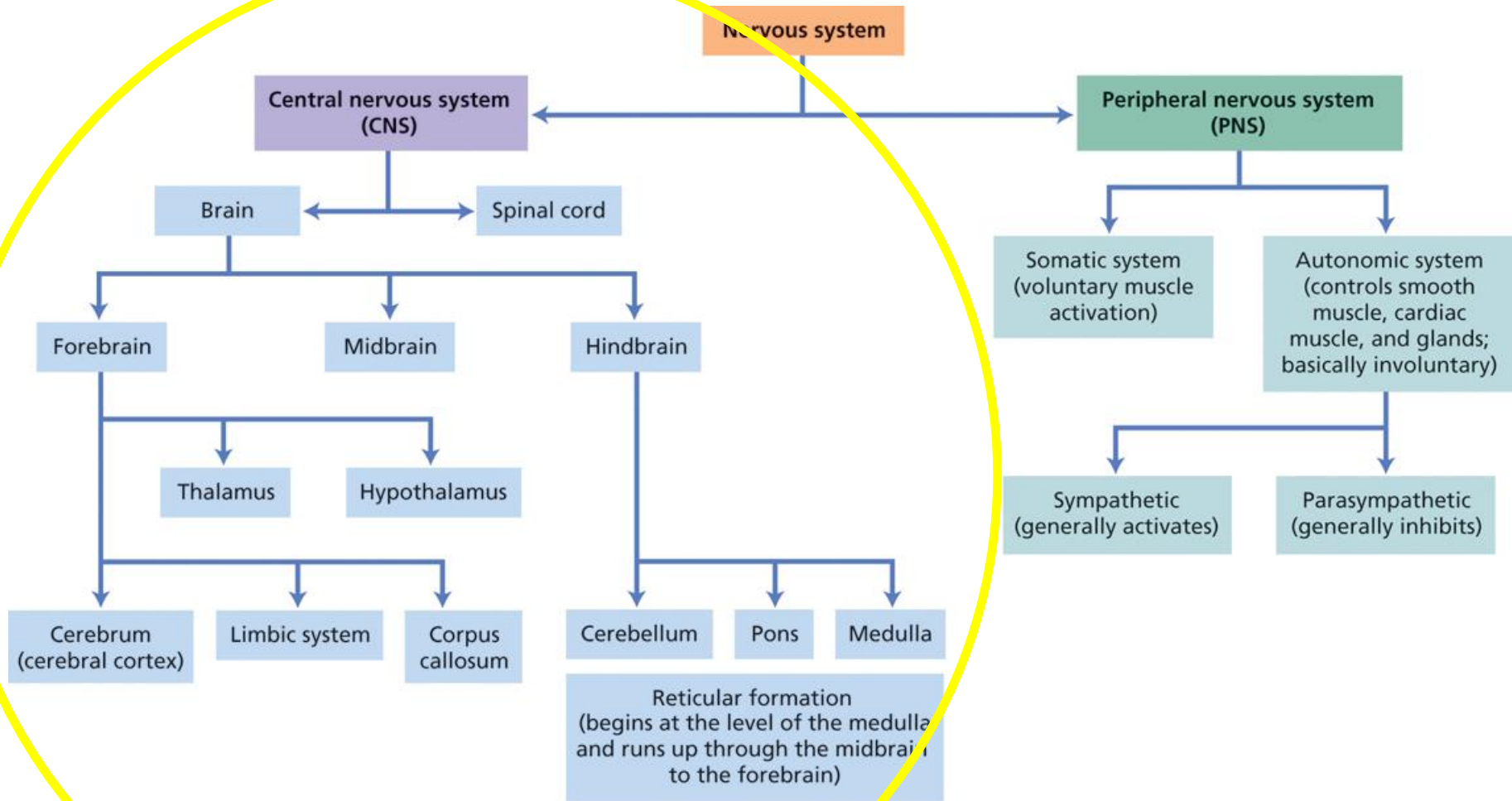


Lecture Nine:

Biological Psychology:

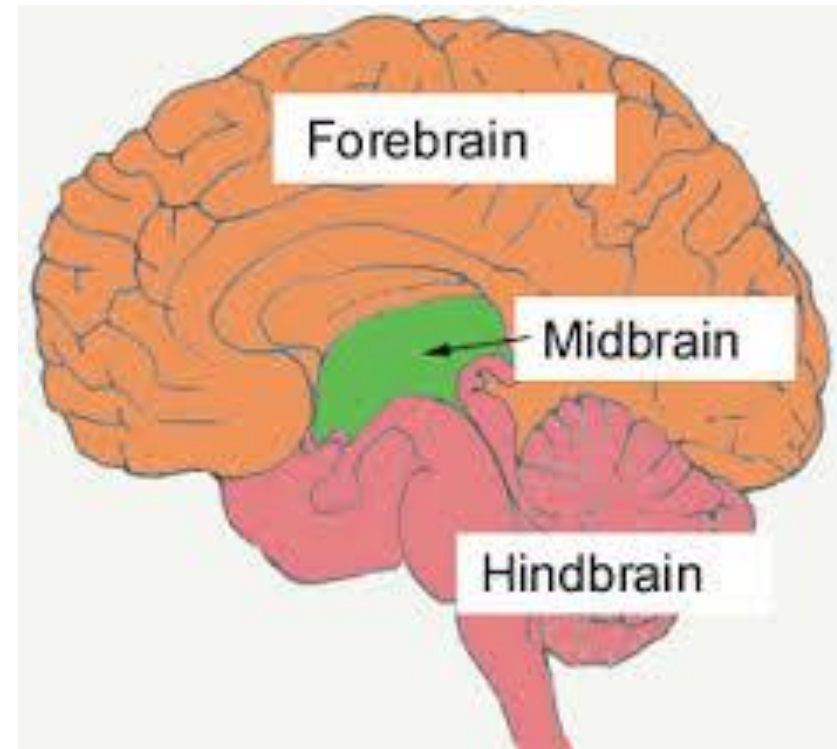
The Peripheral Nervous System
Neurons and Neurotransmitters

Recap

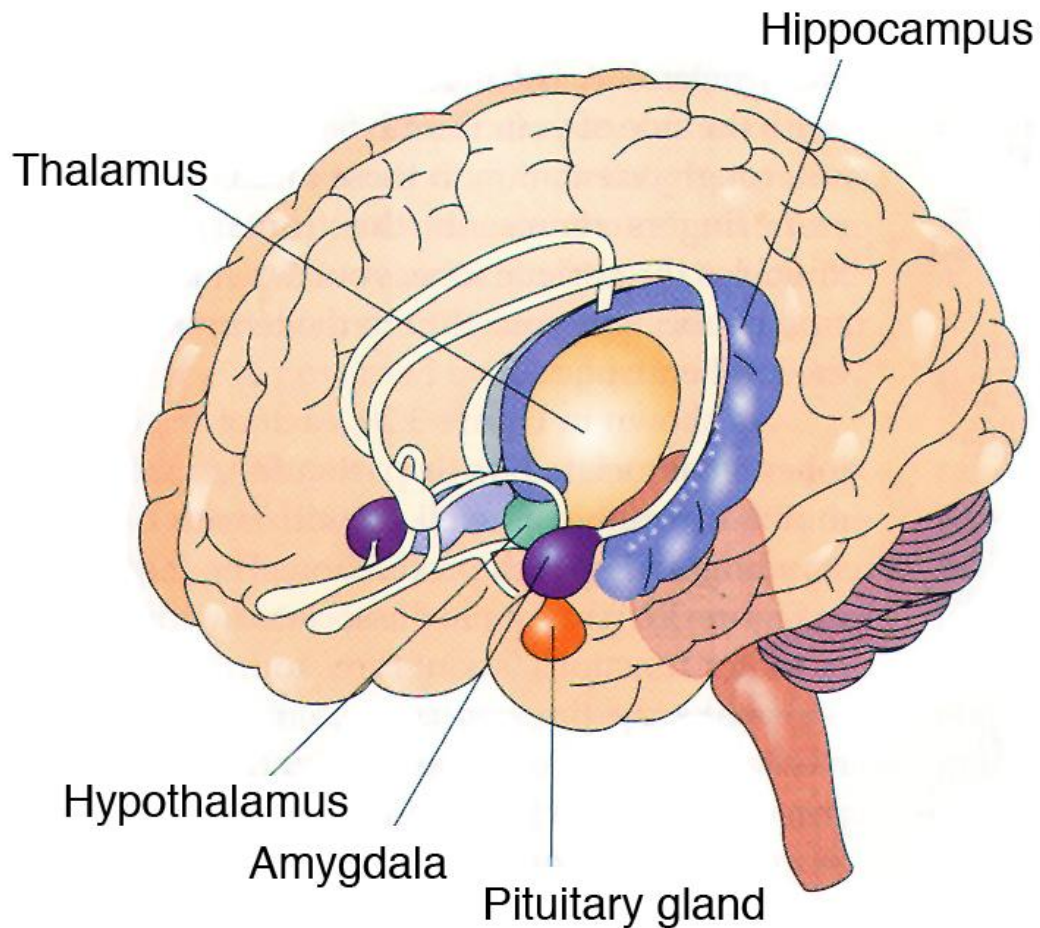


Brain Structure and Function

- Three major subdivisions of the brain:
 - Hindbrain
 - Lowest and most primitive level of the brain
 - Midbrain
 - Contains clusters of sensory and motor neurons
 - Forebrain
 - The brain's most advanced portion from an evolutionary standpoint



Limbic System: Structure



Hippocampus:

Learning and memory

Amygdala:

Emotions and aggression

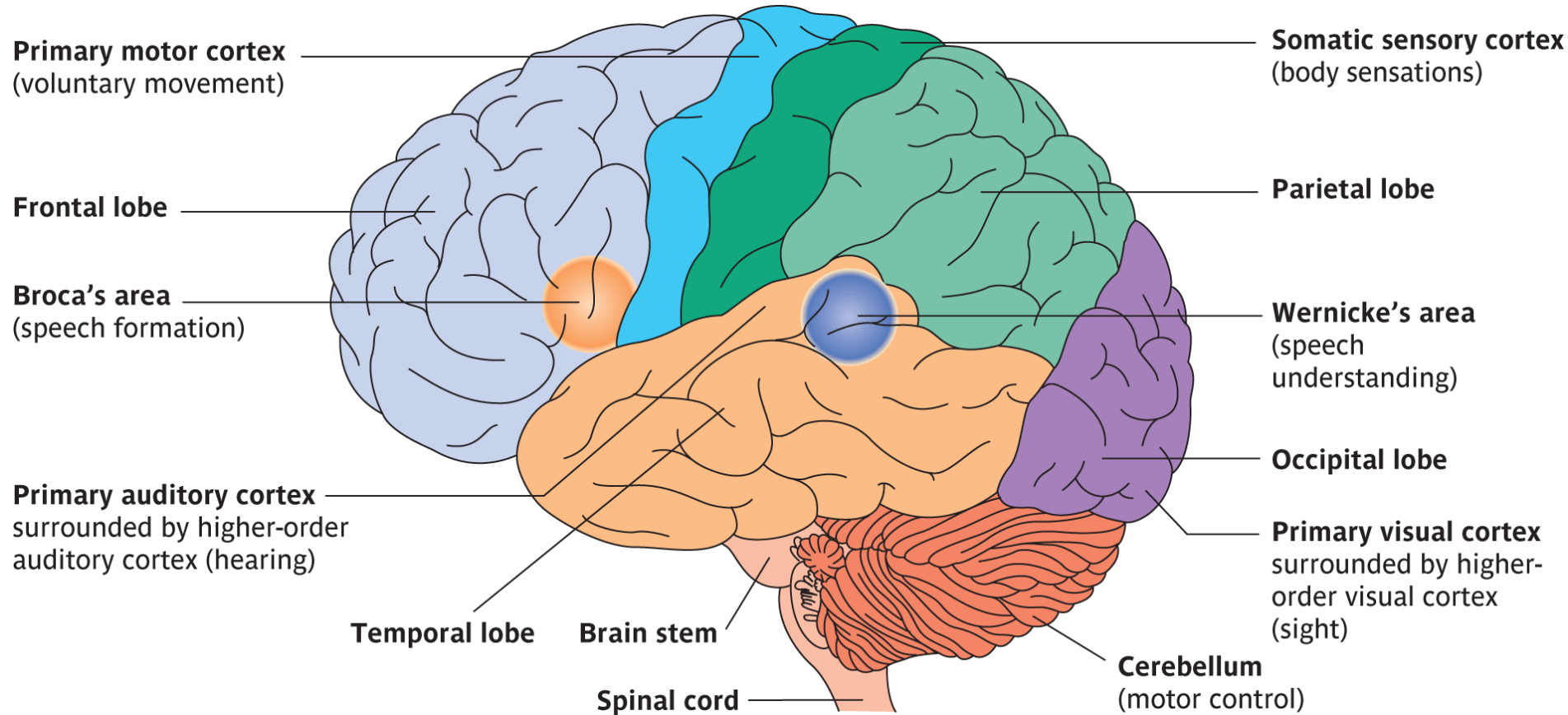
Hypothalamus:

Hunger, thirst, temperature control

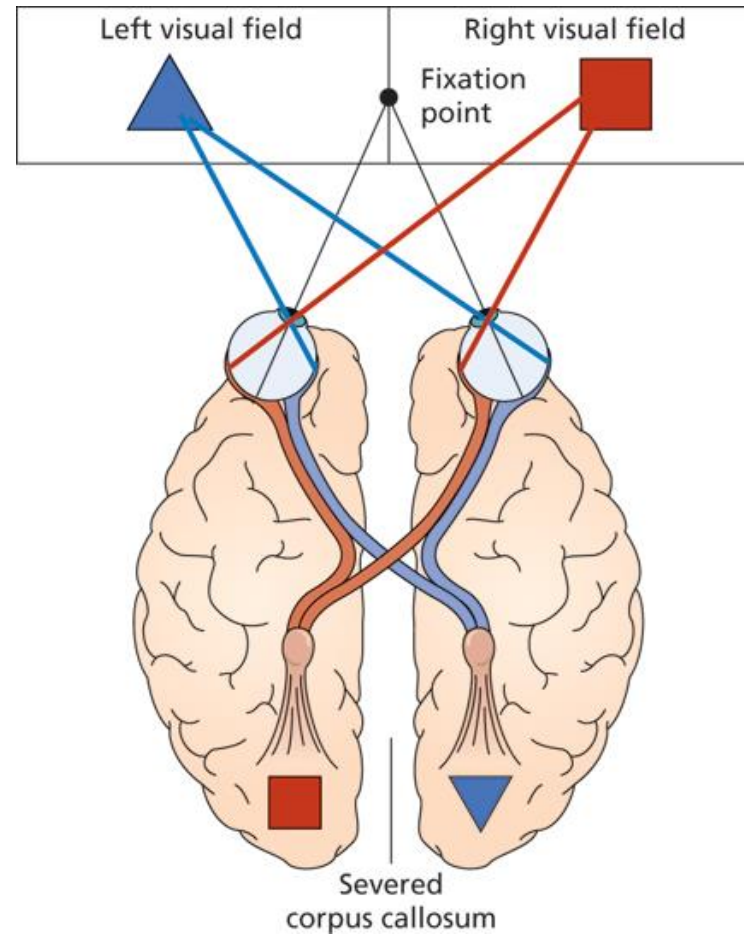
Thalamus:

Relay centre for sensory information

Brain Structure and Function



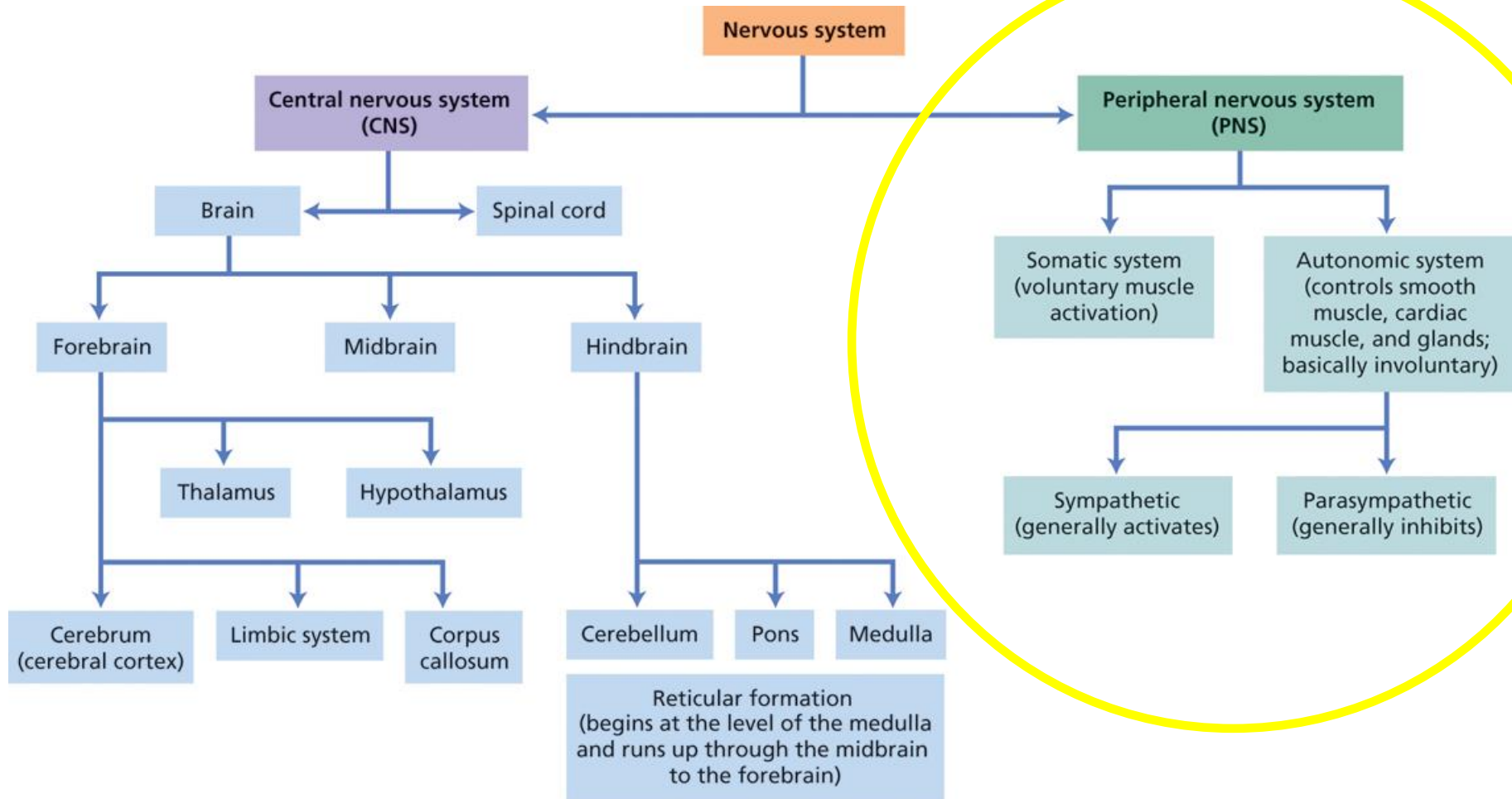
Hemispheric Lateralization



Today's lecture

- The Peripheral Nervous System
 - **Somatic** nervous system
 - **Autonomic** nervous system
 - Sympathetic nervous system
 - Parasympathetic nervous system
- Neurons and neurotransmitters

The Nervous System



Peripheral Nervous System (PNS)

- The PNS contains all the neural structures that lie outside of the brain and spinal cord
 - **Somatic** nervous system:
 - A system of sensory and motor neurons that allows us to sense and respond to our environment
 - **Autonomic** nervous system:
 - A system that senses the body's internal functions and controls many glands and muscles

6a The Central Nervous System

● Central nervous system

● Brain

● Spinal cord

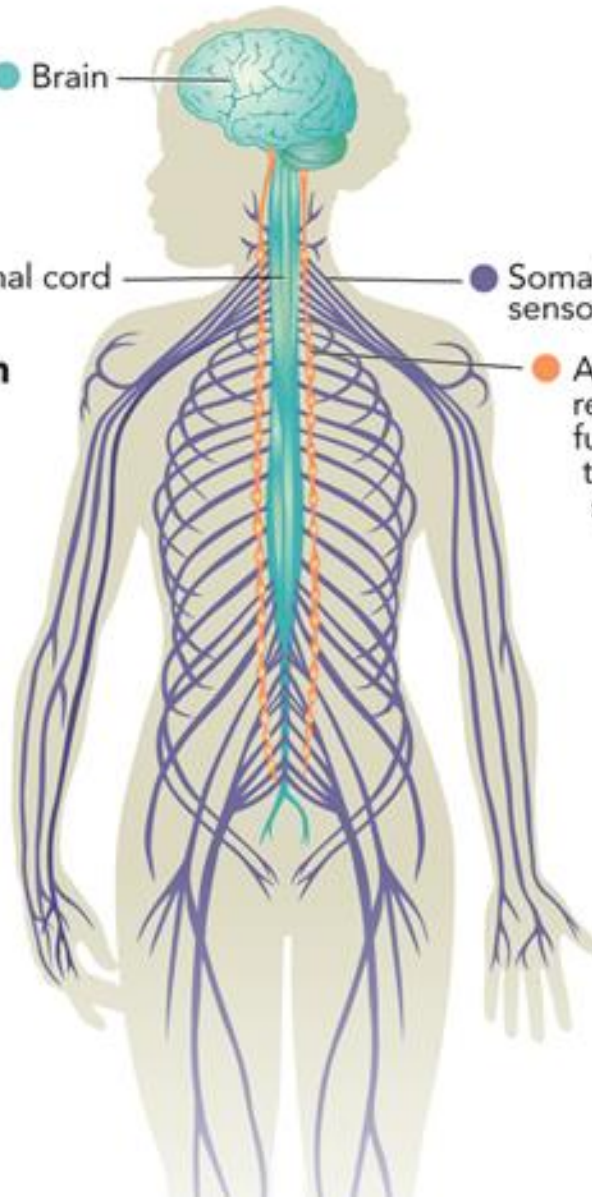
6b The Peripheral Nervous System

● Somatic division of the peripheral nervous system

● Autonomic division of the peripheral nervous system

● Somatic division consists of sensory and motor nerves.

● Autonomic division regulates the body's internal functions and is divided into the parasympathetic and sympathetic branches.



Somatic Nervous System

- Consists of:
 - **Sensory neurons** - specialised to transmit messages from the eyes, ears, and other sensory receptors
 - **Motor neurons** - send messages from the brain and spinal cord to the muscles that control our voluntary movements

Autonomic Nervous System

- Senses the body's internal functions
- Controls the glands and the smooth (involuntary) muscles that form the heart, the blood vessels, and the lining of the stomach and intestines.
- Two divisions – both together are responsible for homeostasis
 - **Sympathetic:** activation or arousal function (fight or flight)
 - **Parasympathetic:** slows down the body; maintains a state of internal equilibrium

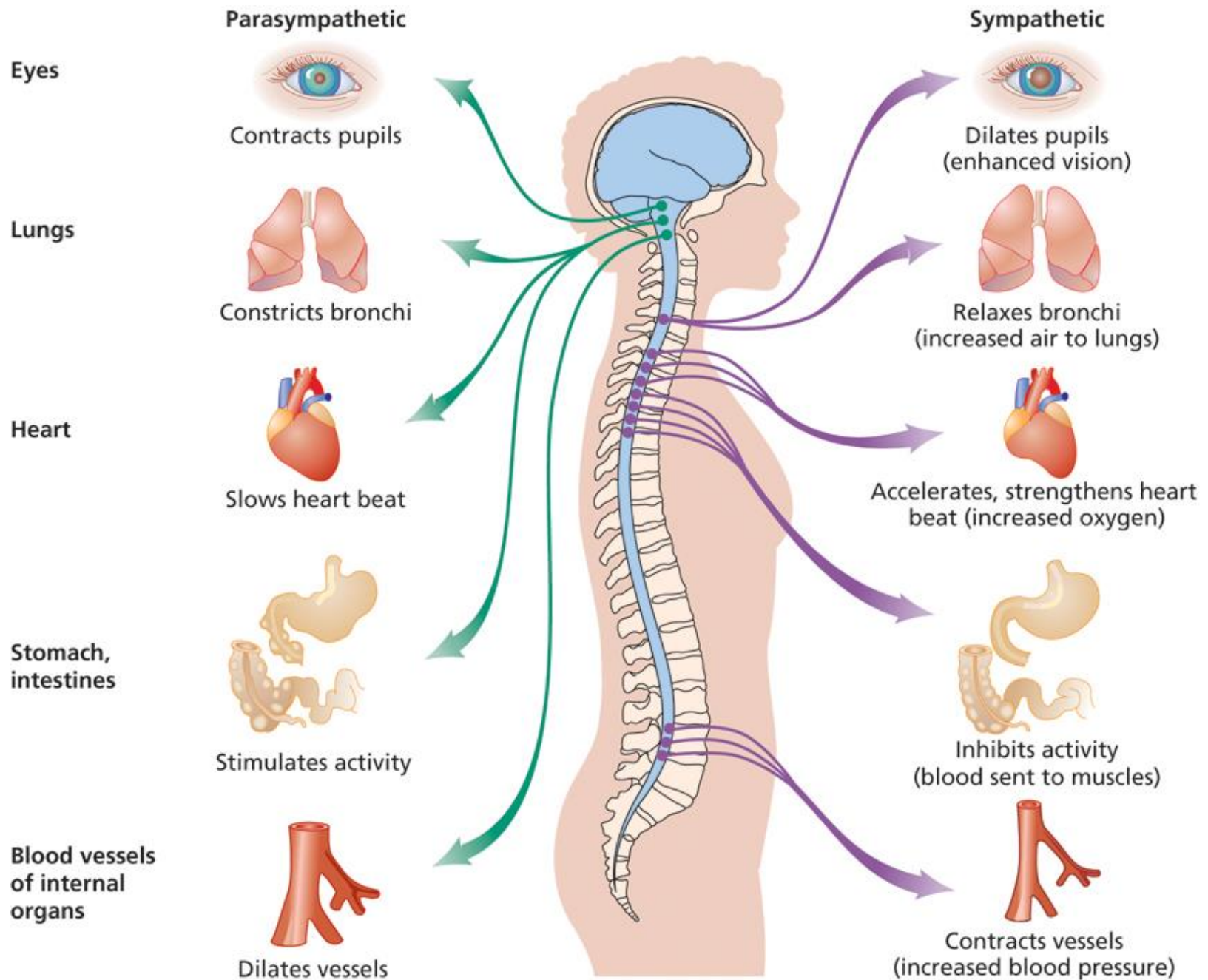
Autonomic Nervous System

Sympathetic

- Takes over whenever the body needs to use energy
- Tends to act as a total unit

Parasympathetic

- Dominant when the body is at rest and energy is being built up
- Far more specific, acts on one or a few organs at a time

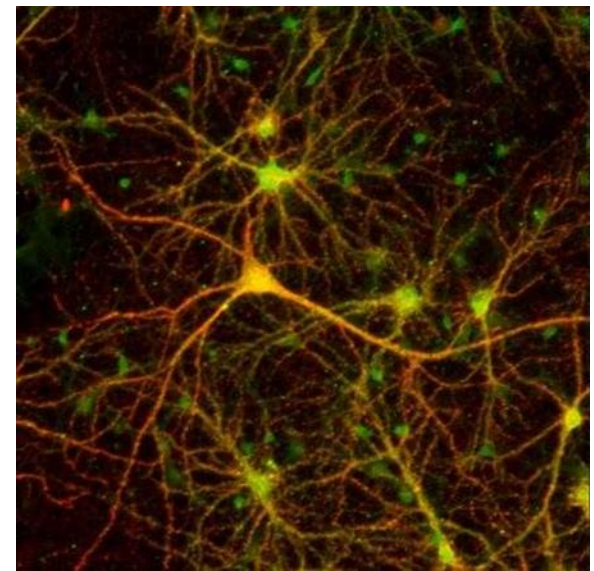
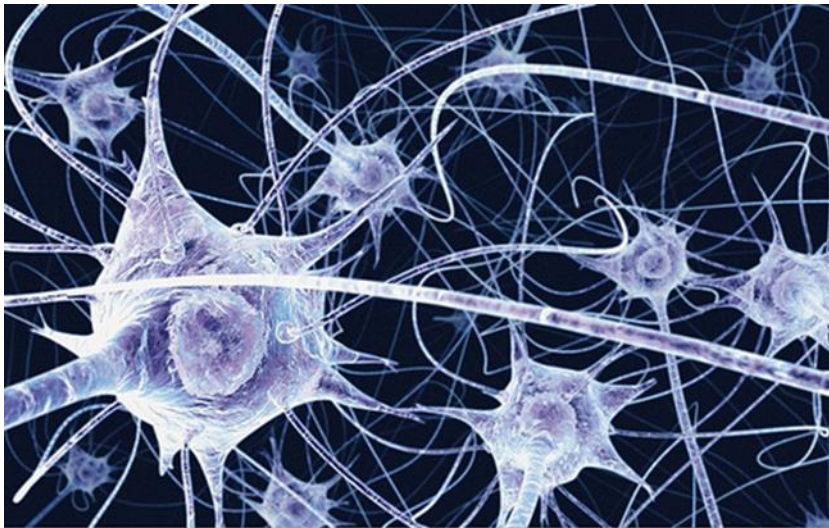


Autonomic Nervous System

Organ/function affected	Sympathetic reaction	Parasympathetic reaction
Heart rate	Increase	Decrease
Blood pressure	Increase	Decrease
Secretion of saliva	Suppressed (dry mouth)	Stimulated
Pupils	Dilate (aids vision)	Constricts
Limbs	Dilation of blood vessels (to help run faster, for example)	Contraction of these blood vessels
Galvanic skin response (GSR)	Decreases (due to increased sweating)	Increases
Bladder muscles	Relaxed (loss of bladder control)	Contracted
Adrenal glands	Stimulated to secrete more adrenaline	Reduced secretion
Breathing rate	Increased (dilated bronchi)	Decreased
Emotion	Experience strong emotions	Less extreme emotions

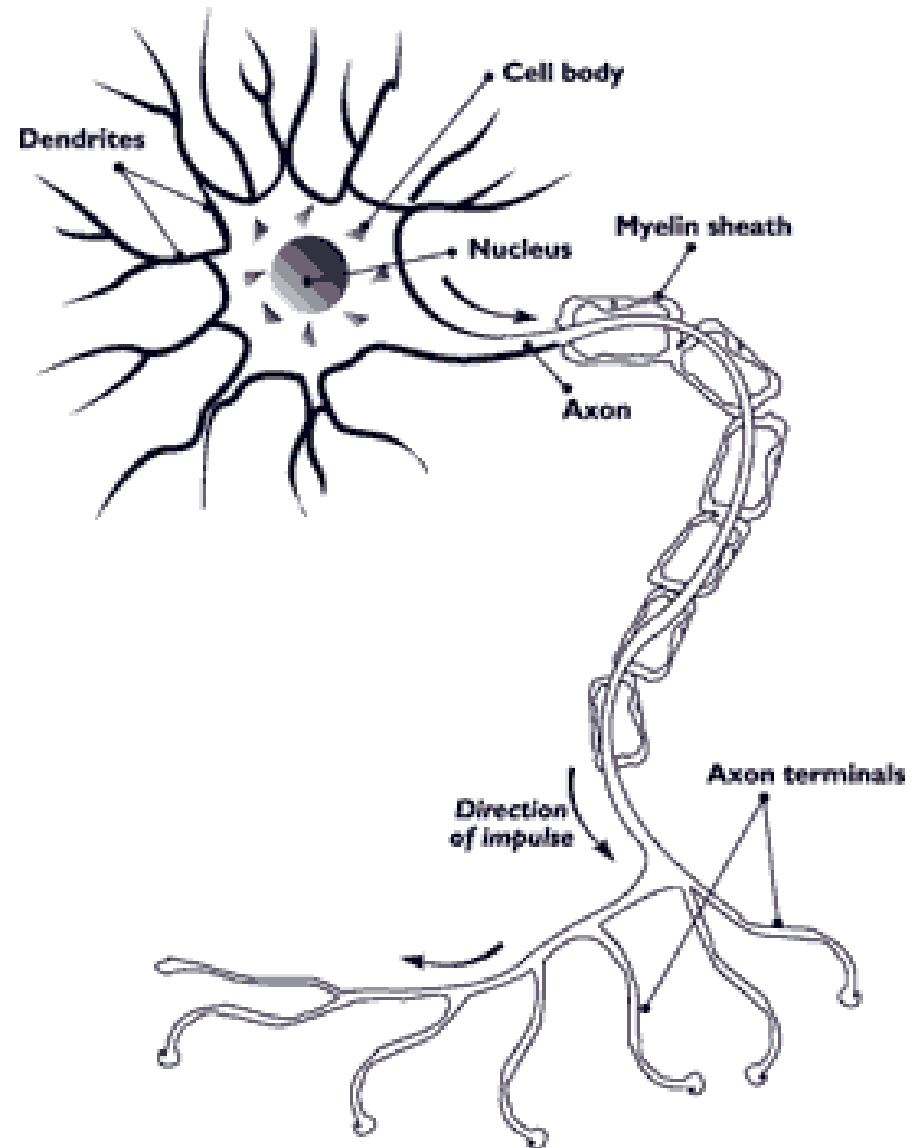


NEURONS AND NEUROTRANSMITTERS



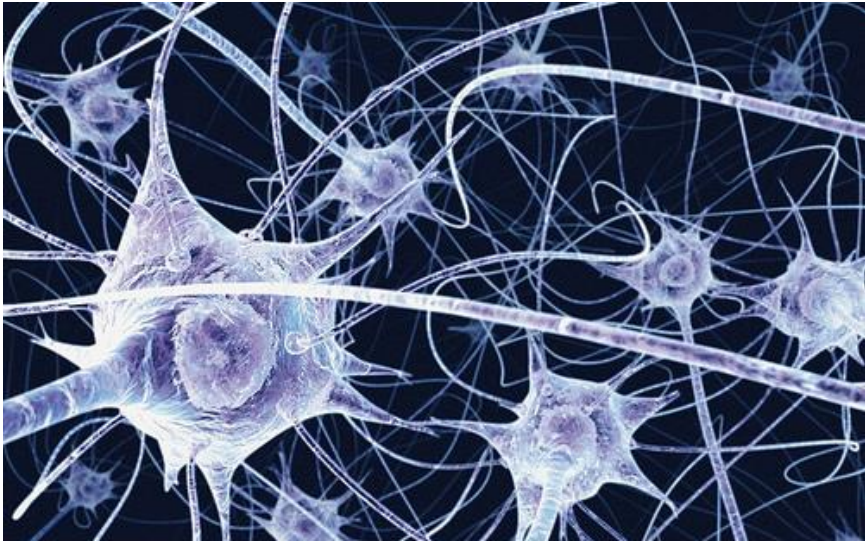
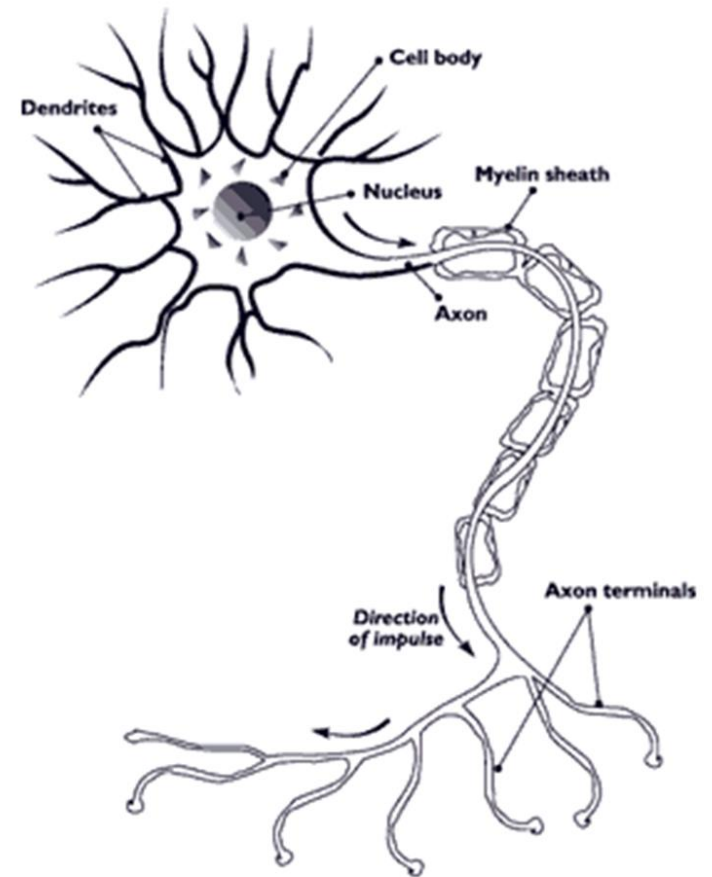
Nervous system is composed of cells

- Most important – ***neurons***
- Neurons are cells - contain the usual cellular components:
 - Mitochondria
 - Nucleus
 - Ribosomes



Neurons

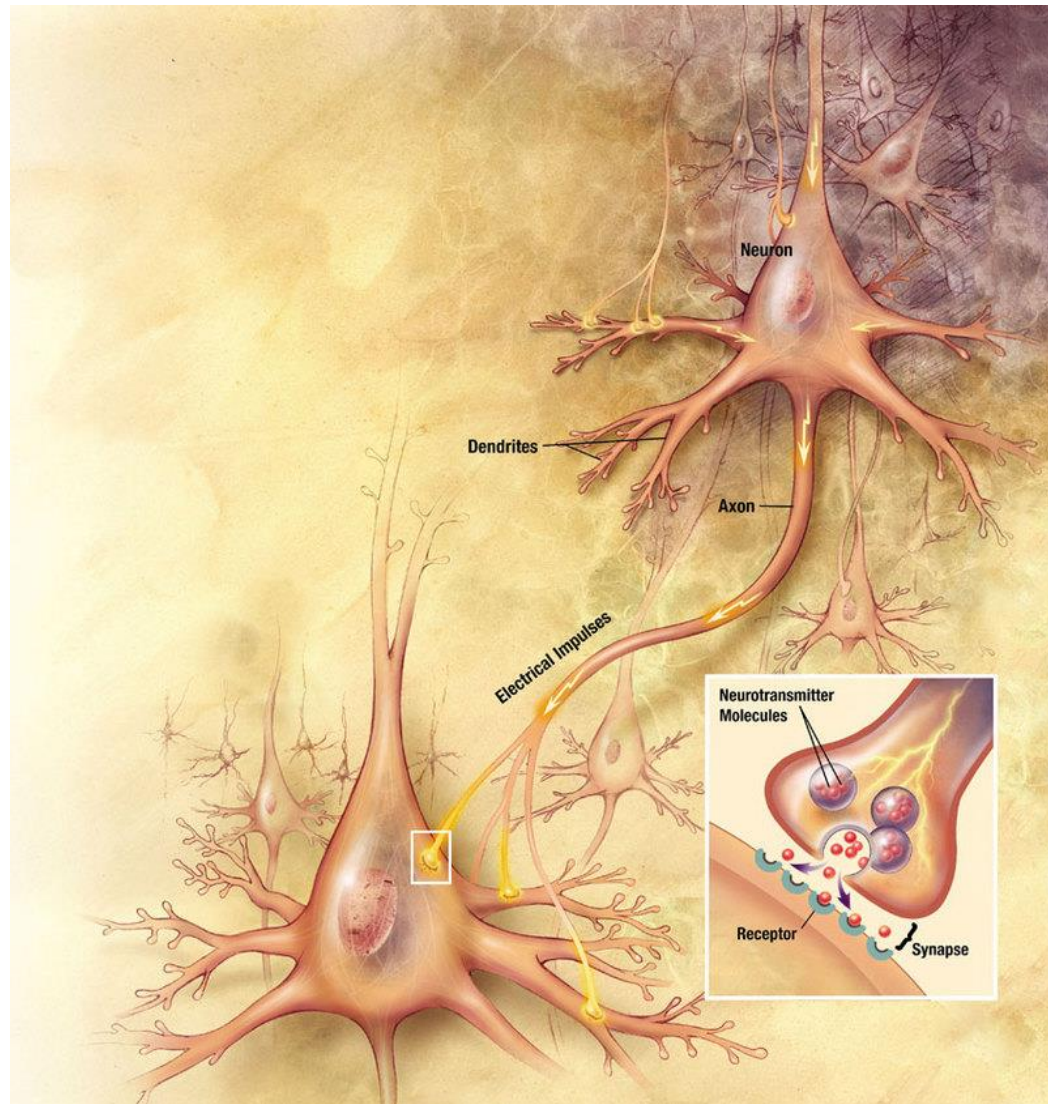
- Assembled into circuits
 - Receive input from other nerve cells
 - Integrates the input
 - Distributes the processed information



Neurons and their connections

- Neurons are ***contiguous*** - separated from each other by a miniscule gap
- Brain is made up of separate neurons and other cells that are independent from each other:
 - structurally
 - metabolically
 - functionally

- Information is transmitted from cell to cell across tiny gaps called ***synapses***
- Information is passed on to other cells by means of ***electrochemical output signals***



Structural divisions

- 1. Input zone

Dendrites - cellular extensions

Greek - 'dendron' - tree

Branch-like fibres emerging from the cell body

Specialised receiving units that collect information from neighbouring neurons

and send them to the cell body



- 2. Integration zone

The ***cell body*** region (soma)

Houses the nucleus; carries genetic information that determines how the cell develops and functions

- 3. Conduction zone

The **axon** - a single extension

- Conducts electrical impulses away from the cell body to other neurons, muscles or glands
- Axon is covered with a sheath of **myelin** - a fatty, insulating substance
- Between each pair of myelinated segments - a small gap - node of Ranvier
- Both myelin and node of Ranvier increase the speed of the conduction of nerve impulses

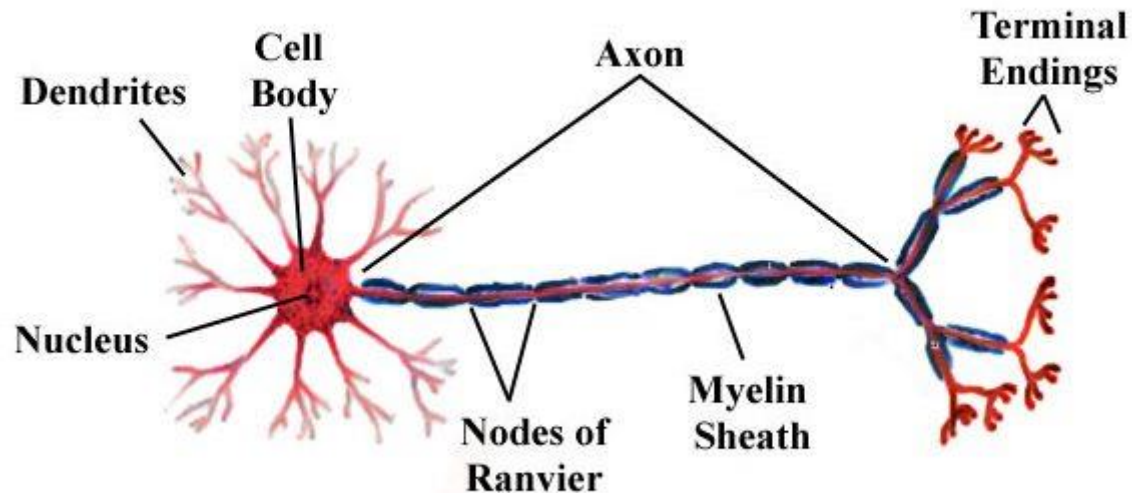
- 4. Output zone

Where the myelination stops

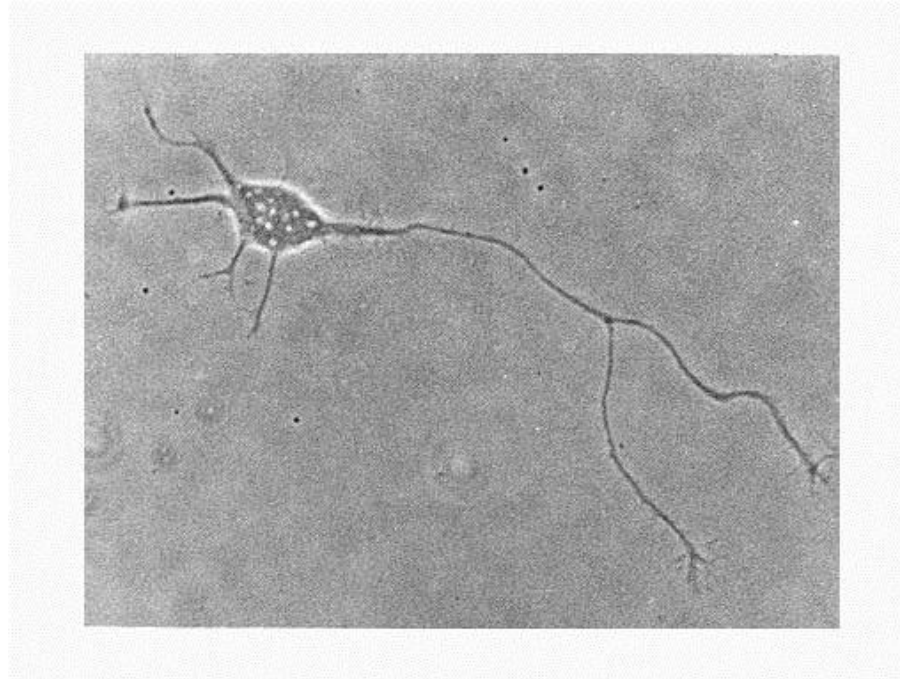
The neuron ends in lots of outgrowths

Each of these end in specialized swellings

- ***axon terminals*** – these communicate the cells activity to other cells



Classifying neurons - Shape



- **Multi-polar neurons**

Lots of dendrites and a single axon

The most common form of neuron

2. Bipolar neuron

Single dendrite at one end of the cell

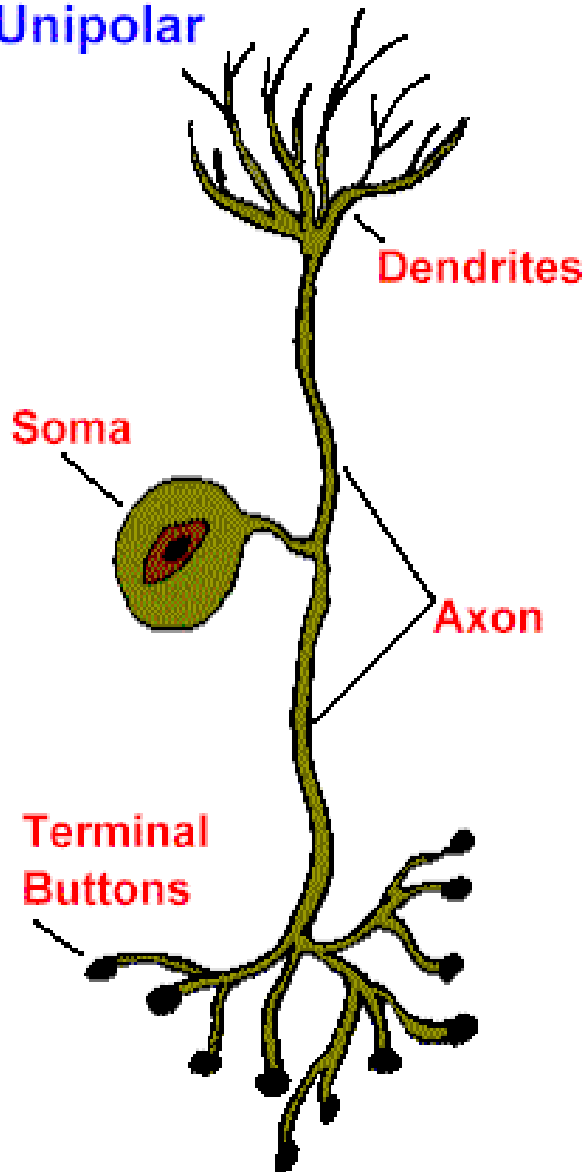
Single axon at the other

In all neurons the dendrites are in the input zone

In multi-polar and bipolar neurons the cell body is also in this
zone



Unipolar



- ***Unipolar neuron***

Single extension (or process)

- axon

Branches off in two directions after leaving the cell body

One end is the input zone

Other end is the output zone

These cells transmit touch information from the body to the spinal cord

Classifying neurons - Size

Nerve cell bodies range from 10 micrometres to 100 micrometres or more in diameter

Larger neurons tend to:

- have more complex inputs and outputs
- cover greater distances
- convey information more rapidly than smaller neurons

Classifying neurons - Function

- ***Motor neurons***

- interact with muscles or glands
- provide a pathway for the brain
- contact and control body movements or organ function

- ***Sensory neurons***

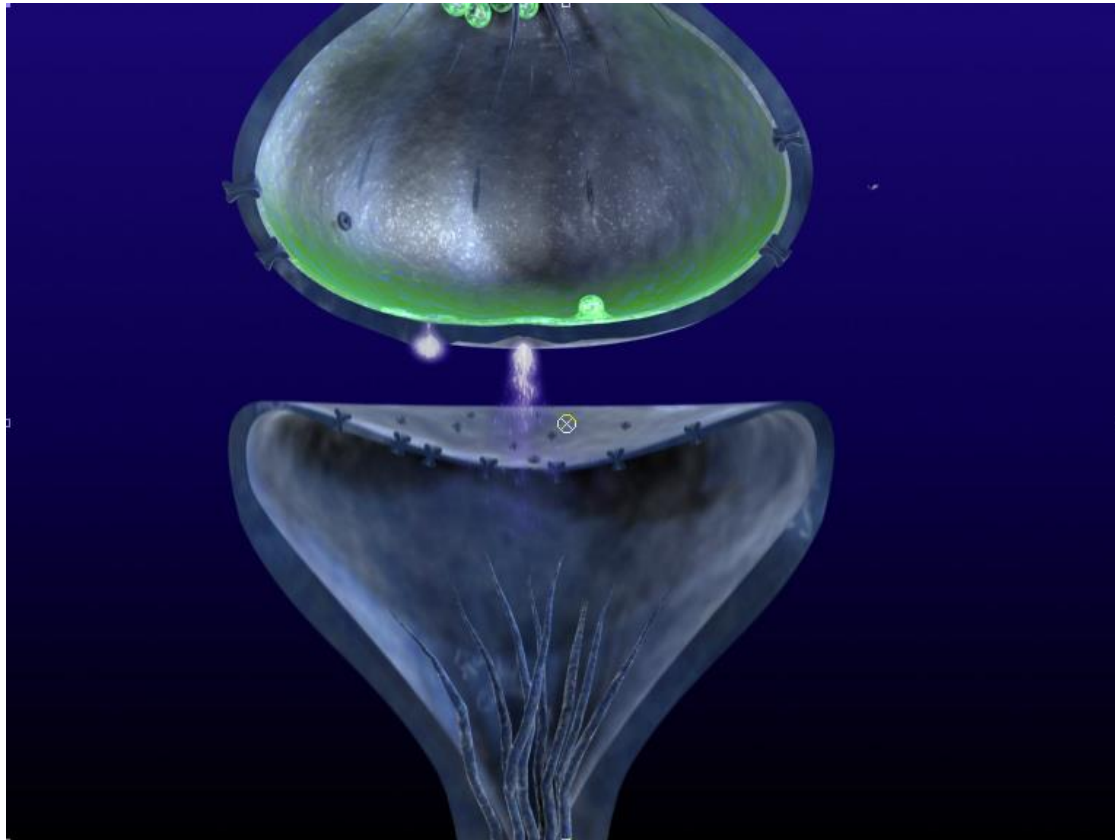
- directly affected by/respond to environmental stimuli

- ***Interneurons*** - the majority of neurons

- receive input from other neurons and
- pass the information along the connection through neighbouring neurons

Synapses

- On surface of dendrite
- Information transmitted from **pre-synaptic** neuron to **post synaptic** neuron



Three major components:

- The **presynaptic membrane** –on axon terminal of presynaptic neuron
- A specialized **postsynaptic membrane** on the surface of the cell body of the postsynaptic neurone
- **Synaptic cleft** – this is tiny gap that separates the presynaptic and postsynaptic membranes - [between 20 and 40 nanometres]

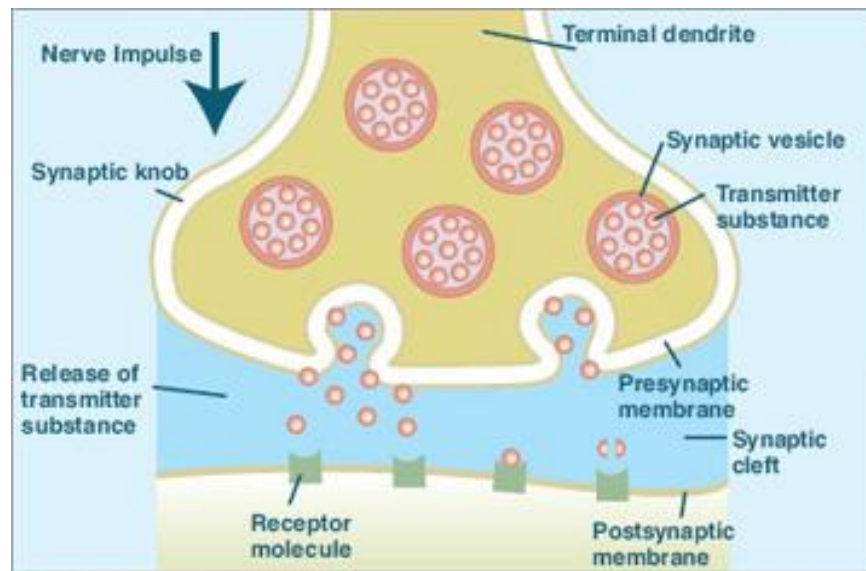
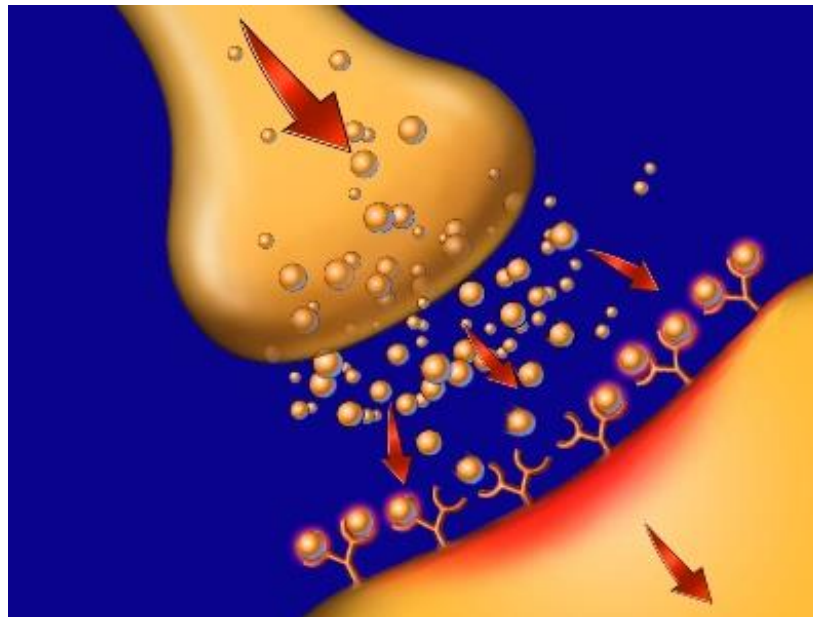


Fig.2 The synaptic cleft

- Axon terminals of the presynaptic neurons have lots of small spheres
 - **synaptic vesicles** (30 – 140nm in diameter)
- Each vesicle contains a **neurotransmitter** - specialised chemical substance
- Vesicles respond to electrical activity in the axon by fusing to the presynaptic membrane and releasing molecules of neurotransmitter into the cleft



- The neurotransmitter flows across cleft and produces electrical changes in the postsynaptic neuron
- Changes might be **excitatory** or **inhibitory**
- That is, they either turn the other neuron on or off
- Postsynaptic neuron adds and subtracts input and will become active only if the excitatory inputs exceed the inhibitory inputs

Glial cells

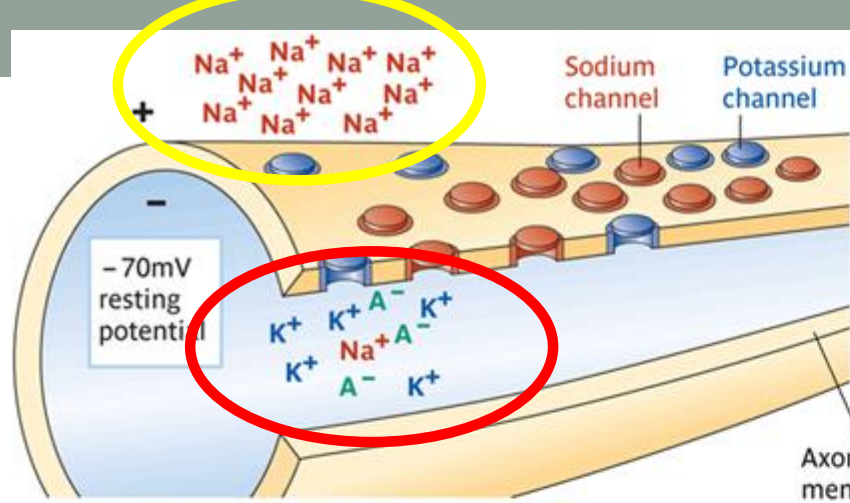
Thought to provide structure, by holding neuronal system together

Can also communicate with each other and with neurons

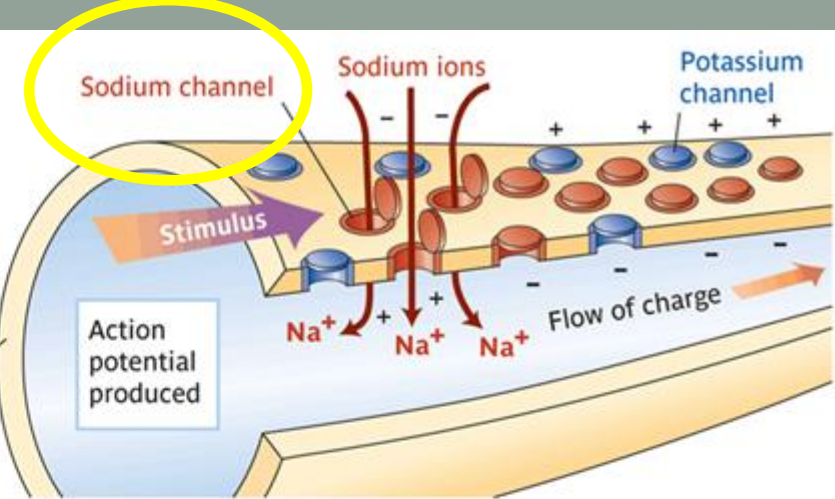
Can directly affect neuronal functioning by providing neurons with raw materials and chemical signals that alter neuronal structure and excitability

Electrochemical Impulses

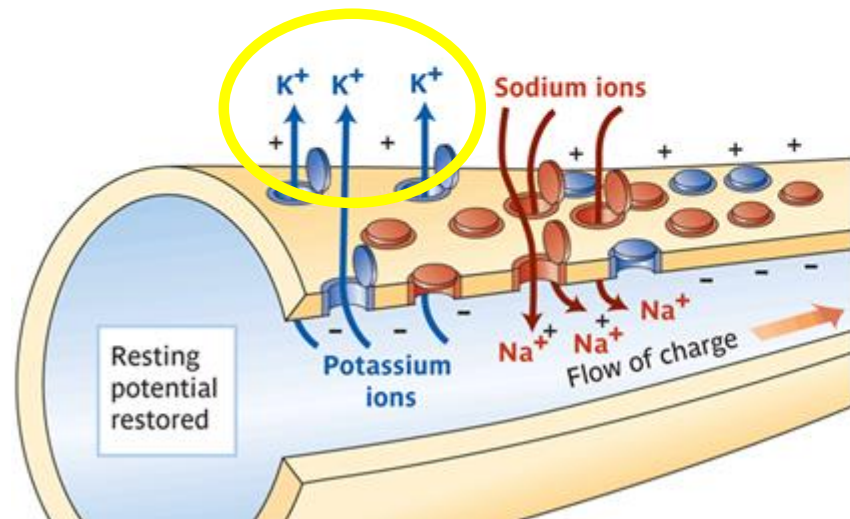
- The electrochemical signal that passes down an axon is called an **action potential**
- At rest, neurons contain positively charged potassium ions (K^+), and negatively charged protein molecules.
- Outside the neuron there are positively charged sodium ions (Na^+) and negatively charged chloride ions (Cl^-).



(a) The 10:1 concentration of sodium (Na^+) ions outside the neuron and the negative protein (A^-) ions inside contribute to a resting potential of -70mV .

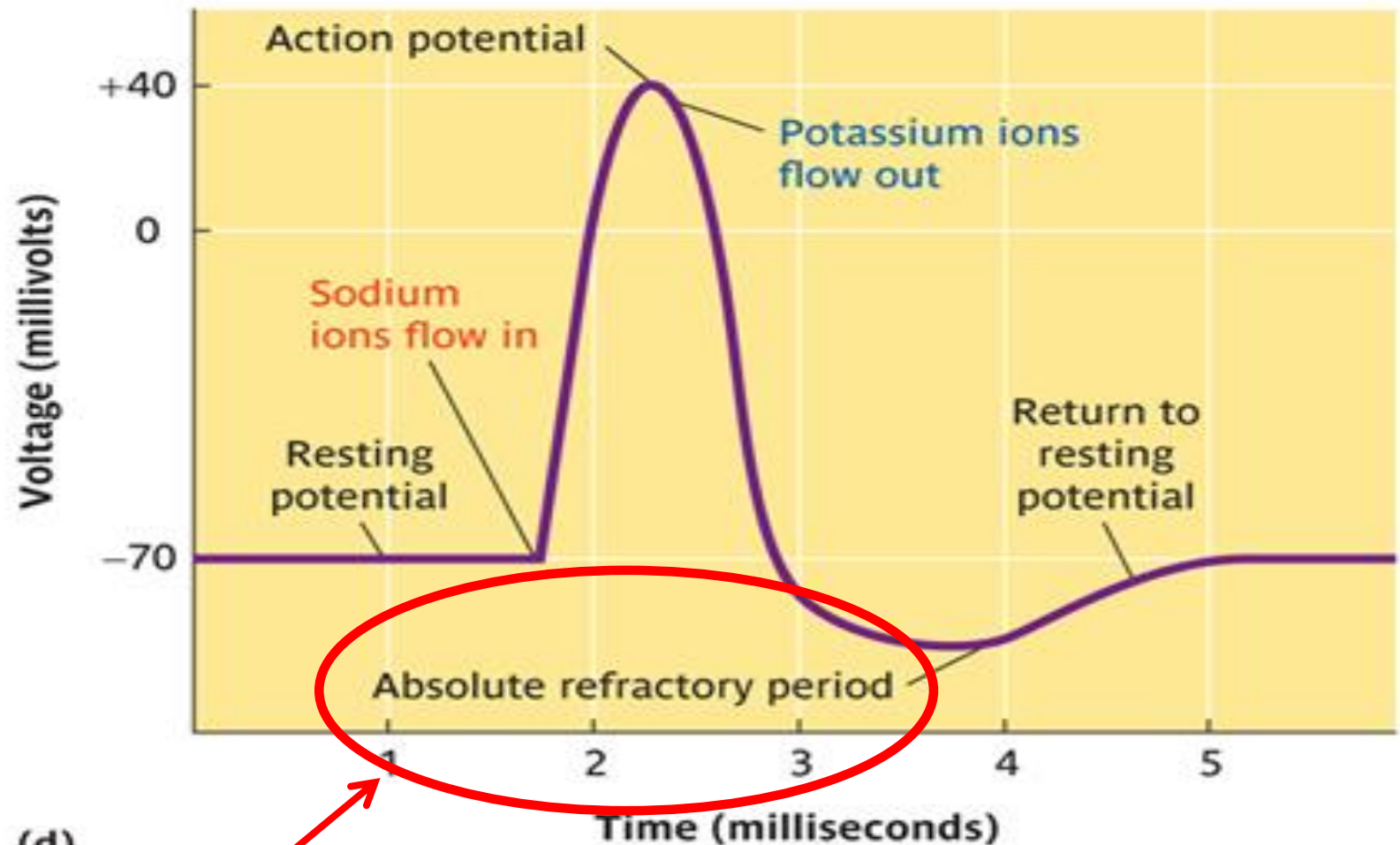


(b) If the neuron is sufficiently stimulated, sodium channels open and sodium ions flood into the axon. Note that the potassium channels are still closed.



(c) Sodium channels that were open in (b) have now closed and potassium channels behind them are open, allowing potassium ions to exit and restoring the resting potential at that point. Sodium channels are opening at the next point as the action potential moves down the axon.

- 1) Resting potential of -70 millivolts is the result of an uneven distribution of positively and negatively charged ions
- 2) When an action potential is produced, sodium channels open to let sodium ions in. This reverses the electrical potential to $+40$ millivolts
- 3) Potassium channels open to allow potassium ions to flow out of the cell. This restores the negative electrical potential inside.



(d)

The membrane of the neuron is not excitable and it cannot discharge another impulse.

Neurotransmitters

- Chemical substances that carry messages across the synaptic spaces to other neurons, muscles or glands.
- Two types of chemical reaction can occur:
 - **Excitatory:** causes the action potential to fire
 - **Inhibitory:** prevents the neuron from firing

Major Neurotransmitters and Their Effects

- **Acetylcholine (ACh)**
 - Neurotransmitter involved in muscle activity and memory
 - Generally excitatory
 - Underproduction of ACh involved in Alzheimer's
 - Overproduction occurs with Black Widow spider bites

Major Neurotransmitters and Their Effects

- **Noradrenaline (Norepinephrine)**
 - Involved in learning, memory, wakefulness and eating
 - Inhibitory in the central nervous system
 - Exhibitory in the autonomic nervous system

Major Neurotransmitters and Their Effects

- **Serotonin**

- Involved in mood, sleep, eating and arousal
- Inhibitory – depression/ eating and sleeping disorders
- Excitatory - OCD

Major Neurotransmitters and Their Effects

- **Dopamine**

- Involved in voluntary movement, emotional arousal, pleasure and pain
- Inhibitory – Parkinson's disease
- Excitatory - Schizophrenia

Major Neurotransmitters and Their Effects

- **Gamma Aminobutyric Acid (GABA)**
 - The most common inhibitor in CNS
 - Motor behaviour
 - Degeneration of GABA = tremors and loss of motor control associated with Huntingdon's disease

Drugs and your brain

- Drugs can have an effect on whether the activity of a neurotransmitter increases or decreases
- **Agonist drugs** increase the activity of a neurotransmitter
- **Antagonist drugs** inhibit or decrease the activity of a neurotransmitter

Drugs and your brain

- **Alcohol (a depressant):**
 - Agonist: stimulates activity of GABA, depression neural activity
 - Antagonist: decreases the activity of an excitatory neurotransmitter (glutamate)
 - Results in inhibited normal brain functioning – reduced clarity of thinking, emotional control and motor coordination
 - Taking sedatives with alcohol can be deadly due to further increase of GABA, i.e., severe depressant effect on the neural system!

Drugs and your brain

- **Caffeine (a stimulant drug):**
 - Reduces activity of neurotransmitter Adenosine (inhibits the release of excitatory neurotransmitters), resulting in increased neural activity and more energy

Drugs and your brain

- **Amphetamines (stimulants):**
 - Boost arousal and mood by increasing the activity of dopamine and noradrenaline
 - After effects similar to Schizophrenia
- **Rohypnol & GHB (date-rape drugs):**
 - Powerful sedatives that suppress general neural activity
 - Can lead to respiratory depression, loss of consciousness and death.

Summary

- The PNS contains all the neural structures that lie outside of the brain and spinal cord and is broken down into the autonomic and somatic nervous systems
- The autonomic nervous system contains two branches; sympathetic and parasympathetic
- Neurons are the basic building blocks of the nervous system
- Neurotransmitters are chemical substances that carry messages across the synaptic spaces to other neurons, muscles or glands
- Drugs can alter the activity of neurotransmitters

Next week...

- Understanding abnormality from a historical perspective
 - The medical model
 - The psychological model