The Endocrine System

Pancreas, Thymus, and Pineal Glands
Most of the pancreas cells are **exocrine** cells: they secrete digestive juices into the small intestine. A small number of cells, though, are **endocrine** cells. These cells make up the **islets of Langerhans**. (They’re called that because they look kind of like small islands of endocrine cells among a sea of exocrine cells.) There are two types of endocrine cells in the islets of Langerhans: alpha-cells (which secrete glucagon) and beta cells (which secrete insulin).
Pancreas

- **Insulin**
  - Protein hormone, β cells
  - Lowers blood glucose:
    - Stimulates glucose uptake in muscle, adipose cells
    - Stimulates glycogen production in the liver.
  - Control: presence of blood glucose, anticipation of food.
  - Pathology: diabetes mellitus

*Insulin* is produced by beta cells in the islets of Langerhans. It’s general effect is to lower blood glucose level by moving glucose from the blood into muscle, liver and adipose cells (as well as other cells, but *not* brain cells). Since glucose cannot diffuse across the cell membrane, it has to rely on transport proteins to get into cells – these transport proteins only become active when bound by insulin. In addition to helping move glucose into muscle and fat cells, insulin stimulates the anabolism of glycogen from glucose in liver cells. A lack of functional insulin is diabetes. One form of diabetes is *diabetes mellitus* (Type I diabetes), in which functional insulin is not produced. Without functional insulin, glucose cannot be taken into cells, so blood glucose level is very high. The kidneys don’t stand for hypertonic blood, so they move excess glucose out of the blood and into the urine. Since this makes the urine hypertonic, large amounts of water also move from the blood into the urine, resulting in dehydration, thirst and frequent urination. Since glucose cannot get into cells to be used as a fuel, the body begins to catabolize lipids and proteins for their fatty acids and amino acids (most cells can use fatty acids and amino acids as a food source in a pinch). This results in wasting of body tissues. Diabetes mellitus is usually treated with either oral insulin or insulin injections.
Glucagon is antagonistic to insulin – it increases blood glucose levels by stimulating the breakdown of glycogen (starch) in liver cells. Glycogen breaks down into glucose, which causes an increase in blood glucose levels. Control of glucagon is straightforward – glucagon production is inhibited by blood glucose. If blood glucose level drops, production is no longer inhibited, so glucagon is produced by the alpha cells. As glycogen is broken down and glucose is released, blood glucose level rises and further glucagon production is inhibited. Insulin and glucagon work together to ensure a steady supply of glucose for the body’s cells.
In children, the thymus gland is very large, but it shrinks to a very small size in adults. In children, the production of thymosin stimulates the development of the immune system by causing immature white blood cells to become active white blood cells. While thymosin serves a similar function in adults, it is much less important in adults than in children. Adults can survive without a thymus gland (with a suppressed immune system) but children cannot.
Melatonin is produced by the pineal gland (part of the diencephalon of the brain) and is involved in controlling biological rhythms, particularly annual biological rhythms. It’s production follows day length – as the days become shorter (spring-to-fall), melatonin secretion increases; as the days become longer (fall-to-spring), secretion decreases. This helps the body predict upcoming changes in weather before the weather actually changes. (E.g. when the days start getting shorter, winter is coming.) Although humans don’t have major behavioral changes with the seasons, many species do. In humans, melatonin is also involved in the onset of puberty. In children, a lot of melatonin is secreted. This inhibits LH and FSH production and prevents puberty. At the onset of puberty, melatonin production surges, then drops significantly, allowing puberty to begin.
Other Hormones

- Some lesser hormones:
  - Damaged tissues: **prostaglandins** (promote the inflammatory response)
  - Kidneys: **erythropoietin** (stimulates RBC development)
  - Digestive organs: several hormones that stimulate production of gastric enzymes
  - Placenta: several hormones necessary to support a developing fetus.