

Section 37.3

(1)

Voltage-gated ion channels

- change the membrane's permeability to particular ions

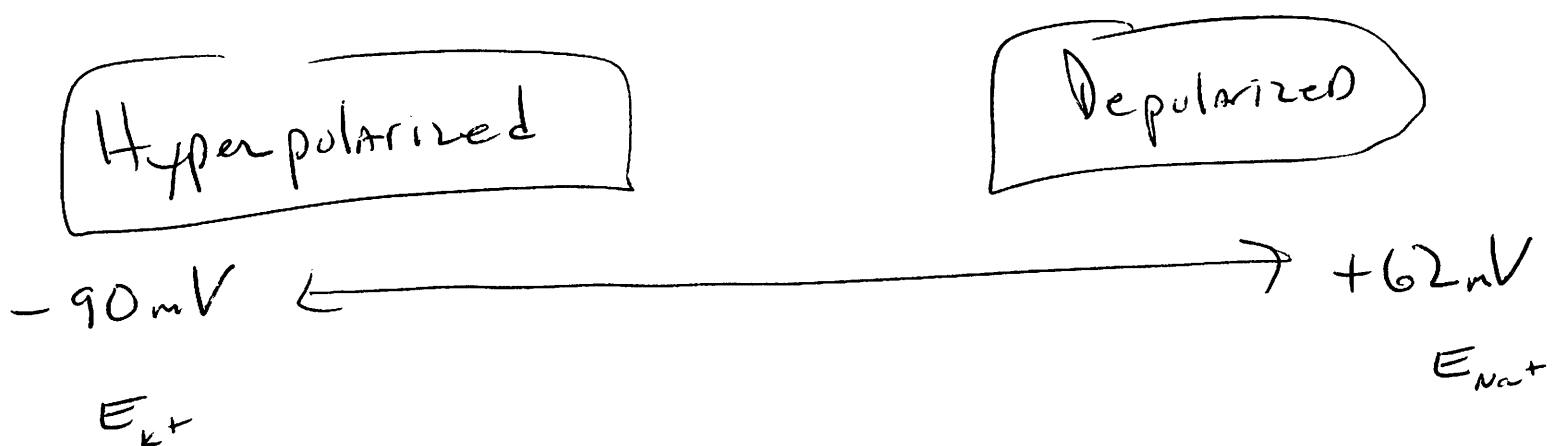
Hyperpolarization

- making the inside of the membrane MORE NEGATIVE; caused by OUTFLOW OF POSITIVE IONS or INFLOW of NEGATIVE IONS

Depolarization

- makes inside the membrane LESS NEGATIVE

* gated sodium channel open in response to stimulus, Na^+ goes in, and membrane potential shifts towards $+62 \text{ mV}$



GRADED POTENTIAL (jk)

- just a slight shift in membrane potential

ACTION POTENTIAL (the real deal!)

★ massive change in membrane voltage

★ spreads along axon → transmits signal

VOLTAGE-GATED SODIUM CHANNELS
ARE A POSITIVE FEEDBACK

- like a chain-reaction; DOMINOES



Threshold Value (all mammals)

- 55 mV

- initiation of ACTION POTENTIAL



ALL or NONE → must hit -55 mV mark.

Undershoot

- membrane potential gets closer to E_{K^+} than it was at resting potential;
eventually all the gated potassium channels close and it's back to resting potential

NOTE: look at the protein "shoppers" on p758.!!

Refractory Period

(3)

- "downtime"
- limits frequency of action potential generation.
- insures signal travels in one DIRECTION

- caused by sodium channels being closed during falling phase and undershoot

★ MUTATIONS in sodium channel proteins can cause DISORDERS !!

- EPILEPSY - seizures
- MYOTONIA - muscle spasms.

Conduction of an ACTION POTENTIAL along an AXON is

A Depolarization - Repolarization Process

Schwann Cells - A glial cell-type (4)
made of myelin

★ Schwann cells wrap around Axons
forming a myelin sheath

→ gaps in the sheath are called
NODES of Ranvier

Myelin Sheath (electrical insulation - lipid)
- in vertebrates

glia { ① Oligodendrocytes in CNS
② Schwann cells - in PNS

★ the voltage-gated sodium channels
are only in the GAPS in the
sheath (the nodes of Ranvier)

↳ "jumping" from NODE to NODE

⇓
SALTATORY CONDUCTION

→ Myelination is an EVOLUTIONARY ADAPTATION → speed and space efficiency (5)

Section 37.4

→ majority of synapses are chemical synapses (as opposed to electrical synapses - i.e. squid, lobster)

Chemical Synapse

- release of a chemical neurotransmitter by the pre-synaptic neuron

→ neurotransmitter is synthesized and packaged into Synaptic Vesicles

→ voltage-gated CALCIUM channels at synaptic terminals increase Ca^{2+} concentration

↳ vesicles fuse with membrane

↳ RELEASED into synapse

(6)

Synaptic Cleft - the gap that separates the pre-synaptic neuron from the post-synaptic cell.

LIGAND-GATED ION CHANNEL (IONOTROPIC RECEPTOR)

- responds to the neurotransmitter
- the neurotransmitter is the receptors ligand $\Rightarrow$ opens or closes channel

Post-synaptic Potentials

Depolarizing $\Rightarrow$ movement toward threshold
 $\downarrow$

EPSP Excitatory post-synaptic potential

Hyperpolarizing $\Rightarrow$ movement away from threshold
 $\downarrow$

IPSP inhibitory postsynaptic potential

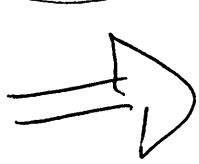
Metabotropic Receptors

- one or more metabolic steps are needed to open a channel

* SIGNAL TRANSDUCTION PATHWAY GETS ACTIVATED → SECOND MESSENGER



SLOWER !! but longer lasting!



cAMP

(remember S.T. Pathways are AMPLIFYING !)

norepinephrine → receptor →
G protein ACTIVATED



ADENYLYL CYCLASE



ATP converted to cAMP



protein kinase A activated



phosphorylated a specific
ion channel protein



gate opens or CLOSES !!



are
you
kidding
me !!

Acetylcholine

- muscle stimulation, memory, learning
- (1) In PNS, ionotropic acetylcholine receptors work at neuromuscular junctions
- (2) In CNS, in brain, it binds NICOTINE
 ↳ that's why it's a stimulant
- (3) METABOTROPIC ACETYLCHOLINE RECEPTOR
 - in heart

↓
 STP open potassium channels in heart muscle cells → creates IPSP to slow heart-rate

Acetylcholine Disruptors

- (1) Sarin Gas !
- (2) Botulism - BOTOX !

over 100 neurotransmitters

- (1) AMINO ACIDS
- (2) BIOGENIC AMINES
- (3) NEUROPEPTIDES
- (4) GASES

Amino Acids

- ① - Glutamate is most common NT in CNS → MEMORY
- ② - GABA (gamma-aminobutyric acid)
 - inhibitory in brain
 - IPSP → VALIUM
- ③ Glycine - IPSP outside brain
 - disrupted by strychnine (RAT POISON)

Biogenic Amines

- norepinephrine
 - dopamine (tyrosine)
 - serotonin (tryptophan)
- LSD disrupts. } sleep, mood, attention learning.

Neuropeptides

- operate via metabotropic receptors
- Endorphins (decrease pain)
 - ↳ childbirth
- OPIATES mimic endorphins !!!

GASES

- NO (Nitric oxide) → smooth muscle
- CO (carbon monoxide)



AZT AS LOCAL REGULATORS

- muscle relaxation
- release of hormones