



Chapter 15 Exercises

Review Questions

- The AUC and AUA codons in mRNA both specify isoleucine. What feature of the genetic code explains this?
 - complementarity
 - nonsense codons
 - universality
 - degeneracy
- How many nucleotides are in 12 mRNA codons?
 - 12
 - 24
 - 36
 - 48
- Which event contradicts the central dogma of molecular biology?
 - Poly-A polymerase enzymes process mRNA in the nucleus.
 - Endonuclease enzymes splice out and repair damaged DNA.
 - Scientists use reverse transcriptase enzymes to make DNA from RNA.
 - Codons specifying amino acids are degenerate and universal.
- Which subunit of the *E. coli* polymerase confers specificity to transcription?
 - α
 - β
 - β'
 - σ
- The -10 and -35 regions of prokaryotic promoters are called consensus sequences because _____.
 - they are identical in all bacterial species
 - they are similar in all bacterial species
 - they exist in all organisms
 - they have the same function in all organisms
- Three different bacteria species have the following consensus sequences upstream of a conserved gene.

	Species A	Species B	Species C
-10	TAATAAT	TTTAAT	TATATT
-35	TTGACA	TTGGCC	TTGAAA

Order the bacteria from most to least efficient initiation of gene transcription.

- $A > B > C$
 - $B > C > A$
 - $C > B > A$
 - $A > C > B$
- Which feature of promoters can be found in both prokaryotes and eukaryotes?
 - GC box
 - TATA box
 - octamer box
 - 10 and -35 sequences
 - What transcripts will be most affected by low levels of α -amanitin?
 - 18S and 28S rRNAs
 - pre-mRNAs
 - 5S rRNAs and tRNAs
 - other small nuclear RNAs
 - How do enhancers and promoters differ?
 - Enhancers bind transcription factors to silence gene expression, while promoters activate transcription.
 - Enhancers increase the efficiency of gene expression but are not essential for transcription. Promoter recognition is essential to transcription initiation.
 - Promoters bind transcription factors to increase the efficiency of transcription. Enhancers bind RNA polymerases to initiate transcription.
 - There is no difference. Both are transcription factor-binding sequences in DNA.
 - Which pre-mRNA processing step is important for initiating translation?
 - poly-A tail
 - RNA editing
 - splicing
 - 7-methylguanosine cap

11. What processing step enhances the stability of pre-tRNAs and pre-rRNAs?
- methylation
 - nucleotide modification
 - cleavage
 - splicing
12. A scientist identifies a pre-mRNA with the following structure:
- | | | | | |
|--------|--------|-------|--------|--------|
| 100 bp | 50 bp | 75 bp | 90 bp | 120 bp |
| Exon | Intron | Exon | Intron | Exon |
- What is the predicted size of the corresponding mature mRNA in base pairs (bp), excluding the 5' cap and 3' poly-A tail?
- 220 bp
 - 295 bp
 - 140 bp
 - 435 bp
13. The RNA components of ribosomes are synthesized in the _____.
- cytoplasm
 - nucleus
 - nucleolus
 - endoplasmic reticulum
14. In any given species, there are at least how many types of aminoacyl-tRNA synthetases?
- 20
 - 40
 - 100
 - 200
15. A scientist introduces a mutation that makes the 60S ribosomal subunit nonfunctional in a human cell line. What would be the predicted effect on translation?
- Translation stalls after the initiation AUG codon is identified.
 - The ribosome cannot catalyze the formation of peptide bonds between the tRNAs in the A- and P-sites.
 - The ribosome cannot interact with mRNAs.
 - tRNAs cannot exit the E-site of the ribosome.

Critical Thinking Questions

16. Imagine if there were 200 commonly occurring amino acids instead of 20. Given what you know about the genetic code, what would be the shortest possible codon length? Explain.
17. Discuss how degeneracy of the genetic code makes cells more robust to mutations.
18. A scientist sequencing mRNA identifies the following strand:
CUAUGUGUCGUAACAGCCGAUGACCCG
- What is the sequence of the amino acid chain this mRNA makes when it is translated?
19. If mRNA is complementary to the DNA template strand and the DNA template strand is complementary to the DNA nontemplate strand, then why are base sequences of mRNA and the DNA nontemplate strand not identical? Could they ever be?
20. In your own words, describe the difference between rho-dependent and rho-independent termination of transcription in prokaryotes.
21. A fragment of bacterial DNA reads:
3'-TACCTATAATCTCAATTGATAGAAGCACTCTAC-5'
- Assuming that this fragment is the template strand, what is the sequence of mRNA that would be transcribed? (Hint: Be sure to identify the initiation site.)
22. A scientist observes that a cell has an RNA polymerase deficiency that prevents it from making proteins. Describe three additional observations that would together support the conclusion that a defect in RNA polymerase I activity, and not problems with the other polymerases, causes the defect.
23. Chronic lymphocytic leukemia patients often harbor nonsense mutations in their spliceosome machinery. Describe how this mutation of the spliceosome would change the final location and sequence of a pre-mRNA.
24. Transcribe and translate the following DNA sequence (nontemplate strand):
5'-ATGGCCGGTTATTAAGCA-3'

25. Explain how single nucleotide changes can have vastly different effects on protein function.
26. A normal mRNA that reads 5'-UGCCAUGGUAUAACACAUGAGGCCUGAAC-3' has an insertion mutation that changes the sequence to 5'-UGCCAUGGUAAUAACACAUGAGGCCUGAAC-3'. Translate the original mRNA and the mutated mRNA and explain how insertion mutations can have dramatic effects on proteins. (Hint: Be sure to find the initiation site.)