Topic: Feedback Mechanism Lab

Summary: Students will model how the endocrine system uses feedback mechanisms to maintain homeostasis.

Goals & Objectives: Students will be able to understand a negative feedback loop. Students will be able to describe how the human body regulates blood sugar.

Standards: CA Biology *9i. Students know* that hormones (including digestive, reproductive, osmoregulatory) provide internal feedback mechanisms for homeostasis at the cellular level and in whole organisms.

Time Length: 60 minutes

Prerequisite Knowledge: Hormones, endocrine system, glucose, pancreas, liver.

Materials:

- Sand
- Scissors
- Sugar or candy
- Butcher paper
- Cardboard box: length of sides at least 40 cm
- Paper towel or toilet paper cardboard tubes
- 100 ml Graduated cylinders
- Masking tape

Lab Setup:
Lever: Cut a flat plane, 40 cm long by 5 cm wide, from the cardboard box. Halfway across the length (20 cm) place the tube perpendicular to the length of the plane. You can cut the tube into two if it is longer than the width of the board. Take a section of butcher paper and tape to the desk. This will enable easy clean up. Tape the tube to the butcher paper. Place the lever onto the tube so that the lever is balanced, with the paper towel tube as its fulcrum.

Labels: Cut out the labels. Put sand in the graduated cylinders and tape the label "Pancreas" on the side of each cylinder. Tape the label "Insulin" on the left side of the board. Tape the label "Glucagon" on the right side of the board. Tape the label blood stream in the center of the board. Place the "Low Blood Sugar" label underneath the insulin side of the lever and tape to the butcher paper. Place the "High Blood Sugar" underneath the glucagon side of the lever and tape to the butcher paper.

Testing: Test your first lever to make sure that students are able to drop sand onto one side and cause the lever to go down. Then drop sand onto the other side. Does the lever come back up? Sand is supposed to fall off the sides, representing hormones falling out of circulation.

Procedures:
1. Explain to students how negative feedback loops help keep your body in homeostasis. Give examples of negative feedback loops like insulin and glucagon. Explain how your body increases and decreases the amount sugar in the bloodstream by converting glucose into glycogen or fat and vise-versa.

2. Students are going to model how your pancreas maintains blood sugar levels. Explain to the students that the sand is hormones and that they come from the pancreas. Their goal is to maintain a balance in blood sugar. When blood sugar is high, the pancreas releases insulin and glucagon is inhibited. When blood sugar is low, the pancreas releases glucagon and insulin is inhibited.

3. Demonstrate to students how they will try to model the endocrine system. Their goal is to keep the lever in balance--"preferred blood sugar level." When the lever touches the high blood sugar, more "insulin" hormones must be added to the insulin side. When the lever touches the low blood sugar side, more "glucagon" hormones must be added to the glucagon side.

4. The students start the activity by eating some sugar. A small chocolate candy will get their attention. Now their blood sugar will rise. They must add insulin form the pancreas bowl to the left side of the lever.

5. The sand or "hormones" that fall off the lever demonstrates that peptide hormones are degraded by liver cells and are no longer in the blood stream. Students continue the balancing act until the lever is in balance.

Accommodations: Students who are not able to participate can instruct their partner to add hormones to the lever and how much to add. Students with an IEP can take the handout home if they need extra time, not create the graph, and/or answer on half of the question in the analysis section.

Evaluation:
The 13 analysis questions are worth 2 points each, for a total of 26 points.

Name: _____ Row: _____

Date:_____ Period:_____

Feedback Mechanisms Lab

Problem Statement:
Feedback mechanisms detect the amount of hormones in the blood stream and then adjust the production or release of more of these hormones.

Hypothesis:
If we provide the right amount of sand to each side of the lever, then we can model how the human body maintains hormone levels in the blood stream.

Prerequisite Knowledge: Hormones, endocrine system.

Materials:

- Sand
- Lever
- Candy or sugar
- 2 Graduated cylinders

Procedures:
1. You are going to model how your pancreas maintains blood sugar levels. To do this, you will use sand, a lever, a graduated cylinder, and a clock. Pretend that the sand is like hormones and they come from your pancreas, the graduated cylinder. You will put the sand on the lever to act as if hormones that regulate blood sugar are added to the blood stream. Placing sand on one side of the lever is like adding insulin and placing sand on the other side is like adding glucagon to the bloodstream. Your goal is to maintain a narrow range of blood sugar (70mg to 110mg), which in your case the lever should be near balanced. When blood sugar is high, the pancreas releases insulin and glucagon is inhibited. When blood sugar is low, the pancreas releases glucagon and insulin is inhibited.

2. Before starting, check to see if the lever is balanced and if not; balance it with your fingers. You start the activity by eating some sugar. This increases the sugar in your bloodstream. Now start adding a small amount of sand/insulin to the insulin side of the lever. Watch to see what happens to the lever. If the lever hits the table, your simulated blood sugar level is too low and now it is time to add glucagon. Try to balance your blood sugar level.

3. When sand falls off the lever, it is acting like the hormones have been degraded. You will continue the balancing act until the lever is in balance.

Analysis: Use complete sentences and explain your reasoning.

1. Independent Variable _____

   Dependent Variable _____

2. What initially happens when you eat a candy bar or a lot of sugar? _____

_____

3. What is released after your blood sugar level is too high? _____

4. Insulin decreases blood glucose by accelerating facilitated diffusion of glucose across cell membranes. How does insulin affect blood sugar levels?

_____

_____

5. What organ in the human body releases insulin? _____

6. What is the name of the gland, found in the organ above, that is used for the blood sugar concentration?

_____

7. Which cells in the pancreas secrete insulin? _____

8. What is released after your blood sugar level is too low? _____

9. Glucagon accelerates a process called *liver glycogenolysis* in which glucose stored in the liver is released into the blood stream. How does glucagon affect blood sugar levels?

_____

10. Which cells in the pancreas secrete glucagon? _____

11. When insulin is released to the blood stream, the release of glucagon is inhibited.

What does inhibition mean? _____

12. Insulin is a peptide (linked amino acids) hormone. How do peptide hormones work?

_____

_____

13. Since insulin and glucagon are not brought into a cell, why do their concentrations

in the blood stream not increase forever?

_____

Low Blood Sugar

High Blood Sugar

Blood Stream

Pancreas

Insulin

Glucagon