

Worksheet – Control Mechanism (lac & trp operons)

Name: _____

1. Complete the comparison of the *lac* Operon and *trp* Operons as a means of gene regulation.

	<i>lac</i> operon	<i>trp</i> operon
Regulates production of:		
Number of genes and how they are controlled		
What binds to the operator & when does this occur		
High levels of what substance affects the operon how?		

2. Why have genes under regulation?

3. What is the function of the promoter?

4. What is the function of the operator?

5. What happens if lactose levels are low? Put the following list in order (1-5).

	RNA polymerase is blocked from transcribing the genes for the lactose metabolizing enzymes
	When RNA polymerase binds to the promoter, it cannot get past the LacI repressor protein
	The enzymes B-galactosidase, B-galactosidase permease, and transacetylase are not required by the cell due to low levels of lactose
	Lactose does not bind to the repressor protein, LacI
	LacI, a repressor protein, is bound to the operator, which follows the promoter

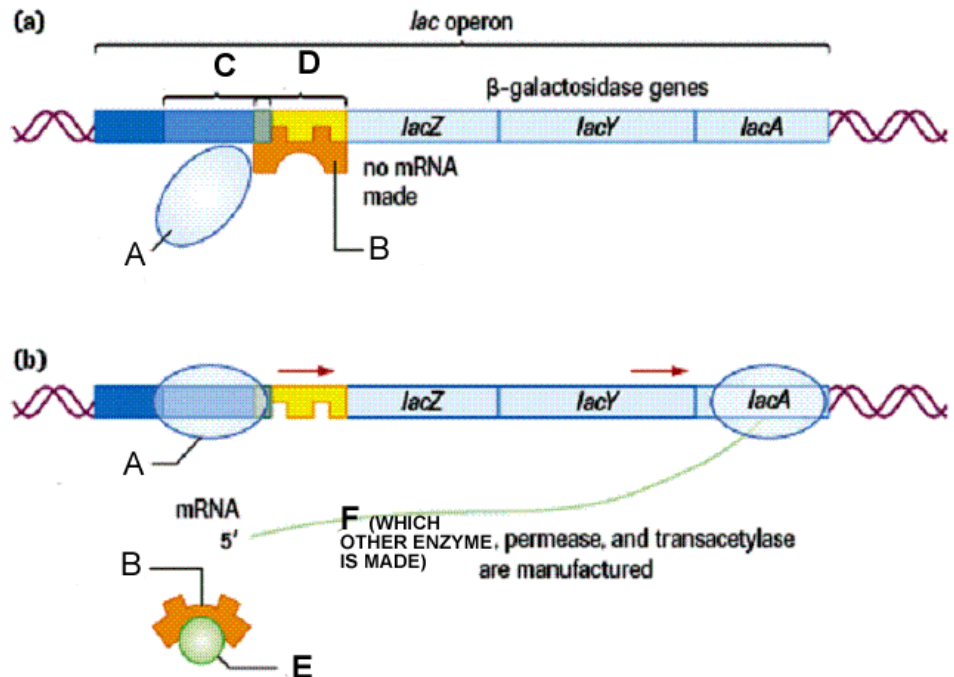
6. What happens if tryptophan levels are high? Put the following list in order (1-4).

	The trp repressor-tryptophan complex can now bind to the operator of the trp operon
	Tryptophan does not need to be produced by the trp operon
	Tryptophan will bind to the repressor protein, changing its conformation
	RNA Polymerase is blocked from transcribing the genes needed to synthesize tryptophan

7. What happens if lactose is present and glucose is scarce? Put the following list in order (1-7). Start with the repressor part first.

	The three enzymes involved in the metabolism of lactose are transcribed and expressed
	cAMP binds to CAP regulatory protein, causing it to bind to the promoter of the lac operon
	The enzymes needed for lactose metabolism must be transcribed when lactose is present
	cAMP levels increase because glucose is scarce (ATP is not being produced through cell respiration)
	Lactose binds to the Lacl repressor, changing Lacl's shape and making it fall off the operator
	CAP binding causes RNA Polymerase to bind to the promoter (higher affinity) and transcribe the gene at a higher level than before
	Now that Lacl has been removed for the operator, RNA polymerase can proceed with transcription

8. Label the following diagram.



Create Playdoh models of both the lac and tryp operon models on a manila folder (so you can transport it). Be able to explain how these operon models work when you show your model. Be able to explain the following: positive regulation, negative regulation, repressible operon, inducible operon, operon, operator, repressor protein, promoter, corepressor and inducer. Students may use their models as resources on the corresponding quiz.

Teacher signature: _____

ANSWERS - Worksheet – Control Mechanism (lac & trp operons)

1. Complete the comparison of the *lac* Operon and *trp* Operons as a means of gene regulation.

	Lac operon	Trp operon
Regulates production of:	It regulates the production of B-galactosidase and other proteins involved in the metabolism of lactose	It regulates the production of the amino acid tryptophan
Number of genes and how they are controlled	It consists of a cluster of three genes under the control of one promoter and one operator	It consists of a cluster of five genes under the control of one promoter and one operator
What binds to the operator & when does this occur	The LacI repressor protein <u>binds to the operator</u> when lactose levels are low	The corepressor tryptophan binds to the trp repressor protein, and the complex <u>binds to the operator</u> when tryptophan levels are high
High levels of what substance affects the operon how?	High levels of lactose induce the operon.	High levels of tryptophan repress the operon.

2. Why have genes under regulation?

- Not all proteins are required at all times
- Not all proteins are diminished quickly
- Waste of the cell's resources if all genes were transcribed and translated at all times
- By having some genes under regulation, the cell can manage its resources as needed

3. What is the function of the promoter?

- Site of RNA polymerase binding

4. What is the function of the operator?

- Site of repressor protein binding, regulates the transcription of the gene

5. What happens if lactose levels are low? Put the following list in order (1-5).

5	RNA polymerase is blocked from transcribing the genes for the lactose metabolizing enzymes
4	When RNA polymerase binds to the promoter, it cannot get past the LacI repressor protein
1	The enzymes B-galactosidase, B-galactosidase permease, and transacetylase are not required by the cell due to low levels of lactose
2	Lactose does not bind to the repressor protein, LacI
3	LacI, a repressor protein, is bound to the operator, which follows the promoter

6. What happens if tryptophan levels are high? Put the following list in order (1-4).

3	The trp repressor-tryptophan complex can now bind to the operator of the trp operon
1	Tryptophan does not need to be produced by the trp operon
2	Tryptophan will bind to the repressor protein, changing its conformation
4	RNA Polymerase is blocked from transcribing the genes needed to synthesize tryptophan

7. What happens if lactose is present and glucose is scarce? Put the following list in order (1-7). Start with the effects if lactose levels then proceed to the effects of glucose levels.

3	Now that LacI has been removed for the operator, RNA polymerase can proceed with transcription
6	cAMP binds to CAP regulatory protein, causing it to bind to the promoter of the lac operon
1	The enzymes needed for lactose metabolism must be transcribed when lactose is present
5	cAMP levels increase because glucose is scarce (ATP is not being produced through cell respiration)
2	Lactose binds to the LacI repressor, changing LacI's shape and making it fall off the operator
7	CAP binding causes RNA Polymerase to bind to the promoter (higher affinity) and transcribe the gene at a higher level than before
4	The three enzymes involved in the metabolism of lactose are transcribed and expressed at moderate levels

9. Label the following diagram.

