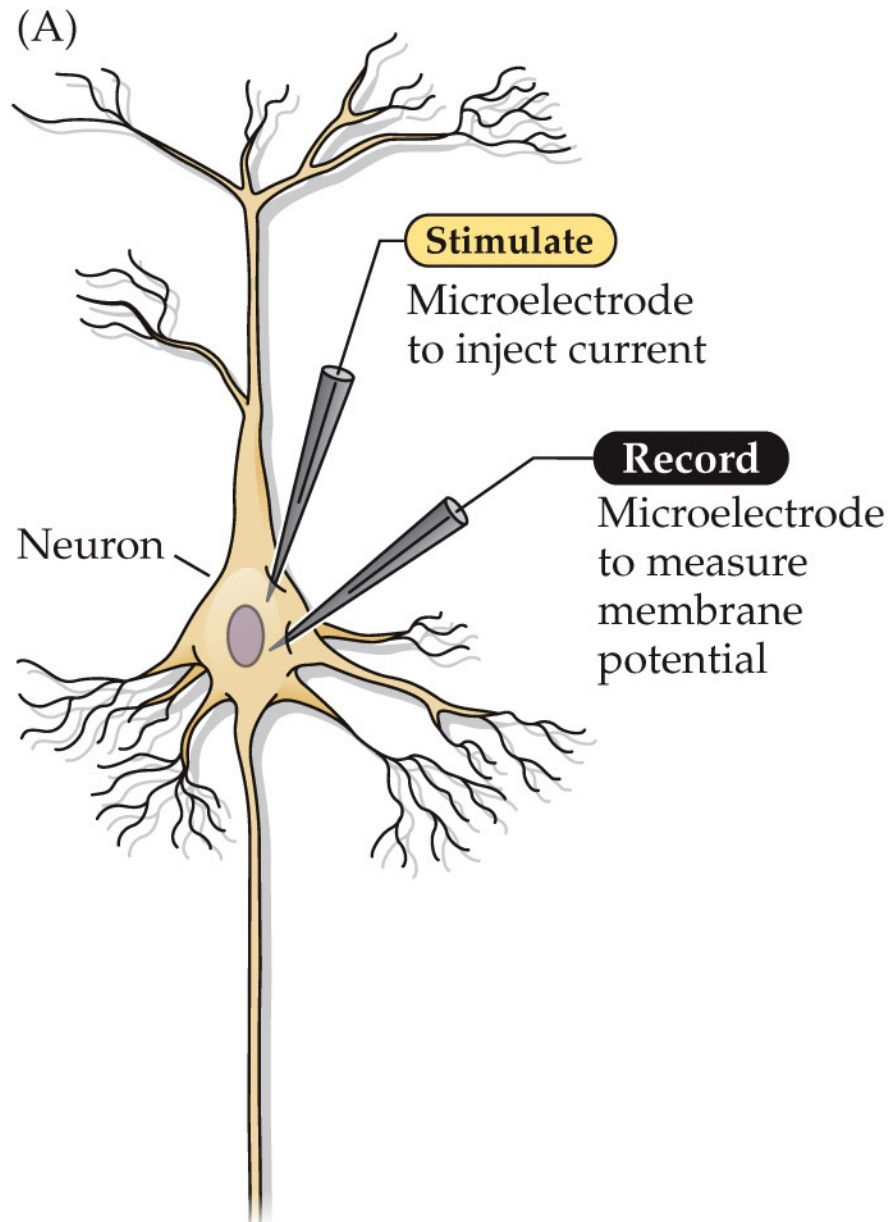


# BMD ENG 301

## Quantitative Systems Physiology (Nervous System)

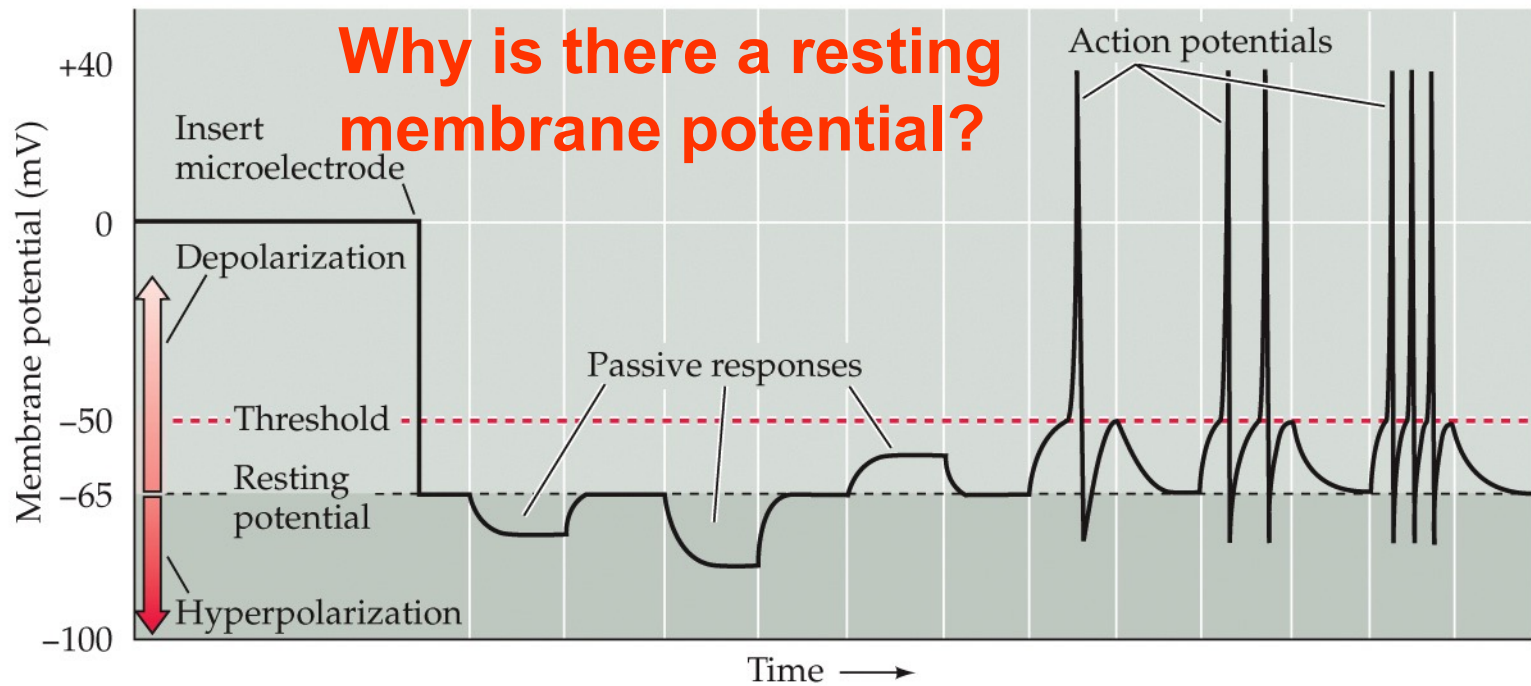
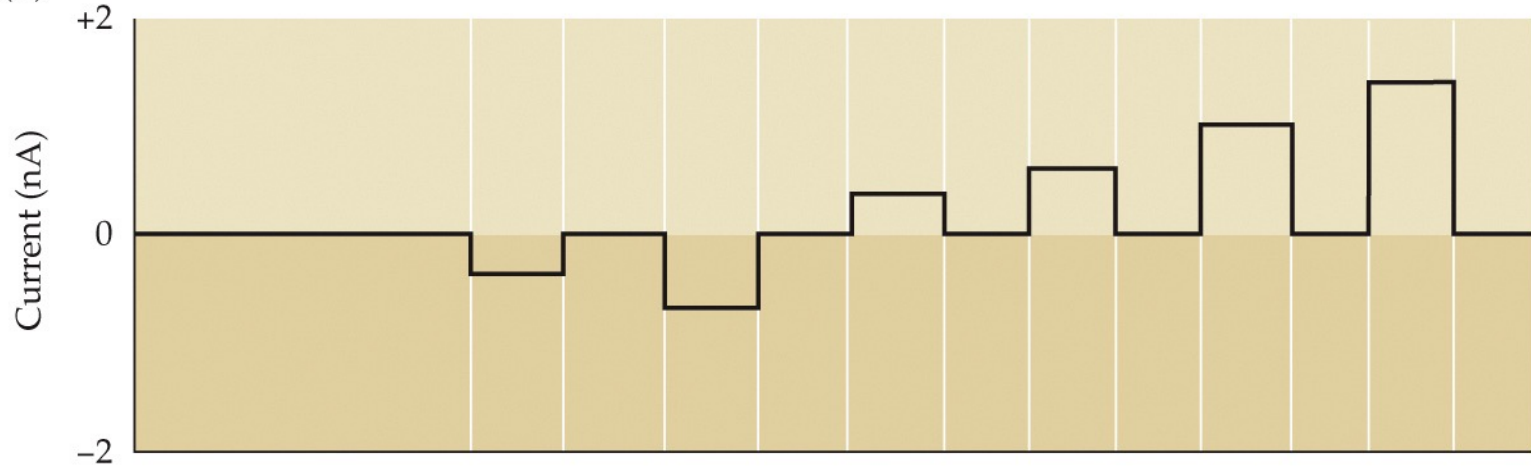
Lecture 5: Resting Membrane Potential  
2022\_v1

Professor Malcolm A. MacIver

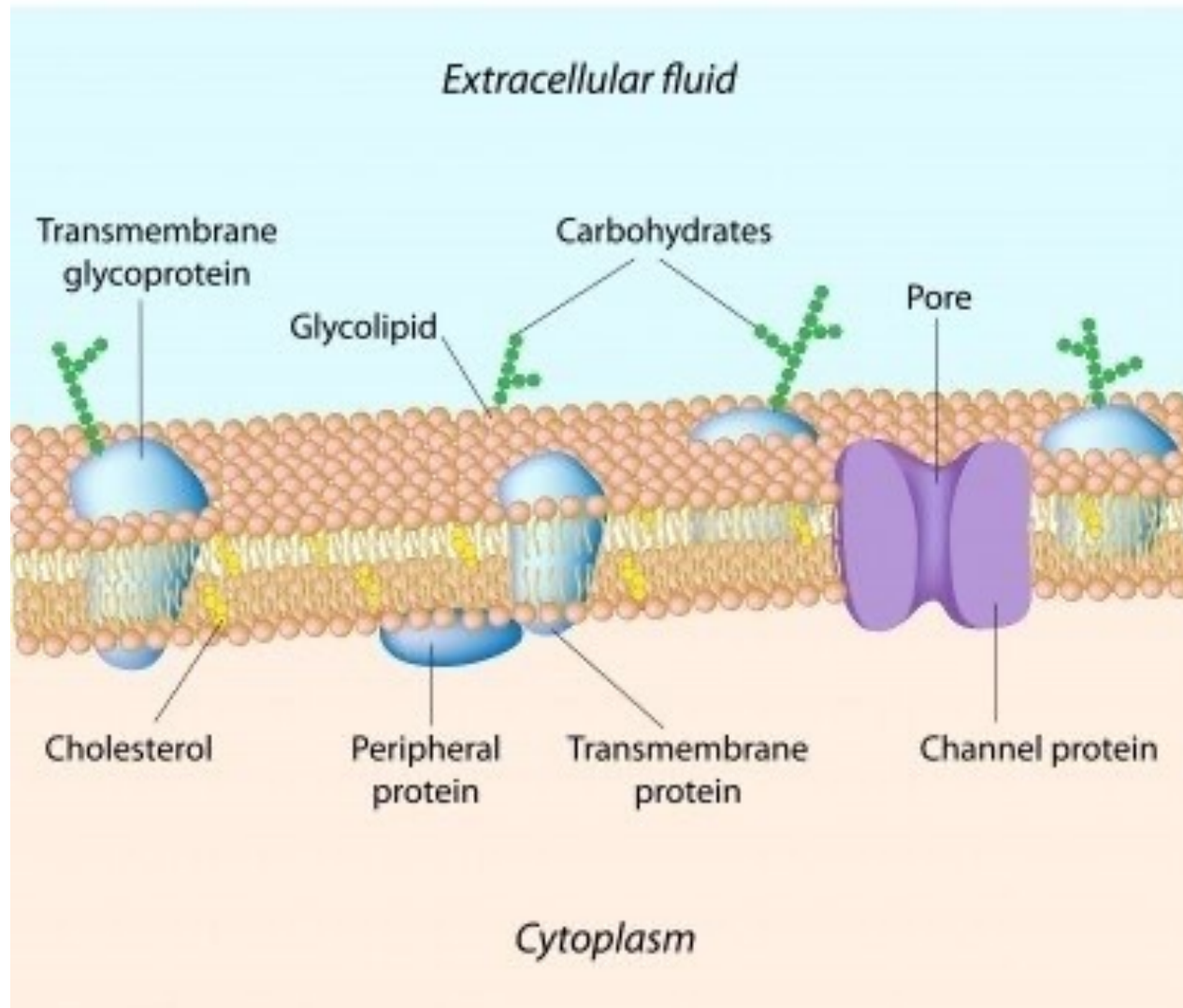


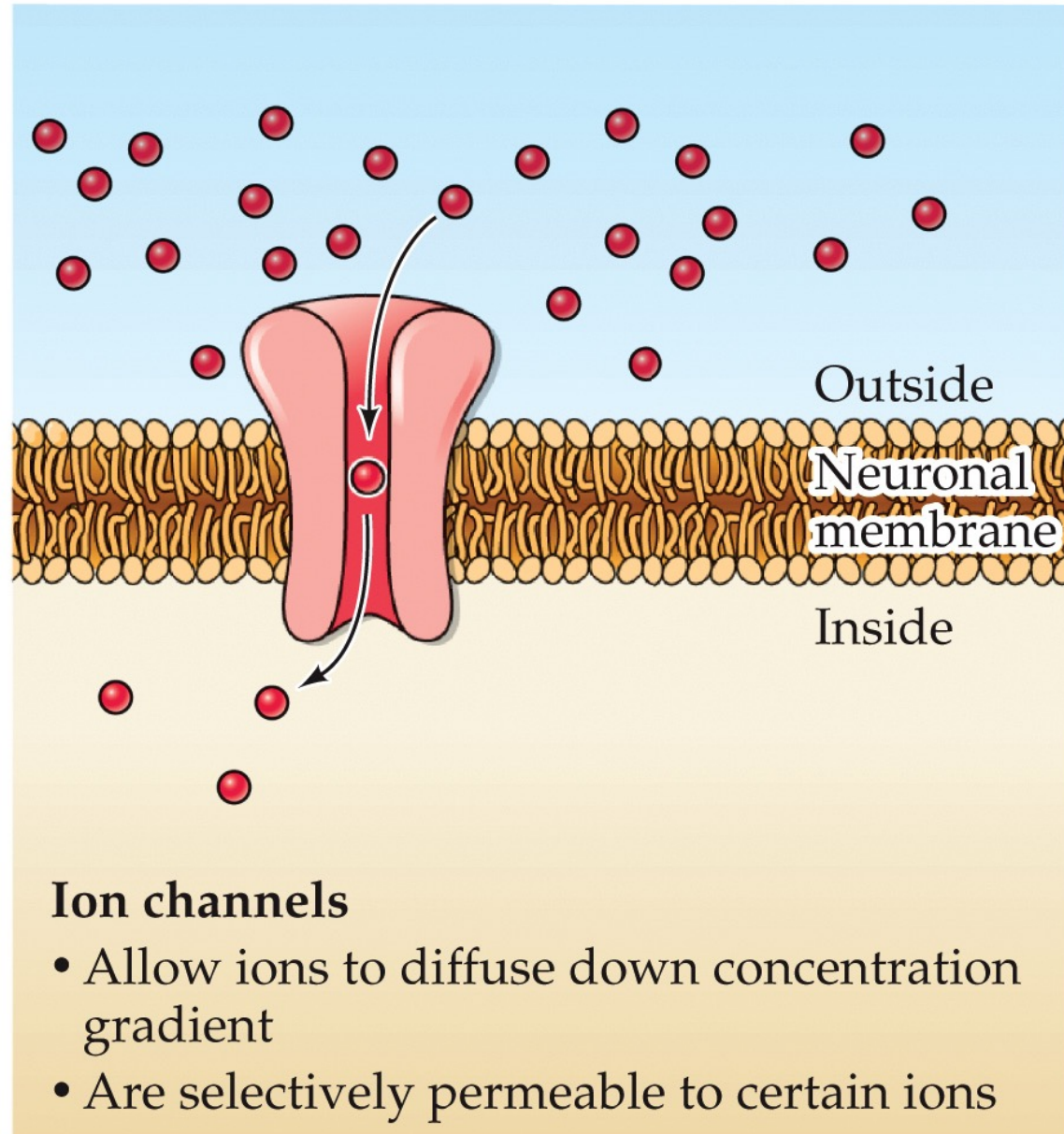
# Recording passive and active electrical signals in a nerve cell

(B)



# Plasma Membrane Structure





Derivation on doc projector

**TABLE 2.1** ■ **Extracellular and Intracellular Ion Concentrations**

Ion	Concentration (mM)	
	Intracellular	Extracellular
<b>Squid neuron</b>		
Potassium ( $K^+$ )	400	20
Sodium ( $Na^+$ )	50	440
Chloride ( $Cl^-$ )	40–150	560
Calcium ( $Ca^{2+}$ )	0.0001	10
<b>Mammalian neuron</b>		
Potassium ( $K^+$ )	140	5
Sodium ( $Na^+$ )	5–15	145
Chloride ( $Cl^-$ )	4–30	110
Calcium ( $Ca^{2+}$ )	0.0001	1–2



## Squid Axon

**Intracellular:**  $400 + 50 - 95$

**Extracellular:**  $20 + 440 + 20 - 560$

## Mammalian Neuron

**Intracellular:**  $140 + 10 - 17$

**Extracellular:**  $5 + 145 + 3 - 110$

**TABLE 2.1** ■ Extracellular and Intracellular Ion Concentrations

Ion	Concentration (mM)	
	Intracellular	Extracellular
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### Squid neuron

- Intracellular excess of cations
- Extracellular excess of anions

### Mammalian neuron

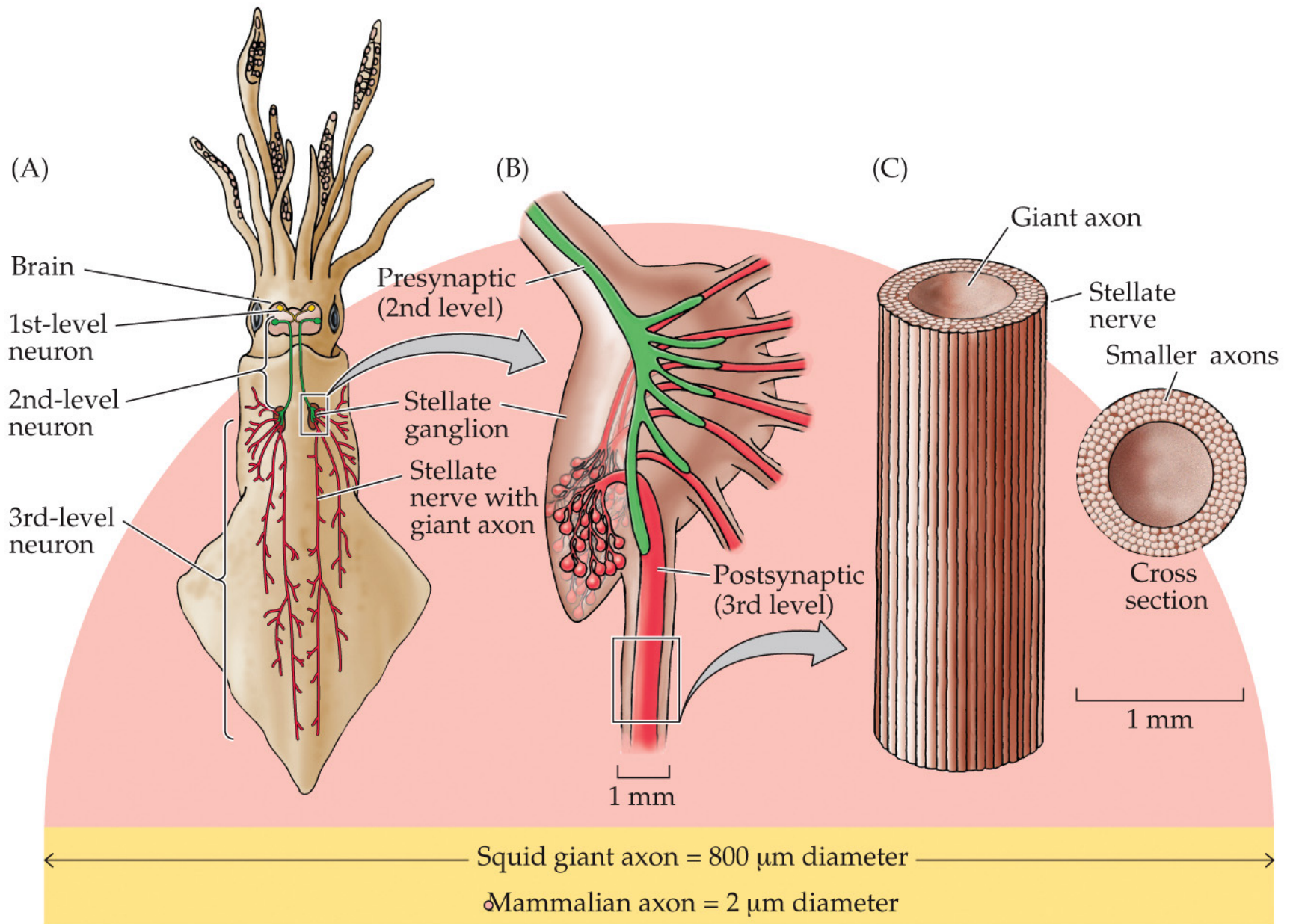
- Intracellular excess of cations
- Extracellular excess of cations

One might expect there to be an excess of intracellular anions and extracellular cations to account for the negative resting membrane potential, but a -65 mV membrane potential is obtained without affecting mM ion concentrations.

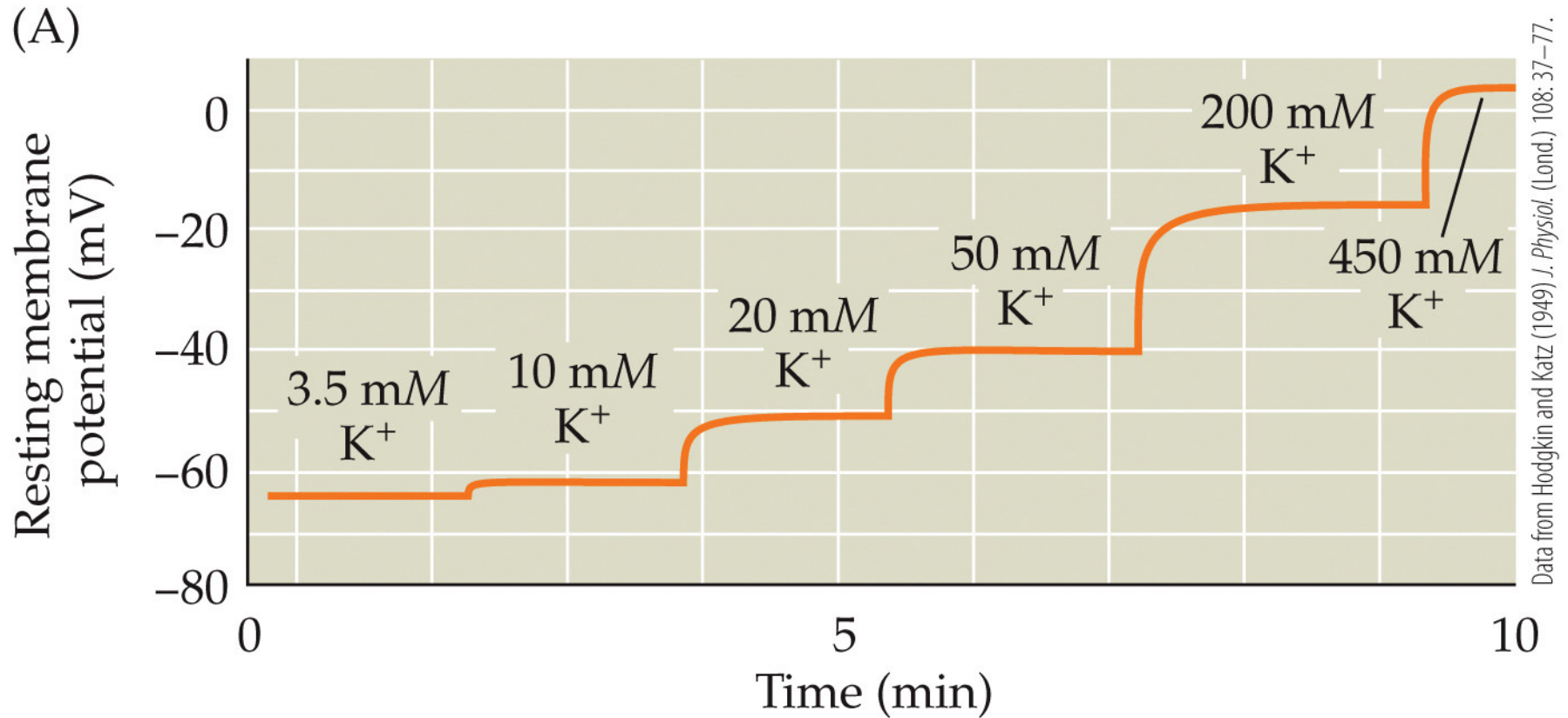
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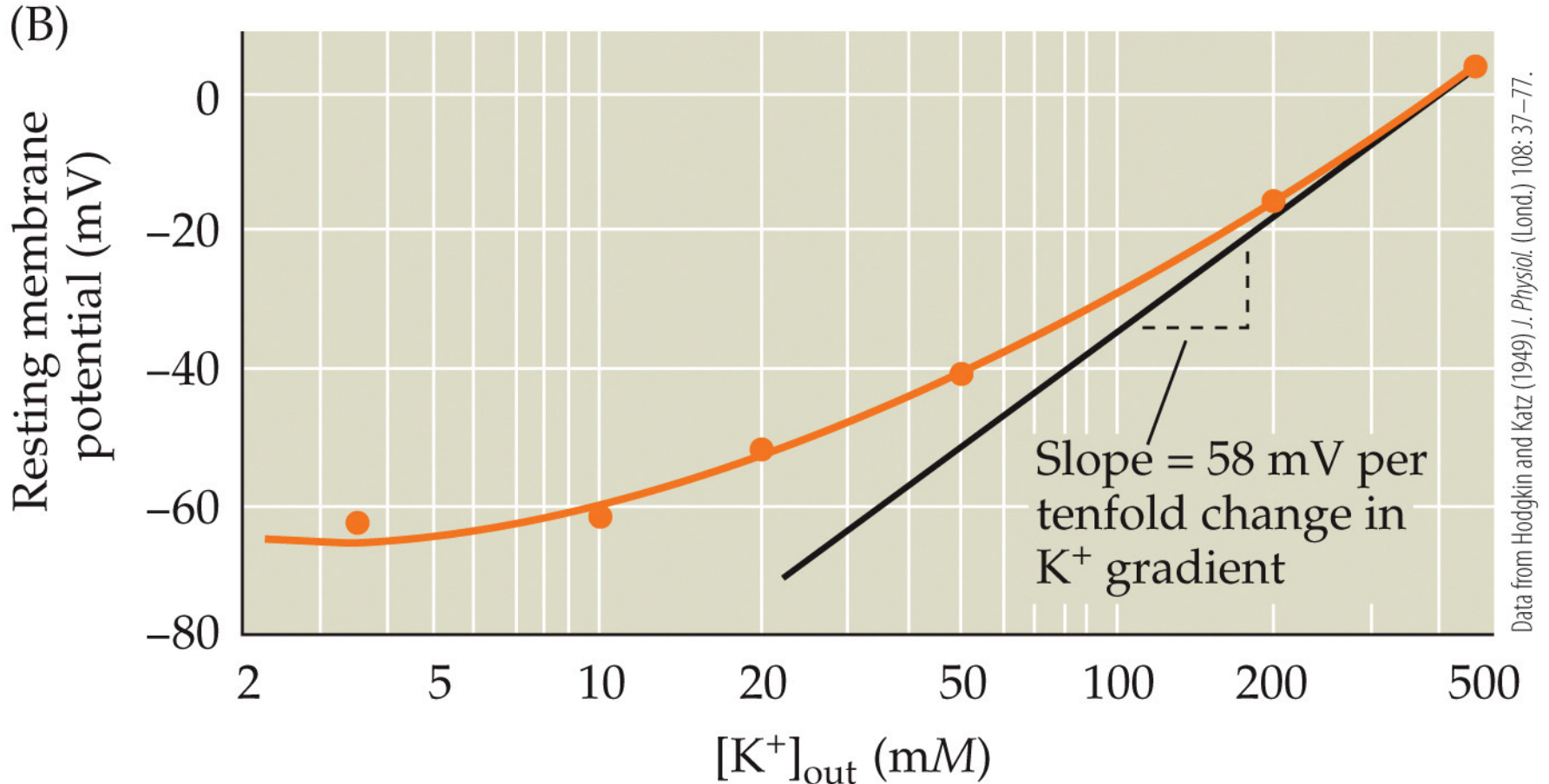
# The Remarkable Giant Nerve Cells of Squid



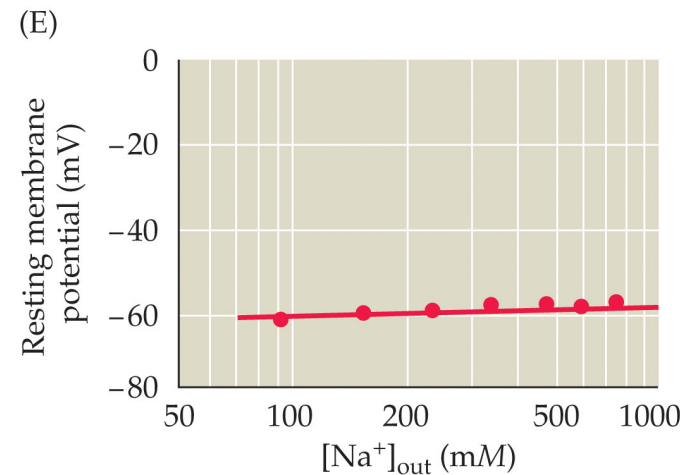
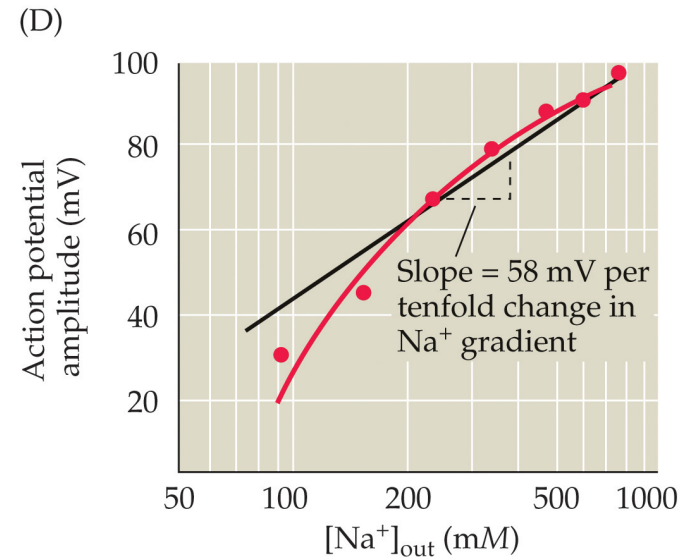
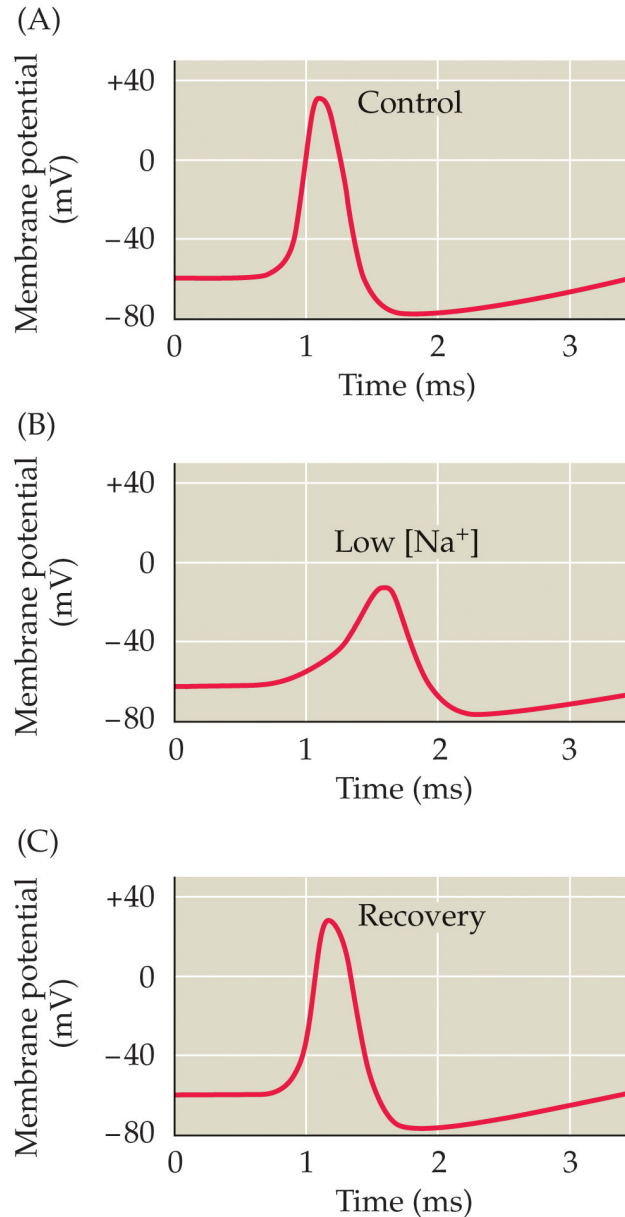
The resting membrane potential of a squid giant axon is determined by the  $K^+$  concentration gradient across the membrane



The resting membrane potential of a squid giant axon is determined by the  $K^+$  concentration gradient across the membrane



# The role of $\text{Na}^+$ in generating an action potential in a squid giant axon



After Hodgkin and Katz (1949) *J. Physiol. (Lond.)* 108: 37–77.

Resting membrane potential  
does depend on  $[\text{Na}^+]_{\text{OUT}}$

Resting membrane potential depends on both  $K^+$  and  $Na^+$ , but the dependence on  $K^+$  ions is clearly more important