Section 10.3: Regulating Blood Sugar

Mini Investigation: Analyzing the Effects of Hormones on the Blood Glucose Level, page 486

A. I hypothesize that John and Ehud ate identical meals at hour 2 (W). This is the point in time that blood sugar levels begin to rise.

B. At point X, I hypothesize that John injected himself with insulin, which allowed his blood sugar levels to decrease and eventually return to normal. Had he not done this, his blood sugar levels would have remained high and he may have become hyperglycemic.

C. Ehud’s blood glucose started to decrease before time X because he is not diabetic and can produce insulin in response to increased blood sugar levels. The production of insulin triggered his tissues to take up glucose from the blood, effectively decreasing his blood sugar levels.

D. John and Ehud’s blood glucose levels began to decrease at time Y because this is when they began to exercise. Exercise requires energy; therefore the tissues of the body have an increased demand for energy and take up glucose from the blood. Their blood glucose levels drop during exercise because of glucose uptake by the body’s tissues to maintain this increased demand for energy.

E. To decrease John’s blood glucose level below Ehud’s at time Z, it is possible that the alpha cells were not producing enough glucagon. Glucagon is secreted from the alpha cell in response to low blood sugar levels to signal the liver to increase blood glucose levels. Alternatively, John could also have reduced glucocorticoid levels. Glucocorticoid normally functions to raise blood sugar levels.

F. Answers may vary. Sample answer: It is more valid to make these kinds of comparisons between two people with the same body mass and composition, rather than people with very different body masses and compositions because hormone secretion and action may be different in people of different sizes. For example, the effects of a hormone in a larger person may be reduced due to the larger volume of the person, therefore diluting the effect of the hormone. Additionally, obesity has been shown to affect hormonal responses (particularly those that regulate blood sugar homeostasis).

G. Overall, Ehud (the healthy, non-diabetic) experiences somewhat increased blood sugar after a meal that returns to normal levels relatively rapidly. Similarly, after exercising, his blood sugar levels drop slightly and quickly go back to normal. John, on the other hand, who is a diabetic, experiences the same pattern of changes in blood sugar levels; however, his changes are much larger, and lowering his high blood sugar was probably done with the help of insulin he took. That is, after a meal, his blood sugar levels go much higher and do not come down on their own, and after exercising, his blood sugar levels drop to a much lower level before returning to normal. Also, the length of time it takes John’s blood sugar levels to return to a normal range after a meal or after exercise is significantly longer.

Research This: Medications for Non-insulin Dependent Diabetes, page 486

A. Answers may vary. Sample answer: It might be possible to manage diabetes by taking oral medications in any condition where the pancreas is still able to make and secrete insulin in response to increased blood sugar levels.

B. Some types of diabetes medications that are available include alpha-glucosidase inhibitors, amylin mimetics, D-phenylalanine derivatives, DPP-4 inhibitors, meglitinides, and sulfonylureas.
C. Diabetes medications work in different ways. Some medications prevent blood glucose levels from going too high after a meal, others work to prevent the liver from releasing too much glucose into the bloodstream, others work by helping the body make more insulin after a meal, and others work by making tissues more sensitive to insulin.

D. Diabetes medications can be very effective at controlling diabetes, especially when taken in combination with a healthy diet and exercise; however, often combinations of one or more medications are required to achieve the appropriate result.

E. Answers may vary. Sample answer: The benefit of taking diabetes medication is controlled blood sugar levels. These medications prevent hyperglycemia, which if left untreated can lead to serious long-term health problems. However, use of diabetes medications comes with potential risks and side effects. For many of these medications, side effects include nausea, diarrhea, and upset stomach when you first start taking the medication. These side effects typically lessen with time. Lactic acidosis, which is the build up of lactic acid in the blood, can occur in rare cases. A risk of taking medication to prevent high blood sugar levels is the development of hypoglycemia (low blood sugar levels), which can also have serious implications for your health. Hypoglycemia typically causes weakness, tiredness, fainting, trembling, sweating, fast heart rate, headache, and trouble sleeping. If left untreated, hypoglycemia can result in seizures, coma, permanent damage to the nervous system, and even death.

F. Reports will vary. Reports should summarize the types of diabetes medications available; the method by which each medication works to control blood glucose levels; and the side effects, risks and benefits. It should be as informative as possible such that it thoroughly explains the medications to someone who has just been diagnosed with diabetes.

Section 10.3 Questions, page 487

1. The two hormones produced by the pancreas that regulate blood glucose level are insulin and glucagon.
2. The three classic symptoms of diabetes mellitus are excessive thirst, excessive urine production, and increased appetite.
3. The adrenal glands also produce glucocorticoids, which raise blood glucose levels, because this provides extra energy that is readily available to any cells may need to react to a stress.
4. Type 1 diabetes is caused by a deficiency of insulin; type 2 diabetes can be caused by either the reduced production of insulin or the inability of insulin to bind to its receptors properly. Type 1 is usually diagnosed when a person is young, while type 2 can develop later in life, particularly in obese people. Treatment for type 1 diabetes requires insulin injections, while type 2 is often controlled with diet and exercise.
5. Answers may vary. Sample answer: Stress is often listed as a risk factor for weight gain or obesity because stress releases glucocorticoids from the adrenal glands, leading to a synthesis of extra glucose from proteins. If physical activity does not use the energy in this newly produced glucose, the extra glucose is later stored as fat.
6. (a) Nutrition Facts labels show the composition of the food, including the amount of sugar and other carbohydrates, fat, protein, fibre and vitamin levels.
   (b) A Nutrition Facts label can help a diabetic person choose foods because it allows the diabetic person to predict how the food will affect his or her blood sugar.
7. An insulin pump may be preferable to insulin injections because the pump better mimics the steady delivery of insulin to the blood in a non-diabetic person.
8. Reports will vary. Some developments in medicine that may lead to a cure for diabetes include: transplantation of islets of Langerhans, bioengineering of islet cells, and growth of islet cells from stem cells.

9. The pancreas produces and secretes two hormones, insulin and glucagon, that help to control blood sugar levels by means of negative feedback. If blood sugar levels are too high, insulin is released to move glucose out of the blood. When blood sugar levels are too low, glucagon signals the body’s glucose storage system to release glycogen from the liver, which increases the level of glucose in the blood.

10. Answers may vary. Sample answer: Two chemical tests that doctors use to detect the presence of glucose in the urine are:

   1) heating the urine sample with Benedict’s solution in a water bath. Colours in the yellow, orange, or red range indicate high glucose levels.

   2) using a glucose tape test, in which copper(II) sulphate (blue) is reduced to copper(I) ions (green or orange) if glucose is present.