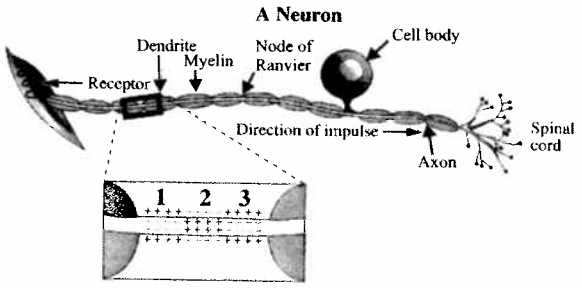
NERVOUS AND ENDOCRINE SYSTEMS

1.1.1.1 Describing the structure and function of a neuron and myelin sheath, explaining the formation and transmission of an action potential and the transmission of a signal across a synapse or neuromuscular junction and the main chemicals and transmitters involved; i.e. norepinephrine, acetylcholine, and the enzyme that breaks them down

A neuron is a nerve cell specialized for conducting nerve signals. It has long cell extensions called fibres, which consist of cytoplasm covered with cell membrane. These fibres are either dendrites, which carry signals toward the cell body, or axons, which carry signals away from the cell body. Neurons that carry signals from sensory organs to the central nervous system (spinal cord and brain) are called sensory neurons. Those that carry signals from the CNS to the muscles are called motor neurons, and neurons that transmit signals within the CNS are called interneurons. Some fibres are covered in a neurilemma, which is a membrane that helps the fibre repair itself should there be an injury. Many of the fibres are also covered with a white myelin sheath composed of Schwann cells. Between the Schwann cells is a small space where the fibre is exposed, called a node of Ranvier.



When the fibre is not transmitting a signal, a sodium/potassium pump maintains the resting potential that involves keeping sodium ions of the fibre and potassium ions inside the fibre. There are also large organic ions inside the fibre – the resting potential can be measured at about –60mV. That is, more negative inside the fibre than outside.

If a fibre is stimulated strongly enough to reach a stimulus threshold, an action potential occurs in which sodium gates open and sodium ions rush in, making the inside of the fibre more positive. When this happens the potassium ions rush out restoring the negative potential inside. This is referred to as depolarization. At this point, the sodium/potassium pump moves the sodium back out and the potassium back in. If the fibre is non-myelinated, this change at one spot stimulates an action potential at the next adjacent spot. In this manner, action potentials flow in a wave along the fibre. If the fibre is myelinated, the action potentials only occur at the nodes, so the signal skips from node to node. A signal travels faster in a myelinated fibre than in a non-myelinated fibre and requires far less energy. If a signal in an individual fibre cannot be strong or weak, we say it is all-or-none. If a fibre carries many signals in quick succession, it may have all the sodium inside and all the potassium outside, and the sodium/potassium pump is then unable to work quickly enough to restore the resting potential. This results in weakened stimulation known as neural fatigue.

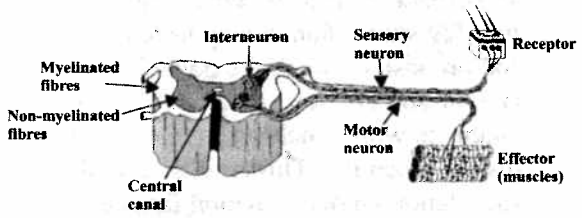
A synapse is the space between the end of an axon and the next neurons dendrite or cell body. When a signal arrives at the end of the axon, calcium ions rather than sodium ions, enter the fibre. The calcium stimulates vesicles of neurotransmitter to be released into the synapse. The neurotransmitter diffuses across the synapse and binds with receptor sites on the postsynaptic membrane, thus causing depolarization in the next neuron. One such neurotransmitter is acetylcholine. Immediately after acetylcholine is released, cholinesterase is released into the synapse. The cholinesterase breaks down the acetylcholine to stop the depolarization. Other common neurotransmitters are norepinephrine, seratonin, and dopamine.

Related Questions: 1, 2, 3, 4, 5, 6, 7, 8, 9

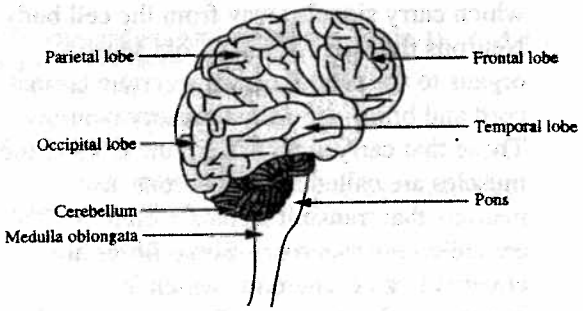
1.1.1.2 describing the composition and function of a simple reflex arc and the organization of neurons into nerves

1.1.1.3 identifying the principal structures of the central and peripheral nervous systems and explaining their functions in regulating the voluntary (somatic) and involuntary (autonomic) systems of the human organism; e.g. cerebral hemispheres, cerebellum, pons, medulla, hypothalamus, pituitary, spinal cord, sympathetic and parasympathetic nervous systems

During a reflex response, a signal travels along a sensory neuron, into the CNS where interneurons coordinate a response that is sent out of the CNS via motor neurons to effect a motor response. The somatic nervous system regulates skeletal muscles that a person can consciously control.



The autonomic nervous system regulates muscles of the glands and internal organs of which a person has no conscious control. The sympathetic component of the autonomic system prepares the body for action by diverting blood from internal organs to skeletal muscles, heart, and brain. As well, the sympathetic system increases blood pressure and breathing rate. The parasympathetic component of the autonomic system normalizes body functions. The neurotransmitter for the sympathetic system is norepinephrine, and the neurotransmitter for the parasympathetic system is acetylcholine. The top of the brain is composed of the two cerebral hemispheres of the cerebrum that control conscious thought. The cerebrum can be divided into the frontal lobes that are responsible for our personality traits, the occipital lobes at the back where visual stimuli are coordinated, the temporal lobes at the bottom sides that control language and hearing stimuli, and, above the temporal lobes, the parietal lobes, that regulate touch sensations. Beneath the cerebrum is the corpus callosum, a band of myelinated fibres that transmit information between the right and left hemispheres. The cerebellum at the back of the skull coordinates muscular movements. The pons in front of the cerebellum is a relay centre for information moving to and from the cerebrum. The medulla oblongata controls basic functioning such as breathing, hearrt rate, and digestive functions. The hypothalamus and the pituitary control the endocrine system.

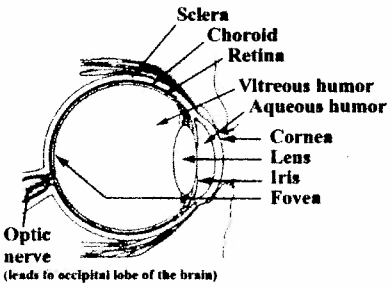


Related Questions: NR1, 10, 11, 12, 13, 14, 15, 16, 17, 18

1.1.1.4 explaining how human organisms sense their environment and their spatial orientation in it; e.g., auditory, visual, skin receptors, olfactory, propioceptors

Sensory organs are all the same in that they all stimulate sensory nerves that carry information to the CNS. The eye converts light signals into action potentials in the optic nerve. The eye is a sac that has three layers. The outer layer, the sclera, is white except for the front transparent part that is called the cornea. The middle layer is the choroid. It is mostly black to ensure that light that is not used to make a nerve signal is absorbed and does not bounce around in the eye. The front part of the choroid is modified into the lens and the ciliary muscles that adjust the shape of the lens.

The iris is the coloured part of the eye. The retina is the sensory membrane that lines the eye, contains the rods, receptors that work well in low light but do not detect colour, and the cones, which require more light and allow us to see in colour. There are three types of cones – red, green, and blue. The fovea is a spot directly at the back of the retina. It contains tightly packed cones and is where a person can see with most precision. Inside the eye is fluid: a watery aqueous humour in front of the lens and a thicker vitreous humour behind the lens. Nearsighted people cannot focus on distant objects because the image focuses in front of the retina instead of directly on it. Farsighted people cannot see close objects because the image is not yet focussed when the light arrives at the retina. The problem with astigmatism is that the cornea does not have a smooth curve so that without corrective glasses one part of the visual field is in focus while other parts are not. A cataract is a lens that has become cloudy. Glaucoma is damage to the retina caused by excessive pressure from fluid in the eye.



The ear consists of an outer ear (the pinna and auditory canal), the middle ear (starting with the eardrum or tympanic membrane), and the fluid-filled inner ear. Air pressure inside the middle ear is kept equal to air pressure in the auditory canal by the Eustachian tube, which allows air to pass between the middle ear and the back of the mouth. Sound is transmitted from the eardrum through the tiny middle ear bones – the hammer (malleus), anvil (incus), and stirrup (stapes). Vibrations of the stirrup cause the oval window of the inner ear cochlea to vibrate, causing vibrations in the fluid of the inner ear which pass out the round window. The vibrations of the inner ear fluid cause hair cells of the organ of Corti to stimulate the auditory nerve. The inner ear also contains the utricle and saccule for stationary balance and the semicircular canals for movement balance.