

# Genetics Objectives

- Nucleic acids transport genetic information
- Structure and Function of Genetic Material
- [Video 1](#)
- Regulation of bacterial gene expression
- Mutations
- [Video 2](#)
- Mechanisms of genetic exchange
- Molecular biology tools
- [Video 3](#)

# Structure and Function of Genetic Material

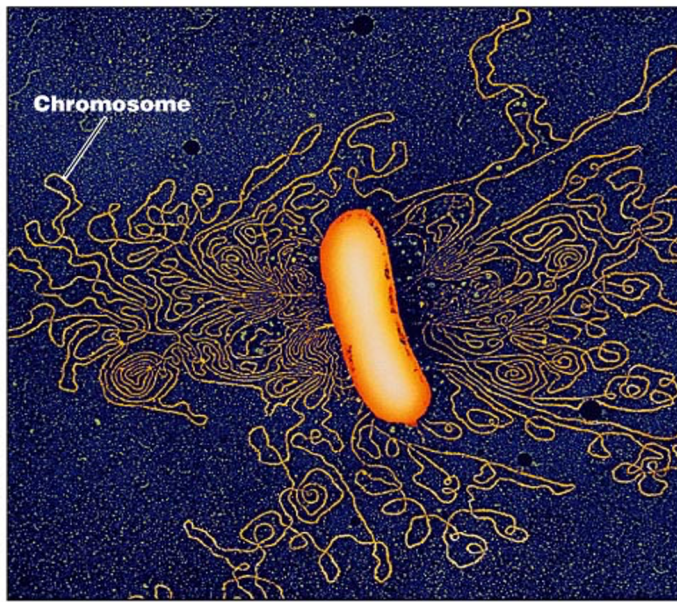
Genotype:  
gene

Phenotype

Genome:  
Chromosome

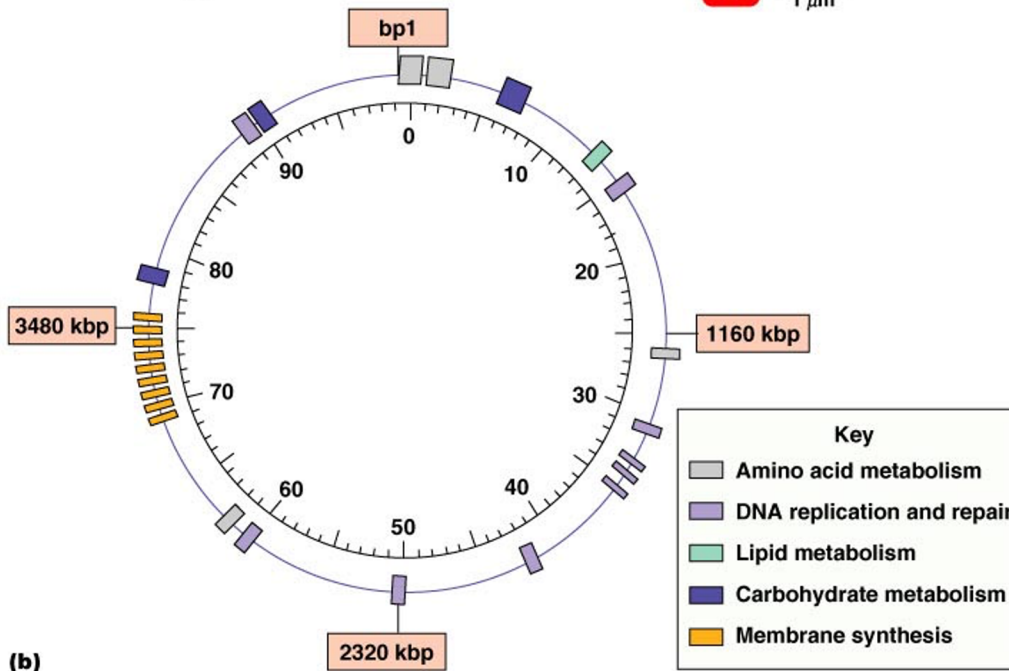
- Plasmids





(a)

TEM 1 μm



(b)

*E. coli* genome is 4.6 million base pairs = 4.6 Mb;

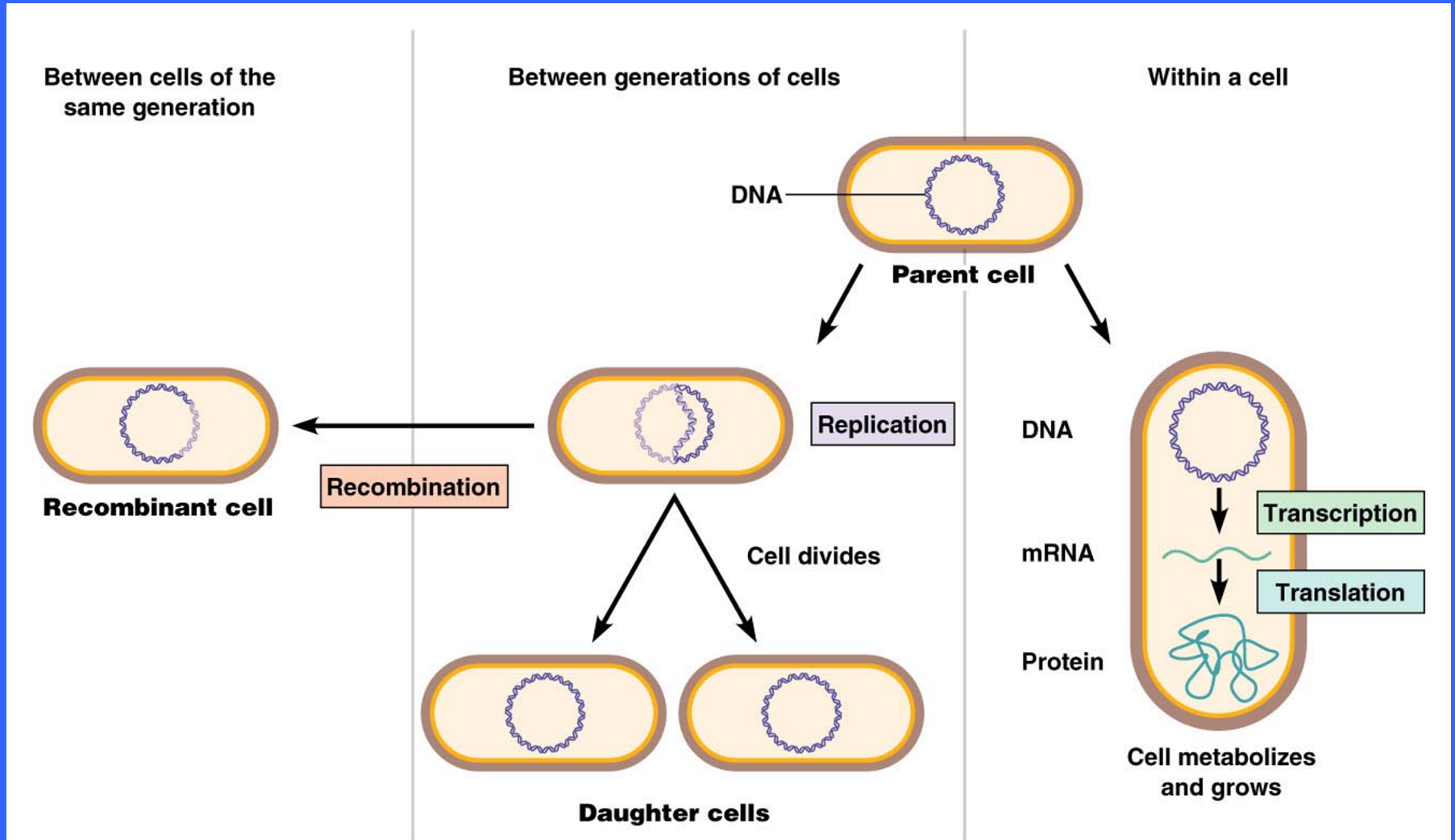
~ 1mm long (1000X cell),

10% cell volume = supercoiled or twisted

# Flow of genetic information

DNA replication

RNA and protein synthesis: transcription and translation

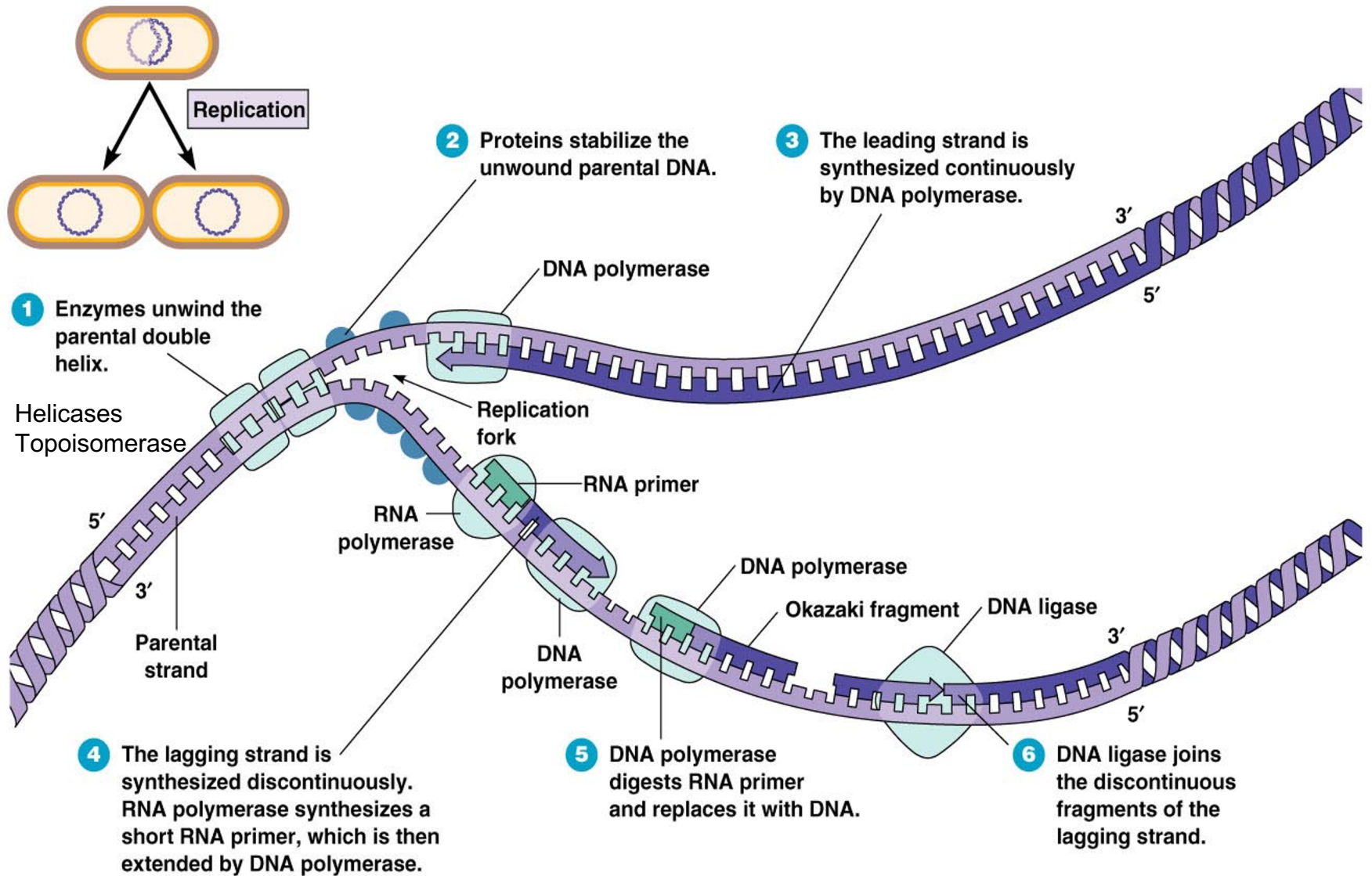


Flow of genetic information

**TABLE 8.1****Important Enzymes in DNA Replication, Expression, and Repair**

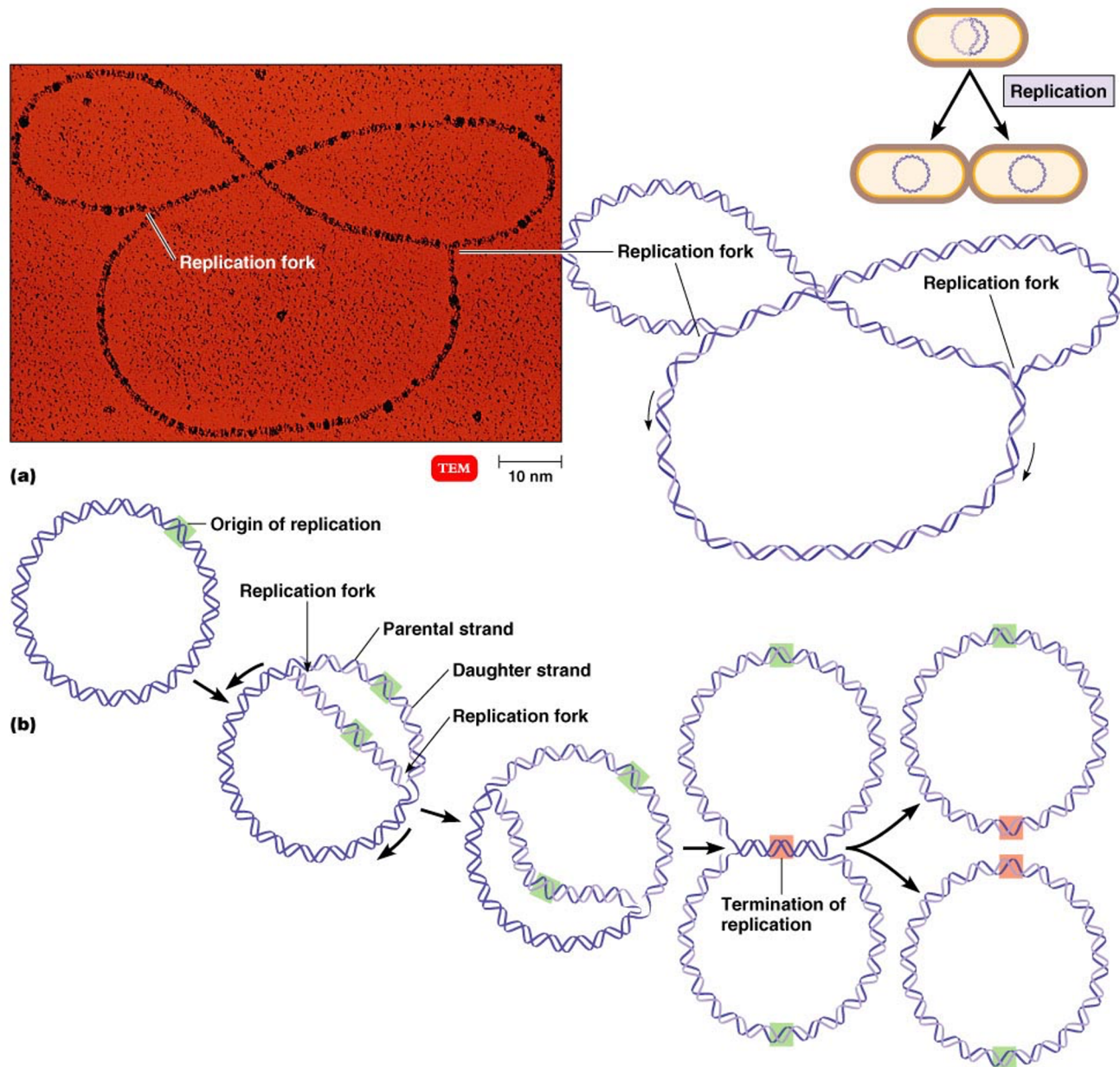
<b>DNA gyrase</b>	Relaxes supercoiling ahead of the replication fork.
<b>DNA ligase</b>	Makes covalent bonds to join DNA strands; joins Okazaki fragments and new segments in excision repair.
<b>DNA polymerase</b>	Synthesizes DNA; proofreads and repairs DNA.
<b>Endonucleases</b>	Cut DNA backbone in a strand of DNA; facilitate repair and insertions.
<b>Exonucleases</b>	Cut DNA from an exposed end of DNA; facilitate repair.
<b>Helicase</b>	Unwinds double-stranded DNA.
<b>Methylase</b>	Adds methyl group to selected bases in newly-made DNA.
<b>Photolyases</b>	Use visible light energy to separate UV-induced pyrimidine dimers.
<b>Primase</b>	Makes RNA primers from a DNA template.
<b>Ribozyme</b>	RNA enzyme that removes introns and splices exons together.
<b>RNA polymerase</b>	Copies RNA from a DNA template.
<b>Topoisomerase</b>	Relaxes supercoiling ahead of the replication fork; separates DNA circles at the end of DNA replication.
<b>Transposase</b>	Cuts DNA backbone leaving single-stranded "sticky ends."





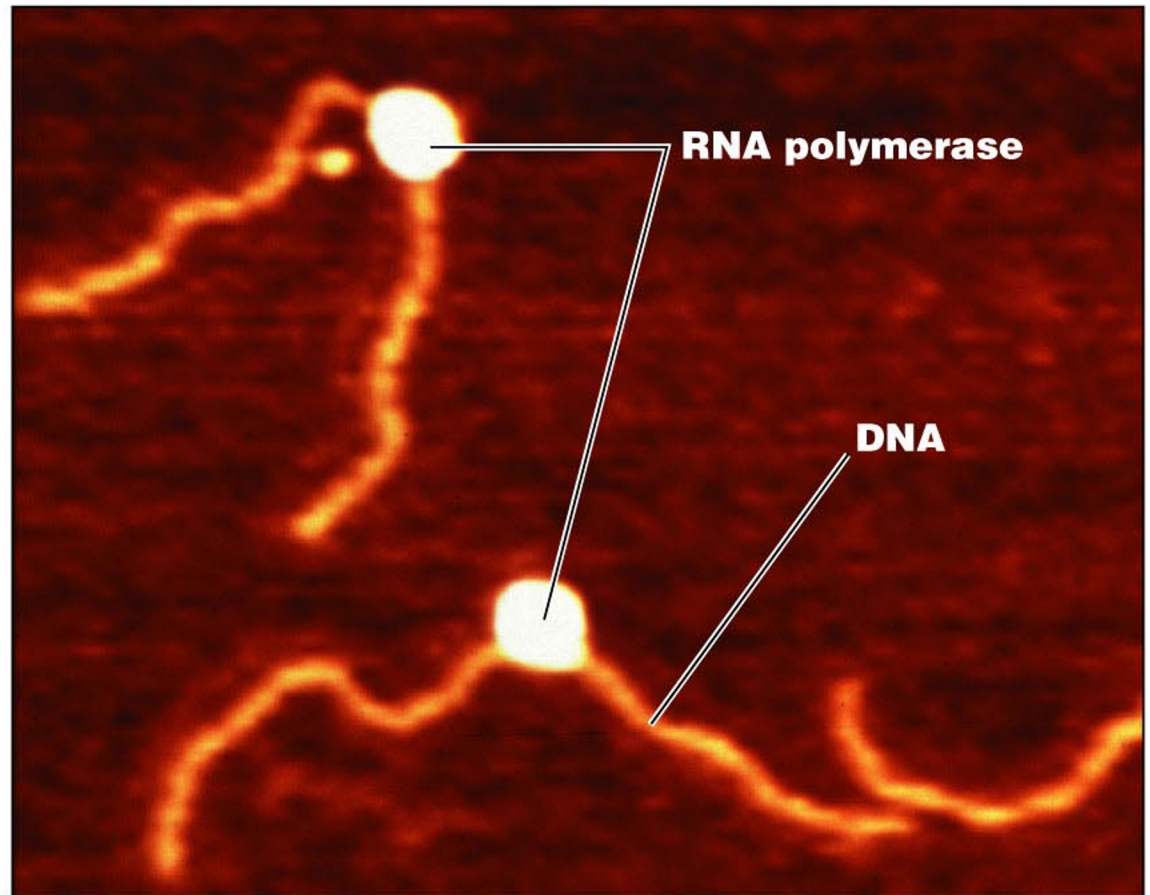
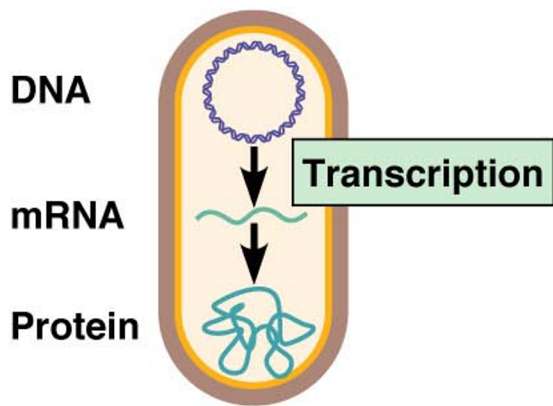
# DNA replication

# Bacterial DNA replication

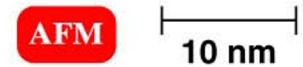


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Figure 8.6 - Overview



RNA polymerase bound to DNA

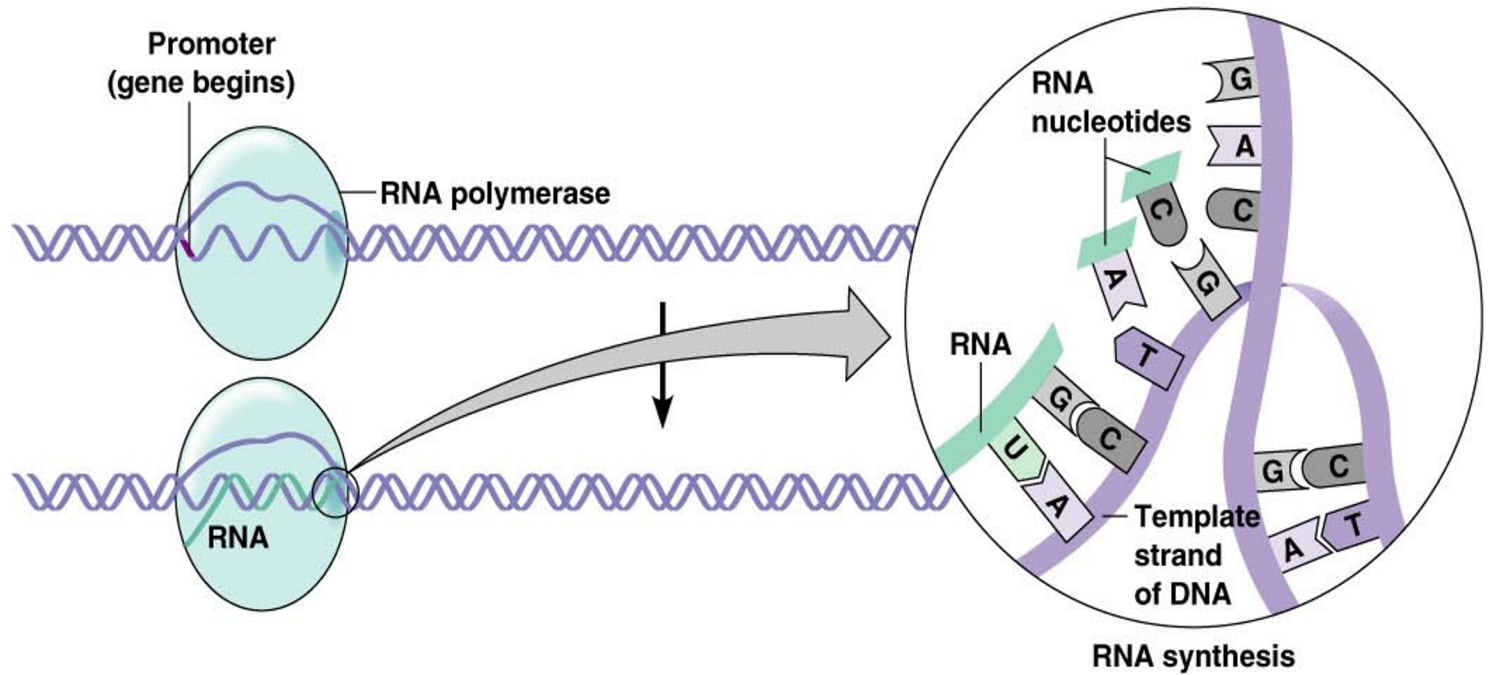


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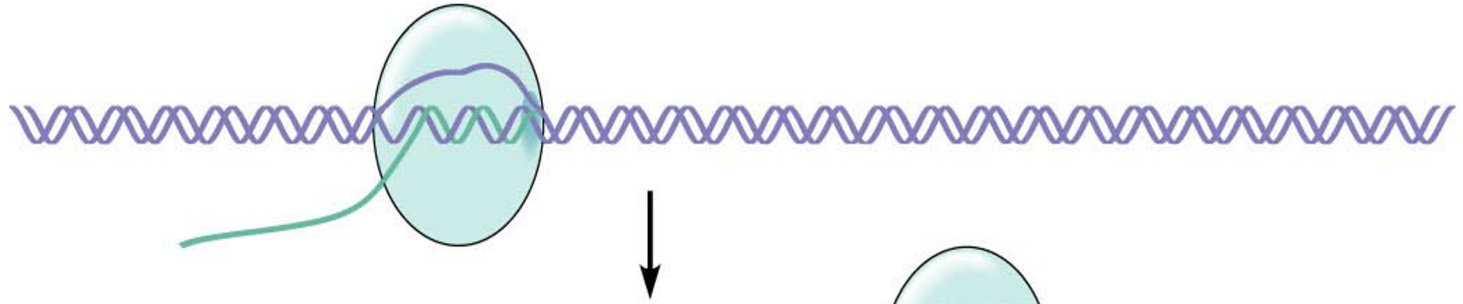
# Transcription

- 1** RNA polymerase binds to the promoter, and DNA unwinds at the beginning of a gene.
- 2** RNA is synthesized by complementary base pairing of free nucleotides with the nucleotide bases on the template strand of DNA.

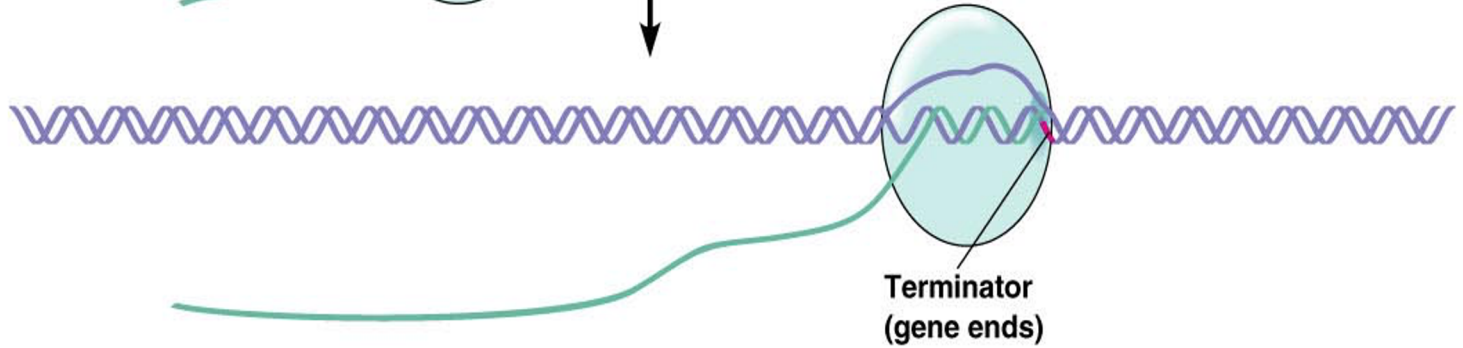


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**3** The site of synthesis moves along DNA; DNA that has been transcribed rewinds.



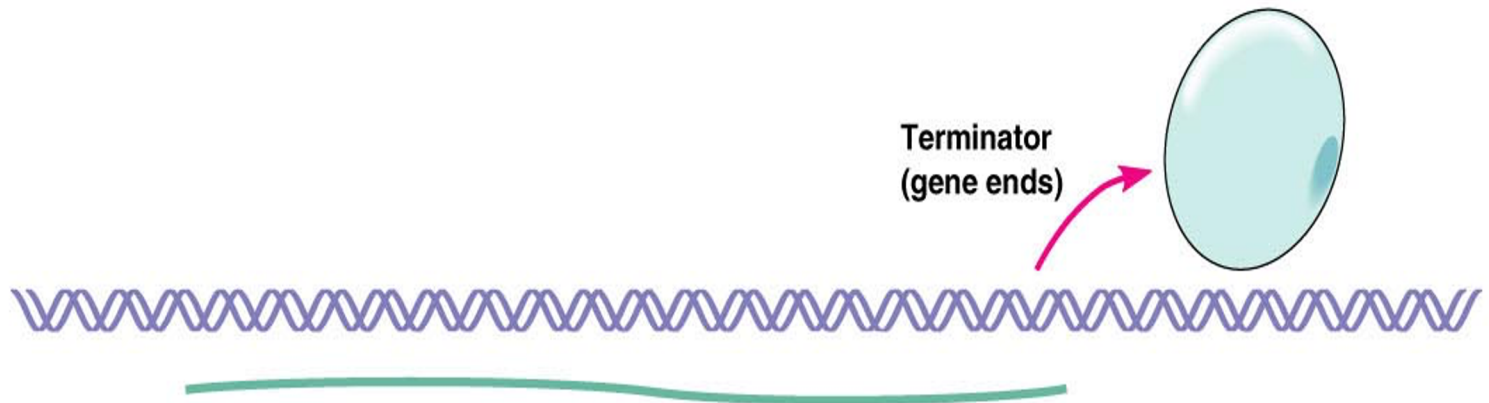
**4** Transcription reaches the terminator.



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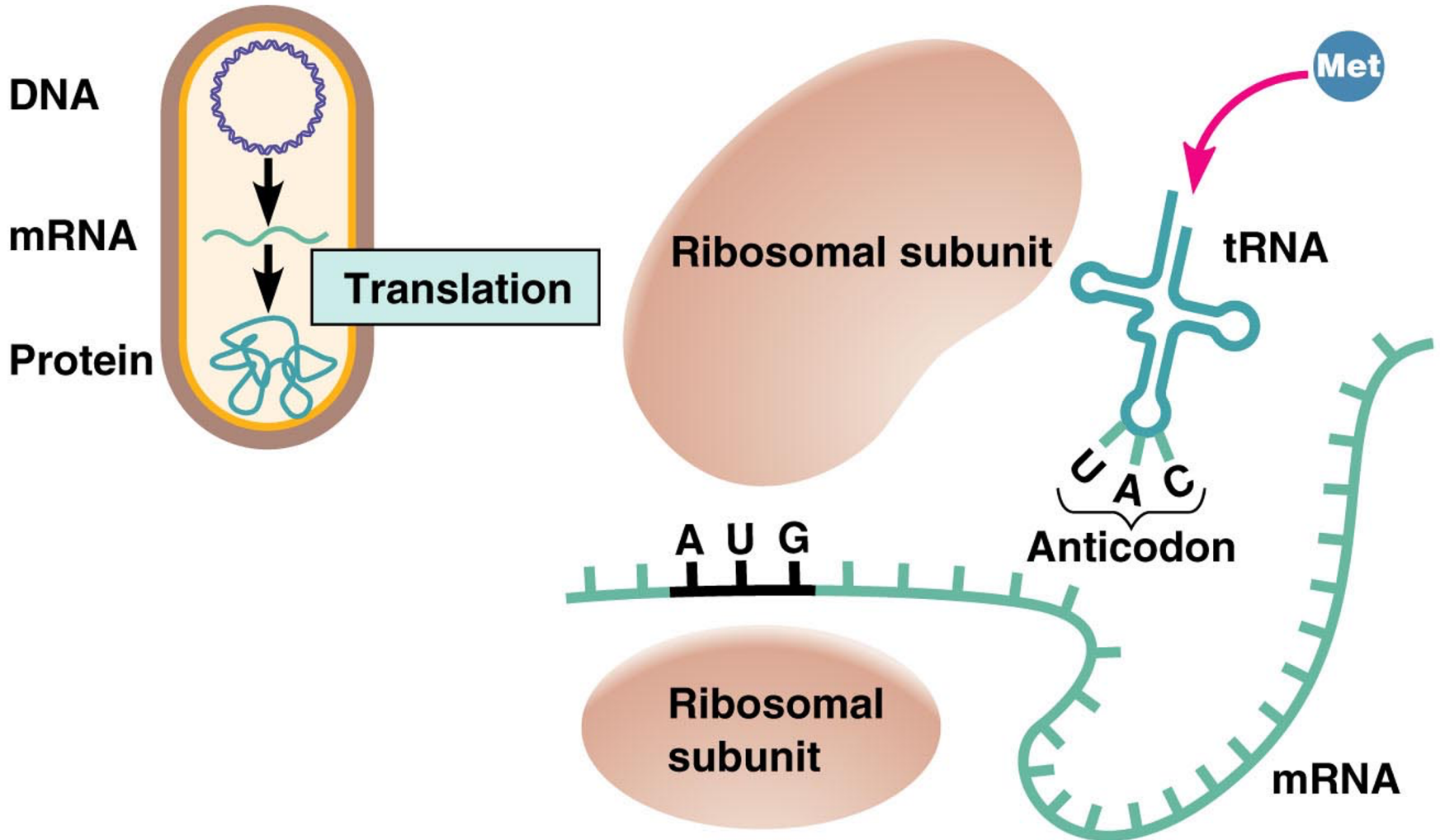


- 5 RNA and RNA polymerase are released and the DNA helix re-forms.



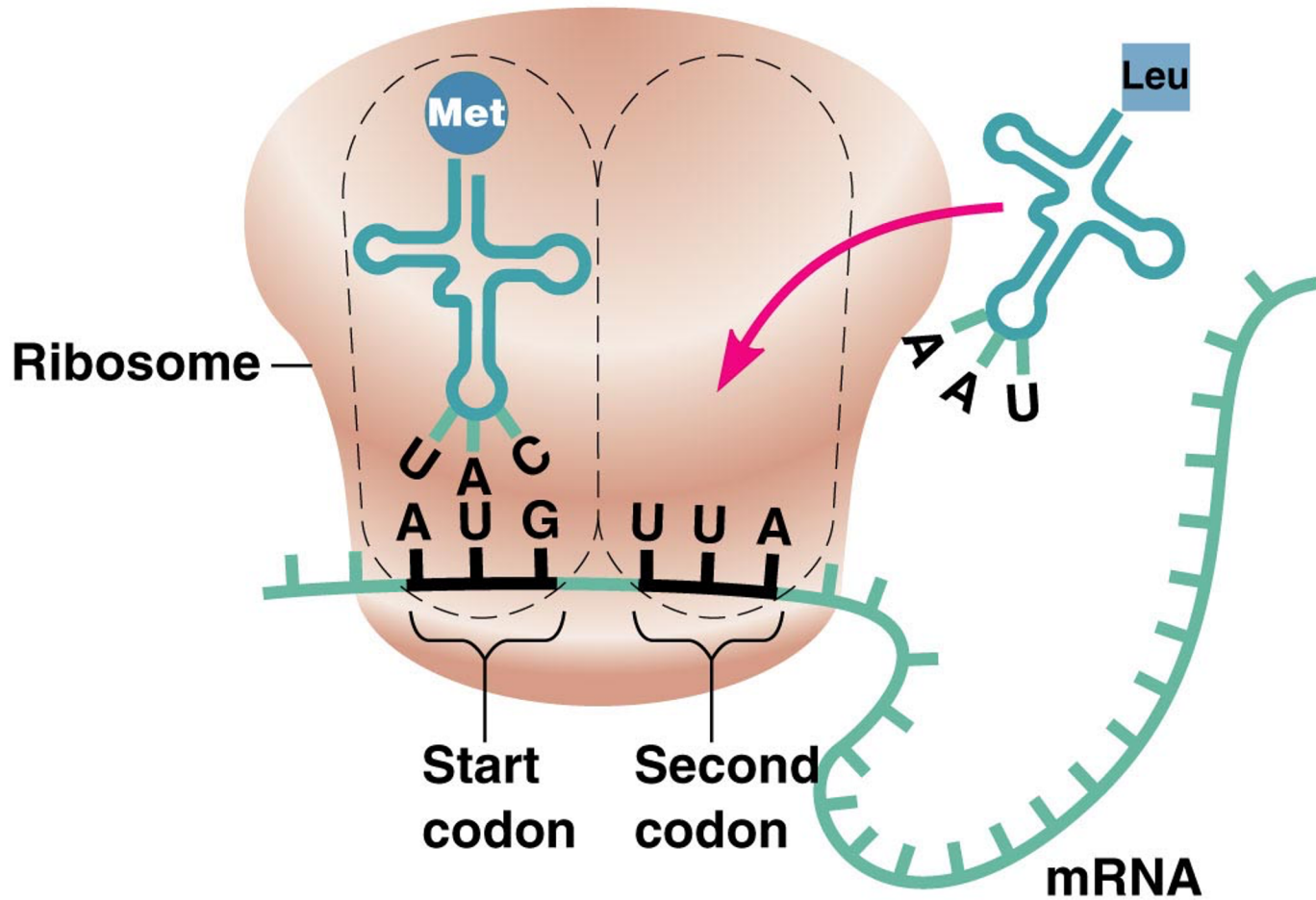
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		Second position				
		U	C	A	G	
First position	U	UUU } Phe	UCU } Ser	UAU } Tyr	UGU } Cys	U
		UUC } Phe	UCC } Ser	UAC } Tyr	UGC } Cys	C
		UUA } Leu	UCA } Ser	UAA Stop	UGA Stop	A
		UUG } Leu	UCG } Ser	UAG Stop	UGG Trp	G
	C	CUU } Leu	CCU } Pro	CAU }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



**1** Components needed to begin translation come together.

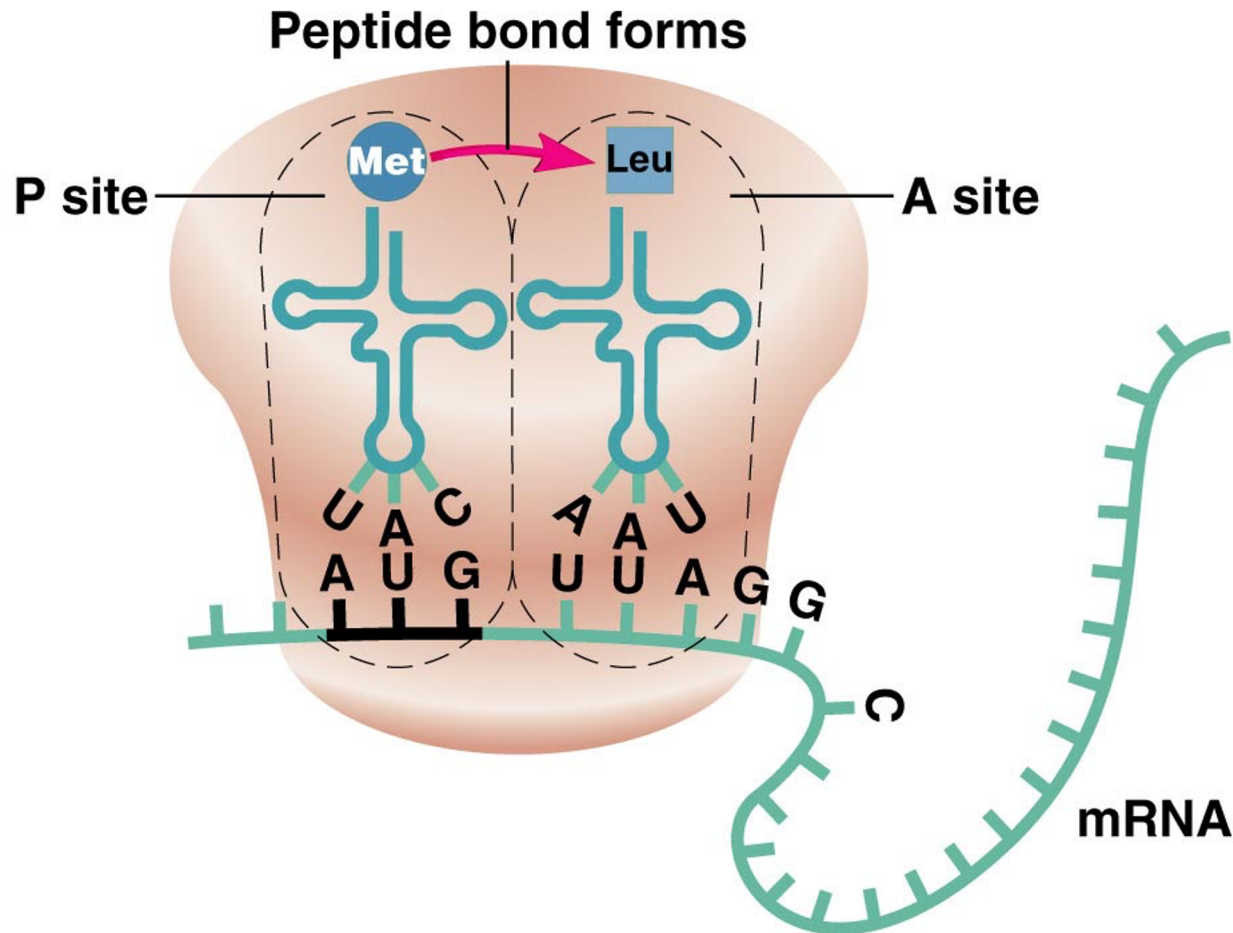
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- 2** On the assembled ribosome, a tRNA carrying the first amino acid is paired with the start codon on the mRNA. A tRNA carrying the second amino acid approaches.

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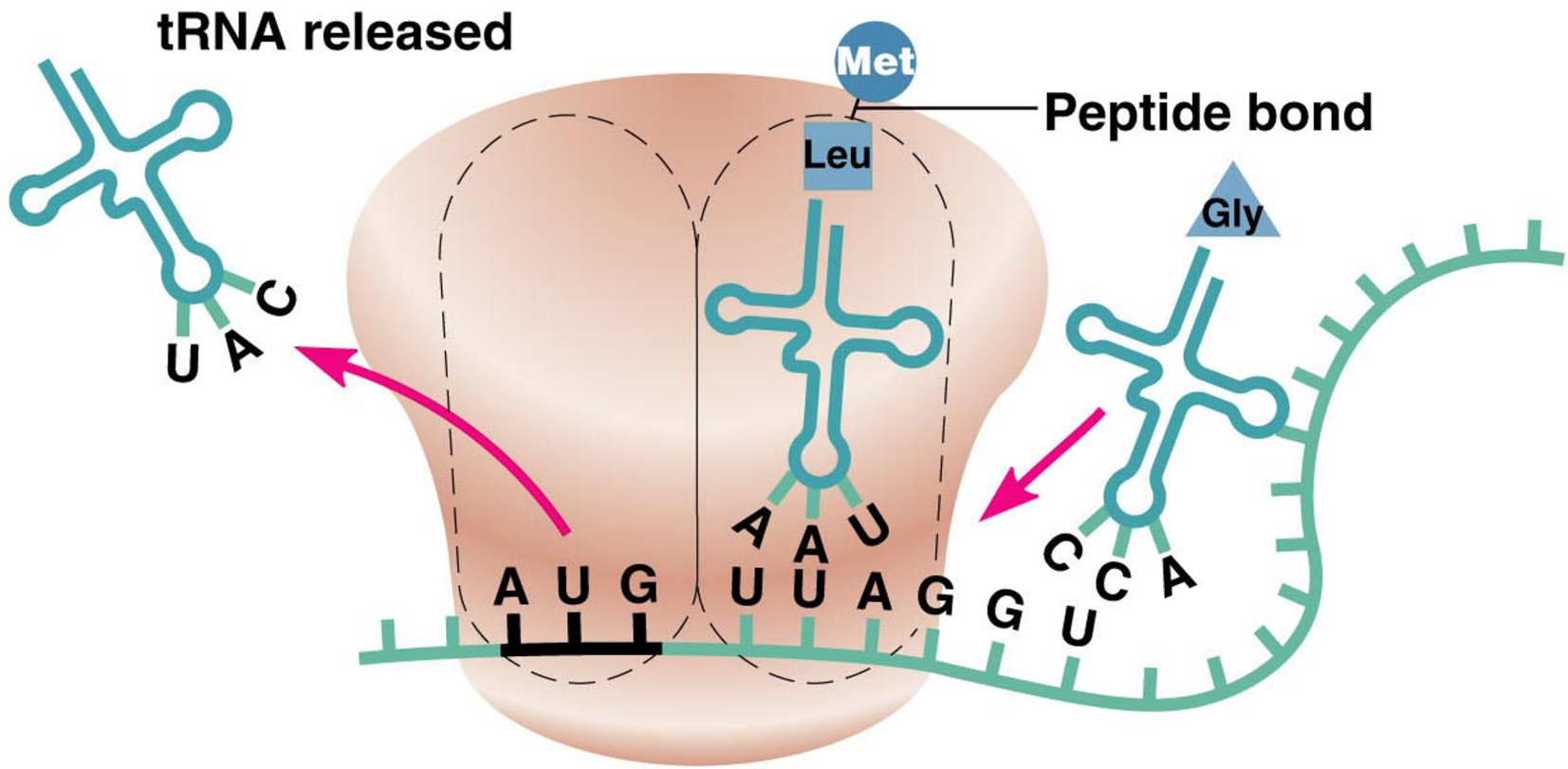
Figure 8.9, step 2



- 3** The place on the ribosome where the first tRNA sits is called the P site. In the A site next to it, the second codon of the mRNA pairs with a tRNA carrying the second amino acid.

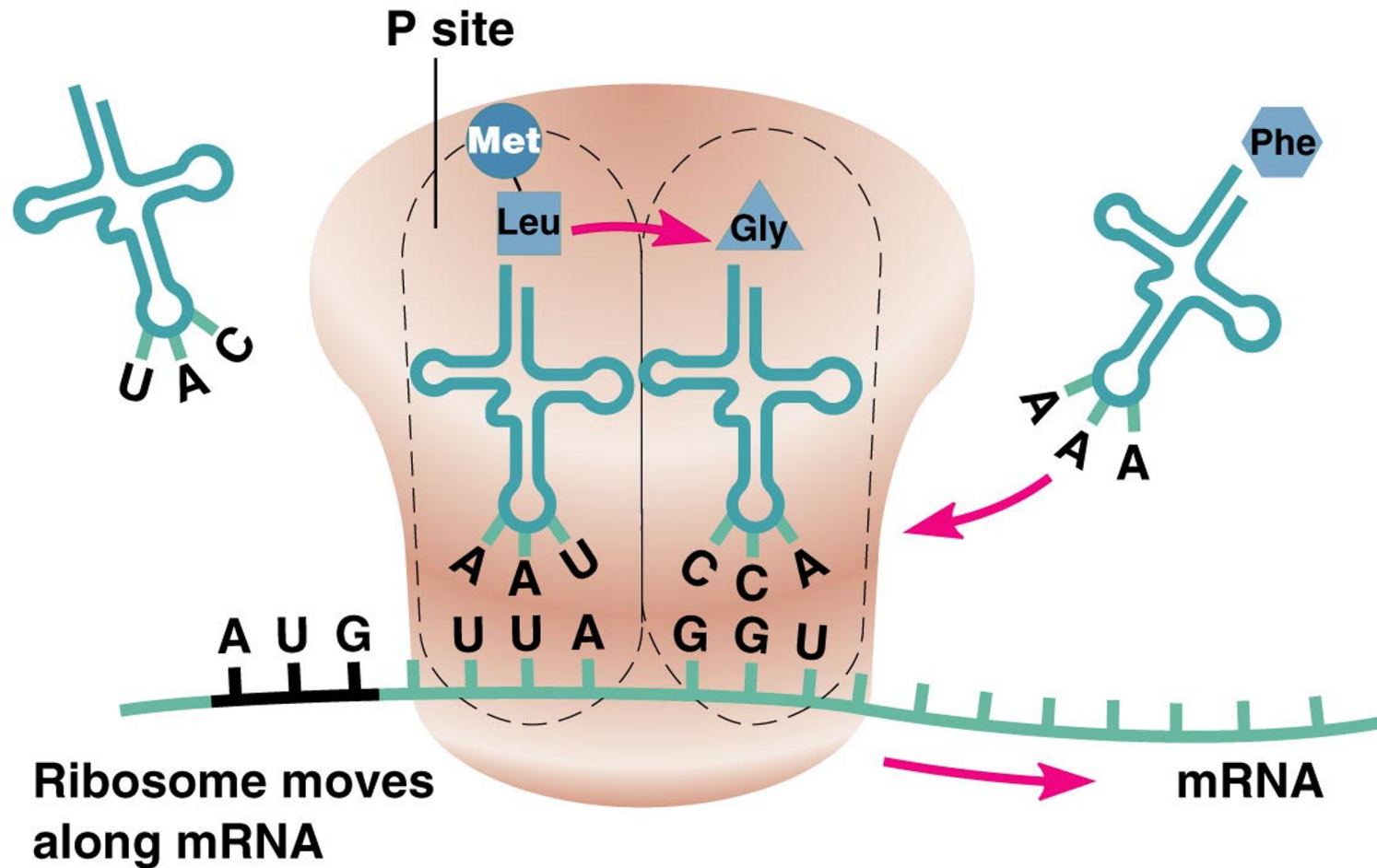
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- 4** The first amino acid joins to the second by a peptide bond, and the first tRNA is released.

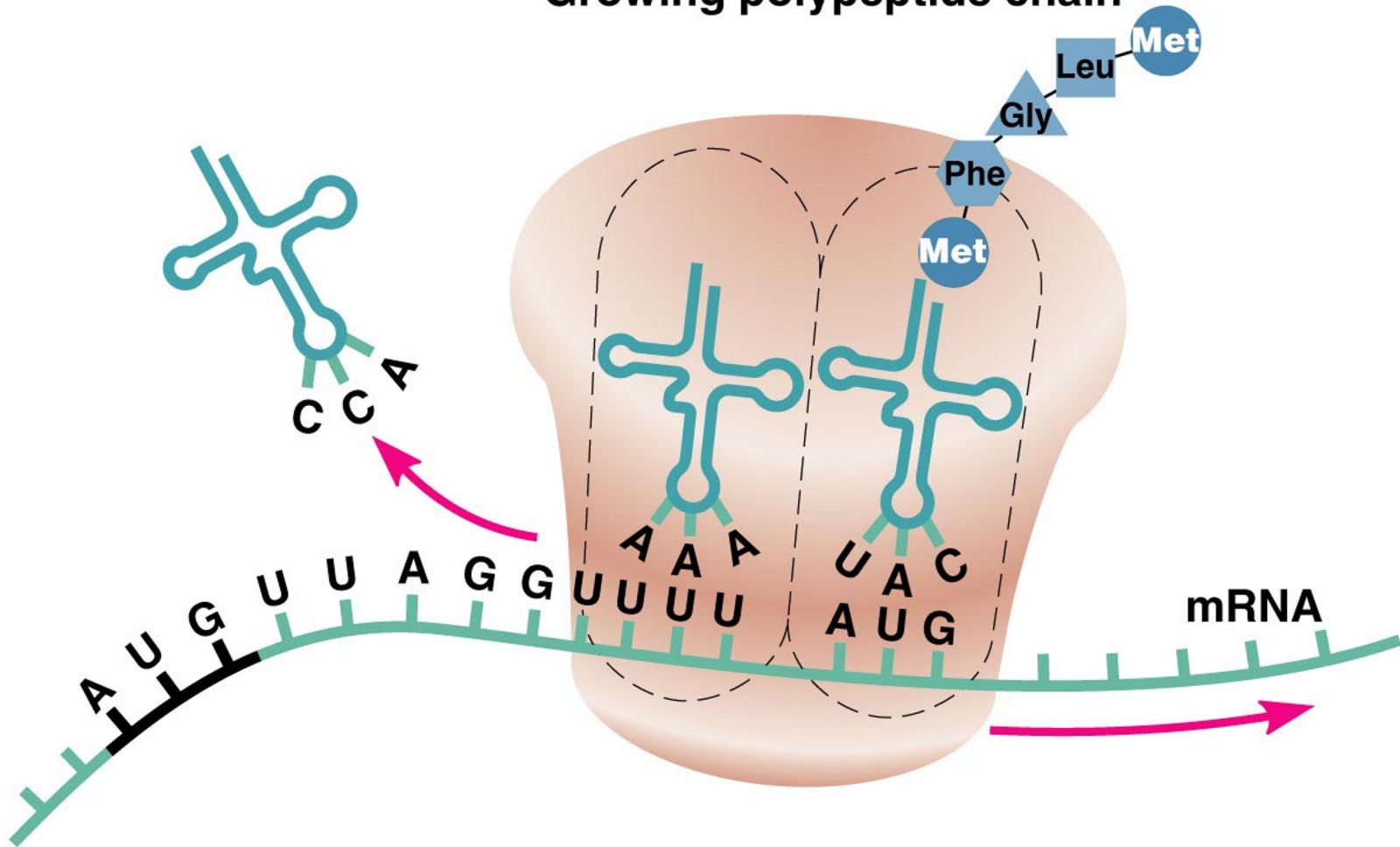
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- 5 The ribosome moves along the mRNA until the second tRNA is in the P site, and the process continues.

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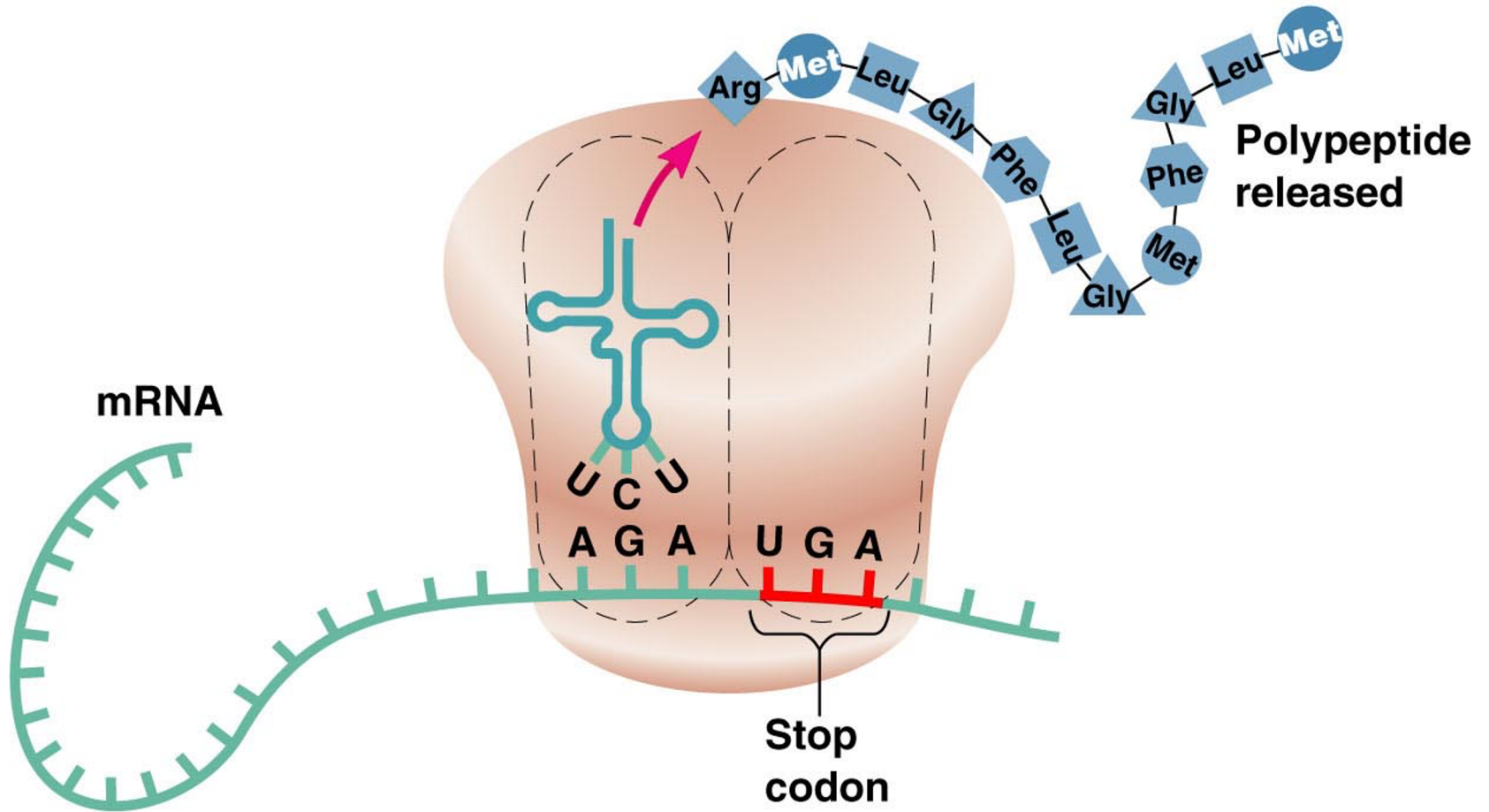
## Growing polypeptide chain



- 6** The ribosome continues to move along the mRNA, and new amino acids are added to the polypeptide.

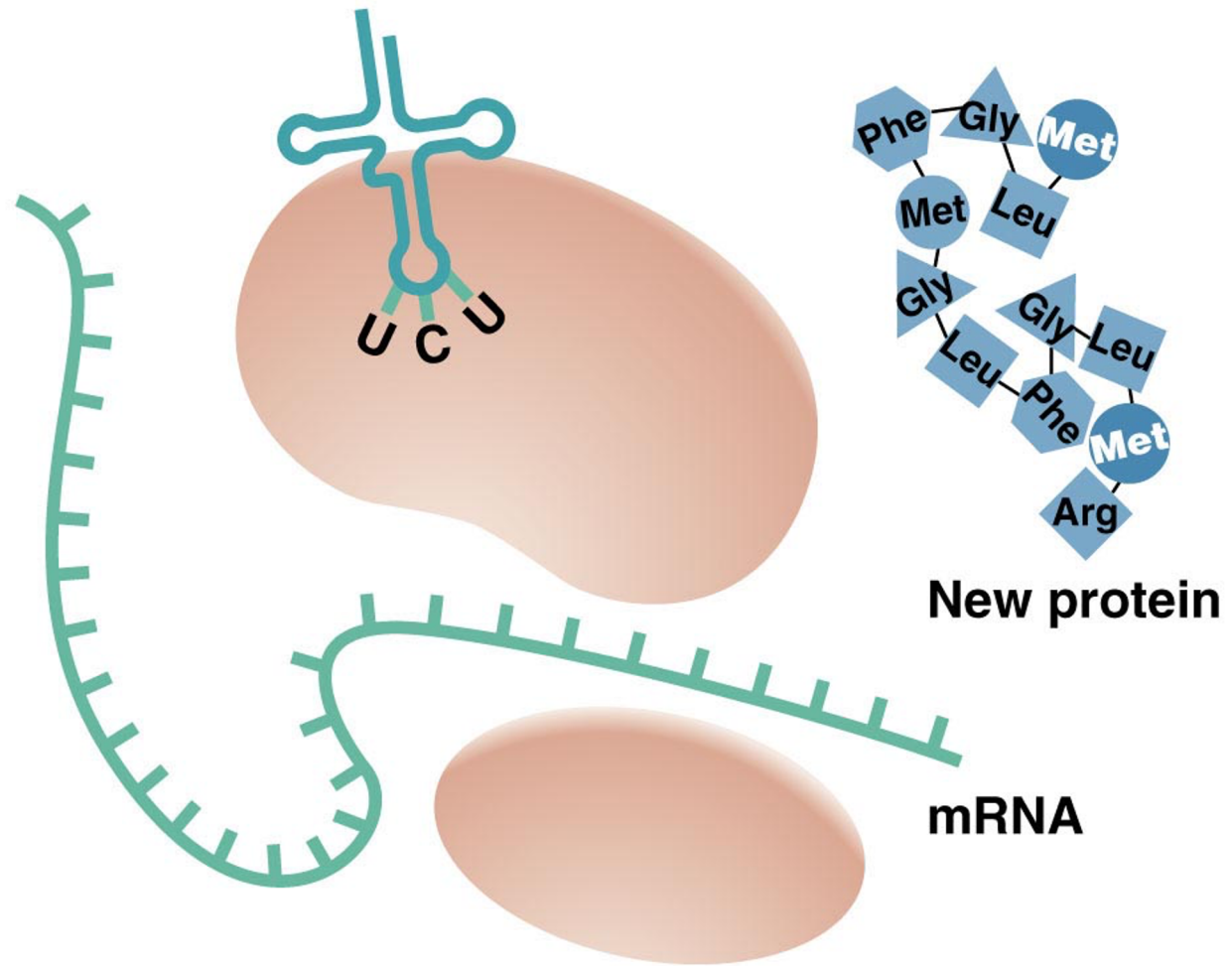
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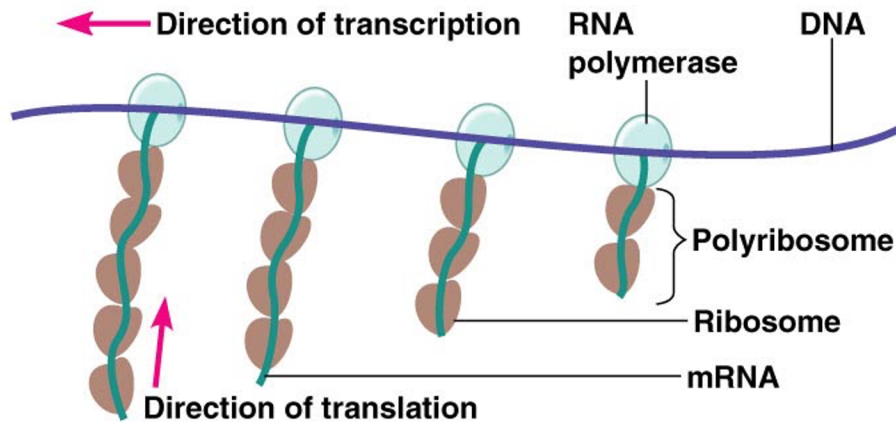
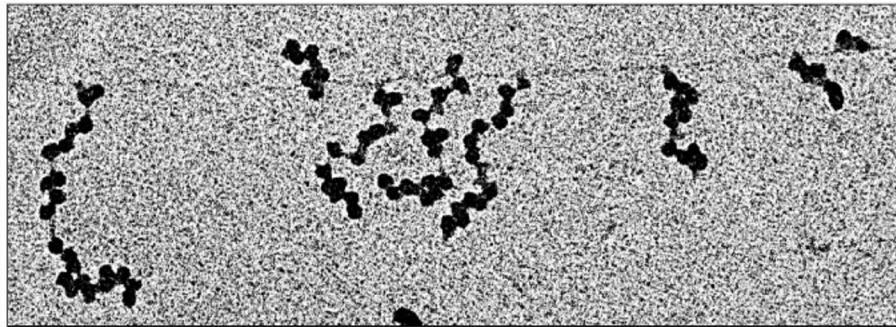
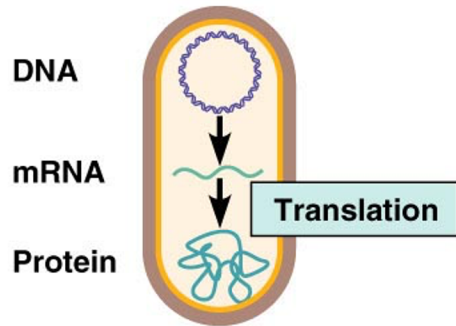


**7** When the ribosome reaches a stop codon, the polypeptide is released.

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**8** Finally, the last tRNA is released, and the ribosome comes apart. The released polypeptide forms a new protein.



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Figure 8.10 - Overview (1 of 4)