EK 3.D.2 Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling. 

- Signals released by one cell type can travel long distances to target cells of another cell type.

1. Endocrine signals are produced by endocrine cells that release signaling molecules, which are specific and can travel long distances through the blood to reach all parts of the body. Illustrative example-insulin

When you ingest carbohydrates your blood glucose level rises, which stimulates your pancreas to secrete insulin which in turn promotes cellular uptake of glucose into the liver and muscle cells where it is stored as glycogen. When your blood sugar level decreases between meals, the pancreas secretes glucagon which promotes the hydrolysis of glycogen to release glucose and fatty acids to raise your blood sugar levels.

The pancreas releases sodium bicarbonate to raise the pH which neutralizes acid chyme from the stomach thereby raising the pH (making the environment more alkaline).

In this simple endocrine pathway a low duodenum pH stimulates endocrine cells in the small intestine (S cells) to secrete the hormone secretin. Secretin travels through the bloodstream to its target cells (pancreatic cells) causing them to release bicarbonate solution resulting in an increase in the pH. The increase serves as a negative feedback mechanism resulting in lower levels of secretin released.
Negative Feedback

- Secretin secretion regulation is an example of negative feedback in action.

Feedback Regulation

- A negative feedback loop inhibits a response by reducing the initial stimulus, thus preventing excessive pathway activity.
- Positive feedback reinforces a stimulus to produce an even greater response.
- For example, in mammals oxytocin causes the release of milk, causing greater suckling by offspring, which stimulates the release of more oxytocin.

An example of positive feedback

Oxytocin stimulates the uterus to contract. This causes the placenta to make more prostaglandins which signal more vigorous uterine contractions which cause more oxytocin to be produced thereby amplifying the contraction process.

Insulin and Glucagon: Control of Blood Glucose

- Hormones work in pairs to maintain homeostasis.
- Insulin (decreases blood glucose) and glucagon (increases blood glucose) are antagonistic hormones that help maintain glucose homeostasis.
- The pancreas has clusters of endocrine cells called pancreatic islets with alpha cells that produce glucagon and beta cells that produce insulin.
Describe the actions that occur when blood glucose levels decline and when they rise. Glucagon and insulin are paired hormones that work together to maintain blood glucose levels between 70 and 110 mg/100mL.

### AP Curriculum Framework

- **EK 3.D.4** Changes in signal transduction pathways can alter cellular response.
  - A. Conditions where signal transduction is blocked or defective can be deleterious, preventative or prophylactic.
    * Illustrative example - diabetes

### Out of Balance: Diabetes Mellitus

- **Diabetes mellitus** is perhaps the best-known endocrine disorder.
  - It is caused by a deficiency of insulin or a decreased response to insulin in target tissues.
  - It is marked by elevated blood glucose levels.

Ask students to explain how a lack of insulin leads to elevated levels of glucose in the blood. Then ask them to suggest reasons this increased level of glucose is harmful to the person with diabetes.

- **Type 1 diabetes mellitus** (insulin-dependent) is an autoimmune disorder in which the immune system destroys pancreatic beta cells.
- **Type 2 diabetes mellitus** (non-insulin-dependent) involves insulin deficiency or reduced response of target cells due to change in insulin receptors.

Type 1 has in the past been referred to as Juvenile Diabetes. Just as a point of interest, the incidence varies from 8 to 17 per 100,000 in Northern Europe and the U.S. with a high of about 35 per 100,000 in Scandinavia to a low of 1 per 100,000 in Japan and China.

When insulin receptors respond properly to the presence of insulin, the result is the transport of glucose from outside the cell to inside the cell via transport protein. People with Type I diabetes do not produce sufficient insulin to maintain a proper level of glucose transport. The disorder is typically treated by providing the patient with insulin.
Insulin & Glucose Regulation

Insulin and Glucose Regulation

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Scroll across the bottom of the to activate the animation controls and press PLAY

Blood calcium levels need to be approximately 10 mg/100 mL. Two hormones, PTH and calcitonin work in tandem to regulate the blood glucose in mammals.

Describe how calcitonin and PTH work together to maintain blood calcium levels. High calcium levels can cause mental confusion, nausea, fatigue. Low blood calcium causes muscle cramps, spasms, twitching and tingling in the fingers and around the mouth.

This animation has more detail than we actually need. The next is illustrative of the amount of detail students need to know. Emphasize it is the “homeostasis” aspect of this process established by cell to cell communication that is important.

Scroll across the bottom of the to activate the animation controls and press PLAY
Ask students to match the events on the right with the numbers in the picture. The next shows the answers.

The two hormones, calcitonin and parathyroid hormone work together to keep blood calcium levels within a homeostatic range. (10 mg/100 mL)