Calculating and Graphing Glucose, Insulin, and GFR

HASPI Medical Biology Activity 19c

Name: _____

Period: _____ **Date:** _____

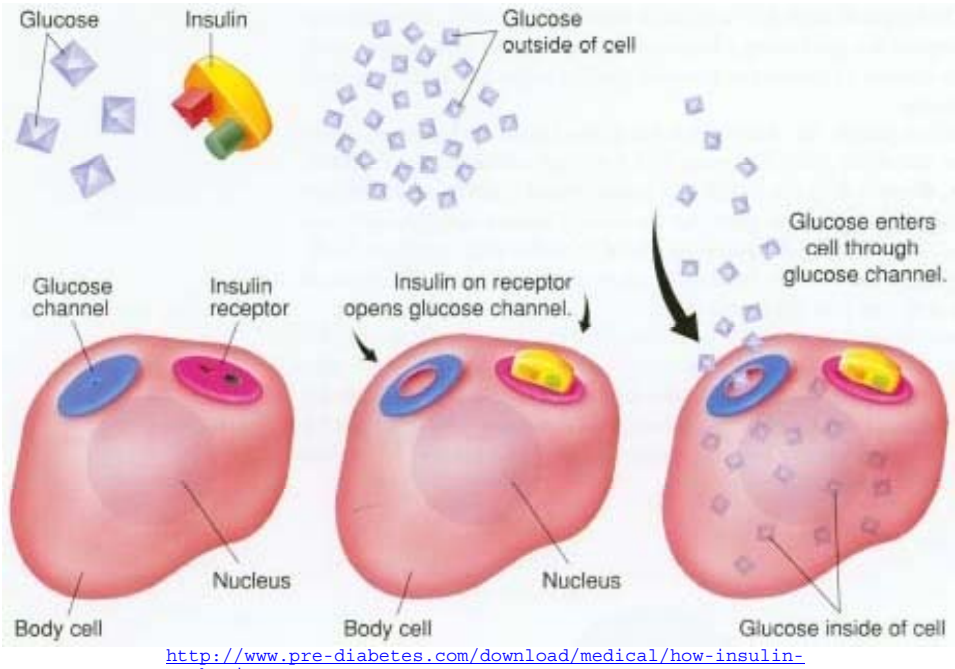
Part A Background

The Pancreas and Insulin

The following background information has been provided by NetWellness. The pancreas is a small organ located just behind the stomach. Its main function is to produce insulin in just the right amount to maintain constant glucose levels in the body. The body's cells are designed so that they function best when there is a certain amount of glucose, or sugar, in the fluid that surrounds them. Too much glucose in the body will turn the fluid that surrounds the body's cells into a bath of sugar that hinders many normal functions of these cells.

Why we need glucose and insulin

Although glucose is not of much use to the body in the bloodstream, or in the fluid that surrounds the body's cells, it is the main source of energy needed for cellular respiration. Glucose must first get inside cells for cellular respiration to occur. Glucose cannot pass through the cells' semi-permeable membranes without the support of insulin.



http://www.pre-diabetes.com/download/medical/how-insulin-works.jpg

Maintaining a constant level of glucose is a delicate process that is controlled by the pancreas and the insulin it produces. Under normal conditions, this process is almost like a dance. Glucose levels in the blood lead the pancreas to release just the right amount of insulin to keep the amount of glucose in the bloodstream and surrounding the cells at a consistent level.

Normal Pancreatic Function

After you eat, nutrients such as carbohydrates, fats, and proteins are broken down by the digestive system. Through this process, nutrients become smaller and simpler molecules that can be absorbed into the bloodstream. One of these simpler molecules is glucose. As the concentration of glucose in the bloodstream rises, the pancreas receives a signal to release insulin.

The insulin attaches to a place on the cell in much the same way that a key would fit into a lock. This "opens the door" for glucose to enter the cell. In muscle cells for example, the insulin will open them up to allow glucose to enter and eventually create the energy needed for that muscle to contract.

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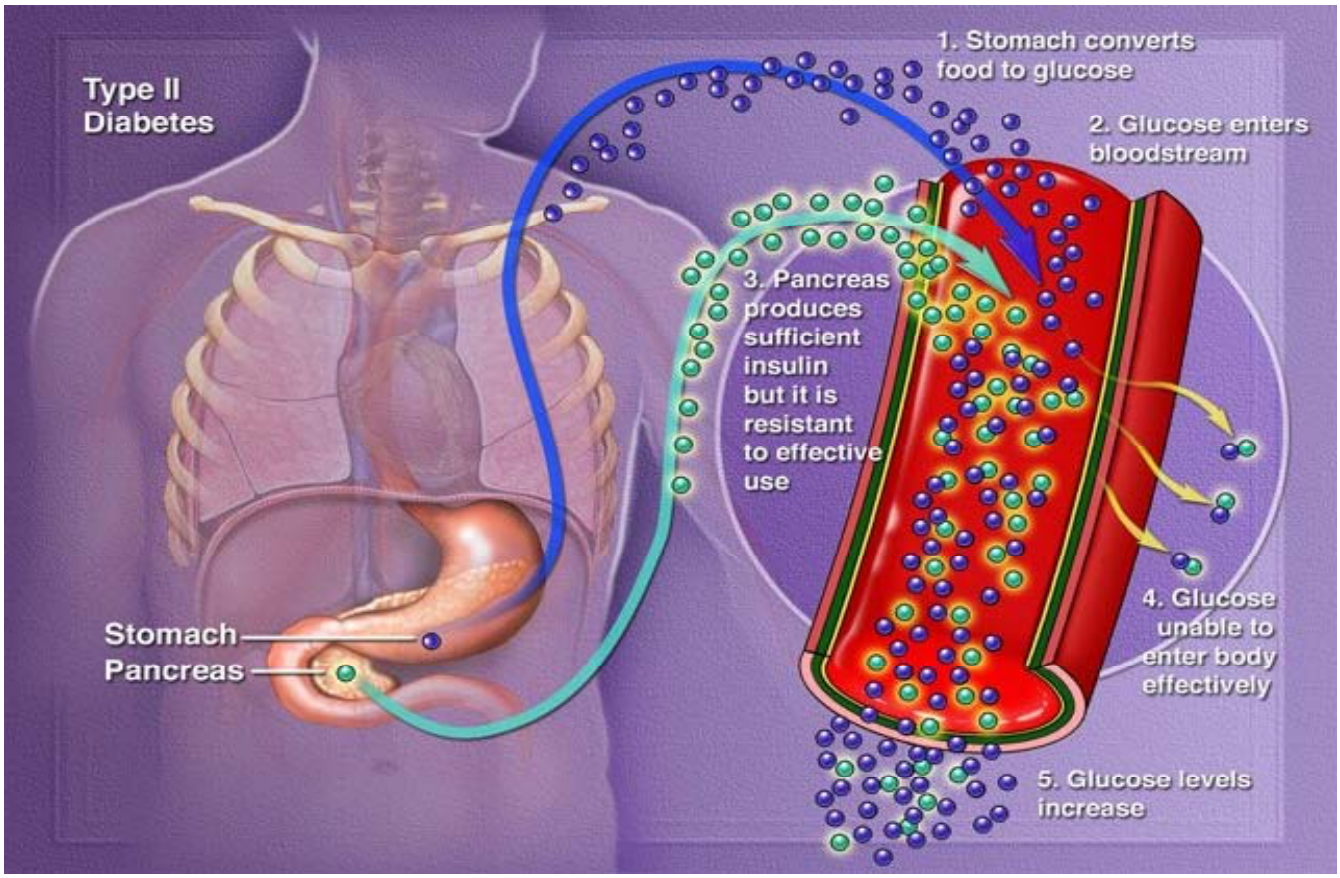
Abnormal Pancreatic Function

The cause of abnormal pancreas function in individuals with diabetes is insulin resistance. Insulin resistance occurs when the cells stop responding to insulin, meaning the door that allows glucose to enter will no longer open. Because the cells aren't allowing glucose to enter, the amount of glucose in the blood gets higher and higher. As long as there is too much glucose in the blood, and too little glucose in the cell, the pancreas will continue to produce insulin until the glucose level in the bloodstream goes down. However, if the cells in the body have become insulin resistant, the amount of glucose in the blood will never go down. The pancreas will continue to try to lower glucose levels by producing more and more insulin, but eventually it will wear out from overexertion. Often this is the first cause of diabetes.



http://savvyhealthfitness.com/wp-content/uploads/2009/01/diabetes_type2.jpg

Cohen, R.M. and Sadler, L. 2006. Diabetes and the Body: Pancreatic Function. NetWellness. http://www.netwellness.org/healthtopics/diabetes/pancreasdiabetes.cfm

Review Questions – *complete the following questions on a separate sheet of paper before completing Part A and B*

1. How are the pancreas and insulin related?
2. What is glucose used for in the body?
3. How does insulin help to move the glucose into our cells?
4. What is the normal pancreatic function following a meal?
5. What is insulin resistance? How can this lead to diabetes?

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Part A Graphing Blood Glucose Levels vs. Blood Insulin Levels

Purpose: The goal of this activity will be to organize and graph data collected on blood glucose and insulin levels following a glucose tolerance test for three patients.

Patient A*: A 31-year-old Hispanic male who is morbidly obese. He does not exercise and has a diet high in sodium. Symptoms that may be related to diabetes include irritability and thirst.*

Patient B*: A 49-year-old African American male who is overweight. He exercises 1-2 days a week and has a diet high in sugar. Grandfather has type 2 diabetes. Symptoms that may be related to diabetes include thirst, urination, increased hunger, and tingling in his lower limbs.*

Patient C*: A 21-year-old Caucasian female who is at a normal weight. She exercises inconsistently and has a diet primarily of proteins and starch. Two aunts have diabetes. Symptoms that may be related to diabetes include increased urination, nausea, and vomiting.*

The Oral Glucose Tolerance Test (OGTT)

Beyond testing glucose levels in the blood, an oral glucose tolerance test is also performed. To prepare for the glucose tolerance test, the patient must fast for 12 hours. To begin the he or she drink a solution that contains a measured amount of glucose. Blood samples are collected immediately before drinking the glucose solution and every 15 minutes after drinking the solution for up to 3 hours.

**From a blood sample drawn 120 minutes after a 75 gram glucose drink*

Glucose Level	Insulin Level	Indication
Less than 140 mg/dL	Less than 50 μIU/ml	Normal glucose tolerance
140 – 200 mg/dL	50 – 150 μIU/ml	Impaired glucose tolerance (Pre-diabetes)
Over 200 mg/dL	Over 150 μIU/ml or remains elevated	Diabetes

Data Table 1

Glucose Level in Blood (mg/dL) Over Time (minutes) After Drinking Glucose Solution

	0 min	15 min	30 min	45 min	60 min	75 min	90 min	105 min	120 min
Normal	70	105	160	125	100	90	80	75	70
Patient A	74	115	148	175	200	192	180	168	160
Patient B	100	125	136	158	177	185	200	212	220
Patient C	150	205	242	256	300	286	260	256	250

Data Table 2

Insulin Concentration (μIU/ml) Over Time (minutes) After Drinking Glucose Solution

	0 min	15 min	30 min	45 min	60 min	75 min	90 min	105 min	120 min
Normal	8	35	60	44	32	20	15	10	9
Patient A	16	30	55	65	72	70	70	68	65
Patient B	30	35	51	70	93	115	140	172	170
Patient C	6	6	7	10	10	12	10	8	6

Complete Graphs 1 and 2 with the data in Data Table 1 and 2.

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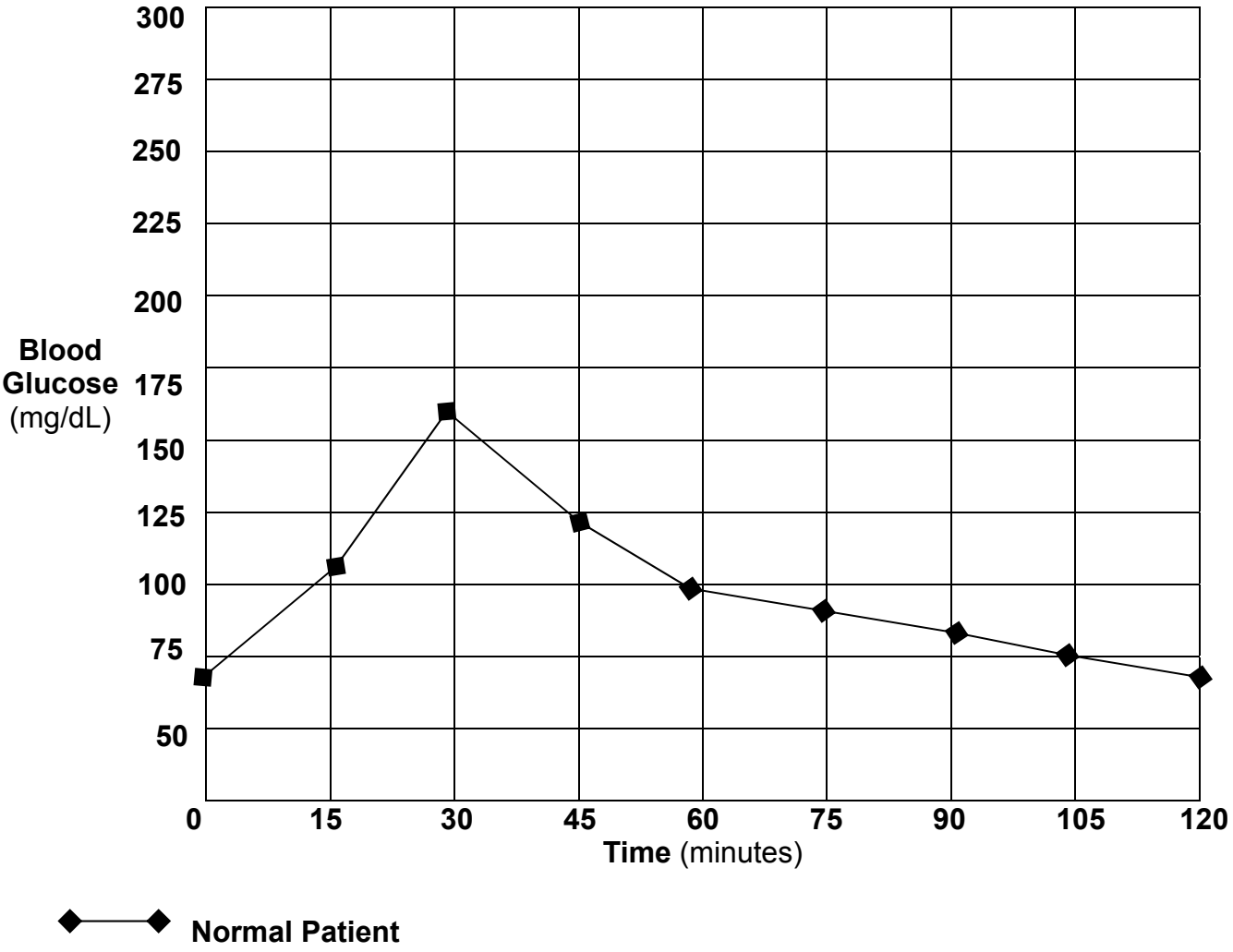
GRAPH 1 – Using the information in ***Data Table 1***, complete the following graph. The title, glucose levels, time, and data for a normal patient have already been completed.

Title: Glucose Level in Blood Over Time After Drinking Glucose Solution



Graph 1 Analysis – *on a separate sheet of paper complete the following*

1. Explain why the blood glucose level for a healthy person was low (70 mg/dL) at the beginning of the glucose tolerance test.
2. Explain why the blood glucose level for the healthy person rises after drinking the glucose solution.
3. What causes the healthy person's blood glucose levels to decrease after 30 minutes?
4. What might cause a patient's blood glucose levels to remain high after 30 minutes?
5. Compare the insulin levels of a normal patient with patients A, B, and C.
6. Based on the information from the graph, which of your patients may have diabetes?

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GRAPH 2 – Using the information in ***Data Table 2***, complete the following graph. Include a title, insulin levels, time, and data for normal patients, as well as patients A, B, and C.

Title: _____

Graph 2 Analysis – *on a separate sheet of paper complete the following*

1. What caused the large sudden increase in insulin production in each patient?
2. Compare the insulin levels of a normal patient with patients A, B, and C.
3. Compare the information in graph 2 to graph 1. What is the relationship between glucose and insulin levels?
4. Based on the information in graph 2, do you think any of your patients have diabetes? Explain.
5. Insulin helps glucose get into our cells. How can a high insulin level lead to diabetes?

Review Questions:

1. How are the pancreas and insulin related? _____

2. What is glucose used for in the body? _____

3. How does insulin help to move the glucose into our cells? _____

4. What is the normal pancreatic function following a meal? _____

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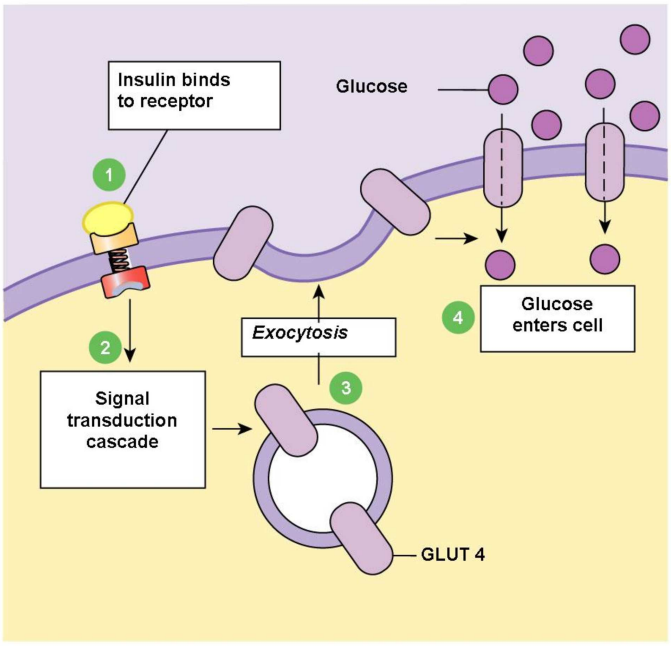

Graph 1 Analysis

1. Explain why the blood glucose level for a healthy person was low (70 mg/dL) at the beginning of the glucose tolerance test. _____

2. Explain why the blood glucose level for the healthy person rises after drinking the glucose solution. _____

3. What causes the healthy person's blood glucose levels to decrease after 30 minutes?

4. What might cause a patient's blood glucose level to remain high after 30 minutes?

5. Compare the insulin levels of a normal patient with patients A, B, and C. _____

6. Based on the information from the graph, which of your patients may have diabetes?

Graph 2 Analysis

1. What caused the large sudden increase in insulin production in each patient? _____

2. Compare the insulin levels of a normal patient with patients A, B, and C. _____

3. Compare the information provided in graph 2 to graph 1. What is the relationship between glucose and insulin levels? _____

4. Based on the information in graph 2, do you think any of your patients have diabetes? Explain. _____

5. Insulin helps glucose get into our cells. How can a high insulin level lead to diabetes?