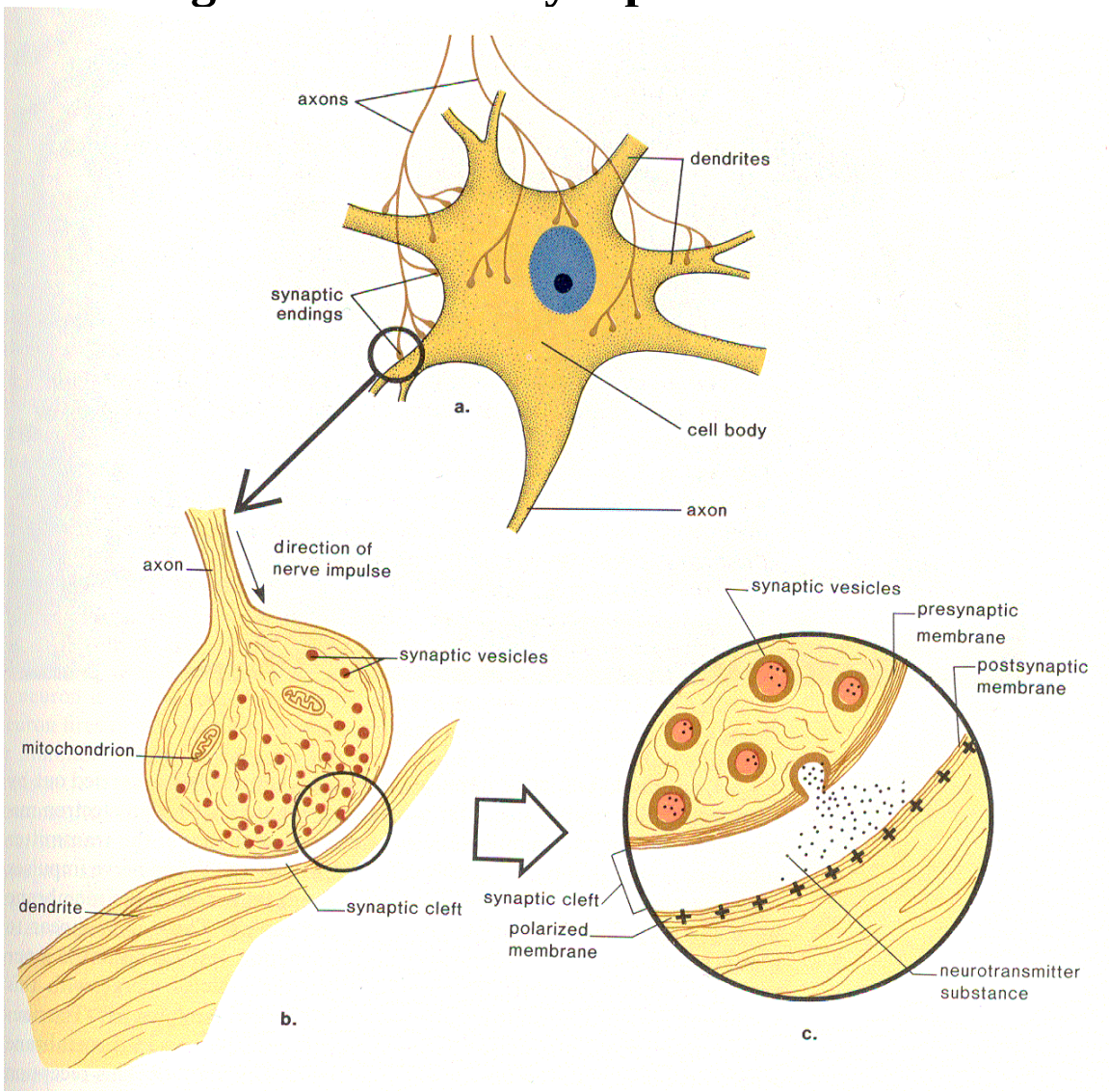
Unit M Notes #3 -Transmission Across A Synapse And the Reflex Arc

A) Neurotransmission:

- The terminal end of each axon branches off to form many terminal branches (fibers) each of which ends in a swelling called an axon bulb. Each of these bulbs lies close to (but not touching) the dendrite of another neuron (or effector). The entire region is called a synapse.

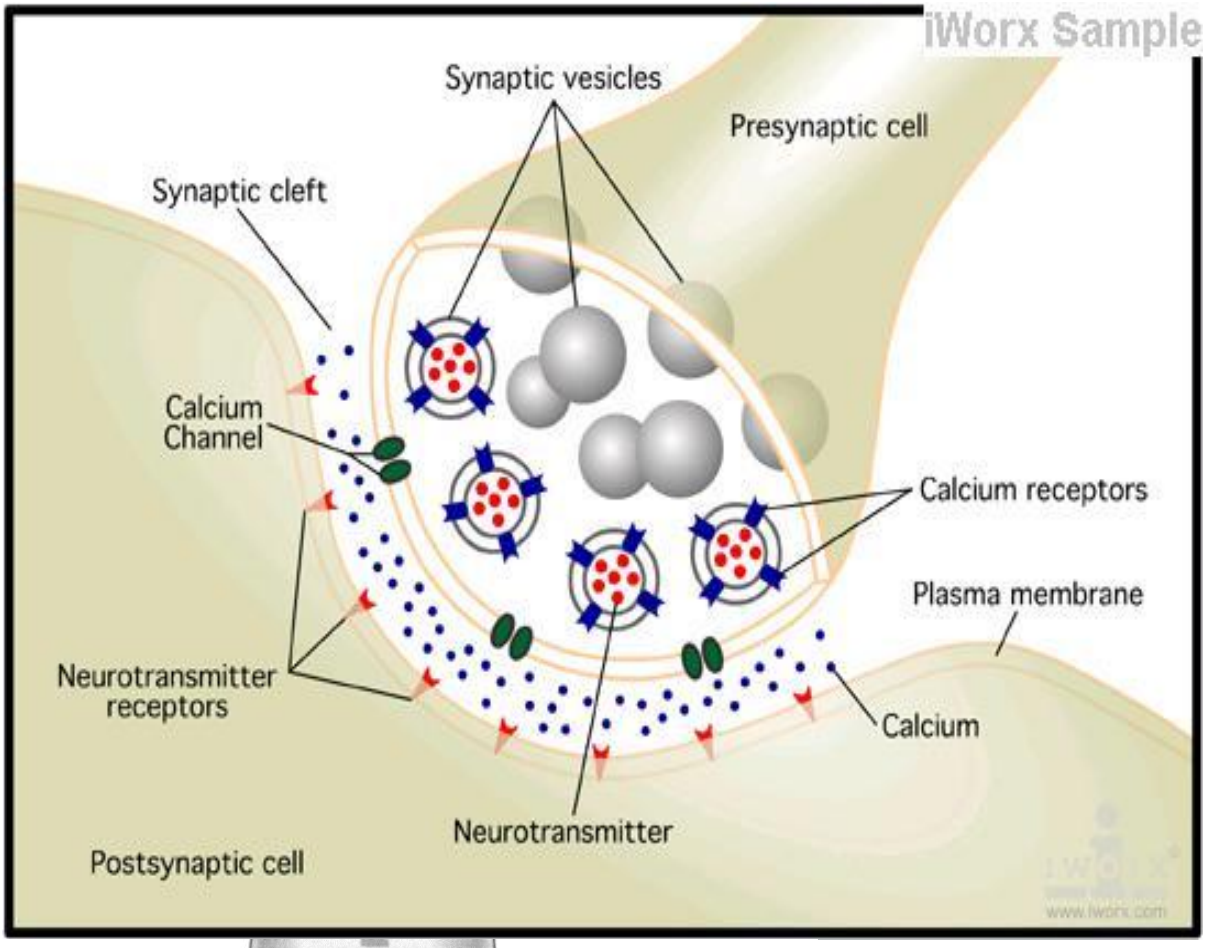


- Transmission of a nerve impulse across a Synaptic cleft (the small gap) is carried out by chemicals called Neurotransmitter Substances. These substances are stored in many vesicles at the end of the axon's terminal fibers.

-Two examples of neurotransmitters are:

i) Norepinephrine - NE (usually speeds up activity)
ii) Acetylcholine – Ach (for normal stimulation, sometimes for slowing down the rate at which the neuron fires)

- As an impulse reaches the end of the axon, not only does Na^{+} come into the axoplasm of the axon bulb, but Ca^{++} also enters. This calcium binds with contractile proteins that pull the Neurotransmitter vesicles out toward the inner surface of the presynaptic membrane. These vesicles join with the presynaptic membrane, resulting in exocytosis of the neurotransmitter molecules so they are released into the synaptic cleft.


iWorx Sample
Synaptic vesicles
Presynaptic cell
Synaptic cleft
Calcium
Channel
Calcium receptors
Plasma membrane
Neurotransmitter
receptors
Calcium
Neurotransmitter
Postsynaptic cell
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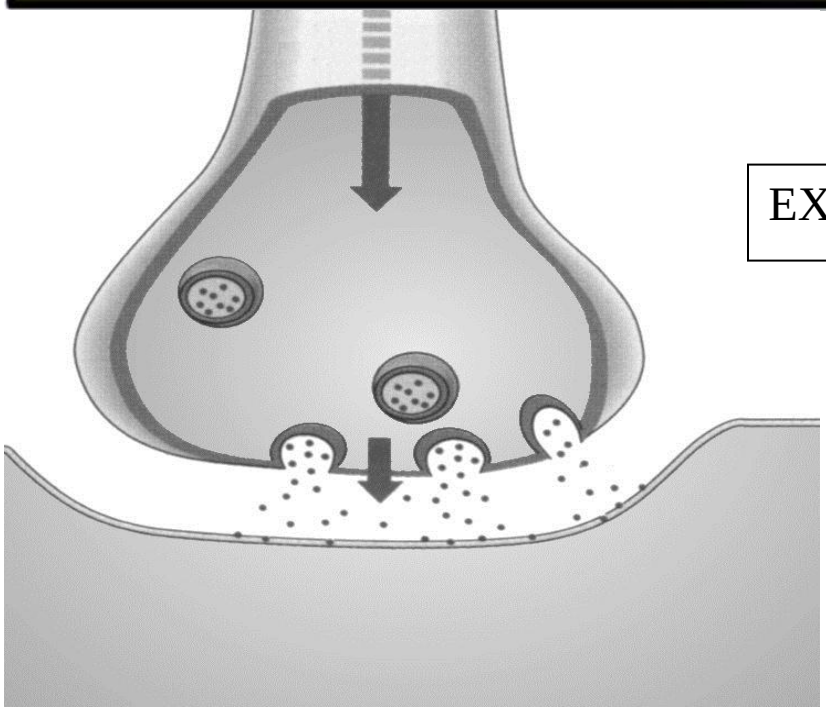
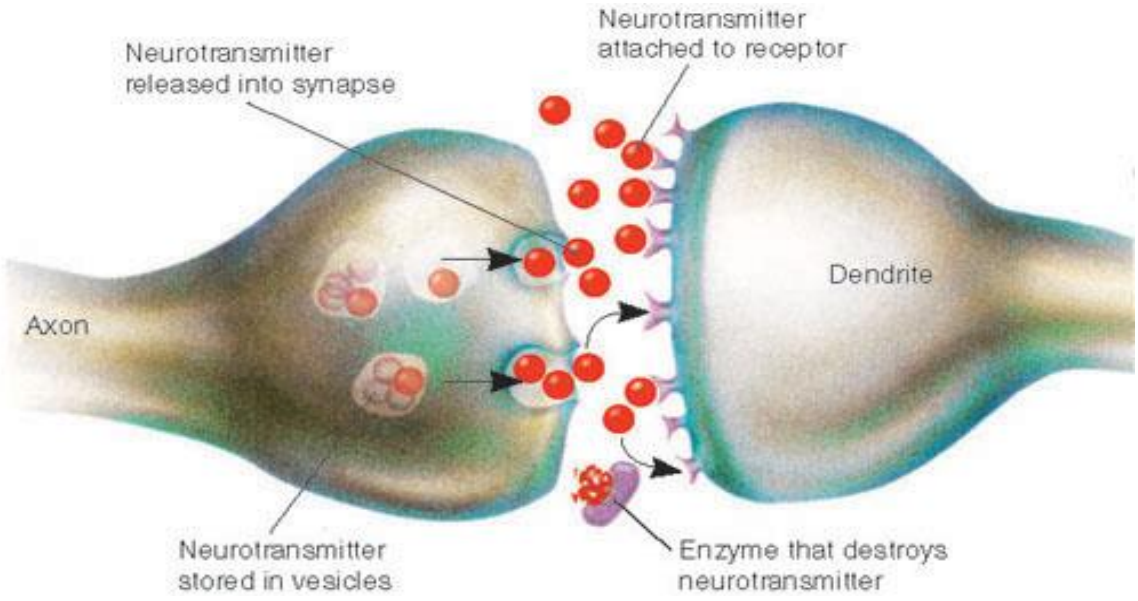


EXOCYTOSIS

- The Neurotransmitter's job is to increase the permeability of the postsynaptic membrane of the next neuron's dendrites to Na+.

- The Neurotransmitter binds to specific receptor sites on the membrane of a dendrite of the next neuron. If enough transmitter substance is received, the Na+ gates will open up and the neuron will "fire" to continue the impulse through the dendrite and then down the axon of that neuron.

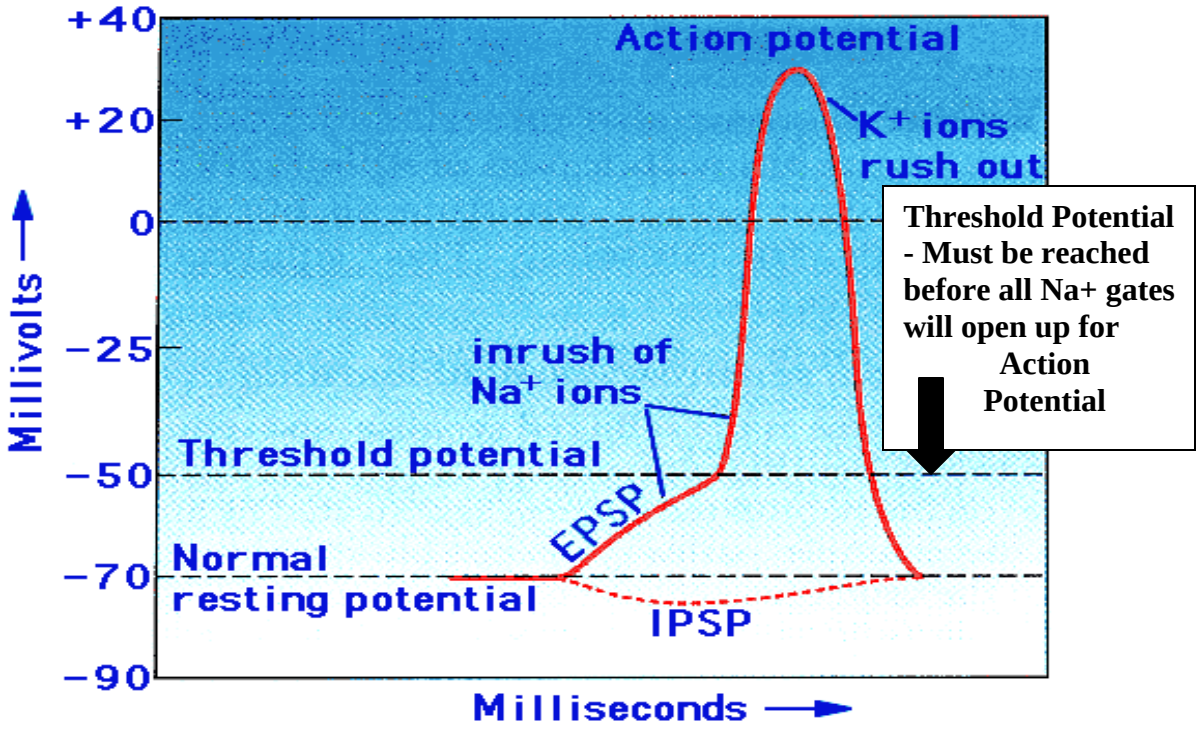
- A neurotransmitter only has a short period of time to work once it has been released into the synaptic cleft. Enzymes rapidly break down these neurotransmitter substances to clear the synapse so the next impulse can be transmitted. Monoamine oxidase breaks down Norepinephrine and Acetylcholinesterase breaks down Acetylcholine.

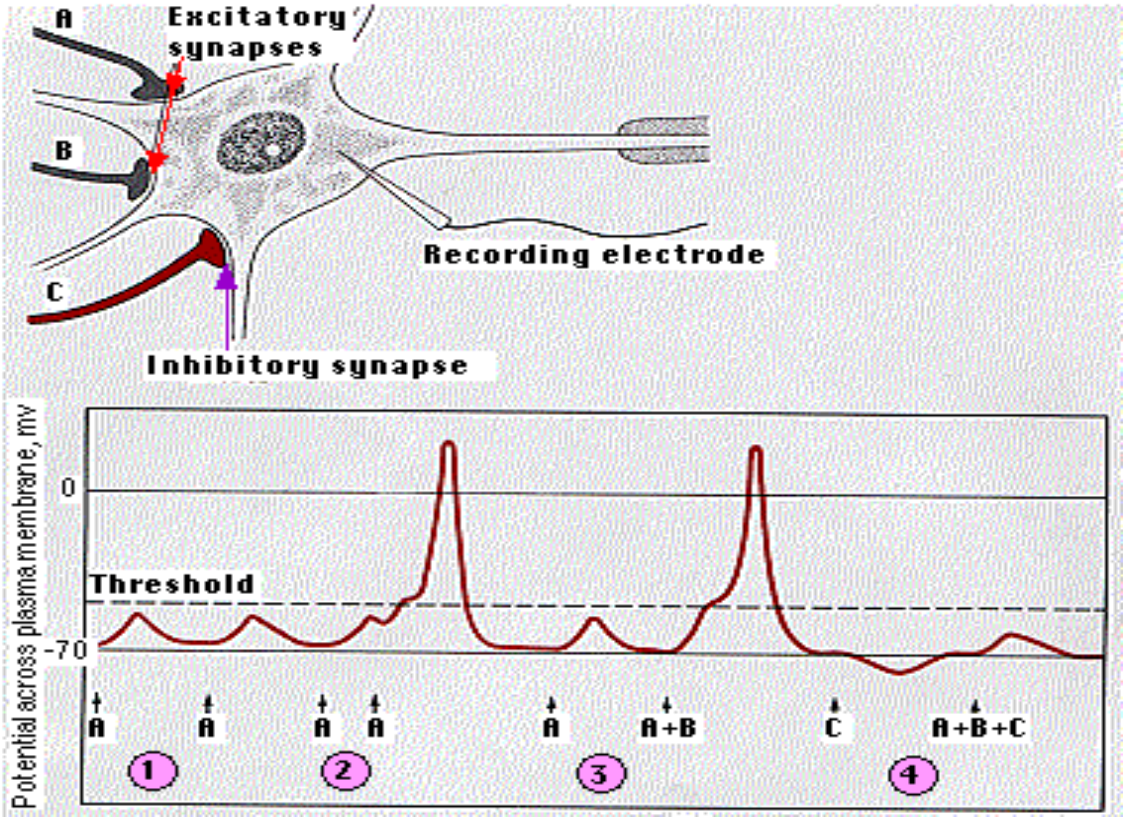


- Only the axon contains neurotransmitter vesicles, so the impulse can only travel in one direction; from the AXON → DENDRITE across a synapse.

*****"ALL OR NONE LAW" (threshold): If enough neurotransmitter is received by the postsynaptic fiber, it will fire 100% (all). If not enough substance is received, it will not fire at all (none).**

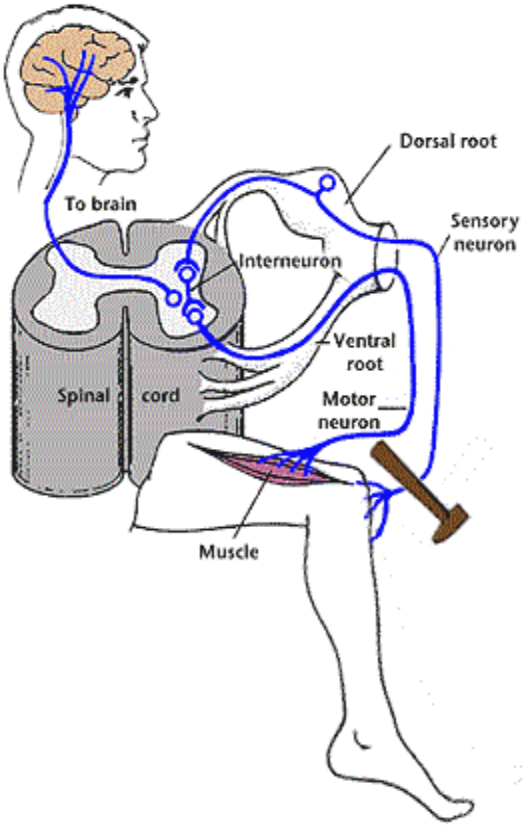
- There are excitatory and inhibitory neurotransmitters in the body. The SUMMATION (integration) of all the excitatory and all the inhibitory molecules near the receptors of a dendrite will determine whether or not the neuron will fire.

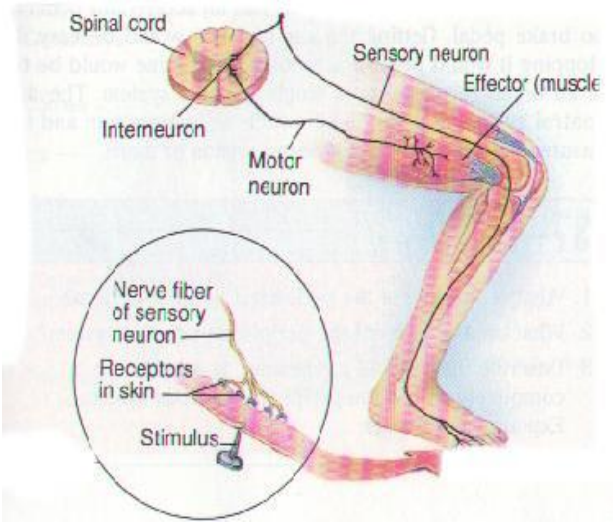

+40
+20
0
−25
−50
−70
−90
Millivolts
Action potential
K+ ions rush out
inrush of Na+ ions
Threshold potential
EPSP
Normal resting potential
IPSP
Milliseconds
Threshold Potential - Must be reached before all Na+ gates will open up for Action Potential


A
Excitatory synapses
B
C
Recording electrode
Inhibitory synapse
Potential across plasma membrane, mv
0
-70
Threshold
A
A
A
A
A
A+B
C
A+B+C
1
2
3
4

B) The Reflex Arc:

- Reflexes are <u>Automatic, involuntary</u> responses to changes occurring inside or outside the body. Some involve the brain (such as blinking the eye), while others do not (such as moving your hand away from a hot object).

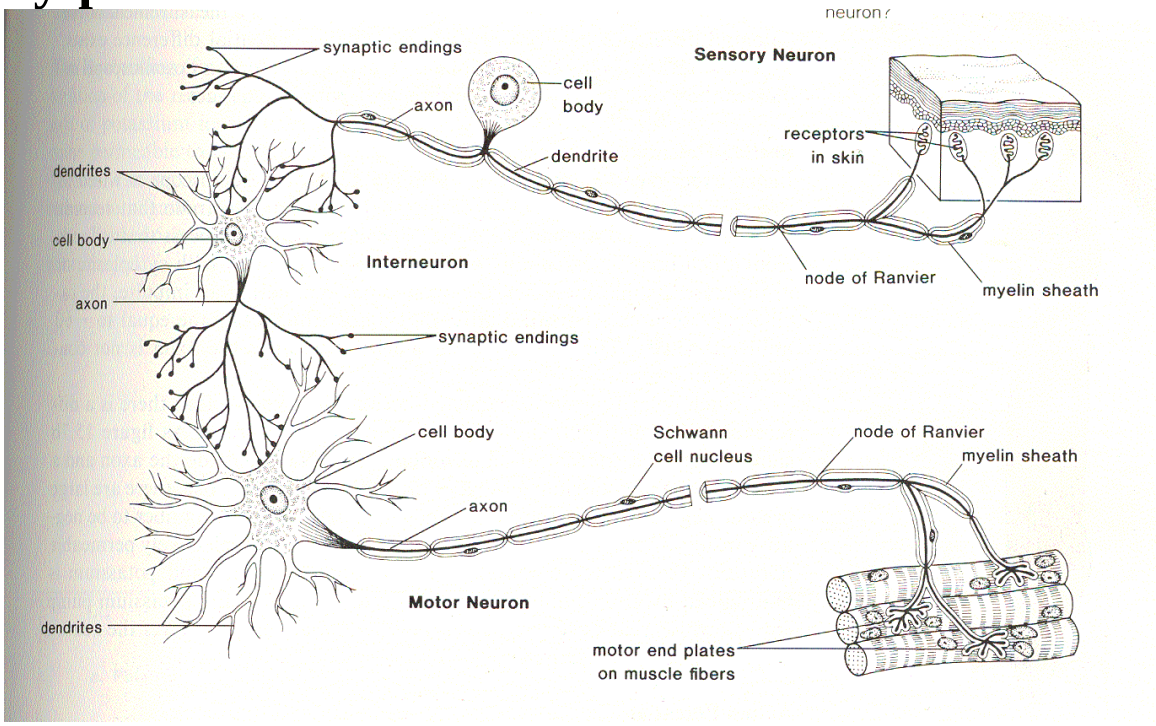




- Why <u>doesn't</u> the brain have to be involved? If the brain were involved it would take too long to respond and serious damage might occur.

- <u>With Brain</u> : An impulse would have to travel to the brain, the brain would then have to interpret the message, then the brain would have to send an

impulse down to the appropriate effectors to coordinate a response.
- The almost perfect solution to this problem is to by-pass the brain.



C) Stages of A Reflex Arc:

1. Sensory receptor is stimulated and formulates a message by triggering a nerve impulse.

2. Sensory (Afferent) neuron carries the message to the Central Nervous System (spinal cord).

3. One of many Interneurons re-routes the incoming nerve impulse directly into a motor (efferent) neuron.

4. This Motor Neuron takes the message away from the C.N.S. carrying it to the appropriate effector (muscle/organ).

5. The muscle receives the message and contracts.

*****The brain finds out later what had happened*****
*****Reflexes, however can be controlled.*****