Western

UNIVERSITY · CANADA

Tutorial 3
Sections 009/010

TA: Greydon Gilmore

Physiology 2130

Sep 23rd, 2019

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Your TA reminding you…

- **1st Peerwise assignment** (1.5%)
  - Post 2 MC questions: due Oct 16th @ midnight
  - Answer 5 MC questions: due Oct 18th @ midnight
    - Currently 47 inactive users
    - Only 10 students completed
- **1st Quiz** (1%)
  - Opens: Oct 21st @ 4pm
  - Closes: Oct 22nd @ 4pm
- **1st Midterm** - Oct 25th @ 6pm-7pm (15%)

Today

- Learning Catalytics Quiz
- Group work
- Osmolarity and tonicity
- Action potential

Group Work

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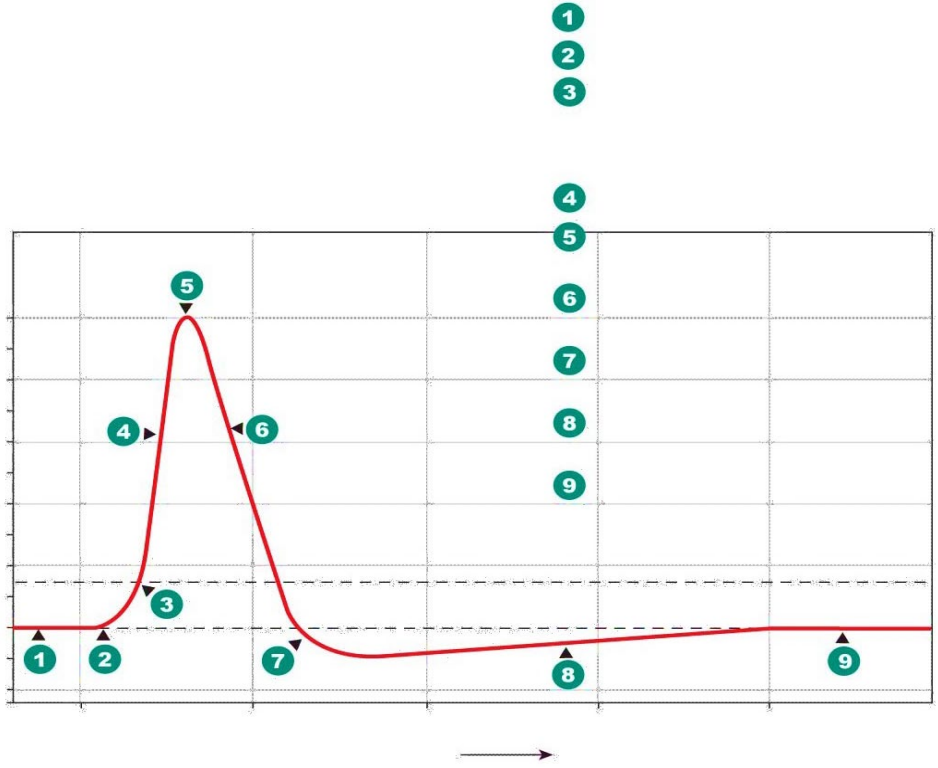
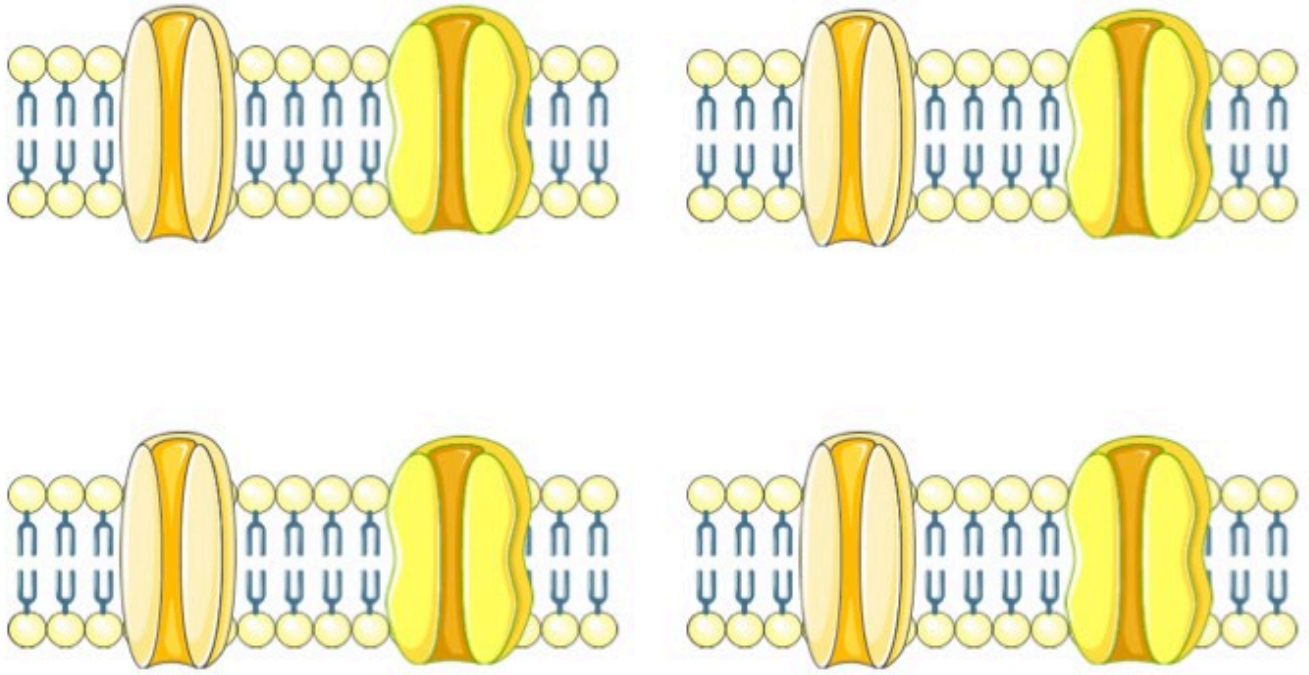
Activity #1: Labelling the Action Potential

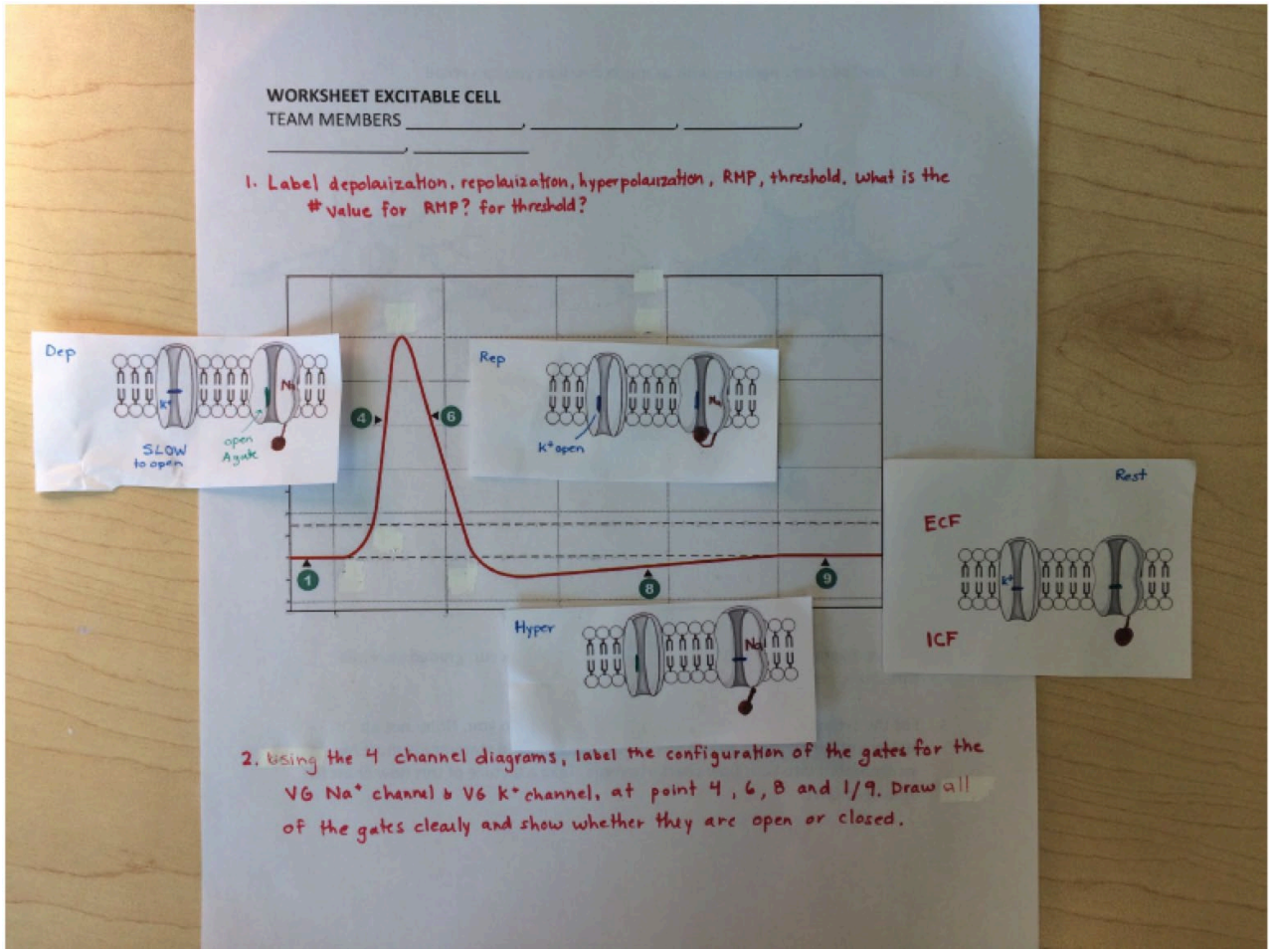
- One VG Na^+ and one VG K^+
- Place appropriate channel on:
  - 4, 6, 8 and 1/9
- Indicate if gates are open/closed: draw the gates
- Take a picture and each group member needs to upload to learning catalytics site



4 Channel Diagrams – label gate configurations for the Na+ voltage-gated channel and the K+ voltage-gated channel and position on the action potential diagram



Activity #1: Answers

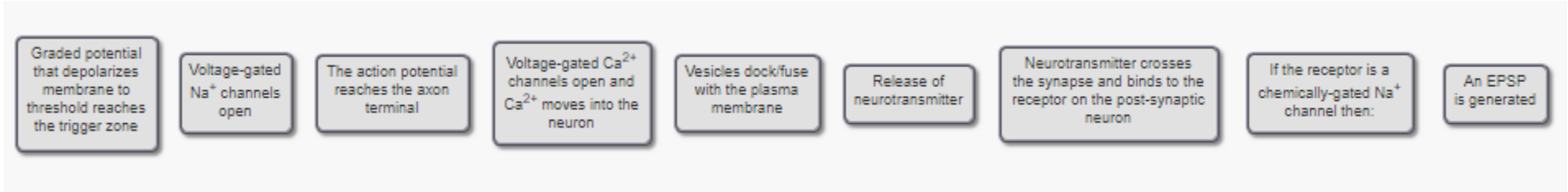


Activity #2: Ordering the events of a chemical synapse

- Login to the Pearson Mastering site https://www.pearsonmylabandmastering.com/northamerica/

- Order the events that occur at the chemical synapse
- If two events occur at same time, then stack them
- Every group member should submit their own, but work as a group to solve

Learning Activity Excitable Cell Answer



Review Questions

Which of the following statements are TRUE regarding osmosis?

1. The osmotic pressure of a solution is proportional to the concentration of the solute
2. A 100 mM NaCl solution has a greater osmolarity than a 100mM LiCl solution because Na is larger than Li
3. The permeability of the membrane affects osmosis
4. Osmosis is the movement of a solute down its concentration gradient

A) If only 1, 2 and 3 are correct
B) If only 1 and 3 are correct
C) If only 2 and 4 are correct
D) If only 4 is correct
E) If ALL are correct

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Which of the following statements regarding the cell's membrane potential is TRUE?

1. Only neurons have a membrane potential
2. When an electrochemical equilibrium is reached (i.e. the electrical gradient force of an ion is equal in magnitude to its chemical gradient force), there is no movement of this ion across the membrane
3. The RMP is generated by the Na/K pump
4. It is affected by the concentration gradient of ions and the membrane permeability

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Which of the following cells are excitable?

1. Neurons
2. Cardiac Muscle Cells
3. Smooth Muscle Cells
4. Skeletal Muscle Cells

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Excitable Cells:
- Generate and respond to electrical signals
- Include neurons and muscle cells

Learning Catalytic Question

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Osmosis, tonicity and the resting membrane potential

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Osmosis

- Osmosis is the net movement of WATER down its concentration gradient
- It is affected by:
  1) permeability of the membrane
  2) concentration gradient of solutes
  3) pressure gradient across the cell membrane
- Osmolarity is concerned only with the NUMBER OF PARTICLES in solution (NOT size or type/composition)

Tonicity

- Tonicity: the ability of a solution to cause osmosis across biological cell membranes
- Isotonic: same osmolarity as body fluids
- Hypotonic: lower osmolarity than body fluids
- Hypertonic: higher osmolarity than body fluids
- Chemical Gradient: molecules move from high concentration to low concentration
- Electrical Gradient: electrically charged molecules (ions) move to areas of opposite charge

A red blood cell is placed in a 200 mM $BeCl_2$ solution. The cell will _____ because the solution is _____.

A) shrink; hypotonic
B) shrink; hypertonic
C) swell; hypotonic
D) swell; hypertonic

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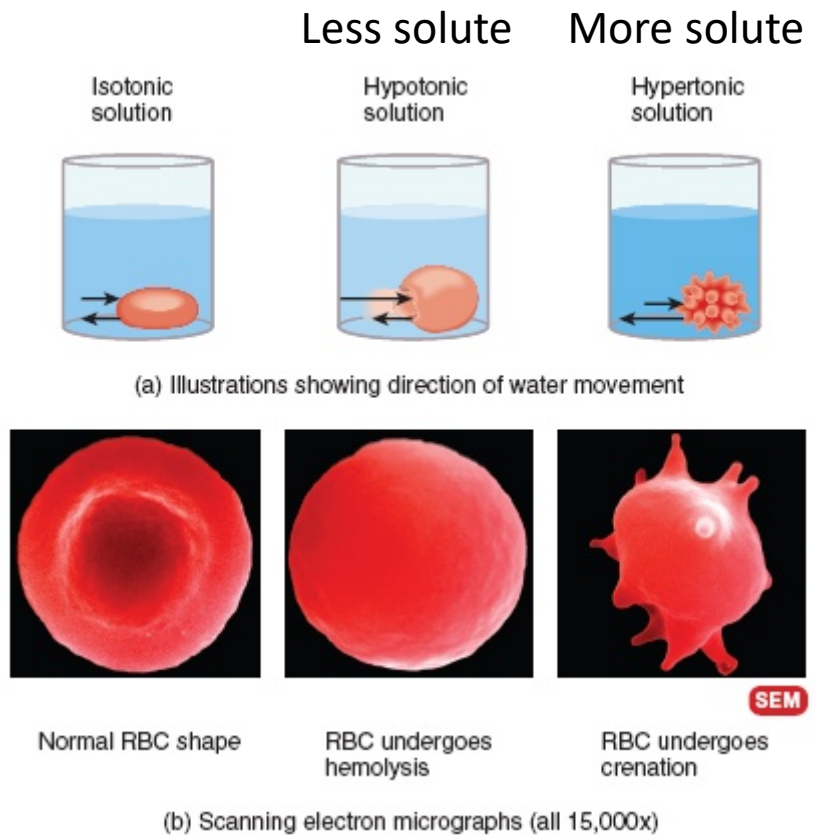
RBC = 300 mOsm

Solution = 200 mM x 3 ions
= 600 mOsm

The solution is hypertonic

Water moves out of cell into the solution, causing the cell to shrink

Tonicity: Review



Compartment Question

Compartments 1 and 2 are separated by a membrane that is permeable to H_2O but not permeable to $CaCl_2$ or glucose. Initially, compartment 1 contains 200 mM of $CaCl_2$ and compartment 2 contains 100 mM of glucose. After osmotic equilibrium is reached, which compartment will have increased in volume?

Compartment 1	Compartment 2
200mM 100 mM $CaCl_2$	100 mM Glucose

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Compartment 1	Compartment 2
200mM 100 mM $CaCl_2$ **= (200 mM x 1 Ca^{2+}) +** **(200 mM x 2 Cl^-)** **= 600 mOsm**	100 mM Glucose **= 100 mOsm**

Terms you should know

- Active transport: moves molecules against their concentration gradient and requires an outside source of energy
- Extracellular fluid: body fluid compartment found outside of cells
- Facilitated diffusion: a mediated-transport process that moves molecules from higher to lower concentrations across a membrane by means of a transporter until the two concentrations become equal.
- Gap junctions: allow chemical and electrical signals to pass directly from cell to cell
- Glycoprotein: protein with sugar groups attached
- Homeostasis: the maintenance of a relatively constant internal environment
- Hydrophobic: molecules that do not dissolve easily in water
- Hypertonic: a fluid bathing a cell that would cause a cell to shrink
- Interstitial fluid: extracellular fluid surrounding cells, excludes plasma
- Paracrine: a chemical that is secreted and communicates locally with a neighbouring cell
- Plasma: the liquid portion of blood, a component of extracellular fluid

The Action Potential

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Which of the following structures are correctly associated with their function?

A) Dendrites send outgoing signals
B) Myelin insulates axons to prevent ion/current leak
C) There are no ion channels at the Nodes of Ranvier
D) There are no organelles at the soma

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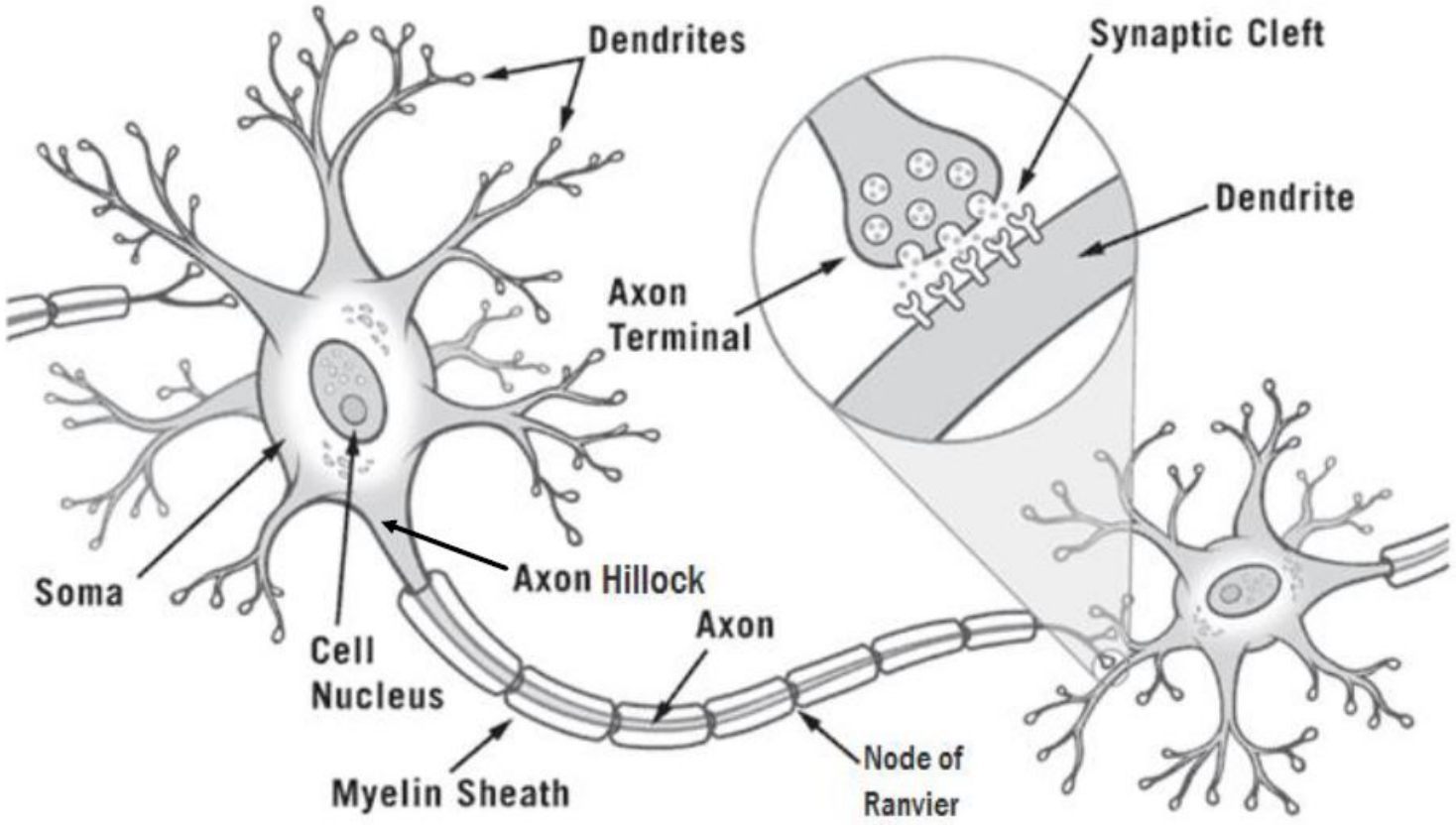
The Neuron


Dendrites
Synaptic Cleft
Dendrite
Axon
Terminal
Soma
Axon Hillock
Axon
Cell
Nucleus
Myelin Sheath
Node of
Ranvier

Key Events and Their Locations

1. Incoming information received by the dendrites
2. Graded potentials occur in the dendrites/soma
3. An action potential is fired at the axon hillock if threshold is met
4. The action potential travels along the myelinated axon via salutatory conduction
5. The action potential arrives at the axon terminal of the pre-synaptic cell and the message is passed to the post-synaptic cell

What is a main difference between a graded potential and an action potential?

A) Graded potentials do not experience current leak, whereas action potentials do

B) Graded potentials travel a long distance, whereas action potentials travel a short distance

C) Graded potentials occur at the soma, whereas action potentials start at the axon hillock

D) The amplitude of the graded potentials is not proportional to the stimulus strength, whereas the amplitude of action potentials is proportional to the stimulus strength

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D) The amplitude of the graded potentials is not proportional to the stimulus strength, whereas the amplitude of action potentials is proportional to the stimulus strength

Graded Potentials vs. Action Potentials

Graded Potentials	Action Potentials
Occur at dendrites/somas	Occur at axon hillock
Caused by mechanical or chemical-gated channels	Caused by voltage-gated channels
Can be a depolarization or hyperpolarization	Always a depolarization
Amplitude of potential is directly proportional to stimulus strength	All or nothing–Amplitude of potential is constant no matter the stimulus strength
Travel short distances	Travel long distances

Depolarization is caused by the opening of ____, causing ___ to flow ___ the cell.

A) VG Na+ channels; Na+ ions; into
B) VG Na+ channels; Na+ ions; out of
C) VG K+ channels; K+ ions, into
D) VG K+ channels; K+ ions, out of

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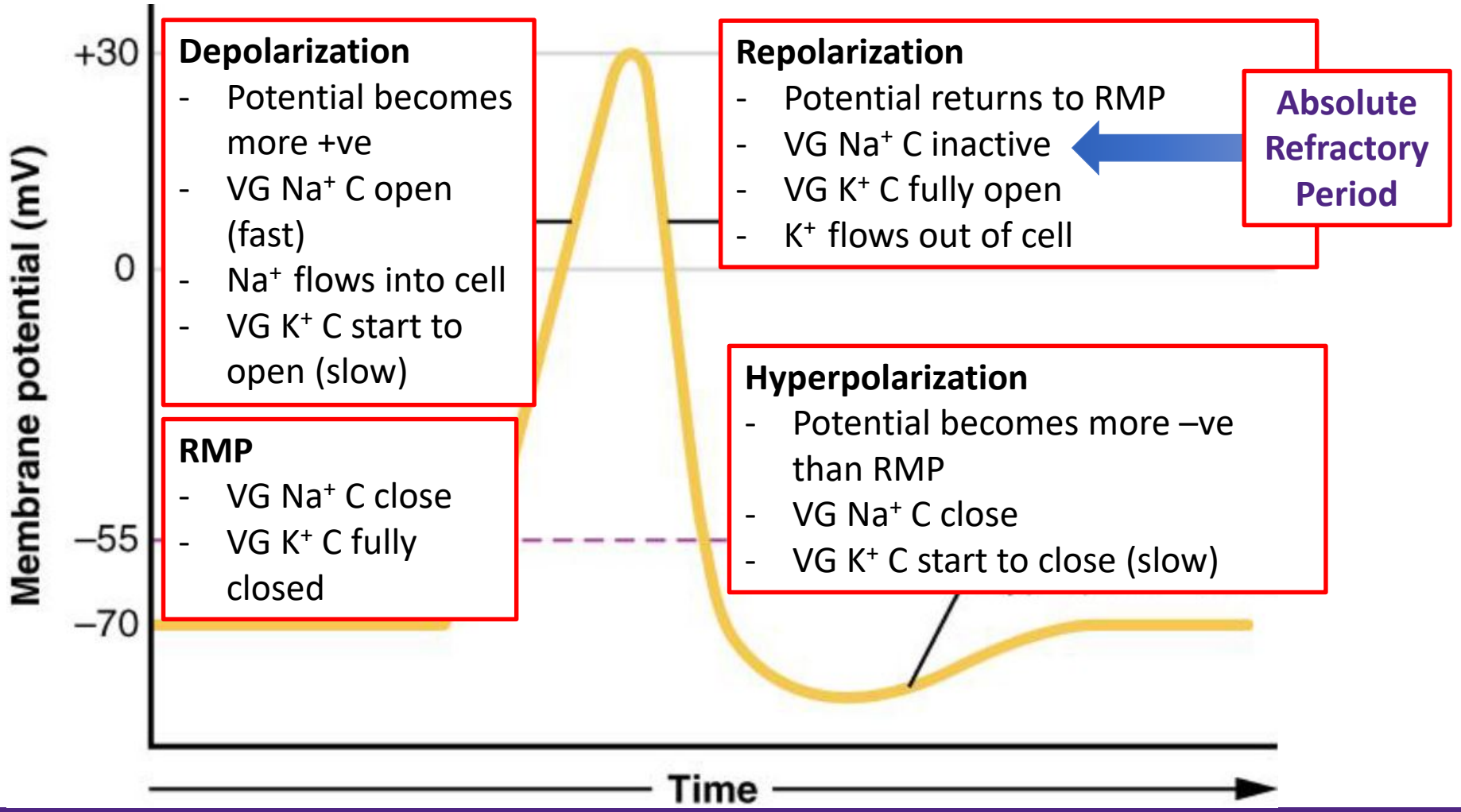
The Action Potential



Depolarization
- Potential becomes more +ve
- VG Na^+ C open (fast)
- Na^+ flows into cell
- VG K^+ C start to open (slow)

RMP
- VG Na^+ C close
- VG K^+ C fully closed

Repolarization
- Potential returns to RMP
- VG Na^+ C inactive
- VG K^+ C fully open
- K^+ flows out of cell

Absolute Refractory Period

Hyperpolarization
- Potential becomes more –ve than RMP
- VG Na^+ C close
- VG K^+ C start to close (slow)

Propagation of The Action Potential

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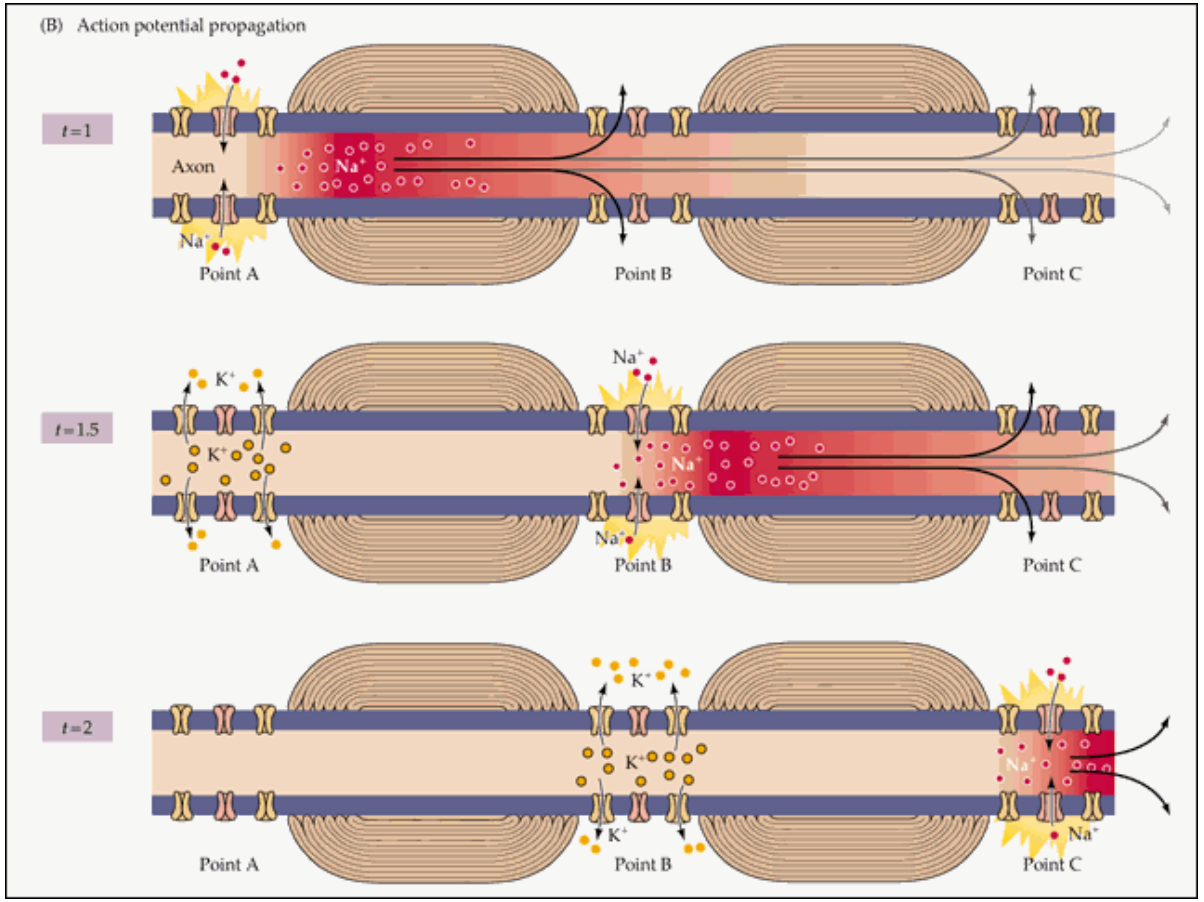
Propagation of the AP

- Myelin prevents ion/current leakage and allows for rapid saltatory conduction
- Ion channels are concentrated at Nodes of Ranvier
- The Na^+ ions flow down the axon (like charges repels and opposites charges attract)
- This brings the next segment of the axon to threshold and an AP is fired



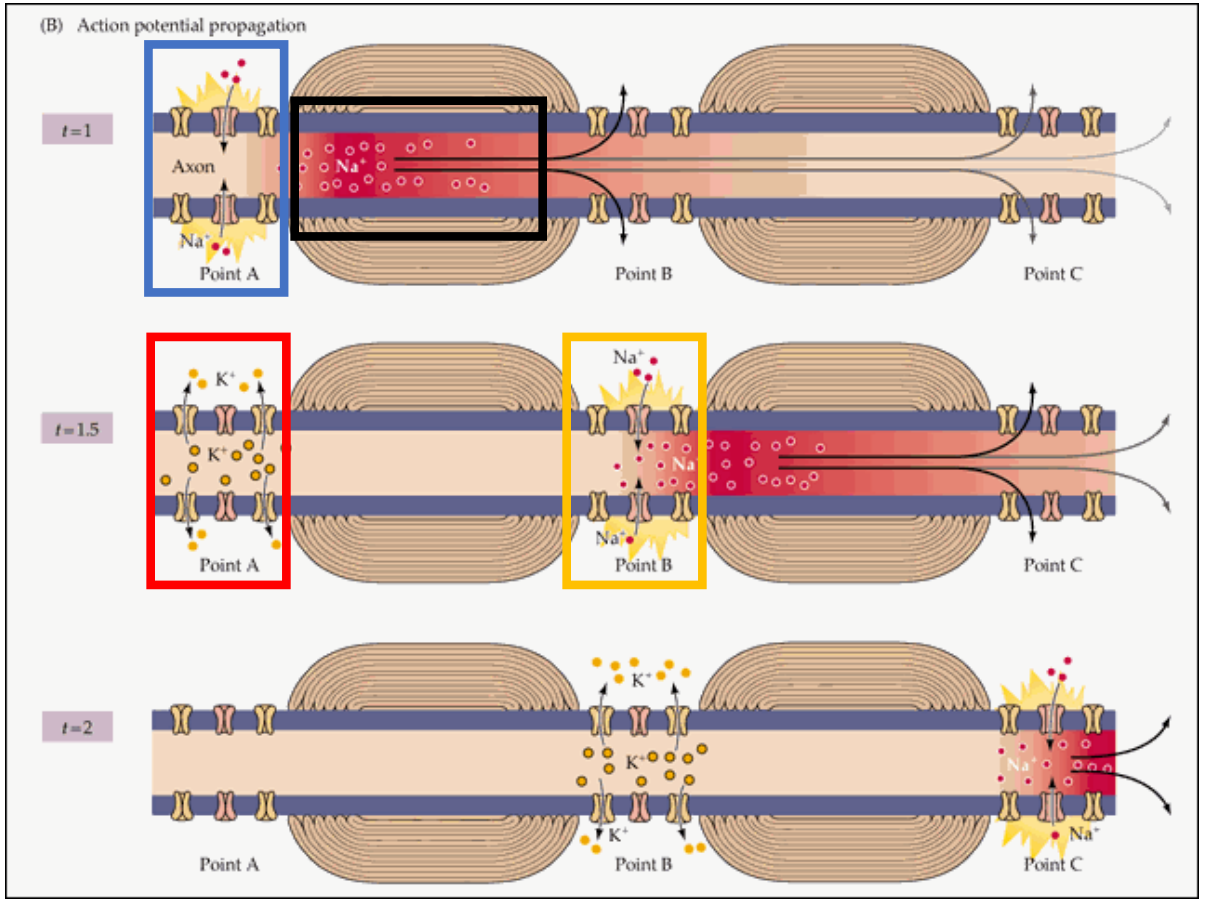
Propagation of the AP

Initial stimulus @ soma
Threshold is met @ axon hillock and AP is fired
Depolarization (Na^+ flows into the cell)

Na^+ flows along the axon

That Na^+ brings the next segment to threshold and AP is fired
Depolarization of next segment
(Na^+ flows into the cell)

Repolarization of initial segment
(K^+ flows out of the cell)



Which of the following events take place at a chemical synapse?

1. VG Ca2+ channels open, allowing Ca2+ to flow out of the cell
2. VG Ca2+ channels open, allowing Ca2+ to flow into the cell
3. Neurotransmitters travel from the post-synaptic cell to the pre-synaptic cell
4. Neurotransmitters travel from the pre-synaptic cell to the post-synaptic cell

A) If only 1, 2 and 3 are correct
B) If only 1 and 3 are correct
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Synapse

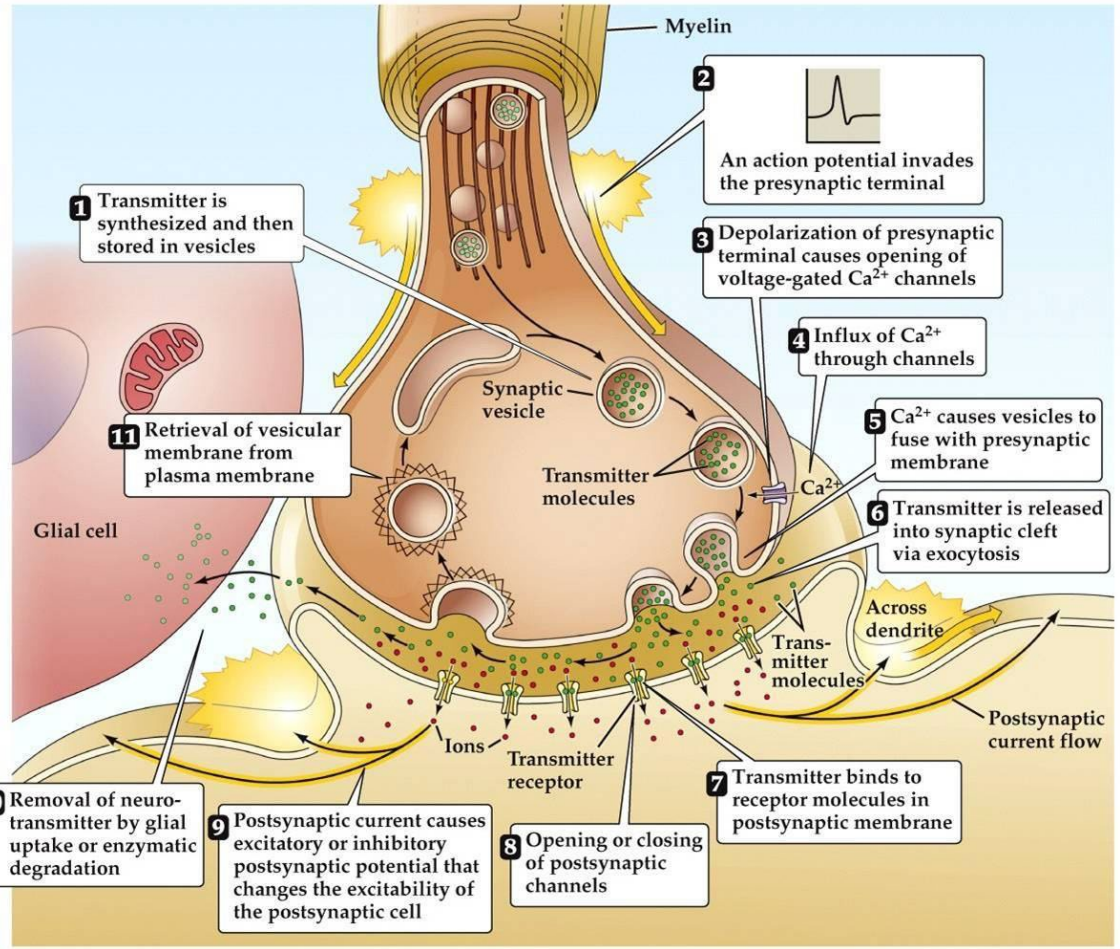
What happens to extra neurotransmitters?

- Recycled into axon terminal
- Degraded by enzymes
- Diffuse out of cleft

What happens to the post-synaptic cell?

If Na+ channels open: EPSP

- Na^+ into cell
- Depolarization of post-synaptic cell (graded potential towards threshold) If K^+ or Cl^- channels open: IPSP
- K^+ out of cell or Cl^- into cell
- Hyperpolarization of post-synaptic cell (graded potential away from threshold)



Next Tutorial (Sep 30th)

- Sensory System
- Nervous system overview
- Touch

What Questions Do You Have?

You can ask in the **Owl forums** as well!

Also anonymously ask questions in the **online dropbox**!!

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