PRINCIPLE: TO PERSIST, LIFE MUST DEAL WITH ENVIRONMENTAL STRESSES

ANN HIRSCH (UCLA, visiting lecturer in Bi1)
- The responses of plants to environmental stress

MMN
- Cont.: responding to the environment – action potentials/effectors

Clicker quiz round
ALL CELLS MAINTAIN A MEMBRANE POTENTIAL

Neurons: -60 to -70 mV
In all animal cell types, membrane potential is maintained by a protein, sodium-potassium ATPase, or pump.

Important - ~25 of ALL cytoplasmic ATP is hydrolyzed by these pumps in mammals. In nerve cells, ~70% of ATP expended for these pumps.
Movie on sodium-potassium pump
**Action potential** a depolarization of the membrane - nerve fires

- Stimulus
- Dendrite (receiving)
- Axon (sending)
- Uninsulated node
- Synapse (electrical or chemical)
- Insulation (myelin)
- Sum of excitatory & inhibitory input

ACTION POTENTIAL BEGINS HERE
Action potential - a depolarization of the membrane

VOLTAGE (mV)

+40
0
-55
-70

Time (ms)

0 1 2 3 4 5

Action potential

Threshold
Depolarization
Repolarlization
Failed initiations
Resting state
Refractory period
Tetrodotoxin-sensitive

Stimulus
Action potential - a depolarization of the membrane

![Graph showing the action potential and its phases](image)

1. **Threshold**
2. **Stimulus**
3. **Depolarization**
4. **Repolarization**
5. **Refractory period**
6. **Resting state**

**Na+** and **K+** channels:

- **Na+ channels open**
- **K+ channels close/K+ channels open**
- **Na+ channels open**

**In** phase:
- Na+ enters the cell
- K+ leaves the cell

**Out** phase:
- Na+ leaves the cell
- K+ enters the cell

**Potassium channels close**
Axon terminal of motor neuron interfaces with effectors:

- e.g.,
  - muscles
  - chromatophores
Botulinum sensitive

Neuromuscular Junction

Axon of motor junction
Neuromuscular junction
Muscle fiber
Capillary
Myofibrils
Synaptic vesicles
Presynaptic terminal
Sarcolemma
Mitochondrion
Postsynaptic membrane
Synaptic cleft
Sliding filaments of a muscle
Alternative strategies for quick movement:

3 short movies:
1) Chameleon feeding
2) Chameleon feeding slo-mo
3) Mantis shrimp
Chameleons – launch tongue at speeds exceeding 26 body lengths/sec
Can catch insects 1.5 body lengths away in 0.1 sec.
Tongue acceleration at 51g (m s\(^{-2}\))
Works as a catapult – muscles slowly load an elastic energy store
Mantis shrimp: claw acceleration of 10,400 g (102,000 m/s²) and speeds of 23 m/sec (~140 body lengths/sec; ~.22 caliber bullet). Forces up to 1500 Newtons.
TAKE HOME MESSAGES:

- Cells maintain a membrane potential; they have a net negative charge on the inside, net positive on the outside.

- The resting potential of a neuron is maintained by a sodium-potassium ATPase that pumps more sodium out of the cell than potassium in.

- An action potential in a neuron involves a depolarization of the membrane.

- Muscles are ‘effectors’ that innervated by motor neurons. The nerve and muscle cells communicate at the neuromuscular junction through a chemical synapse.

- Muscle fibers are used in various ways depending on the animal’s need.