Topic Page: Sensitivity

Summary Article: **sensitivity**
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In biology, the ability of an organism, or part of an organism, to detect changes in the environment. All living things are capable of some sensitivity, and any change detected by an organism is called a stimulus. Plant response to stimuli (for example, light, heat, moisture) is by directional growth (tropism). In animals, the chain of events linking a stimulus to a response can become highly complex, as stimuli may be processed by sensory organs and the central nervous system (CNS) before leading to a response.

In animals, the body cells that detect the stimuli are called receptors, and these are often contained within a sense organ. For example, the eye is a sense organ, within which the retina contains rod and cone cells which are receptors. The part of the body that responds to a stimulus, such as a muscle, is called an effector, and the communication of stimuli from receptors to effectors is termed ‘coordination’; messages are passed from receptors to effectors either via the nerves or by means of chemicals called hormones. Rapid communication and response to stimuli, such as light, sound, and scent, can be essential to an animal's well-being and survival, and evolution has led to the development of highly complex mechanisms for this purpose.

Nervous systems Most animals have a nervous system that coordinates communication between stimulus and response. Nervous systems consist of special cells called neurones (see nerve cell) which are fundamentally the same as other body cells in that each contains a nucleus, cytoplasm, and cell membrane. In addition, in order to receive and pass messages, they also have long thin fibres of cytoplasm extending out from the cell body termed ‘nerve fibres’. The longest of these, which can be more than a metre long, are called **axons**. The shorter fibres are called **dendrites**.

Nerve nets Small animals, such as jellyfish, which do not need to coordinate complex messages between stimuli and response mechanisms, have simple nervous systems, termed ‘nerve nets’. In a nerve net, each neurone is connected by fibres to adjacent neurones, so that a message received in any one part of the nervous system is relayed from neurone to neurone throughout the whole of the organism's body.

Central nervous systems The evolution of larger and more complex animals, such as humans, has necessitated the development of far more elaborate nervous systems, and most animals have a central nervous system (CNS). The main difference between a simple nerve net and a central nervous system is the addition of a brain and spinal cord to coordinate and relay messages between receptors and the appropriate effectors, without involving the whole body. Thus rapid responses to specific stimuli are triggered.

Simple nervous systems The sensitive properties of protoplasm in unicellular organisms, such as protozoans, enable them to respond negatively to light and other harmful stimuli, and positively to food. Simple multicellular organisms have nerve cells, or neurones, with which to effect and control responses to stimuli. Moving up the evolutionary scale, in animals such as the earthworm, there is a large nerve cord that extends along the ventral surface of the body, which widens at each segment of the body into a collection of nerve cells called ganglia. The nerve system of the grasshopper is similar except

that it has specialized sense organs: feelers, or antennae, and two compound eyes on top of the head with three simple eyes (ocelli) between. The antennae are sensitive to scent and feeling, the simple eyes are sensitive to light change, and the compound eyes are sensitive to light, motion, and colour.

Human nervous system The central nervous system is one of the first body systems to develop in the human embryo. It is the control system for all human thought and action, and is like a telephone network with the brain as its control centre sending information to every part of the body along nerves channelled through the spinal cord. The brain has three main divisions – the cerebrum, cerebellum, and medulla oblongata – which control particular functions of physical and mental activity.

Sense organs The human sense organs are the eyes, the ears, the nose, the tongue, and the skin, each of which is structurally adapted to respond rapidly to specific stimuli in the environment. Thus they are able to receive and interpret the sensations of sight, sound, smell, taste, and touch, and initiate instantaneous reflex actions that do not require thought or judgement. For instance, the stimulus of extreme heat, such as a finger touching a hot stove, affects the nerve endings of touch in the skin. The impulse is carried along the sensory nerves, or neurones, to the spinal cord where it connects with cell bodies and is transferred to motor nerves. These carry the impulse back to the muscles of the arm and hand, with the result that the finger is pulled away from the heat. This constitutes a reflex action, and the arrangement of sensory neurones, relay neurones, and motor neurones is called a **reflex arc**.

Chemical messengers Nerves carry electrical messages very rapidly from one part of the body to another, but another, slower, reaction to stimuli is by the body's use of chemical messages in the form of hormones. Hormones, which are produced in the endocrine glands, are secreted directly into the bloodstream and carried to all parts of the body. Particular hormones affect only specific parts of the body. Thus the ‘fight or flight’ hormone, adrenalin, which helps the body to cope with danger, causes the heart to beat faster and so increases the oxygen supply to the brain and muscles, enabling them to respond more rapidly. At the same time, it causes the blood vessels in the skin and digestive system to contract, so that more blood can be directed to the brain and muscles. While the transmission of messages via the nervous system is very rapid, so that response can be almost instantaneous, the effect of the message is usually very short-lived. On the other hand, although the passage of hormonal messages through the blood system is slower, their effect is usually much more long lasting, and is normally continued until the stimulus ceases.

Tropisms When plant response to a stimulus is growth towards the stimulus, it is termed **positive tropism**; growth away from the stimulus is termed negative tropism. For example, plant roots grow in the direction of water and down towards the pull of gravity, while leaves and stems grow towards sunlight. These responses are termed, respectively, positive hydrotropism, positive geotropism, and positive heliotropism. Responses of plants to light are called phototropisms, to contact or touch, haptotropisms, and to chemicals, chemotropisms. Plants such as the Venus fly trap are sensitive to the touch of insects and close upon contact. Such stimuli invoke a change in the water pressure of the cells, rather than a growth response, which is termed a nastic movement.

animations

how reflexes work

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