

The Nervous System

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The *nervous system* is a network consisting of the brain, spinal cord, autonomic nervous system, and peripheral nerves.

All the other body systems are connected to this network.

Electrical and chemical stimuli, from both internal and external sources, are transmitted through the nervous system, which receives and analyses them, and initiates appropriate responses.

Nerves

Nerves may be grouped into three types:

Sensory nerves. These transmit stimuli from peripheral areas to the spinal cord, and onwards to the brain.

Motor nerves. These transmit stimuli from the brain, via the spinal cord, to striated muscles to initiate contraction.

Mixed nerves. These occur where sensory and motor nerves are grouped together within the same sheath of connective tissue.

Neurones

The nervous system is made up from over 10^{11} neurones. A *neurone* comprises a nerve cell and its extensions. [Figure 7 - 1]

Neurone extensions

Each nerve cell has a series of extensions which carry the body's messages.

The *axon* carries nerve impulses away from the cell, and may be up to 1m in length. Generally a neurone has only one axon, although the axon may have some side branches.

Large axons, and those of peripheral nerves, are protected by a sheath formed from layers of membrane holding a substance called *myelin*.

Dendrites, which have a branched structure, carry impulses towards the nerve cell.

A neurone may have up to 200 dendrites.

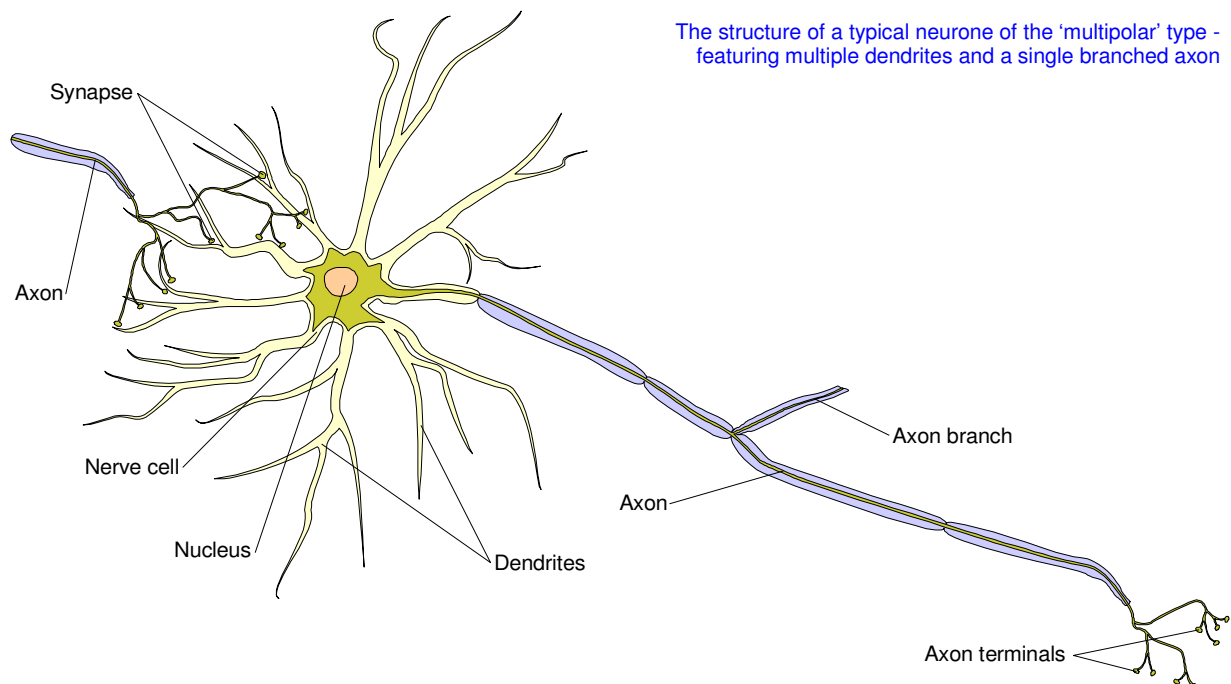
Neurone classifications

Neurones may be classified according to their function, and according to their basic structure:

Afferent (sensory) neurones. These carry signals towards the spinal cord and brain.

Efferent (motor) neurones. These carry signals from the brain and spinal cord towards muscles and glands.

Figure 7 - 1 a typical neurone



The structure of a typical neurone of the 'multipolar' type - featuring multiple dendrites and a single branched axon

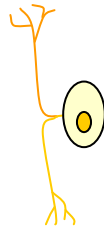
Interneurons. These are mostly situated in the central nervous system. They act as links between sensory and motor neurones. They also form a major part of the functions of learning, memory, and language.

Multipolar neurones. These have one axon and multiple dendrites. They are found mainly in the brain and spinal cord.



Bipolar neurones. These have one axon and a single dendrite. In the adult, they are found only in the sensory organs of the eye, ear, and nose.

Unipolar neurones. These have a single branched structure of one axon and dendrite. They are the most common sensory neurones in the peripheral nervous system.



Nerve Impulses

Impulses are the communication units of the nervous system. They are similar in nature to small electrical charges and result from differing concentrations of Potassium and Sodium ions internal and external to nerve fibres.

Impulses travel along chains of neurones, passing from one to the next by a system of chemical transmission, via *synapses*. At a *synapse*, the axon of one neurone terminates in *end bulbs*, which pass the impulse into the next neurone in the chain. This transmission relies on Calcium ions and minute quantities of *neurotransmitter* compounds.

Between cardiac cells, those in the smooth muscle of the intestinal tract and in the retinas of the eyes, the synapses are more closely linked and operate with electrical transmission.

Sensory impulses are generated in response to touch, pain, heat, cold, in fine branching filaments of the dendrites of sensory nerves.

Motor nerves pass their impulses to tiny pads, *motor end plates*, branched from the ends of their axons, into the associated muscle.

Central Nervous System

The brain and the spinal cord form the *central nervous system*.

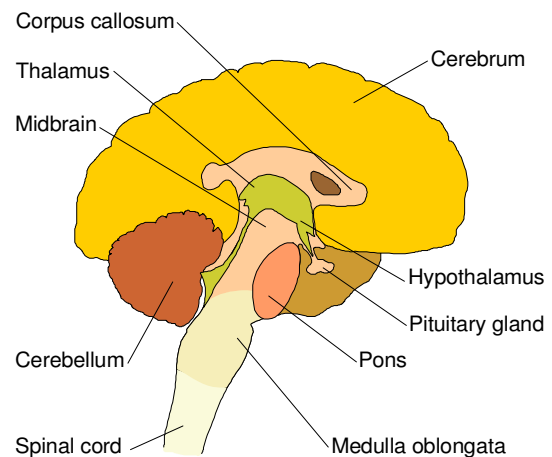
The neurones in the central nervous system are supported by specialised cells of connective tissue known as *glial cells*. These cells make up a major proportion of brain tissue, and (unlike neurones) are continually regenerated.

Brain

The *brain* is situated inside the cranium, and comprises seven major sections: cerebrum, thalamus, hypothalamus, midbrain, pons, medulla oblongata, and cerebellum. [Figure 7 - 2]

Figure 7 - 2 the brain

A sagittal section of the brain showing the main areas



Cerebrum

The *cerebrum* is the largest section, forming the majority of the brain.

The cerebrum is formed as two hemispheres, left and right, each comprising four lobes.

[Figure 7 - 3]

Its main functions are :

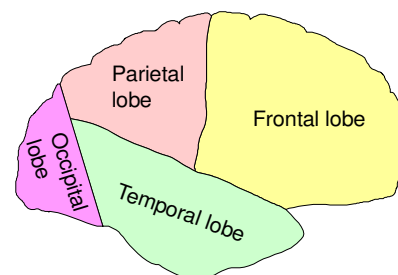
Control of voluntary muscles.

The 'senses' - touch (including pain and temperature), sight, hearing, smell, and taste.

Mental activity, including 'thought', memory, and the ability to learn.

Figure 7 - 3 the lobes of the cerebrum

Lateral view of the cerebrum, showing the four lobes



Between the left and right hemispheres of the cerebrum is a bridge of nerve tissue known as the *corpus callosum*.

Thalamus

The *thalamus* is located in the centre of the cerebrum.

It acts as a relay and processing centre for all sensory information, except smell.

Hypothalamus

The *hypothalamus* is a small mass, positioned just below the thalamus.

It controls most glandular activity through its close relationship with the pituitary gland. It also regulates body temperature, sleep patterns, and emotional behaviour.

Midbrain

The *midbrain* is situated immediately below the centre of the cerebrum.

It comprises nerve cells which operate as relay points between the cerebrum and the other parts of the central nervous system.

Pons

Also known as the *pons Varolii*, the *pons* is the area between the midbrain and the medulla oblongata.

Similar to the midbrain, the pons operates as a relay point between the other parts of the central nervous system, including the cerebellum which is immediately behind it.

Medulla oblongata

The *medulla oblongata* forms the uppermost section of the spinal cord.

It contains the control centres for the 'vital functions':

Cardiac centre. This controls the heart beat rate.

Respiratory centre. This controls the intercostal muscles and diaphragm to regulate respiratory rate. The medulla oblongata monitors Carbon Dioxide concentration in the blood, regulating respiration in response.

Vasomotor centre. This controls the smooth muscle of the blood vessels to regulate constriction or dilation.

Reflex centres. These control the reflex actions of swallowing, coughing, sneezing, and vomiting.

Also in the medulla oblongata, the majority of motor nerves cross from one side of the body to the other, hence the right side of the brain controls movements in the left side of the body, and vice versa. This crossover is known as the *decussation of the pyramids*. Some sensory nerves also cross over within the medulla oblongata; the remainder cross at lower points within the spinal cord.

The combination of the midbrain, the pons, and the medulla oblongata is known as the *brain stem*.

Cerebellum

The *cerebellum* is situated behind the pons.

It controls the co-ordination of voluntary muscles.

It also controls balance, taking impulses from the eyes and the inner ears.

Spinal Cord

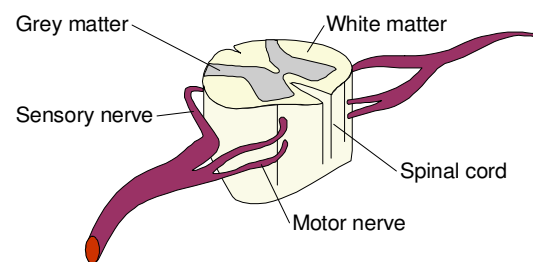
The *spinal cord* is the main pathway for nerve impulses to and from the brain, and the rest of the body. [Figure 7 - 4]

The spinal cord lies inside the vertebral column; branches from it, on each side of each vertebra, lead into the peripheral nerves.

The spinal cord begins with the medulla oblongata, and continues downwards to the first lumbar vertebra, where it terminates in a series of branches, the *cauda equina*.

Figure 7 - 4 the spinal cord

The basic construction of the spinal cord



The spinal cord is made up from two main types of nerve tissue:

Grey matter. This forms an 'H' shaped centre of the cord, and consists mainly of nerve cell bodies and dendrites, and un-myelinated neurone axons.

White matter. This forms the outer layers of the cord, and consists mainly of myelinated nerve fibres.

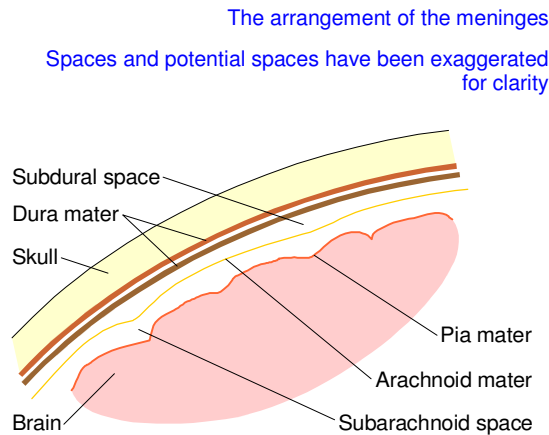
Nerves exit from the points of the 'H' - motor nerves on the anterior, sensory nerves on the posterior.

Meninges

The brain and spinal cord are completely covered by three layers of membrane, the meninges. [Figure 7 - 5]

The *meninges* separate the brain and spinal cord from the skull and vertebrae respectively.

Figure 7 - 5 the meninges



Dura mater (outer layer)

Within the skull, this is formed by two layers of fibrous tissue - the outer layer replaces the periosteum for the inner skull surfaces, and the inner layer forms a protective covering for the brain.

Within the vertebrae, a continuation of the cerebral dura mater forms a sheath for the spinal cord, ending by fusing with the periosteum of the coccyx.

Between the two layers is the *extradural space*, although in most areas this is only a potential space.

Arachnoid mater (middle layer)

This is a delicate serous membrane between the other two meninges.

Between the inner dura mater and the arachnoid mater is the *subdural space*.

Pia mater (inner layer)

This is a thin layer of tissue, containing many tiny blood vessels. It closely follows the surface of the brain and spinal cord. Beyond the end of the spinal cord it becomes the *filum terminae*, meeting the dura mater at the coccyx.

Between the arachnoid mater and the pia mater is the *subarachnoid space* which is occupied by cerebro-spinal fluid.

Cerebro-Spinal Fluid

Cerebro-spinal fluid is secreted from the bloodstream into the subarachnoid space.

It is a clear watery fluid, with dissolved salts and proteins.

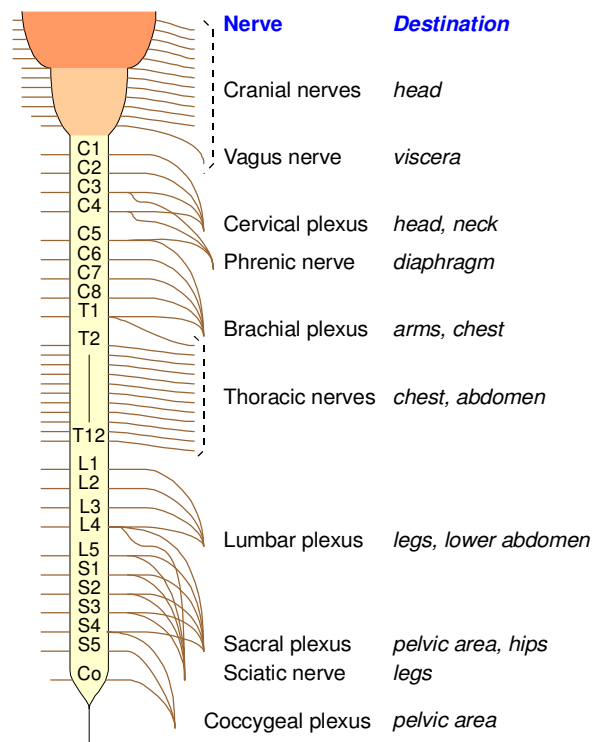
Cerebro-spinal fluid moistens, protects, and supports the brain and spinal cord, maintaining a uniform pressure, and acting as a shock absorber.

Peripheral Nervous System

The *peripheral nervous system* forms the networks of sensory and motor nerves between the spinal cord and sensory organs, muscles, glands, and other organs. The peripheral nervous system is made up from cranial nerves, spinal nerves, and the autonomic nervous system. [Figure 7 - 6]

Figure 7 - 6 the peripheral nervous system

The layout of major nerves in the peripheral nervous system



Cranial Nerves

The *cranial nerves* are twelve pairs of nerves originating from within the skull interior.

[Table 7 - 1]

Table 7 - 1 the cranial nerves

The names and main functions of the cranial nerves

No.	Name	Type	Function
1	Olfactory	Sensory	Sense of smell
2	Optic	Sensory	Sense of sight
3	Oculomotor	Motor	Movement and focusing of eyes
4	Trochlear	Motor	Movement of eyes (up / down)
5	Trigeminal	Mixed	Facial sensation, motion of chewing
6	Abducent	Motor	Movement of eyes (lateral)
7	Facial	Mixed	Sense of taste, movement of facial muscles
8	Vestibulocochlear	Mixed	Sense of hearing, control of balance
9	Glossopharyngeal	Mixed	Sense of taste, saliva secretion, swallowing action
10	Vagus	Motor	Movement and secretion of thoracic and abdominal organs
11	Accessory	Motor	Movement of head, shoulders, larynx, voice production
12	Hypoglossal	Motor	Movement of tongue

Spinal Nerves

The *spinal nerves* are 31 pairs of nerves originating in the spinal cord.

The nerves are named, indicating the vertebra at the point at which they leave the spinal cord.

Note: the first cervical nerve leaves the spinal cord above the atlas, and the eighth below the seventh cervical vertebra. The other nerves take the number of the vertebra above their points of exit from the spinal column.

After leaving the spinal cord, the majority of spinal nerves group together as *plexuses*, before splitting and proceeding to their appropriate areas of the body. In a plexus, nerve fibres performing a particular function, but from different spinal nerves, are sorted and combined.

Each nerve is one of a pair, supplying the left or right side of the body as appropriate:

Cervical plexus. (nerves C1 to C4) This supplies nerves to the head and neck.

The *phrenic nerve*, which originates from nerves C3, C4, and C5, controls the diaphragm.

Brachial plexus. (nerves C5 to C8, T1) This supplies nerves to the arm and some chest muscles.

Thoracic or intercostal nerves. (nerves T2 to T12) These do not group into plexuses, but pass directly to the intercostal areas.

Lumbar plexus. (nerves L1 to L4) This supplies nerves to the lower abdomen and leg.

Sacral plexus. (nerves L4, L5, S1 to S3) This supplies nerves to the pelvic area and hips, and the *sciatic nerve* (the largest nerve in the body) to the legs.

Coccygeal plexus. (nerves S4, S5, Co1) This supplies nerves to the lower pelvic area.

Autonomic Nervous System

The *autonomic nervous system* operates together with the rest of the nervous system, but is considered separately as it is not under the control of conscious will. [Figure 7 - 7 and Table 7 - 2]

The autonomic nervous system operates mainly under the control of the hypothalamus and the medulla oblongata, and controls cardiac muscle, smooth muscle in internal organs, and the secretory actions of glands.

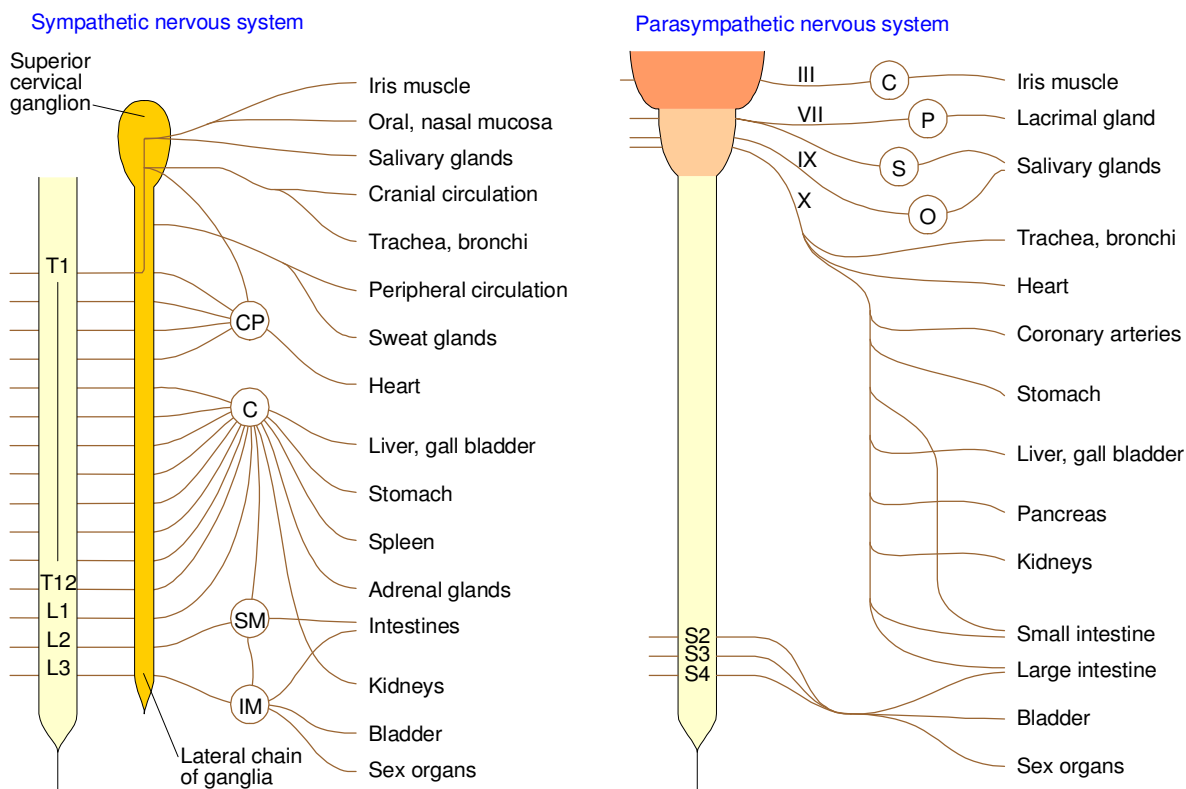
The autonomic nervous system is formed from two divisions, which tend to have opposite effects on the organs they control:

Sympathetic nerves. These tend to cause an 'excitement' effect. They exit from the spinal column in the thoracic and lumbar regions. Sympathetic stimulation tends to prepare the body for exciting or stressful situations.

Parasympathetic nerves. These tend to cause a 'calming' effect. They exit from the spinal column in the cervical and sacral regions.

Figure 7 - 7 the autonomic nervous system

The layout of major nerves in the sympathetic and parasympathetic nervous systems



CP - cardiac plexus
 C - coeliac ganglion
 SM - superior mesenteric ganglion
 IM - inferior mesenteric ganglion

C - ciliary ganglion
 P - pterygopalatine ganglion
 S - submandibular ganglion
 O - otic ganglion

Table 7 - 2 the effects of autonomic nervous stimulation

The effects of autonomic nervous stimulation on the main organs innervated

Organ	Sympathetic stimulation	Parasympathetic stimulation
Eyes (pupils)	Dilation	Constriction
Bronchi	Dilation	Constriction
Heart and circulation	Increase of rate and strength of beat, increase of blood supply to voluntary muscles	Decrease of rate and strength of beat, decrease of blood supply to voluntary muscles
Peripheral blood vessels	Constriction	Generally not innervated
Intestines	Decrease of digestive activity	Increase of digestive activity
Urinary bladder	Relaxation and sphincter constricted	Contraction and sphincter relaxed
Sweat glands	Increase of secretion	Not innervated
Salivary glands	Secretion of viscous saliva	Secretion of watery saliva
Intestinal sphincters	Constriction	Relaxation
Reproductive organs	Vasoconstriction (orgasm)	Vasodilation (erection - male, lubrication - female)

Ganglia

The nerves in the autonomic nervous system, in particular the sympathetic nerves, form groups of ganglia, or linkages, on the sides of the spine.

A *ganglion* occurs where nerve synapses, dendrites, and short interneurons meet. Cross links between individual nerve paths form the ganglia into chains.

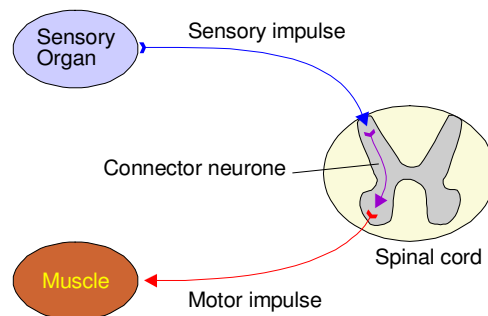
Reflex Actions

A *reflex action* occurs when a stimulus in a sensory nerve passes directly into a motor nerve to cause an appropriate muscular action, without reaching the brain. [Figure 7 - 8]

Reflex paths pass via the sides of the grey matter 'H' in the spinal cord. Depending on the reflex path, the sensory and motor neurones may link directly, or may be linked by interneurons, known as *connector neurones*.

Figure 7 - 8 a typical reflex path

A reflex path involving a connector neurone



Autism

Autism is caused by abnormal development in the brain, the underlying cause of which is unknown although genetic factors may well be involved.

Autism prevents development of what are classed as normal communication and social abilities.

Characteristics of the condition vary, but often include heightened sensory perceptions as well as impairments in the ability for social interaction and communication, and behavioural problems.

The condition usually develops during the first years of life and tends to lead to solitary, withdrawn personalities, with a strong need for fixed routine, but also with unpredictable aggressive tendencies.

Degenerative Diseases

Alzheimer's disease

Alzheimer's disease, sometimes associated with the term *senile dementia*, is a progressive, degeneration of neurones in the brain. It tends to occur after the age of 60 years.

The exact cause of Alzheimer's disease is not known, but both environmental and genetic factors are believed to contribute, together with factors such as long term high blood pressure, previous head injury, and chronic problems such as heart disease and depression.

Within the brain, neurone cells degenerate at an abnormally rapid rate, with a reduction of neurotransmitter chemicals and a loss of normal communication between areas of the brain. The degeneration may include twisted protein fragments clogging neurone cells, plus abnormal clusters of dead or damaged neurones and other matter.

Initial indications of Alzheimer's disease are rarely severe, featuring short term amnesia and personality changes.

As the disease progresses, the amnesia becomes more pronounced, and hallucinations, delusions, aggression, violence, and depression develop as the general level of ability at even basic tasks diminishes.

Huntington's disease

Huntington's disease, also known as *Huntington's chorea*, is an incurable inherited condition.

Neurones in the brain degenerate over time, leading to abnormal muscular movement - which manifests itself in a variety of ways, psychiatric disturbances, and eventually dementia.

Signs tend to appear first in middle age, and are initially minor, but progressively worsen into disability and finally death.

Motor neurone disease

Motor neurone disease is a progressive degeneration of the neurones in the motor pathways. The neurones in the spinal cord and in the brainstem are more commonly affected.

The condition tends to develop during middle age, and leads to muscular weakness, followed by wasting of muscle tissue as activity becomes more and more difficult.

Motor neurone disease is eventually fatal. The cause is unknown, although inherited factors may be involved.

Parkinson's disease

Parkinson's disease is a brain disorder which usually leads to generalised muscular tremors and difficulty with activities such as walking.

The disease occurs through a progressive degeneration of neurones in the motor areas of the brain. The degeneration reduces production of *dopamine*, a neurotransmitter substance, and prevents proper transmission of nerve impulses.

In addition to muscular control difficulties, Parkinson's disease may also cause depression, hallucinations and dementia.

Drugs and Medications

Many drugs and medications - legal and illegal - operate by altering the degree to which neurotransmitter chemicals act.

Anaesthetics. *General anaesthetics* depress central nervous system activity, inducing unconsciousness.

Local anaesthetics prevent pain sensations by blocking conduction of impulses in the sensory nerves in the area in which they are administered.

Analgesics. These reduce pain sensations. Opiate analgesics operate by inhibiting activity in the thalamus. Other types have more complex and widespread actions reducing pain impulse transmission.

Antidepressants. These generally increase levels of noradrenaline in the brain. Some increase serotonin levels.

Their effect is to reduce the symptoms of psychological depression.

Depressants. These reduce activity in the central nervous system. Many types decrease activity in specific areas of the brain, and some interfere with the production or effects of adrenaline, noradrenaline, or *serotonin* - a neurotransmitter responsible for mood.

Their effect is to reduce tension and to induce a soporific effect on the body.

Hallucinogens. These tend to reduce the effects of serotonin in the brain. They increase and distort sensory perception and give rise to hallucinations.

Stimulants. These increase central nervous system activity, particularly in the brain. Some stimulate the sympathetic nervous system, and many types enhance nerve impulse transmission at synapses.

Their effect is to stimulate mood, increase bodily activity levels and to combat fatigue.

Tranquillisers. These act on the brainstem, depressing its activity, and block the action of adrenaline and other neurotransmitters.

Their effects depend on type, but include reduction of anxiety, induction of sleep, and reduction of 'awareness'.

Epilepsy

Epilepsy is a condition in which seizures may occur at unpredictable times, although certain situations - such as flashing lights - may trigger a seizure in a susceptible person.

A seizure occurs when neurones in the brain send message at random, and often without stimulation. Most seizures take place in motor areas of the brain, and thus manifest themselves in the muscular system.

In some cases, the onset of epilepsy can be traced to a specific problem such as a tumour in the brain, an infection, a head injury, or certain types of poisoning. In most cases, the condition is idiopathic.

Types of epilepsy

There are several different varieties of epilepsy, manifested in the characteristics of the associated seizures.

Absence seizure (*petit mal*)

This type of seizure is different from others as the problem affects the sensory areas of brain.

This may simply show as a short term lapse of awareness and cessation of normal behaviour, or may involve spasmodic muscular actions such as turning around, staggering, squinting, or grinning.

Absence seizures tend to occur only during childhood years.

Tonic seizure

This is a sudden stiffening of muscles, followed by rigidity and collapse, but without convulsions.

Atonic seizure (*drop attack*)

This is a sudden loss of muscle tone, leading to collapse.

Tonic-clonic seizure (*grand mal*)

A *tonic-clonic seizure* typically occurs in four stages:

Stage 1. There may be a premonition of the seizure - an *aura*.

The larynx then convulses and air is expelled from the lungs, giving the effect of a shout or crying out.

Consciousness is lost, leading to collapse and coma.

Stage 2. This is the *tonic* phase. The body becomes rigid, maybe in an abnormal skeletal position. Respiration may well cease, with flushed skin, dilated pupils and a rapid pulse.

Stage 3. This is the *clonic* phase. The muscles convulse, causing violent, uncontrollable movements of the entire body.

Breathing may be noisy and foamy, possibly bloodstained, sputum may be produced.

Incontinence may occur.

Stage 4. The convulsions subside, muscles relax, and a slow return to full consciousness takes place.

Simple partial seizure (*Jacksonian epilepsy*)

This begins in a particular motor area and shows as a series of convulsive movements in a single muscle or group of muscles. Convulsions may then spread to other muscles - usually on the same side of the body.

Complex partial seizure (*temporal lobe epilepsy*)

This type of seizure is centred in a temporal lobe and may be preceded by an *aura*.

It gives a sensation of unreality, with other people and objects appearing unnaturally distant. There may be 'automatic' movements such as staggering, wandering, chewing, or even undressing, with unintelligible sounds being produced.

Communication or understanding are inhibited for the duration of the seizure.

Automatism

A state of *automatism* may follow a seizure (particularly a tonic-clonic seizure). Some particular action is performed with no level of awareness. The action performed tends always to be the same for a particular individual.

Status epilepticus

This can occur during a tonic-clonic seizure. Instead of recovery, the seizure reverts to the tonic stage, and begins a continuous cycle of tonic and clonic stages (with perhaps a small period of rest in between). This condition may last up to several hours if not treated, and can be life threatening - often through pure exhaustion.

Head Injury

Any injury to the head may involve potential damage to the brain or the nervous connections to sensory organs or muscles.

Concussion

Concussion may result from a blow to the head, or violent head movement. It is caused by excessive shaking of the brain. In concussion without complications, the brain itself is not damaged and the condition is temporary. However, it usually includes a period of unconsciousness, and often leads onto some degree of amnesia.

Cerebral contusion

Extreme force applied to the head may cause the brain to impact with the interior of the skull, causing bruising or laceration.

The damage may occur on the same side of the head as the applied force (*coup* injury), or on the opposite side (*contre-coup* injury).

Cerebral contusion is a serious condition and often causes deep unconsciousness and cerebral compression.

Cerebral compression

Compression is caused by a build up of pressure within the skull. As the skull has almost no openings, this pressure is applied directly to the brain.

Compression may be a result either of head injuries, or of medical conditions such as tumours or strokes. A shortage of Oxygen (and a build up of Carbon Dioxide) in the brain leads to a dilation of cerebral blood vessels, which in turn increases intra-cranial pressure; this further reduces the blood supply and Oxygen in the brain.

As the pressure increases, the brain is further and further compressed, with a falling level of consciousness, and loss of bodily control - potentially reaching the level of seizures.

Paralysis may occur, affecting the body on the opposite side to the injury.

Pressure on the nerves to the eyes may cause the pupil of the eye on the side of the injury to become fixed and dilated, maybe followed by the other eye.

Compression of the brain stem affects the control of respiration and heart beat leading to a slow strong pulse and slow, deep, noisy breathing.

Cheyne-Stokes respiration

Cheyne-Stokes respiration is characteristic of deep compression, and occurs as the respiratory centre is progressively compressed.

The respiration cycles between slow shallow breaths, to rapid deep breaths, back to slow shallow breaths again, after perhaps a short period of apnoea.

Subarachnoid haemorrhage

A *subarachnoid haemorrhage* occurs when there is bleeding into the subarachnoid space. The main causes are associated with direct trauma, although a ruptured aneurysm may also be a cause.

Extradural haemorrhage

An *extradural haemorrhage* (sometimes known as an *epidural haemorrhage*) occurs when there is bleeding between the dura mater and the inside of the skull. The main causes are head injury associated with low velocity impact - often associated with skull fracture.

A pattern involving a loss of consciousness immediately after the head injury (a period of concussion), followed by a *lucid interval* (a period of relative consciousness), and then followed by a further loss of consciousness, is particularly characteristic of an extradural haemorrhage.

Subdural haemorrhage

A *subdural haemorrhage* occurs when there is bleeding into the subdural space.

Subdural haemorrhages are often associated with head injuries caused by higher velocity impacts. The haemorrhage tends to be extensive, spreading across a large proportion of the brain's surface area.

Manic-depressive Psychosis

Manic-depressive psychosis, also known as *bipolar disorder*, is a condition which leads to repeated episodes of mania, depression, or both. It may degenerate into chronic mania or chronic depression.

Episodes may be triggered by unpleasant or upsetting events, but tend to be disproportionate to the level of severity of these events.

Mania is characterised by hyper-activity and excessive cheerfulness. A euphoric mood may, however, suddenly switch to irritability.

There may be uninhibited, overbearing, extravagant, or even violent behaviour, incoherent thought and speech patterns, impaired judgement, and hallucinations with delusions of grandeur.

Depression is characterised by intense misery - beyond that appropriate to prevailing circumstances. A pessimistic and despairing outlook disrupts appetite, sleep patterns, and the ability to concentrate.

Behaviour may be retarded and sluggish, or may be restless and agitated.

There may be delusions of worthlessness, ill health, or wickedness, and hallucinations of voices - commanding and accusing.

Physical reactions may disturb the digestive process and cause constipation.

The cause of manic-depressive psychosis is unknown although vulnerability may be inherited. Onset tends to be very slow, with barely perceptible early signs.

Meningitis

Meningitis is an infection - usually severe - of the meninges.

There are several types of meningitis. All are infectious.

The more common types are those caused by non-specific viral infection (this type of meningitis is relatively benign), and infections by haemophilus influenzae type b virus (HIB), meningococcus bacteria, and pneumococcus bacteria.

Meningitis may also occur as a side-effect of other diseases.

Meningitis first presents as a vague sensation of unwell, with slight fever and maybe vomiting. The fever then worsens to a high level, with an intense headache, and a stiff painful neck.

Photophobia, twitching or convulsions, confusion, and possibly delirium, may also be present.

Meningococcal meningitis is specifically characterised by a rash with small irregular purple or red spots all over the body. These spots contain blood and do not fade when pressed.

If not treated, meningitis (especially meningococcal) may lead to brain damage or epilepsy, and may be fatal.

Multiple Sclerosis

Multiple sclerosis (MS) is a slowly progressing loss of myelin from neurone sheaths. Subsequent attacks of inflammation may lead to scarring and irrecoverable loss of nerve function.

The condition is subject to attacks and remissions. Because nerves anywhere in the body may be involved, symptoms vary widely from case to case, but usually include loss of function and muscular control.

The cause of MS is not known.

Myalgic Encephalopathy

Myalgic encephalopathy (ME) is also known as *chronic fatigue syndrome*.

The exact causes of ME are unknown, although it has been attributed to the after-effects of viral infections, abnormalities in the hypothalamus, or inflammation of neural pathways. External factors may also contribute.

ME leads to a period of several months of extreme fatigue, not relieved by rest, and perhaps accompanied by mild fever, tenderness of the lymph nodes, muscular weakness and pain, and problems with memory and concentration.

Nerve Tissue Injury

Neurons in the central nervous system, with only rare exceptions, are unable to regenerate following injury or degradation.

Neurons in the peripheral nervous system may sometimes regenerate and restore a degree of nerve function following injury. Motor neurones are able to regenerate their axons and sensory neurones their dendrites.

Repair of nerve tissue

The regeneration process for a damaged neurone occurs in three main stages. [Figure 7 - 9] (This is described for a motor neurone).

Stage 1

The part of the axon distal to the injury degenerates - completely disappearing within a few weeks. The cell body begins to produce extra protein to promote the regeneration process.

Stage 2

New axon branches, known as *terminal sprouts*, begin to grow from the cut end of the axon. Adjacent neurones may assist the process by sending out *collateral sprouts* to join the regenerating axon. At the same time, cells in the axon sheath begin to grow into *cords* along the original neurone path. These cords guide the growth of the sprouts, most of which will not actually achieve viable nerve connections.

Stage 3

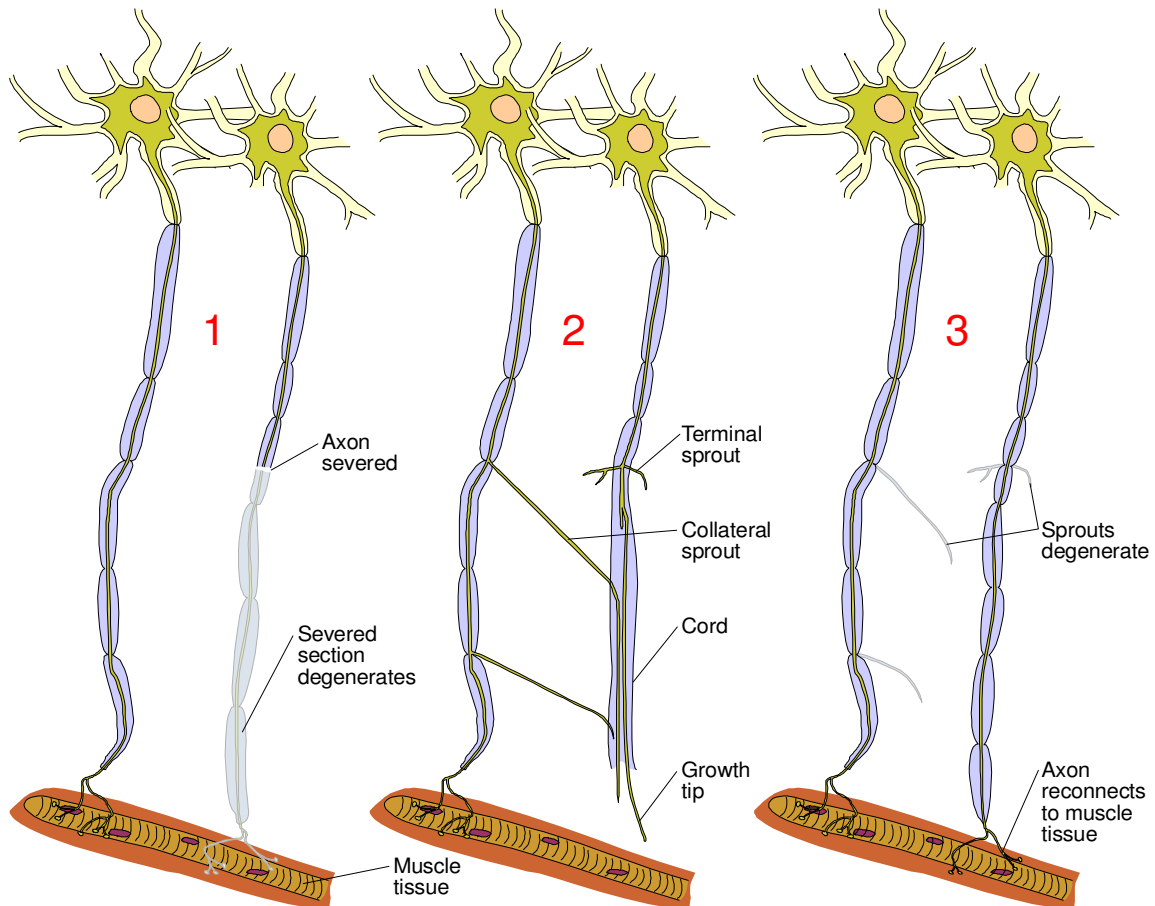
If a sprout eventually reaches tissue of a type to match the neurone's original role, it may form a physical connection.

Once this has occurred, the axon sheath re-forms to its normal pattern, myelin protection is restored, unsuccessful sprouts die back, and the neurological circuit is reconnected.

This overall process may take over a year.

Figure 7 - 9 repair of nerve tissue

Motor nerve neurones, showing the three main stages of nerve tissue repair
The diagram is not to scale, and is much simplified for clarity



Neuralgia

Neuralgia literally means “nerve pain”. It is often idiopathic, although it can result from some chemicals, injury, inflammation, compression from tumours or nearby swelling, infection, diabetes, and many other conditions.

The condition causes pain, but without apparent reason. This pain follows the route of the affected nerve, is usually intermittent and may be extreme in nature. The pain may occur spontaneously, or may be triggered by a particular action or movement.

The condition tends to last for many months, and may recur.

Trigeminal neuralgia, affecting the trigeminal nerve, is a common form of the problem. This involves sudden, short attacks of pain, and even muscular spasm, on one side of the face.

Peripheral Neuropathy

Peripheral neuropathy is a failure of nerves in the peripheral nervous system. Causes are varied (and not always identifiable), including inherited disorders, metabolic disorders, and the effects of infections or inflammations, poisoning.

The results of the neuropathy depend on the nerves affected:

Motor nerve neuropathy will lead to loss of function or muscular control.

Sensory nerve neuropathy will lead to loss of sensation or to abnormal sensation.

Autonomic nerve neuropathy will lead to disruption to the functions controlled by the affected nerves.

Schizophrenia

Schizophrenia is a complex condition affecting the brain. It disrupts the ability to react to life situations in an expected manner.

The causes of schizophrenia are not clear, although it is believed that genetic factors, problems during foetal development or birth, environmental issues, and social factors may all contribute.

The condition displays a variety of signs, which may initially go unnoticed.

Delusions, hallucinations, and uncoordinated thought patterns may occur, as may *catatonic* behaviour - unusual muscular activity or general hyperactivity, or the *flat effect* - an emotionless mood or appearance.

Schizophrenia may be grouped into five different types:

Paranoid type. This generally leads to a fear of persecution, or delusions of grandeur, accompanied often by anxiety and aggression.

Disorganised type. This generally leads to delusions and hallucinations, inappropriate behaviours, the flat effect, or incoherent speech.

Catatonic type. This generally leads to negative thoughts, motor or sensory disturbances, agitation, and an overall reduction of ability.

Undifferentiated type. This type includes characteristics from more than one other type.

Residual type. This occurs when partial recovery from schizophrenia reduces the significant characteristics, but some remain.

Sciatica

Sciatica is a form of *neuritis* - inflammation of a nerve - located in the sciatic nerve. This leads to pain and altered sensations along the path of the sciatic nerve, and possibly a reduction of muscular control in the leg.

A common cause is pressure on the sciatic nerve resulting from a damaged intervertebral disc. Disease, or direct damage to the nerve itself, are also potential causes of sciatica.

Spinal Injury

Any injury to the vertebrae has the potential of causing damage to the spinal cord or the nerves as they exit the spinal column.

Nerve tissue damage may occur directly, particularly if the vertebrae or discs have been badly damaged. Direct nerve damage may also occur during violent excessive movement of the spine, such as during whiplash type incidents.

Indirect damage to nerve tissue may occur through pressure from other damaged tissues, or from accumulating blood or oedema. Hypoxia to the spinal cord may lead to additional oedema and compound other problems.

Signs and symptoms of spinal injury vary greatly depending on the severity and position of the damage.

Stroke

A *stroke*, also known as a *cerebro vascular accident (CVA)* or a *cerebro vascular event (CVE)* is caused by failure of the blood supply to an area of the brain.

There are two basic causes:

Cerebral haemorrhage. This occurs through rupture of a blood vessel within the brain.

Thrombosis. This occurs when a blood clot, usually formed elsewhere in the body, blocks the artery feeding an area of the brain.

The effects of a stroke vary from the almost undetectable right through to death, but often involve loss of sensation, function, or control affecting significant portions of the body.

Transient ischaemic attack

A *transient ischaemic attack (TIA)* is often known as a *mini stroke*.

It is similar in nature to a stroke, but it clears within a short period of time, having been caused by a thrombosis which dissolved or broke up after causing a temporary blockage to an artery within the brain.

Tetanus

Tetanus (lockjaw) is a paralysing infection by clostridium bacteria. These bacteria are present in soil and animal faeces. They spread through infection of open wounds. Tetanus is a risk whenever a wound occurs.

The bacteria produce a toxin which causes nerves to signal spasmodic muscular contractions.

The condition first shows as a headache, with mild fever, and stiffness of the jaw, neck, and other areas.

As the condition worsens, muscular spasms increase, spreading to affect the entire body. High fever and painful convulsions often accompany the condition.

Tetanus is potentially fatal as the resultant paralysis inhibits respiration.