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Writing Assignment 1

There are many examples of harmonic oscillation found in the natural world. Some cases, such as the motion of a spring-mass system or swinging of a pendulum arise from the physical laws governing our world. However, there are cases of harmonic oscillation which arise in unforseen places. Take, for example, the harmonic oscillation of insulin secretion from one's pancreas. Insulin, a hormone responsible for promoting the uptake of glucose from the bloodstream into cells, is released not as a continuous stream, but in periodic oscillations ranging from 3 to 6 minutes in period, depending on the person.

This dynamic of periodic insulin secretion may be roughly modeled as a harmonic oscillation. The amount of insulin secreted by the pancreas is not directly related to the concentration of insulin in the bloodstream as one might expect. Rather, it is influenced primarily by the concentration of calcium within the cells. For the purposes of the model, however, we may ignore this fact. A second order, constant coefficient, linear ordinary differential equation models and predicts insulin secretion well. This is because when blood insulin concentration is low, the pancreas increases the rate of insulin production, and when blood insulin concentration is high, the pancreas decreases its rate of insulin production. In other words, the rate of insulin production is proportional to the amount of insulin in the bloodstream. Since insulin production could reasonably be measured in units of insulin per unit time, a change in the rate of insulin production could be thought of as the 'acceleration' of insulin production. Thus, the system oscillates through high insulin production and low insulin cycles in regular intervals – a harmonic oscillator.

Modeling insulin secretion cycles as harmonic oscillation carries the benefit of simplicity. Simple harmonic oscillation is simple to understand and does not rely on a complex amalgamation of several biological systems, each complex in their own right. A harmonic oscillation model is able to

encapsulate the basic principle behind insulin mechanics. In addition, a layman would find such an explanation easily accessible without advanced knowledge of biology.

This model, however, is not without flaws. For one, the model does not account for the change of the cycle's amplitude as a result of food consumption. Thus, the model only holds for when a person has refrained from eating for several hours, which somewhat limits its application. In addition, the model does not account for factors which can change the frequency of secretion cycles over time, which further limits the model by restricting it to relatively short time frames. As such, the model assumes both that food intake is not a factor, and the period being considered is small enough to not experience fluctuations.