Exercise 6: Glucose and Insulin Dynamics

November 30, 2014

1. Insulin Sensitivity:

$$\partial \dot{G}/\partial G = -(p_1 + X(t)) \tag{1}$$
$$S_I = \partial^2 \dot{G}/\partial G \partial I = -\partial X(t)/\partial I \tag{2}$$

   Steady state conditions of insulin means:

$$\frac{dX(t)}{dt} = 0 = -p_2 X(t) + p_3(I(t) - I_b), \quad X(0) = 0, I(0) = I_b \tag{3}$$
$$X(t) = \frac{p_3}{p_2}(I(t) - I_b) \tag{4}$$
$$S_I = -\partial X/\partial I = -\frac{p_3}{p_2} \tag{5}$$

   The experiment is dynamic and steady-state conditions of the insulin level is not valid for most part of the experiment.

2. Minimal Model Simulation: The glucose response can be seen in Fig. 2.

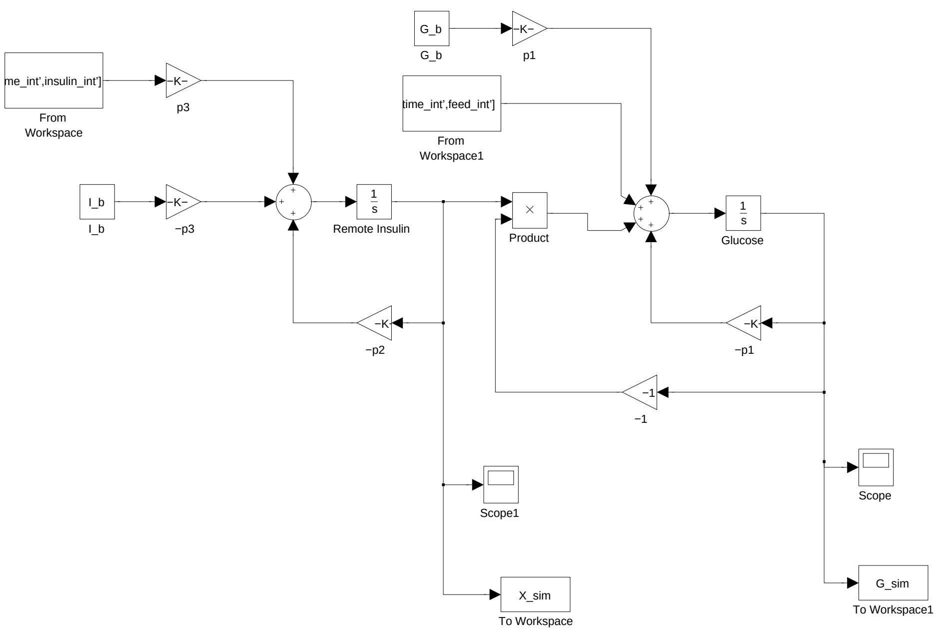

Figure 1 Minimal model Simulink model.

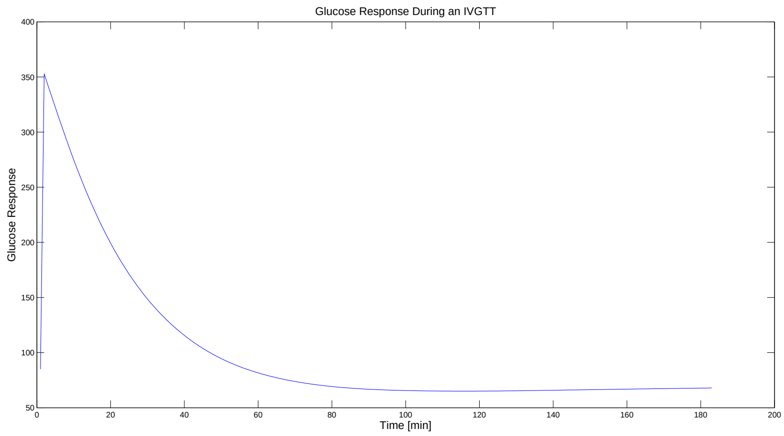

Figure 2 Minimal model Simulink model.

3. k_{gri} represents the kinetic coefficient between the solid and the liquid compartments of the stomach. In comparison between boiled potatos and mashed potatos it seems likely that the mashed potatos would have a larger value for this parameter, thereby resulting in faster dynamics.

4. The differential equation becomes:

$$\dot{G}_{ISF}(t) = -k_3 \cdot G_{ISF}(t) + k_3 G_p \tag{6}$$

$$L(G_{ISF}) = \frac{k_3}{k_3 + s} L(G_p) \tag{7}$$

Thus, $K = 1$ and $\tau = 1/k_3$