



Chapter 16 Exercises

Review Questions

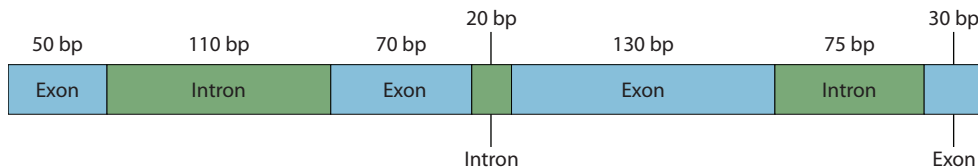
- Control of gene expression in eukaryotic cells occurs at which level(s)?
 - only the transcriptional level
 - epigenetic and transcriptional levels
 - epigenetic, transcriptional, and translational levels
 - epigenetic, transcriptional, post-transcriptional, translational, and post-translational levels
- Post-translational control refers to:
 - regulation of gene expression after transcription
 - regulation of gene expression after translation
 - control of epigenetic activation
 - period between transcription and translation
- How does the regulation of gene expression support continued evolution of more complex organisms?
 - Cells can become specialized within a multicellular organism.
 - Organisms can conserve energy and resources.
 - Cells grow larger to accommodate protein production.
 - Both a. and b.
- If glucose is absent, but so is lactose, the *lac* operon will be _____.

a. activated	c. activated, but only partially
b. repressed	d. mutated
- Prokaryotic cells lack a nucleus. Therefore, the genes in prokaryotic cells are:
 - all expressed, all of the time
 - transcribed and translated almost simultaneously
 - transcriptionally controlled because translation begins before transcription ends
 - both b. and c.
- The *ara* operon is an inducible operon that controls the production of the sugar arabinose. When arabinose is present in a bacterium, it binds to the protein AraC, and the complex binds to the initiator site to promote transcription. In this scenario, AraC is a(n) _____.

a. activator	c. repressor
b. inducer	d. operator
- What are epigenetic modifications?
 - the addition of reversible changes to histone proteins and DNA
 - the removal of nucleosomes from the DNA
 - the addition of more nucleosomes to the DNA
 - mutation of the DNA sequence
- Which of the following are *true* characteristics of epigenetic changes?
 - allow DNA to be transcribed
 - move histones to open or close a chromosomal region
 - are temporary
 - all of these
- The binding of _____ is required for transcription to start.

a. a protein	c. RNA polymerase
b. DNA polymerase	d. a transcription factor

10. What will result from the binding of a transcription factor to an enhancer region?
- decreased transcription of an adjacent gene
 - increased transcription of a distant gene
 - alteration of the translation of an adjacent gene
 - initiation of the recruitment of RNA polymerase
11. A scientist compares the promoter regions of two genes. Gene A's core promoter plus proximal promoter elements encompasses 70 bp. Gene B's core promoter plus proximal promoter elements encompasses 250 bp. Which of the scientist's hypotheses is most likely to be correct?
- More transcripts will be made from Gene B.
 - Transcription of Gene A involves fewer transcription factors.
 - Enhancers control Gene B's transcription.
 - Transcription of Gene A is more controlled than transcription of Gene B.
12. Which of the following are involved in post-transcriptional control?
- control of RNA splicing
 - control of RNA shuttling
 - control of RNA stability
 - all of these
13. Binding of an RNA-binding protein will _____ the stability of the RNA molecule.
- increase
 - decrease
 - neither increase nor decrease
 - either increase or decrease
14. An unprocessed pre-mRNA has the following structure.



- Which of the following is not a possible size (in bp) of the mature mRNA?
- 205 bp
 - 180 bp
 - 150 bp
 - 100 bp
15. Alternative splicing has been estimated to occur in more than 95% of multi-exon genes. Which of the following is not an evolutionary advantage of alternative splicing?
- Alternative splicing increases diversity without increasing genome size.
 - Different gene isoforms can be expressed in different tissues.
 - Alternative splicing creates shorter mRNA transcripts.
 - Different gene isoforms can be expressed during different stages of development.
16. Post-translational modifications of proteins can affect which of the following?
- protein function
 - transcriptional regulation
 - chromatin modification
 - all of these
17. A scientist mutates eIF-2 to eliminate its GTP hydrolysis capability. How would this mutated form of eIF-2 alter translation?
- Initiation factors would not be able to bind to mRNA.
 - The large ribosomal subunit would not be able to interact with mRNA transcripts.
 - tRNAⁱ-Met would not scan mRNA transcripts for the start codon.
 - eIF-2 would not be able to interact with the small ribosomal subunit.
18. Cancer-causing genes are called _____.
- transformation genes
 - tumor suppressor genes
 - oncogenes
 - mutated genes

19. Targeted therapies are used in patients with a set gene expression pattern. A targeted therapy that prevents the activation of the estrogen receptor in breast cancer would be beneficial to which type of patient?
 - a. patients who express the EGFR receptor in normal cells
 - b. patients with a mutation that inactivates the estrogen receptor
 - c. patients with a lot of the estrogen receptor expressed in their tumor
 - d. patients that have no estrogen receptor expressed in their tumor

Critical Thinking Questions

20. Name two differences between prokaryotic and eukaryotic cells and how these differences benefit multicellular organisms.
21. Describe how controlling gene expression will alter the overall protein levels in the cell.
22. Describe how transcription in prokaryotic cells can be altered by external stimulation, such as excess lactose in the environment.
23. What is the difference between a repressible and an inducible operon?
24. In cancer cells, alteration to epigenetic modifications turns off genes that are normally expressed. Hypothetically, how could you reverse this process to turn these genes back on?
25. A scientific study demonstrated that rat mothering behavior impacts the stress response in their pups. Rats that were born and raised with attentive mothers showed low activation of stress-response genes later in life, while rats with inattentive mothers had high activation of stress-response genes in the same situation. An additional study that swapped the pups at birth (i.e., rats born to inattentive mothers grew up with attentive mothers and vice versa) showed the same positive effect of attentive mothering. How do genetics and/or epigenetics explain the results of this study?
26. Some autoimmune diseases show a positive correlation with dramatically decreased expression of histone deacetylase 9 (HDAC9, an enzyme that removes acetyl groups from histones). Why would the decreased expression of HDAC9 cause immune cells to produce inflammatory genes at inappropriate times?
27. A mutation within the promoter region can alter transcription of a gene. Describe how this can happen.
28. What could happen if a cell had too much of an activating transcription factor present?
29. A scientist identifies a potential transcription regulation site 300 bp downstream of a gene and hypothesizes that it is a repressor. What experiment (with results) could they perform to support this hypothesis?
30. Describe how RBPs can prevent miRNAs from degrading an RNA molecule.
31. How can external stimuli alter post-transcriptional control of gene expression?
32. Protein modification can alter gene expression in many ways. Describe how phosphorylation of proteins can alter gene expression.
33. Alternative forms of a protein can be beneficial or harmful to a cell. What do you think would happen if too much of an alternative protein bound to the 3' UTR of an RNA and caused it to degrade?
34. Changes in epigenetic modifications alter the accessibility and transcription of DNA. Describe how environmental stimuli, such as ultraviolet light exposure, could modify gene expression.
35. A scientist discovers a virus encoding a Protein X that degrades a subunit of the eIF4F complex. Knowing that this virus transcribes its own mRNAs in the cytoplasm of human cells, why would Protein X be an effective virulence factor?
36. New drugs are being developed that decrease DNA methylation and prevent the removal of acetyl groups from histone proteins. Explain how these drugs could affect gene expression to help kill tumor cells.
37. How can understanding the gene expression pattern in a cancer cell tell you something about that specific form of cancer?