

ME 411 / ME 511

Biological Frameworks for Engineers

ME 411 / ME 511

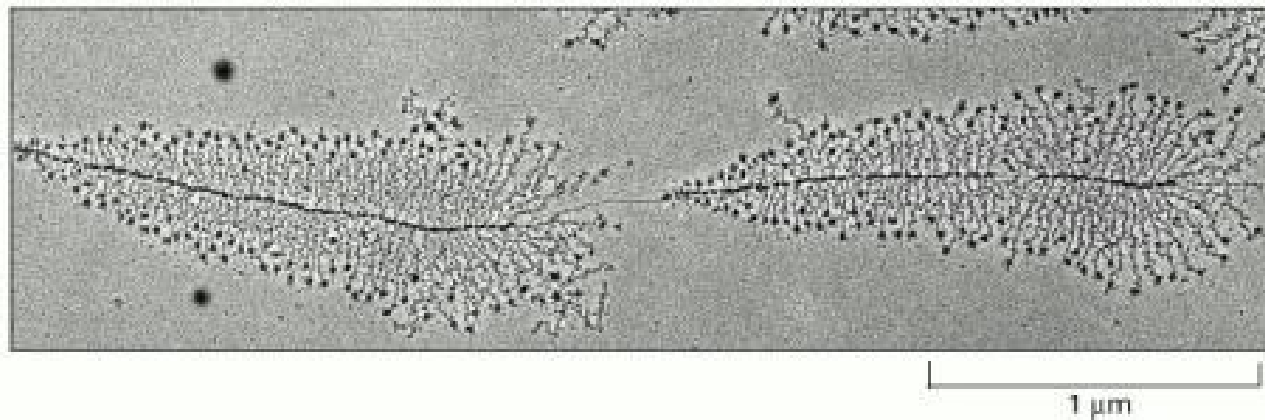
DNA

DNA = Ticker Tape?



DNA to RNA

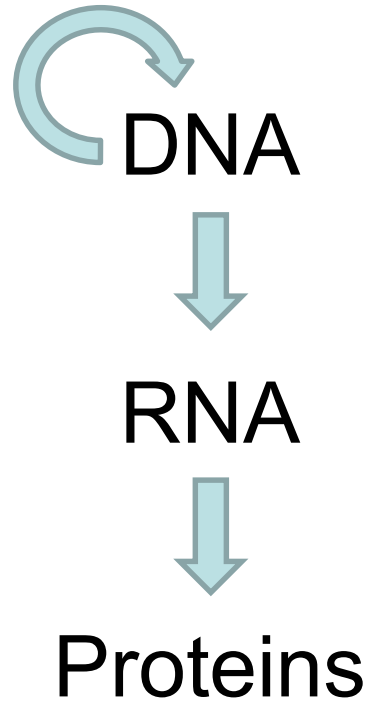
Electron micrograph below shows many molecules of RNA polymerase simultaneously transcribing two genes.



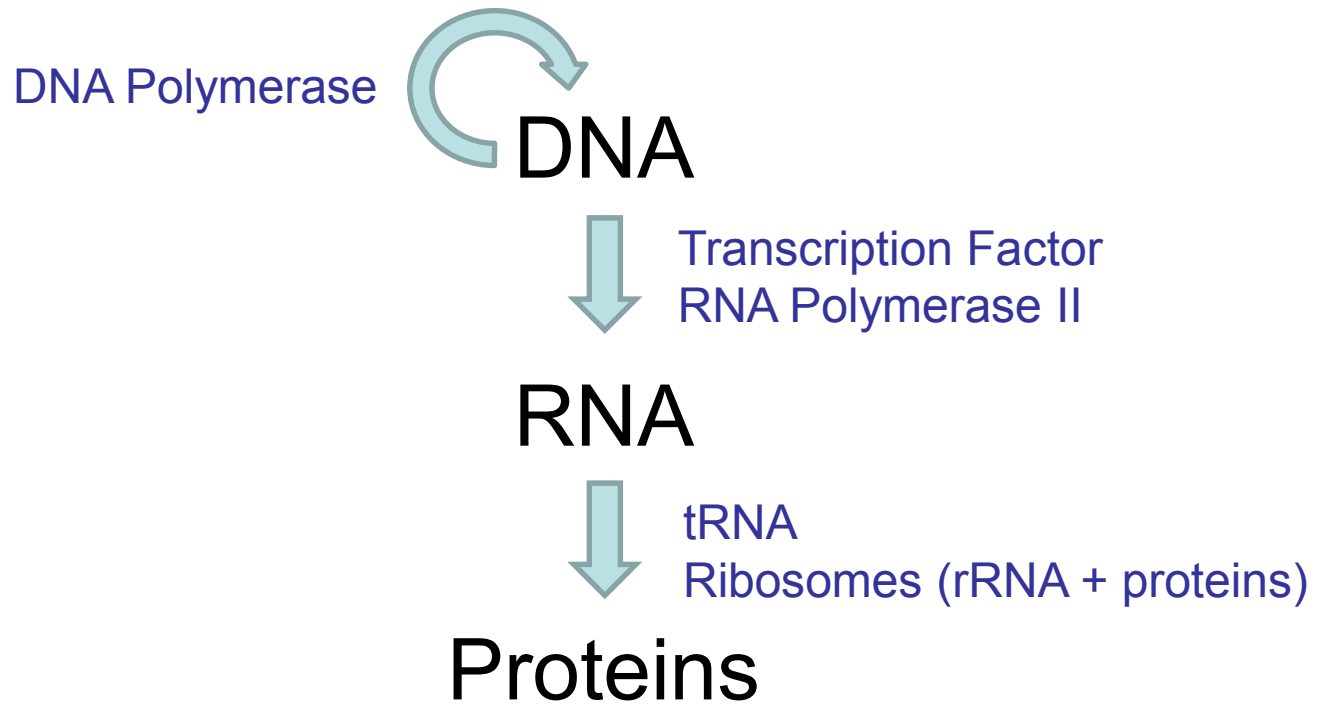
Individual RNA polymerases are visible as dots along the DNA. New RNA (fine threads) are attached to them.

Lengths of new RNA indicates that DNA is read from left to right (3' to 5' of DNA)

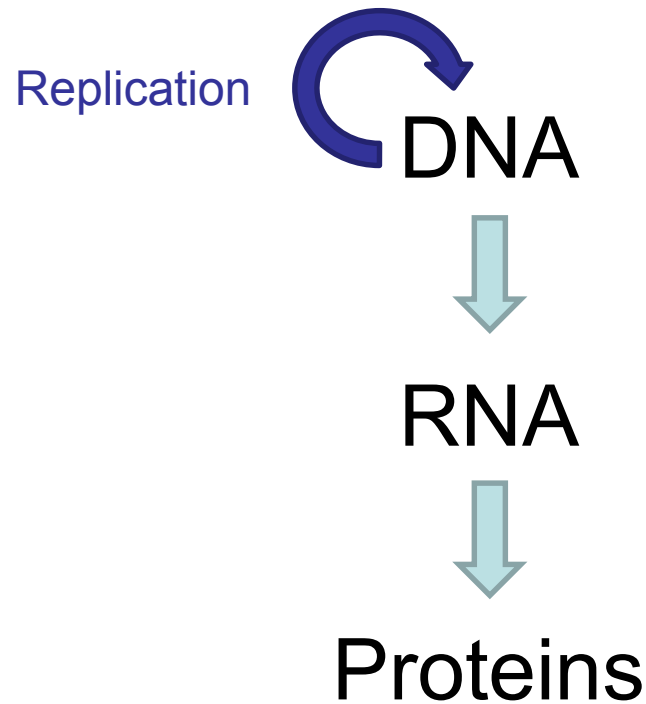
Central Dogma



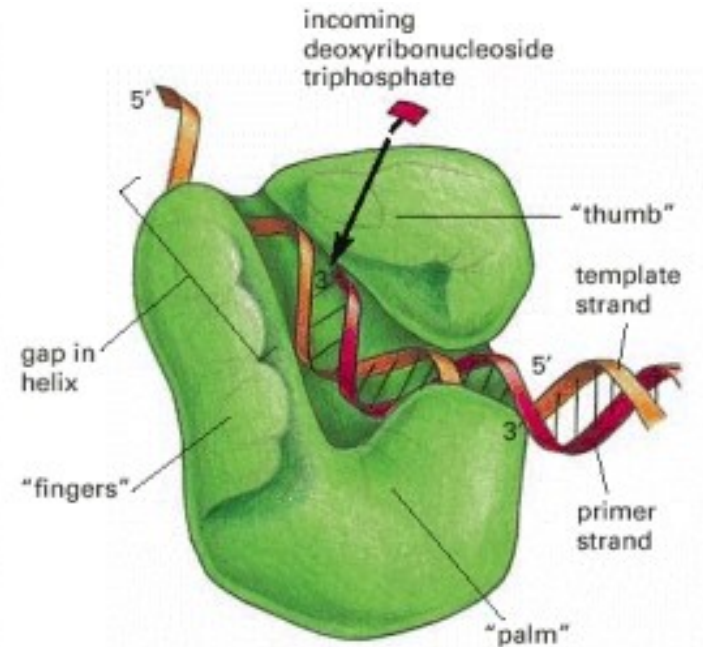
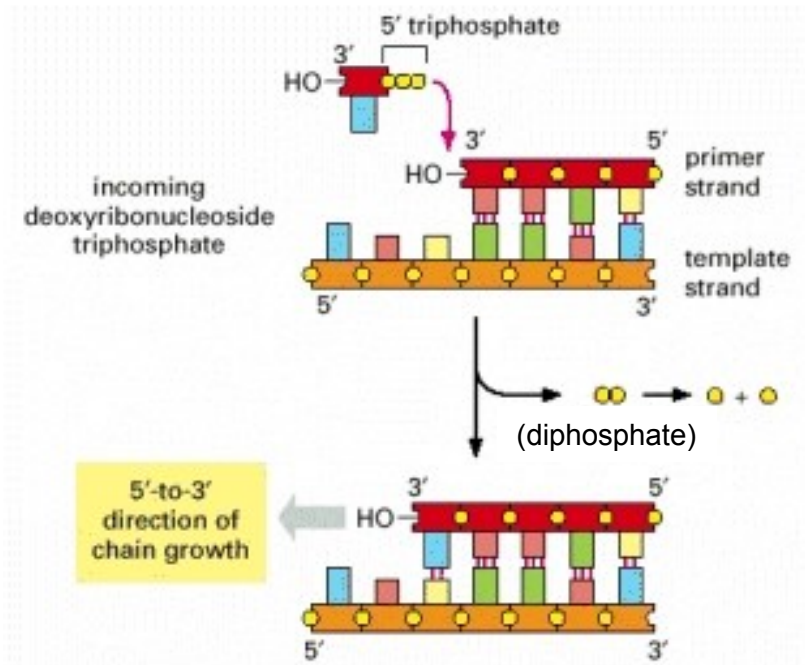
Central Players



Central Dogma



DNA Replication

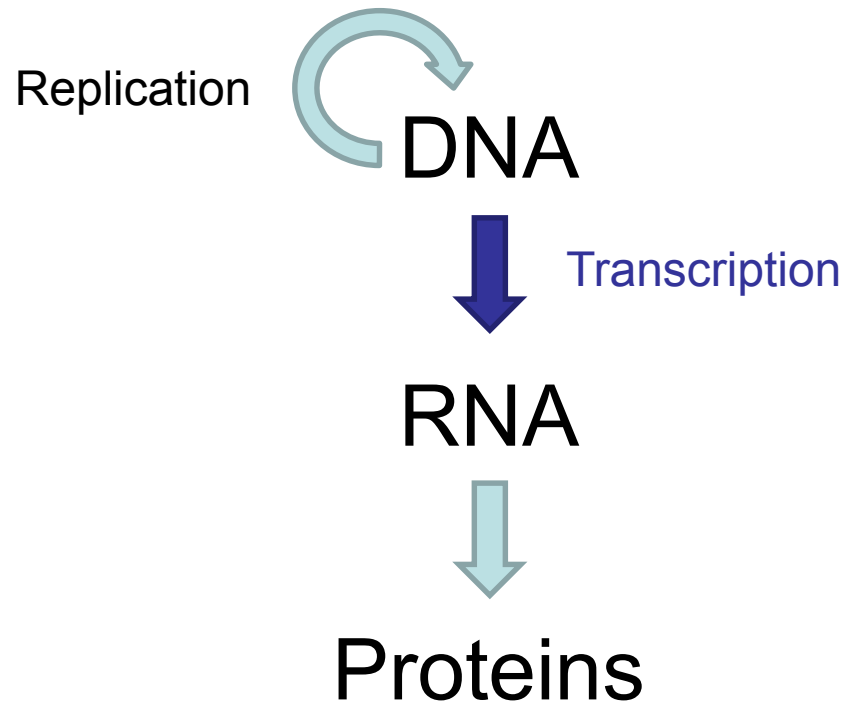


(DNA Polymerase)

Reads DNA 3' → 5'

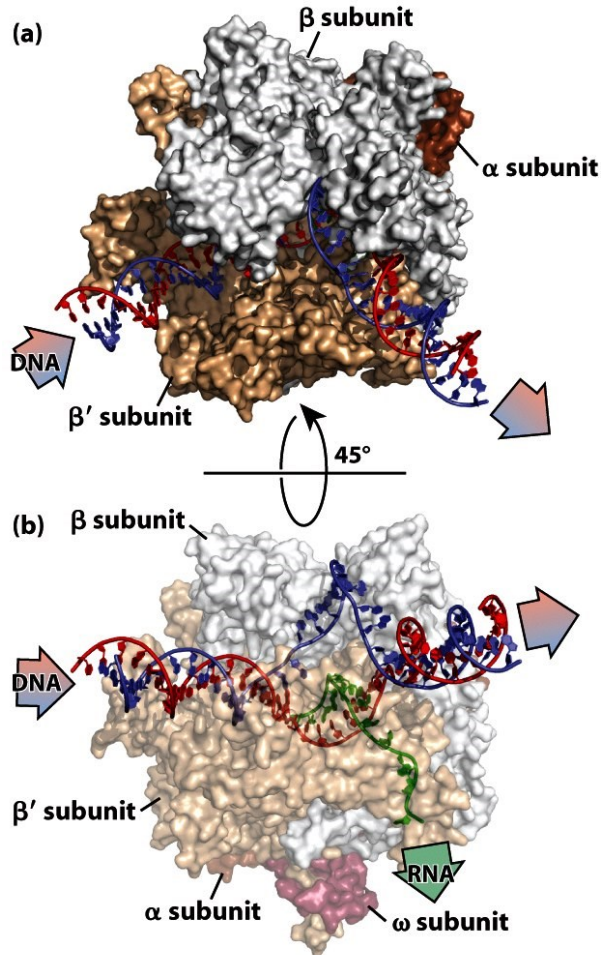
Makes DNA 5' → 3'

Central Dogma

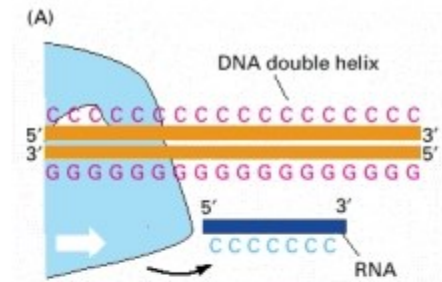


Transcription

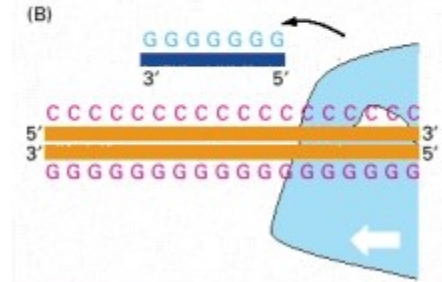
(RNA Polymerase II)



Reads DNA $3' \rightarrow 5'$
Makes RNA $5' \rightarrow 3'$



an RNA polymerase that moves from left to right makes RNA by using the bottom strand as a template



an RNA polymerase that moves from right to left makes RNA by using the top strand as a template

Figure 4-12
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Transcription Factors & Promoter Sequences

(TBP) TATA box-binding protein

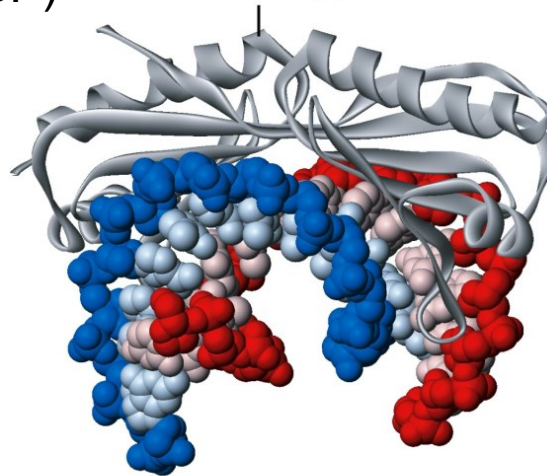


Figure 4-5
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Element	Promoter Sequence	Transcription Factor
TATA	T A T A A / T A A / T	TBP
BRE	G / C G / C G / A C G C C	TFIIB
INR	C / T C / T A x T / A C / T / C / T	TFIID
DPE	A / G G A / T C G T G	TFIID

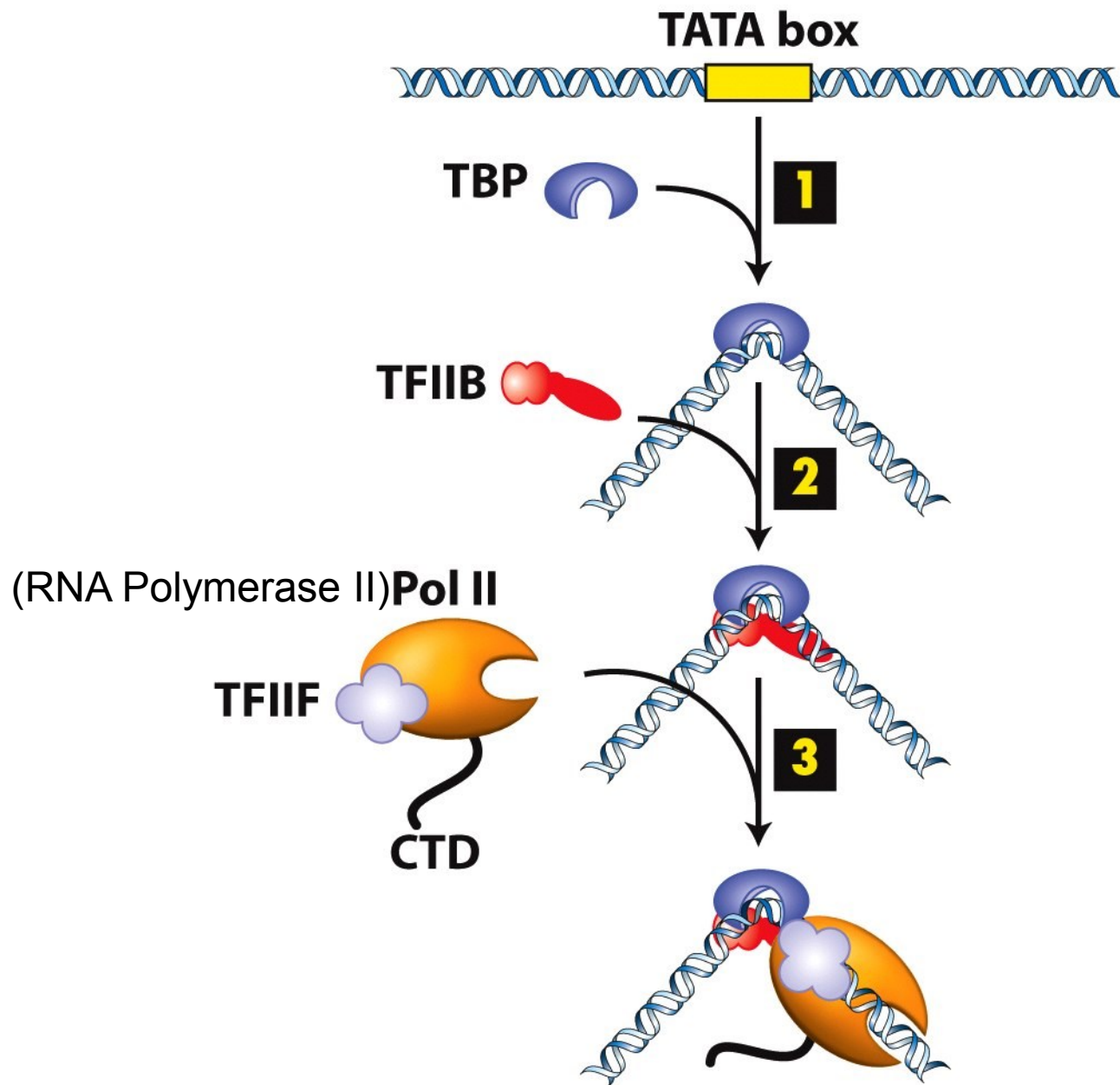


Figure 7-31 part 1
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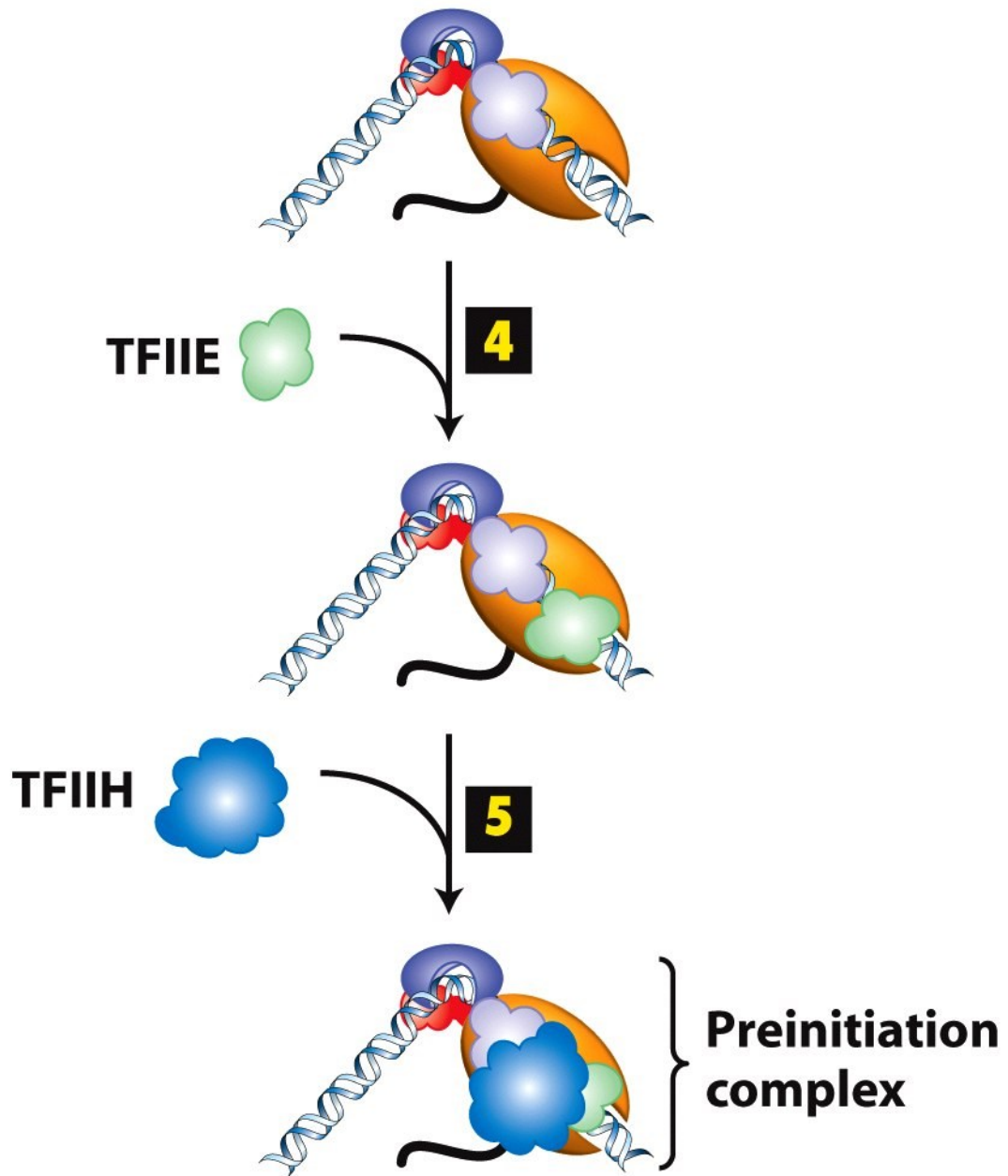


Figure 7-31 part 2
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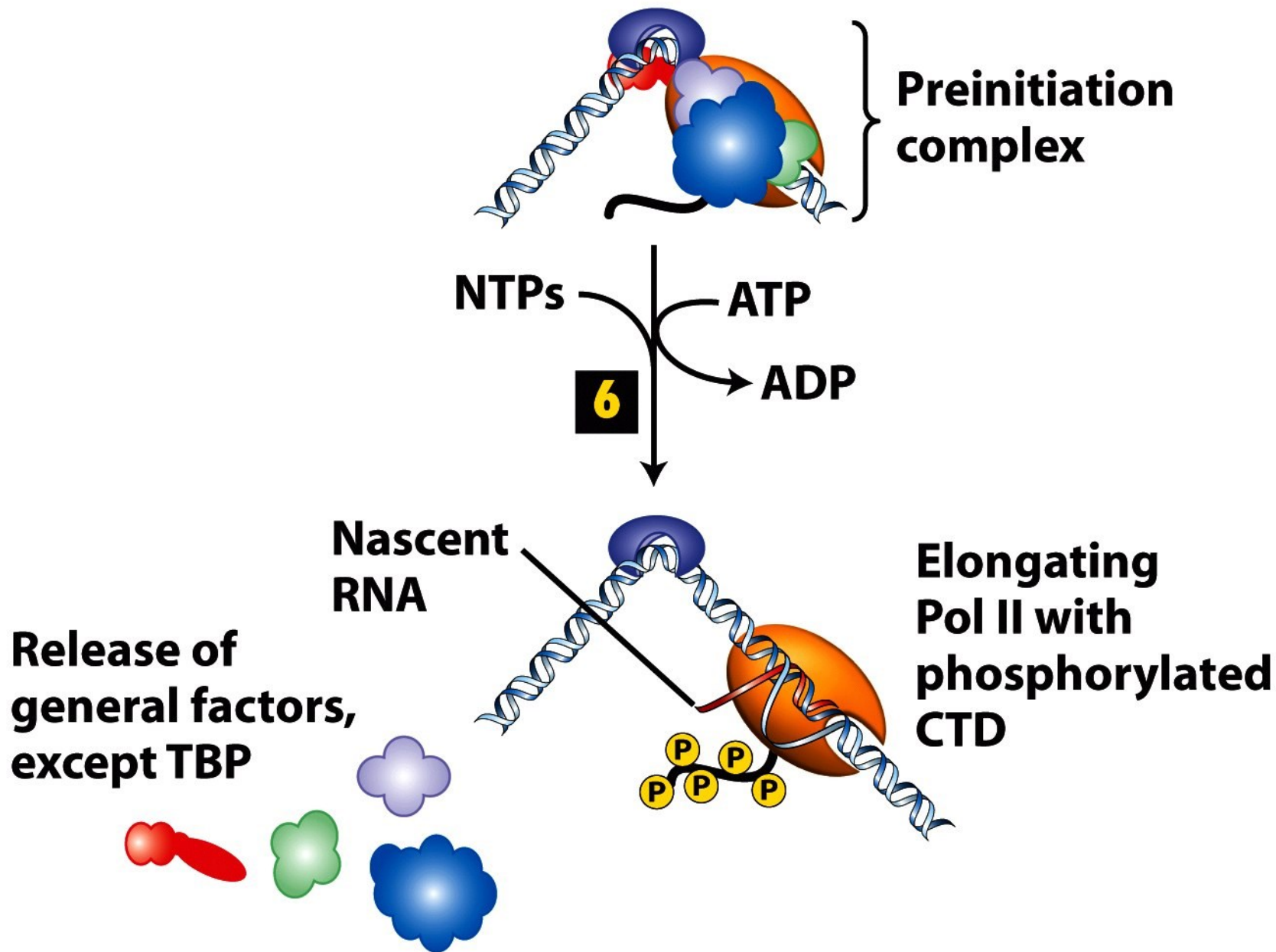
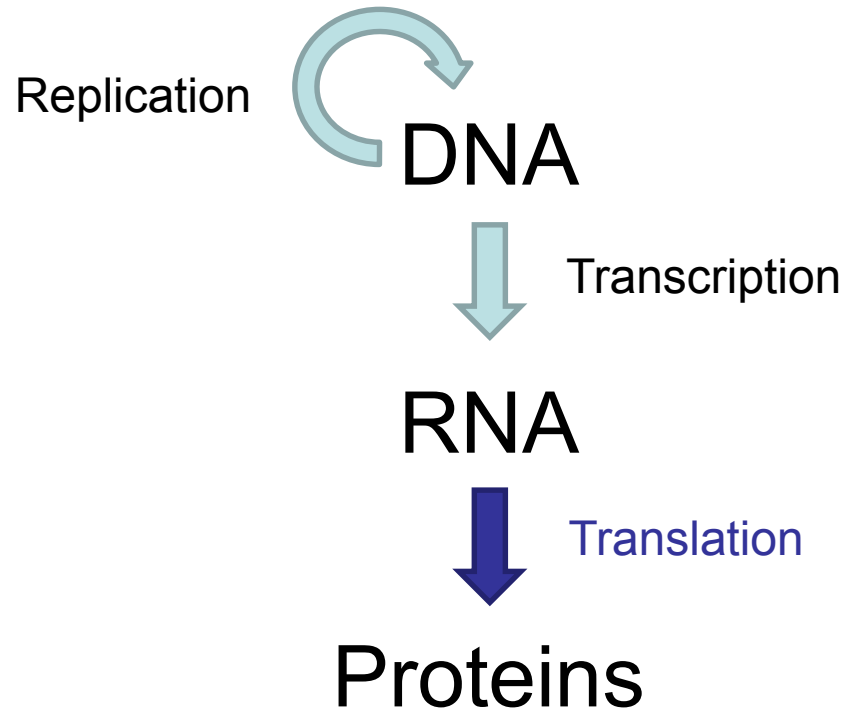


Figure 7-31 part 3
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Central Dogma



Translation

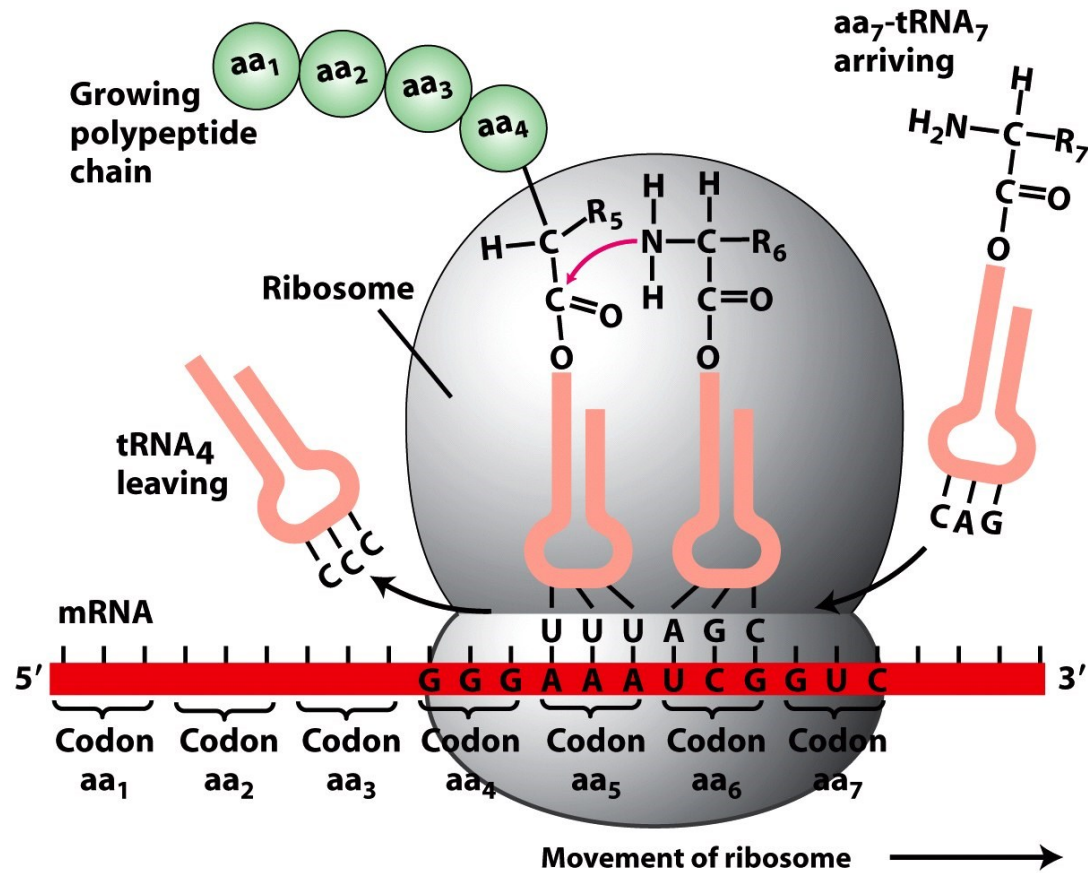
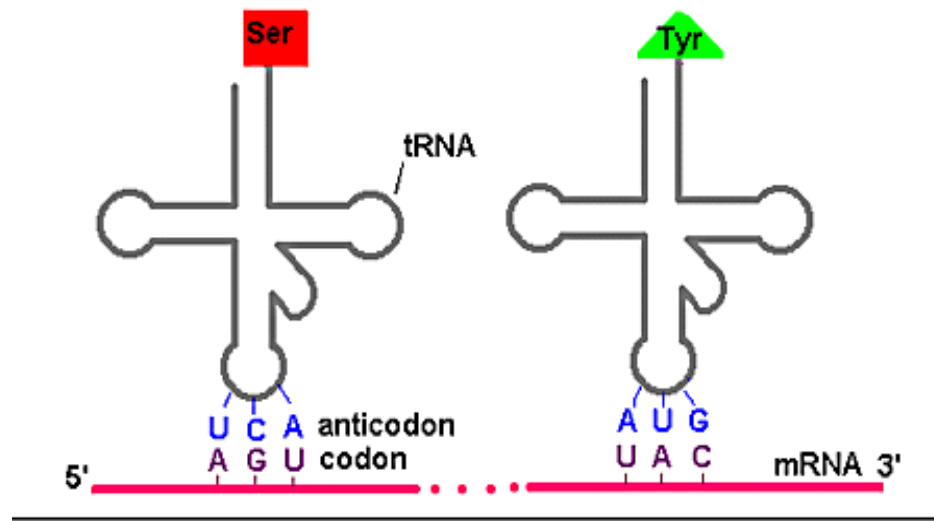


Figure 4-17
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2nd base in codon

		U	C	A	G		
1st base in codon	U	Phe Phe Leu Leu	Ser Ser Ser Ser	Tyr Tyr STOP STOP	Cys Cys STOP Trp	3rd base in codon	U C A G
	C	Leu Leu Leu Leu	Pro Pro Pro Pro	His His Gln Gln	Arg Arg Arg Arg	U C A G	
	A	Ile Ile Ile Met	Thr Thr Thr Thr	Asn Asn Lys Lys	Ser Ser Arg Arg	U C A G	
	G	Val Val Val Val	Ala Ala Ala Ala	Asp Asp Glu Glu	Gly Gly Gly Gly	U C A G	

The Genetic Code

Proteomic Numbers

- Proteome: final product of gene expression
 - A cell has 10,000-20,000 different proteins
 - For each protein: 20,000 – 100 million copies per cell
 - 2,000 housekeeping proteins (>50,000 copies)

Genetic Code

- What if...
 - 1 base pair encoded 1 protein?
 - 2 base pairs encoded 1 protein?
 - 3 base pairs encoded 1 protein?

When is a cell like a computer?



WORKSHEET: Genetic Code

DNA (5') G G A T A G C A T G A A A C C C G C A T A A (3')

DNA

mRNA

Amino acid

		2nd base in codon				
		U	C	A	G	
1st base in codon	U	Phe Leu Leu	Ser Ser Ser	Tyr STOP STOP	Cys STOP Trp	U C A G
	C	Leu Leu Leu	Pro Pro Pro	His Gln Gln	Arg Arg Arg	U C A G
	A	Ile Ile Met	Thr Thr Thr	Asn Asn Lys Lys	Ser Ser Arg Arg	U C A G
	G	Val Val Val	Ala Ala Ala	Asp Asp Glu Glu	Gly Gly Gly Gly	U C A G

WORKSHEET: Genetic Code

DNA (5') G G A T A G C A T G A A A C C C G C A T A A (3')

DNA (3') C C T A T C G T A C T T T G G G C G T A T T (5')



mRNA

Amino acid

		2nd base in codon				
		U	C	A	G	
1st base in codon	U	Phe Phe Leu Leu	Ser Ser Ser Ser	Tyr Tyr STOP STOP	Cys Cys STOP Trp	U C A G
	C	Leu Leu Leu Leu	Pro Pro Pro Pro	His His Gln Gln	Arg Arg Arg Arg	U C A G
	A	Ile Ile Ile Met	Thr Thr Thr Thr	Asn Asn Lys Lys	Ser Ser Arg Arg	U C A G
	G	Val Val Val Val	Ala Ala Ala Ala	Asp Asp Glu Glu	Gly Gly Gly Gly	U C A G

3rd base in codon

WORKSHEET: Genetic Code

DNA (5') G G A T A G C A T G A A A C C C G C A T A A (3')

DNA (3') C C T A T C G T A C T T T G G G C G T A T T (5')



mRNA (5') G G A U A G C A U G A A A C C C G C A U A A (3')

Amino acid

		2nd base in codon				
		U	C	A	G	
1st base in codon	U	Phe Leu Leu	Ser Ser Ser	Tyr STOP STOP	Cys STOP Trp	U C A G
	C	Leu Leu Leu	Pro Pro Pro	His Gln Gln	Arg Arg Arg	U C A G
	A	Ile Ile Met	Thr Thr Thr	Asn Lys Lys	Ser Arg Arg	U C A G
	G	Val Val Val	Ala Ala Ala	Asp Glu Glu	Gly Gly Gly	U C A G

3rd base in codon

WORKSHEET: Genetic Code

DNA (5') G G A T A G C A T G A A A C C C G C A T A A (3')

DNA (3') C C T A T C G T A C T T T G G G C G T A T T (5')

mRNA (5') G G A U A G C AUG AAA CCC GCA UAA (3')



Amino acid Methionine Lysine Proline Alanine



		2nd base in codon				
		U	C	A	G	
1st base in codon	U	Phe Leu Leu	Ser Ser Ser	Tyr STOP STOP	Cys STOP Trp	U C A G
	C	Leu Leu Leu	Pro Pro Pro	His Gln Gln	Arg Arg Arg	U C A G
	A	Ile Ile Met	Thr Thr Thr	Asn Lys Lys	Ser Arg Arg	U C A G
	G	Val Val Val	Ala Ala Ala	Asp Glu Glu	Gly Gly Gly	U C A G

3rd base in codon

Questions ?