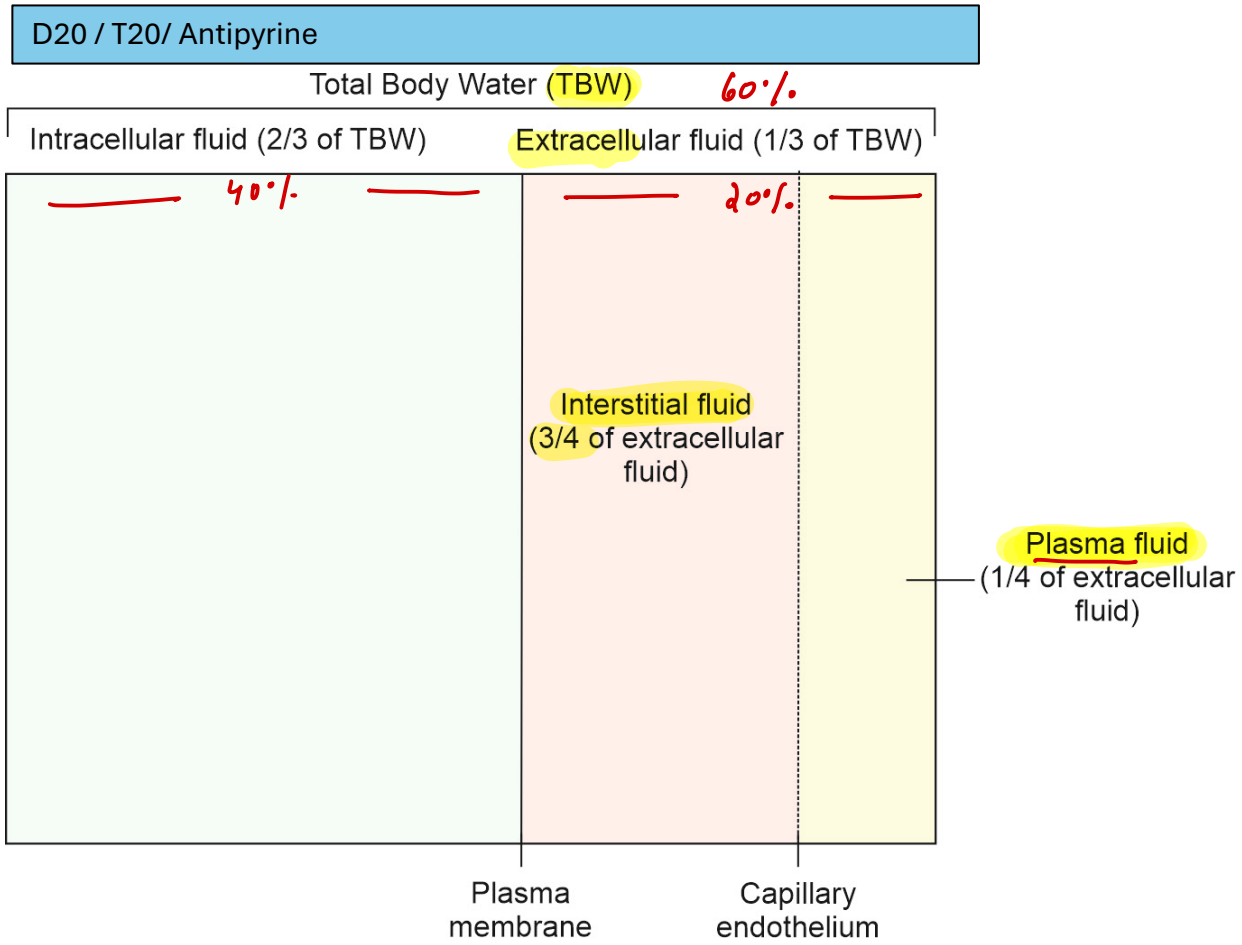
General Physiology

Body fluid compartments



RISA
Evans Blue (T-1824)

Mannitol
Sucrose
Inulin
Na thiosulfate

Age- TBW ↓
Male > Female
60% 50%

	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
Mg^{++}	1.2 mEq/L	58 mEq/L
Cl^-	103 mEq/L	4 mEq/L
HCO_3^-	28 mEq/L	10 mEq/L
Phosphates	4 mEq/L	75 mEq/L
$SO_4^=$	1 mEq/L	2 mEq/L
Glucose	90 mg/dl	0 to 20 mg/dl
Amino acids	30 mg/dl	200 mg/dl ?
Cholesterol, Phospholipids, Neutral fat	0.5 g/dl	2 to 95 g/dl
PO_2	35 mm Hg	20 mm Hg ?
PCO_2	46 mm Hg	50 mm Hg ?
pH	7.4	7.0
Proteins	2 g/dl (5 mEq/L)	16 g/dl (40 mEq/L)

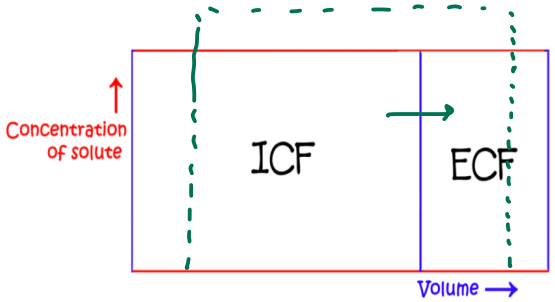
K Mg PO_4

Darrow-Yannet diagrams

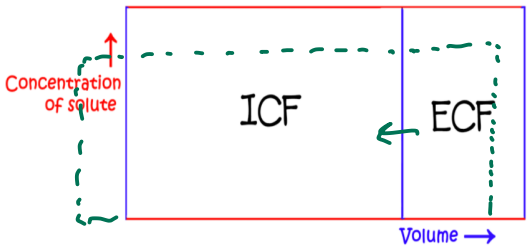
< ECF ↓osm → ↑osm

Loss of isotonic fluid = vomiting / diarrhea / hge

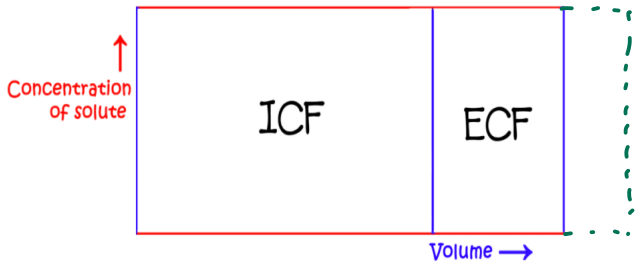
Loss of hypotonic fluid - sweating / DI



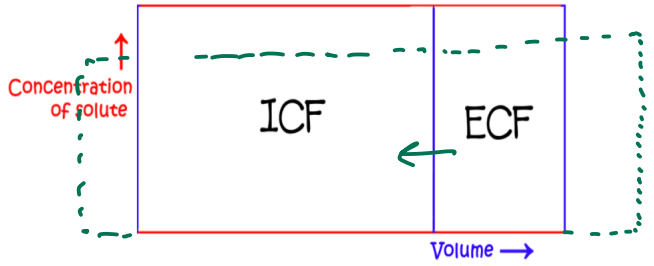
Loss of hypertonic fluid Addison / Loop D



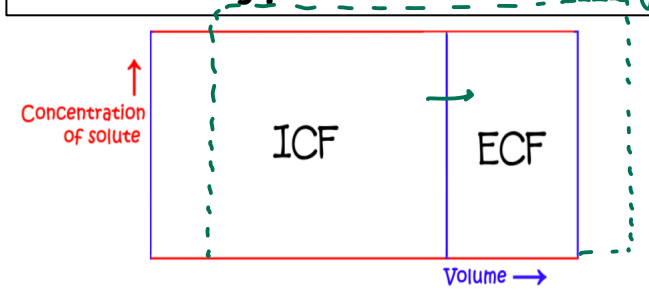
Gain of isotonic fluid - crystalloid - NS/RL



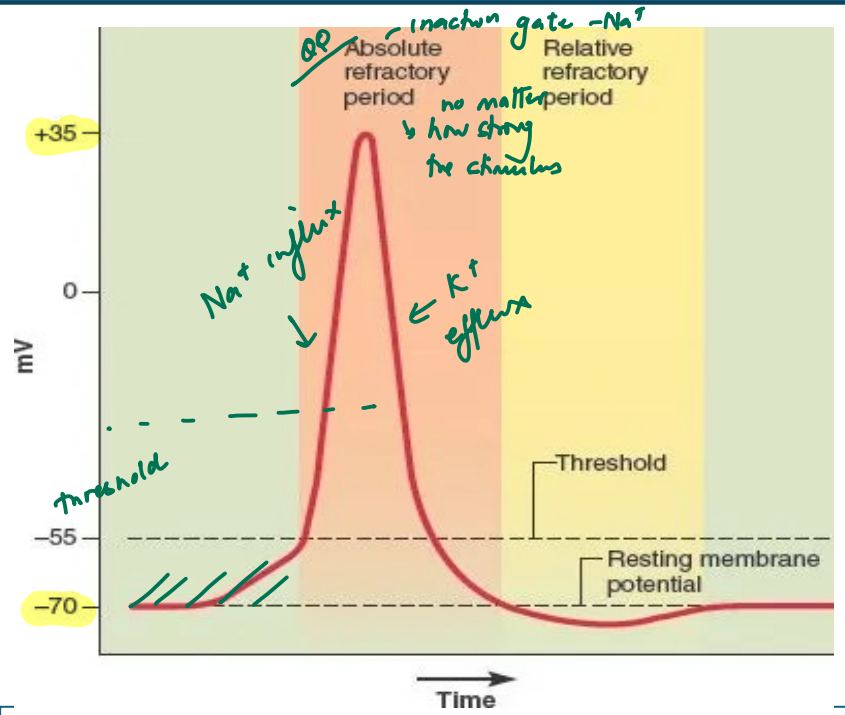
Gain of hypotonic fluid - SIADH 1° polydipsia

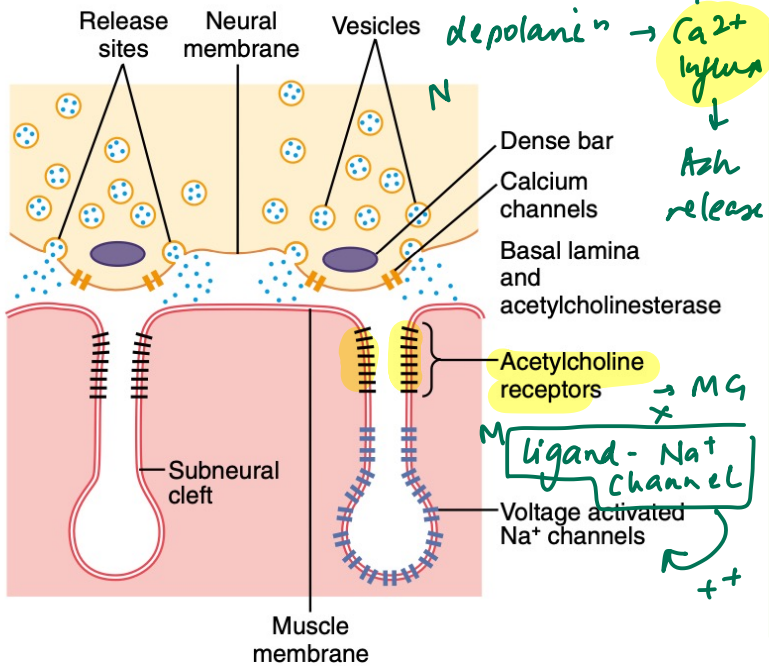


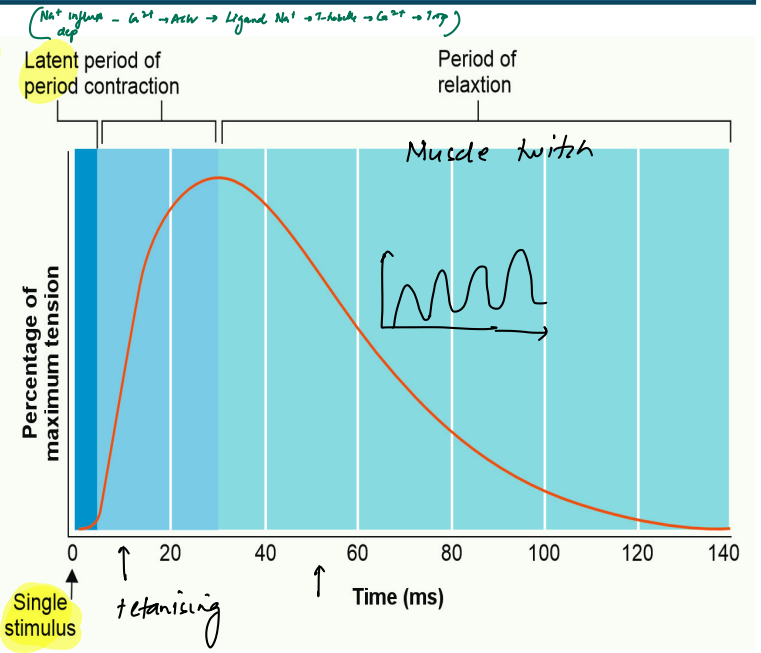
Gain of hypertonic fluid Hypertonic saline infusion



Nerve-muscle physiology



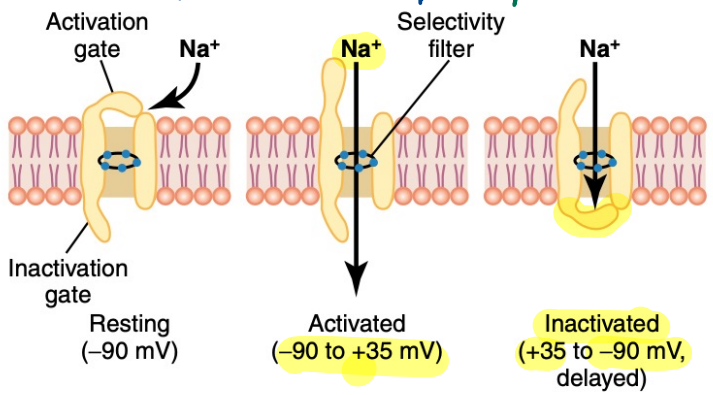


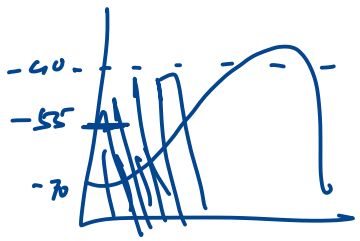


Hyperkalemia-effect on RMP:

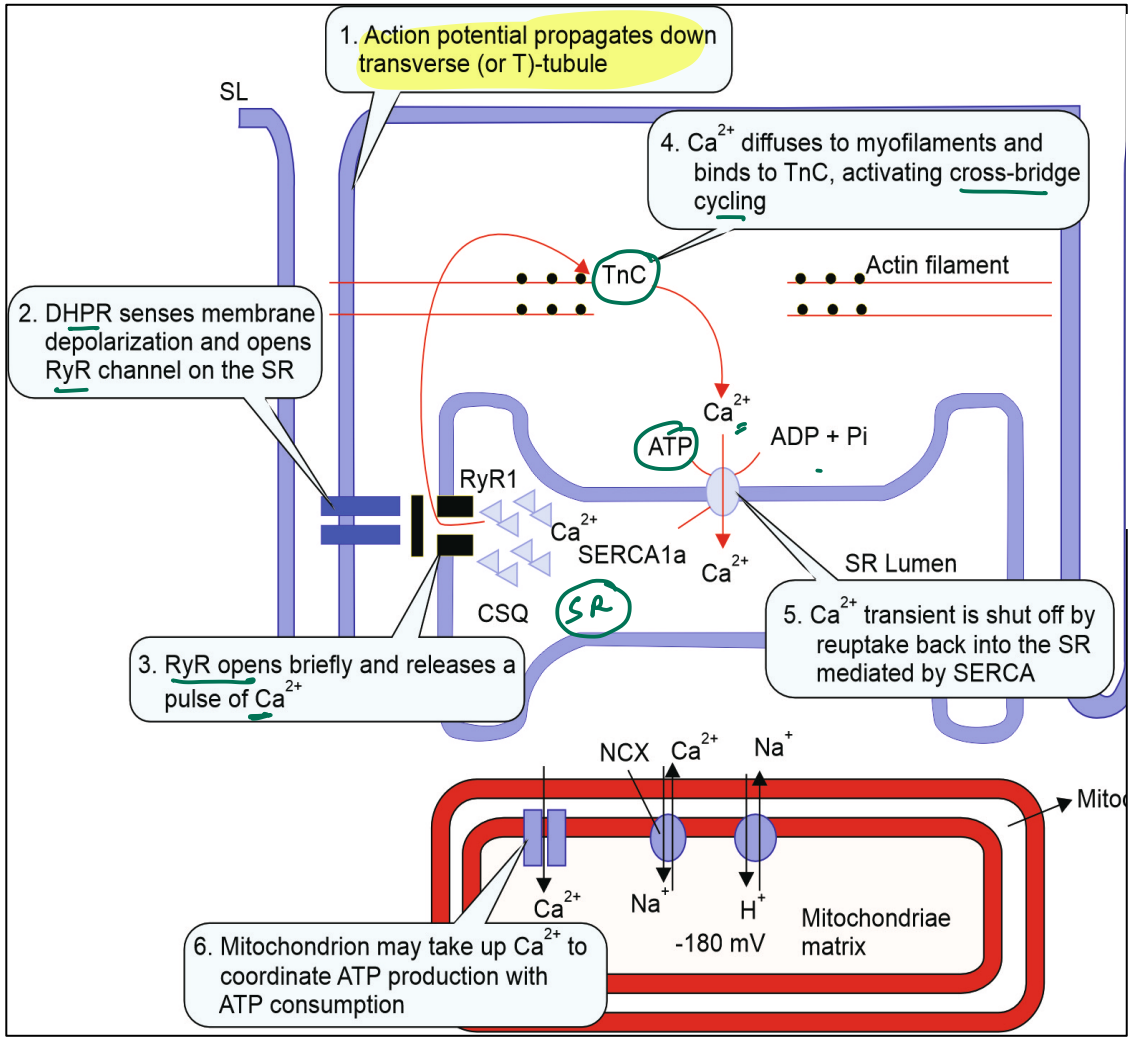
Accomodation:

Adaptation:

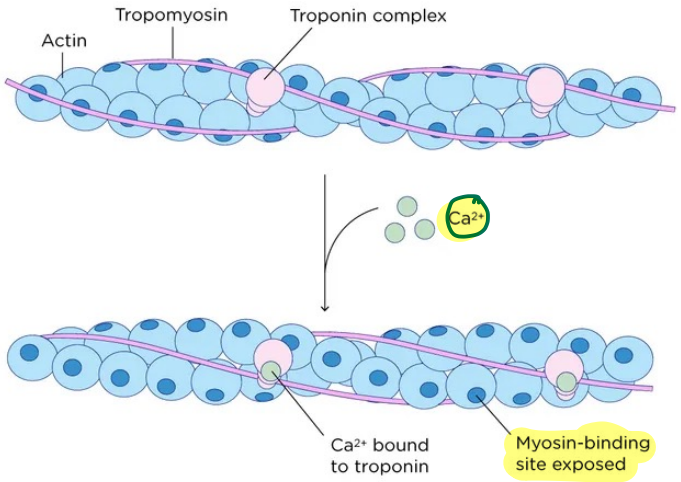


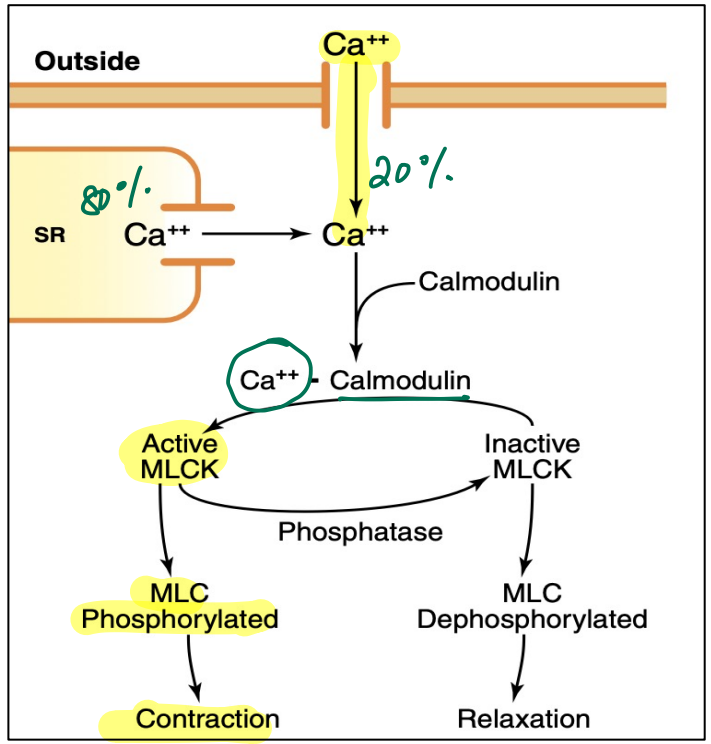


Skeletal/ Smooth muscle contraction



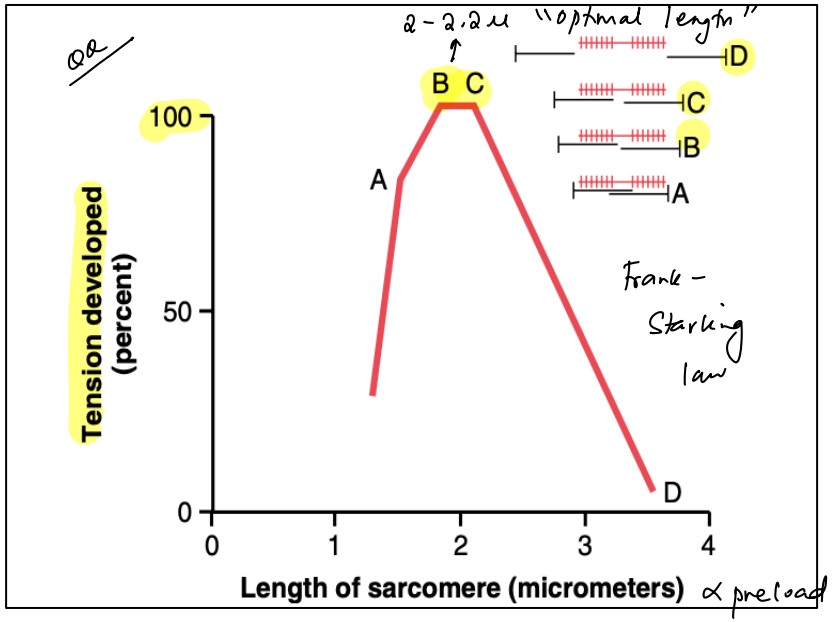
skeletal M

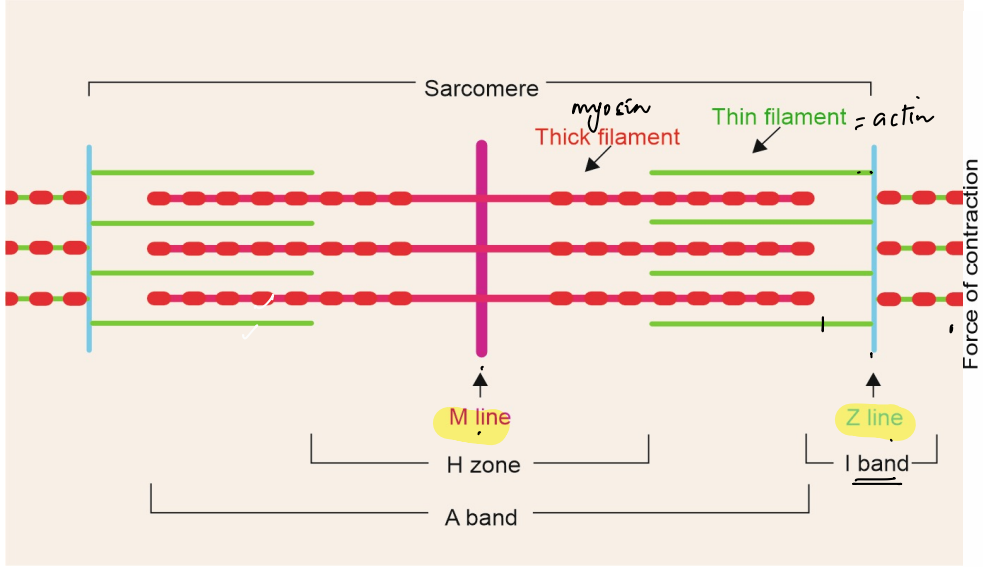


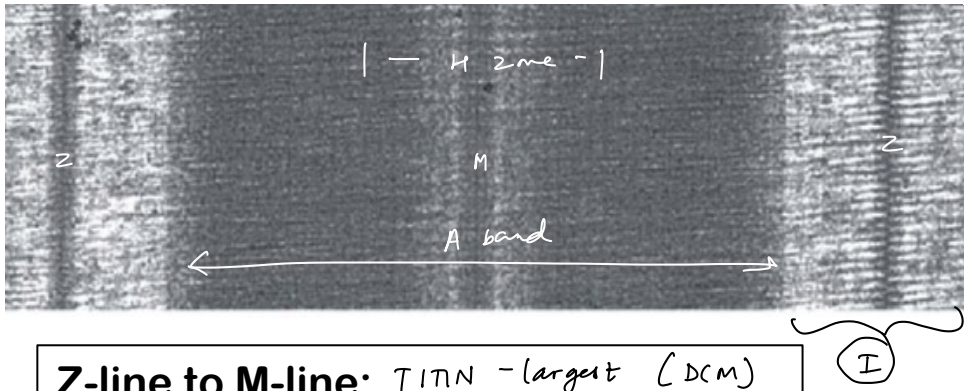


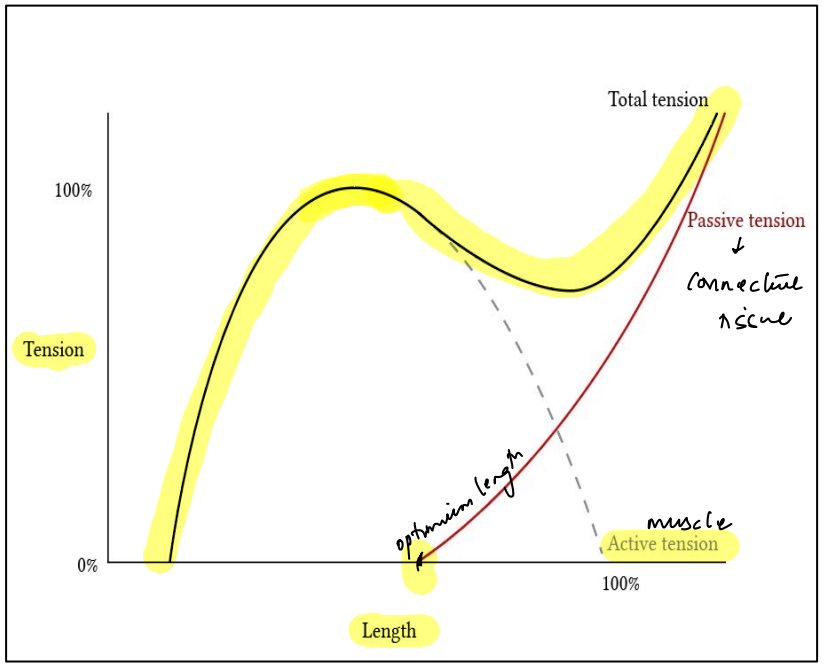
Intracellular Ca – 100% (SR)
Absence of Ca: ⊗ contracⁿ
Absence of ATP: ⊗ relaxⁿ – Cadaveric Spasm

Electromechanical coupling:
DHPR (Ca V1)-RYR1 coupling
GOF: Malignant hyperthermia
Electro-chemical coupling: ♡ / Smooth M
DHPR (CaV2)-RYR2/3 coupling
CICR Ca^{2+} - Induced - Ca^{2+} release
MLCK

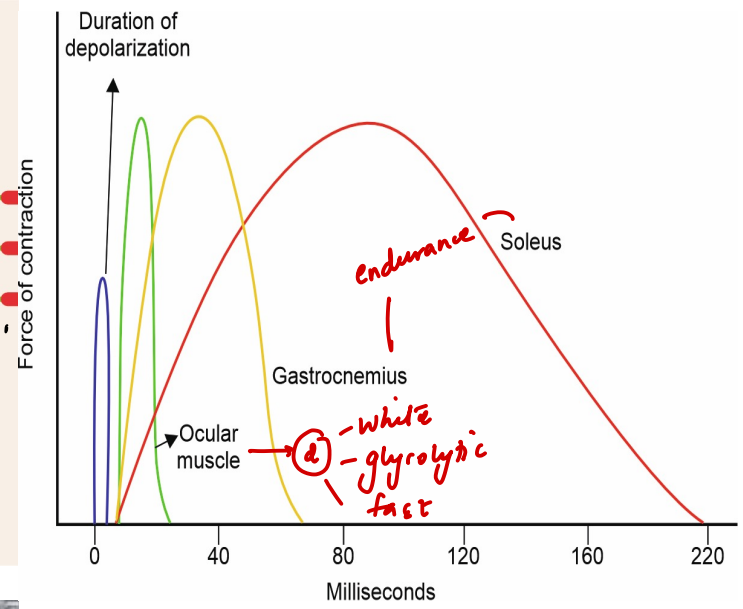








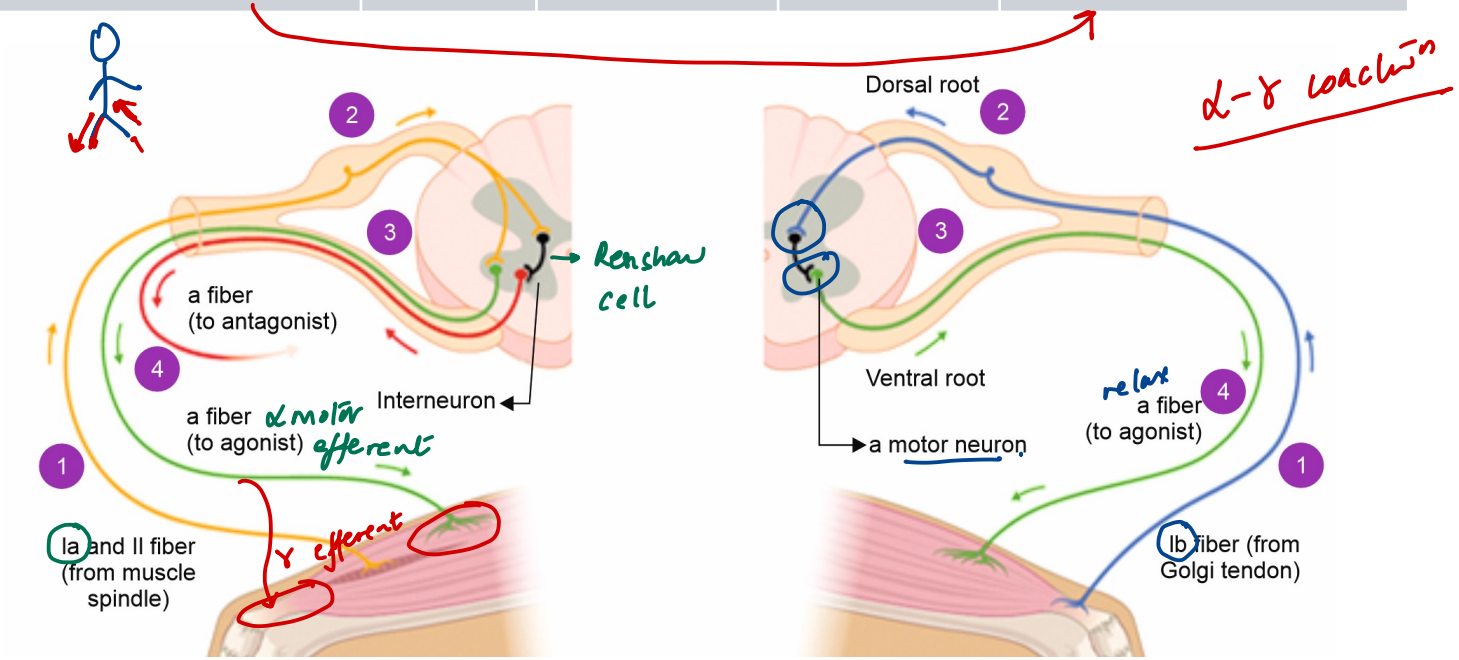
Z-line to M-line: TITIN - largest (DCM)
Actin to Z-line: α-actinin
Stabilise actin: Nebulin
During contraction:
Prominent- M-line
Disappear- H-zone
Shorten- I ↓↓
Constant- A-band



"1 slow Red ox"
type 1 = slow
·Red - ↑Mb ↑mitochondria
· oxidative

Muscle reflex

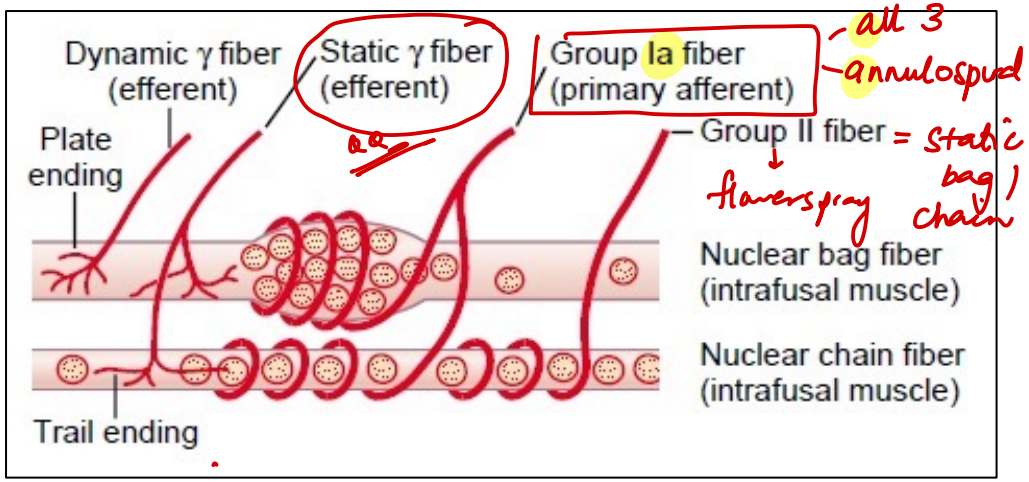
Reflex	Type	Stimulus	Afferent	Response
Stretch reflex/ Spindle	Monosyn	change in length	Ia	- agonist contract - antagonist relax
Golgi tendon (Inverse stretch)	Bisynap	tension	Ib	agonist relax
Withdrawal Crossed extensor reflex	polysynaptic	pain	Aδ / C	Affected: flexor contract Unaffected: extensor contract



α-γ coaction

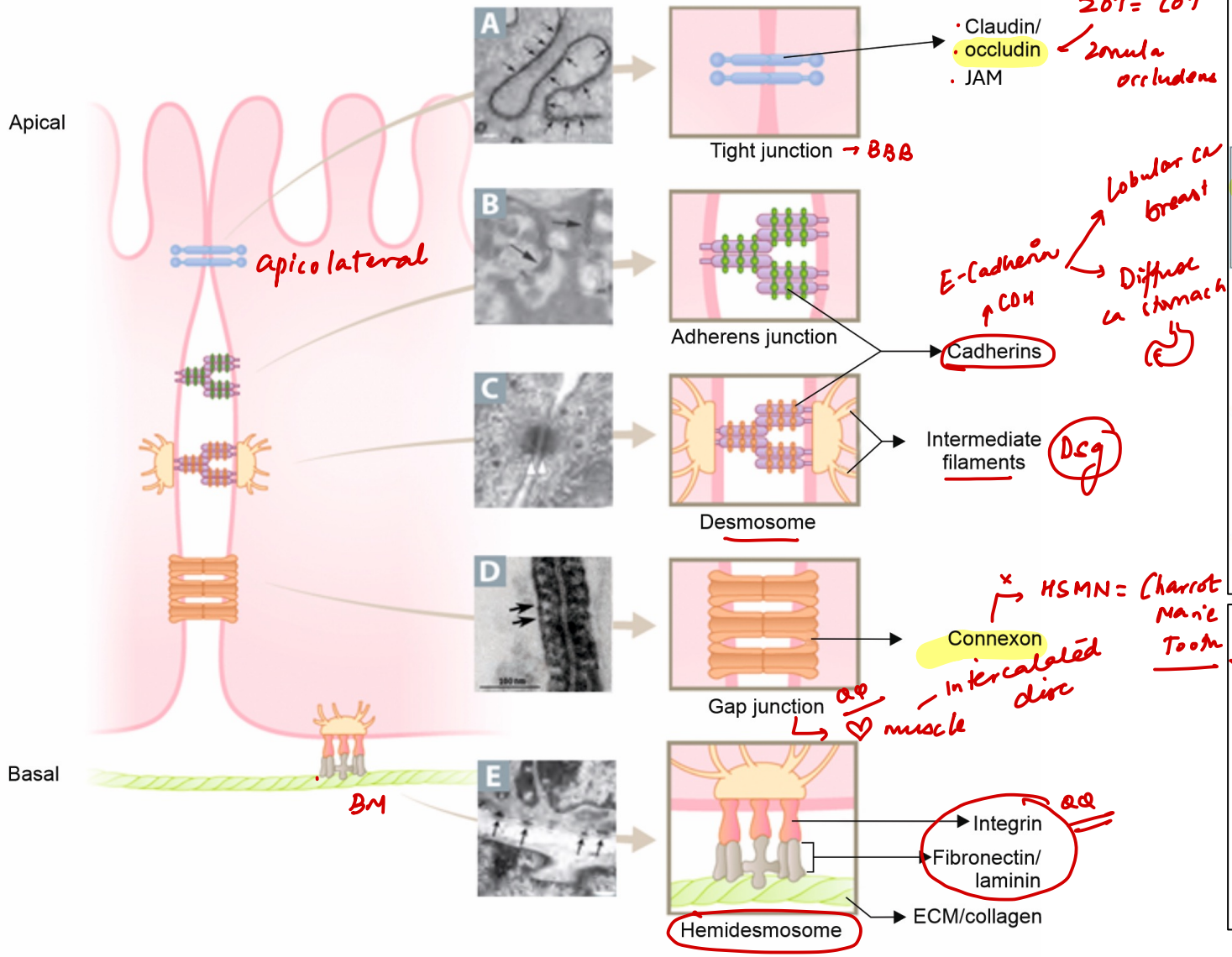
Muscle Spindles

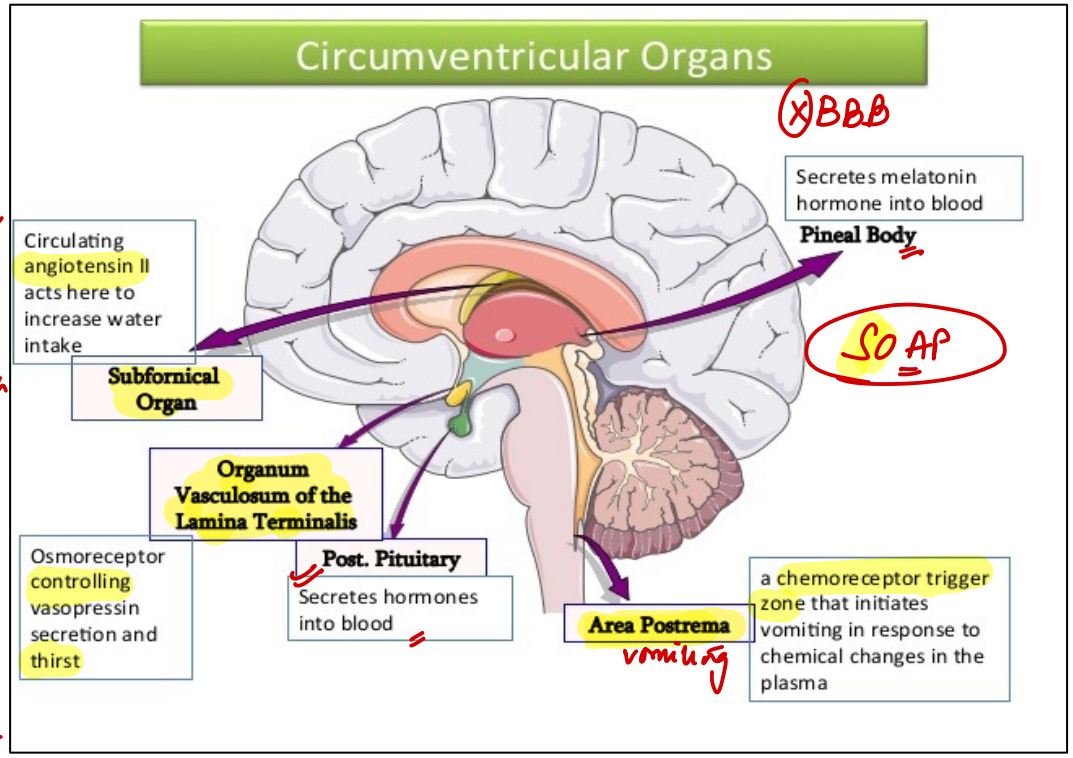
- **Nuclear bag fibers (NBF)- Static/ Dynamic**
- **Nuclear chain fibers (NCF)** - static

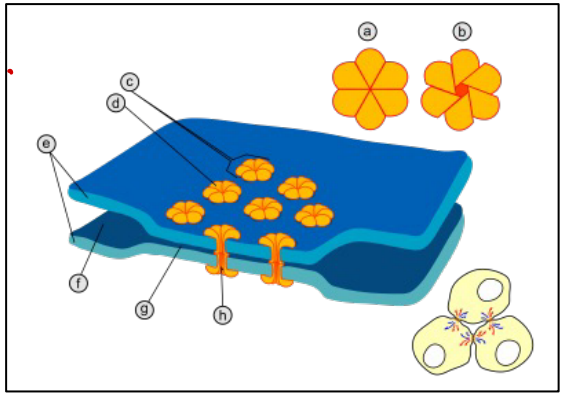


Type	Lloyd-Hunt sensory nerves	
Ia (1° afferent)	Muscle spindle Annulo-spiral ending	Aα
Ib	Golgi tendon organ	
II (2° afferent)	Muscle spindle Flower-spray ending	Aβ
III	Pain and cold receptors	Aδ
IV	Pain, temperature	→ C

Epithelial cell junctions







Cytoskeleton

Microfilament

Muscle contraction
Cytokinesis
Actin(7nm), microvilli

Intermediate filament

Maintain cell structure(10nm)

Cytokeratin: carcinoma - epithelial
Desmin: muscle
Vimentin: mesenchymal T
GFAP: Glial cells

Microtubule MT ⊖

Mebendazoles.
Colchicine
Taxanes/ Vinca
Griseofulvin

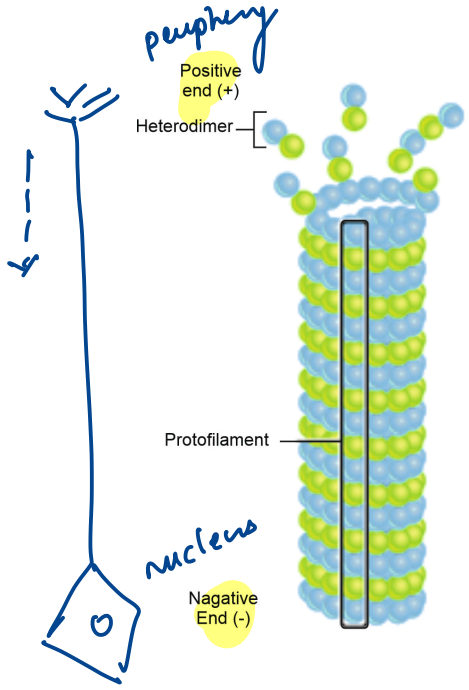
Movement, cell division (25nm)
Cilia, flagella, mitotic spindle, centriole, neurons

1° ciliary dyskeneia
- sinusitis
- bronchiectasis
- infertility ♂ ♀

YOUNG Sx

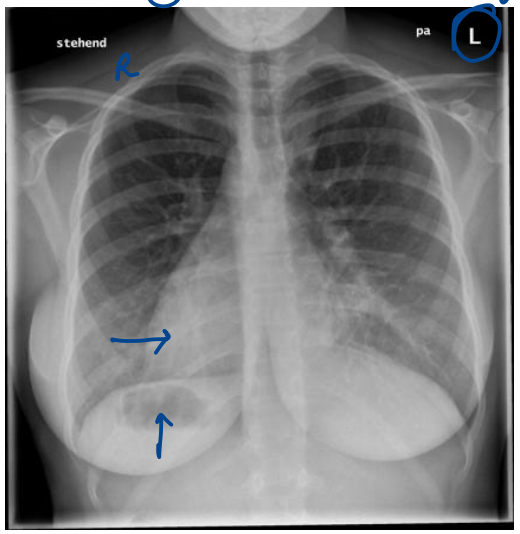
(+) situs inversus = Kartagener Sx

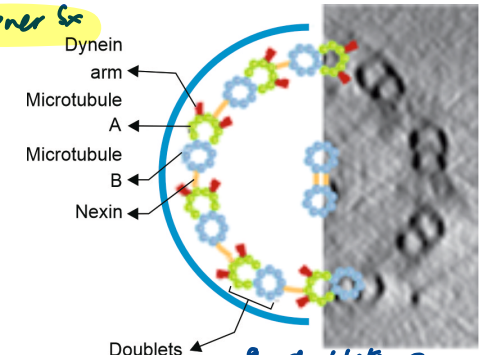
CILIA



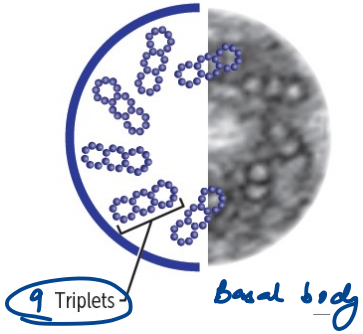
Retrograde:
+ve → −ve
→ infn → HSV/Polio/VZV/Rabies
· Dyenin

Antegrade:
−ve → +ve
· Reactivation of HSV/VZV
· Kinesin

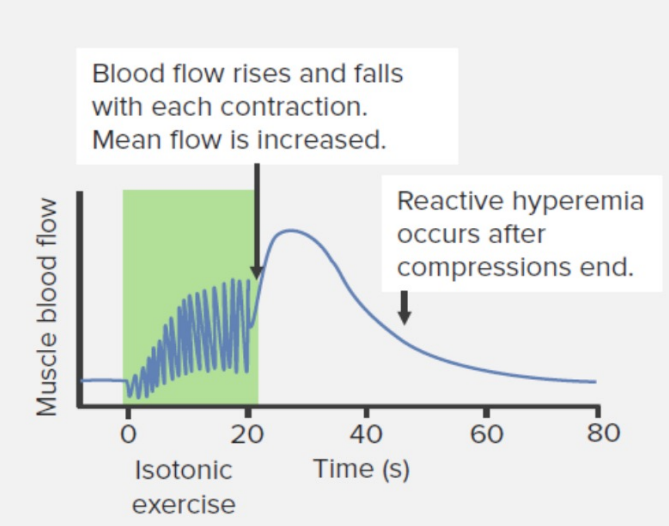


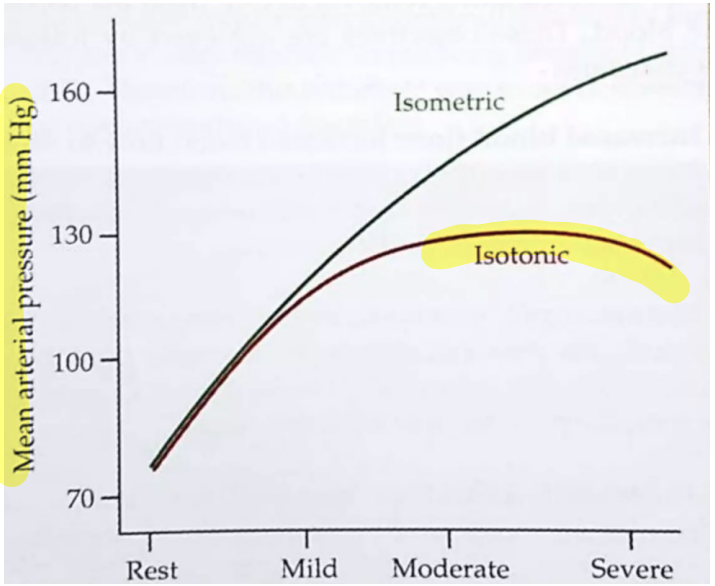


9 doublets (9+2)
2 singles



EXERCISE PHYSIOLOGY





Isotonic exercise:
- CO: ↑
- HR: ↑
- SV: ↑
- SBP: ↑
- TPR: ↓
- DBP: ↓
- MAP: ↓

severe

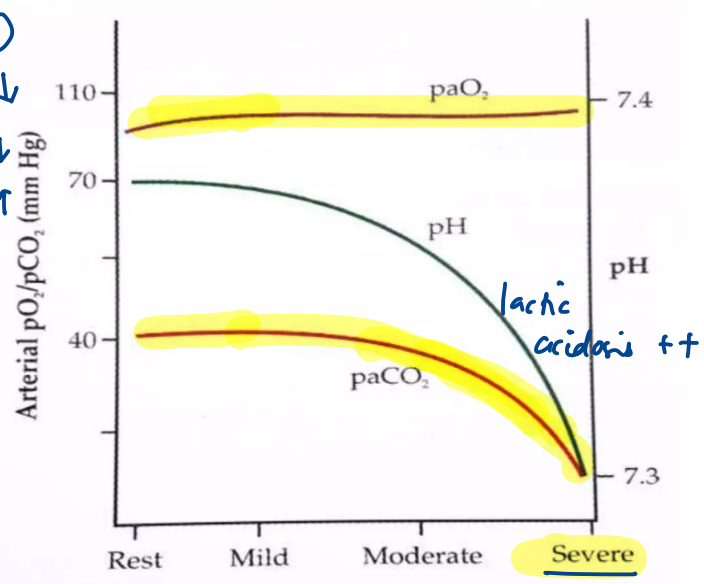
2/3 DBP

Isometric exercise:
- CO: ↑
- HR: ↑
- SV: N
- SBP: ↑
- TPR: ↑
- DBP: ↑
- MAP: ↑

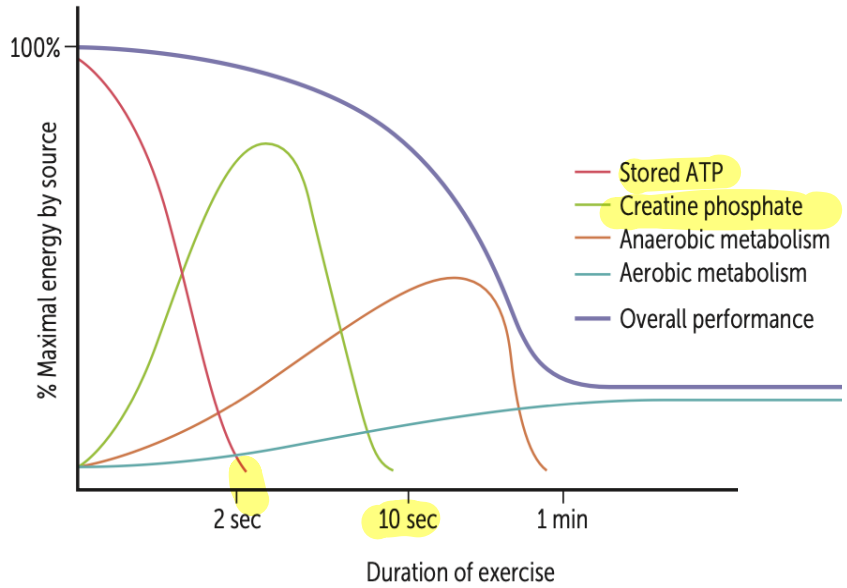
Blood flow:
Muscular (20x) > Coronary > Cerebral > Renal/ Splanchnic

constant

severe: N
- paO_2 ↓
- $paCO_2$ ↓
- pvO_2 ↓
- $pvCO_2$ ↑



MV: ↑
V/Q ratio: Equalin = zone 3 ↑V ↑Q.
ODC: Rt
PvO2 ↓
PvCO2 ↑



Miscellaneous

Nerst equation-Equilibrium potential – electrochem equilibrium

$$V_{Eq.} = \frac{RT}{zF} \ln\left(\frac{[X]_{out}}{[X]_{in}}\right)$$

$\pm$ 60 log $\left(\frac{X_{out}}{X_{in}}\right)$ $\frac{Na_o\ 140}{Na_i\ 14}$

Na: +60 mV
Ca: +100 mV
Cl: -70mV ≈ RMP nerve
K: -90V ≈ RMP myocyte
maintains

Gibbs Donnan: Diffusion of permeable ions changes due to large impermeable molecule like protein

Coughing:
Deep inspiration -> forced expiration against closed glottis -> sudden glottis opening
Sneeze: forced expiration against open glottis

Goldman equation: Calculate RMP
RMP of cell closest to RMP of **K** due to open leaky channels
Neuron: -70 mV
Skeletal muscle, Cardiac myocyte: -90 mV
SAN/ Cajal cell/ Pre-Botzinger complex: -60mV
pacemaker = delayed depolarn automatic

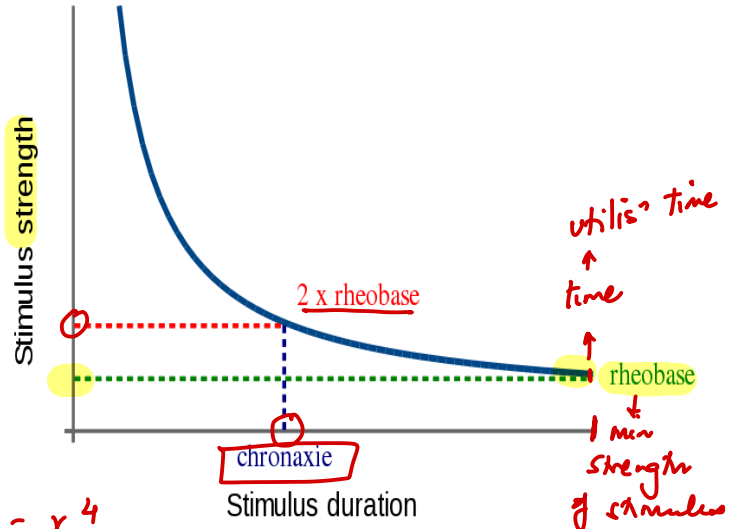
Q	Flow rate
P	Pressure
r	Radius
η	Fluid viscosity
l	Length of tubing

Poiseuille's law

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

Q = Flow

$\frac{Q = r^4}{l} = \frac{2 \times 2 \times 2 \times 2}{2}$ = 8 times



Singer-Nicholson: Fluid mosaic model
Protein (55) > Phospholipid (25)> Cholesterol (13) > Carbs (3)
Except-inner mitochondrial membrane
Prtn ↑↑
Q→ philic head
— phobic tail
xTG
fluidity

Walter Cannon: Homeostasis → urine output

FEEDBACK:

Baroreceptor reflex: (-ve) ↑BP → Baroreceptor → ↓BP

Parturition-Ferguson reflex / Milk let down-ejection

Clotting

CICR

LH surge

Hodgkin cycle-Na opening

Salivation on thinking about food:

Exercise

Core body Temperature

↑cortisol → ↑oxytocin-R + ↳ ↑PG

E ⊖ → FSH / LH

>200pg x 2d ⊕ → LH

+ve feedback

Feedforward = anticipn

also -ve feedback

Gain = Correction / Error

100mm → ↑ 175mm

100mm → ↓ 125mm

correc^n = $\frac{-50}{25}$ (2)

(-2)

- Carrageenan theory: inflammation
- Windkessel effect: ↓radial A
- Bitter taste transmitted by: Alkaloids

Taste	Receptor type	Key receptor examples
Sweet Umami (MSG) Bitter	"SUB" GPCR = metabot	TAS1R2 + TAS1R3
Sour	Ion channels- H+ ligand	PKD2L1, TRPV1
Salty	Ion channels- Na+	ENaC