

London School of Massage



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Neurological System

At the end of this section you will understand and appreciate:

- Structure and function of the nervous system
- Classification of nervous tissue
- Classification of the nervous system
- Coverings of the brain and spinal cord
- The Reflex Arc
- Conditions affecting the nervous system
- How massage affects the nervous system

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Neurological System

The Neurological or Nervous System transmits and receive messages to and from the brain and all parts of the body. It can be thought of as the electrical wiring of the body.

THE NERVE CELL

The basic cell of the nervous system is called the **neurone**

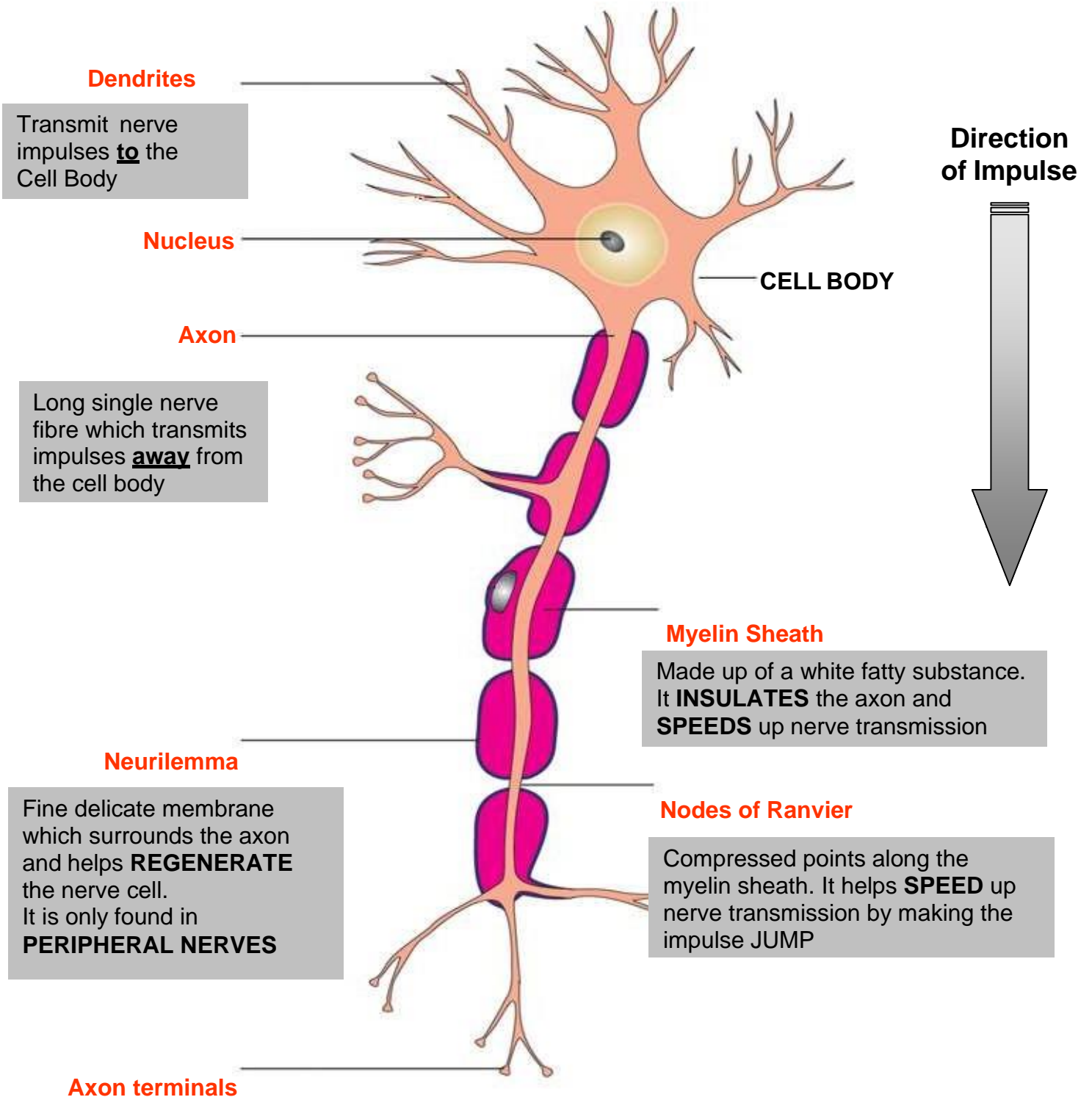
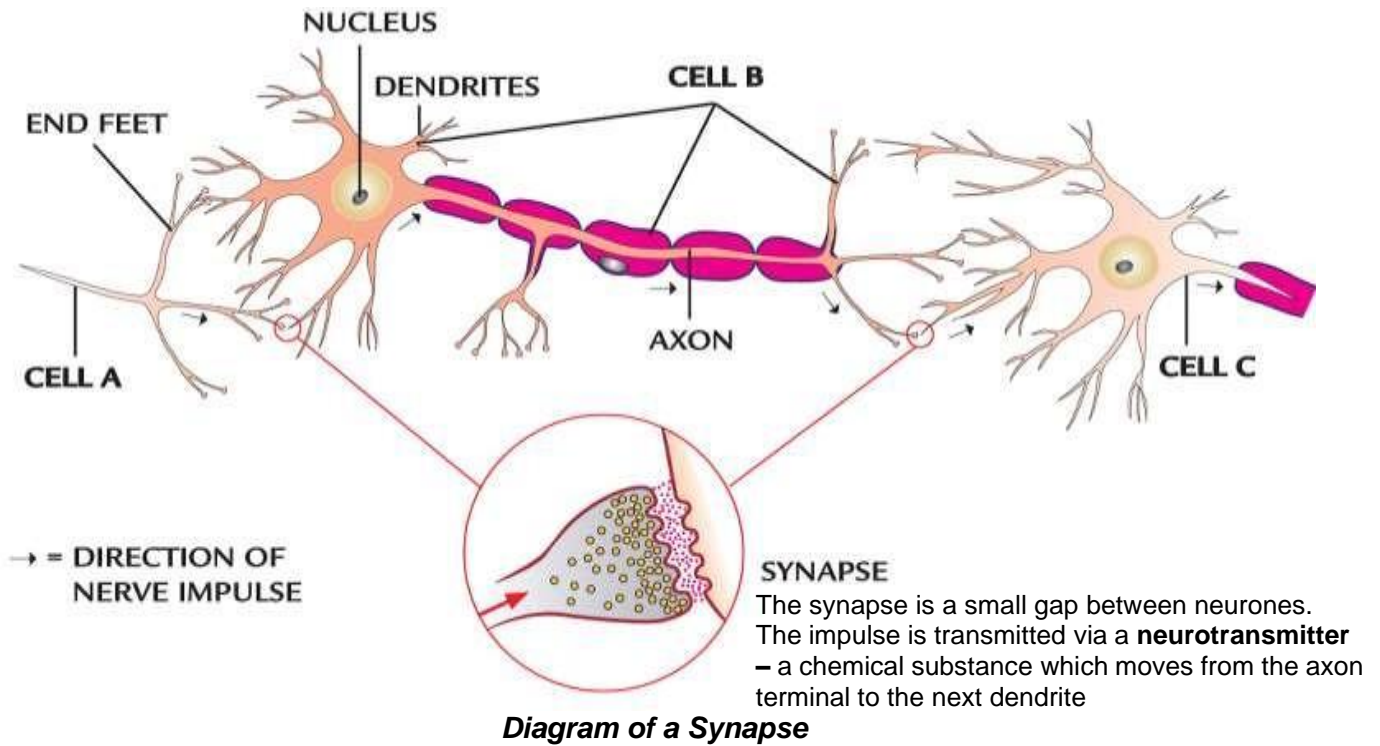


Diagram of Neuron and Nerve Sheath

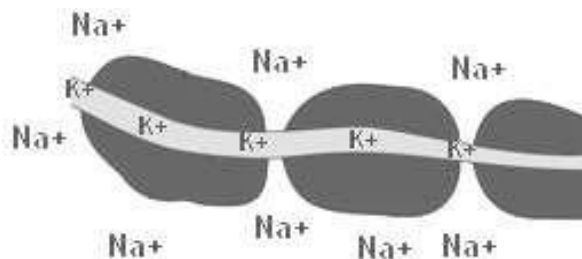


NERVE TRANSMISSION

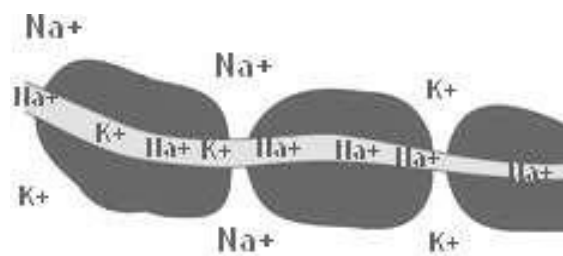
Nerve cells transmit and receive impulses throughout the body. Impulses do not continually run along each nerve but are created in response to internal or external stimuli.

The transmission of a nerve impulse along a neuron from one end to the other occurs as a result of chemical changes across the membrane of the neuron. The membrane of an unstimulated neuron is **polarized**—that is, there is a difference in electrical charge between the outside and inside of the membrane. The inside is negative with respect to the outside. This is maintained by differences in the permeability to these ions and by the sodium potassium pump.

Na⁺ = Sodium Ions



When a stimuli is detected, the axon membrane become temporarily permeable to sodium ions, which rush in, making the inside of the cell more positive (**depolarisation**). The electrochemical charge continues in waves along the length of the nerve cell as a nerve impulse.



After it has passed the resting state is restored (**repolarisation**).

TYPES OF NERVOUS TISSUE

Individual neurones have the same function throughout the body (to transmit information), but collectively they make up **5** different types of nerves and nervous tissue, which have specific function:

Type		Function
1	Motor Nerve (Efferent)	<ul style="list-style-type: none"> ▪ Carry impulses from brain or spinal cord to muscular and glandular tissue. ▪ Provide instruction to muscle on movement and contraction
2	Sensory Nerve (Afferent)	<ul style="list-style-type: none"> ▪ Carry impulse from all parts of the body to the brain
3	Mixed Motor & Sensory)	<ul style="list-style-type: none"> ▪ Carry both sensory and motor nerves ▪ Are only present in the PERIPHERAL NERVES
4	White Matter	<ul style="list-style-type: none"> ▪ Found: <ol style="list-style-type: none"> a. Inner part of BRAIN b. Outer part of the SPINAL CORD ▪ Made up of bundles of myelinated nerve fibres
5	Grey Matter	<ul style="list-style-type: none"> ▪ Found: <ol style="list-style-type: none"> a. Outer part of BRAIN b. Inner part of the SPINAL CORD ▪ Made up of bundles of unmyelinated nerve fibres

THE TWO DIVISIONS OF THE NERVOUS SYSTEM

There are two divisions to the nervous system. These are:

1. **Central Nervous System (CNS)** - Brain + Spinal Cord

2. **Peripheral Nervous System**

i. **Cranial Nerves**

ii. **Spinal Nerves**

iii. **Autonomic Nervous System**



Sympathetic Nervous System

Parasympathetic Nervous System

THE CENTRAL NERVOUS SYSTEM

THE BRAIN

For descriptive purposes, the brain can be divided into three separate structures:

1. **Cerebrum**
2. **Cerebellum**
3. **Brain Stem** – (Hypothalamus, Midbrain, Pons Varolii, Medulla Oblongata)

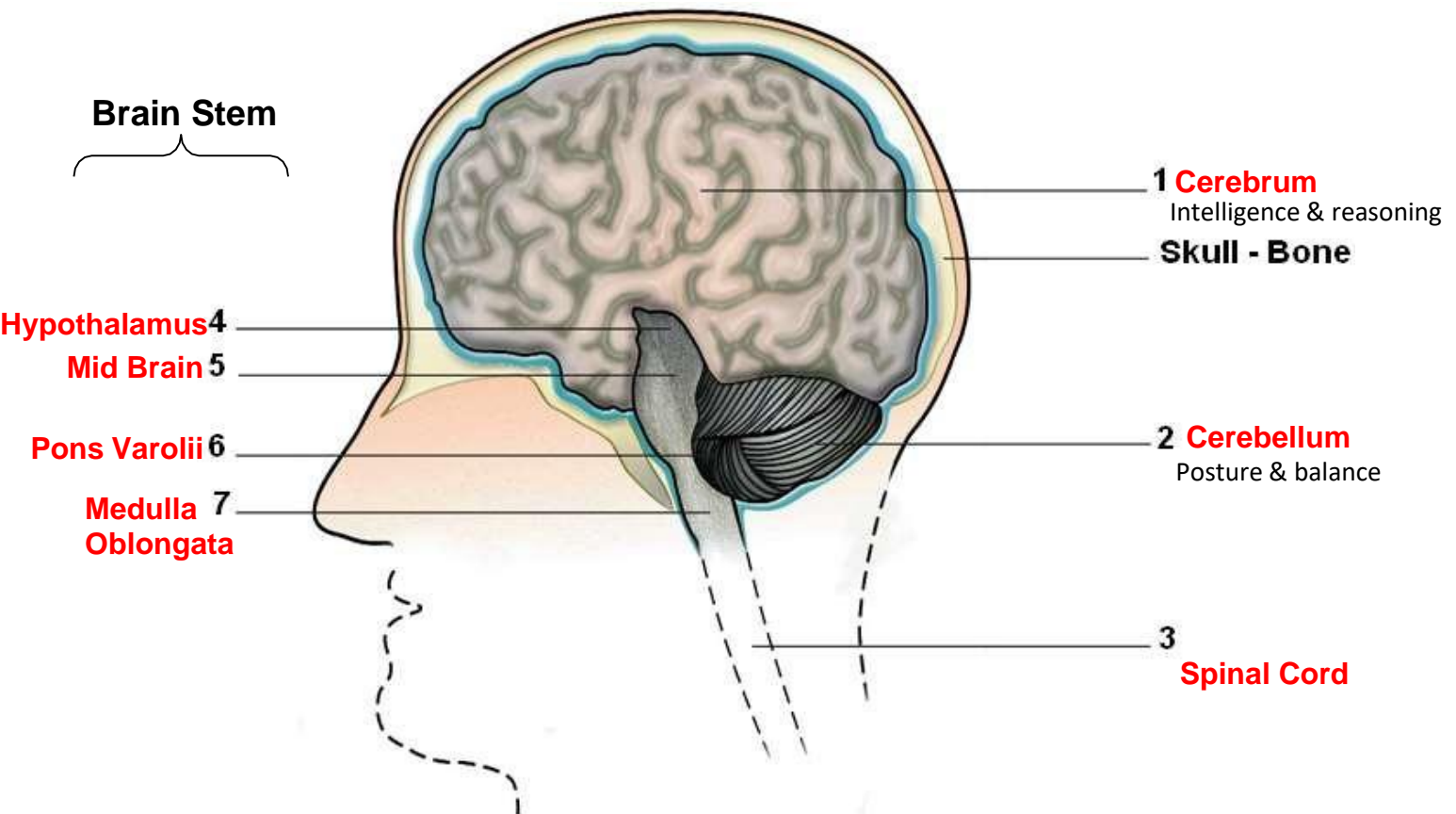


Diagram of the Brain

1. Cerebrum

- Is divided into a right and left hemisphere (half)
- Has many folds on its which consist of **white** and **grey** matter

The functions of the cerebrum are:

- Controls **voluntary** movements
- Controls **mental** activity like **intelligence** and **reasoning**
- **Interprets** and perceives **conscious** sensation like temperature and pain.

2. Cerebellum

This is similar in make up to the cerebrum (white and grey matter).

The functions of the Cerebellum are:

- Coordinate **muscular** activity and makes actions smooth
- Maintains **posture** and **balance**

3. Brain Stem

This is divided into: The **Mid Brain, Medulla Oblongata** and **Pons Varolii**

Mid Brain

This lies between the cerebrum and cerebellum and above the pons varolii and medulla oblongata. The Functions are:

- Is a relay station of the brain transmitting messages from the spinal cord, cerebellum and cerebrum.

Medulla Oblongata

This joins the spinal cord and brain – lowest part of the brain stem. It is interspersed with white and grey matter. It is known as the **vital centre** as it controls the actions of the **heart** and the **lungs**.

The medulla has 4 centres. These are:

- **Cardiac Centre** : controls rate and force of heart contraction
- **Respiratory Centre** : controls rate and depth of breathing
- **Vasomotor Centre** : controls vasoconstriction and vasodilation
- **Reflex Centre** : controls vital reflexes like vomiting & coughing

Pons Varolii

The pons acts as a bridge, which unites the left and right hemispheres of the cerebellum and transmits messages to and from the spinal cord and cerebellum.

Hypothalamus

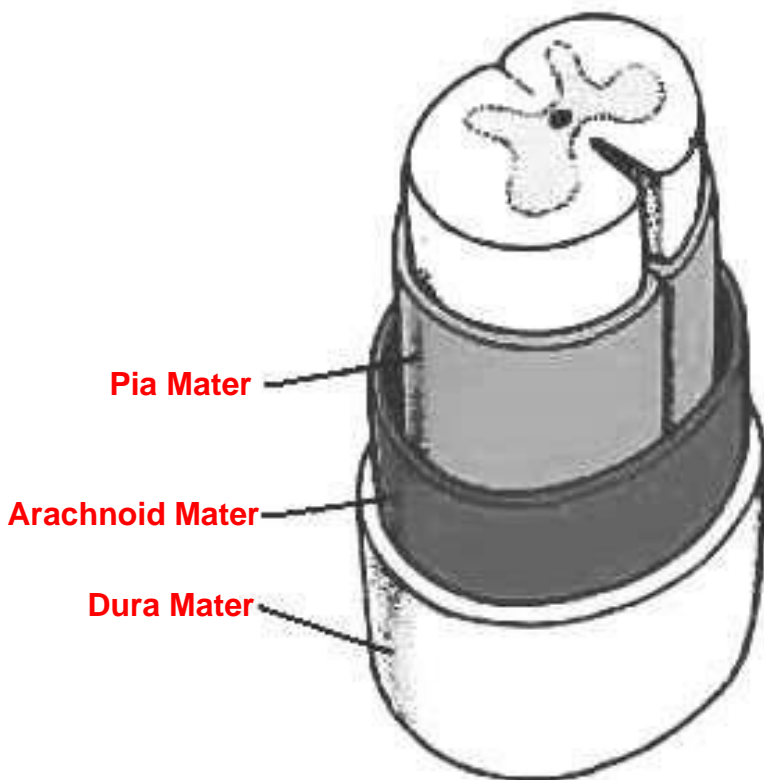
This is situated at the top of the brain stem and with the pituitary gland attached to its base. It contains the heat regulating centre as well as controlling bodily drives (appetite, thirst, sex etc.).

It also regulates the pituitary gland thus forming the main link between the nervous and endocrine systems – **NEUROENDOCRINE LINK**

COVERINGS OF THE BRAIN & SPINAL CORD

The Brain and the spinal cord are surrounded by **3** membranes. These are called the **Meninges** and lie between the skull and brain and spinal cord and vertebra (see diagram below).

1. **Dura Mater**: Tough fibrous double layered membrane. Travels from the skull to the sacrum
2. **Arachnoid mater**: A delicate membrane positioned under the dura. It connects with the **Subarachnoid space** which is filled with **C.S.F**
3. **Pia Mater**: A thin vascular membrane, which closely covers the brain. It supplies **blood** to the **brain** and **Spinal cord**.



Meninges covering the Spinal Cord

Cerebrospinal Fluid (CSF)

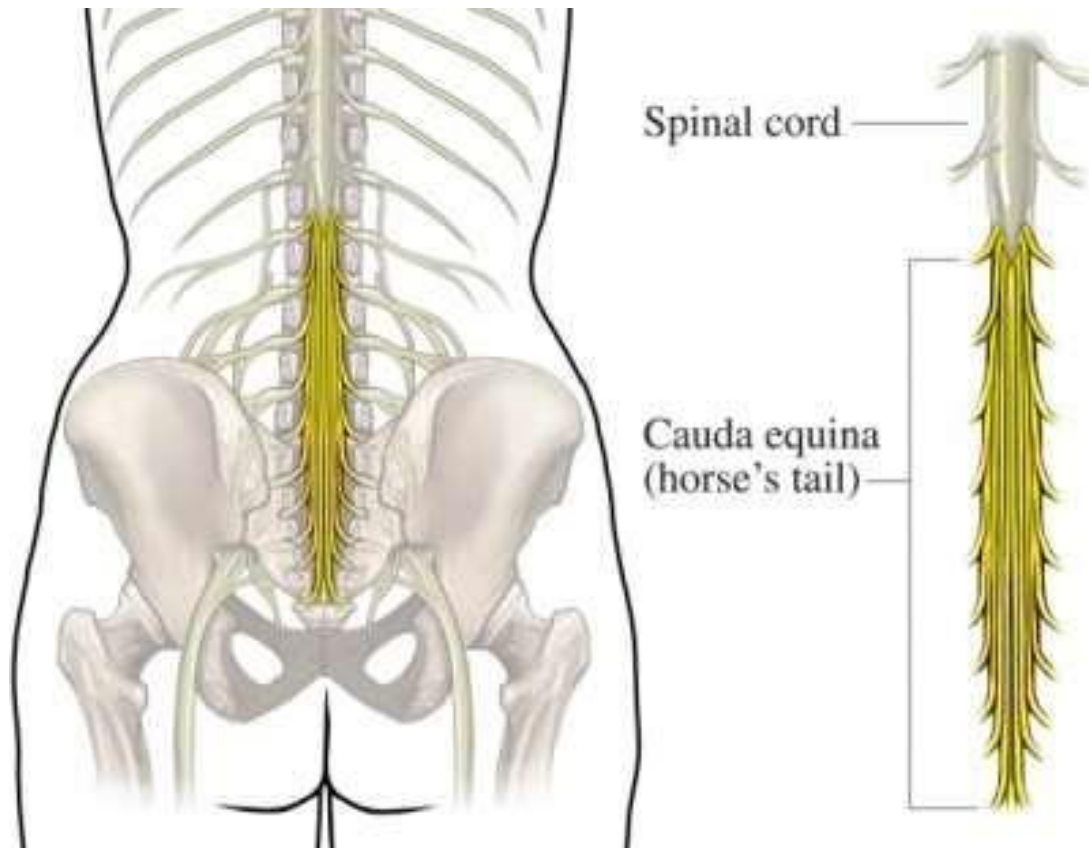
Is a colourless fluid similar to **plasma** and produced by the **CHOROID PLEXUS** in the brain and reabsorbed by the arachnoid mater.

Functions:

1. **Protects** brain & spinal cord forming a cushion and acting as a shock absorber.
2. Keeps the **pressure** around the brain constant.
3. **Provides** nutrients and removes waste from the brain

SPINAL CORD

This continues from the Medulla, lying in the vertebral canal. It gives out nerve roots **(31 pairs in total)** at various levels that then go onto form the **CAUDA EQUINA**



Nerve fibres travelling up the spinal cord pass through the Medulla where they cross to the opposite side. Therefore, the right half of the body is controlled by the left side of the brain and left half of the body is controlled by the right side of the brain.

PERIPHERAL NERVOUS SYSTEM (PNS)

The PNS concerns all the nervous system outside the CNS and contains **Sensory** and **Motor** nerves that transmit information to and from the body and the brain. It consists of:

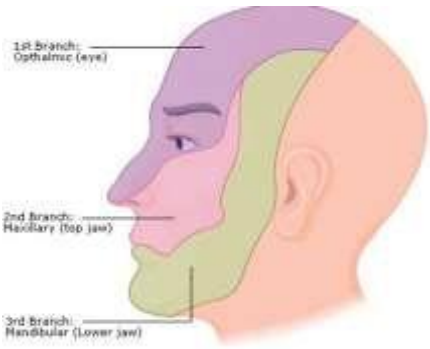
1. CRANIAL NERVES
2. SPINAL NERVES
3. AUTONOMIC NERVES

(i) Sympathetic Nerves

(ii) Parasympathetic Nerves

Cranial Nerves

These nerves originate in the brain. There are **12** pairs altogether. They consist of sensory, motor and mixed nerves.

No	Cranial Nerve	Type	Mnemonic	Function
I	Olfactory	SENSORY	Some	Sense of smell
II	Optic	SENSORY	Say	Sense of vision
III	Oculomotor	Motor	Money	Supplies muscles moving the eye
IV	Trochlear	Motor	Must	Supplies muscles moving the eye
	Trigeminal	Motor		Supplies muscles moving the eye
V		Mixed	Be	Sensation from face (heat, pain, pressure) as well as supplying muscles of mastication Nerve has 3 division: Ophthalmic – Sensory around the eye Maxillary – sensory around the mouth Mandibular – sensory around the lower jaw
VI	Abducent	Motor	Made	Supplies muscles moving the eye
VII	Facial	Mixed	But	Supplies muscles of facial expression as well as sense of taste from tongue.
VIII	Vestibulocochlear	SENSORY	Some	Supplies sense of hearing as well as balance
IX	Glossopharyngeal	Mixed	Borrow	Sense of taste from tongue, sensation from throat as well as muscles connecting to the pharynx
X	Vagus	Mixed	Because	Sensory and motor to digestive and respiratory organs
XI	Accessory	Motor	Money	Supplies sternocleidomastoid and upper trapezius
XII	Hypoglossal	Motor	Matters	Supplies muscle of tongue

Cranial Nerves – For Reference

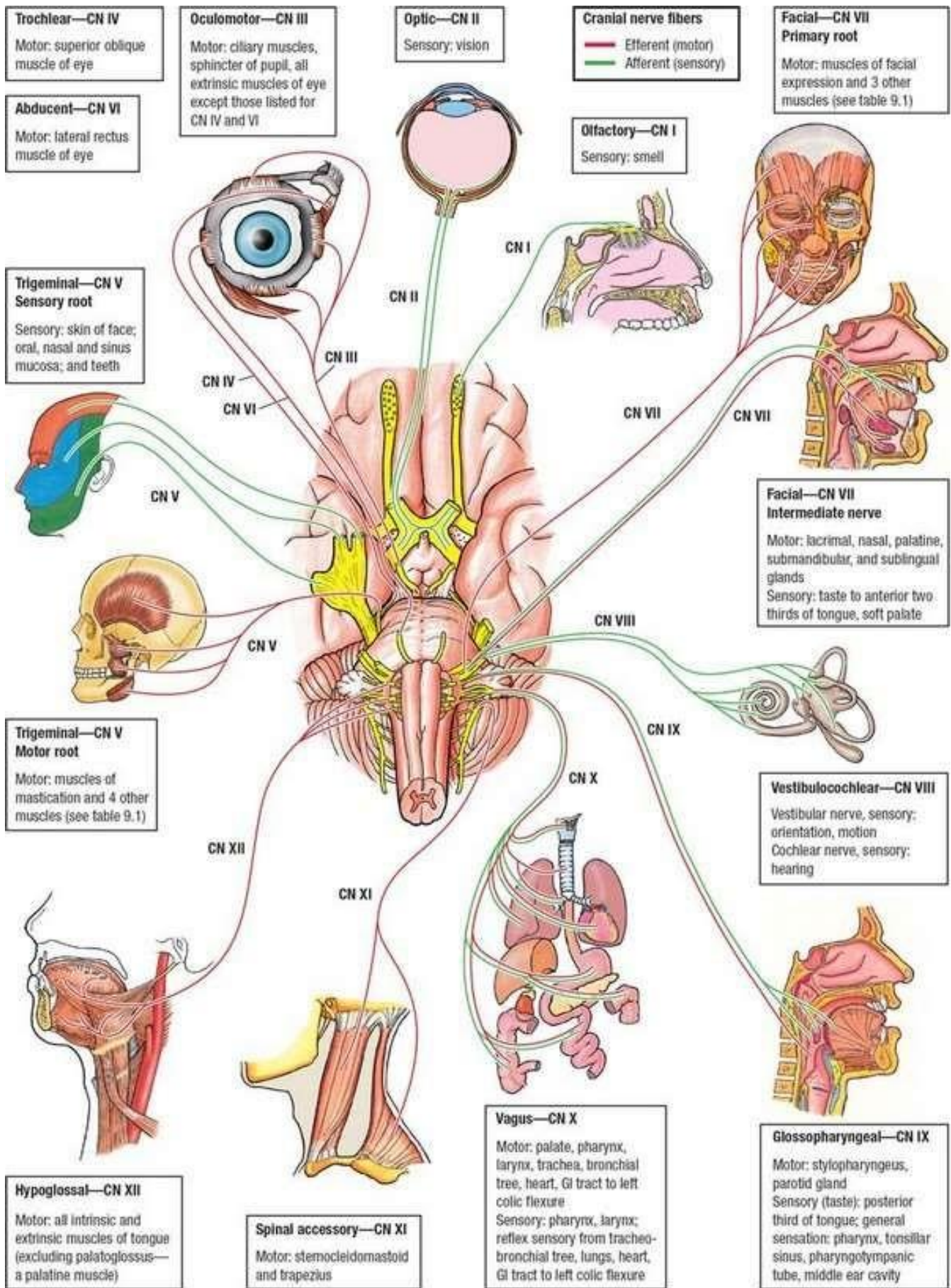
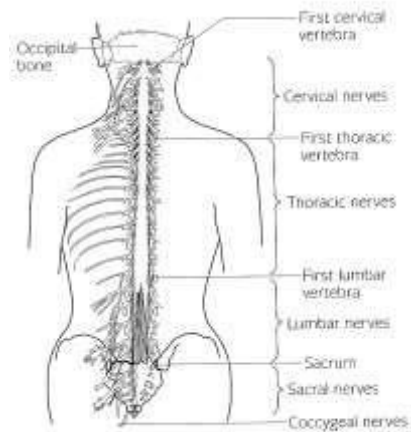


Diagram of the Cranial Nerves

Spinal Nerves

There are 31 pairs of spinal nerves. These are:

- Cervical region - **Eight** pairs
- Thoracic region - **Twelve** pairs
- Lumbar region - **Five** pairs
- Sacral region - **Five** pairs
- Coccygeal region - **One** pair



Spinal nerves exit the foramina combine in different ways to form nerves.

The spinal nerves at each level (**cervical, thoracic and lumbar**) combine together to form a network called a **Plexus**

Name of Plexus	Supplies
Cervical Plexus C1 – C4	Muscles and skin to <u>neck</u> & upper <u>shoulder</u> Gives off the PHRENIC nerve which supplies the <u>Diaphragm</u>
Brachial Plexus C5 – T2	Muscles and skin from base of neck to the whole of the <u>upper</u> extremity.
Thoracic Nerves T3 – T12	Supplies muscles of the <u>chest</u> and main part of the abdomen as well as sensation to this area.
Lumbar Plexus L1 – L3 (L4)	Supplies skin and muscles of the lower <u>abdomen</u> , <u>groin</u> & anterior <u>thigh</u> .
Sacral Plexus L4 – S4	Supplies skin and muscles to the lower pelvic floor. Gives rise to the Sciatic Nerve . Including the whole leg and posterior thigh.
Coccygeal	This group forms a second small plexus on the back of the pelvic cavity. It supplies the anal sphincter muscles and external genitalia.

Dermatomes

In massage therapy, the tendency is to focus on the role of muscles in pain or injury, sometimes excluding other soft tissues. Nerves are one of these often forgotten tissues, yet they play a critical role in many pain complaints.

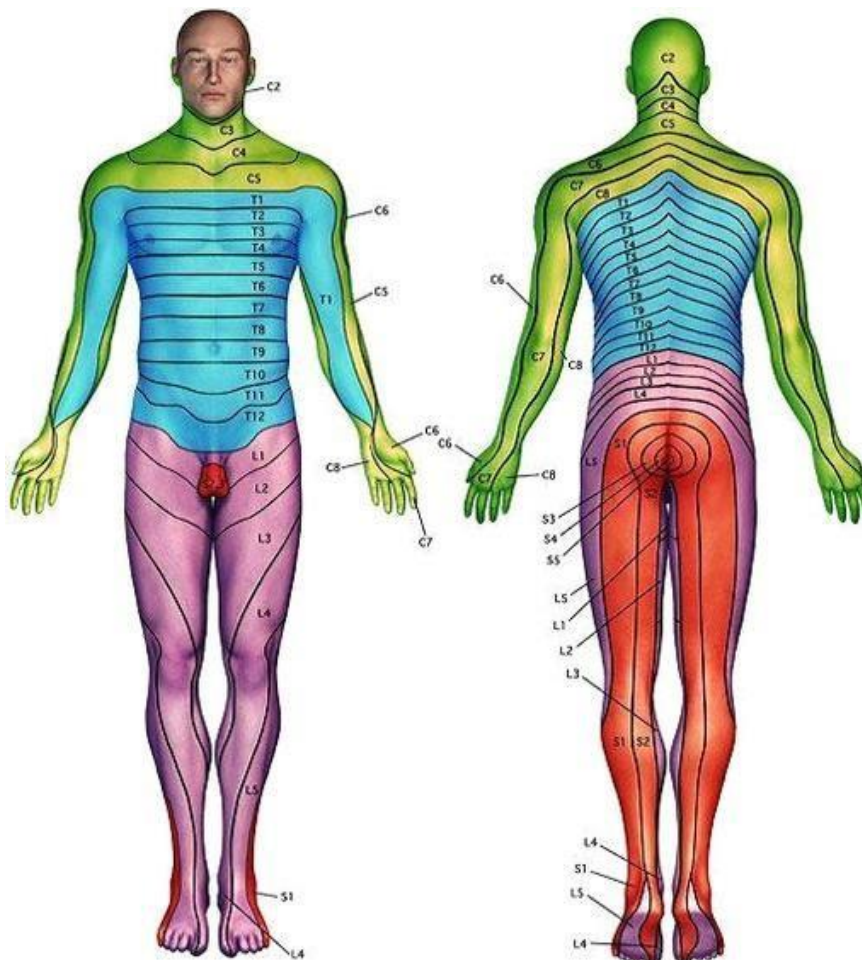
The central nervous system is comprised of the brain and spinal cord. The peripheral nervous system consists of cranial nerves, which branch out of the brain, and spinal nerves, which branch out of the spinal cord. A total of 31 sets of nerves branch out of the spinal cord. The point at which the nerve branches out from the cord is known as the nerve root. Each nerve travels a short distance (about ½ inch) from the cord and then divides into small posterior divisions (dorsal rami) and larger anterior divisions (ventral rami).

Spinal nerves have motor and sensory fibres. The motor fibres stimulate certain muscles, while the sensory fibres innervate (means to 'stimulate via nerves') certain areas of skin. A skin area stimulated by the sensory fibres of a single nerve root is known as a **dermatome**.

A **plexus** is any complex structure containing an intricate network of parts, in this case 'nerves'.

Following are the four main nerve plexuses.

Plexus	Locations	Innervates the ...
C ervical plexus	C1 – C4	diaphragm, shoulder and neck
B rachial plexus	C5 – T1	upper limbs
L umbar plexus	T12/L1 – L4	thigh
S acral plexus	L4 – S4	leg and foot



Autonomic Nervous System (ANS)

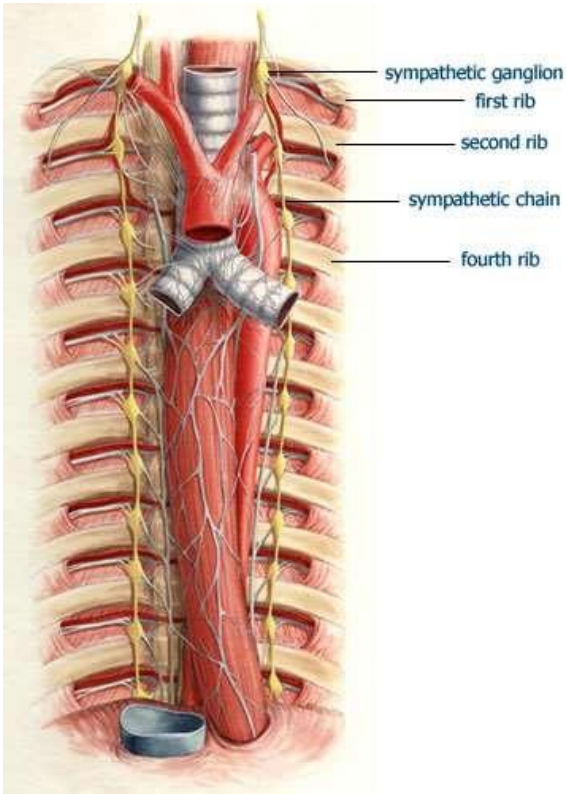
The ANS controls the functions of the body, which happen “automatically”. That is, it is concerned with all that which we cannot control consciously.

It is controlled by the **HYPOTHALAMUS**.

All internal organs are supplied by both the **Sympathetic Nervous System** and **Parasympathetic Nervous System** and the way the organ functions is dependent on which one of the systems is more active.

The Autonomic Nervous System is divided into two parts:

1. The Sympathetic Nervous System (SNS)

Structure	Function
<p>Consists of Ganglia (collection of nerve cells), which are situated in front of vertebral column and travel length of body from the Thoracic to the Lumbar region.</p> 	<ul style="list-style-type: none"> • Prepares the body for stressful situations / physical Activity – “Flight or Fight Syndrome”. • Neurones release the neurotransmitters ACETYLCHOLINE and NORADRENALIN at the synapse. • Accelerates action of heart, increasing rate and force of contraction. • Causes dilation of arteries increasing blood supply to the Heart. • Causes dilation of arteries increasing blood supply to Skeletal muscle, increasing nourishing and waste removal process thus enabling muscle to work better. • Raises blood pressure by constricting small arteries and arterioles that supply the skin therefore making it look pale / white. • Causes sustained contraction of spleen, thus increasing volume of blood circulating. • Constricts blood vessels in secretory glands of Digestive system, restricting flow of digestive juices. This slows down the system.

2. Parasympathetic Nervous System (PNS)

Structure	Function
<p>Consists of the:</p> <ol style="list-style-type: none"> <u>Vagus</u> <u>Glossopharangeal</u> <u>Oculomotor</u> <u>Facial</u> <u>Sacral Outflow</u> <p>These branch to the organs of the:</p> <ul style="list-style-type: none"> • Head (salivary glands) • Chest • Abdomen • Genitalia 	<ul style="list-style-type: none"> • Stimulates opposite action in organs to that produced by SNS • When active, it slows down the action of an organ (except digestive system). • Neurones release ACETYLCHOLINE as the neurotransmitter at the synapse. • Slows action of heart, reducing rate and force of contraction. • Constricts flow of blood to heart muscle. • Stimulates the digestive system & urinary system. • Has a relaxing effect on the body – “chills you out”

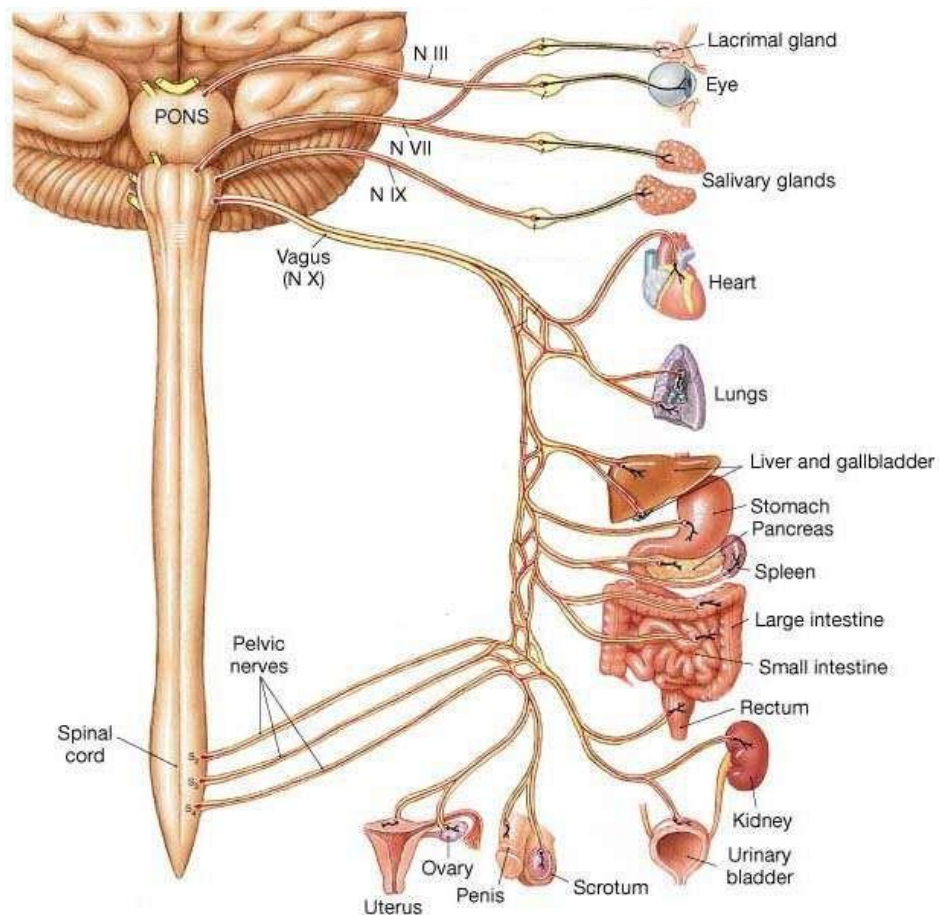


Diagram of the Parasympathetic Nervous System

THE REFLEX

A reflex is an **involuntary** (not controlled by the brain) movement as a result of a sensory stimulus, e.g. letting go of a hot object instinctively.

The action is instant and involuntary.

Several structures are involved in the production of a reflex and together they form a **Reflex arc**.

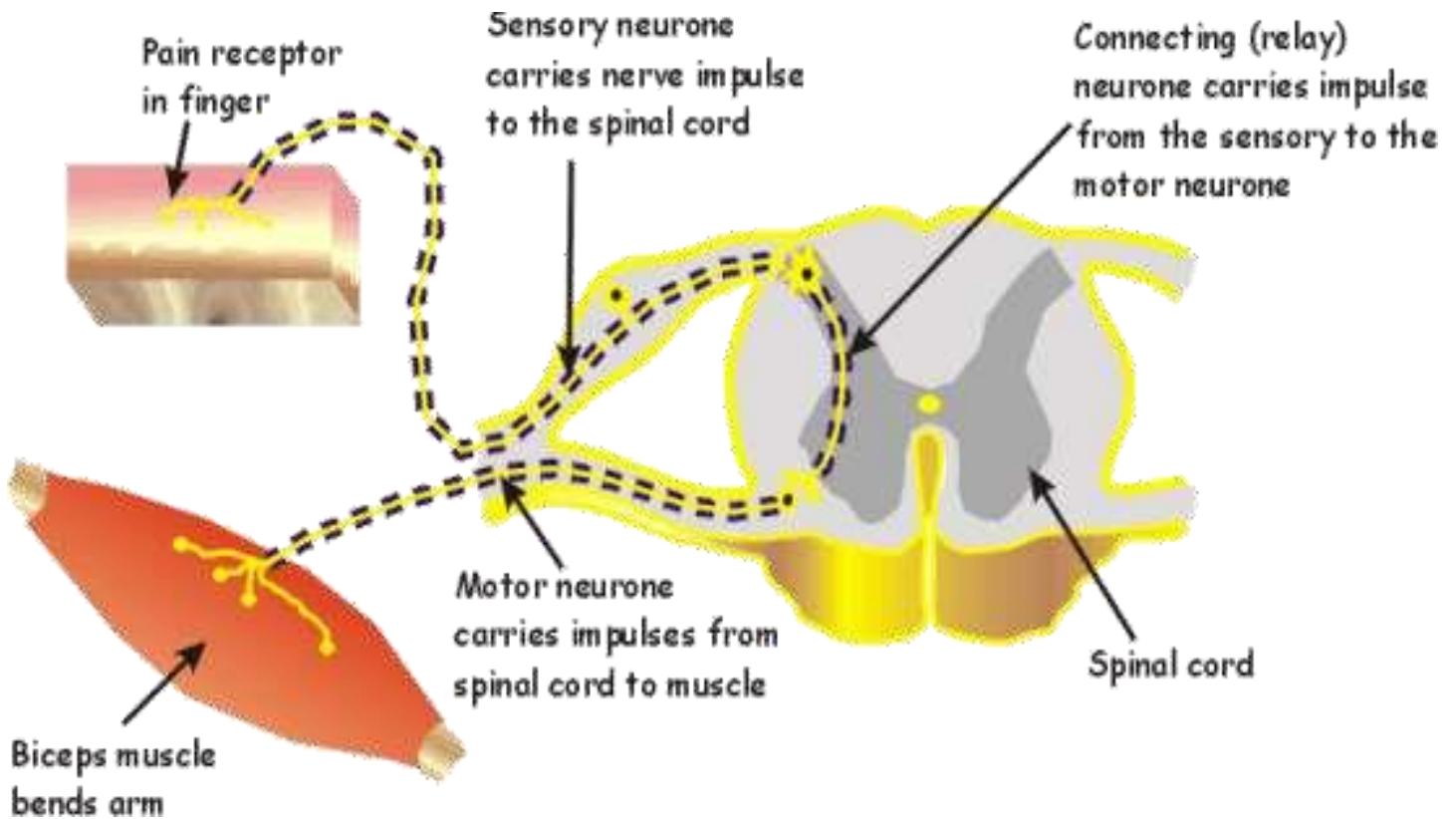
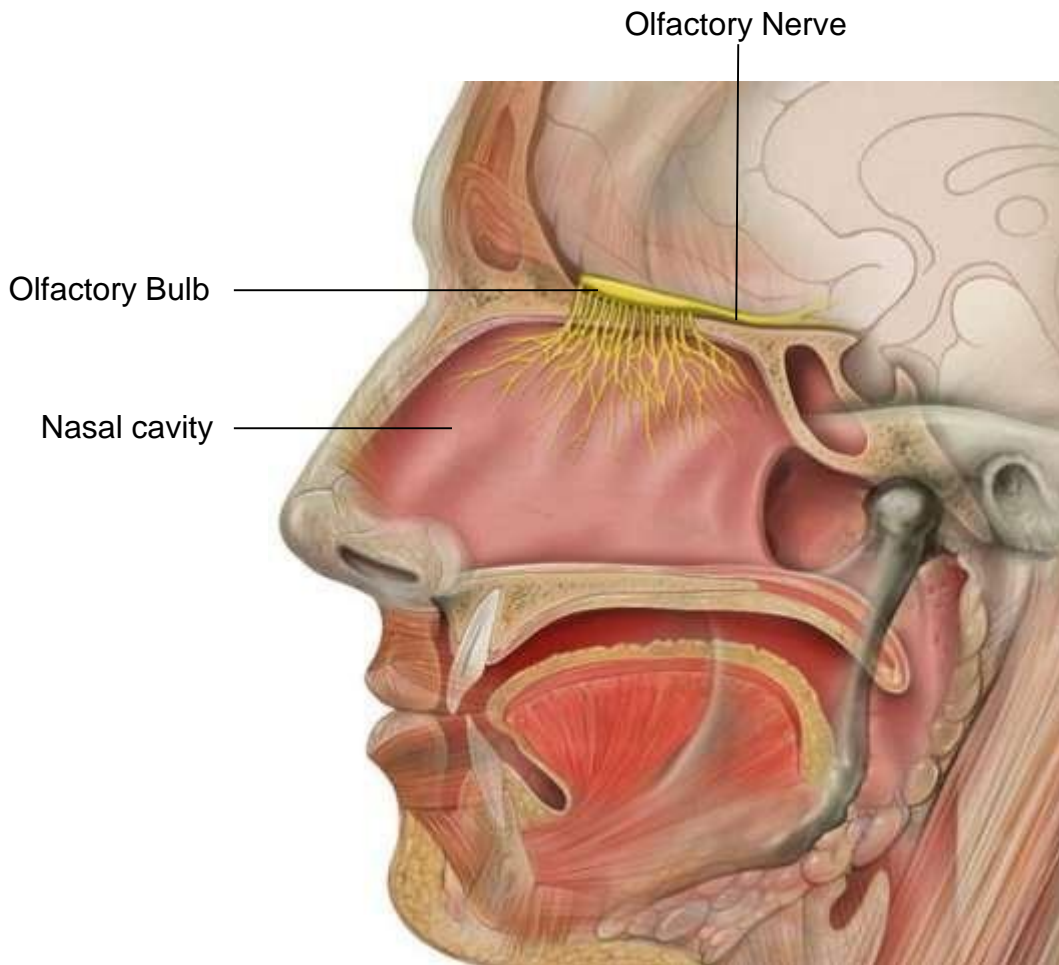


Diagram of the Reflex Arc

Note that it consists of:

1. Sense Organ e.g. temperature receptors
2. Sensory nerve travelling TO the spinal cord.
3. Spinal Cord
4. Motor nerve travelling to the motor organ










OLFACTORY SYSTEM

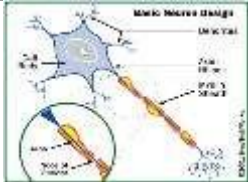


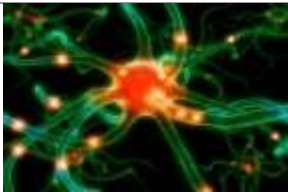
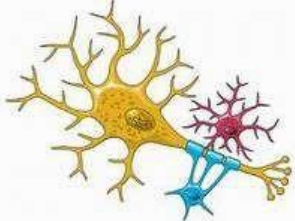








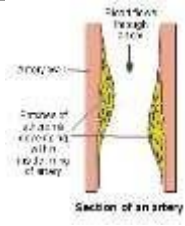
The nose is the organ of olfaction (smell).

At the top of the nose are two areas of pigmented tissue known as olfactory membranes. They contain the smell – sensing cells that contain cilia (small hairs).

DISORDERS & DISEASES OF THE NERVOUS SYSTEM

Disorder	Description	Picture
Alzheimer's disease	The most common form of dementia in order people that affects many areas of cognitive function.	
Bell's Palsy	Injury or infection of the facial nerve that subsequently becomes inflamed Effect: facial paralysis.	
Cerebral Palsy	Damage to the brain, caused during birth or resulting from a pre-natal defect. Effect: affects motor system control.	
Concussion	An injury to the brain caused by a blow; usually resulting in loss of consciousness.	
Depression (SAD - seasonal affective disorder)	Is a bipolar affective disorder – also known as manic depression, seasonal affective disorder (SAD) – also known as winter depression or winter blues, post-natal is a form of clinical depression that can affect women, and less frequently men, after childbirth.	
Epilepsy	A disorder of the central nervous system characterised by loss of consciousness and convulsions (fits).	
Headache	Headache or cephalalgia is a symptom of a number of different conditions of the head. Some of the causes are benign while others are medical emergencies.	
Migraine	A severe, disabling headache, usually affecting the one side of the head, and often accompanied by nausea, vomiting, photophobia (dislike for light) and visual disturbances.	
Motor Neurone Disease	A rare progressive disorder, in which the motor neurons in the body gradually deteriorate Effect: weakness and wasting of muscles	

<p>Multiple Sclerosis</p>	<p>(also known as disseminated sclerosis) Loss of the protective myelin sheath from nerve fibres in the central nervous system. Effect: causes muscular weakness, loss of muscular coordination, problems with skin sensation, speech and vision.</p>	
<p>Myalgic Encephalomyelitis (ME)</p>	<p>Also known as post-viral fatigue or chronic fatigue syndrome. Effect: exhaustion, general aches and pains, headaches and dizziness, inflammation of the brain and spinal cord.</p>	
<p>Myasthenia Gravis</p>	<p>The Chronic progressive disorder characterized by fatigue and a muscular weakness especially in the face and neck.</p>	
<p>Neuralgia</p>	<p>Various causes. Effect: bouts of burning or stabbing pain along the course of one or more nerves.</p>	
<p>Neuritis</p>	<p>Inflammation of a nerve, caused by infection, injury, poison, etc. Effect: pain along the nerve's length and/ or loss of use of the structures supplied by the nerve.</p>	
<p>Parkinsons Disease</p>	<p>Progressive disease caused by damage to basal ganglia of the brain and resulting in loss of dopamine (neuro-transmitter). Effect: causes tremor and rigidity in muscles, as well as difficulty and slowness with voluntary movement.</p>	
<p>Poliomyelitis</p>	<p>An acute viral disease marked by inflammation of the nerve cells of the brainstem and spinal cord.</p>	
<p>Sciatica</p>	<p>Pressure on the roots of the sciatic nerve often caused by degeneration of an intervertebral disc Effect: pain down the back and outside of the thigh, leg and foot</p>	

Spina Bifida	A developmental birth defect involving the neural tube; a not uncommon congenital defect in which a vertebra is malformed and therefore does not form properly.	
Stress	Stress is any factor that affects mental or physical well-being. Emotions such as anxiety, fear and other negative feelings can affect the nervous system causing increased heart rate, breathing difficulties, sleep disturbances and stomach problems. All of these physical effects are caused by the nervous system over-working in response to stress.	
Stroke	A sudden loss of consciousness resulting when the rupture or occlusion of a blood vessel leads to lack of oxygen in the brain.	 <p style="text-align: center;">“F A S T”</p>
Transient Ischaemic Attack (TIA)	Sometimes called a mini-stroke: a temporary restriction in the blood supply to the brain, which causes short –term symptoms such as temporary vision loss or impairment. Should not last for more than 24 hours.	

INTERRELATIONSHIP OF NERVOUS SYSTEM WITH OTHER BODY SYSTEMS

All the systems	Provides nutrition to the whole body.
Circulatory	Nerves control the heart rate.
Respiratory	Nerves control the process of respiration.
Endocrine	Works closely with endocrine system to maintain homeostasis – balance in the body.
Muscular	Muscles require a nerve supply to contract.
Skeletal	Muscle contraction (caused by nerve impulses) produces movement in the skeleton.
Skin	Skin contains a variety of nerve endings, at different levels in the layers.

EFFECTS OF MASSAGE ON THE NERVOUS SYSTEM

1. Has a “calming and soothing” effect on nerve pathways leading to the higher centres
2. Some movements have a stimulatory effect on nerve endings –(tapotement movements)
3. Encourages the release of **endorphins** - substances that reduce pain and promote sense of well being.

SYMPTOMS OF THE NERVOUS SYSTEM

Symptoms can vary greatly as the system is vast. Some common symptoms are listed below:

- Pins and needles feeling / tingling sensation radiating into the extremities
- Loss of control of part of limb or body.
- Loss of sensation
- Loss of balance
- Pain / Radiating pain
- Loss of memory and higher function