Topic 8

Gene Activity: How Genes Work

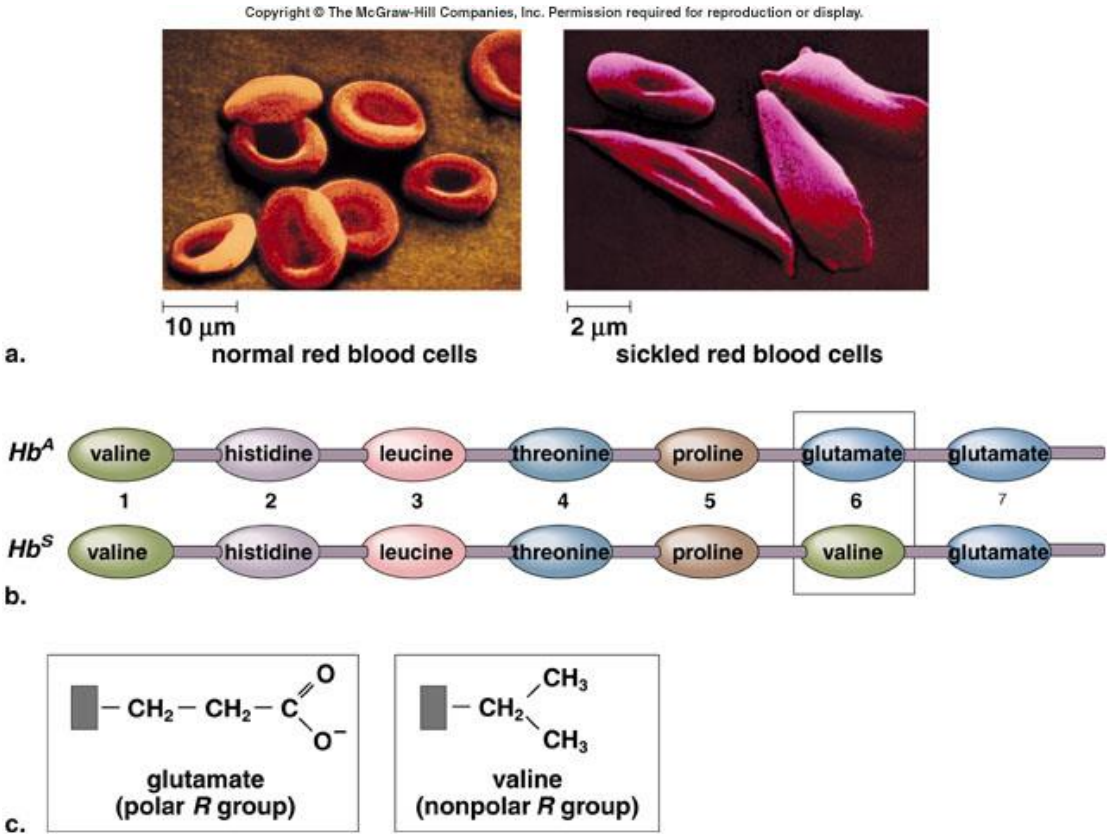
Function of Genes

A gene is a segment of DNA that specifies the sequence of amino acids in a polypeptide of a protein.

From DNA to RNA to Protein

Central Dogma of Molecular Biology: DNA → RNA → Protein

Genes code for the sequence of nucleotides in RNA molecules.
RNA brings about formation of a protein coded for by DNA of a particular gene.



RNA

Uracil (U) replaces thymine (T) of DNA.
Types of RNA

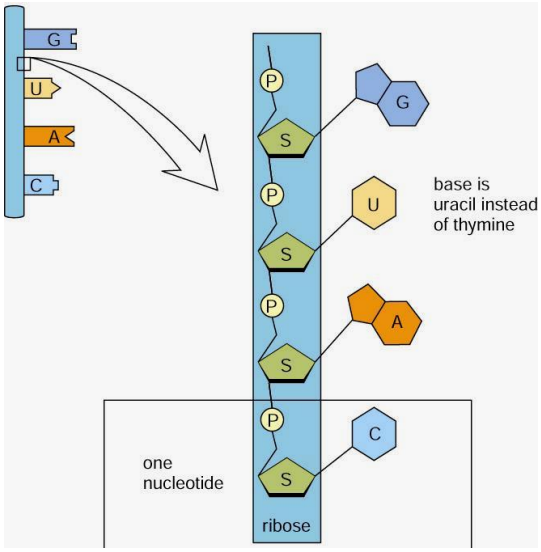
- Messenger (mRNA) - Takes message from DNA in nucleus to ribosomes in cytoplasm.
- Transfer (tRNA) - Transfers amino acids to ribosomes.
- Ribosomal (rRNA) - Help make up ribosomes.

Structure of RNA

Table 14.1

RNA Structure Compared to DNA Structure

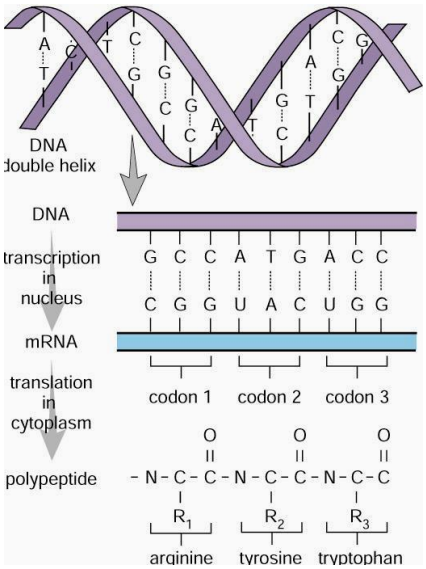
	RNA	DNA
Sugar	Ribose	Deoxyribose
Bases	Adenine, guanine, uracil, cytosine	Adenine, guanine, thymine, cytosine
Strands	Single stranded	Double stranded with base pairing
Helix	No	Yes



Steps of Gene Expression

- During transcription, DNA serves as a template for RNA formation.
- During translation, an mRNA transcript directs the sequence of amino acids in a polypeptide.

Gene Expression



The Genetic Code

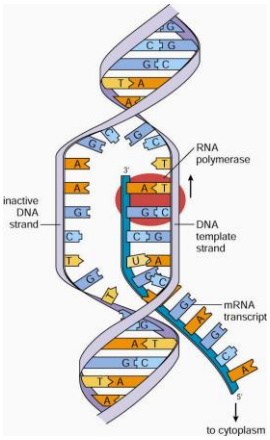
There is a genetic code for each of the 20 amino acids found in proteins.
Genetic code is a triplet code, with each codon consisting of three nucleotide bases.

- Code Properties
  - Universal
  - Degenerate
  - Unambiguous
  - Contains start and stop signals

First Base	Second Base				Third Base
	U	C	A	G	
U	UUU phenylalanine	UCU serine	UAU tyrosine	UGU cysteine	U
	UUC phenylalanine	UCC serine	UAC tyrosine	UGC cysteine	C
	UUA leucine	UCA serine	UAA *stop*	UGA *stop*	A
	UUG leucine	UCG serine	UAG *stop*	UGG tryptophan	G
C	CUU leucine	CCU proline	CAU histidine	CGU arginine	U
	CUC leucine	CCC proline	CAC histidine	CGC arginine	C
	CUA leucine	CCA proline	CAA glutamine	CGA arginine	A
	CUG leucine	CCG proline	CAG glutamine	CGG arginine	G
A	AUU isoleucine	ACU threonine	AAU asparagine	AGU serine	U
	AUC isoleucine	ACC threonine	AAC asparagine	AGC serine	C
	AUA isoleucine	ACA threonine	AAA lysine	AGA arginine	A
	AUG (*start*) methionine	ACG threonine	AAG lysine	AGG arginine	G
G	GUU valine	GCU alanine	GAU aspartate	GGU glycine	U
	GUC valine	GCC alanine	GAC aspartate	GGC glycine	C
	GUA valine	GCA alanine	GAA glutamate	GGA glycine	A
	GUG valine	GCG alanine	GAG glutamate	GGG glycine	G

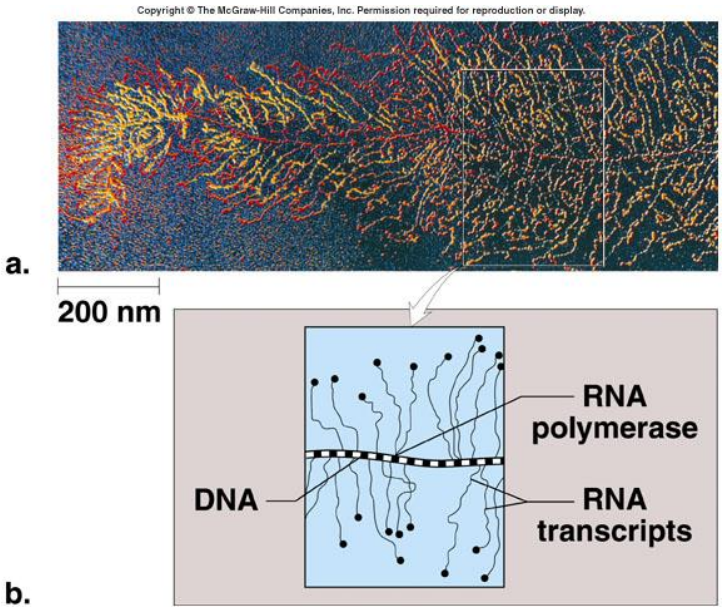
Transcription

During transcription, an mRNA molecule is formed with a sequence of bases complementary to a portion of one DNA strand. RNA polymerase joins the nucleotides together in 5' → 3' direction. Promoter defines start of a gene, the direction of transcription, and the strand to be transcribed. Elongation continues until polymerase comes to a DNA terminator sequence.



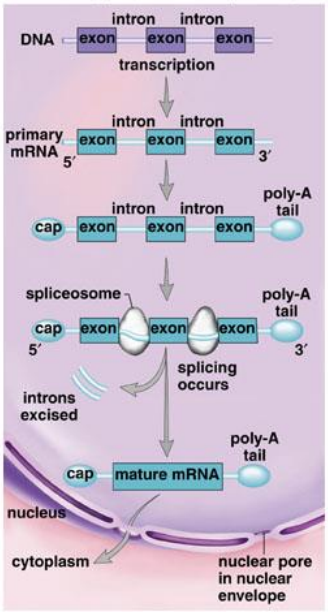
Processing Messenger RNA

Newly formed mRNA molecule, primary mRNA transcript, is modified before it leaves the eukaryotic nucleus. Modifications include adding a cap on 5' end, and poly-A tail on 3' end.
Non coding parts of this mRNA called introns are removed during RNA processing by a process called splicing, leaving only exons to produce mature mRNA.

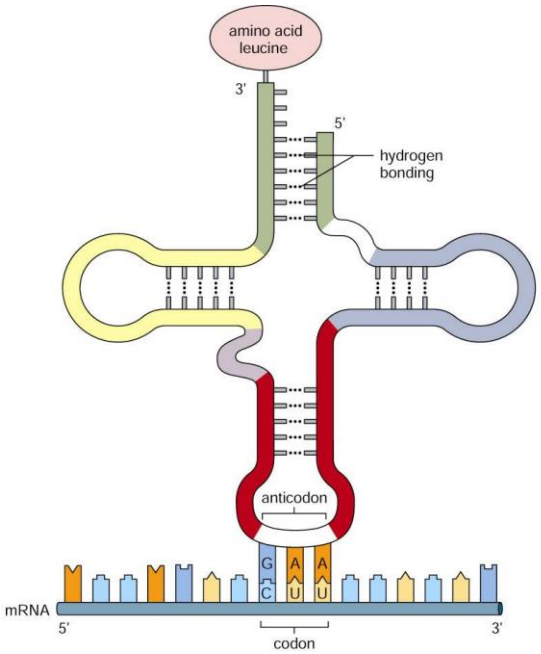


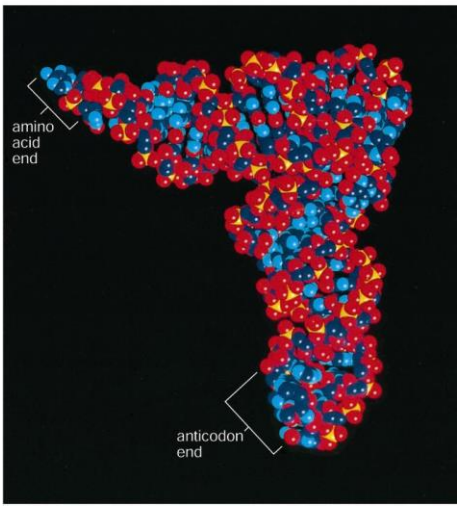
Translation

Transfer RNA molecules transfer amino acids to the ribosomes. Each tRNA molecules bind with one particular amino acid, and bear an anti-codon complementary to the codon for that amino acid. A group of enzymes, tRNA synthetases attach correct amino acid to the correct tRNA molecule.



Transfer RNA

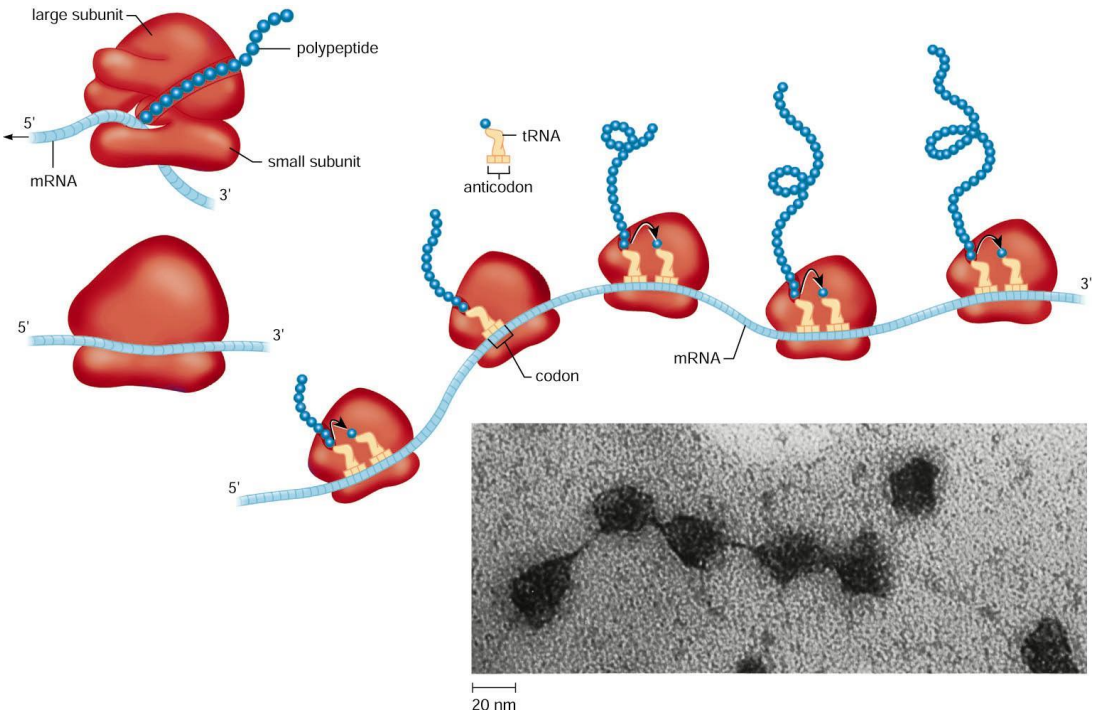




Role of Ribosomal RNA

Ribosomal RNA (rRNA) is produced off a DNA template in the nucleolus of a nucleus. It is packaged with proteins into ribosomal subunits, one larger than the other. Ribosomes contain binding sites to facilitate complementary base pairing between tRNA anti-codons and mRNA codons.

Ribosome Structure and Function



Overview of Protein Synthesis in the Cell