

PHYSIOLOGY

RR-8.0

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GENERAL & CELLULAR PHYSIOLOGY

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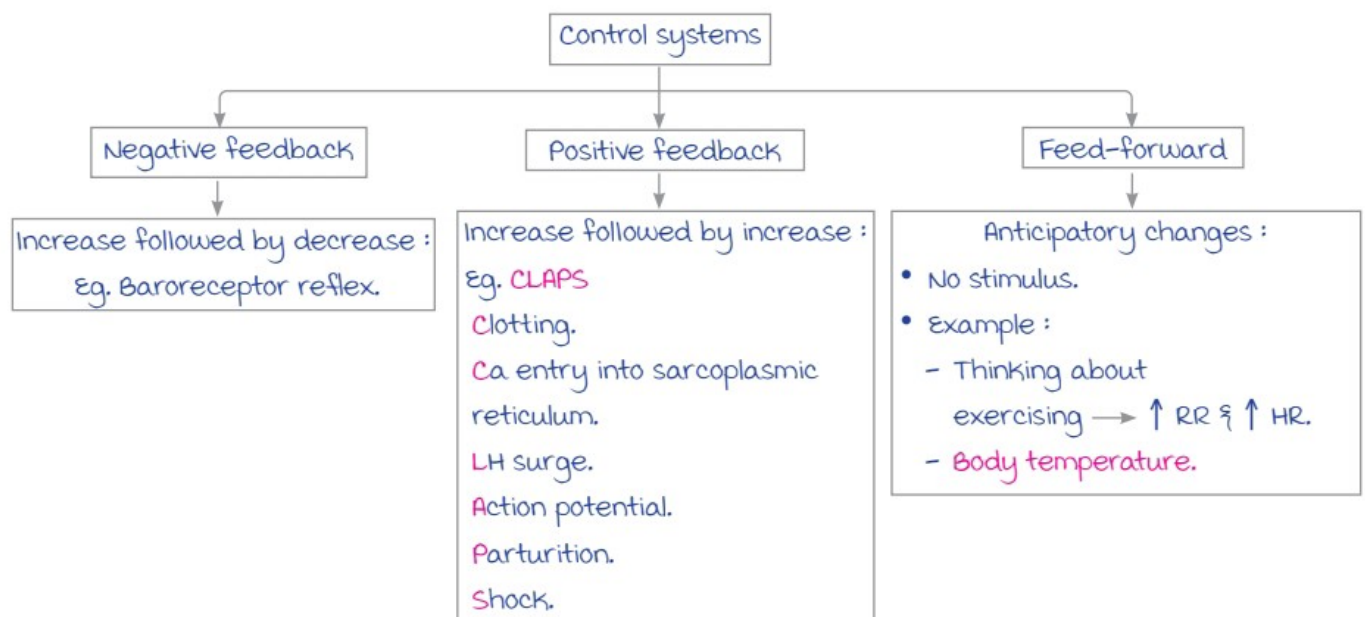
Homeostasis

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Claude Bernard : Coined the term milieu interieur (Internal environment).

Walter Cannon : Coined the term homeostasis.

Maintenance of homeostasis :



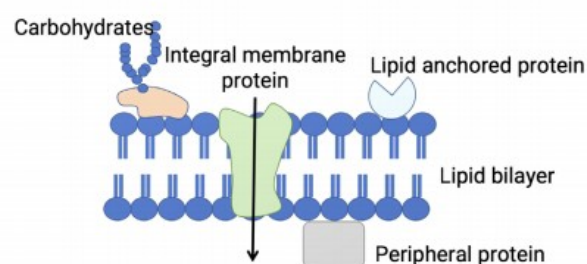
Assessment of effectiveness of negative feedback :

$$\text{Gain} = \frac{\text{Correction}}{\text{Error left after feedback}}$$

- error left \oplus \rightarrow Not a good control system.
- 0 error left \rightarrow Gain is infinity (Role of kidneys in regulating BP).

Cell Membrane

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membrane Lipids :

Phospholipids :

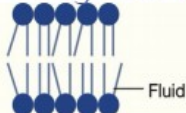
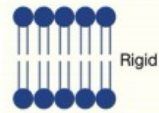
- Phosphatidylcholine/Lecithin/Dipalmitoyl phosphatidylcholine (DPPC) : Present in **surfactant**.
- Sphingomyelin : Present in nerve & surfactant.
 - Lecithin - sphingomyelin ratio : $\frac{L}{S} \geq 2 \rightarrow$ Adequate **fetal lung maturity**.
- Phosphatidylserine (PS) :
 - **Inner surface** of cell membrane.
 - If expressed outside : Eat-me signal \rightarrow Cell undergoes **apoptosis**.
- Phosphatidylinositol : Second messenger.
- Cardiolipin : **mitochondria of heart**.

Glycolipids :

Types	Site	Significance
Cerebrosides	CNS	-
Gangliosides	GIT	G _M -1 gangliosides : Receptors for cholera toxin \rightarrow Fragment B .

Sterols : Cholesterol (Fluidity buffer) \rightarrow maintains membrane fluidity.

Characteristics of fluidity :

	Increased fluidity	Decreased fluidity
Effect on health	Good	Bad
Type of fatty acids	unsaturated (essential)	Saturated (Trans)
Examples	<ul style="list-style-type: none"> • Linoleic acid. • Linolenic acid. • Arachidonic acid. • Omega-3 fatty acids : Abundant in fish. 	<ul style="list-style-type: none"> • Stearic acid. • Palmitic acid. (Abundant in junk food). 

membrane Proteins :

Transmembrane proteins :

Cystic fibrosis transmembrane conductance regulator (CFTR) :

- Chloride channel.
- mutation : **Cystic fibrosis**.

Peripheral proteins :

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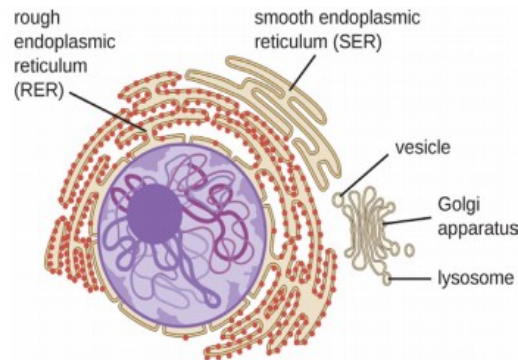
Cell	Protein	Diseases due to mutations
RBC (Biconcave disc)	Spectrin	Elliptocytosis
	Ankyrin	Spherocytosis
Skeletal muscle	Dystrophin	Duchenne muscular Dystrophy (DMD)

Lipid anchored proteins/GPI anchored protein :

- Present in RBC only.
- Examples : CD55 & CD 59
- mutation : Paroxysmal Nocturnal Hemoglobinuria (PNH).

Cell Organelles

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Endoplasmic reticulum :

	Rough ER	Smooth ER
Granulations	⊕ due to ribosomes	⊖
Functions	<ul style="list-style-type: none"> • Biosynthesis of proteins. • Along with chaperones, aid in protein folding. • ER-associated degradation : Destruction of misfolded proteins. 	<ul style="list-style-type: none"> • Drug detoxification (By CYP450 in liver). • Calcium storage. • Steroid biosynthesis. (Adrenal gland, liver, testis, ovary)

Golgi apparatus :

Two ends :

- Cis end/receiving end : Receives protein Post translational modification → vesicles.
- Trans end/releasing end : Releases vesicles.

Lysosomes : Aka suicidal bags/residual bodies.

- Involved in acid mediated destruction.
- Enzymes : Acid phosphatase, acid hydrolase.
- Autophagy : During starvation.

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Peroxisomes :

- AKA microbodies.
- Functions :
 - Oxidation of long chain & very long chain fatty acids.
 - Generation & degradation of H_2O_2 by **catalase**.
 - Synthesis of **plasmalogens**.
- Peroxisomal disorders : Zellweger syndrome, Refsum disease.

mitochondria :

- Derived from ovum (**maternal** inheritance).
- Human mitochondrial DNA : **Circular dsDNA** (16,500 base pairs).
- mitochondrial DNA mutations :
 - > 10 times the rate for nuclear DNA.
 - Affects **organs** with **high metabolic** requirements :
Skeletal muscle, CNS, liver.

Nucleus :

- Contain blue prints for DNA : Chromosomes.
- DNA + histones = Chromatin : Repeating structural unit called nucleosomes.
- Nuclear pore complex : Regulates movement of substances in (Importins) & out (Exportins).

MARKER ENZYMES

Cell organelle	marker enzyme
Cell membrane	$Na^+ - K^+$ ATPase
Endoplasmic reticulum	Glucose-6-phosphatase
Golgi apparatus	Galactosyl transferase
Lysosomes	Acid phosphatase
Peroxisomes	Catalase
mitochondria	ATP synthase
Nucleus	RNA polymerase

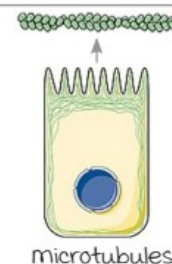
Cytoskeletal Filaments

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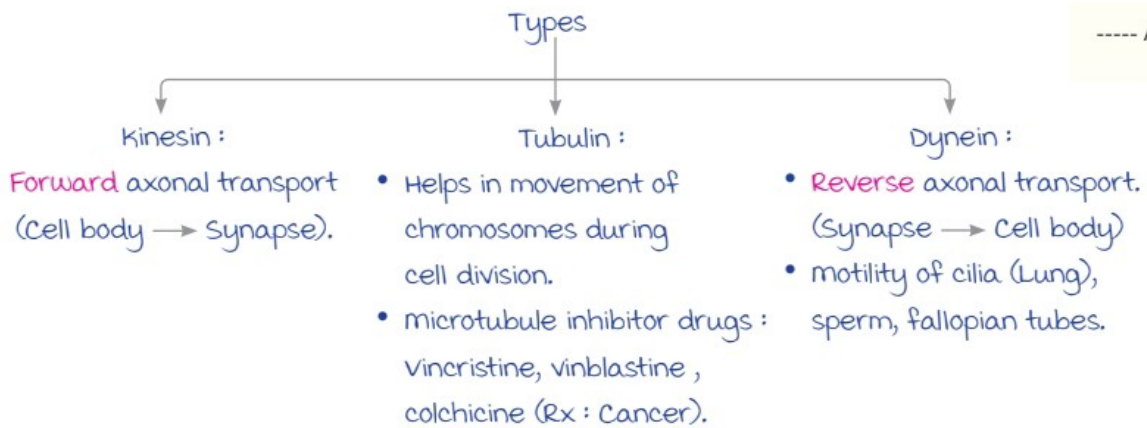
Types :

microtubules :

Size : Largest.



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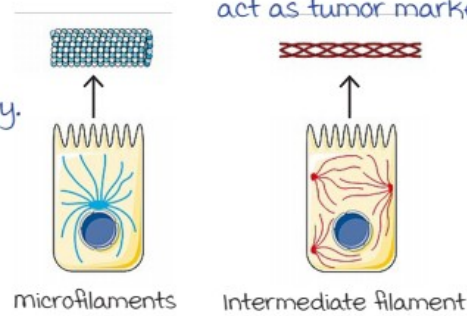


microfilaments :

- Size : Small
- Types : Actin & myosin.
- Function :
 - muscle contraction : Sliding filament theory.
 - Cell motility : By actin polymerisation.
Eg : Tumbling motility in *listeria*.

Intermediate filaments :

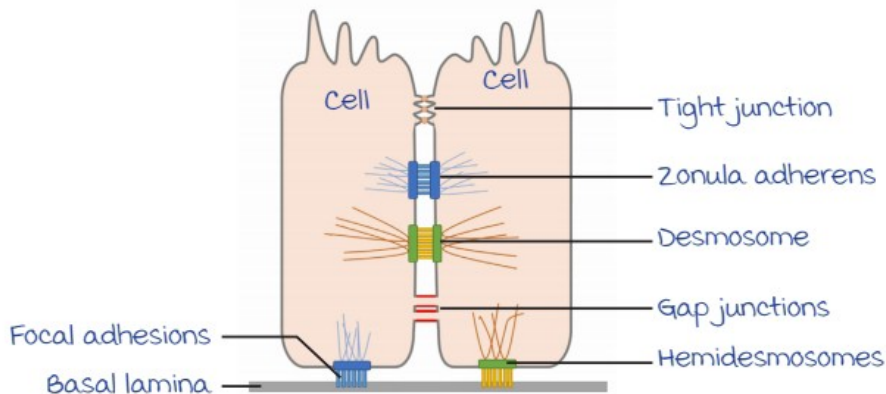
- most abundant & act as tumor markers.



Filament	Tissue	marker for
Keratin	Epithelial tissue	Epithelial carcinoma
	Liver (Mallory-Denk bodies)	Alcoholic liver disease
Desmin	Muscle	Rhabdomyosarcoma
Vimentin	Connective tissue (Fibroblasts)	Mesenchymal tumors
Glial fibrillary acidic protein (GFAP)	Astrocytes	Astrocytoma
Lamin	Nucleus	Progeria (Premature aging)

Cellular Junctions

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Cell Junctions	Protein	Characteristics & Clinical importance
Cell - Cell junctions		
Zonula adherens	Cadherins	<ul style="list-style-type: none"> • Calcium dependent linkages. • Linked to actin.
Desmosomes	<ul style="list-style-type: none"> • Desmoglein. • Desmocollins. 	<ul style="list-style-type: none"> • Linked to intermediate filaments. • Seen in areas of mechanical stress : Skin, uterine cervix. • Antibodies against desmoglein ↓ Pemphigus vulgaris
Zonula occludens	Occludin	-
	Claudin	mutation in claudin ↓ Familial hypomagnesemia with hypercalciuria & nephrocalcinosis
Gap junctions	Connexon (1 Connexon = 6 connexins)	<ul style="list-style-type: none"> • Abundant in heart. • mutations in connexin → Cardiac arrhythmia. • Charcot-Marie-Tooth disease.
Cell basal lamina junctions		
Hemidesmosomes	-	Linked with intermediate filaments
Focal adhesions	-	Linked with actin

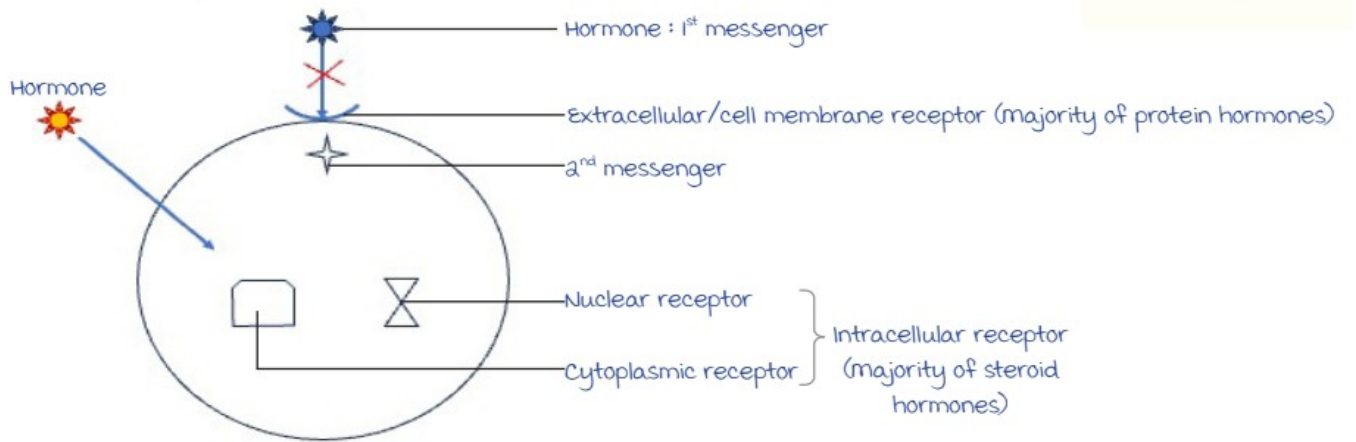
Cellular Messenger & Receptors

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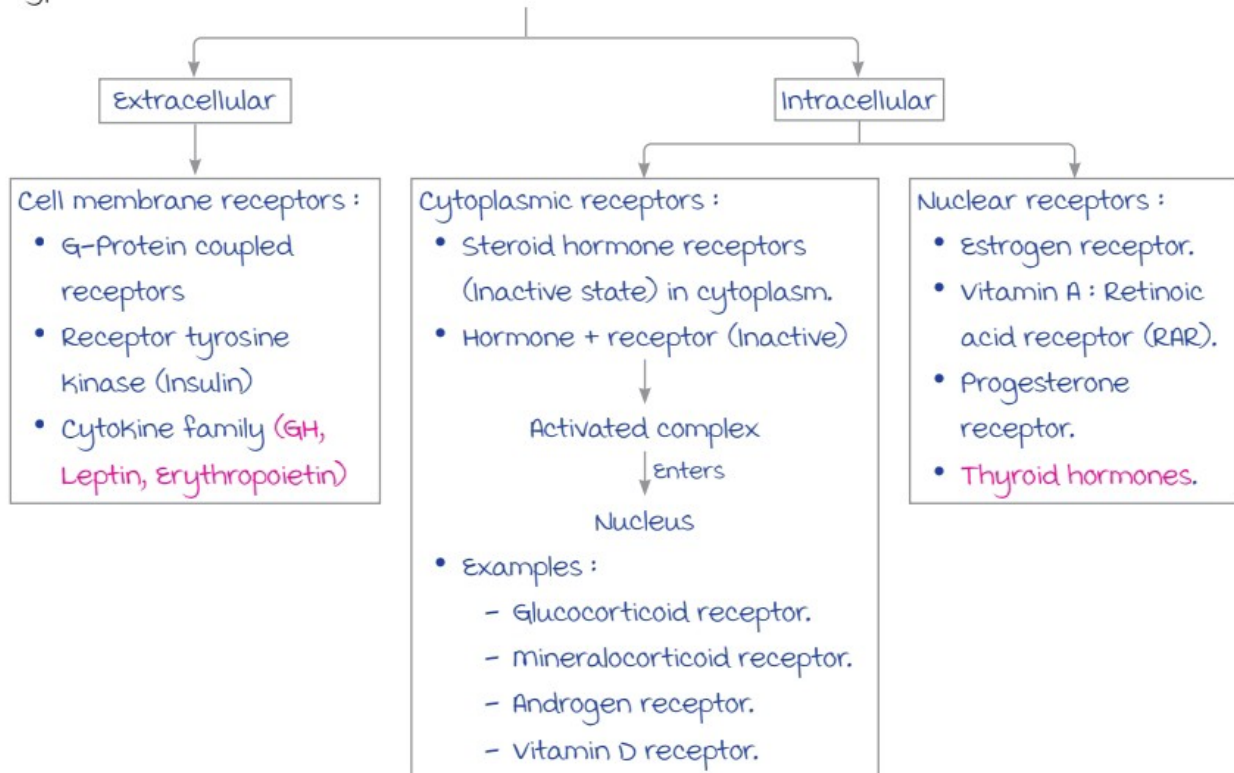
Cellular messengers/Hormones :

Class	Examples
Amino acid derivatives	Tyrosine → Catecholamines : - Epinephrine. - Norepinephrine. - Dopamine.
Protein hormones	Large protein hormones : • 51 AA : Insulin. • 84 AA : Parathormone.
Cholesterol derivatives	Steroid hormones : • Aldosterone, cortisol. • Estrogen, progesterone. • Testosterone.
Vitamin derivatives	Vitamin A & D

Hormone Receptors :



Types :



G protein - coupled receptors (GPCRs) :

- AKA 7 transmembrane/serpentine receptors.
- Heterotrimeric : 3 subunits (Alpha, beta, gamma).
- mechanism of action : Inactive GPCR

