Nerves and Conduction of Nerve Impulses

A. Introduction

1. Innovation in Cnidaria - Nerve net

a. We need to talk more about nerves

b. Cnidaria have simple nerve net - 2 way conduction

c. Basis for more complex system in Vertebrates

B. Vertebrate Nerves - anatomy

1. Types of nerves:

a. Afferent - sensory - come from sense organs

b. Efferent - motor - go to muscles

c. Interneurons - go between other neurons - connectors

2. Structure of nerve cells

a. Dendrite

b. Cell body

c. Axon

1. May be covered with myelin - fatty stuff

a. produced by Schwann cells

2. Nodes of Ranvier - really important

3. Axons can be very long - length of giraffe neck

3. Neuroglial cells

a. Don't transmit nerve impulse - They "support" the nerve cells

b. Schwann cells

c. Astocytes - nutrient and ion reservoirs

4. Clustering of Axons into nerves

a. Axons are bundled into groupings - we call nerve fibers

b. Cell bodies in ganglia

5. Nerve impulses - how nerve cells transmit information

a. Electro-chemical process -

b. Action potential - nerve impulse

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1. All or none phenomenon

2. Conducted down axon

3. Frequency of firing - contains information

c. Resting membrane potential

1. Cells have more K+ ion in them then outside

2. K+ leaks out of cell - the + in K+ is normally balanced by large proteins that cannot leak out of cell - a little K+ diffused out of cell

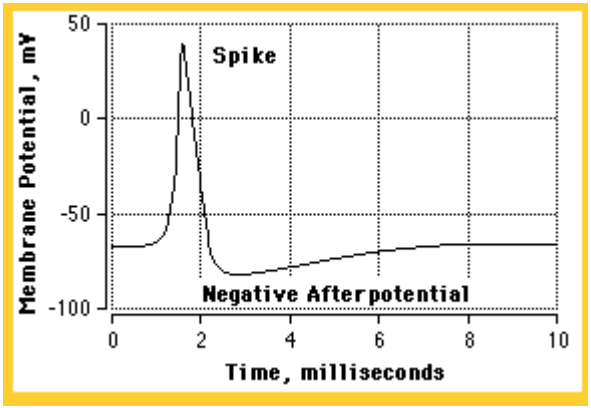
a. The result is a slight deficit of K+ inside cell relative to negative ions

b. The outside of cell is then + relative to inside

c. Voltage about -70mv

1. This is the case in most cells

d. Nerve impulse is conducted along axon by changing the resting membrane potential



1. Action potential

a. Starts at dendrite - slightly depolarizes resting membrane potential

1. If this depolarization exceeds a certain threshold, the action potential is started

b. Action potential comes down nerve

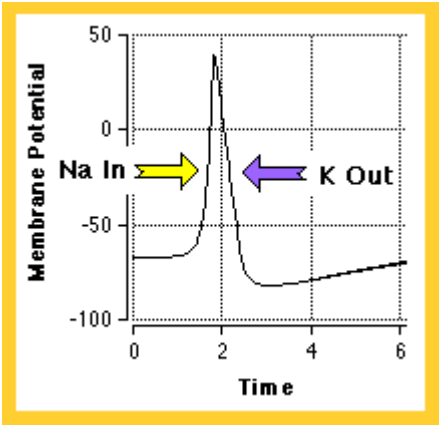
1. Specialized channels - Na channels that suddenly open and let Na+ enter into cell

a. Reverses resting membrane potential for an instant

b. When membrane potential gets sufficiently positive sodium channel close

c. Action potential passes

1. K+ leaks out again to re-establish the resting membrane potential



d. Membrane ready to transmit another impulse (action potential)

2. Action of drugs

a. Lidocaine - inhibitor of Na+ channels -

a. Na+ can't get into nerve cell

b. Stops action potential - stops pain

b. Tetrodotoxin - from puffer fish

a. Really strong Na+ channel blocker

b. Shuts down nerve conduction

c. Death from asphyxiation - because control of breathing stops

2. This cannot go on forever - the amount of sodium in cell would get too large

a. Sodium pump

1. There is a "pump" that actively transports Na+ out of the cell

2. Requires ATP

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3. Actually exchanged Na+ for K+

4. This is where energy is used in nervous system

5. The sodium pump ultimately keeps the nerves functioning

6. High Speed Conduction

a. How to make conduction of nerve impulses faster -

1. .1 m/sec in sea anemones

2. 120 m/sec in mammalian motor neurons

b. Make them bigger

1. Squid giant axon - really big - 1 mm thick axons

a. escape mechanism

c. Saltatory Conduction - jumping

1. Nodes of Ranvier and myelin

a. Nodes about every 1 mm down axon in mammals

b. Action potential jumps between nodes

1. Myelin prevents action potential between nodes

2. Speeds up movement of action potential down the axon

3. In multiple sclerosis the myelin breaks down

a. Ruins action potentials and nerve transmission

C, Synapses

1. How are neurons connected together?

a. Through gaps called synapses (synaptic cleft) 20 nm

b. Presynaptic neuron

c. Postsynaptic neuron

2. Axon ends in a bunch of "synaptic knobs"

a. Also, dendrite is in contact with other neurons through synapses

3. Action potential jumps the gap by means of neurotransmittor

a. Acetylcholine main one, but there are others

b. Acetylcholine present in synaptic vesicles

1. When action potential comes - acetylcholine is released and diffuses across synaptic cleft
2. Starts a new action potential on other side
3. Acetylcholine is destroyed

4. Parkinson's disease
   a. Loss of Dopamine neurons
      1. Some neurons use Dopamine - Dihydroxyphenylalanine amine
         a. Control involuntary actions
         b. Walking
      2. Progressive disease of ageing
         a. Can also be caused by illegal drugs – PCP
         b. Tremors – first sign
         c. Eventual loss of swallowing and breathing
         d. Pope, Billy Graham, Micheal J. Fox, Mohammed Ali

D. Evolution of nervous systems
   1. Progressive increase in complexity through the metazoan phyla
      a. Simplest system in Cnidaria - nerve net
         1. No synapses - no unidirectional transmission
         2. Impulse spreads from start location
      b. Flatworms have anterior ganglia
         1. Two nerve trunks
         2. Central and peripheral nervous systems