Summary of background information given in a reading and reinforced in lecture:

The lac operon contains genes required for the uptake and utilization of the sugar, lactose. When lactose is not present, the proteins encoded by the genes are not needed and the operon is not transcribed. When lactose is present, the gene products are needed and the operon is transcribed. The system is controlled by a protein call lac repressor. Lac repressor is a DNA binding protein that binds to a site on the DNA called the operator. The operator partially overlaps with the promoter, which is the site where RNA polymerase binds to initiate transcription. When lac repressor binds to the operator site, RNA polymerase cannot bind to the promoter, i.e. lac repressor blocks transcription by blocking the promoter. In the absence of lactose, lac repressor binds to the DNA. When lactose is present, it is taken into the cell and converted to allolactose. Allolactose binds to lac repressor and causes a conformation change that alters the structure of lac repressor so that it cannot bind to DNA. Therefore, in the presence of lactose, lac repressor does not bind to the operator and RNA polymerase can transcribe the genes in the lac operon.

Strip sequence:

Order the relevant steps to show how the lac operon moves from the “off” state in which it is not transcribed, to the “on” state in which the genes are transcribed. Some of the steps below are not involved. Explain why they are not part of the process.

RNA polymerase binds to the operator.
Genes of the lac operon are transcribed.
Lac repressor binds to allolactose.
Lac repressor is bound to the operator.
RNA polymerase binds to the promoter.
Lactose enters the cell and is converted to allolactose.
Lac repressor is released from the operator.
Allolactose binds to RNA polymerase.
Lac repressor transcribes genes in the lac operon.

- What concepts are being assessed?
- What level of Blooms taxonomy is being assessed?
- How might student/instructor get information about student’s understanding of the concept(s)?

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Concept Sketch:

Draw a sketch showing how addition of lactose shifts the lac operon from being repressed by lac repressor to being transcribed.
Annotate the drawing with notes outlining the role of the key players in the system.

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Predict the outcome (think, pair, share / clicker questions):

Work the problem first individually then compare your answer with your neighbor and explain your reasoning to him or her.

Predict whether the lac operon will be transcribed under the following conditions.

genotype	lactose	No lactose
wild type	+++	-
mutant with disrupted DNA sequence of the operator		
mutant with amino acid change in lac repressor that prevents conformational change when allolactose binds		
mutant with amino acid change in DNA binding domain of lac repressor		

Extension:
Draw a diagram explaining each of your answers.

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Case study (homework or longer in class activity done in groups):

You recover a mutant strain of *E. coli* in which the lac operon is transcribed constitutively, even when lactose is not present.

Name two different types of mutations that affect different components of the system that could lead to this phenotype.
Draw a diagram or write a short explanation showing how each type of mutation would lead to the phenotype.
How would you test to see which type of mutation you had? Explain how the test will work.

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Exit poll (students answer questions before leaving class):

- What general principles about gene regulation did you learn from our discussion of the lac operon?
- Why did we learn about the lac operon?
- How does what you learned about the lac operon relate to concepts that we covered previous classes?
- What questions to you have about this topic?

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