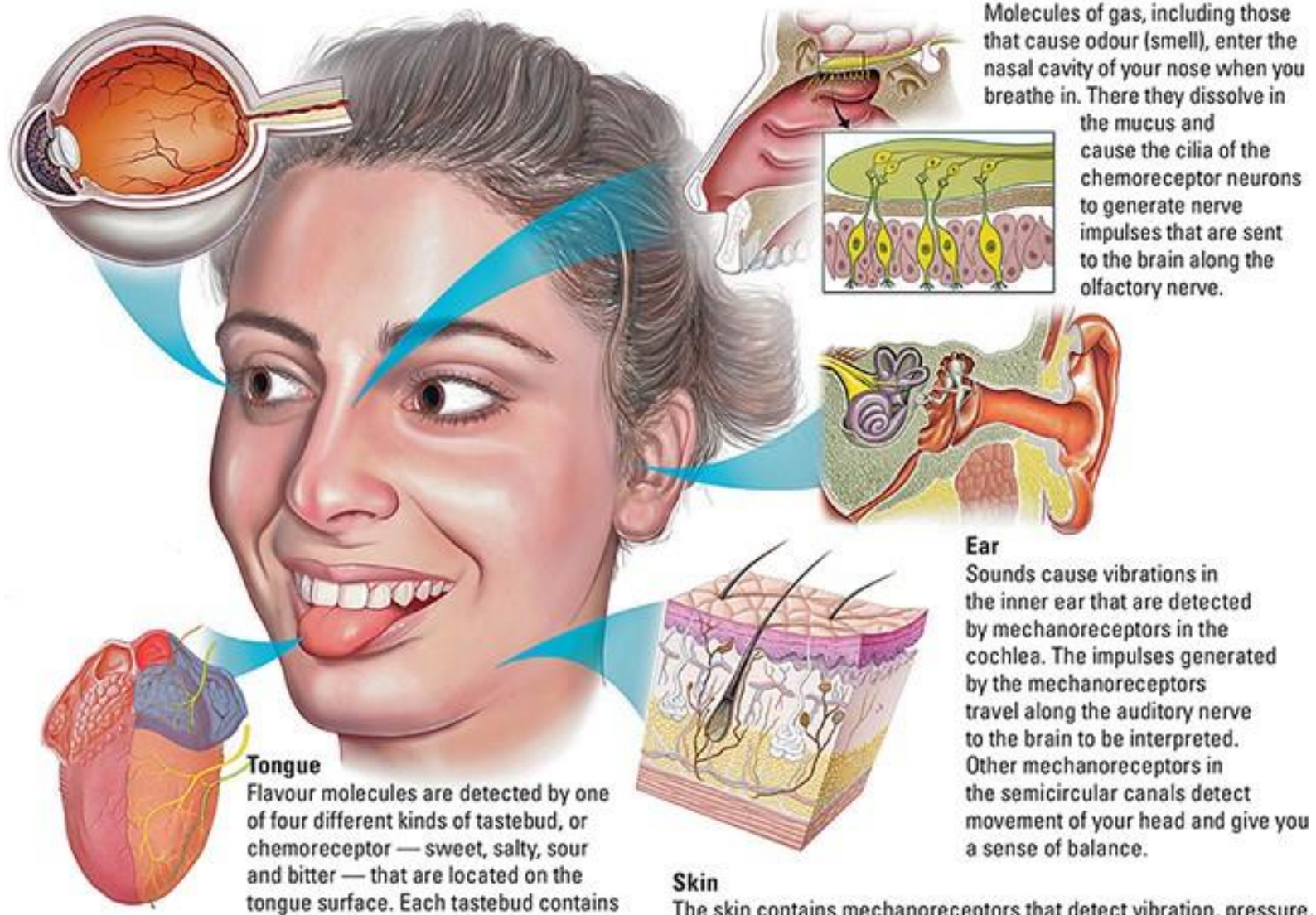
The Nervous System

Receptor cells are a special type of nerve cell that identify changes in the environment both inside and outside the body.

Receptor cells are located in the sense organs.

They respond to a particular stimulus.

Type of receptor	Stimulus these receptors respond to	Example of places where these are found
Chemoreceptors	Chemicals	Tongue
Photoreceptors	Light	Eye
Mechanoreceptors	Pressure or distortion	Skin, inner ear
Thermoreceptors	Heat	Skin



Eye
Photoreceptors in the retina of the eye detect light. There are two types of photoreceptor: rods and cones. Rods cannot detect colour, but only low light is needed to trigger a nerve impulse from rod cells. Cones are involved in colour vision. In humans cone cells respond to blue, red and green light respectively.

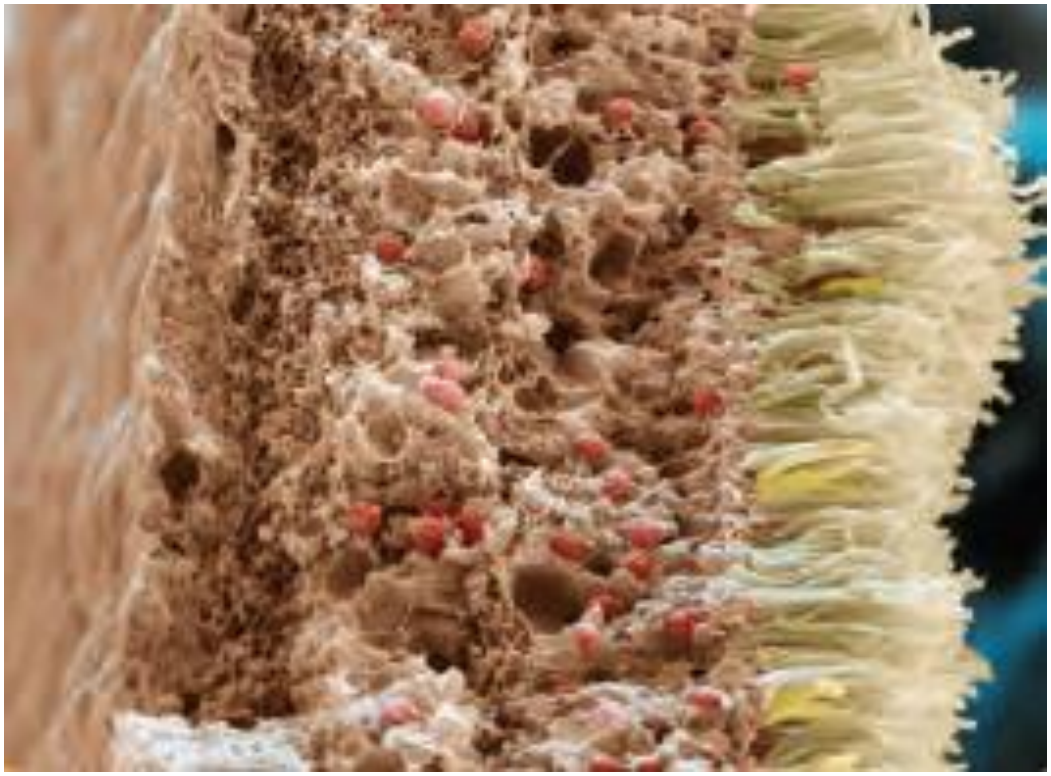
Nose
Molecules of gas, including those that cause odour (smell), enter the nasal cavity of your nose when you breathe in. There they dissolve in the mucus and cause the cilia of the chemoreceptor neurons to generate nerve impulses that are sent to the brain along the olfactory nerve.

Ear
Sounds cause vibrations in the inner ear that are detected by mechanoreceptors in the cochlea. The impulses generated by the mechanoreceptors travel along the auditory nerve to the brain to be interpreted. Other mechanoreceptors in the semicircular canals detect movement of your head and give you a sense of balance.

Tongue
Flavour molecules are detected by one of four different kinds of tastebud, or chemoreceptor — sweet, salty, sour and bitter — that are located on the tongue surface. Each tastebud contains one of the four types of chemoreceptor.

Skin
The skin contains mechanoreceptors that detect vibration, pressure, touch and pain. Touch and pressure receptors are stimulated by compression of the skin. Thermoreceptors in the skin detect heat.

Sense organs



A scanning electron microscope photograph of rods and cones

Eye tests

Aim: To find your eye's blind spot.

Equipment
Pen and paper or card

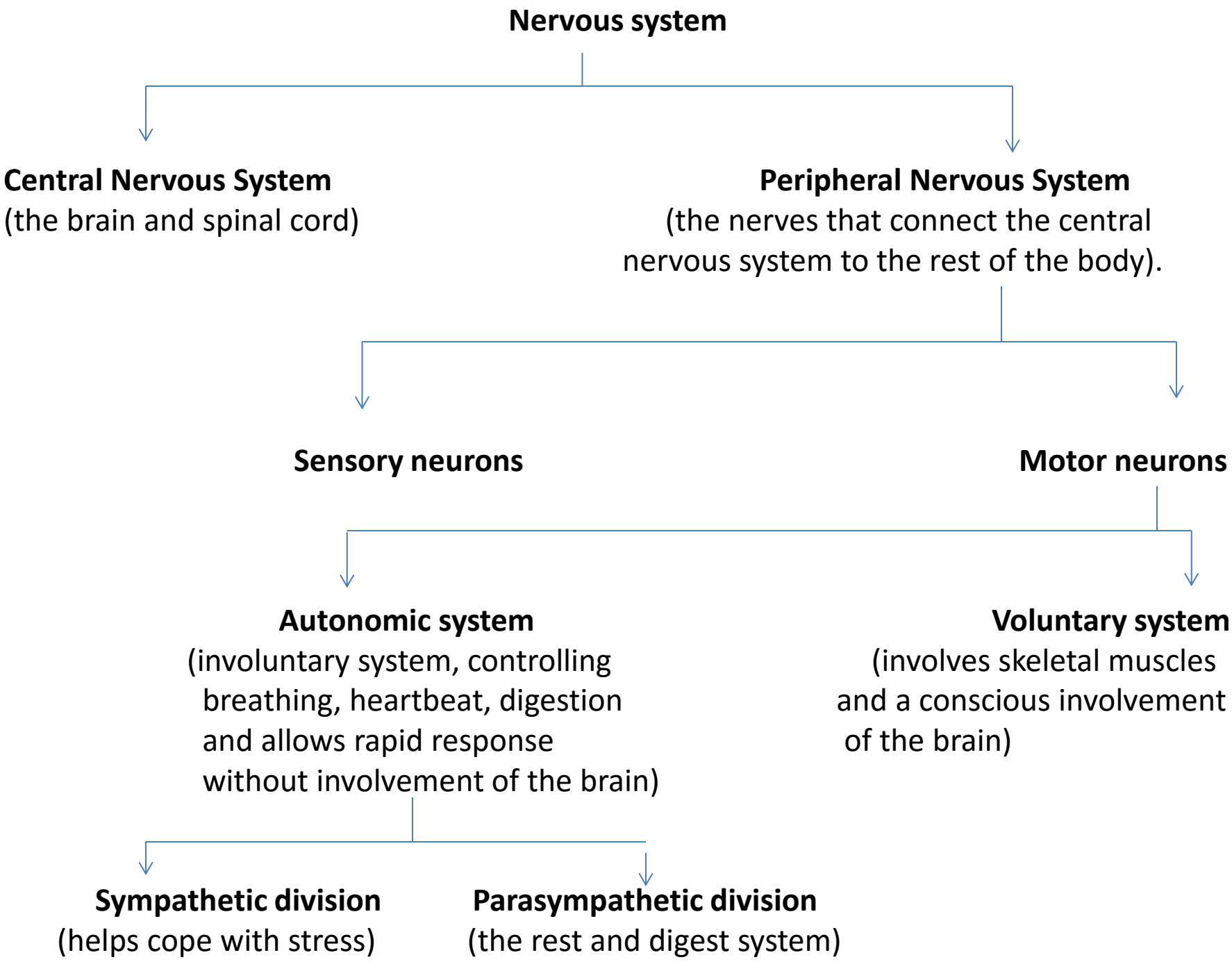
Method
1 Hold the textbook at arm's length and look directly at the figure

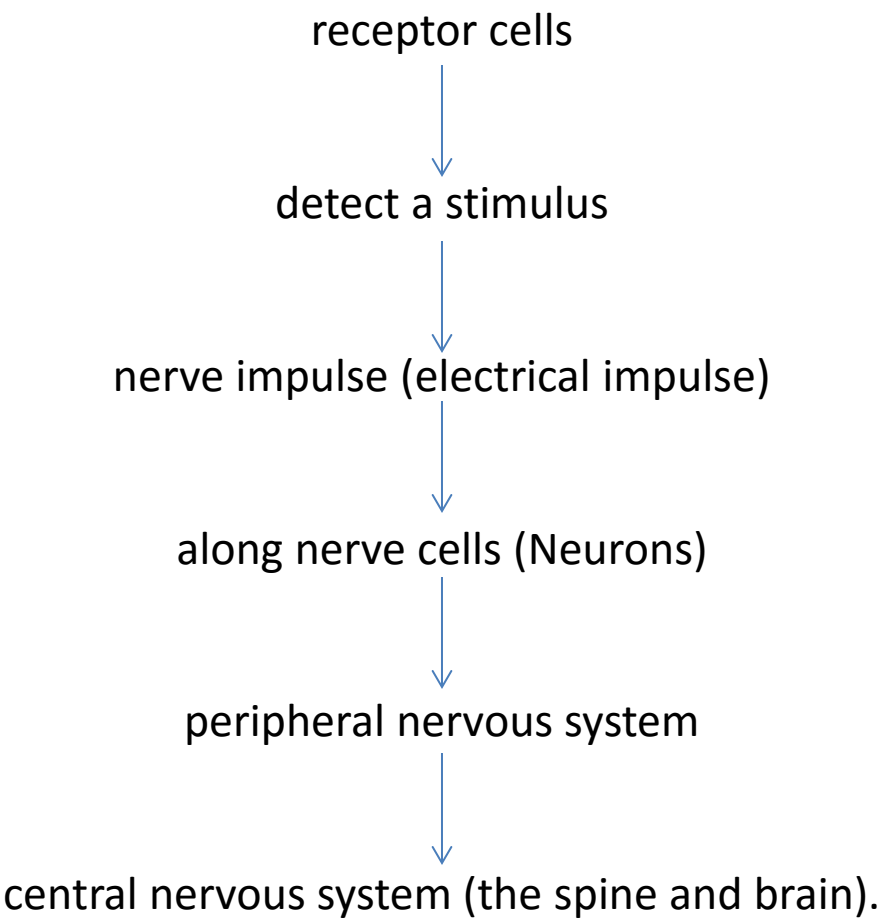
2 Shut your left eye, and stare at the cross with your right eye.
3 Gradually bring the textbook closer and note when the dot disappears. This happens when light from the dot falls on your right eye's blind spot.
4 Repeat with your left eye open and right eye closed.

Discussion:

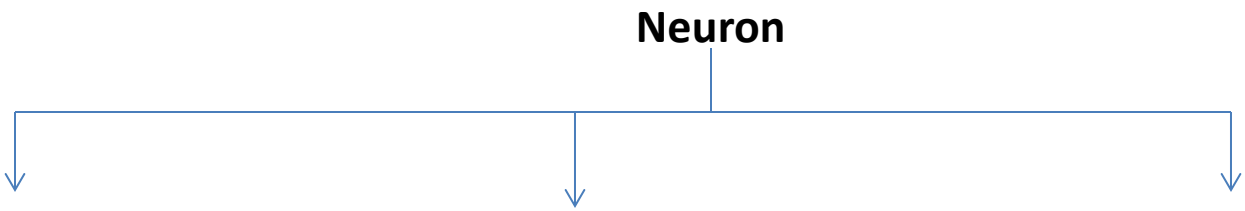
a. At what distance from your eye did the cross disappear (when its light fell on your blind spot)?

b. Compare this with others in your class.


Nervous system
Central Nervous System
(the brain and spinal cord)
Peripheral Nervous System
(the nerves that connect the central nervous system to the rest of the body).
Sensory neurons
Motor neurons
Autonomic system
(involuntary system, controlling breathing, heartbeat, digestion and allows rapid response without involvement of the brain)
Voluntary system
(involves skeletal muscles and a conscious involvement of the brain)
Sympathetic division
(helps cope with stress)
Parasympathetic division
(the rest and digest system)


receptor cells
detect a stimulus
nerve impulse (electrical impulse)
along nerve cells (Neurons)
peripheral nervous system
central nervous system (the spine and brain).

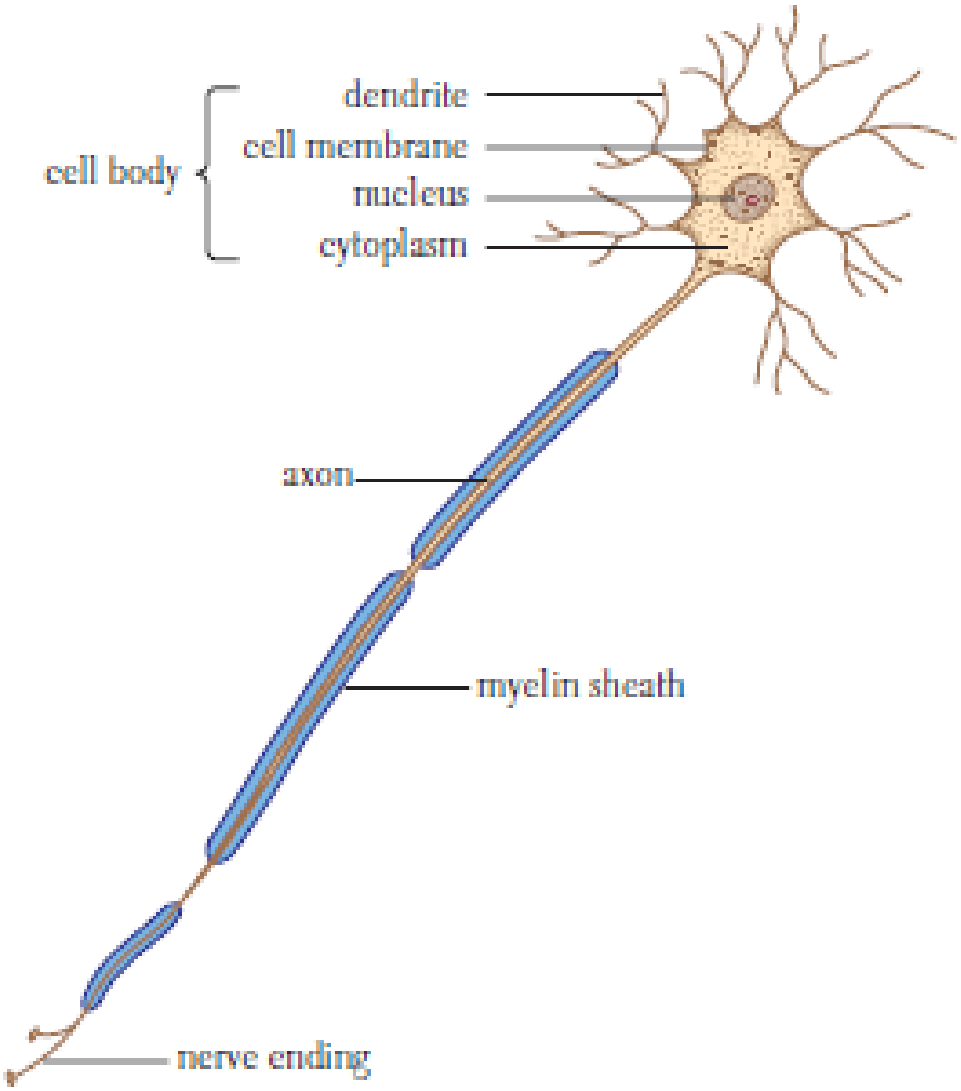
Neurons grouped together form a nerve.



Sensory neurons	**Interneurons**	**Motor neurons**
carry the impulse generated by the stimulus to the central nervous system	carry the impulse generated by the stimulus through the central nervous system	carry the impulse to the effector from the central nervous system

<u>Effectors</u> are the muscles or glands.

A typical neuron



The structure of a neuron

A neuron is a long cell.

Cell body:
It contains a nucleus and supplies energy and nutrients for the activity of the neuron.

Dendrites: They are fine branches that extend from one end of the cell and receive messages from receptors and other neurons.

Axon: It is a long thread like structure through which the nerve impulse passes along, away from the cell. There are axon branches at the end of the axon.

Myelin sheath: Axons are encased in a white fatty substance, called **myelin**, which insulates the axon like the plastic coating on an electrical wire. It also enables messages to pass more quickly along the axon.

Nerve impulses travel along a neuron in one direction only — from **dendrite to axon** branch.

<u>Speed of nerve impulses</u>:

The information is carried by electrical impulses that travel at speeds between 1 and 100 metres per second.

The nervous system provides rapid messages.

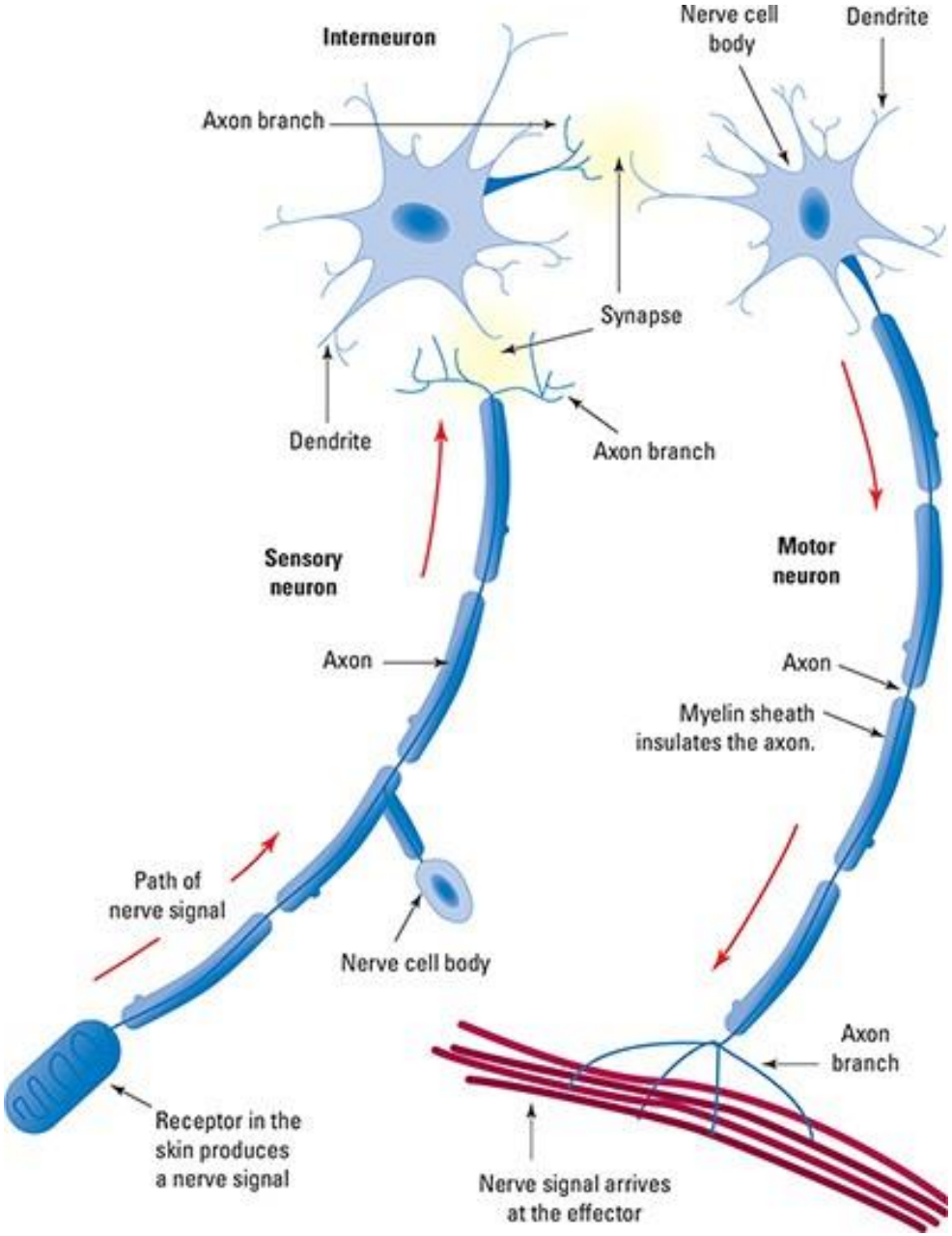
Multiple sclerosis

In the disease called multiple sclerosis, patches of myelin deteriorate at intervals along neurons in the CNS.

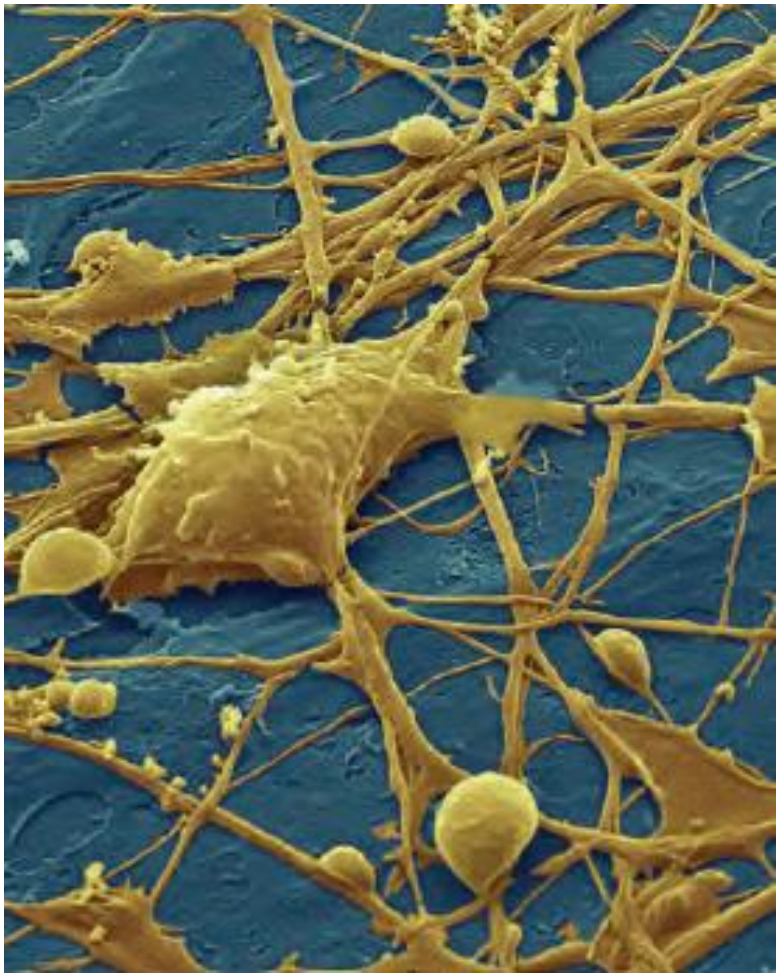
The affected areas cannot conduct electrical impulses and the neurons cannot be replaced if damaged.

Victims of multiple sclerosis have symptoms including loss of coordination, tremors, difficulty in seeing and partial paralysis.

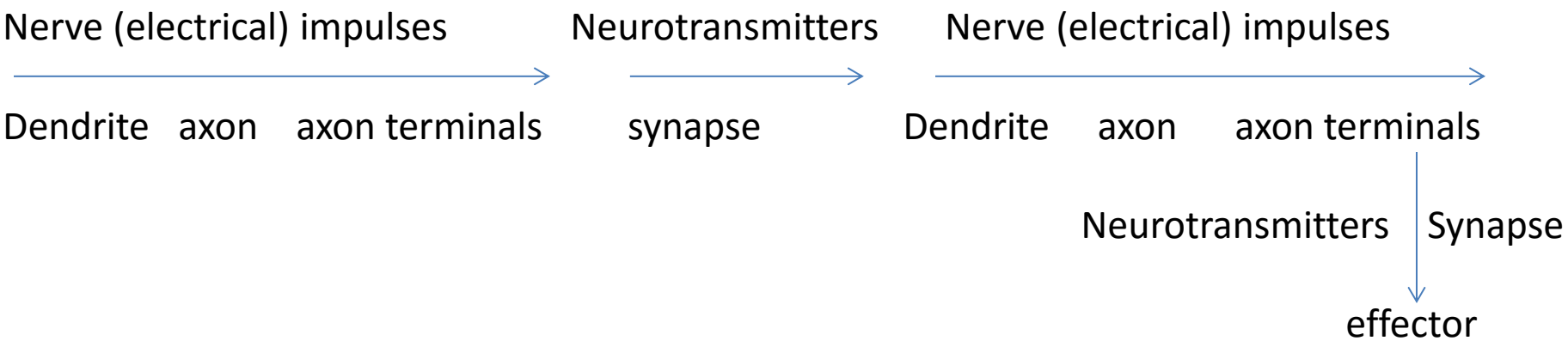
The cause is still a mystery, but evidence suggests that a measles-like virus may be responsible in genetically susceptible people.



Relationship between the sensory neuron, interneuron and motor neuron

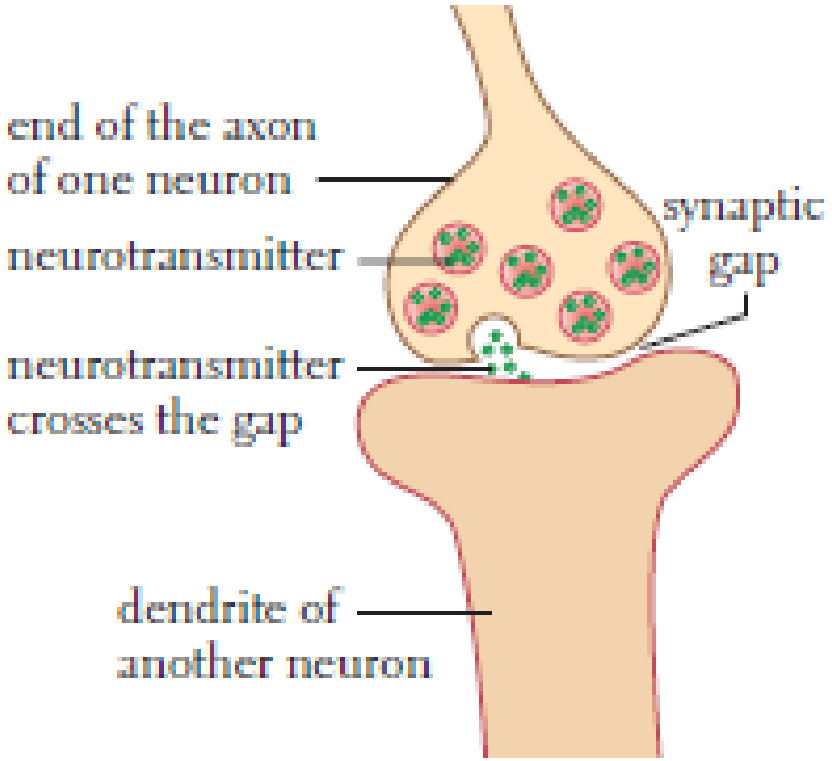


A scanning electron microscope image of a neuron (light brown) showing the thick axon and several thin dendrites.

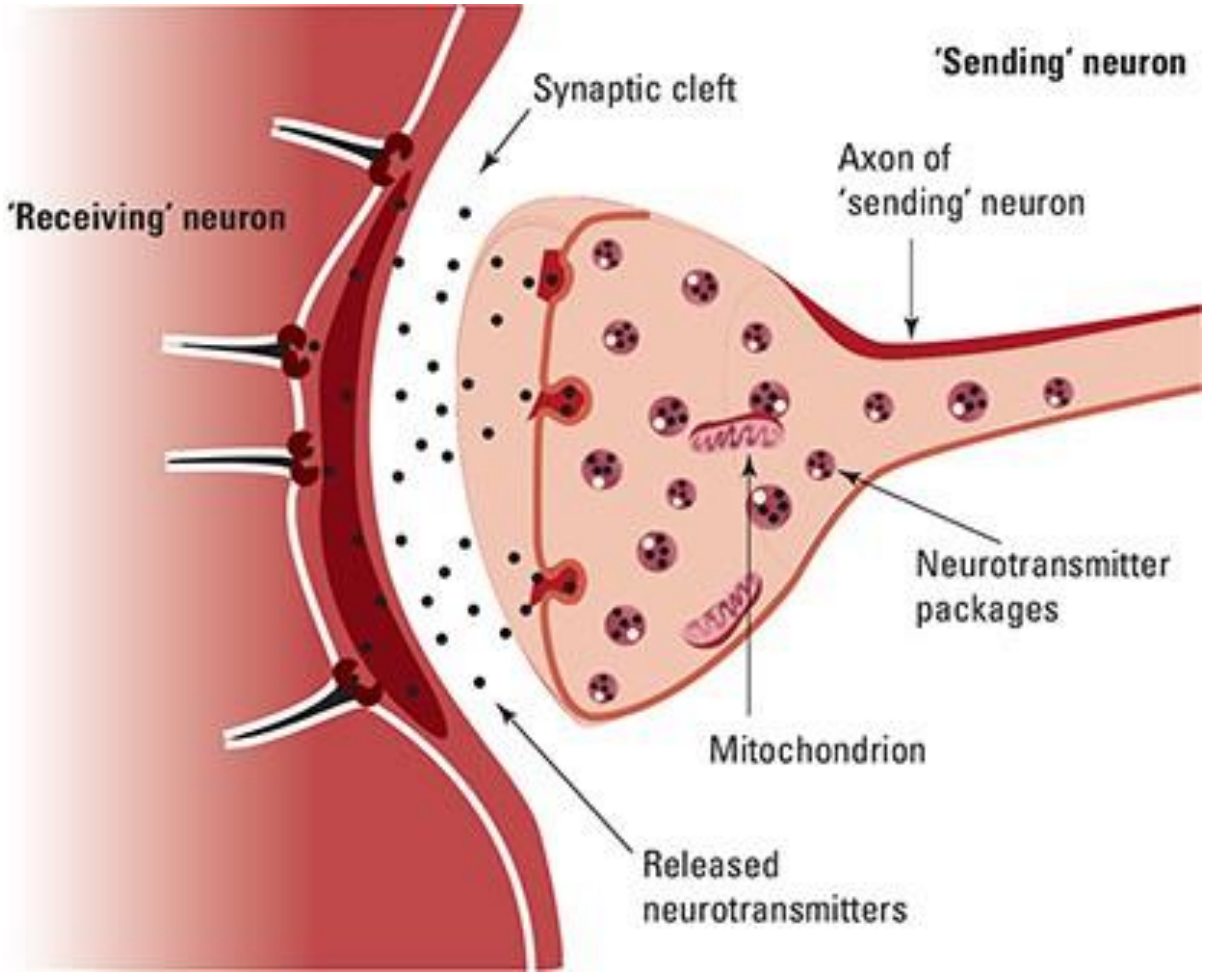


Synapse: It is the junction (synaptic gap) between two nerve cells.

Neurotransmitters: A message is carried chemically, across a synaptic gap, by special compounds called **neurotransmitters**.



Crossing a synapse


'Sending' neuron
Synaptic cleft
Axon of
'sending' neuron
'Receiving' neuron
Neurotransmitter
packages
Mitochondrion
Released
neurotransmitters

A synapse

Many **drugs and poisons affect neurotransmitters**.

- Curare is a poison used by South American Indians on arrow tips.
- It blocks reception of the neurotransmitter **acetylcholine**, preventing messages from getting to muscles, stopping breathing and other movements.
- Some insecticides work by preventing the breakdown of acetylcholine, so messages are constantly received, resulting in continuous muscle spasms.
- The poison from a red-back spider, for example, empties the impulses out of the neurotransmitters and can cause spasms and paralysis.

The significance of synapses

If neurons touched each other it would be something like turning on one switch and having every light in the house come on at once.

Synapses are similar to a switchboard, allowing messages to be directed to the correct places.

Neurotransmitters like **noradrenalin**, is associated with alertness.

Dopamine, associated with emotions.

Drugs such as **amphetamines, cocaine and ecstasy** increase production of these neurotransmitters.

- This results in an increased state of alertness and heightened emotions, along with high blood pressure, irritability and, later, depression and insomnia.

https://www.youtube.com/watch?v=VitFvNvRIIY

Pain relief

The pain-relieving processes of acupuncture and hypnosis appear to be related to neurotransmitters called **encephalins**.

These are the body's own pain-deadening neurotransmitters.

Acupuncture is thought to stimulate the production of encephalins.

Morphine, codeine and pethidine act in much the same way as these neurotransmitters.

Endorphins are morphine-like chemicals that act as natural painkillers. They block out some of the mild pain associated with exercise.

When you exercise your brain releases neurotransmitter molecules called endorphins.

Reflex arc

The pathway through which actions are carried out automatically, without thinking and very fast is the reflex arc.

For example, if you prick your finger with a pin

(the stimulus), pain receptors in the skin

↓ send a message via a sensory neuron

to the spinal cord

↓

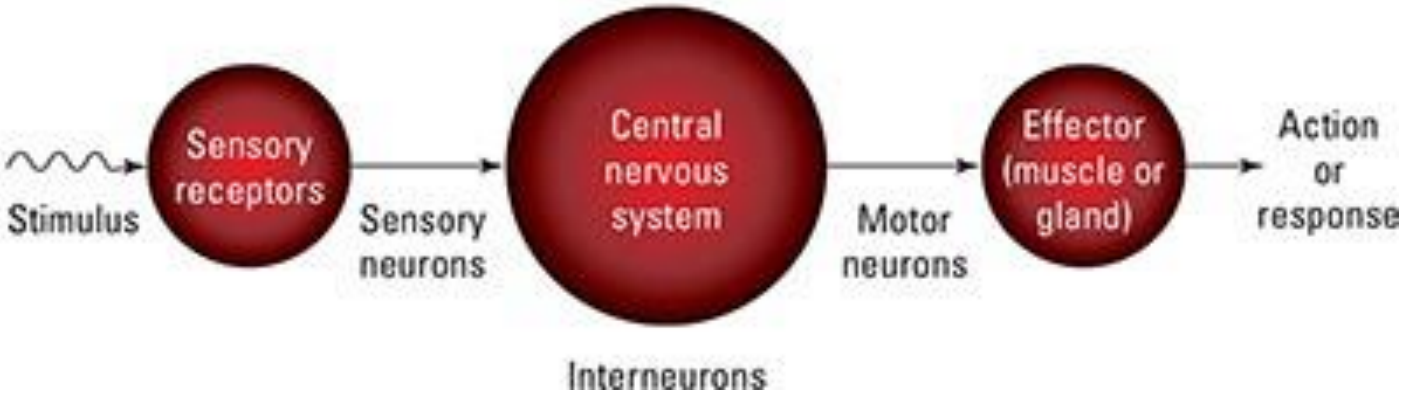
The message crosses synapses

↓ through an inter neuron

↓ to a motor neuron which carries the message

to muscles in your arm (the effector)

Diagram of the reflex arc



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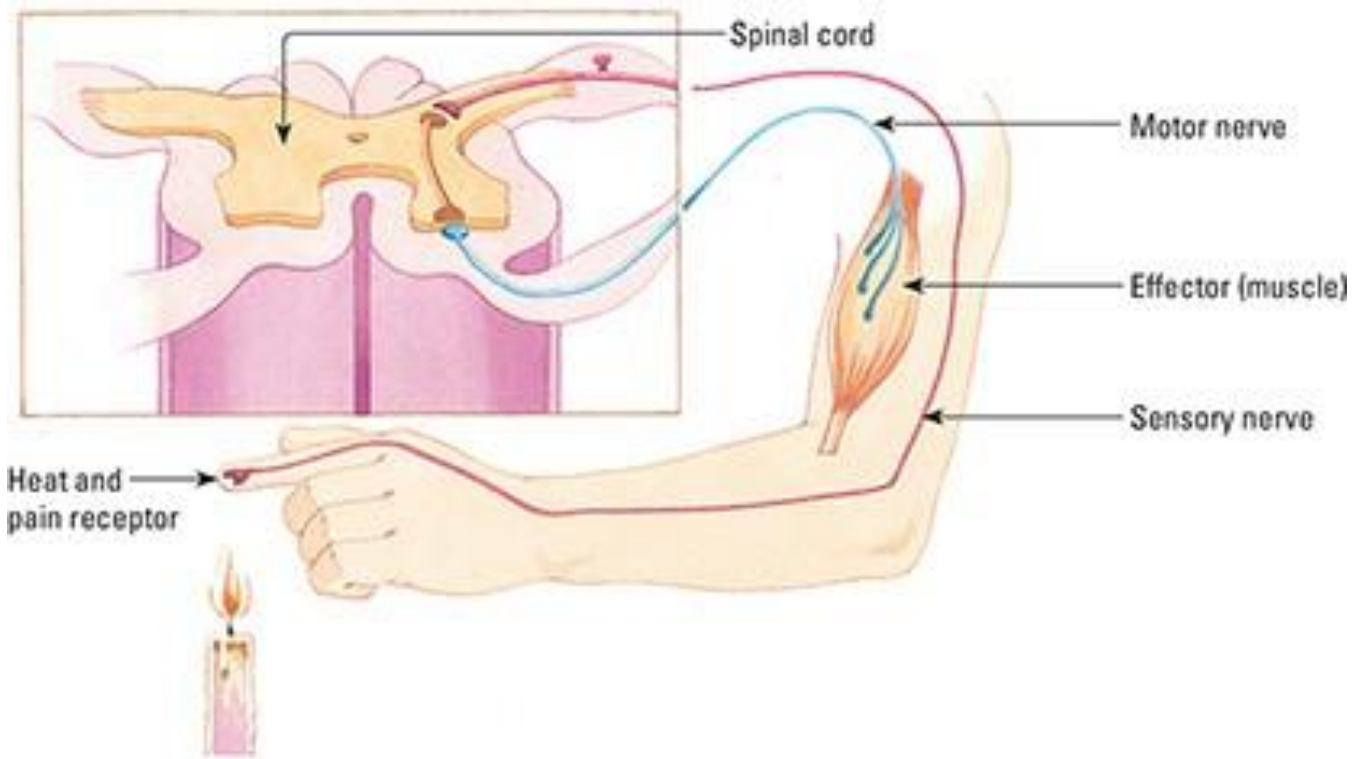
to muscles in your arm (the effector)

↓

You move your arm away and/or cry in pain

The brain itself is not yet involved.
A message may be sent to the brain, but only to keep it informed of what is happening.
The brain may also store information so that next time you avoid touching the pin.


Spinal cord
Motor nerve
Effector (muscle)
Sensory nerve
Heat and
pain receptor

A reflex arc

Conscious response

More complex actions require messages to be sent to the brain, through the spinal cord, decisions made and responses sent back to various effectors, through motor neurons. They involve many interconnecting neurons

When thinking takes place, we can make decisions about which responses are needed.

Relationship between conscious thought and reflex responses

Some learned actions may become so automatic as to appear to be reflexes. This because they depend on practice during which the same pathways are often used.

Examples:

- Skill development and control in playing musical instruments and sport

- Eating with a spoon

(A nine-month-old baby, eating, especially with a spoon, requires conscious effort. As the years pass, pathways that control this process become so well established that the action appears to be automatic)