Regulation of Gene Expression
Chapter 18

1. Bacteria often live in erratic environments. Propose a selective advantage for bacteria that are able to regulate gene expression.

2. a) Explain how the trp operon allows the production of the enzymes required to synthesize tryptophan only in the absence of tryptophan.
   b) Predict what would happen to the trp operon as a cell uses up its store of tryptophan.

3. Describe how the binding of the *trp* corepressor to the *trp* repressor alters repressor function and transcription. Describe how binding of the *lac* inducer to the *lac* repressor alters transcription.

4. Describe the difference between a repressible and an inducible operon.

5. Bacterial cells are grown in the absence of lactose and then lactose is added to the culture medium. Describe the change you would expect to see in the lac operon.

6. When *E. coli* cells are grown in the presence of lactose and glucose, they preferentially use glucose, not lactose. Explain how the cells are able to avoid using lactose even though it is present in the culture medium.

7. A certain mutation in *E. coli* changes the lac operator so that the active repressor cannot bind. Describe how this would affect the cell's production of β-galactosidase. Predict whether this mutation would be adaptive or not.

8. All cells of an organism have the same genes, yet cells are able to be differentiated. Explain how this possible.

9. a) Describe the effect of histone acetylation on gene expression.
   b) Describe the effect of methylation of bases on gene expression.

10. Most eukaryotic genes have segments of noncoding DNA associated with them that serve as binding sites for proteins called transcription factors. Describe the function of these so-called control elements.

11. Both liver cells and lens cells have the genes for making the proteins albumin and crystallin, but only liver cells make albumin (a blood protein) and only lens cells make crystallin (the main protein of the lens of the eye).

12. Use the concept of control elements to propose a mechanism by which several, related genes in a given cell could be activated by a single signal.

13. Suppose you compared the nucleotide sequences of the distal control elements in the enhancers of three genes that are expressed only in muscle cells. Make a claim about the sequences. Support your claim.

14. Regulation of translation initiation, degradation of the mRNA, activation of the protein (by chemical modification, for example), and protein degradation are four mechanisms to regulate the amount of a protein in a cell once the mRNA encoding that protein reaches the cytosol. Describe each mechanism.

15. Describe the mechanism by which am miRNA can prevent the expression of a particular gene.

16. Imagine a particular mRNA coded for a protein that promotes cell division in a multicellular organism. Predict the effect of a mutation that disabled the gene for the miRNA that normally triggers the degradation of the mRNA.

17. Mitosis produces two daughter cells that are genetically identical to the parent cell. Adult organisms, the product of many mitotic divisions, are not composed of identical cells. Explain how this is possible.

18. a) Describe the role of cytoplasmic determinants in the development of an early embryo.
    b) Describe the role of induction in early embryonic development.

19. Explain how the signaling molecules released by an embryonic cell can induce changes in a neighboring cell without entering the cell.

20. Predict the effect on differentiation of a cell in which a mutation in the myoD gene resulted in the production of an altered MyoD protein that could not activate the myoD gene.