Chapter 36 Review: Endocrine & Cellular Communication

How Do Organisms Send Chemical Signals?
- There are three general types of chemical signals.
  1. Pheromones – secreted by organism to communicate with other organism
  2. Hormones – secreted in circulation to give specific effects on target cells
  3. Paracrine Signals – secreted directly onto target cells by special duct
- Hormones are known as endocrine signals. Paracrine signals are known as exocrine signals.

Q. What are some examples of these three signals?

Blood Glucose Regulation
The glucose concentration in the blood stream is highly regulated. It is the most important source of energy heterotrophs derive from the outside world because it can be directly converted into usable energy. Glycogen is an efficient way of storing excess glucose in the body, as it is made from long strands of glucose (similar to but different from cellulose). Whether or not the body produces glycogen is dependent on whether or not it is in one of two states:

1. Absorptive state – This state usually occurs right after a meal when the blood glucose is high. This triggers the release of insulin from β-cells in the pancreas. Insulin binds to body cell receptors and causes the uptake of glucose and conversion to glycogen when there is excess stores in the blood. This is an anabolic reaction.

2. Post-absorptive state – This state exists after the effects of insulin have taken place or during a period when not much food has been ingested, and the blood glucose is low. The release of glucagon from α-cells in the pancreas now causes increased breakdown of glycogen and release of glucose into the bloodstream, a catabolic reaction.
Q. What are two ways of raising your blood glucose?

Diabetes mellitus can occur when the body is unable to successfully produce or use insulin, causing a rise in glucose in the blood and the urine. Two types of diabetes mellitus exist:

1. **Type I – Insulin-dependent diabetes mellitus (IDDM)**
   - Occurring mostly in younger people, this is a condition when the body is unable to make glucose due to the lack of insulin producing cells in the pancreas.

2. **Type II – Non-insulin-dependent diabetes mellitus (NIDDM)**
   - Occurring mostly in middle age, this is a condition when the body is able to produce insulin but for some reason cannot use it properly.

Organs Which Produce Hormones
- Pancreas
  - Exocrine secretions that function in digestion
  - Endocrine secretions into bloodstream (insulin, glucagon, somatostatin)
- Adrenal Glands
  - Cortex makes cortisol (stress control) and aldosterone (regulates kidney function)
  - Medulla makes epinephrine (adrenaline) which can function in “fight or flight”
- Thyroid & Parathyroid
  - Thyroid produces thyroid hormone (control of growth and metabolism)
  - Parathyroid makes parathryoid hormone (increase Ca²⁺ in blood stream)
- Testes (make testosterone) & Ovaries (make estrogen and progesterone)
- Hypothalamus (actual master of glands) helps control pituitary (subject to negative feedback)
  - Neurons in the hypothalamus release “releasing or inhibiting hormones” which exert their affect on the anterior pituitary. The hormones are released into the portal circulatory system (a special isolated group of capillaries running from the hypothalamus to the pituitary and back). The portal capillaries carry the hormones to the anterior pituitary where they act to inhibit the release or inhibit the release of the particular hormones. Some examples of hormones released by this part of the hypothalamus are GNRH (gonadotrophin releasing hormone) and TRH (thyrotropin releasing hormone).
  - Some cell bodies of the hypothalamus are the origin of nerve tracts that extend processes that become the posterior pituitary. The terminals of these processes release oxytocin and vasopressin directly into the general circulation.
- Pituitary (also subject to some negative feedback)
  - Anterior – Releases endocrine hormones in response to hypothalamic signals. Some examples are thyrotropin, adreocorticotropin, lutenizing hormone (LH), follicle stimulating hormone (FSH), and growth hormone.
  - Posterior – Extension of hypothalamus
    - Releases vasopressin (ADH – retains water in blood)
- Releases oxytocin (uterus contraction and production of milk)

How Do Hormones Find Their Targets?
- Lipid-soluble vs. Water-soluble signals
  1. Lipid-soluble signals are easily able to travel across the cell membrane, and therefore usually have intracellular receptors at their targets. These receptors are often transcription factors which then help to regulate production of RNA in the nucleus.
    - Steroids are an example of lipid-soluble signals. These are derived from cholesterol and many are important in sex determination, metabolism, and ion control. Some examples are testosterone, estrogen, and progesterone.
2. Water-soluble signals are not able to move freely across the cell membrane and must communicate their signal via another mechanism. Most are amines, peptides, or proteins and have specific receptors located on the outsides of cell membranes which they use to trigger communication via second messengers. Second messengers are special molecules or signals that change within the cell after a signal molecule has bound a receptor on the cell membrane. This is an effective way of communicating the signal when the water-soluble signal can’t make it through. Some examples of second messengers are:

1. cAMP
2. Ca^{2+}
3. PIP_{2} \rightarrow \text{DAG + IP}_{3}

Even though these are officially called the second messengers, there may be a signalling molecule between the receptor and the second messenger. This signalling molecule is usually a G protein.
Signals may mediate different responses in a variety of ways. Cells may respond differently internally, signals may have multiple receptor types, and gene transcription may be affected differently in different types of cells.

Termination of signals is extremely important to maintain the integrity of hormonal responses. Termination may occur by G-protein inactivation by hydrolysis of GTP to GDP, breakdown of the signal molecule by enzymes or local environment, or phosphatases which take off phosphate groups (the opposite of kinases).

Q. What is the ultimate goal of releasing a hormone?