Physiology

World of Revision

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Instructions

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Contents

Physiology

GENERAL & CELLULAR PHYSIOLOGY : PART 1

----- Active space -----

Homeostasis

00:01:51

- Concept of constancy.
- Walter Cannon Termed → Homeostasis.
- Claude Bernard Termed → Milieu interior (Internal environment).

Maintenance :

Dynamic process.

Control systems :

	Negative feedback	Positive feedback	Feed forward control
mechanism	↑ f/b ↓	• ↑ f/b ↑ • Amplification (Vicious cycle)	Anticipatory changes
Examples	• Insulin regulation of glucose • Baroreceptor reflex • Endocrine hormone regulation	'CLAPS' : • Clotting • Ca^{2+} entry into SR • LH surge • Action potential • Parturition • Shock	Body temperature regulation

Gain :

- Assessment of effectiveness of negative feedback.

$$\text{Gain} = \frac{\text{Correction}}{\text{Error remaining}}$$

- If Error = 0, Gain = ∞ (Role of kidneys in BP regulation).

Cell Membrane

00:15:24

- Fluid mosaic model :

Components

Proteins (50%) :
- Mosaic component.
- Max : Inner mitochondrial membrane.

Lipids (45%) :
- Fluid component
- Lipids > proteins : Myelin sheath.

Carbohydrates (5%).

----- Active space -----

Membrane Lipids :

1. Phospholipids :

	Site	Features
Phosphatidylcholine	Lung	• AKA lecithin • Major surfactant
Sphingomyelin	• Nerve • Lung	• Minor surfactant • L/S ratio ≥ 2 : Fetal lung maturity
Phosphatidylserine	Cell membrane : Inner surface	If exposed extracellularly : Signal for apoptosis (Eat me signal)
Phosphatidylinositol	Endocrine	Second messenger
Cardiolipin	Heart : Mitochondria	-

2. Glycolipids : Lipids + carbohydrates.

- Gangliosides :
  - GIT.
  - Fragment B of GM_1 ganglioside : Receptor for cholera toxin.
- Cerebrosides : CNS.

3. Sterols :

- Cholesterol → Vitamin D synthesis.
  → Fluidity buffer.
- Membrane fluidity :

	Increased fluidity	Decreased fluidity
Effect on membrane function	Good	Bad
Type of fatty acids	Unsaturated (Essential)	Saturated
Examples	• Linoleic acid • Linolenic acid • Arachidonic acid • Omega-3-FA (Fish)	• Stearic acid • Palmitic acid

Membrane Proteins :

	Location	Features
Transmembrane/ integral membrane protein	-	• Receptor : GPCR • Pump : Na^+-K^+ ATPase • Channel (Cl^-) : CFTR —Mutation→ CF
Peripheral protein	RBC	Mutation of : • Spectrin : Hereditary elliptocytosis • Ankyrin : Hereditary spherocytosis
Lipid/ GPI anchored protein	RBC	• CD-55 • CD-59 —mutation→ Paroxysmal nocturnal hemoglobinuria

Cell Organelles

00:35:34 ----- Active space -----

Endoplasmic Reticulum :

	RER (Granular)	SER (Agranular)
Ribosomes	⊕	⊖
Functions	• Protein biosynthesis • Protein folding with chaperones • ER associated degradation : Destruction of misfolded proteins ↓ Accumulation ↓ Prion disease	• Drug metabolism (Liver) • Calcium storage : Sarcoplasmic reticulum (Skeletal muscle) • Steroid hormone synthesis (Adrenal cortex)

Golgi Apparatus :

Located close to RER.

Functions :

- Cis end (Receives protein) → Post translational modification (E.g. : Glycosylation) → Trans end (Releases vesicles).

- Protein tagging, sorting & delivery :
  I - cell disease : Mannose-6-phosphate tagging ⊖.

Lysosomes :

- AKA suicidal bags/residual bodies.
- Acid mediated destruction :
  - Acid lipase.
  - Acid hydrolase.
- Autophagy : Starvation → Mitochondrial destruction → Energy release.

Peroxisomes :

- AKA microbodies.
- Abundant in liver & kidney.

Functions :

- VLCFA : Oxidation.
- H_2O_2 : Generation and degradation (Catalase).
- Synthesis of plasmalogens (myelin sheath).

----- Active space -----

Peroxisomal storage disorders :

- Zellweger syndrome : VLCFA accumulation.
- Refsum's disease : Phytanic acid accumulation.

Mitochondria :

Derived from ovum : Maternal inheritance.

Mitochondrial DNA :

- Double stranded.
- 16,500 base pairs.
- Mutation rate : 10 x nuclear DNA.

Mitochondrial disorders :

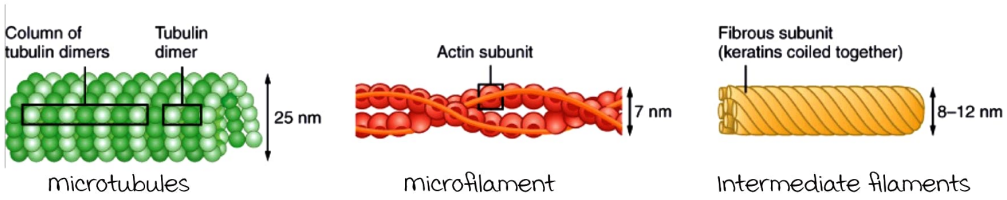
- MELAS : Mitochondrial encephalomyopathy, lactic acidosis & stroke-like episodes.
- Affects organs with high metabolic rate : Muscle, brain.

Nucleus :

- Contains chromosomes (DNA) : Blueprint.
- Nucleosome : DNA (String) + histone proteins (Beads).
- Chromatin : whole complex of DNA + proteins.
- Nuclear pore complex (NPC) :
  - Exportin.
  - Importin.
- Units of heredity - genes.

Cytoskeletal Filaments

00:56:24



Microtubules | Microfilament | Intermediate filaments

Microtubules :

Types : Kinesin, dynein, tubulin.

Function :

- Axonal transport → Anterograde → Kinesin.
  Retrograde (Rabies) → Dynein.
- Ciliary motility : Defect → Kartagener syndrome → Dynein.
- Chromosome separation → Cell division.
  Cancer Rx : Vincristine (Microtubule inhibitor drug).

----- Active space -----

Microfilaments :

Actin polymerization → Cell movement (Listeria monocytogenes).
→ Maintains cell structure.

Intermediate Filaments :

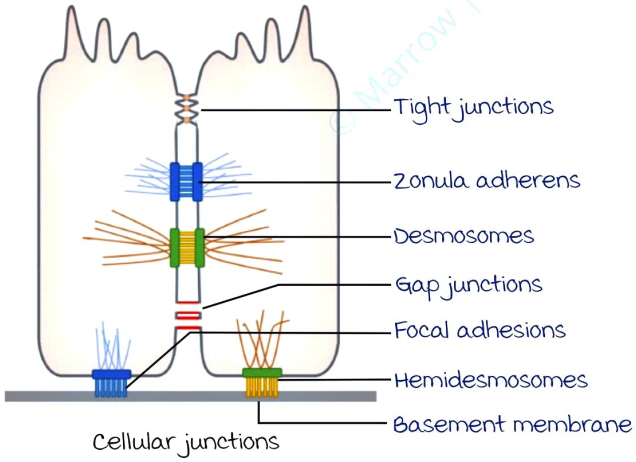
Functions :

- Resist external pressure
- Cellular/tumor markers :

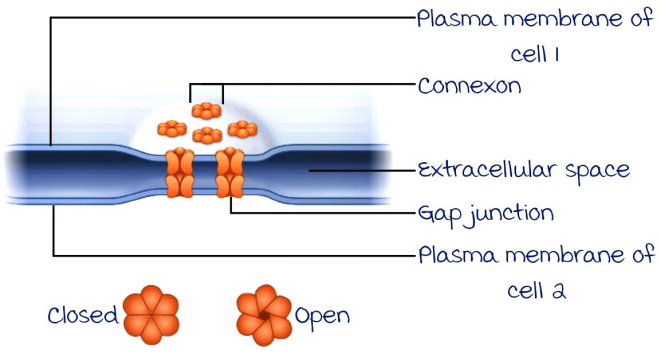
Filament	Tissue	Marker for
Keratin	Epithelial cells	Carcinoma
	Liver (Mallory bodies)	Alcoholic hepatitis
Desmin	Muscle cells	Rhabdomyosarcoma
Vimentin	Connective tissue (Fibroblast)	Connective tissue tumors
Glial fibrillary acidic protein (GFAP)	Astrocytes	Astrocytoma
Lamin	Nucleus	Progeria (Premature aging)

Cellular Junctions

01:11:17



Cellular junctions



Gap junction

----- Active space -----

Cell junctions	Proteins	Features
Cell-cell junctions :		
Zonula adherens	Cadherins	• Calcium dependent linkages • Linked to actin
Desmosomes	• Desmogleins • Desmocollins	• Areas of mechanical stress : Skin, uterine cervix • Antibodies against desmoglein ↓ Pemphigus vulgaris
Zonula occludens/ Tight junctions	• Occludin • Claudin	• BBB, Kidney, GIT • Apicolateral • Regulates paracellular transport • Zonula occludens toxin : – Produced in cholera – Loosens tight junctions
Gap junctions	Connexon (1 connexon = 6 connexins)	Heart (Functional syncytium arrangement)
Cell-basement membrane junctions :		
Hemidesmosomes	–	A/w intermediate filaments
Focal adhesions	–	A/w actin