Biophysics I (BPHS 4080)

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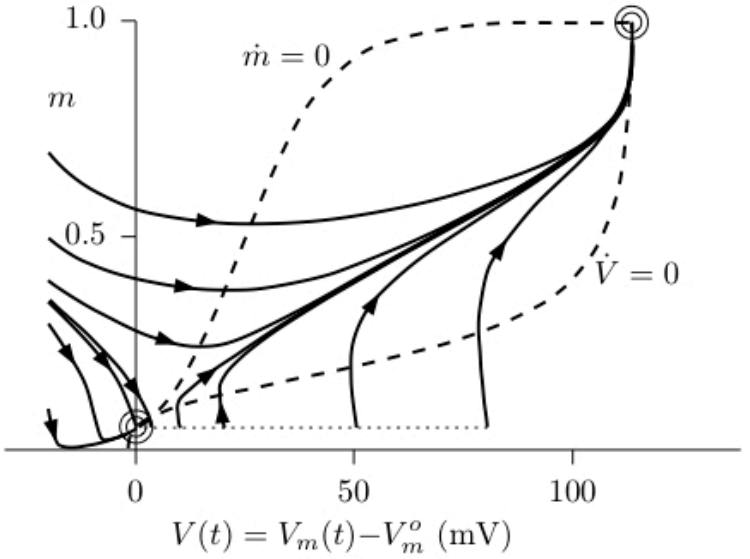
Website: http://www.yorku.ca/cberge/4080W2018.html

York University
Winter 2018
Lecture 26

Reference/Acknowledgement:
- TF Weiss (Cellular Biophysics)
- D Freeman

Threshold: Phase Plane Portrait



zoomed-in

assumes n and h are constant, but m varies dynamically

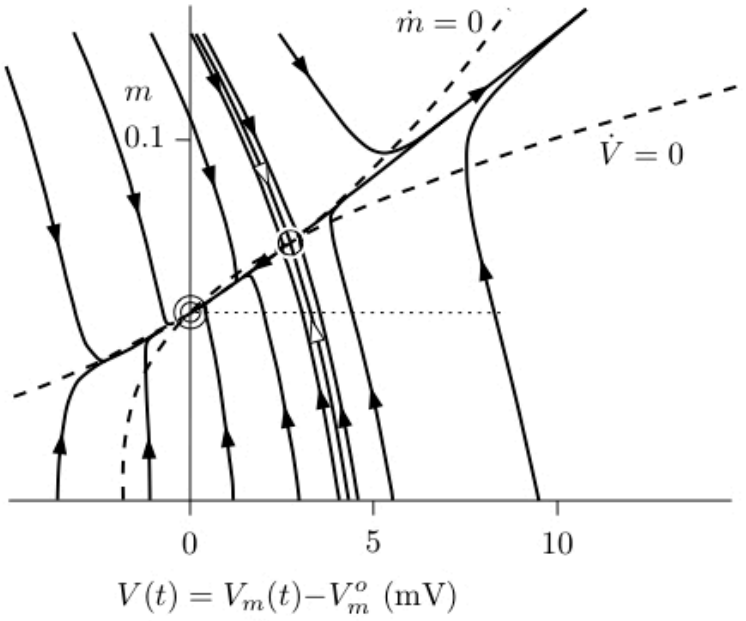


Figure 4.49

Refractory Period

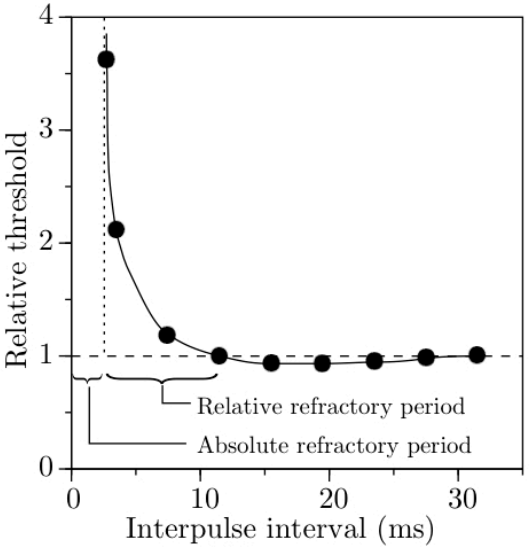


Figure 1.13

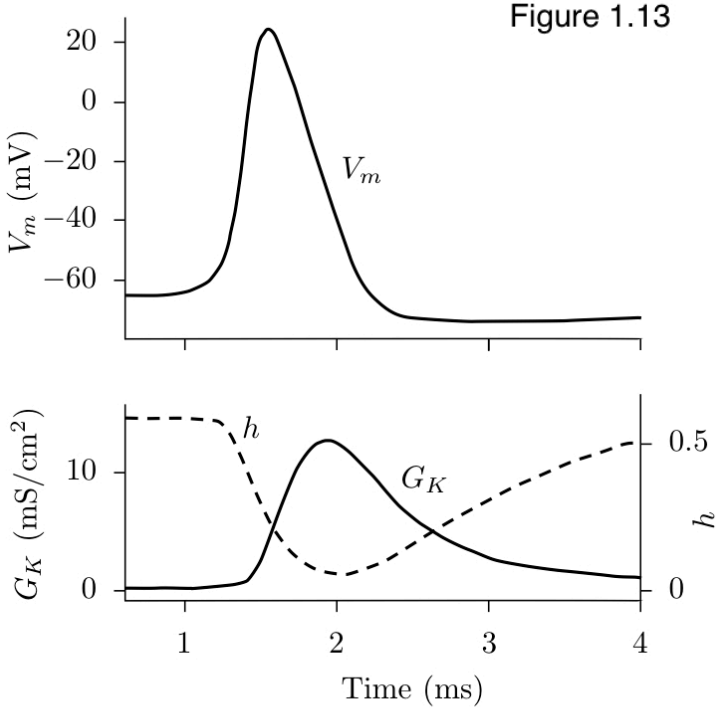


Figure 4.52

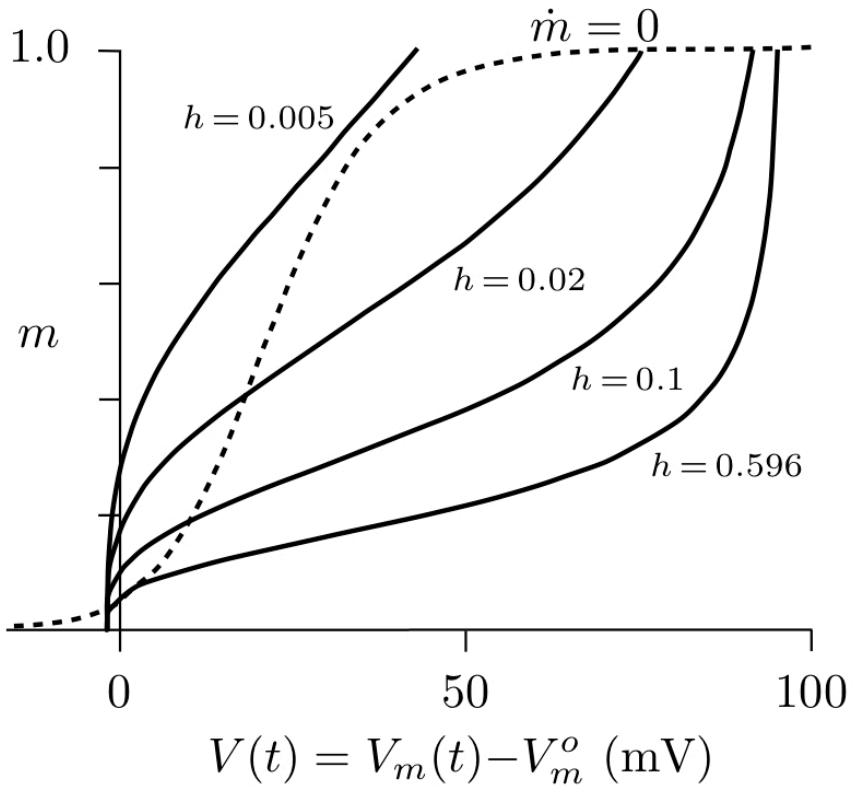


Figure 4.53

Back to the question of spatial propagation...

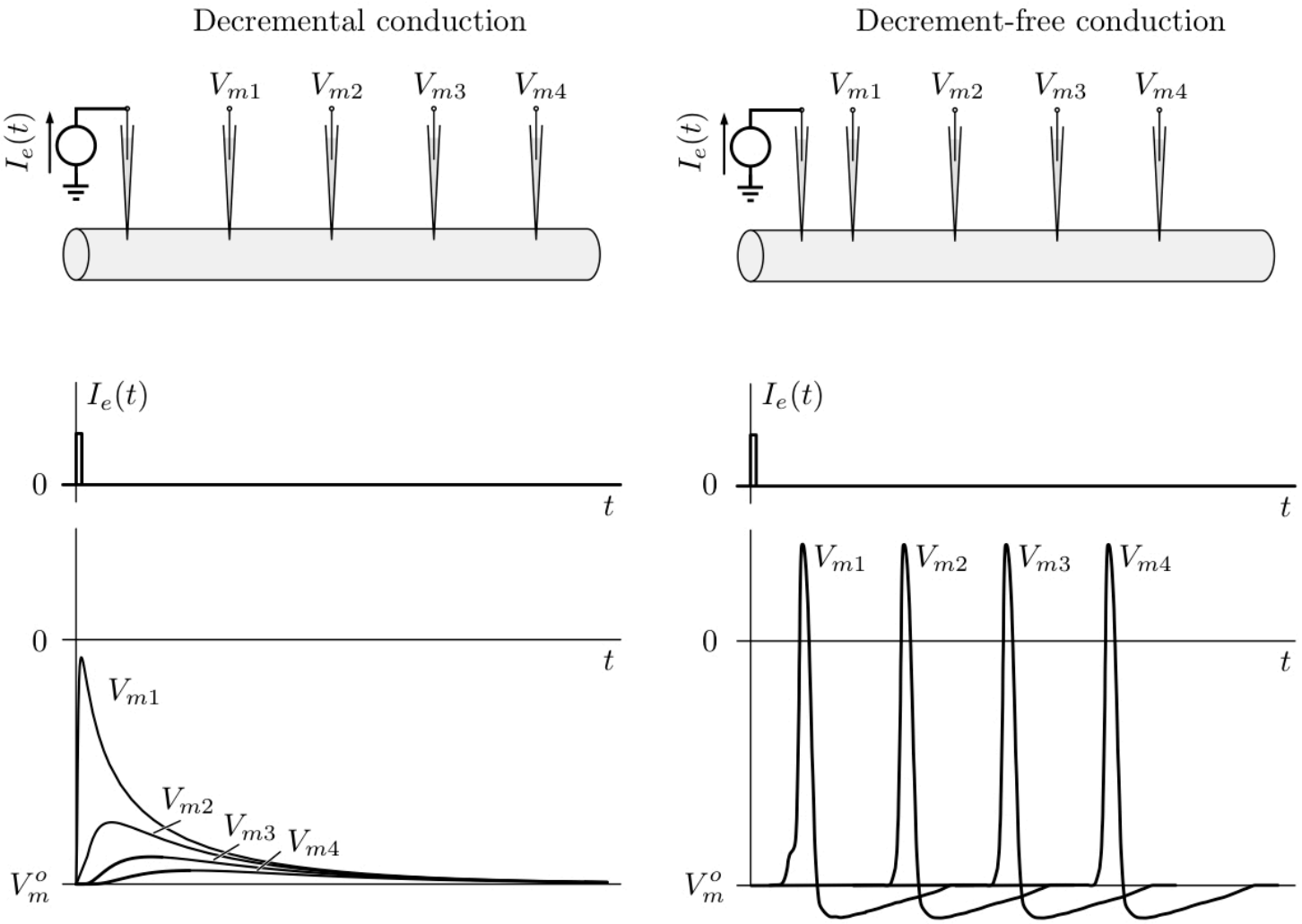
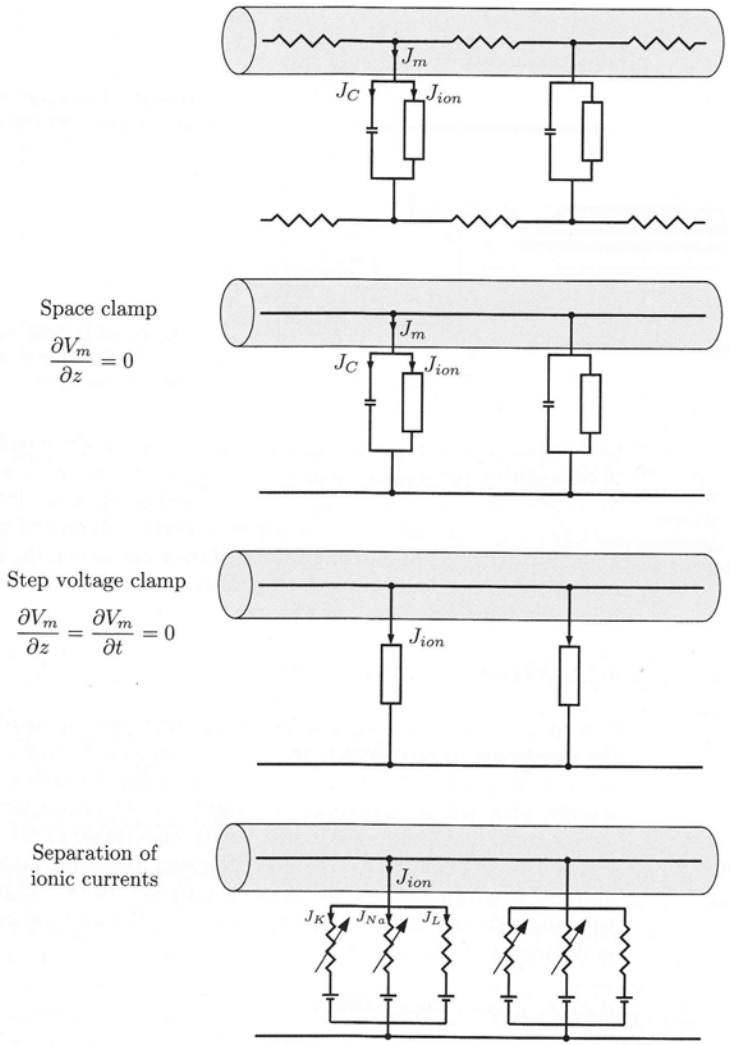


Figure 1.16

Propagated APs



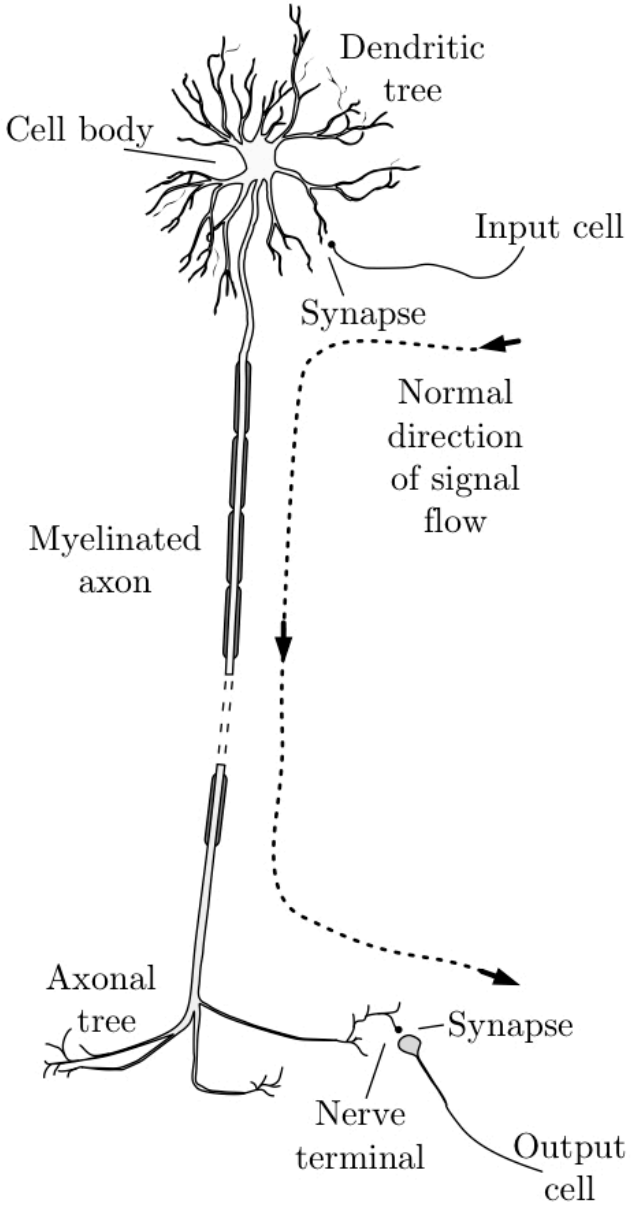


Figure 1.22

Propagated APs

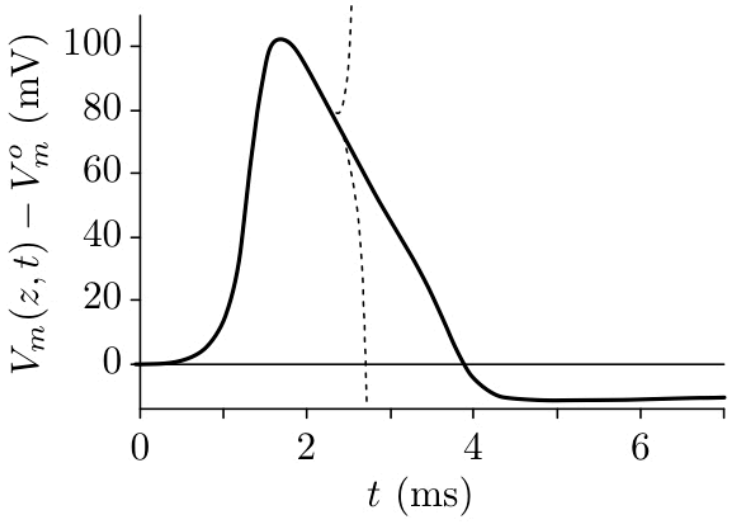


Figure 4.30

→ Solutions only stable for appropriate choice of conduction velocity

(think back to cable model; C_m matters!)

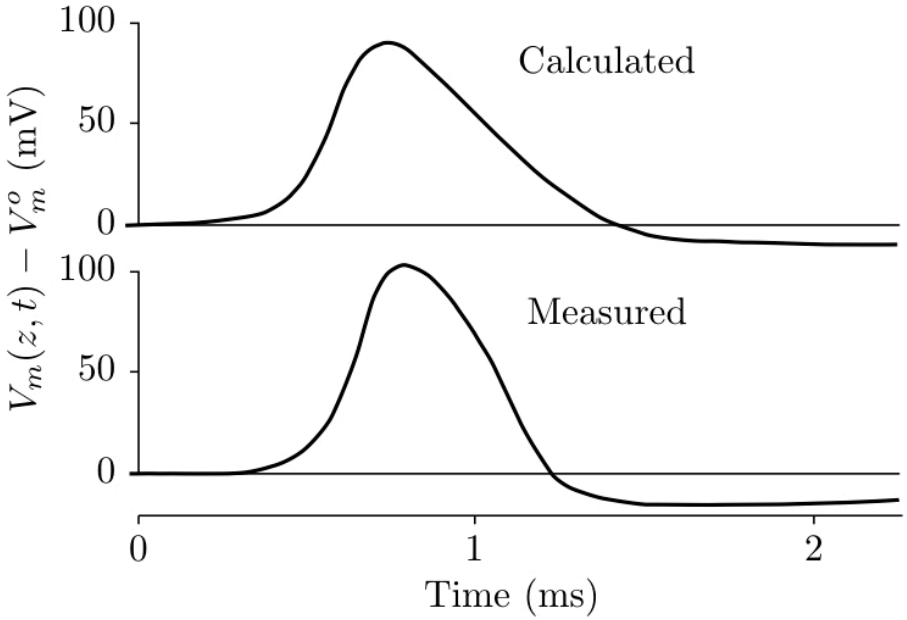
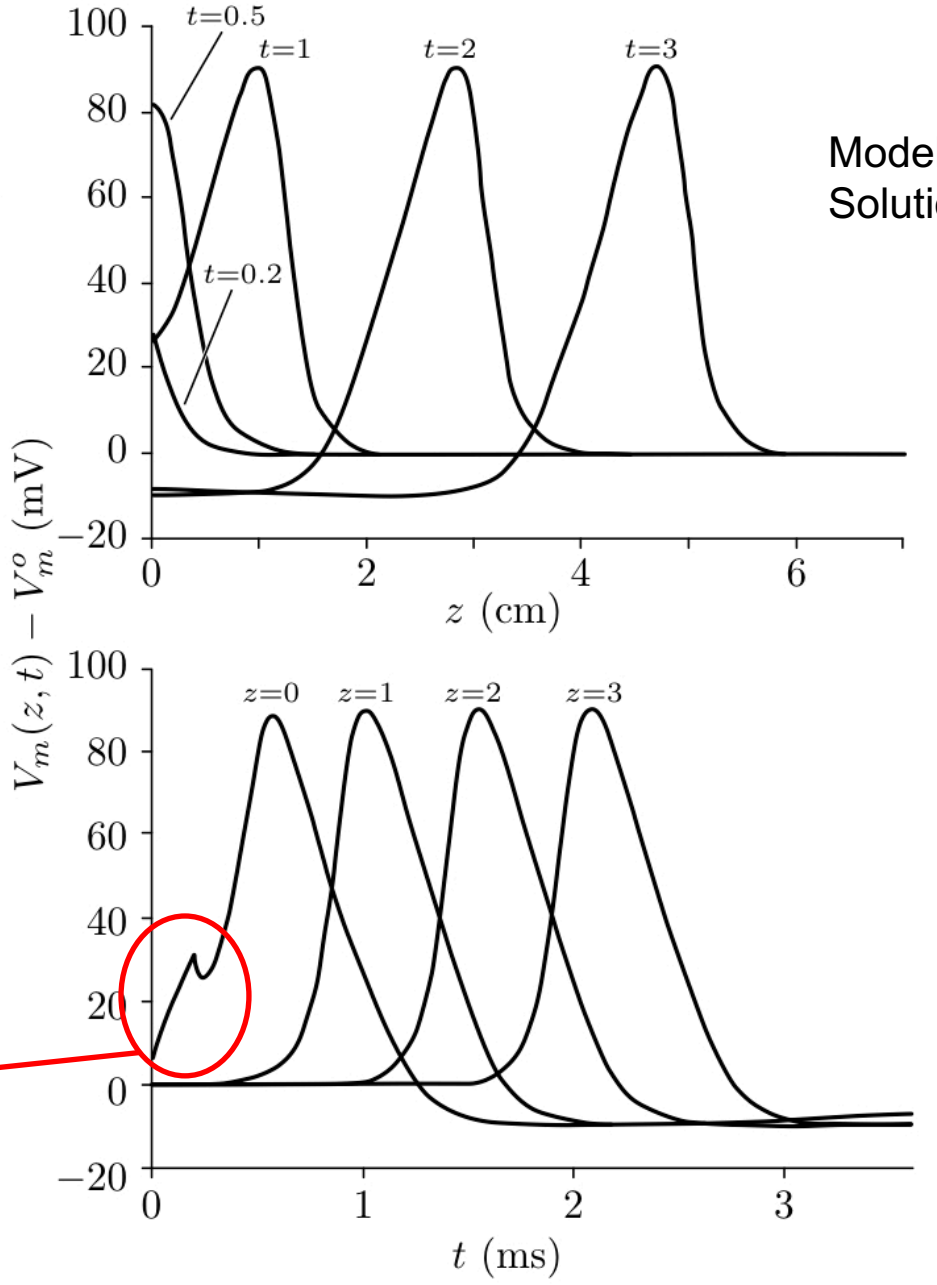


Figure 4.31

Propagated APs



Model Solutions

Stimulus
(think cable model)

Figure 4.29

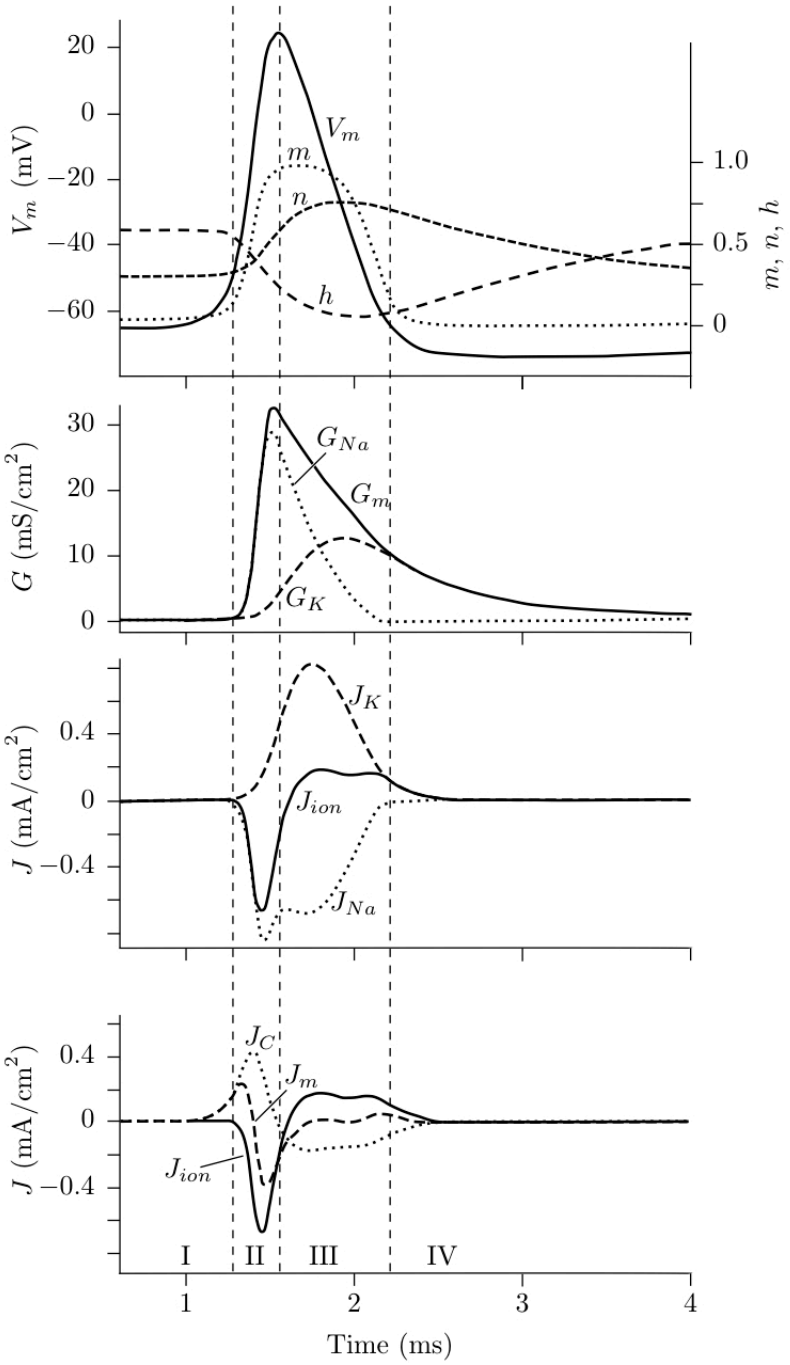
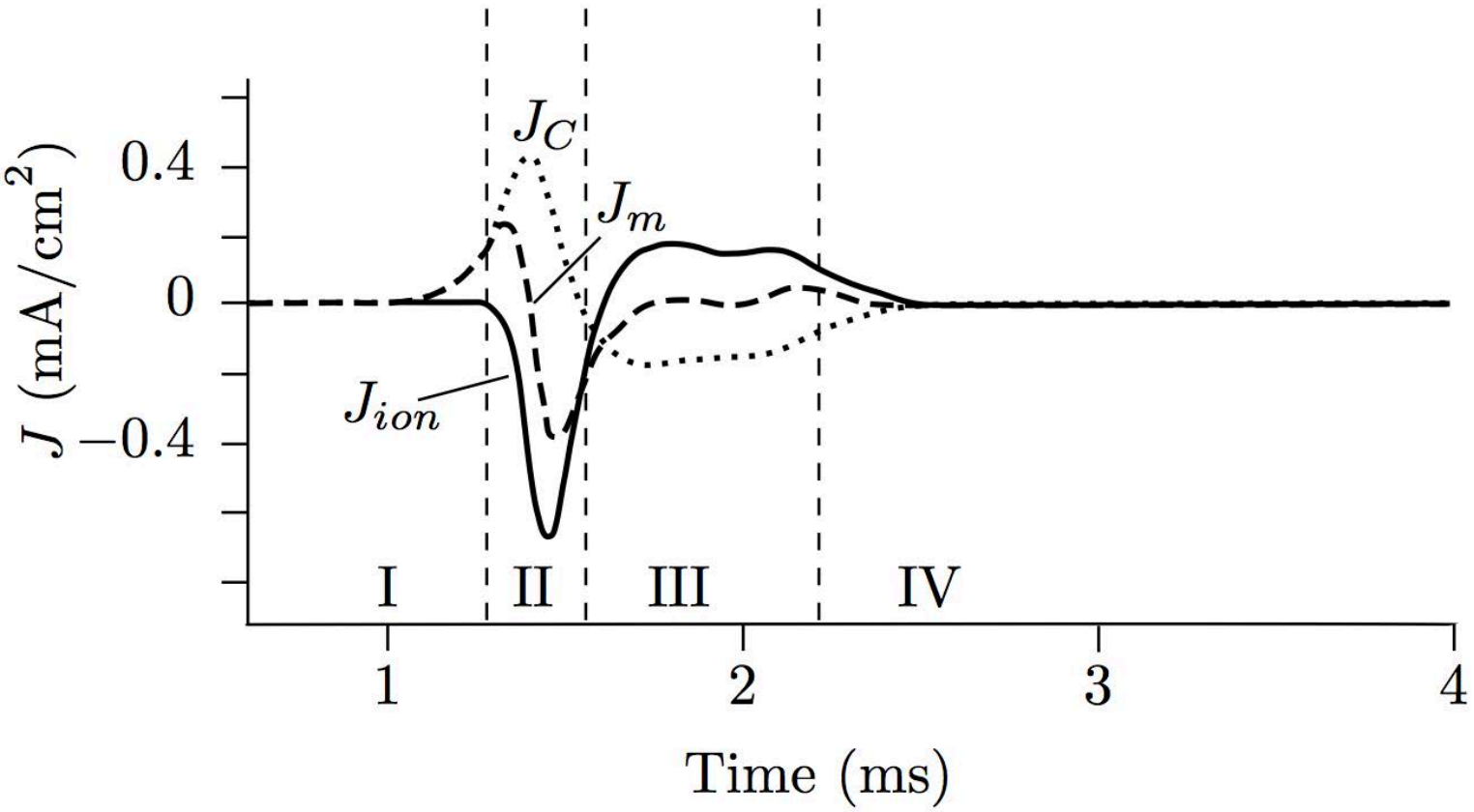


Figure 4.32

Similar picture as before for propagated AP

→ Note lag between V_m and G_m

(stems from capacitive surge)



→ Note lag between V_m and G_m

(stems from capacitive surge)

Myelination

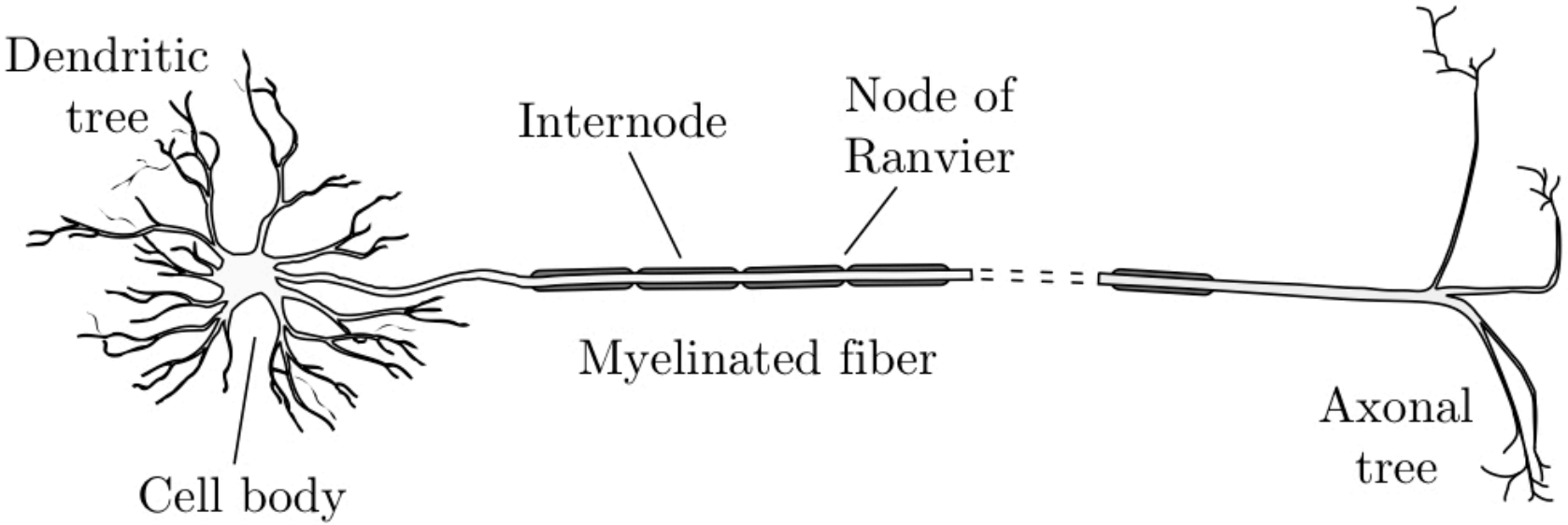


Figure 5.1

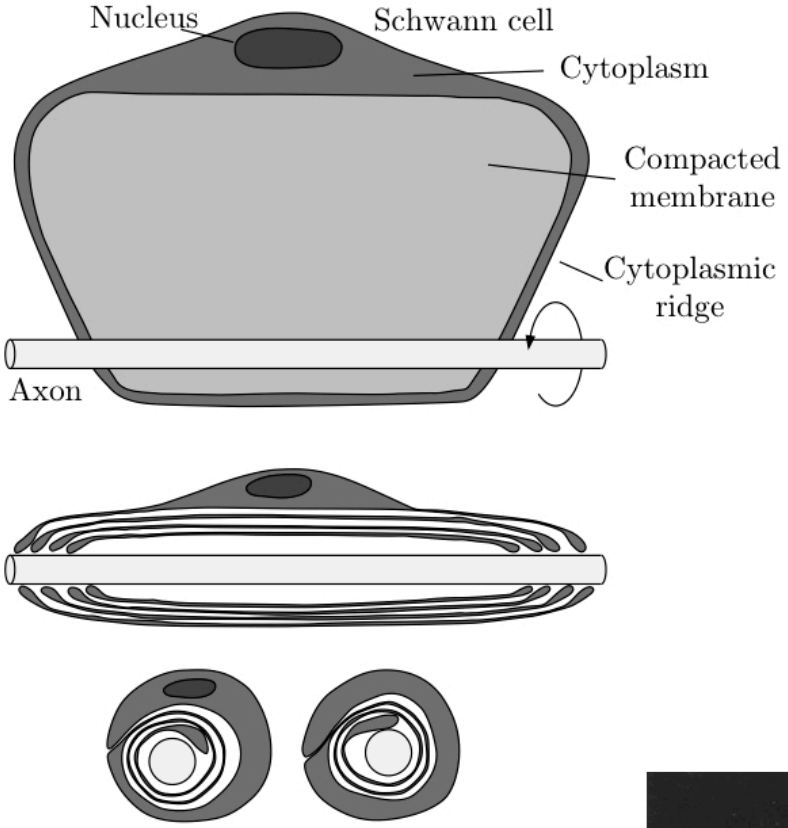


Figure 5.5

Figure 5.6

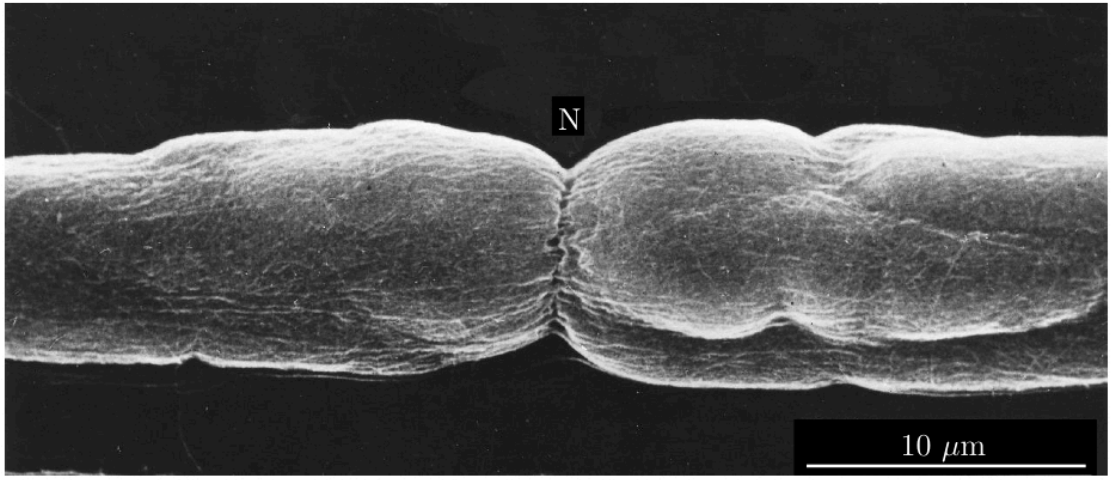


Figure 5.2

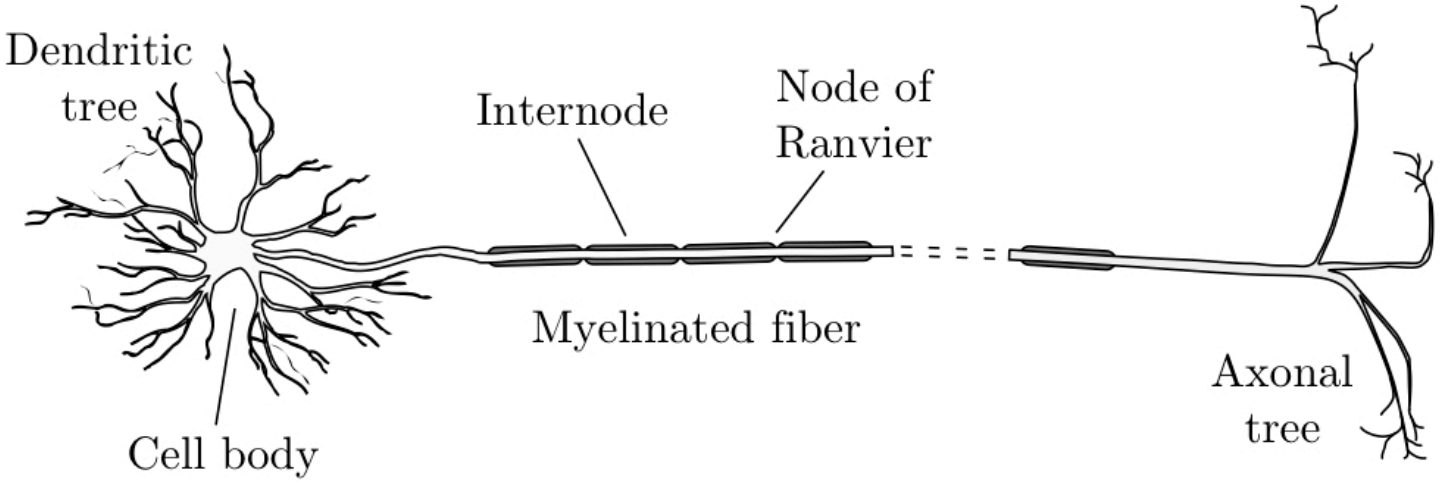
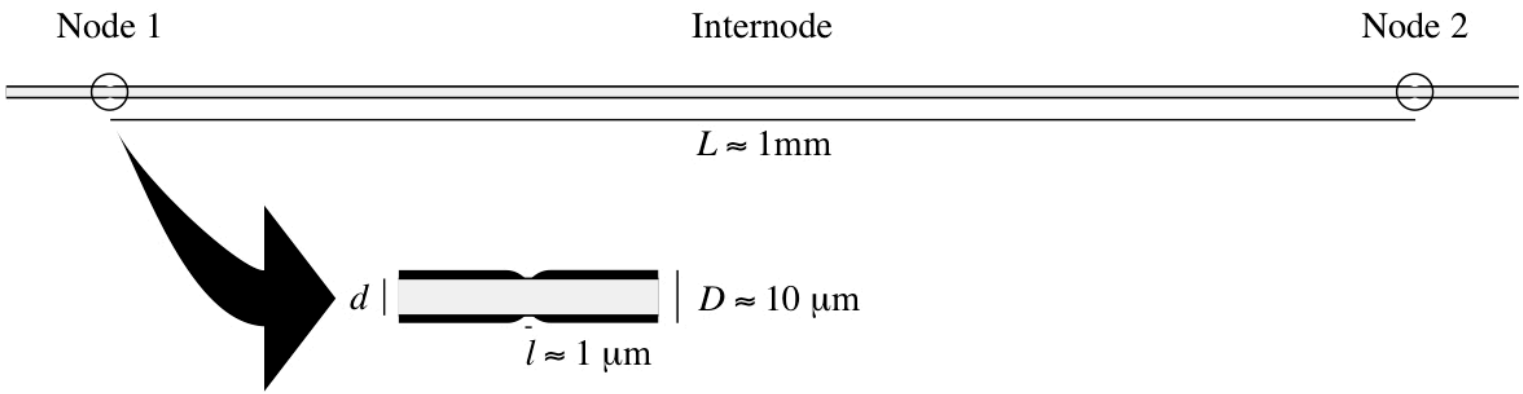

Dendritic
tree
Internode
Node of
Ranvier
Myelinated fiber
Axonal
tree
Cell body

Figure 5.1


Node 1
Internode
Node 2
$L \approx 1$mm
d
$D \approx 10$ μm
$l \approx 1$ μm

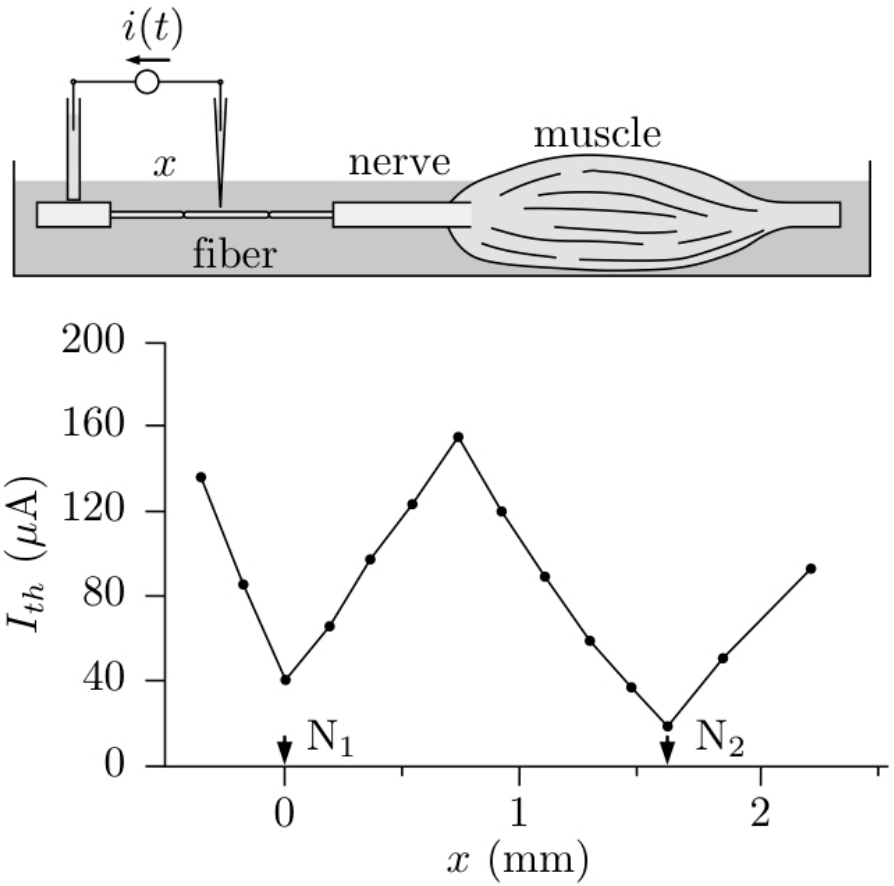


Figure 5.12

→ 'Hopping' behavior of current

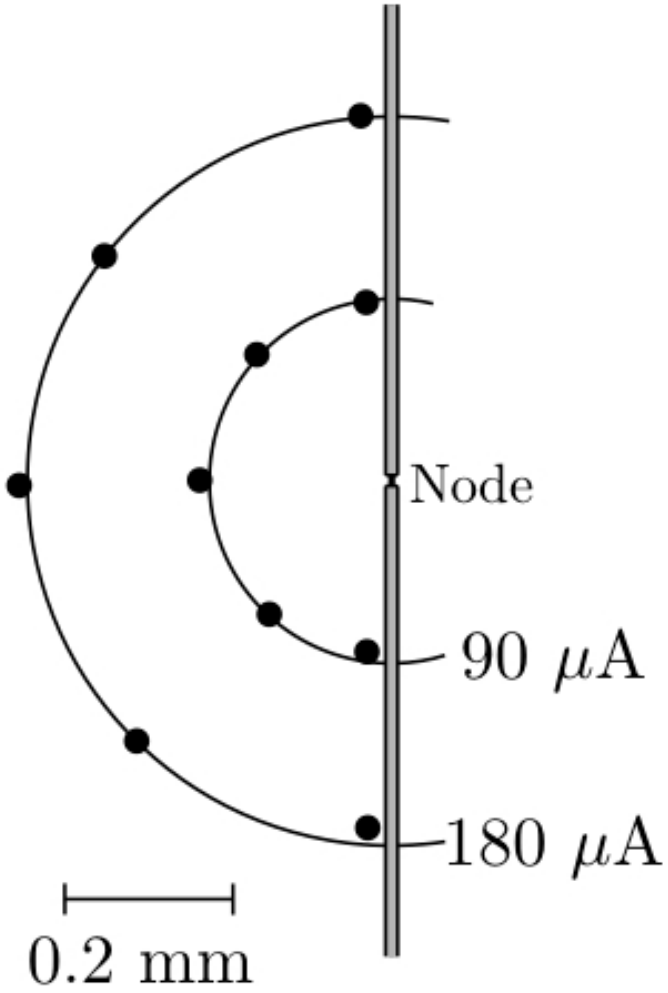


Figure 5.13

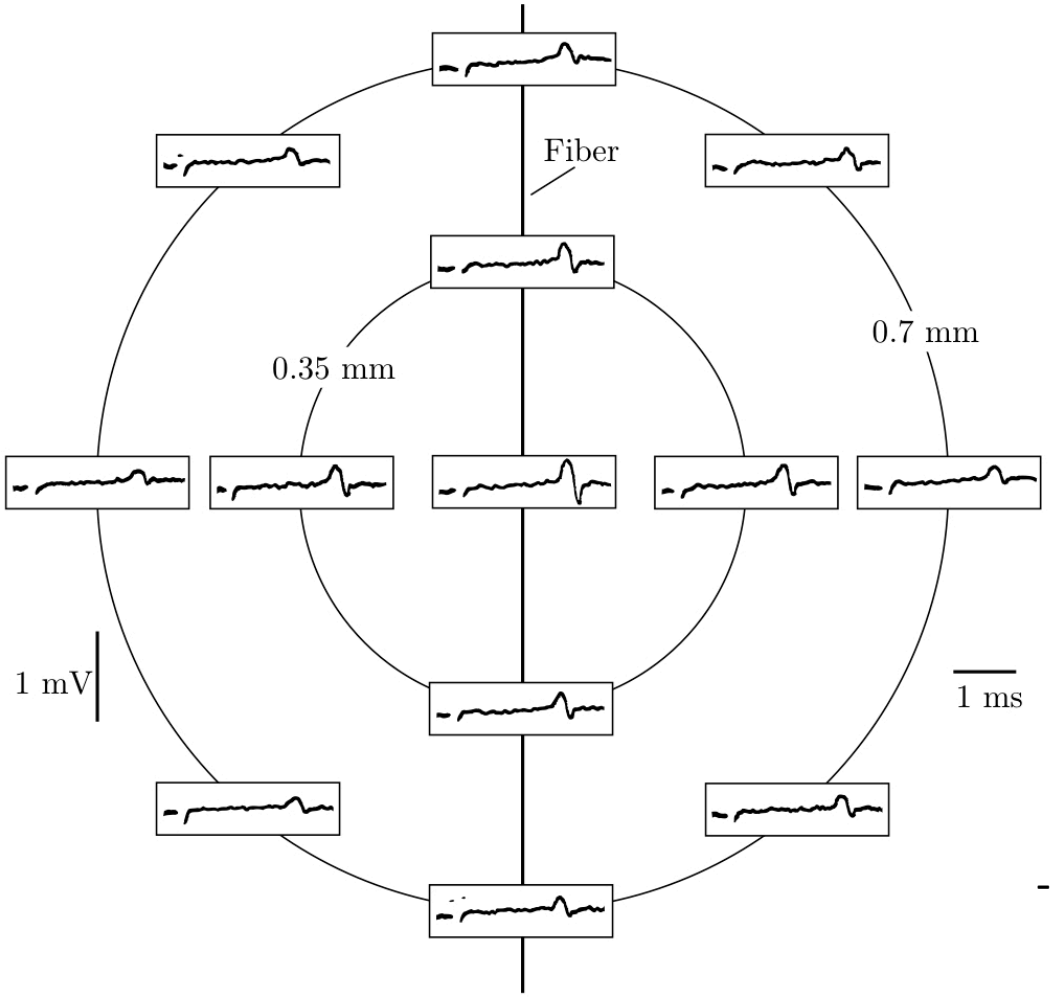


Figure 5.14

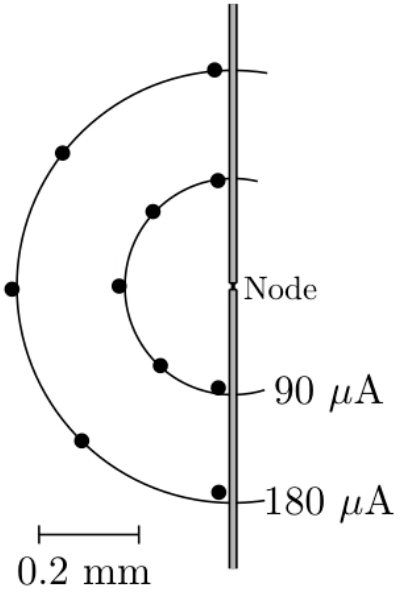


Figure 5.13

- Radial distance from node is important

→ Saltatory conduction

Saltatory Conduction

Plausible biophysical model for saltatory conduction?

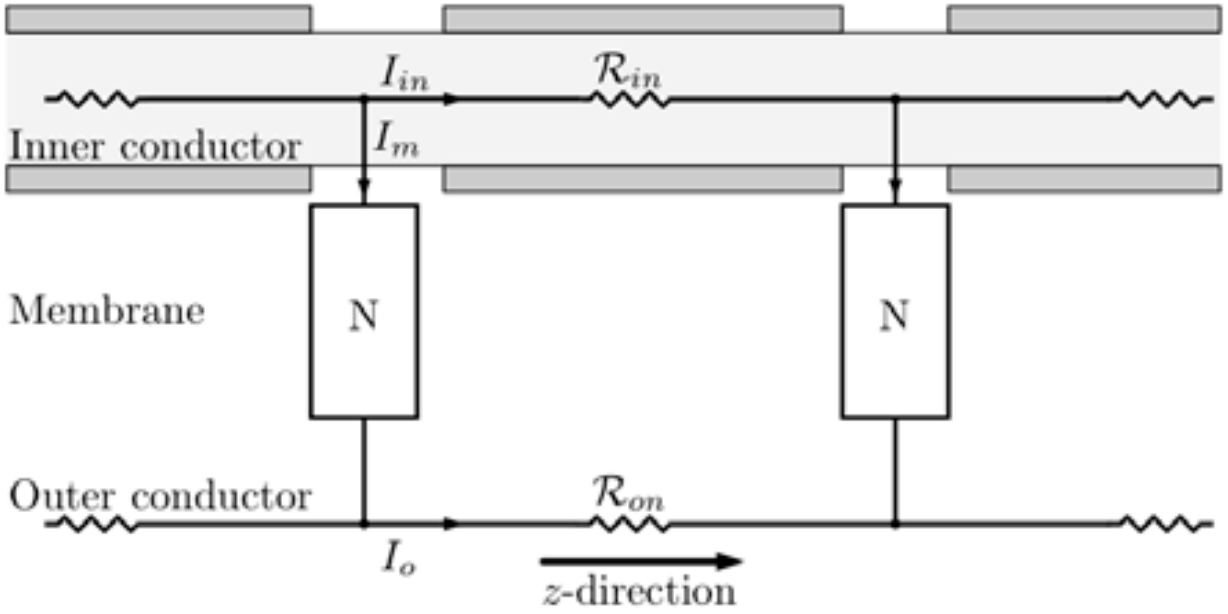
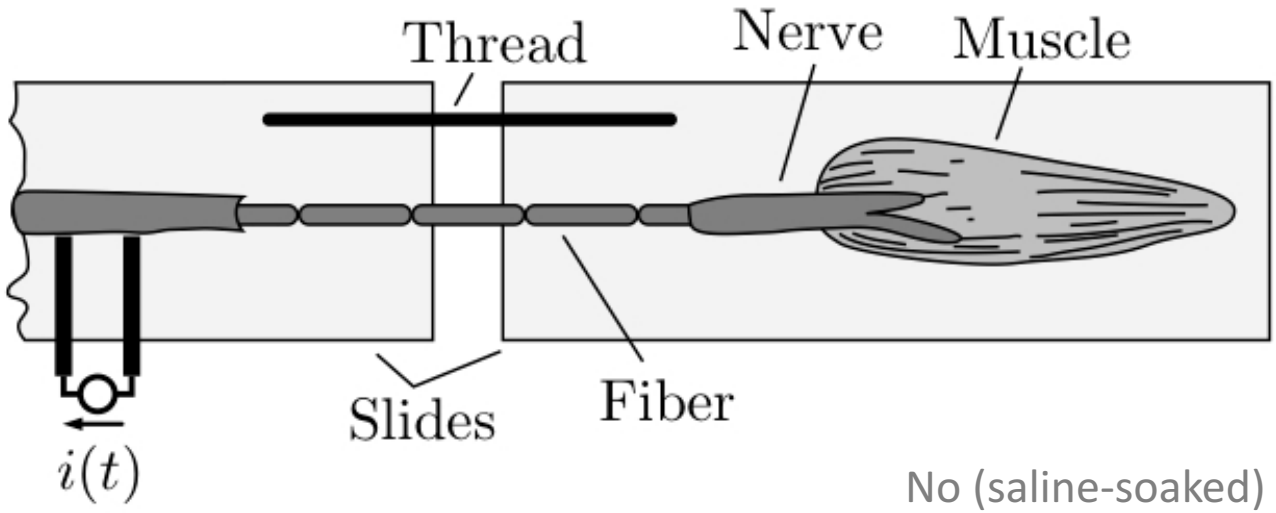


Figure 5.16

- Internodes act as insulators

- APs generated at nodes of Ranvier

- Speeds up propagation without need for larger axon diameter



No (saline-soaked) thread = no AP

Figure 5.15

→ Extracellular path between nodes is critical

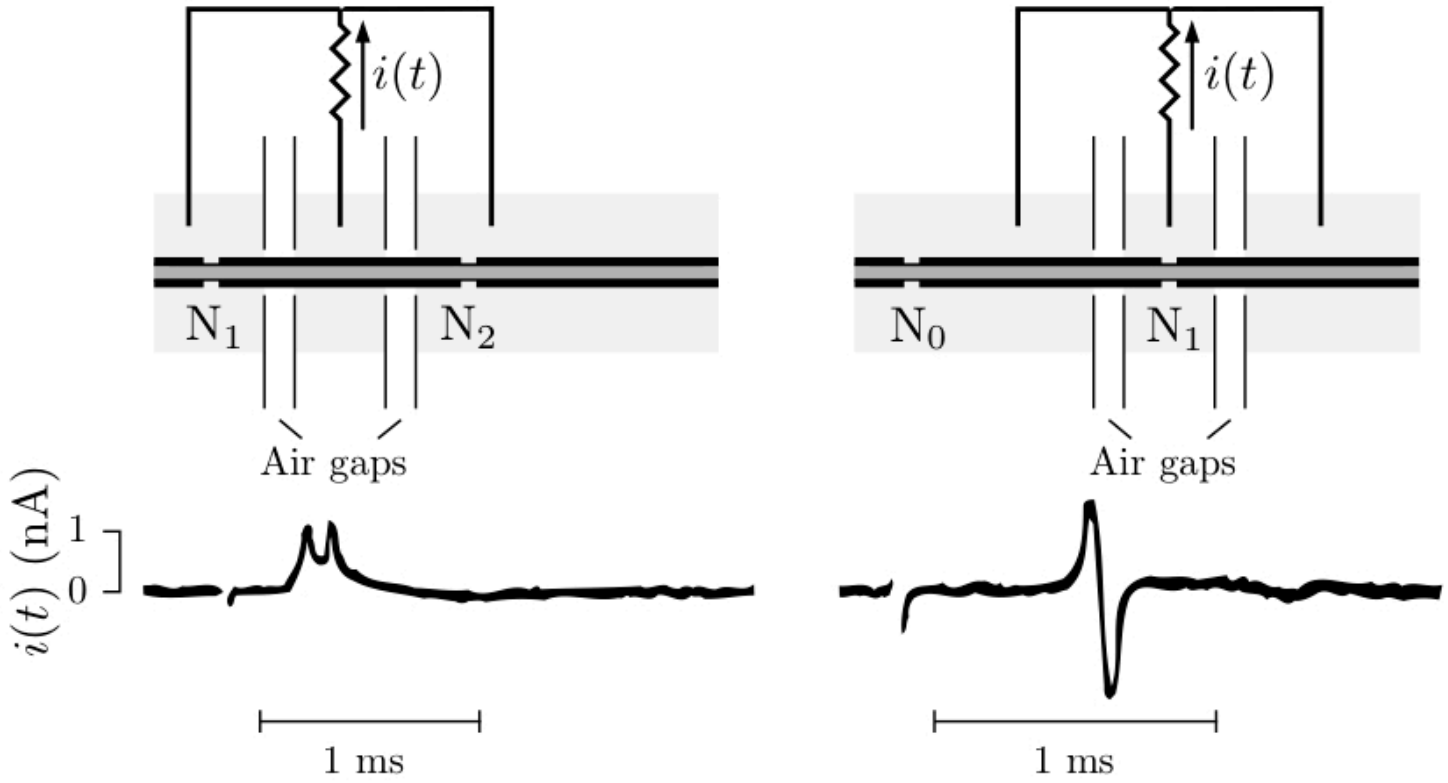


Figure 5.17

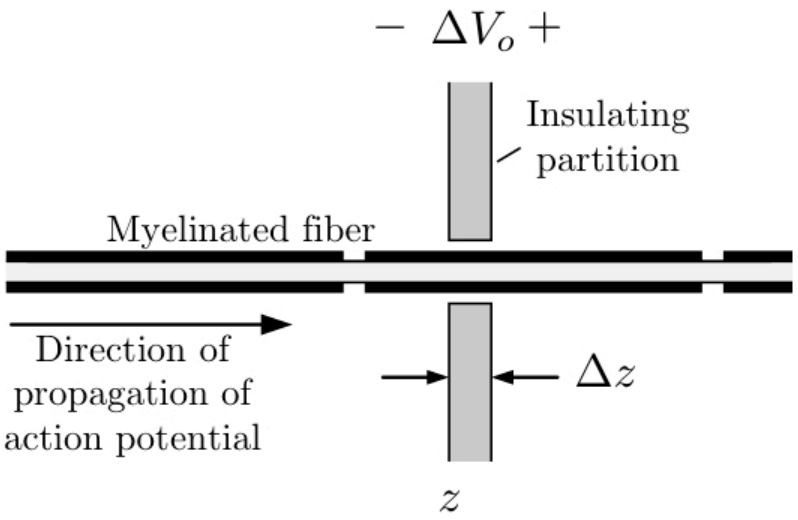


Figure 5.18

→ Current through internodes is non-zero

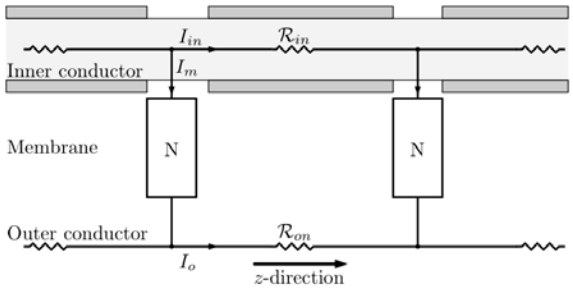


Figure 5.16

This model isn't quite right....

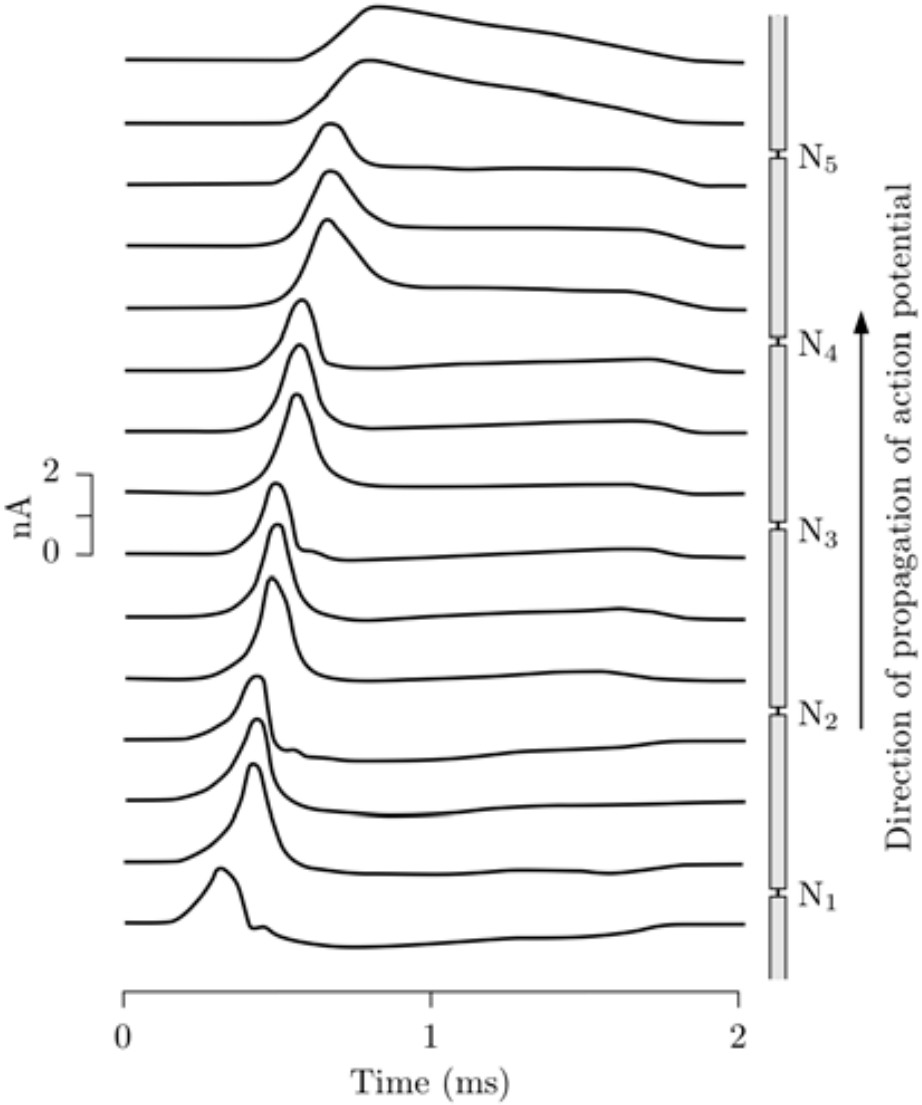


Figure 5.19

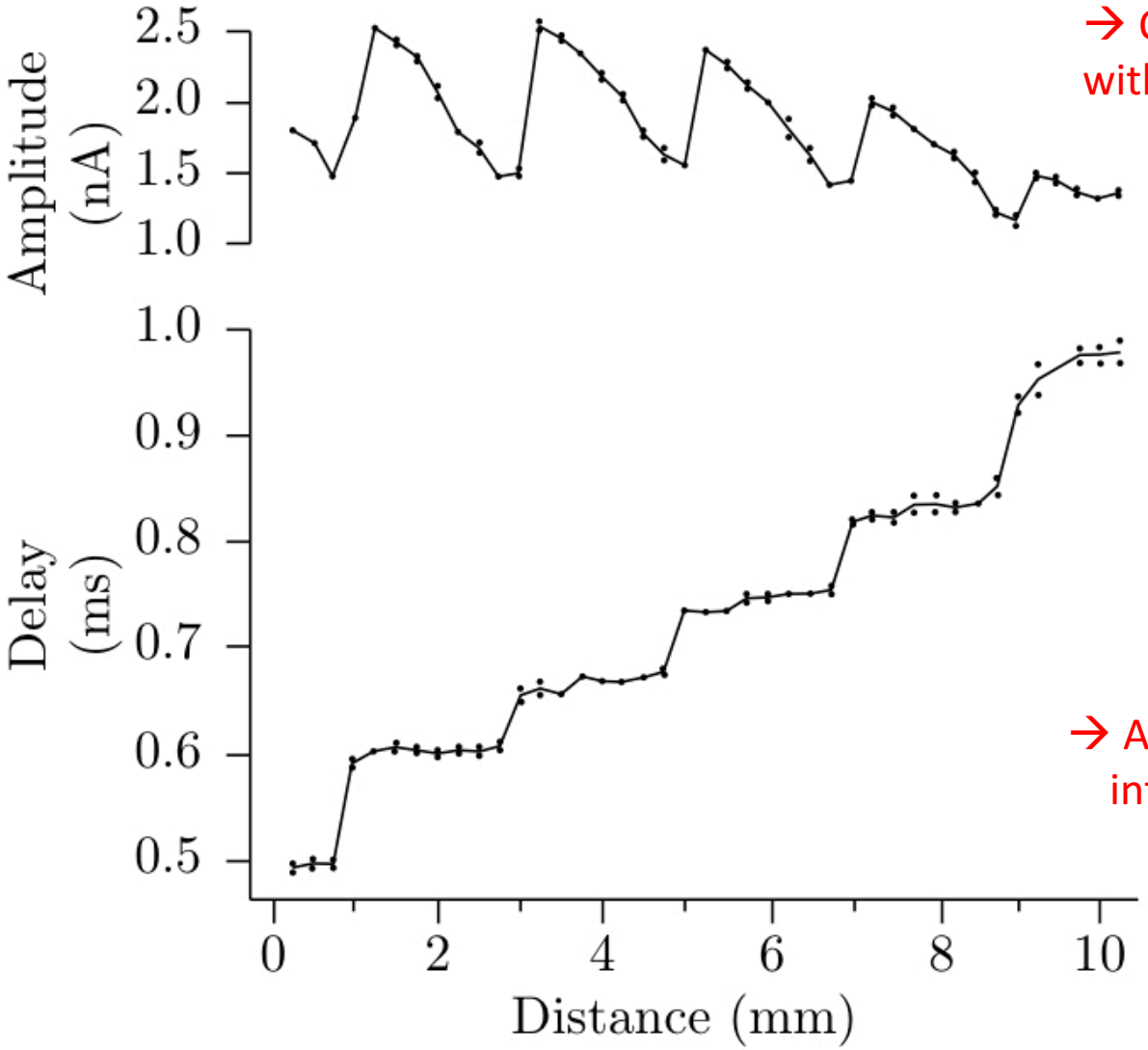


Figure 5.20

→ Current amplitude decreases with distance from node

→ APs move much faster along internodes than at nodes

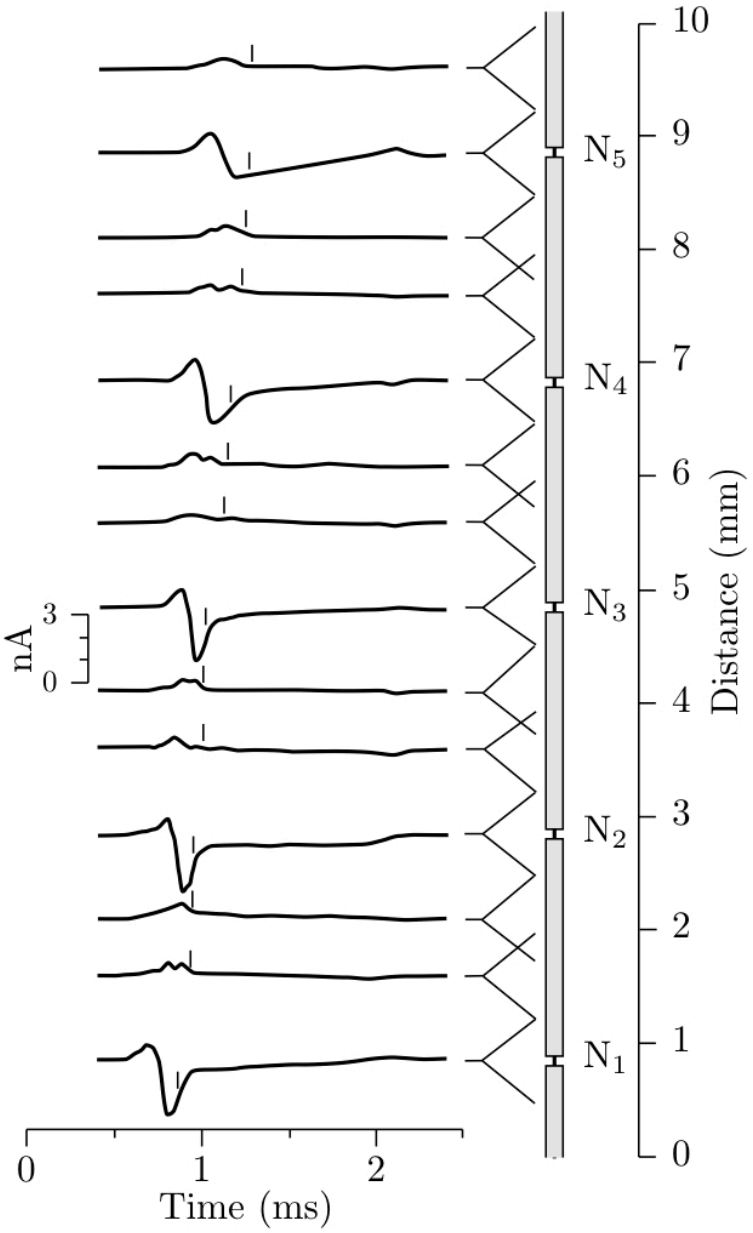
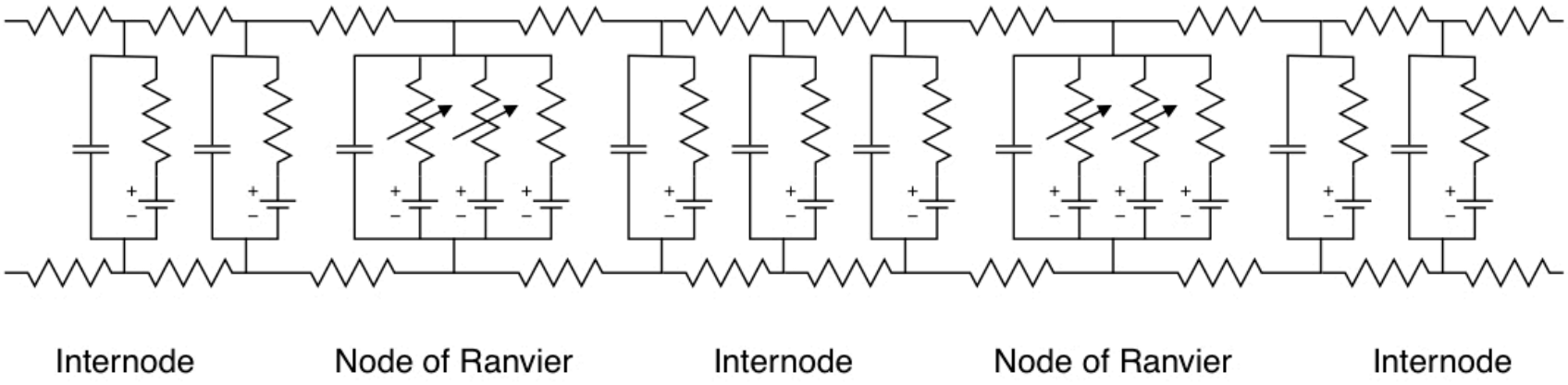


Figure 5.21

→ Internodes behave like cable model

(i.e., leaky submarine cable)

Model of myelinated nerve fiber



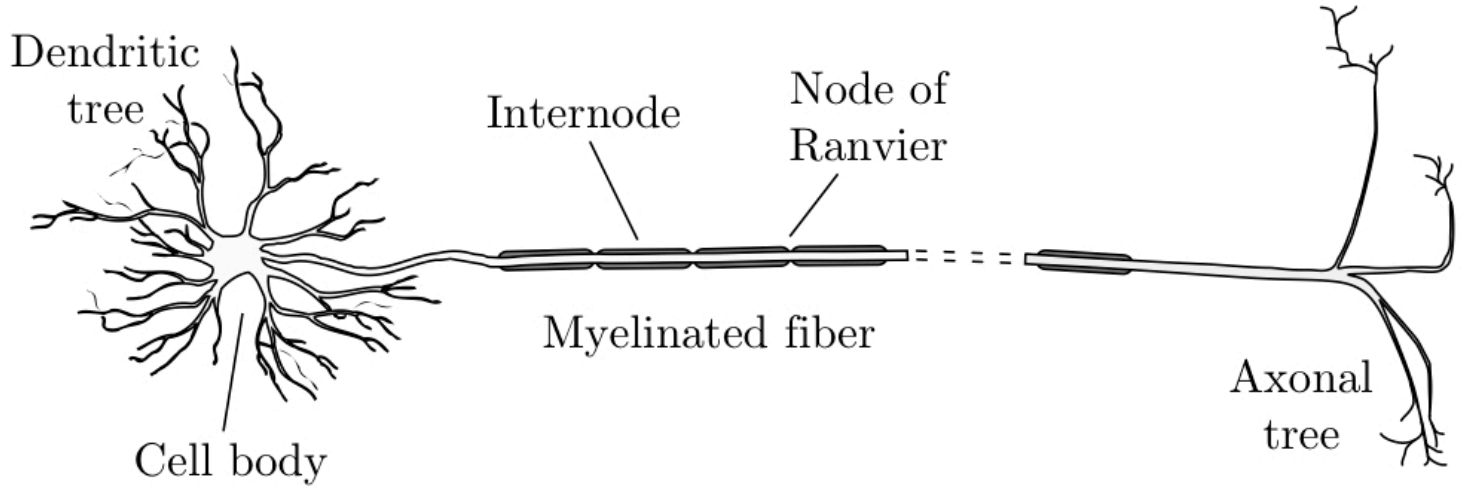
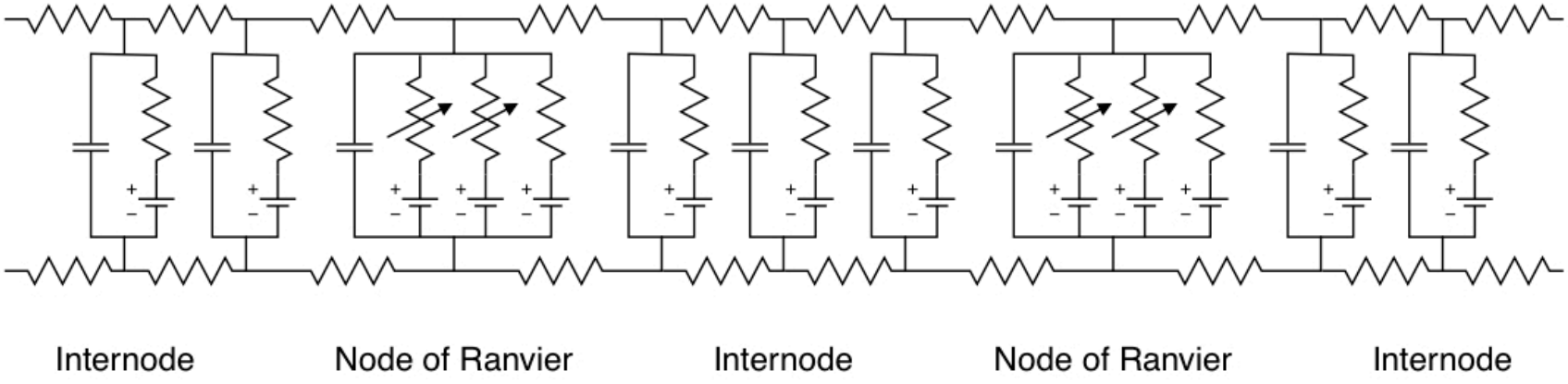


Figure 5.1

Model of myelinated nerve fiber



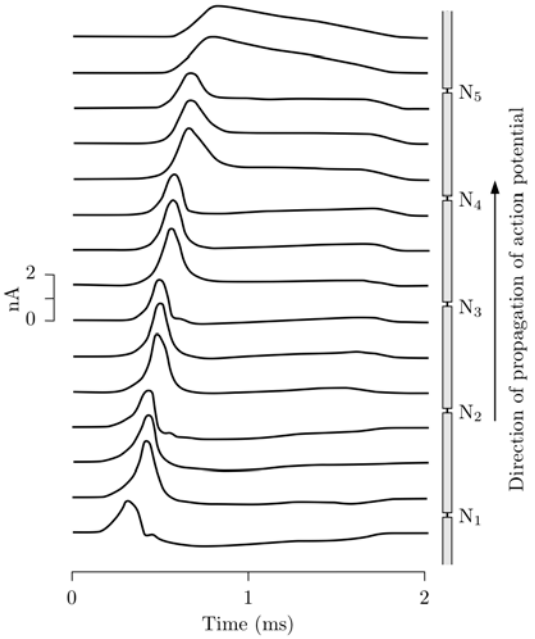


Figure 5.19

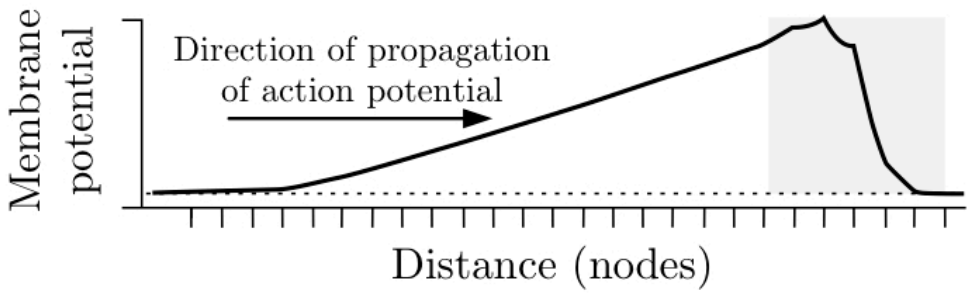


Figure 5.22

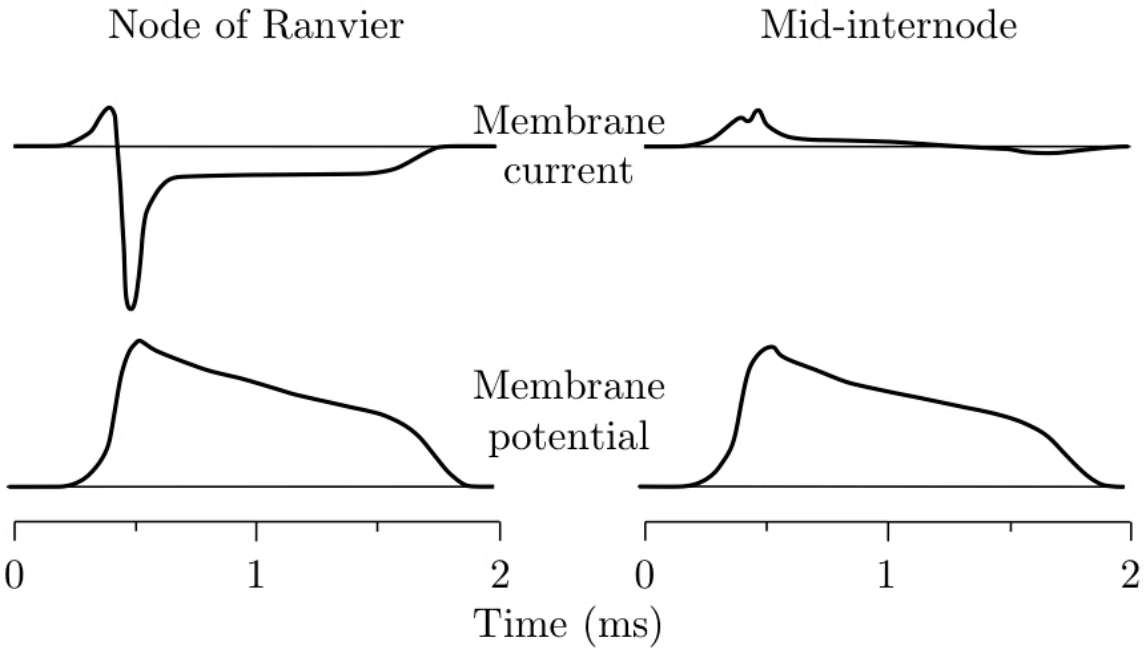


Figure 5.23