

Solution Key - 7.013 Recitation 7 - 2010

Questions:

1. The following is a partial sequence from the hypothetical gene, gene X. The boxed region is the promoter, and the direction of transcription is indicated by the arrow. Transcription begins at and includes the first G/C base pair after the box.

```

5' GGACCGCGGGGCGAGGATTGCTCCGGGCTGTTTCATGACTTGTCTAGGTGGGATGACTTGGATGGAAAAGTAGAAGGTCATG
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3' CCTGGCGCCCCGTCCTAACGAGGCCCGACAAAGTACTGAACAGTCCACCCTACTGAACCTACCTTTTCATCTTCCAGTAC

5' GGGTGGCCAACTTGGGCGAGAAAAGGTATATAAAGGTCTCTTGCTCCCATCTACTGCCCCATTTGTAGGTATTCCAGCAG
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3' CCCACCGGTTGAACCCGCTCTTTTCCATATATTTCCAGAGAACGAGGGTAGATGACGGGGTAAACATCCATAAGGTCGTC

5' ATCAGACAACGTCTCATGGGAGTACTTGGATGGAAGAGTAGAAGGTCATGACCAACCTCTTCCAATCCAACCACAAACAG
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3' TAGTCTGTTGCAGAGTACCCTCATGAACCTACCTTCTCATCTTCAGTACTGGTTGGAGAAGGTTAGGTTGGTGTGTTGTC

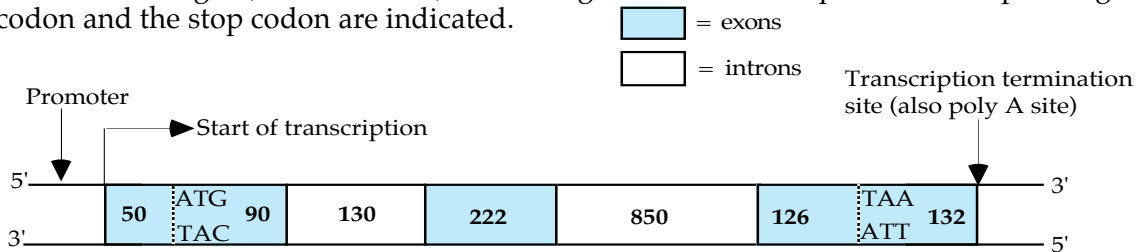
5' AAAATCAGCCAATATGTCCGACTTCGAGAACAAAGACCCCAACAACGTCCTTGGCGGACACAAGGCCACCCTTCACAACC
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3' TTTTAGTCGGTTATACAGGCTGAAGCTCTTGTCTTGGGGTTGTTGCAGGAACCGCCTGTGTTCCGGTGGGAAGTGTGTTGG

5' CTAGTATGTATCCTCCTCAGAGCCTCCAGCTTCCGTCCTCGTCGACATTTTCCTTTTTTTCATATTACATCCATCCAAG
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3' GATCATACATAGGAGGAGTCTCGGAGGTCGAAGGCAGGGAGCAGCTGTAAAGGAAAAAAGTATAATGTAGGTAGGTTC
  
```

What are the first 10 nucleotides of the mRNA produced from gene X?

In the sequence above the top strand is the template strand for transcription that always proceeds in a 5'→3' direction. Therefore the first 10 nucleotides of the mRNA will be 5'CUUCCAUCCA3'.

2. Shown below is the genomic structure of the human β-globin gene. The numbers within the boxes indicate the length (in nucleotides) of each region. The DNA sequences corresponding to the start codon and the stop codon are indicated.



What is the length (in nucleotides) of the mature, processed β-globin mRNA?

It is 620bp long since the introns are spliced out.

3. Drawn below is part of a wild-type gene. The DNA sequence shown encodes the last amino acids of a protein that is normally 380 amino acids long. The **bold & underlined** codon indicates the correct reading frame of this gene. The lower strand of the gene is used as the template during the transcription of mRNA from this gene.

```

...GCTAAGTATTGCTCAAGATTAGGATGATAAATAACTGG-3'
...CGATTCATAACGAGTTCTAATCCTACTATTTATTGACC-5'
  
```

a) In the copy of the sequence drawn below, circle one base pair that you could change to make a mutant form of the gene that produces a protein that is now 381 amino acids long. Indicate the identity of one new base pair that could take its place.

```

...GCTAAGTATTGCTCAAGATTAGGATGATAAATAACTGG-3'
...CGATTCATAACGAGTTCTAATCCTACTATTTATTGACC-5'
 373 374 375 376 377 378 379 380 stop stop
                        codon codon
                        1
  
```

You should change the stop codon immediately after the codon for 380th amino acid to get a protein that is 381 amino acids long. Please note that the codon immediately after the first stop codon is also a stop codon.

b) In the copy of the sequence drawn below, draw a slash between two base pairs where you could add one extra base pair in order to make a single mutant form of the gene that produces a protein that is 373 amino acids long. Indicate the identity of the one new base pair you are adding.

You should add a "T" before the 1st base in the 374th codon so that you get a stop codon.

4. For each of the following types of mutations, state how they impact the final gene product.

a) **Silent:** *It changes a codon but does not change the amino acid encoded by that codon.*

b) **Missense:** *It changes the identity of the amino acid at one position.*

c) **Frameshift:** *It either inserts or deletes a single nucleotide from the coding region of a gene, leading to a change in the reading frame of that gene.*

d) **Nonsense:** *It results in a truncated protein due to a premature stop codon.*