Chap# 15

Control and Coordination

Features of endocrine system:

=) consists of ductless glands, known as endocrine glands.

=) Secrete hormones into the blood.

=) Hormones are chemical messangers.

=) reach the target organs/cells through Blood circulation.

=) Water soluble peptide hormone such as: insulin, ADH and glucagon, are polar so cannot pass through the membrane directly, hence they bind to the receptors on cell membranes.

Comparison / Difference

	Nervous system	Endocrine system
1) Communication	Impulse / action potential	Hormone
2) Nature of Communication	Electrical and chemical nature	Chemical
3) mode of transmission	Neurone	Blood
4) Response destination	muscle / gland	Target organs / cells
5) Transmission speed	Faster	Slower
6) Effects	Specific	~~Curde~~ Wide spread
7) Response speed	Faster	Slower
8) Duration	Temporary	Permanent
9) Receptor location	on cell surface membrane	either on cell membrane or within a cell

Similarities:

~~Both~~ Both involving cell signalling

Both involve signal molecule binding to receptor.

Both involve chemicals.

Motor Neurones:

=) Transmit impulses or action potential from CNS to effector (function)

=) Nuclear in cell body

=) ~~Sho~~ Short dendrites

=) axon

=) axons much larger than dendrites

=) cell body

=) Cell body has mitochondria, RER, golgi

=) many mitochondria at synaptic knob / terminal ~~branch~~ branch

=) Synaptic vesicles containing neurotransmitter such as acetylcholine.

function of mitochondria in motor neurone?

=) produce ATP

=) ↳ needed for movement of vesicle

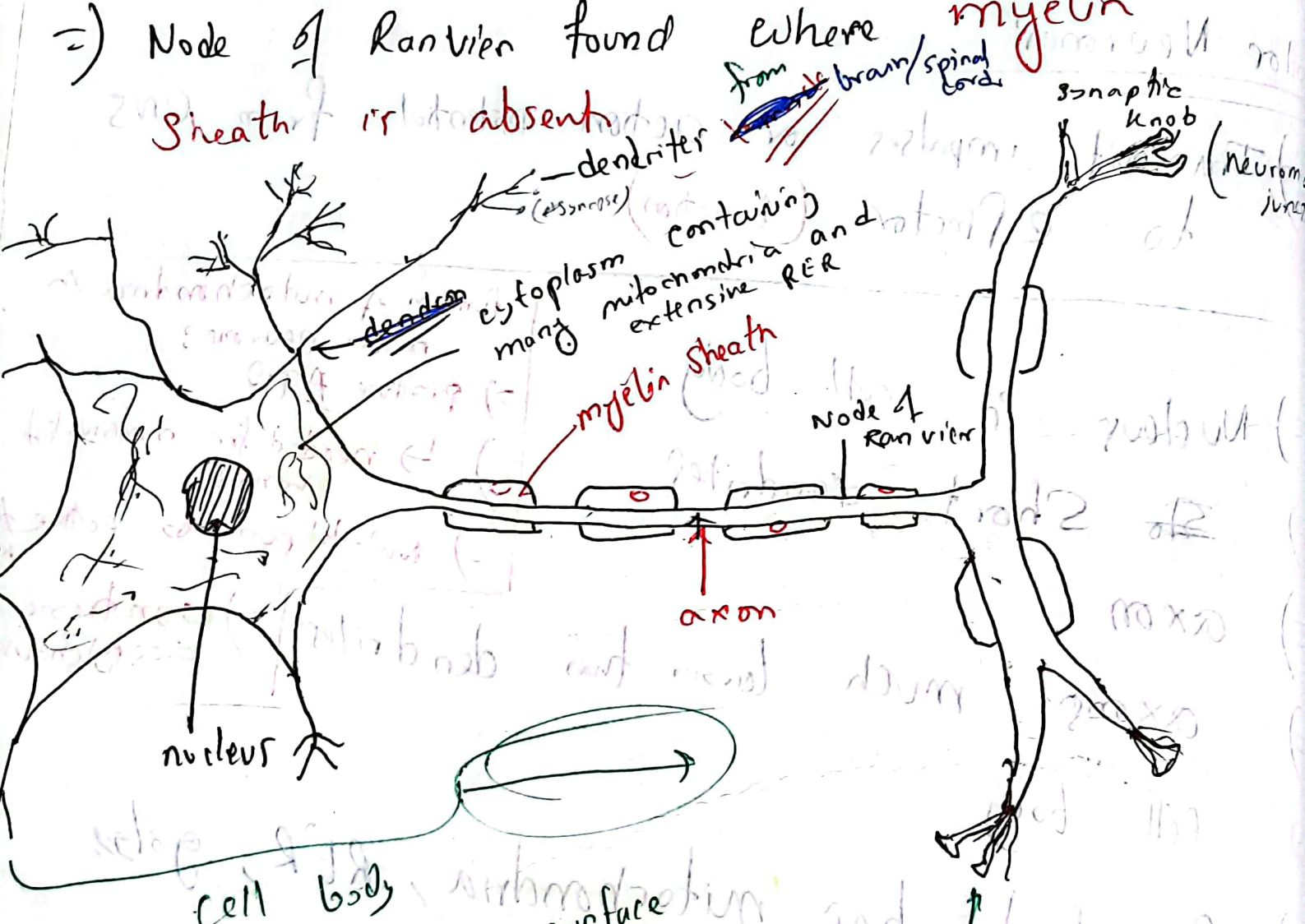
=) Na^+-K^+ pump to active

=) synthesis acetylcholine

=) Outer membrane of cell covered by ~~myel~~ myelin sheath (made up of lipid & proteins) by Schwann cells.

=) ~~Outer~~ Nucleus in Schwann cell.

=) Node of Ranvier found where myelin sheath is absent



=) thereafter surface area

=) dendrites receives AP from other ~~neu~~ neurones

=) ~~Syna~~ Synaptic knobs transmit to muscle

Synaptic knobs ↓ to muscle or glands

Sensory ~~Neuro~~ neurone :

=) Function: Sensory receptor converts or transduce stimulus into an electrical ~~im~~ impulse passing through sensory neurone
(transmit AP from receptors to CNS)

=) Nucleus in cell body

=) long ~~dendron~~ axon

=) ~~long~~ ~~short~~ ~~axon~~ short

=) many mitochondria in cell body

=) many RER in cell body.

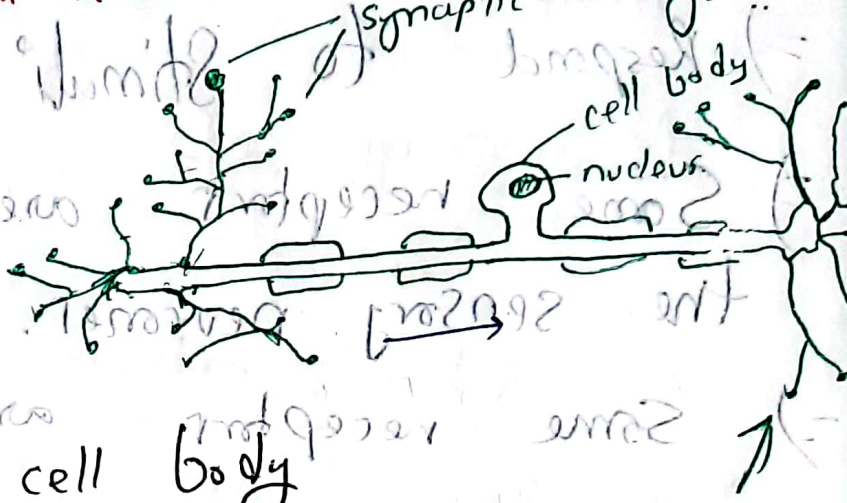
=) Synaptic knobs

=) Secrete neurotransmitter like Ach in the synaptic cleft.

Terminal clendrites

=) whole ~~Nev~~ Nevrone is covered ~~by~~ with myelin sheath,

~~Note~~ Nodes of Ranvier is ~~found~~ where no myelin sheath is found.



Intermediate neurones connect sensory neurones and motor neurones.

Transmit impulses from sensory neurones to motor neurones

Role of sensory receptor in detecting stimuli

=) Respond to stimuli

=) Some receptors are the end of the sensory neurones.

Some receptors are cells.

They are energy transducers.

Stimulus causes Na^+ ion channels to open.

Na^+ ions enter cell.

depolarisation occurs on the sensory neurone membrane

Receptor potential generated

if receptor potential greater than ~~threshold~~ threshold then ~~act~~ action potential generated

receptor	Sense	Energy of stimulus
# Rod or cone cells in retina	sight	light
# taste buds on ~~tong~~ tongue	taste	chemical potential.

=) increased stimulus strength leads to increased frequency of action potential.

Role of chemoreceptor in detecting stimuli:

=) Chemical acts as a stimulus.

=) ~~Chemoreceptor~~ Chemoreceptor are specific

=) Na^+ ions diffuse into the cell.

=) via ~~mit~~ microvilli.

=) membrane depolarised

=) receptor potential generated

=) stimulates the opening of Ca^{2+} ion channel

2) Ca^{2+} ions enter cell.

=) causes the movement of vesicles containing neurotransmitter.

2) ~~Neurotra~~ Neurotransmitter released by exocytosis.

2) Neurotransmitter stimulates action potential when above threshold.

=) Chemoreceptors act as transducers.

~~of stimulus at which impulse is generated.~~

which require a threshold intensity of stimulus at which impulse is generated.

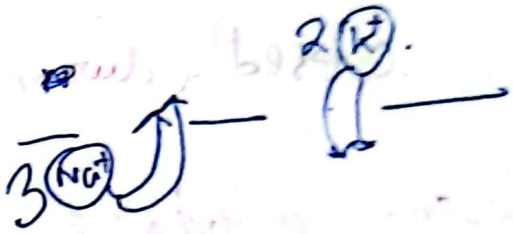
More intensity of the stimulus it's more frequency of action potential

Describe how resting potential is maintained in an axon:

=) axon is a phospholipid bilayer impermeable to K^+ and Na^+.

=) It has sodium- potassium pumps.

=) which are globular ~~trans~~ transmembrane protein.



=) ATP used.

=) 3 Na^+ pumped out ; 2 K^+ pumped in.

=) Na^+ diffuse in ; K^+ diffuse out through protein Channels transport proteins.

=) more K^+ channels open than Na^+ Channels

=) therefore membrane more permeable to K^+

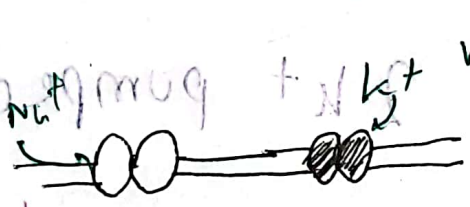
=) inside for negative than outside.

⇒ - 65mV

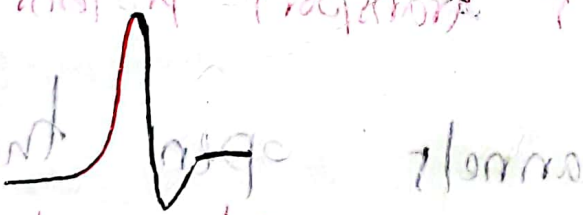
⇒ K^+ leakage is responsible for resting potential.

⇒ After certain concentration, ions diffuses voltage-gated channels are closed (during resting potential)

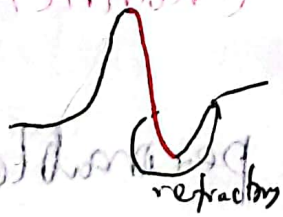
Resting potential:



Na^+ VGC K^+ VGC closed

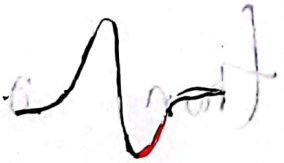


Na^+ VGC opened



K^+ VGC opened:

Na^+ VGC closed:



* Describe and explain the transmission of an action potential in a myelinated neurone; during occurring in direction of AP

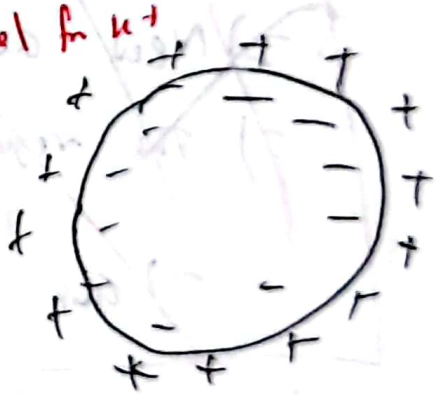
=) Na^+ ion channels open

=) Na^+ ion enter the axon.

=) inside the p.d becomes less negative.
so cause depolarisation. → if exceed threshold potential

=) Na^+ ion channels close → voltage-gated channel for Na^+

=) K^+ ion channels open. → voltage-gated channel for K^+



=) K^+ moves out of cell.

=) ~~K~~ inside p.d becomes negative
cause repolarisation. (outside -ve হয়ে)

↓ Function of myelin sheath.

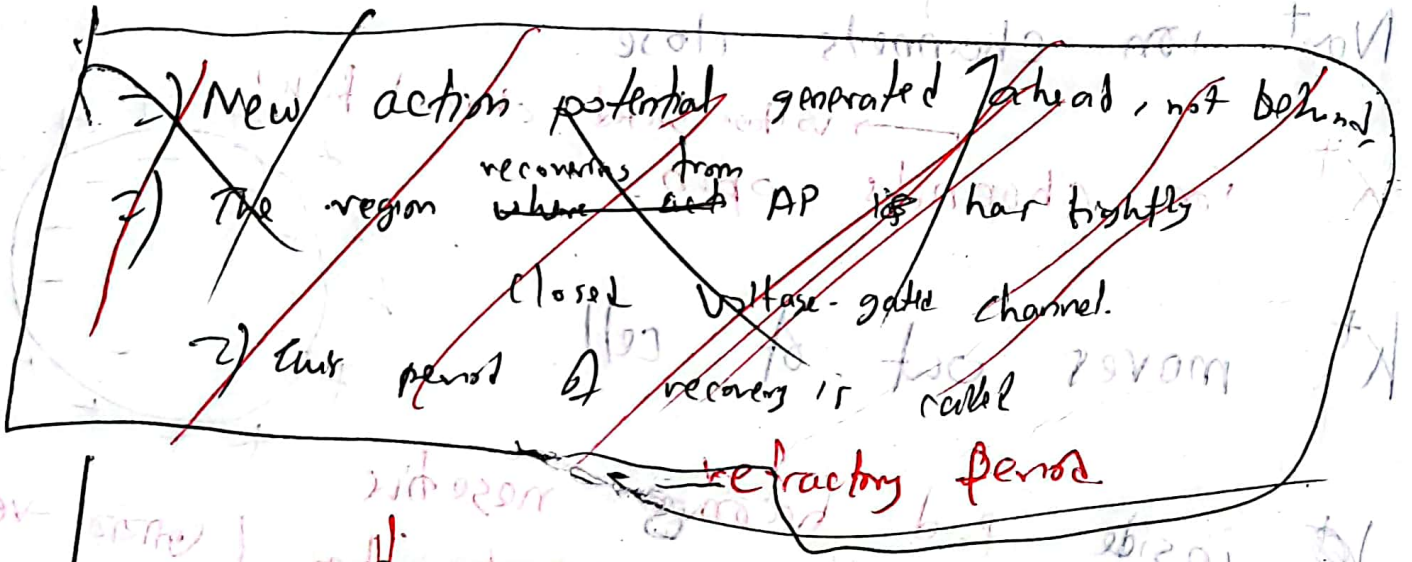
=) local circuit forms between nodes

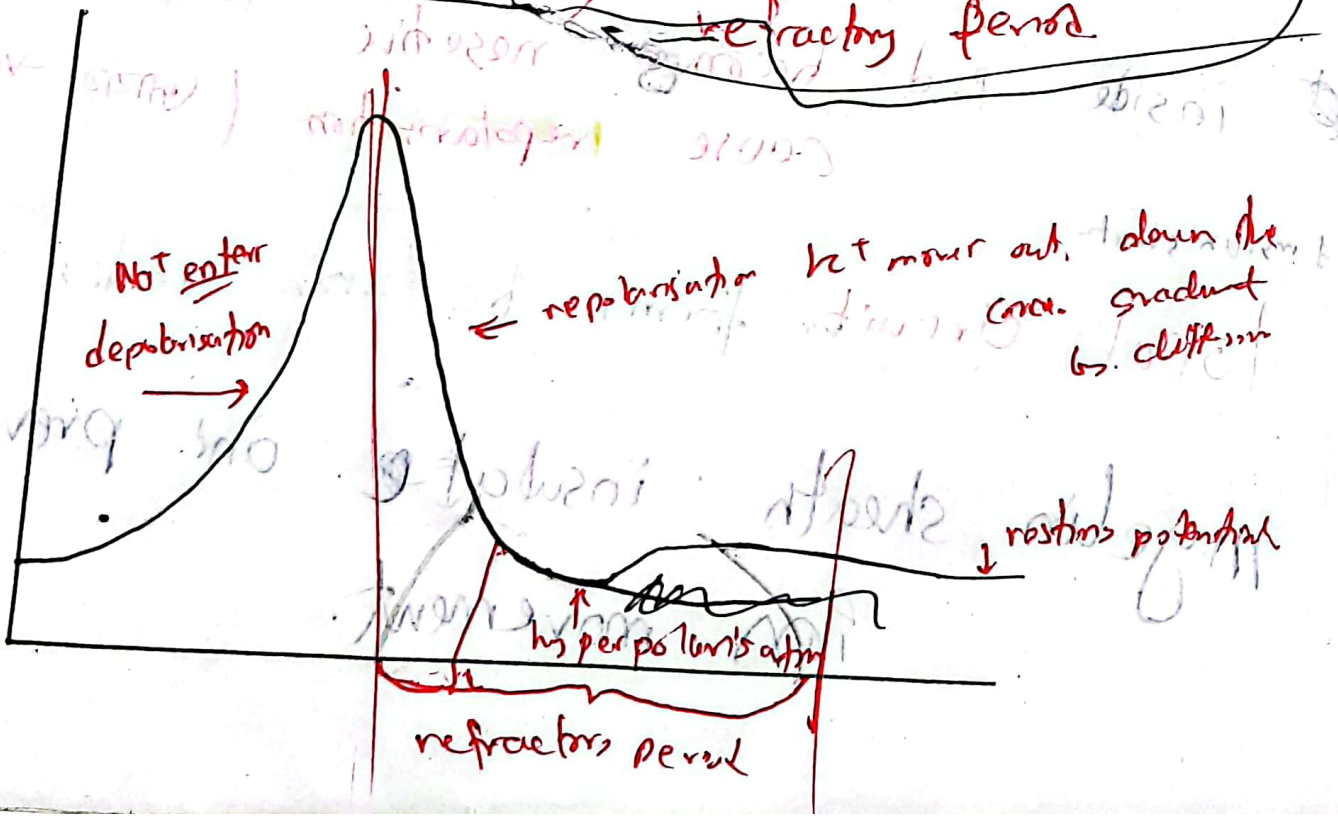
=) myelin sheath insulate and prevent ion movement.

2) Action potential and depolarisation only occurs at nodes of Ranvier.

3) Saltatory conduction occurs where action potential jumps from node to node.

4) Transmission in one direction due to hyperpolarisation or refractory period





~~Advantage of~~ begin when repolarisation ~~starts and~~ ends when resting state reestablished.

Importance of ~~refact~~ refractory period:

=) ensures that AP are discrete events.

=) controls maximum frequency of AP.

=) ensures new AP generated ahead,

=) so impulse can only travel in one direction.

=) The length of the refractory period is used to find the max. frequency at which impulse can be transmitted.

How Resting potential restored during refractory period?

=) ~~Depo-Repola~~ Repolarisation occurs where K^+ moved out of axon by diffusion down the concen. gradient.

=) P.d. in axon becomes more negative inside wrt to out.

=) Once the resting potential is close to being ~~reac~~ reestablish, Na^+ volta channel proteins open and

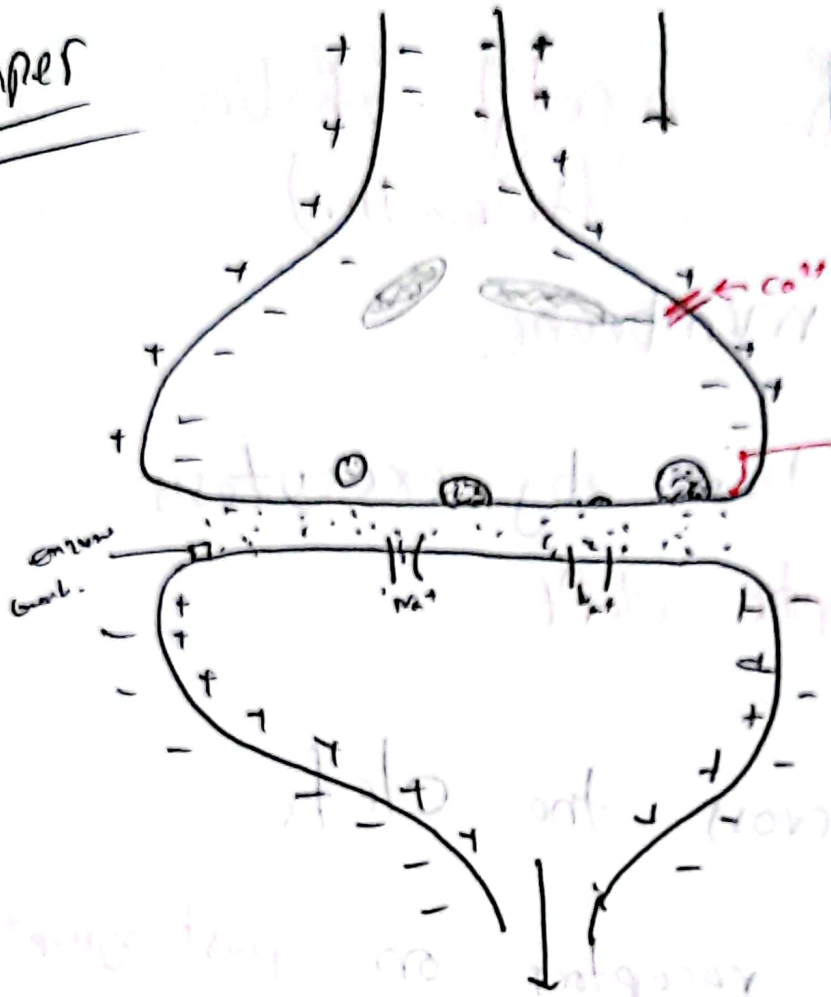
K^+ voltage-gated channel protein closed.

⇒ so this section again responsive to depolarisation again.

⇒ greater speed of conduction:

- presence of myelin sheath (100 ms^{-1}) nm: 0.5 ms^{-1}
- larger diameter of axons.

Synapses



(Cholinergic synapse)

1) Action potential / Depolarisation at Presynaptic membrane

2) Ca^{2+} voltage-gated channels opens, increased Permeability to Ca^{2+} ion

3) Ca^{2+} ions enter presynaptic membrane

4) by facilitated diffusion down the electrochemical ~~concentration~~ gradient.

⇒ Vesicle with acetyl-choline (transmitter) fuse with membrane.

⇒ Ach ~~exits~~ leave by exocytosis into synaptic cleft.

⇒ Diffuser across the cleft.

⇒ Binds to receptors on post-synaptic membrane.

⇒ Nat ion ~~chapp~~ channels open.

2) Na^+ ion enter ~~posts~~ post synaptic membrane.

⇒ membrane depolarised, AP produced

⇒

=) Acetylcholinesterase breaker down Ach to acetate and choline.

=) stops continuous production of AP in post-synaptic neurone by depolarisation.

=) choline recycled in presynaptic neurone to form Ach.

function of synapses:

=) Ensure one-way transmission

why?

=) vesicle found only in presynaptic neurone

=) receptor potential found only in post-synaptic membrane.

=) allow interconnection of many neurones

=) memory and learning

=) wide range of responses

=) summation

Describe the roles of neuromuscular junctions, the t-tubule system and sarcoplasmic reticulum in stimulating contraction in striated muscle.

=) Depolarisation produces action potential in the ~~synaptic~~ pre-synaptic membrane.

=) Voltage gated calcium ion channels open.

=) Ca^{2+} ion enter the presynaptic knob

=) Vesicle containing Ach fuse with ~~presyna~~ presynaptic membrane, and released into the synaptic cleft by exocytosis.

⇒ Ach ~~bind~~ binds to receptor on sarcolemma, the muscle cell membrane.

⇒ sodium ion channels open, so ~~it~~ they enters the sarcoplasm.

⇒ Depolarisation ~~in the~~ of the sarcolemma

⇒ Depolarisation spreads to T-tubules.

⇒ ~~Depolarisation~~ Depolarisation of adjacent Sarcoplastic reticulum membrane.

⇒ Voltage-gated calcium ion channel open

⇒ Ca^{2+} ions diffuse out of SR.

⇒ Ca^{2+} ion into sarcoplasm.

⇒ ~~Ca~~ Ca^{2+} ions bind to troponin, start contraction

⇒ When Ca^{2+} ions bind to troponin

⇒ troponin changes shape.

⇒ tropomyosin is displaced
uncover myosin binding sites on actin

⇒ so myosin binding sites exposed

⇒ myosin binds to actin

⇒ myosin heads form cross-bridges with the thin filaments and the sarcomere shortens. As myosin pulls actin and Z-discs are pulled together.

=) Twin actin filament ←
=) Twin myosin filament ←

=) Each myosin heads is ~~ATPsy~~ ATPase.

=) ATP hydrolysis occur / ATP → ADP + P.

=) Causes myosin head to stand up

=) forms cross-bridges with actin

=) ADP and Pi detach

=) ~~Myosin head~~ returns to previous position

=) actin is moved / power stroke occur

=) new ATP binds → ATP hydrolysis occur.
=) myosin head returns to its previous position

=) Myosin detaches from actin

Rapid Response of Venus fly trap!

- mechanical energy converted to electrical
- sensory hair cell is receptor
- cell membrane depolarises
- if at least two hairs touched within 35 seconds
  - action potential occurs
  - Depolarisation cause AP spreads over the leaf
  - hinge / midrib cells.
  - H^+ pumped out of cells
  - cell wall loosens.
  - Calcium pectate dissolves in middle lamella.

=) Ca^{2+} ions enter cells

=) Water enter by osmosis.

=) cells become turgid

=) Change from convex to concave

=) traps shut quickly in 0.3 s.

=)

Role of auxin in elongation growth

=) acid - growth hypothesis, auxin binds to receptor protein

=) auxin stimulates proton pumps.

=) in cell surface membrane.

=) H^+ pumped into cell wall

=) using energy by active transport

=) pH of cell wall decreases

=) pH - dependent enzymes activated.

=) e.g. like expansins.

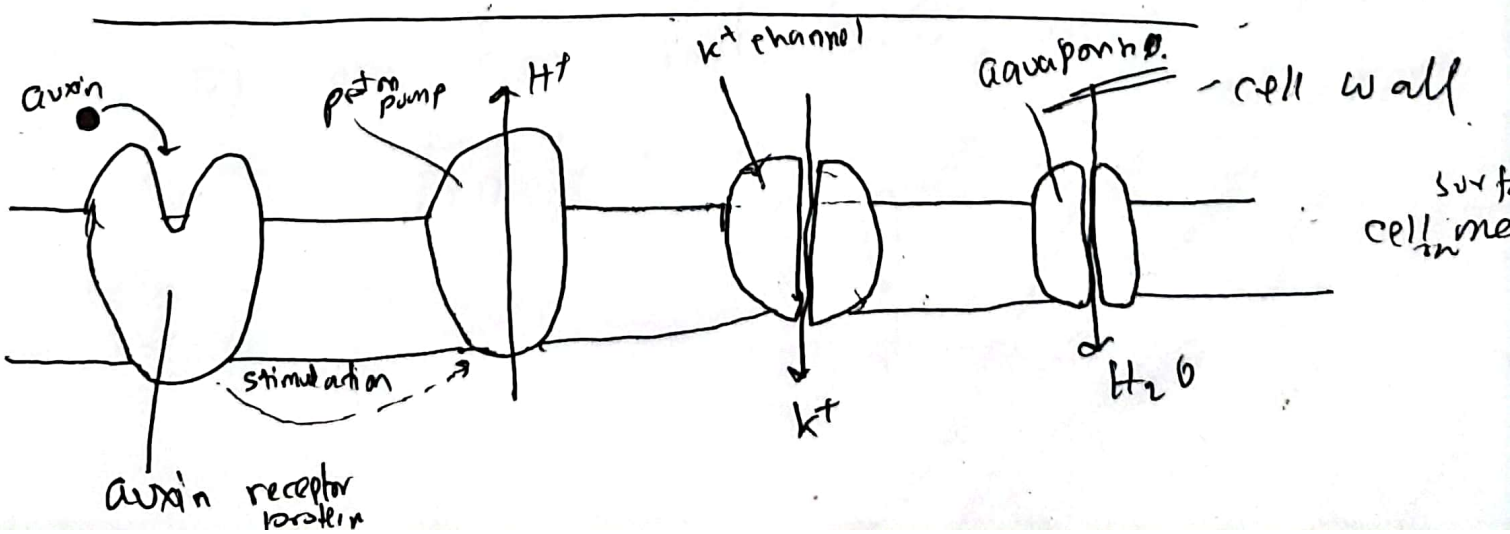
=) bonds between cellulose microfibrils broken

=) cell wall loosens / able to stretch

=) more water enters cells by osmosis

=) so cell expands due to turgor pressure.

K^+ ions enter the cells so lower ψ



Role of gibberellins in germination of barley seeds

1) Barley seed is dominant
2) seed absorbs water
3) embryo produces gibberellin
4) which stimulates aleurone layer
5) to produce amylase.
6) in endosperm
7) to convert maltose to sucrose → needs water to hydrolyse
8) embryo use sugars for respiration
9) energy / ATP used for growth
10) gibberellins affects transcription of mRNA.