

# Translation

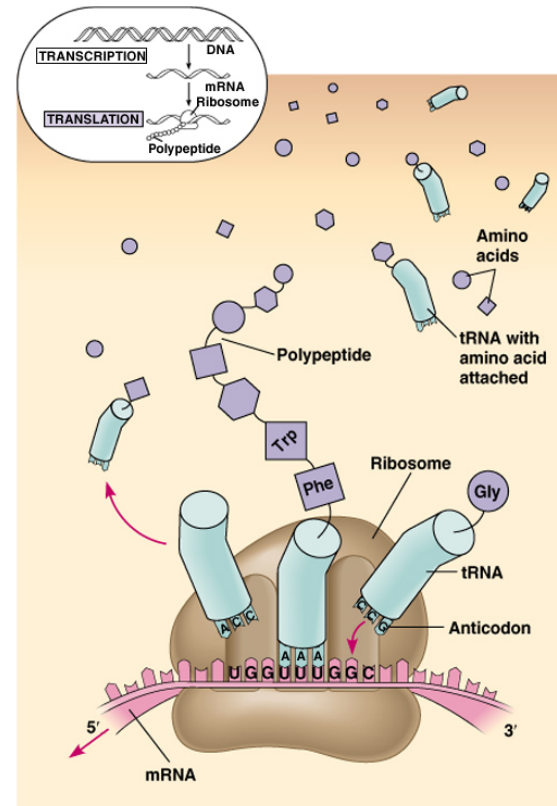
## Chapter 17

# Objectives

- Understand the process of translation
- Recognize the role of mRNA, rRNA, and tRNA
- Understand how protein may be modified prior to use

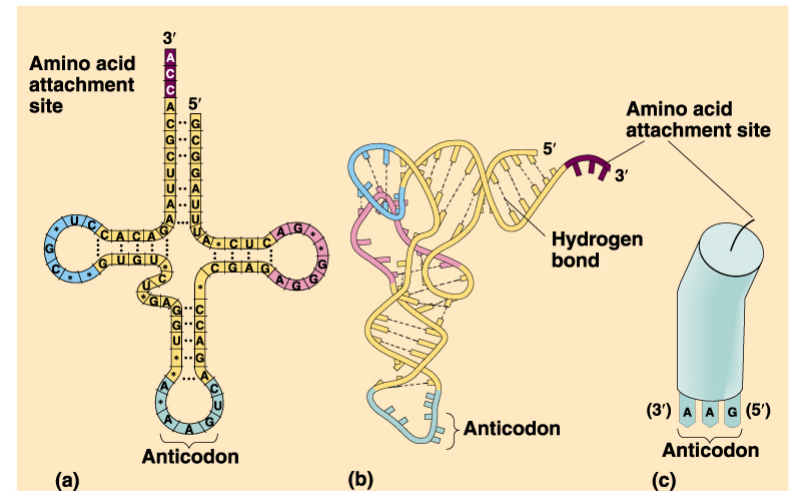
# Process of Translation

- Flow of genetic information from mRNA to protein
- Change in cellular language from nucleotide to protein
- tRNA acts as the interpreter
- There is a different tRNA for “each kind of codon” except the stop codons



# How does Transfer RNA work?

- tRNA has a 3-D structure that includes the formation of three loops within the molecule
- 3-D structure defines 2 different working ends
  - 3' end attaches to a specific AA
  - **anticodon** (2nd loop) that compliments the codon on mRNA



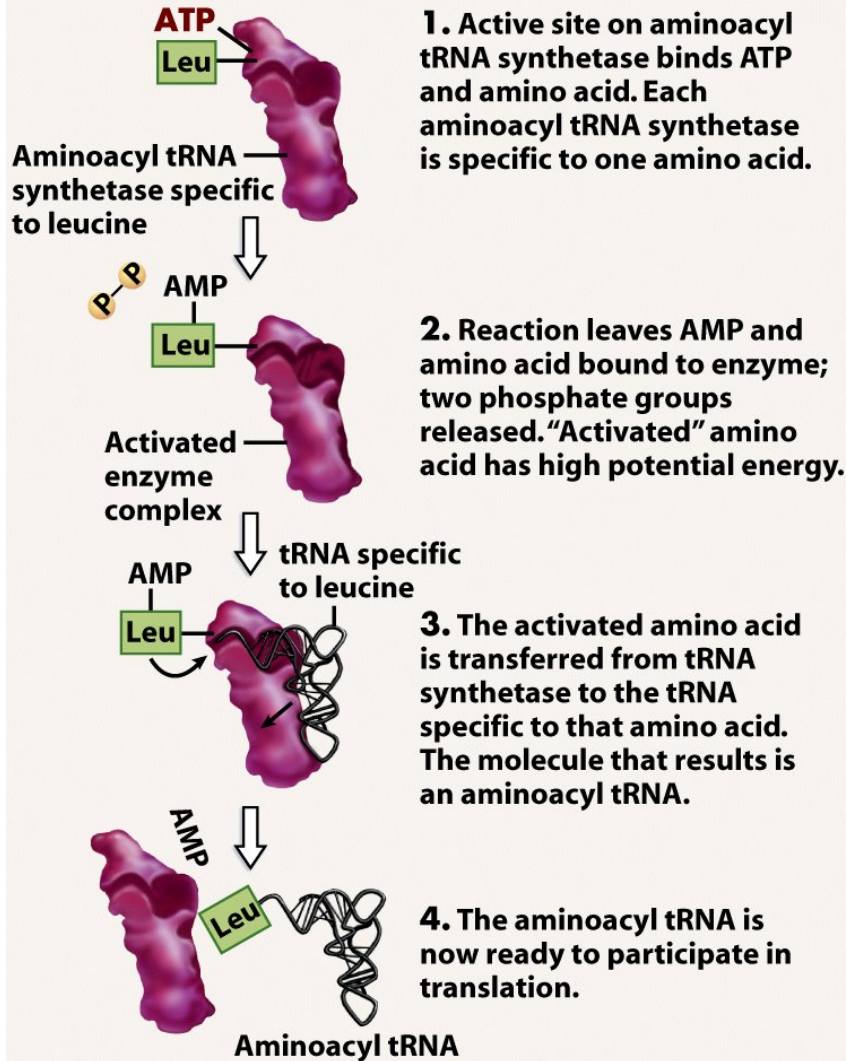
**Wobble:** the third base in the anticodon may be free to bind in a non-complimentary fashion to the third base of a codon (U to A or G & I (inosine) to U,A,C)

		SECOND BASE				
		U	C	A	G	
FIRST BASE (5' end)	U	UUU ] Phe	UCU ]	UAU ] Tyr	UGU ] Cys	U
		UUC ]	UCC ] Ser	UAC ]	UGC ]	C
		UUA ] Leu	UCA ]	UAA Stop	UGA Stop	A
		UUG ]	UCG ]	UAG Stop	UGG Trp	G
	C	CUU ]	CCU ]	CAU ] His	CGU ]	U
		CUC ] Leu	CCC ] Pro	CAC ]	CGC ] Arg	C
		CUA ]	CCA ]	CAA ] Gln	CGA ]	A
		CUG ]	CCG ]	CAG ]	CGG ]	G
	A	AUU ]	ACU ]	AAU ] Asn	AGU ] Ser	U
		AUC ] Ile	ACC ] Thr	AAC ]	AGC ]	C
		AUA ]	ACA ]	AAA ] Lys	AGA ] Arg	A
		AUG Met or start	ACG ]	AAG ]	AGG ]	G
	G	GUU ]	GCU ]	GAU ] Asp	GGU ]	U
		GUC ] Val	GCC ] Ala	GAC ]	GGC ] Gly	C
		GUA ]	GCA ]	GAA ] Glu	GGA ]	A
		GUG ]	GCG ]	GAG ]	GGG ]	G

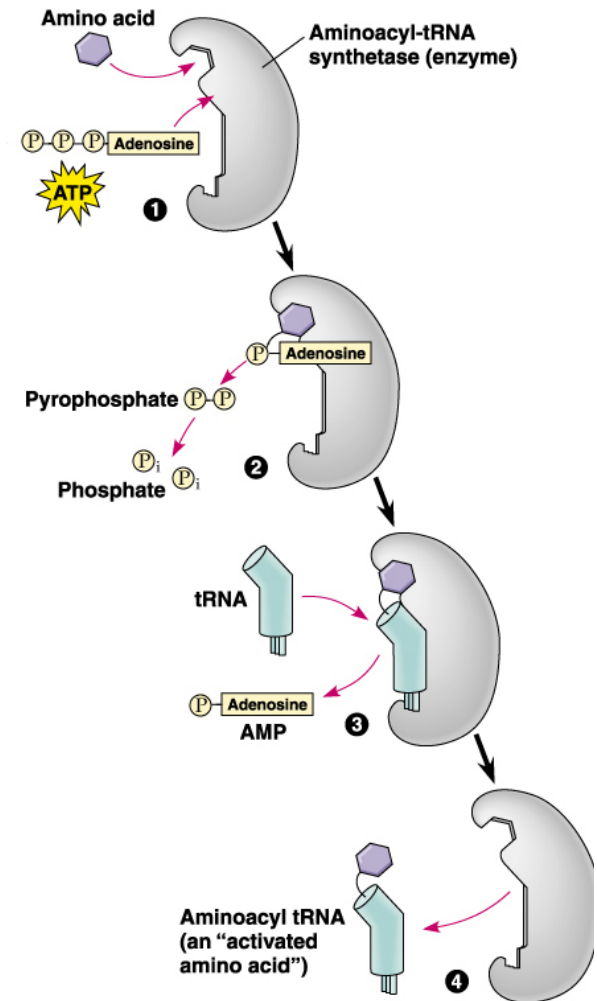
THIRD BASE (3' end)

# How are AA attached to tRNA?

## HOW AMINO ACIDS ARE LOADED ONTO tRNAs



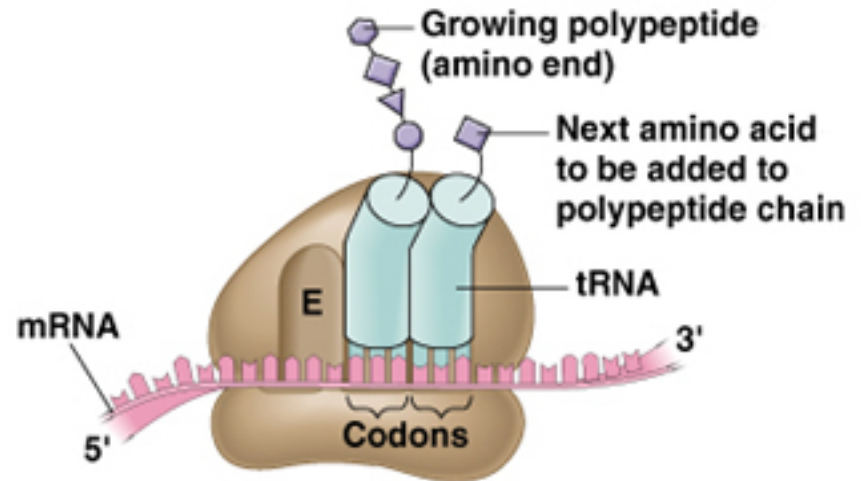
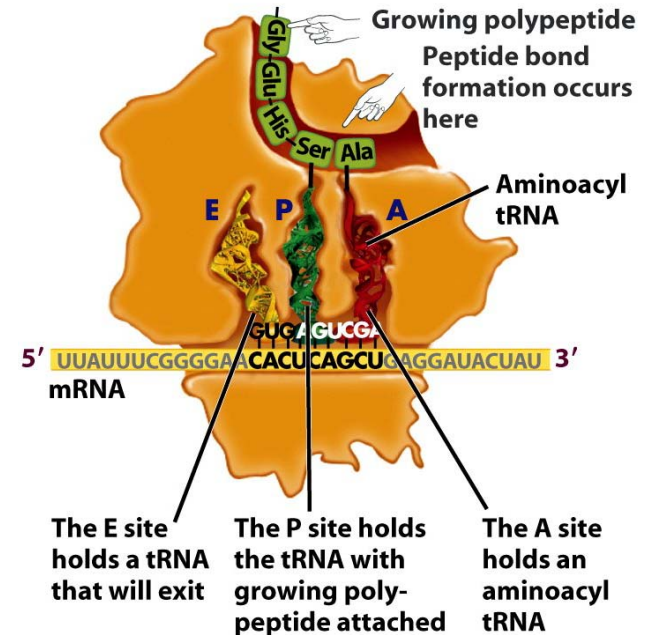
- Before a peptide can be assembled tRNA must bind to a specific AA
- This process involves the enzyme **aminoacyl-tRNA synthetase** and ATP



# Ribosome Anatomy

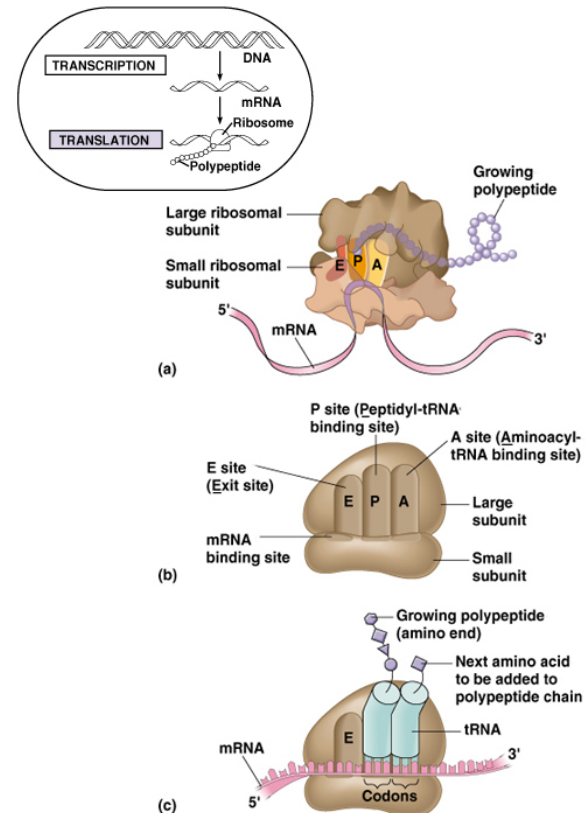
- **Ribosomes:** structures composed of rRNA (2 subunits) and protein
- Responsible for aligning tRNA anticodons with mRNA codons
- Stage for synthesis of peptides

(b) Diagram of ribosome during translation



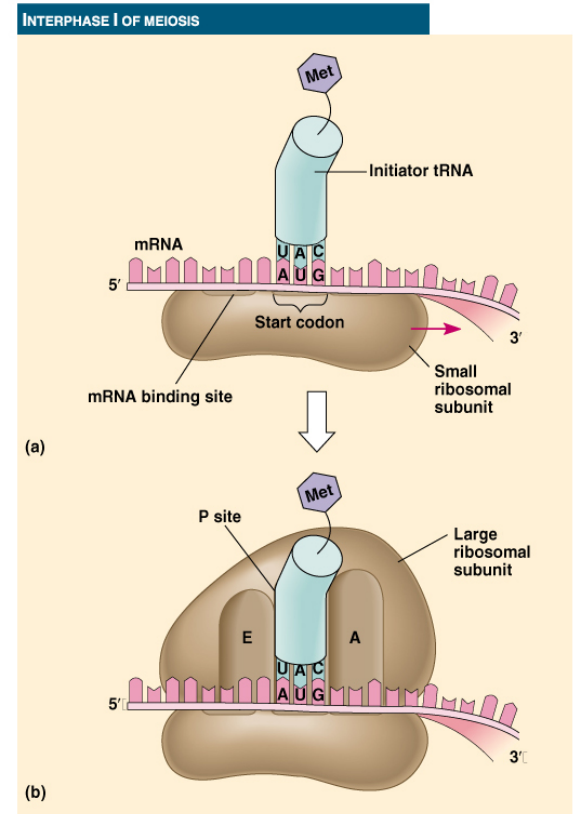
# Pieces and Parts

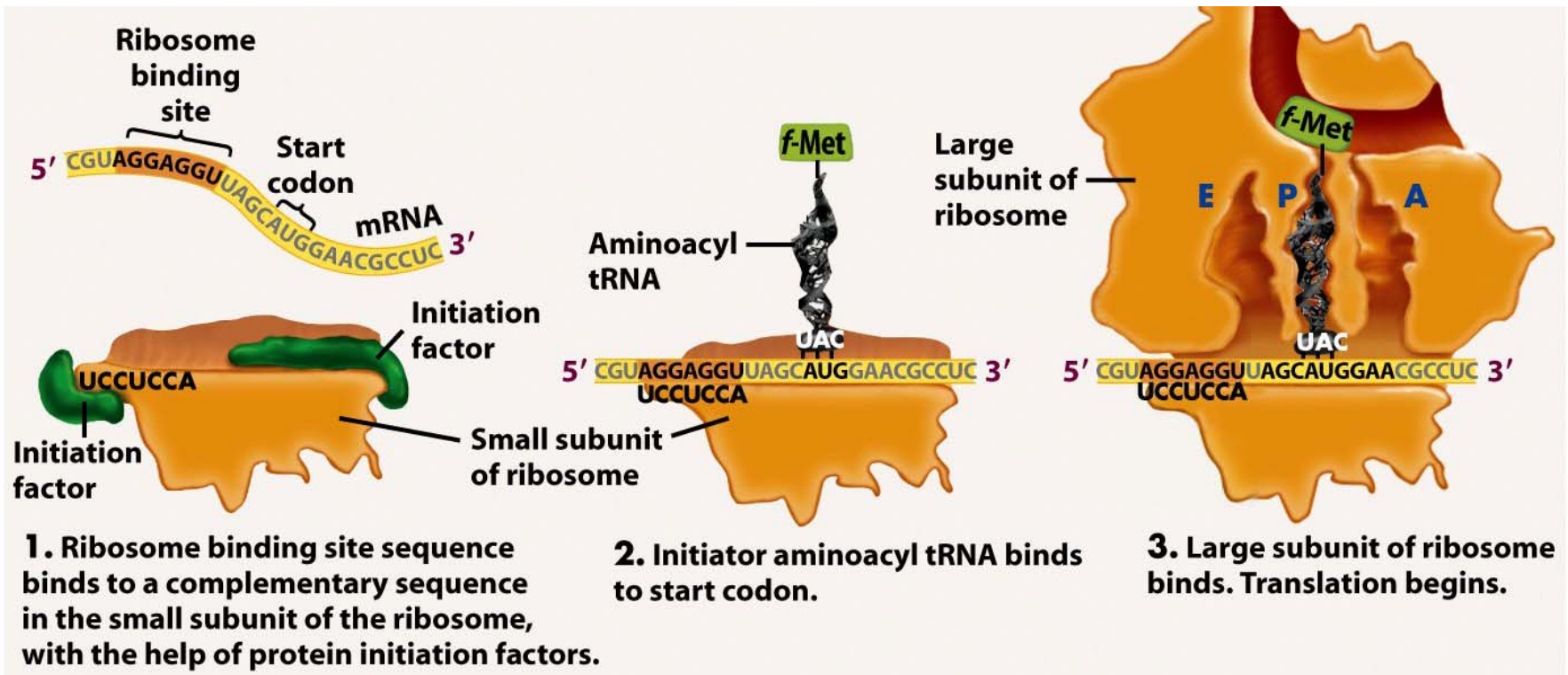
- Each ribosome has:
  - a binding site for mRNA
  - three binding sites each for a molecule of tRNA
    - E: Exit site
    - P: holds tRNA with growing peptide chain
    - A: holds tRNA containing the next AA to be added to the polypeptide



# The Process

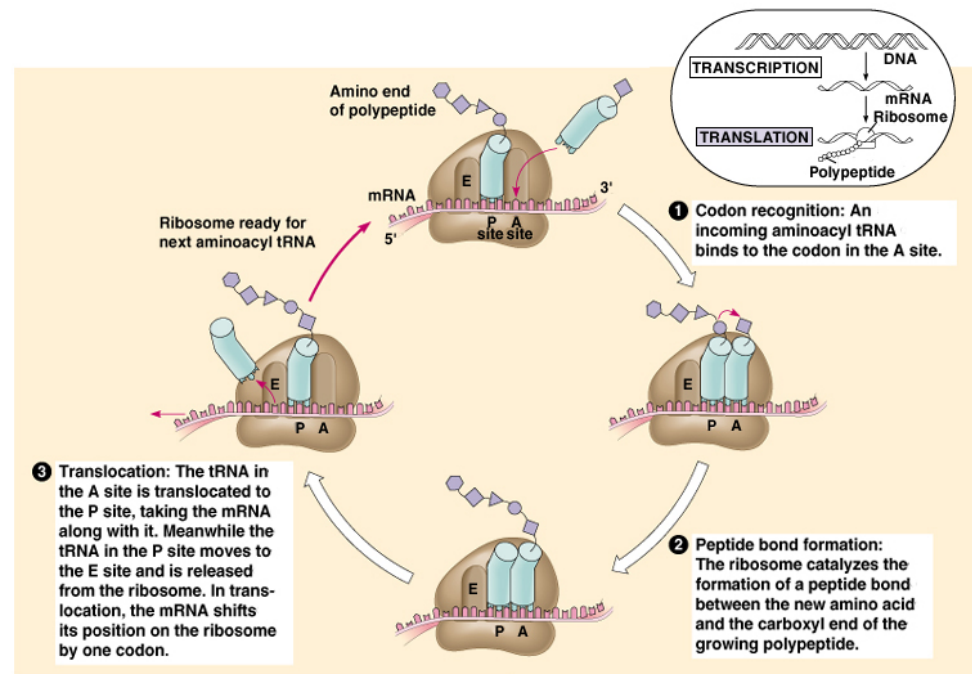
- **Initiation:** Binding of the small and large ribosomal subunits to mRNA and the first tRNA
- Initiation factors and energy (GTP) involved in the formation of **initiation complex**
  - Small subunit attaches to mRNA near the 5' cap
  - tRNA carrying the AA Methionine attaches to the start codon (P site)
  - Large subunit attaches





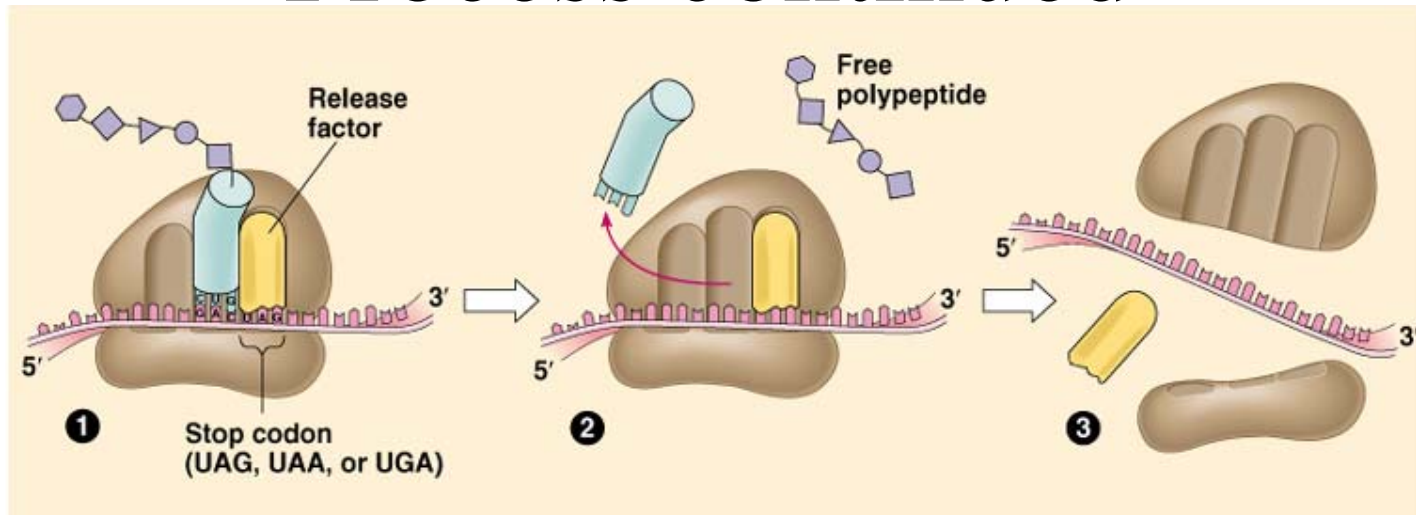
# Process continued

## Elongation: lengthening of polypeptide



- **Codon recognition:** Site A codon forms bonds with the anticodon of tRNA; requires elongation factors and energy
- **Peptide bond formation:** large subunit rRNA catalyzes the formation of a peptide bond between the AA of tRNA's at P & A sites. AA at P site transferred to A site
- **Translocation:** rRNA shifts position by one codon with respect to mRNA. The H bonded mRNA-tRNA unit is moved from the A site to the P site. Any tRNA occupying P site is moved to the E site where it is released. Translocation requires energy. mRNA is read from 5' to 3'.

# Process continued



- **Termination:** stoppage of synthesis and peptide release
  - elongation continues until the a stop codon is read by the ribosome
  - Release factor protein binds to the stop codon
  - Release factor adds  $H_2O$  to the protein causing it to be released from tRNA
  - Translation assembly falls apart

# Oh, One last thing

- Most synthesized proteins must undergo further modification before use including
  - attachment of sugar, lipids, functional groups
  - leading end of protein may have some AA removed (recall that all protein sequencing starts with AA methionine but not all finished protein do)
  - Polypeptide chain may be divided up into smaller units
  - Protein may require several polypeptide chains