

Course Number: BME 3

Course Title: Engineering Innovations in Treating Diabetes (**Abbreviated Title:** Treating Diabetes)

Course Goals and Description: The goal of this course is to introduce students to engineering in medicine. The course teaches both a qualitative description of engineering innovations in medicine over the past century and numerical techniques to find approximate solutions to optimization problems. Throughout the course, these medical engineering innovations are tied to optimization. The idea that practical engineering solutions must be optimal is stressed.

Catalogue Description: Innovations in diabetes treatment from the 1800's until the present: purification of insulin, measuring and control of blood glucose, recombinant DNA, clinical trials and ethics. Solving optimization problems in engineering with Excel.

Prerequisites: None.

Fulfills General Education Categories: II (Science and Technology), Vb (Quantitative, Symbolic, and Computational Reasoning)

Outline of Lectures by week:

1. Getting Started
 - a. Video: <intro video>
 - i. Homework:
 1. Register with Perusall.com
 2. Install Microsoft Excel 365 with Solver.
 - b. Readings: syllabus on Perusall.
 - c. Quiz.
2. Pre-insulin. Nineteenth Century. The importance of basic research. Diabetes discovery pre1800. The discovery of the pancreas. Improvements in surgical technique. Oscar Minkowski's removal of the pancreas. Animals in testing, anti-vivisection.
 - a. Video lectures: 01,02,03,04,05,06,07
 - b. Readings: [OscarMinkowski] The discovery of pancreatic diabetes: the role of Oscar Minkowski
 - c. Homework: Hand optimization of TSP (due week 3)
 - d. Quiz
3. Discovery of insulin. Fred Banting's early life. Banting's idea and move to Toronto. Banting, Best, Macleod discovery of insulin. Treating Leonard Thompson the first patient.
 - a. Video lectures: 08,09,10,11,12,14
 - b. Readings: [RewritingMedicalHistoryBliss1993] Rewriting Medical History by Michael Bliss
 - c. Homework: None
 - d. Quiz.
4. Industrialization and purification of insulin. Alcohol purification works, then fails at scale up. pH, Arnold Beckmann develops the first integrated pH meter 1930s. Patent, licensing and Eli Lilly. George Walden discovers isoelectric precipitation.
 - a. Video lectures: 16,17,18,19

- b. Readings: [DiscoveryandManufactureofInsulin] The Discovery and Manufacture of Insulin, by Gene McCormack
 - c. Homework: Excel aided optimization of TSP (due week 5)
 - d. Quiz
- 5. Complications. Complications from diabetes. Peripheral arterial disease and foot, kidney, eye problems. Neuropathy and other complications. Examples with particular historical patients: George Minot and case studies.
 - a. Video lectures: 13,21,22
 - b. Readings: [QuestforNormoglycemia] The Quest for NormoGlycemia
 - c. Homework: None
 - d. Quiz.
- 6. Glucose measurement. Measurements from urine. Ames Reflective Meter. Detlev Müller and the isolation of glucose oxidase. Leland Clarke invents the oxygen electrode. Today, continuous glucose monitors. Control of glucose by changing food and insulin. NPH insulin.
 - a. Video Lectures: 23,24,25
 - b. Readings:
 - i. [Transcripts of Interviews History of Blood . . .] History of Blood Glucose Meters
Transcripts of Interviews
 - ii. [HistoryofBloodGlucoseMeters] A history of blood glucose meters and their role in self monitoring of diabetes mellitus
 - c. Homework: Excel automated solving of TSP. (Due week 7)
 - d. Quiz.
- 7. Clinical Trials. Understanding the structure of clinical trials. The Tolstoi control controversy resolved by DCCT and fundus photography. Modern clinical trials with beta carotene.
 - a. Video Lectures: 15, 26, 27
 - b. Readings: [Medical Studies Vary in Validity of Findings]
 - c. Homework: None.
 - d. Quiz.
- 8. Recombinant DNA and production of insulin. Projected insulin shortage in the 70's. Synthesis of insulin. Axel Ulrich clones insulin from an insulinoma. Ethical concerns in the US about recombinant DNA research. Eli Lilly and Irving Johnson mass produce recombinant insulin. Modern engineered insulins.
 - a. Video Lectures: 28,29,30
 - b. Readings: [TrialsandTribulations] Trials and Tribulations by Irving Johnson
 - c. Homework: Hand optimization of the nurse scheduling problem.
 - d. Quiz.
- 9. Future of technology for diabetes, diversity in engineering.
 - a. Video Lectures: 20,31,32
 - b. Readings:
 - i. [Opinion_Could Women Be Trusted With...] Could Women Be trusted with their own pregnancy tests?
 - ii. [The Unknown Designer of the First Home . . .]
 - c. Homework: Scheduling employees at an amusement park (Due week 10)
 - d. Quiz