What is Gene Regulation in Prokaryotes?

Worksheet

Gene regulation in prokaryotes is the control of transcription through operons - DNA segments with a shared promoter and operator that let repressor or activator proteins turn a whole set of genes on or off together, such as the lac operon in E. coli.

Questions

1. What directly blocks RNA polymerase in the lac operon when lactose is absent?

A) CAP protein
B) The lac repressor bound to the operator
C) Allolactose
D) cAMP

2. What molecule inactivates the lac repressor?

A) Glucose
B) cAMP
C) Allolactose
D) Tryptophan

3. In the trp operon, tryptophan acts as a

A) Inducer
B) Corepressor
C) Promoter
D) Enhancer

4. Why is lac operon expression low even with lactose present if glucose is also present?

A) The repressor is permanently bound
B) Catabolite repression - low cAMP means CAP can't boost the promoter
C) The operator is deleted
D) RNA polymerase is degraded

5. In E. coli, glucose is absent and lactose is present. Explain what happens to the lac operon.

6. The trp operon: tryptophan levels are high in the cell. What happens to transcription?

7. Both glucose and lactose are present in the medium. What happens to lac operon expression?

8. Define: What is an operon?

9. Define: What does the lac repressor do?

10. Define: What is a corepressor?

Answer Key

1. B) The lac repressor bound to the operator - The repressor protein binds the operator and physically blocks transcription.

2. C) Allolactose - Allolactose (a lactose derivative) binds the repressor and changes its shape so it releases the operator.

3. B) Corepressor - Tryptophan binds the repressor and activates it, so it can bind the operator and shut down transcription - that's a corepressor.

4. B) Catabolite repression - low cAMP means CAP can't boost the promoter - High glucose keeps cAMP low, so CAP-cAMP cannot bind and strongly activate the promoter.

5. Low glucose raises cAMP levels, so CAP-cAMP binds near the promoter and enhances RNA polymerase binding Lactose is converted to allolactose, which binds and inactivates the lac repressor With the repressor off the operator and CAP boosting the promoter, the lac operon is transcribed at a high rate

6. Excess tryptophan acts as a corepressor and binds the inactive trp repressor protein The tryptophan-repressor complex changes shape so it can now bind the operator RNA polymerase is blocked, so the trp operon (tryptophan biosynthesis genes) is switched off

7. Glucose lowers cAMP levels, so CAP cannot bind the promoter efficiently (catabolite repression) Lactose still inactivates the repressor, so the operator is free Without CAP-cAMP help, RNA polymerase binds weakly, so lac operon transcription stays low until glucose runs out

8. A cluster of genes under control of one shared promoter and operator, transcribed together as a single mRNA.

9. It binds the operator and blocks RNA polymerase when lactose is absent.

10. A small molecule (like tryptophan) that binds a repressor protein and activates it, turning transcription off.