PHYSIOLOGY BINGE REVISION

Medsynapse by Dr. Nikita

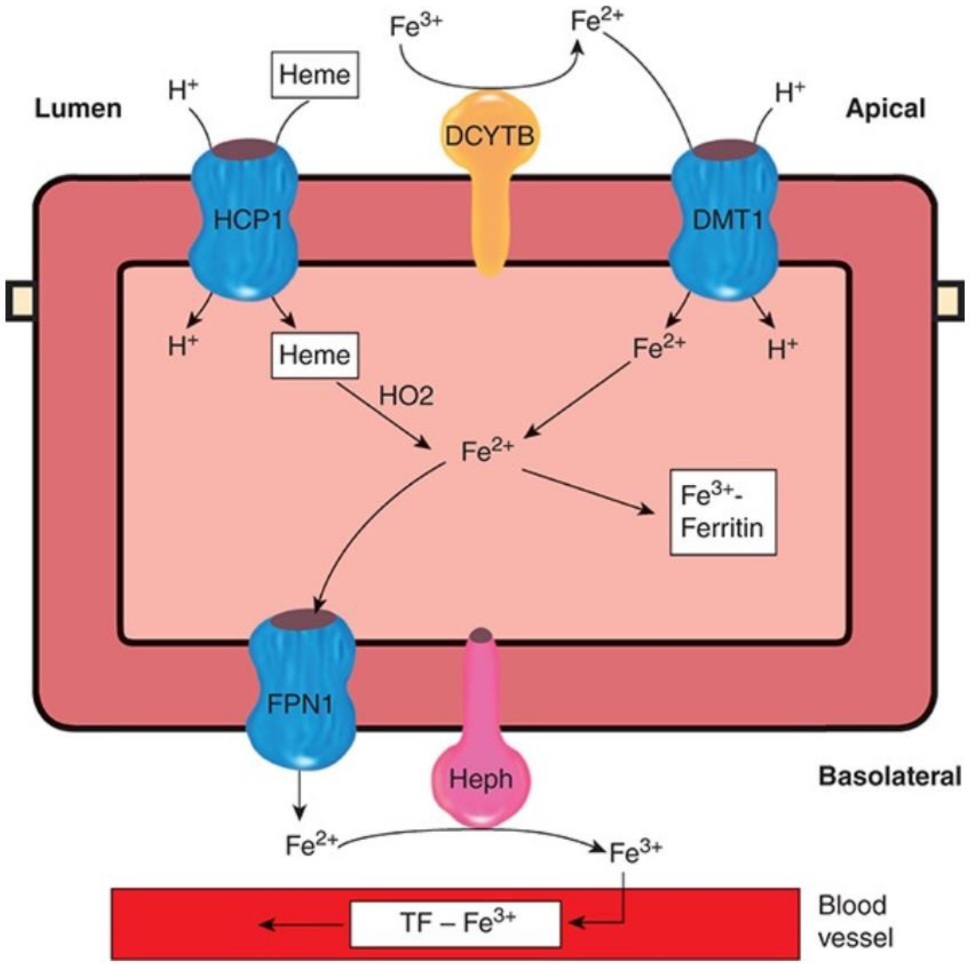
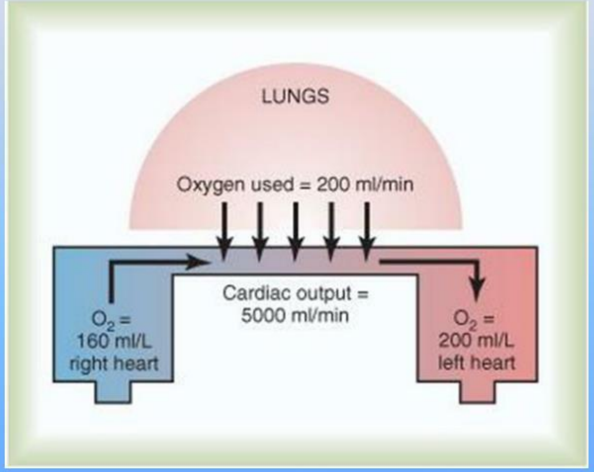


FIGURE 26–8 Intestinal absorption of iron. Fe^{3+} is converted to Fe^{2+} by the ferric reductase DCYTB, and Fe^{2+} is transported into the enterocyte by the apical membrane iron transporter DMT1. Heme is transported into the enterocyte by a separate heme transporter (most likely heme carrier protein 1, HCP1), and heme oxygenase-2 (HO2) releases Fe^{2+} from the heme. Some of the intracellular Fe^{2+} is converted to Fe^{3+} and bound to ferritin. The rest binds to the basolateral Fe^{2+} transporter ferroportin-1 (FPN1) and is transported to the interstitial fluid. The transport is aided by hephaestin (Heph) which converts Fe^{2+} to Fe^{3+}. In plasma, Fe^{3+} is transported bound to the iron transport protein transferrin (TF).

$$Q = \frac{\pi \Delta P r^4}{8 \eta l}$$

- Cardiac output can be computed as $CO = \frac{V_{O_2}}{C_a - C_v}$
- Where V_{O_2} is oxygen uptake, and C_a and C_v are oxygen content of the arterial and venous blood.
- V_{O_2} is determined by breathing or mechanical method using a spirometer or indirectly by a calorimeter monitor.

FICK PRINCIPLE



Output of Left Ventricle

$$= \frac{\text{Oxygen Uptake by lungs ml/min}}{A_{O_2} - V_{O_2}}$$

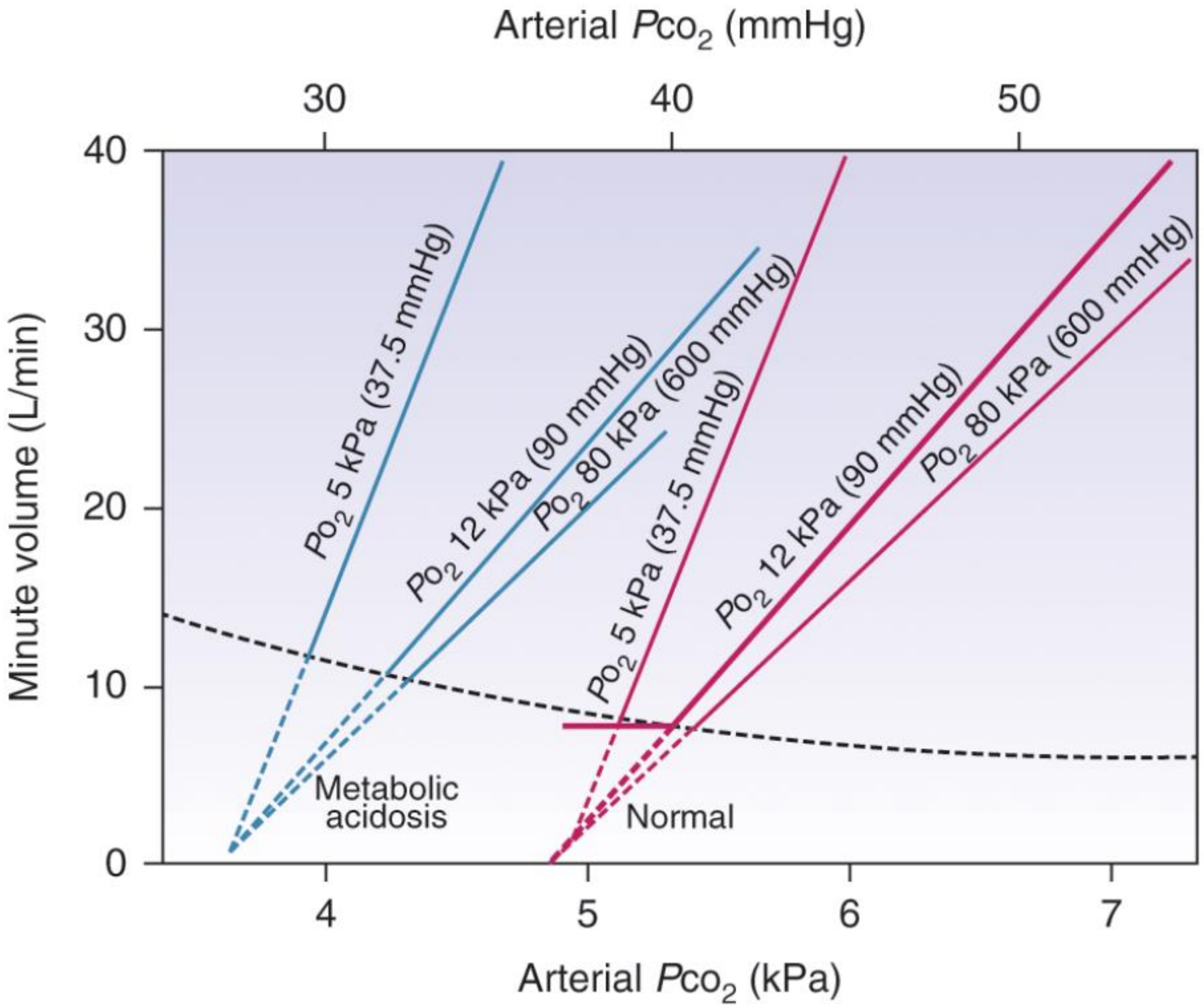
$$= \frac{200\ \text{ml / min}}{200\ \text{ml / L} - 160\ \text{ml / L}}$$

Art blood – Venous blood [Pul artery]

$$= \frac{200\ \text{ml/min}}{40\text{ml / liter}}$$

= **5 L/min**

32



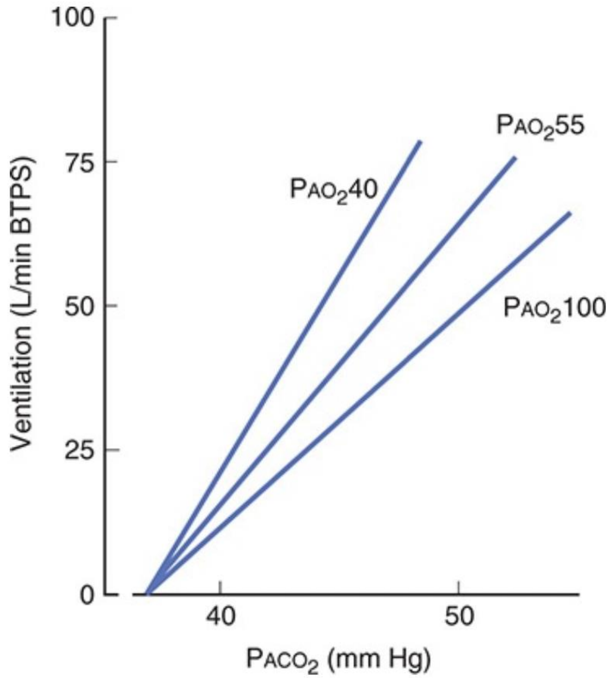


FIGURE 36–12 Fan of lines showing CO_2 response curves at various fixed values of alveolar Po_2. Decreased P_{AO_2} results in a more sensitive response to P_{ACO_2}.

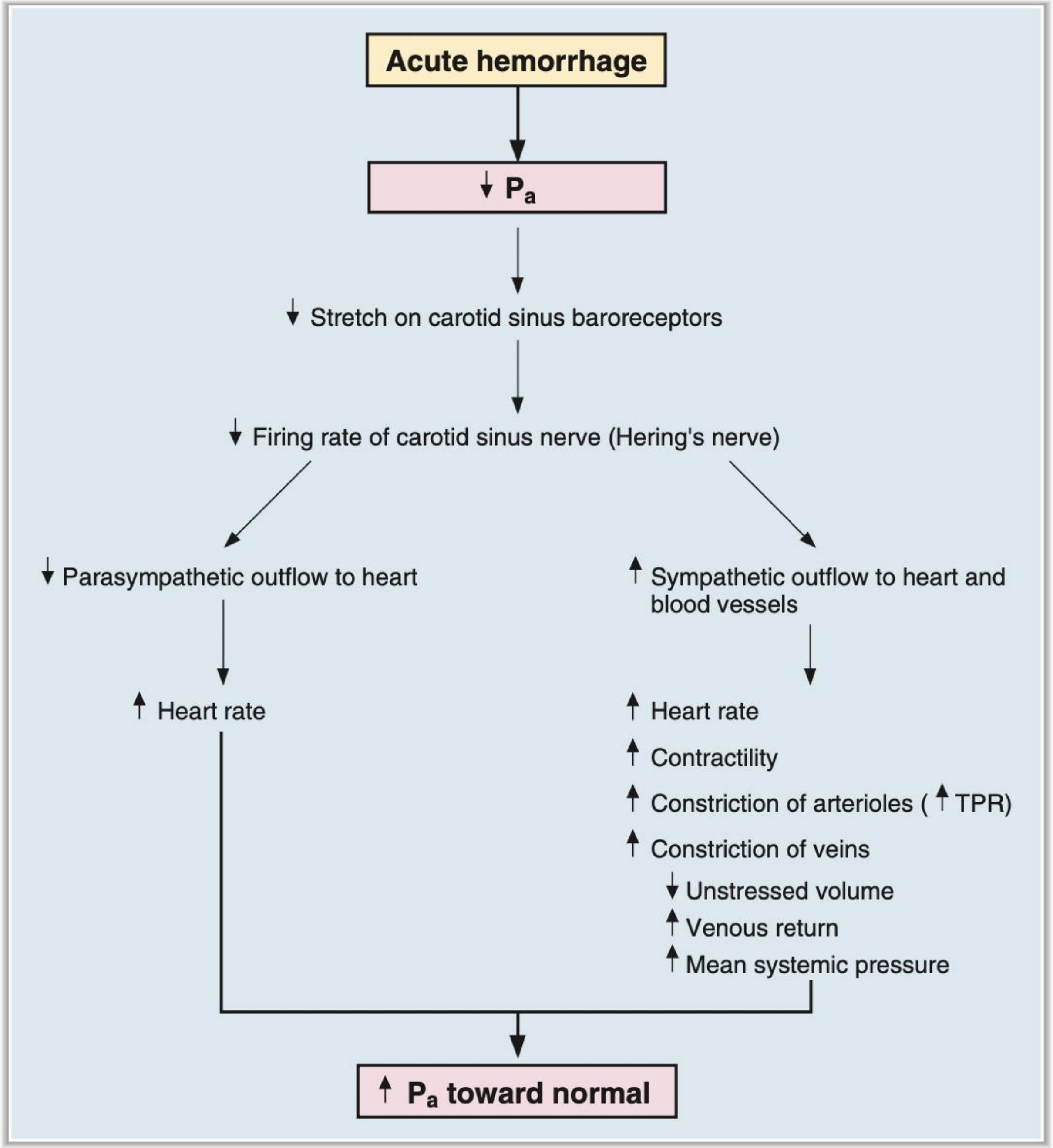


FIGURE 3.16 Role of the baroreceptor reflex in the cardiovascular response to hemorrhage. P_a = mean arterial pressure; TPR = total peripheral resistance.

Hormone	Stimulus for Secretion	Time Course	Mechanism of Action	Actions on the Kidneys
PTH	↓ plasma [Ca^{2+}]	Fast	Basolateral receptor Adenylate cyclase cAMP→urine	↓ Phosphate reabsorption (proximal tubule) ↑ Ca^{2+} reabsorption (distal tubule) Stimulates 1α-hydroxylase (proximal tubule)
ADH	↑ plasma osmolarity ↓ blood volume	Fast	Basolateral V_2 receptor Adenylate cyclase cAMP (Note: V_1 receptors are on blood vessels; mechanism is Ca^{2+}–IP_3)	↑ H_2O permeability (late distal tubule and collecting duct principal cells)
Aldosterone	↓ blood volume (via renin–angiotensin II) ↑ plasma [K^+]	Slow	New protein synthesis	↑ Na^+ reabsorption (ENaC, distal tubule principal cells) ↑ K^+ secretion (distal tubule principal cells) ↑ H^+ secretion (distal tubule α-intercalated cells)
ANP	↑ atrial pressure	Fast	Guanylate cyclase cGMP	↑ GFR ↓ Na^+ reabsorption
Angiotensin II	↓ blood volume (via renin)	Fast		↑ Na^+–H^+ exchange and HCO_3^- reabsorption (proximal tubule)

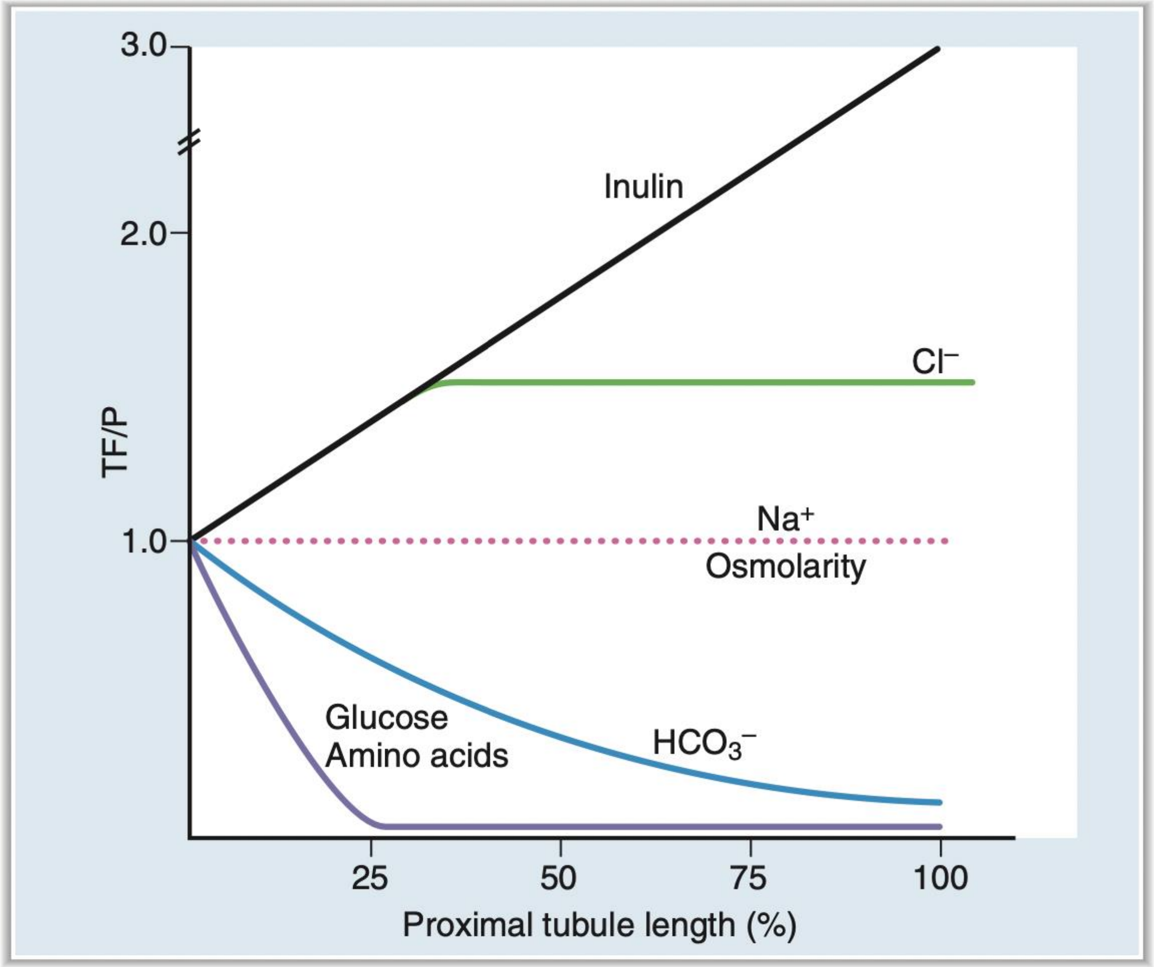


FIGURE 5.10 Changes in TF/P concentration ratios for various solutes along the proximal tubule.

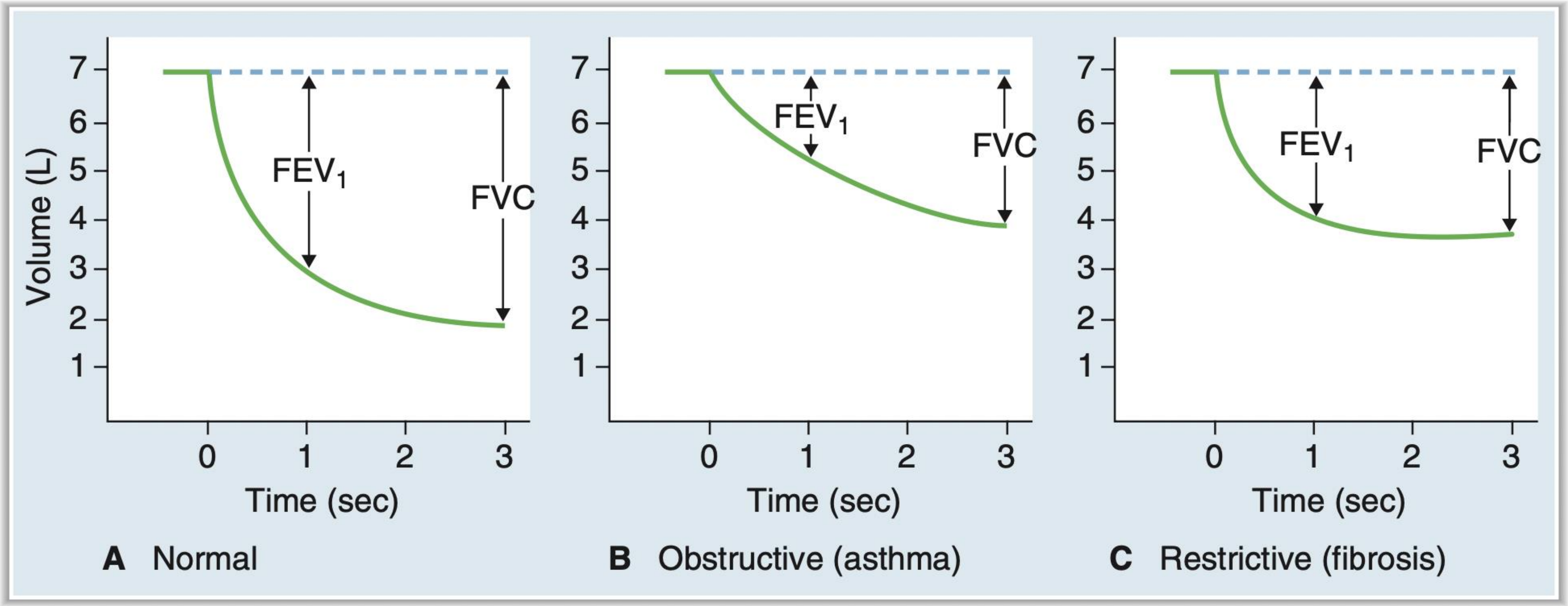
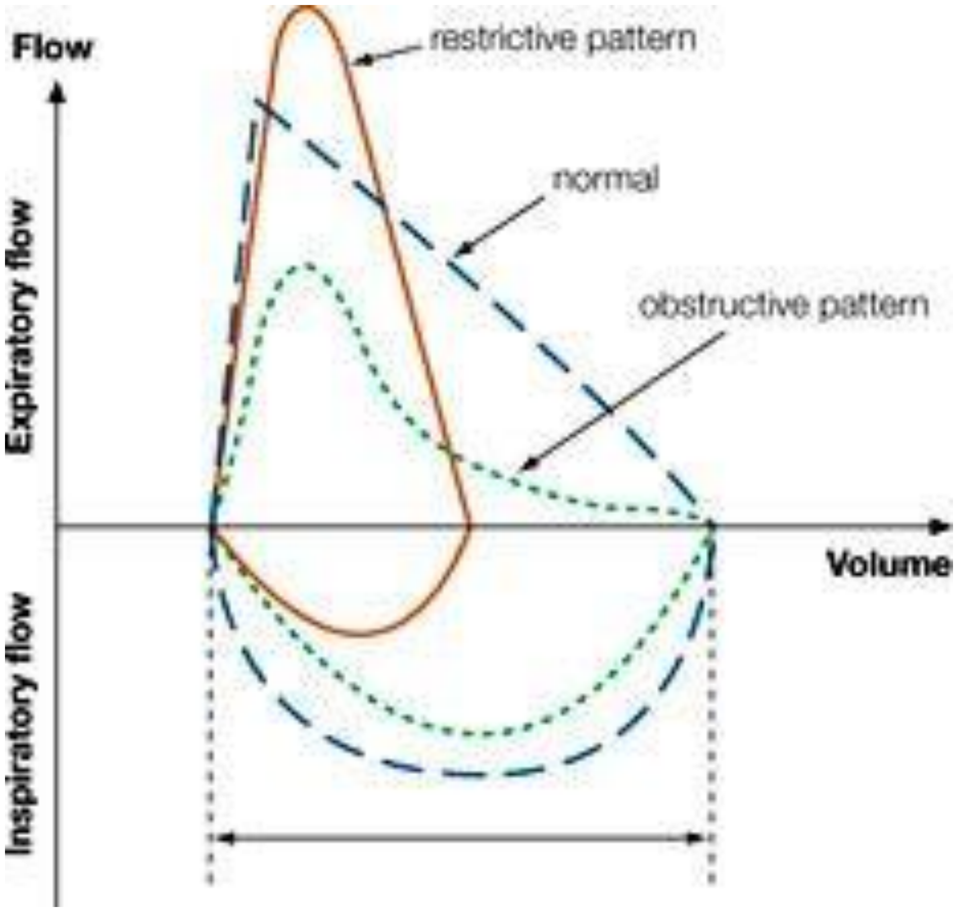
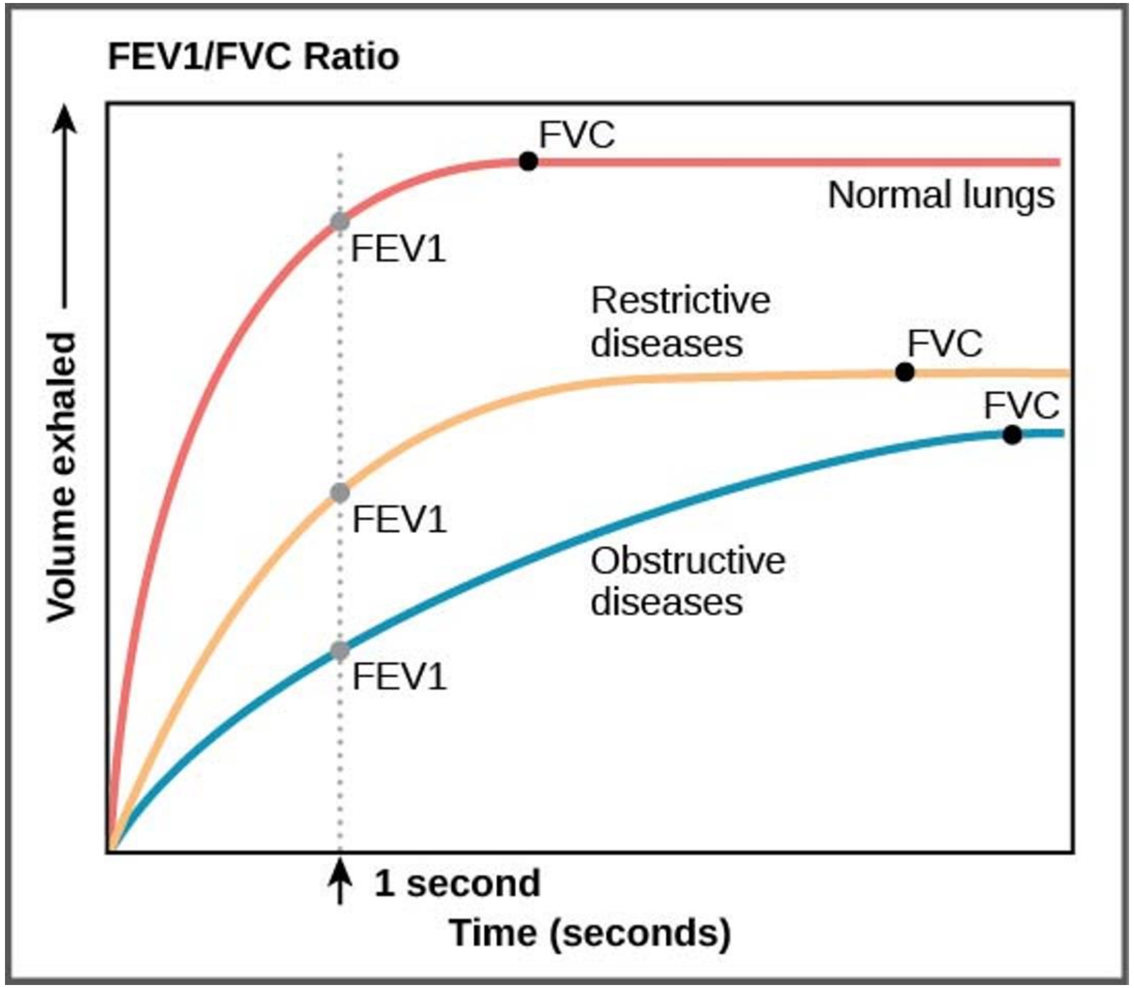
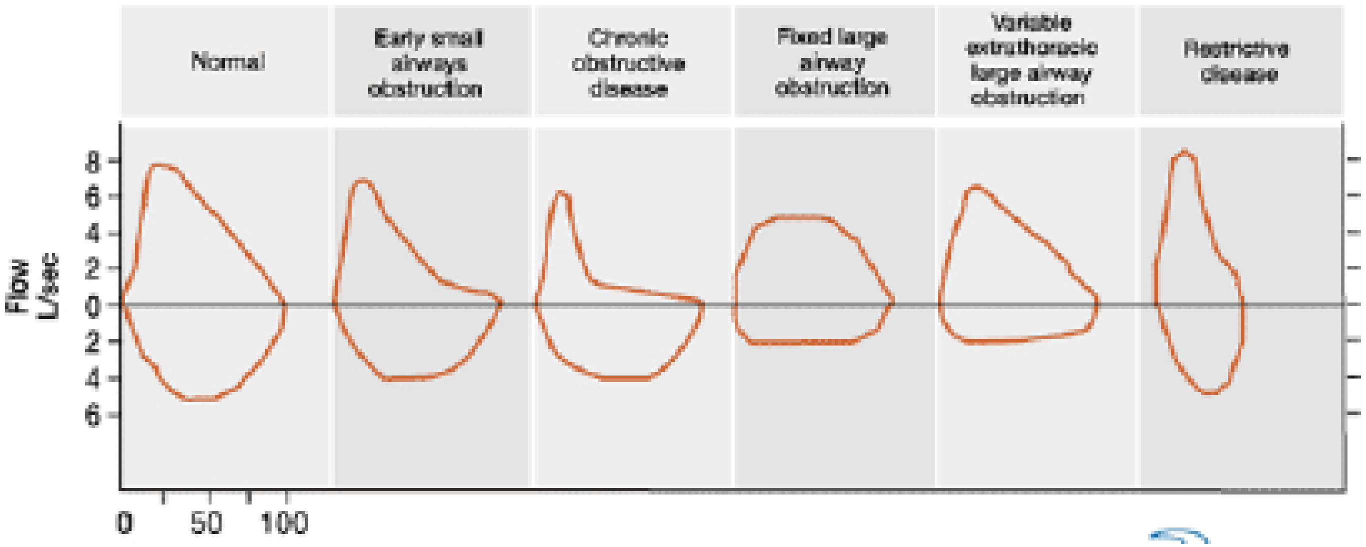
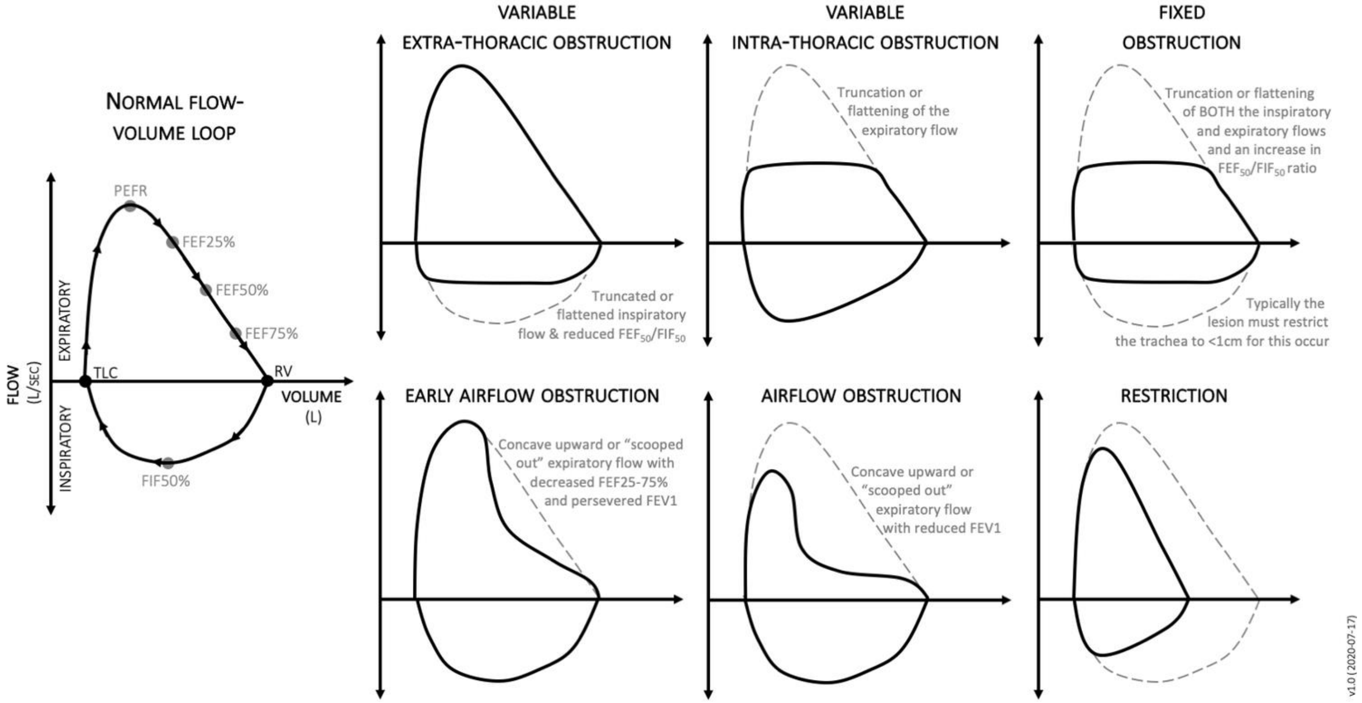


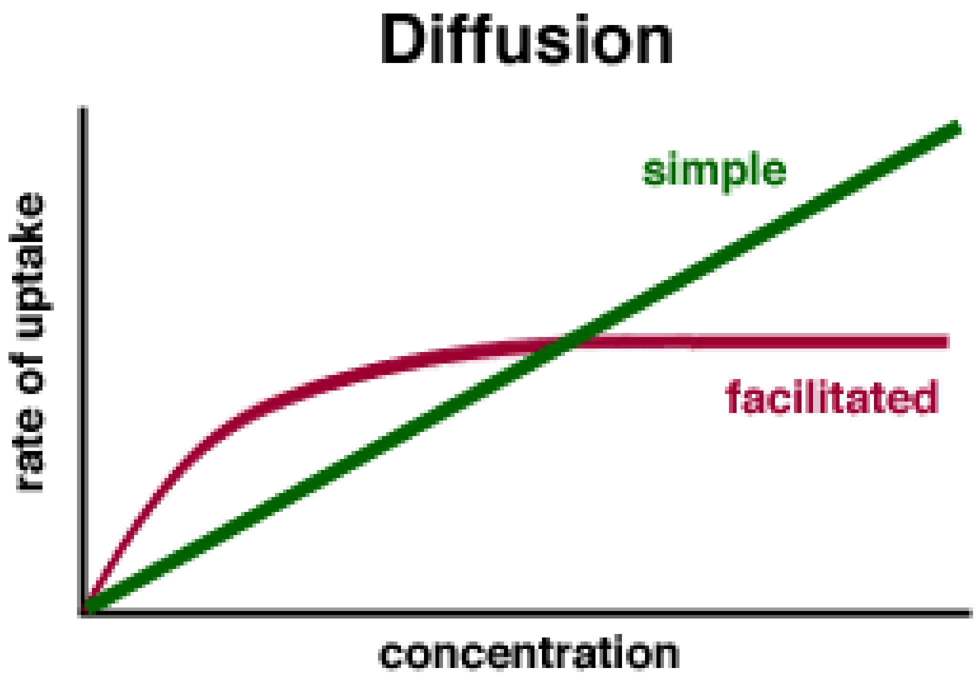
FIGURE 4.2 Forced vital capacity (FVC) and FEV_1 in normal subjects and in patients with lung disease. FEV_1 = volume expired in first second of forced maximal expiration.

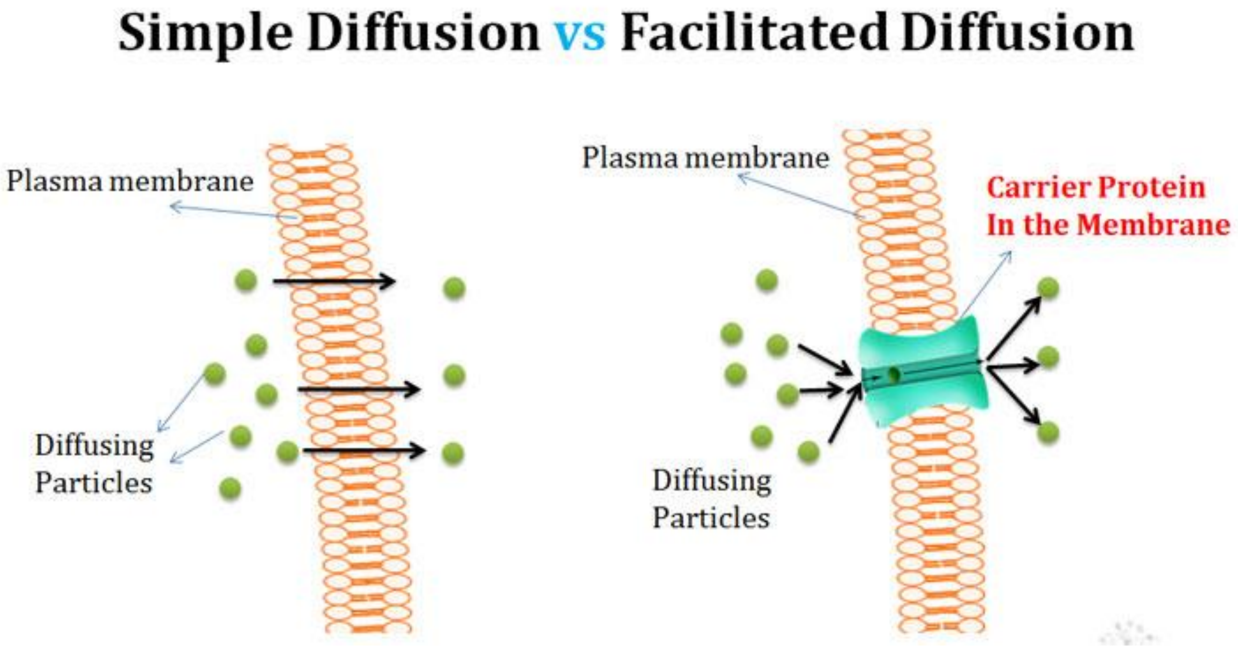

Flow
restrictive pattern
normal
obstructive pattern
Expiratory flow
Inspiratory flow
Volume


FEV1/FVC Ratio
FVC
Normal lungs
FEV1
Restrictive diseases
FVC
FVC
FEV1
Obstructive diseases
FEV1
Volume exhaled
1 second
Time (seconds)

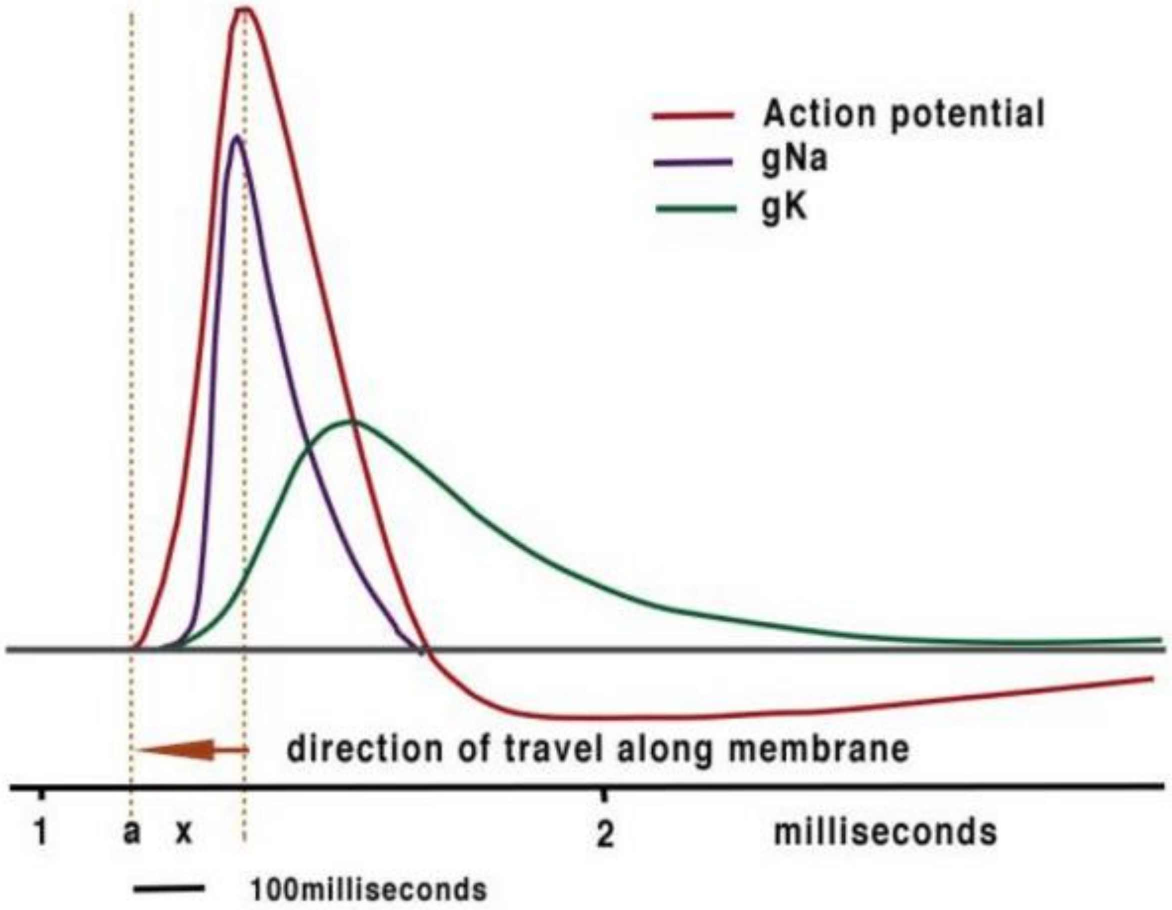

Normal
Early small airways obstruction
Chronic obstructive disease
Fixed large airway obstruction
Variable extrathoracic large airway obstruction
Restrictive disease
Flow L/sec
8
6
4
2
0
2
4
6
0
50
100

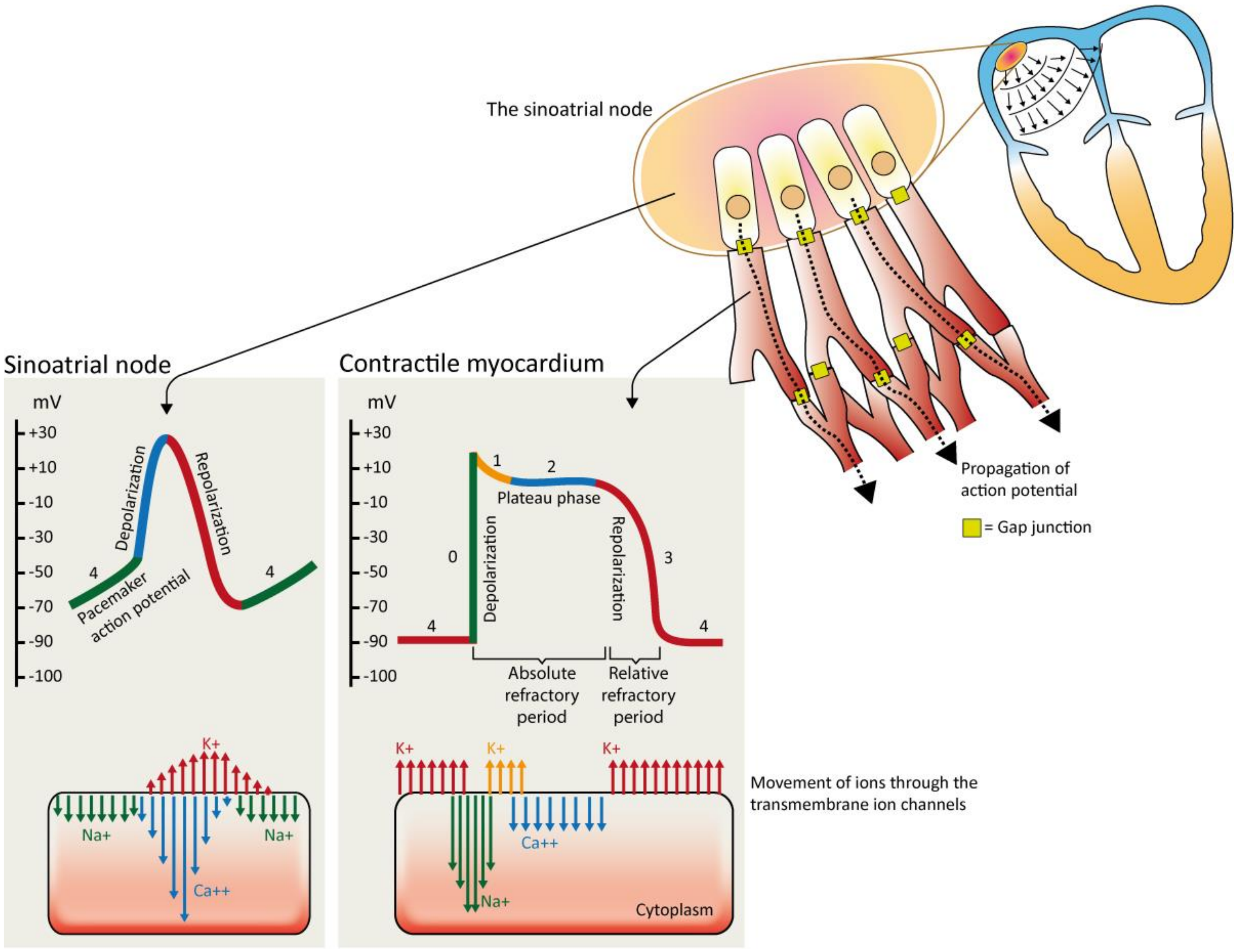

NORMAL FLOW-VOLUME LOOP
PEFR
FEF25%
FEF50%
FEF75%
TLC
RV
FLOW (L/SEC)
EXPIRATORY
INSPIRATORY
VOLUME (L)
FIF50%
VARIABLE EXTRA-THORACIC OBSTRUCTION
Truncated or flattened inspiratory flow & reduced FEF_{50}/FIF_{50}
VARIABLE INTRA-THORACIC OBSTRUCTION
Truncation or flattening of the expiratory flow
FIXED OBSTRUCTION
Truncation or flattening of BOTH the inspiratory and expiratory flows and an increase in FEF_{50}/FIF_{50} ratio
Typically the lesion must restrict the trachea to <1cm for this occur
EARLY AIRFLOW OBSTRUCTION
Concave upward or "scooped out" expiratory flow with decreased FEF25-75% and persevered FEV1
AIRFLOW OBSTRUCTION
Concave upward or "scooped out" expiratory flow with reduced FEV1
RESTRICTION
v1.0 (2020-07-17)


Diffusion
simple
facilitated
rate of uptake
concentration


Simple Diffusion vs Facilitated Diffusion
Plasma membrane
Diffusing
Particles
Plasma membrane
Carrier Protein
In the Membrane
Diffusing
Particles

GLUT 1	Basal glucose uptake	Placenta, blood-brain barrier, brain, red cells, kidneys, colon, many other organs
GLUT 2	β-cell glucose sensor; transport out of intestinal and renal epithelial cells	β cells of islets, liver, epithelial cells of small intestine, kidneys
GLUT 3	Basal glucose uptake	Brain, placenta, kidneys, many other organs
GLUT 4	Insulin-stimulated glucose uptake	Skeletal and cardiac muscle, adipose tissue, other tissues
GLUT 5	Fructose transport	Jejunum, sperm
GLUT 6	Function not known	Brain, spleen, leucocytes
GLUT 7	Glucose-6-phosphate transporter in the endoplasmic reticulum	Liver


Action potential
gNa
gK
direction of travel along membrane
1
a
x
2
milliseconds
100milliseconds



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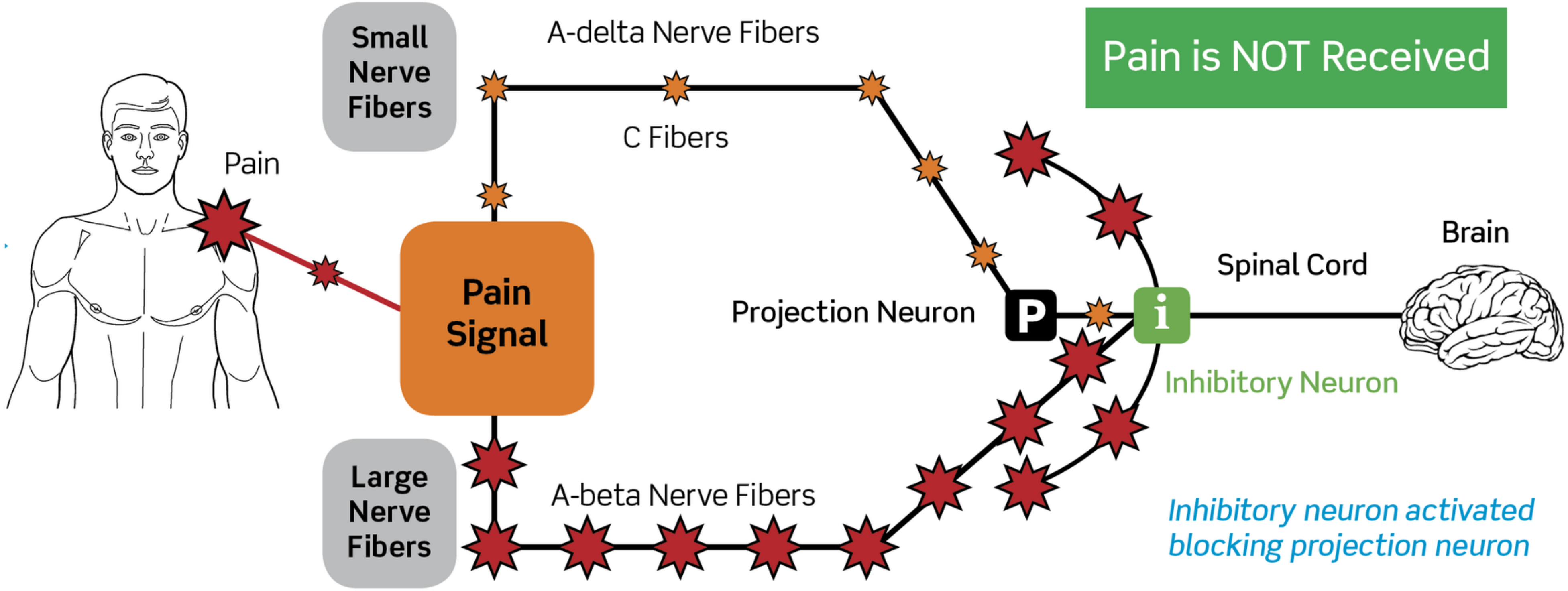
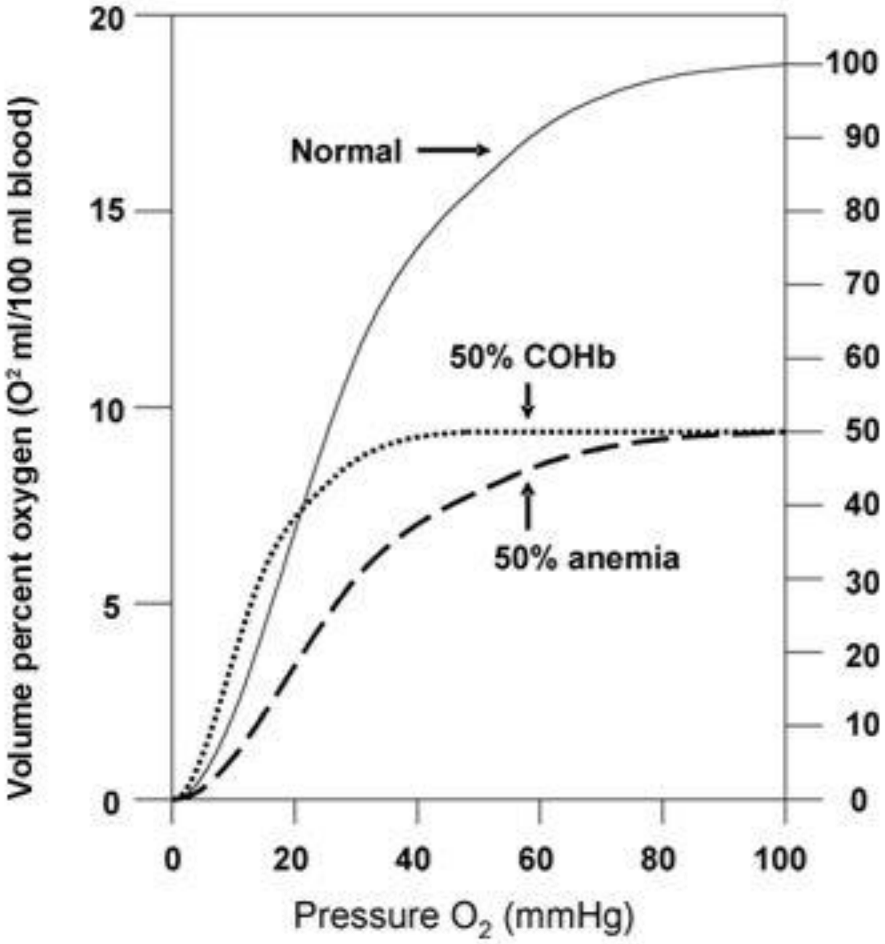
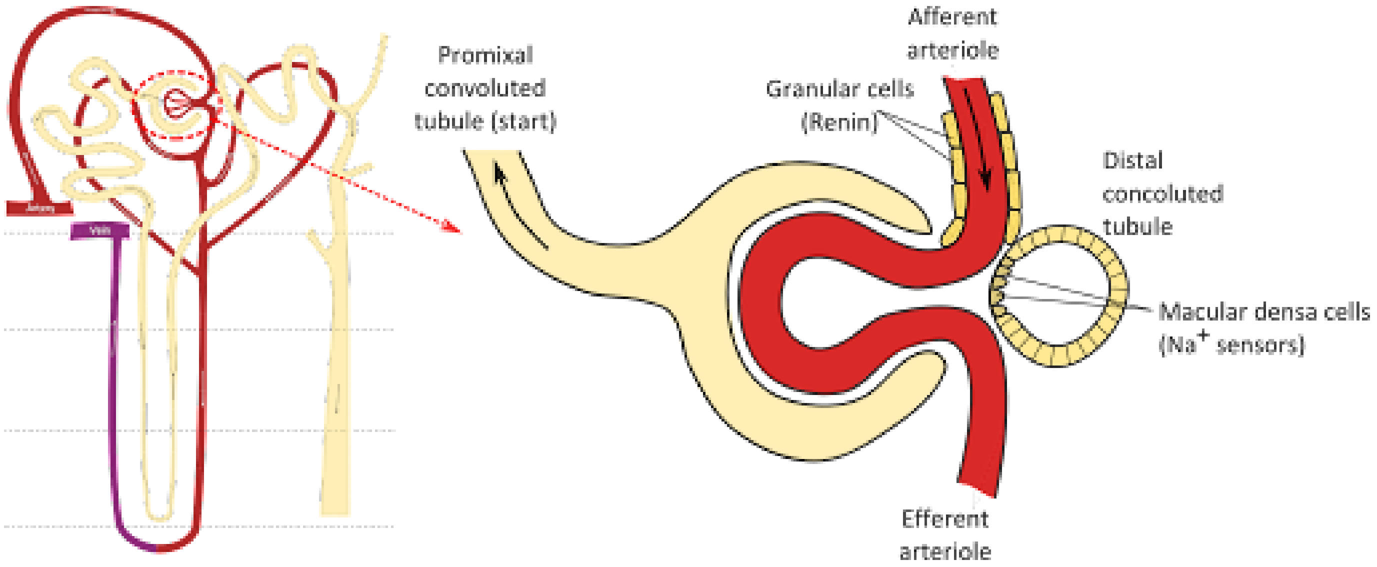
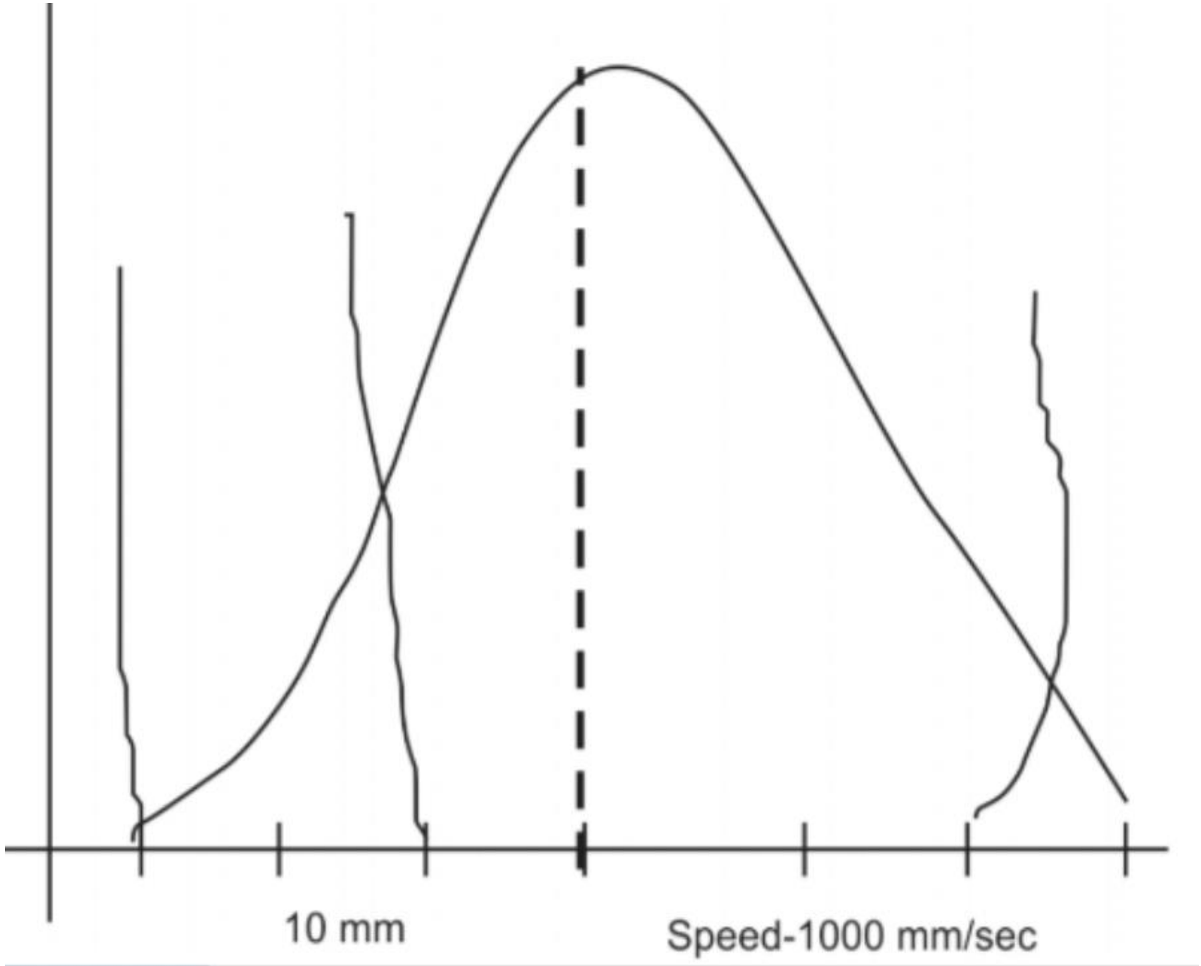

Small Nerve Fibers
A-delta Nerve Fibers
C Fibers
Pain is NOT Received
Pain
Pain Signal
Projection Neuron
P
i
Spinal Cord
Brain
Inhibitory Neuron
Large Nerve Fibers
A-beta Nerve Fibers
Inhibitory neuron activated blocking projection neuron

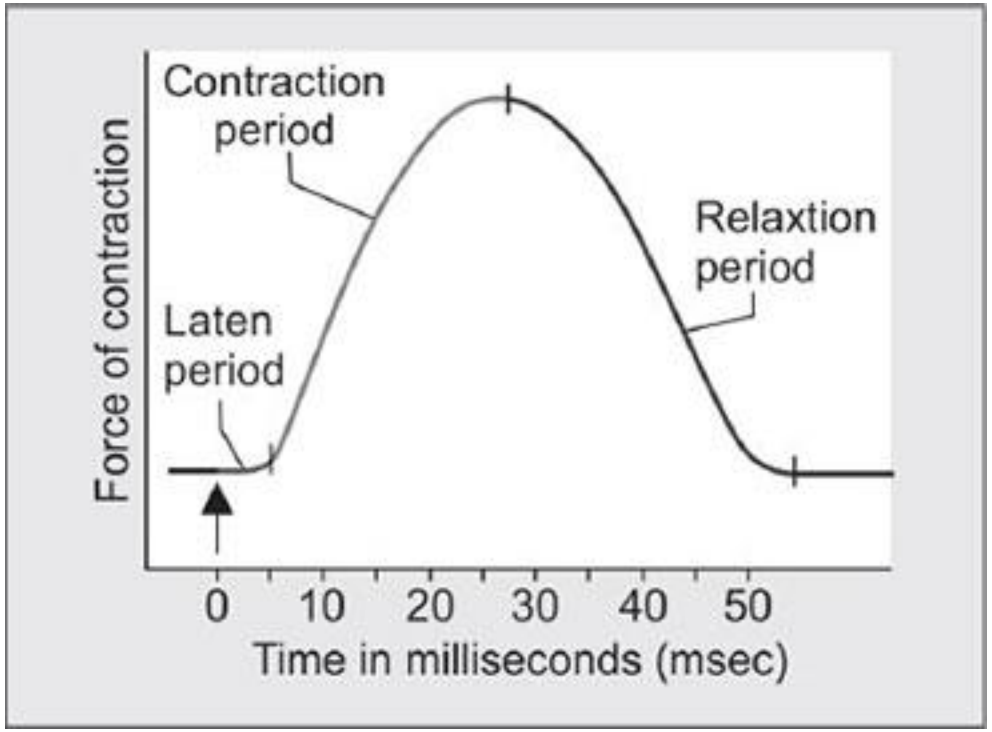


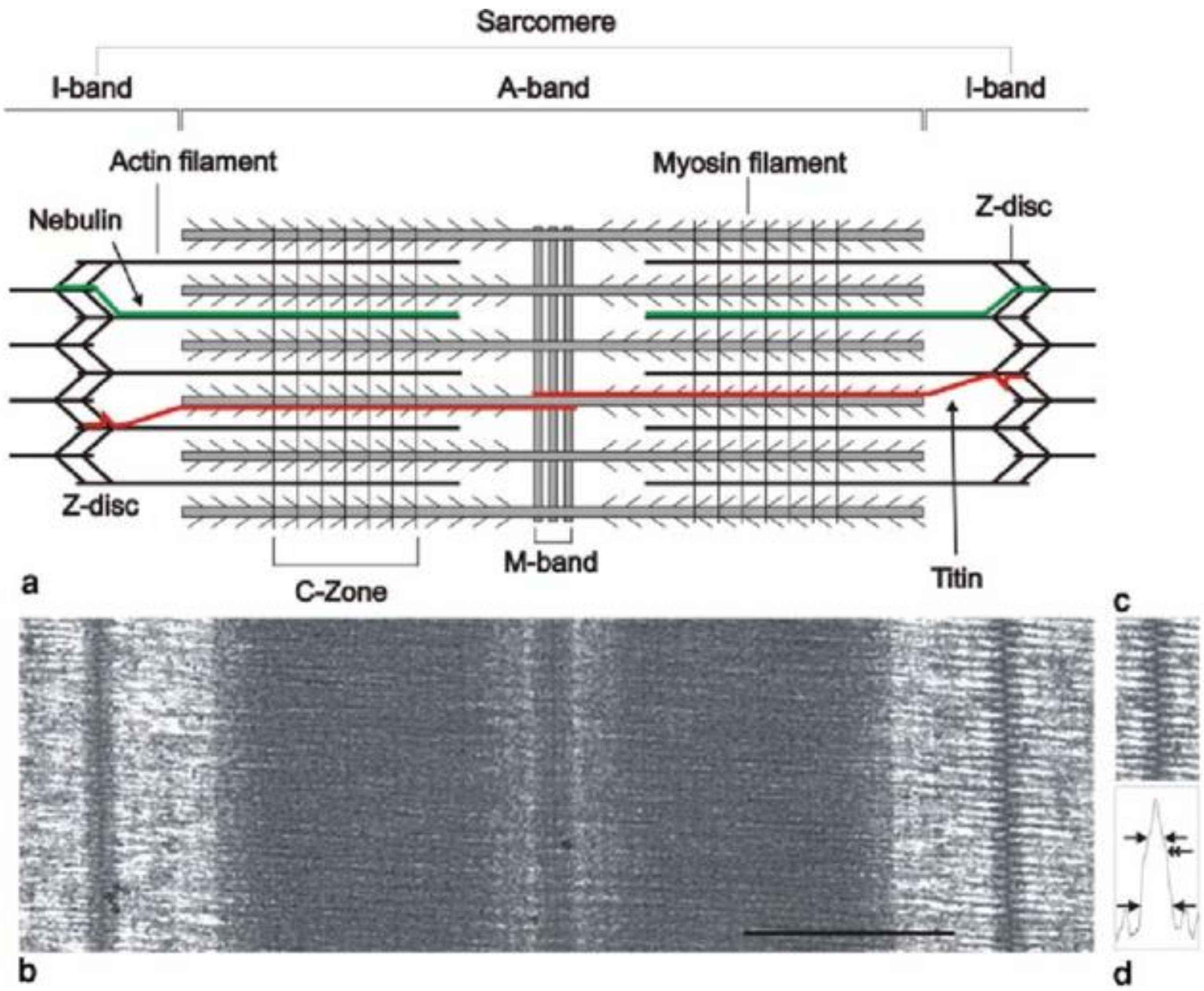
Volume percent oxygen (O² ml/100 ml blood)
20
15
10
5
0
100
90
80
70
60
50
40
30
20
10
0
Normal
50% COHb
50% anemia
0
20
40
60
80
100
Pressure O2 (mmHg)

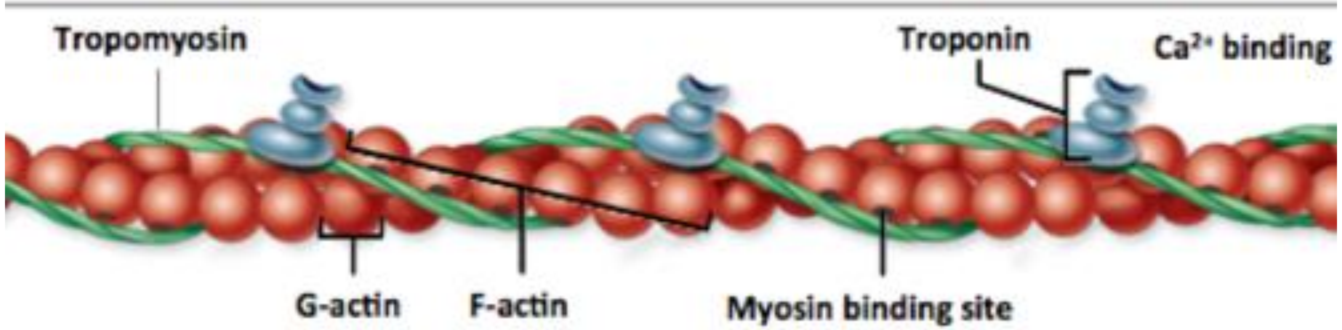


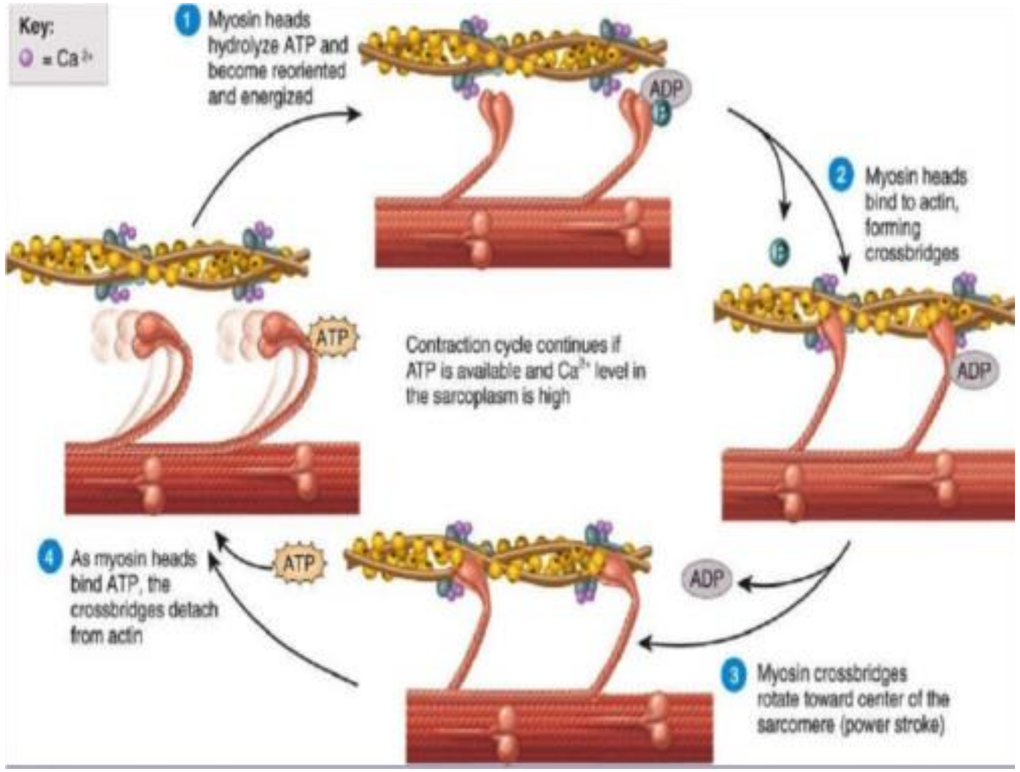
Promixal
convoluted
tubule (start)
Afferent
arteriole
Granular cells
(Renin)
Distal
concoluted
tubule
Macular densa cells
(Na+ sensors)
Efferent
arteriole


10 mm
Speed-1000 mm/sec


Contraction period
Relaxtion period
Laten period
Force of contraction
0
10
20
30
40
50
Time in milliseconds (msec)

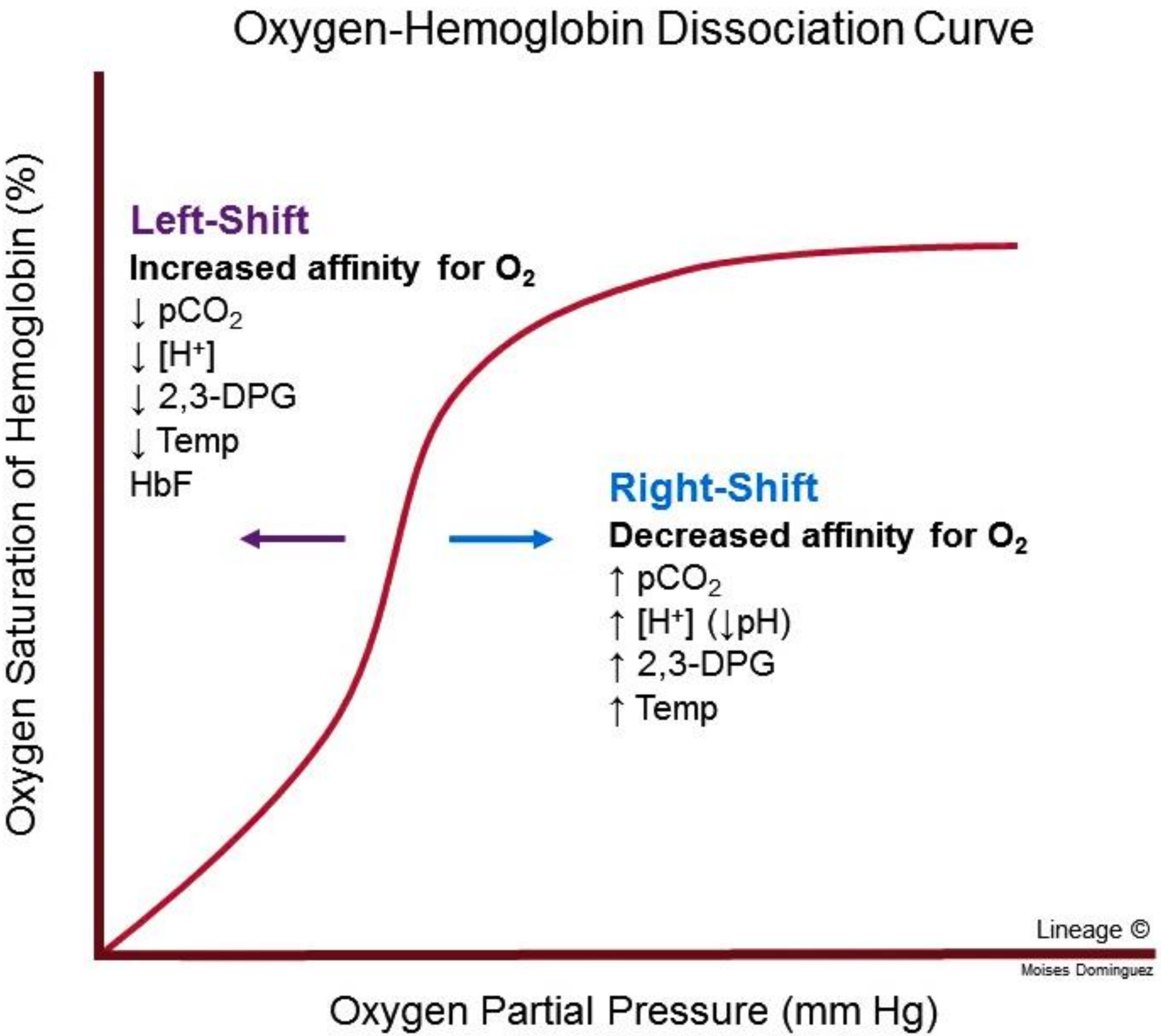

Sarcomere
I-band
A-band
I-band
Actin filament
Myosin filament
Nebulin
Z-disc
Z-disc
M-band
C-Zone
Titin
a
b
c
d


Tropomyosin
Troponin
Ca²⁺ binding
G-actin
F-actin
Myosin binding site


Key:
= Ca²⁺
1 Myosin heads hydrolyze ATP and become reoriented and energized
ADP
2 Myosin heads bind to actin, forming crossbridges
ADP
Contraction cycle continues if ATP is available and Ca²⁺ level in the sarcoplasm is high
ATP
ADP
3 Myosin crossbridges rotate toward center of the sarcomere (power stroke)
ATP
4 As myosin heads bind ATP, the crossbridges detach from actin

Increase in all of the following shift O2-Hb dissociation curve to right except

a) pCo2
b) 2,3 BPG
c) pH
d) Tenperature


Oxygen-Hemoglobin Dissociation Curve
Left-Shift
Increased affinity for O_2
↓ pCO_2
↓ $[H^+]$
↓ 2,3-DPG
↓ Temp
HbF
Right-Shift
Decreased affinity for O_2
↑ pCO_2
↑ $[H^+]$ (↓pH)
↑ 2,3-DPG
↑ Temp
Oxygen Saturation of Hemoglobin (%)
Oxygen Partial Pressure (mm Hg)
Lineage ©
Moises Dominguez

Which of the following transection results in apneusis

a) Above the pons with vagus cut
b) Below medulla with vagi intact
c) Midpontine with vagus intact
d) Midpontine with vagus cut

Label	Level of transection	Vagi intact	Vagi cut
A	Complete transection above pons	Regular breathing continues	Regular breathing continues but depth of inspiration increases
B	Mid-pontine level section	Regular breathing continues	Apneusis develops
C	Transection midway between pons and medulla	Irregular but rhythmic respiration	Irregular but rhythmic respiration
D	Complete transection below medulla	Spontaneous respiration ceases	Spontaneous respiration ceases

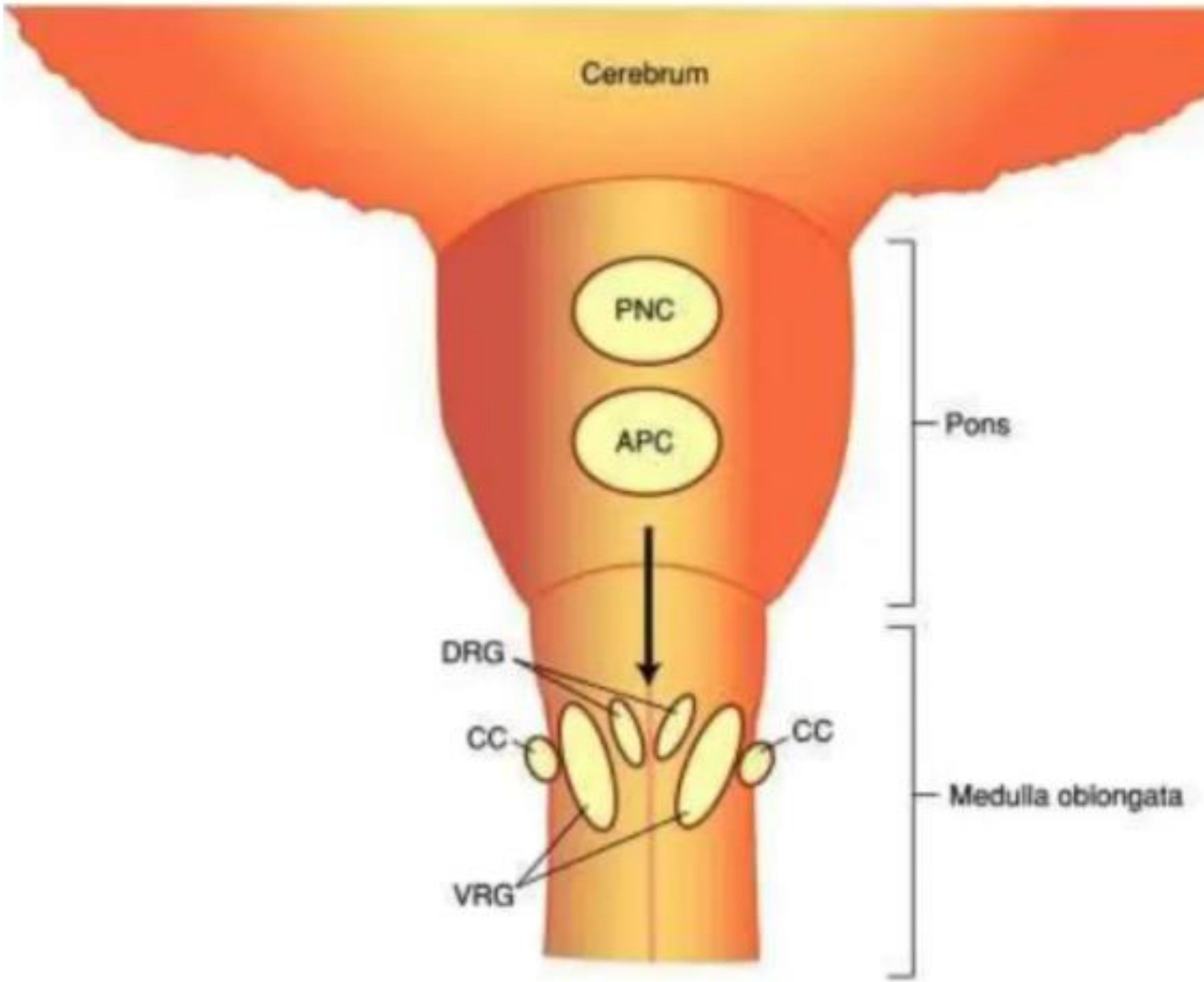
Depth of inspiration controlled by:

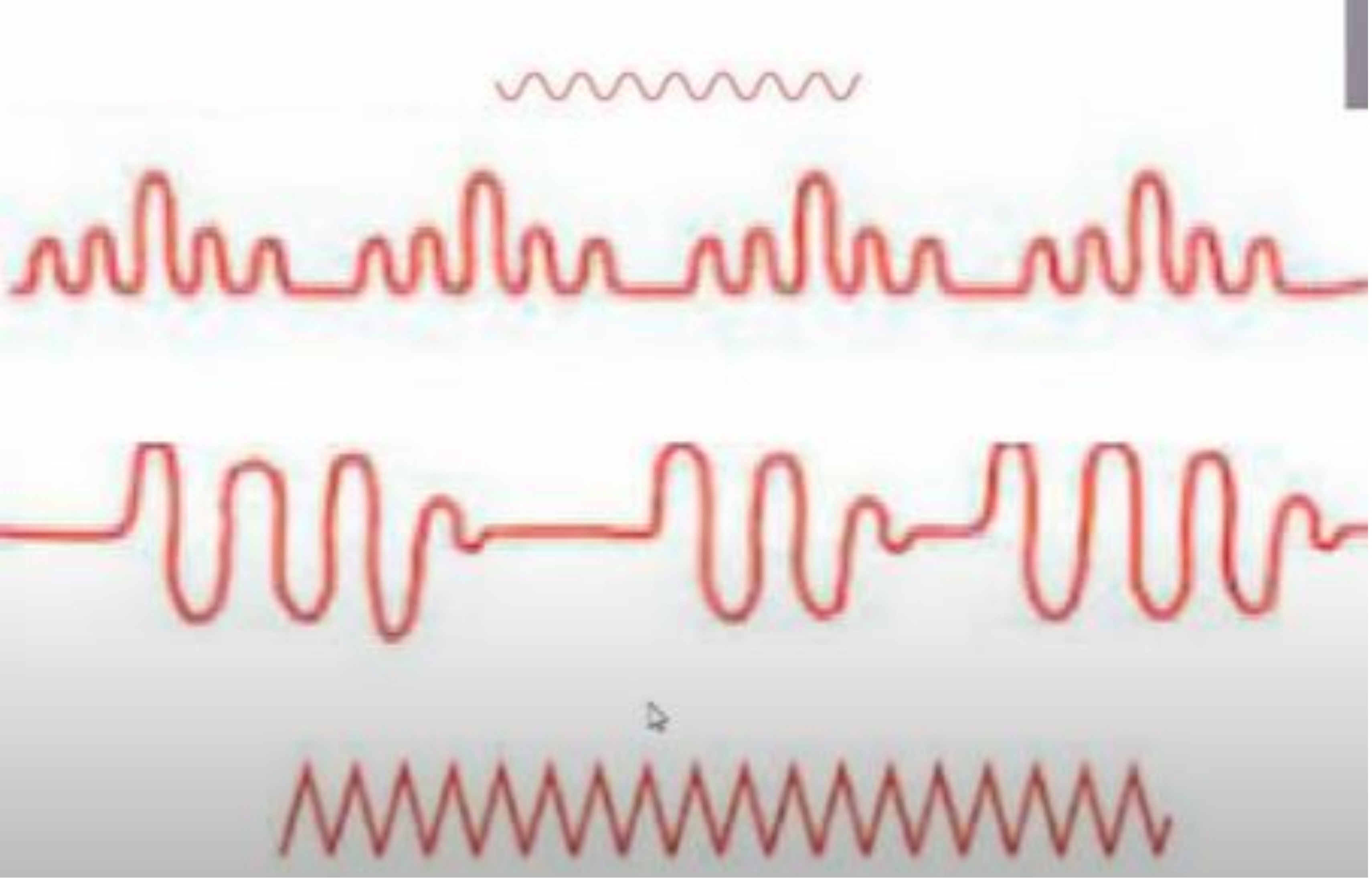
a. Pneumotaxic center
b. Posterior medulla
c. Apneustic center
d. Pons

Pacemaker regulating the rate of respiration:

a. Pneumotaxic center
b. Dorsal group of nucleus
c. Apneustic center
d. Pre-Bötzinger

Respiratory centre component	Primary function
Pre-Bőtzinger complex	Pacemaker cells of spontaneous or automatic breathing
DRG	Respiratory rhythm generator (inspiratory ramp signal)
VRG	Overdrive mechanism
Pneumotaxic centre	Controls the “switch off” point of inspiratory ramp signal
Apneustic centre	Delays switch off signal- promotes inspiration
Vagi	Inhibits inspiratory discharge


Cerebrum
PNC
APC
Pons
DRG
CC
CC
Medulla oblongata
VRG



Evan’s blue is used for measurement of

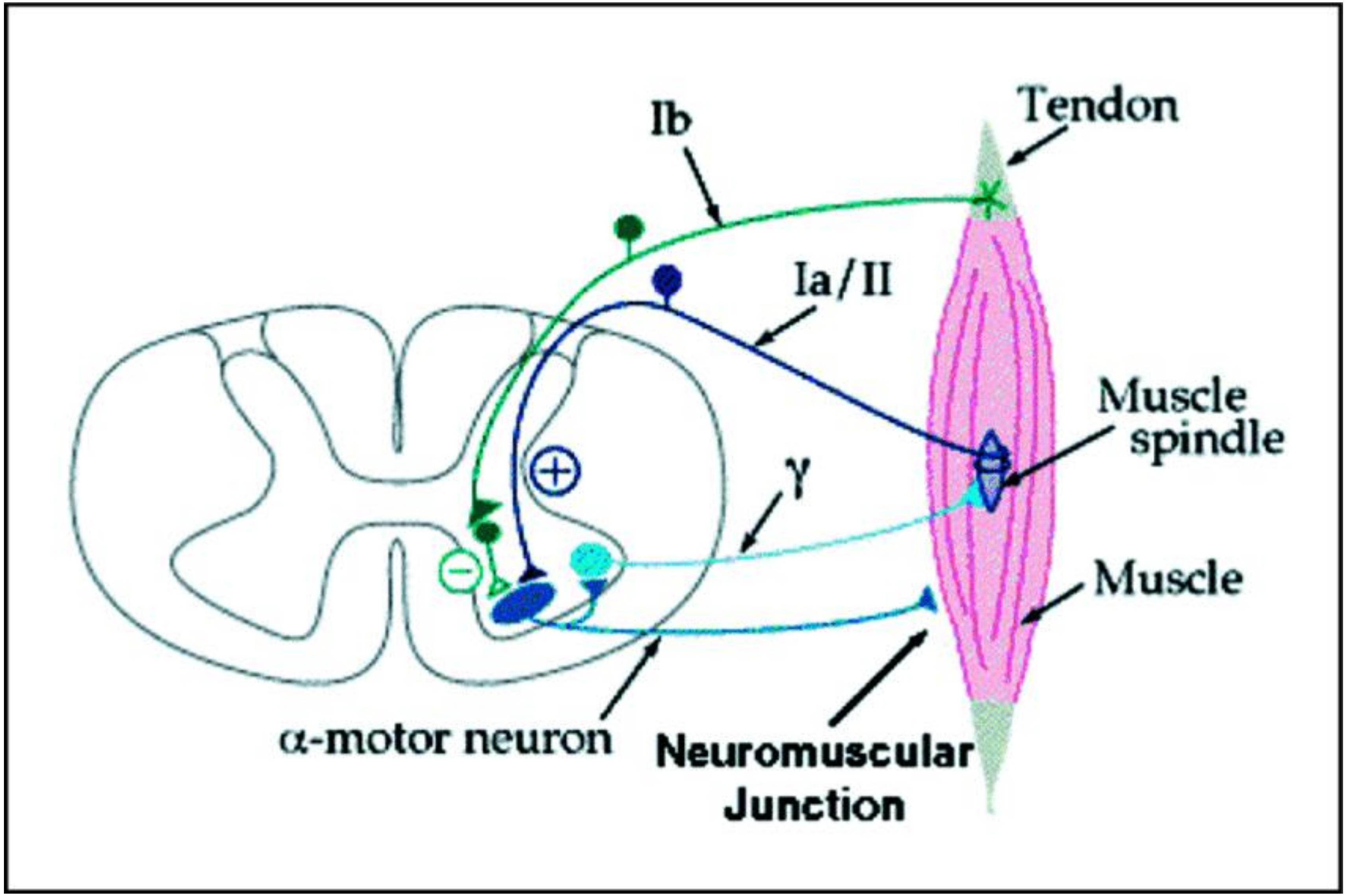
a) ICF
b) ECF
c) Plasma
d) TBW

Lung compliance is increased in

a) Pulmonary edema
b) Pulmonary fibrosis
c) Emphysema
d) Interstitial lung disease

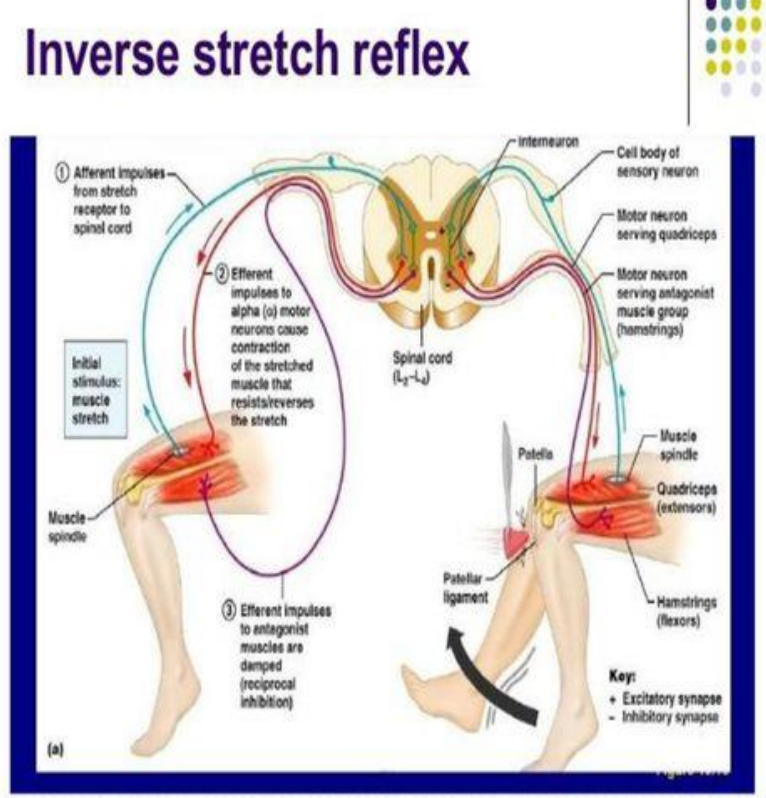
True about Golgi tendon reflex

a) Bisynaptic
b) Afferent is type II fiber
c) Response is muscle contraction
d) Activated by decrease in muscle tension


Ib
Tendon
Ia/II
Muscle
spindle
γ
Muscle
α-motor neuron
Neuromuscular
Junction

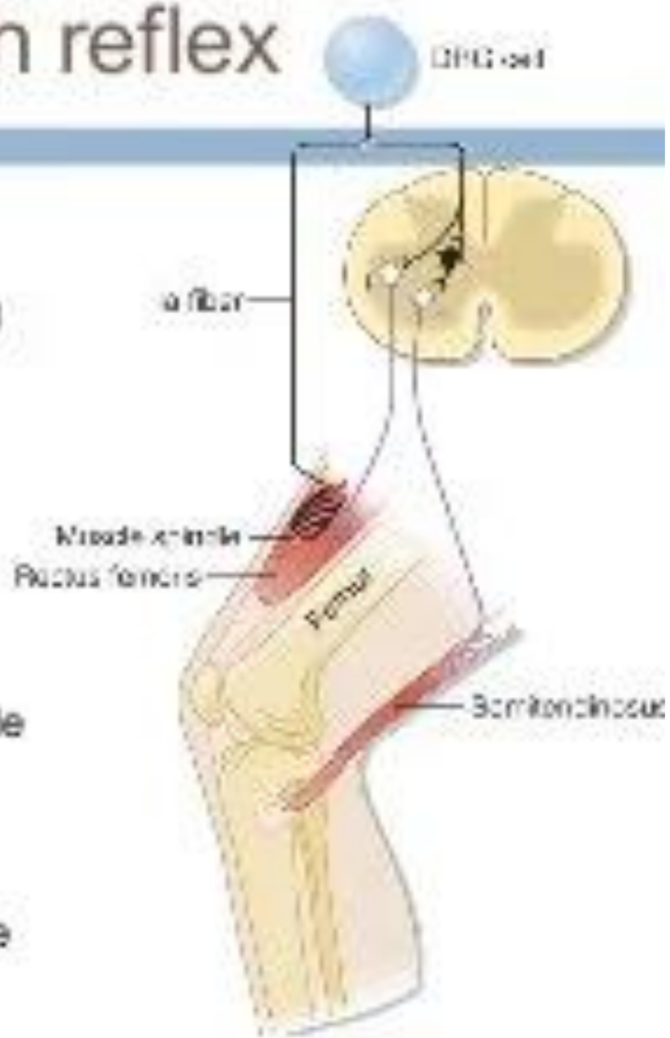
Golgi Tendon Reflex (Inverse Stretch Reflex)-2

- It is called inverse stretch reflex because it is the inverse of stretch reflex
- It is initiated by an increase in muscle tension
- This activates Group Ib nerve fibers in Golgi tendon organ
- The sensory input activates an inhibitory interneuron in the spinal cord
- This interneuron inhibits the activity of motor neuron innervating the same muscle causing muscle relaxation

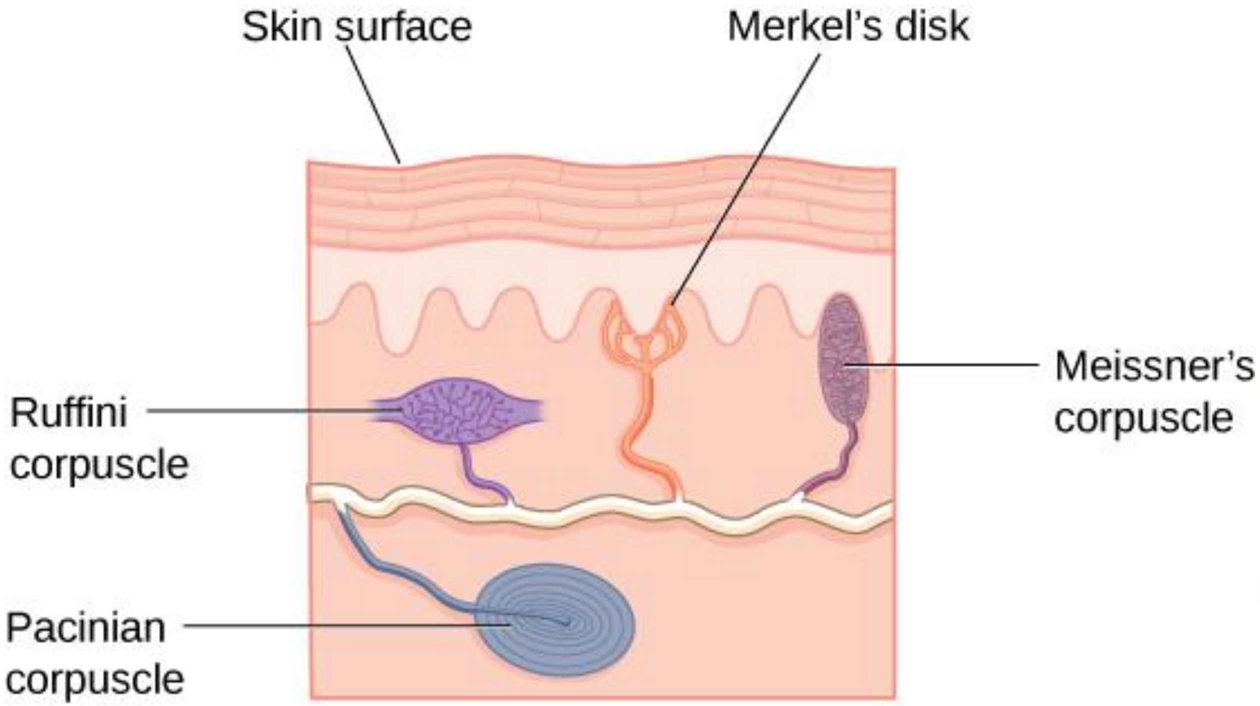


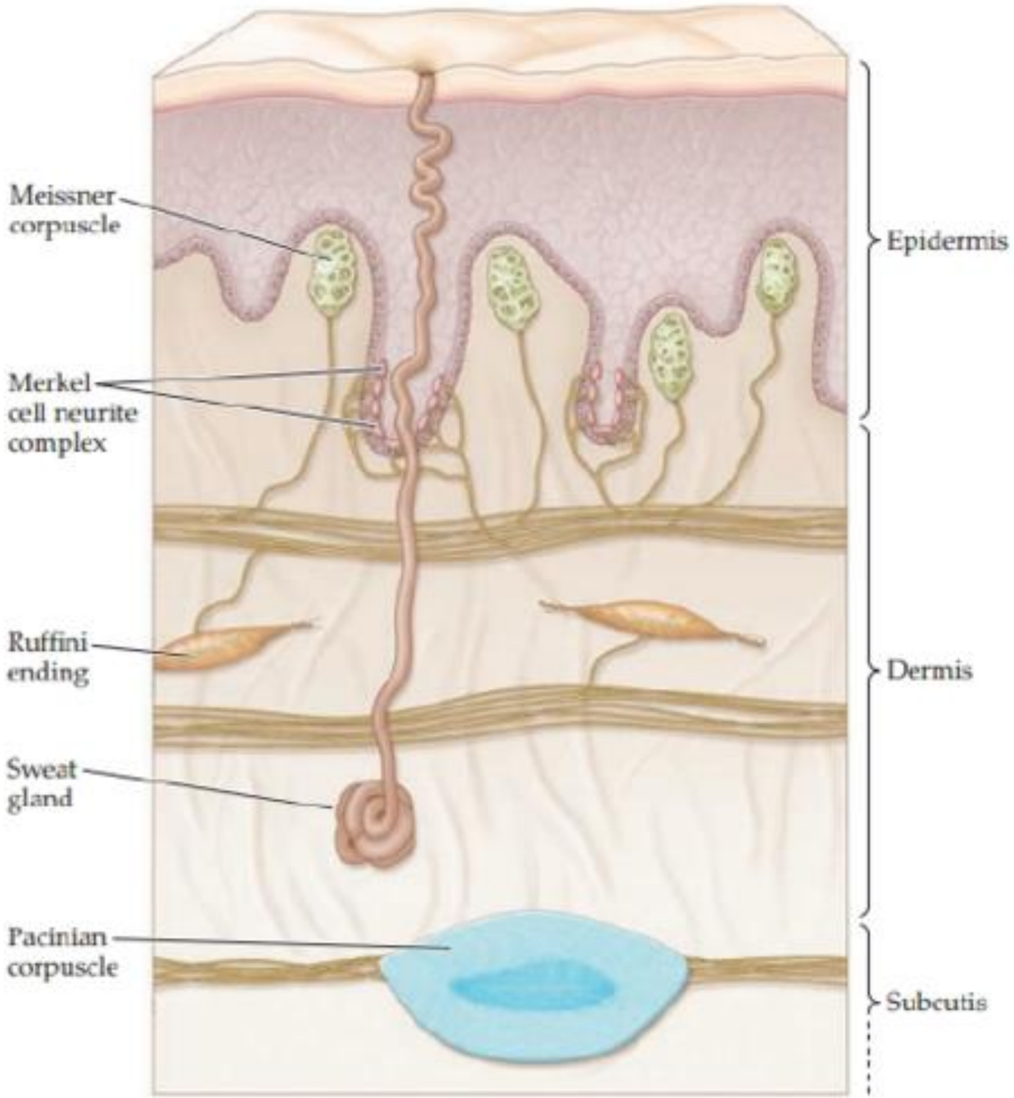
Myotatic or stretch reflex

- Monosynaptic reflex mediated by muscle spindles
  - Contraction in response to lengthening
- Reflex arc:
  1. Muscle stretches
  2. Ia afferent of muscle spindle increase firing
  3. Synapse on α motor neuron and inhibitory interneuron in spinal cord
  4. α motor neuron of homonymous muscle excited, and of antagonist muscle inhibited
  5. Homonymous muscle contracts to oppose lengthening, antagonist muscle relaxes



B&L Figure 9-6


Skin surface
Merkel's disk
Meissner's corpuscle
Ruffini corpuscle
Pacinian corpuscle


Meissner corpuscle
Merkel cell neurite complex
Ruffini ending
Sweat gland
Pacinian corpuscle
Epidermis
Dermis
Subcutis

	Extracellular fluid	Intracellular fluid
Na^+	**142 mEq/L**	10 mEq/L
K^+	4 mEq/L	**140 mEq/L**
Ca^{++}	**2.4 mEq/L**	0.0001 mEq/L
Cl^-	**103 mEq/L**	4 mEq/L
HCO_3^-	**28 mEq/L**	10 mEq/L
PO_4^{3-}	4 mEq/L	**75 mEq/L**
Glucose	**90 mg/dL**	0-20 mg/dL
Proteins	2 g/dl (5mEq/L)	**16 g/dL (40 mEq/L)**
pH	7.4	7.0
Osmolarity	282 mOsm/L	281 mOsm/L
Major Cation	Na^+	K^+
Major Anion	Cl^-	Phosphate
Buffer	$HCO3^-$	Protein
Most osmotically active ion	Na^+	K^+