

IPRO 308: The Artificial Pancreas

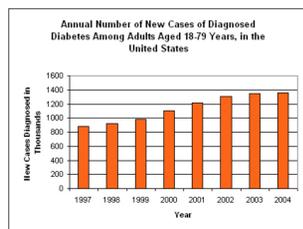
"Makin' life sweet for diabetics"

What Is Diabetes?

Diabetes is a condition which is defined by the inability of the body to produce or utilize insulin. There are two major types of diabetes: Type I and Type II. In a Type I individual, the pancreas is unable to produce insulin. A Type II patient is able to produce insulin, but can not use it.

Who Has Diabetes?

Approximately 3 people are diagnosed as being Type I diabetic every hour in the U.S. About 10% of all diabetics are affected by Type I diabetes. The graph below shows that there is an increasing incidence of Type I diabetes; to be exact the number of people with the disease has doubled within the last fifteen years and it continues to be a pressing health concern.



Why Is Diabetes Dangerous For Your Body?

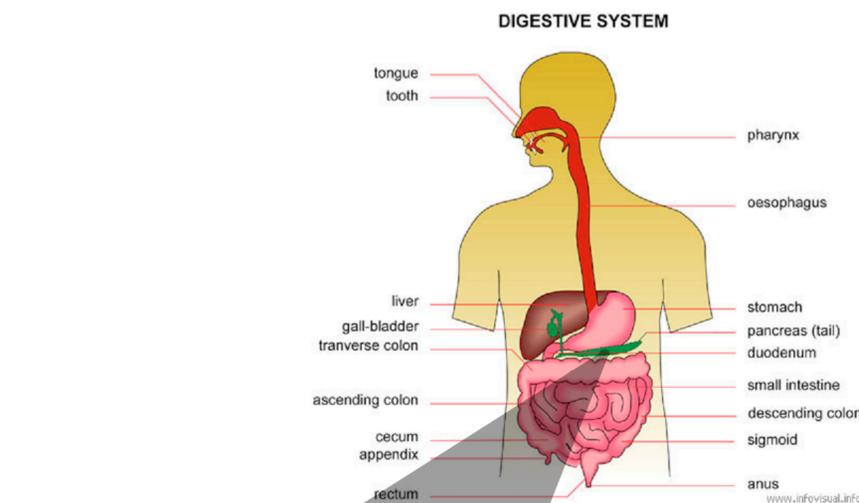
The most common disorders associated with Type I diabetes are hypoglycemia, hyperglycemia, ketoacidosis and celiac disease. The disease can also lead to several complications, such as heart disease, blindness, nerve damage and kidney damage.

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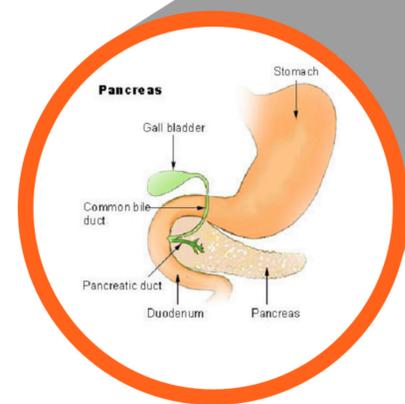
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How Is Diabetes Inconvenient To Your Life?

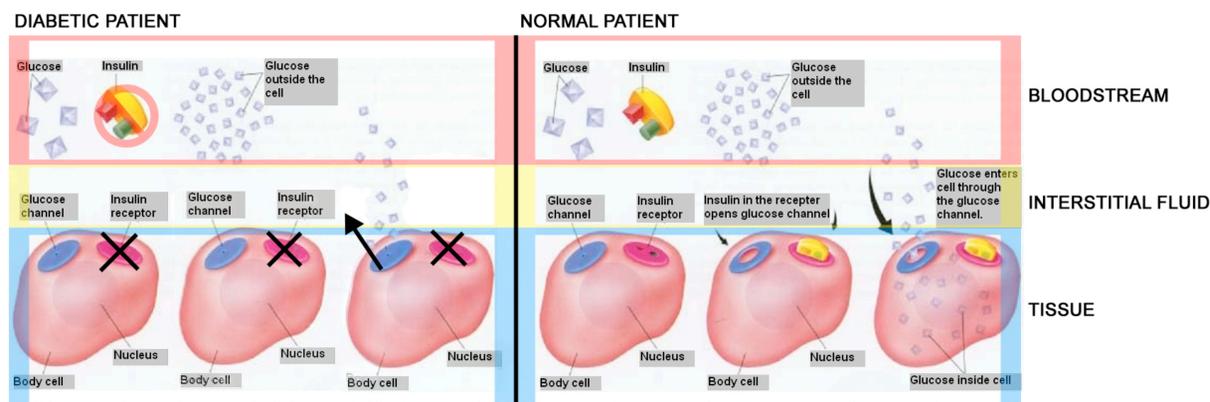
- ❖ **Sleeping:** glucose levels must be checked during the night to avoid slipping into a hypoglycemic coma
- ❖ **Eating:** meals have to be scheduled and they can only contain a calculated amount of carbohydrates
- ❖ **Exercising:** too much insulin during exercise can lead to a hypoglycemic coma
- ❖ **Social Activities:** leaving to check glucose levels or injecting yourself with glucose poses an awkward situation at parties or a restaurant



Digestion of food begins in the mouth and continues in stomach. The food then travels to the intestines, where the glucose from the food is absorbed into the bloodstream.



Depending on your activity (sleep, exercise, eating, etc.) the amount of glucose in your bloodstream will vary. This activity stimulates the pancreas to secrete a specific amount of insulin and other hormones to maintain a normal glucose level. Insulin is a hormone which signals cells to uptake glucose from the bloodstream. For example, eating increases blood glucose levels; the pancreas then releases insulin to aid glucose storage in the liver.



In a diabetic patient, either insulin is not produced (Type I diabetes) or the insulin receptor is flawed (Type II diabetes). In both cases, glucose does not flow into cells and its level remains high in the bloodstream.

In a normal patient, insulin will bind to the insulin receptor. This will signal a glucose channel to open up. Then glucose is free to flow into the cell.



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What Has Been Done So Far?

Traditional treatments include pricking fingertips for blood glucose reading, following injection of insulin. For severe cases of diabetes, patients lean towards pump therapy for constant delivery of insulin.

The most advanced pump available at the moment is MiniMed's Paradigm™ Pump. This device incorporates an invasive continuous blood glucose monitor with insulin delivery.

What Is Unique About the Artificial Pancreas?

- ❖ **Non-Invasive:** No poking or pricking of sharp needles at any time!
- ❖ **Automated Insulin Delivery:** There is no need for you to calculate the amount of insulin you will need!
- ❖ **Freedom:** Flexibility during meals! No more carb counting or scheduled meals!

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Artificial Pancreas

Glucose Monitoring

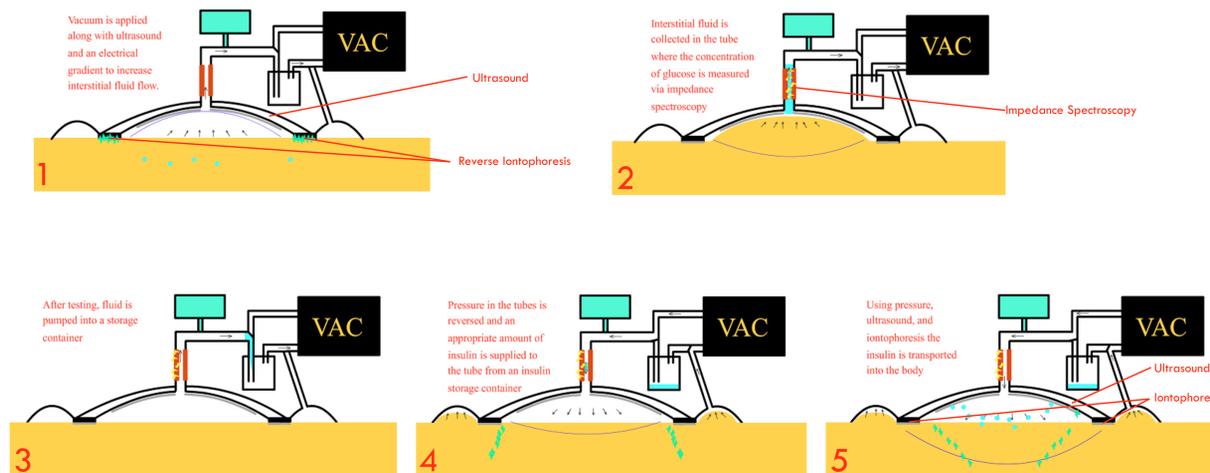
The glucose monitoring system is comprised of three simultaneous steps:

A) Ultrasound- by emitting frequencies higher than the normal ear can hear, pores in the skin will be dilated; this will aid in the extraction of interstitial fluid

B) Reverse Iontophoresis- a gradient is created between the skin and the device; this causes the charged fluid to migrate towards the collection vial

C) Vacuum- the suction allows for further extraction of the interstitial fluid

Mechanics



Aesthetics



Insulin Delivery

The insulin delivery system steps also occur simultaneously

A) Ultrasound- the same frequency that was administered during the glucose monitoring is also administered in the insulin delivery to keep pores dilated

B) Iontophoresis- current which forms the gradient aids the flow of the insulin through the pores of the skin

C) Positive Pressure- this will push the insulin into the body

The Past, The Present & The Future

In the previous IPROs, the methodology for non-invasive blood glucose monitoring was created. This semester, IPRO 308 has formed the technology for non-invasive insulin delivery and incorporated it with the glucose monitor to construct the artificial pancreas.

The future IPROs will be dedicated to perfecting the current device while adding complimentary features such as safety alarms, aesthetic options, and a user-friendly program.