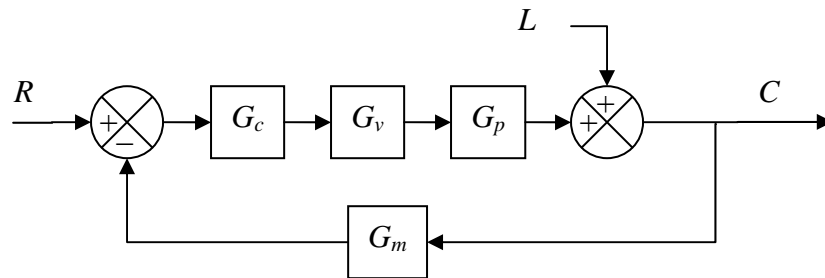


- A common genetic manipulation employed by cell biologists is to delete a particular gene. What would be the effect of deleting the following genes in the *lac* repressor system?
  - lacY*
  - lacZ*
  - lacI*
- Using the Keasling article as a guide, draw a simplified control block diagram for the diauxic growth system. Use lactose concentrations as the input and cell growth rate as the output. You may neglect parts of the system which are not important for the dynamics while glucose concentration is constant, and you may lump some processes together if you clearly explain your modeling choices. Label each arrow representing input/output variables between blocks, and label the process represented by each block (e.g. 'transcription'). Remember, each transfer function should have one input and one output, and quantities affected by multiple inputs can be described by summing the contributions from separate transfer function blocks.
- Consider the standard process control loop below with  $G_v = G_m = 1$ ,  $G_p = \frac{1}{(2s+1)(3s+1)}$ , and a PI controller  $G_c = K_c \left(1 + \frac{1}{2s}\right)$ .



- Determine the closed-loop transfer function  $C/L$ .
  - Outline* the steps to *analytically* determine the response to a step function input in the load variable.
  - Create a Simulink model for this process. Show the output to a unit step function input in the load for  $K_c = 1, 3, \text{ and } 5$ .
- Complete the midterm survey on the course website.