Control of gene expression in bacteria

I. Gene expression overview:
The expression of a gene is a two step process.
One strand of DNA is transcribed into an RNA strand.
And the RNA strand is used to specify the sequence of amino acids within a polypeptide.

changes in gene expression allow bacterial cells to _______ to environmental changes (intra- or extracellular environment)
for example:

The polypeptide then functions within the cell, thereby influencing an organisms traits.

Gene expression is controlled at three levels:

II. Gene regulation in prokaryotes

• Genes switch on and off as conditions in the intracellular environment change!
  – Lactose Metabolism - a model for understanding regulation in prokaryotes, an example of coordinate control.
  ➢ bacteria can use
    • lactose, glucose, galactose, maltose etc.

Galactoside permease – ___________ catalyzes the breakdown of lactose
These are only needed when lactose is present and glucose absent!

A. Operon Regulation - transcriptional control in prokaryotes
Operon = Grouping functionally related genes together so they can be easily regulated;
feedback regulation involved possible by __________so they can be transcribed into multi-gene mRNAs ___________
✓ _______“switch” used to control expression of ___________ genes
✓ Happens because
Types of control:
1) Positive Control - protein binds to switch to
2) Negative Control - protein binds to switch to

constitutive enzymes: synthesized at __________________________
some genes transcribed more often than others because promoters more efficient at attracting RNA polymerase
inducible/repressible enzymes: enzymes produced __________________________
________________________ of a specific compound

components of operons
• promoter sequence – sequence of DNA where RNA polymerase can bind
• operator sequence – site where either activator or repressor can bind
• inducers / _______________ - proteins that increase transcription by RNA Polymerase
• repressors – proteins that ____________________________ by the RNA polymerase
  - Encoded by the repressor ____________________________
  - binds reversibly
  - may have an _______________ site, in addition to its DNA binding site
  - lacI gene codes for a repressor protein (switches genes off)

Operons work well in prokaryotes because:
- Expression of genes can be ____________________________
- The entire operon can be controlled by a single ____________________________
  - Operator = DNA segment located within or next to the promoter that controls access of RNA polymerase to the genes
  - Genes next to one another can be continuously transcribed into a POLYCISTRONIC mRNA (transcription & translation linked)

B. Lac Operon: Lactose metabolism first studied in ________________
- Contains 3 structural genes that code for the enzymes which allow

  1) Beta galactosidase (lacZ) =
  2) Galactosidase permease (lacY) = transports lactose ________________
  3) Galactoside transacetylase (lacA) = ? may be involved in removing toxic byproducts
  - upstream regulatory region consisting of an
Lac operon -

1. Under ______________________________
   - Glucose is the preferred carbon source for E. coli. It uses lactose ________ when glucose is depleted.
   - When E. coli grown without lactose, enzymes for lactose digestion are present in low concentrations
   - Enzyme concentrations can increase
   - Negative control: Repressor ________________ transcription when lactose ___________
   - Positive control: CAP protein increases transcription when lactose ___________ and ____________ absent

2. Lac operon is under dual regulation to ensure that the cell will use __________________ then it will use ______________ when glucose is absent

1) Negative control by repressor,
2) Positive control: by __________________
   - CAP = allosteric protein that binds cAMP and works as an __________________ to increase transcription
   - As glucose decreases, cAMP increases
   - cAMP + CAP = activator (switches the genes “on”)
   - cAMP-CAP binds to an activator site

__________________________ occurs when one of the product molecules (the catabolite) of a reaction represses the production of the enzyme(s) responsible for that reaction. In the case of the lac operon, __________________ is the catabolite.
Lactose present, glucose absent, cAMP-CAP activates transcription

If both glucose & lactose is present, _________
__________ – CAP is inactive because cAMP levels ________.

3. Types of lactose metabolism mutants

- *lacZ* mutants lack functional
- *lacY* mutants lack the membrane protein galactoside permease and
  - *lacI* mutants do not properly __________ production of β-galactosidase and galactoside permease, producing them even when lactose ____________ (constitutive).

- This plate made with X-gal, a substance that is colorless but when cleaved by β-galactosidase, products turns blue.