260-2015-09-18-neurophys-II

Rick Gilmore

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Just for fun

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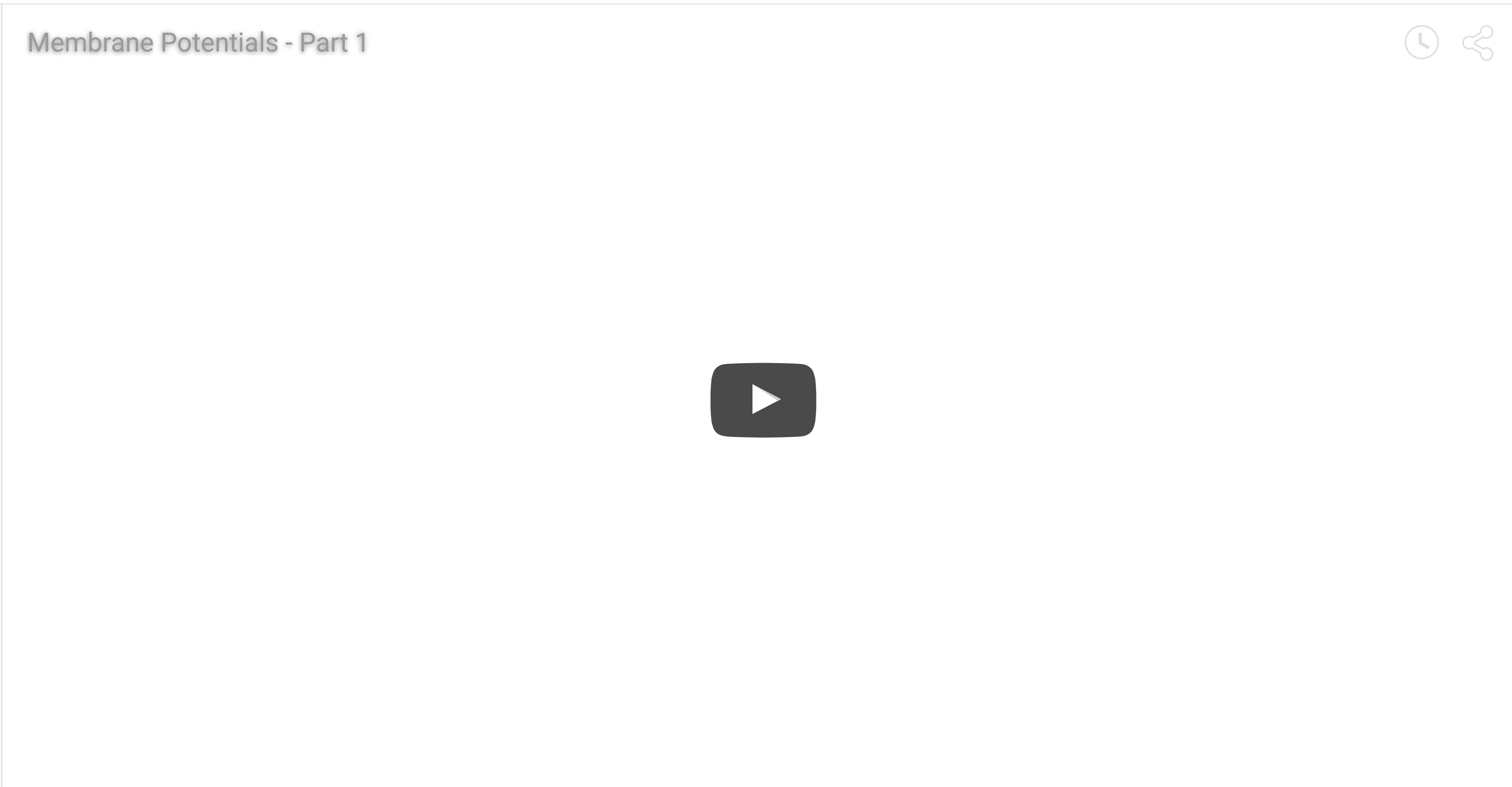
Announcements

- Exam 1 review on Monday, 9/21
- **No class** on Wednesday, 9/23
- Exam 1 on Friday, 9/25

Today's Topics

- The Action Potential

Video summary of resting potential



Question

- Where is Na+ concentration [Na+] **highest**?
  - Inside
  - Outside

Question

- Where is Na+ concentration [Na+] **highest**?
  - Inside
  - **Outside**

Question

- The force of diffusion will tend to push Na+
  - Inward
  - Outward

Question

- The force of diffusion will tend to push Na+
    - Inward
    - **Outward**

Question

- The force of diffusion will tend to push K+
  - Inward
  - Outward

Question

- The force of diffusion will tend to push K+
  - Inward
  - **Outward**

Question

- The electrostatic force tends to
  - Pull K+ in
  - Push K+ out

Question

- The electrostatic force tends to
  - Pull K+ in
  - **Push K+ out**

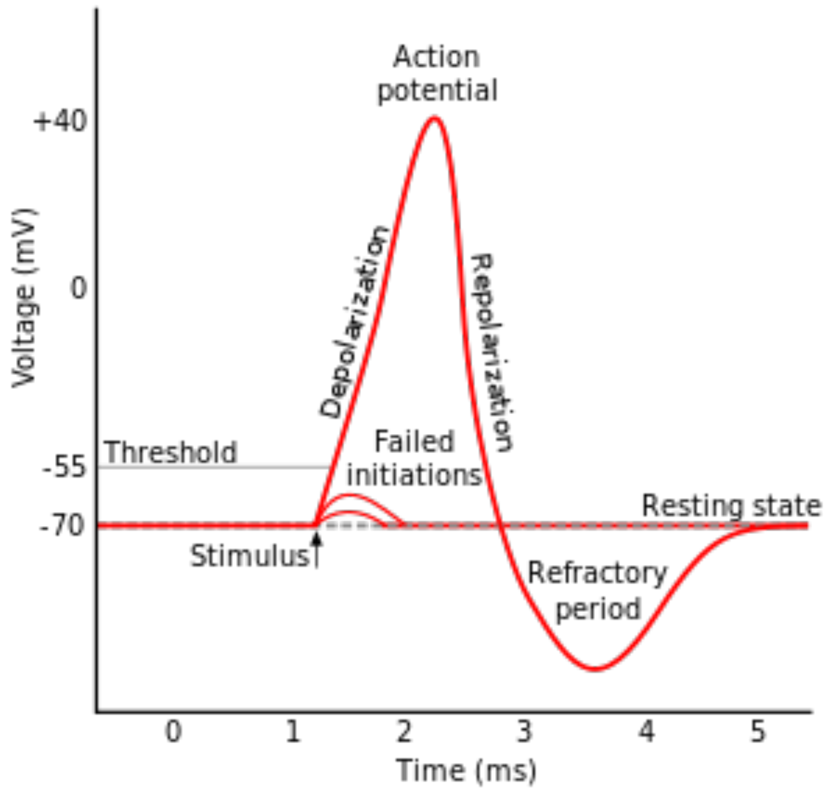
Question

- The electrostatic force tends to
  - Pull Na+ in
  - Push Na+ out

Question

- The electrostatic force tends to
  - Pull Na+ in
  - **Push Na+ out**

Action potential



https://upload.wikimedia.org/wikipedia/commons/thumb/4/4a/Action_potential.svg/3(Action_potential.svg.png

Action potential

- Threshold of excitation
- Increase (rising phase/depolarization)
- Peak
  - at positive voltage
- Decline (falling phase/repolarization)
- Return to resting potential (refractory period)

Action potential break-down

Phase	Neuron State
Rise to threshold	+ input makes membrane potential more +
Rising phase	Voltage-gated Na+ channels open, Na+ enters
Peak	Voltage-gated Na+ channels close and deactivate; voltage-gated K+ channels open
Falling phase	K+ exits
Refractory period	Na+/K+ pump restores [Na+], [K+]; voltage-gated K+ channels close

Question

- During rising phase, Na+ enters because
  - Force of diffusion pushes Na+ in
  - Electrostatic force pushes Na+ in
  - Electrostatic force pushes K+ out

Question

- During rising phase, Na+ enters because
  - **Force of diffusion pushes Na+ in**
  - **Electrostatic force pushes Na+ in**
  - Electrostatic force pushes K+ out

Question

- Why does membrane potential go from - to +?
  - Na+ ions are +, inward flow makes interior more +
  - K+ ions are +, outward flow makes interior more +

Question

- Why does membrane potential go from - to +?
    - **Na+ ions are +, inward flow makes interior more +**
    - K+ ions are +, outward flow makes interior more +

Question

- During falling phase, K+ flows out of cell because
  - Force of diffusion pushes K+ out.
  - Force of diffusion keeps K+ in.
  - Electrostatic force pushes K+ out.
  - Electrostatic force keeps K+ in.

Question

- During falling phase, K+ flows out of cell because
    - **Force of diffusion pushes K+ out.**
    - Force of diffusion keeps K+ in.
    - **Electrostatic force pushes K+ out.**
    - Electrostatic force keeps K+ in.

Question

- At peak of action potential, why does electrostatic force push K+ out?
  - Membane potential is +, K+ repelled from interior
  - Membrane potential is -, K- attracted to interior

Question

- At peak of action potential, why does electrostatic force push K+ out?
  - **Membane potential is +, K+ repelled from interior**
  - Membrane potential is -, K- attracted to interior

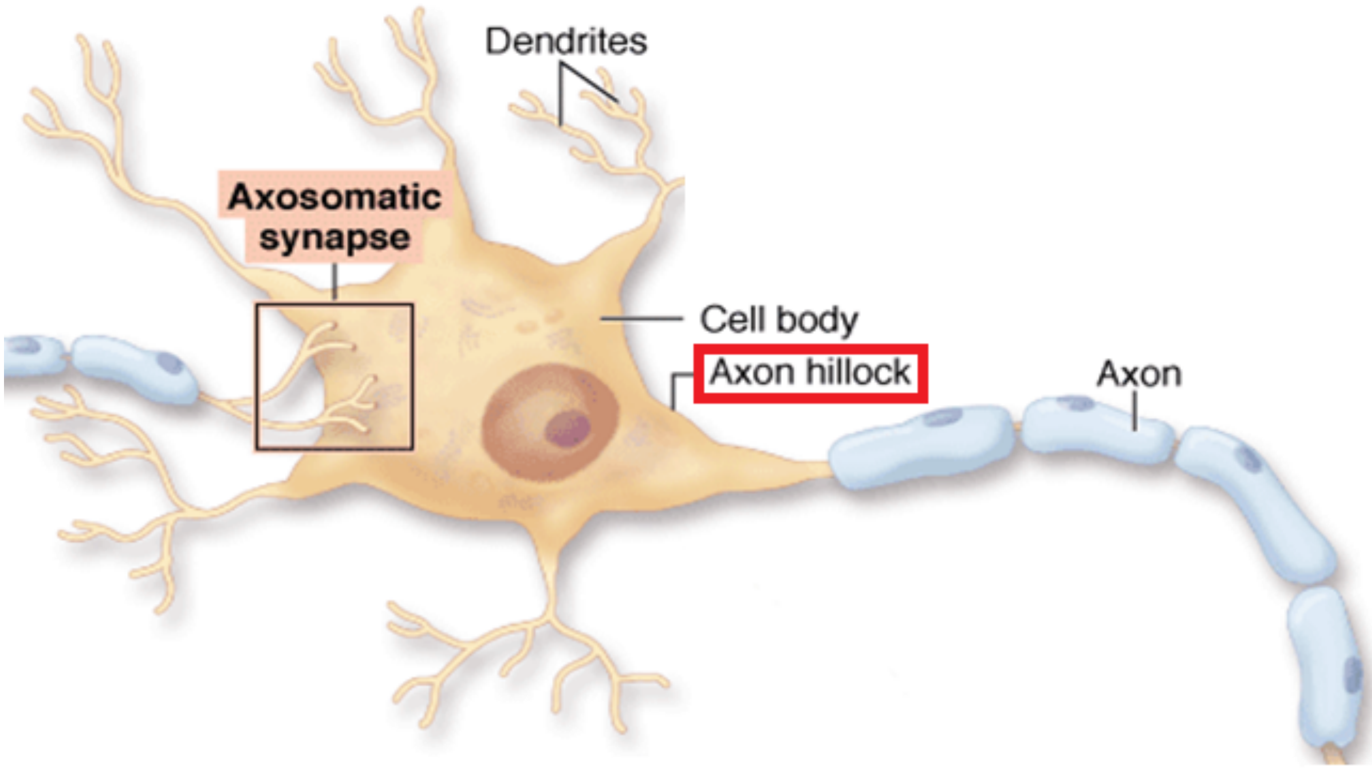
Refractory periods

- Absolute
  - Cannot generate action potential (AP) no matter the size of the stimulus
  - Voltage-gated Na+ channels inactivated, reactivate in time.
- Relative
  - Can generate AP with larg(er) stimulus
  - Some voltage-gated K+ channels still open
- Refractory periods put 'spaces' between APs

Generating APs

- Axon hillock
  - Portion of soma adjacent to axon
  - Integrates/sums input to soma
- Axon initial segment
  - Umyelinated portion of axon adjacent to soma
  - Voltage-gated Na+ and K+ channels exposed
  - If sum of input to soma > threshold, voltage-gated Na+ channels open

Axon hillock, axon initial segment

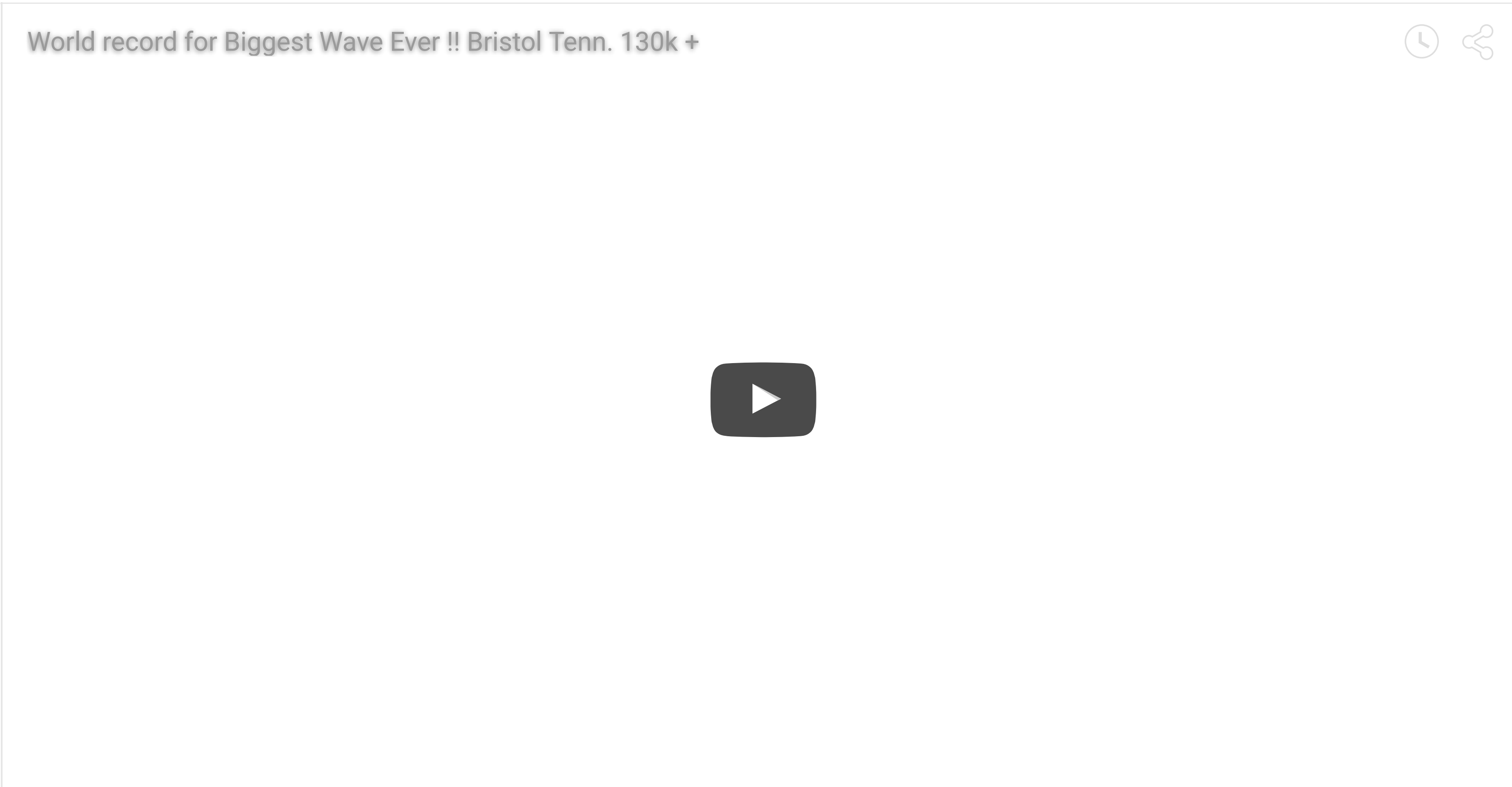


Axon Hillock" by M.aljar3i - Own work. Licensed under CC BY-SA 3.0 via Commons

AP propagation

- Propagation
    - move down axon, away from soma, toward axon terminals.
- Unmyelinated axon
    - Each segment "excites" the next

AP propagation is like



AP propagation

- Myelinated axon
  - AP "jumps" between Nodes of Ranvier, *saltatory conduction*
  - Nodes of Ranvier == unmyelinated sections of axon
  - voltage-gated Na+, K+ channels exposed
  - Current flows through myelinated segments

Question

- Why does AP flow in one direction, away from soma?
    - Soma does not have (many) voltage-gated Na+ channels.
    - Soma is not myelinated.
    - Refractory periods mean polarization only in one direction.

Question

- Why does AP flow in one direction, away from soma?
  - **Soma does not have (many) voltage-gated Na+ channels.**
  - Soma is not myelinated.
  - **Refractory periods mean polarization only in one direction.**

Conduction velocities

Nerve conduction velocity

From Wikipedia, the free encyclopedia

Nerve conduction velocity is an important aspect of nerve conduction studies. It is the speed at which an electrochemical impulse propagates down a neural pathway. Conduction velocities are affected by a wide array of factors, including age, sex, and various medical conditions. Studies allow for better diagnoses of various neuropathies, especially demyelinating conditions as these conditions result in reduced or non-existent conduction velocities.

Contents

What happens when AP runs out of axon?

- Rapid change in voltage triggers neurotransmitter (NT) release
- Voltage-gated calcium Ca++ channels open
- Ca++ causes *synaptic vesicles* to bind with presynaptic membrane, merge
- NTs diffuse across *synaptic cleft*
- NTs bind with *receptors* on *postsynaptic membrane*
- NTs unbind, are inactivated

Wrap-up

Nerve Impulse Mechanism [3D Animation]

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Measuring APs in actual neurons

Sir Alan Hodgkin and Sir Andrew Huxley

Next time

- Review for Exam 1