

## Chapter 10

Topic: RNA transcription

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### Main concepts:

- Beadle and Tatum's work with the fungus *Neurospora* lead to the understanding that most proteins are coded for by single genes. If the genes for enzymes involved in chemical pathways for synthesizing biomolecules that the fungus needed were broken, the enzymes did not work, and the fungus could not synthesize that particular biomolecule. (The "gene" as a unit of information had been hypothesized in the early 20th century.)
- DNA contains information for proteins. mRNA ("messenger" RNA) is used to make copies of that information. This allows DNA to remain protected in the nucleus, and allows the cell to copy only the genes that it needs.
- Transcription is the process of making an mRNA copy of a gene. Translation is the process of using the information in the mRNA copy and using it to assemble amino acids in the right order to make a working protein. Transcription happens in the nucleus. Translation happens in the rough ER, and is carried out by ribosomes.
- Like DNA replication, transcription is carried out by enzymes. RNA polymerase is the most important enzyme in this process.
- When a particular protein is needed, the DNA is unzipped just where the gene for the protein is located.
- RNA polymerase copies ONE of the strands, the "sense" strand. (The matching DNA strand is the "non-sense" strand.)
- Because RNA contains Uracil instead of Thymine, the base-pairing rule is slightly different when going from RNA to DNA:
  - A of DNA matches U of RNA
  - T of DNA matches A of RNA
  - C and G still match as they do in DNA
- The mRNA strand detaches from the DNA strand, and moves from the nucleus into the rough ER for translation.
- mRNA carries the code from a single gene, a code for the sequence of amino acids to make a protein.
- mRNA moves from the nucleus to the Rough ER, where it is caught by a ribosome.
- Ribosomes are made of ribosomal RNA (rRNA), and consist of two subunits. The ribosome carries out an enzyme-like function as it reads the mRNA code and constructs an amino acid chain (polypeptide).
- Transfer RNA (tRNA) has an anticodon at one end, which matches (using the base-pairing rule) a codon of mRNA. Each tRNA transports a single amino acid.
- Both mRNA and tRNA bind to a ribosome. Together, the three build the protein chain.
- The catalytic site on the ribosome carries out dehydration synthesis between amino acids, forming peptide bonds between them.
- After a tRNA has delivered its amino acid, it moves back to the cytoplasm to pick up another amino acid. Where do the amino acids come from? We animals get them from the food we eat. Plants and other photosynthesizers make amino acids.
- If something is wrong with either the DNA sequence (the gene) or the mRNA transcription, there will be errors in the amino acid chain. Some errors will be of little consequence. Some will change the nature of the protein and cause it to malfunction.
- Most mutations are the result of base substitutions (point mutations), insertions, or deletions. If a whole codon is inserted or deleted, it will change only one amino acid. But if a single base is inserted or deleted, it changes the entire reading frame so that it codes for an entirely different sequence of amino acids.
- Point mutations may or may not cause a problem. Redundancy in the genetic code (the fact that there may be more than one codon that codes for an amino acid) provides some protection against point mutations.

### Common misconceptions:

- The most common confusion for students concerns uracil in RNA. Many students are able to associate T with U, but believe T in DNA should match up with U in RNA. Remember that RNA still has Adenine, so a T
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in DNA still matches A in RNA. Remember that RNA has no T, so substitute a U where the base-pairing rule would normally put a T.

- Some students either don't think about where amino acids come from, or believe that they are made during translation.
- Most students trip up when going from DNA to mRNA. Remember that T does NOT match up with U. RNA has Uracil instead of Thymine, so A in DNA will match U in RNA. T in DNA still matches A in RNA.
- Many students forget the role of the anticodon in tRNA, or get confused about how the base-pairing rule works in RNA. Remember, there are no thymines in RNA. A will match U, C will match G when matching codon to anticodon.

### Reading notes:

- Describe the *Neurospora* study, and why this suggested the "one gene, one protein" rule.
- List several ways in which RNA is different from DNA.
- List the three major types of RNA.
- Summarize what happens in transcription and translation.
- Define the "genetic code." Note that this code is the same for all living things on the planet.
- Define "codon."
- If an mRNA strand was made entirely of adenine (A), what amino acids would it code for?
- Define "start codon" and "stop codon."
- Describe the role of RNA polymerase.
- Define what a promoter is.
- State what is meant by "transcription is selective."
- Define the role of mRNA, and what a codon is.
- Describe the ribosome and what it does.
- Define the role of tRNA, and what an anticodon is.
- Describe initiation, elongation, and termination.
- Define nucleotide substitution (point mutation), insertion mutation, and deletion mutation.
- List the possible consequences of a mutation. Are mutations always harmful?

### Useful websites:

- "Transcribe and Translate a Gene" <http://learn.genetics.utah.edu/units/basics/transcribe/> is an interactive animation that walks you through transcription and translation. Notice that you must first find the "start" codon before the reading frame will appear.
  - "DNA transcription tutorial" [http://edtech.clas.pdx.edu/gene\\_expression\\_tutorial/transcription.html](http://edtech.clas.pdx.edu/gene_expression_tutorial/transcription.html) is a guided tour through the transcription process.
  - "Animation of Transcription" <http://www.fed.cuhk.edu.hk/~johnson/teaching/genetics/animations/transcription.htm> is an animated sequence showing how transcription works.
  - "Transcribe and Translate a Gene" <http://learn.genetics.utah.edu/units/basics/transcribe/> is an interactive animation that walks you through transcription and translation. Notice that you must first find the "start" codon before the reading frame will appear.
  - "What makes a Firefly Glow?" <http://gslc.genetics.utah.edu/units/basics/firefly/> ties together DNA, RNA, transcription, translation, proteins, and enzyme function.
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