March 3, 2014

Synaptic Transmission

Crawdad labs 8 and 9
Crayfish NMJ as a model for human brain fast synapses

Neuromuscular Innervation

Uni-terminal
Uni-neuronal
Excitation Only

Multi-terminal
Poly-neuronal
Inhibition
Often no APs

Mammals
Anthropoids

Crayfish NMJ preparation

Example Data

Figure 5. Correlation of APs and EPSPs: Action potentials in rat cerebellum pyramidal neurons in a slice of the superior colliculus. Note that there are at least two different circulation of APs and several series of EPSPs.
Synaptic Inhibition

This week!
Map Muscle Innervation Patterns
Also better distinguish number of axons in nerve 1

Steps in ionotropic chemical synaptic transmission

Release of Transmitter

Snake Neuronal Junction Model
Freeze-fracture of NMJ

EM section of NMJ

Ca<sup>2+</sup> channel complexes

Brain Synapse

Few vesicles at each synaptic site

Quantal nature of transmitter release

Record spontaneous transmitter release

“Minis”

Record postsynaptic membrane potential

Record evoked transmitter release

Reduce [Ca]<sub>o</sub>

record evoked transmitter release
Normally around 300 quanta at NMJ/AP (could be only a few at central synapses)

**Spontaneous “mini” and evoked potentials - quantal steps**

Quantal content: $m = \text{mean EPP/mean MEPP}$

**Spontaneous “mini” synaptic potentials**

Quantal hypothesis of transmitter release

Post synaptic depolarization results from the coordinated release of transmitter packets (quanta) from the vesicles as the AP enters the terminal

**Physical evidence for vesicle fusion for transmitter release**

4-AP broadens presynaptic AP

**Squid giant synapse as a model system**

Presynaptic axon

giant axon ~1 mm

George Augustine, Marine Biological Laboratory, 2008
Technical help: Bruce Johnson
Importance of calcium for transmitter release

Block transmitter release with presynaptic Ca buffer

Presynaptic Ca injection causes transmitter release and Ca indicator dye shows presynaptic Ca entry

Any depolarization will cause transmitter release, even high K-out triggers opening of voltage-gated Ca channels

What is the role of the AP in transmitter release?
provides trigger and timing for calcium entry

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Synapse tutorial
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