

UNIT 3: MIND, BRAIN & BODY

CONSCIOUSNESS

NEURONS: THE LEGO OF THE NERVOUS SYSTEM

As **Area of Study 1** for Unit 3 Psychology involves studying the nervous system it will be helpful for you to learn some basic information about the brain (from Unit 1) and neurons. The term human nervous system refers to the entire system of neurons throughout the human body.

Made up of the brain, spinal cord, and the nerves which connect to our muscles and organs, the nervous system is our communication centre. The nervous system allows us to interact with the external world and the world inside our bodies. It carries information to the brain from our senses so the brain can interpret the incoming information and respond to it by transmitting messages initiating action or movement in nerves in different parts of our bodies. It is helpful to think of the vast and precisely organised network of neurons in the human nervous system as a huge railway network linking places across a vast landscape we call our own body.

The human nervous system involves thousands of millions of neurons each linking with up to a thousand other neurons at connection points called synapses. **A neuron is simply a single nerve cell.** Playing cricket, preparing a meal and eating it, watching television, writing poetry or completing a complex essay all rely on neurons which are organised in precise networks. Even a simple tap on the shoulder involves messages being passed through sensory neurons in the shoulder to the spinal cord and onto the brain until they arrive in an area of the brain associated with touch (the primary somatosensory cortex) which interprets the message, and then sends further messages to a different area of the brain responsible for initiating movement so you can turn around and look at the person to decide how to respond to them.

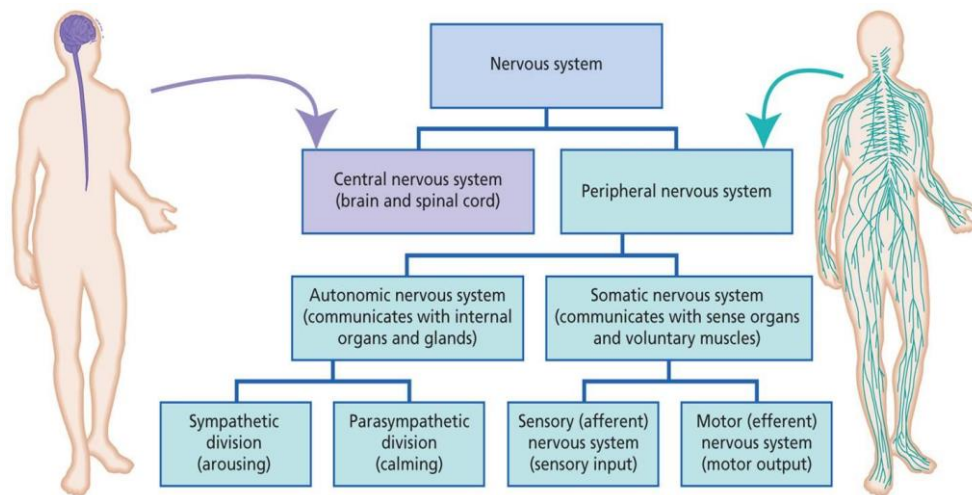
Nerve impulses are responsible for the way information is transmitted from one neuron to another throughout the nervous system in a rapid manner. Neurons are able to communicate through bodily chemicals called **neurotransmitters** which are released at connection points called **synapses**. When neurotransmitters cross the tiny gap (synaptic gap) they attach themselves to receptor sites on the dendrites of the next neuron. If there are enough neurotransmitters the neuron will fire an impulse and so on.

There are three main types of neurons (or nerve cells) in the human nervous system which all have a similar structure.

- **Sensory** (or **afferent**) neurons are specialist neurons that transfer messages away from the sense organs in the PNS up the spinal cord to the brain in the CNS.
- **Interneurons** transmit messages between sensory and motor neurons which don't make direct connections, and from one neuron to another within the CNS. The most numerous neurons, they are only found in the CNS.
- **Motor** (or **efferent**) neurons are specialist neurons which transfer messages away from the CNS to the muscles, organs and glands in the PNS enabling bodily movement, activation of internal organs and glandular secretions.

REMEMBER – S A M E

STRUCTURE OF THE NERVOUS SYSTEM



Source: HASPI Medical Anatomy & Physiology 11a, The Nervous System <http://www.haspi.org/curriculum-anatomy-physiology.html>

The human nervous system can be organised into two major divisions:

- Central Nervous System (CNS)
- Peripheral Nervous System (PNS)

CNS	PNS
<ul style="list-style-type: none"> • Comprised of the brain and spinal cord • The spinal cord connects the brain and the PNS 	<ul style="list-style-type: none"> • Includes all parts of the nervous system that lie outside the brain and spinal cord. • Links the CNS to all other parts of the body • Subdivided into the: <ul style="list-style-type: none"> • Somatic NS: Specialises in the control of voluntary movements and the communication of information to and from the sense organs. Consists of <i>sensory neurons</i> (carry information from receptors to the CNS) and <i>motor neurons</i> (carry information from CNS to muscles). • Autonomic NS: Specialises in connecting the CNS to the body's internal muscles, organs and glands. Does not require conscious control (automatic). Functions continuously. Further subdivided into the: <ul style="list-style-type: none"> • Sympathetic NS: Activates internal muscles, organs and glands to prepare the body for activity (fight or flight response) • Parasympathetic NS: Counteracts the activity initiated by the sympathetic NS to return the body to a state of calm (homeostasis)

NEURONS

Neurons are individual specialised nerve cells. They make up the CNS and PNS. Neurons are communication specialists that transmit information to and from the nervous system.

- **Sensory neurons:** Pass sensory information from sensory receptors to CNS
- **Motor neurons:** Pass motor information from the CNS to muscle cells or glands
- **Interneurons:** Send messages through the CNS

Dendrite

Receives the nerve impulse or signal from adjacent neurons.

Axon

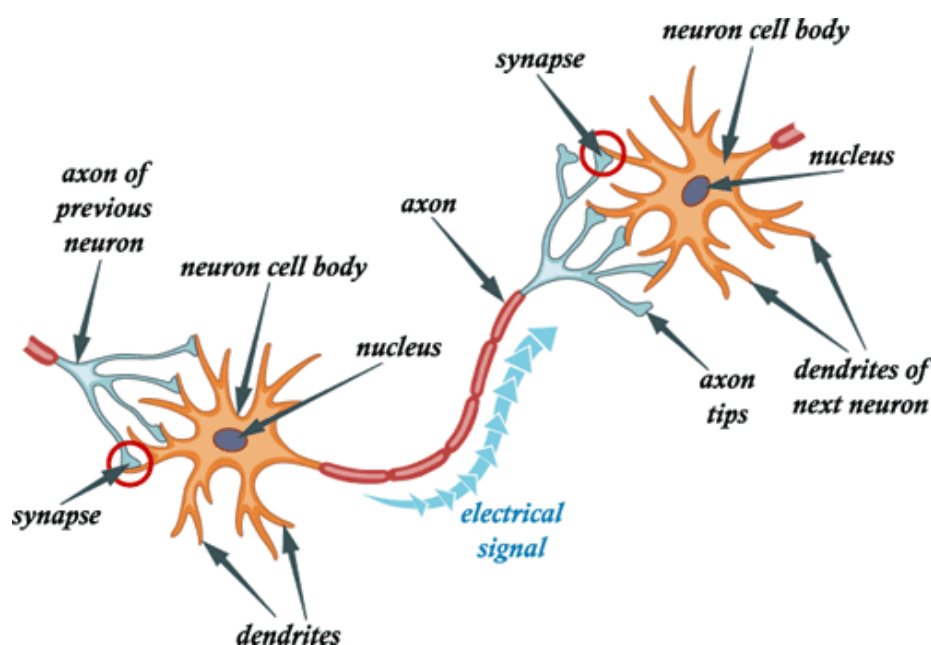
Where the electrical signals pass along.

Myelin sheath

Insulates /protects the axon from external influences that might affect the transmission of the nerve impulse down the axon.

Axon terminals

Terminal buttons store neurotransmitters in vesicles and can send these neurotransmitters across the synapse to an adjacent cell, muscle or gland.



The message that is passed along the neuron is electrical, but neurons don't actually touch each other. There is a small gap between them called a **synapse**. When the signal travels across this gap, it is sent as a chemical signal using **neurotransmitters**.

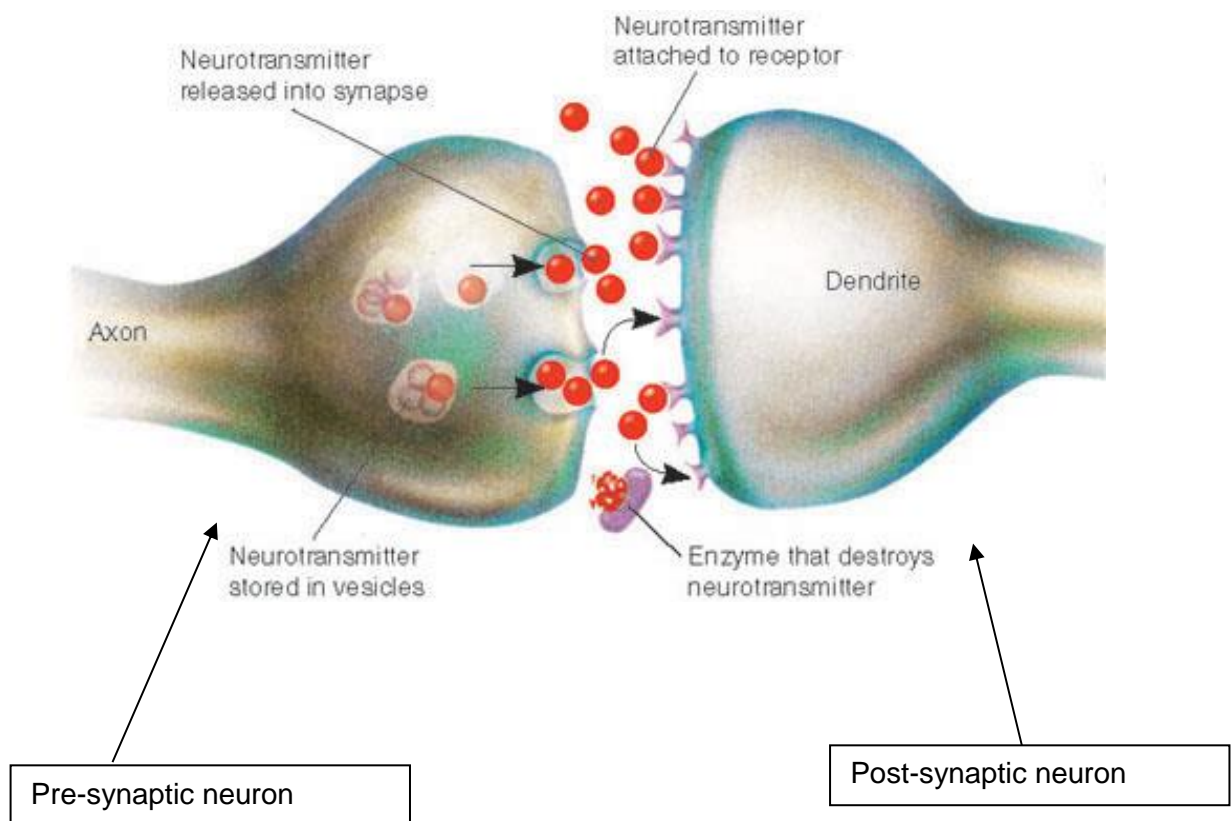
Neurotransmitters are...

- Chemicals that are released from a synaptic vesicle into the synapse by neurons.
- They affect the transfer of an impulse to another nerve or muscle.
- These neurotransmitters are “taken back up” into the terminal buttons of neurons through the process of reuptake.

Synapse:

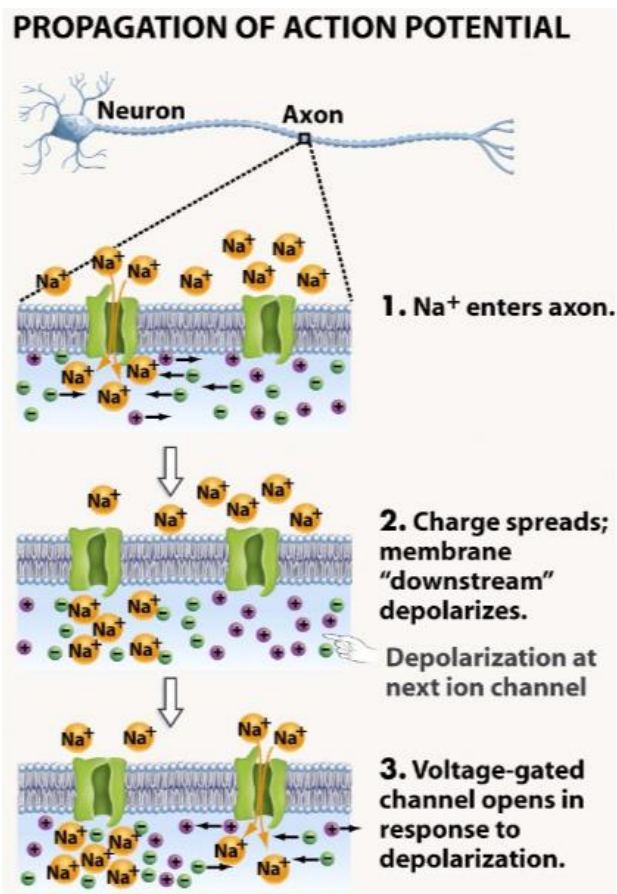
The gap between the end of one neuron and the dendrites of the next neuron.

SYNAPSE BETWEEN 2 NEURONS

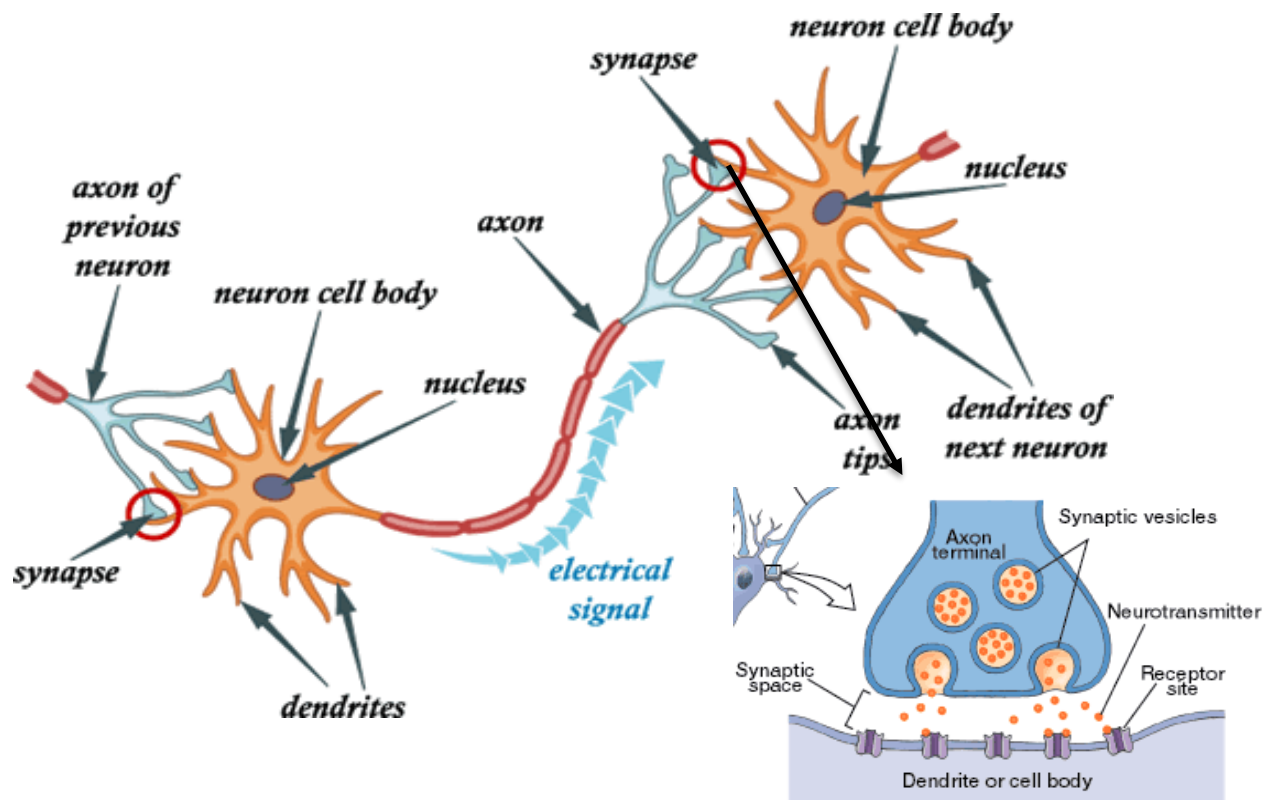


What you need to label:

1. Direction of impulse
2. Axon terminal
3. Synaptic vesicles containing neurotransmitter
4. Synaptic gap (synapse)
5. Dendrite
6. Receptor site

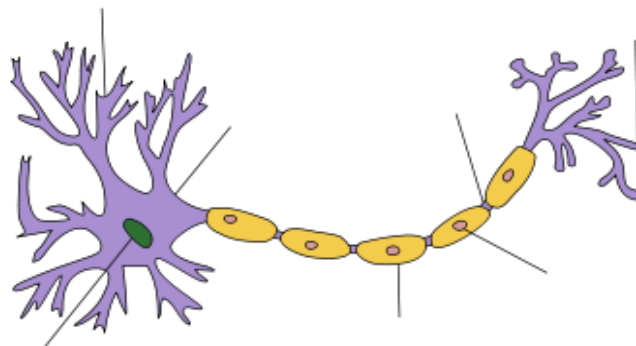


STRUCTURE OF THE NEURON



The message that is passed along the neuron is electrical, but neurons don't actually touch each other. There is a small gap between them called a **synapse**. When the signal travels across this gap, it is sent as a chemical signal using **neurotransmitters**.

Label the neuron below:



THE ROLE OF NEURONS IN TRANSMITTING INFORMATION

To understand how information is processed in the brain, it is important to know that it is a physiological process. Cells called neurons receive information from other neurons, process this information, and then communicate it to other neurons. These cells share similarities with other cells in the body in that they are surrounded by a cell membrane, have a nucleus that contains genes, and are made up of cytoplasm, mitochondria and other organelles. However, they also differ in structure and the manner in which they communicate with each other.

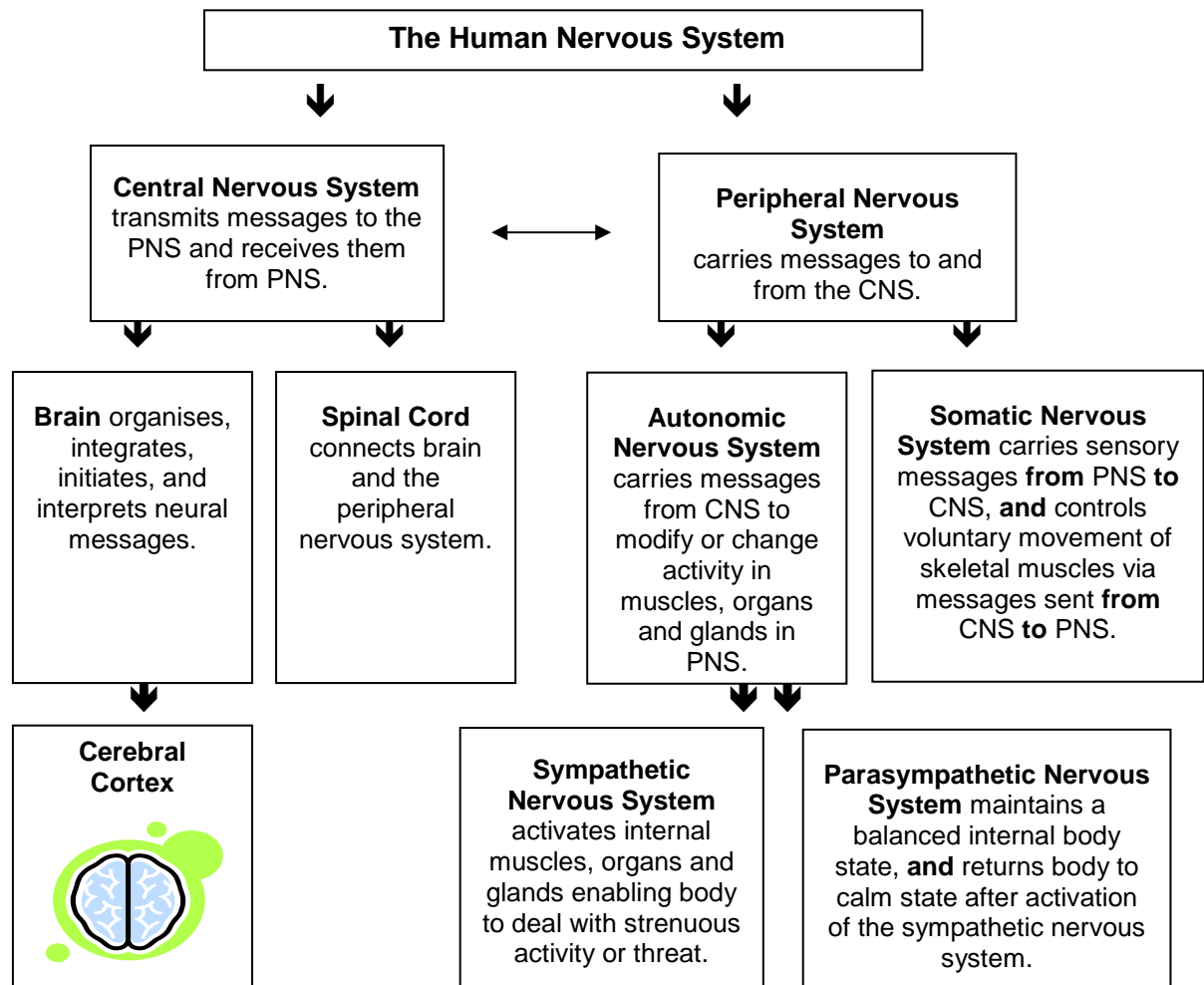
The structure of neurons is important knowledge to recall from VCE Psychology Units 1&2. Although there are many types of neurons of all different shapes and sizes, they are generally comprised of **dendrites**, the **soma**, the **axon** and the **axon terminals**. Most axons are coated with **myelin** (a myelin sheath).

Complete the table below that differentiates the function of the different elements that make up the structure of a neuron.

Structure	Function
Dendrites	
Soma	
Axon	
Myelin	
Axon terminals	

THE HUMAN NERVOUS SYSTEM

FUNCTION AND ORGANISATION



Any serious study of human behaviour will involve the brain and human nervous system. This is because psychological (or mental) processes are only made possible by our physical bodies which function due to certain biological processes. Movement, seeing, thinking, learning and using our memory all involve biological processes as well as psychological ones.

The human nervous system is organised into a number of branches or divisions in terms of their basic functions.

- The central nervous system (CNS) is a complex network of neurons forming the brain and spinal cord which function together in a coordinated manner. The CNS connects the brain to the PNS.
- The peripheral nervous system (PNS) includes all other parts of the human nervous system outside or on the periphery of the brain and the spinal cord. It links the CNS to other parts of the body.

- The PNS is subdivided into the somatic nervous system, which controls all voluntary actions, and the autonomic nervous system (ANS) that controls involuntary actions.
- Somatic nervous system, also called the skeletal nervous system, has a motor function and a sensory function. (A network of sensory (afferent) neurons carries information **to** CNS, and motor (efferent) neurons that carry information **from** the CNS). Allows control of skeletal muscles by carrying neural message to skeletal muscles from CNS, releasing neurotransmitters onto the muscles, causing them to expand or contract, thus initiating movement.
- Autonomic nervous system is a neural network that connects the body's internal organs and glands to the CNS. Acts involuntarily, activating visceral muscles allowing the heart, lungs, stomach, liver.

For example, the brain receives feedback from the PNS telling you that you are uncomfortable because you are hot. The sympathetic nervous system in the ANS will act to cool the body by increasing perspiration and the CNS will send other messages to muscles in the somatic division of the PNS which allows you to act. Having special neurons which end in muscles and other body parts like arms and fingers allows you to take off some clothing. Then the brain receives more feedback from the body, perhaps telling you how much more clothing you'll need to remove to be even cooler.

THE 'FIGHT-FLIGHT-FREEZE' RESPONSE

When the brain perceives an experience as a threat to the organism the sympathetic nervous system is activated and this prepares the body to deal with the stressor. When activated the adrenal glands release hormones adrenalin and noradrenalin. These cause the heart, lungs, sweat glands and gall bladder to **increase** activity, and the stomach, salivary glands and bladder to **decrease** activity.

This response energises the body in preparation for flight (allowing the organism to flee) or fight, (allowing the organism to confront) the stressor, or the organism may become paralysed in the face of danger, like the stunned 'deer in the headlights'. This response is known as the 'fight-flight-freeze' response. The fight-flight-freeze response is activated via the hypothalamic–pituitary–adrenal (**HPA**) **axis**, a self-regulating system involving the sympathetic nervous system and adrenal glands.

When the perceived threat has passed the parasympathetic nervous system reverses the above activity, and returns the body to a state of homeostasis.

EXAM STYLE QUESTIONS

QUESTION 1

The primary function of the autonomic nervous system is:

- A The control of the skeletal muscles.
- B The regulation of the visceral muscles.
- C To provide biofeedback to the brain.
- D To coordinate the activity of the adrenal glands.

QUESTION 2

When experiencing the fight-flight-freeze response the:

- A Sympathetic nervous system will be activated and will decrease the activities of the sweat glands, bladder and intestinal system.
- B Parasympathetic nervous system will be activated and will decrease the activities of the sweat glands, bladder and intestinal system.
- C Sympathetic nervous system will be activated and will increase the activities of the sweat glands, heart and lungs.
- D Parasympathetic nervous system will be activated and will increase the activities of the bladder, intestinal system and salivary glands.

QUESTION 3

Karina was attending a concert performed by the Melbourne Symphony Orchestra. **Describe** with reference to the central nervous system and the peripheral nervous system how Karina would be able to process this experience.

QUESTION 4

Identify the major functions of the autonomic nervous system.

QUESTION 5

Using an example **explain** the function of the parasympathetic nervous system.

ACTIVITIES OF THE SYMPATHETIC AND PARASYMPATHETIC NERVOUS SYSTEM

Body Organs	This organ is responsible for.....	During activation of the sympathetic nervous system.....	During activation of the parasympathetic nervous system.....
Adrenal glands	Secreting adrenalin and noradrenalin.	Increased secretion stimulating heart rate, blood pressure, respiration, relaxation of intestinal muscles.	Inhibits (decreases) hormone secretion, calming autonomic functions.
Heart	Pumping blood.	Heart rate is increased, pumping more blood through the body.	Heart rate is decreased.
Bronchioles in lungs	Breathing.	It dilates (expands) the bronchioles, increasing lung capacity.	Contracts bronchioles, decreasing lung capacity.
Liver	Produces bile to aid digestion, maintains glucose level in blood.	Inhibits (decreases) the production of bile. Increases conversion of glycogen to glucose.	Stimulates (increases) the production of bile. Decreases conversion of glycogen to glucose.
Sweat Glands	Regulate body temperature.	Increase production of perspiration.	Decrease production of perspiration.
Pupils	Regulating the amount of light entering the eyes.	Pupils dilate allowing more light to enter eyes so vision is enhanced.	Pupils contract.
Bladder	Urine storage.	Relaxes.	Increases contractions.
Salivary Glands	Aids digestion.	Salivation decreases and digestion is suspended. Participant gets a dry mouth.	Salivation increases and digestion resumes.
Stomach and digestive system	Digestion.	Decreases contractions. Blood flow can be diverted to other critical areas.	Increases contractions.
Gall Bladder	Stores bile.	Inhibits the release of bile thus slowing digestion.	Increases the release of bile thus increasing digestion.

BRANCHES OF THE AUTONOMIC NERVOUS SYSTEM AND BODILY FUNCTIONS

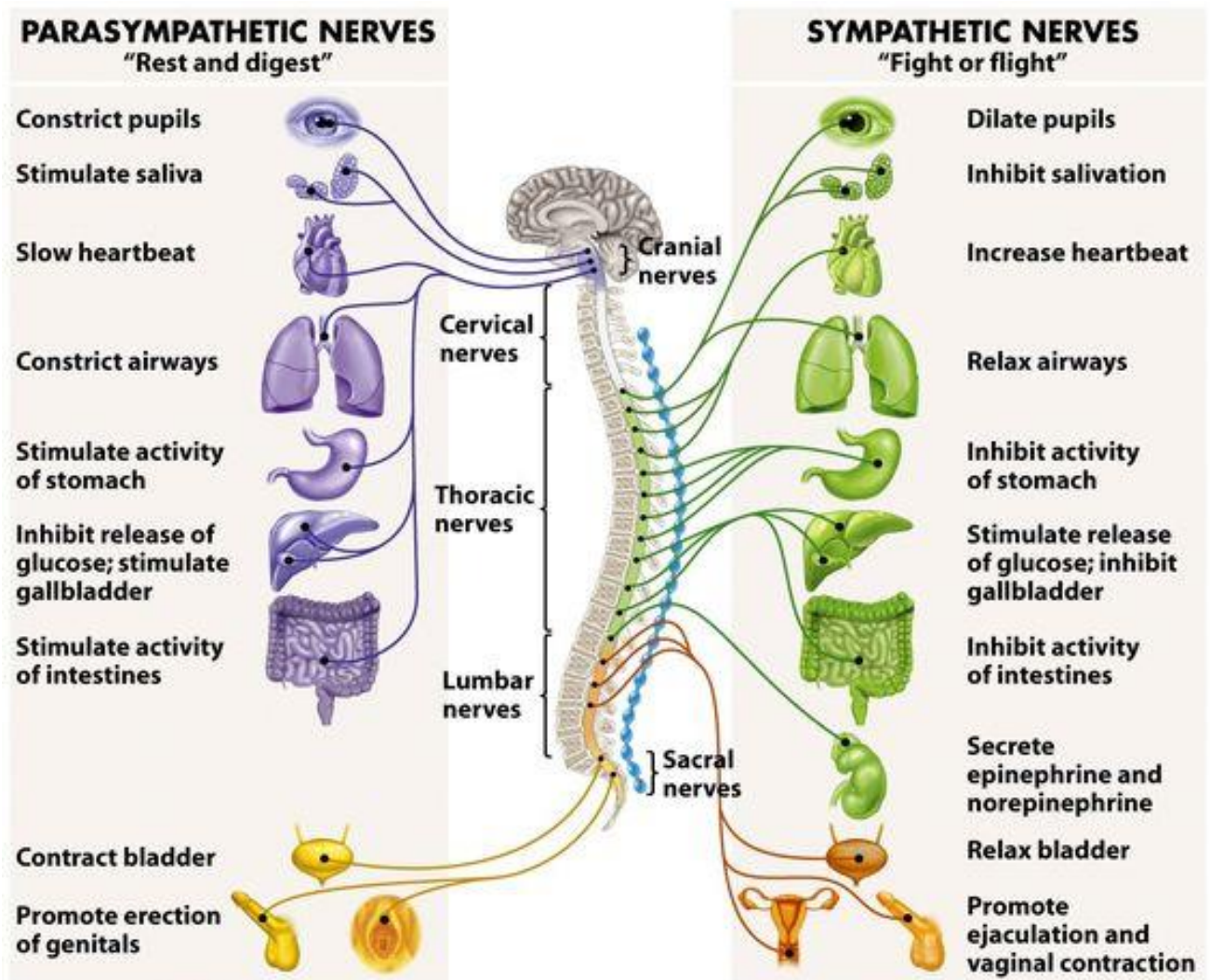


Figure 45-20 Biological Science, 2/e
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Additional Notes:

Complete the following table to describe changes in the functions of various visceral muscles, organs and glands alternatively, as either the sympathetic or parasympathetic division of the autonomic nervous system is activated.

Body Organs	This organ is responsible for.....	During activation of the sympathetic nervous system.....	During activation of the parasympathetic nervous system.....
Adrenal glands			
Heart			
Bronchioles in Lungs			
Liver			
Sweat Glands			
Pupils	Regulating the amount of light entering the eyes.	Pupils dilate allowing more light to enter eyes so vision is enhanced.	Pupils contract.

Watch these below:

Salivary Glands	Aids digestion.	Salivation decreases and digestion is suspended so blood flow can be diverted to other critical areas.	Salivation increases and digestion resumes.
Stomach and Digestion			
Gall Bladder			

Note: Make sure you are aware why each physical change listed above **is adaptive**.

QUESTION 6

Which of the following is an incorrect statement about the peripheral nervous system?

- A The PNS is subdivided into the autonomic and somatic nervous systems.
- B Without the CNS the PNS would not receive information about the external environment.
- C Sensory information is received via receptor cells, or sensory neurons, in the PNS which travel to the somatosensory cortex by way of electrochemical transmission.
- D Movement of skeletal muscles would not be possible without communication between the CNS and the PNS.

QUESTION 7

Which of the following is an incorrect statement about the autonomic nervous system (ANS)?

- A The nerves in the ANS connect the brain to the body's internal organs such as the heart and liver.
- B The nerves in the ANS initiate movement of skeletal muscles.
- C The nerves in the ANS regulate the activities of the visceral muscles.
- D The nerves in the ANS connect the brain to the adrenal, salivary and sweat glands.

QUESTION 8

The fight-flight-freeze response is termed an adaptive process. **Explain** this statement with reference to a specific example.

QUESTION 9

The area of the nervous system that is responsible for keeping the heart and lungs operating without conscious effort is known as:

- A The autonomic nervous system.
- B The parasympathetic nervous system.
- C The sympathetic nervous system.
- D The somatic nervous system.

QUESTION 10

The primary function of the autonomic nervous system is:

- A The control of the skeletal muscles.
- B The regulation of the visceral muscles.
- C To provide biofeedback to the brain.
- D To coordinate the activity of the adrenal glands.

QUESTION 11

Using an example **explain** the function of the parasympathetic nervous system.

[illegible]

THE SCIENCE BEHIND THE REFLEX ARC

Reflexes are responses to sensory stimuli, which are unlearned and innate. These responses tend to be simple behaviours that contribute to our safety and survival.

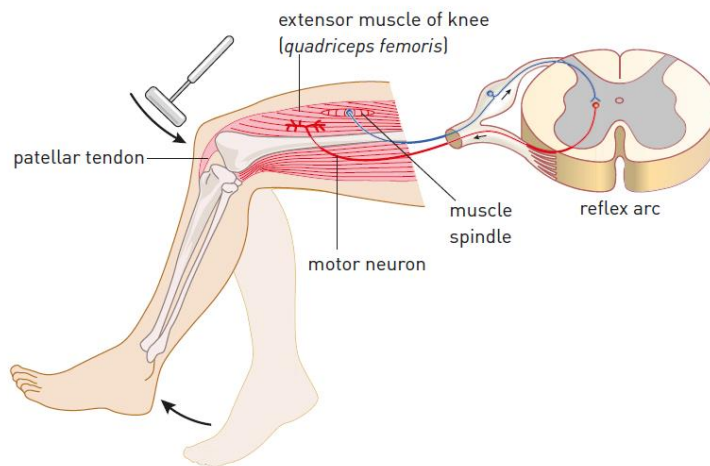
Many of these are controlled within the spinal cord without involving the brain and are therefore referred to as **spinal reflexes**. This enables an organism to respond faster than if a nerve impulse needed to be sent to the brain. This means that pulling away from a hot or sharp object, for example, can be almost instantaneous.

The process of receiving a sensation and responding to it reflexively involves a reflex arc. There are two forms of reflex arc:

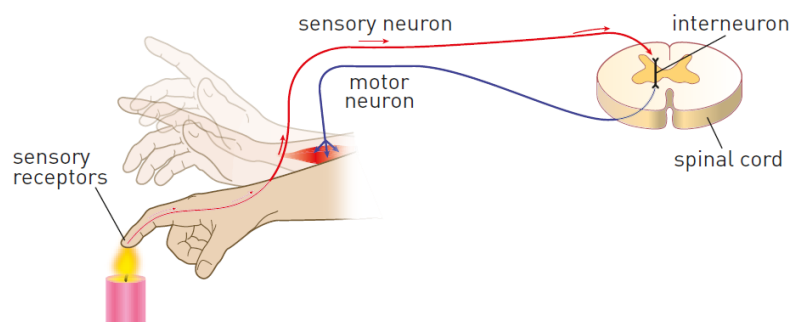
- **Monosynaptic reflex arc:** involving only one synapse, where an **afferent neuron (sensory neuron)** brings a sensation from receptors in the body and an **efferent neuron (motor neuron)** carries motor messages to the muscles of the body
- **Polysynaptic reflex arc:** involving **interneurons** connecting the afferent and efferent neurons, and, therefore, at least two synapses

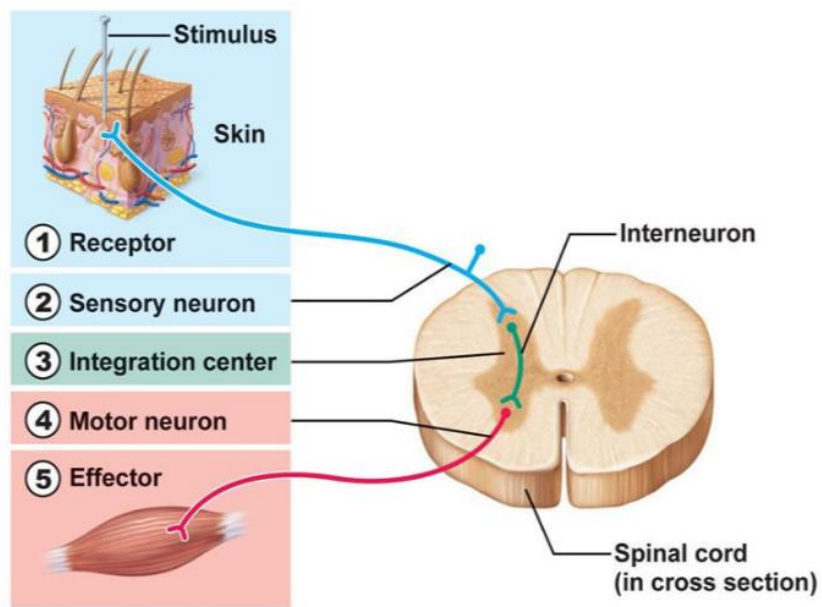
Only a few of the simplest reflexes, such as the 'knee-jerk' or patellar reflex are monosynaptic.

Monosynaptic reflex arc



Polysynaptic reflex arc

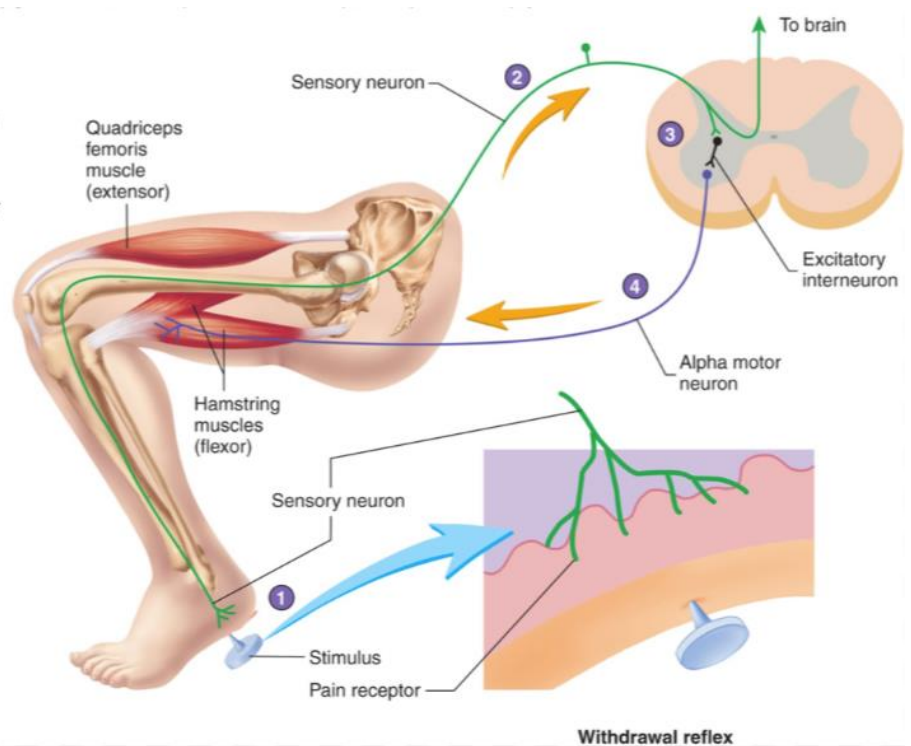




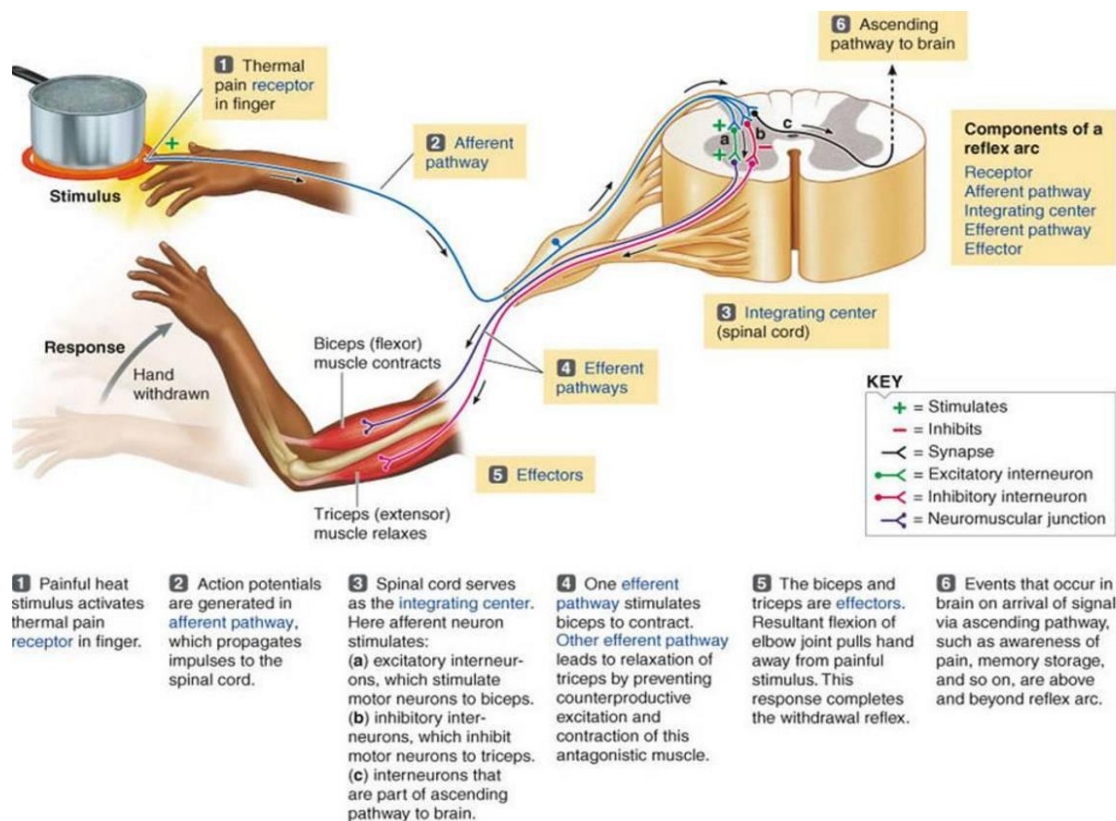
Examples of spinal reflex

Stimulation of pain receptors results in:

- 1 Pain receptors detect a painful stimulus.
- 2 Sensory neurons conduct action potentials to the spinal cord.
- 3 Sensory neurons synapse with excitatory interneurons that synapse with alpha motor neurons.
- 4 Excitation of the alpha motor neurons muscles and withdrawal of the limb from the painful stimulus.



An example of an intricate reflex arc



Excitatory interneurons vs Inhibitory interneurons

Excitatory interneurons stimulate the activation of motor neurons connected to effectors. They involve the release of excitatory neurotransmitters that are the nervous system 'on switches', speeding up neural activity and increasing the likelihood that an excitatory signal is sent.

Physiologically, the excitatory neurotransmitters act as the body's natural stimulants, generally serving to promote alertness, energy and activity. Glutamate is an example of a major excitatory neurotransmitter and is used at the great majority of fast excitatory synapses in the brain and spinal cord. It is also used at most synapses that are modifiable and is therefore associated with long-term potentiation, creating links between neurons that form the basis of learning and long-term memory.

Inhibitory interneurons (involving inhibitory neurotransmitters)

Inhibitory interneurons inhibit the activation of motor neurons connected to effectors. They are the nervous system's 'off switches', decreasing the likelihood that an excitatory signal is sent and slowing down the neural activity. Physiologically, the inhibitory neurotransmitters act as the body's tranquilisers, generally serving to induce sleep, promote calmness and decrease aggression. GABA is the major inhibitory neurotransmitter found in the CNS and it plays a role in regulating anxiety and reducing stress. It can act like a brake on the excitatory neurotransmitters (such as norepinephrine, adrenaline and dopamine).

THE ROLE OF NEUROTRANSMITTERS IN THE TRANSMISSION OF NEURAL INFORMATION BETWEEN NEURONS

The following table summarises the effects of imbalance in some neurotransmitters:

Neurotransmitter	Function/role	Too much can cause:	Too little can cause:
Glutamate	<p>Main excitatory neurotransmitter in the brain, speeding up neural activity</p> <p>Associated with long-term potentiation (learning and long term memory)</p>	<p>Parkinson's disease</p> <p>Anxiety disorders/phobia</p> <p>Bipolar disorder</p> <p>Overstimulation of the brain leading to seizures</p> <p>ADD/ADHD</p>	<p>Impaired memory and learning</p>
GABA	<p>Main inhibitory neurotransmitter in the brain, slowing down neural activity</p>	<p>Sedation</p> <p>Impaired short-term memory</p>	<p>Parkinson's disease</p> <p>Anxiety disorders/phobia</p> <p>Stress</p> <p>Insomnia</p> <p>Huntington's disease</p> <p>Seizures</p> <p>Alcoholism</p> <p>Bipolar disorder</p>
Dopamine	<p>Voluntary movement</p> <p>Learning and memory</p> <p>Alertness and attention</p> <p>Pleasure/reward seeking</p>	<p>Schizophrenia</p> <p>Addiction</p> <p>Tourette syndrome</p>	<p>Parkinson's disease</p> <p>ADD/ADHD</p> <p>Depression</p>