CONTROL OF HEART RATE

The normal resting heart rate for an adult is 60-100 contractions per minute. However, that rate changes moment-to-moment depending upon what is happening in the environment and on the needs of the body. There are a variety of psychological and physiological factors that affect heart rate but the system is self-regulating – that is, it adjusts to circumstances automatically. How is it that your heart rate increases when you need it and decreases when you don't? This responsiveness to need is the work of the ***nervous system****. It is the nervous system that gathers information about what is happening, processes that information, and finally, sends orders telling the muscles or glands (collectively known as "****effectors****") what to do about it .*

How information is brought into and moved through the body:

Receptors are highly specialized ***neurons*** (nervous system cells) that are sensitive to changes in the internal (inside the body) or external (outside the body) environment. Each type of receptor is sensitive to a particular "trigger" or ***stimulus***. Some receptors are sensitive to light, some to pressure, some to stretching, some to specific chemicals…and so on. When receptors bring information about what is happening in the external or internal environment to your ***central nervous system*** or CNS (made up of the brain and spinal cord), the CNS processes that information and can respond in one (or both) of two possible ways: 1) by sending electrical signals (called ***nerve impulses***) back and forth to specific parts of the body, or 2) by sending and receiving chemical messengers (called ***hormones***) through the bloodstream. Both electrical and chemical signals are important in controlling heart rate.

Heart rate and change in the external environment:

When receptors from any of the five senses bring information from the environment to the CNS that elicits fear or excitement the brain sends nerve impulses to the adrenal glands. This causes the adrenal glands to produce the hormone epinephrine (aka adrenaline). Epinephrine travels through the bloodstream, affecting the heart and many other parts of the body in ways that are designed to enable you to better respond to the urgency of the situation. Its effect on the heart is to cause it to beat very rapidly. If you have ever experienced a fluttery feeling in your chest when you were anxious, afraid, or excited you have felt the effects of epinephrine. When the situation is resolved, the brain stops signaling the adrenal glands and they stop producing epinephrine. With no epinephrine stimulating it, the heart rate returns to normal.

Heart rate and change in the internal environment - response to activity level:

Heart rate also automatically adjusts to the changing needs that accompany changing activity levels. When you exercise, your cells work harder so they need more energy. Producing more energy requires them to use more oxygen (O_2) and, as a result, produce more carbon dioxide (CO_2). The increase in blood concentration of CO_2 is the internal environmental trigger that is sensed by special receptors in the blood vessels and this information is sent to a part of the brain called the medulla. In response to the message of increased blood CO_2 the medulla produces epinephrine (and several other hormones) and ALSO generates nerve impulses that travel to the heart, stimulating it to contract more frequently. There are several other internal triggers that affect heart rate, but we will focus on this one for now.

When the vigorous activity stops, the body uses less O_2 and produces less CO_2. The drop in blood CO_2 is detected by receptors in the heart and blood vessels. These receptors send their messages along a different pathway of neurons in the medulla than the one that increases heart rate. This pathway sends electrical signals that tell the heart to slow down. It also sends chemical messages, but uses a different hormone called acetylcholine (Ach). Ach causes the heart to contract at a <u>slower</u> rate until eventually it returns to its normal resting rate.