

Chapter 10: Gene Expression and Regulation

Important

- how is DNA genetic code read by the cell to make protein?
- what makes up a gene?
- how is a gene activated (eg. turned on and off)?
- how are genes interrupted
- what is the difference between *transcription* and *translation*

Central Dogma of Biology!!!

DNA (transcription in nucleus) \Rightarrow RNA (translation in cytoplasm) \Rightarrow Protein

Transcription

- converts double stranded DNA code into single stranded RNA code
- uses enzyme machine (RNA polymerase) to perform transcription
- RNA polymerase only reads one of the two DNA strands
- RNA polymerase matches RNA nucleotide with DNA nucleotides to produce single RNA strand with same code

RNA Polymerase (transcription process)

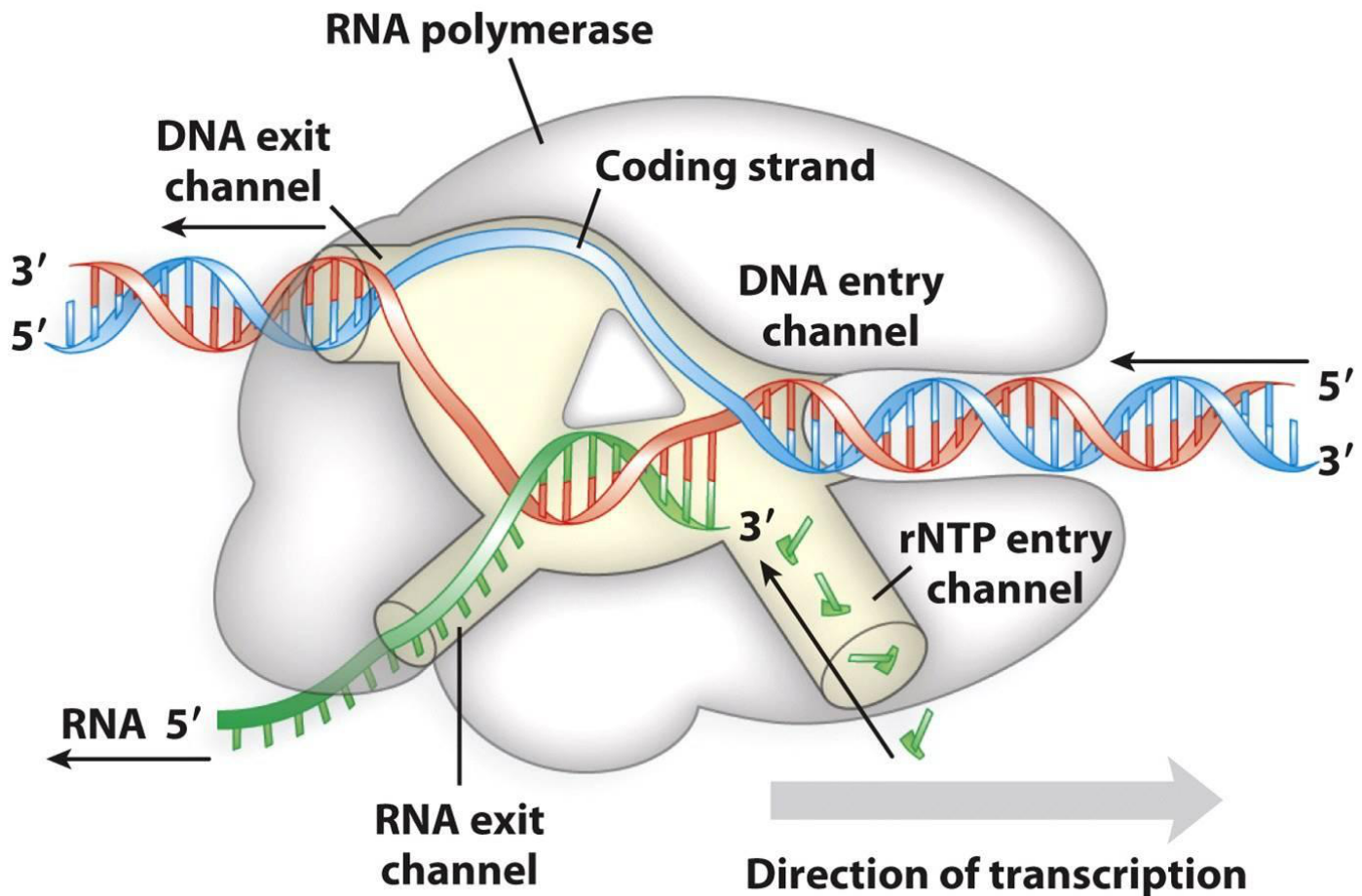


Figure 15-14
Molecular Biology: Principles and Practice
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What Makes Up a Gene?

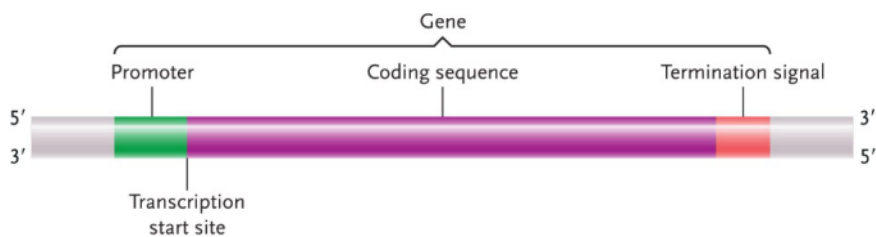


FIGURE 10.3 A typical bacterial gene contains information to make a protein: the promoter, the coding sequence, and the termination signal.

Gene: sequence of DNA on a specific region of the chromosome that makes RNA product

Promoter: region of DNA that acts as on/off switch for transcription

- All genes have promoters (sequences of DNA) that control when and at what level the gene is expressed

Terminator: region of DNA that acts to end transcription

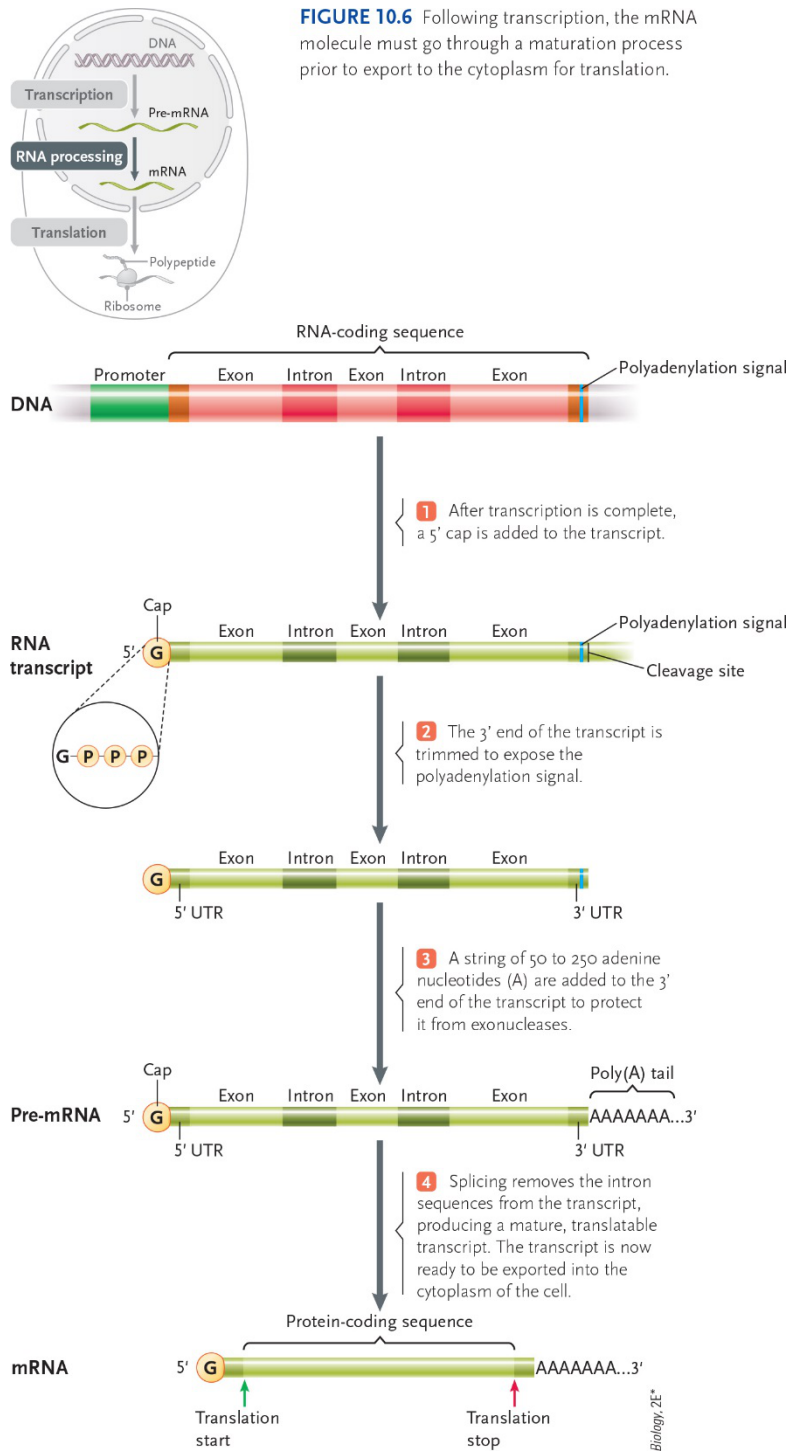
- not all genes are on/off at the same time
- number of genes on at a specific time control cell type/function (eg genes in brain cells are different than skin cells)
- changes in DNA sequence can affect gene function (alleles)

Is all of the transcribed gene coding region translated into protein?

Prokaryotes=Yes, Eukaryotes=No

In eukaryotes, genes are called interrupted since not all of the transcribed RNA is translated into protein.

Coding regions=**Exons**, “building blocks of life”, spliced together to form mature mRNA which is translated into protein
 Non-coding regions=**Introns** (removed before translation)



Translation

- mature mRNA (exported from nucleus) is translated by **ribosomes** in cytoplasm
- cells have transfer RNAs (tRNA) which recognizes specific **three letter codes (codons)** on the mRNA which correspond to specific amino acids
- **tRNA** act as intermediary between mRNA and amino acids- brings in amino acids into growing polypeptide chain

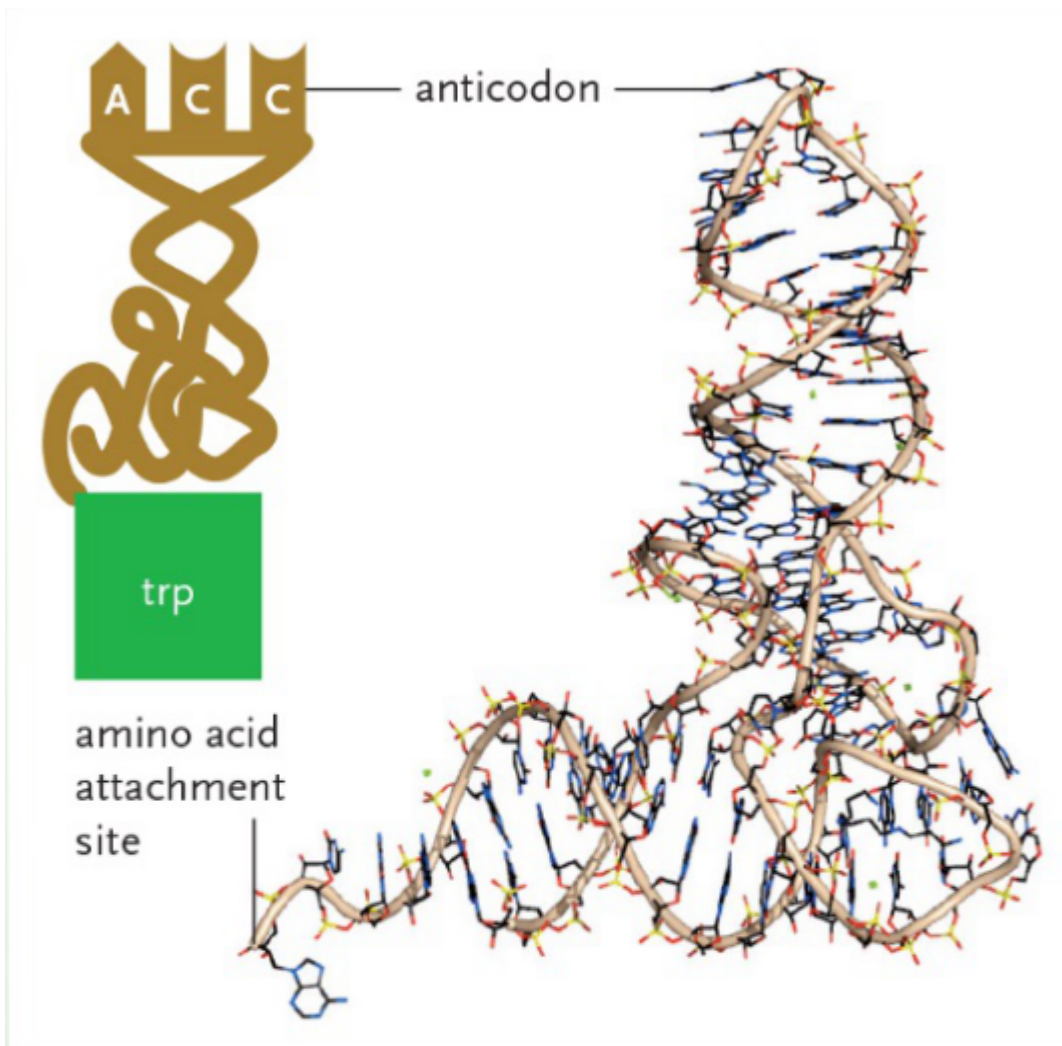


FIGURE 1 tRNAs help the ribosome translate the genetic code. The anticodon reads the mRNA codon, and the tRNA delivers the correct amino acid to the growing protein during translation.

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Codon

- codon code is *redundant*: multiple codons code for same amino acid

		Second base of codon					
		U	C	A	G		
First base of codon	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } Ser UCC } UCA } UCG }	UAU } Tyr UAC } UAA UAG	UGU } Cys UGC } UGA UGG } Trp	U C A G	Third base of codon
	C	CUU } Leu CUC } CUA } CUG }	CCU } Pro CCC } CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } Arg CGC } CGA } CGG }	U C A G	
	A	AUU } Ile AUC } AUA } AUG Met	ACU } Thr ACC } ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G	
	G	GUU } Val GUC } GUA } GUG }	GCU } Ala GCC } GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } Gly GGC } GGA } GGG }	U C A G	

KEY

Ala = alanine
 Arg = arginine
 Asn = asparagine
 Asp = aspartic acid
 Cys = cysteine
 Gln = glutamine
 Glu = glutamic acid
 Gly = glycine
 His = histidine
 Ile = isoleucine
 Leu = leucine
 Lys = lysine
 Met = methionine
 Phe = phenylalanine
 Pro = proline
 Ser = serine
 Thr = threonine
 Trp = tryptophan
 Tyr = tyrosine
 Val = valine

Biology, 2E*

FIGURE 10.9 The genetic code. The 64 possible codons allow some redundancy when encoding 20 amino acids and the stop signal (in red).

- turning genes on/off can occur at many level: *Gene regulation*

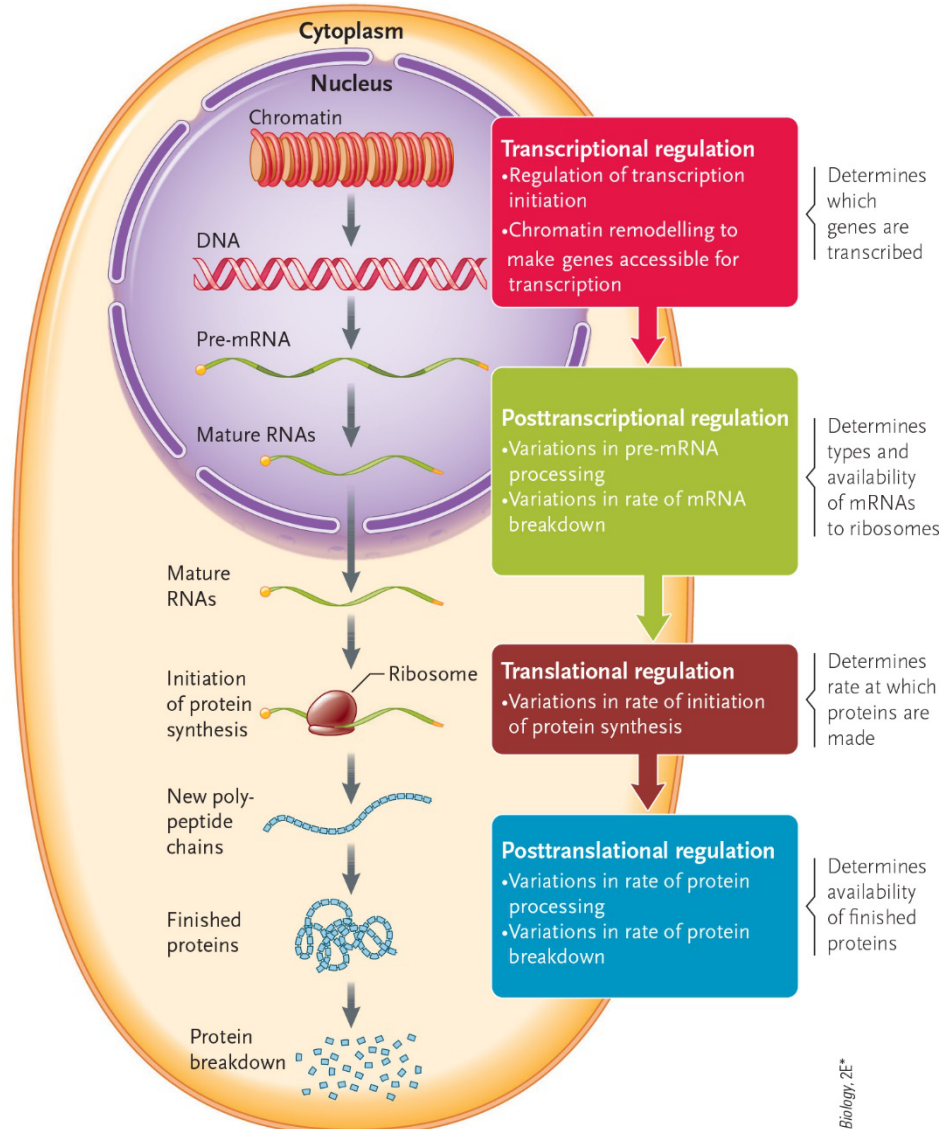


FIGURE 10.11 Points where gene expression can be regulated in eukaryotic cells.