Soon after a meal, your digestive system breaks down the food you have eaten into a simple sugar called glucose. Glucose is absorbed from the gut into the bloodstream, causing your blood sugar level to increase. In healthy individuals, feedback mechanisms in the body bring blood sugar levels back to normal. In some people, this process breaks down, resulting in diabetes. In this video, we'll take a closer look at feedback loops, how they tie into the body's mechanism of internal regulation, and what happens when these mechanisms fail. This video is part of the Information Flow series. A system is shaped and changed by the nature and flow of information into, within, and out of the system. Hi, my name is Leah Okumura and I am a Technical Instructor in the Biology Department at MIT. Before watching this video, you should be familiar with the concept that your body is a tightly regulated environment. After watching this video, you will be able identify the general components of a feedback loop, examples of negative and positive feedback loops in the body, and describe how feedback loops are vital to healthy function and survival. Our bodies rely heavily on feedback loops to control and regulate important biochemical and physiological functions. There are two types of feedback loops in biology: negative feedback loops, and positive feedback loops. These act to either reduce or amplify the changes that occur in a given system. Let's see how feedback loops can be applied to thermoregulation. Imagine walking into a room that has an air conditioner on at full blast. After a few minutes, you find yourself shivering from the cold. Does the shivering serve a purpose? Yes! The rapid muscle contractions from shivering generate heat within the body and warm you back up. Now imagine taking a walk outside on a very hot and sunny day. After a few minutes under the hot sun, you are perspiring profusely. What purpose does sweating serve? As sweat evaporates from your skin, it helps to cool you down. Thermoregulation serves to control our body's temperature much like a thermostat regulating the temperature of a room. From this diagram, you can see how thermoregulation follows a simple loop. Because the response in this case is always to reverse a given change in body temperature, we call this a negative feedback loop. Positive feedback loops are just the opposite. When a change occurs in a system, a positive feedback loop acts to increase or exacerbate it. Labor preceding childbirth is a classic example of a positive feedback loop. Contractions of the uterus during childbirth stimulate the release of a hormone, oxytocin, which in turn induces more uterine contractions. The self-amplifying nature of the positive feedback loop is repeated over and over with increasing intensity until the baby is born. After birth, contractions stop and the feedback loop ceases. Here are a few well-known physiological processes and parameters that involve feedback loops. Pause the video here and determine which ones involve negative feedback and which ones involve positive feedback. Negative feedback loops minimize deviations within a system, keeping its parameters close to a desired set-point. The control of blood glucose, blood pressure, and breathing rates rely heavily on negative feedback loops. Positive feedback loops, on the other hand, tend to destabilize a system by amplifying a stimulus towards an extreme. This is important in irreversible processes such as action potential generation, blood clotting, lactation, and ovulation. There are many other examples of negative and positive feedback loops in the human body. Now let's take a closer look at specific components involved in a feedback loop. The receptor is the component that detects and measures changes in a given parameter. The receptor then relays this information to a control center. The control center compares the measured parameter to a desired set point. Based on the extent of deviation, the control center decides on the appropriate response and sends signals to an effector. Effectors can be muscles, organs, or any other component that receives signals from the control center. In response to these signals, the effectors can either enhance or reduce the deviation. If the deviation is enhanced, we have a positive feedback loop. And if it is reduced, we have a negative feedback loop. Now let's go back to our thermoregulation example in greater detail. Here, the parameter we are controlling is internal body temperature. The receptors of temperature in our body are specialized cells called thermoreceptors. Thermoreceptors continually monitor our temperature and pass this information to the control center in the brain, called the hypothalamus. The hypothalamus compares the measured temperatures to the set point of 37 áµ'C. It can distinguish temperature differences as small as a hundredth of a degree! The hypothalamus then sends out signals to effectors in the body to initiate corrective mechanisms when our temperatures are too high or too low. The effectors react accordingly to adjust our body temperature. When we are too hot, signals are sent to activate our sweat glands. Blood vessels in the skin are also stimulated to dilate. These changes increase heat loss from the skin. When we are too cold, signals are sent to the tissues to increase metabolism, and to the muscles to induce shivering. These mechanisms generate heat. Signals are also sent to constrict blood vessels and to raise skin hairs to minimize heat loss. Both negative and positive feedback loops are equally important for the healthy functioning of one's body. Complications can arise from failure of these mechanisms. Let's look at blood glucose regulation, and see what happens if the feedback mechanisms do not work as they should. Glucose is the primary source of energy for the body's cells. Thus, in a healthy individual, glucose levels are tightly regulated to maintain a fairly constant and optimal supply in the bloodstream. Too little or too much blood glucose could be damaging to the body. Circulating levels of glucose are monitored by specialized beta cells in islets of Langerhans in the pancreas. In response to high glucose levels, for example after a large meal, these same beta cells release a hormone called insulin into the bloodstream. Insulin is transported to the rest of the body, whereupon it stimulates the cells to take up and adsorb glucose. Insulin also promotes the storage of glucose in muscle and liver tissues. These actions act to remove glucose from the blood, thus lowering blood glucose levels to the normal set-point. Blood glucose regulation is a classic example of negative feedback. Pause the video and identify the receptor, control center, and effectors in this particular feedback system. The receptors are the beta cells in the pancreas. These same cells also act as the control center and send signals to the effectors in the form of insulin. The effectors are the cells of the body that increase their uptake and storage of glucose in response to insulin. Now let's see how failure of the body to regulate blood glucose levels results in a disease known as diabetes. There are two common forms of the disease. In Type I diabetes, also known as early-onset diabetes, the insulin-producing beta cells of the pancreas are destroyed due to an autoimmune reaction. In this form of diabetes, the body is unable to produce insulin. The lack of insulin means that the cells of the body do not take up glucose in response to increasing glucose levels. Hence, glucose levels in the blood continue to rise. In Type II diabetes, or late-onset diabetes, insulin is still produced but the body's cells no longer respond to it. This is often due to years of insulin over-production, caused by a high-sugar diet. The inability of cells to use insulin properly means that high glucose levels in the blood persist with time. Type I and Type II diabetes have very similar symptoms but they arise from different causes. Pause the video and identify the parts of the feedback loop that break down in each. In Type I diabetes, there is a lack of signaling between the control center and the effectors. In Type II diabetes, the effectors fail to respond to the signals from the control center. The end result is the same in both forms of the disease - glucose accumulates to toxic levels in the blood. If left unchecked, diabetes can lead to kidney failure, blindness, and heart disease. Feedback loop breakdown leads to the development of an unstable internal environment. This tips the scales towards imbalance, increasing the risk of illness and progressive damage to the body. Many other diseases and pathological conditions follow a similar progression. In this video, you learned about negative and positive feedback loops, their general components, and how they regulate the flow of information. We identified feedback loops in the body and examined their role in childbirth, thermoregulation, and blood glucose regulation. Our body relies on a finely-tuned system of checks and balances to function smoothly. Feedback loops, like the ones described in this video, provide this balance. Failure of these mechanisms, as in the case of diabetes, can be detrimental. We hope that you will apply your knowledge of feedback loops and the consequences of their failure in the study of other biological processes and diseases.