Name(s):	Period:	Date:

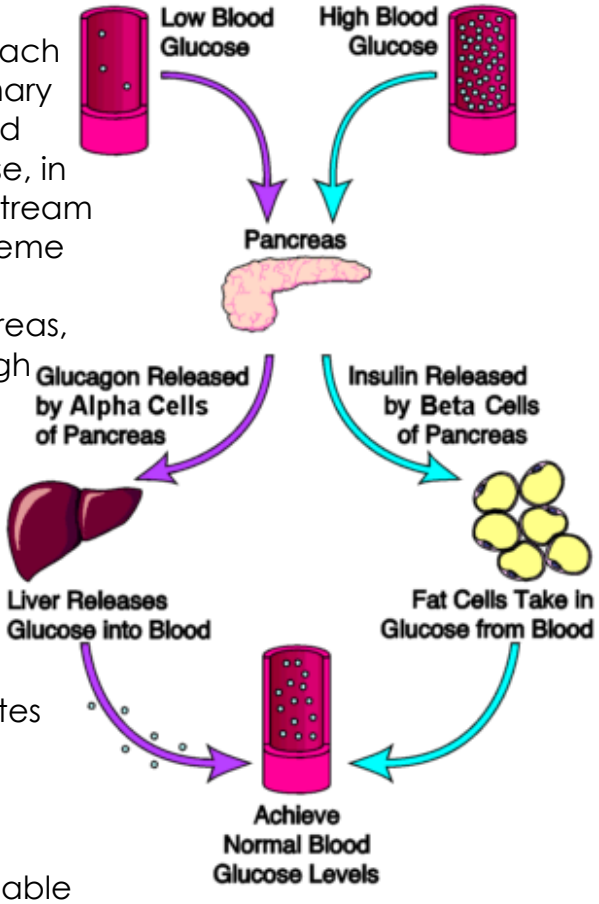
Homeostasis FAIL: A System Out of Balance

HASPI Medical Biology Lab 04b

Background/Introduction

Regulating Sugar in The Blood

The **pancreas** is a small organ that sits behind the stomach and produces hormones and enzymes. One of its primary functions is to produce two hormones called **insulin** and **glucagon** that regulate the amount of sugar, or glucose, in the blood. Too much or too little glucose in the bloodstream can have an adverse impact on the body, and in extreme cases can even lead to death. The body controls the amount of insulin and glucagon released by the pancreas, and therefore the amount of sugar in the blood, through negative feedback mechanisms.

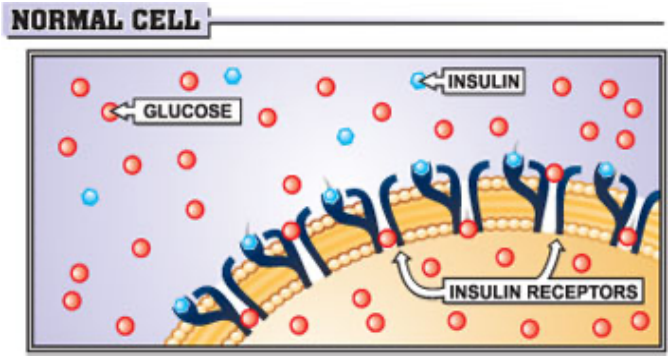


http://bio1152.nicerweb.com/Locked/media/ch45/45_12GlucoseHomeostasis.jpg

Negative Feedback: Insulin, Glucagon, and Glucose

After you eat a meal, the large molecules of proteins, fats, and carbohydrates are broken down into smaller molecules that can absorb into the bloodstream through the process of digestion. **Glucose** is a small molecule that results from the digestion of carbohydrates and is required for cellular respiration within cells.

As glucose is absorbed into the bloodstream following digestion, the blood sugar level rises above normal, signaling the pancreas to release insulin. Glucose is unable to pass into the cells of the body on its own and needs insulin to assist. Insulin essentially "opens the door" to allow glucose to move into cells, which need the glucose to perform cellular respiration and create energy in order to function.



http://pre-diabetes.insulitelabs.com/

As glucose leaves the bloodstream into cells, the blood sugar level drops. The body must compensate to return the blood sugar level to normal. When blood sugar levels are lower than normal, the pancreas is signaled to stop releasing insulin and release glucagon. Excess glucose can be stored in liver and muscle cells. Glucagon causes excess glucose stored in liver and muscle cells to be released.

The back and forth between insulin and glucagon to maintain a normal amount of glucose in the blood is a great example of how the body uses negative feedback to maintain homeostasis within the body. Remember that negative feedback is when the body corrects imbalances back to normal values. So, what happens if this negative feedback becomes imbalanced?

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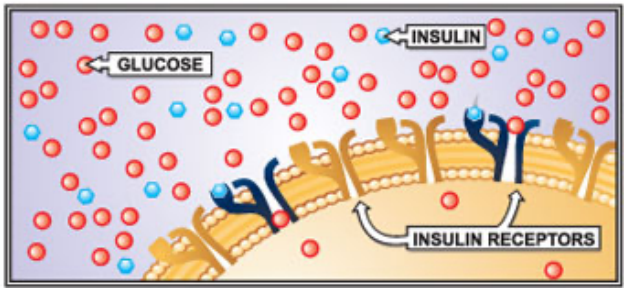
Diabetes: Homeostasis FAIL



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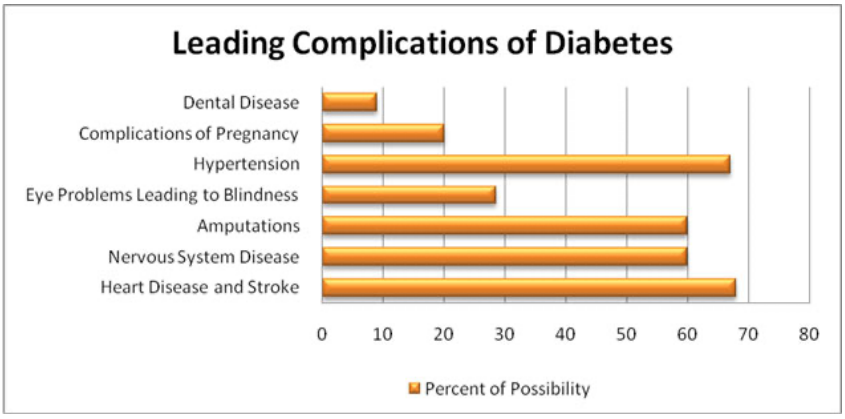
Diabetes is a group of diseases, all of which are characterized by abnormal blood glucose levels that result from the inability of the body to produce and/or use the hormone insulin. Insulin is produced by the pancreas and is needed to maintain normal glucose levels in the blood. If insulin is either not produced or cells become resistant to insulin, the level of sugar in the blood continues to rise. The negative feedback controls that should maintain the normal blood sugar level are thrown off and the homeostatic imbalance, known as diabetes, occurs.

Generally, diabetes is separated into Type 1 and Type 2. **Type 1 diabetes** is a genetic disease that is normally diagnosed very early on in life, and results in the body not producing insulin. **Type 2 diabetes** is the most common form and results when the body does not produce sufficient amounts of insulin OR when cells become insulin resistant. Type 2 diabetes can be hereditary, but is strongly impacted by diet and exercise. A condition known as **pre-diabetes** is present before the onset of Type 2 diabetes, and more than 79 million people in the U.S. have pre-diabetes.



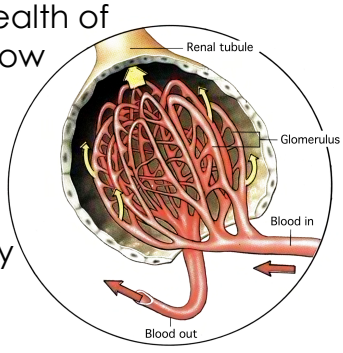
http://media.mercola.com/Assets/images/infosite/diabetes/leading-complications-diabetes.jpg

Diabetes can cause a wide variety of symptoms including frequent urination, frequent thirst, extreme hunger, recurring infections, fatigue, vision loss, reduced healing, limb numbness, increased cancer occurrence, and high blood pressure just to name a few. More importantly, these symptoms can lead to further complications if diabetes is left uncontrolled.

The American Diabetes Association estimates that more than 11% of the U.S. population has diabetes, and approximately 54% of long-term hospital patients that are hospitalized have conditions resulting from complications with diabetes.

Diabetes and High Blood Pressure: An Example of Positive Feedback

Diabetes has a large array of symptoms that can adversely impact the health of an individual. One of the symptoms of diabetes is high blood pressure. How diabetes causes higher blood pressure provides an example of a positive feedback loop. The kidneys are the most important regulator of blood pressure through balancing the amount of fluids and substances in the blood. The filtering units of the kidneys are called **glomerulus,** and are surrounded by dense networks of capillaries. These capillaries have a very thin surface, allowing substances and fluids to diffuse in/out of the blood and in/out of the glomerulus. Any excess fluids or substances are passed on to the bladder and secreted as urine.



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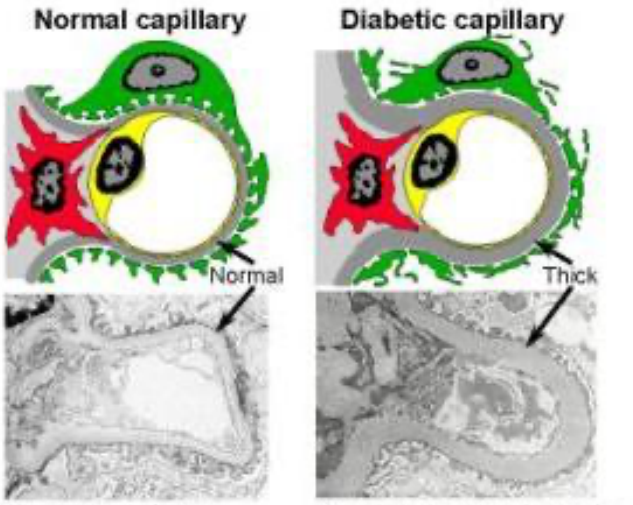

Diagram and electron microscopic photograph of a cross section of a normal glomerular capillary. The basement membrane is normal.

Cross section of a glomerular capillary injured by diabetes in a kidney biopsy specimen. The basement membrane is abnormally thick compared to normal.

http://www.unckidneycenter.org/images/diabetesgraphic.jpg

High amounts of sugar in the blood damages capillaries by causing them to thicken and degrade. When this happens, less fluids and substances are able to diffuse through the glomerulus into the kidneys. When this happens, the kidneys sense that less blood is passing through the capillaries and sends hormones that increase blood pressure so more blood is passing through the capillaries. Essentially, the kidneys are trying to return the body to "normal" blood pressure, not realizing the problem is that less blood is able to pass through the damaged capillaries.

The more damage to the capillaries caused by high blood sugar, the higher the kidneys raise the blood pressure as they try to correct the imbalance. It becomes a vicious cycle causing extensive damage that will eventually lead to death without regulation of blood sugar levels.

Blood Glucose Level Testing

Since an individual with diabetes has abnormal amounts of glucose in the blood, and his or her body is unable to control these amounts, it is important for diabetics to perform tests to check their blood glucose levels. If these levels are drastically high or low it can result in coma and eventually death; hence the importance of knowing the levels! Diabetes medications and insulin can assist a diabetic in balancing his or her glucose levels if an imbalance is detected.

Review Questions – *answer questions on a separate sheet of paper*

1. What is the pancreas and how does it assist the body in maintaining the amount of glucose in the blood?
2. What is the purpose of glucose in the body? Hypothesize why it is so important for your body to have a constant supply of glucose.
3. Explain how insulin and glucagon help the body maintain normal blood glucose levels.
4. Hypothesize why glucose needs insulin to enter cells.
5. Give and explain an example (other than temperature or blood sugar levels) of how the body uses negative feedback to maintain homeostasis.
6. What causes diabetes?
7. What is the difference between Type 1 and Type 2 diabetes?
8. What are the 4 most common leading complications of diabetes?
9. Explain in detail how high blood sugar and high blood pressure demonstrate a positive feedback loop.
10. Why is it important for a diabetic to perform regular blood glucose level tests?