

## Section 1: The Nervous System

### • What is the function of the nervous system?



Nerves inside the spine carry signals between the brain and the rest of the body

The basic job of the nervous system is to detect stimuli and coordinate responses to them. These stimuli may be external, such as a noise or a smell, or internal, such as body temperature. Because the nervous system includes the brain, it can use prior experiences and learning to help coordinate any response. Only animals have a nervous system, and this allows them to respond quickly to dangers and opportunities.

#### • Suggested Films

- What Is a Memory?
- Intuition
- The Nervous System

### Extension Question

Q1. What examples are there of the nervous system at work?

Examples might include the nervous system detecting a danger and responding by causing the person to run away. The nervous system is also involved in storing memories, generating speech and learning. Your heart rate and breathing rate are also under the control of your nervous system.

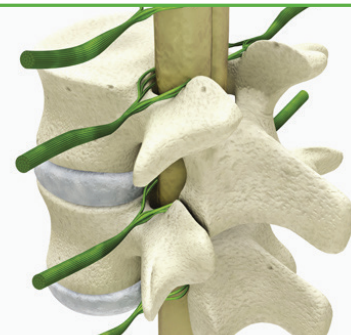
### • What does the human nervous system consist of?

The nervous system can be divided into the Central Nervous System (CNS) and the Peripheral Nervous System (PNS). The CNS is made up of the brain and spine. All the nerves coming into and out of the CNS make up the PNS. Those nerves coming in and out of the brain are called cranial nerves, while those travelling to and from the spinal cord are called spinal nerves.

The CNS contains billions of specialised cells called neurons. Neurons have the ability to conduct electrical impulses, and so can transmit messages around the body extremely quickly. Specialised neurons called receptors can detect stimuli, such as light or sound. The impulses from these receptors are transferred to the CNS by sensory neurons, and those taking messages away are called motor neurons. Motor neurons stimulate effectors, such as muscles and glands, leading to a response. The neurons which make up the CNS are called connector neurons.

#### • Suggested Films

- Introduction to the Brain
- FactPack: The Spinal Cord
- The Nervous System



Nerves at the spinal cord

### Extension Questions

#### Q2. What protects the brain and spine?

The brain is enclosed within the skull and the spinal cord within the vertebrae of the spine. Both are surrounded by a fluid called cerebro spinal fluid which helps to act as a shock absorber.

#### Q3. What is meningitis?

The brain and spinal cord are surrounded by protective membranes called the meninges. If these membranes become inflamed, for example because of an infection, this can lead to meningitis. Symptoms of meningitis include fever, vomiting, headaches, confusion, and if serious enough, coma and death.

#### Q4. What is a nerve?

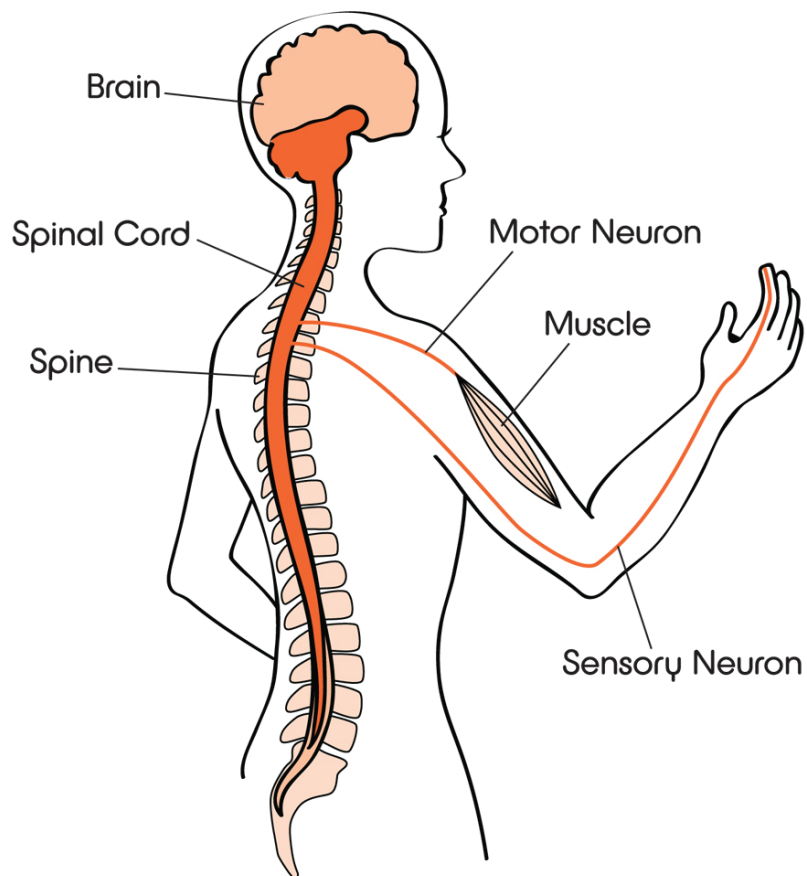
A nerve is a collection of many neurons. Sensory nerves consist of numerous sensory neurons, motor nerves of motor neurons, and mixed nerves are made up of both sensory and motor neurons. The optic nerve is an example of a sensory nerve carrying impulses from the receptor cells at the back of the eye to the brain.

### DIAGRAM 01:



### Nervous System Organisation

BIOLOGY • BEING HUMAN • BRAIN



Section 2: Neurons and Connections

- How are neurons adapted for their function?

Neurons have the ability to conduct electrical impulses at speeds of up to 100m/s. They usually have a long extension called an axon, and some can be up to a metre in length, such as those running up and down the leg. The axon is often insulated by a myelin sheath to speed up the rate of conduction. As well as an axon, neurons often have a number of other projections, called dendrites, to make contact with other neurons.

- Suggested Film  
Neurons As Networks

Extension Question

Q5. What is the advantage of having one long neuron running up the leg rather than lots of shorter cells joined end to end?

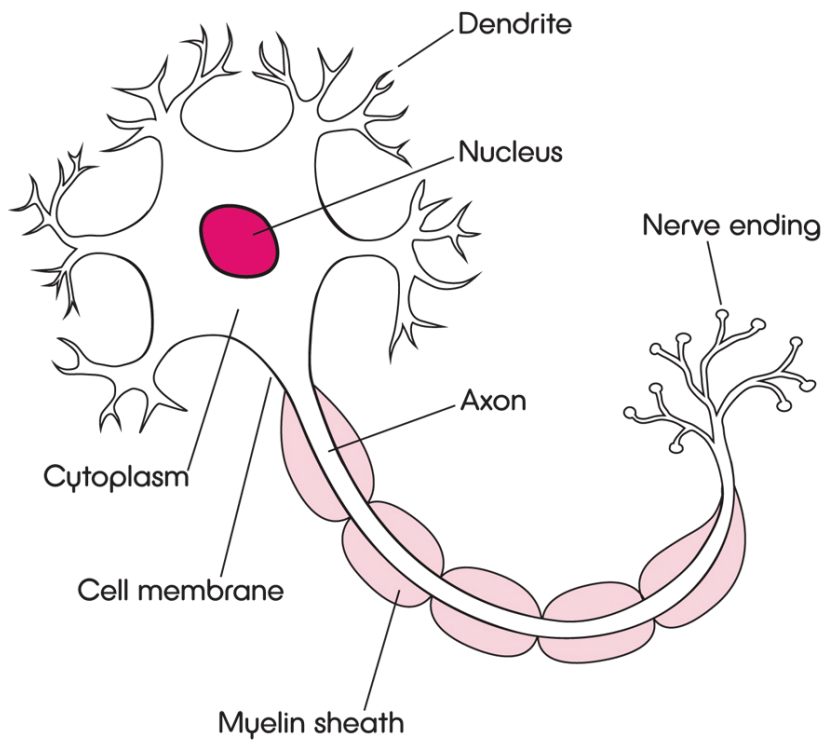
One long neuron will transmit a nerve impulse faster because there is no delay in transmitting the message across the gaps (called synapses) between cells. Neural pathways with very few cells, and therefore few synapses, transmit impulses very quickly.

DIAGRAM 02:



Motor Neuron

BIOLOGY • BEING HUMAN • BRAIN

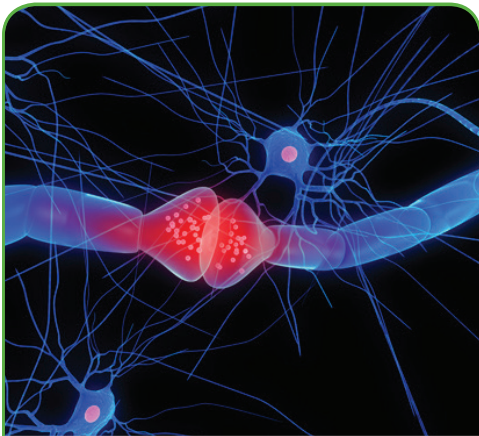


### • What is a synapse?

Neurons don't quite touch each other. The gap between two neurons is called a synapse, and chemicals called neurotransmitters have to diffuse across this tiny space before the next cell is stimulated. Different types of neurotransmitter have different functions: some can be excitatory, some inhibitory. Examples of neurotransmitters include serotonin and dopamine.

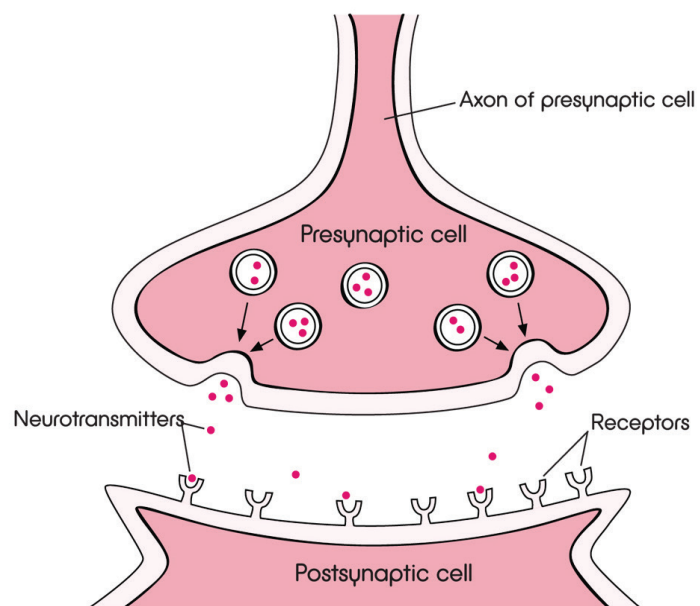
### • Suggested Film

– Neurons As Cells



Neurons meeting at a synapse

## DIAGRAM 03:



### Extension Questions

#### Q6. What are the advantages of synapses?

Although synapses slow the speed of an impulse along a nerve pathway, they also prevent messages travelling backwards and allow for communication between several neurons.

#### Q7. How do drugs and toxins affect the nervous system?

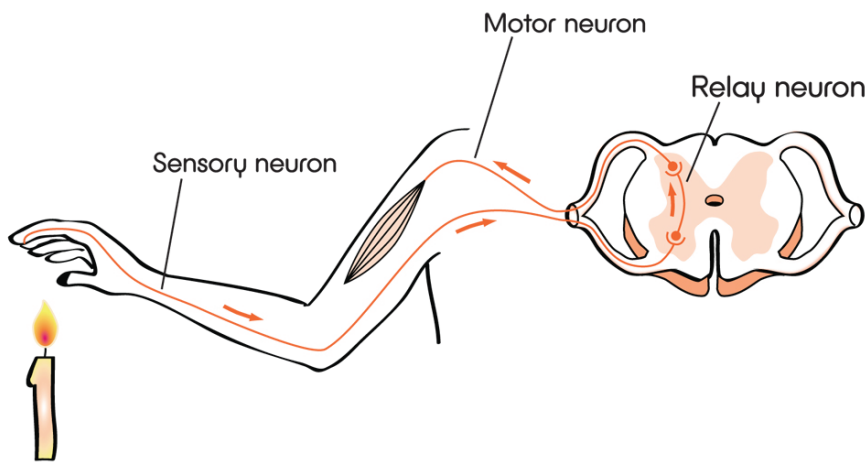
Some drugs and toxins can mimic naturally occurring neurotransmitters, while others can block the activity of neurotransmitters. This can cause changes in behaviour, mood, vision and balance. Sometimes these drugs are used by doctors to treat conditions such as pain, anxiety and depression, though often people take them for recreational use.

• What is a reflex arc?

A reflex arc is the simplest form of neural network. It is a pathway which usually involves very few neurons, thereby speeding up response times. For example, if you accidentally put your hand on something hot, a message is sent up a sensory neuron to the spinal cord before a response message is immediately sent by a motor neuron to the muscle, causing the hand to be lifted away from danger. The brain is not involved, so the pathway is shorter and involves few synapses; hence the response is automatic and quick.

DIAGRAM 04:

**Reflex Arc**  
BIOLOGY • BEING HUMAN • BRAIN



• Suggested Film

– FactPack: Reflex Arcs

Extension Question

Q8. Can you think of any other examples of reflex actions?

Blinking rapidly to protect the eye from damage is an example of a reflex action, as is the contraction and dilation of the pupil in response to different light intensities. When a doctor taps the tendon below the kneecap, he is testing the knee-jerk reflex in order to check for any disruption to this neural pathway, for example damage to the lower spine. The knee-jerk reflex helps us to maintain balance and posture.

### Section 3: The Brain

#### • What is the function of the brain?

The brain has a huge range of functions. Much of what it does is out of conscious awareness and involves the control of key physiological processes. For example, the brain stem coordinates bodily processes such as heart rate, breathing rate and blood pressure, while the cerebellum controls balance and posture. Other parts of the brain, such as the cerebrum, are involved with the higher processes of thinking, language, memory and the conscious awareness of emotion.

#### • Suggested Films

- Introduction to the Brain
- What Is a Memory?
- How We Learn
- Can We Control Pain?
- Developing Brain: Baby Brain
- Developing Brain: That's Me!
- Developing Brain: Theory of Mind
- Developing Brain: Tantrums
- The First Brain Surgeon
- The Curious Case of Phineas Gage
- The Lobotomist
- Winning and Losing



MRI scans of the human brain

#### • Suggested Activities

- Ask students to produce an annotated poster of the different brain regions
- Ask students to research and present on the effects of one drug

#### Extension Questions

##### Q9. What is a stroke?

When a region of the brain doesn't get sufficient blood, for example due to a blockage or haemorrhage, the neurons in that region can die causing loss of brain function. People who suffer from a stroke may lose their ability to speak, their sight, or control of a limb on one side of their body. This depends upon which region of the brain has been damaged.

##### Q10. How do we know what different regions of the brain do?

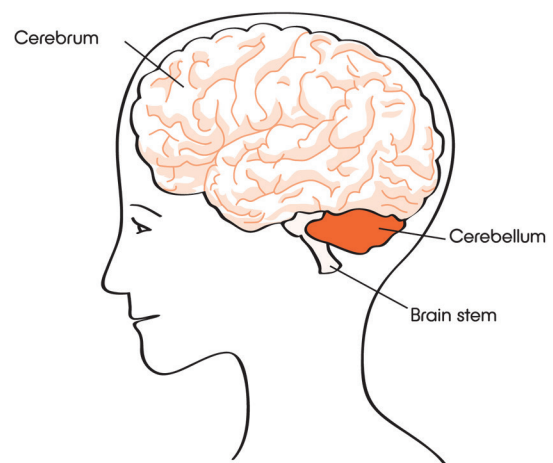
Today, doctors can use various scanning techniques to see the regions of the brain in detail and to relate those regions to their functions - known as brain localisation. One of the best known techniques is called fMRI (functional magnetic resonance imaging). Before the introduction of scanners, doctors learnt a lot about brain function from patients who had suffered brain damage as a result of accidents and strokes. When the patient died, their brains could be examined to relate the damaged region to the lost function.

#### DIAGRAM 05:



#### Key Regions of the Brain

BIOLOGY • BEING HUMAN • BRAIN



## • Quizzes

## Introduction to the Brain

## Basic

• What protects the brain?

- A – the heart
- B – the nerves
- C – the skull
- D – the rib cage

• What is the bundle of nerves found inside the spine called?

- A – the brain
- B – the spinal cord
- C – neurons
- D – the backbone

• What are the three main regions of the brain?

- A – cerebrum, cerebellum, brain stem
- B – cranium, cerebellum, brain stem
- C – cranium, cerebrum, cerebellum
- D – cranium, cerebrum, brain stem

## Advanced

• Approximately what percentage of your daily energy needs are used by your brain?

- A – 10%
- B – 20%
- C – 30%
- D – 40%

• What region of the brain controls balance and posture?

- A – cranium
- B – brain stem
- C – cerebrum
- D – cerebellum

• What region of the brain controls the senses and speech?

- A – cranium
- B – brain stem
- C – cerebrum
- D – cerebellum



## Neurons As Cells and Networks

### Basic

• What is the scientific name for a nerve cell?

- A – neuron
- B – axon
- C – nucleus
- D – synapse

• What is the nature of the message that nerve cells conduct?

- A – chemical
- B – hormonal
- C – audible
- D – electrical

• What is the gap between two nerve cells called?

- A – a neuron
- B – an axon
- C – a junction
- D – a synapse

### Advanced

• What is the scientific name for cells which make up the nervous system?

- A – neurons
- B – axons
- C – nuclei
- D – synapses

• What is the gap between two nerve cells called?

- A – a neuron
- B – an axon
- C – a junction
- D – a synapse

• Which of the following is an example of a neurotransmitter?

- A – electricity
- B – insulin
- C – serotonin
- D – hormones



## • Answers

## Introduction to the Brain

## Basic

• What protects the brain?

- A – the heart
- B – the nerves
- 
- D – the rib cage

• What is the bundle of nerves found inside the spine called?

- A – the brain
- 
- C – neurons
- D – the backbone

• What are the three main regions of the brain?

- 
- B – cranium, cerebellum, brain stem
- C – cranium, cerebrum, cerebellum
- D – cranium, cerebrum, brain stem

## Advanced

• Approximately what percentage of your daily energy needs are used by your brain?

- A – 10%
- 
- C – 30%
- D – 40%

• What region of the brain controls balance and posture?

- A – cranium
- B – brain stem
- C – cerebrum
- 

• What region of the brain controls the senses and speech?

- A – cranium
- B – brain stem
- 
- D – cerebellum

Neurons As Cells and Networks

Basic

• What is the scientific name for a nerve cell?

A – neuron

B – axon

C – nucleus

D – synapse

• What is the nature of the message that nerve cells conduct?

A – chemical

B – hormonal

C – audible

D – electrical

• What is the gap between two nerve cells called?

A – a neuron

B – an axon

C – a junction

D – a synapse

Advanced

• What is the scientific name for cells which make up the nervous system?

A – neurons

B – axons

C – nuclei

D – synapses

• What is the gap between two nerve cells called?

A – a neuron

B – an axon

C – a junction

D – a synapse

• Which of the following is an example of a neurotransmitter?

A – electricity

B – insulin

C – serotonin

D – hormones