

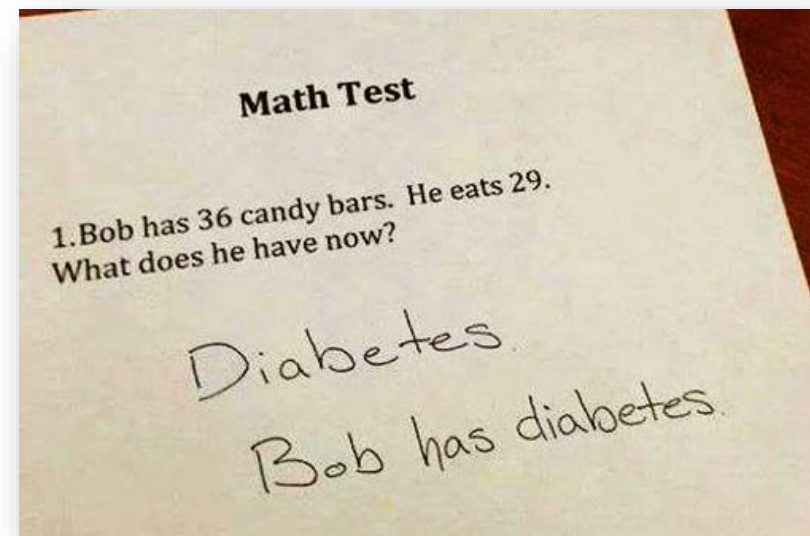


Diabetes

When Sugar's Not
So Sweet

Joe Bean, M.D.
LLI Spring 2025

(Images are from a variety of sources and used only for educational purposes!)



Not so long ago...

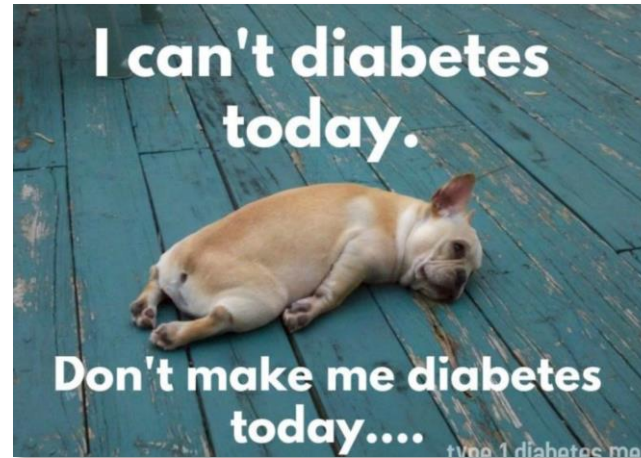


J. Bond Francisco, *The Sick Child*, 1893, oil on canvas, Smithsonian

- What was diabetes like for most people throughout history?



Cornelis de Bie, *A Medical Practitioner Examining a Urine Flask*, 1621



- Why is it important to understand this disease now?

- What will we talk about this afternoon?

Diabetes Statistics, U.S., 2021

Prevalence: 38.4 million (11.6%)
5% with type 1; 95% with type 2
10% undiagnosed
In seniors (65 and older) – 16.5 million (29.2%)

New Cases: 1.2 million each year

Diabetes by race/ethnicity:
13.5% of American Indians/Alaskan native adults
12.1% of non-Hispanic Black adults
11.7% of Hispanic adults
9.1% of Asian American adults
6.9% of non-Hispanic White adults

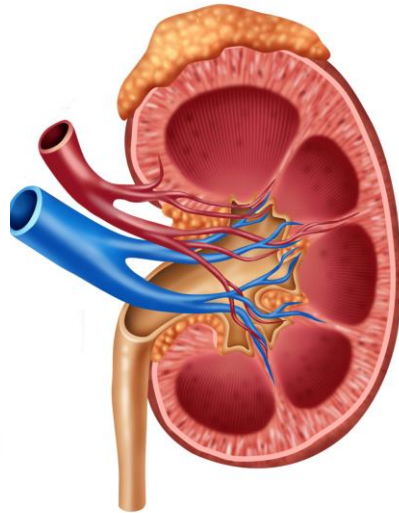
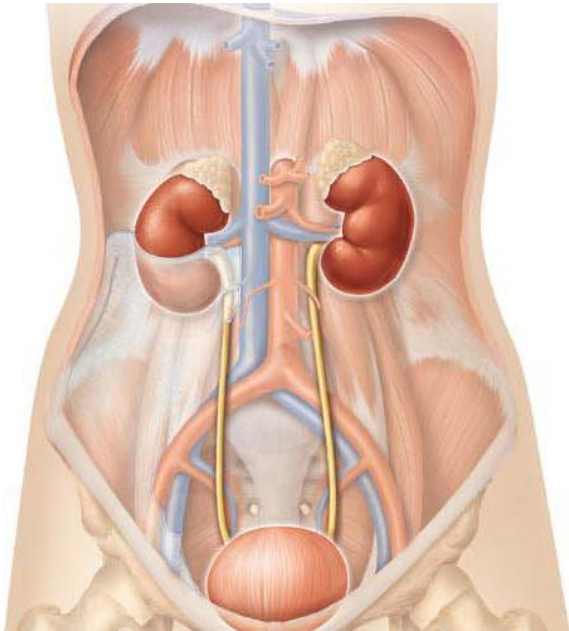
Deaths: 8th leading cause of death in 2021 (103,000)

Cost: \$412.9 billion per year,
Average patient expense 2.5x more than if they did not have diabetes



What is Diabetes?

- Chronic disease named for its chief presenting symptom: **Increased Urination**



- From Greek *Dia* “through”



Diabainen “to pass through”



- Diabetes mellitus vs. Diabetes insipidus



- Assumed to be a kidney disease until the 19th century



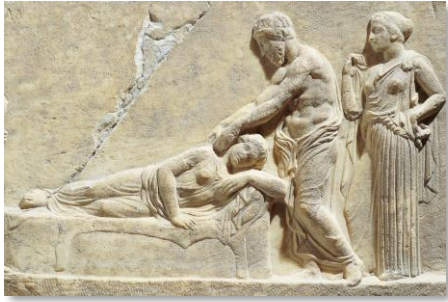
A Disease with Ancient History...

- **16th century BCE:** descriptions on Egyptian medical papyri



Ebers papyrus

- **5th century BCE** – Hindu physician **Sushruta** describes honey-like urine that attracts ants

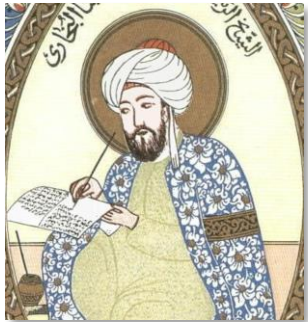


- **3rd century BCE** – Greek physician **Apollonius of Memphis** coins the term “diabetes”

- **3rd century** – “Chinese Hippocrates” **Chang Chung-Ching** describes symptoms



- **10th century** – Persian polymath **Avicenna** notes sweet taste in the *Canon of Medicine*



- **11th century** – Sephardic Rabbi **Maimonides** describes symptoms, including respiratory effects



- **1674**– English physician **Thomas Willis** differentiates types of “pissing evil” by taste

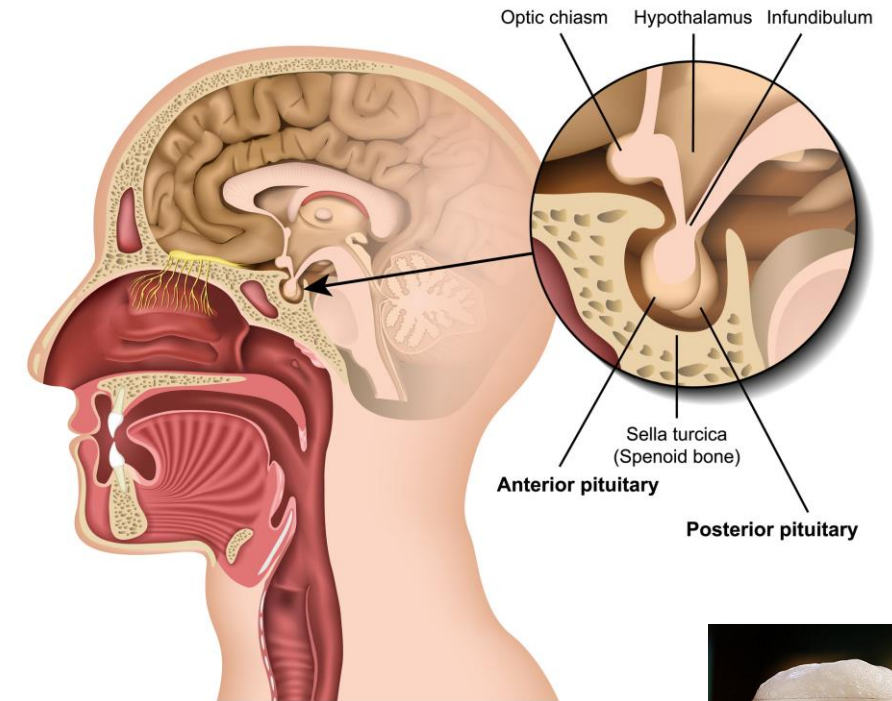
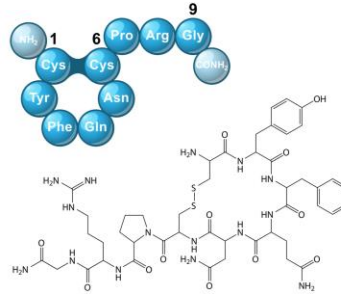


The Other Diabetes...Diabetes Insipidus

- A failure to make or failure to use antidiuretic hormone (ADH)



- Normally released from the pituitary gland
- Causes kidneys to keep water in the body

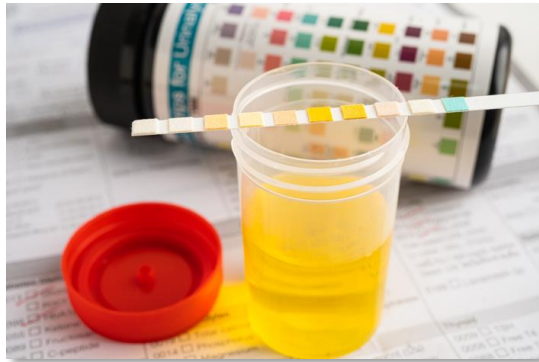


- Without ADH, too much water is lost in the urine

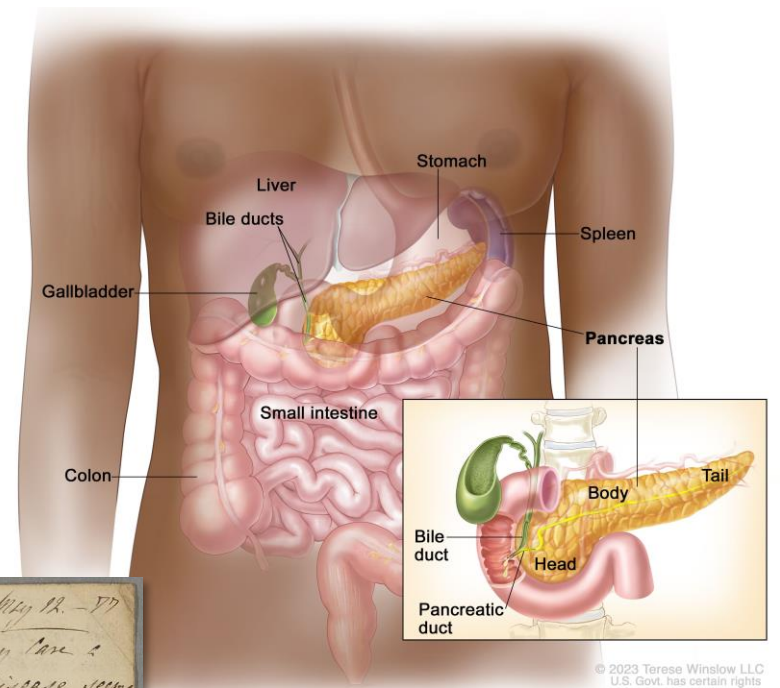


Diabetes Mellitus

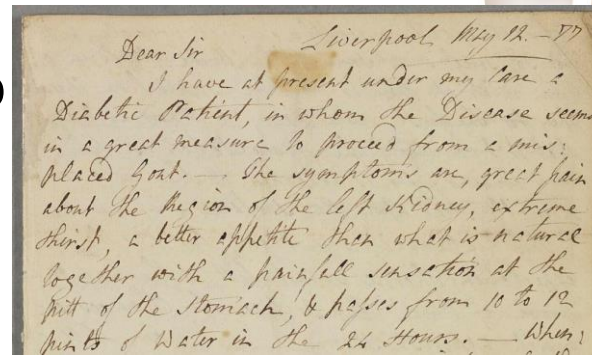
- Failure to make or failure to use insulin →
- Results in high blood sugar (hyperglycemia)
- Normally made by the pancreas



- Leads to sugar in urine (glycosuria)



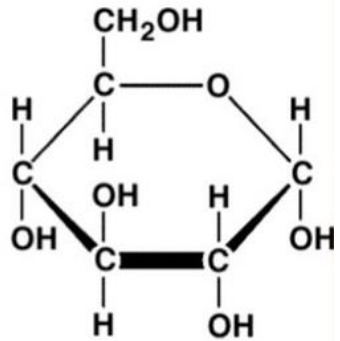
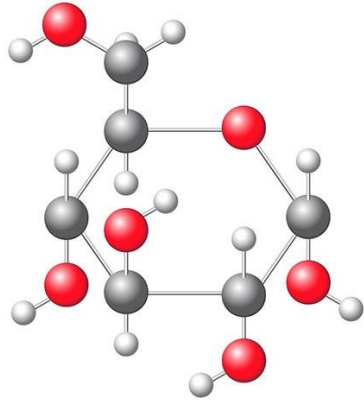
- 1776 **Matthew Dobson** – boiled urine to dryness, crystallized “brown sugar” taste, subsequently found high glucose in blood



- Type 1 vs. Type 2

What is Blood Sugar?

- Glucose – main energy source in cells



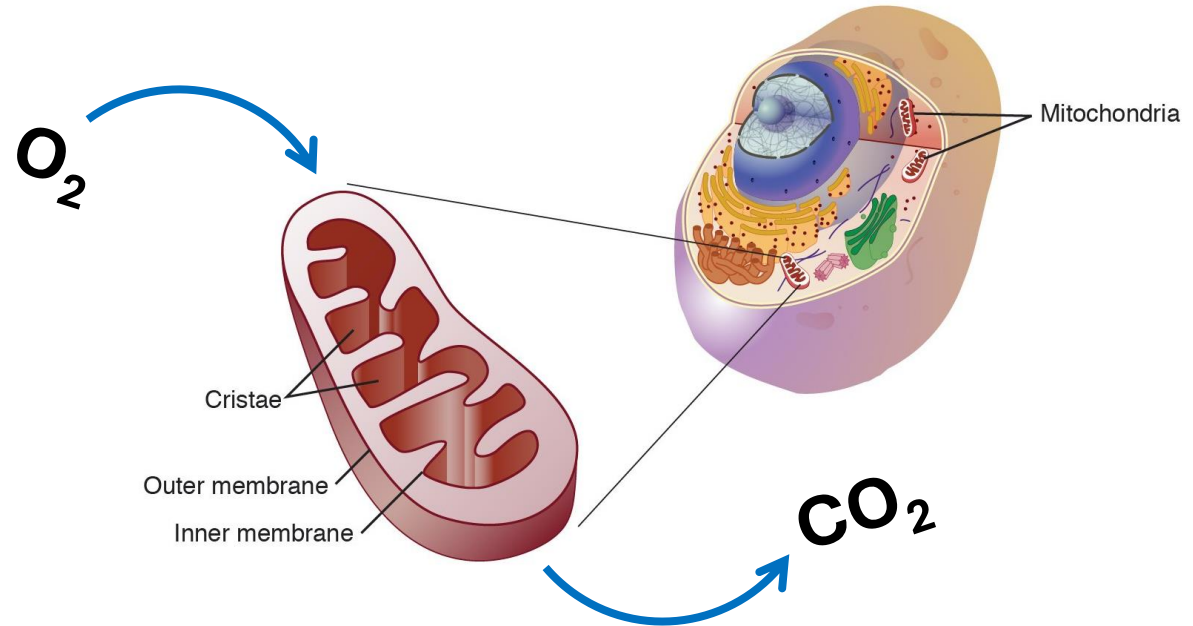
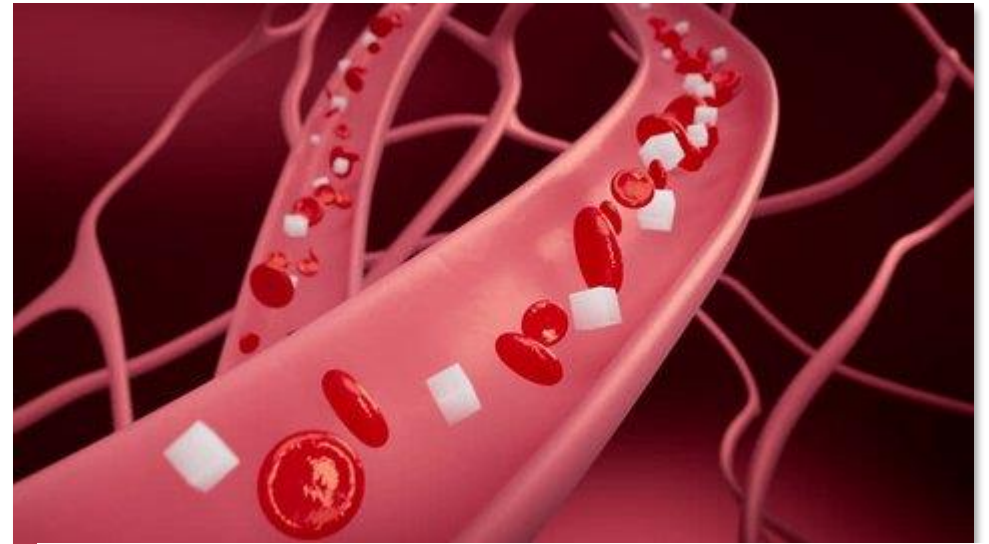
- Glycolysis and Cellular Respiration



Breakdown of glucose

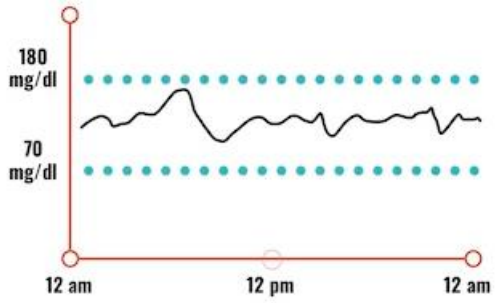


Occurs in mitochondria, uses oxygen and makes carbon dioxide

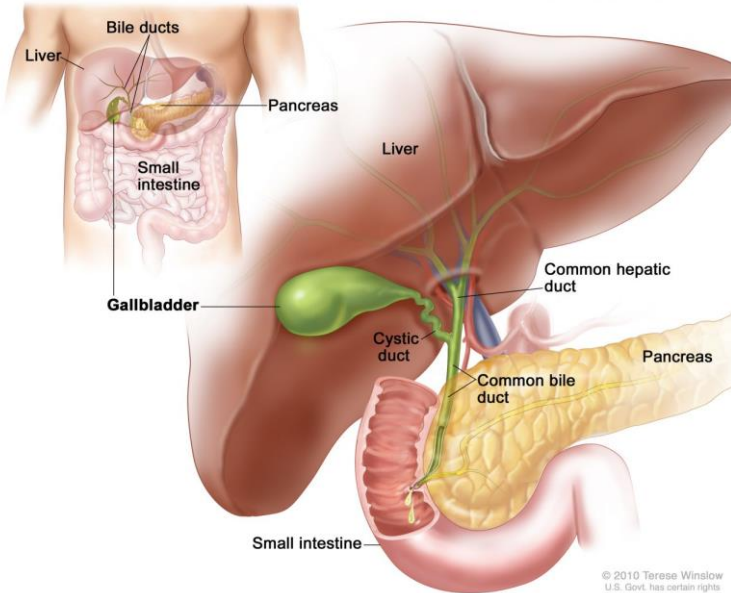
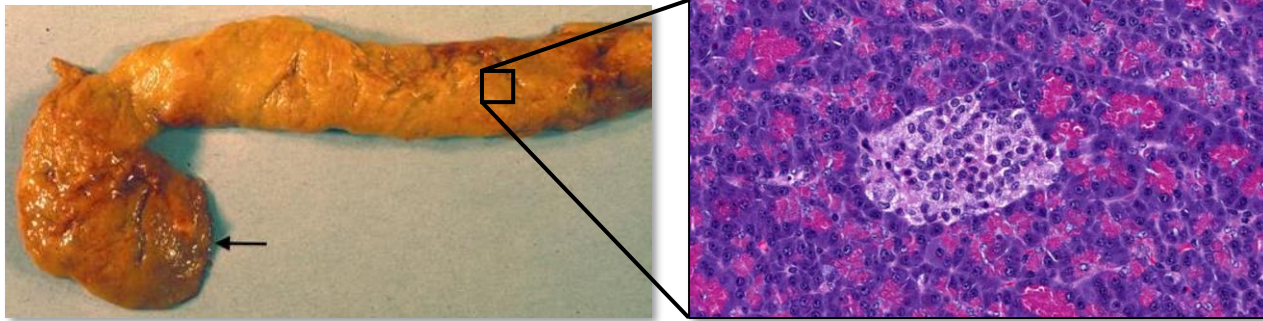


- Energy is used to make ATP

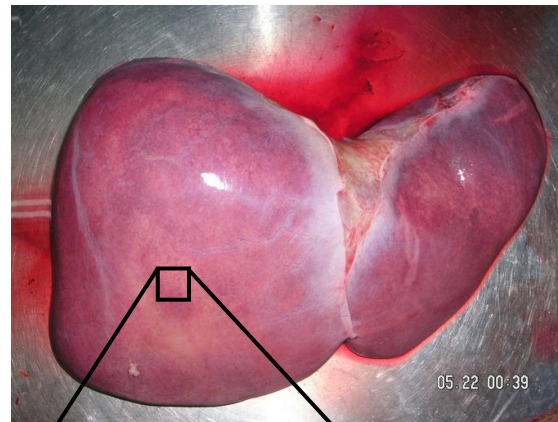
Blood Glucose Regulation



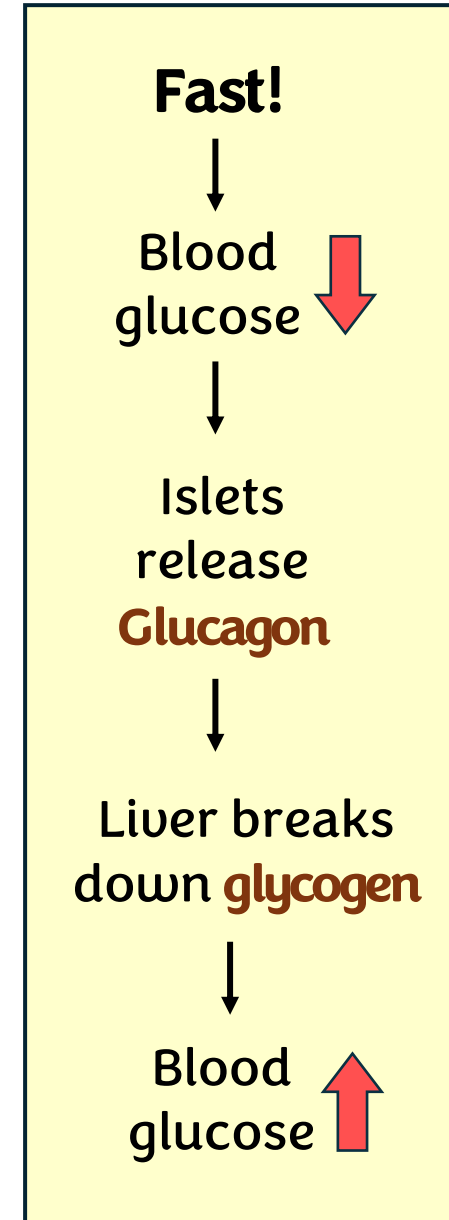
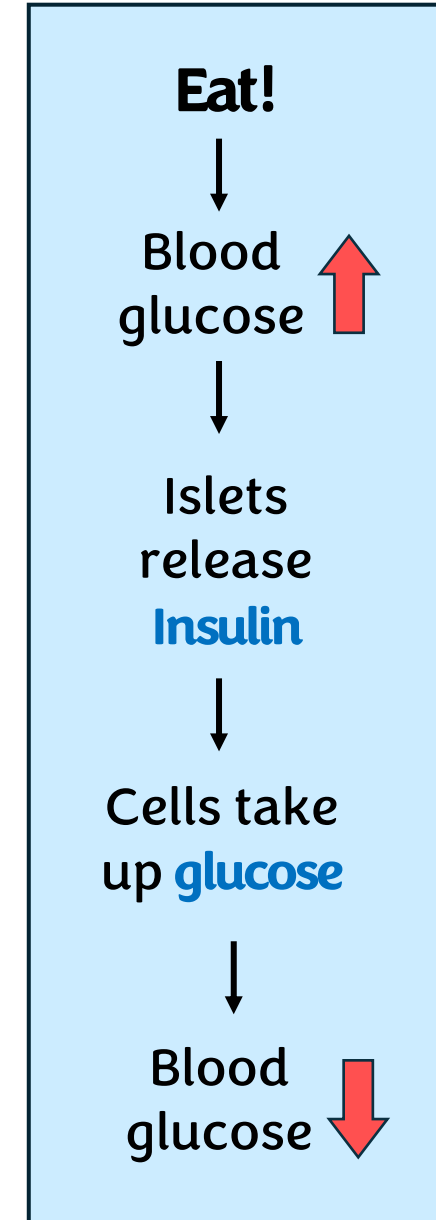
- Meet the pancreas!
- Pancreatic islets



- Meet the liver!



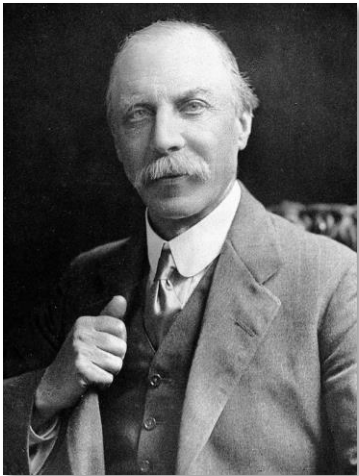
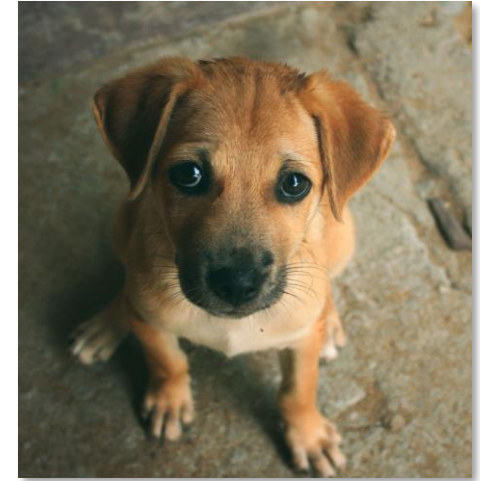
Glycogen (glucose storage)



Discovering the Problem



- **1889 - Oskar Minkowski and Joseph von Mering**
- Removed pancreas from dogs, causing fatal diabetes



- **1910 - Edward Albert Sharpey-Schafer**
- Hypothesized insulin, named from “insula” meaning island



- **1921 - Frederick Banting and Charles Best**
 - Discovered insulin!
 - Induced diabetes in dogs and cured it with purified pancreatic extract
 - Leonard Thompson, age 14, first person to receive insulin

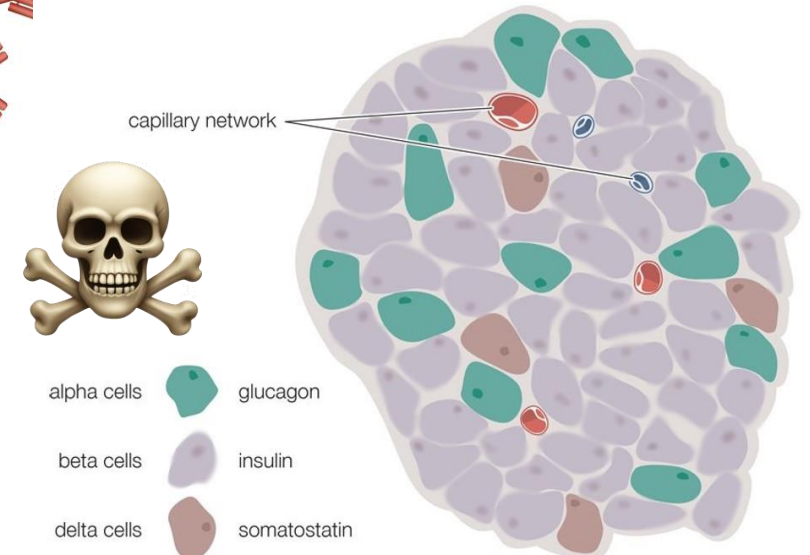
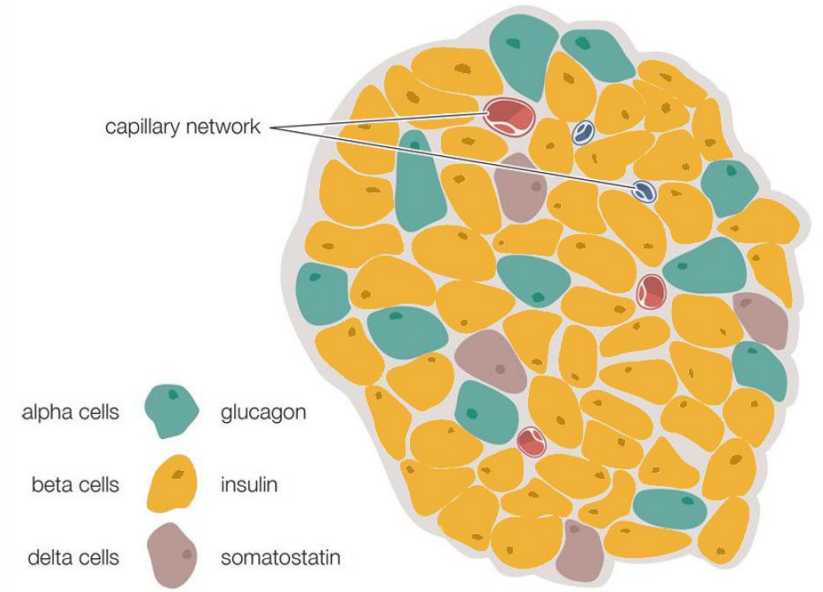
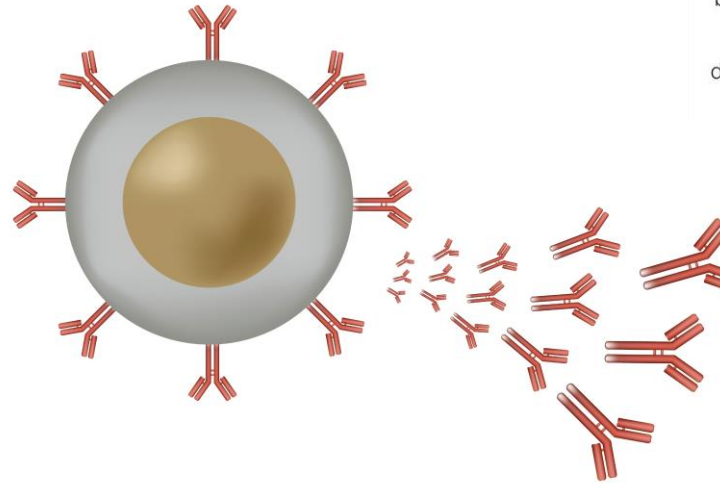
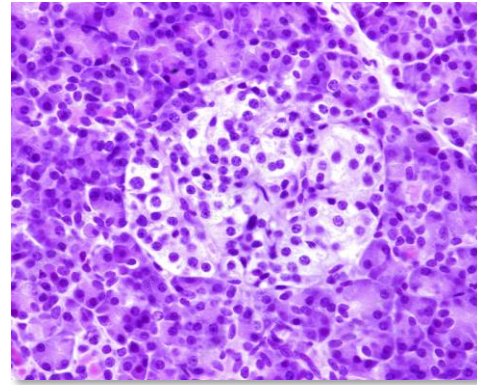


Type I Diabetes

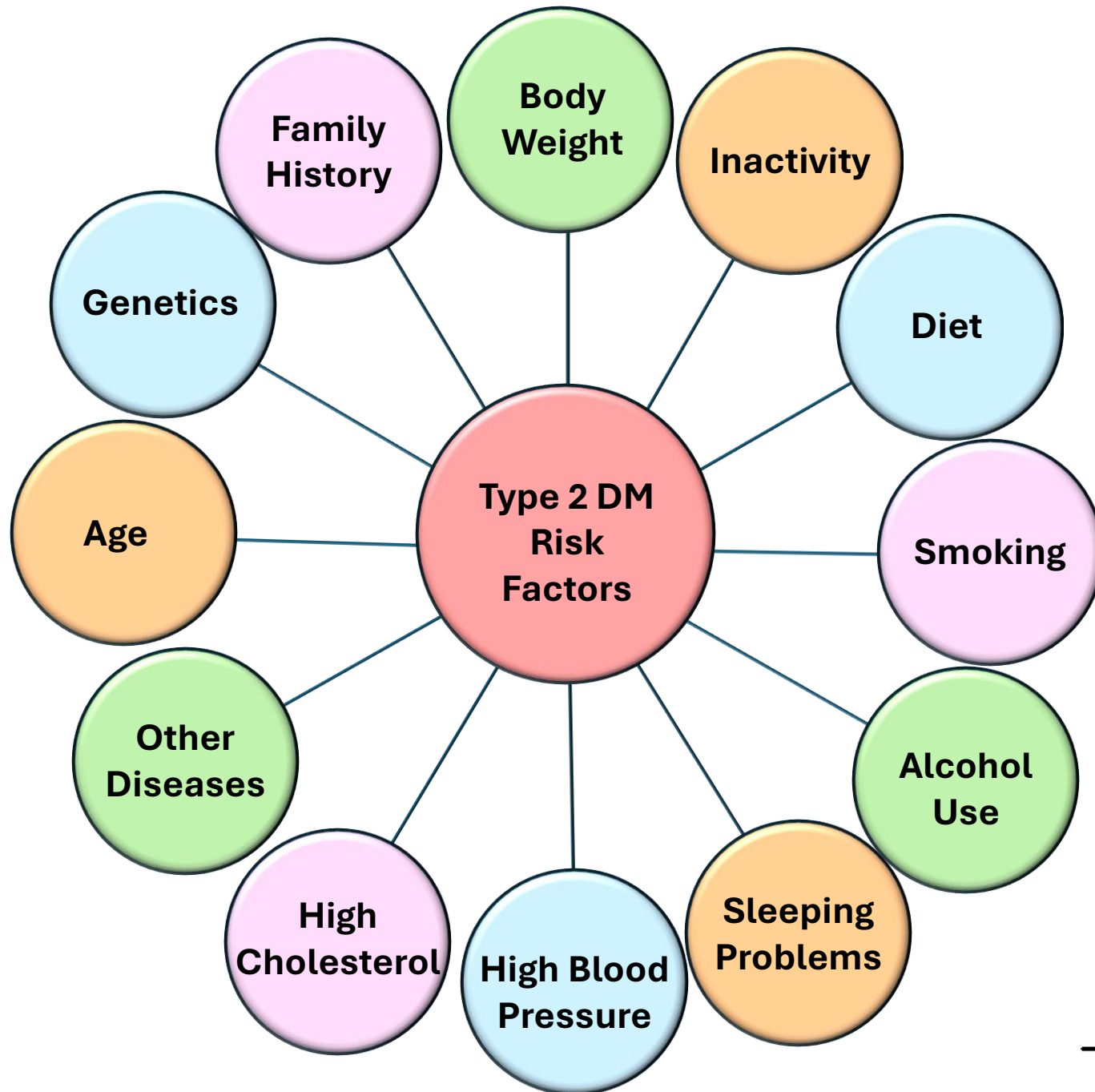
- Formerly “childhood onset”



- Autoimmune destruction of pancreatic beta cells
- Insulin-dependent



Type II Diabetes



- Formerly “adult onset”

- Decreased insulin production, pancreas “burnout”



- Insulin resistance, cells are not as responsive

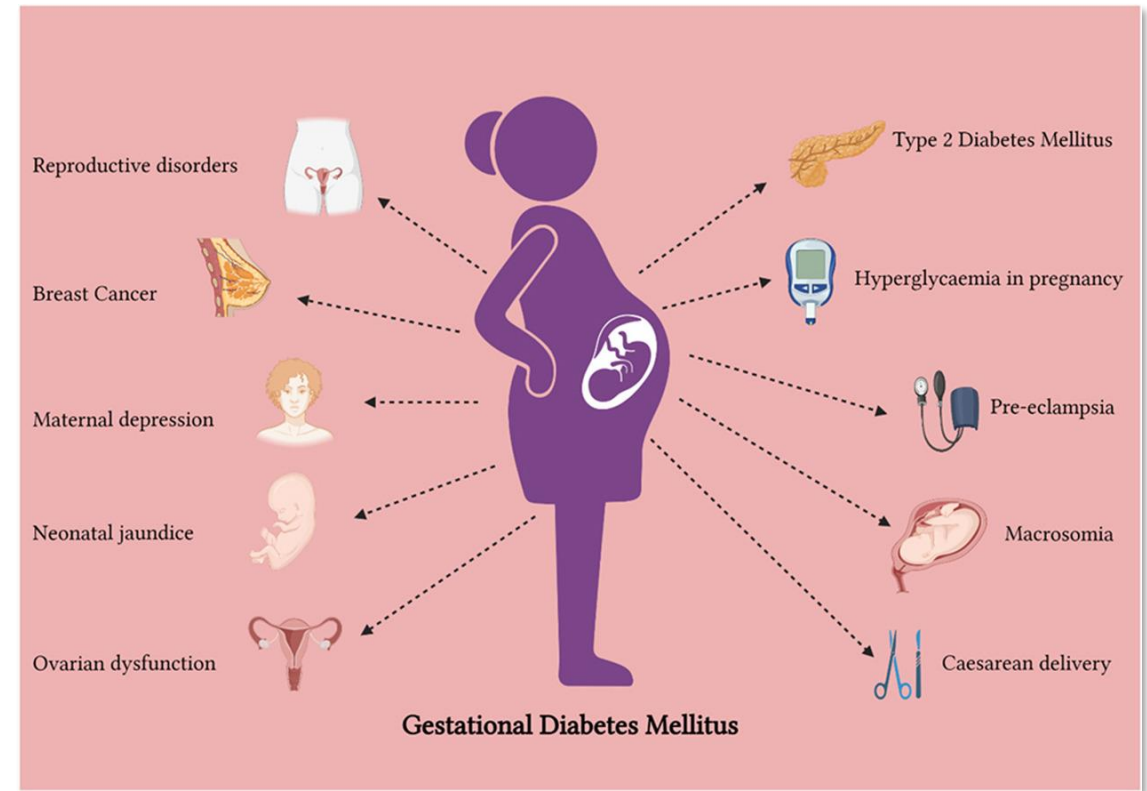
Gestational Diabetes

- Diabetes appearing for the first time during pregnancy
- Cause unknown, excess weight prior to pregnancy increases risk



Complications for baby

- Higher birth weight
- Increased risk of preterm birth
- Higher risk of obesity and type II diabetes later in life



Complications for mom

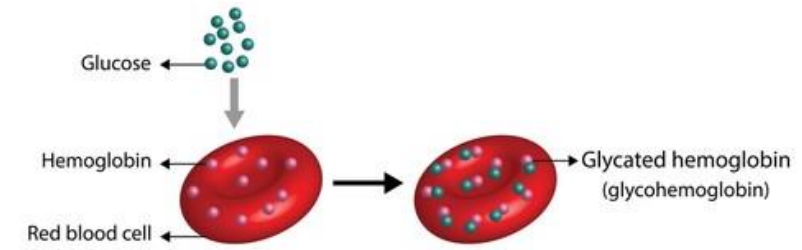
- Hypertension and preeclampsia
- Higher likelihood of C-section
- Future diabetes more likely

Symptoms

- Increased urination
- Thirst
- Hunger
- Weight loss
- Fruity odor to breath
- Nausea
- Fatigue and weakness
- Blurred vision
- Numbness and tingling of hands and feet
- Frequent infections, poorly healing wounds



Diagnosis



Tests



Normal

Prediabetes

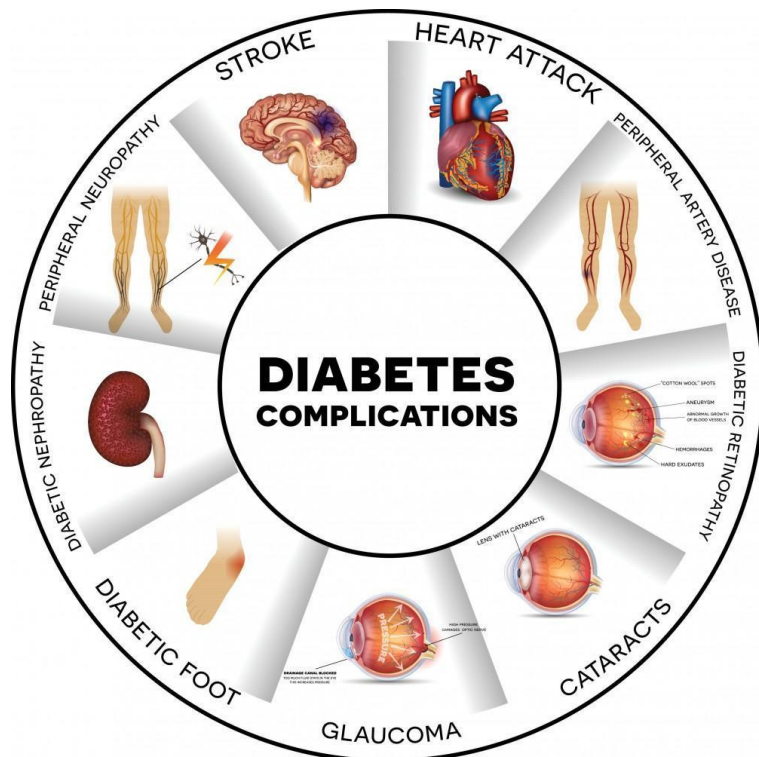
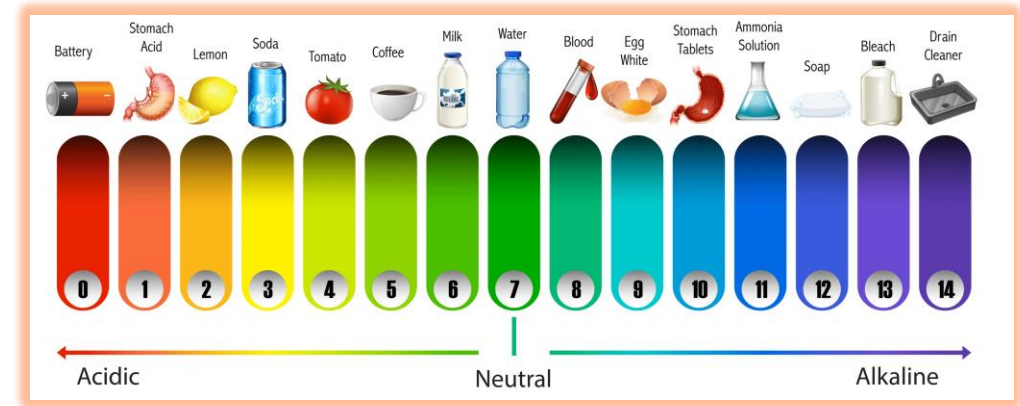
Diabetes

	Fasting Glucose	Oral Glucose Tolerance Test	Hemoglobin A1C%
Normal	<100	<140 (2hrs)	5.6 or less
Prediabetes	100-125	140-199	5.7-6.4
Diabetes	126+	200+	6.5+

Diabetes Complications

Acute problems

- Ketoacidosis (diabetic crisis)
- Rapid fat breakdown creates acids



Chronic problems

- All long-term diabetic complications are due to **BLOOD VESSEL damage**
- The most highly vascular systems are most affected: brain, heart, nerves, eyes, kidneys, healing ability

Prevention is Key

- **Prediabetes is curable**



- Health education
- Elimination of trans fats
- Listing calorie content in restaurants
- Public school cafeteria offerings

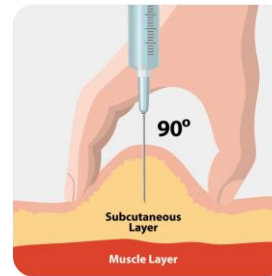
- Rethinking sugar-sweetened beverages
- Food label serving size realism, ingredient transparency



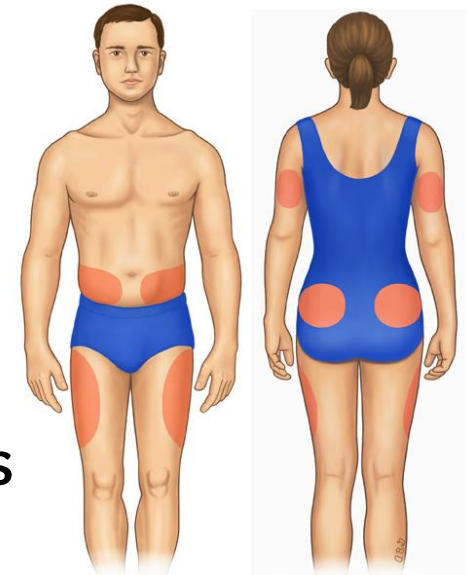
Modern Therapy

Treatments

- Exercise and dietary changes
- Glucose monitoring
- Insulin administration



- Medications

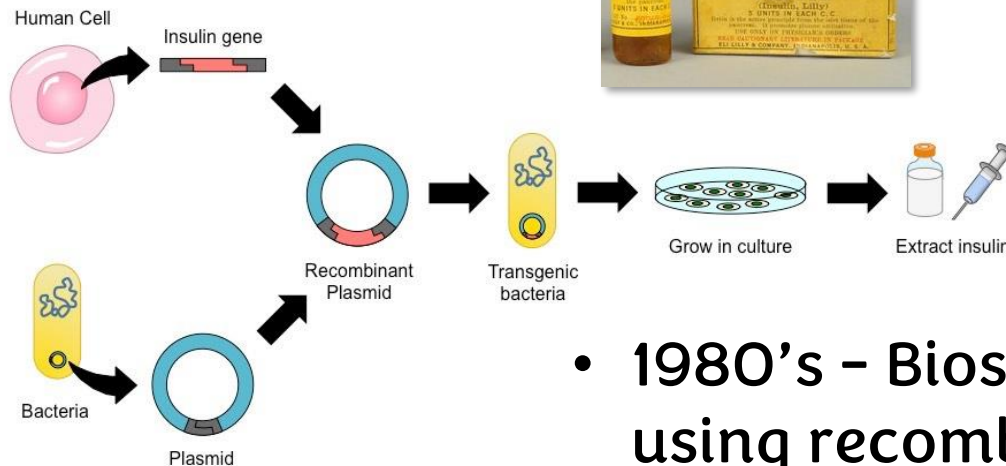
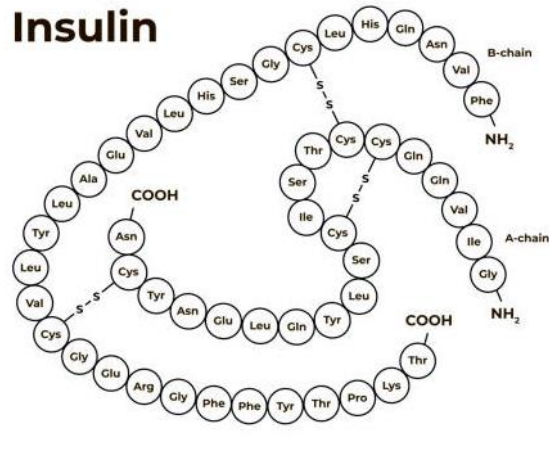


- **Preventative** and multimodal treatment, stress avoidance
- Watch for hypoglycemia!



The Story of Insulin

- Before insulin – fasting and diet modification
- 1920's – insulin purified from bovine and porcine pancreases
- 1950's – **Frederick Sanger** determines amino acid sequence



- 1980's – Biosynthetic human insulin using recombinant DNA technology

Glucose Monitoring

- 1908 – Stanley Benedict develops copper reagent for urine glucose



- 1965 – First blood glucose test strip developed (Dextrostix)



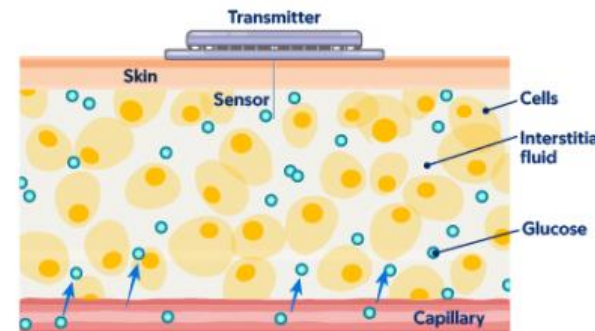
- 1980s – Glucose meters become available for home glucose monitoring,



- Steady improvement over decades – less blood, less pain, more accuracy

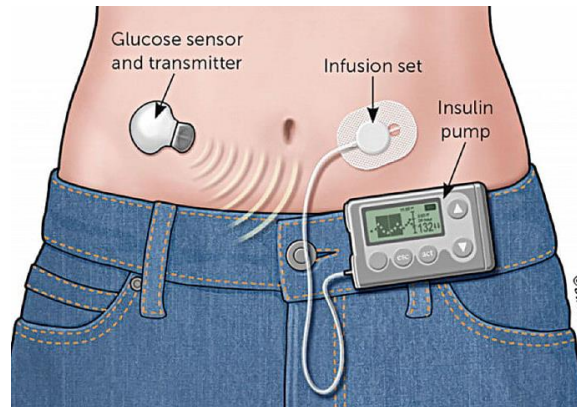


- 2000's – Continuous glucose monitoring



Injected insulin

- Several subtypes



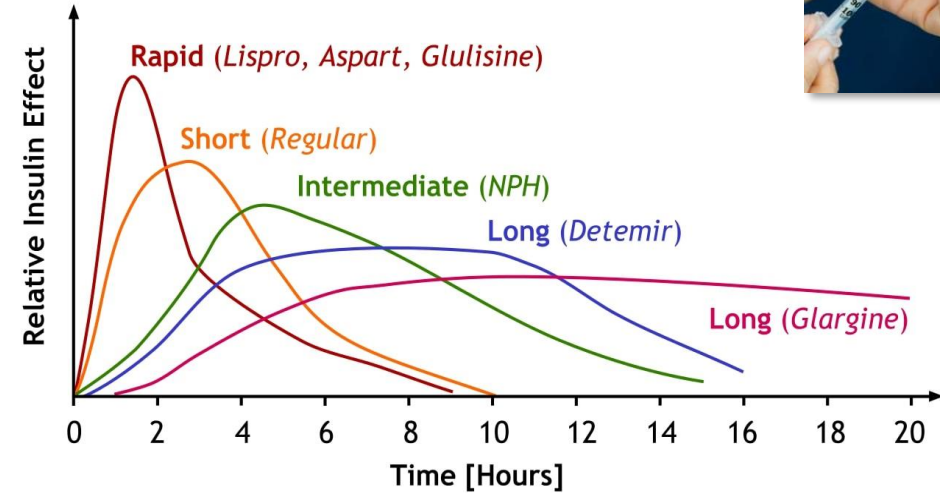
Medications



Oral medications

- 10 major classes of drugs with many mechanisms...

- Increase insulin secretion
- Decrease glucose release from liver
- Make cells more responsive to insulin
- Decrease glucose absorption in the gut
- Block the kidney from retaining sugar
- Alter carbohydrate metabolism in cells
- Promote weight loss
- And more!

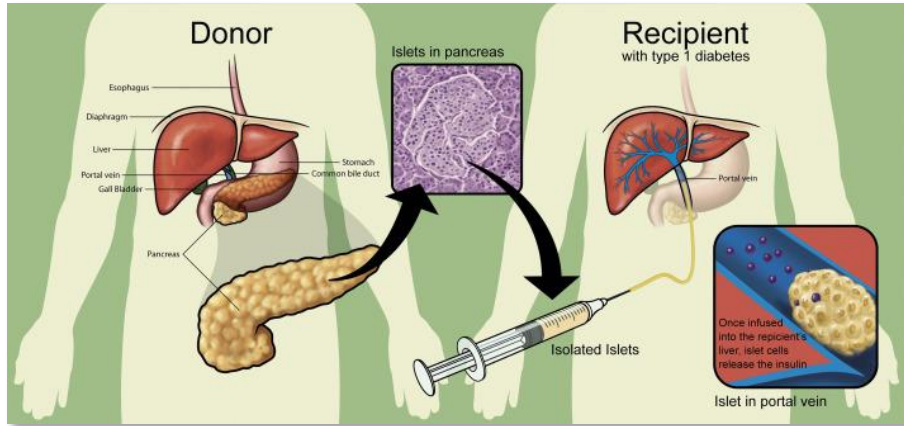


- Pens, patches, pods and pumps

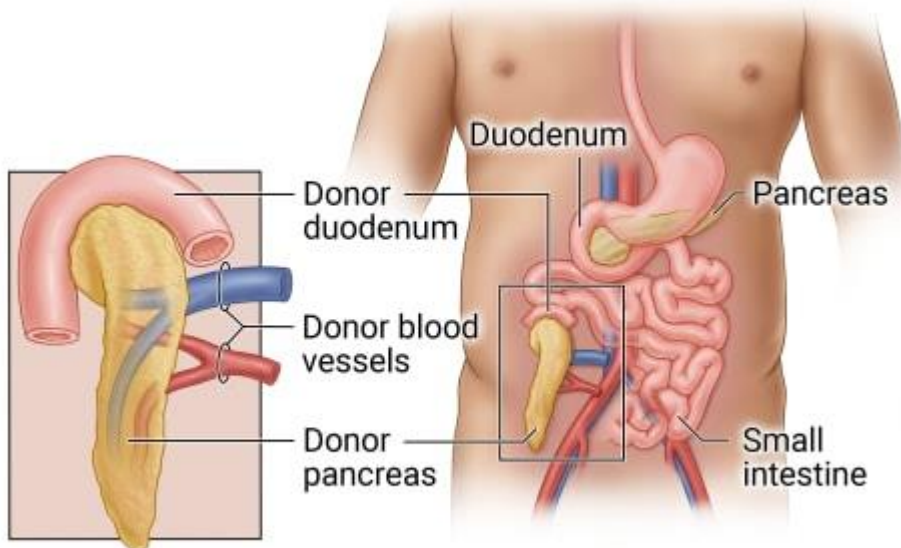


- Artificial pancreas

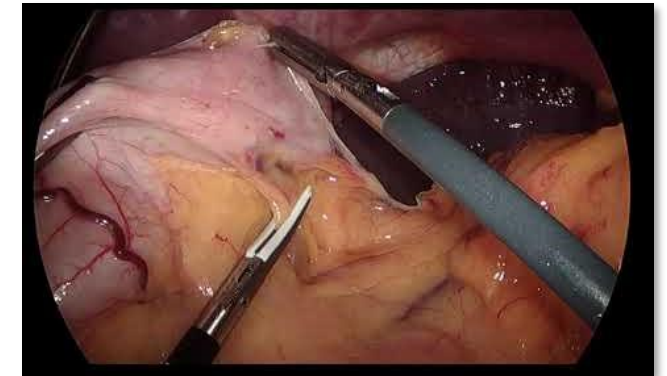
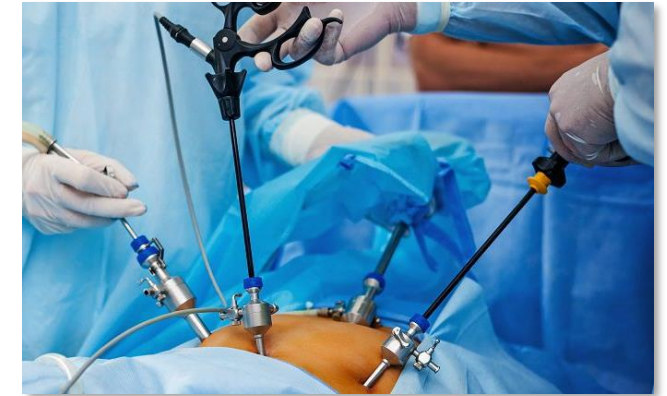
Surgical Treatments



- Islet cell or pancreas transplant



- Bariatric surgery
 - Gastric bypass
 - Sleeve gastrectomy
 - Lap band
 - Balloons



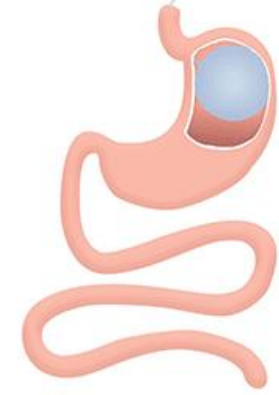
Gastric Sleeve



Gastric Bypass



Gastric Band



Intra-gastric
Balloons



- New medications



- Transplant improvements

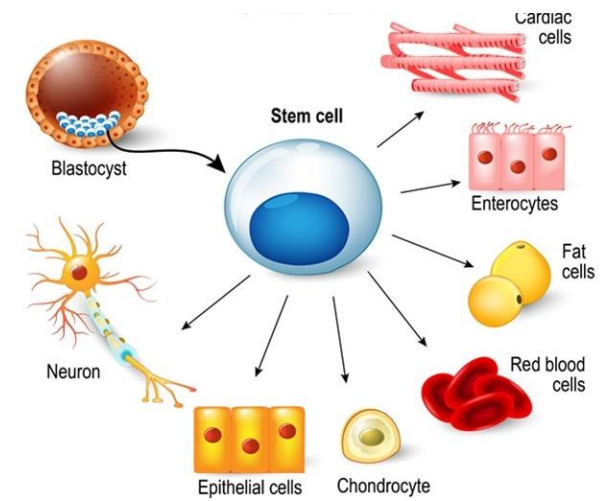
- Artificial pancreas improvements



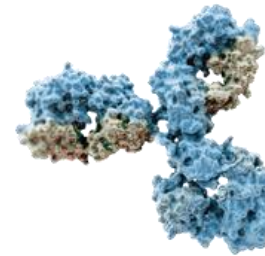
Future Treatments



- Stem cell therapies



- Immunotherapy



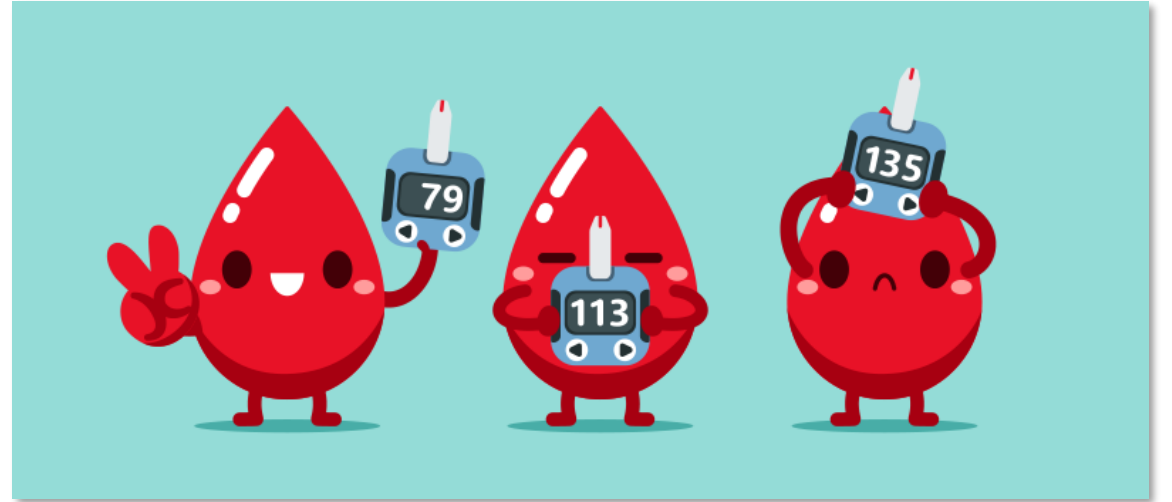
- Gene editing

- 3-D tissue printing





Thank you!



Questions?