Biophysics I (BPHS 4080)

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Website: http://www.yorku.ca/cberge/4080W2018.html
Threshold: Phase Plane Portrait

assumes $n$ and $h$ are constant, but $m$ varies dynamically
Refractory Period

Figure 1.13

Figure 4.52

Figure 4.53
Back to the question of spatial propagation...

![Diagram showing decremental and decrement-free conduction with time plots for $I_e(t)$ and $V_m(t)$](image)

Figure 1.16
Propagated APs

Space clamp
\[ \frac{\partial V_m}{\partial z} = 0 \]

Step voltage clamp
\[ \frac{\partial V_m}{\partial z} = \frac{\partial V_m}{\partial t} = 0 \]

Separation of ionic currents

Figure 1.22
Propagated APs

Solutions only stable for appropriate choice of conduction velocity
(think back to cable model; $C_m$ matters!)

Figure 4.30

Figure 4.31
Propagated APs

Model Solutions

Stimulus (think cable model)

Figure 4.29
Note lag between $V_m$ and $G_m$ (stems from capacitive surge)

Similar picture as before for propagated AP

\[ \Rightarrow \text{Note lag between } V_m \text{ and } G_m \]

(stems from capacitive surge)
Note lag between $V_m$ and $G_m$ (stems from capacitive surge)
Myelination

Dendritic tree

Cell body

Internode

Node of Ranvier

Myelinated fiber

Axonal tree

Figure 5.1
‘Hopping’ behavior of current

Figure 5.12

Figure 5.13
- Radial distance from node is important

→ Saltatory conduction
Saltatory Conduction

- Internodes act as insulators

- APs generated at nodes of Ranvier

- Speeds up propagation without need for larger axon diameter

Plausible biophysical model for saltatory conduction?
No (saline-soaked) thread = no AP

Figure 5.15

→ Extracellular path between nodes is critical
Figure 5.17
$- \Delta V_o +$

Myelinated fiber

Direction of propagation of action potential

$\Delta z$

$z$

Figure 5.18

→ Current through internodes is non-zero

This model isn’t quite right....
APs move much faster along internodes than at nodes. Current amplitude decreases with distance from node.
Internodes behave like cable model (i.e., leaky submarine cable)
Model of myelinated nerve fiber

Internode  Node of Ranvier  Internode  Node of Ranvier  Internode
Figure 5.1

Model of myelinated nerve fiber