Coordinating Systems: The Receptors and Effectors

Receptor cells and organs

The cells and organs that receive internal and external stimuli are called receptors. These receptors vary in complexity from single cells to complex organs. Their function is to receive information from the external and internal environment and to convey that information to the nervous system. One way to classify sensory receptors is to consider them as biological transducers.....meaning they take one form of energy and convert it to another. They are constructed to receive certain kinds of stimuli and are categorized by this feature. One can divide them according to their sensitivity to various forms of energy. Thus we have mechanoreceptors that respond to touch, pressure, tension, sound and motion. Photoreceptor respond to light; thermoreceptors respond to heat; pain receptors respond to tissue damage; osmoreceptors that respond to changes in water volume; and chemoreceptors that respond to chemicals and result in taste or smell sensations.

Mechanoreceptors vary greatly. The skin contains specialized mechanoreceptor cells that react to touch and muscles have stretch receptors. The ear has the ability to process sound waves and to detect acceleration and orientation of the body. It is a very complex receptor organ, has two distinct functions, balance and hearing. Both functions, however, rely on mechanoreception. The sound is transmitted by air pressure changes to the eardrum, the inner ear ossicles (hammer, anvil and stirrup), and finally the oval window of the cochlea. The movement of the oval window

causes the fluid inside the cochlea to move and, depending on the frequency of the sound, specialized ciliated cells are stimulated. The inner ear also contains three fluid filled canals (vestibular apparatus) which also contains ciliated cells. The stimulation of these cells signals the adjacent sensory neurons to let us know which direction we are moving and how fast.

The senses of taste and smell are both received by chemoreceptors. Both taste and smell require that the chemical stimuli they process are dissolved in fluid. The receptor cells of the tongue and nose are specialized to receive only certain chemicals. Thus the tongue can be mapped to show where sweet, sour, salty and bitter substances are detected.

Chemoreceptors respond to chemical stimuli such as the molecules which give taste and smell. The chemicals are dissolved in fluids and for aquatic animals, taste and smell are the same. The thermoreceptors respond to temperature changes. The photoreceptors respond to light and include our eyes which are image forming. Pain receptors, unlike the other receptors, is often a "raw" nerve ending and does not utilize a specialized receptor cell or organ.

The vertebrate eye is another example of a complex receptor organ. Our eyes are image forming but not all photoreceptors form images. The eye is designed to collect and focus light rays on the retina at the back of the eye. This is where the actual photoreceptor cells, the rods (black and white vision) and cones (color vision) are located.
Whether a receptor is a part of a neuron or in close contact with one, all convert the energy they receive into the electrical energy of the nerve

impulse by depolarizing the connecting nerve cell's membrane. They do this by producing a chemical transmitter as a consequence of receiving the external stimulus. This chemical transmitter then depolarizes the next cell in the chain which is a sensory neuron belonging to the peripheral nervous system. Receptor cells in any of these categories show much variability in structural appearance, location and associations with other cells. They can be single cells, a few cells or an entire organ. As an example, mechanoreceptors detect blood pressure, sound, position or muscle stretch. And these cells may be in special organs or dispersed singly.

When stimulated, all receptor cells and organs release a chemical transmitter which depolarizes the adjacent sensory neuron(s). These sensory neurons are part of the peripheral nervous system. If they lead into the brain, they are cranial nerves or if they lead into the spinal cord, they are spinal nerves. The peripheral nervous system consists of both sensory neurons ending in the brain or spinal cord and motor neurons originating in the brain or spinal cord and going out to effector cells or organs.

Effector Cells and Organs

Those cells and organs that carry out the instructions of the nervous system are the glands and muscles of the body. It seems almost too simple that everything is done by two types of cells and organs! Muscles move our hands to write or play the piano, to put food in our mouths, to talk, to run and dance. The glands are the endocrine glands that produce hormones and exocrine glands that produce digestive enzymes, gametes, etc.).