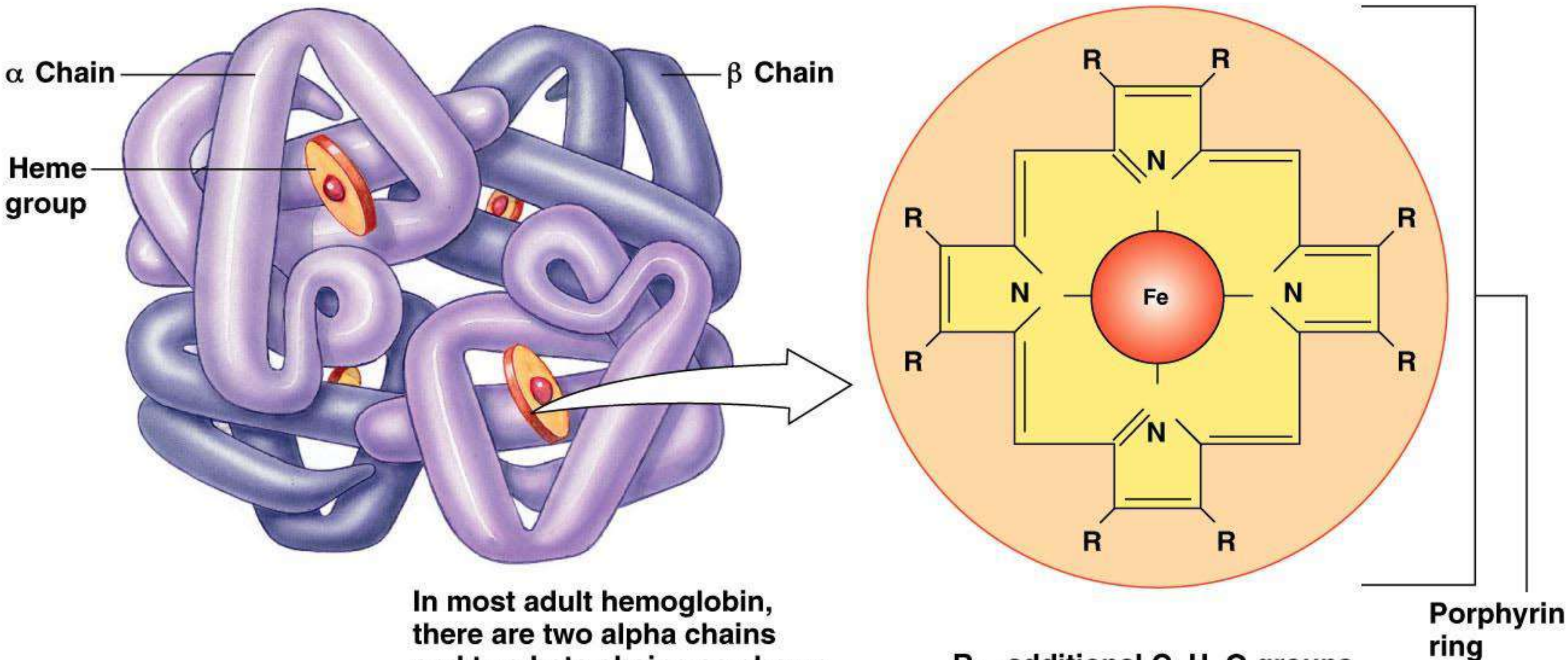

ARTERIAL BLOOD
Capillary endothelium
O_2 dissolved in plasma (~ P_{O_2}) < 2%
O_2
O_2 + Hb → Hb·O_2
> 98%
Red blood cell
Alveolus
Alveolar membrane
Transport to cells
Cells
Hb·O_2 → Hb + O_2
O_2
Used in cellular respiration
O_2 dissolved in plasma

Figure 18-6

(a) A hemoglobin molecule is composed of four protein globin chains, each surrounding a central heme group.

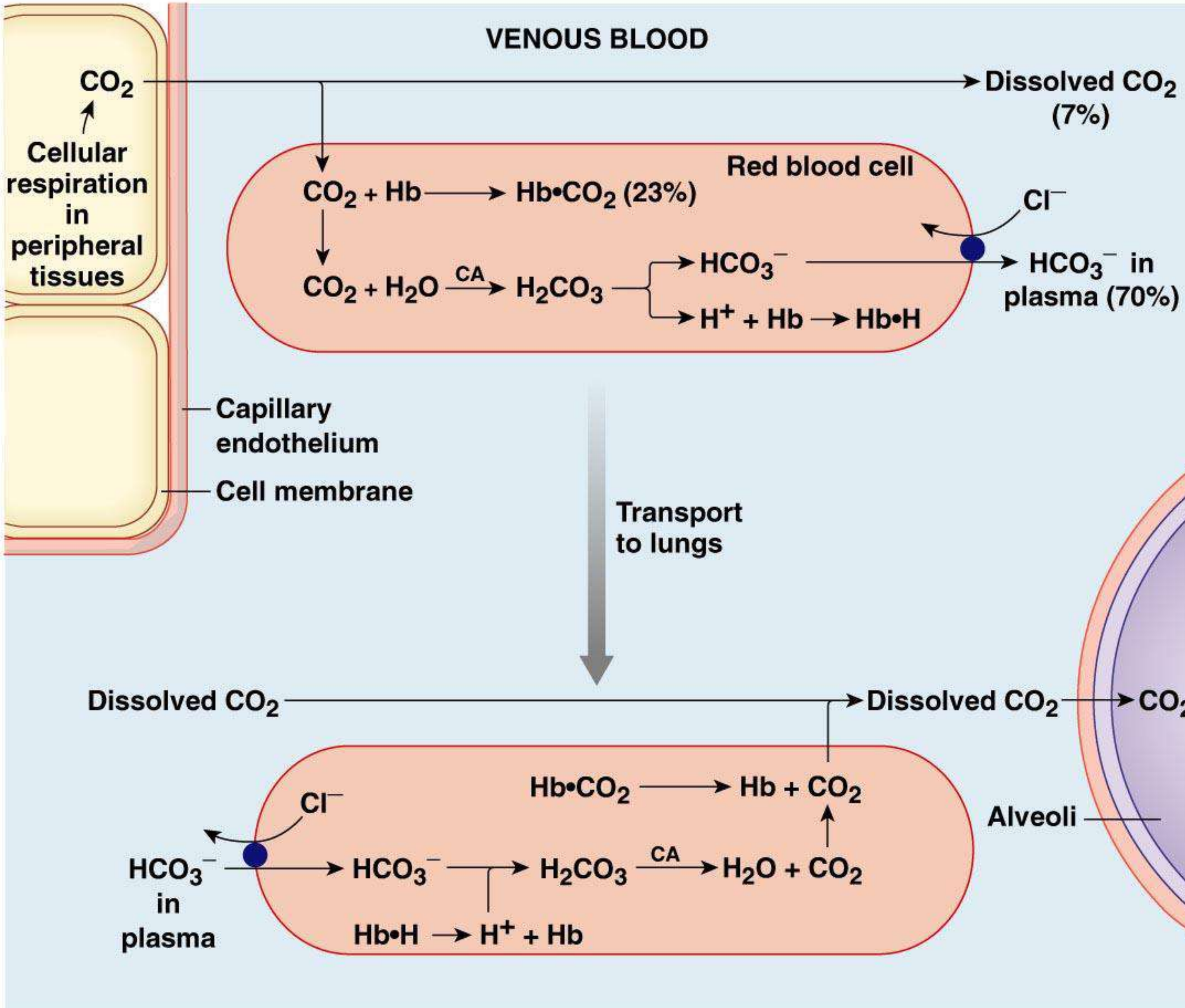
(b) Each heme group consists of a porphyrin ring with an iron atom in the center.



In most adult hemoglobin, there are two alpha chains and two beta chains as shown.

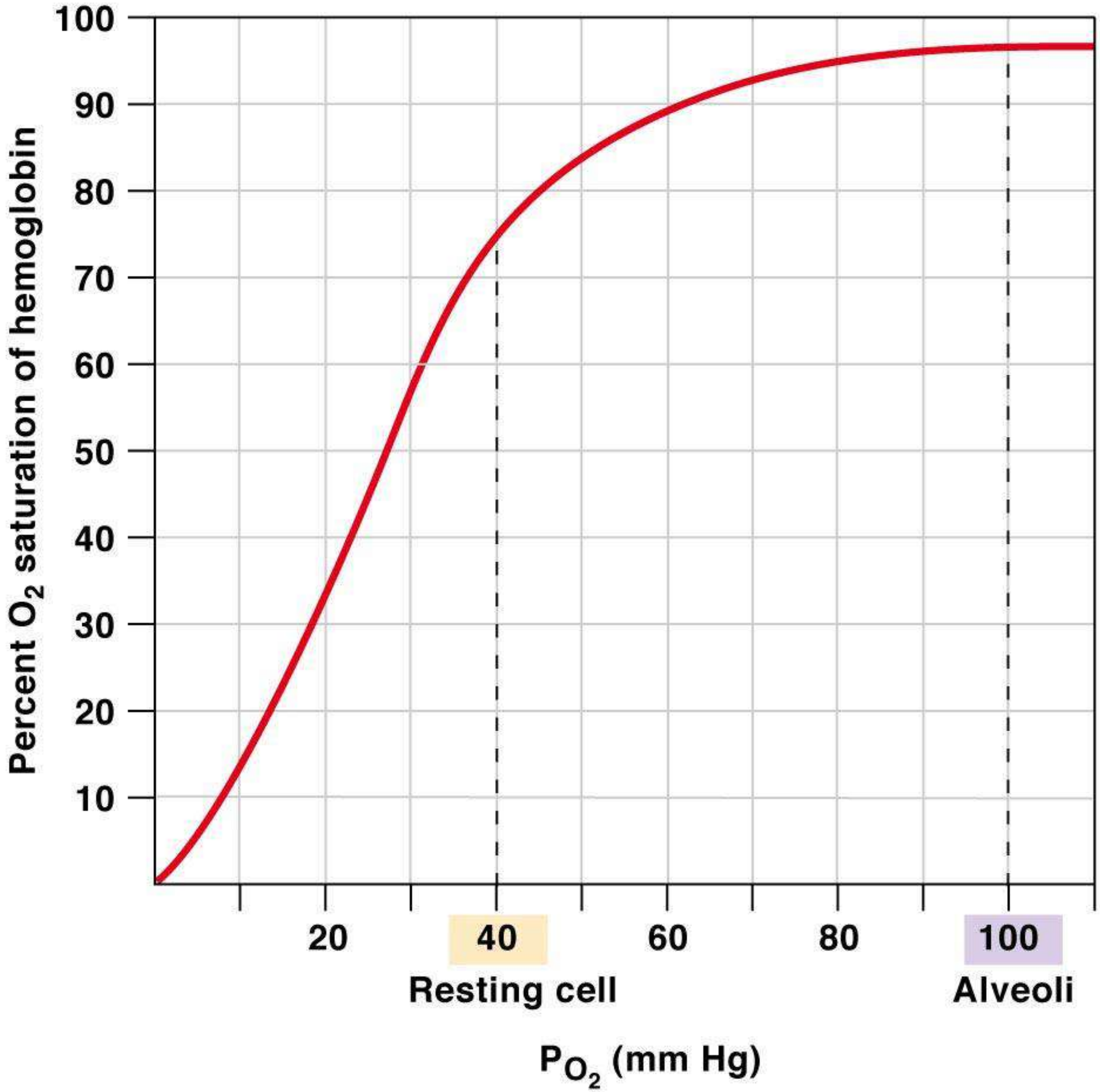
R = additional C, H, O groups

Figure 18-8 - Overview



VENOUS BLOOD
CO_2
Cellular respiration in peripheral tissues
Dissolved CO_2 (7%)
Red blood cell
CO_2 + Hb → Hb•CO_2 (23%)
CO_2 + H_2O → H_2CO_3
CA
HCO_3^-
H^+ + Hb → Hb•H
Cl^-
HCO_3^- in plasma (70%)
Capillary endothelium
Cell membrane
Transport to lungs
Dissolved CO_2
Dissolved CO_2 → CO_2
Hb•CO_2 → Hb + CO_2
Cl^-
HCO_3^- in plasma
HCO_3^- → H_2CO_3 → H_2O + CO_2
CA
Hb•H → H^+ + Hb
Alveoli

Figure 18-14



100
90
80
70
60
50
40
30
20
10
Percent O2 saturation of hemoglobin
20
40
60
80
100
Resting cell
Alveoli
PO2 (mm Hg)

Figure 18-9

(a) Effect of pH

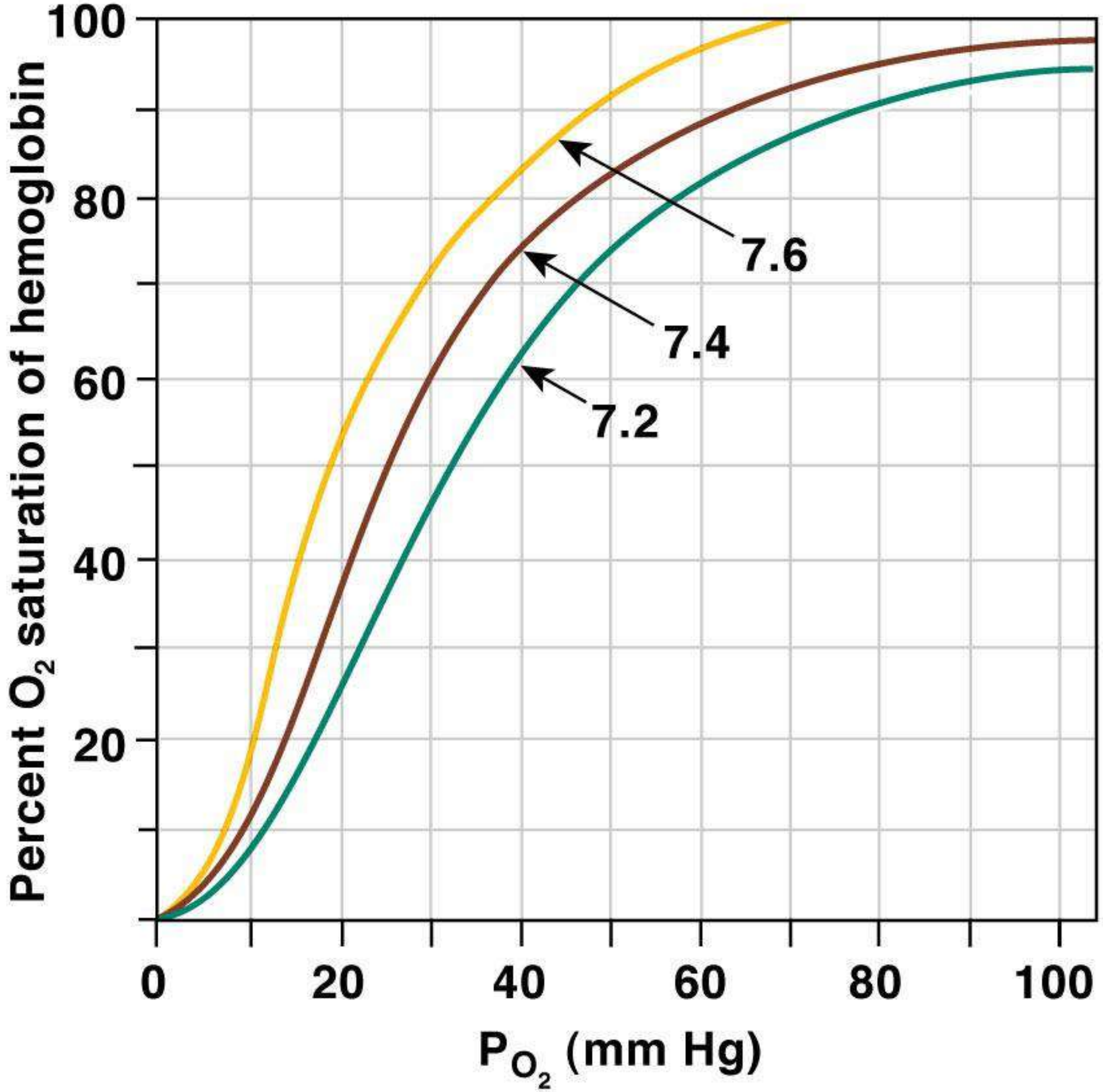


Figure 18-10a

(b) Effect of temperature

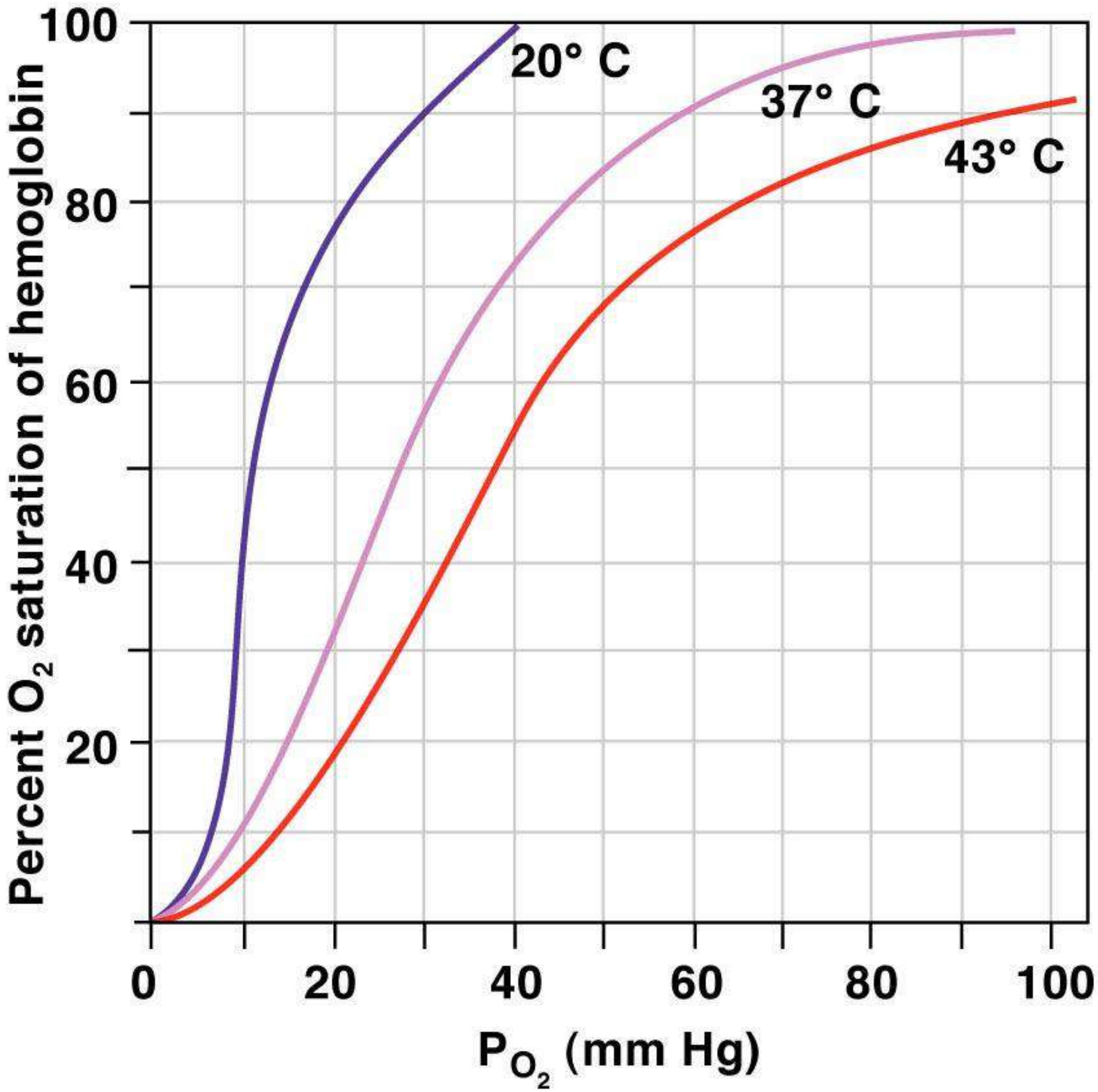


Figure 18-10b

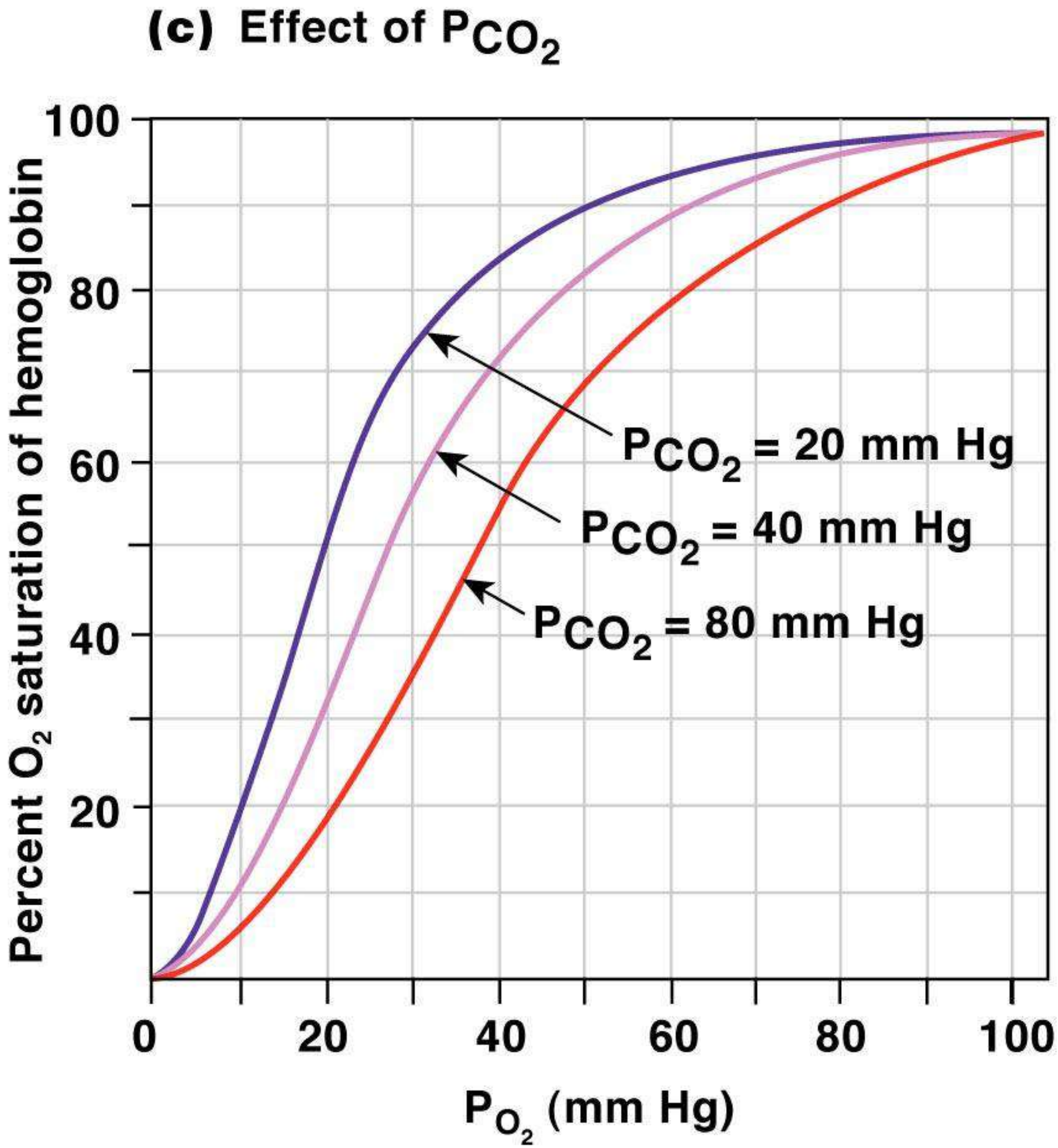
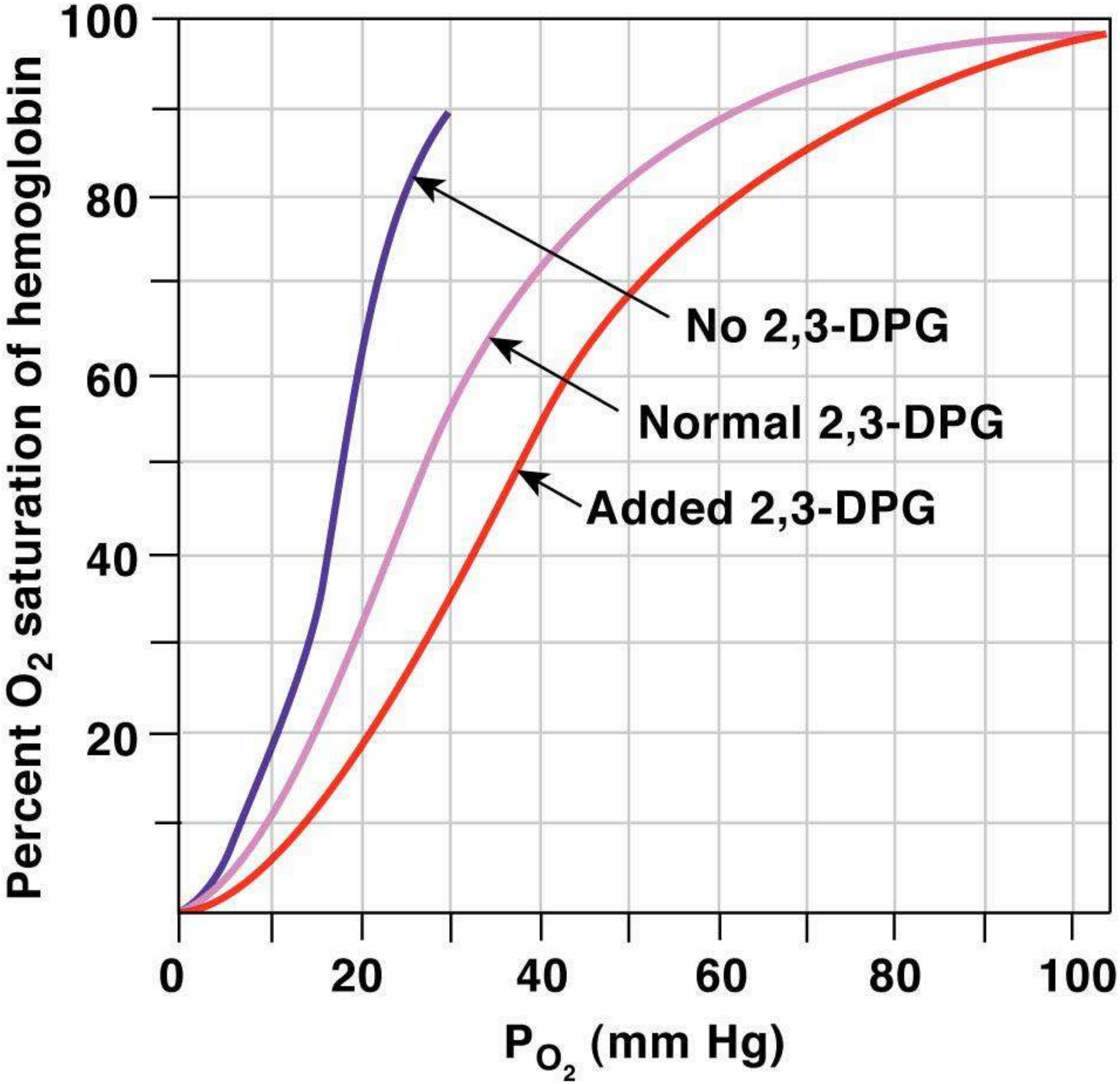


Figure 18-10c



100
80
60
40
20
Percent O_2 saturation of hemoglobin
No 2,3-DPG
Normal 2,3-DPG
Added 2,3-DPG
0
20
40
60
80
100
P_{O_2} (mm Hg)

Figure 18-11

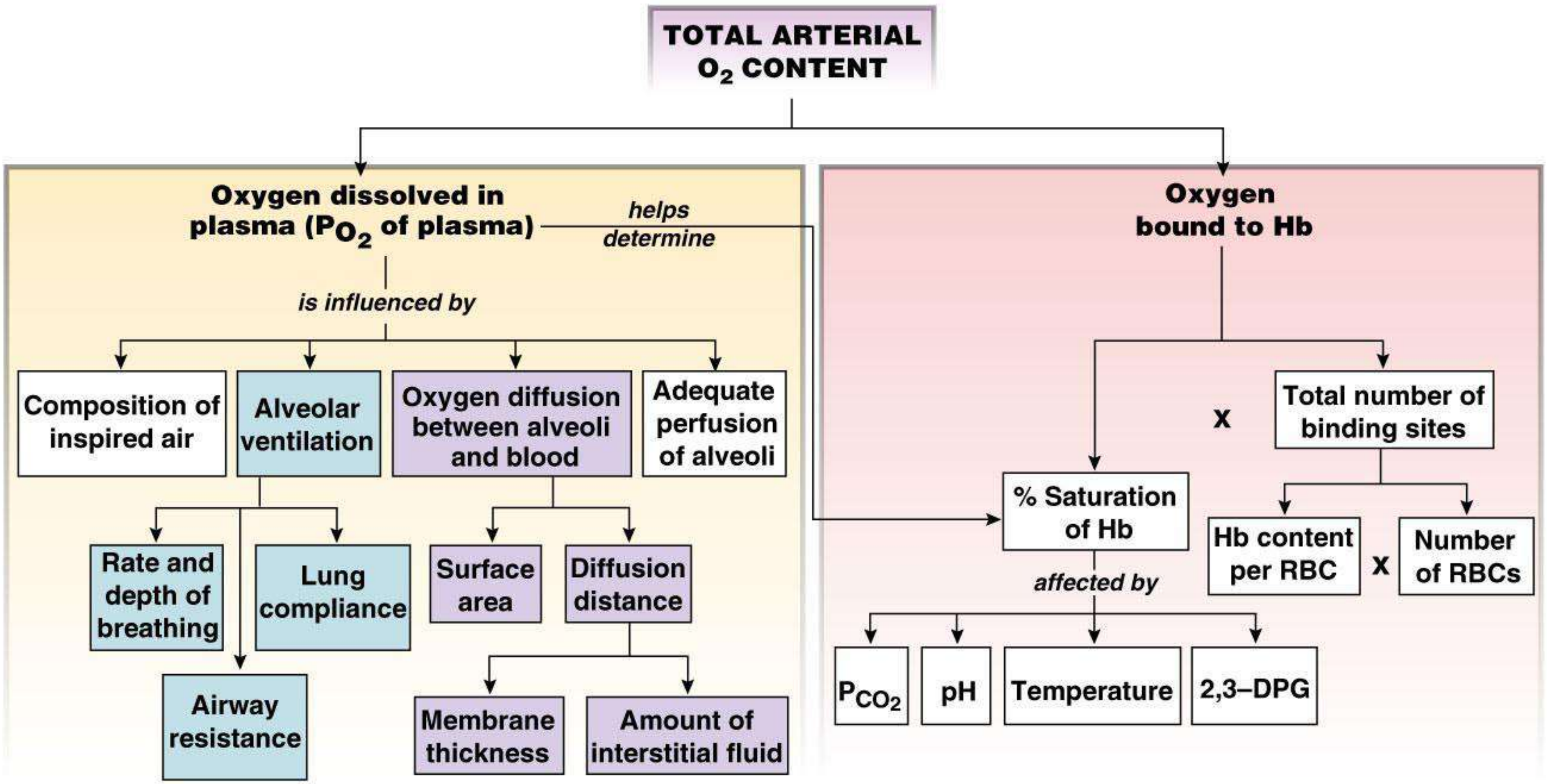

TOTAL ARTERIAL
O_2 CONTENT
Oxygen dissolved in
plasma (P_{O_2} of plasma)
helps
determine
is influenced by
Composition of
inspired air
Alveolar
ventilation
Oxygen diffusion
between alveoli
and blood
Adequate
perfusion
of alveoli
Rate and
depth of
breathing
Lung
compliance
Airway
resistance
Surface
area
Diffusion
distance
Membrane
thickness
Amount of
interstitial fluid
Oxygen
bound to Hb
% Saturation
of Hb
X
Total number of
binding sites
affected by
P_{CO_2}
pH
Temperature
2,3–DPG
Hb content
per RBC
X
Number
of RBCs

Figure 18-13

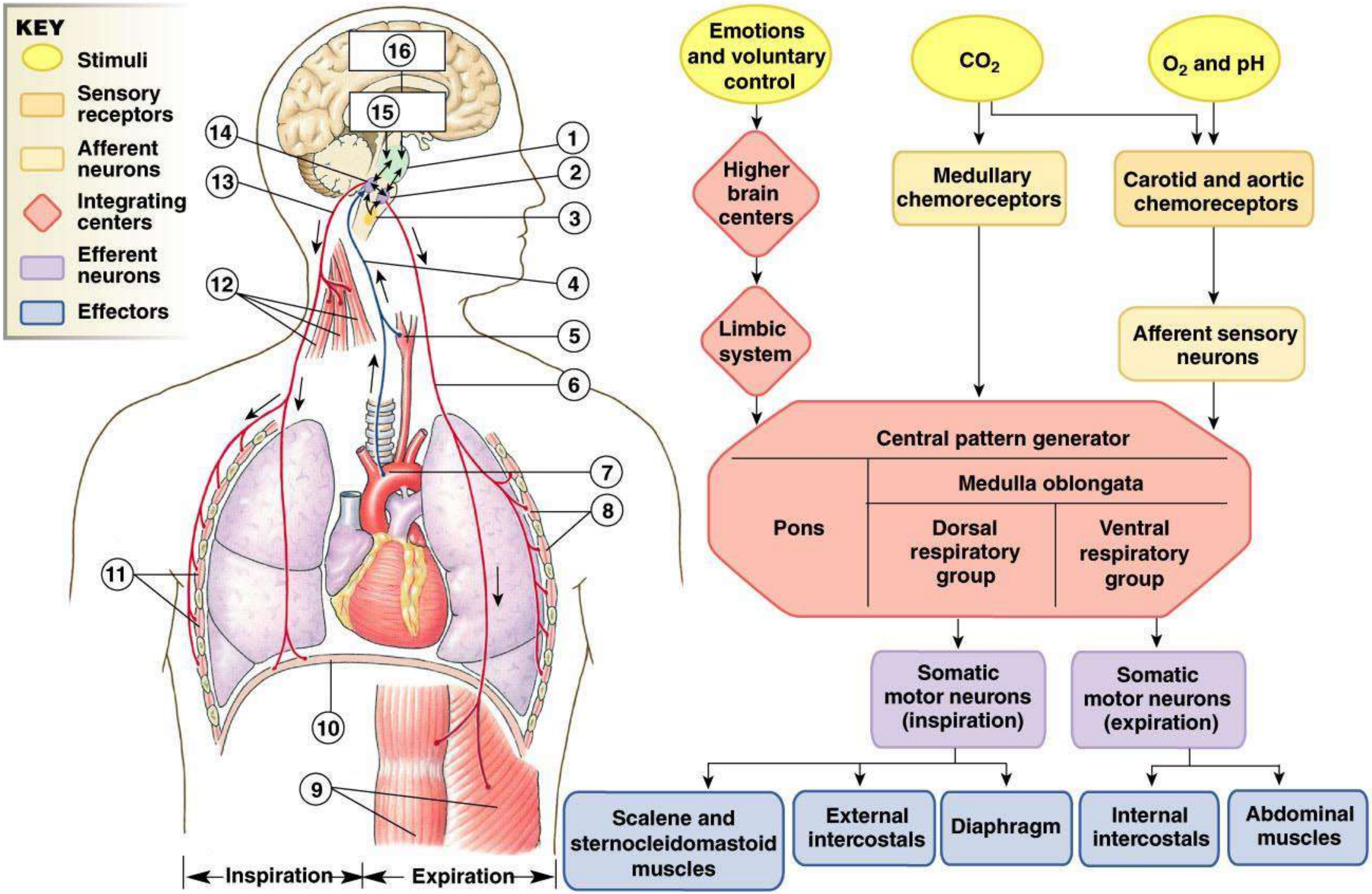

KEY
Stimuli
Sensory receptors
Afferent neurons
Integrating centers
Efferent neurons
Effectors
16
15
14
13
12
11
10
9
1
2
3
4
5
6
7
8
Inspiration
Expiration
Emotions and voluntary control
Higher brain centers
Limbic system
CO_2
Medullary chemoreceptors
O_2 and pH
Carotid and aortic chemoreceptors
Afferent sensory neurons
Central pattern generator
Medulla oblongata
Pons
Dorsal respiratory group
Ventral respiratory group
Somatic motor neurons (inspiration)
Somatic motor neurons (expiration)
Scalene and sternocleidomastoid muscles
External intercostals
Diaphragm
Internal intercostals
Abdominal muscles

Figure 18-16

Medullary Respiratory Centers

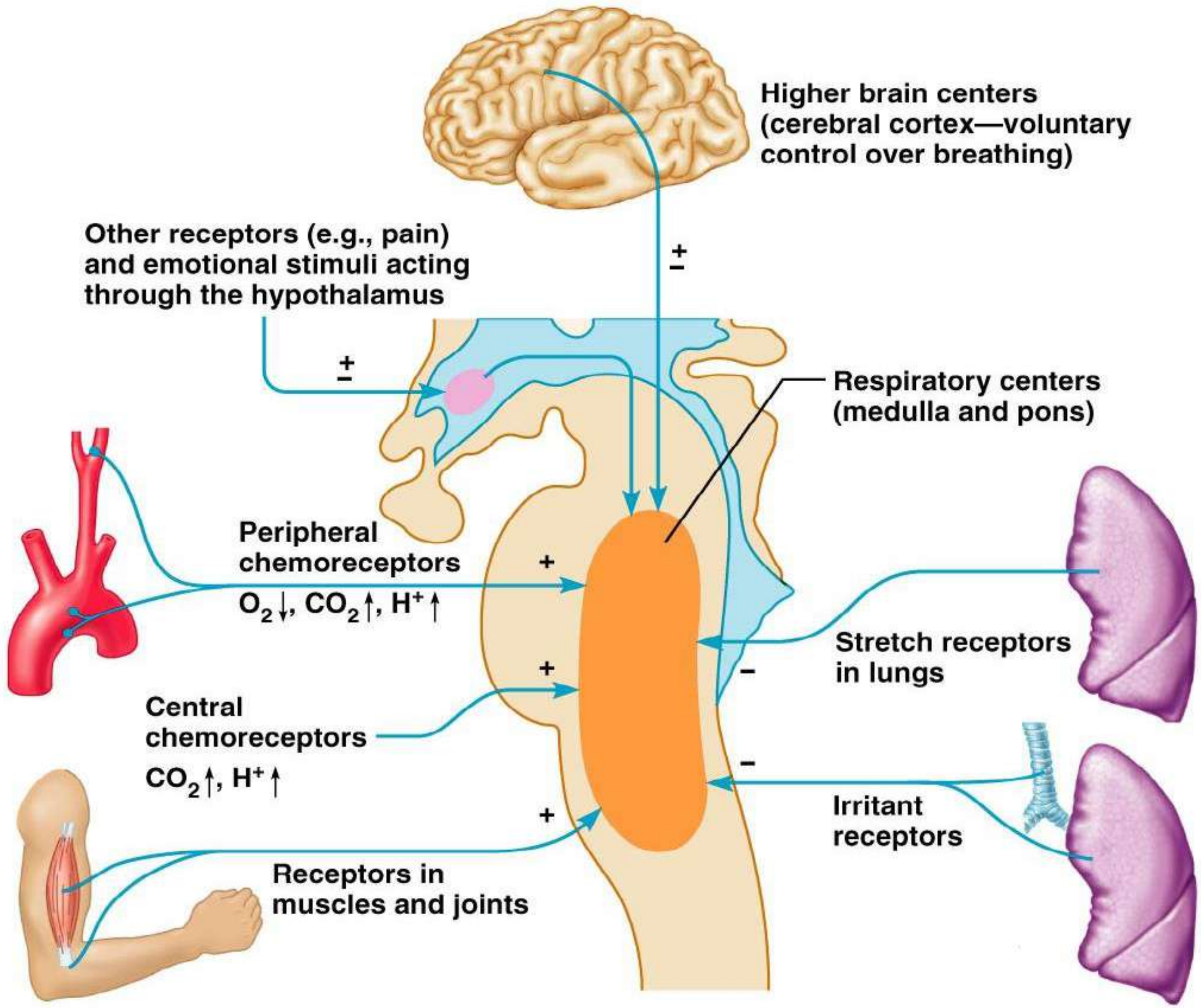


Figure 22.25

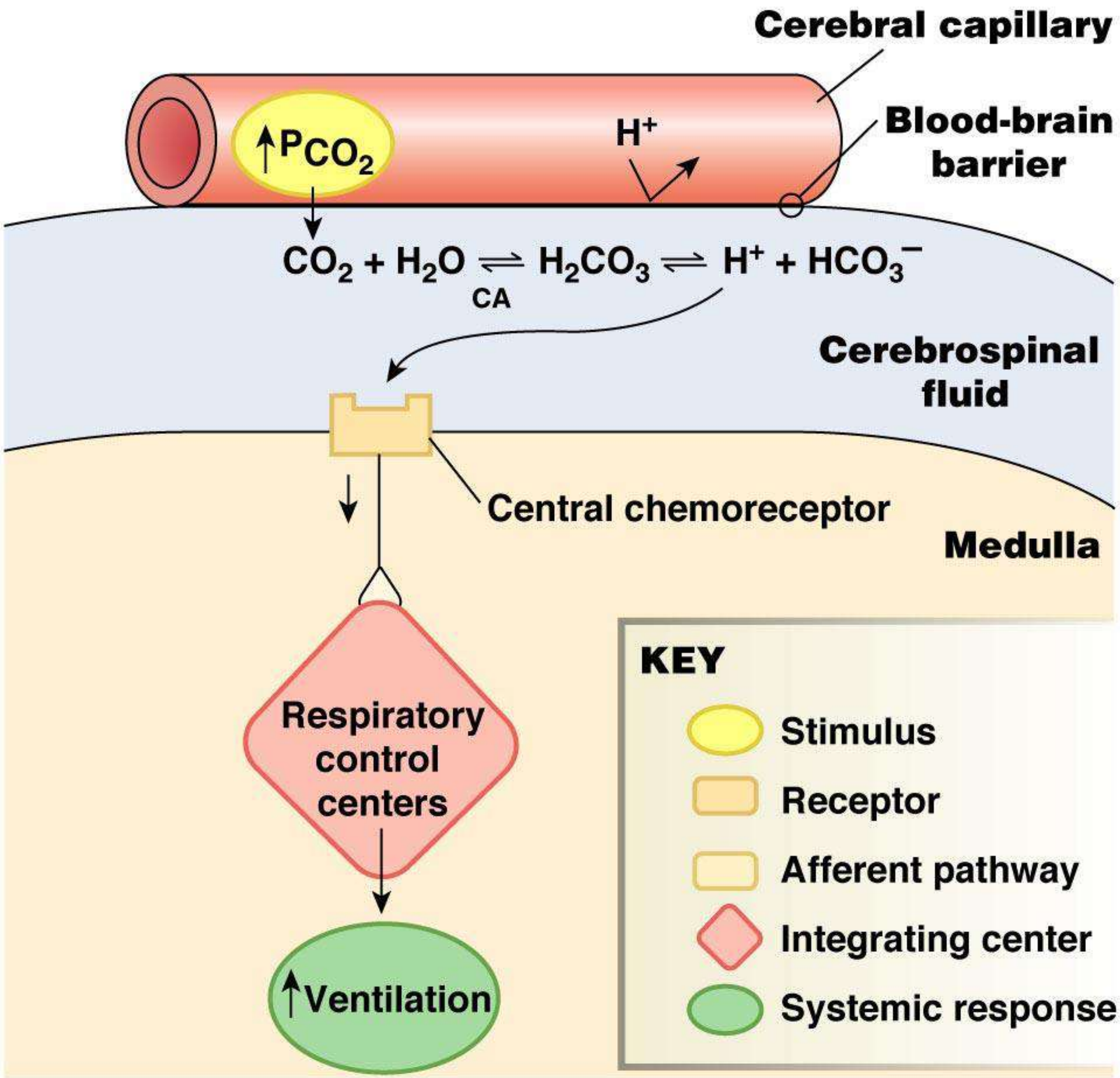
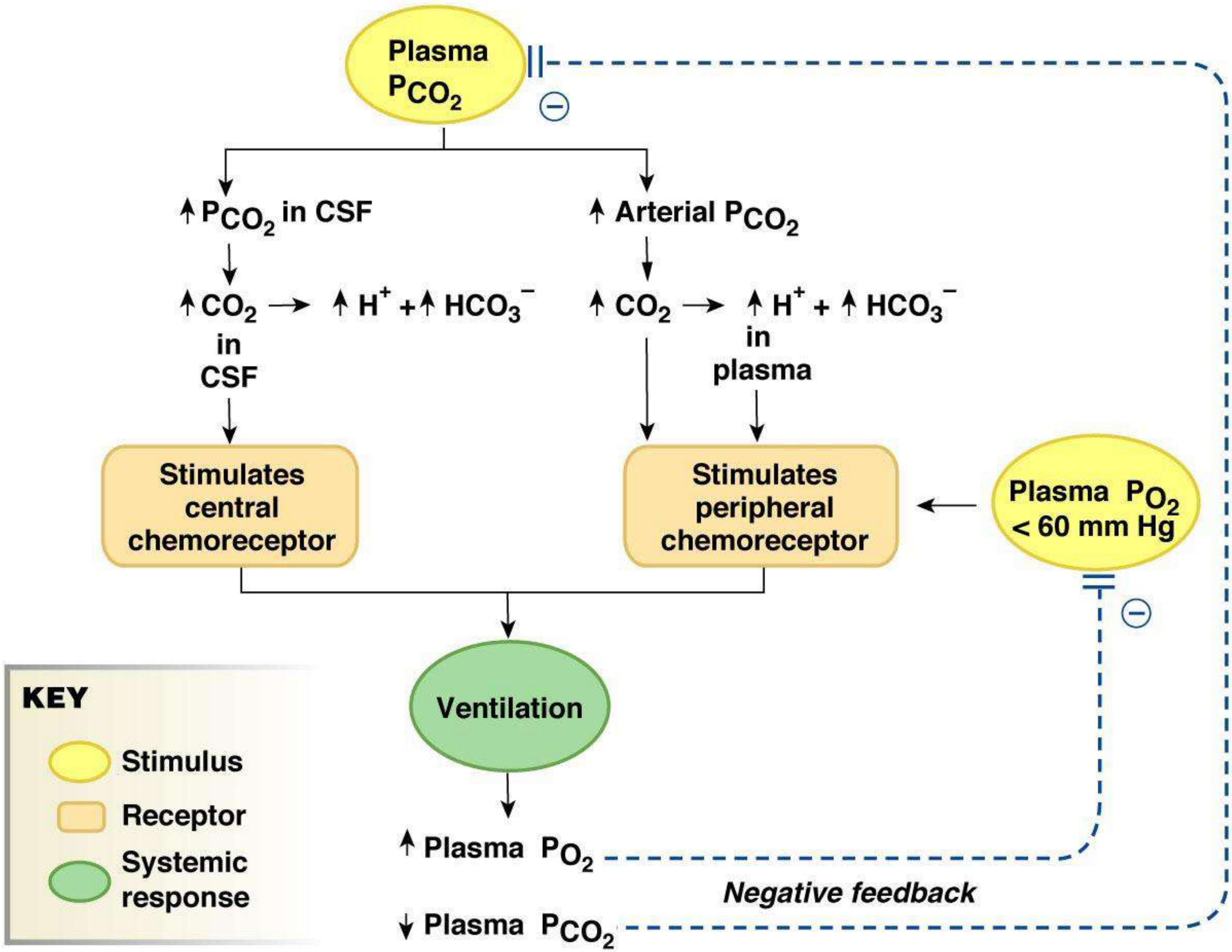

Cerebral capillary
↑P_{CO_2}
H^+
Blood-brain barrier
$CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$
CA
Cerebrospinal fluid
Central chemoreceptor
Medulla
Respiratory control centers
↑Ventilation
KEY
Stimulus
Receptor
Afferent pathway
Integrating center
Systemic response

Figure 18-19



Plasma P_{CO_2}
⊖
↑ P_{CO_2} in CSF
↑ Arterial P_{CO_2}
↑ CO_2 in CSF → ↑ H^+ + ↑ HCO_3^-
↑ CO_2 → ↑ H^+ + ↑ HCO_3^- in plasma
Stimulates central chemoreceptor
Stimulates peripheral chemoreceptor
Plasma P_{O_2} < 60 mm Hg
⊖
Ventilation
↑ Plasma P_{O_2}
↓ Plasma P_{CO_2}
Negative feedback
KEY
Stimulus
Receptor
Systemic response

Figure 18-20