

MODULE B6: BRAIN AND MIND – OVERVIEW

How the human brain functions remains largely unknown. Neuroscience is an area at the frontiers of medical research, and has huge potential impact for an aging population.

This module begins by looking at how, in order to survive, simple organisms respond to changes in their environment. The nervous system of multicellular animals is also considered.

The second topic considers how information is transmitted from receptor cells to effector cells, including a simple description of chemical transmission across synapses. Simple, learnt and modified reflexes are introduced in the third topic, with reference to survival and adaptation.

The fourth topic takes a closer look at the brain, and how neuron pathways become 'preferred' although potential pathways are available to allow for adaptation to new situations. The fifth topic illustrates specialised areas of the brain, methods scientists have used to map the cerebral cortex and introduces a basic understanding of memory. Finally the effects of drugs on synapses in the brain are explored (for example, Ecstasy)

Topics

B6.1 How do organisms respond to changes in their environment?

Co-ordination of responses to stimuli via the central nervous system.

B6.2 How is information passed through the nervous system?

Structure of motor neurons

Transmission of electrical impulses including synapse.

B6.3 What are reflex actions?

Simple reflex actions for survival, mechanism of a reflex arc conditioned reflexes.

B6.4 How do humans develop more complex behaviour?

Formation of neuron pathways and learning through repetition.

B6.5 What do we know about the way in which the brain co-ordinates our senses?

Mapping brain function, Models for understanding memory.

B6.6 How do drugs affect our nervous systems?

Effects of Ecstasy on synapse action.

ICT Opportunities

This module offers opportunities for illustrating the use of ICT in science, for example:

- observing and recording human and animal behaviour;
- logging, recording and displaying physiological data.

Use of ICT for teaching and learning can include:

- video clips to illustrate patterns in the behaviour of living things;
- animation to explain synapse function and the effects of drugs on synapses;
- the internet to research behaviour and memory.

MODULE B6: BRAIN AND MIND

B6.1 How do organisms respond to changes in their environment?

1. recall that a stimulus is a change in the environment of an organism;
2. understand that animals respond to stimuli in order to keep themselves in favourable conditions;
3. understand that the central nervous system (CNS) coordinates an animal's responses via:
 - sensory neurons carrying impulses from receptors to the CNS;
 - motor neurons carrying impulses from the CNS to effectors;
4. understand that receptors and effectors can form part of complex organs, for example:
 - light receptor cells in the retina of the eye;
 - hormone secreting cells in a gland;
 - muscle cells in a muscle;
5. recall that in the mammalian nervous system the CNS (brain and spinal cord) is connected to the body via the peripheral nervous system (sensory and motor neurons).

B6.2 How is information passed through the nervous system?

1. recall that neurons transmit electrical impulses when stimulated;
2. recall that in motor neurons the cytoplasm forms a long fibre surrounded by a cell membrane called an axon;
3. understand that some axons are surrounded by a fatty sheath, which insulates the neuron from neighbouring cells and increases the speed of transmission of a nerve impulse;
4. recall that there are gaps between adjacent neurons called synapses;
5. **understand that at the end of a sensory neuron an impulse triggers the release of chemicals into the synapse, which diffuse across and bind to receptor molecules on the membrane of a motor neuron;**
6. **understand that the receptor molecules only bind to specific chemicals, initiating a nerve impulse in the motor neuron.**

MODULE B6: BRAIN AND MIND

B6.3 What are reflex actions?

1. recall that simple reflexes produce rapid involuntary responses;
2. understand the nervous pathway of a reflex arc;
3. understand that simple reflexes ensure that an animal will respond to a stimulus in a way that is most likely to result in its survival, to include finding food, sheltering from predators, and finding a mate;
4. understand that simple animals rely on reflex actions for the majority of their behaviour;
5. understand that the disadvantage of this simple behaviour is that these animals have difficulty responding to new situations;
6. recall examples of simple reflexes in humans, to include newborn reflexes, pupil reflex;
7. **understand that a reflex response to a new stimulus can be learned by introducing a secondary stimulus in association with the primary stimulus, e.g. Pavlov's dogs (conditioned reflex action);**
8. **understand that in a conditioned reflex the final response has no direct connection to the stimulus;**
9. **understand that some conditioned reflexes increase the animal's chances of survival, e.g. rejection by birds of caterpillars with particular colouring;**
10. **recall that in some circumstances the brain can modify a reflex response via a neuron to the motor neuron of the reflex arc, to include keeping hold of a hot dinner plate.**

MODULE B6: BRAIN AND MIND

B6.4 How do humans develop more complex behaviour?

1. recall that mammals have a complex brain of billions of neurons that allows learning by experience, including social behaviour;
2. understand that during development the interaction between mammals and their environment results in neuron pathways forming in the brain;
3. understand learning as the result of experience where certain pathways in the brain will become more likely to transmit impulses than others;
4. understand that this is why some skills may be learnt through repetition;
5. understand that the variety of potential pathways in the brain makes it possible for the animal to adapt to new situations;
6. **understand that there is evidence to suggest that children may only acquire some skills at a particular age, to include language development in feral children.**

MODULE B6: BRAIN AND MIND

B6.5 What do we know about the way in which the brain co-ordinates our senses?

1. recall that the cerebral cortex is the part of our brain most concerned with intelligence, memory, language and consciousness;
2. recall that a variety of methods have been used by scientists to map the regions of the cortex (including studies of patients with brain damage, studies in which different parts of the brain are stimulated electrically and, more recently, MRI brain scans);
3. describe memory as the storage and retrieval of information;
4. understand that verbal memory can be divided into short-term memory and long-term memory;
5. **understand that humans are more likely to remember information if they can see a pattern in it (or impose a pattern on it), if there is repetition of the information, especially over an extended period of time, or if there is a strong stimulus associated with it, including colour, light, smell, sound;**
6. understand that scientists have produced models for memory but so far none of these has been able to provide an adequate explanation.

B6.6 How do drugs affect our nervous systems?

1. recall that some drugs and toxins affect the transmission of impulses across synapses;
2. **understand that Ecstasy (MDMA) blocks the sites in the brain's synapses where the chemical serotonin is removed;**
3. **understand that the mood-enhancing effects of Ecstasy are due to the subsequent increase in serotonin concentration.**