13.E: Genetic Code (Exercises)

Questions for Chapter 13. Genetic Code

13.1 How does the enzyme polynucleotide phosphorylase differ from DNA and RNA polymerases?

13.2 A short oligopeptide is encoded in this sequence of RNA

5' GACUAUGCUAUUGGUCCUUUGACAAG

a) Where does it start and stop, and how many amino acids are encoded?

b) Which codon position usually shows degeneracy?

The template strand of a sample of double-helical DNA contains the sequence:

(5')CTTAACACCCCTGACTTCGCGCCGTCG

a) What is the base sequence of mRNA that can be transcribed from this strand?

c) Suppose the other (nontemplate) strand of this DNA sample is transcribed and translated. Will the resulting amino acid sequence be the same as in (b)? Explain the biological significance of your answer.

13.5 The Basis of the Sickle-Cell Mutation.

b) Leu can be converted to either Ser, Val, or Met by a single nucleotide substitution (a different nucleotide substitution for each amino acid replacement). What is the codon for Leu?
13.10 (POB) Identifying the Gene for a Protein with a Known Amino Acid Sequence.

H₃N⁺-Ala-Pro-Met-Thr-Trp-Tyr-Cys-Met-Asp-Trp-Ile-Ala-Gly-Gly-Pro-Trp-Phe-Arg-Lys-Asn-Thr-Lys---

13.11 Let's suppose you are in a lab on the Starship Enterprise. One of the “away teams” has visited Planet Claire and brought back a fungus that is the star of this week’s episode. While the rest of the crew tries to figure out if the fungus is friend or foe (and gets all the camera time), you are assigned to determine its genetic code. With the technologies of two centuries from now, you immediately discover that its proteins are composed of only eight amino acids, which we will call simply amino acids 1, 2, 3, 4, 5, 6, 7, and 8. Its genetic material is a nucleic acid containing only three nucleotides, called K, N and D, which are not found in earthly nucleic acids.

The results of frameshift mutations confirm your suspicion that the smallest possible coding unit is in fact used in this fungus. Insertions of a single nucleotide or three nucleotides into a gene cause a complete loss of function, but insertions or deletions of two nucleotides have little effect on the encoded protein.

You make synthetic polymers of the nucleotides K, N and D and use them to program protein synthesis. The amino acids incorporated into protein directed by each of the polynucleotide templates is shown below. Assume that the templates are read from left to right.

<table>
<thead>
<tr>
<th>Template</th>
<th>Amino acid(s) incorporated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kₙ</td>
<td>KKKKKKKKKK 1</td>
</tr>
<tr>
<td>Nₙ</td>
<td>NNNNNNNNNN 2</td>
</tr>
<tr>
<td>Dₙ</td>
<td>DDDDDDDDDDD 3</td>
</tr>
<tr>
<td>(KN)ₙ</td>
<td>KNKKNKKNKN 4 and 5</td>
</tr>
<tr>
<td>(KD)ₙ</td>
<td>KDKDKDKDKD 6 and 7</td>
</tr>
<tr>
<td>(ND)ₙ</td>
<td>NDNDNDNDND 8</td>
</tr>
<tr>
<td>(KND)ₙ</td>
<td>KNDKNDKNDKND 4 and 6 and 8</td>
</tr>
</tbody>
</table>

Please report your results on the genetic code used in the fungus from Planet Claire.

a) What is size of a codon?

b) Is the code degenerate?
e) What is the mutation that will change a codon for amino acid 6 to a codon for amino acid 5? Show both the initial codon and the mutated codon.

f) What is the mutation that will change a codon for amino acid 8 to a codon for amino acid 7? Show both the initial codon and the mutated codon.