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Biomedical Engineering and Diabetes

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Introduction

Biomedical Engineering is a technology that has joined together molecular and genomes medicine with engineering methods. Biomedical engineering can be both enhancing and complicated to human life. This is thought to be true because many people are in need of the technology to help them manage serious and complicated diseases like diabetes. Although people need bioengineering technology, many people may not adopt some of the innovations to their life style because issues arise, such as family value about having artificial parts in the body.

Diabetes is a disease that prevents the body from using the sugars and starches in food for energy. Diabetes is caused when the body does not make or cannot use insulin. This unit will focus on biomedical engineering and diabetes. The first part of the unit will discuss diabetes, it causes, and old and current technology to control the disease. The second part of the unit will discuss biomedical engineering and new technology to control the disease.

The unit will be designed for students in grades 5-8. It will include content, lesson plans, reading list, teacher resources and a bibliography. It is hoped that teachers will use this unit to make students aware: 1) Diabetes is a serious disease; 2) How to prevent or make themselves less vulnerable to the disease; 3) How to control diabetes and 4) What new innovative technology are available for now and the future. This section of the unit will address what is diabetes, the types of diabetes, symptoms, how diabetes affects you, race factors and health factors.

Diabetes

Diabetes is a disorder of metabolism, which is the way our bodies' use digested foods for growth and energy. When we eat, the digestive juices break down food into a simple sugar called glucose. Glucose is the major source of fuel used by cells. Glucose enters the bloodstream where it is accessible for cells to use for growth

and other functions. However, glucose cannot get into the cell unless insulin is present. Insulin is a hormone produced by the pancreas. The pancreas is a large organ located behind the stomach. In a normal functioning pancreas, the right amount of insulin is produced to move glucose into the cells. In an abnormal pancreas, little or no insulin is produced, or the body cells do not respond to the insulin that is produced. Glucose builds up in the blood flows over into the urine, and passes out of the body. This causes the cells in the body to lose it main source of fuel, even through the blood contains large amounts of glucose.

Types of Diabetes

There are three types of diabetes. They are Type 1 Diabetes, Type 2 Diabetes and gestational Diabetes. First, Type 1 Diabetes also known as juvenile diabetes is an autoimmune disease. In an autoimmune disease, the body's system for fighting infection turns against a part of the body. In diabetes, the immune system attacks the insulin-producing beta cells in the pancreas and destroys them. In this case, they produce little or no insulin.

People who have Type 1Diabetes need daily injections or insulin to live. There are no known exact causes of diabetes. Scientists do not know what causes the body's immune system to attack the beta cells. However, it is highly speculated that both genetic factors and viruses are involved. In fact, Type 1 Diabetes accounts for about 5 to 10 percent of diagnosed diabetes in the United States. [1] It is important to denote that Type 1 Diabetes develops itself most often in children and young adults, but it can occur at any age.

Some of the symptoms of diabetes are increased thirst and urination, constant hunger, weight loss, blurred vision, and extreme tiredness. If not diagnosed and treated with insulin, a person can drift off into a life-threatening coma.

Type 2 Diabetes is the most common. Type 2 Diabetes is a non insulin-dependent diabetes mellitus, but some Type 2 diabetics use insulin. About 90 to 95 percent of people with diabetes have Type 2 Diabetes. This type of diabetes most often develops in adults over the age 40 and is most common among adults over age 55. About 80 percent with Type 2 diabetes are overweight. [2] In Type 2 diabetes, the pancreas usually produces insulin, but the body cannot use the insulin effectively. This means just like Type 1 Diabetes there is an unhealthy buildup of glucose in the blood and an inability of the body to make use of its main source of fuel.

Some symptoms of Type 2 Diabetes are that the disease develops gradually and are not as noticeable as in Type 1 diabetes. Other symptoms of Type 2 Diabetes are feeling tired or ill, frequent urination, mostly at night, unusual thirst, weight loss, blurred vision, frequent infections, and slow healing of scores.

Gestational Diabetes develops or is discovered during pregnancy. When pregnancy is over, this type of diabetes disappears. Women who have gestational diabetes have a greater risk of developing Type 2 Diabetes later in life.

How does diabetes affect you

Before the discovery of insulin in 1921, all people with Type1 diabetes died within a few years after they got the disease. [3] Today people with Type1diabetes must take insulin daily, must balance their daily meals, exercise and closely monitor their glucose level. If they do this, they can live long lives.

Diabetes is one of the leading causes of death and disability in the United States. It is simply out of control. Diabetes is a very complicated disease and it affects almost every major part of the body. Diabetes can cause you to become blind, have heart disease, stokes, kidney failure, amputations, complicated pregnancy and nerve damage. It is important to develop better ways to control diabetes, because control of diabetes reduces the likelihood of these other complications.

Certain factors can increase one's risk of developing diabetes. People who are overweight often end up with some type of diabetes. While lifestyles and environmental factor play a big role, it is not the only factor that some people get diabetes. Several ethnic groups develop diabetes more often than other--African Americans, Hispanics, and Native Americans seem to be at a greater risk of getting diabetes. The genes that you inherit play an important role as well. Some people have a pre-disposition for the disease.

Type1 diabetes occurs equally among males and females, but is more common in whites than in nonwhite males. Type1 diabetes is rare in most Asian African, and American Indian populations. [4]

Type 2 Diabetes is more common in older people, especially older women who are overweight and the disease occurs more often among African Americans than Hispanics and American Indians. [5]

People with diabetes must take on the responsibility of monitoring their diabetes. Part of that responsibility is keeping record of blood sugar levels. If the blood sugar level is too high (hyperglycemia) or too low (hypoglycemia) they must get the proper amount of insulin into the body to control their glucose level. The next section of this unit will discuss insulin delivery devices.

Technology and Insulin Delivery Devices

The demand for better diabetes care products did not increase exceptionally until the results of the Diabetes Control and Complications Trial (DCCT were released in 1993. [6] This was a trial that showed tightly controlled insulin therapy delays the onset and progression of long-term complications, such as nerve damage and kidney failure, in individuals with type 1 diabetes. [7]

As a result of the DCCT and other reports, diabetes care technology advanced rapidly throughout the 1990s. This included further advancements in insulin pump therapies, available types of insulin, and glucose monitoring systems. [8]

New technologies have improved everyday life for people with type1 diabetes. Before modern insulin pumps, glucose meters and better forms of insulin were introduced, life was tremendously stressful for people with

type 1diabetes. New technology has brought greater flexibility to what and how a person with Type1 diabetes can live. Today, advances in diabetes technology are responding to the hope for a life in which people with Type1diabetes don't have to constantly check blood glucose levels and give themselves insulin.

The most recently released glucose monitoring system, Medtronic MiniMed's Guardian RT, has a subcutaneous sensor to take readings from interstitial fluids. [9] The sensor sends readings to the monitor every five minutes--up to 228 a day--and these generate a continuous report of a patient's glucose levels. Instead of getting isolated readings a few times a day, people with diabetes can now view a continuous reading of their glucose levels, which allows them to intervene earlier and more effectively to prevent high and low emergencies.10

This latest advance in technology has scientists thinking about developing an artificial pancreas. An Artificial pancreas would combine two tasks: glucose sensing and insulin delivery through a closed loop system, thereby taking up the function of a human pancreas. A closed loop system has an implantable sensor, which is coupled to an implanted pump, which would deliver insulin in response to the monitor signal. A system, which combines an implantable glucose monitor with an implantable pump and associated controls, would be in effect, an artificial pancreas with potential for a dramatic impact on the health of diabetics, both Type 1 and those 40% of Type 2 who requires insulin injections. [11]

The three interacting elements of a closed loop implantable artificial pancreas are: a glucose monitor which has a long life, a miniature pump which deliver precise quantities of insulin in response to the signal from the glucose monitor and a power supply and controller which provides the interface between the monitor and pump and also provide telemetered diagnostics of the system performances. [12] To date no implantable glucose monitor has been demonstrated with long life. This has been the principal obstacle to the development of an artificial pancreas. [13]

Developing an artificial pancreas for people with type1diabetes would stop the constant pressure of worrying about controlling their glucose throughout the day. It would allow the freedom and flexibility for people to do anything they set out to accomplish because they can monitor themselves and control their blood sugar levels.

There are many insulin delivery devices. For example, insulin pumps are not the only way for diabetic to get the insulin into the body, insulin pens, continuous subcutaneous glucose sensors; new finger stick devices are convenient methods of insulin administration. The next section of this unit will address types of insulin delivery devices.

Types of Insulin Delivery Devices

Insulin

Insulin lowers blood sugar, which is the same as glucose, by moving sugar from the blood into the cells of the body. Once inside the cells, sugar provides energy. People taking insulin will need to eat on time and match their insulin injections to their meals. Insulin should peak at the same time blood sugar levels from meals are also peaking. Working with a health care provider will be necessary in establishing a meal plan and in working out how to take insulin in relation to meals. Remember, some insulin is needed in the body all of the time. In

the section below is a discussion of several insulin delivery devices.

Types of Insulin

Short-Acting Insulin or Regular Insulin

Regular Insulin is the first used insulin and is considered mealtime insulin. It lowers blood sugar most in 2-5 hours and finishes its work in 5to 8 hour. Regular insulin is basal insulin because it still remains in the body cell after food is absorbed. [14]

Fast Acting Insulin

The fastest acting insulin is called lispro (Humalog) and insulin aspart (Novolog). This type of insulin should be injected under the skin within 15 minutes before you eat or 15 minutes after you take a shot or you may experience hypoglycemia because fast acting insulin starts working in five to 15 minutes to lower your blood sugar. With regular insulin you have to wait 30 to 45 minutes before eating. But lispro works most in 45 to 90 minutes and it finishes working in three to four hours. The quick action of insulin lispro makes it the best insulin for maintaining blood glucose levels below 180 mg per dl (10 mmol per L) for two hours after a meal. Many people like using lispro because it is easier to coordinate eating with this type of insulin. [15]

Intermediate Acting Insulin

NHP (N) or Lente (L0) insulin starts working in one to three hours and shows more rapid onset. It lowers blood sugar most in 6 to 12 hours and finishes working in 20 to 24 hours. Intermediate acting insulin has several important consequences. It affects the bioavailability and absorption rate of subcutaneously injected insulin. [16]

Another important factor that influences glycemia is the length of time between the administration of regular insulin or insulin lispro and the consumption (lag time) of a meal. In general, to ensure insulin availability during food consumption, regular insulin needs to be given 20 to 30 minutes before food consumption. Lag time need to be decreased when quick-acting insulin lispro is used. [17]

Insulin Mixtures

There may be advantages of using insulin mixtures. Most people who use insulin inject it with a needle and syringe, but there are several other devices that are available. One of these devices is a syringe. Syringes are one way insulin is delivered to the body. Today there are many different syringes, but all syringes are not the same. People who use syringes need to make sure that the dosages lines on the syringe match the dose of insulin being taken. The length of the needle can change how fast your body absorbs the insulin. [18]

Pumps

Another insulin delivery device is called a pump. Pumps are small mechanical and computerized devices that are about the size of a cell phone. Implantable insulin pumps are used to measure blood sugar or glucose

levels and continuously produce insulin and release it into the blood stream with the exact amount of insulin needed. The way this works is that insulin is stored in the pump and travels to the body through a thin plastic tube called a catheter. One end of the tube is hooked to the pump. With help of a needle, the other end is pushed through the skin into fatty tissue and is taped into place. A pump is constantly dribbling insulin. This is called basal delivery since it forms a base of the insulin needed. [19]

Pumps should be worn at all times. Most pumps have the option for setting several rates. Pumps release bolus doses of insulin, which means several doses at a time at meals and when blood sugar is too high based on the user's programming. If an insulin pump is used, it is really important to monitor your blood sugar frequently so you can determine the right dose and also to be sure that the insulin is being delivered to the site. [20]

Blood sugar should be checked several times a day to make sure the pump and the catheters are working okay. By monitoring the blood sugar, adjustments can be made to avoid hypoglycemia or hyperglycemia. Pumps can help some people better control their diabetes. [21] It is important to check their pump and infusion site at least once every day. [22] This probably means that only very conscious users should try pumps.

Implantable pump developers have overcome biocompatibility problems, which have been an obstacle to other implantable devices. Using microchip technology, have succeeded in creating a capsule that will not be attacked and destroyed by the body's immune system. [23]

Insulin Pens

Insulin pens are an easy, convenient and accurate method of insulin delivery. Insulin pens combine insulin and syringe in one piece. They have needles with an insulin cartridge all in one. In insulin pen all that needs to be done is to dial to measure out the dose by selecting the desired dose of insulin and press a plunger on the end to deliver insulin. The goal of delivering insulin with insulin pens is to improve glycemic control by making it less challenging to follow intensive insulin regimes.

Two types of insulin pens are in existence: a prefilled pen and reusable pen. In prefilled insulin pens you simply discard the pen when you use the entire cartridge. The reusable pens have a replaceable insulin cartridge that is loaded into and removed from the pen by patients. Prefilled and reusable have the same function. [24] Children, whose perceptions of syringe injections include pain and rejection by peers, often have positive feelings about the pens.

Jet Injectors

Jet injectors are needle free insulin delivery devices that get insulin into the cells of the body. It does the same thing as syringes or pens. When jet injectors deliver one dose of insulin, they send a fine spray of insulin through the skin by a high-pressure air mechanism instead of needles. Insulin is forced through the skin with pressure. Pretend that you have a water gun and you squirt water out of the gun with a pressure-releasing device. You have the idea. Instead of a small amount of pressure, jet injectors require a lot of pressure. [25] The insulin is distributed throughout a larger area of subcutaneous tissue that much greater than a needle administered insulin. [26] In jet injectors there is a greater surface area of body tissue exposed to the insulin. This means a quicker rate of insulin abortion. [27] The ability for a jet projector to liver insulin to the subcutaneous area does have advantages.

Infusers

Infusers are insulin delivery devices that make an opening in your skin where you can inject insulin. A tiny needle or tube is inserted right under the skin. It is taped so that it can stay in place for a few days. Instead of using the needle on a syringe or insulin pen to inject insulin, it is squirted through the infuser and right into the body.

Advanced or Future Technology

Technolgy for diabetes advancement for the delivery of insulin has changed. Technology advancements have led to new forms of insulin, such as human insulin produced through genetic engineering, better ways for doctors to monitor blood glucose levels and for people with diabetes to test their own blood glucose level at home, and development of external and implantable insulin pumps that deliver appropriate amounts of insulin, replacing daily injections. [28] New Insulin and insulin delivery systems can make this easier while offering additional benefits of lifestyle flexibility and improved glycemic control. This section of the unit will discuss a few of these technologies.

Insulin Inhalers

Insulin inhalers, an insulin delivery, that are about the size of flashlight and uses rapid acting insulin. The sprayed insulin is inhaled into the mouth and coats the mouth, throat and tongue. The insulin passes quickly into the bloodstream. Scientists have shown some success at controlling inhaled insulin at controlling blood glucose levels. Inhaled insulin does not replace longer-acting insulin. Long-acting insulin would still be needed. [29]

There are several disadvantages of using inhaled insulin. For example, you have to inhale a lot of insulin to get the amount the body needs because only a small percentage of the inhaled insulin actually reaches the bloodstream and lowers blood glucose. Insulin inhalers waste a lot of insulin for that reason. [30] In addition, scientists have questions about the safety of delivering insulin to the lungs. They think the lungs are a great place to deliver a drug because of the large surface area and ready absorption. But absorption of insulin is not a normal function of the lungs, so the long-term safety remains a problem. [31]

Buccal insulin is similar to inhaled insulin in many ways, but has a different delivery system. Buccal has a device that delivers a spray of insulin like what you'd get out of a can of spray. Instead of going into the lungs, the insulin is absorbed in the lining at the back of the mouth and throat. The good news is that it avoids any problems from putting large amounts of insulin into the lungs. However, there is still a large amount of insulin wasted. [32]

Oral Insulin

In this unit I have discussed insulin pumps, inhaled insulin, and insulin sprays just to name a few. It is important to mention that insulin taken as a pill is quickly broken down in the stomach makes it useless for lowering blood glucose levels. Insulin cannot be used as a pill form by itself, so scientists are packaging insulin by using a special coating or by altering it to get it through the stomach. Insulin pills are one way to advance

this research. For example, Insulin pills are another way of delivering insulin into the cells of the body. The insulin pill is a new polymer, which is used as a coated pill. When used as a pill coating, it allows insulin to get into the bloodstream without being destroyed by the digestive system. Insulin pills however have only tested on animals. Some scientists question whether insulin in pill form will prove useful. [33]

Transdermal Insulin Delivery System

The skin is an amazing organ because it is difficult for anything to get pass it. A major function of the skin is to keep things out of the body and just allow a few selected things pass. For example, Insulin is too large to get through the skin without a lot of help. Trying to develop something to do that is very hard. However, scientists have been working on patches using electrical currents, ultrasound waves, and chemical to help transport insulin through the skin. Scientists are a long way from developing a delivery system as of now, but any successes for transdermal-delivery delivery are likely to come with basal delivery of relatively small amounts over time. [34]

Islet Cell Transplant

The pancreas is a narrow organ about the length of your hand that is located in back of the stomach. The pancreas releases enzymes into the small intestine to break down nutrients. It also releases hormones such as insulin into the bloodstream to help the body to use glucose. In Type1diabetes the pancreas releases little or no insulin.

To help the pancreas to release glucose, a new treatment for diabetes is now in clinical trials. This new islet cell transplant or the Edmonton technique is for people with Type1 Diabetes. The procedure is still evolving, but the islet cell transplant has resulted in seven patients becoming insulin free for up to 14 months after treatment. [35] The islet cell transplant uses islet cells from the pancreas of two or more donor pancreases. The cells are transplanted into a person with diabetes and then special medications are given to prevent rejection of the new cells. It contains insulin-secreting cells that borrow nutrients from the body to keep producing insulin indefinitely. [36] The challenge for patients who have the transplant is that even though a person may become free of the need of insulin, the medications to prevent rejection of new tissue must be taken for a lifetime. [37]

In order to get islet cells transplant, patients have participated in clinical trials. Although survival rates for transplant continue to improve, there are many unanswered questions about their long-term function. However, what is known about the islet cell transplant is patients immune system play a major role in the success of their survival. [38]

Gene Therapy

Gene Therapy is an insulin delivery system that has not been used on humans but scientists have used genes in the past to induce production of insulin in rats. When inserted into rat liver cells, a gene developed by team of researchers drove the cell to produce insulin. But the problem is that the cell produces too much insulin and the animal died from low blood sugar. [39] Scientists think that the big challenge that must be overcome is to create an insulin gene that is regulated, that can create more insulin when needed and that can turn itself off

when necessary. The potential of gene therapy is that diabetic patients would not have to give themselves insulin shots or make decisions about how much insulin must be given because the gene would make that decision. [40] It is important to understand that human insulin gene is separate from rat genetic material. In humans cells carrying the foreign genes will be destroyed with time, and the genes will no longer work. Scientists reported going forward that a harmless virus needs to be identified that can carry the new insulin to a permanent spot in a cell's genetic material. [41]

Vaccine and Diabetes

The relationship between vaccines and diabetes is much talked about among scientists. They have developed a drug that stops the destruction of pancreatic beta cells in human.

The vaccine has a molecule that is identical to part of the islet cells (they produce insulin). When you add this molecule to human blood it stops the body's white cells from destroying beta cells. The drug is a peptide, a type of protein. By modifying a fragment of the protein, the developers created a drug that can block the activity of immune cells that attack the pancreas. It deactivates the cell that attacks the pancreas without interfering with the rest of the body's immune system. Vaccines offer the possibility of preventing type1 Diabetes in people at risk. [42]

Vocabulary

AIC: Previously known as an HbA1c test is a blood test that measures the average amount of glucose in your body over a 2-3-month period based upon the percentage of hemoglobin molecules (found in red blood cells) with glucose attached to them. AIC is a numerical term used to represent how much of your hemoglobin has blood sugar.

Beta cells: The cells in the Islets of Langerhans that make insulin.

Carbohydrates: Any of a group of compounds that share a general biochemical structure containing carbon, hydrogen, and oxygen; includes sugars and starches

Diabetes mellitus a disorder characterized by the inadequate production or utilization of insulin

Glucagon: A hormone produced by a healthy pancreas that causes the liver to release glucose while it slows the release of insulin in your body. A glucagons injection will help raise your glucose level when it is generously low. It comes in a kit and is available by prescription.

Glucose : A simple form of sugar your body makes from the food you eat to use as fuel to live.

Hyperglycemia : Is a term for high blood sugar.

Hypoglycemia : also known as an insulin reaction): A condition that occurs when blood glucose levels fall very low.

Insulin : A hormone produced by a healthy pancreas that helps the body use glucose as energy. If the pancreas does not make insulin or enough insulin, or if the body rejects the insulin it makes, animal and genetically engineered human insulin may be injected into the bloodstream as a replacement.

Islets of Langerhans clusters of cells that compose the endocrine portion of the pancreas and secrete insulin

Pancreas: A gland located behind your stomach and near your liver that produces enzymes used in digestion and the hormones insulin and glucagons to regulate blood glucose.

Type 1 Diabetes (also known as immune-medicated diabetes): A metabolic condition where the pancreas makes too little insulin and eventually no insulin at all. This happens because the immune system destroys the pancreas cells that make insulin. Type 1 diabetes patients must take insulin.

Type 2 Diabetes (also known as insulin-resistant diabetes): A metabolic condition where the pancreas makes insulin but the body will not use it or the pancreas makes too little insulin to be of use or both. A combination of diet, exercise and oral diabetes medication help some type 2 diabetes patients' bodies use their own insulin, but others may still need to take insulin.

Diabetes Pre-Post Test

Test your knowledge of diabetes with this true-false quiz

1. There are two main categories of diabetes: type 1 and type 2. How many people with diabetes have type 2?

A. 10 to 15 percent
B. 30 to 35 percent
C. 45 to 50 percent
D. 90 to 95 percent

2. Pregnant women can develop a temporary form of diabetes called gestational diabetes. What percent of these women could develop diabetes within 10 years after their pregnancy?

A. Less than 10 percent
B. Less than 15 percent
C. 20 to 50 percent
D. 90 percent

3. Insulin is produced by what gland in the body?

A. Pituitary gland
B. Pancreas
C. Adrenal glands
D. Kidneys

4. Why is insulin critical in the chemistry of blood sugar?

A. It enables glucose to enter cells
B. It lowers blood pressure
C. It raises cholesterol
D. It stabilizes sucrose levels

5. Early detection and good control of diabetes will help avoid complications. People with diabetes are at increased risk of developing which of these?

A. Heart Disease
B. Cancer
C. Stroke
D. A and C

6. Type 1 diabetes usually begins in childhood, when the beta cells in the pancreas are destroyed. What destroys them?

A. The immune system
B. Environmental toxins
C. Free radicals
D. Bacteria

7. Which ethnic groups are most likely to develop diabetes?

A. Caucasian Americans
B. African Americans
C. Hispanic Americans
D. B and C

8. The development of type 2 diabetes is associated with obesity. What are other risk factors for it?

A. Older age
B. Family history of diabetes
C. Physical inactivity
D. All of the above

Diabetes Pre-Post Test

Quiz Answers

1. D, 90 to 95 percent. Type 2 diabetes is the most common form of diabetes, according to the American Diabetes Association (ADA). In type 2 diabetes, the body doesn't produce enough insulin, or the body isn't able to use the insulin that's produced.
2. C, 20 to 50 percent. The ADA estimates that women who have had gestational diabetes have a 20 to 50 percent change of developing diabetes in the next five to 10 years.
3. B, pancreas **.** Insulin is produced by the pancreas.
4. A, it enables glucose to enter cells **.** Insulin unlocks the cell door so that a chemical reaction can take place and produce energy. Diabetes is a group of diseases marked by high levels of blood sugar. These levels are the result of defects in insulin production, insulin action, or both.
5. D, A and C. Heart disease is the leading cause of diabetes-related deaths. Adults with diabetes have heart disease death rates about 2 to 4 times higher than adults without diabetes. The risk for stroke is 2 to 4 times higher among people with diabetes. In addition, diabetes causes other complications: It is the leading cause of new cases of blindness among adults 20 to 74 years old;

60 to 70 percent of people with diabetes have forms of nervous system damage that include impaired sensation pain in the feet or hands, slowed digestion of food in the stomach, carpel tunnel syndrome, and other nerve problems.
6. A, the immune system **.** Type 1 diabetes develops when the body's immune system destroys the cells in the body that make insulin. Type 1 diabetes usually appears in children and young adults and accounts for up to 10 percent of diabetes cases. People with type 1 diabetes need to have insulin injections several times a day or an insulin pump.
7. D, B and C. According to the ADA, nearly 8 percent of Caucasian Americans who are not Hispanic have diabetes, and 13 percent of African Americans have diabetes. African Americans are two times more likely to have diabetes than non-Hispanic Caucasians, says the ADA. Ten percent of Hispanic Americans have diabetes, and Hispanic Americans are nearly twice more likely to have diabetes than Caucasian Americans.

D, all of the above **.** Risk factors for diabetes include older age, obesity family history of diabetes, gestational diabetes, impaired glucose intolerance, physical inactivity and race or ethnicity, the ADA says. Type2 diabetes is increasing more common in children and teens

Source: Adapted from mercksource.com 2006, Copyright 2003 Health Ink & Vitality Communications

Lesson Plan One

Purpose: To help students to recognize how important it is to understand diabetes and what causes it and how it can impact their lives

Objective: Students will be able to

· Define and explain what is diabetes
· What causes diabetes

· Identify symptoms, impact and treatment of different types of diabetes
· Assess personal lifestyle for risk factors of diabetes

Standards: Scientific Inquiry-CINQ.1 Identify questions that can be answered through scientific investigations, CINQ.2 Read, interpret and examine the credibility of scientific claims in difference sources of information.

Procedure: Teacher will discuss diabetes: Students will be divided into small groups with no more than 4 students in each group. They will use the following six steps process to solve problems and make decisions: 1) State the problem; 2) Ask question/Gather information; 3) Compare alternatives; 4) Imagine the consequences/Values; 4) Decide and act; 5) Evaluate the decision

Diabetes is not my Fault

Activity: This card game will help students understand the cause-and-effect relationships of diabetes, that those with type I diabetes are not responsible for having diabetes, and that there is treatment.

Materials

· 3" x 5" notecards or a pad of removable sticky notes
· pencils or pens

1. On separate cards, list plausible causes of diabetes, symptoms, and statements for understanding it, and treatments, along with some inaccurate ideas about the causes of diabetes. Use the vocabulary below as a resource for your listings.

Vocabulary

Beta cells the cells in the Islets of Langerhans that make insulin **carbohydrates** any of a group of compounds that share a general biochemical structure containing carbon, hydrogen, and oxygen; includes sugars and starches **Glucose** the sugar derived from the breakdown of carbohydrates and starches that the body uses for fuel **Diabetes mellitus** a disorder characterized by the inadequate production or utilization of insulin **Insulin** a hormone produced by the beta cells of the pancreatic islets that enables sugar in the blood to enter the body cells **Islets of Langerhans** clusters of cells that compose the endocrine portion of the pancreas and secrete insulin **Pancreas** a large elongated gland situated behind the stomach; secretes pancreatic juices, insulin, and glucagon for the regulation of carbohydrate metabolism

Here are some examples:

· I ate too much sugar.

· White blood cells didn't attack a germ that got into my body, so the germ was able to attack my pancreas.
· I didn't behave in class.
· My stomach stopped making insulin.
· I am overweight.
· I caught it from another diabetic.
· Islets of Langerhans are clusters of cells found in the pancreas that secrete insulin

2. Make enough cards so that there is one for each student. You may duplicate information on more than one card, but do not make more than three cards with any one fact.

Divide the class into four teams. Have each student chose a card and take it back to his or her team. The objective is for each team to gather a set of cards that correctly explains how diabetes comes about, its symptoms, and treatment.

3. Rules: Any member may trade a card with a member of another team. There can be only one member per team on his or her feet at any one time. Set a time limit, or play until one team gets a complete set of cards and wins. The winning team must explain the statements on its set of cards.

Questions

1. Why is it important to realize that type I diabetes is not caused by a person's actions or by "catching it"? What health problems are a direct result of individual behaviors and choices?

2. If you had diabetes, what would you have to do differently? What if you had just taken your shot of insulin and had eaten your dinner, and then you were invited out for pizza? What if you were so tired, you wanted to sleep until noon on Saturdays?

Procedure: Class will be divided into four students in each group. Each group will discuss one scenario per class period. Use the first 25 minutes of the class to response to the scenario and then write a group response to each of the scenarios. Then the whole group will share each group response to the scenarios for the latter part of the class.

Day 1 -Scenario 1: Many people who have any kind of permanent disease or ailment don't like to be labeled with the name of the disease. They may prefer to say, "I have diabetes," rather than, "I am a diabetic." Why is this semantic difference important to consider?

Day 2-Scenario 2: Invite some people who have diabetes into your classroom to talk with the class about diabetes. If possible, your guests might be willing to show how they inject insulin and test for blood-sugar levels. Suggested time is one class period.

Day 3-Scenario 3: List on the board the following famous people who have or had diabetes:

· Bret Michaels, rock vocalist
· Jackie Robinson, major-league baseball player
· Ernest Hemingway, writer
· Mary Tyler Moore, actress
· Wade Wilson, professional football player

Are there more? Are there famous people with other diseases such as: Epilepsy? Arthritis? Learning differences? Does this information matter?

Source: Adapted from: Newton's Apple Resources. Newton's Apple encourages duplication of their materials for educational use, 1-800-588-Newton

Lesson Plan Two

Goal **:** Blood glucose goals should be higher than those listed above in children with frequent hypoglycemia or hypoglycemia unawareness.

Objective: Students will learn how to control diabetes and prevent complications. The American Diabetes Association has developed recommendations for blood glucose goals for young people with type 1diabetes. Although there are no national recommendations for children with type 2diabetes, it may be reasonable to use the values in the following table as a guide.

Blood Glucose Goals

Purpose: Blood glucose levels must be managed as close to a normal range as is safely possible (70 to 100 mg/dl before eating.

Optimal plasma blood glucose and AIC (A blood test that measures the average amount of glucose in your body over a 2-3-month period based upon the percentage of hemoglobin molecules found in red blood cells with glucose attached to them. AIC is a numerical term used to represent how much of your hemoglobin has blood sugar) goals for Type 1 diabetes for adolescents and young adults.

Plasma Blood Glucose Goal

(table available in print form)

Source: This chart is adapted from the National Diabetes Information Clearinghouse, www. Nddk.nih.gov

* A lower goal (7.0) is reasonable if it can be achieved without excessive hypoglycemia.

Hypoglycemia

Diabetes treatment can sometimes cause blood glucose levels to drop too low, with resultant hypoglycemia. Taking too much insulin, missing a meal or snack, or exercising too much may cause hypoglycemia or low blood glucose. You can become irritable, shaky, and confused. When blood glucose levels fall very low, loss of consciousness or seizures may develop. The child should drink or eat a concentrated sugar to raise the blood glucose value to greater than 80 mg/dl. Once the blood glucose is over 80, the child can eat food-containing protein to maintain blood glucose levels in the normal range. The concentrated sugar will increase blood glucose levels and cause resolution of symptoms quickly, avoiding over-treatment.

Hyperglycemia

Causes of hyperglycemia include forgetting to take medications on time, eating too much, and getting too little exercise. Being ill also can raise blood glucose levels. Over time, hyperglycemia or high blood sugar can cause damage to the eyes, kidneys, nerves, blood vessels, gums, and teeth.

Student Will Do This:

List the symptoms of hypoglycemia and hyperglycemia. What actions should you take if you or someone you know were either hypoglycemic or hyperglycemic?

Explain why exercise and eating properly are important to a person with diabetes.

Keep a daily exercise log and food diary for two weeks. Develop a sample nutritious meal a diabetic patient should eat. Keep a count of the carbohydrate intake

Lesson Plan Three

Model to understand Type 1 Diabetes and Type 2 Diabetes

(table available in print form)

Objective: Students will examine the various types of insulin delivery systems and demonstrate an understanding of each type of delivery system.

Procedure: Use the model above to help you understand how each technique gets insulin into the cells of the body. Each member of the class will choose an insulin delivery system and explain the following:

· What is the delivery system?

· How does it work?
· What are the advantages of the system?
· What are the disadvantages?

Whole group discussions: After each student examines and investigates a technique of insulin delivery. Each student will create a project of their technique ---research projects, a design, skits, etc. to explain what happens when their technique is used properly or improperly.

Lesson Plan Four

The incidence and prevalence of Type 2 Diabetes in children are increasing and if this increase cannot be reversed, society will face major challenges, such as, complications and deaths from diabetes. Many more Americans will be taking potent medications, which have risks, for most of their lives.

Objective: Students will learn whether or not Type 2 diabetes can be prevented in children and adolescents.

Procedure: Each student will write an essay answering the question that shows evidence based on research from web, books, lectures and discussions on the question: Can diabetes be prevented in children and adolescents? Debate both questions, why and why not.

Assessments

Assessments for the above lesson plans will include test, oral presentations, projects, essay, and students' portfolios

Lesson Plan Four:

· Students will interview a person that has diabetes and write a new article for publication in the class diabetes newsletter.
· Students will create posters advertising the fight against diabetes. They can work in groups of two. The assignment become a contest to see who will create the most factual and creative poster.
· Students will discuss and suggest ways of how to reduce the rate of diabetes in African Americans, Hispanics and Native Americans.

Teacher Resources

American Academy of Pediatrics. Website(www.aap.org.) Materials are for all grade levels. This website has good resources for teachers.

American Diabetes Association. Website (http://www.diabetes.org) Excellent materials for all grade levels.

American Diabetes Association. Website (http://www.diabetes.org). Excellent materials. A curriculum; excellent hands-on activities. Designed for teens, but appropriate for grades 7-8. Excellent for diabetes management not awareness.

American Association of Diabetes Educators.(www.aadenet.org). This is a resource only.

American School Health Association. Health in Action (August/September 2002). (www.ashaweb.org). Excellent overall information for all teachers and school personnel to understand Diabetes types 1 and 2. This resource has specific reference to school responsibility.

Center for Disease Control. And Prevention (www.cdc.gov) This website has good materials for all grade levels.

Becton & Dickinson. (www.bd.com/diabetes). Getting Started. We have Diabetes Too! 1998. Free resources only for grades 5-8.

Krames/Staywell Health and Safety Materials. Growing Up With Type 1 Diabetes (2001). (http://www.krames.atmedicaasia.com/). This website is better as a resource for Type 1 Diabetes. Excellent resource and good for grades 7-8.

National Institute of Diabetes, Digestive, and Kidney Disease (NIDDK)http://www.niddk.nih.gov/health/diabetes/diabetes.htm NIH Publication No. 02-3873). Use as a resource, not a curriculum.

U.S. Department of Health and Human 0Sevices. Office of Minority Heath (http://www.omhrc.gov). This is a resource only.

Endnotes

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