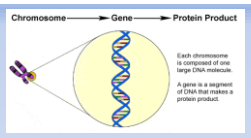
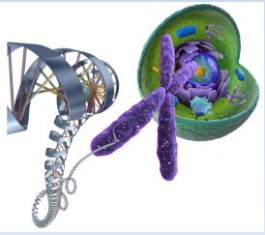
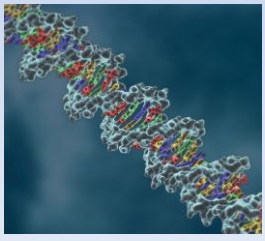


DNA Transcription and Translation

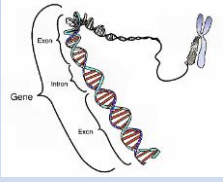


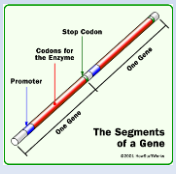


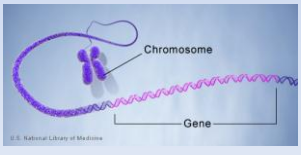
- Overview of everything: http://www.youtube.com/watch?v=hnSPGlpZx_Q&feature=related

Gene

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

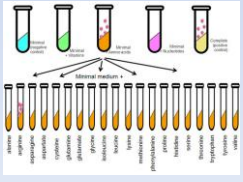




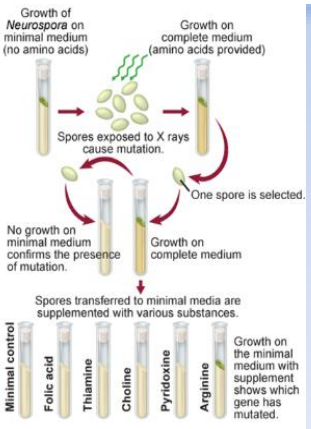


History: One Gene – One Enzyme

- 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)

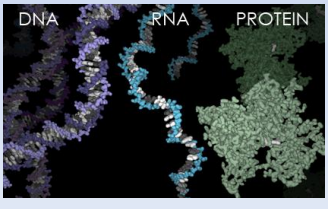


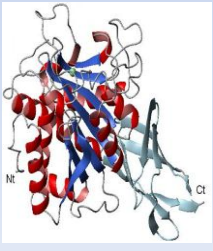
Beadle and Tatum Experiment



DNA, RNA, and Protein

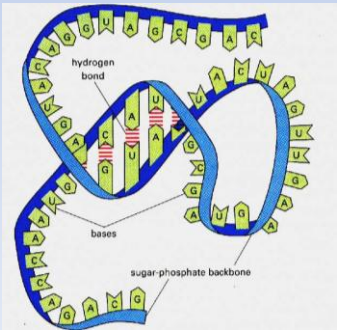
- DNA is the template for DNA and RNA
- RNA is what eventually codes proteins
  - Because we get RNA from DNA, though, we call DNA the template or blueprint for all proteins

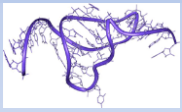




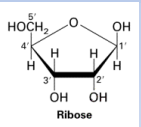
Observations about RNA's structure…

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

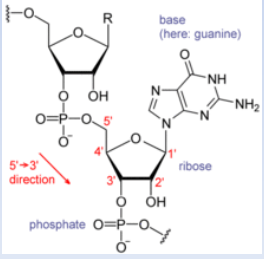




RNA

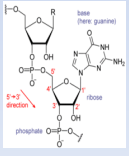


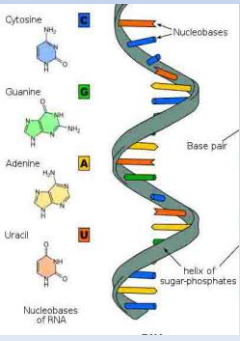
- RNA stands for Ribonucleic Acid
  - Ribose pentose has one more O atom than deoxyribose
- Found in the Nucleus and Cytoplasm



RNA Structure

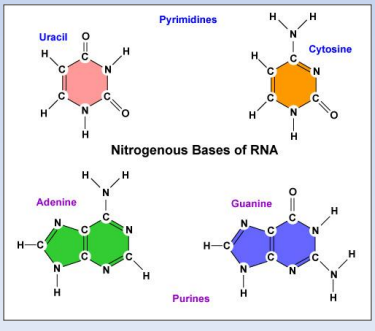
- Like DNA, RNA is made up of subunit nucleotides which are made of three parts:
  - Sugar (ribose)
  - Phosphate
  - Nitrogen Base

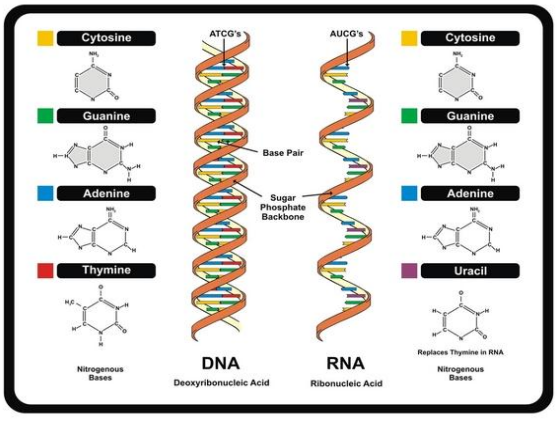




RNA's Nitrogen Bases

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





There are 3 types of RNA:

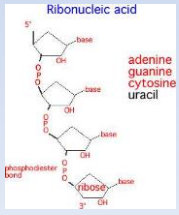
- Messenger RNA (mRNA)
- Ribosomal RNA (rRNA)
- Transfer RNA (tRNA)

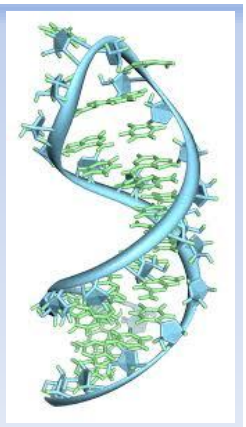
Comparison of Three Types of RNA

Name	mRNA	rRNA	tRNA
Function	Carries genetic information from DNA in the nucleus to direct protein synthesis in the cytoplasm	Associates with protein to form the ribosome	Transports amino acids to the ribosome
Example			

All RNA is …

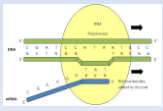
- Single stranded
- Many different shapes
- "Cheap copy" of DNA

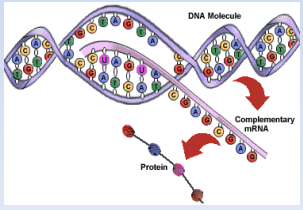


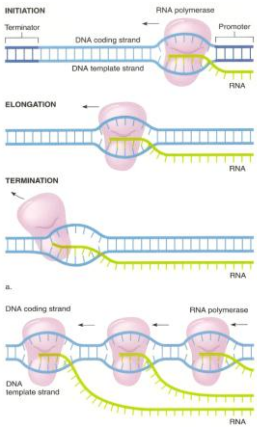


Transcription

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

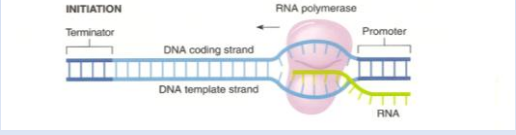






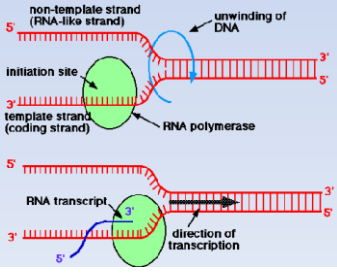
Steps to Transcription

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



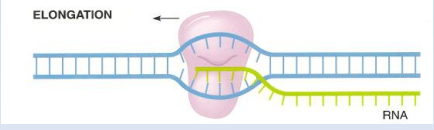
Steps to Transcription (Cont.)

- 2. One strand acts as a template.



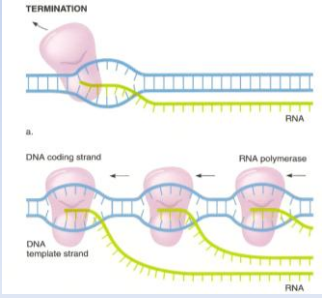
Steps to Transcription (Cont.)

- 3. A mRNA copy is made from the DNA template strand by the enzyme **RNA polymerase**

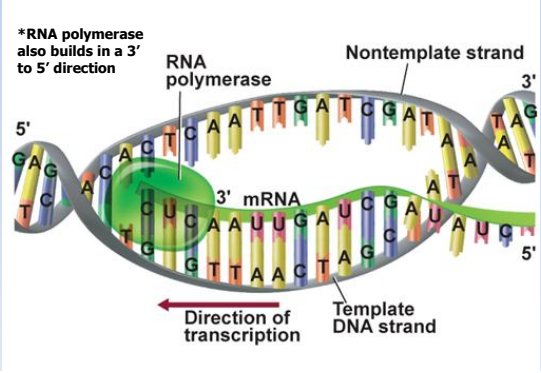


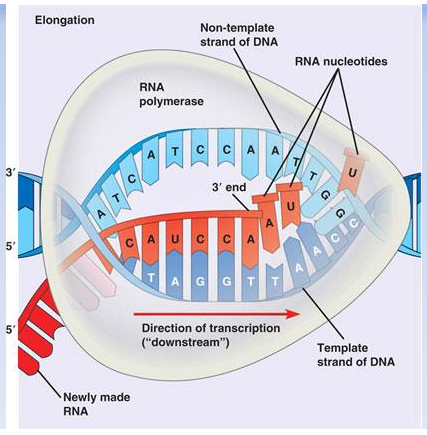
Steps to Transcription (Cont.)

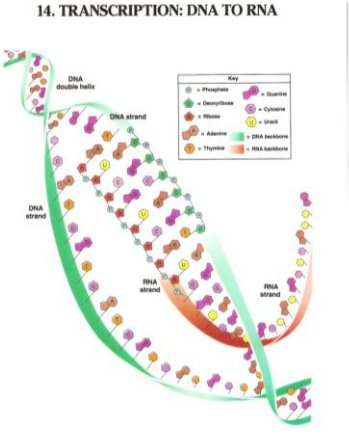
- 4. A mRNA copy is made until it reaches the **termination** (stop signal) sequence
- 5. The two strands of DNA rejoin.



Template vs. Non Template Strands


*RNA polymerase also builds in a 3' to 5' direction





Transcription animation

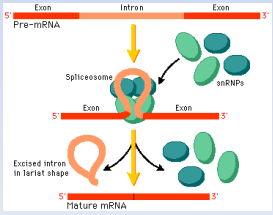
- http://www.johnkyrk.com/DNAtranscription.html

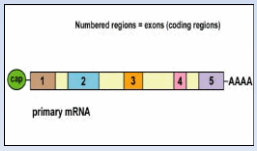
Transcribe this DNA to mRNA

GCCATTACGATCGAT

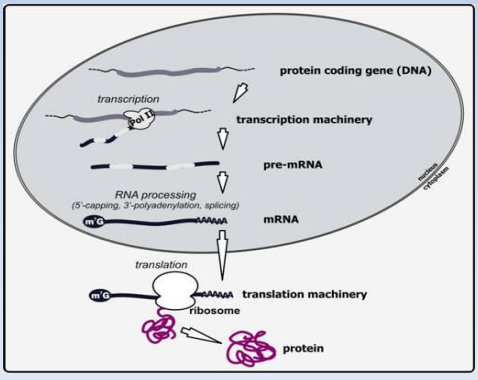
mRNA Processing

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



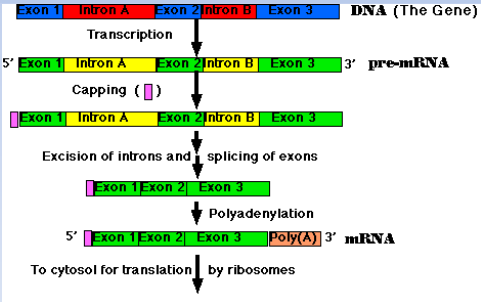


RNA Processing

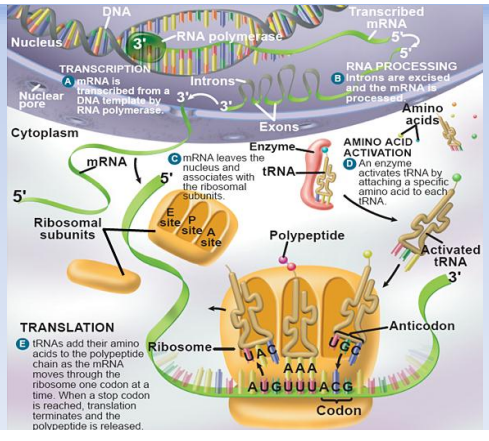


What is RNA Processing?

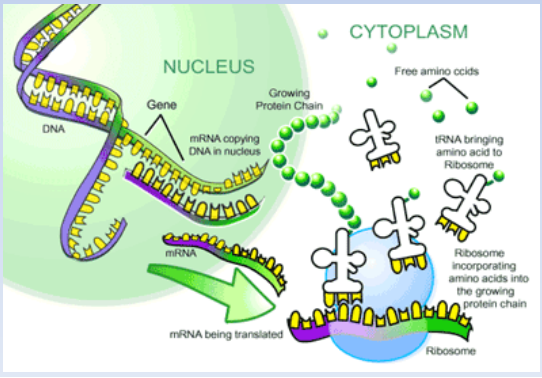
- After transcription the pre-mRNA molecule undergoes processing
  - 5' cap is added: stability in translation
  - Poly A tail is added to the 3' end: lots of adenines protect mRNA and facilitate transport
  - In Eukaryotes only:
    - Introns- non-coded sections—removed in processing
    - Exons- codes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



Why is it necessary to add the poly A tail and 5' cap?

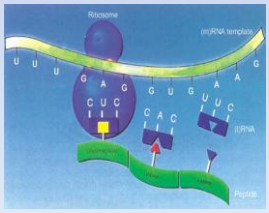


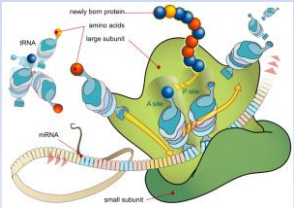
Translation

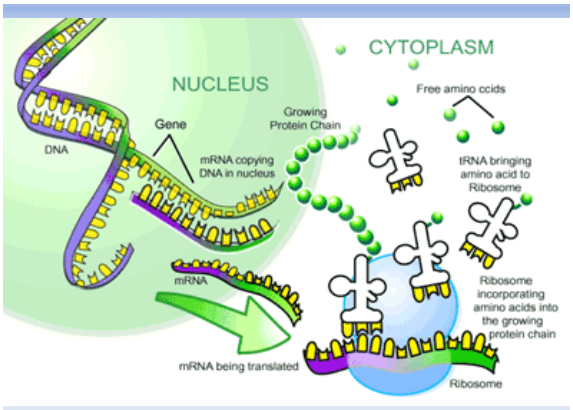


Translation

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

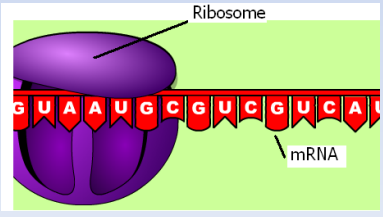




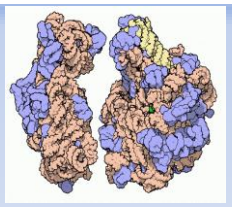


Steps to Translation

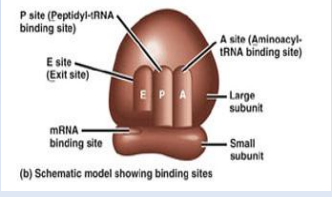
- 1. mRNA leaves the nucleus and binds to a ribosome
  - the 5' end of mRNA binds to ribosome



Ribosome

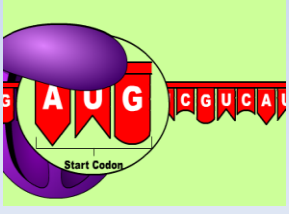


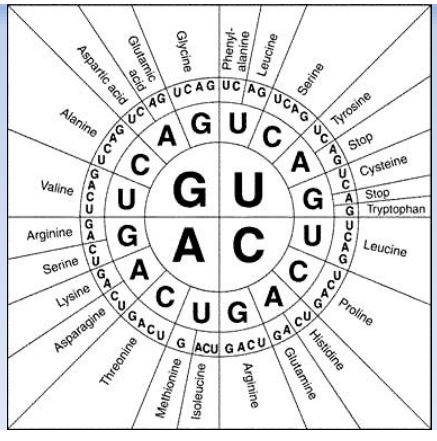
- Two subunits to the ribosome
- 3 grooves on the ribosome (A, P, E)
- A: tRNA binding site
- P: polypeptite bonding site
- E: exit site



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)



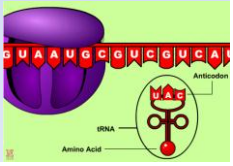


Steps to Translation (Cont.)

- 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

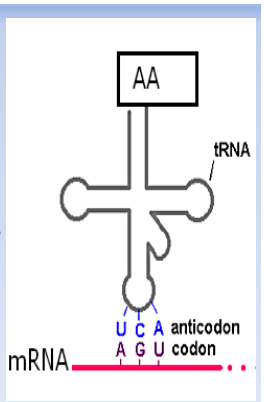
Anticodon:

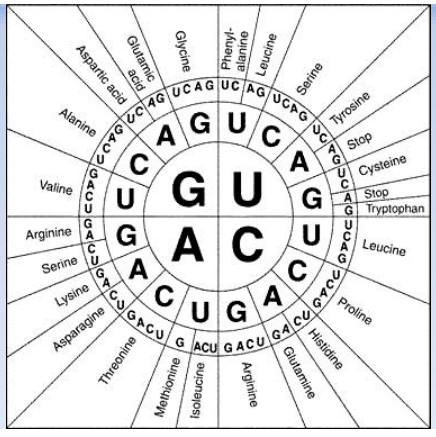
Group of 3 unpaired nucleotides on a tRNA strand. (binds to mRNA codon)



tRNA

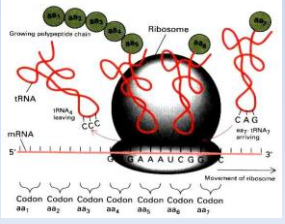
- Link between DNA/RNA and protein amino acid sequence
- Single strand of ~80 bases
- Carries one amino acid each to join to specific mRNA codon

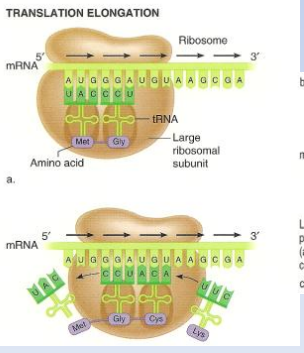


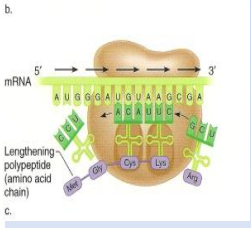


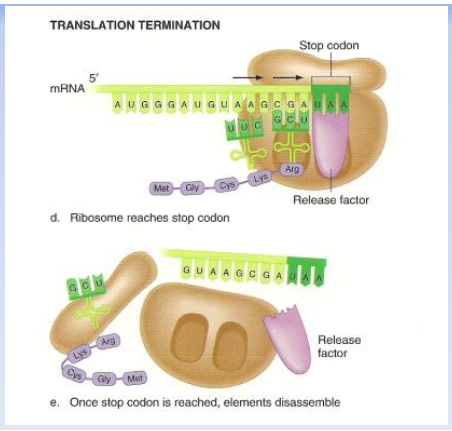
Steps to Translation (Cont.)

- 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



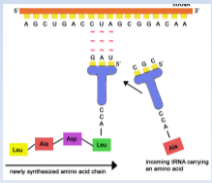


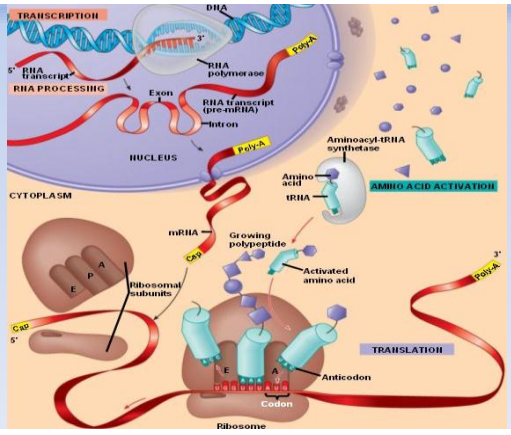




Steps to Translation (Cont.)

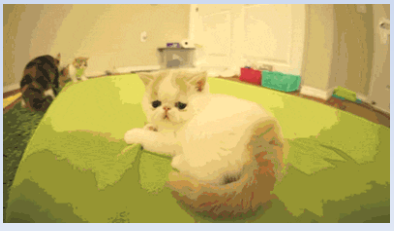
- 9. The mRNA sequence continues until a stop codon is reached.
- 10. The amino acids disconnect from the mRNA sequence and a protein is formed.





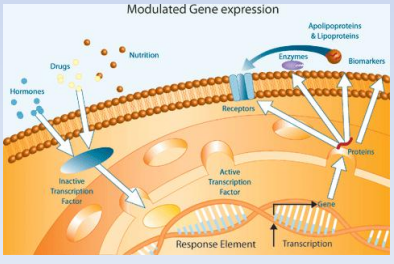
Translation Animation

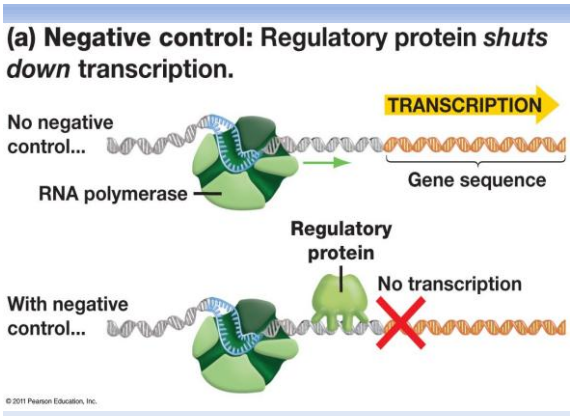
- http://www.johnkyrk.com/DNAtranslation.html

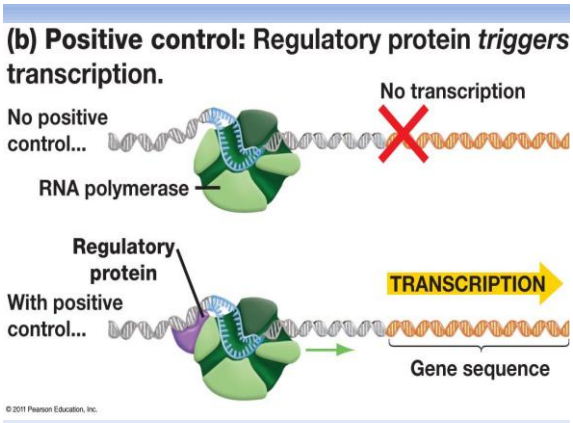


How do cells know what protein to make when?

- **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.