BME331: Physiological Control Systems

Lab 1 – Prelab

1. Explain the difference between sources and sinks in Simulink.

Sources generate or import signal data blocks. Source blocks have no inputs and a single output.

Sinks are used to display or output signal data blocks. They receive physical signal output from other blocks. Sink blocks have inputs (mostly single) and no outputs.

2. Explain why the threshold operators are needed in the model shown in Figure 1.

Threshold operators are needed to monitor and control glucose and insulin concentrations in the blood. If the concentrations are above a certain threshold level, the operator lets the signal proceed to the next block. If the concentrations are below the threshold, no signal is sent.

3. Explain the difference between Type I and Type II diabetes.

In Type 1 diabetes, pancreas produces little or no insulin. Usually, the body's own immune system mistakenly destroys the insulin producing islets of Langerhans cells in the pancreas.

In Type 2 diabetes, cells respond poorly to insulin, in other words they develop an insulin resistance. Pancreas secretes more insulin to be able to get cells to respond, however despite the increased amount of insulin in the blood, cells fail to respond.

4. At the level of the cell membrane, how can insulin help to promote the uptake of glucose into the cell?

The only mechanism by which cells can take up glucose is by facilitated diffusion. In many tissues, the major transporter used for the uptake of glucose (GLUT4) is made available in the plasma membrane through the action of insulin. Binding of insulin to receptors on cells leads rapidly to fusion of cytoplasmic vesicles, in which GLUT4 glucose transporters are present, thereby giving cell an ability to efficiently take up glucose.

5. On a copy of Figure 1, circle and label the portions of the system that correspond to each of the terms in Equation (6).
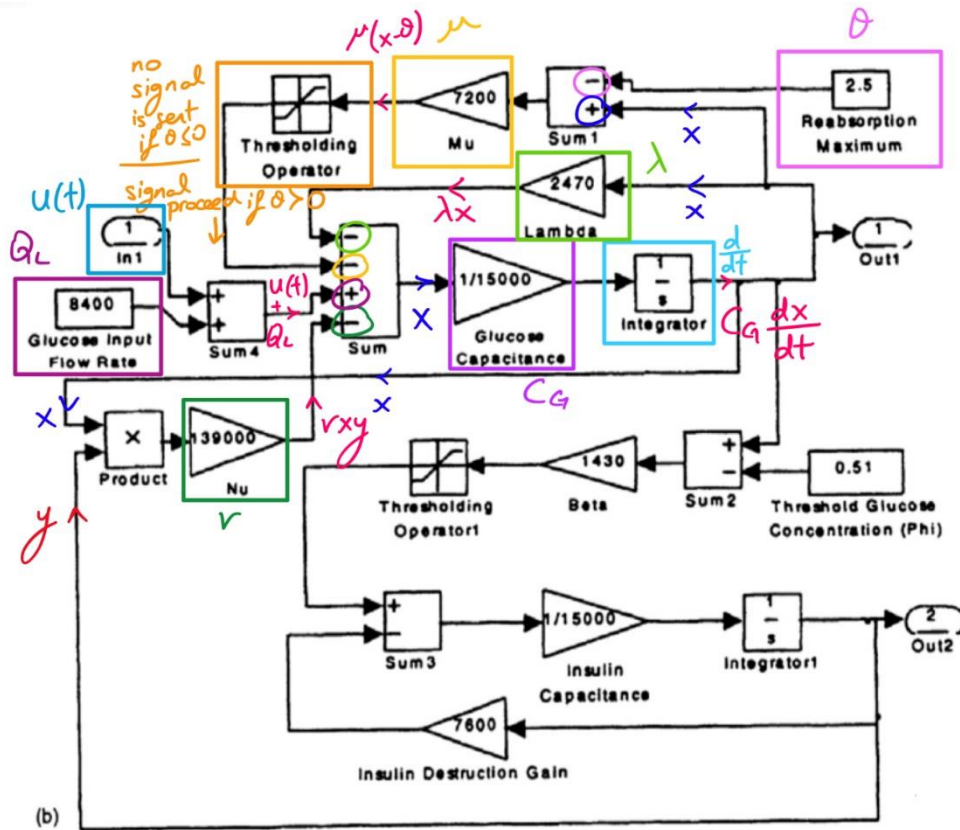
Figure 5.16 SIMULINK model of blood glucose–insulin regulation. (a) The input to and outputs from the model. (b) Details of the dynamic structure.

Figure 1: The glucose-insulin Simulink model

$$C_G \frac{dx}{dt} = U(t) + Q_L - \lambda x - v\,xy \qquad\qquad, \quad x \leq \vartheta$$

$$C_G \frac{dx}{dt} = U(t) + Q_L - \lambda x - v\,xy - \mu(x-\vartheta), \quad x > \vartheta$$