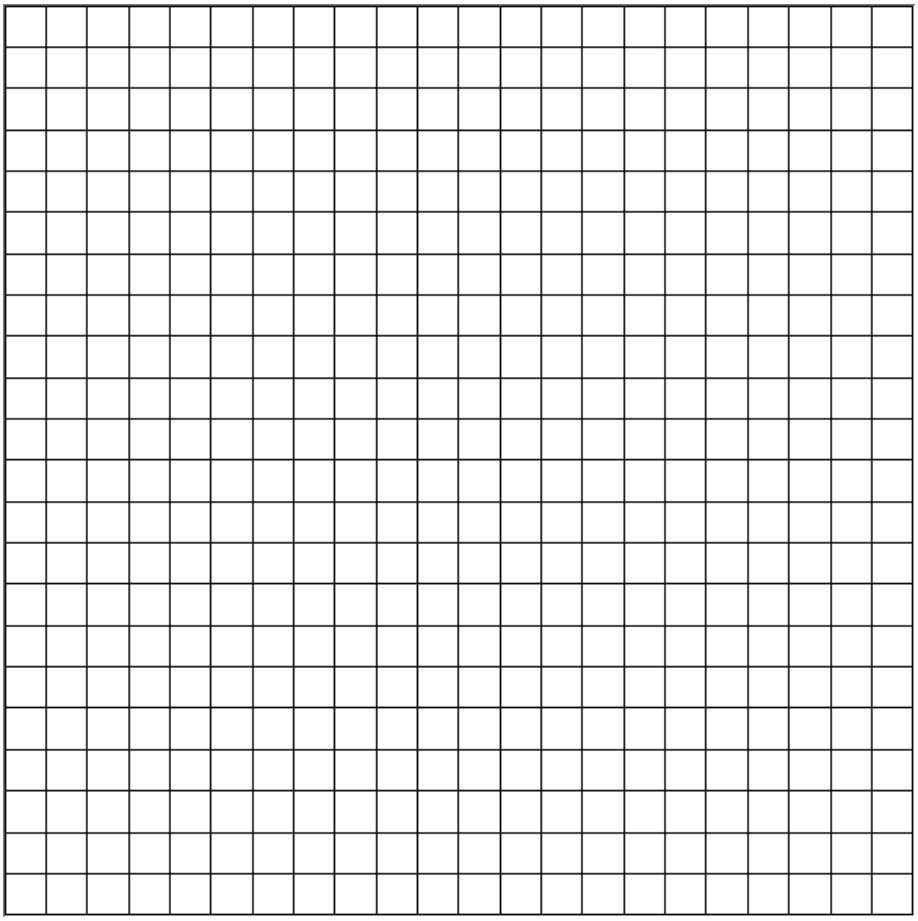
Glucose Homeostasis

Two patients, Ms. N.G. and Mr. P.D. take a glucose tolerance test as part of their annual physicals. After an overnight fast, each patient has to drink a drink containing 75 g of glucose, then have their blood drawn every 30 minutes for 5 hours. The first 3 hours of the patients' test results are shown below. Plot glucose data for Ms. N.G. and Mr. P.D. on the same graph.

Minutes after glucose drink	Blood glucose (mg/dL)		Insulin (pmol/L)	
	Ms. N.G.	Mr. P.D.	Ms. N.G.	Mr. P.D.
0	80	120	50	100
30	140	200	380	300
60	130	200	390	400
90	110	160	300	400
120	85	140	200	300
150	75	130	160	200
180	70	120	100	160



1. On your graph, what is the **regulated variable**?

2. What is the **stimulus** that causes a change in the regulated variable?

3. Blood concentration of glucose decreases as more time passes after drinking the glucose drink. What has happened to the glucose? [Hint: use additional data provided about patient physiology.]

4. Normal fasting blood glucose concentration is within the range 70 – 100 mg/dL. Using the this information and the data in the table above, predict Ms. N.G.'s blood glucose concentration after 4 hours.

5. Which patient has abnormal blood glucose levels after the drink? Give 3 criteria you used to decide between the two patients.

Teaching Tips for Peer Leaders

The purpose of this activity is for students to practice applying their knowledge when asked to analyze new or unfamiliar data. The data table gives concentrations of blood glucose and concentrations of circulating insulin. Students are instructed to graph blood glucose levels and to answer questions about blood glucose. The insulin data are provided for 2 reasons: 1) to provide practice in identifying data relevant to solving a specific problem and 2) to give them additional information needed to answer Questions 3 & 4.

1. Optional opening activity: Your professor may suggest a video describing glucose homeostasis in vertebrates. If so, show this video before students begin the problem set.

2. Have students work in pairs to complete the Glucose Homeostasis graphing exercise. Each individual should make a graph.

3. Students should work together to answer the questions. Boldface words in questions 1 and 2 are vocabulary used to describe homeostasis of any physiological variable. Encourage students to look up definitions in their textbook or their notes if they don't know these terms.

4. Question 3 is asking students to think about where glucose goes when it leaves the blood. Is it simply being excreted in urine? Ask students to consider what they have learned earlier about membrane transport, cellular respiration, and insulin. Encourage them to use all the data available to them about the patients so that they look at how the patients' insulin concentrations are changing.

5. To guide students on Question 4, ask them what happens to any regulated variable after a change away from the set point. Lead them to the apply their knowledge of set points, homeostasis and insulin action to predict a return to the pre-stimulus set point for the specific patient (around 80 mg/dL for Ms. N.G.)

6. Question 5: Criteria for identifying the patient with abnormal blood glucose levels include:

- Fasting blood glucose level: Is it in the range 70 – 100 mg/dL? Two data points give info on fasting blood glucose: Glucose level at 0 minutes after the drink (no glucose has been absorbed into the blood yet) and glucose level 180 min (3 hrs) after the drink, a long enough time for glucose to have been absorbed from the blood by body cells.
- Insulin concentrations: How does insulin change in response to the increase in blood glucose after the drink? The normal response is an increase in insulin after blood glucose increases and a decrease in insulin as blood glucose returns to the set point.
- Timing of insulin concentration change: The normal response is for insulin concentrations to return to the fasting concentration (concentration at 0 min after drink) when the blood glucose has returned to its fasting concentration.

7. Summary: Stress to students that they will be expected to interpret data on exams. We asked them to graph data for themselves because that's the best way to improve graph analysis skills.

Graphing is a skill we expect students to have mastered by the end of their freshmen year because they will need it in their other courses and if they continue in any medical or research related field.

Background. You can explain that the glucose tolerance test is given to most pregnant women during the 24th – 28th week to test for gestational diabetes. Pregnancy changes maternal metabolism, especially blood glucose and insulin regulation. Women who have high blood pressure, were overweight before the pregnancy began, or have a family history of diabetes are at particular risk of developing gestational diabetes (Coustan, D, *Glob. libr. women's med*., *(ISSN: 1756-2228)* 2009; DOI 10.3843/GLOWM.10162, www.glowm.com, accessed 7/28/2015).

Note: For your entertainment: Ms. N.G. is Ms. Normal Glucose. Mr. P.D. is Mr. Pre-Diabetic. Only share this with students AFTER they've completed the entire activity, or you give away the answer to Question 5.

Notes to Faculty

Optional opening: You may want students to begin this activity with a short review of glucose homeostasis in vertebrates. If so, evaluate glucose homeostasis videos available with your textbook study materials or find one online that emphasizes the processes on which you want to focus.

Note that the clinically standard glucose tolerance test does not require blood to be drawn every 30 minutes for 5 hours. A patient drinks the glucose drink, then returns for a single blood draw at the end of 3 hours. However, to develop this protocol, data were collected from many patients at multiple time points after drinking the glucose solution. Multiple data points are listed for this activity to provide sufficient information for students to create a graph showing how glucose changes over time.