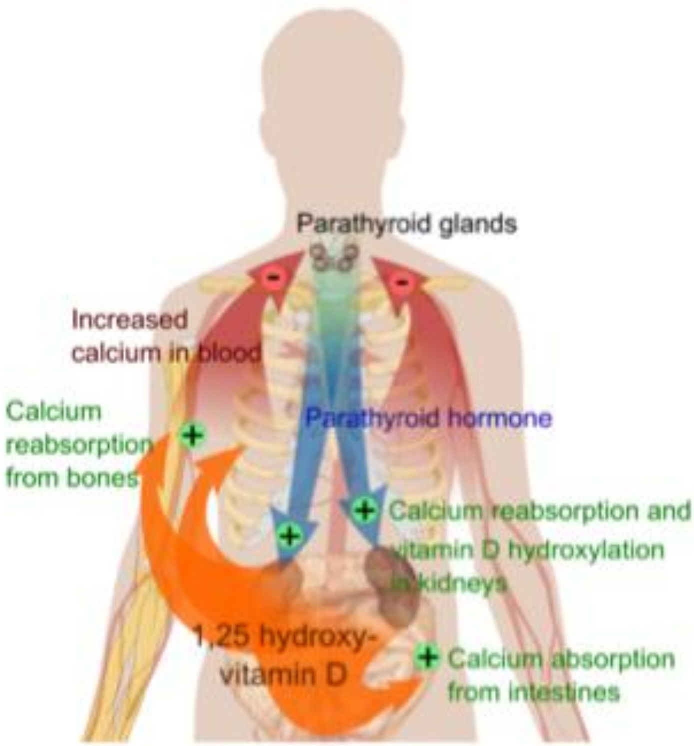
PROJECTREADi

Name ____________ Date ______

Teacher ______________________

Homeostasis Reader



How does your body work to maintain balance?
What happens when this balance is disrupted?

The intended use of these materials is in tandem with ongoing professional development focused on supporting reading as scientific practice. This work is funded by the Reading for Understanding Initiative of the Institute for Education Sciences, U.S. Department of Education, through Grant R305F100007 to University of Illinois at Chicago. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.

inquirium Northern Illinois University NORTHWESTERN UNIVERSITY UIC UNIVERSITY OF ILLINOIS AT CHICAGO WestEd

Images obtained from: Walter F., PhD. Boron (2003) *Medical Physiology: A Cellular And Molecular Approach*, Elsevier/Saunders, pp. 1,300; BSCS Biology: A Human Approach 2nd edition; http://science.kennesaw.edu

PROJECT READi

Name ______________ Date ________

Teacher ________________________

Homeostasis Reader
Table of Contents

Homeostasis I: Sodium balance	
Exploring the phenomena: How does our body work to maintain balance? What happens when this balance is disrupted?	Page
Hypernatremia Due to Dehydration in Dementia	R1-2
When Too Much Water Hurts a Runner	R3-4
Hyponatremia: What's going on inside the body?	R5
Exploring the role of salt balance and disruption in the human body	
Homeostasis	R6-7
What's in our blood?	R8
Salt: A World History	R9
Slow Ideas	R10-11
Understanding the role of communication in regulating balance	
Regulation of water by vasopressin	R12
Vaptans for the treatment of hyponatremia	R13
Homeostasis II: Sugar balance	
Exploring the phenomena: How is diabetes an example of imbalance in the body? How big of a problem is it?	
Type 2 diabetes in the United States	R14
Kim's Story	R15-16
The Young Epidemic: The Rise in Type 2 Diabetes Among Children	R17
Getting a closer look: Explaining glucose regulation in the human body	
How Does the Body Regulate Glucose?	R18-19
When cell communication goes wrong	R20-23
Is the glycemic index diet useful if you have diabetes?	R24

Hypernatremia Due to Dehydration in Dementia

Author: V. Dimov, M.D., Assistant Professor of Medicine and Pediatrics, University of Chicago
Reviewer: S. Randhawa, M.D., Allergist/Immunologist, Internist, Fort Lauderdale, FL

An 86-year-old African American female was admitted to the hospital after she had a seizure. Her family members report that the patient has baseline advanced dementia, which has been worsening over the last year. She is not verbal (she cannot conduct a meaningful verbal communication).

Past medical history

Dementia, hypertension, constipation.

Social history

The patient is a nursing home resident, and she is totally dependent in terms of activities of daily living.

Physical examination

The examination of Head, Eyes, Ears, Nose, and Throat showed that the head was normocephalic, atraumatic, and she had dry mucosal membranes.

The cardiovascular system examination showed that she had clear heart sounds but she was tachycardic. There were no murmurs, rubs or gallops.

The examination of the extremities showed no clubbing, cyanosis and edema. She had a decreased skin turgor.

What is the most likely diagnosis?

In her case, the seizure can be due to hypernatremia, or less likely, to an intracranial process.

Why does the patient have hypernatremia?

Poor oral intake of water is often seen in advanced dementia, and can lead to hypernatremia.

What laboratory tests would you suggest?

Complete blood count with differential, basic metabolic panel to confirm the presence and to quantify the degree of hypernatremia, and to look for other metabolic abnormalities and signs of infection.

Adapted from: Case-Based Curriculum of Medicine by Assistant Professors at University of Chicago and NSU. http://clinicalcases.org/2004/05/hypernatremia-due-to-dehydration-in.htm

The New York Times

By SUSAN GILBERT
Published November 2, 1999

When Too Much Water Hurts a Runner

Sports bottles of water have become indispensable accessories in gym bags and symbols of good health. But sports doctors are warning people not to drink too much water during endurance events like the New York City Marathon, which takes place on Sunday.

Though athletes need to drink regularly during a race to prevent dehydration, experts say that excess water can lead to hyponatremia, a potentially fatal condition that is rare but increasing among recreational athletes. Hyponatremia is an abnormally low concentration of sodium in the blood. The cause is unknown, but overconsumption of water is thought to increase the risk by diluting blood sodium.

Until recently, hyponatremia was seen almost exclusively in ultramarathons and other extremely high-endurance events, said Dr. Michael Sawka, chief of thermal and mountain medicine at the United States Army Research Institute of Environmental Medicine in Natick, Mass. ''Now we're seeing it in marathons, hiking and military occupations,'' he said. Symptoms include nausea and vomiting, muscle weakness, headache and disorientation, as well as bloating and puffiness in the face and fingers. In the last year or so, a dozen marathon runners in this country were known or suspected of having hyponatremia, said Dr. William Roberts, a spokesman for the American College of Sports Medicine, the professional organization of sports physicians. One victim was a 43-year-old woman who died after running the Chicago Marathon last fall.

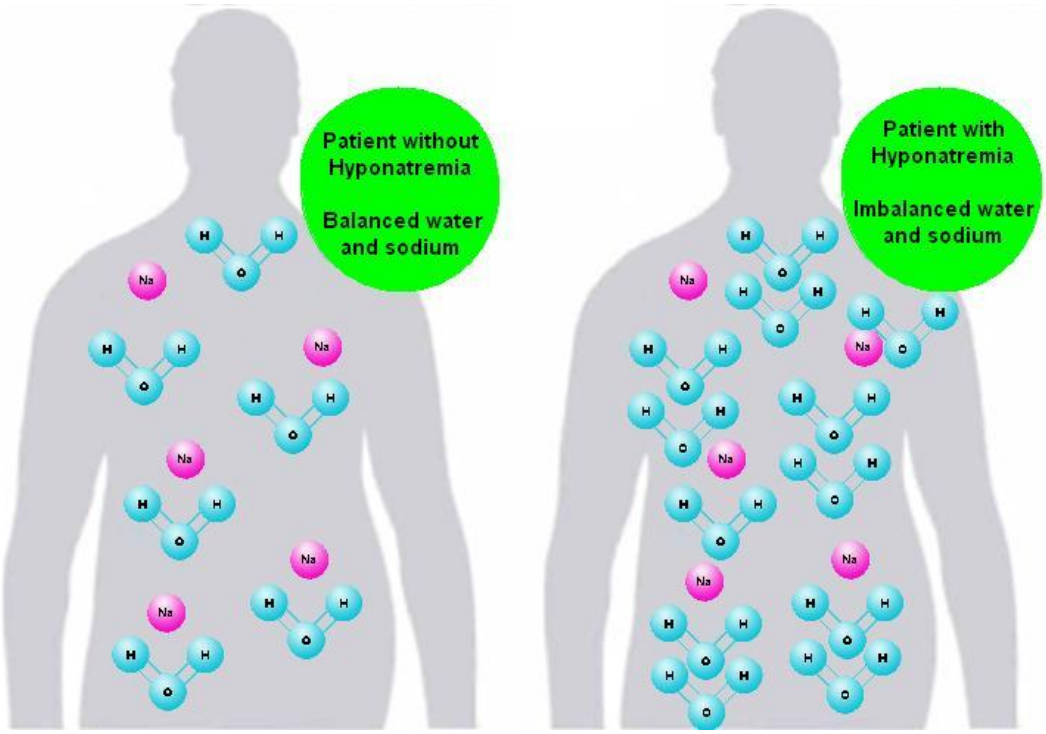
Doctors are looking for hyponatremia more now than ever before, but they say that increased vigilance does not fully explain the increased diagnoses. Another reason may be that many recreational athletes are drinking too much water. ''We've done a good job of educating people on proper rehydration, but some people have taken that to the nth degree, thinking that the more you drink, the better,'' Dr. Sawka said. Doctors say that most of the marathon runners with hyponatremia were relatively inexperienced athletes who entered races to raise money for charity.

The condition seems more common among women than men. Medicine and Science in Sports and Exercise, a journal, recently reported that about half the women studied who finished the New Zealand Ironman triathlon developed hyponatremia, compared with 14 percent of the men. Doctors are not sure why. It may be that women simply drink more water than men. The guidelines, set by the sports medicine organization, call for about 17 ounces of fluid two hours before exercise, and then early and at regular intervals to replace all the water lost through perspiration.

Whether sports drinks help prevent hyponatremia is under study, the American College of Sports Medicine says. In any case, doctors say, an effective way for runners to maintain healthy blood sodium concentrations in Sunday's race is to salt their food every day between now and then.

Adapted from The New York Times
http://www.nytimes.com/1999/11/02/health/when-too-much-water-hurts-a-runner.html

Hyponatremia: what's going on inside the body?



Source: http://trialx.com/curetalk/wp-content/blogs.dir/7/files/2011/05/diseases/Euvolemic_Hyponatremia-1.jpg

Homeostasis

Have you ever wondered why you don't faint every time you stand up? Does it surprise you that even if you skip lunch you still can walk and talk? Explanations of those occurrences are quite complex. For instance, the cells in your brain all are exceedingly sensitive to tiny changes in the levels of oxygen and sugar. Even small decreases in those critical substances can cause fainting. Your blood pressure automatically rises when you stand up in order to maintain adequate oxygen flow to your brain. Likewise, you can skip lunch because a declining level of sugar in your bloodstream triggers your liver to release sugar held in storage. Your body must continuously make adjustments to create and maintain an environment for your brain to function.

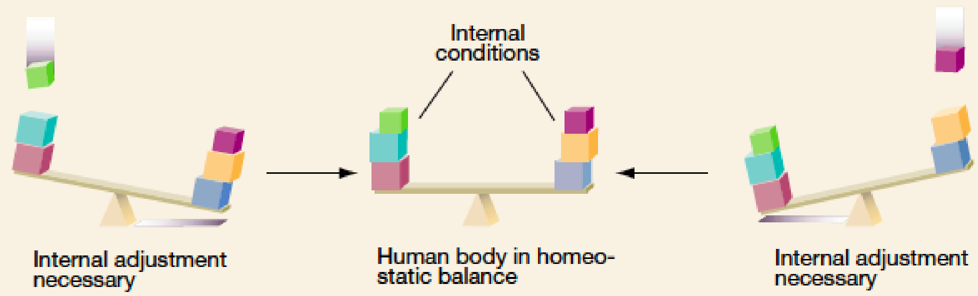


Figure E5.1 Homeostasis The human body is maintained in a state in which the internal conditions are balanced. When the balance is disturbed, the body adjusts its internal conditions to restore balance.

These adjustments are made *automatically* and assure that conditions within your body remain within rather narrowly defined limits, a condition of balance called **homeostasis** (see Figure E5.1). Humans are not the only organisms that maintain homeostasis. In fact, homeostasis is a fundamental characteristic of all living systems. In animals, internal organs that are similar in function to those in humans help to maintain homeostasis. In plants, specialized structures, such as those illustrated in Figure E5.2, enable plants to maintain balance. Although organisms use different mechanisms to remove wastes and maintain balance, all organisms depend on maintaining homeostasis. Maintaining balance means life, and losing homeostatic balance for an extended period of time means death. To maintain homeostasis, two things are required. First, an organism must be able to sense when changes have occurred in the external and internal environment. Second, it must be able to respond with appropriate adjustments.

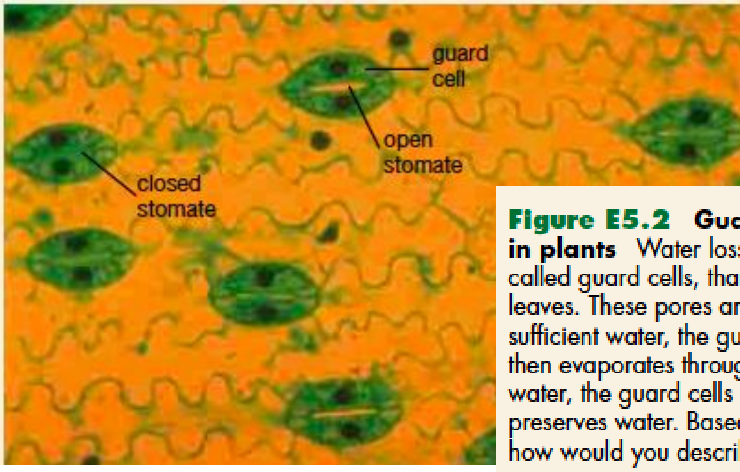


Figure E5.2 Guard cells control the rate of water loss in plants Water loss is controlled by the condition of special cells, called guard cells, that regulate the size of microscopic pores in leaves. These pores are called **stomates.** When the plant has sufficient water, the guard cells swell and the stomates open. Water then evaporates through the stomates. When the plant is low on water, the guard cells shrink, and the stomates remain closed, which preserves water. Based on the appearance of stomates in this leaf, how would you describe this plant's water balance?

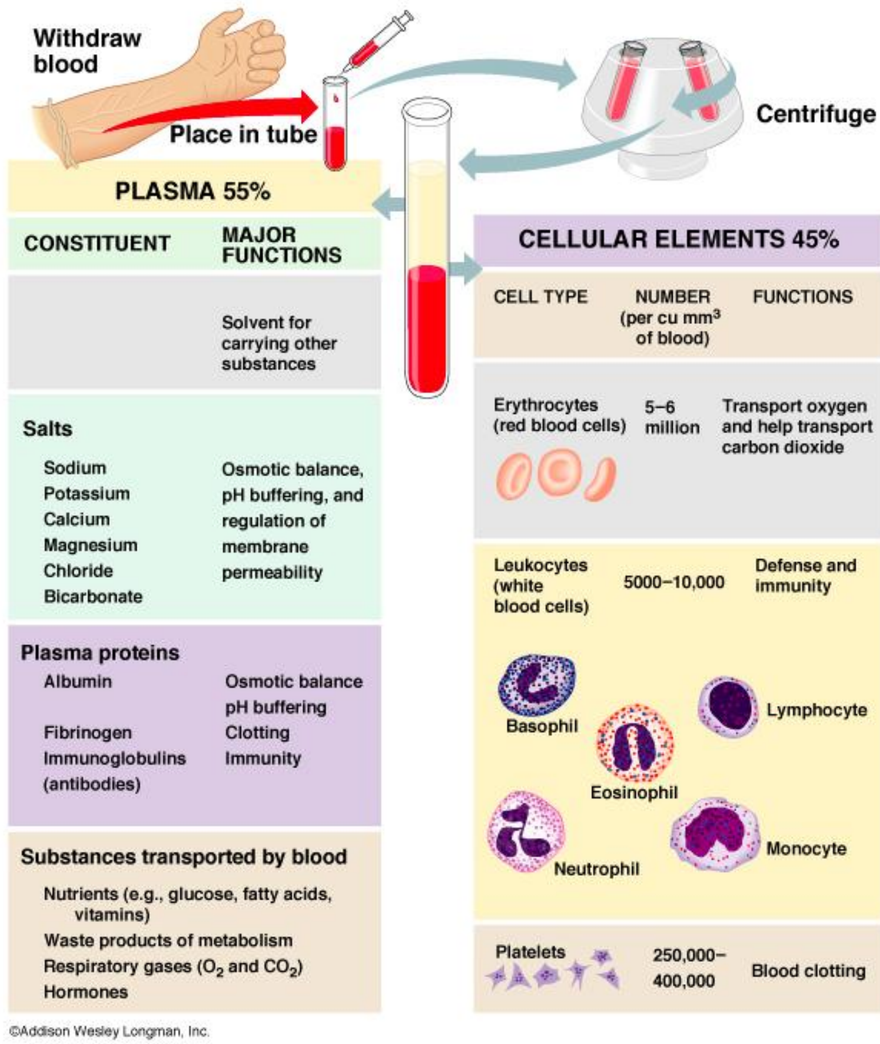
For example, humans can monitor stimuli, or external signals such as cold, because we have sensory neurons in our skin that allow us to feel the outside temperature. Once the message "cold" is received in the brain, our body can respond by changing blood flow. Our heart rate may increase, and certain blood vessels may constrict. This change is involuntary, or automatic. We do not consciously control this physiological process. In other words, we do not decide what the body should do. The body attempts to keep the brain, heart, and liver at a nearly constant temperature even if that means sacrificing fingers and toes.

The human body's response to change is quite specific as well as involuntary. For example, the body responds to cold temperature by diverting circulation to keep the most important internal organs warm. This type of response is appropriate for the external conditions. If the body becomes too hot, however, the circulatory system diverts blood flow away from the internal organs to protect them from damage caused by excess heat.

These examples are rather dramatic, but the human body routinely senses and responds to thousands of small changes each day. It is through many small, specific, automatic changes that living organisms sense and react to an environment that is ever changing and sometimes hostile. Luckily, the mechanisms for maintaining balance are always on the job.

Adapted from: *BSCS Biology: A Human Approach,* 2nd edition.

What's in our blood?



Plasma is the liquid portion of blood – a protein-salt solution in which red and white blood cells and platelets are suspended. Plasma, which is 92 percent water, constitutes 55 percent of blood volume. Plasma contains albumin (the chief protein constituent), fibrinogen (responsible, in part, for the clotting of blood) and globulins (including antibodies). Plasma serves a variety of functions, from maintaining a satisfactory blood pressure and volume to supplying critical proteins for blood clotting and immunity. It also serves as the medium for exchange of vital minerals such as sodium and potassium and helps to maintain a proper pH (acid-base) balance in the body, which is critical to cell function. Plasma is obtained by separating the liquid portion of blood from the cells.

Diagram from: http://www.iteachbio.com/Anatomy-Physiology/Circulatory%20System/ComponentsofBlood.png;
Text from American Red Cross http://www.redcrossblood.org/learn-about-blood/blood-components/plasma

Salt: A World History

Mark Kurlansky

"Without sodium, which the body can not manufacture, the body would be unable to transport nutrients or oxygen, transmit nerve impulses, or move muscles including the heart. An adult human being contains about 250 grams of salt, which would fill three or four salt shakers, but is constantly losing it through bodily functions. It is essential to replace this lost salt."

"Modern scientists argue about how much salt an adult needs to be healthy. Estimates range from two-thirds of a pound to more than sixteen pounds each year. People who live in hot weather, especially if they do physical labor, need more salt because they must replace the salt that is lost in sweating. This is why West Indian slaves were fed salted food. But if they do not sweat excessively, people who eat red meat appear to derive from it all the salt they need. The Masai, nomadic cattle herders in East Africa, meet their salt needs by bleeding livestock and drinking the blood. But vegetable diets, rich in potassium, offer little sodium chloride. Wherever records exist of humans in different stages of development, as in seventeenth- and eighteenth-century North America, it is generally found that hunter tribes neither made nor traded for salt but agricultural tribes did. On every continent, once human beings began cultivating crops, they began looking for salt to add to their diet. How they learned of this need is a mystery. A victim of starvation experiences hunger, and so the need for food is apparent. Salt deficiency causes headaches and weakness, then light-headedness, then nausea. If deprived long enough, the victim will die...most people choose to eat far more salt than they need, and perhaps this urge - the simple fact that we like the taste of salt- is a natural defense."

"The other development that created a need for salt was the move to raise animals for meat rather than kill wild ones. Animals also need salt. Wild carnivores, like humans, can meet their salt needs by eating meat. Wild herbivores forage for it, and one of the earliest ways humans searched for salt was to follow animal trails. Eventually they all lead to a salt lick or a brine spring or some other source of salt. But domesticated animals need to be fed salt. A horse can require five times the salt intake of a human, and a cow needs as much as ten times the amount of salt a human requires."

Excerpts taken from: Kurlansky, M. (2002). *Salt: A World History*. Toronto: Alfred A. Knopf Canada

Optional

THE NEW YORKER

ANNALS OF MEDICINE

SLOW IDEAS

By Atul Gawande, MD

July 29, 2013

In 1968, *The Lancet* published the results of a modest trial of what is now regarded as among the most important medical advances of the twentieth century. It wasn't a new drug or vaccine or operation. It was basically a solution of sugar, salt, and water that you could make in your kitchen. The researchers gave the solution to victims of a cholera outbreak in Dhaka, the capital of what is now Bangladesh, and the results were striking.

Cholera is a violent and deadly diarrheal illness, caused by the bacterium *Vibrio cholera*, which the victim usually ingests from contaminated water. The bacteria secrete a toxin that triggers a rapid outpouring of fluid into the intestine. The body, which is sixty per cent water, becomes like a sponge being wrung out. The fluid pouring out is a cloudy white, likened to the runoff of washed rice. It produces projectile vomiting and explosive diarrhea. Children can lose 1/3 of their body's water in less than 24 hours, a fatal volume. Drinking water to replace the fluid loss is ineffective, because the intestine won't absorb it. As a result, mortality commonly reached 70 percent or higher. During the nineteenth century, cholera pandemics killed millions across Asia, Europe, Africa, and North America. The disease was dubbed the Blue Death because of the cyanotic blue-gray color of the skin from extreme dehydration.

In 1906, a partially effective treatment was found: intravenous (IV) fluid solutions reduced mortality to 30 percent. Prevention was the most effective approach. Modern sewage and water treatment eliminated the disease in affluent countries. Globally, though, millions of children continued to die from diarrheal illness each year. Even if victims made it to a medical facility, the needles, plastic tubing, and litres of intravenous fluid required for treatment were expensive, in short supply, and dependent on medical workers who were themselves in short supply, especially in outbreaks that often produced thousands of victims.

Then, in the nineteen-sixties, scientists discovered that sugar helps the gut absorb fluid. Two American researchers, David Nalin and Richard Cash, were in Dhaka during a cholera outbreak. They decided to test the scientific findings, giving victims an oral rehydration solution containing sugar as well as salt. Many people doubted that victims could drink enough of it to restore their fluid losses, typically ten to twenty liters a day. So the researchers confined the Dhaka trial to 29 patients. The subjects proved to have no trouble drinking enough to reduce or even eliminate the need for intravenous fluids, and none of them died.

Modified excerpt taken from *The New Yorker*
http://www.newyorker.com/reporting/2013/07/29/130729fa_fact_gawande?currentPage=all

PROJECT**READi**

Regulation of water by vasopressin

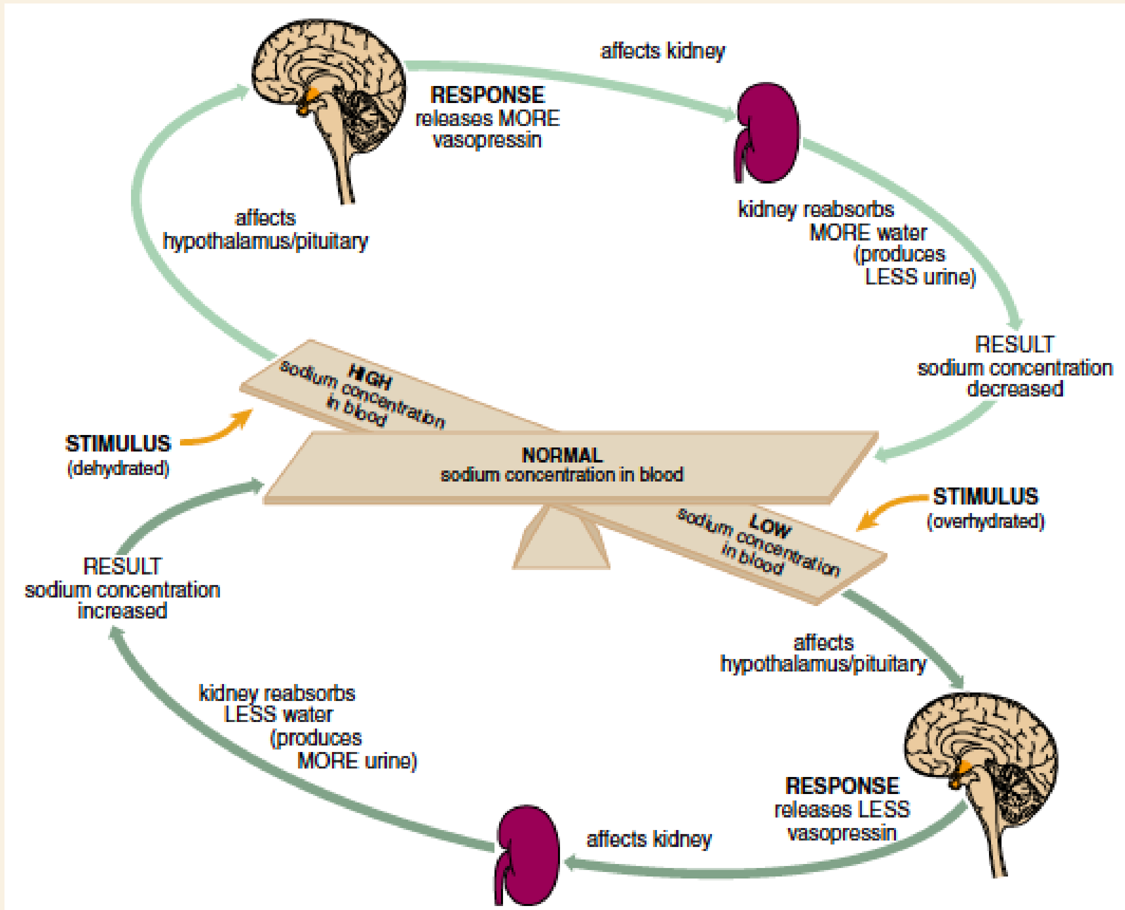


Figure E5.6 Regulation of water balance by vasopressin (also known as ADH) When the sodium concentration in the blood rises, the hypothalamus and pituitary gland in the brain respond. This causes the release of vasopressin (ADH), which stimulates the kidneys to reabsorb more water. As a result, the sodium concentration decreases, restoring water balance. What would happen if a person consumed a diuretic, such as caffeine or alcohol? Diuretics block the production of vasopressin.

Figure from: *BSCS Biology: A Human Approach*, 2nd edition.

nature REVIEWS ENDOCRINOLOGY

Vaptans for the treatment of hyponatremia

Nature Reviews Endocrinology 7, 151-161 (March 2011)

Gary L. Robertson, MD. Professor Emeritus in Medicine-Endocrinology at Northwestern University Feinberg School of Medicine

Vaptans constitute a new class of pharmaceuticals developed for the treatment of the some forms of hyponatremia. Vaptans are *vasopressin antagonists* that interfere the hormone vasopressin, also called AVP, by competitively binding to its receptors in the kidney. Vassopressin performs two primary roles in the body: 1) retain water in the body and 2) constrict blood vessels.

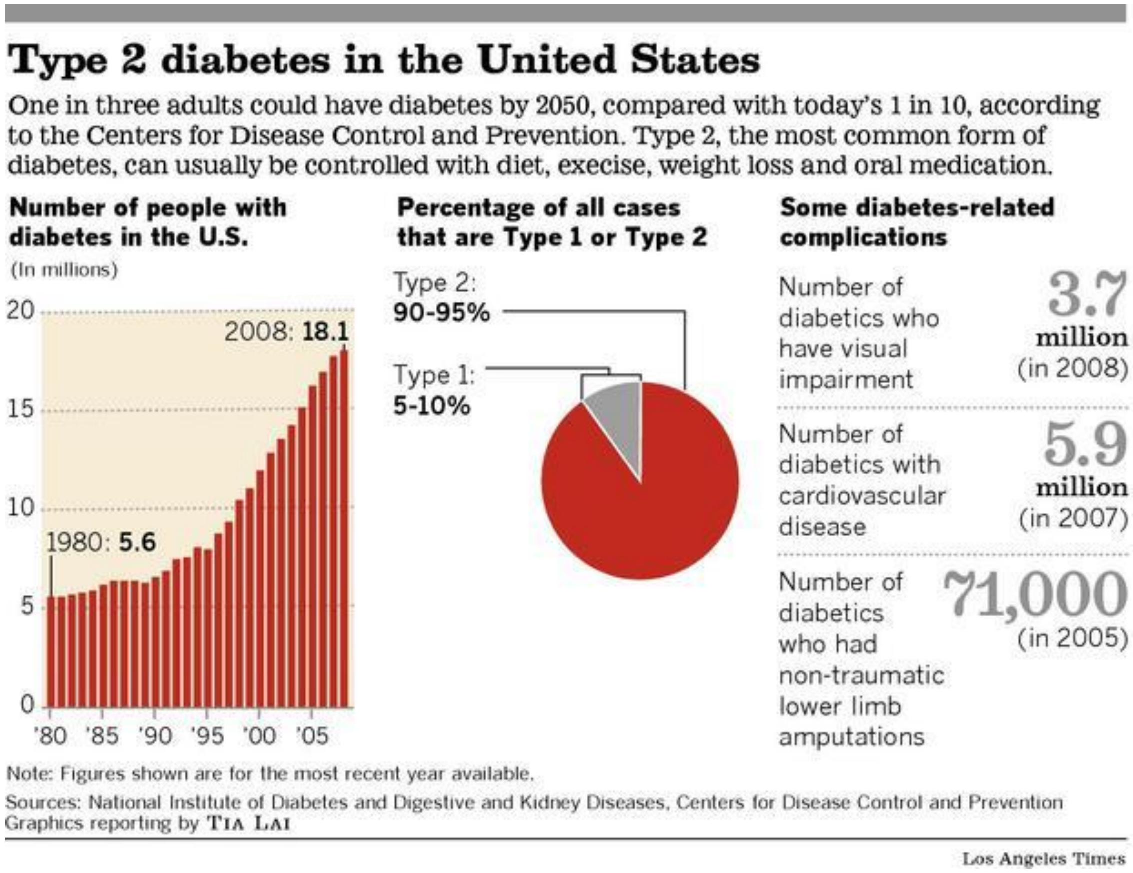
One of the most important roles of AVP is to regulate the body's retention of water; it is released when the body is dehydrated and causes the kidneys to conserve water, thus concentrating the urine and reducing urine volume.

This blockade results in water diuresis that, if not offset by increased fluid intake, reduces body water content and raises plasma sodium levels. Nonetheless, vaptans are particularly useful to treat hypervolemic hyponatremia associated with severe congestive heart failure or chronic liver failure, as the only other treatments currently available, such as fluid restriction and diuretics, are slow-acting and minimally effective.

The use of Vaptans to treat acute, symptomatic forms of hyponatremia is still debatable, because their effects on plasma sodium vary unpredictably from patient to patient

Excerpts from: *Nature Reviews Endocrinology* 7, 151-161 (March 2011)
http://www.nature.com/nrendo/journal/v7/n3/full/nrendo.2010.229.html

Los Angeles Times



Graphic obtained from LA Times: http://www.latimes.com/health/lat-b82485127z.1-20101029223751-000gs20101029,0,3776283.graphic#axzz2uYMwV5Vb

My Story

My name is Kimberly Marie Thiele. (My Dakota name is "Mahpiya Duta Winyan" which translates as "Red Cloud Woman." This name had been given to me by my grandfather from Canada.)

My life began on a summer day on July 17, 1987. I was born early, weighing only 3 pounds and 7 ounces. I developed yellow jaundice a couple of days later so I stayed for an extra week. Other than that, I was healthy and went home after two weeks. It took me a while to catch up with the other kids my age but after a while I caught up and grew up to be a healthy and happy little girl.

As I grew into my teens, my life was good; I came from a two-parent family, had good friends, and enjoyed school. In January of 2003, I noticed something was wrong. I was always thirsty, like really thirsty to the point where I started bringing a glass with a pitcher of water to my bedroom at night, and then of course, I was also urinating a lot, especially at night, maybe two, three times a night. I lost a lot of weight. It didn't really dawn on my to think that I might have some type of disorder like diabetes.

On April 26, 2003, in school, I had a headache, was tired, and weak. I called my father, and he came after me. We went to the clinic, and I signed up as a walk-in and waited. My name was called. They took my temp and blood pressure, etc., etc. My father asked if they could check my sugar. In the past weeks, little did I know, my father would wake up every time I went to the bathroom during the night. (He noticed how frequently I was visiting the restroom.) He suspected diabetes but didn't really think that it could be it, after all, I was only 16 years old. The nurse did a blood sugar test, and my blood sugar was 670* that day. I was given a dose of insulin and was prescribed diabetes pills. (A year later, I was switched from pills to insulin.)

I had been diagnosed with type 2 diabetes. After the doctor informed me I had diabetes, I was sent to talk to a dietician and a public health nurse. Both of these people are also certified diabetes educators. They explained to me that the type of diabetes I had was usually found in older people but was increasingly being diagnosed in young children and teenagers. They also explained to me that I would have to do A1c testing every three to six months. (What an A1c test does is monitor the glucose control of diabetics over time; it also aids in treatment decisions.) They also taught me how to check my blood sugar and how often (twice a day), and explained that I could control my diabetes with diet and exercise.

When I was diagnosed, I never thought too much about it. It didn't really matter because I didn't know what diabetes was all about. On the other hand, my parents were heartbroken. It was heartbreaking for them because I was just 16, and they had seen what effects diabetes had on the human body and also the pain that it causes emotionally and physically.

After learning all about diabetes and that it is a lifelong disease with severe consequences if not taken care of, I went into denial big time. I told myself, "I don't have diabetes, how can I? I am only 16 years old." I wouldn't test my blood sugar, on some days I didn't take my insulin, and I ate whatever I wanted and whenever I wanted.

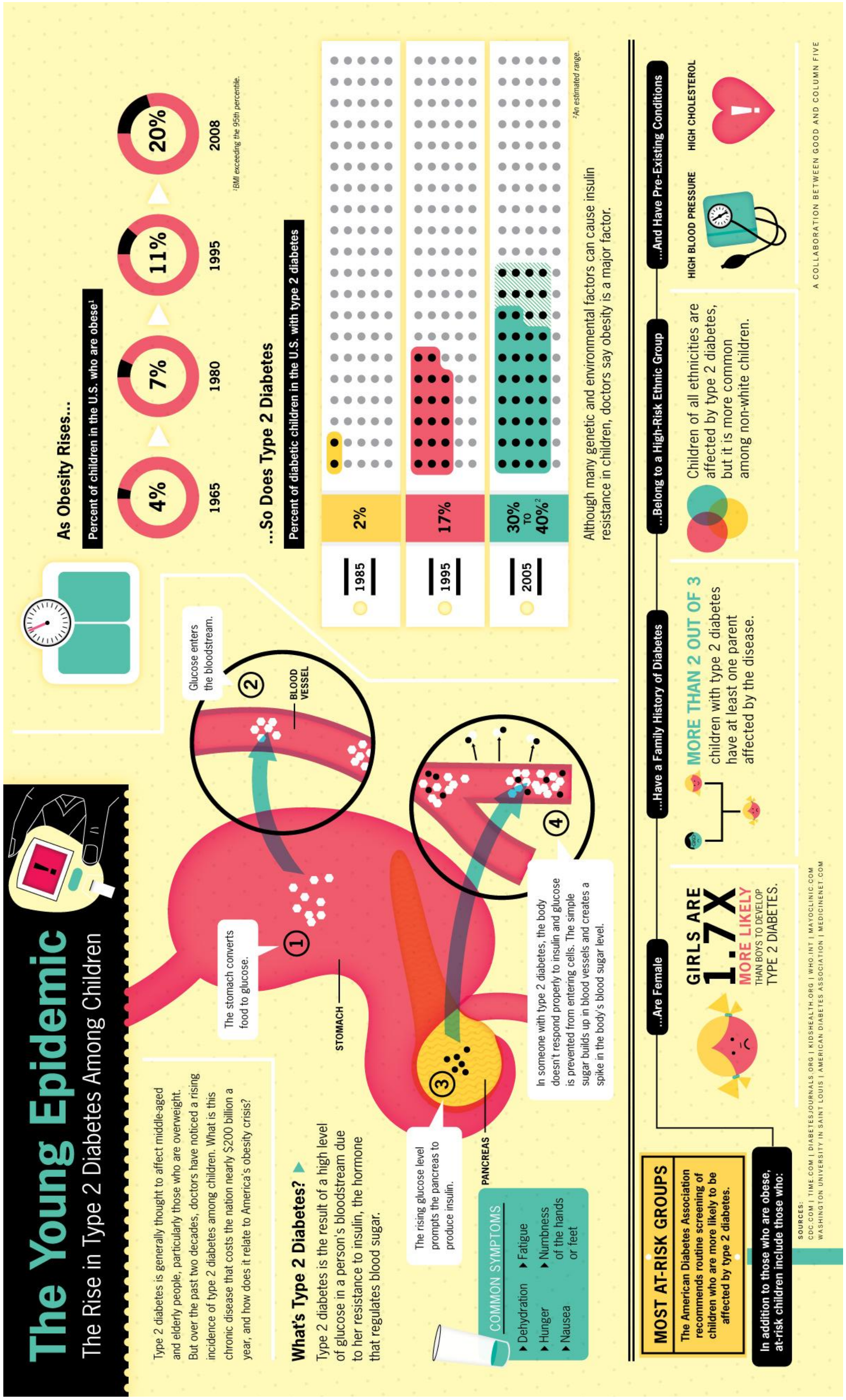
*670 milligrams / deciliter (mg/dL)

My parents enrolled us in an educational counseling program taught by a nurse, but I wouldn't cooperate and didn't believe I needed to be there.

One day in school, my blood sugar became so low that I got a headache and was shaky, tingly, confused. I got the scare of my life. After that incident, I was determined to take care of myself, and it went well for while. Then I was back in denial and fell back into not taking care of myself again. I didn't want to be treated any different that anyone else. I figured at one point, what's the use? My death will have something to do with diabetes anyway.

In the spring of 2005, I suspected that I was pregnant, and in May it was confirmed. I didn't want to tell my parents and break their hearts again. I tried to wait a couple of more months to July when I would be turning 18 years old. I was told by my school counselor that, because of my health, if I didn't tell my parents that day that she would. I couldn't face them so I e-mailed my mom. (Yes I know that sounds crazy but you just had to be there to understand the situation I was in.) We all went thought accepting the fact, that yes, I was pregnant, and went from there. My parents supported me, especially my dad, who drove me once a month and then twice a week to the special prenatal clinic which was a 180-mile round-trip. Thank you, Dad, I love you.

Obtained from Diabetes Education in Tribal Schools "Health Is Life Balance" curriculum.



Source: *Good Magazine* http://magazine.good.is/articles/the-young-epidemic-the-rise-of-type-2-diabetes-in-children

How Does the Body Regulate Glucose?

The body normally keeps the blood glucose concentration between about 70 and 140 milligrams per deciliter. To do this, your body has to have a way to determine when the amount of glucose in the blood is either low or high. Two hormones play important roles in keeping the glucose concentration in this normal range. Hormones are a type of chemical messenger in the body. They are released from specialized cells or glands into the blood. The blood carries them to other cells where they cause a specific response. The two hormones that regulate glucose in the body are insulin and glucagon. Both hormones are made by cells in the pancreas.

Insulin and glucagon have opposite effects to control the concentration of glucose in the blood. The pancreas always makes and releases small amounts of insulin and glucagon. When a person eats carbohydrates, they are broken down into glucose, and the amount of glucose in the blood increases. The body detects this increase and triggers specific cells in the pancreas to release insulin. The insulin acts on many other cells in the body so they can take up the glucose. This lowers the concentration of glucose in the blood. Glucagon is released from the pancreas when the concentration of glucose in the blood is low. Glucagon stimulates primarily the cells of the liver to release stored glucose into the blood. This makes the blood glucose concentration increase.

It is the controlled release of both of these hormones that keeps the blood glucose concentration within the normal range. Eating carbohydrates stimulates the release of insulin from cells of the pancreas. The glucose inhibits or "turns off" the release of glucagon from the pancreas. Insulin in the blood also inhibits the release of glucagon. When the concentration of glucose in the blood is low, the cells in the pancreas that produce glucagon are stimulated and they release their hormone into the blood.

This coordinated release of insulin and glucagon and is an example of a feedback system. A feedback system can be defined as a situation in which one activity of a body system affects another, which in turn affects the first. Feedback systems are important ways in which the body maintains balance. A high blood glucose concentration triggers the release of insulin. When the blood glucose concentration decreases, it signals the pancreas to stop releasing insulin. When the blood glucose concentration is low, cells in the pancreas are stimulated to release glucagon. When the blood glucose concentration increases, the cells release much less glucagon.

The cells of the pancreas can sense small changes in blood glucose concentration. Because they are so sensitive, the cells of the pancreas can respond to changes before the blood glucose concentration can increase or decrease much. This is also a constant process. If a person eats a meal with a lot of carbohydrates, a larger amount of insulin will be released. If a person eats a meal with less carbohydrates, the pancreas releases a smaller amount of insulin. In the same way, the amount of glucagon that is released depends on how close or how far below normal the blood glucose concentration is.

The actions of insulin and glucagon to control the amount of glucose in the blood, along with feedback mechanisms that can either turn on or turn off the release of these hormones into the blood, are all part of homeostasis. Homeostasis refers to the processes used by the body to maintain conditions within a narrow range. For example, the body normally maintains blood glucose concentrations at around 95 milligrams per deciliter (mg/dL) in a healthy person. After a person eats and the blood glucose concentration is high, insulin works to lower the level to around 95 milligrams per deciliter (mg/dL). If the blood glucose concentration is low, glucagon released into the blood functions to increase the concentration. Therefore, by making adjustments to raise or lower the blood glucose concentration, the body can maintain a relatively stable environment.

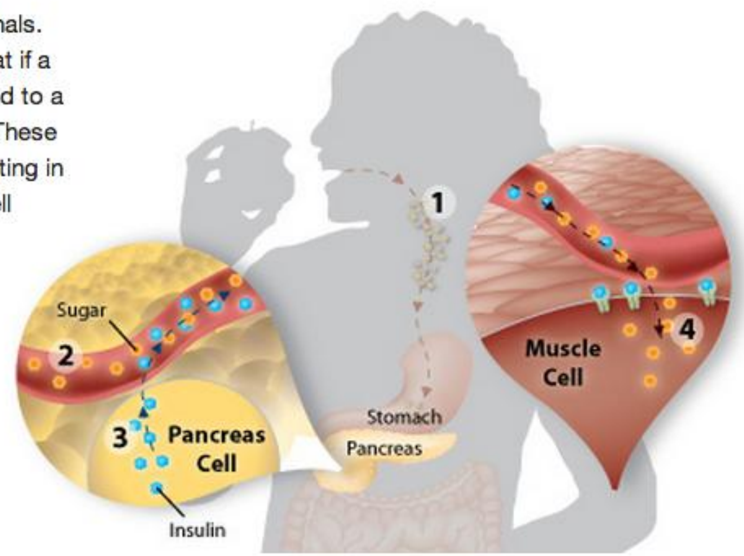
Obtained from: Diabetes Education in Tribal Schools “Health Is Life Balance” curriculum.

WHEN CELL COMMUNICATION GOES WRONG

The cells in our bodies are constantly sending out and receiving signals. But what if a cell fails to send out a signal at the proper time? Or what if a signal doesn't reach its target? What if a target cell does not respond to a signal, or a cell responds even though it has not received a signal? These are just a few ways in which cell communication can go wrong, resulting in disease. In fact, most diseases involve at least one breakdown in cell communication.

Losing The Signal

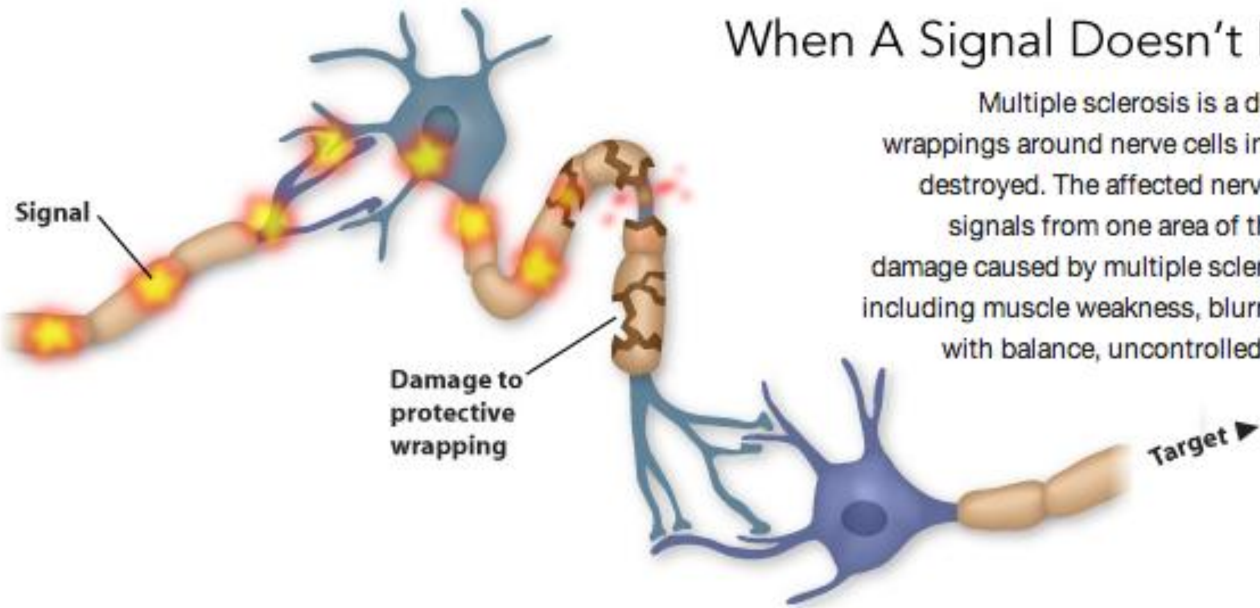
The food that you eat is broken down into sugar, which enters the blood stream. Normally, cells in the pancreas release a signal, called insulin, that tells your liver, muscle and fat cells to store this sugar for later use. In type I diabetes, the pancreatic cells that produce insulin are lost. Consequently, the insulin signal is also lost. As a result, sugar accumulates to toxic levels in the blood. Without treatment, diabetes can lead to kidney failure, blindness and heart disease in later life.



Normal blood sugar regulation. After food enters the body (1), it is broken down and sugar enters the bloodstream (2). Sugar stimulates cells in the pancreas to release insulin (3). Insulin travels through the blood to other cells in the body and signals them to take up sugar (4).

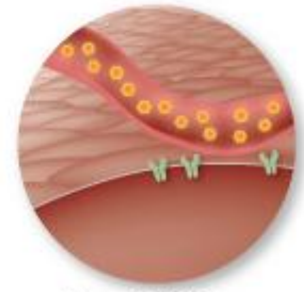
When A Signal Doesn't Reach Its Target

Multiple sclerosis is a disease in which the protective wrappings around nerve cells in the brain and spinal cord are destroyed. The affected nerve cells can no longer transmit signals from one area of the brain to another. The nerve damage caused by multiple sclerosis leads to many problems, including muscle weakness, blurred or double vision, difficulty with balance, uncontrolled movements, and depression.



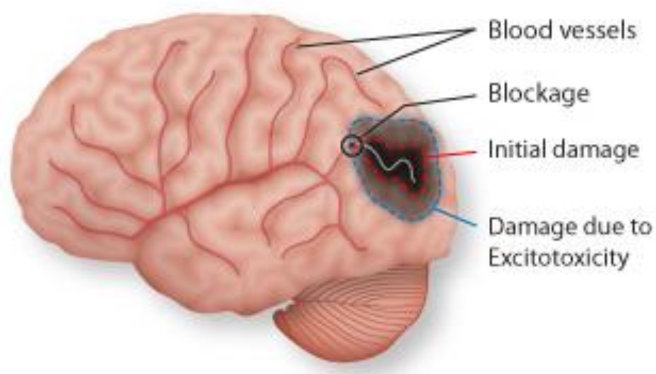
When The Target Ignores The Signal

Type I and type II diabetes have very similar symptoms, but they have different causes. While people who have type I diabetes are unable to produce the insulin signal, those with type II diabetes do produce insulin. However, the cells of type II diabetics have lost the ability to respond to insulin. The end result is the same - blood sugar levels become dangerously high.



Type I Diabetes
No insulin signal

Type II Diabetes
No response



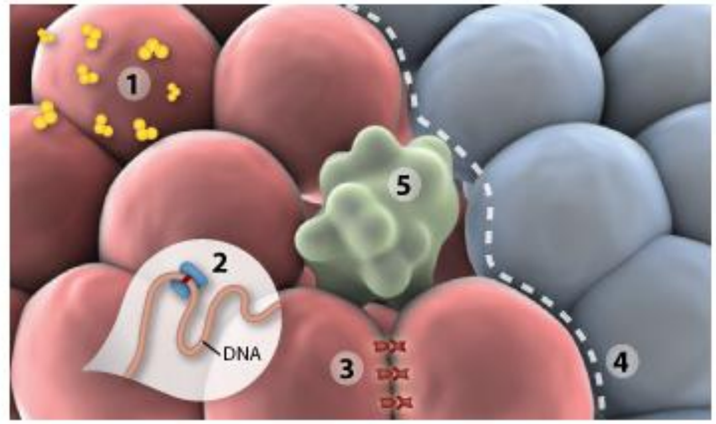
Excitotoxicity: After a brain injury such as a stroke, lethal amounts of signaling molecules leak out of dying nerve cells resulting in widespread damage to the brain.

Too Much Signal

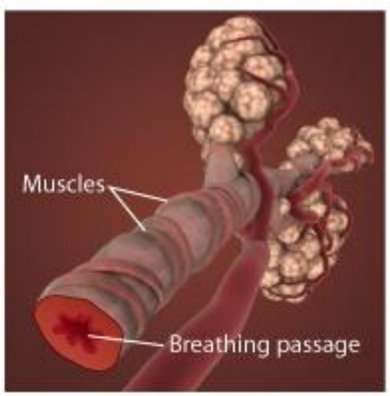
A stroke occurs when a blockage forms in a blood vessel, cutting off blood flow to part of the brain. The immediate result is the death of nearby brain cells. But the most catastrophic event comes later, when the dying cells release large amounts of the signaling molecule glutamate. Low concentrations of glutamate control many actions in the brain, but at high concentrations it is toxic to cells. Through a process called excitotoxicity, glutamate spreads through the brain and kills cells that were not affected by the blockage, often leading to widespread brain damage.

Multiple Breakdowns

Cell growth and division is such an important process that it is under tight control with many checks and balances. But even so, cell communication can break down. The result is uncontrolled cell growth, often leading to cancer. Cancer can occur in many ways, but it always requires multiple signaling breakdowns. Often, cancer begins when a cell gains the ability to grow and divide even in the absence of a signal. Ordinarily this unregulated growth triggers a signal for self-destruction. But when the cell also loses the ability to respond to death signals, it divides out of control, forming a tumor. Later cell communication events cause blood vessels to grow into the tumor, enabling it to grow larger. Additional signals allow the cancer to spread to other parts of the body.



Many mechanisms maintain appropriate cell growth: Cell division occurs in response to external signals (1). Enzymes repair damaged DNA (2). Cells make connections with their neighbors (3). If these connections suddenly change, neighboring cells send out an alert. Cells respect and stay within tissue boundaries (4). If a cell is beyond repair, it initiates its own death (5).



During an asthma attack, signaling molecules cause a narrowing of breathing passages in the lungs, making it difficult to breathe.

Many drugs that treat asthma mimic natural signals that tell muscle cells in the lungs to relax, allowing breathing passages to open.

Treatments

Just as cell communication can go wrong resulting in disease, many disease treatments rely on cell communication. If you think of disease as a roadblock in cell communication, treatment is an alternate route. The first step is to locate the problem. The second step is to find a way around the problem. Sometimes it's easy. The treatment for type I diabetes is to inject insulin into the blood stream. Other times it's more difficult, especially in diseases such as cancer where cell communication has broken down in multiple places.

Source: The Learn Genetics Center, The University of Utah.
http://learn.genetics.utah.edu/content/begin/cells/badcom/

Optional

MAYO CLINIC

Diseases and Conditions

Is the glycemic index diet useful if you have diabetes?

Answers from Maria Collazo-Clavell, M.D.

Some people with diabetes use the glycemic index (GI) as a guide in selecting foods — especially carbohydrates — for meal planning. The glycemic index classifies carbohydrate-containing foods according to their potential to raise your blood sugar level. Foods with a high glycemic index value tend to raise your blood sugar faster and higher than do foods with a lower value. The glycemic index diet has potential benefits but may be problematic as well:

Possible benefits	Potential problems
• Lowers blood sugar level	• Includes single food items rather than combinations of foods, which can impact blood sugar differently
• Helps regulate blood sugar level throughout the day, which may reduce the risk of insulin resistance	• Doesn't consider all variables that affect blood sugar, such as how food is prepared or how much is eaten
• Reduces the need for diabetes medication	• Only includes foods that contain carbohydrates
• Controls appetite and delays hunger cues, which may help with weight management	• Doesn't rank foods based on nutrient content — foods with a low GI ranking may be high in calories, sugar or saturated fat

It can be difficult to follow a glycemic index diet on your own. For one thing, most foods aren't ranked by glycemic index. Packaged foods don't generally list their GI ranking on the label, and it can be hard to estimate what it might be. Still, basic principles of the glycemic index diet may help you better manage and control your blood sugar:

- Choose high-fiber foods, such as whole grains, legumes, fruits and vegetables.
- Choose fresh or raw foods over canned or processed foods.

If you have diabetes, the glycemic index diet is just one tool to consider when determining your diet. If you're interested in learning more, talk to a registered dietitian. He or she can help you make changes in your diet.

Source: http://www.mayoclinic.org/diseases-conditions/diabetes/expert-answers/diabetes/faq-200

