50 Marks (My portion)

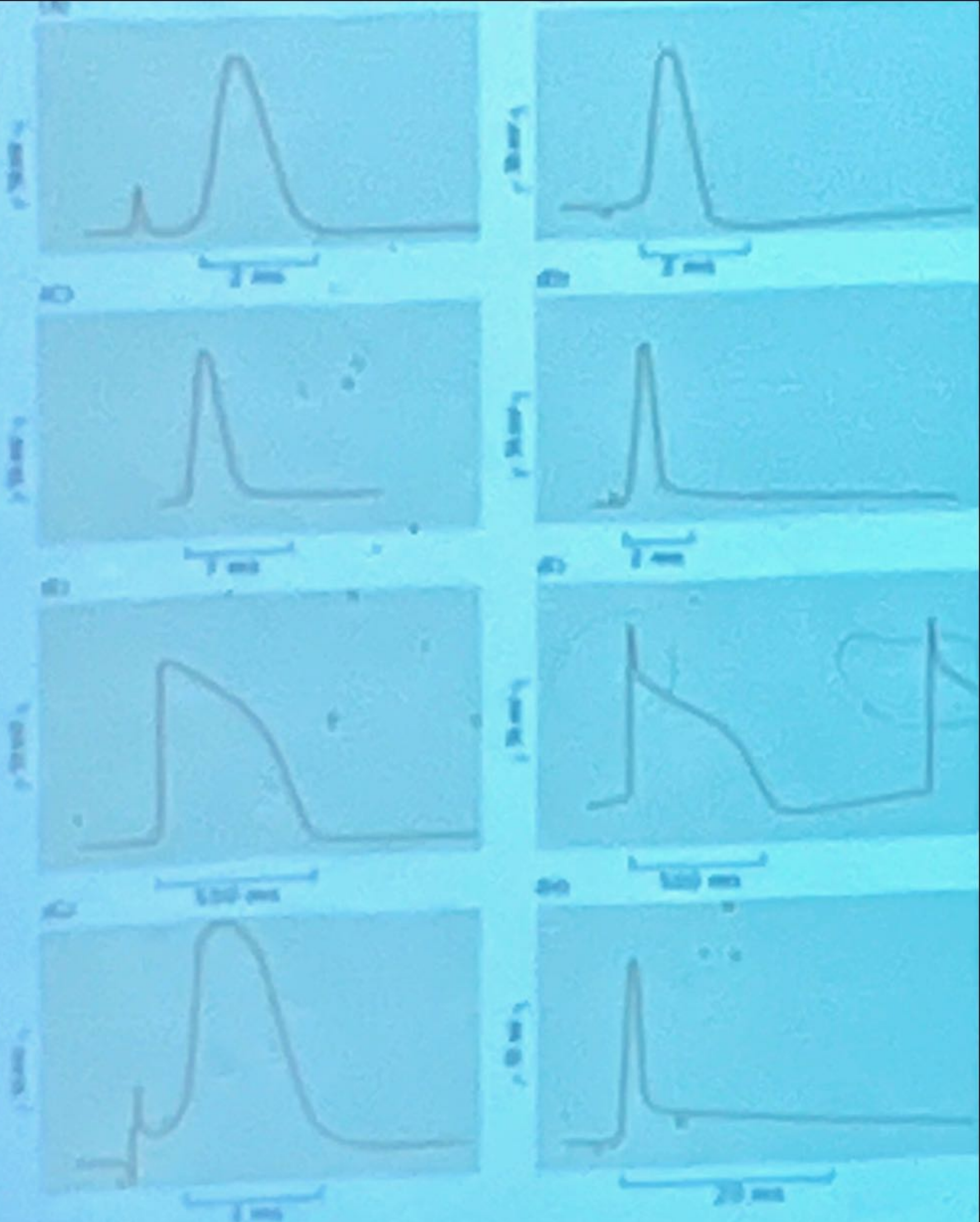
End Sem Exam
(35 Marks)

Group Project
(4 Teams)
Group Discussion
(4 Teams)
(15 Marks)

All Lectures/Tutorials will be examined

EVALUATION (TENTATIVE)

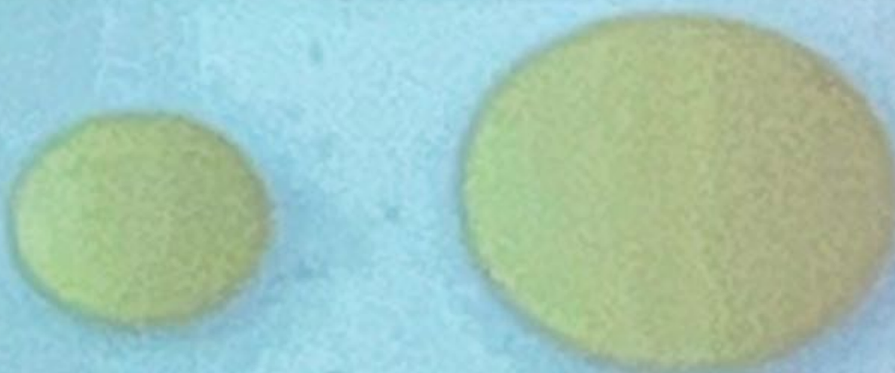
EVALUATION



Action Potentials (Many Shapes)

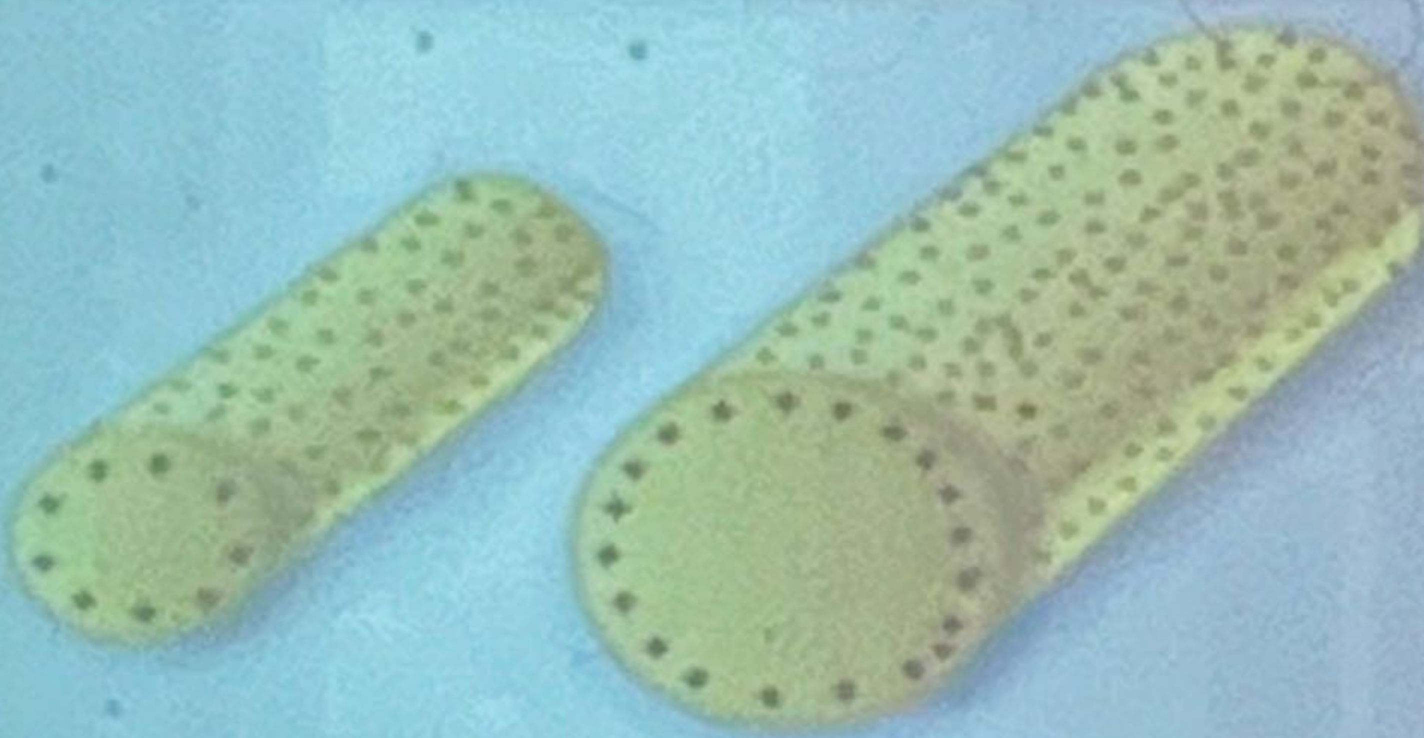
1 **Resistance**

In larger axons, the resistance is lower, allowing for faster propagation of current.



2 **Capacitance**

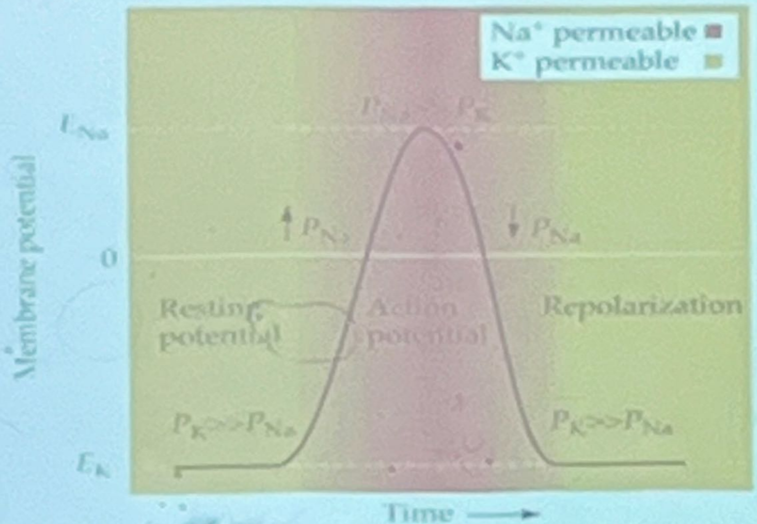
In larger axons the membrane surface area is larger, increasing the capacitance, or amount of charge accumulated at the membrane.



FACTORS INFLUENCING ACTION POTENIAL

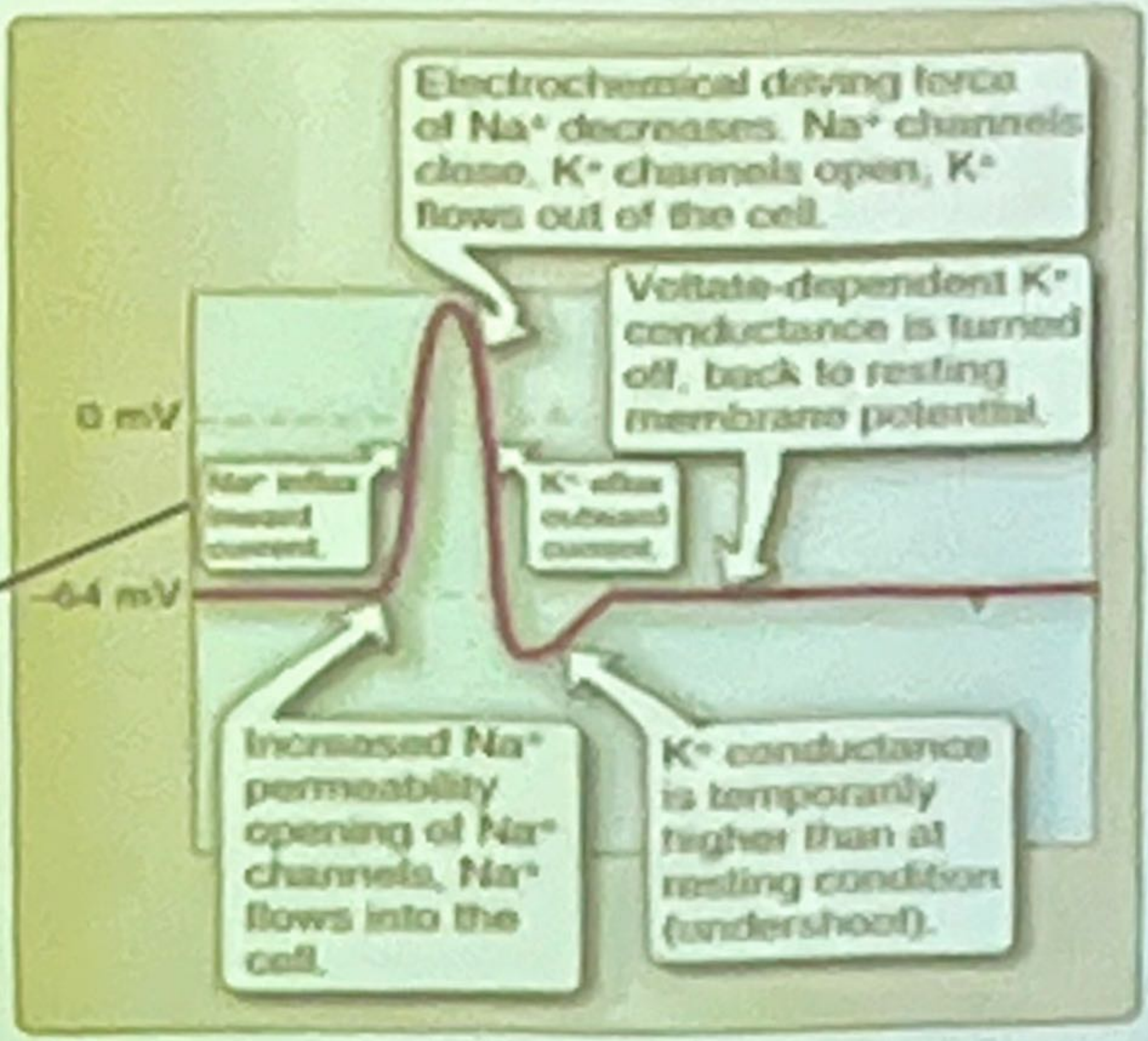
Resistance/Capacitance in Axons?

Action Potential (Membrane permeability to K+ and Na+)



Cont ce by Claudia Krebs

al (Ions Involved)



e by Claudia Krebs

Ohm law

Conductance or membrane permeability

Equilibrium potential

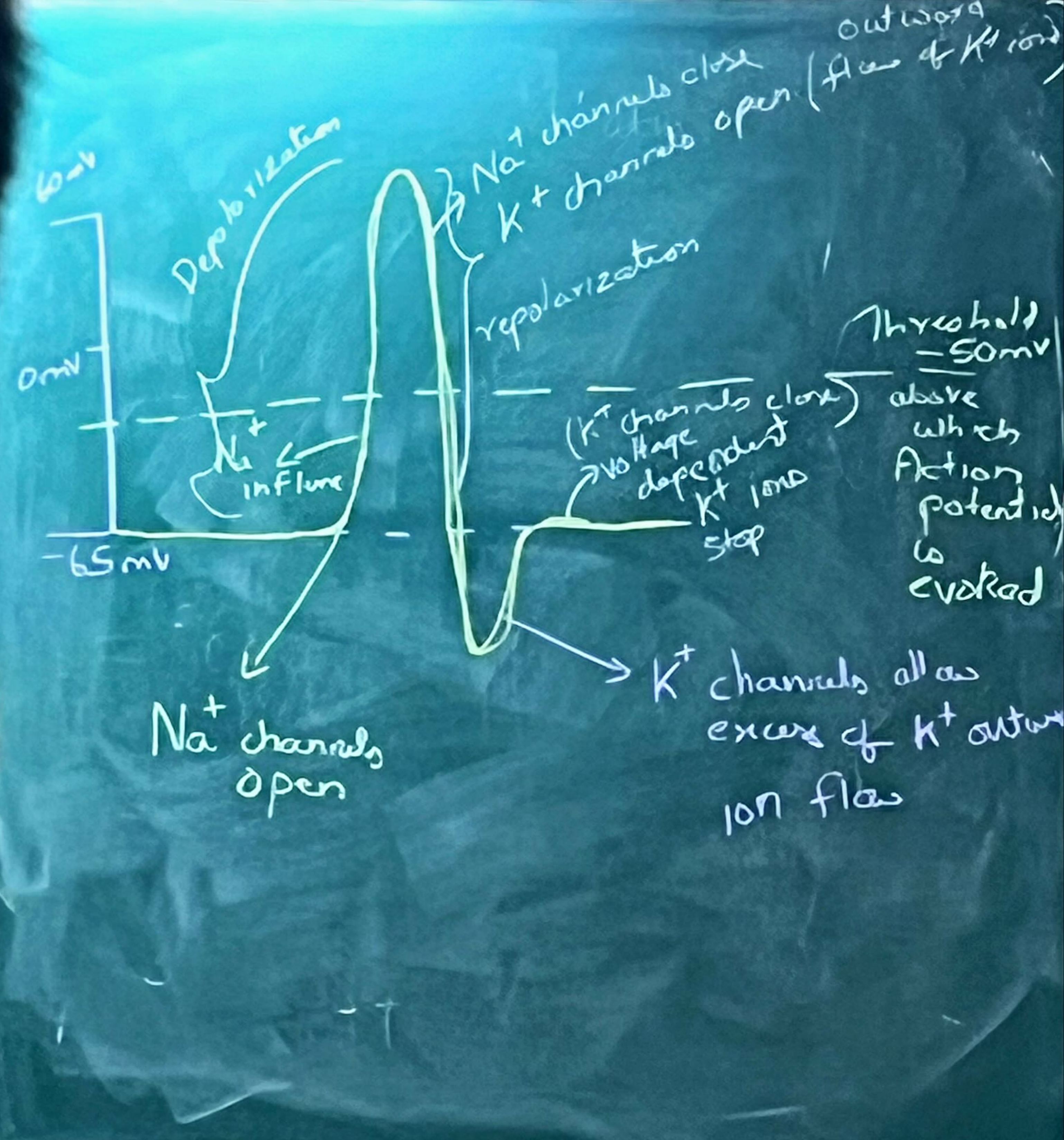
$$I_{ion} = g_{ion} (V_m - E_{ion})$$

Ionic current

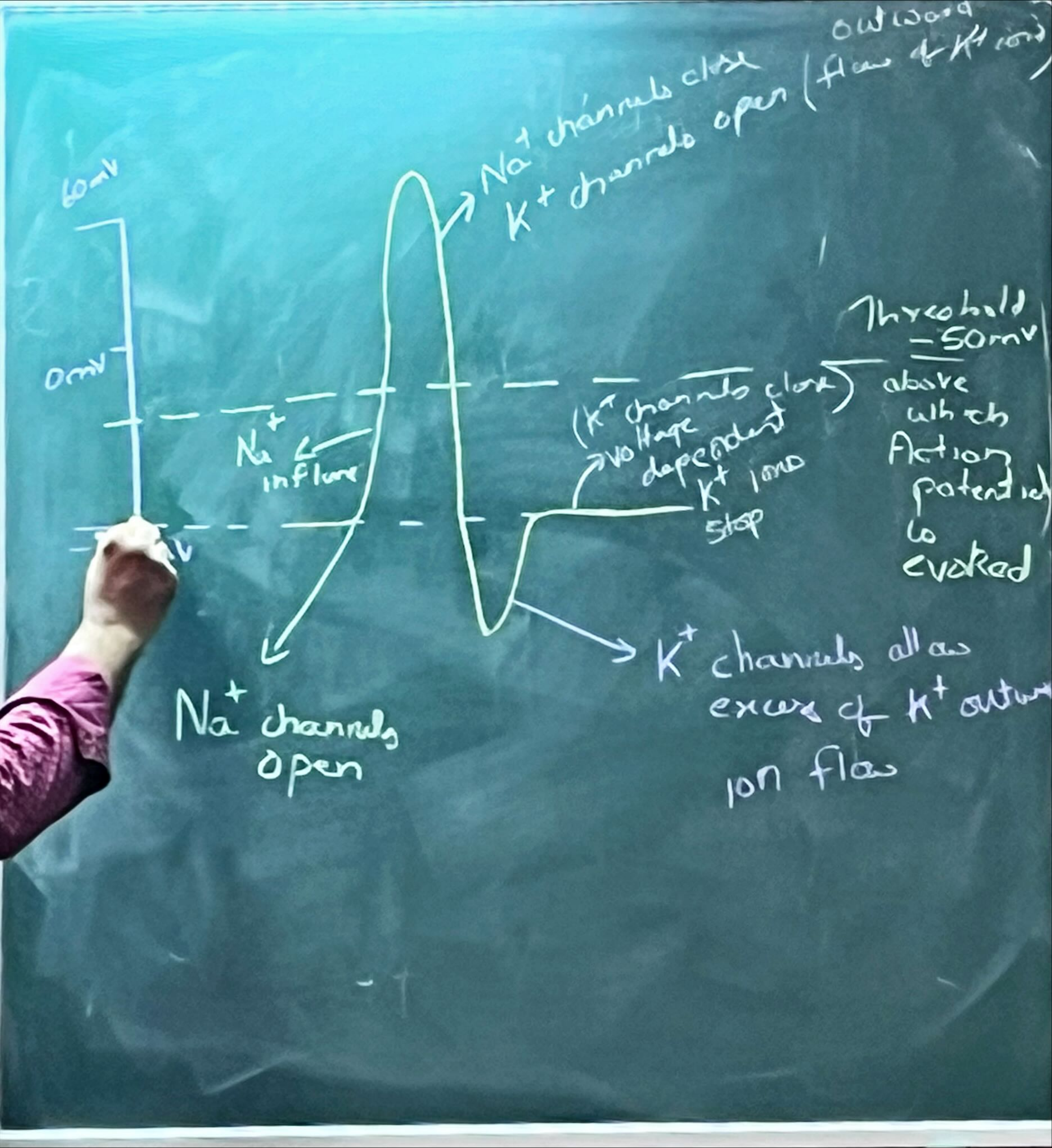
Membrane potential

$(V_m - E_{ion})$
elect
forc

Current is dependen
permeability (conc
electrochemi



outward
Na+ channels close
K+ channels open (flow of K+ ions)
60mV
Depolarization
repolarization
Threshold
-50mV
above which
Action
potential
is
evoked
0mV
-65mV
Na+
influx
(K+ channels close)
voltage
dependent
K+ ions
stop
K+ channels allow
excess of K+ outward
ion flow
Na+ channels
open



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Na+ channels close
K+ channels open (flow of K+ ions
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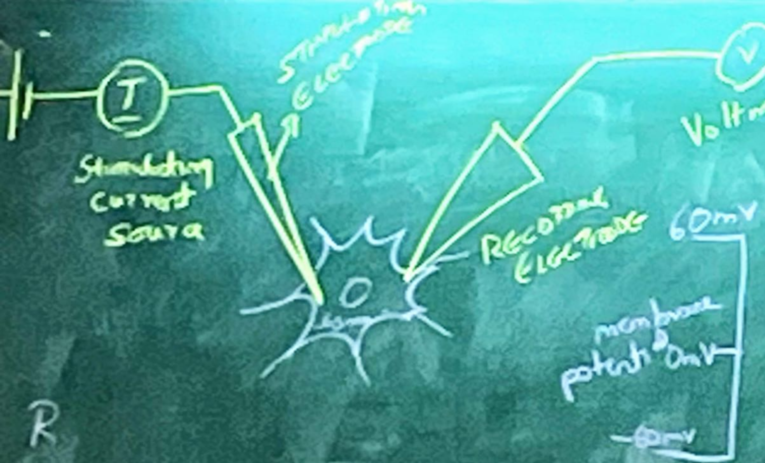
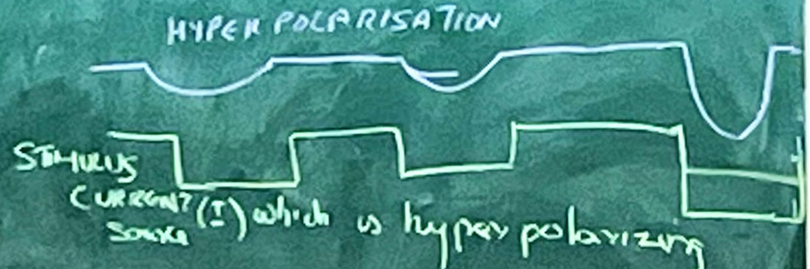




R

$I = VG$ → conductance

G → permeability or conductance

$I = G_{ion}(V_m - E_{ionic})$

V_m → membrane voltage

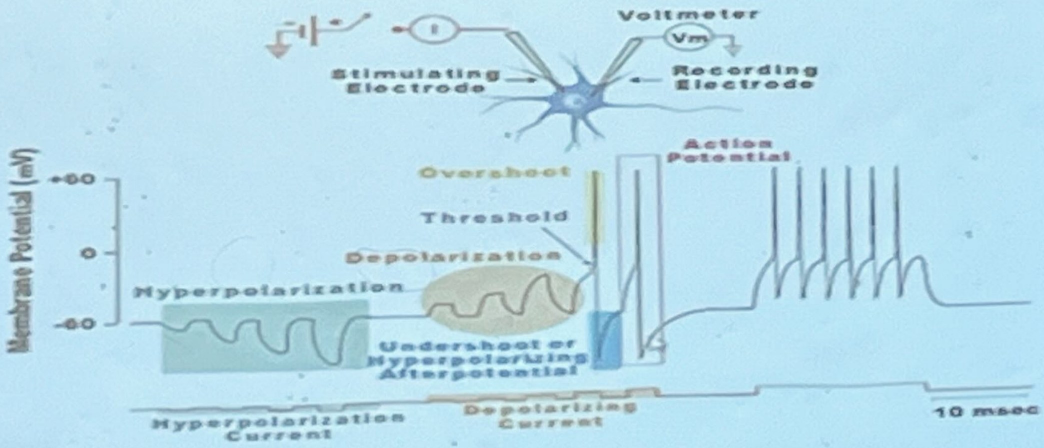
E_{ionic} → Eqt potential of ion considered

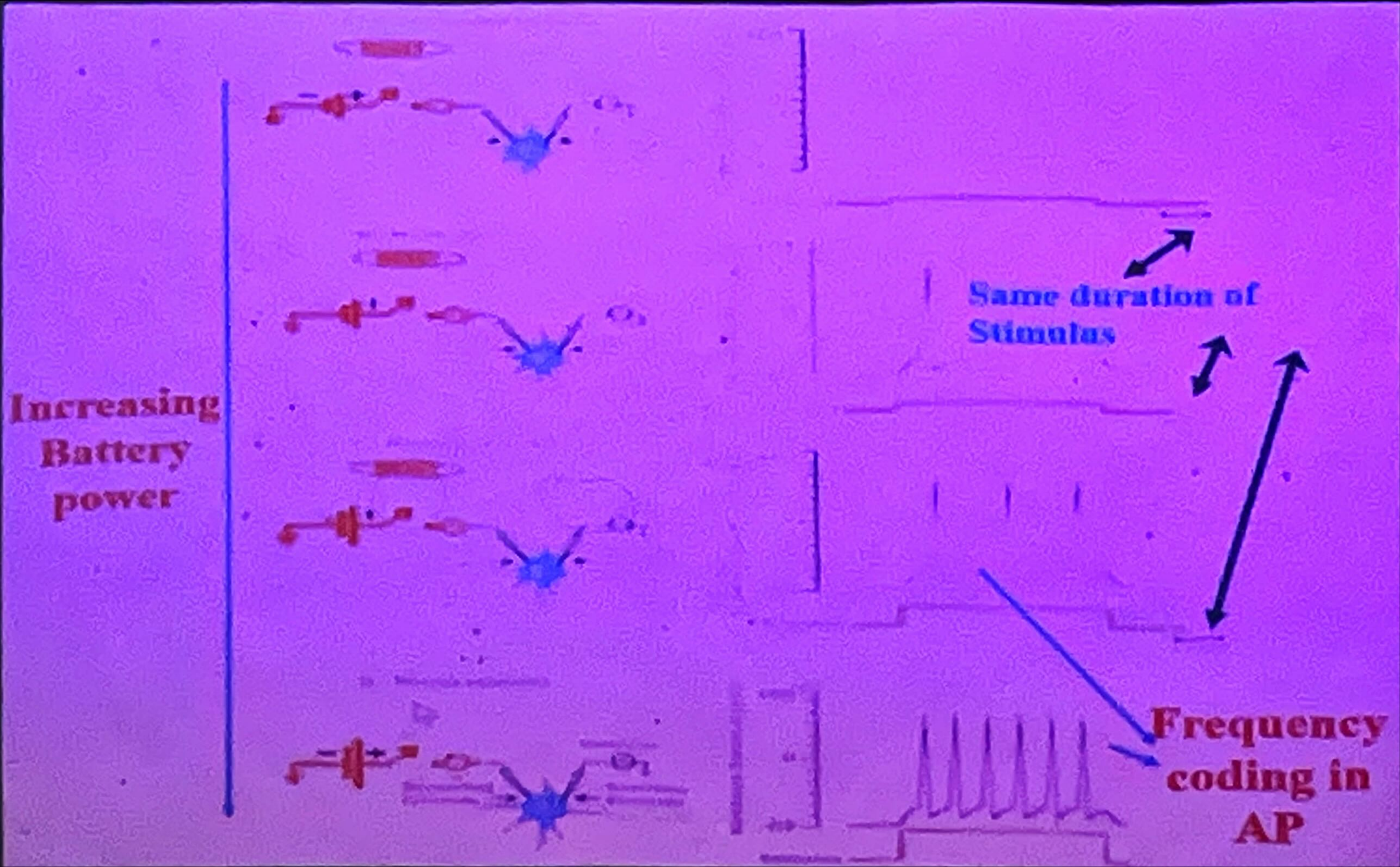
10

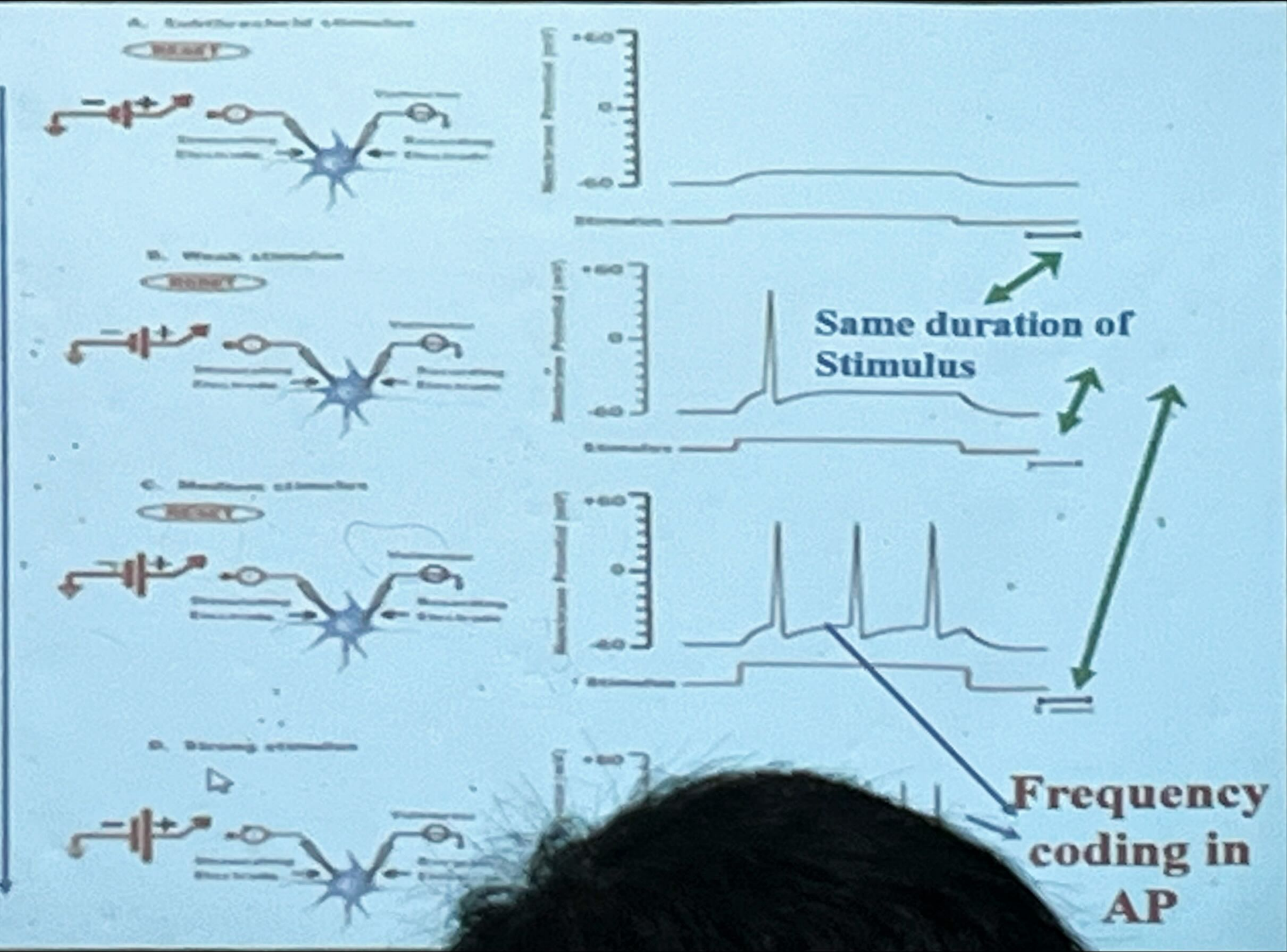
Ohms Law

Current Flow (Action Potential) in Axon Depends on ?

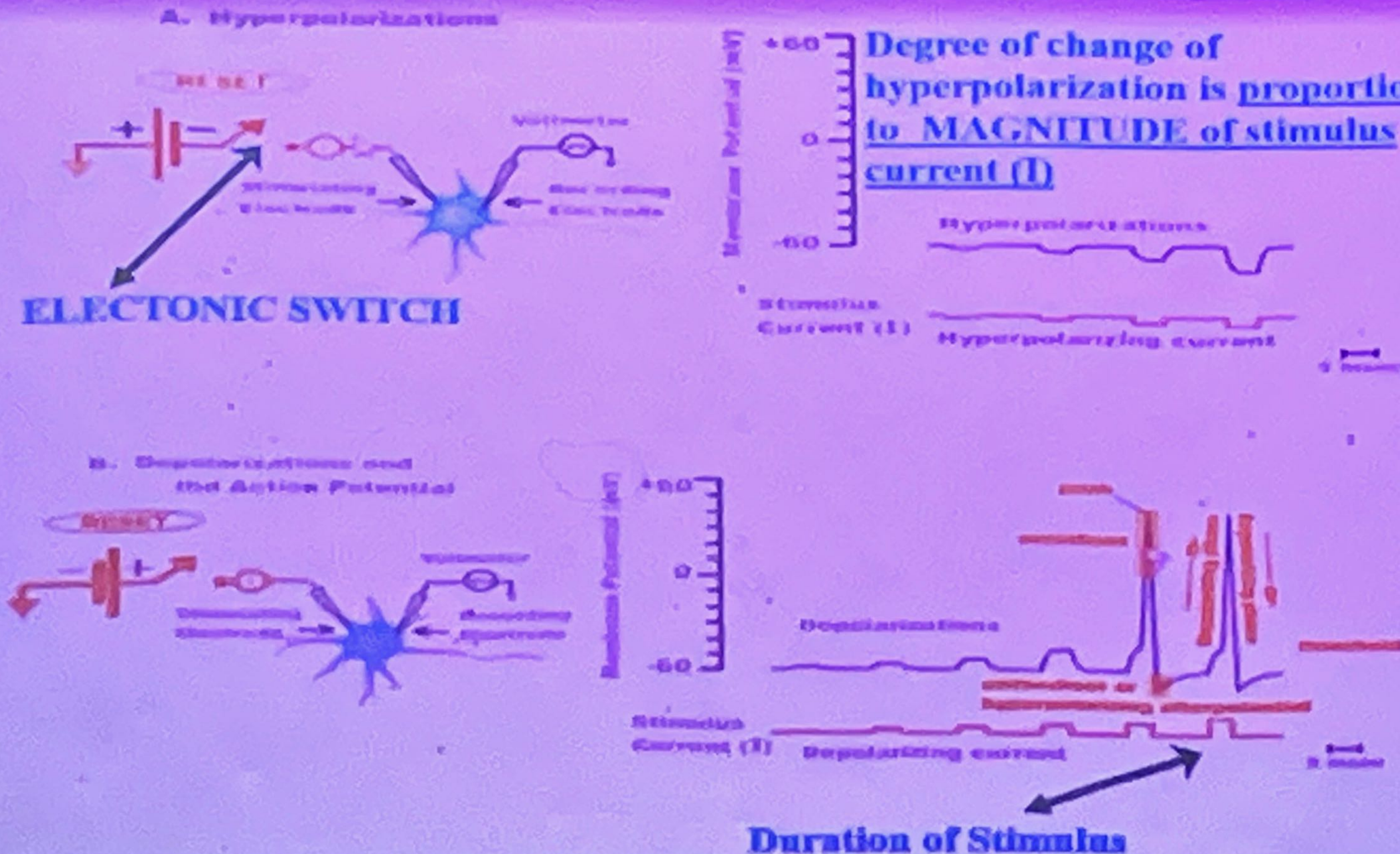
Frequency coding in Action Potential



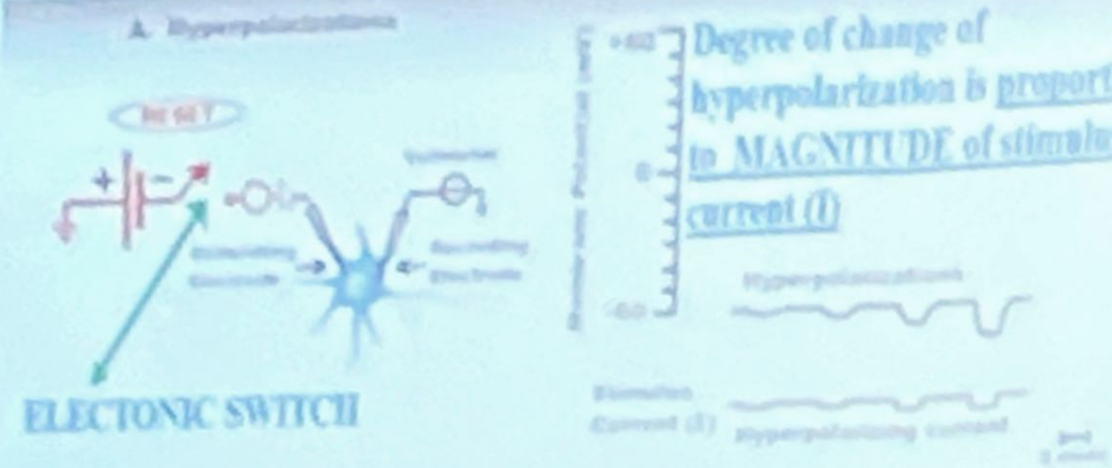

Increasing Battery power
Same duration of Stimulus
Frequency coding in AP


Same duration of
Stimulus
Frequency
coding in
AP

Action Potential (Electrical Viewpoint)

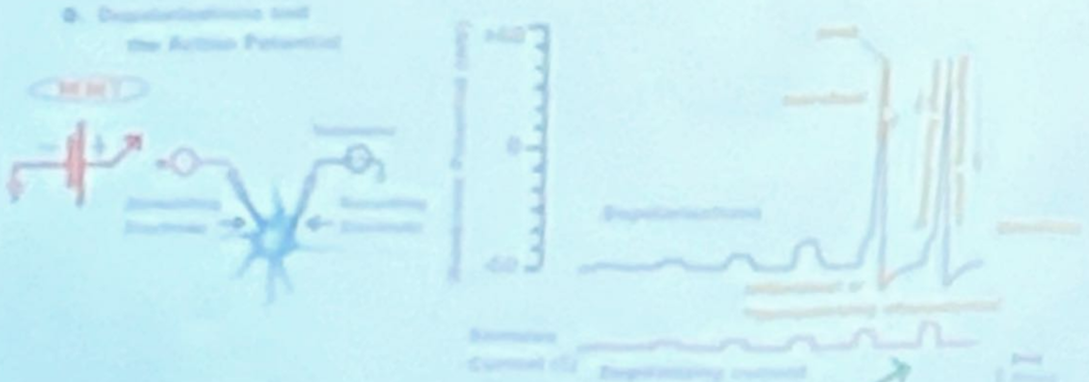


Action Potential (Electrical Viewpoint)

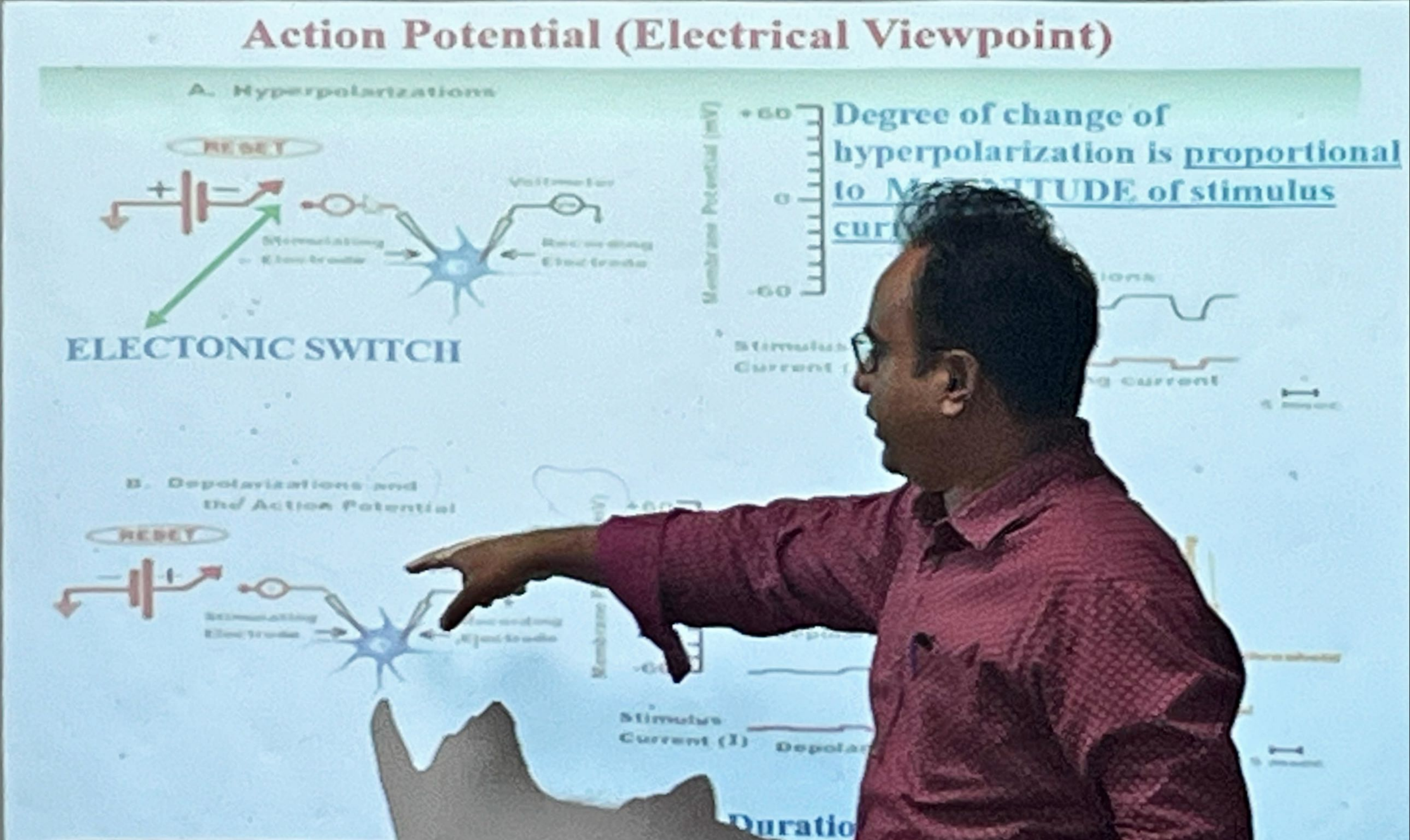


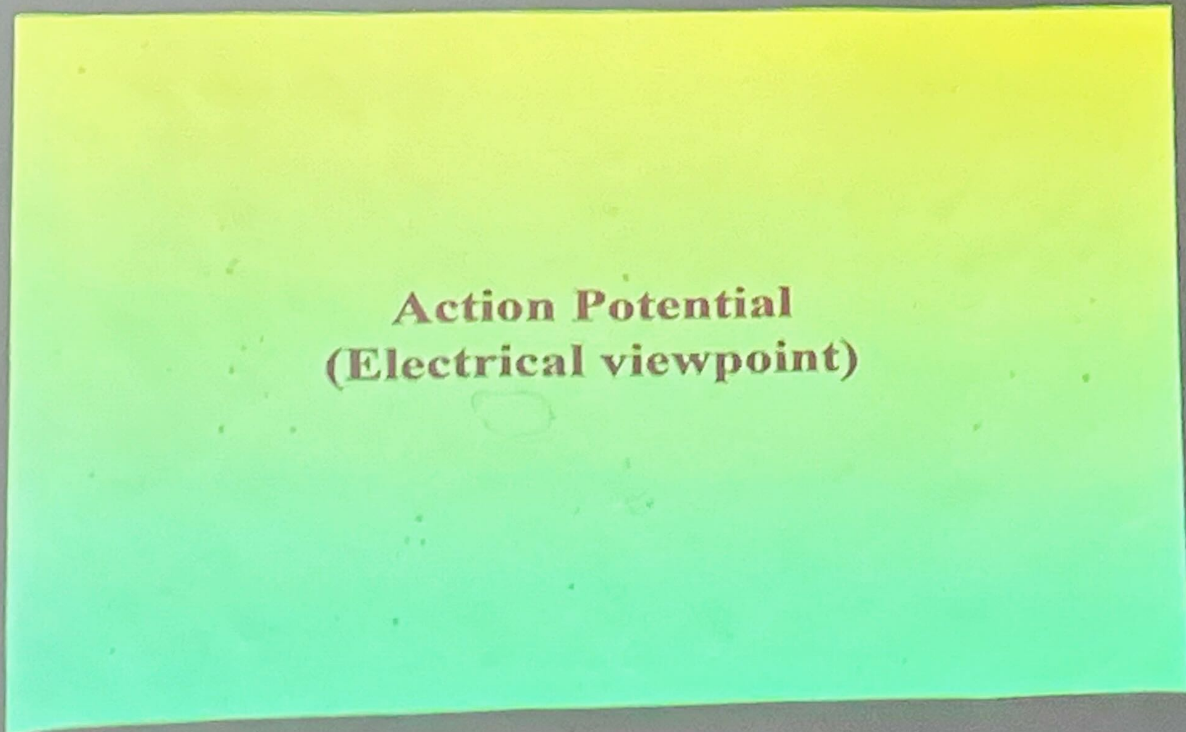
Degree of change of hyperpolarization is <u>proportional to MAGNITUDE of stimulus current (I)</u>

ELECTONIC SWITCH

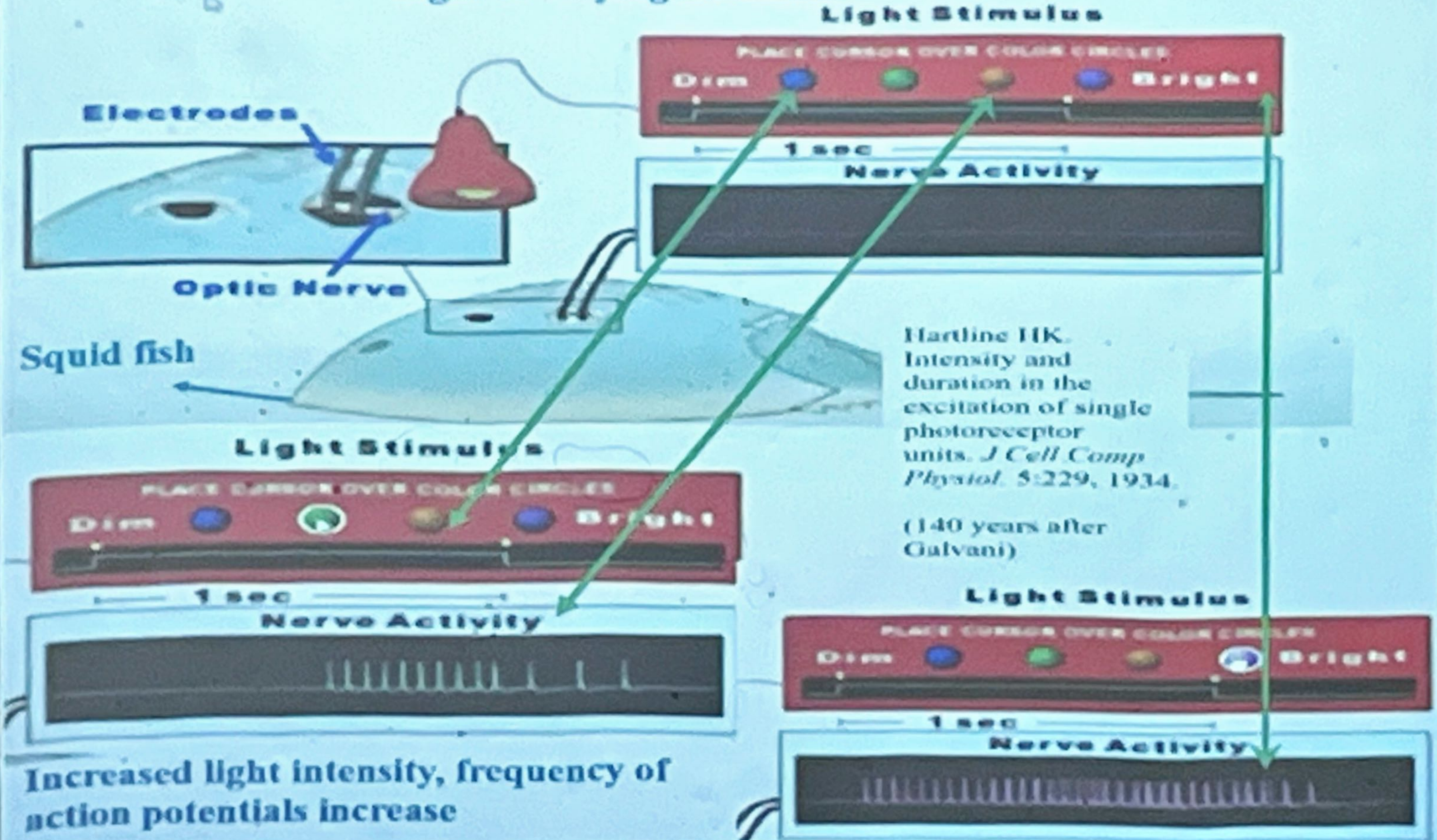


Duration of Stimulus


Action Potential (Electrical Viewpoint)
A. Hyperpolarizations
RESET
Voltmeter
Stimulating Electrode
Recording Electrode
+60
0
-60
Membrane Potential (mV)
Degree of change of
hyperpolarization is proportional
to M
TUDE of stimulus
ELECTONIC SWITCH
Stimulus
Current
current
B. Depolarizations and the Action Potential
RESET
Stimulating Electrode
Stimulus
Current (I)
Duratio


Action Potential
(Electrical viewpoint)

Light of varying intensities

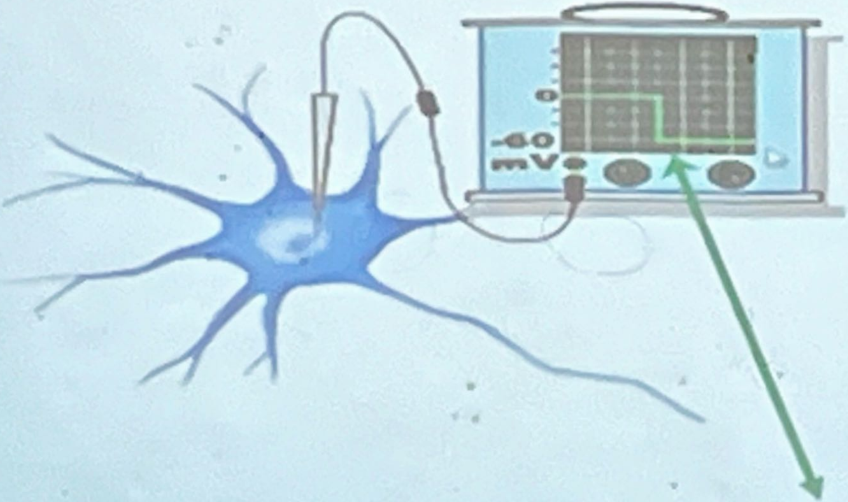


Hartline HK. Intensity and duration in the excitation of single photoreceptor units. *J Cell Comp Physiol.* 5:229, 1934.

(140 years after Galvani)

Increased light intensity, frequency of action potentials increase

Studying Electric/Ionic Mechanisms in Nerve Cell



Hartline HK. Intensity and duration in the excitation of single photoreceptor units. *J Cell Comp Physiol.* 5:229, 1934.

(140 years after Galvani)

RESTING POTENTIAL (Around -60 mv)

Generation of Action Potential

Study how 100 billion Neurons are firing of nearly 50 action potentials per second thereby controlling what we do, how we think, move muscles, listen to lecture

Todays Lecture

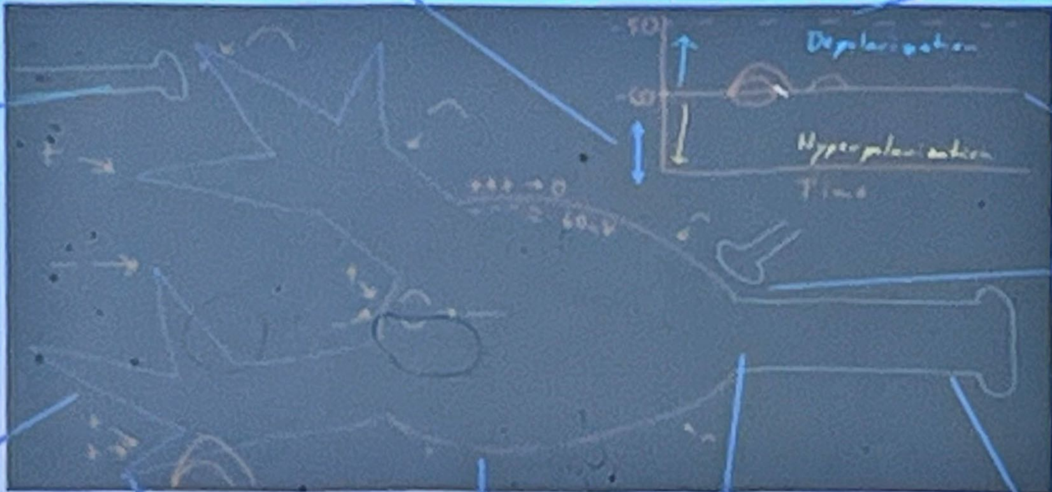
Membrane Transport Process

a. **Action Potential**
   i. Electrical Viewpoint
   ii. Chemical Viewpoint

b. **Evaluation Process**

Acknowledgment: Aggregated Lecture from resources (Textbooks/Coursera/Youtube lectures, Journal Papers)

Graded Potentials (Quick Look)

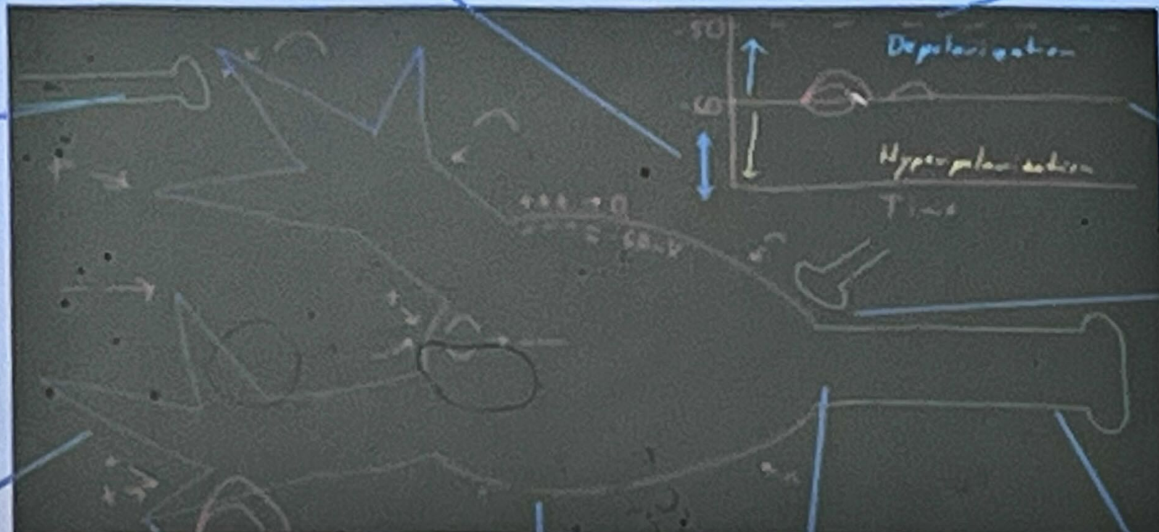


Modified Figure from Khan Academy

Graded Potentials

- *Transient membrane potential* changes occur in resting potential of neurons and are called *Graded potentials.*
- They occur in the *dendrites* and *soma* of the neuron.
- Excitatory input *depolarizes* while inhibitory input *hyperpolarizes* membrane potential.
- Size and duration of graded potentials is determined by size/duration of inputs (Excitatory and inhibitory).
- Graded potentials decay with time and distance.
- Graded potentials do not pass into the *axons of the neurons*.

Graded Potentials (Quick Look)



Modified Figure from Khan Academy

At times neuronal membrane is permeable to multiple ions (say Na+ and Cl^-) these ions could contribute miniscule amounts to Resting potential as well.

Goldmann equation

$$V = 61 \log \frac{P_K[K^+]_o + P_{Na}[Na^+]_o + P_{Cl}[Cl^-]_o}{P_K[K^+]_i + P_{Na}[Na^+]_i + P_{Cl}[Cl^-]_i}$$

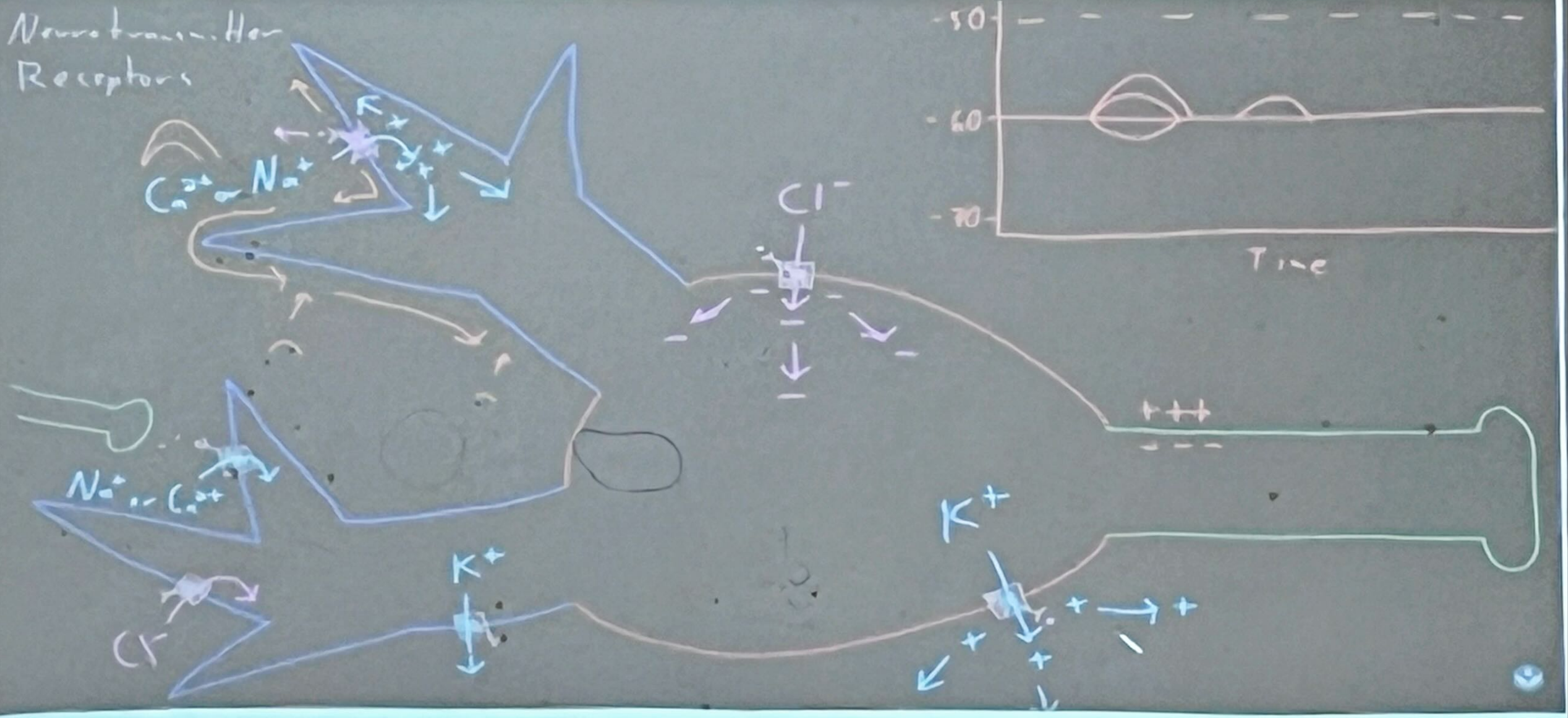
V=membrane potential in V

P=permeability for each ion

The Goldmann equation takes into account the permeability (P) for each ion as well as the concentration gradient of each ion. The sum of this determines the resting membrane potential.

The permeability of the membrane deter can cross the membrane.

Figure from Illustrated Reviews of Neuroscien


Neurotransmitter Receptors
K+
Ca2+ or Na+
Cl-
Na+ or Ca2+
Cl-
K+
K+
-50
-60
-70
Time