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# Simulated Diabetes Testing

## Objectives

- **Study the types, causes, symptoms and treatments for diabetes**
- **Perform standard diagnostic tests on fictional patients using simulated blood and urine samples**
- **Diagnose the patient based upon the test results and their medical history**
- **Develop a plan for managing the patient's condition**

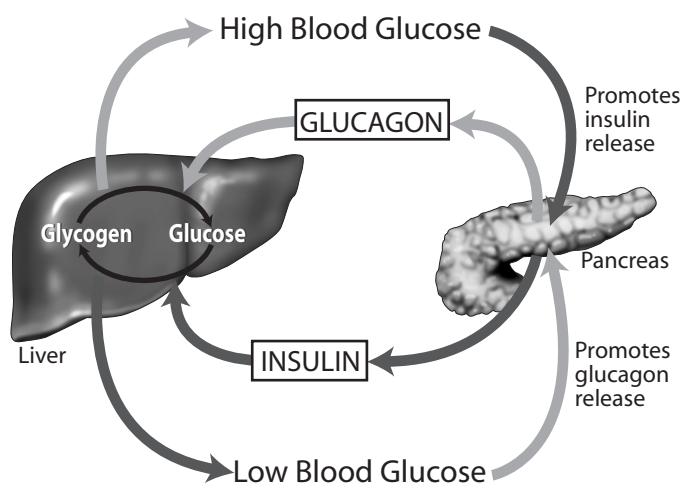
## Background

### What is Diabetes?

Diabetes mellitus is one of the most common chronic diseases in children and adults. Approximately 16 million people in the United States are affected, and about 1/3 of those people do not know that they have the disease.

Diabetes mellitus is a disease in which high levels of glucose accumulate in the blood. This is a condition known as hyperglycemia.

In most people, insulin produced in the pancreas enters the bloodstream and helps cells take up glucose to use it as fuel. Glucose levels increase after a meal, but quickly return to normal as cells remove excess glucose from the bloodstream. In a diabetic person, either the pancreas cells do not make insulin or cells of the body can not use the insulin properly. Without insulin, cells are unable to take up glucose.



### Type 1 Diabetes

Type 1 diabetes, also known as Insulin Dependent Diabetes Mellitus (IDDM) or child onset diabetes, generally develops during childhood or puberty but it can occur at any age. Only about 6% of diabetes diagnoses are Type 1. Most people with Type 1 diabetes are diagnosed before they are 30 years old, are lean, and have had ketoacidosis (sometimes leading to a coma) or have high levels of ketones in their urine.

Type 1 diabetes occurs when the immune system destroys the pancreas cells that produce insulin. Because no insulin is produced, Type 1 patients must receive regular insulin injections in order to control their blood sugar level.

### Type 2 Diabetes

Approximately 90% of all diabetes diagnoses are Type 2. Type 2 diabetes, also known as Non-Insulin Dependent Diabetes Mellitus (NIDDM) or adult onset diabetes, most often affects adults who are over 30 and overweight. These patients usually do not have urine ketones.

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Type 2 diabetes occurs when muscle and fat cells are unable to use insulin properly — also known as insulin resistance. Most people with Type 2 diabetes can keep their blood sugar at an acceptable level by modifying their diet, getting regular exercise, or taking medication that helps their body use insulin more effectively.

### Gestational Diabetes

Gestational diabetes only occurs during a pregnancy. It affects about 4% of all pregnancies, but the symptoms generally subside within 6 weeks of delivery. The placenta, which supplies the fetus with nutrients from the mother's blood, produces several hormones that have a blocking effect on insulin. When the pancreas cannot produce enough insulin to compensate, gestational diabetes occurs.

### Risk Factors for Diabetes

- Family history of diabetes
- Low activity level
- Poor diet
- Excess body weight (especially around the waist)
- Age greater than 45 years
- High blood pressure
- High blood levels of triglycerides (a type of fat molecule)
- HDL cholesterol of less than 35
- Previously identified impaired glucose tolerance by your doctor
- Previous diabetes during pregnancy or baby weighing more than 9 pounds
- Certain ethnicities -- African-Americans, Hispanic-Americans, and Native Americans, Pacific Island descent all have high rates of diabetes

Scientific researchers have found mutations in many different genes that appear to put people at risk for developing the diabetes.

### Symptoms of Diabetes

Some signs of either Type 1 or Type 2 diabetes, as a result of changes in blood sugar levels, are:

- Thirst
- Frequent urination
- Sudden weight loss
- Blurred vision
- Mood swings
- Fatigue
- Irritability

### Diagnosing Diabetes

A person has diabetes when two diagnostic tests done on different days show that the blood glucose level is high.

During a fasting plasma glucose test, a person is asked to eat or drink nothing for 8 hours before having their blood drawn (usually first thing in the morning).

Blood glucose results of 64-110 mg/dl are considered normal. A range of 110-126 mg/dl is considered to be pre-diabetic. A patient with blood levels within this range is considered to have impaired glucose tolerance, a precursor to diabetes. Blood levels at 126 mg/dl or higher are indicative of diabetes.

High urine glucose levels give doctors a clue that something is wrong. But urine tests are not a good way to diagnose diabetes. Urine tests are not as accurate as blood tests. And the level of blood glucose needed to make glucose appear in the urine is different for each person. Your glucose level could be high, yet high levels of glucose may not appear in the urine. So in diagnosing diabetes, doctors measure glucose in the blood.

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### Long Term Health Concerns

Diabetes can have serious consequences for tissues and organs throughout the body. This is partly because sugars, such as glucose, bind to proteins and change their structure and function causing damaged vessels and increased fat levels. This can lead to heart attacks, angina, stroke, or pain in the legs. High levels of blood sugar also damages the eyes, nerves, and kidney, often leading to blindness and kidney disease.

### Diabetes Treatment Plans

The goal of any diabetes treatment plan is to keep blood sugar levels as close to normal as possible. Diabetics who keep their blood sugar levels under control can lead long healthy lives. Treatments may include:

**Diet:** A diet that is low in sugar and high in complex carbohydrates such as beans, vegetables, and grains prevents high glucose levels in the blood, and minimizes the need for insulin. Although people with both Type 1 and Type 2 diabetes need to watch their diet carefully, only Type 2 diabetics can use diet alone to control the disease.

**Exercise:** Regular moderate exercise helps the body use glucose more effectively. Exercise and learning new behaviors and attitudes can help facilitate long-term lifestyle changes.

**Oral medications:** There are many medications available that help diabetics use their body's insulin more effectively. These medications are only effective for Type 2 diabetics who produce some insulin.

**Insulin injections:** In Type 1 diabetes, or more severe forms of Type 2 diabetes, insulin injections are needed in order to keep the blood glucose level under control.

### Diabetes Prevention

Researchers continue to search for the cause or causes of diabetes and ways to prevent and cure the disorder. Scientists are looking for genes that may be involved in Type 1 or Type 2 diabetes. Some genetic markers for type 1 diabetes have been identified, and it is now possible to screen relatives of people with Type 1 diabetes to see if they are at risk. For Type 2 diabetes, the focus is on ways to prevent diabetes. Preventive approaches include identifying people at high risk for the disorder and encouraging them to lose weight, be more physically active, and follow a healthy eating plan.

## Overview

Your class is a team of doctors at the local hospital. Currently, you have three patients who are concerned that they may have diabetes. You will go through the process of collecting background information, performing diagnostic tests, properly treating each patient, retesting, and devising a maintenance plan for each patient's condition. You will also take a diabetes risk test for yourself.

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### Collecting Patient Background Information

**Patient C:** Mr. Canfield is a mildly overweight Native American 45 year old male. He has noticed a recent increase in thirst and urination. Also, over the past 3 years or so, he has noticed that his skin has become increasingly dry and itchy. He thinks that one of his grandparents may have had diabetes. He likes to eat lots of carbohydrates, and his favorite meal is dessert.

#### What to do...

##### Step 1

Carefully read the following list of patients, their medical history, their nutritional habits and their symptoms.

**Patient A:** Mr. Adams is an overweight African-American 37 year old male who has suddenly, within the past week, experienced excessive thirst. He also claims that he has been extremely irritable lately. He has no history of diabetes in his family that he is aware of. He does not exercise regularly, and he recently started to eat more foods that are high in sodium, but other than that, he considers his diet to be well-rounded.

**Patient B:** Ms. Burns is a thin Caucasian 23 year old female. Within the past month, she has been waking up in the middle of the night, 2-3 times a night, to go to the bathroom. She has also been nauseous and vomiting for the past week or so. She thinks that one of her distant relatives may have had diabetes, but she is not sure. She exercises 1-2 times per week, and her diet consists of meat and potatoes.

#### Questions

1. What are some common symptoms of diabetes?

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2. What are some of the risk factors for this disease?

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3. What is the difference between Type 1 and Type 2 diabetes?

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5. Are patient backgrounds enough to diagnose diabetes? Why or why not?

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4. Based on their backgrounds, predict which patients have diabetes.

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## ACTIVITY

2

### Testing for Glucose in Urine Samples

#### What to do...

##### Step 1

Obtain a spot plate. Using a wax pencil or other writing utensil, label the spot plate as noted below:

*A, B, and C* refer to the patients identity. *IU* refers to the initial urine sample, and *FU* refers to the final urine sample. *IB* and *FB* are the initial and final blood samples, respectively.

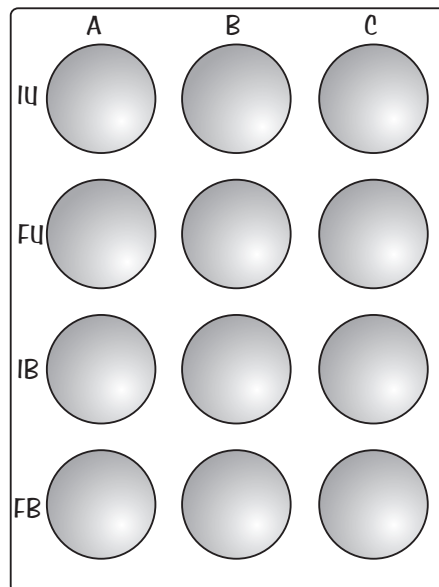
#### What you need

##### Per group

- 1 Spot plate
- 3 Glucose test strips
- 1 Urine Glucose Chart

##### Shared

- 1 Patient A Initial Urine Sample
- 1 Patient B Initial Urine Sample
- 1 Patient C Initial Urine Sample



##### Step 2

Obtain the initial urine sample of one of your designated patients. Place 2-3 drops of this urine sample into the appropriate well on your spot plate.

##### Step 3

Repeat Step 2 for your other patients.

**Important:** *Be sure that you do not cross-contaminate the urine samples on your spot plate.*

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**Step 4**

Obtain a glucose strip. Place the padded end of the strip into the first well for 1-2 seconds. Compare the coloration on the pad to the Urine Glucose Chart. Record the glucose level in Table 1. Discard the glucose strip into a receptacle that your teacher designates.

**Step 5**

Repeat Step 4 for your other patients, making sure to use a NEW glucose strip for each patient.

**Step 6**

Share your results with the rest of the class.

**IMPORTANT!** *Glucose should not be detected in normal urine. Results of 100mg/dL or higher are considered to be significantly abnormal.*

**Table 1**

Patient	Initial Urine Glucose Level (mg/dl)	Normal or Abnormal Result?
Patient A		
Patient B		
Patient C		

**Questions**

1. Why is it important to use a separate analysis strip each time you test for glucose?

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2. Why is it so important that urine from one patient was not placed into the wrong well or that it was mixed with the urine from another patient?

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3. In a diabetic patient, how do large amount of glucose get into the urine?

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4. Do these results in Table 1 change your original predictions from Activity 1?

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5. What are ketones?

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6. In your opinion, which patient has the greatest likelihood of having ketones in their urine?

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7. Is a urine glucose test enough proof to indicate to a doctor whether or not a person has diabetes? Why or why not?

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8. What is the amount of glucose in urine that signals diabetes or a concern of diabetes?

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## ACTIVITY

# 3

### Testing for Glucose in Blood Samples

#### What you need

##### Per group

- 1 Spot plate
- 3 Glucose test strips
- 1 Blood Glucose Chart

##### Shared

- 1 Patient A Initial Blood Sample
- 1 Patient B Initial Blood Sample
- 1 Patient C Initial Blood Sample

#### What to do...

##### Step 1

Obtain the initial blood sample of one of your designated patients. Place 2-3 drops of this blood sample into the appropriate well on your spot plate.

##### Step 2

Repeat Step 2 for your other patients.

**Important:** Be sure that you do not cross-contaminate the urine samples on your spot plate.

##### Step 3

Obtain a glucose strip. Place the padded end of the strip into the first well for 1-2 seconds. Compare the coloration on the pad to the Blood Glucose Chart. Record the glucose level in Table 2. Discard the glucose strip into a receptacle that your teacher designates.

##### Step 4

Repeat Step 4 for your other patients, making sure to use a NEW glucose strip for each patient.

##### Step 5

Share your results with the rest of the class.

**Note:** During a real-life diabetes test, a patient would need to be tested twice (once on two separate days) before they could accurately be diagnosed with diabetes. Imagine, in this activity, that the results you get here are the same for both tests.

**IMPORTANT!** Results of 64-110 mg/dl are considered normal. A range of 110-126 mg/dl is considered to be pre-diabetic. A patient with blood levels within this range is considered to have impaired glucose tolerance, a precursor to diabetes. Blood levels at 126 mg/dl or higher are indicative of diabetes.

Table 2

Patient	Initial Blood Glucose Level (mg/dl)	Normal or Abnormal Result?
Patient A		
Patient B		
Patient C		

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**Questions**

1. Why is it important to place the proper blood samples into the appropriate well?

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2. How do elevated levels of glucose get into the bloodstream of a diabetic patient?

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3. Does this blood glucose test give a better indication of diabetes than the urine test? Why or why not?

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4. Why is it important that a patient fast at least 24 hours before a urine or blood glucose test?

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5. During a real test for diabetes, how many blood tests must be performed before a definite diagnosis can be made?

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6. How do these results compare to your predictions in Activity 1 and Activity 2.

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7. What may be a reason for any discrepancies?

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8. What is the amount of glucose in blood that signals diabetes?

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## ACTIVITY

**4**

### Preparing Diagnoses

### What to do...

#### Step 1

Using all of the information that they collected from Activities 1, 2 and 3, determine which patients do or do not have diabetes. If so, decide if they have Type 1 or Type 2. Record your answers in Table 3.

**Important:** *Even if a patient does not test positive for diabetes, continue with this patient throughout the following activities. There may still be a high risk for developing diabetes.*

### What you need

Information from Activity 1, 2 and 3

Table 3

Patient	Diabetes: Yes or No?	If so, Type 1 or Type 2?	Conclusive Evidence
Patient A			
Patient B			
Patient C			

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**Questions**

1. Which patients have diabetes? Which do not?

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2. Of those having diabetes, which have Type 1, if any? What information was critical in diagnosing this?

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3. Do any of these patients have Type 2 diabetes? If so, which ones? And, what information was critical in diagnosing this?

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4. It is important for doctors to consider, not only the test results from a patient, but their medical history as well. Why?

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5. Compare your results from Table 3 with the rest of the lab groups in your class. Are there any discrepancies? If so, what could be possible sources of error?

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## ACTIVITY

**5**  
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### Creating Treatment Plans for Diabetes

**What to do...**

#### Step 1

Based on what you have discovered so far about each patient, suggest several ways in which you would treat the patients' diabetes (or pre-diabetes).

Patient A:

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Patient B:

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Patient C:

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#### Step 2

You have advised your patients to start their treatments immediately. You have also reminded your patients that they should call you at any point if they have questions or concerns about their treatment. After 1 month, you ask your patients to return to your office for a check-up. Here is what you discover after talking with each one:

**Patient A:** Mr. Adams did not follow his treatment plan at all

**Patient B:** Ms. Burns followed her treatment plan as scheduled

**Patient C:** Mr. Canfield followed her treatment plan as scheduled

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**Questions**

1. Why do you think it is difficult for some individuals to follow a treatment plan such as those that you devised in this investigation?

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2. Why are these following medical professionals important to a diabetic?: exercise physiologist, nutritionist, nurse, and pharmacist.

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## ACTIVITY

6

### Retesting for Glucose in Urine and Blood Samples

#### What you need

##### Per group

- 1 Spot Plate
- 6 Glucose Test Strips
- 1 Urine Glucose Chart
- 1 Blood Glucose Chart

##### Shared

- 1 Patient A Final Urine Sample
- 1 Patient B Final Urine Sample
- 1 Patient C Final Urine Sample
- 1 Patient A Final Blood Sample
- 1 Patient B Final Blood Sample
- 1 Patient C Final Blood Sample

#### What to do...

##### Step 1

Fill in Table 4 with the initial urine and blood glucose data from Tables 1 and 2.

##### Step 2

Obtain the final urine sample for one of your patients. Place 2-3 drops of this urine sample into the appropriate well on your spot plate.

##### Step 3

Repeat Step 2 for your other patients.

**Important:** *Be sure that you do not cross-contaminate the urine samples on your spot plate.*

##### Step 4

Obtain a glucose strip. Place the padded end of the strip into the first well for 1-2 seconds, then they wait for two minutes. Compare the coloration on the pad to the Urine Glucose Chart. Record the glucose level in Table 4. Discard the glucose strip into a receptacle that your teacher designates.

##### Step 5

Repeat Step 4 for your other patients making sure to use a NEW glucose strip for each patient.

##### Step 6

Share your results with the rest of the class.

##### Step 7

Repeat Steps 2-6 for the final blood sample, making sure to use a NEW glucose strip for each patient. Make sure you use the Blood Glucose Chart for comparison. Record your data in Table 4.



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Table 4

Patient	Initial Urine Glucose Level (mg/dl)	Final Urine Glucose Level (mg/dl)	Change (+ or -) in Urine Glucose Level	Initial Blood Glucose Level (mg/dl)	Final Blood Glucose Level (mg/dl)	Change (+ or -) in Blood Glucose Level	Opinion: Is this patient doing better or worse or the same after treatment?
Patient A							
Patient B							
Patient C							

**Questions**

1. With the treatment plans in place, did any of the patients improve their urine glucose or blood glucose levels from the initial test? Did any of the patients become worse over time?

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2. What may be some possible reasons for the improvements or the setbacks for each patient? Explain.

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3. Why is it so important to properly manage diabetes?

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4. Are treatment plans different for Type 1 and Type 2 patients?

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## ACTIVITY

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### Creating Maintenance Plans for Patients

#### What you need

Information from Activities 1-6

#### What to do...

##### Step 1

Review all of the patient histories and the test results you determined for each patient throughout Activities 1-6. You should fill in the information that you already collected in Table 5.

##### Step 2

Now that you have an idea of how the original treatment worked or did not work for each patient, and whether each patient followed their treatment plan, devise a maintenance plan of your own for each patient. Use all of the information that you have collected so far in order to come up with these plans. Be sure to consider both short-term and long-term goals for maintenance.

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**Table 5**

Patient Name	Type of Diabetes	Followed Treatment Plan?	Improved Conditions after Treatment?	Short Term Goals	Long Term Goals
A: Mr. Adams					
B: Ms. Burns					
C: Mr. Canfield					

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**Questions**

1. Briefly summarize the procedure that you used to test for diabetes.

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2. What are the acute, short term consequences and the major long term consequences if diabetes is not treated?

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3. What types of lifestyle changes do people with diabetes have to make?

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4. Are there any ways to prevent diabetes?

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## ACTIVITY

**8**

### Take a Diabetes Risk Test

#### What to do...

As stated earlier, 16 million Americans have diabetes - and one out of three doesn't even know it! Are you at risk for diabetes? Take the following test to find out. Circle "yes" or "no" for each of these questions.

#### DIABETES RISK TEST

Circle Yes or No to the following questions.

1. Are you between the ages of 40-64?  
**Yes or No**
2. Do you have a blood relative with diabetes?  
**Yes or No**
3. Have you had a baby weighing over 9 pounds?  
**Yes or No**
4. Do you rarely exercise?  
**Yes or No**
5. Does your waist measure over 100cm (males)/95cm (females)?  
**Yes or No**
6. Do you urinate excessively?  
**Yes or No**

7. Are you always thirsty?  
**Yes or No**
8. Have you lost weight for no reason?  
**Yes or No**
9. Do you have numbness or tingling in your legs or feet?  
**Yes or No**
10. Do you have blurred vision?  
**Yes or No**
11. Are you always tired?  
**Yes or No**
12. Are you of African-American, Latino, Native American, Asian-American or Pacific Island descent?  
**Yes or No**

**If you have answered yes to three or more of the above questions, you may be at a high risk for diabetes. Share this test with your family members as well.**

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### Learn and Read More About It

American Diabetes Association. *American Diabetes Association Complete Guide to Diabetes*. 2000. Bantam.

Becker, Gretchen. *The First Year Type 2 Diabetes: An Essential Guide for the Newly Diagnosed*. 2001. Marlowe and Company.

McAuliffe, Alicia. *Growing Up with Diabetes: What Children Want Their Parents to Know*. 1998. John Wiley and Sons.

### Neat Websites

[http://www.ndep.nih.gov/diabetes/youth/youth\\_FS.htm](http://www.ndep.nih.gov/diabetes/youth/youth_FS.htm)

<http://www.diabetes.org/home.jsp>

<http://www.jdf.org/>