DNA Transcription and Translation

Overview of everything:
http://www.youtube.com/watch?v=hnSPGlpZx_Q&feature=related

Gene
- Segment of DNA that codes for a protein
- DNA codes for RNA and RNA makes protein

History: One Gene – One Enzyme
- The Beadle and Tatum experiment showed that one gene codes for one enzyme.
- One gene codes for one polypeptide.
- polypeptide - a chain of covalently bonded amino acids.
- (proteins are made of one or more polypeptide)

Beadle and Tatum Experiment

DNA, RNA, and Protein
- DNA is the template for DNA and RNA
- RNA is what eventually codes proteins
  - Because we get RNA from DNA, though, we call DNA the template or blueprint for all proteins
Observations about RNA’s structure...

- Single stranded
- Uracil instead of Thymine
- Hydrogen bonds make it curl up on itself

RNA Structure

- Like DNA, RNA is made up of subunit nucleotides which are made of three parts:
  - Sugar (ribose)
  - Phosphate
  - Nitrogen Base

RNA’s Nitrogen Bases

- Adenine (A)
- Cytosine (C)
- Guanine (G)
- Uracil (U)

There are 3 types of RNA:

- Messenger RNA (mRNA)
- Ribosomal RNA (rRNA)
- Transfer RNA (tRNA)
All RNA is ...

- Single stranded
- Many different shapes
- “Cheap copy” of DNA

**Transcription**

- First step in making proteins
- Process of taking one gene (DNA) and converting into a mRNA strand
- DNA → RNA
- **Location:**
  - Nucleus of the cell

**Steps to Transcription**

1. An enzyme attaches to the promoter (start signal region) of a gene and unwinds the DNA

**Steps to Transcription (Cont.)**

2. One strand acts as a template.

**Steps to Transcription (Cont.)**

3. A mRNA copy is made from the DNA template strand by the enzyme RNA polymerase
Steps to Transcription (Cont.)

4. A mRNA copy is made until it reaches the **termination** (stop signal) sequence.
5. The two strands of DNA rejoin.

Template vs. Non Template Strands

*RNA polymerase also builds in a 3’ to 5’ direction.

Template strand of DNA

Non-template strand

Transcription animation

- [http://www.johnkyrk.com/DNAtranscription.html](http://www.johnkyrk.com/DNAtranscription.html)

Transcribe this DNA to mRNA

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GCCATTACGATCGAT
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mRNA Processing

• **Pre-mRNA** — the original sequence of RNA created during transcription
• **mRNA** reaches the ribosomes

What is RNA Processing?

• After transcription the pre-mRNA molecule undergoes processing:
  – 5’ cap is added: stability in translation
  – Poly A tail is added to the 3’ end: lots of adenines protect mRNA and facilitate transport
  – In Eukaryotes only:
    • Introns - non-coded sections — removed in processing
    • Exons - codes for a protein
  – Different enzymes control these processes

Why is it necessary to add the poly A tail and 5’ cap?
**Translation**

- Production of proteins from mRNA template
- **Location**: mRNA goes to the ribosomes in the cytoplasm or the RER and produces proteins

**Steps to Translation**

1. mRNA leaves the nucleus and binds to a ribosome
   - the 5’ end of mRNA binds to ribosome

**Ribosome**

- Two subunits to the ribosome
- 3 grooves on the ribosome (A, P, E)
  - A: tRNA binding site
  - P: polypeptide bonding site
  - E: exit site

**Steps to Translation (Cont.)**

2. Ribosome looks for the start **Codon** (AUG)
   - **Codon**: group of 3 nucleotides on the messenger RNA that specifies one amino acid (64 different codons)
Steps to Translation (Cont.)

- 3. Amino acids are attached to a tRNA molecule and are brought over to the mRNA.
- 4. This tRNA has an **anticodon** that matches the codon on the mRNA strand.

**Anticodon:**
Group of 3 unpaired nucleotides on a tRNA strand. (binds to mRNA codon)

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tRNA

- Link between DNA/RNA and protein amino acid sequence
- Single strand of ~80 bases
- Carries one amino acid each to join to specific mRNA codon

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Steps to Translation (Cont.)

- 5. tRNA binds to the mRNA sequence and adds an amino acid
- 6. Each amino acid matches up with 1-6 tRNA molecules
- 7. tRNA leaves and amino acids bond together through a polypeptide bond
Steps to Translation (Cont.)

9. The mRNA sequence continues until a stop codon is reached.

10. The amino acids disconnect from the mRNA sequence and a protein is formed.

Translation Animation


How do cells know what protein to make when?

- **Gene Regulation**: ability of an organism to control which genes are transcribed.
Controlling Transcription

• Transcription factors ensure that a gene is used at the right time and that protein are made in the right amounts
• The complex structure of eukaryotic DNA also regulate transcription.