

7.013 Recitation 8 - 2013

Summary of Lecture 13:

Translation: Translation begins when the ribosome orients itself at the start codon 5'-AUG-3' on an mRNA. A tRNA that recognizes and base pairs with that codon (i.e. a tRNA with the anticodon 3'-UAC-5') fits into the ribosome and donates the amino acid to which it is bound (methionine) to the new protein. From then on, every three nucleotides in the mRNA are read by another tRNA as a single amino acid. Each time, the next tRNA comes and fits into the ribosome, donates its amino acid to the new protein, waits for the next tRNA to come in, and then exits. This proceeds until a stop codon is reached, and the ribosome dissociates from both the mRNA and the newly made protein. Every protein has an N (amino) and a C (carboxyl) terminus, and proteins are synthesized in the N to C direction, such that the 5' end of the mRNA corresponds to the N terminus of the protein.

Mutations: Most mutations that geneticists study are single nucleotide mutations that cause phenotypic changes. The four types of single nucleotide mutations are silent, missense, nonsense, and frameshift. A silent mutation changes a codon but does not change the amino acid encoded by that codon. A missense mutation changes the identity of the amino acid at one position. A nonsense mutation causes a protein to be truncated because a codon is changed to a stop codon. A single nucleotide frameshift is a change that 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.

Questions:

1. Assume that the sequence of DNA below is a short protein-encoding gene; the sequences in between the transcription start and stop sites are shown. The entire DNA sequence of the very short gene is:

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5' CGCTTATAGAACCCAATCTCTCATAGGC 3'  
3' GCGAATATCTTGGGTTAGAGAGTATCCG 5'
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- What would the resulting mRNA be if the top strand of this DNA molecule were used as a template in transcription? Label the 5' and 3' ends of your molecule.
- What is the full sequence of the protein that would be translated from this RNA? Label the N and C termini of your molecule.
- What would happen to the encoded protein if the underlined nucleotide C were mutated to a T?

2. 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.

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

- 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.

- ii. 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.

3. For each of the following types of mutations, state whether they can cause a loss-of-function of the gene product, a gain-of-function of the gene product, either, or neither:

- i. Silent
- ii. Missense
- iii. Frameshift
- iv. Nonsense:

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7.013 Introductory Biology
Spring 2013

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