

Diabetes: A National Epidemic

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Disclaimer: The findings and conclusions in this report are those of the author(s) and do not necessarily represent the views of the Centers for Disease Control and Prevention.

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Summary

This lesson is for a general biology or anatomy and physiology class. The lesson emphasizes the importance of glucose homeostasis in the body, and the effects of type 1 and 2 diabetes on glucose homeostasis by using a classroom enactment of glucose regulation in the body.

Learning Outcomes

- Students will graph trends in diabetes and obesity prevalence
- Students will be able to explain the regulation of glucose homeostasis between the bloodstream and cells
- Students will be able to explain the physiological changes that occur in the homeostatic regulation of glucose in diabetic persons

Materials

1. Photocopies of data of “The National Epidemic”—one per student
2. Graph papers—two pages per student
3. Photocopies of data of “Obesity: By Body Mass Index”—one per student
4. Photocopies of “Pretest – The National Epidemic”—one per student
5. Photocopy of role-play cards for the “Glucose Regulation Activity”—one per class; each role should be on a different color of paper
6. Site labels for role-play activity
7. A chair for the role-play activity Part C
8. Photocopies of the “Glucose Regulation Worksheet”
9. Photocopies of “6-Trait Writing Rubric”—one per student
10. Papers of two different colors for “Different Diabetes” activity –each student needs one of each color
11. Photocopies of “Complications of Diabetes” –one per student
12. Outline of body to illustrate locations of diabetes complications –one per student
13. Photocopies of “Diabetes Today” requirements and rubric—one per student
14. Newspapers to familiarize students with the layout of such a publication
15. Computers with Internet access
16. Textbooks to use as reference materials

Total Duration

5 hours

Procedures

Teacher Preparation

The teacher should prepare photocopies of the “The National Epidemic”, “Obesity: The Other National Epidemic”, and “Glucose Regulation Worksheet” handouts and review the “Glucose Regulation Activity Instructions”. The classroom should be prepared for the role-play activity

and nametags for each role should be prepared using the instructions contained in the “Glucose Regulation Activity Instructions”.

This lesson can be taught as an introduction to biological regulation, the interconnection of various body systems, and the importance of a healthy lifestyle. For additional information on these topics, visit the Web resources included below.

Web Resources

Title: CDC’s Diabetes Program – FAQs – Basics About Diabetes

URL: <http://www.cdc.gov/diabetes/faq/basics.htm>

Description: This site contains basic information concerning diabetes and is a source for background knowledge to enhance the discussion following the pretest. It can be used by the teacher for background information.

Title: American Diabetes Association

URL: <http://www.diabetes.org>

Description: This site contains basic information concerning diabetes and is a source for background knowledge to enhance the discussion following the pretest. It can be used by the teacher for background information.

Title: MedlinePlus Interactive Health Tutorials: Diabetes Introduction

URL: <http://www.nlm.nih.gov/medlineplus/tutorials/diabetesintroduction/htm/index.htm>

Description: This NIH website has an interactive tutorial with useful information about diabetes. The information in the tutorial is also available in a printer-friendly version. This site would be useful for information about diabetes for teachers or students

Supplemental Documents

Title: Glucose Regulation Activity Instructions

Description: This document provides instructions for the teacher for the “Glucose Regulation Activity” used in steps 2 and 3 and the conclusion.

Title: Venn Diagram Activity Instructions

Description: This document contains instructions for the teacher for the “Venn Diagram Activity” used in the conclusion step.

Introduction

Duration: 45 minutes

Begin the lesson by informing students that they are going to become disease detectives and investigate a national epidemic of a mystery disease. Instruct students to create a graph of data contained in the table included in “The National Epidemic”. Do not tell the students what disease is being investigated. After the data is graphed, have the class give hypotheses about what national epidemic is being illustrated. Reveal to students that the mystery disease is type 2 diabetes and explain that diabetes is a disease in which the body does not produce or properly use insulin (a hormone that is needed to convert sugar, starches and other food into energy needed for daily life). Conduct a class discussion about why the number of persons diagnosed with diabetes might be increasing. If student responses do not include a rise in obesity as one of the factors contributing to the rise in type 2 diabetes, then the teacher can prompt them to include it. (Teachers should note that a rise in obesity is only one reason for the rise in numbers of people with diabetes. There may be a number of other reasons, including an aging population, heightened public awareness of the disease, and better detection. Age is also a risk factor for

developing type 2 diabetes.) Assign the students to graph the data from “Obesity: By Body Mass Index”. Again, elicit hypotheses for the reason for the rise in obesity. Refer to the website “Preventing Chronic Disease: January 2005 and April 2005” for suggested hypotheses. Be sure the students notice that the trends are similar. Also stress to the students that the numbers in the first graph (“The National Epidemic”) represent diagnosed diabetes only. The National Institute of Health and Centers for Disease Control and Prevention (CDC) estimates that another one-third of persons with diabetes are unaware that they have the disease.

A quiz created by the International Diabetes foundation can be used to assess students’ prior knowledge of diabetes. The pretest and answer key are available in PDF format at the “Quiz: Test Your Knowledge of Diabetes” website listed in the Web Resources section. Once the students have answered the pretest, go over the answers and supplemental discussion points with them as described in the answer key.

Web Resources

Title: CDC’s Diabetes Program – Data & Trends – Prevalence of Diabetes

URL: <http://www.cdc.gov/diabetes/statistics/prev/national/tablepersons.htm>

Description: This site maintains data from the National Diabetes Surveillance System and is the source for the number of persons with diagnosed diabetes. It can be used for the source of data to be graphed to determine the “Prevalence of Diabetes”

Title: BRFSS Trend Data – Data Display

URL: <http://apps.nccd.cdc.gov/brfss/>

Description: This site maintains data from the Behavioral Risk Factor Surveillance System and is the source for the percentage of obesity of various groups of populations. It can be used for the source of data to be graphed to illustrate the relationship between the number of obese persons and the number of diabetics. The site allows viewers to stratify the data by various factors, including state, gender, and age.

Title: Preventing Chronic Disease: January 2005

URL: http://www.cdc.gov/pcd/issues/2005/apr/04_0038.htm

Description: This site is the publication of Part 1 of a CDC study of childhood obesity and its trend relationship to societal activities including transportation, physical education, and diet. This study can be used as an additional resource for teachers to enhance the discussion about the increase in obesity in the U.S.

Title: Preventing Chronic Disease: April 2005

URL: http://www.cdc.gov/pcd/issues/2005/apr/04_0039.htm

Description: This site is the publication of Part 2 of a CDC study of childhood obesity and its trend relationship to societal activities including transportation, physical education, and diet. This study can be used as an additional resource for teachers to enhance the discussion about the increase in obesity in the U.S.

Title: Quiz: Test Your Knowledge of Diabetes

URL: www.diabetes.ca/files/obesity_quiz.pdf

Description: This quiz created by the International Diabetes Foundation can be used as a pretest to assess students’ prior knowledge of diabetes. It also includes an answer key.

Title: CDC’s Diabetes Program – FAQs – Basics About Diabetes

URL: <http://www.cdc.gov/diabetes/faq/basics.htm>

Description: This site contains basic information concerning diabetes and is a source for background knowledge to enhance the discussion following the pretest. It can be used by the teacher for background information.

Supplemental Documents

Title: The National Epidemic

Description: This is the data that is to be graphed to introduce the students to the prevalence of diabetes and the increase that is observed. For data after 2004, the teacher can refer to the “CDC's Diabetes Program – Data & Trends – Prevalence of Diabetes” website.

Title: Obesity: The Other National Epidemic

Description: This is the data that is to be graphed to illustrate the nationwide trend in obesity as measured by BMI. For data after 2002, the teacher can refer to the “BRFSS Trend Data – Data Display” website.

Step 2

Duration: 45 minutes

Following the pretest, explain that students will further investigate the diabetes epidemic by exploring the relationship between blood glucose levels and insulin. Introduce normal glucose regulation by using the role-play activity described in Part A of the “Glucose Regulation Activity Instructions” document. Assign the students to complete Part A of the “Glucose Regulation Worksheet”. Once Part A of the worksheet is complete, review the answers with students. Assign the students to write a paragraph to explain glucose regulation using the following terms: blood glucose, insulin, glycogen, glucagon, pancreas, tissue cells, muscle, glycogen, and liver. Have the students share their paragraph with a partner and allow the partners to add any missing or inaccurate information. These paragraphs should then be graded using the “6-Trait Writing Model.” Information for this grading rubric can be found at the “6-Trait Writing” website listed in the Web Resources section.

Web Resources

Title: How Diabetes Works

URL: <http://www.howstuffworks.com/diabetes.htm>

Description: This site explains how the body uses insulin to control glucose. It includes graphics illustrating the regulation of glucose levels in the bloodstream. The teacher can use this site for background information and as a visual aid for the students during the role-playing exercise.

Title: 6-Trait Writing

URL: <http://www.kent.k12.wa.us/staff/LindaJancola/6Trait/what.htm>

Description: This is a site that describes the use of the 6-Trait writing rubric in the classroom. The teacher should use the information at this site to grade the students' paragraphs.

Supplemental Documents

Title: Glucose Regulation Activity Instructions

Description: This document provides detailed instructions for the teacher for the glucose regulation activity. Part A should be used for this step.

Title: Glucose Regulation Worksheet

Description: This worksheet will be completed by students during the glucose regulation activity. It provides the students an opportunity to solidify their understanding of the role of insulin, glucagon, and glucose in maintenance of blood-glucose levels and cellular requirements. Part A will be completed in this step.

Title: Glucose Regulation (Answer Key)

Description: This document provides the answers to the “Glucose Regulation Worksheet”.

Step 3

Duration: 30 minutes

Now that the students have been introduced to the normal cycle of glucose regulation, introduce the importance of insulin production and receptor affinity in maintenance of this physiological phenomenon. Use Part B of the “Glucose Regulation Activity” to facilitate the class discussion. After completing Part B of the activity, begin the discussion by asking the questions, “What happens to glucose levels when insulin is not available, and how does this affect the cell’s ability to make energy?” Also ask them, “What happens if there is too little glucose in the bloodstream?”, and “What happens if there is too much insulin in the bloodstream?” (Refer to the “Glucose Regulation Activity Instructions” for the answers to these questions.) Assign the questions in Part B of the “Glucose Regulation Worksheet” and review the answers with the students. To further assess the understanding of this topic, have the students write a short description of a physiological scenario in which insulin would be needed and a physiological scenario in which glucose would be needed. They should then trade their scenarios with a partner and have the partners identify which treatment would be recommended and why for each scenario.

Web Resource

Title: American Diabetes Association

URL: <http://www.diabetes.org>

Description: This site contains information about hypoglycemia and hyperglycemia, including the symptoms and treatments for each condition. It can be used by the teacher for background information.

Title: The National Diabetes Education Program

URL: www.cdc.gov/diabetes/ndep or www.ndep.nih.gov

Description: This site, created by a joint CDC and NIH program, may be used by the teacher for background information.

Supplemental Documents

Title: Glucose Regulation Activity Instructions

Description: This document provides detailed instructions for the teacher for the glucose regulation activity. Part B should be used for this step.

Title: Glucose Regulation Worksheet

Description: This document is for the students to explain the imbalances in glucose regulation. Part B will be completed in this step.

Title: Glucose Regulation (Answer Key)

Description: This document provides the answers to the “Glucose Regulation Worksheet”.

Conclusion

Duration: 45 minutes

Once students understand the mechanism of the maintenance of glucose levels, the teacher should use Part C of the “Glucose Regulation Activity Instructions” to introduce information on type 1 and type 2 diabetes, being sure to emphasize the definition of diabetes (a fasting glucose greater or equal to 126 mg/dl) and the role of obesity as a risk factor for type 2 diabetes. Relate this information to the graphs created in the introduction and the discussion about why these trends exist. Emphasize that there are more children being diagnosed with type 2 diabetes, and have the students provide hypotheses for why this is so. Information concerning the differences between the two types of diabetes can be found on the “Diabetes Information - American Diabetes Association” website listed in the Web Resources section. Use the animation clip on the McGraw-Hill Higher Education website listed in the Web Resources for clarification. Compare and contrast the two types of diabetes using a Venn diagram by following the instructions in the “Venn Diagram Activity Instructions.”

Web Resources

Title: Diabetes Animation

URL: www.mhhe.com/biosci/genbio/animation_quizzes/graphics/inm5s8c.ram

Description: This Real player animation from McGraw-Hill Higher Education gives a visual demonstration of the interaction of glucose and insulin in a normal system and in type 1 and 2 diabetes.

Title: Diabetes Information - American Diabetes Association

URL: <http://www.diabetes.org/about-diabetes.jsp>

Description: This site gives detailed information concerning the similarities and differences between type 1 and 2 diabetes. The teacher can use this for background information for the Venn diagram activity.

Title: MedlinePlus Interactive Health Tutorials: Diabetes Introduction

URL: <http://www.nlm.nih.gov/medlineplus/tutorials/diabetesintroduction/htm/index.htm>

Description: This NIH website has an interactive tutorial with useful information about diabetes. The information in the tutorial is also available in a printer-friendly version. This site would be useful for information about diabetes for teachers or students

Supplemental Documents

Title: Glucose Regulation Activity Instructions

Description: This document provides detailed instructions for the teacher for the glucose regulation activity. Part C should be used for this step.

Title: Glucose Regulation Worksheet

Description: This worksheet will be completed by students during the glucose regulation activity. Part C will be completed in this step.

Title: Glucose Regulation (Answer Key)

Description: This document provides the answers to the student worksheet “Glucose Regulation”.

Title: Venn Diagram Activity Instructions

Description: This document contains instructions for the teacher for the “Venn Diagram Activity.”

Assessment

The students will be evaluated on their paragraphs of glucose management in step 2 using the 6-Trait writing model. Their description of physiological scenarios requiring insulin and scenarios requiring glucose will be assessed in Step 3. In the conclusion, they will be informally assessed using the “Venn Diagram Activity.”

Modifications

Extensions

Now that the students understand what diabetes is and how diabetes is treated, the students can strengthen their vocabulary skills by translating a list of technical terms for complications of diabetes into more commonly used terms and indicating the location of the complications on a diagram of the human body. This list is found on the “Common Complications of Diabetes Worksheet” included in the Supplemental Documents section. Students can find additional information about these complications and a guide to medical terminology by using the sites listed in the Web resources section.

Web Resource

Title: Type 2 Diabetes Complications

URL: <http://www.diabetes.org/type-2-diabetes/complications.jsp>

Description: This site from the American Diabetes Association describes the clinical complications associated with type 2 diabetes. Students or teachers can use this site for additional information about each complication.

Title: Type 1 Diabetes Complications

URL: <http://www.diabetes.org/type-1-diabetes/complications.jsp>

Description: This site from the American Diabetes Association describes the clinical complications associated with type 1 diabetes. Students or teachers can use this site for additional information about each complication.

Title: National Diabetes Information Clearinghouse

URL: <http://diabetes.niddk.nih.gov/complications/index.htm>

Description: This site from the NIH lists the clinical complications associated with diabetes and provides links to further information regarding each condition as well as tips for healthy management. Students or teachers can use this site for additional information about each complication.

Title: U.S. Food and Drug Administration Diabetes Information

URL: <http://www.fda.gov/diabetes/related.html>

Description: This site lists the clinical complications associated with diabetes and various statistics for each condition. It also provides links to further information about each condition. Students or teachers can use this site for additional information about each complication.

Title: Medical Terminology

URL: <http://ec.hku.hk/mt/>

Description: This site from the University of Hong Kong shows a list of commonly used medical root words. It can be used by the students as they are deciphering technical terms into common language.

Supplemental Document(s)

Title: Common Complications of Diabetes Worksheet

Description: Students will complete this worksheet by translating the list of technical terms for complications of diabetes into more commonly used terms.

Title: Common Complications of Diabetes Answer Key

Description: This document contains the answer key for the “Common Complications of Diabetes Worksheet”.

When the students have demonstrated an understanding of the scope of the complications of the disease, they will develop a classroom newspaper as detailed in the handout “*Diabetes Today Project*”. The students will be assigned roles to create and publish a newspaper to educate the community about the characteristics of diabetes, its effects, and prevention tools. The departments and sections of the newspaper should include Headlines (facts, statistics, and latest research), Lifestyle (prevention techniques and ideas for recipes), Opinion (advice columns and letters to the editor), Entertainment (crossword and educational comics), and Advertising (careers and equipment involved in the management of diabetes). After the teacher has proofed the content for accuracy and graded it using the “Rubric for the *Diabetes Today Project*”, the publication could then be distributed throughout the community in areas such as senior centers, grocery stores, video arcades, places of worship, bowling alleys, schools, sporting events, or at various neighborhood meeting sites.

Web Resource(s)

Title: American Diabetes Association

URL: <http://www.diabetes.org>

Description: This site describes the characteristics of diabetes and its research, ideas for nutritional recipes, prevention, and management. Students can use it for researching their newspaper section.

Title: National Diabetes Information Clearinghouse

URL: <http://diabetes.niddk.nih.gov/complications/index.htm>

Description: This site gives an overview of the disease, identifies treatments, complications, and statistics. Students can use this site for researching their newspaper section.

Title: U.S. Food and Drug Administration Diabetes Information

URL: <http://www.fda.gov/diabetes/>

Description: This site discusses questions and answers related to diabetes, the equipment and behaviors associated with its management, and complications of the disease. Students can use this site for researching their newspaper section.

Title: CDC’s Diabetes Program – FAQs – Basics About Diabetes

URL: <http://www.cdc.gov/diabetes/faq/basics.htm>

Description: This site gives an overview of frequently asked questions about diabetes, including its characteristics, symptoms, types, risk factors, treatments, prevention methods, and cures being investigated. Students can use this site for researching their newspaper section.

Supplemental Documents

Title: *Diabetes Today* Project

Description: This document describes requirements for the *Diabetes Today* project.

Title: Rubric for the *Diabetes Today* Project

Description: This is the grading rubric for the section of the newspaper that each student developed.

Other Modifications

In the introduction, the students could write a paragraph comparing the trends of the graphs and include various hypotheses raised during the class discussion.

During the role-playing activity, the students could graph the relative amounts of glucose and insulin in the bloodstream over time on a multidata line graph.

To improve time management, the teacher could do the role-playing activity described in Steps 3 and the conclusion (Parts B and C) together and have the students complete the worksheet on their own, then do the assessments the following day in class.

To save time, or for students at lower levels, the teacher could give the students graphs of the data rather than completing the graphing activity in class.

For upper level students, the teacher could emphasize that nearly 33% of the diabetes cases are undiagnosed (some people don't know that they have diabetes), and the students could add this proportion of people to their data to further emphasize the magnitude of the epidemic during the graphing activity in the introduction.

For lower levels, the students could draw a diagram of the normal and diabetic blood glucose management rather than writing paragraphs in Step 2.

During the role-playing activity, students with physical limitations can observe or play glucagon molecules in the simulation, as it requires little activity.

To help in classroom management, the roles of students in the "Glucose Regulation Activity" can be substituted with Legos® or other interlocking pieces. Rather than labeling areas of the room, have poster board with the various sites of glucose regulation (liver, pancreas, bloodstream, and cells) labeled in a diagram. The various "participants" in the activity could be represented with different colors of Legos®, such as yellow for insulin, blue for glucose. The role of glucagon would not have to be represented. As the glucose is stored in the liver, the students could lock together the glucose pieces; as the insulin transports the glucose to the cell or liver, the insulin and glucose could interlock until the destination is reached, then insulin is free to "escort" another glucose molecule. To simulate the inability of a cell to bind with insulin, a piece of tape could be put over the insulin Lego® "bumps" so that it cannot connect to another piece.

For lower level students, the list of complications associated with diabetes could be translated to common terms for the students and then the locations of their effects could be drawn onto a body outline.

The teacher could assign groups for the *Diabetes Today* extension based on abilities, interests, or leadership of students.

Education Standards

National Science Education Standards

LIFE SCIENCE, CONTENT STANDARD C:

As a result of their activities in grades 9-12, all students should develop understanding of

- **The cell**
- Molecular basis of heredity
- Biological evolution
- Interdependence of organisms
- **Matter, energy, and organization in living systems**
- Behavior of organisms

SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES, CONTENT STANDARD F:

As a result of activities in grades 9-12, all students should develop understanding of

- **Personal and community health**
- Population growth
- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

A National Epidemic

Carrie Newdigger and Laurie Hayes, CDC's 2006 Science Ambassador Program

Using the following data, make a line graph to illustrate the trend of a national epidemic. Be sure to title your graph and label the X and Y axes.

Year	Number of persons diagnosed with the disease (in millions)
1980	5.8
1981	5.8
1982	5.8
1983	5.9
1984	6.1
1985	6.4
1986	6.6
1987	6.6
1988	6.5
1989	6.4
1990	6.7
1991	7.0
1992	7.6
1993	7.8
1994	8.3
1995	8.2
1996	8.5
1997	10.3
1998	10.5
1999	11.1
2000	12.0
2001	12.9
2002	13.6
2003	14.3
2004	14.7

Note to teachers: The information contained in the “A National Epidemic” worksheet is taken from figures published on the website “CDC’s Diabetes Program – Data & Trends – Prevalence of Diabetes” available at <http://www.cdc.gov/diabetes/statistics/prev/national/tablepersons.htm>. Accessed July 12, 2006.

Trends Data: Obesity by Body Mass Index

Diabetes: A National Epidemic
Carrie Newdigger and Laurie Hayes, CDC's 2006 Science Ambassador Program

Using the following data, make a line graph to illustrate the trend of another national epidemic. Be sure to title your graph and label the X and Y axes.

Year	Percent of population that is classified as obese (BMI >30.0)
1990	11.6
1991	12.6
1992	12.6
1993	13.7
1994	14.4
1995	15.8
1996	16.8
1997	16.6
1998	18.3
1999	19.7
2000	20.1
2001	21
2002	22.1

Information from "BRFSS Trend Data –Data Display" website available at <http://apps.nccd.cdc.gov/brfss/>. Accessed July 12, 2006.

Glucose Regulation Activity Instructions

Diabetes: A National Epidemic
Carrie Newdigger and Laurie Hayes, CDC's 2006 Science Ambassador Program

Background information:

Glucose is a simple sugar that fuels all the cells of the body. Glucose is absorbed by the intestines from the food that we eat and is distributed all over the body through the bloodstream. It is important for the body to have a steady level of glucose even between mealtimes. The brain is a major consumer of glucose and it needs a steady supply of it. Our bodies rely on insulin and glucagon, two hormones produced by the pancreas, to achieve a constant level of glucose. When we eat food, glucose is absorbed by the intestines and the level of glucose in the bloodstream rises. (The level of glucose in the blood is also called the blood sugar or blood glucose level.) When there is a high level of glucose in the blood, insulin is secreted by the pancreas. Insulin helps move glucose from the bloodstream into cells by functioning as a key that unlocks receptors on the cell. Once the receptors are unlocked by insulin, glucose can enter the cell and is used by the cell to make energy. Insulin also stimulates the formation of glycogen. Glycogen molecules are long chains of glucose molecules that can be stored in the liver and released when the level of glucose in the blood is low. When blood glucose is low, for example when a person hasn't eaten for a long time or is sleeping, glycogen can be converted back to glucose by the hormone glucagon. Glucagon is released by the pancreas when blood glucose is low. Glucagon helps raise blood glucose by converting glycogen back to glucose and by stimulating gluconeogenesis, a process that the body uses to make glucose by intermediate compounds in other metabolic pathways. However, the storage of glucose as glycogen is limited; therefore, most excess glucose is stored as fat, of which we can store a lot!

As an example of glucose homeostasis, an average person usually secretes about 1 unit of insulin per hour; however, approximately one hour after eating, the pancreas secretes up to 5 units of insulin per hour to help transport the additional glucose that is available in the bloodstream. [Note: These numbers are approximate, depending on the amount of food consumed, the person's body weight and degree of insulin resistance (the body's responsiveness to insulin)]. As time goes by and more glucose is being taken in by the body cells, the amount of glucose in the bloodstream is decreased. This stimulates the glucagon to convert stored glycogen in the liver into glucose, which is released into the bloodstream. In turn, the newly released blood glucose causes the pancreas to secrete more insulin to transport the glucose into the cells for use. As the amount of glucose in the bloodstream drops, the pancreas secretes less insulin.

The interrelationship of insulin and glucagon facilitates the maintenance of a stable blood glucose level. However, if a person does not produce enough insulin (insulin deficiency), or the insulin is not capable of transporting the glucose into the cells (insulin resistance), the cells will not get the energy needed to function. This condition is known as diabetes. In type 1 diabetes, the pancreas does not make insulin. Without insulin present to unlock the receptors on the cells, glucose cannot enter the cells and builds up in the bloodstream. In type 2 diabetes, the body still produces insulin but it may make a lower amount than average, or there may be a decrease in the number and/or responsiveness of the receptors on the cell. Even though insulin is present, it cannot be used as effectively as it should be, so it is more difficult for glucose to enter the cells. Eventually the beta cells will become exhausted trying to overcome the insulin resistance.

The following activity is designed to help students understand the physiology of glucose regulation. Students will act out the process of glucose homeostasis. The activity has three parts: a simulation of normal glucose homeostasis, a discussion of hypoglycemia and hyperglycemia (low and high levels of glucose in the blood), and simulations of glucose regulation in a person with type 1 diabetes and a person with type 2 diabetes. This activity must be conducted in an area where the students will have room to move. The materials listed are for a class of 30 students, however, the amounts can be adjusted accordingly for larger or smaller numbers of students.

Materials:

- Site Labels
- Student Role Tags with string
- Chair
- Script

Preparation:

Label various sites around the room with the Site Label Cards or other labeling method. The bloodstream could be represented with red yarn that “flows” near the other sites.

Make the appropriate number of Student Role Tags. Each role should be either written in a different color on a large index card or use different colors of paper to identify the various roles. For example, write “Glucose (sugar)” on 24 pieces of red paper, “Glucagon” on 1 piece of yellow paper, and write “Insulin” on 5 pieces of white paper. Punch a hole at either end of the paper and use string to allow the role tag to hang around the students’ neck.

The chair should be placed near the “Tissue Cells” site.

All “Glucose” students should be placed in an area near the bloodstream, but not actually in the bloodstream. All “Glucagon” and “Insulin” students should be located at the pancreas site.

Script to be read by the teacher: Activities performed by the students follow.

Part A: Normal Blood Glucose Regulation

1. All cells in the body need energy. Glucose is a simple sugar that fuels all the cells of the body. Glucose is absorbed by the intestines from the food that we eat and is distributed all over the body through the bloodstream. One glucose molecule should enter the bloodstream.

2. When there is a high level of glucose in the blood, insulin is secreted by the pancreas. Insulin is a hormone produced in the pancreas that allows cells to be able to absorb glucose to be used for energy. Most people produce approximately 1 unit of insulin per hour. One insulin molecule should leave the pancreas and enter the bloodstream.

3. Insulin helps move glucose from the bloodstream into cells by functioning as a key that unlocks receptors on the cell. Once the receptors are unlocked by insulin, glucose can enter the cell and is used by the cell to make energy. This is similar to having special access to concert events because you are being escorted by a band member. The insulin and glucose molecules should lock arms and the insulin molecule should escort the glucose molecule to the cell site.

- 4. Cells use the energy stored in the glucose molecule to carry out life processes.** The glucose molecule should begin a slow series of 20 jumping jacks to simulate the energy being used.
- 5. Cells require several glucose molecules to get enough energy to function.** A second and third glucose molecule should enter the bloodstream, and each molecule should be escorted to the cell site by the insulin. As soon as each glucose molecule is in the cell, it should begin its series of 20 jumping jacks.
- 6. Once a cell has acquired enough glucose for its energy requirement, any additional glucose in the bloodstream is taken to the liver for storage.** Three new glucose molecules should enter the bloodstream. Each molecule should be escorted by the insulin to the liver site. Note that only one insulin is in the blood at this time and that the sugar molecules are entering at a slow rate. (*see note below)
- 7. Glucose is stored in the liver in the form of glycogen*. Glycogen can be stored away for use when there is not enough glucose in the bloodstream. Glucose molecules form bonds by the process of dehydration synthesis.** Once the three students are at the liver site, they should hold hands to simulate bonding to form a glycogen molecule.
- 8. As glucose molecules are being used up in the body cells, new glucose molecules from the bloodstream replace them.** Once the glucose molecules in the cells have finished their jumping jacks, they may sit down. New glucose molecules enter the bloodstream one at a time and are escorted to the cells by the insulin to maintain the idea that the cells require a constant supply of glucose. All glucose molecules should begin a slow series of 20 jumping jacks once they are at the cell site.
- 9. As more glucose enters the bloodstream, the insulin molecules transport them either to the cells for immediate use or to the liver for storage.** The glucose molecules continue to enter the bloodstream and be escorted by the insulin to either the cells or to the liver. When in the cells, the glucose molecules do jumping jacks. When in the liver, they bond together to form glycogen. If possible, have half of the glucose molecules not enter immediately, but wait until step 12.
- 10. If a person does not have glucose in the blood, (for example the person has not eaten for a long time) glucagon is released from the pancreas, and travels to the liver to break the bonds of glycogen storage to release more glucose into the bloodstream. These glucose molecules are then taken into the body cells by insulin.** The glucagon student travels from the pancreas to the liver where he or she should break the bonds between the glucose molecules and “pushes” each one into the bloodstream where the insulin molecule locks arms with the glucose molecule and escorts the glucose to the cell site. The glucose molecules then begin their slow series of 20 jumping jacks. Maintain the release of glucose molecules from the glycogen chain until 3 students are in the cell; the others should remain in the liver as stored glycogen.
- 11. When a person eats, this supplies a large amount of glucose to the bloodstream. Approximately one hour after eating, the pancreas will secrete up to 5 units of insulin to deal with all of this new glucose.** All remaining glucose molecules (except two) should enter the bloodstream at once. All insulin molecules should be released from the pancreas. Cells should be provided with their three glucose molecules for immediate energy and the remaining glucose molecules are put into storage in the liver as glycogen.

12. Once the blood glucose level has gone back down, the pancreas returns to secreting only one unit of insulin per hour, and the glucagon breaks down glycogen and releases glucose as needed from the liver to supply the cells with a constant glucose supply. The final two glucose molecules enter the bloodstream one at a time and are put where they are needed, either in the cell or in the liver.

13. Now answer the questions on Part A of the worksheet using what you have just learned. The teacher should allow the students time to answer the questions on Part A and then go over them to be sure the students understand the basic regulation of blood glucose concentrations.

14. On a separate sheet of paper, write a paragraph to explain glucose regulation using the following terms: blood glucose, insulin, glycogen, glucagon, pancreas, cells, glycogen, muscle, fat cells, and liver. Once you have your paragraph written, share your paragraph with a partner, so that any missed or inaccurate information can be included and clarified. These paragraphs will be graded using the “6-Trait Writing Model.” The teacher should then allow the students to write their paragraphs, peer-edit, and turn them in.

***Please note:** Glycogen is also stored in muscle and most excess glucose is stored as fat (thus the link between obesity and diabetes). Since this lesson serves as an introduction to diabetes, this information will not be included in the activity, but may be explained verbally by the teacher.

Part B: Hypoglycemia and Hyperglycemia

The teacher should read and discuss the following questions with the class.

1. What happens to glucose levels when insulin is not available? The glucose levels in the blood increase, but the cells cannot use this glucose for energy. Therefore, more glucose will be excreted as waste from the body

2. How does this affect the cell’s ability to make energy? The cells cannot make energy, so they will die.

3. What happens if there is too little glucose in the bloodstream? The cells will not be able to get enough glucose for energy.

4. What happens if there is too much insulin in the bloodstream? There will not be enough glucose in the bloodstream to maintain a healthy homeostasis.

5. When blood sugar levels increase due to a lack of insulin, a condition known as hyperglycemia results. What do you think the treatment for this condition would be? Injection of insulin or ingestion of oral medications so that the glucose can get into the cells or into the liver for storage.

6. Low blood glucose is known as hypoglycemia. If a person has hypoglycemia, what do you think the best treatment would be? A quick way to raise blood sugar and treat hypoglycemia would be to eat or drink something with a lot of easily available sugar, like candy or fruit juice.

To further assess the understanding of this topic, have the students write a short description of a physiological scenario in which insulin would be needed and a physiological scenario in which glucose would be needed. They should then trade their

scenarios with a partner and have the partners identify which treatment would be recommended and why for each scenario.

Part C: Diabetes

1. Now that we know about glucose regulation and what happens if levels of glucose or insulin are too high or too low, we can learn more about diabetes, a disease that makes it difficult for the cells to get the glucose that they need. We have seen that blood glucose levels are dependent upon the secretion of insulin from the pancreas. So what will happen if the pancreas does not secrete enough insulin to keep up with the blood glucose amounts? Let's see how this lack of insulin affects the body:

Glucose molecules enter the bloodstream. The glucose students enter the bloodstream in a single-file line.

However, unlike in normal glucose regulation, insulin is not released from the pancreas to put the glucose into the cells, so the sugar molecules continue on their journey. Eventually there is such a high concentration of glucose in the bloodstream that the glucose is excreted by the kidneys as waste. This condition of glucose in the urine is known as glycosuria. The insulin students stay in the pancreas as the glucose molecules walk past the cells and end up outside the bloodstream, representing being excreted from the body as waste.

2. Not producing any insulin is known as type 1 diabetes (or preexisting diabetes). People with type 1 diabetes must take insulin to maintain normal blood glucose levels. About 5-10 percent of people with diabetes have type 1 diabetes.

3. There is another way that diabetes can make it difficult for cells to get the glucose that they need to make energy. In this type of diabetes, known as type 2 diabetes, the pancreas still makes insulin but the cells can't use it very well. Let's see what happens in this condition.

The teacher should put a chair in front of the "Cells" location so that the glucose cannot enter the area.

Glucose molecules enter the bloodstream. The glucose students enter the bloodstream in a single-file line.

The pancreas secretes insulin. One insulin student leaves the pancreas and finds a glucose molecule to lock arms with.

In type 2 diabetes, the body produces insulin, but there is a decrease in the number of receptors on the cell. Even though insulin is present, it cannot be used as effectively as it should be, so it is more difficult for glucose to enter the cells.

The insulin tries to enter the cell, but the chair is in the way. Therefore, the insulin breaks off the glucose, the glucose continues on the bloodstream to be excreted, and the insulin tries again with another glucose molecule. The beta cells try to overcome the resistance by producing more insulin and eventually "die" of exhaustion.

Another way that type 2 diabetes can occur is that the body produces too little insulin. The glucose students enter the bloodstream in a single file line but no insulin arrives to escort them into the cells.

4. Ask students: Although there is insulin available, what happens to the cell's ability to get energy? It decreases because glucose cannot get through the cell membrane.

Site Cards: Place these at various stations around the room. The “bloodstream” might be labeled with pieces of red yarn that “flows” by the other sites.

Liver	Pancreas
Bloodstream	Cells

Student Role Cards: Each type of molecule role should be printed in a different color or on a different color of card for easy identification. The type of molecule label is on the left and the number of cards of each type is listed on the right. These numbers are given for a class of 30, but the amounts of each molecule type can be changed proportionally to allow for larger or smaller class sizes.

Glucose (sugar)	24
Insulin	5
Glucagon	1

Glucose Regulation Worksheet

Diabetes: A National Epidemic
Carrie Newdigger and Laurie Hayes, CDC's 2006 Science Ambassador Program

Part A: Normal Glucose Regulation

1. What molecule do cells use for energy?
2. What hormone aids the diffusion of glucose across cell membranes?
3. How is glucose stored in the body for periods of fasting?
4. Where is glycogen stored?
5. What hormone causes glycogen to break down into glucose molecules?
6. Among glucose (G), insulin (I), and glucagon (C) identify which molecule is being described.

_____ causes the blood sugar level to decrease

_____ causes the blood sugar level to increase

_____ is the molecule measured in "blood-sugar" levels

_____ promotes movement of glucose into certain cells

_____ stimulates cells to break down glycogen into glucose

_____ stimulates formation of glycogen from glucose

Part B: Hypo- and Hyperglycemia

1. Define hypoglycemia and explain how it is treated.
2. Define hyperglycemia and explain what might cause this.

Part C: Diabetes

1. What chronic disease occurs when blood glucose levels are too high?
2. What are two types of diabetes?

3. What is the physiological problem that occurs in type 1 diabetes and how is it treated?

4. What is the physiological problem that occurs in type 2 diabetes?

Glucose Regulation (Answer Key)

Diabetes: A National Epidemic
Carrie Newdigger and Laurie Hayes, CDC's 2006 Science Ambassador Program

Part A:

1. What molecule do cells use for energy? **Glucose**
2. What hormone aids the diffusion of glucose across cell membranes? **Insulin**
3. How is glucose stored in the body for periods of fasting? **Glycogen**
4. Where is glycogen stored? **Liver**
5. What hormone causes glycogen to break down into glucose molecules? **Glucagon**
6. Among glucose (G), insulin (I), and glucagon (C) identify which molecule is being described.
__**I**__ causes the blood sugar level to decrease
__**C**__ causes the blood sugar level to increase
__**G**__ is the molecule measured in "blood-sugar" levels
__**I**__ promotes movement of glucose into certain cells
__**C**__ stimulates cells to break down glycogen into glucose
__**I**__ stimulates formation of glycogen from glucose

Part B: Hypo- and Hyperglycemia

1. Define hypoglycemia and explain how it is treated. **A condition in which blood glucose levels are too low. It can be treated by giving a person food or drink that will raise the blood sugar quickly, like orange juice or candy.**
2. Define hyperglycemia and explain what might cause this. **A condition in which blood glucose levels are too high. It can be caused by not enough insulin present in the body, or by cells that are not able to use insulin as efficiently as cells of people who do not have diabetes.**

Part C:

1. What chronic disease occurs when blood glucose levels are too high? **Diabetes**
2. What are two types of diabetes? **Type 1 and type 2 diabetes**
3. What is the physiological problem in type 1 diabetes and how is it treated? **People with type 1 diabetes do not produce insulin. Type 1 diabetes must be treated with insulin.**

4. What is the physiological problem in type 2 diabetes? People with type 2 diabetes are not able to use insulin as efficiently as they should and may also produce less insulin than they should

Venn Diagram Activity Instructions

Diabetes: A National Epidemic
Carrie Newdigger and Laurie Hayes, CDC's 2006 Science Ambassador Program

Give each student two different-colored sheets of paper. On one, write "Type 1", and on the other write "Type 2". As the teacher reads the following statements, have the students hold up the appropriate paper. If the statements applies to both type 1 and type 2 diabetes, the students should hold up both papers. The answers are in parentheses.

- Blood sugar is too high (Both)
- Cells can't use insulin as well and/or less insulin is produced (Type 2)
- Increasing in prevalence in children (Type 2)
- Managed by eating healthy foods, exercise, maintaining healthy body weight, checking blood glucose levels (Both)
- May account for 5% to 10% of all diagnosed cases of diabetes (Type 1)
- May account for 90% to 95% of all diagnosed cases of diabetes (Type 2)
- People with this type of diabetes must take insulin to control their diabetes (Type 1)
- Pancreas stops making insulin (Type 1)
- Risk factors include older age, obesity, family history, prior history of gestational diabetes, impaired glucose tolerance, physical inactivity, and race/ethnicity (Type 2)
- Risk factors involve autoimmune, genetic, and environmental factors (Both)
- Risk of developing this type of diabetes may be reduced by regular physical activity and maintenance of healthy body weight (Type 2)
- Suspected to follow exposure to an "environmental trigger", such as an unidentified virus, stimulating an immune attack against the insulin-producing cells of the pancreas (Type 1)
- Symptoms may include frequent urination, excessive thirst, unexplained weight loss, extreme hunger, sudden vision changes, fatigue, tingling or numbness in hands or feet, very dry skin, sores that are slow to heal, increase in infections (Both)
- Used to be called "adult onset diabetes" or "non-insulin-dependent diabetes mellitus (NIDDM)" (Type 2)
- Used to be called "insulin dependent" or "juvenile diabetes" (Type 1)

A summary of statements used in the “Venn Diagram Activity is provided below:

Type 1:

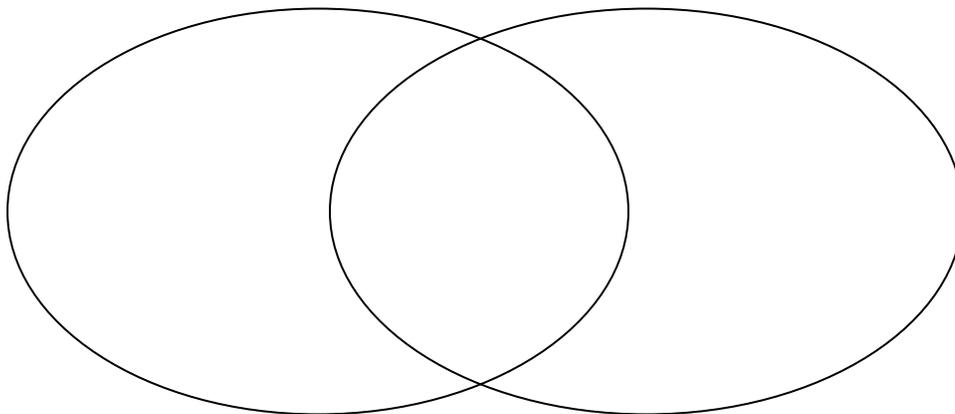
- The pancreas stops making insulin
- People with type 1 diabetes must take insulin to control their diabetes
- Used to be called “insulin dependent” or “juvenile diabetes”
- May account for 5% to 10% of all diagnosed cases of diabetes
- Risk factors involve autoimmune, genetic, and environmental factors
- Suspected to follow exposure to an “environmental trigger”, such as an unidentified virus, stimulating an immune attack against the insulin-producing cells of the pancreas

Both

- Blood sugar is too high
- People can help control their diabetes by eating healthy foods, exercise, maintaining healthy body weight, checking blood glucose levels
- Symptoms may include frequent urination, excessive thirst, unexplained weight loss, extreme hunger, sudden vision changes, fatigue, tingling or numbness in hands or feet, very dry skin, sores that are slow to heal, increase in infections

Type 2:

- People with type 2 diabetes do not produce enough insulin and/or cannot use the insulin their bodies make as well as people who do not have diabetes
- Used to be called “adult onset diabetes” or “non-insulin-dependent diabetes mellitus (NIDDM)”
- May account for 90% to 95% of all diagnosed cases of diabetes
- Increasing in prevalence in children
- Risk factors include older age, obesity, family history of type 2 diabetes, prior history of gestational diabetes, impaired glucose tolerance, physical inactivity, and race/ethnicity
- Risk of developing the disease may be reduced by regular physical activity and maintenance of a healthy body weight



Common Complications of Diabetes

Diabetes: A National Epidemic
Carrie Newdigger and Laurie Hayes, CDC's 2006 Science Ambassador Program

Diabetes affects the body cells ability to obtain glucose. Since glucose is essential for cellular energy, the inability to obtain this molecule can lead to death of cells. Undiagnosed or uncontrolled diabetes can lead to severe complications throughout the body.

The following list of complications are associated with diabetes. Using your knowledge of Greek and Latin root words in medical terminology (or a dictionary if you need help), translate each of these complications into common, or "layman's" terms. Then, using an outline of a body, illustrate where these complications would occur. The first one is done for you.

Diabetes Complication	Common Term	Area Where Complications Might Occur
Cardiovascular disease	Heart disease, leading to stroke, heart attack	Heart and vessels
Gastroparesis		
Hypertension		
Nephropathy		
Neuropathy		
Pedal ulcers		
Periodontal disease		
Renal disease		
Retinopathy		
Urologic problems		

Common Complications of Diabetes

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Diabetes affects the body cells ability to obtain glucose. Since glucose is essential for cellular energy, the inability to obtain this molecule can lead to death of cells. Undiagnosed or uncontrolled diabetes can lead to severe complications throughout the body.

The following list of complications are associated with diabetes. Using your knowledge of Greek and Latin root words in medical terminology (or a dictionary if you need help), translate each of these complications into common, or "layman's" terms. Then, using an outline of a body, illustrate where these complications would be expressed. The first one is done for you.

Diabetes Complication	Common Term	Area Where Complications Might Occur
Cardiovascular disease	Heart disease, leading to stroke, heart attack	Heart and vessels
Gastroparesis	NERVE DAMAGE IN THE STOMACH	STOMACH
Hypertension	HIGH BLOOD PRESSURE	VESSELS AND HEART
Nephropathy	KIDNEY DISEASE	KIDNEYS
Neuropathy	NERVE DISEASES	NERVES THROUGHOUT MAINLY EYES, KIDNEYS, STOMACH
Pedal ulcers	FOOT ULCERS	FEET AND LOWER EXTREMITIES
Periodontal disease	GUM DISEASE	GUMS IN MOUTH
Renal disease	KIDNEY DISEASE	KIDNEYS
Retinopathy	EYE DISEASE, SPECIFICALLY RETINAL VESSELS	EYES
Urologic problems	URINARY TRACT, BLADDER	KIDNEYS, URETER, URETHRA

Diabetes Today

Diabetes: A National Epidemic
Carrie Newdigger and Laurie Hayes, CDC's 2006 Science Ambassador Program

In this assignment, you will develop a class newspaper to explain the characteristics, effects, and prevention methods for diabetes. The sections for the paper will include the following:

- Headlines: facts, statistics, and latest research
- Lifestyle: prevention techniques and ideas for recipes
- Opinion: advice columns and letters to the editor
- Entertainment: crossword and educational comics
- Advertising: careers and equipment involved in the management of diabetes

Feel free to look at the newspapers provided to get an idea of the layout and organization of a newspaper publication.

Each group of students will be responsible for a section. Each group (except for the Entertainment section) will consist of a copy editor and at least one reporter.

The purpose of the reporter is to research the information required for his/her particular section, and write at least one story related to that sector of news. The purpose of the copy editor is to proofread submitted stories for accuracy, mechanics, and thoroughness, and write a headline for each article.

All final stories are due on or before: _____

You will be graded according to the following rubric for your section.

Sections: Headlines (facts, statistics, and latest research) and **Lifestyle** (prevention techniques and ideas for recipes)

Element	1 pts	2 pts	3 pts	4 pts	5 pts	Points Awarded
Idea and Content Development	Little or no scientific information	States the information, but some is inaccurate	Scientific information is accurate, but unclear and undeveloped	Scientific information is accurate, and clear, but few specific details	Scientific information is well developed with details and examples	
Organization	The reader feels lost	Identifiable sense of structure	Easy to follow, logical order, but weak introduction or conclusion	Easy to follow, introduction and conclusion strong, but transitions	Transitions are smooth, organization is logical with strong introduction and	

				are hard to follow	conclusion	
Word Choice	Little or inaccurate use of scientific terminology	Words are used properly, but lacks adjectives and development	Some use of strong describing words, and scientific terms	Language is functional and the message gets across	Scientific terms convey the intended message in a precise way	
Conventions	Errors in spelling, punctuation, usage, and grammar make it difficult to read	Some use of punctuation, capitalization, correct spelling of common words	Spelling usually correct, most conventions are used properly	Writer has few conventional mistakes, and nearly all terms are spelled correctly	Good use of grammar, capitalization, punctuation, usage, spelling, paragraphing, and uses these conventions wisely	
Participation in the Group and Effort	Did not complete his/her share of the project; frequently off-task	Rarely contributed to the group; often needed to be reminded to focus and produce	Was helpful and cooperative in completing his/her share	Contributed great effort to the group's project; helped organize the group and keep people on task	Went above and beyond the call of duty to further the group's work	
Overall Result	The section is extremely weak in most areas	The section is not well polished, hard to read, and appears that the students do not understand the topic	The section shows evidence of little effort and research; diagrams and graphics do not add much clarity or interest	The section shows evidence of some effort and diagrams aide the information, but the authors' own thinking is not evidenced	The section shows evidence of effort, the students understand the topic, and diagrams and illustrations add to the information	

Section: Opinion (advice columns and letters to the editor)

Element	1 pts	2 pts	3 pts	4 pts	5 pts	Points Awarded
Idea and	Little or no	States the	Scientific	Scientific	Scientific	

Content Development	scientific information in either the letter or advice	information in the letter, but some the advice is inaccurate	information is accurate, but unclear and undeveloped	information is accurate, and clear, but few specific details	information is well developed with details and examples	
Organization	The reader feels lost; the letter and advice do not match up	Identifiable sense of structure; either the letter or the advice sounds rational, but not both	Easy to follow, logical order, but weak introduction or conclusion	Easy to follow, introduction and conclusion strong, but transitions are hard to follow	Transitions are smooth, organization is logical with strong introduction and conclusion	
Word Choice	Little or inaccurate use of scientific terminology	Words are used properly, but lacks adjectives and development	Some use of strong describing words, and scientific terms	Language is functional and the message gets across	Scientific terms convey the intended message in a precise way	
Conventions	Errors in spelling, punctuation, usage, and grammar make it difficult to read	Some use of punctuation, capitalization, correct spelling of common words	Spelling usually correct, most conventions are used properly	Writer has few conventional mistakes, and nearly all terms are spelled correctly	Good use of grammar, capitalization, punctuation, usage, spelling, paragraphing, and uses these conventions wisely	
Participation in the Group and Effort	Did not complete his/her share of the project; frequently off-task	Rarely contributed to the group; often needed to be reminded to focus and produce	Was helpful and cooperative in completing his/her share	Contributed great effort to the group's project; helped organize the group and keep people on task	Went above and beyond the call of duty to further the group's work	
Overall Result	The section is extremely weak in most areas	The section is not well polished, hard to read, and appears that the students do	The section shows evidence of little effort and research; diagrams	The section shows evidence of some effort and diagrams aide the	The section shows evidence of effort, the students understand the topic, and	

		not understand the topic	and graphics do not add much clarity or interest	information, but the authors' own thinking is not evidenced	diagrams and illustrations add to the information	
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Section: Entertainment (crossword or other interactive puzzle)

Element	1 pts	2 pts	3 pts	4 pts	5 pts	Points Awarded
Concepts Covered	The concepts covered are trivial and not related to the topic	The concepts covered are related to the topic, but some information is inaccurate	The concepts covered are related to the topic, but the information is trivial	The concepts covered are related to the topic and important but do not summarize the topic	The concepts covered are important and function well to summarize the information of the topic	
Usability	The task is very poorly constructed and will not work	The instructions of the task are not well defined	The instructions of the task are well defined, but there are inaccuracies in the reliability of the information	The task is clearly defined and accurate, but no self-check is available	The task is clearly defined, accurate, and self-check is available	
Neatness	The task is not neatly presented	The task is neatly done, but lacking in graphics	The task is neatly and presented, and but graphics are inappropriate to the content	The task is neatly presented, and graphics are appropriate to the content	There is a clear and thoughtful organization between the graphics and the topic content	
Creativity and Design of the Task	Little creativity is expressed by the author to the target audience		The task is creatively presented, but little thought will be required to complete it		The task is creatively presented, and the target audience will be intrigued	
	Did not	Rarely	Was helpful	Contributed	Went above	

Participation in the Group and Effort	complete his/her share of the project; frequently off-task	contributed to the group; often needed to be reminded to focus and produce	and cooperative in completing his/her share	great effort to the group's project; helped organize the group and keep people on task	and beyond the call of duty to further the group's work	
Overall Result	The section is extremely weak in most areas	The section is not well polished, hard to read, and appears that the students do not understand the topic	The section shows evidence of little effort and research; diagrams and graphics do not add much clarity or interest	The section shows evidence of some effort and diagrams aide the information, but the authors' own thinking is not evidenced	The section shows evidence of effort, the students understand the topic, and diagrams and illustrations add to the information	

Section: Entertainment (educational comics)

Element	1 pts	2 pts	3 pts	4 pts	5 pts	Points Awarded
Content and Organization	The content is not related to the topic	The content is related to the topic, but is inaccurate	The content is accurate, but undeveloped	The content is accurate and clear, but hard to follow	The content is accurate, clear, and easy to follow	
Originality and Creativity	No frames of the comic strip reflect creativity.	Some frames of the comic strip reflect creativity but characters do not portray important objects of the topic	Some frames of the comic strip reflect creativity and characters portray important objects of the topic	Most frames of the comic strip reflect creativity	All frames of the comic strip reflect an exceptional degree of student creativity and portrayal of the topic	
Conventions	Errors in spelling, punctuation, usage, and grammar make it difficult to	Some use of punctuation, capitalization, correct spelling of common words	Spelling usually correct, most conventions are used properly	Writer has few conventional mistakes, and nearly all terms are spelled	Good use of grammar, capitalization, punctuation, usage, spelling, paragraphing,	

	read			correctly	and uses these conventions wisely	
Visual Appeal and Artistry	The comic strip is distractively messy or very poorly designed.	The comic strip is hard to identify roles due to a lack of artistic skill	The cartoon is acceptably attractive but it may be a bit messy.	The comic strip is attractive in terms of design, layout, and neatness.	The comic strip is exceptionally attractive in terms of design, layout, and neatness.	
Participation in the Group and Effort	Did not complete his/her share of the project; frequently off-task	Rarely contributed to the group; often needed to be reminded to focus and produce	Was helpful and cooperative in completing his/her share	Contributed great effort to the group's project; helped organize the group and keep people on task	Went above and beyond the call of duty to further the group's work	
Overall Result	The section is extremely weak in most areas	The section is not well polished, hard to read, and appears that the students do not understand the topic	The section shows evidence of little effort and research; diagrams and graphics do not add much clarity or interest	The section shows evidence of some effort and diagrams aide the information, but the authors' own thinking is not evidenced	The section shows evidence of effort, the students understand the topic, and diagrams and illustrations add to the information	

Section: Advertising (careers and equipment involved in the management of diabetes)

Element	1 pts	2 pts	3 pts	4 pts	5 pts	Points Awarded
Content	Little or no information related to the topic	States the information, but some is inaccurate, and/or does not look like a real ad	Scientific information is accurate, but not much information is provided	Scientific information is accurate, and clear, but few specific details	Scientific information is well developed with details and examples	

Visual Appeal and Artistry	The ad is distractively messy or very poorly designed.	The ad is hard to understand due to a lack of artistic skill	The ad is acceptably attractive but it may be a bit messy.	The ad is attractive in terms of design, layout, and neatness.	The ad is exceptionally attractive in terms of design, layout, and neatness.	
Graphics	The ad does not contain graphics	The graphics are inappropriate	The graphics are appropriate but lack quality	Quality graphics are included but do not aid the purpose of the ad	Quality graphics are included and well used to aid the purpose of the ad	
Conventions	Errors in spelling, punctuation, usage, and grammar make it difficult to read	Some use of punctuation, capitalization, correct spelling of common words	Spelling usually correct, most conventions are used properly	Writer has few conventional mistakes, and nearly all terms are spelled correctly	Good use of grammar, capitalization, punctuation, usage, spelling, paragraphing, and uses these conventions wisely	
Participation in the Group and Effort	Did not complete his/her share of the project; frequently off-task	Rarely contributed to the group; often needed to be reminded to focus and produce	Was helpful and cooperative in completing his/her share	Contributed great effort to the group's project; helped organize the group and keep people on task	Went above and beyond the call of duty to further the group's work	
Overall Result	The section is extremely weak in most areas	The section is not well polished, hard to read, and appears that the students do not understand the topic	The section shows evidence of little effort and research; diagrams and graphics do not add much clarity or interest	The section shows evidence of some effort and diagrams aide the information, but the authors' own thinking is not evidenced	The section shows evidence of effort, the students understand the topic, and diagrams and illustrations add to the information	

“Daily Diabetes” Rubric

Diabetes: A National Epidemic
Carrie Newdigger, CDC’s 2006 Science Ambassador Program

The following rubrics are to be used to assess each person’s contribution to the assigned section of the newspaper. The area of “Overall Result” can be an assessment of each section’s group product.

Sections: Headlines (facts, statistics, and latest research) and **Lifestyle** (prevention techniques and ideas for recipes)

Element	1 pts	2 pts	3 pts	4 pts	5 pts	Points Awarded
Idea and Content Development	Little or no scientific information	States the information, but some is inaccurate	Scientific information is accurate, but unclear and undeveloped	Scientific information is accurate, and clear, but few specific details	Scientific information is well developed with details and examples	
Organization	The reader feels lost	Identifiable sense of structure	Easy to follow, logical order, but weak introduction or conclusion	Easy to follow, introduction and conclusion strong, but transitions are hard to follow	Transitions are smooth, organization is logical with strong introduction and conclusion	
Word Choice	Little or inaccurate use of scientific terminology	Words are used properly, but lacks adjectives and development	Some use of strong describing words, and scientific terms	Language is functional and the message gets across	Scientific terms convey the intended message in a precise way	
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Participation	Did not complete	Rarely contributed	Was helpful and	Contributed great effort	Went above and beyond	

in the Group and Effort	his/her share of the project; frequently off-task	to the group; often needed to be reminded to focus and produce	cooperative in completing his/her share	to the group's project; helped organize the group and keep people on task	the call of duty to further the group's work	
Overall Result	The section is extremely weak in most areas	The section is not well polished, hard to read, and appears that the students do not understand the topic	The section shows evidence of little effort and research; diagrams and graphics do not add much clarity or interest	The section shows evidence of some effort and diagrams aide the information, but the authors' own thinking is not evidenced	The section shows evidence of effort, the students understand the topic, and diagrams and illustrations add to the information	

Section: Opinion (advice columns and letters to the editor)

Element	1 pts	2 pts	3 pts	4 pts	5 pts	Points Awarded
Idea and Content Development	Little or no scientific information in either the letter or advice	States the information in the letter, but some the advice is inaccurate	Scientific information is accurate, but unclear and undeveloped	Scientific information is accurate, and clear, but few specific details	Scientific information is well developed with details and examples	
Organization	The reader feels lost; the letter and advice do not match up	Identifiable sense of structure; either the letter or the advice sounds rational, but not both	Easy to follow, logical order, but weak introduction or conclusion	Easy to follow, introduction and conclusion strong, but transitions are hard to follow	Transitions are smooth, organization is logical with strong introduction and conclusion	
Word Choice	Little or inaccurate use of scientific terminology	Words are used properly, but lacks adjectives and development	Some use of strong describing words, and scientific terms	Language is functional and the message gets across	Scientific terms convey the intended message in a precise way	

Conventions	Errors in spelling, punctuation, usage, and grammar make it difficult to read	Some use of punctuation, capitalization, correct spelling of common words	Spelling usually correct, most conventions are used properly	Writer has few conventional mistakes, and nearly all terms are spelled correctly	Good use of grammar, capitalization, punctuation, usage, spelling, paragraphing, and uses these conventions wisely	
Participation in the Group and Effort	Did not complete his/her share of the project; frequently off-task	Rarely contributed to the group; often needed to be reminded to focus and produce	Was helpful and cooperative in completing his/her share	Contributed great effort to the group's project; helped organize the group and keep people on task	Went above and beyond the call of duty to further the group's work	
Overall Result	The section is extremely weak in most areas	The section is not well polished, hard to read, and appears that the students do not understand the topic	The section shows evidence of little effort and research; diagrams and graphics do not add much clarity or interest	The section shows evidence of some effort and diagrams aide the information, but the authors' own thinking is not evidenced	The section shows evidence of effort, the students understand the topic, and diagrams and illustrations add to the information	

Section: Entertainment (crossword or other interactive puzzle)

Element	1 pts	2 pts	3 pts	4 pts	5 pts	Points Awarded
Concepts Covered	The concepts covered are trivial and not related to the topic	The concepts covered are related to the topic, but some information is inaccurate	The concepts covered are related to the topic, but the information is trivial	The concepts covered are related to the topic and important but do not summarize	The concepts covered are important and function well to summarize the information of the topic	

				e the topic		
Usability	The task is very poorly constructed and will not work	The instructions of the task are not well defined	The instructions of the task are well defined, but there are inaccuracies in the reliability of the information	The task is clearly defined and accurate, but no self-check is available	The task is clearly defined, accurate, and self-check is available	
Neatness	The task is not neatly presented	The task is neatly done, but lacking in graphics	The task is neatly and presented, and but graphics are inappropriate to the content	The task is neatly presented, and graphics are appropriate to the content	There is a clear and thoughtful organization between the graphics and the topic content	
Creativity and Design of the Task	Little creativity is expressed by the author to the target audience		The task is creatively presented, but little thought will be required to complete it		The task is creatively presented, and the target audience will be intrigued	
Participation in the Group and Effort	Did not complete his/her share of the project; frequently off-task	Rarely contributed to the group; often needed to be reminded to focus and produce	Was helpful and cooperative in completing his/her share	Contributed great effort to the group's project; helped organize the group and keep people on task	Went above and beyond the call of duty to further the group's work	
Overall Result	The section is extremely weak in most areas	The section is not well polished, hard to read, and appears that the students do not understand the topic	The section shows evidence of little effort and research; diagrams and graphics do not add much clarity or interest	The section shows evidence of some effort and diagrams aide the information, but the	The section shows evidence of effort, the students understand the topic, and diagrams and	

				authors' own thinking is not evidenced	illustrations add to the information	
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Section: Entertainment (educational comics)

Element	1 pts	2 pts	3 pts	4 pts	5 pts	Points Awarded
Content and Organization	The content is not related to the topic	The content is related to the topic, but is inaccurate	The content is accurate, but undeveloped	The content is accurate and clear, but hard to follow	The content is accurate, clear, and easy to follow	
Originality and Creativity	No frames of the comic strip reflect creativity.	Some frames of the comic strip reflect creativity but characters do not portray important objects of the topic	Some frames of the comic strip reflect creativity and characters portray important objects of the topic	Most frames of the comic strip reflect creativity	All frames of the comic strip reflect an exceptional degree of student creativity and portrayal of the topic	
Conventions	Errors in spelling, punctuation, usage, and grammar make it difficult to read	Some use of punctuation, capitalization, correct spelling of common words	Spelling usually correct, most conventions are used properly	Writer has few conventional mistakes, and nearly all terms are spelled correctly	Good use of grammar, captalization, punctualtion, usage, spelling, paragraphing, and uses these conventions wisely	
Visual Appeal and Artistry	The comic strip is distractively messy or very poorly designed.	The comic strip is hard to identify roles due to a lack of artistic skill	The cartoon is acceptably attractive but it may be a bit messy.	The comic strip is attractive in terms of design, layout, and neatness.	The comic strip is exceptionally attractive in terms of design, layout, and neatness.	
Participation in the Group and Effort	Did not complete his/her share of the project;	Rarely contributed to the group; often needed to be	Was helpful and cooperative in completing	Contributed great effort to the group's project;	Went above and beyond the call of duty to further the group's	

	frequently off-task	reminded to focus and produce	his/her share	helped organize the group and keep people on task	work	
Overall Result	The section is extremely weak in most areas	The section is not well polished, hard to read, and appears that the students do not understand the topic	The section shows evidence of little effort and research; diagrams and graphics do not add much clarity or interest	The section shows evidence of some effort and diagrams aide the information, but the authors' own thinking is not evidenced	The section shows evidence of effort, the students understand the topic, and diagrams and illustrations add to the information	

Section: Advertising (careers and equipment involved in the management of diabetes)

Element	1 pts	2 pts	3 pts	4 pts	5 pts	Points Awarded
Content	Little or no information related to the topic	States the information, but some is inaccurate, and/or does not look like a real ad	Scientific information is accurate, but not much information is provided	Scientific information is accurate, and clear, but few specific details	Scientific information is well developed with details and examples	
Visual Appeal and Artistry	The ad is distractively messy or very poorly designed.	The ad is hard to understand due to a lack of artistic skill	The ad is acceptably attractive but it may be a bit messy.	The ad is attractive in terms of design, layout, and neatness.	The ad is exceptionally attractive in terms of design, layout, and neatness.	
Graphics	The ad does not contain graphics	The graphics are inappropriate	The graphics are appropriate but lack quality	Quality graphics are included but do not aid the purpose of the ad	Quality graphics are included and well used to aid the purpose of the ad	
Conventions	Errors in spelling, punctuation,	Some use of punctuation, capitalization,	Spelling usually correct,	Writer has few conventional	Good use of grammar, capitalization,	

	usage, and grammar make it difficult to read	correct spelling of common words	most conventions are used properly	mistakes, and nearly all terms are spelled correctly	punctuation, usage, spelling, paragraphing, and uses these conventions wisely	
Participation in the Group and Effort	Did not complete his/her share of the project; frequently off-task	Rarely contributed to the group; often needed to be reminded to focus and produce	Was helpful and cooperative in completing his/her share	Contributed great effort to the group's project; helped organize the group and keep people on task	Went above and beyond the call of duty to further the group's work	
Overall Result	The section is extremely weak in most areas	The section is not well polished, hard to read, and appears that the students do not understand the topic	The section shows evidence of little effort and research; diagrams and graphics do not add much clarity or interest	The section shows evidence of some effort and diagrams aide the information, but the authors' own thinking is not evidenced	The section shows evidence of effort, the students understand the topic, and diagrams and illustrations add to the information	

