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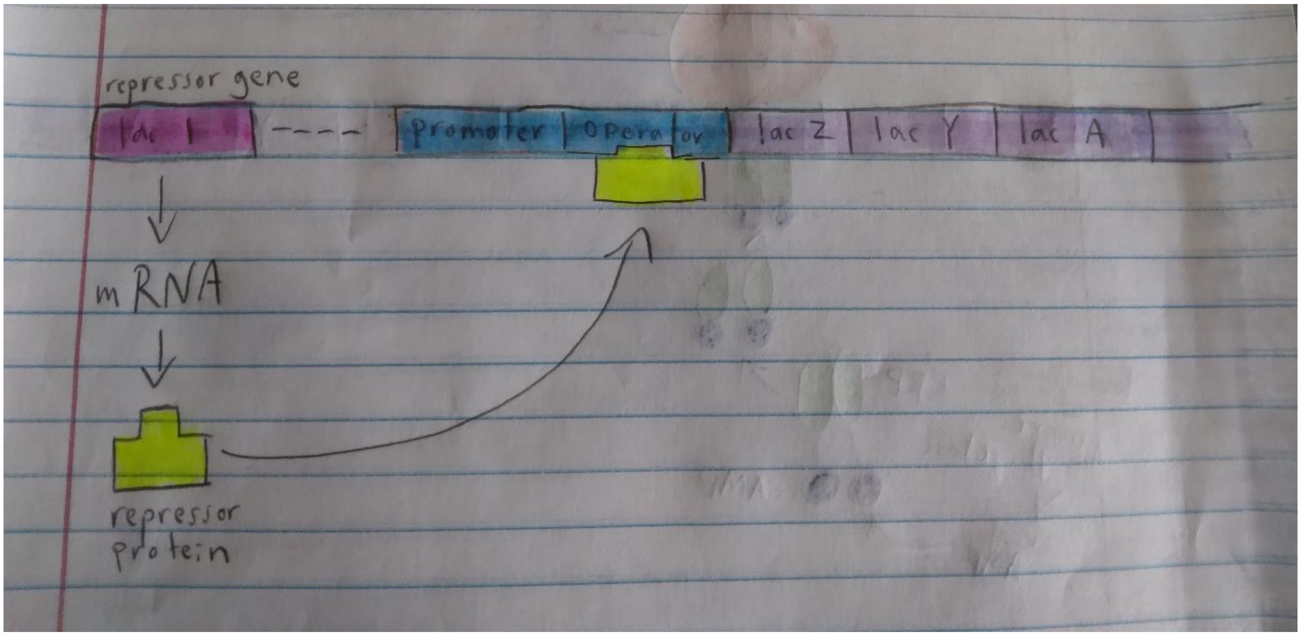
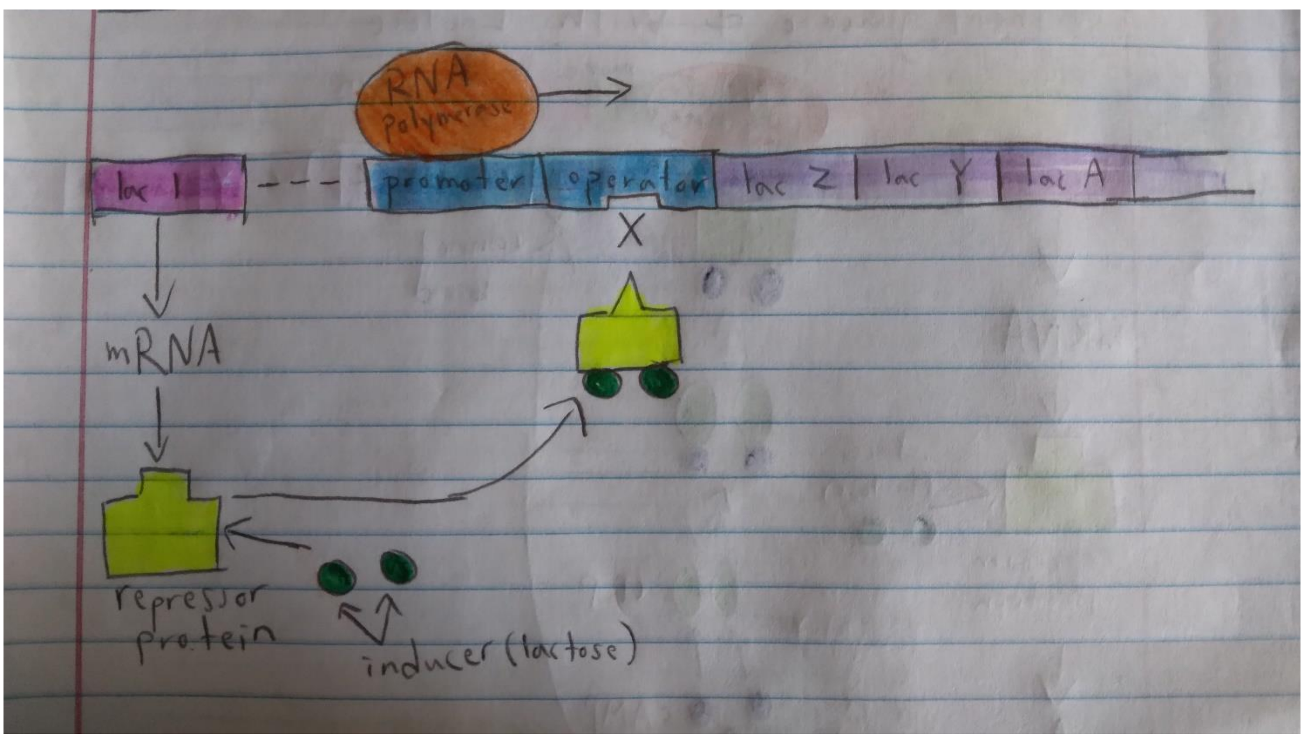
1. Without Lactose:



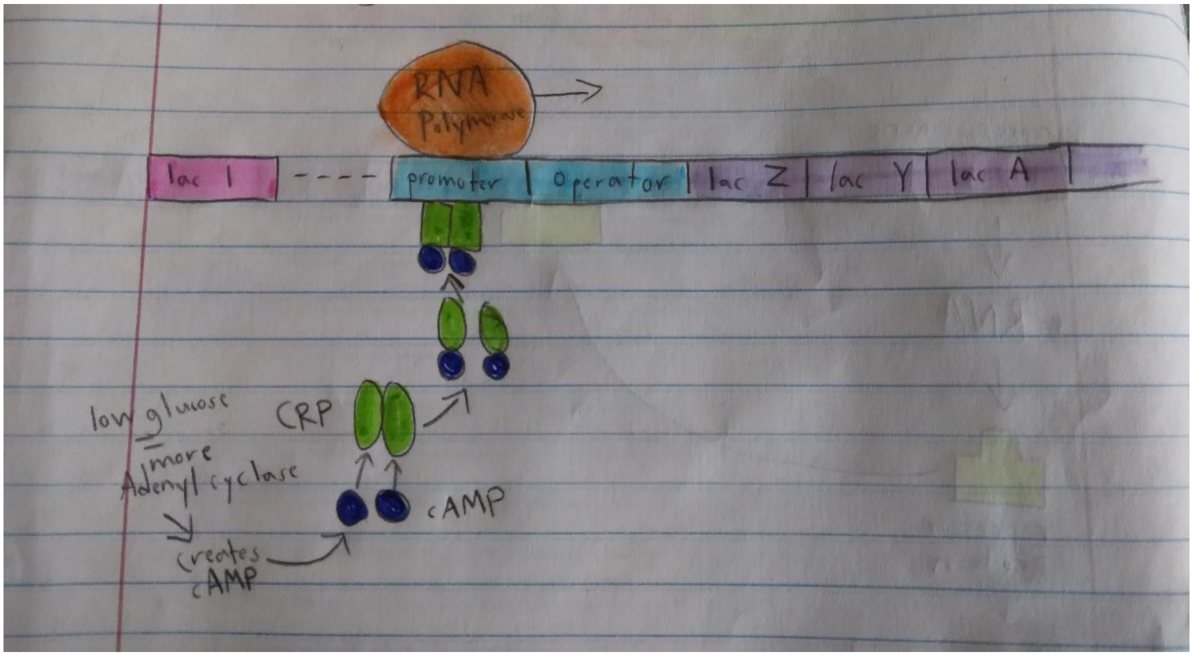
If there is no lactose in the cell, the repressor will bind to the operator and prevent RNA polymerase from transcribing the lacZ, lacY, and lacA genes.

2. With Lactose:



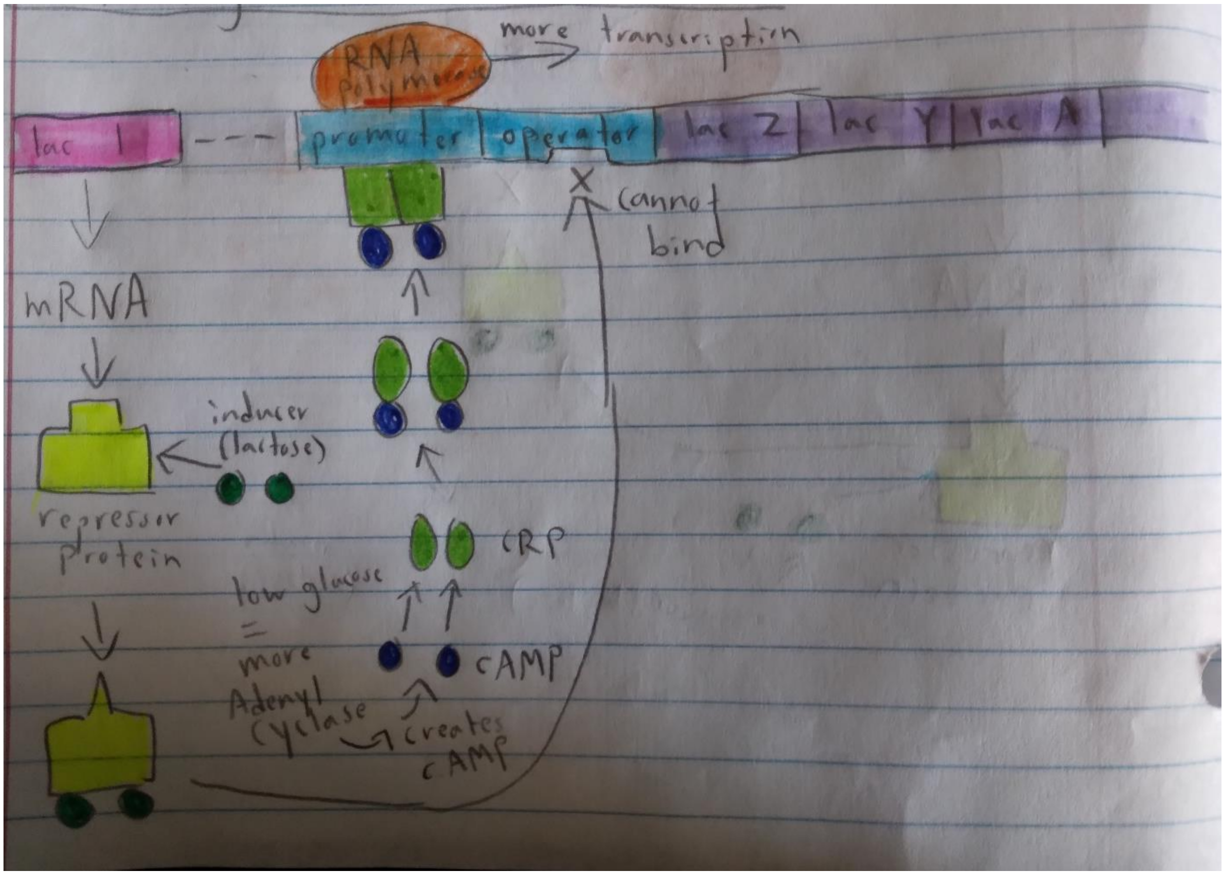
If there is lactose in the cell, the lactose serves as an inducer that binds to the repressor protein; therefore, changing its shape. Since the repressor protein can no longer bind to the operator and prevent transcription, RNA polymerase can do its job and transcribe the lac genes.

3. Without glucose:



In low levels of glucose, there is more adenyl cyclase available, which creates more cyclic AMP, or cAMP. They bind to CRP (cAMP receptor proteins) which change the shape of the CRP and allow it to bind to the promoter and act as an activator to initiate transcription.

4. Without glucose and with lactose:



In the absence of lactose and the presence of glucose, lactose binds to the repressor protein, changing its shape and therefore preventing it from binding to the operator. In the absence of glucose, more adenyl cyclase is present, which creates more cAMP that binds to CRP and binds to the promoter. Because both of these processes allow transcription on their own, more transcription occurs.

5. This regulation occurs during gene transcription. In the *E. Coli* cell, transcription depends on whether or not lactose or glucose is present. Lactose can produce enzymes that initiate transcription, while the presence of glucose slows or even stops transcription because fewer enzymes help initiate transcription.

Additional Sources I used:

https://www.khanacademy.org/science/ap-biology/gene-expression-and-regulation/regulation-of-gene-expression-and-cell-specialization/v/lac-operon