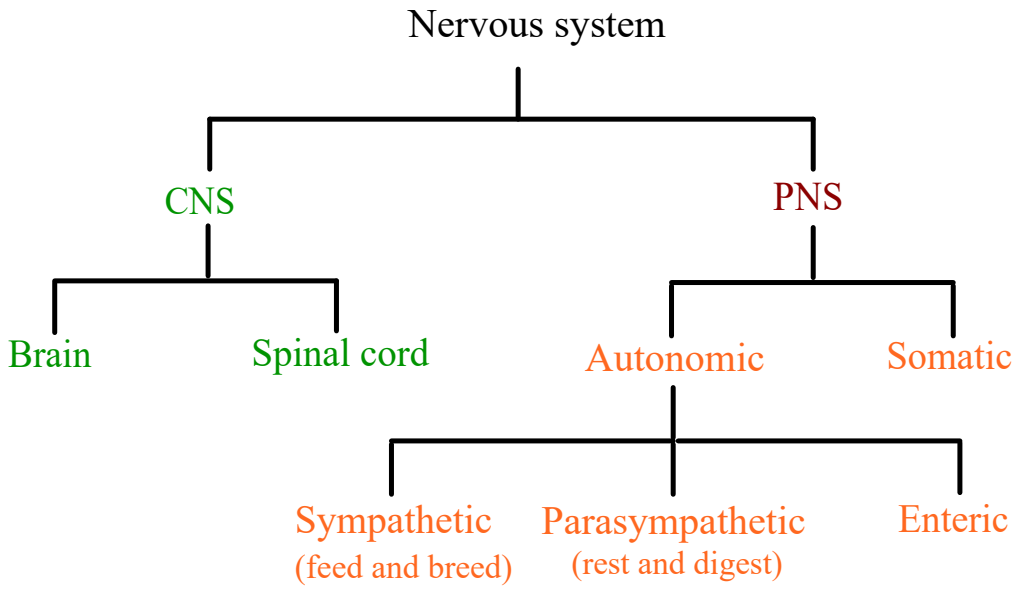
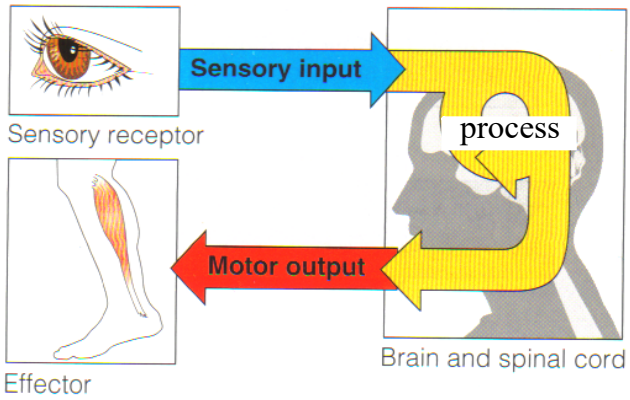
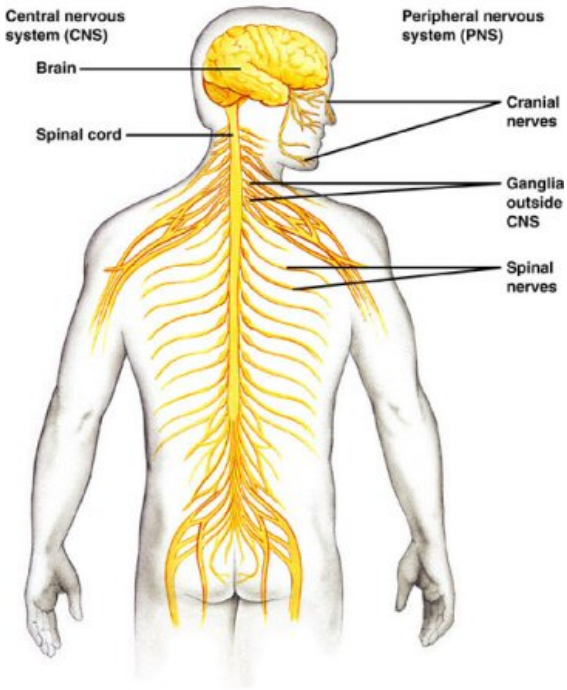
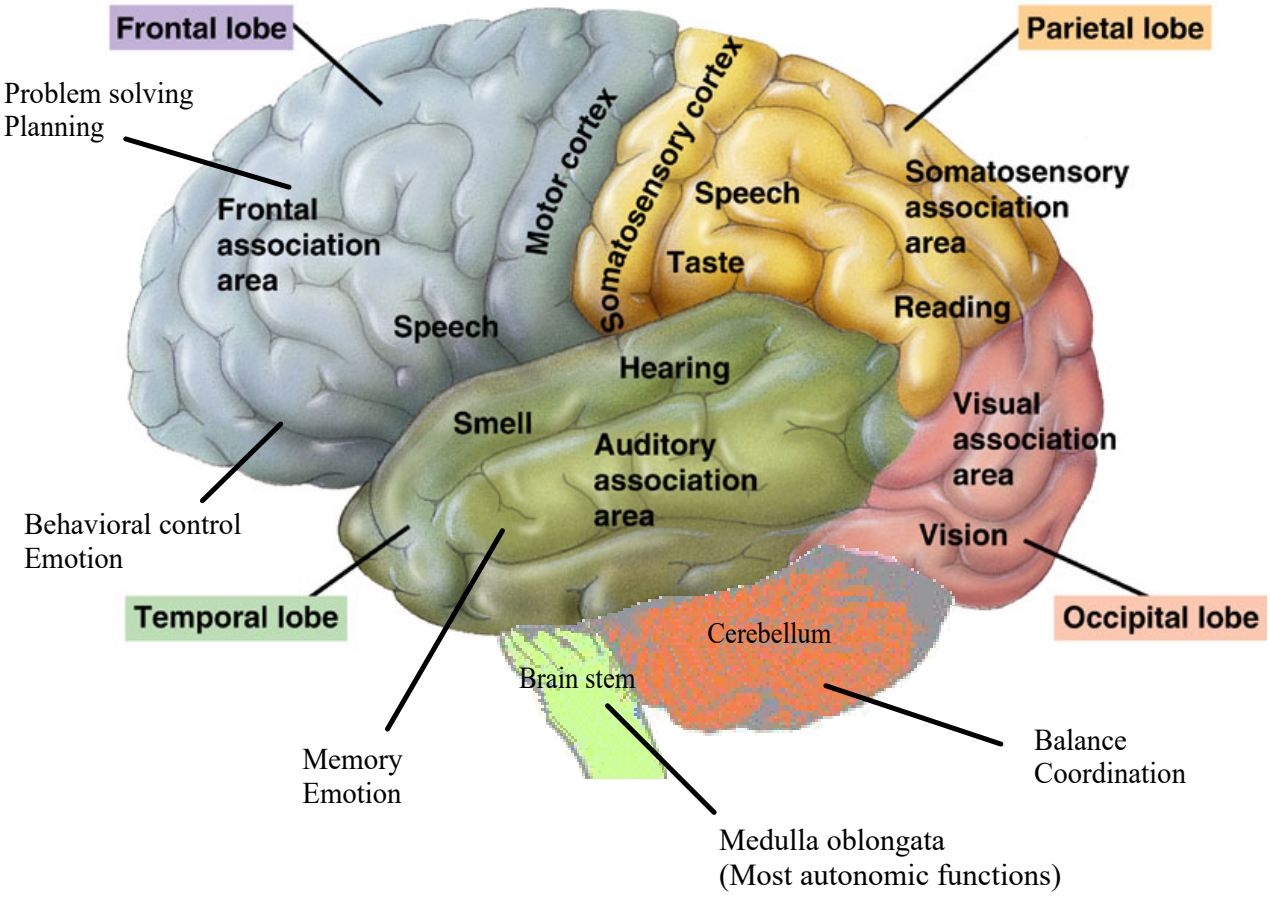

Nervous system
CNS
PNS
Brain
Spinal cord
Autonomic
Somatic
Sympathetic
(feed and breed)
Parasympathetic
(rest and digest)
Enteric


Sensory input
process
Motor output
Sensory receptor
Effector
Brain and spinal cord


Central nervous system (CNS)
Peripheral nervous system (PNS)
Brain
Spinal cord
Cranial nerves
Ganglia outside CNS
Spinal nerves

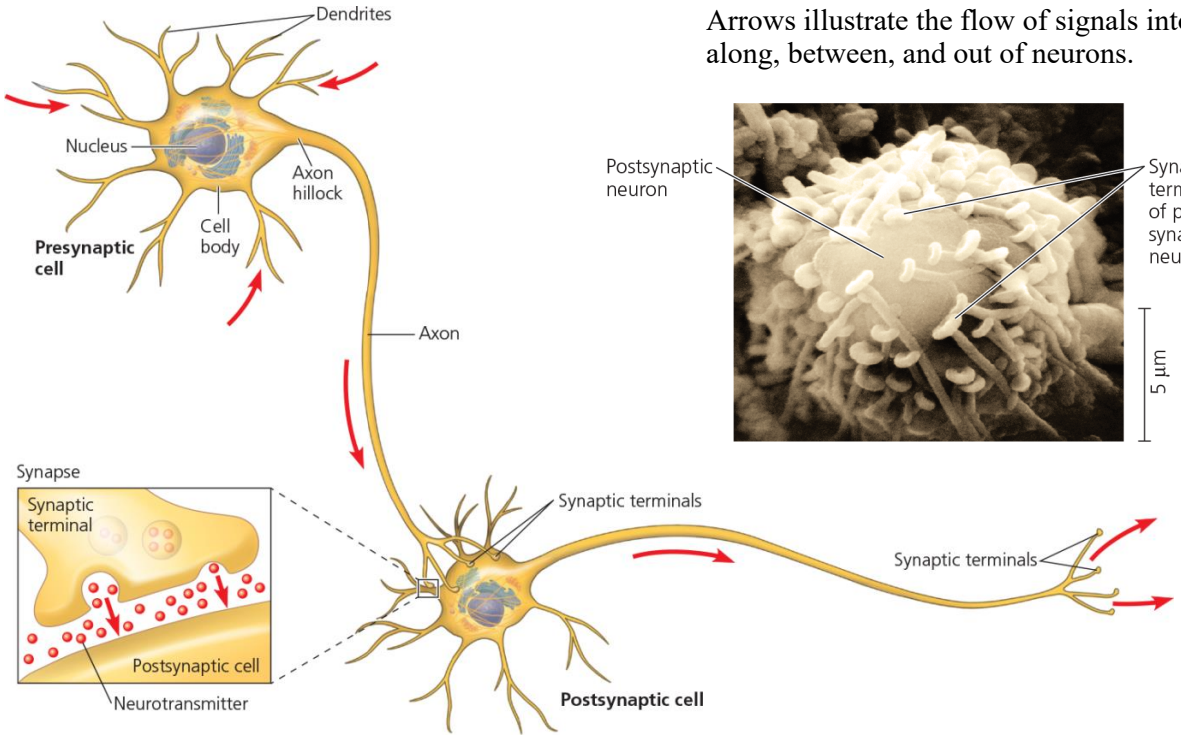

Frontal lobe
Parietal lobe
Problem solving
Planning
Frontal association area
Motor cortex
Somatosensory cortex
Speech
Taste
Somatosensory association area
Reading
Speech
Hearing
Smell
Auditory association area
Visual association area
Vision
Behavioral control
Emotion
Temporal lobe
Occipital lobe
Cerebellum
Brain stem
Memory
Emotion
Balance
Coordination
Medulla oblongata
(Most autonomic functions)

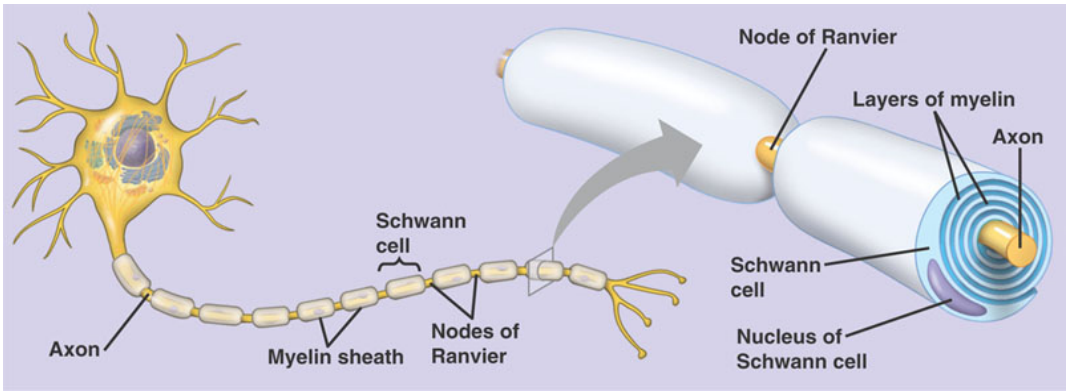
1. Identify the part of the nervous system that is involved in each of the following:
a) throwing a ball
b) releasing bicarbonate from the pancreas
c) falling asleep
d) increasing your breathing rate slightly
e) running away from a vampire

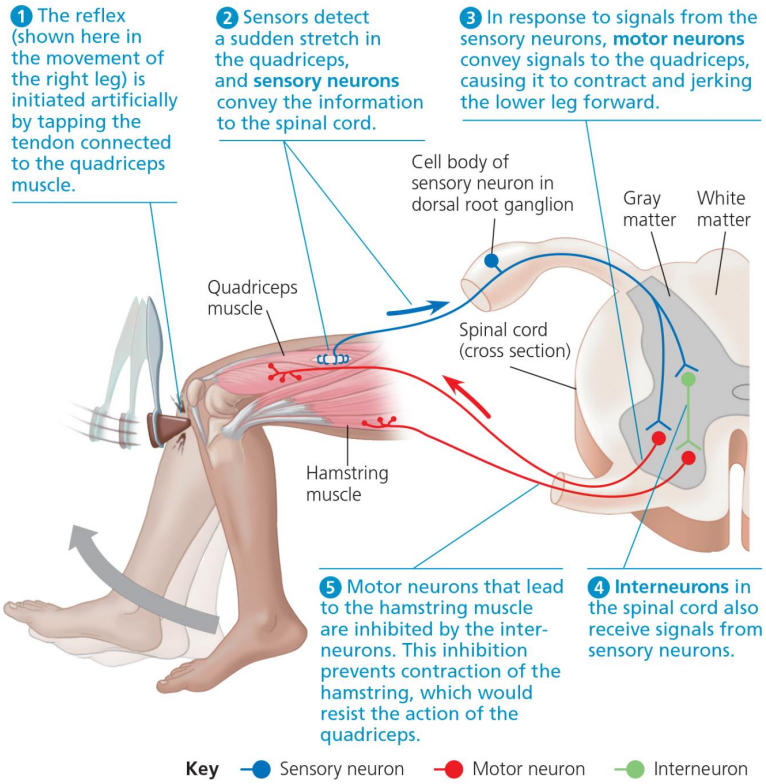
2. Imagine you cut yourself and some nerves are severed. Predict the effect this would have on the transmission of impulses.

3. Imagine an accident victim suffers a spinal cord injury at the neck, resulting in paralysis. Describe the effect this would have on the affected parts of the body.

Arrows illustrate the flow of signals into, along, between, and out of neurons.







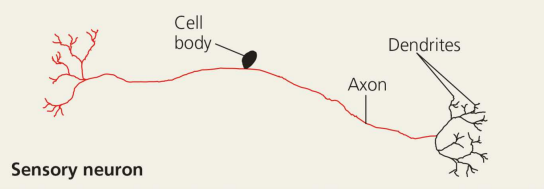
Describe the purpose of a reflex.

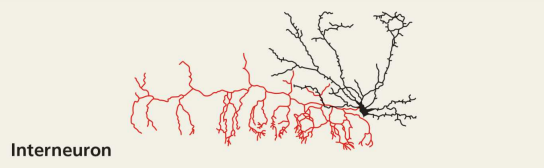
- protects the body by providing a fast, involuntary response to a particular stimulus

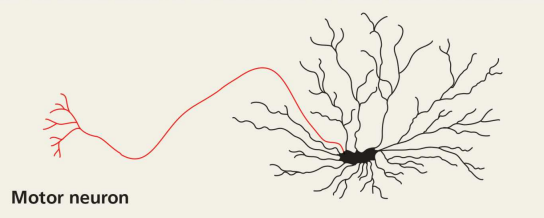
What makes a reflex so fast?

- sensory information activates motor neurons without the information first having to travel from the spinal cord to the brain and back

(cell bodies and dendrites are black and axons are red)







Propose a reason the interneuron has highly branched dendrites and axons.

- to receive input from many other neurons and send signals to many other neurons

Describe the basic pathway of information flow through neurons that causes you to turn your head when someone calls your name.

1. Sensors in your ear transmit information to your brain.

2. Information is transmitted by interneurons in hearing and language centers to enable you to recognize your name.

3. Signals transmitted via motor neurons cause contraction of muscles that turn your neck.

Describe how increased branching of an axon might help coordinate nervous system responses to stimuli.

- increased branching would allow signals to be send to a greater number of postsynaptic cells, allowing greater coordination of responses

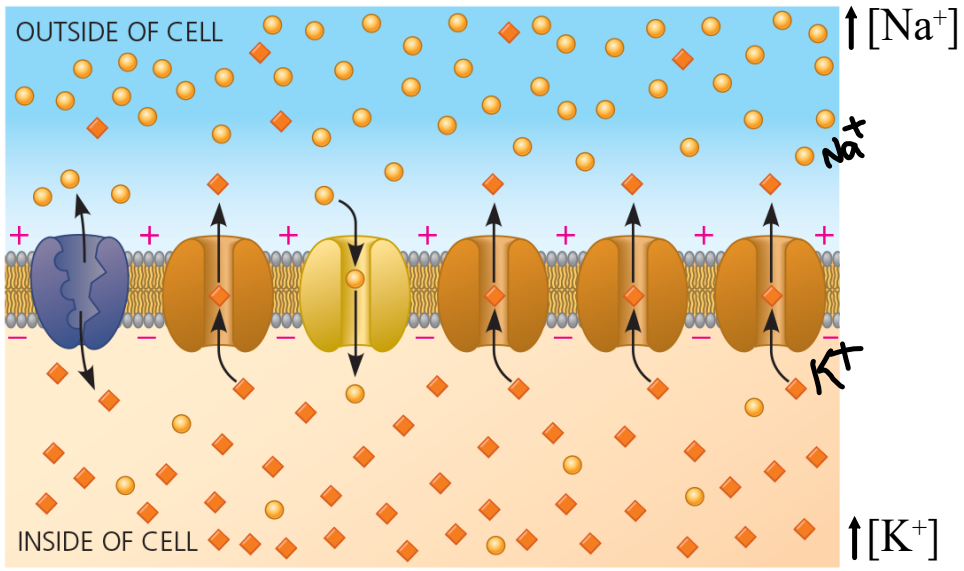
4. Describe the advantage of a reflex response to an organism.

5. You accidentally touch a hot iron. Your hand quickly moves away from the iron.
a) Identify what type of response this is.
b) Describe when you would feel pain relative to the moment you pull your hand away. Explain the difference.
c) Describe when you would feel pain relative to the moment you pull your hand away. Explain the difference.

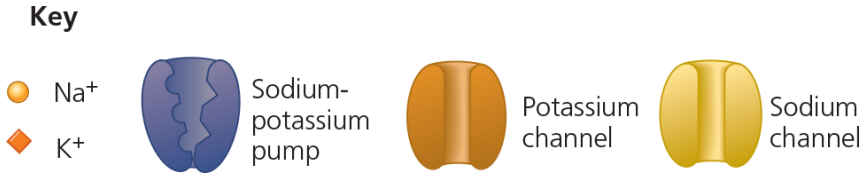
6. Pain receptors are far more abundant in the skin than are cold receptors. Propose a reason why this is adaptive.

7. Suppose that your skin was not sensitive to pressure or pain. Predict what might happen to the muscles and internal organs beneath the skin.

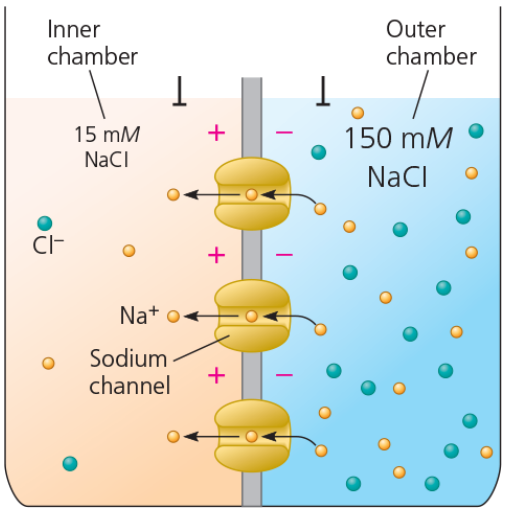
8. Some neurons are wrapped in a coating called the myelin sheath.
a) Describe the advantages of myelinated nerve axons.
b) Explain how the functions of myelin account for the symptoms of MS.



Resting potential (*i.e.*, voltage) is -70 mV



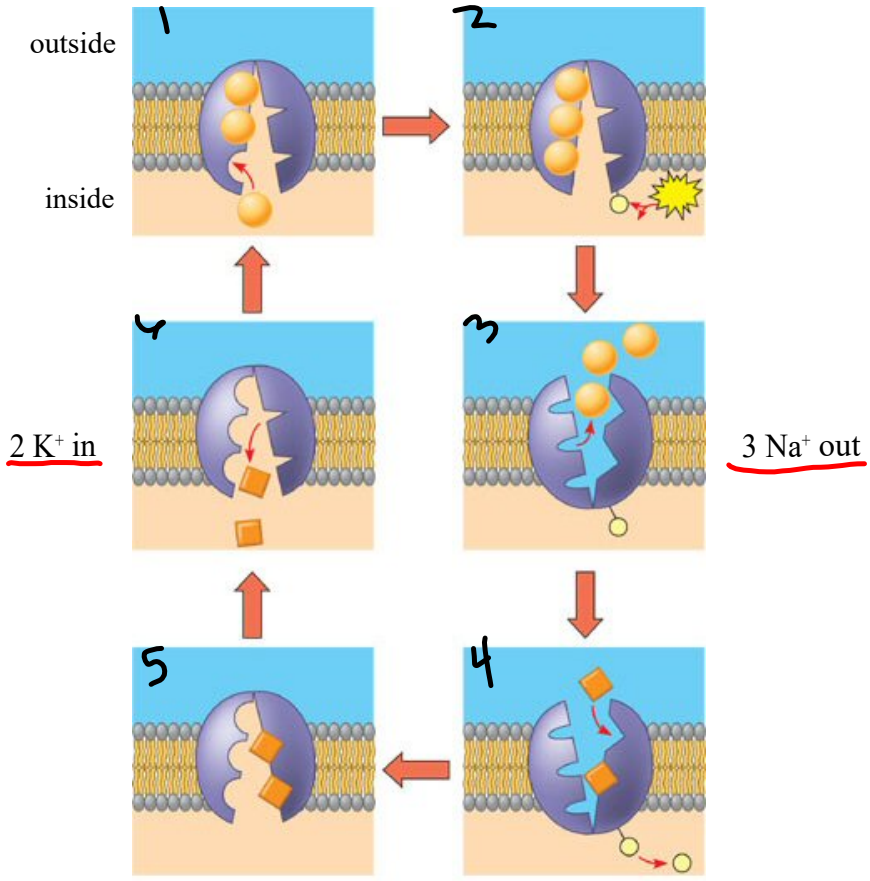
why is it + inside and − outside?



Describe how the addition of potassium or chloride channels to the membrane would affect the membrane potential.

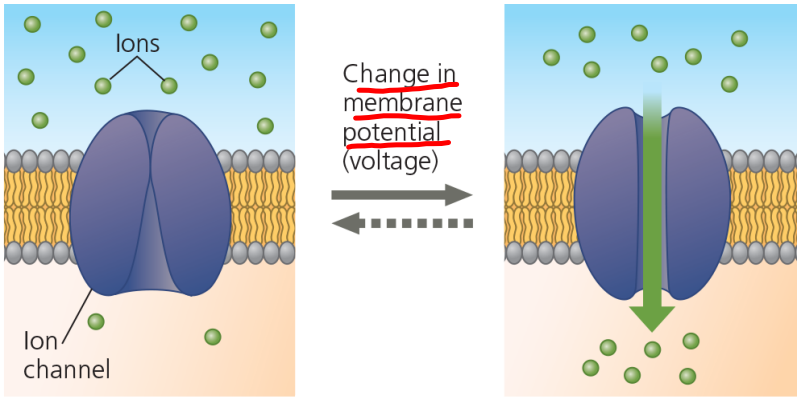
- adding chloride channels would make the membrane potential less positive

- adding potassium channels would have no effect because there are no potassium ions present


outside
inside
1
2
3
4
5
2 K+ in
3 Na+ out

When a neuron sends a signal in response to a stimulus the membrane potential changes.

How does a stimulus bring about a change in the membrane potential?



Gate closed: No ions flow across membrane.

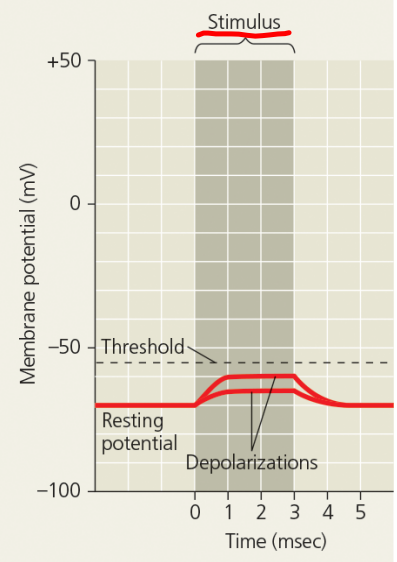
Gate open: Ions flow through channel.

A change in the membrane potential in one direction (solid arrow) opens the voltage-gated channel.

The opposite change (dotted arrow) closes the channel.

Explain why ions move when the channel opens.

- ions are more concentrated outside of the cell and move in when the channel opens



Depolarization

- an increase in the membrane potential

(toward zero; inc.)

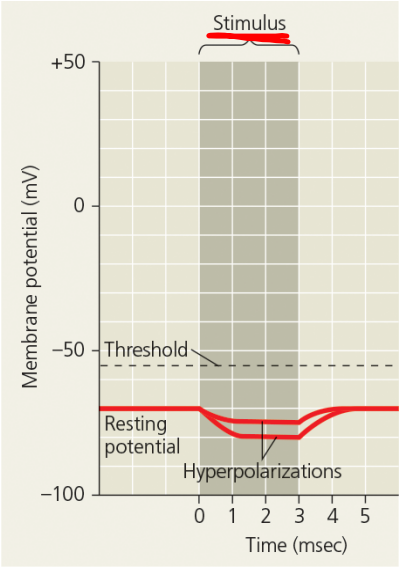
Describe what would cause the membrane potential to ~~decrease~~.

- opening Na+ gates to allow Na+ to flow into the cell

Predict whether the neuron would be more or less likely to reach action potential. Justify your response.

- more likely

- the potential is closer to threshold



Hyperpolarization

(away fr. zero i.e., move -ve)

- an decrease in the membrane potential

dec.

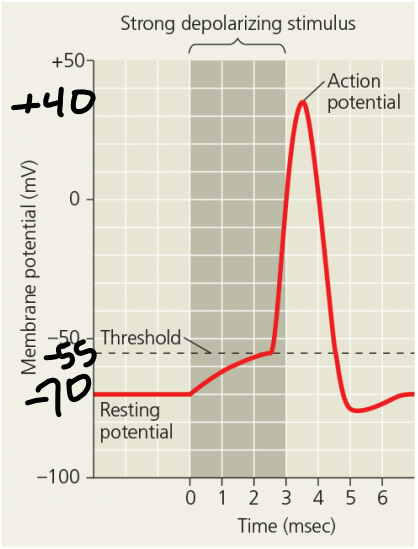
Describe what would cause the membrane potential to ~~increase~~.

- opening K+ gates to allow K+ to flow out of the cell

Predict whether the neuron would be more or less likely to reach action potential. Justify your response.

- less likely

- the potential is further from threshold

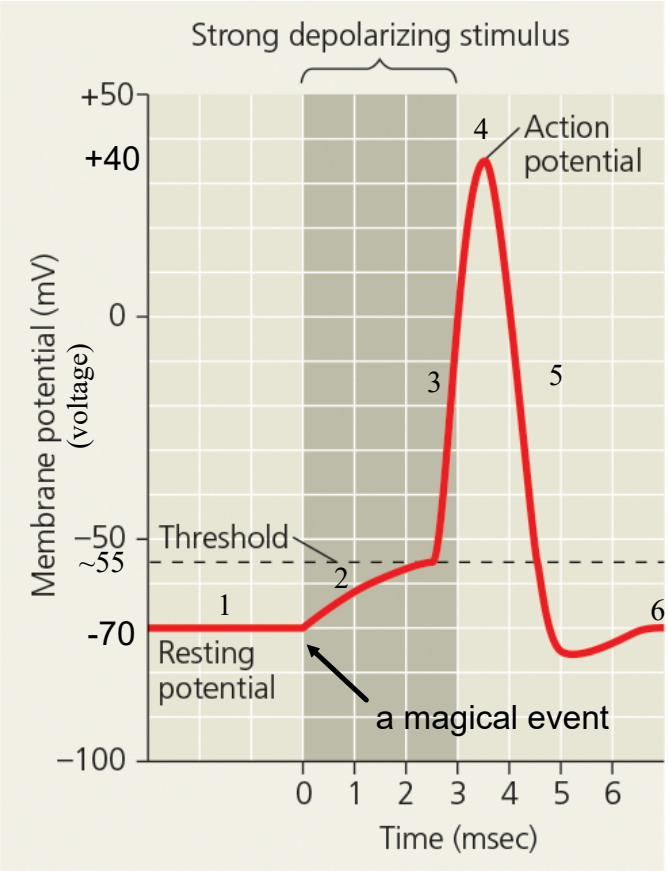


Action potential

- depolarization increases the membrane potential to a level called threshold

- the neuron sends a signal

- let's see the details...



What does action potential mean?

Depolarizing makes the inside of the membrane less negative.

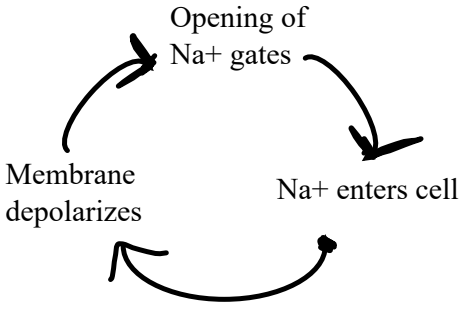
Describe the events that would make the neuron depolarize.

- Na+ gates could open
- Na+ would enter the cell
- the inside would become less negative (more +ve)

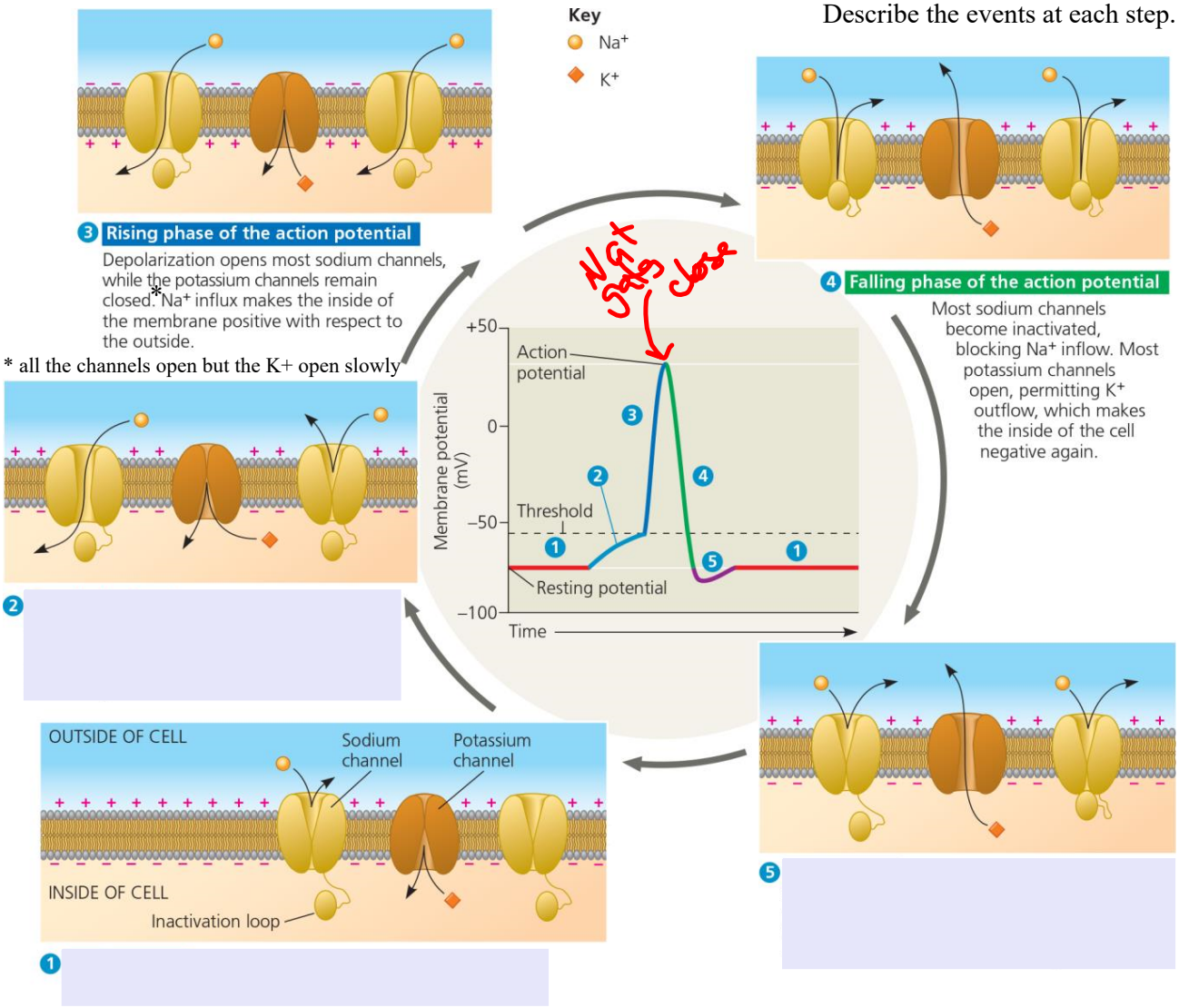
What made the potential begin to increase?

What happens when a depolarization increases the membrane potential to a level called threshold?

- the voltage-gated sodium channels open (JK. all the gates open)
- Na+ flows into the neuron
- this increases depolarization (more +ve)
- increased depolarization causes more sodium channels to open
- even more Na+ flows in
- this positive feedback triggers a very rapid opening of many voltage-gated sodium channels and a dramatic temporary change in membrane potential
- this is called an action potential



Describe the events at each step.



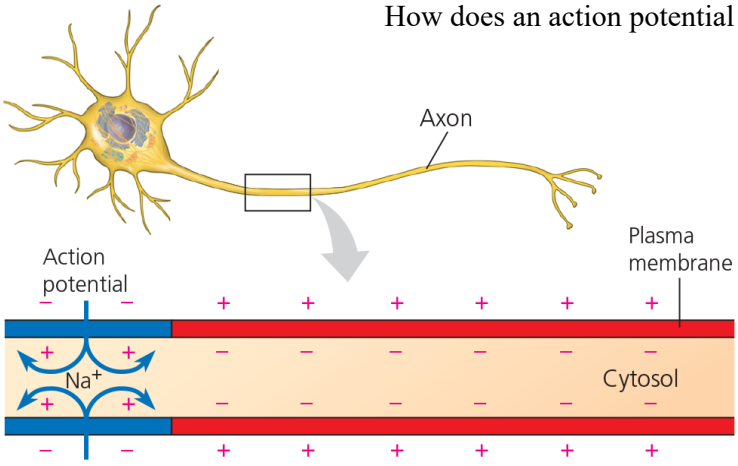
* all the channels open but the K+ open slowly

Sodium channels open when the membrane potential reaches threshold. Explain why the neuron could not function if sodium channels were also closed by voltage rather than just closing after a set time.

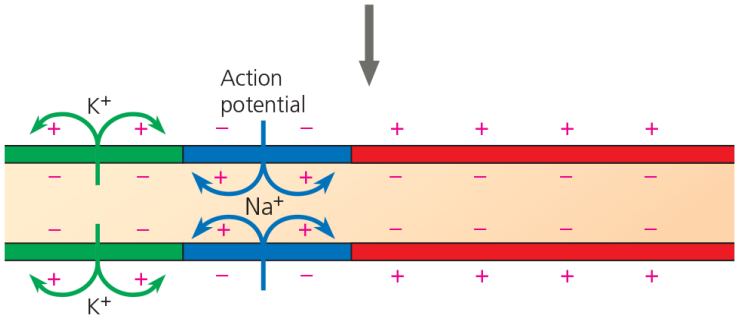
While the Na+ gates are resetting, the are unable to open again. Predict what would happen if another stimulus occurred while the Na+ gates are resetting.

Suppose a mutation caused gated sodium channels to remain inactivated longer after an action potential. Predict the effect on the frequency at which action potentials could be generated. Justify your prediction.

How does an action potential move along an axon?

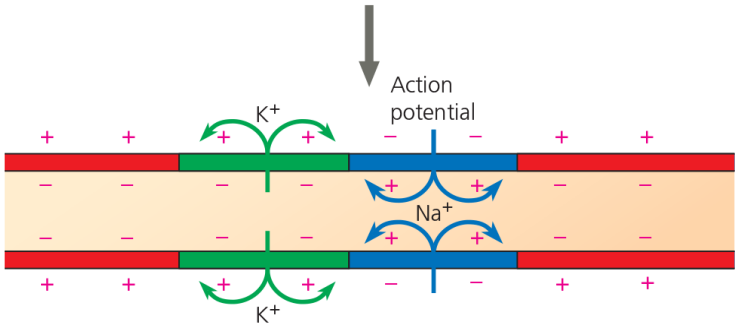


Remember, in each colored section the voltage-gated ion channels go through the same steps sequence of events we discussed.



What made the neighboring Na+ gates open?

Why is K+ flowing out of the cell?



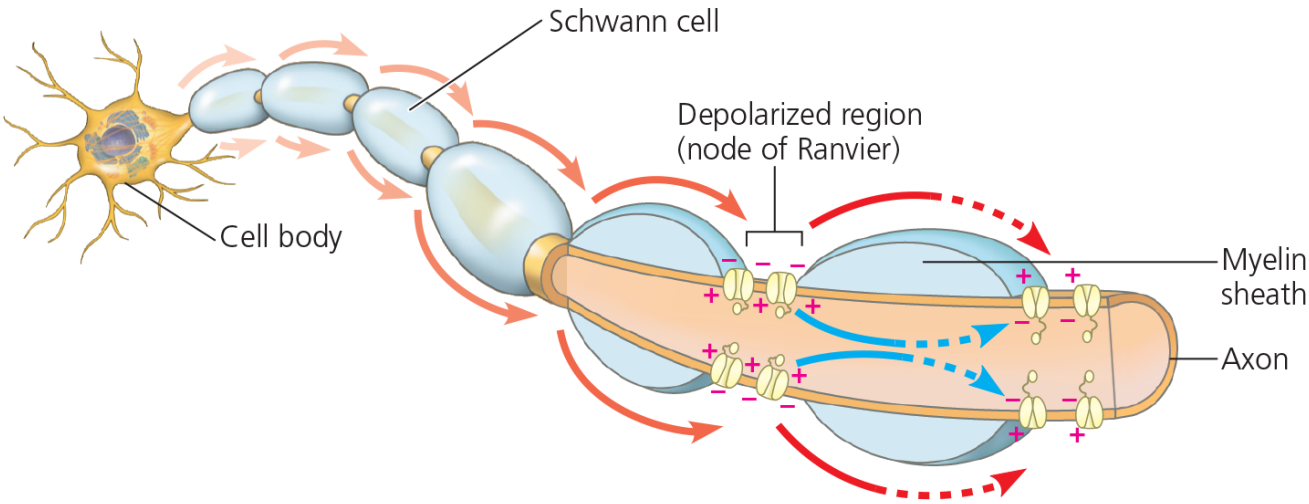
Describe the direction of motion of the action potential.

Depolarization of a section of a membrane causes depolarization of the neighboring section. This means that the action potential should be able to travel in both directions along an axon. Explain why an action potential moves in one direction only.

What's the deal with myeline?

- in myelinated axons, voltage-gated channels are found only in gaps in the myelin sheath called nodes of Ranvier
- the myelin insuates the axon so the extracellular fluid is in contact with the axon membrane only at the nodes
- as a result, action potentials are not generated in the regions between the nodes

Considering the presence of myelin, describe the predicted path of an action potential along an axon.



Describe what is being shown by the blue arrows.

What is the result at the next node?

Describe what is being shown by the red arrows.

In multiple sclerosis, a person's myelin sheaths harden and deteriorate. Describe how you would predict this would affect nervous system function.

Explain the effect.

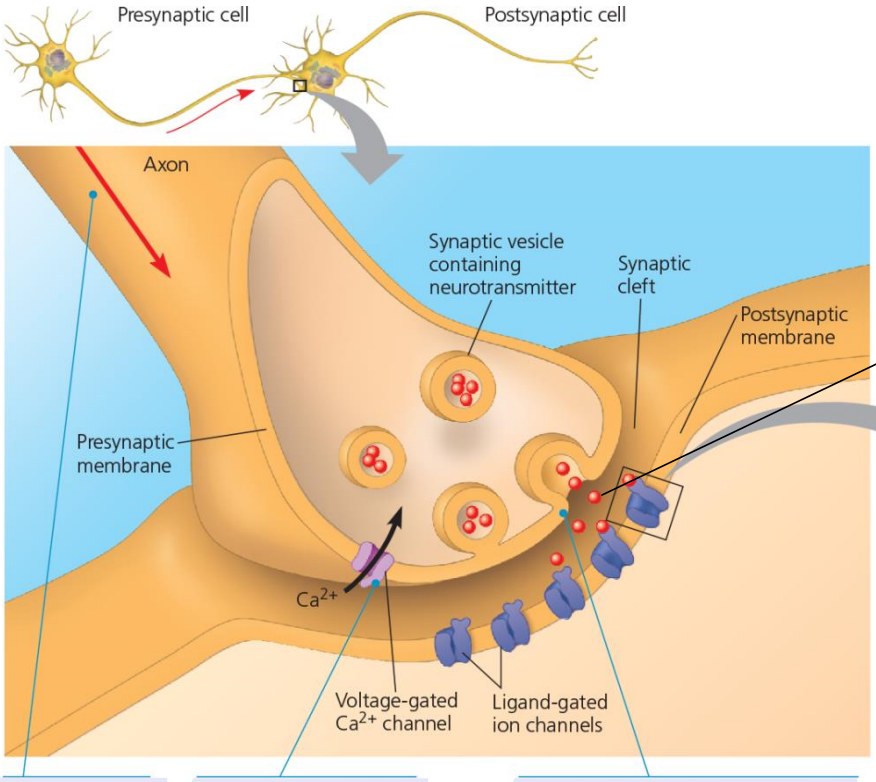
9. Explain why the resting neuron is polarized.

10. Describe the distribution of ions across the cell membrane as it changes from a resting potential to an action potential and then into refractory period.

11. Explain how the membrane potential of the resting cell is restored after a nerve impulse has passed.

12. Tetrodotoxin is a toxin present in the spines of the puffer fish. It has the capability of blocking the function of voltage-regulated sodium channels. Predict the effect tetrodotoxin would have on the contractions of muscles.

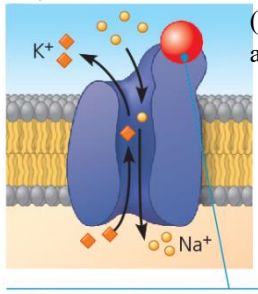
13. Draw a fully labelled graph showing the potential of the neural membrane as it fires



Now we know how a signal travels along an axon.

Describe what must happen for neurons to communicate.

-neurotransmitter diffuses across synaptic cleft



(Pretend this is a Na+ channel.)

Describe the result of opening this Na+ channel.

Predict what would happen if enough Na+ entered the cell to depolarize it to threshold.

Propose a reason calcium is an important part of your diet.

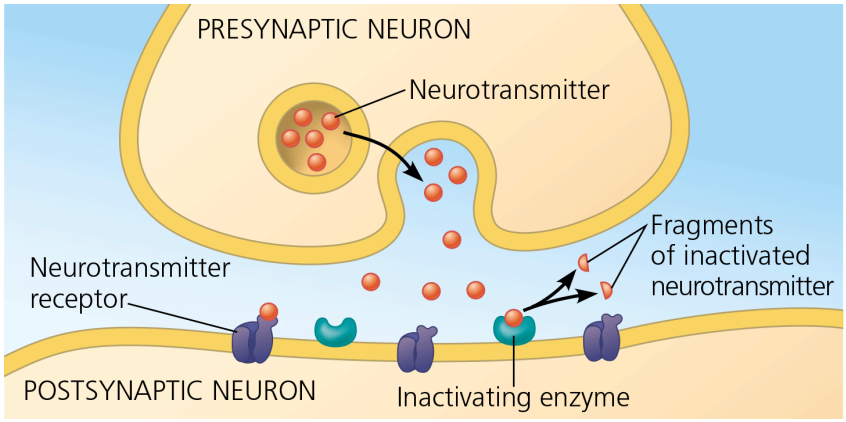
Suppose all the Ca^{2+} in the fluid surrounding a neuron were removed. Predict how this would affect the transmission of information within and between neurons.

14. a) Describe what is meant by the all-or-none response.
b) Explain how you can distinguish different intensities of stimuli even though all action potentials are equivalent.

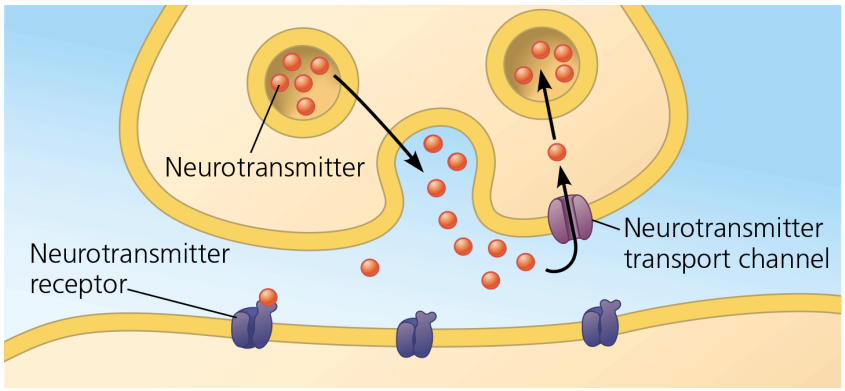
15. Use the idea of threshold levels to explain why some individuals can tolerate more pain than others.

Describe what must happen in order for the synapse to return to its resting state after a response is triggered.

This can happen in two ways:



1. The neurotransmitter in the synaptic cleft is destroyed by an enzyme.



2. The neurotransmitter is absorbed by the presynaptic neuron. This is called reuptake.

Predict the effect of blocking this processes described in these diagrams.

Predict the effect on the nervous system.

acetylcholine ✖

acetylcholinesterase

e.g.,

e.g., Sarin gas

- 1939 - Nazi Germany has plans for the mass-production of Sarin for use against allied forces in WWII (Hitler refused to allow its use)

- 1950s - NATO adopted it as a weapon and the USSR and US produced it

- since then, about 14 attacks have been reported

For a neuron to pass a signal to another neuron, two things must happen:

1. The presynaptic neuron must
2. The postsynaptic neuron must

The effect of a neurotransmitter depends on

A particular neurotransmitter might stimulate one postsynaptic cell while inhibiting another. Explain how this is possible.

stimulated

inhibited

Understanding how neurotransmitters function can help us understand how drugs affect us.

Acetylcholine is one of the most common neurotransmitters

- it has an excitatory effect on skeletal muscle cells
- in the CNS it functions in memory formation and learning
    - nicotine acts as a stimulant by binding to acetylcholine receptors in the CNS
    - the nerve gas sarin blocks enzymatic cleavage of acetylcholine
    - botulinum toxin (which causes botulism) inhibits presynaptic release of acetylcholine, preventing the muscles required for breathing from contracting
    - Botox injections minimize wrinkles around the eyes or mouth by inhibiting synaptic transmission to particular facial muscles

GABA (gamma-aminobutyric acid, an amino acid) is the main inhibitory neurotransmitter in the brain

- Xanax and Valium can be used for anxiety and panic disorders by binding to a GABA receptor

Dopamine is associated with the reward system

- active mostly in the anticipation of reward (seeking versus liking)
- some evidence suggests it might be associated with all motivators, positive and negative
- might be involved in learning to associate new behavior with a reward
- normally released when a need is filled, causing a feeling of pleasure or satisfaction

Serotonin

- regulation of mood (feeling of happiness), appetite, sleep
- cognitive functions include memory and learning
    - some antidepressants block the breakdown of serotonin
    - SSRI drugs (*e.g.*, Prozac) inhibit the uptake of serotonin
    - stimulants (amphetamines like meth and ecstasy, cocaine)
        - block the removal of dopamine, serotonin and norepinephrine from the synaptic cleft
        - nicotine inhibits the enzymes that breakdown dopamine and serotonin

Norepinephrine is involved in the fight-or-flight response

- nicotine increases alertness and arousal by binding norepinephrine receptors
- at low doses (quick puffs) - enhances norepinephrine and dopamine, having a stimulant effect
- at high doses (deep puffs) - enhances serotonin - having a calming effect

- Alcohol is a depressant that slows down the function of the CNS
- binds to acetylcholine, GABA, serotonin, and NMDA receptors
- blocking NMDA receptors results in:
    - hallucinations
    - paranoid delusions
    - confusion
    - difficulty concentrating
    - agitation
    - alterations in mood
    - catatonia
    - ataxia
    - anaesthesia
    - learning and memory deficits

Endorphins are natural analgesics (pain killers)

- produced in the brain during times of physical or emotional stress
- block the release of GABA and increase the release of dopamine
- block pain signals.

Opioids (like heroin, codeine, morphine, fentanyl and oxycodone)

- bind to the same receptor proteins as endorphins to mimic the effects of endorphins

Explain why opioids are so addictive.

16. Describe how the nerve impulse crosses the space between two nerve cells.

17. Describe the feature of a synapse that ensures a nerve impulse can move from neuron A to neuron B but not *vice versa.*

18. Describe the functions of acetylcholine and cholinesterase in the transmission of nerve impulses.

19. Explain the concept of summation.

20. Explain how some drugs act as stimulants while others act as depressants.

21. Describe endorphins and explain how they work.

Attachments

- Lilac-Chaser.gif
- Lilac-Chaser.gif
- Eye - Optical illusion.flv
- Myelin and impulse conduction.flv
- Synapse.flv
- Derren Brown - Cold Reading a Psychologist.flv
- Derren Brown Car Salesmen.flv
- Derren Brown Mental Conducting.flv
- Derren Brown - Person Swap.flv
- Colour changing card trick.flv
- Test Your Awareness.flv
- Derren Brown Robs a Guy.flv
- Derren Brown How to get drunk without drinking.flv
- Derren Brown - Winning ticket.flv
- Derren Brown Colourblind.flv
- Derren Brown - Paying with Paper.flv
- Derren Brown How to take someones wallet, just by asking.flv
- Derren Brown Hypnotizes People on a train.flv
- Derren Brown Controls Shopping Mall Visitors.flv
- Derren Brown - Ad influence.flv
- Derren Brown Gift influence.flv