The Nervous System

AusDBF - eLearning Modules

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The Nervous System

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– The Nervous System.

This presentation contains texts, graphics, videos and an online survey questionnaire.

It is important that you read all the text and instructions before you proceed to the next page or option.

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General functioning of the Nervous System

At the most basic level, the function of the nervous system is to send signals from one cell to others, or from one part of the body to others.

There are multiple ways that a cell can send signals to other cells.

- by releasing chemicals called hormones into the internal circulation, so that they can diffuse to distant sites.
- via electrical impulses, point-to-point signals, where neurons project their axons to specific target areas and make synaptic connections with specific target cells.

This neural signalling is capable of a much higher level of specificity than hormonal signalling.

It is also much faster: the fastest nerve signals travel at speeds that exceed 100 metres per second.

General functioning of the Nervous System

At a more integrative level, the primary function of the nervous system is to control the body.

It does this by extracting information from the environment using sensory receptors, sending signals that encode this information into the central nervous system.

The CNS processes the information to determine an appropriate response, and sends output signals to muscles or glands to activate the response.

The evolution of a complex nervous system has made it possible for various animal species to have advanced perception abilities such as vision, complex social interactions, rapid coordination of organ systems, and integrated processing of concurrent signals.

In humans, the sophistication of the nervous system makes it possible to have language, abstract representation of concepts, transmission of culture, and many other features of human society that would not exist without the human brain.

The Nervous System…….what it does

- at the cellular level, the nervous system is defined by the presence of a special type of cell, called the neuron, also known as a "nerve cell"
- neurons have special structures that allow them to send signals rapidly and precisely to other cells.
- they send these signals in the form of electrochemical waves traveling along thin fibres called axons
- the connections between neurons can form neural pathways, neural circuits, and larger networks that generate our perception of the world and determine our behaviour.
- along with neurons, the nervous system contains other specialized cells called glial cells which provide structural and metabolic support.

The Nervous System – an introduction

THE NERVOUS SYSTEM

- is a highly complex part of humans that coordinates it's actions and sensory information by transmitting signals to and from different parts of it's body

- it detects environmental changes that impact the body, then works in tandem with the endocrine system to respond to such events**.**

THE NERVOUS SYSTEM CONSISTS OF TWO MAIN PARTS

- the central nervous system (CNS)
- the peripheral nervous system (PNS)

The CNS consists of the brain and spinal cord.

- nerves that exit from the cranium are called cranial nerves
- nerves exiting from the spinal cord are called spinal nerves

The PNS is divided into separate subsystems,

- ✓ the autonomic nervous system (including the Sympathetic & Parasympathetic Nervous Systems)
- ✓ the somatic nervous system,
- ✓ the enteric nervous system

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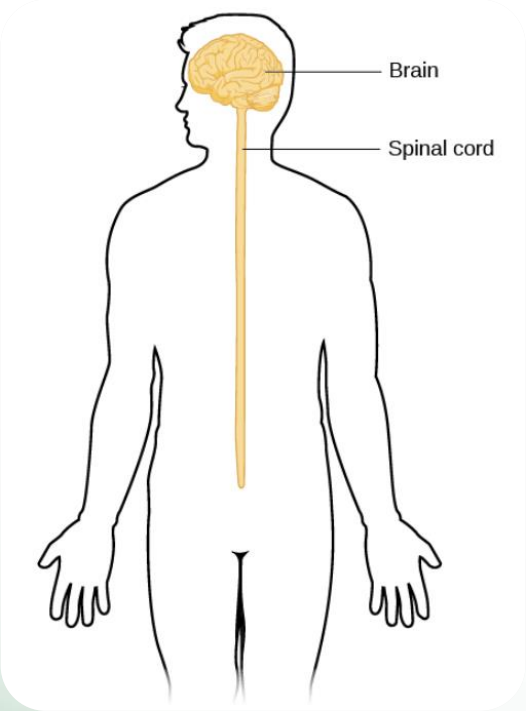
The Nervous System



CNS

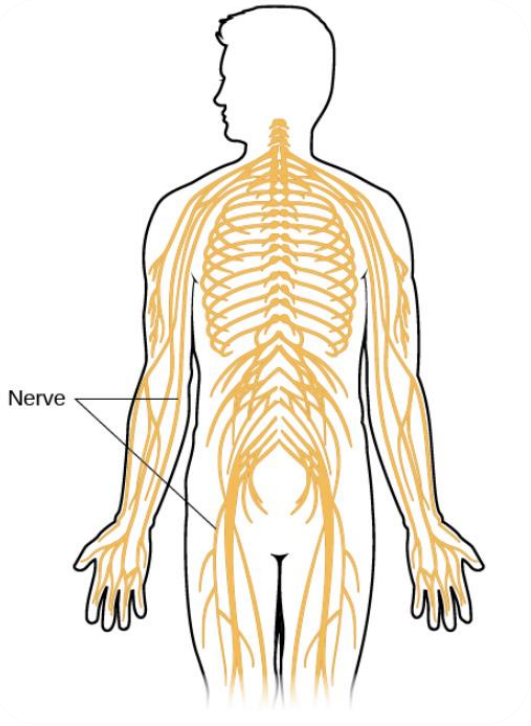
THE NERVOUS SYSTEM is divided into two systems

Central Nervous System (CNS)

- is the body's master control unit
- is made up of the Brain, and the Spinal Cord.

Peripheral Nervous system (PNS)

- consists mainly of nerves, which are enclosed bundles of the long fibres or axons
- connects the rest of the body to the CNS



PNS

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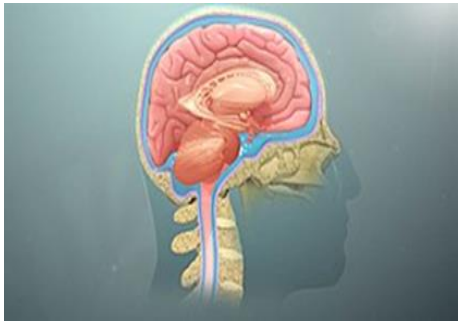
The Central Nervous System….



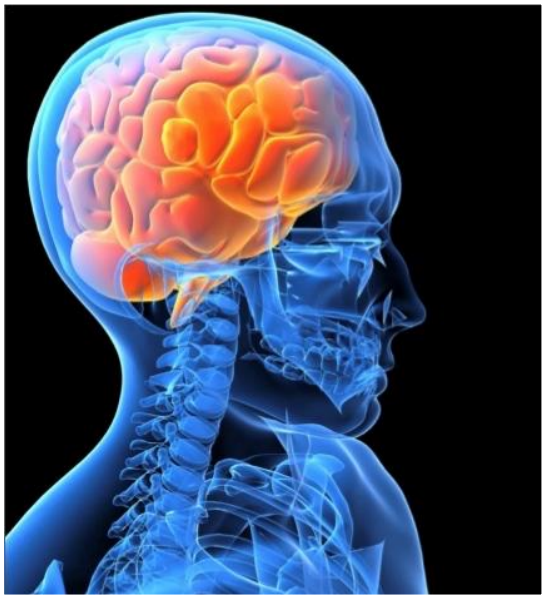
The central nervous system is protected by major physical and chemical barriers.

Chemically, the brain and spinal cord are isolated by the blood–brain barrier, which prevents most types of chemicals from moving from the bloodstream into the interior of the CNS.

These protections make the CNS less susceptible in many ways than the PNS
… the flip side, however, is that damage to the CNS tends to have more serious consequences.

The brain…….

- contains about 86 billion nerve cells called neurons, known as our “grey matter”
- the adult human brain weighs about 1.4kilograms
- makes up approx. 2% of our body weight
- made up of billions of nerve fibres, called axons and dendrites, our white matter
- these neurons are connected by trillions of connections, or synapses
- receives and processes our sensory information and initiates responses
- stores information, memories and generates thoughts and emotions



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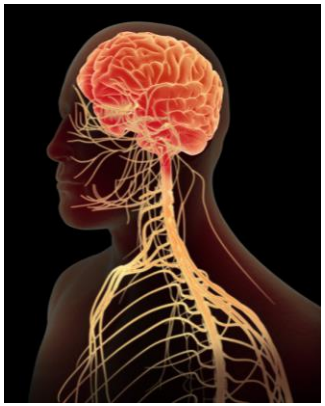
The Central Nervous System - The Brain

- physically, the brain and spinal cord are surrounded by tough meningeal membranes, and enclosed in the bones of the skull and vertebral column, which combine to form a strong physical shield.



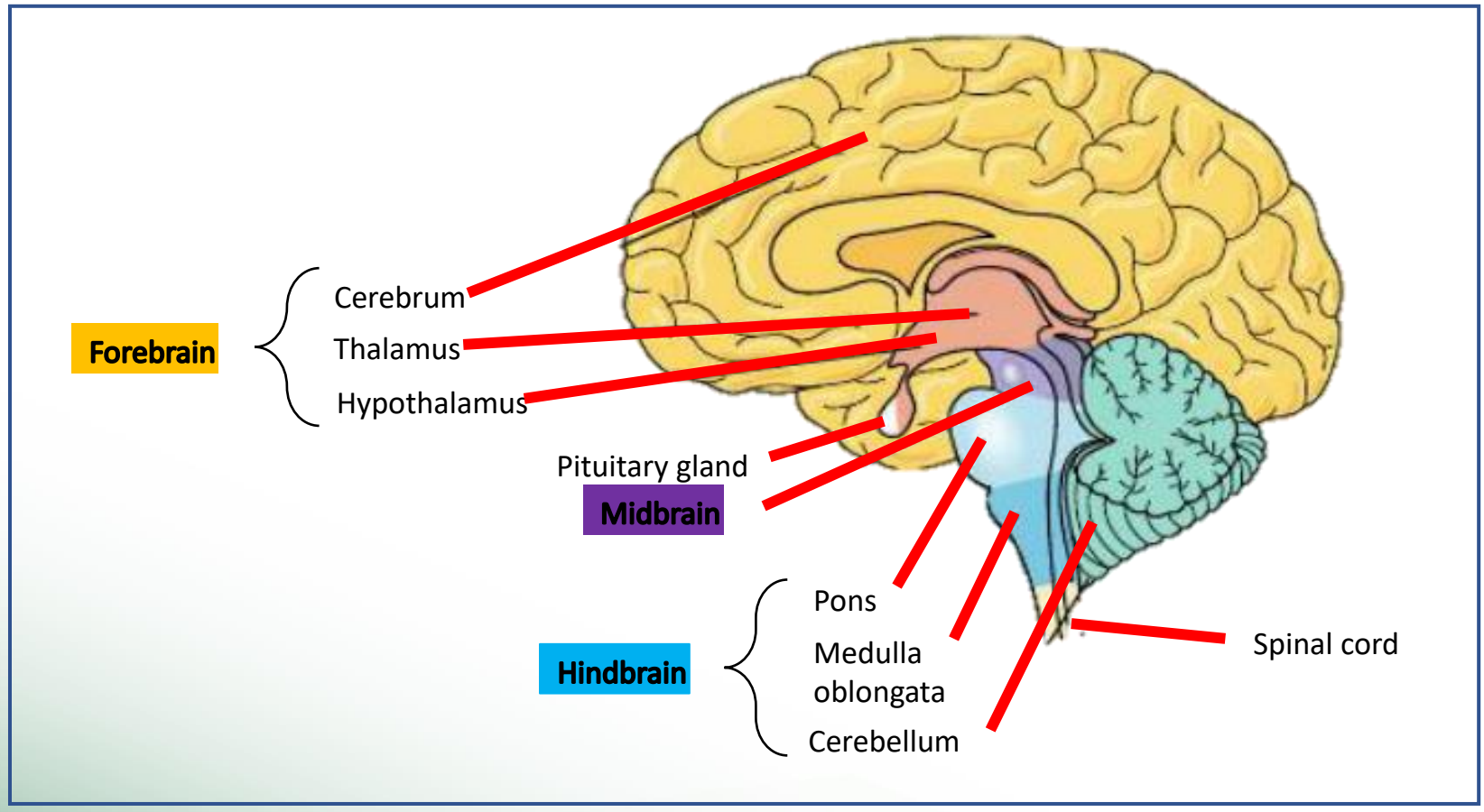
THE CEREBRUM

- the largest and uppermost part of the brain
- is divided into 2 hemispheres, left and right
- the brainstem lies underneath the cerebrum

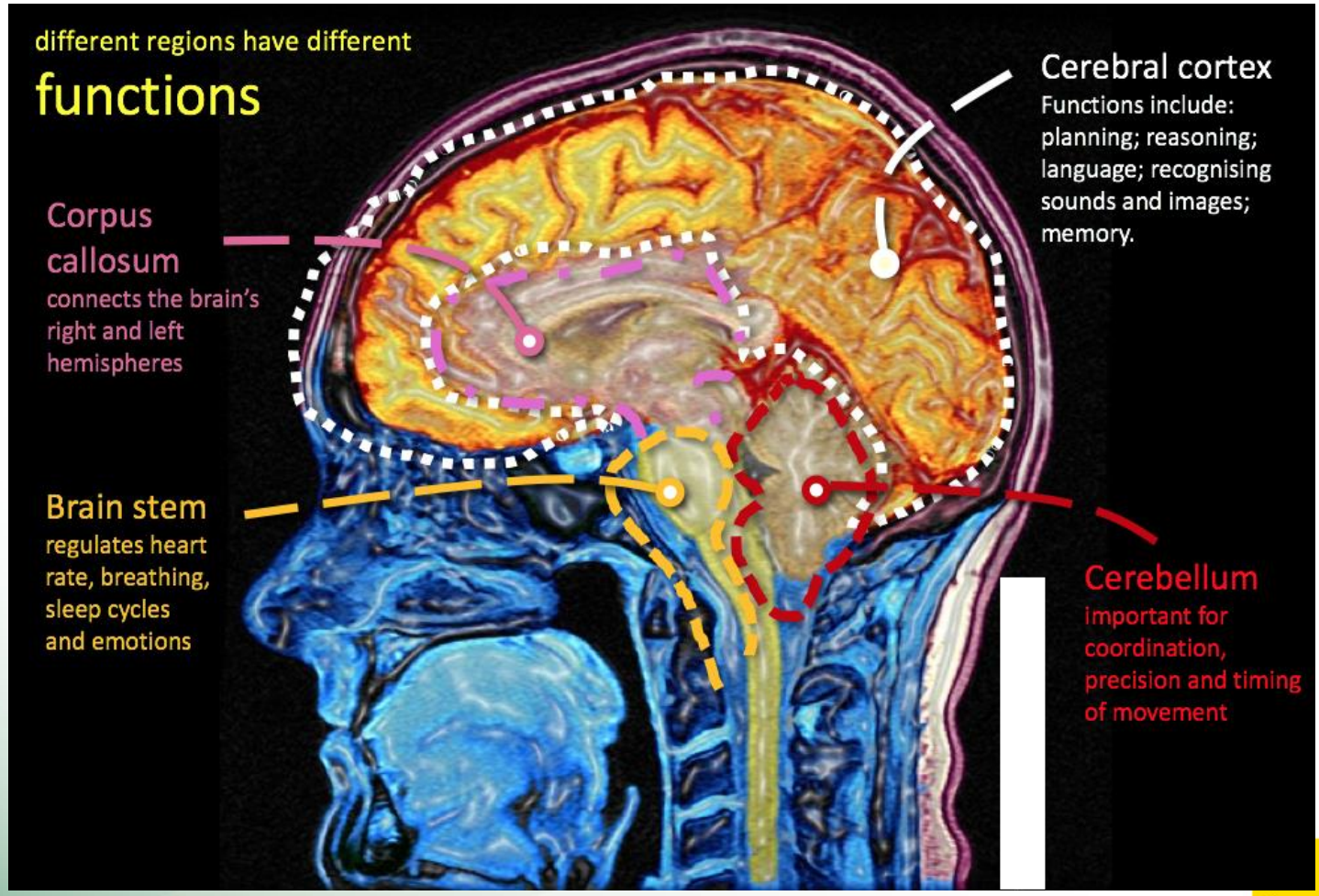
CEREBRAL CORTEX

- Is the outermost part of our cerebrum
- consists of four lobes,
  - ✓ frontal lobe - responsible for our voluntary movement,
  - ✓ parietal lobe - which functions include sensation, perception & spacial reasoning.
  - ✓ temporal lobes - primary function is the processing of auditory sounds
  - ✓ occipital lobe - responsible for our visual processing

The Brain


Forebrain
Cerebrum
Thalamus
Hypothalamus
Pituitary gland
Midbrain
Hindbrain
Pons
Medulla oblongata
Cerebellum
Spinal cord

Functions of the brain



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The Central Nervous System

THE SPINAL CORD

- conducts signals to and from the brain
- controls our reflex actions

- nerves that transmit signals FROM the brain are called motor or EFFERENT nerves
- nerves that transmit information from the body TO the CNS are called SENSORY OR AFFERENT nerves
- nerves that serve both functions are called MIXED nerves.

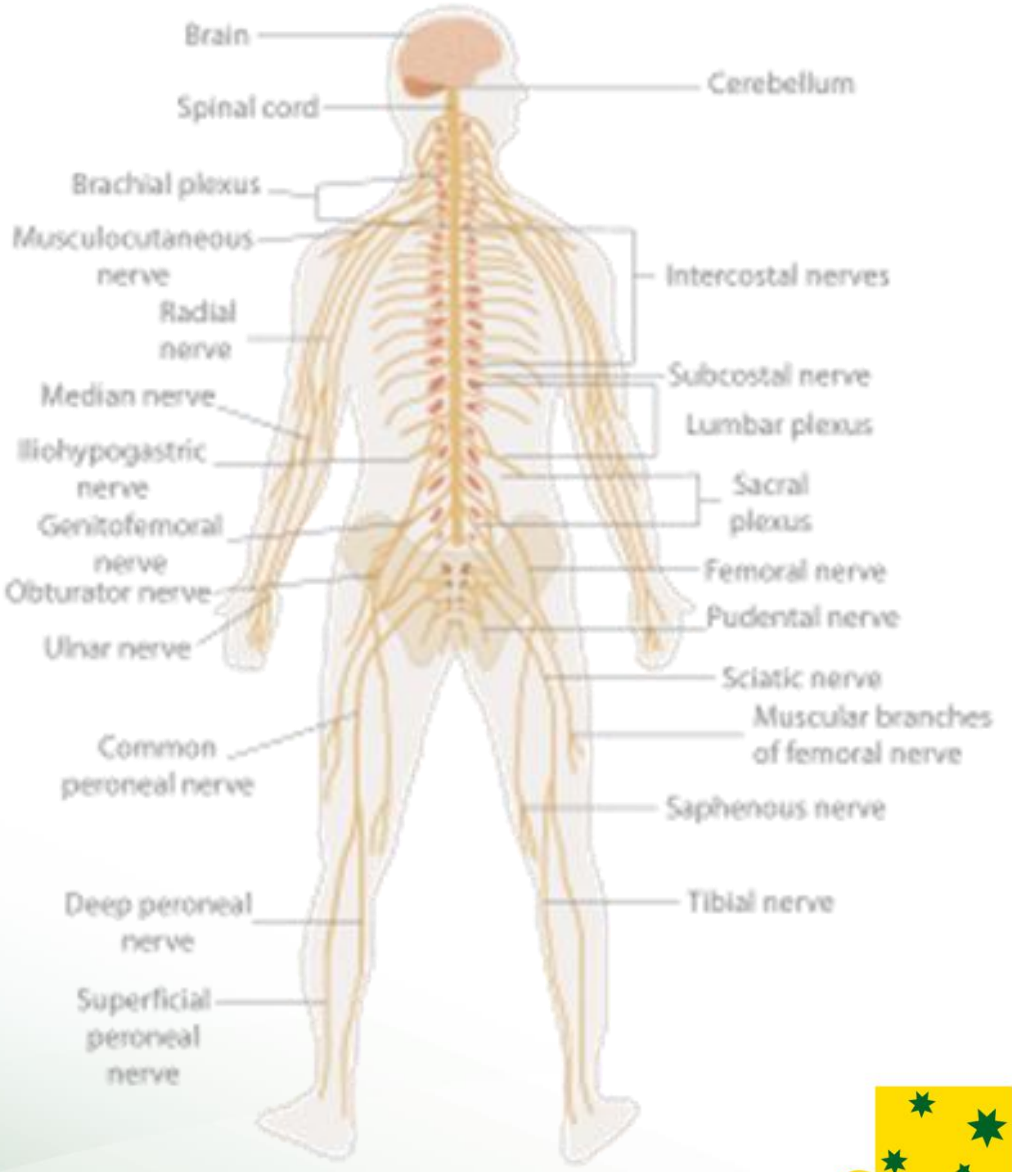
- is a column of nerves between the brain and peripheral nervous system PNS
- a pair of spinal nerves leaves each segment of the spinal cord
- these leaves transmit information to our peripheral nervous system (PNS)

SPINAL COLUMN

- vertebral column, made up of interconnecting vertebrae and protects the spinal cord

The Peripheral Nervous System

Major nerves of the body



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The Peripheral Nervous System (PNS)

THE PERIPHERAL NERVOUS SYSTEM (PNS)

- is the body's link to the outside world

- consists of subsystems -
  - ✓ the autonomic nervous System, and is further divided into
    - ➢ the sympathetic nervous System
    - ➢ the parasympathetic nervous System.
  - ✓ the somatic nervous system
  - ✓ the enteric nervous system

- both autonomic and enteric nervous systems function involuntarily.

THE AUTONOMIC NERVOUS SYSTEM

Regulates our bodily processes including our heart rate, our respiration, digestion and our pupil contraction. These operate automatically without any conscious direction. Further subdivided into the Sympathetic and Parasympathetic nervous systems

The Peripheral Nervous System (PNS)……

THE SOMATIC NERVOUS SYSTEM

Carries sensory information from our sensory organs to our Central Nervous System and relays motor (our movement) commands to our muscles.
This controls our VOLUNTARY movements.

THE SYMPATHETIC NERVOUS SYSTEM

Prepares our body for action and stress. This is called our “fight or flight” response.
Part of the Autonomic Nervous System - INVOLUNTARY

THE PARASYMPATHETIC NERVOUS SYSTEM

Calms our body, enables rest & relaxation and also helps the body to conserve energy.
Part of the Autonomic Nervous System - INVOLUNTARY

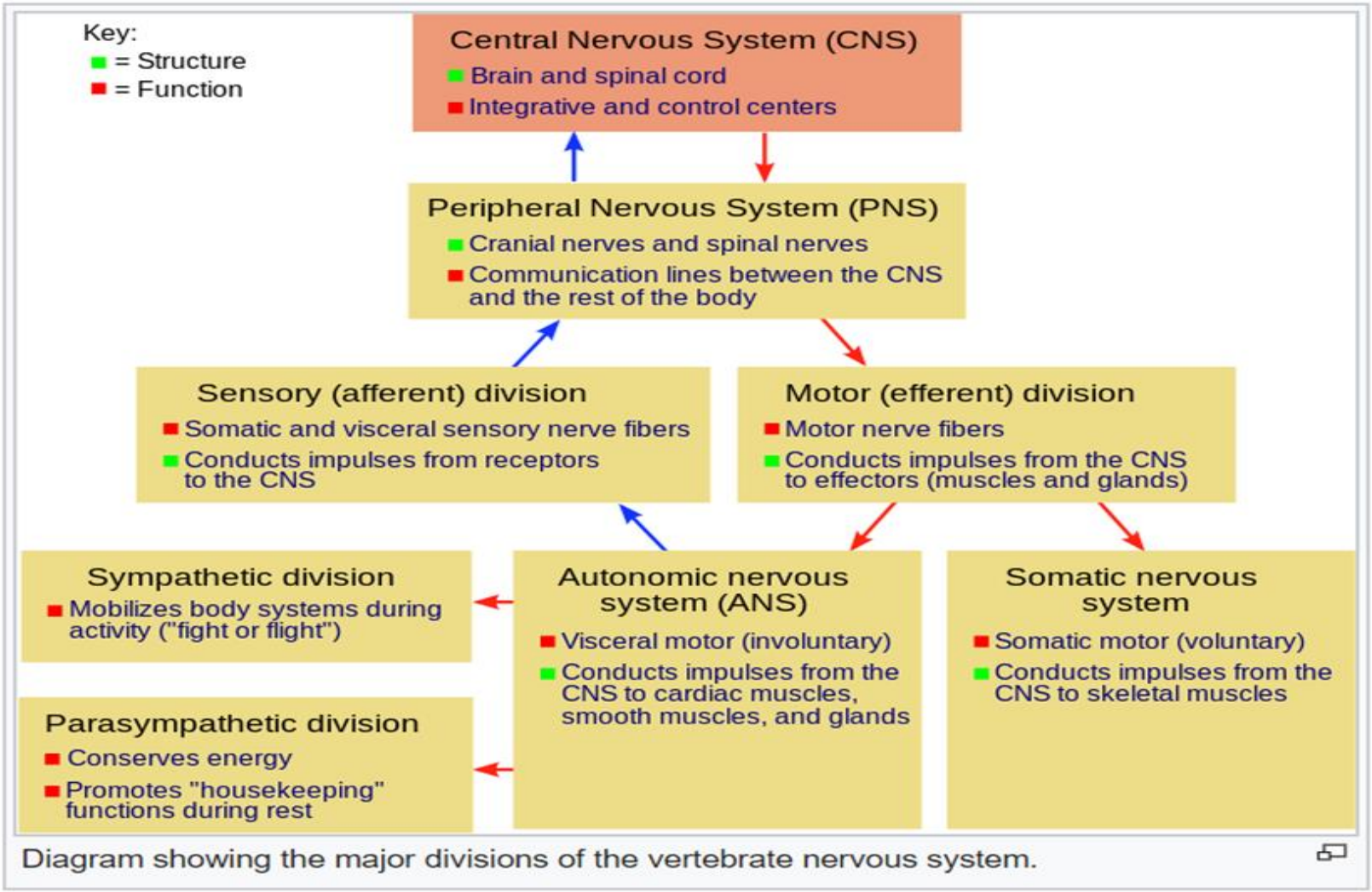

Diagram showing the major divisions of the vertebrate nervous system.

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Neurons (the nerve cell)

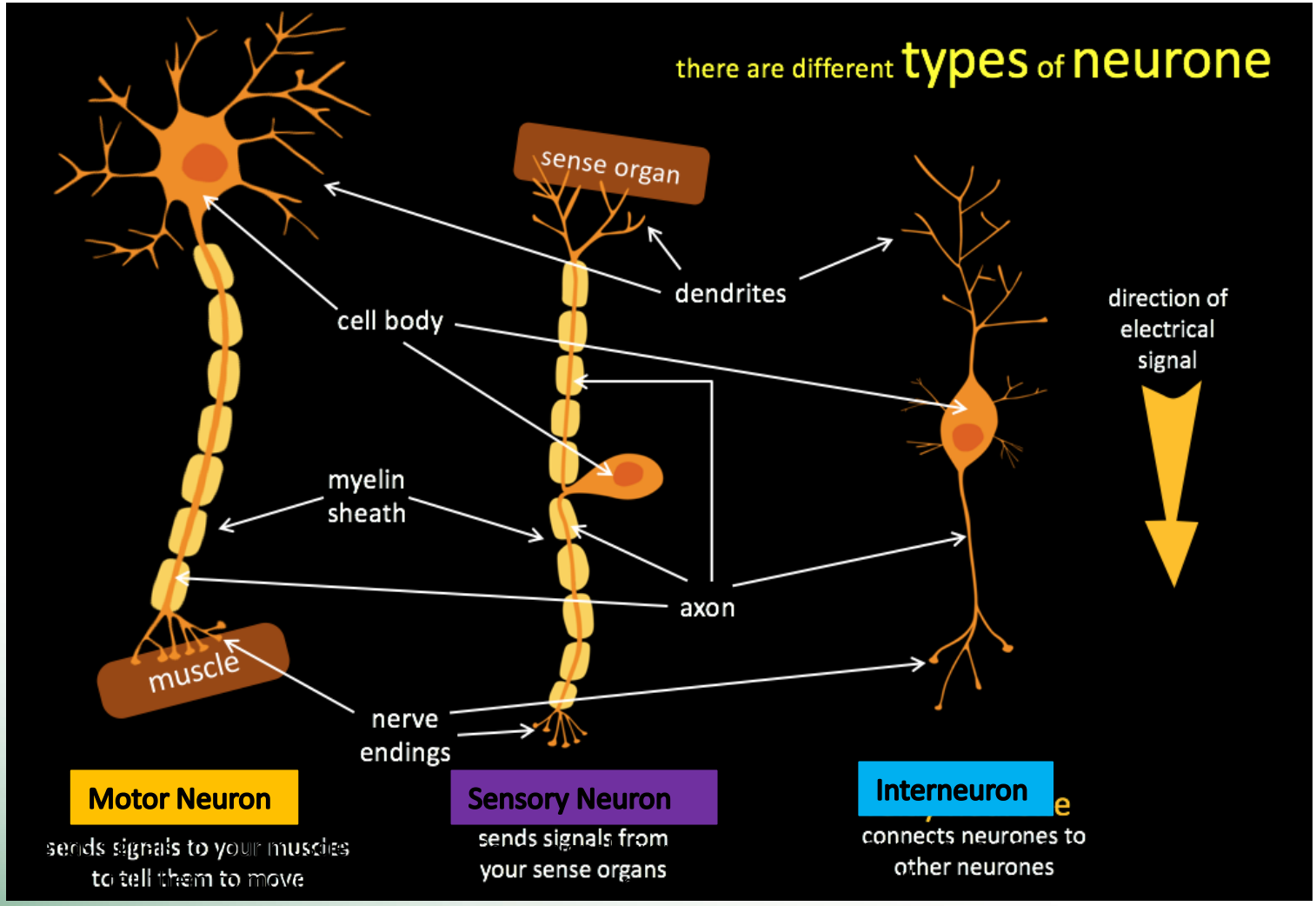
- there are three types of neurons – sensory, motor and inter neuron

- all three have different functions, however the brain needs them all to communicate effectively

SENSORY NERVES
- are activated by physical modalities such as visible light, sound, heat, physical contact,
- also activated by chemical signals such as smell and taste

MOTOR NEURONS are located in the CNS

INTER NEURONES are neither sensory or motor
- these are located in the CNS and operate locally



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The structure of a neuron (nerve cell)

CELL BODY *(or soma)*

- each neuron has a cell body that contains a nucleus, and other cellular components

AXONS

- are tube like, long slender projections, extend throughout the body in bundles
- conduct the electrical impulses from the cell body to the
- extend to distant parts of the body, to the axon terminals
- make thousands of synaptic contacts
- are covered with myelin and create a myelin sheath along the length of the axon

DENDRITES

- are branch like structures found extending away from the cell body
- these receive messages from other neurons and allow messages to travel to the cell body

MYELIN

- is made up of white, fatty material composed of lipids,
- acts as an insulator
- acts as a conductor to speed up the communication process

The structure of a neuron (nerve cell)

SYNAPSES

- is a chemical junction (rather than a actual structure)
- this gap, is also known as a neuromuscular junction
- are found between the axon terminal of one neuron and the dendrites of the next

NODES OF RANVIER

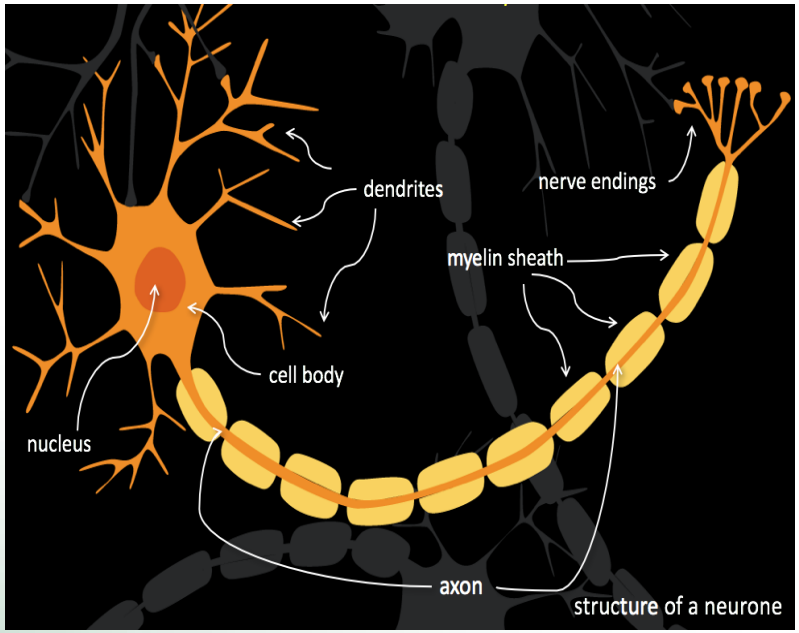
- periodic gaps in the myelin sheath where the signal is recharged as it moves along the axon

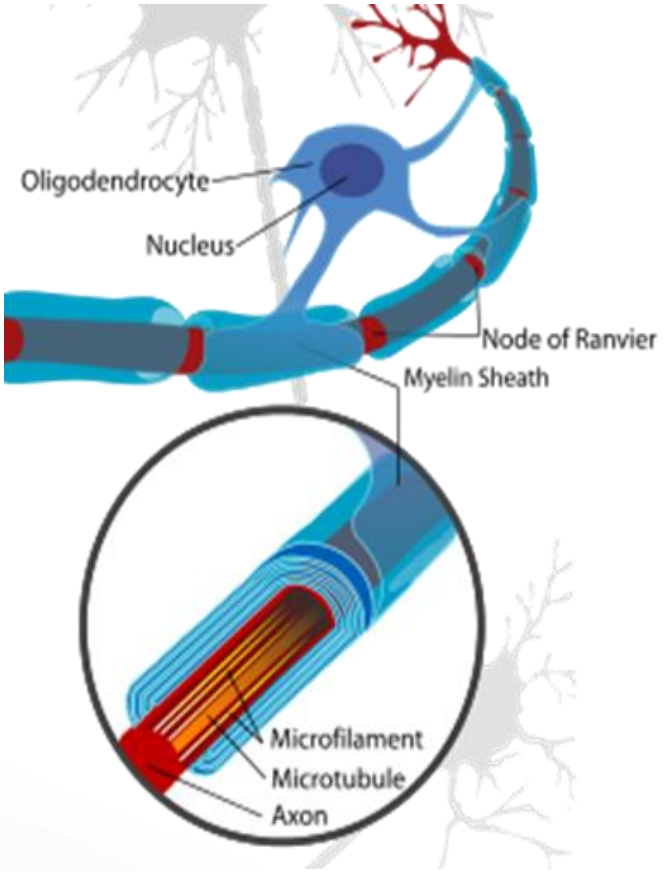
GLIAL CELLs

- are non neuronal cells that provides structure and support to neurons
- produce myelin hold the neurons in place
- supply with nutrients and remove pathogens

- in the CNS glial cells are called oligodendrocytes,
- in the PNS they are called Schwann cells

The structure of a neurone





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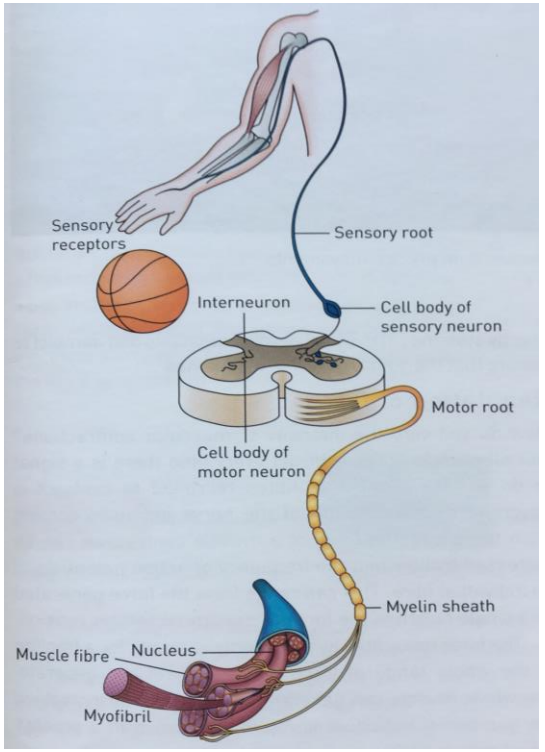
So how does a muscle contract?

- The **brain** is responsible for initiating all actions
- **Spinal cord** carries it's messages
- Messages are sent by **electrical impulses** via motor neurons (nerve cells)
- **Motor neurons** (nerve cell) stimulate muscular contraction
- one Motor Neuron – only stimulates a small portion of the muscle (not the whole muscle)



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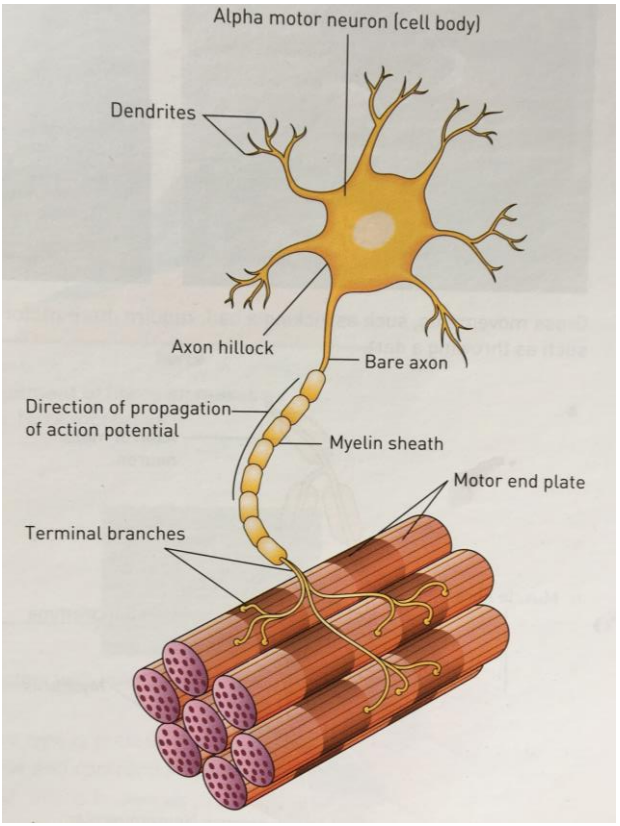
What is a motor unit?

One motor neuron only stimulates a small portion of the muscle, not the whole muscle.

MOTOR UNIT =
the motor neuron + the muscle fibre it stimulates

- where precision is required one motor unit may stimulate one or two muscle fibres
- where gross movement is required the neuron may be responsible for stimulating thousands of muscle fibres



A motor unit

PREFERENTIAL RECRUITMENT

– the body recruits fibres according to the activity's demand.

- fast twitch muscle fibres - immediate rapid response is required
- slow twitch fibres - slower response, lower intensity

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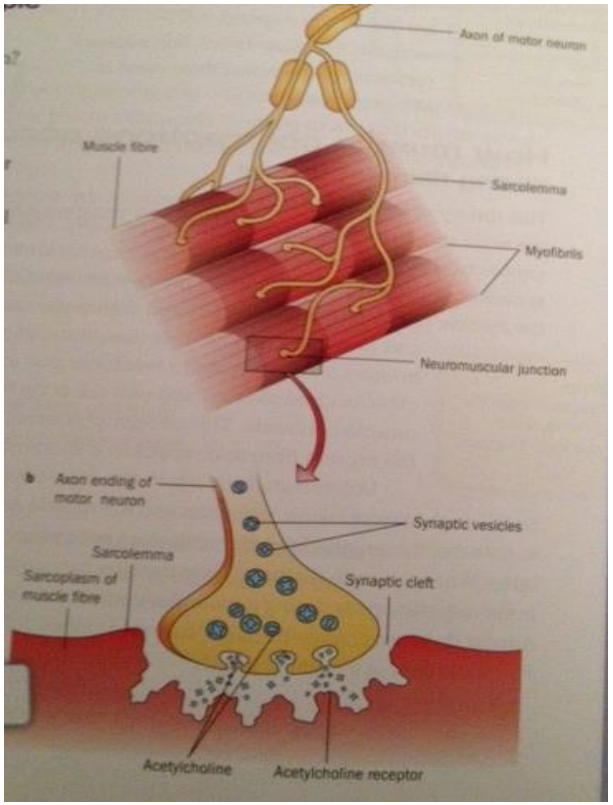
What happens at the Neuromuscular Junction?

- motor neurons “connect” to muscles at SYNAPSES on the individual myofibril and known as NEUROMUSCULAR JUNCTIONS
- SYNAPSES - the junction, or gap, between a neuron and a muscle fibre
- ACETYLCHOLINE – (a neurotransmitter) the chemical responsible for the transfer of impulses from a neuron to a muscle across the neuromuscular junction
- local depolarisation at the motor end plate causes release of calcium, resulting in muscle contraction (actin & myosin movement)
- ACETYLCHLOINESTERASE (enzyme) breaks down acetylcholine and the muscle relaxes.



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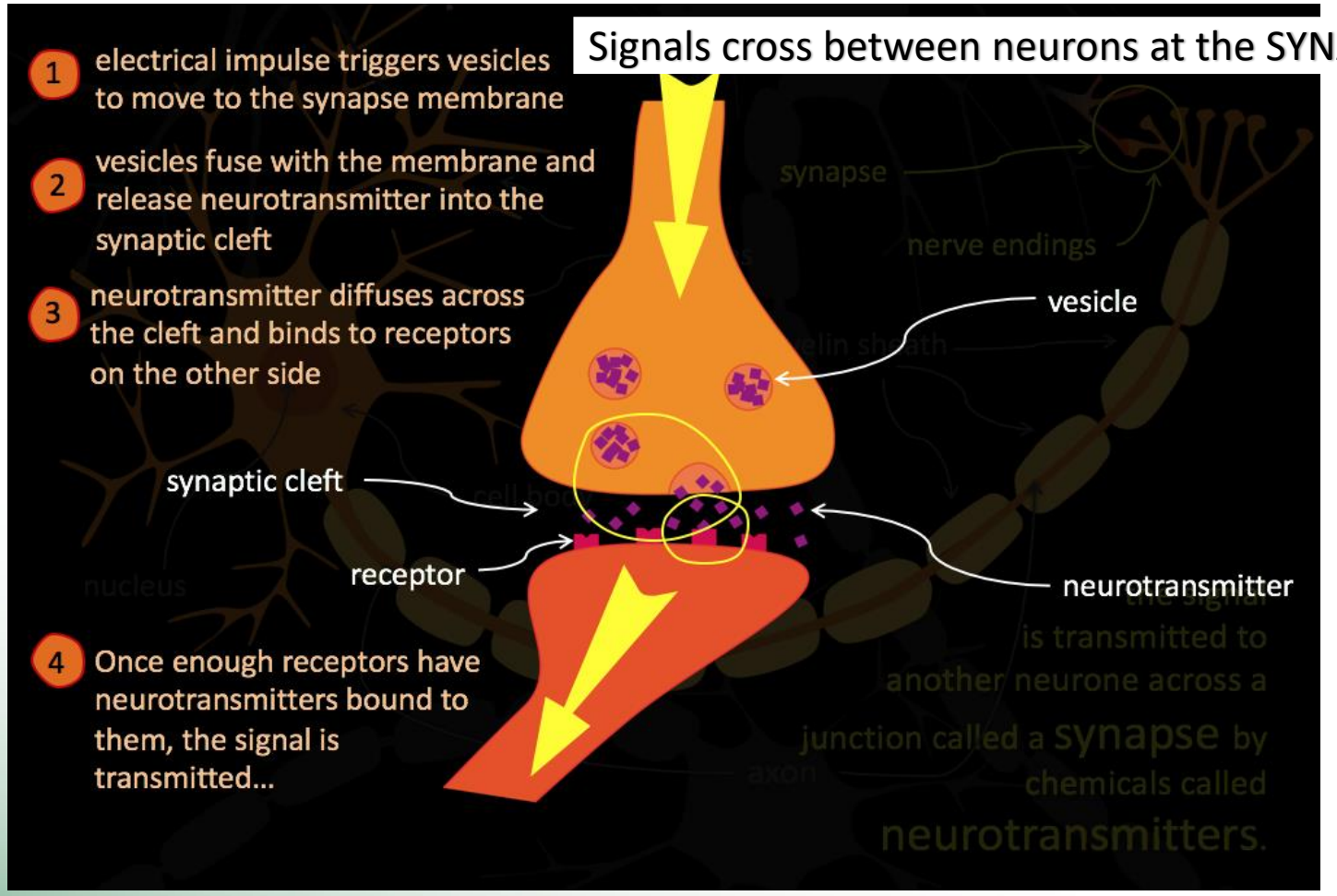
Signals cross between neurons at the SYNAPSE



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The ALL or NOTHING Principle

- when the electrical impulse reaches a certain threshold, all of the fibres of that motor unit will contract at the same time & as forcefully as possible.
- once impulse passes the threshold, the ATP stored in the muscle fibre is split with the resultant energy release allowing the muscle to contract.
- the amount of ATP stored at the muscle site is limited, hence it must be resupplied to enable the muscle to continue working
- the number of fibres recruited to contract is governed by the strength of nerve impulses coming from the brain
- the greater the nerve impulses the more muscle fibres will contract
- the greater the frequency of arrival of impulse, the greater the force developed at that muscle

Neuropathy and nerve damage

The failure of effective nerve impulse conduction throughout the nervous system can be caused by both physical damage such as trauma or injury, and a variety of medical issues, including …..

- genetic conditions,
- metabolic conditions such as diabetes,
- inflammatory conditions such as Guillain–Barré syndrome,
- vitamin deficiency,
- infectious diseases such as leprosy or shingles,
- poisoning by toxins such as heavy metals.
- demyelinating disorders such as multiple sclerosis, amyotrophic lateral sclerosis

Many cases of malfunction have no identifiable cause, and are referred to as idiopathic.

It is also possible for nerves to lose function temporarily, resulting in numbness as stiffness —common causes include mechanical pressure, a drop in temperature, or chemical interactions with local anaesthetic drugs such as lidocaine.

Neuropathy and nerve damage

PHYSICAL DAMAGE to the spinal cord may result in loss of sensation or movement.

Although nerves tend to lie deep under the skin except in a few places such as the ulnar nerve near the elbow joint, they are still relatively exposed to physical damage, which can cause pain, loss of sensation, or loss of muscle control.

If an injury to the spine produces nothing worse than swelling, the symptoms may be transient, but if nerve fibres in the spine are actually destroyed, the loss of function is usually permanent.

Experimental studies have shown that spinal nerve fibres attempt to regrow in the same way as nerve fibres, but in the spinal cord, tissue destruction usually produces scar tissue that cannot be penetrated by the regrowing nerves.

Damage to nerves can also be caused by swelling or bruises at places where a nerve passes through a tight bony channel, as happens in carpal tunnel syndrome.

"The right half of the brain controls the left half of the body. This means that only left handed people are in their right mind."

Please turn up your volume
then click on the URL link below to view a short video
of The Nervous system.
When the video is completed please return
and go to the next slide in this presentation.

https://youtu.be/uaAwIN1gPm4