9.01 Introduction to Neuroscience
Fall 2007

9.01 Recitation (R02)

RECITATION #2: Tuesday, September 18th

Review of Lectures: 3, 4
Reading: Chapters 3, 4 or *Neuroscience: Exploring the Brain (3rd edition)*

Outline of Recitation:

I. Previous Recitation:
   a. Questions on practice exam questions from last recitation?
II. Review of Material:
   a. Exploiting Axoplasmic Transport
   b. Types of Glia
   c. THE RESTING MEMBRANE POTENTIAL
   d. THE ACTION POTENTIAL
III. Practice Exam Questions
IV. Questions on Pset?

Exploiting Axoplasmic Transport:
Maps connections of the brain

Rates of transport:
- slow: - fast:

Examples:
Uses anterograde transport:
-

Uses retrograde transport:
-
-
-

Types of Glia:
- Microglia:

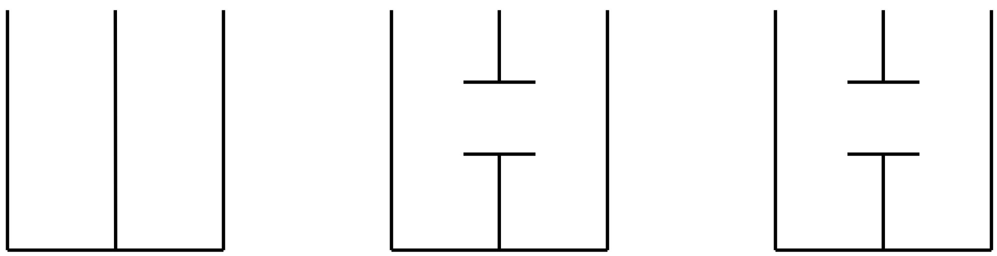
- Astrocytes:

- Myelinating Glia:

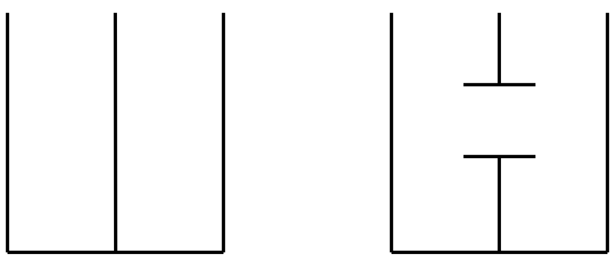
THE RESTING MEMBRANE POTENTIAL:

The Cast of Chemicals:

The Movement of Ions:
- Influences by two factors:
  (1) Diffusion:

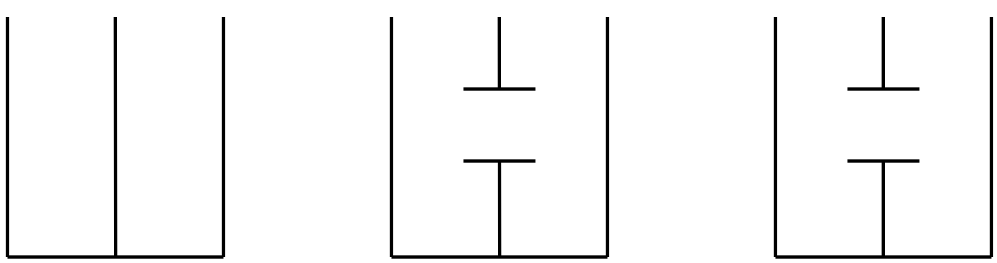


  (2) Electricity:



Ohm's Law:
I = gV

Ionic Equilibrium Potentials (E_{ION}):
- Example: E_{Ns}^{+}



* diffusional and electrical forces are equal

Nernst Equation:

$$E_{ION} = 2.303\ RT/zF\ \log\ [ion]_0/[ion]_i$$

Calculates equilibrium potential for a SINGLE ion.

	Inside	Outside	E_{ION} (at 37°C)
$[K^+]$			
$[Na^+]$			
$[Ca^{2+}]$			
$[Cl^-]$			

*Pumps maintain concentration gradients (ex. sodium-potassium pump; calcium pump)

Resting Membrane Potential (V_M at rest):
Measured resting membrane potential: **- 65 mV**

Goldman Equation:

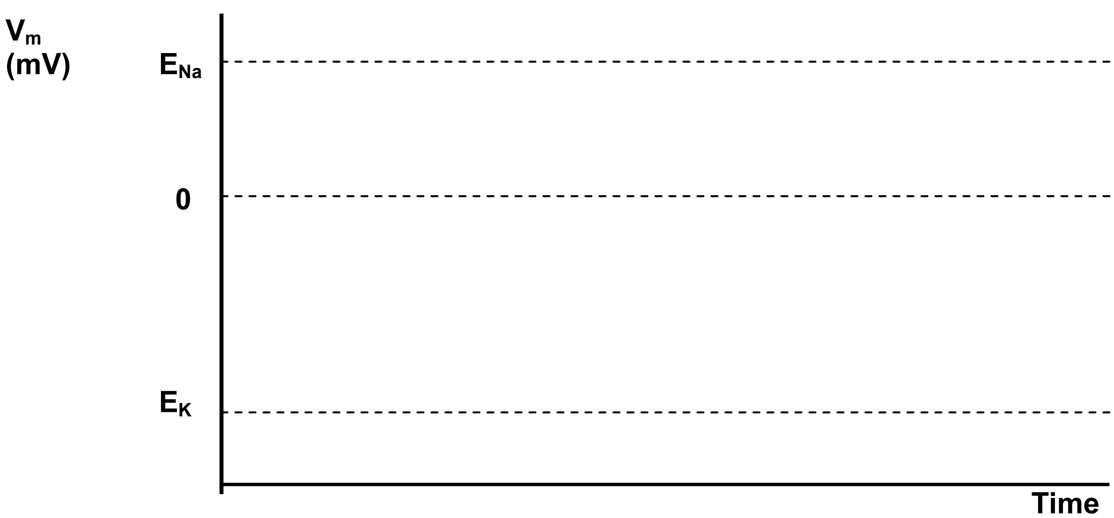
$$V_M = 61.54\ mV\ \log\ (P_K[K^+]_o + P_{Na}[Na^+]_o)/\ (P_K[K^+]_I + P_{Na}[Na^+]_i)$$

Calculates membrane potential when permeable to both Na^+ and K^+.

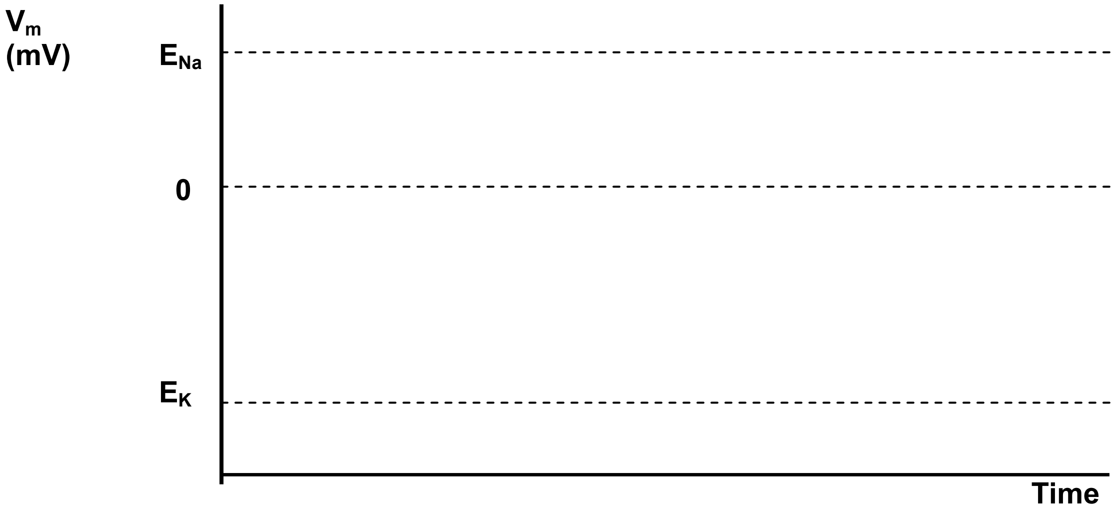
Remember: at REST, $g_K >>> g_{Na}$ therefore, V_M is closer to E_K

THE ACTION POTENTIAL (Nerve Impulse):

Phases of an Action Potential:



Conductance of Ion Channels during AP:
Remember: Changes in conductance, or permeability of the membrane to a specific ion, changes the membrane potential.



- Voltage-gated Sodium Channels:
    - opens at -40 mV

(a) (b) (c) (d)

Initiation of AP:
- Mechanically-gated sodium channels
- Inject current:

Conduction:
- A ____________ axon diameter and ________________ increase conduction velocity.

Practice Exam Problems:
From Brown Exam I 2000:

9. Ion X is negatively charged and more concentrated inside than outside of the cell. Therefore:
   (a) E_x is negative
   (b) E_X is positive
   (c) E_X is zero
   (d) The cell will fail its Olympic drug test

10. The resting membrane potential is closer to E_K than E_{Na} because at rest:
   (a) $V_m - E_{Na} = 0$
   (b) $g_{Na} = 0$
   (c) $g_K >> g_{Na}$
   (d) $g_K = 0$

11. You discover an ion channel that, when open, is permeable to all ions. This channel lacks:
   (a) gating
   (b) quaternary structure
   (c) selectivity
   (d) an alpha subunit

14. Increasing extracellular K^+ would lead to:
   (a) depolarization of the membrane (V_m becomes more negative)
   (b) depolarization of the membrane (V_m becomes less negative)
   (c) hyperpolarization of the membrane (V_m becomes more negative)
   (d) hyperpolarization of the membrane (V_m becomes less negative)

15. Increasing intracellular Na^+ in a typical neuron would have what effect on E_{Na}?
   (a) E_{Na} would become more positive
   (b) E_{Na} would become less positive
   (c) E_{Na} would stay the same
   (d) That is not enough information to determine E_{Na}

16. How would the mental pain caused by this exam be encoded as a neuronal signal?
   (a) By the amplitude of action potentials transmitted
   (b) By the duration of action potentials transmitted
   (c) By the frequency of action potentials transmitted
   (d) All of the above
   (e) None of the above

19. What would happen if the S4 domains of the voltage-gated sodium channels important in action potential generation had their primary structure significantly altered?
   (a) Nothing important of interest
   (b) The action potentials generated would be of shorter duration
   (c) The gating properties of these channels would be disrupted
   (d) The channels will be phosphorylated

20. I. Axon diameter II. Axon myelination III. Axon length IV. Axonal membrane resistance

Which of the above are important factors in the determination of action potential conduction velocity?
   (a) I only (b) I and II (c) I and III (d) I, II, IV (e) All of the above

Answers:
9. B 10. C 11. C 14. B 15. B 16. C 19. C 20. D