

Anatomy and Physiology Exam 2

The Endocrine System: An Overview

Define an endocrine gland and list the major endocrine glands of the body and their locations.

An Endocrine gland is a gland in the body that releases its substance to the blood stream within the body. The substances, called hormones, and then go their respective target tissues to cause an effect.

The major endocrine glands in the body are the pituitary gland, the thyroid and parathyroid, the adrenal glands, and the pineal gland. The pituitary is located near the hypothalamus in the brain, the thyroid is near the throat, the parathyroid is behind the thyroid, the adrenal is above the kidneys, and the pineal is also in the brain.

Hormones

2. Define a hormone, and describe the chemical categories of hormones.

The hormone is the chemical messengers that are released from these endocrine glands. They travel the blood stream, and cause widespread affects on the body when they bind to their target. The effects, unlike neural signals, are long lasting. The effects range from mostly growth and repair, development, homeostasis, pH balance etc.

Now there are two categories of hormones and these depend on the structure. The peptide hormones are made by amino acids and the steroid hormones are made from cholesterol (another reason cholesterol is important). Then you have another class called the eicosanoids, which arise from lipids. They work by altering cell permeability, protein synthesis, enzyme activation/deactivation, stimulate mitosis.

The peptide hormones are amino acid based, meaning they can't cross the cell's membrane. Thus they act via a second messenger system.

The steroid hormones can readily diffuse into the cell and will act directly on a receptor in the cell to exert its effects.

The eicosanoids are the leukotrienes and the prostaglandins. These help mediate inflammation and blood pressure.

Explain the relationship of hormones to target cells and the types of changes that result in target cells in response to hormone stimulation.

Hormones are released to the blood stream and will bind to their target cells (could be in different part of the body than where they were released). They act on the cell by altering cell permeability, protein synthesis, enzyme activation/deactivation, stimulate mitosis. The eicosanoids work to control inflammation, regulate blood pressure

They promote widespread effects throughout the body.

4. Describe the second messenger systems used by amino acid-based hormones.

Since the amino-acid based hormones are, well, made of amino acids, they can't cross the hydrophobic portion of the plasma membrane. So they will bind to a receptor on the surface of the cell. So it exerts its effects through a second messenger system called cyclic AMP.

First, the hormone will bind to the receptor. This binding will then initiate a chain inside the cell called the second messenger system. A molecule called a G-protein will be activated via a GTP, which is activated when the hormone binds. The G-protein will then in turn activate something called adenylate cyclase. This enzyme will then use an ATP molecule and convert it to cAMP, and this will go to activate a protein kinase. Everything in the body is really done through phosphorylation and dephosphorylation, and the protein kinase is the enzyme that does that.

So the one hormone attached to the receptor, went through many steps (which you have to know) to finally activate a protein kinase. The second messenger system is effective as there is a huge amplification effect. For example, it only takes one molecule of the hormone to start the cascade, but many G-proteins can be activated, which can activate many adenylate cycles, which activate many more cAMP etc.

Now cAMP isn't always used, sometimes the cells used the PIP-calcium messenger. This follows the G-protein to activate a phospholipase C. This will then split to a PIP and DAG/IP₃. The DAG goes on to activate a kinase, and the IP₃ will be the one to release calcium from its storage. THEN calcium will bind to another protein called calmodulin to amplify its effects if necessary.

This is all really memorizing pathways.

5. Explain the mechanism of intracellular activation used by steroid hormones and thyroid hormone.

Now the steroid hormones are different, as they can diffuse right into the cell to exert their effects. They still bind to a receptor, but the receptor is intracellular—inside the cell.

They will bind to the receptor, and then it'll act directly on the DNA to exert whatever its effects are. So no cascade of effects to go through.

6. Examine the factors that determine target cell activation and compare how the cell uses up-regulation and down-regulation to alter its responsiveness to a hormone.

The factors that determine if a hormone will bind to a cell are first, the cell needs the proper receptors for the hormone. For example, ADH hormone (we will get to the different hormones later) acts to absorb water from the kidneys, so there will not be receptors for this hormone on a muscle cell, as it does not act on the muscle.

Other factors depend on the blood level of the hormone, or how much is in the blood. This will be important for the up and down-regulations. Also, the number of available receptors and the strength of the binding will all affect the cell activation.

Up-regulation occurs when a certain stimuli, say a need for a certain hormone in the body, causes the cell to express more receptors for that hormone. Thus, the regulation of that hormone is increased and with more receptors, more will bind and the hormonal effect will be greater.

Down-regulation is the exact opposite—when the cell no longer needs that hormone, it will repress its receptors.

So the cell controls its intake of the hormone by expressing either more or fewer receptors.