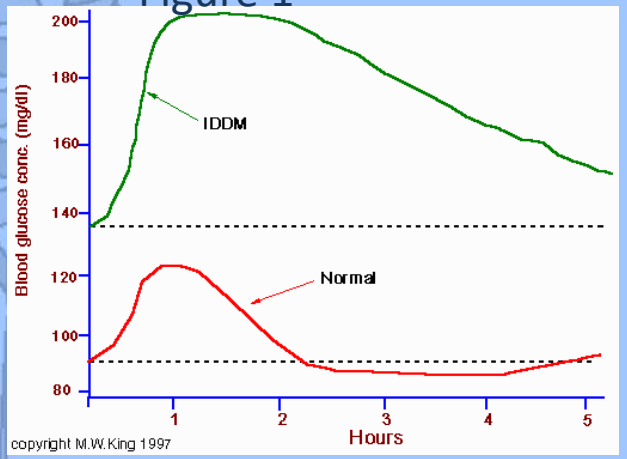
Insulin-Dependent Diabetes Mellitus: Cause and Cure

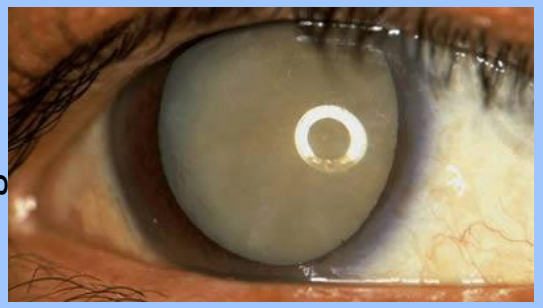
By Nadra Rahman

Figure 1



Physiology

Figure 2



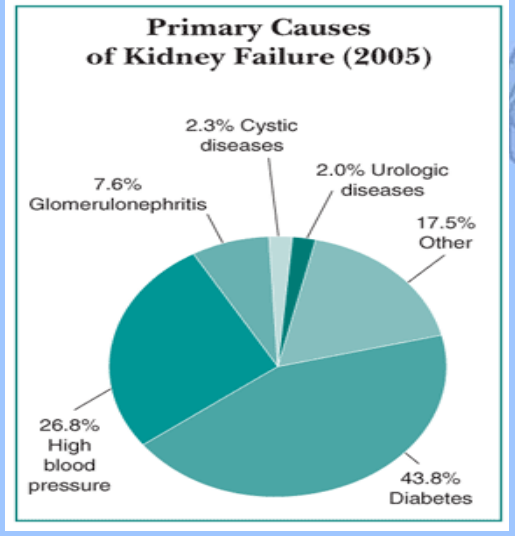
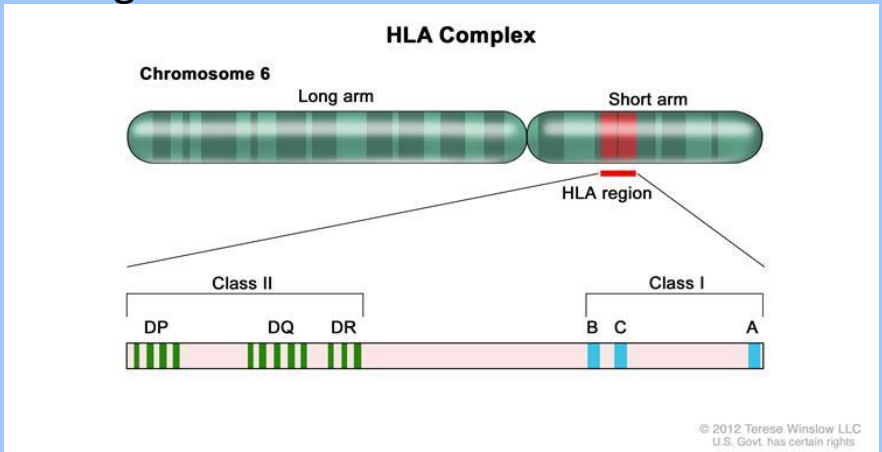


Figure 3

- Insulin-Dependent Diabetes Mellitus (IDDM) is a condition caused by the autoimmune destruction of islet β cells in the pancreas. Because β cells produce insulin (in response to glucose), this causes insulin deficiency.
- The age of onset ranges, as loss of insulin reserve can take place over many years.
- White people of northern European descent are more prone to the disease, with North American Caucasians having a 1 in 300 risk of developing IDDM.
- Phenotypic features: fasting hyperglycemia (high blood sugar), ketoacidosis (acids called ketones build up in the blood and urine, poisonous), polyuria (excessive urination), polydipsia (chronic excessive thirst), polyphagia (excessive appetite), glucose intolerance, wasting
- Medical issues linked to IDDM include atherosclerosis (thickening of artery walls), peripheral neuropathy (damage to the nerves of the peripheral nervous system), renal disease, cataracts, retinopathy.
- About half of all patients eventually die of renal failure, but the risk of complications is cut sharply if glucose levels are controlled

Molecular Cause

Figure 4



- The mode of inheritance for IDDM is as of yet undetermined.
- IDDM occurs as the result of an unknown abnormality associated with the HLA (human leukocyte antigens) complex on chromosome 6. HLAs are proteins on cell surfaces that allow the body to tell the difference between self and foreign intruder.

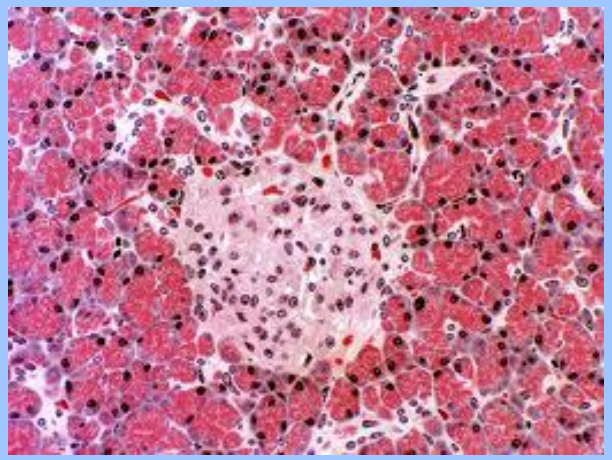


Figure 5

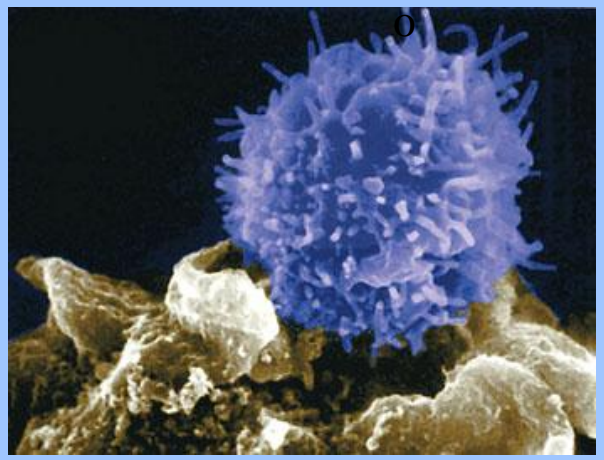


Figure 6

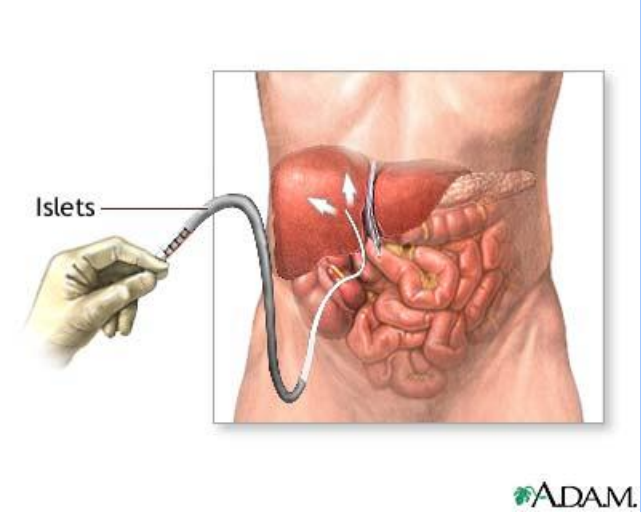
- There are certain susceptibility alleles:
- 95% of diabetics have the HLA-DR3, HLA-DR4, and (a specific) HLA-DQ-Beta gene.
- Protective allele? Possibly HLA-DR2

- The abnormality causes the immune system to recognize beta cells as alien, so the immune system attacks them. T-lymphocytes turn against β cells, soon joined by B-lymphocytes. Byproducts include autoantibodies. May be linked to chr. 11 genes as well.
- There may possibly be viral / environmental triggers involving exposure to certain illnesses with the same allotropes as β cells.

Treatment

Figure 7

Figure 8



- IDDM can be diagnosed through simple blood tests that check for high blood glucose; physicians also look for symptoms such as increased urination, increased thirst, and unexplained weight loss. Urine will be tested for the presence of ketones.
- Many people who have IDDM learn to manage it through insulin therapy: insulin shots daily/multiple times a day, daily exercise, balanced diet (tracking carbohydrates), monitor glucose levels. The purpose of this therapy is to control how much insulin is in the bloodstream.
- Limits/Drawbacks: Patients must inject themselves consistently, which may become a problem is one is unmotivated; insulin shots can increase the risk of hypoglycemia (low blood glucose) episodes and initial weight gain
- Experimental: Pancreatic islet transportation, pancreas transplantation
- Limits/Drawbacks: Invasive, immunosuppressant drugs

Proposed Cure

- Based on the technological advances of machines like the DRI BioHub
- One possible cure involves the insertion of a “mini organ” into the body; it would mimic the pancreas, containing insulin-producing cells
- These cells would react to the presence of glucose just as real β cells do, with precision and accuracy; they would be grouped in clusters.
- Cells’ natural environment would be closely replicated, with the proper amount of oxygen, space, and nutrients.
- The cells would be in biocompatible platforms: possibly a silicon scaffold (a small, porous material with pores); more natural platforms such as the venous sac may also be used.
- Conditions such as oxygen supply and the particular types of “helper cells” and growth factors available can be modified.
- Any type of insulin-producing cell engineered in the future may be housed in the platform, including cells that produce betatrophin, a recently discovered hormone that caused mice to produce pancreatic β cells at a much higher rate than normal.
- The islet cells would be protected by a thin coating made of special polymers.
- Pros: no daily injections, limited use of immunosuppressant drugs, immune system will not attack islet cells/they will be protected
- Limits/Drawbacks: some use of immunosuppressant drugs, somewhat invasive.

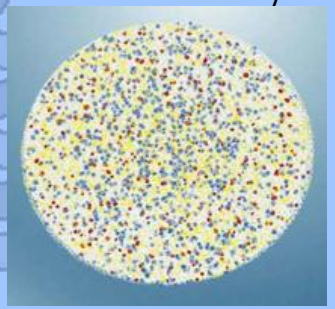


Figure 9

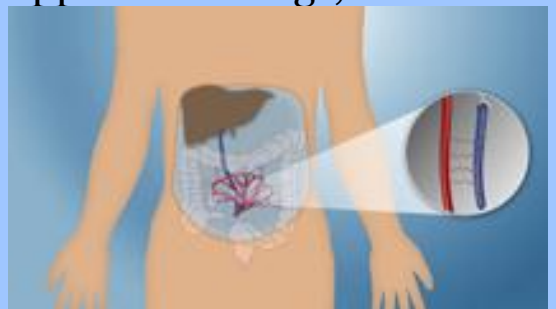


Figure 10

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