NUKLEOVÉ KYSELINY

MISCHER – **nuklein** (1868 – 1869)

Složení :

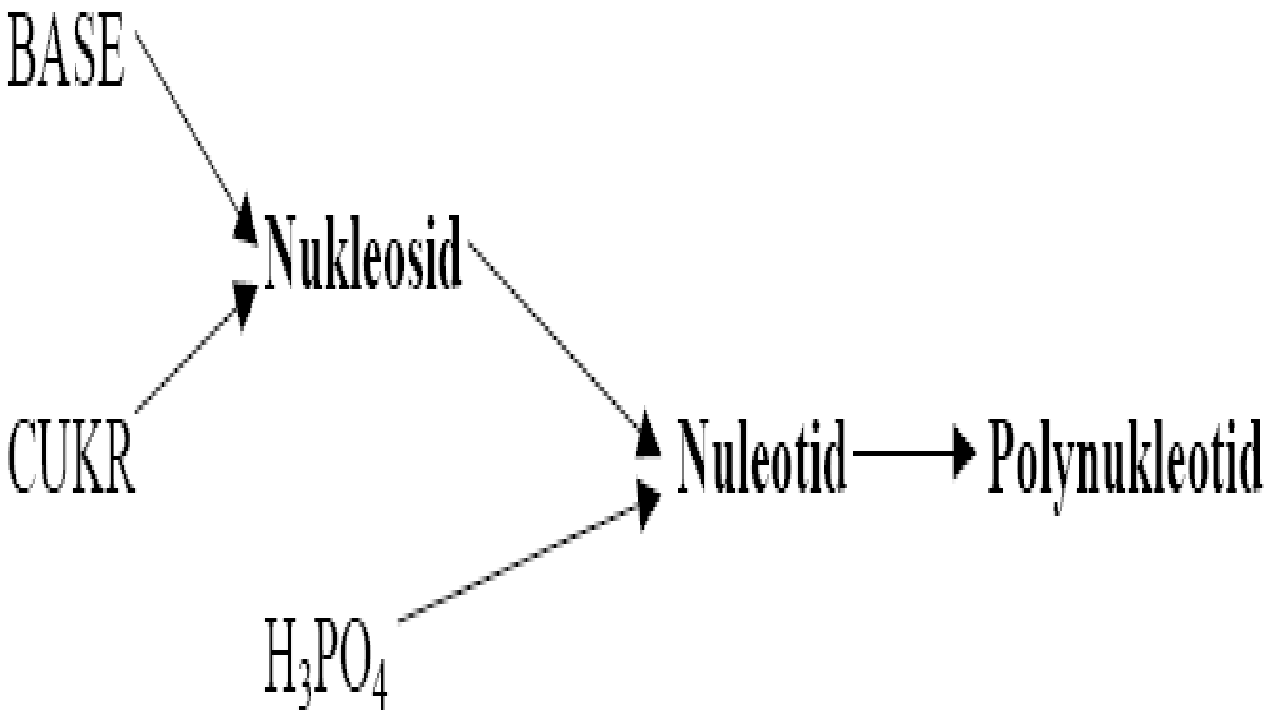
- Dusíkaté báze – purinové, pyrimidinové
- Sacharid – ribosa, deoxyribosa
- H_3PO_4

Funkce :

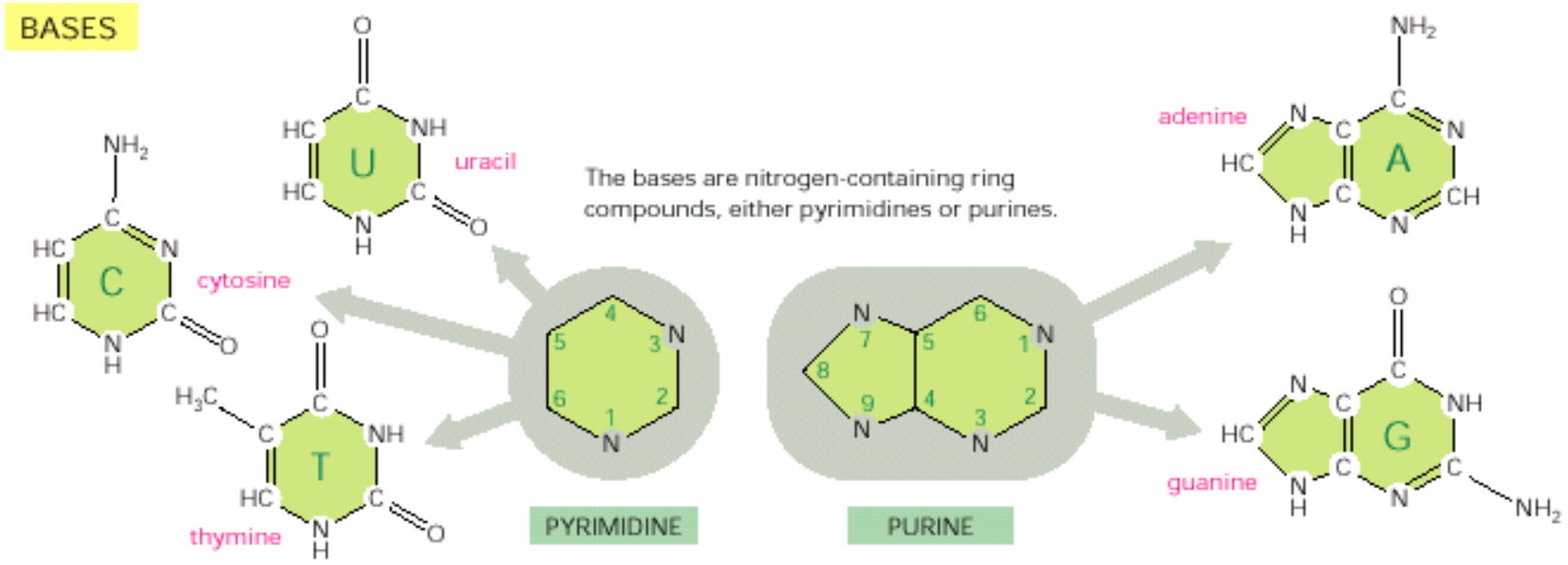
DNA – nositel genetické informace

- Viry
- Prokaryonta –cytoplazma
- Eukaryonta – jádro, mitochondrie, chloroplasty

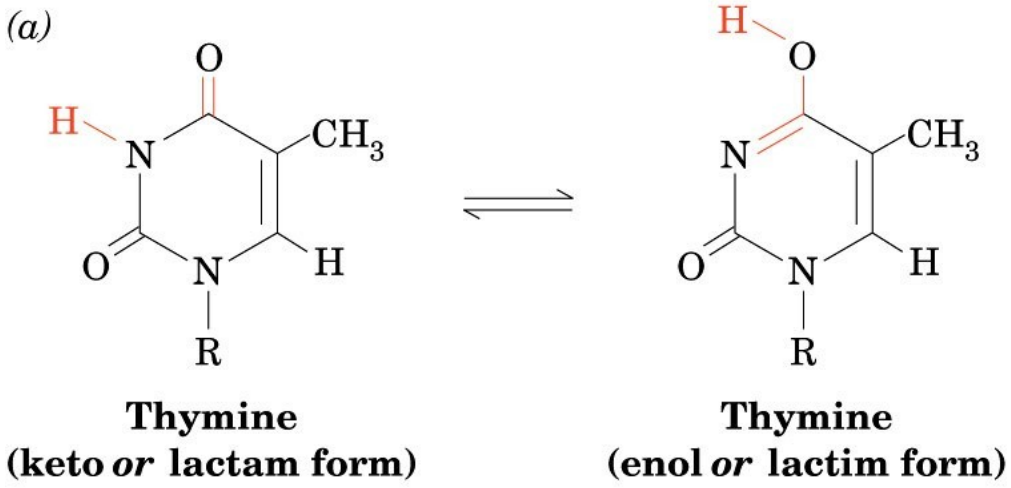
RNA – realizace genetické informace (u RNA virů i nositel genetické informace)


BASE
Nukleosid
CUKR
Nuleotid
Polynukleotid
H_3PO_4

Báze

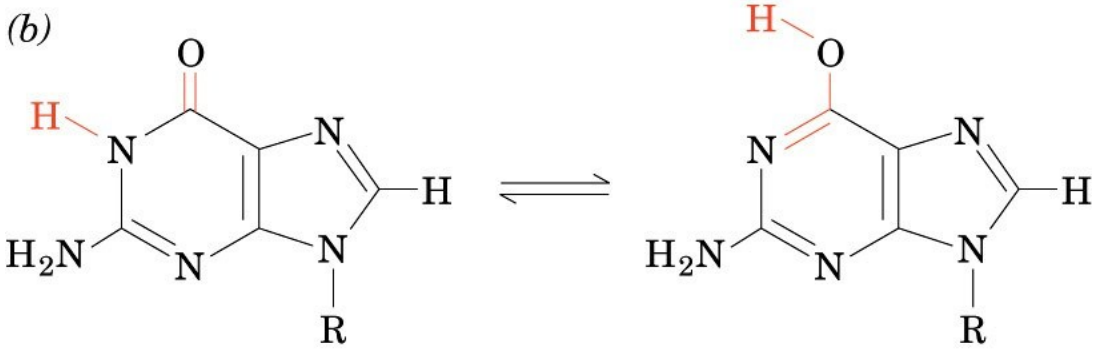

BASES
cytosine
uracil
thymine
adenine
guanine
The bases are nitrogen-containing ring compounds, either pyrimidines or purines.
PYRIMIDINE
PURINE

Báze -tautomerie



Thymine
(keto *or* lactam form)

Thymine
(enol *or* lactim form)



Guanine
(keto *or* lactam form)

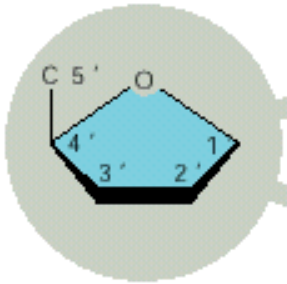
Guanine
(enol *or* lactim form)

Monosacharidy

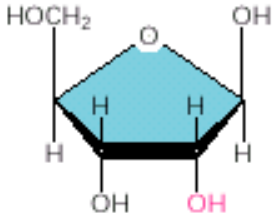
SUGARS

PENTOSE

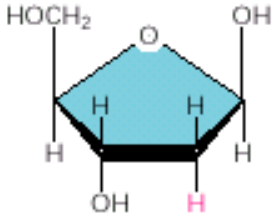
a five-carbon sugar



two kinds are used



β-D-ribose
used in ribonucleic acid

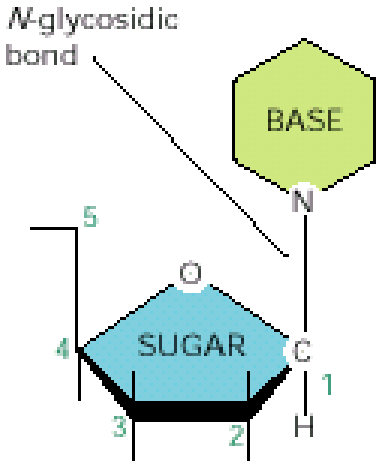


β-D-2-deoxyribose
used in deoxyribonucleic acid

Each numbered carbon on the sugar of a nucleotide is followed by a prime mark; therefore, one speaks of the "5-prime carbon," etc.

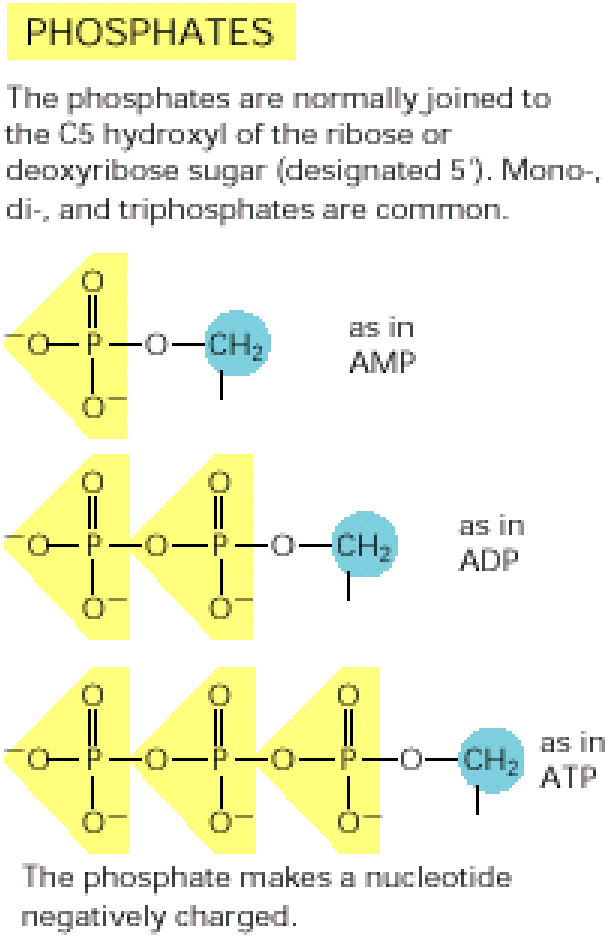
Nukleosid

BASIC SUGAR LINKAGE



The base is linked to the same carbon (C1) used in sugar-sugar bonds.

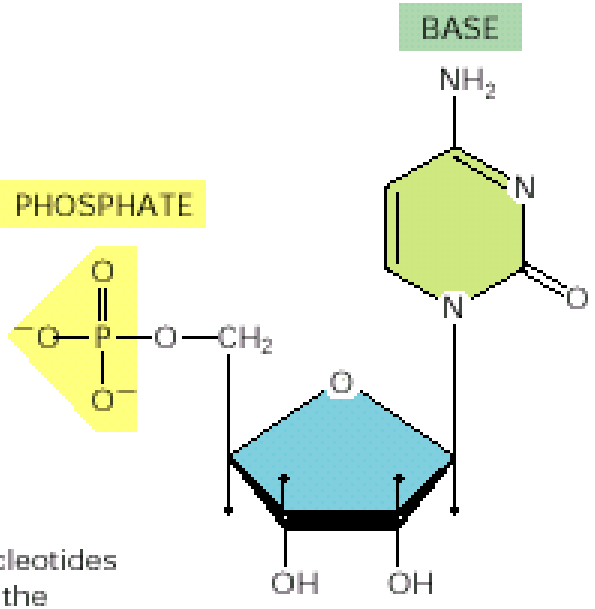
Kyselina fosforečná



Nukleotid

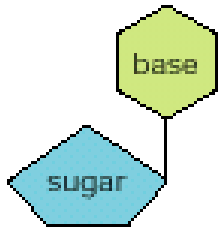
NUCLEOTIDES

A nucleotide consists of a nitrogen-containing base, a five-carbon sugar, and one or more phosphate groups.

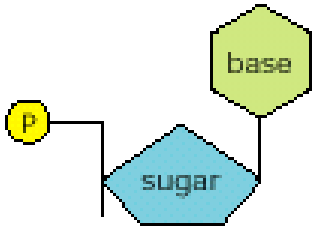


Nucleotides are the subunits of the nucleic acids.

Názvosloví



BASE + SUGAR = NUCLEOSIDE



BASE + SUGAR + PHOSPHATE = NUCLEOTIDE

BASE	NUCLEOSIDE	ABBR.
adenine	adenosine	A
guanine	guanosine	G
cytosine	cytidine	C
uracil	uridine	U
thymine	thymidine	T

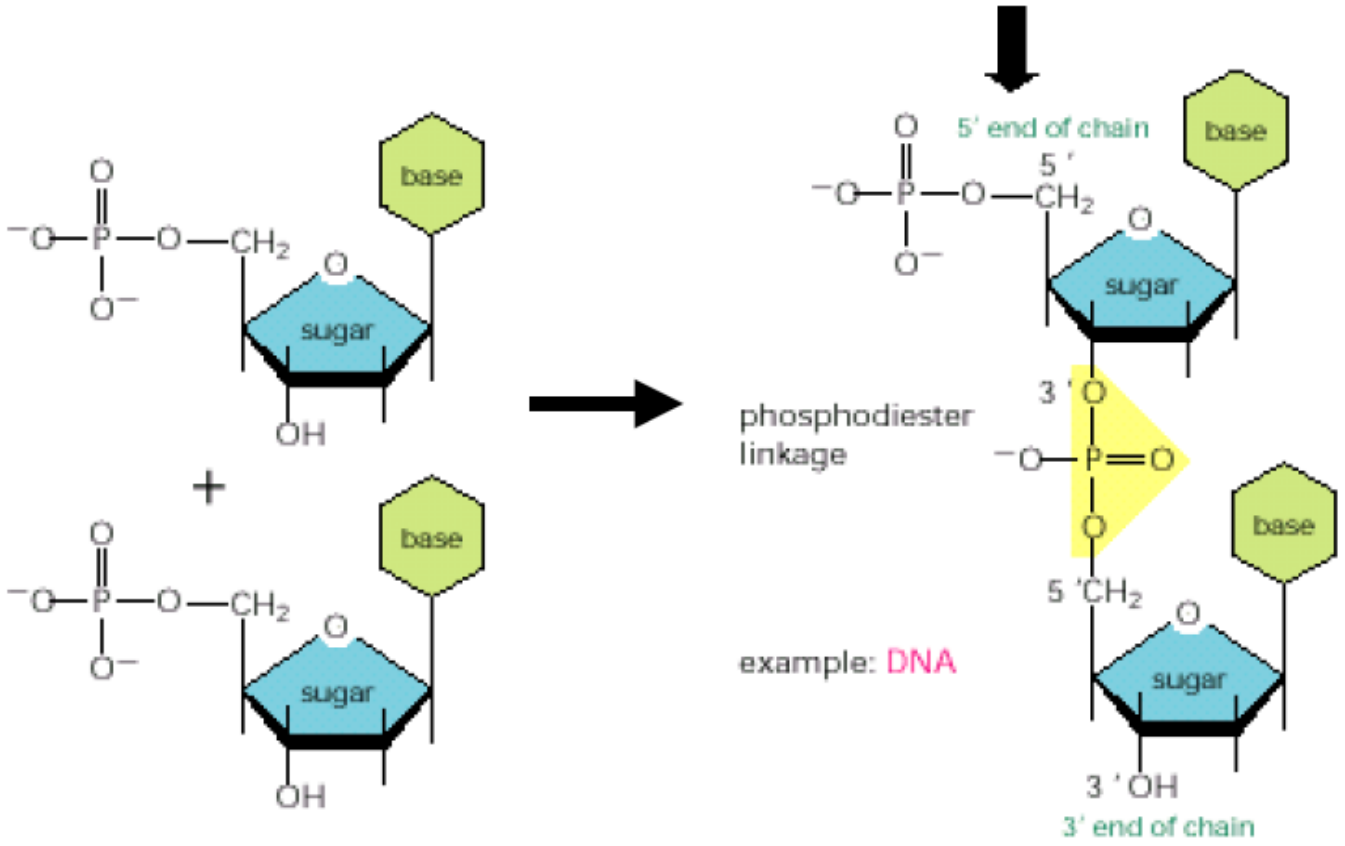
Nucleotides are abbreviated by three capital letters. Some examples follow:

AMP = adenosine monophosphate
dAMP = deoxyadenosine monophosphate
UDP = uridine diphosphate
ATP = adenosine triphosphate

Funkce nukleotidů

- přenašeče energie (ATP, GTP, ligasy, hydrolasy)
- fosforylační činidla (ATP - kinasy)
- aktivátory meziproduktů biosyntéz - UDP glukosa
- součásti kofaktorů - NAD(P), FAD, PAPS,
- využití v terapii - antivirotika(AIDS, herpes) – AZT
- stavební složky nukleových kyselin

Polynukleotid – nukleová kyselina



Struktura a funkce DNA

A,T,G,C + deoxyribosa

Primární struktura – sekvence basí

Sekundární struktura – Watson, Crick (1953) – dvojšroubovice

- Chragaffovy pravidla – poměr bazí v DNA
  A+G=T+C A=T G=C A+C=G+T
- Donohue – báze v tautomerních ketoformách
- Franklinová –RTG difrakční analýza

Unnumbered figure pg 9 Concepts in Biochemistry, 3/e

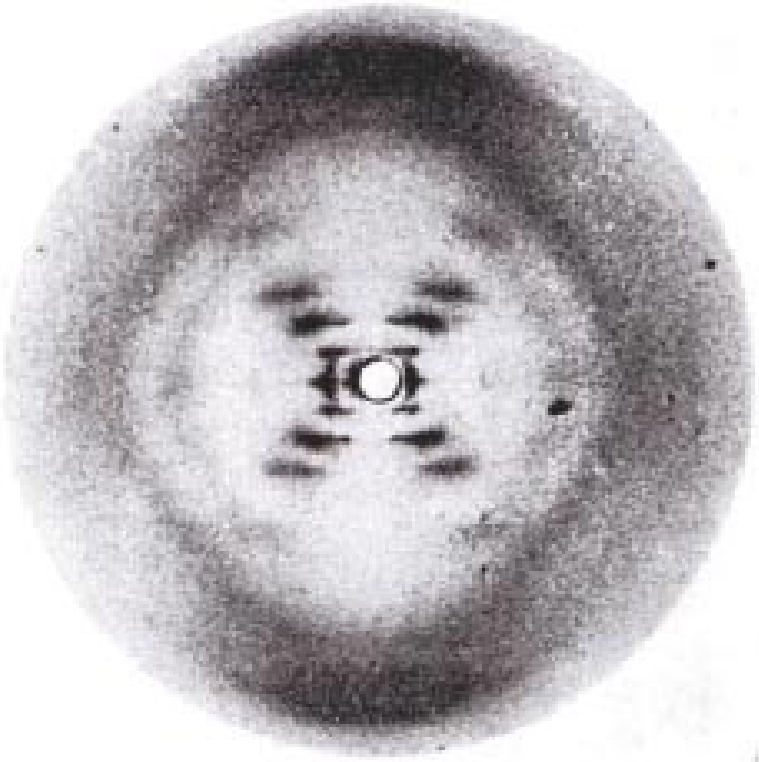
Chargaffovy pravidla

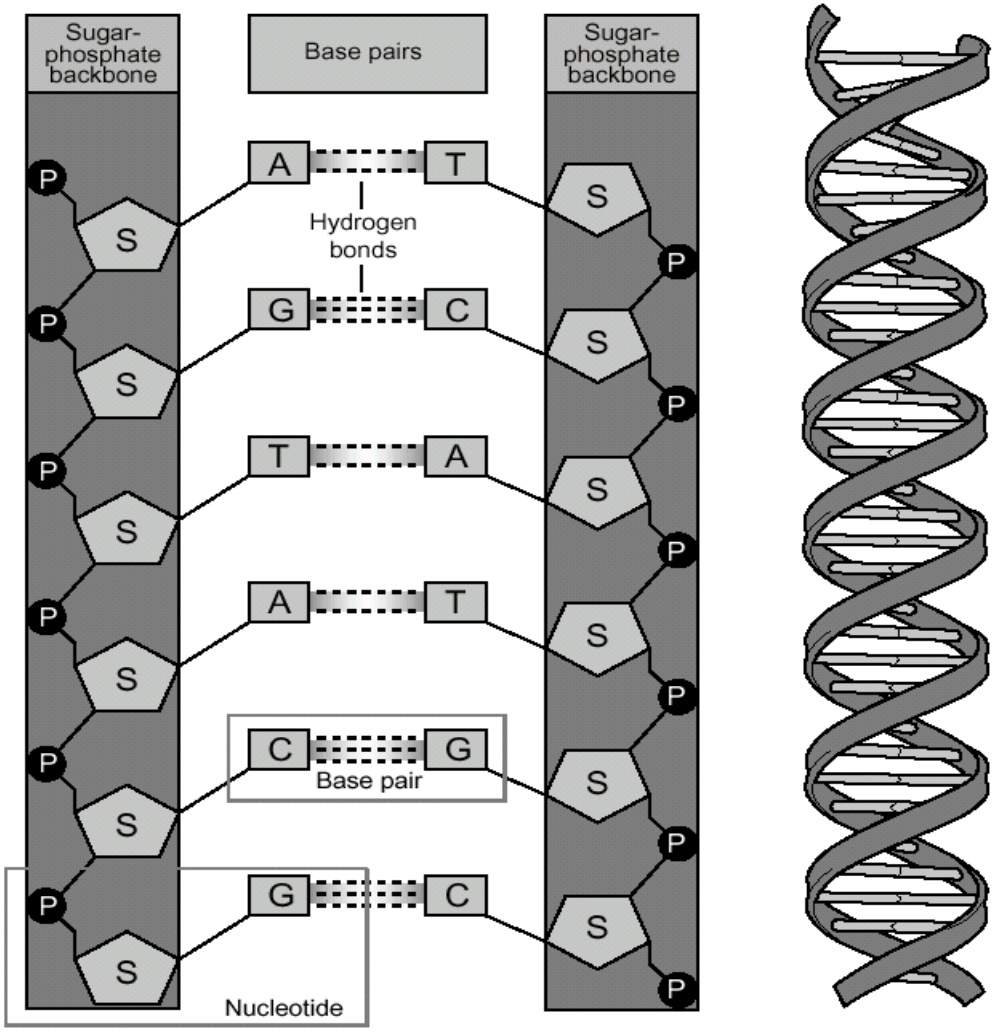
A+G=T+C A=T G=C

A+C=G+T

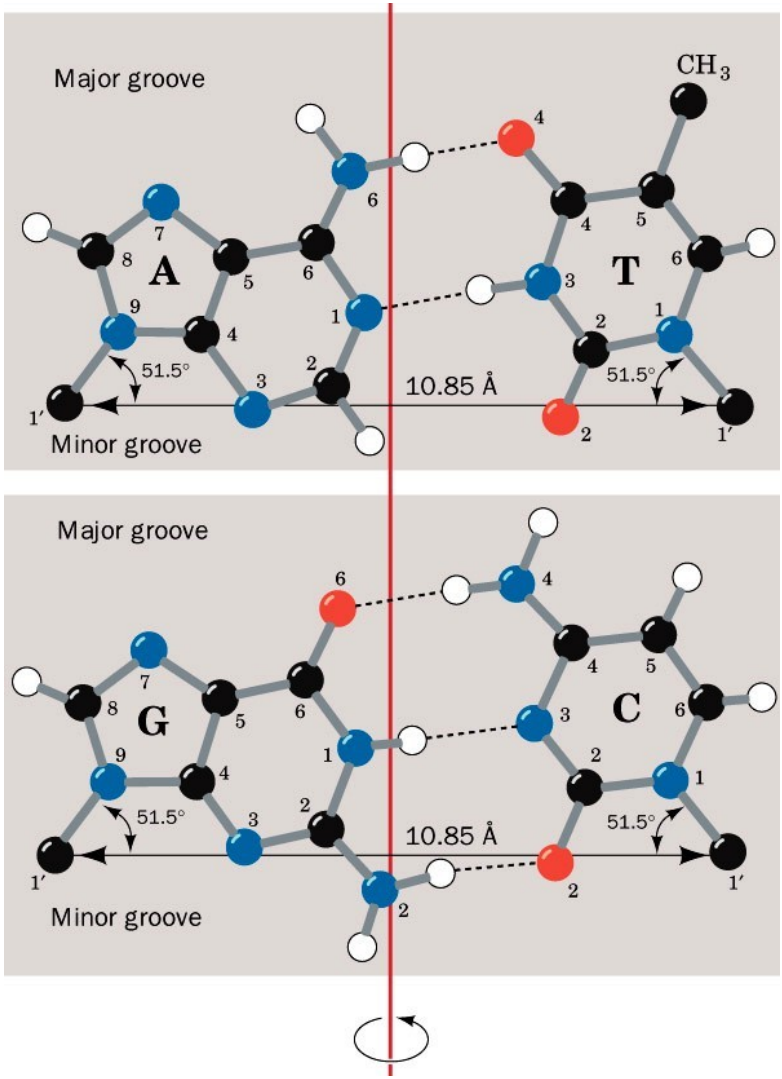
Zastoupení basí v DNA (molární %)

Organismus	A	T	G	C
Člověk	30.9	29.4	19.9	19.8
Kuře	28.8	29.2	20.5	21.5
Kobylka luční	29.3	29.3	20.5	20.7
Pšenice	27.3	27.1	22.7	22.8
Kvasinky	31.3	32.9	18.7	17.1
E. coli	24.7	23.6	26.0	25.7

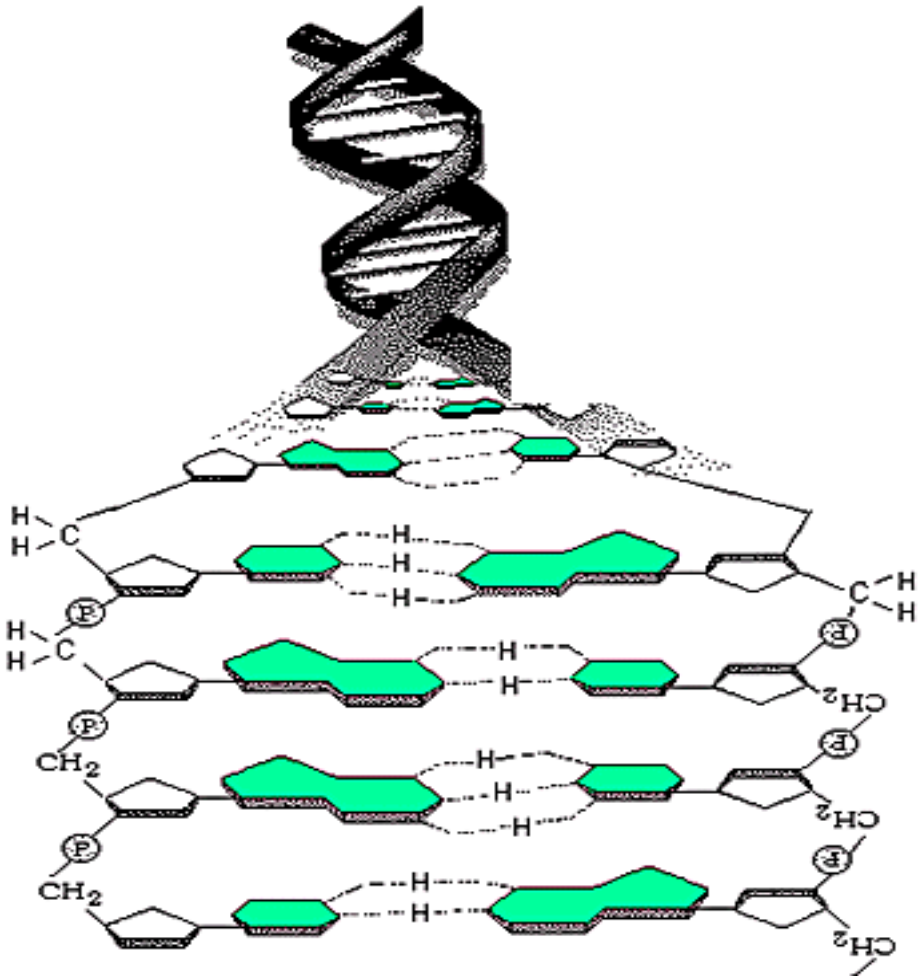



Sugar-phosphate backbone
Base pairs
Sugar-phosphate backbone
A
T
Hydrogen bonds
G
C
T
A
A
T
C
G
Base pair
G
C
Nucleotide
P
S

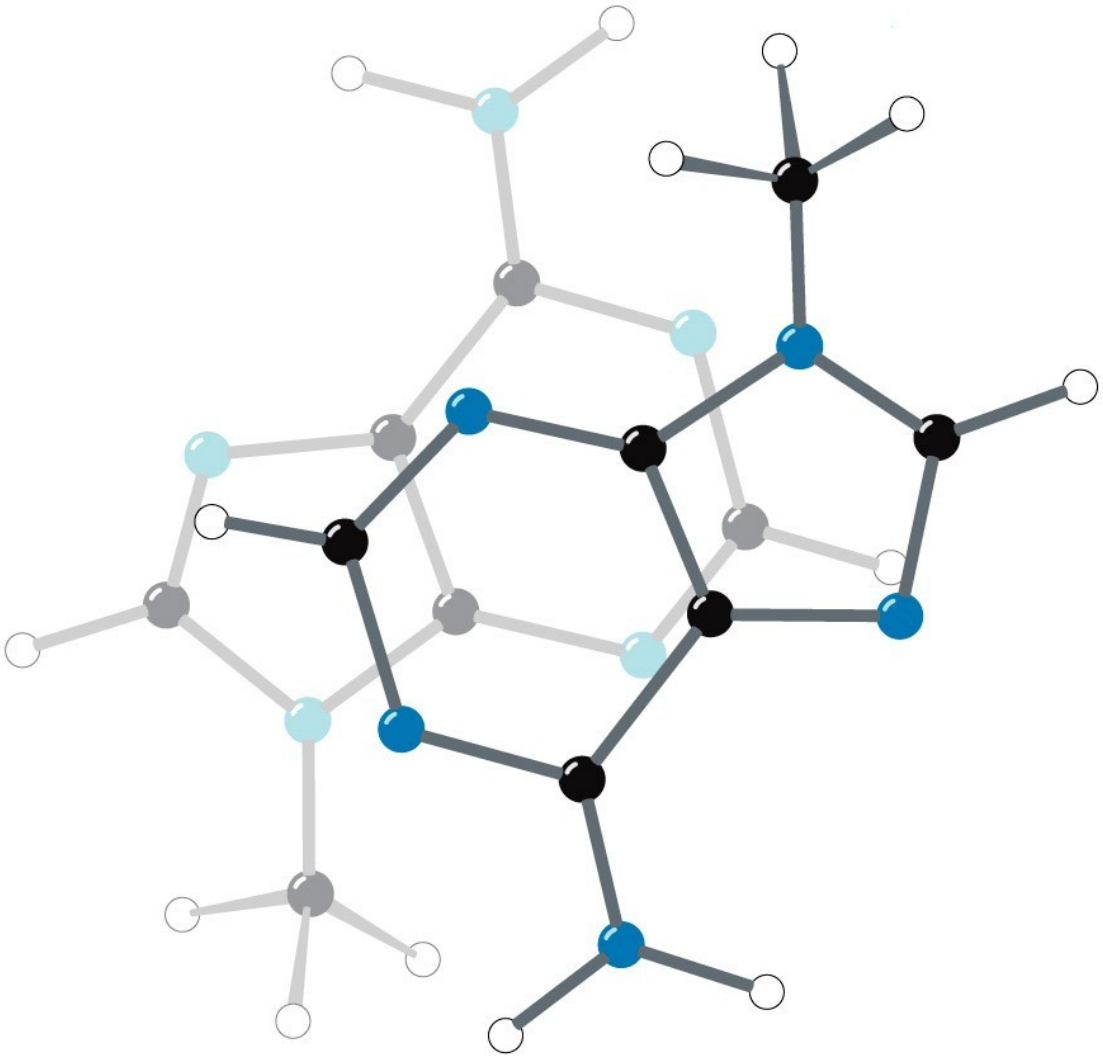
Párování basí – H můstky



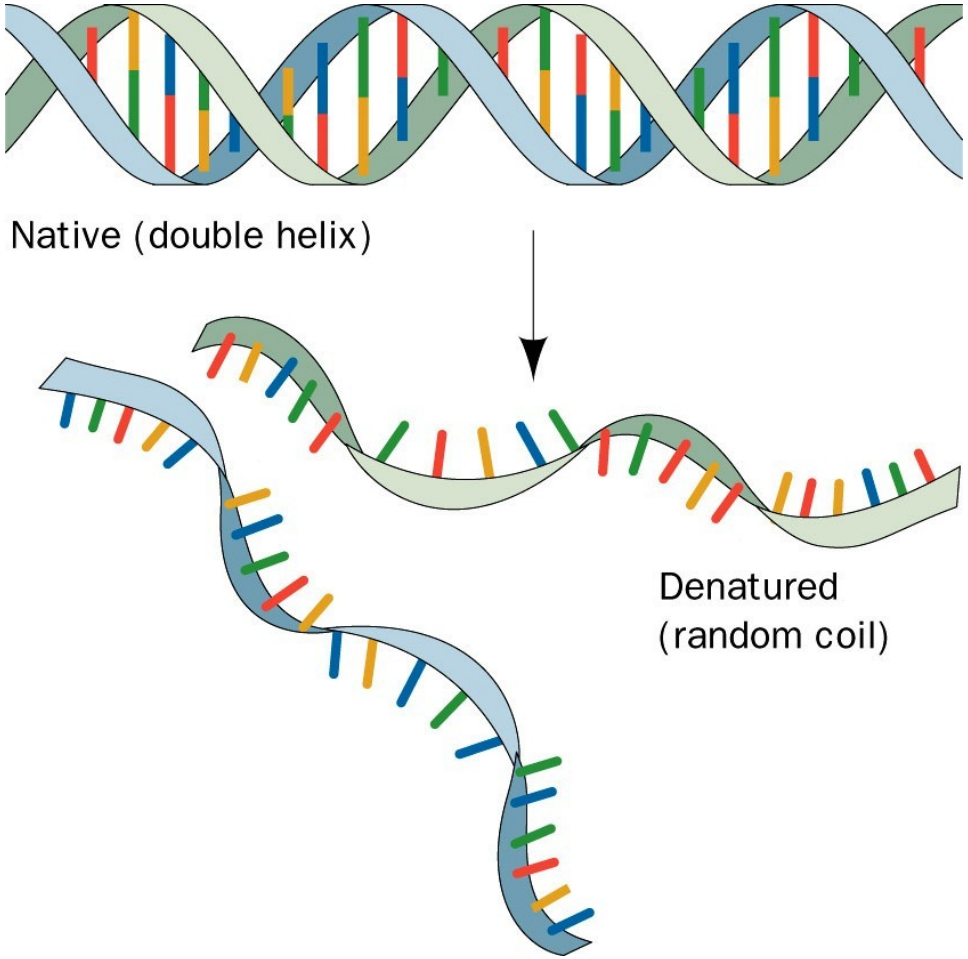
Stabilizující vazby v DNA



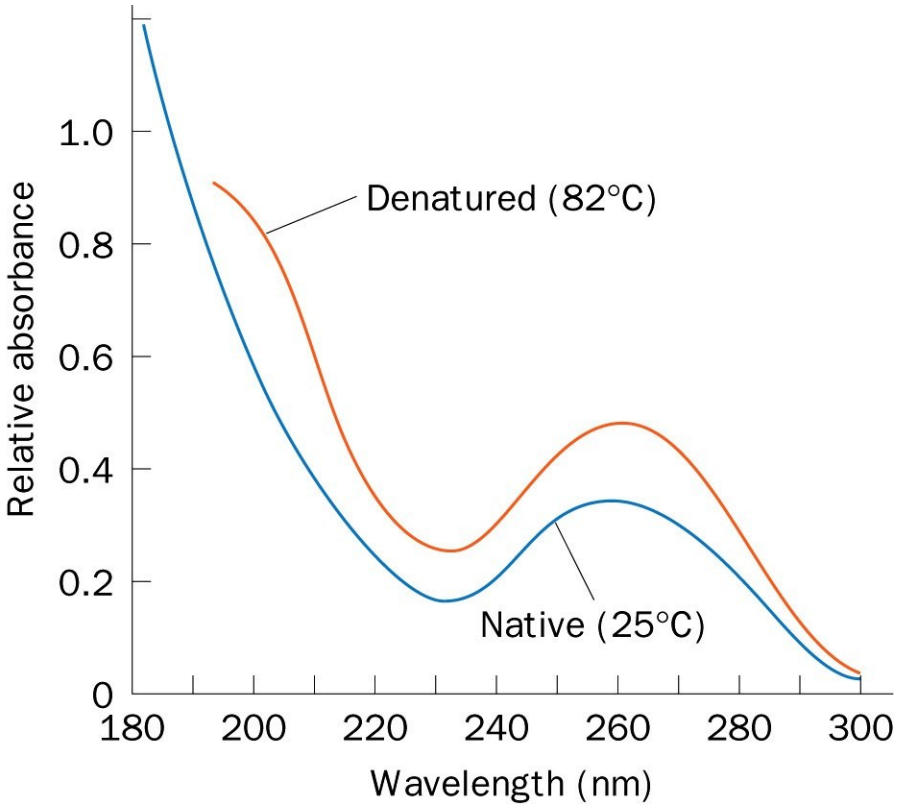
Stohování bází

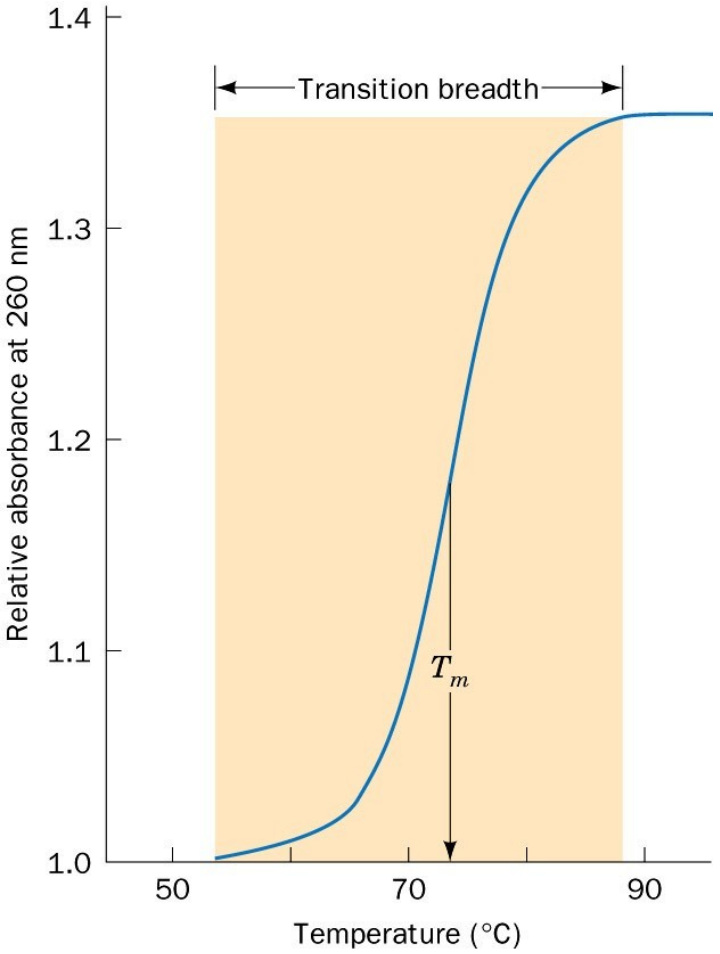


Denaturace - renaturace



Denaturace - renaturace

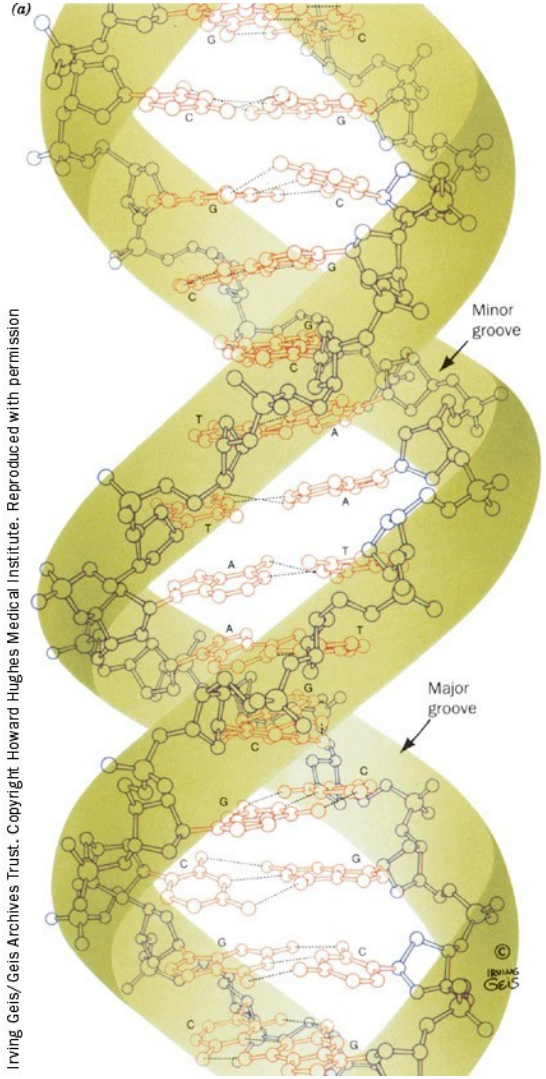


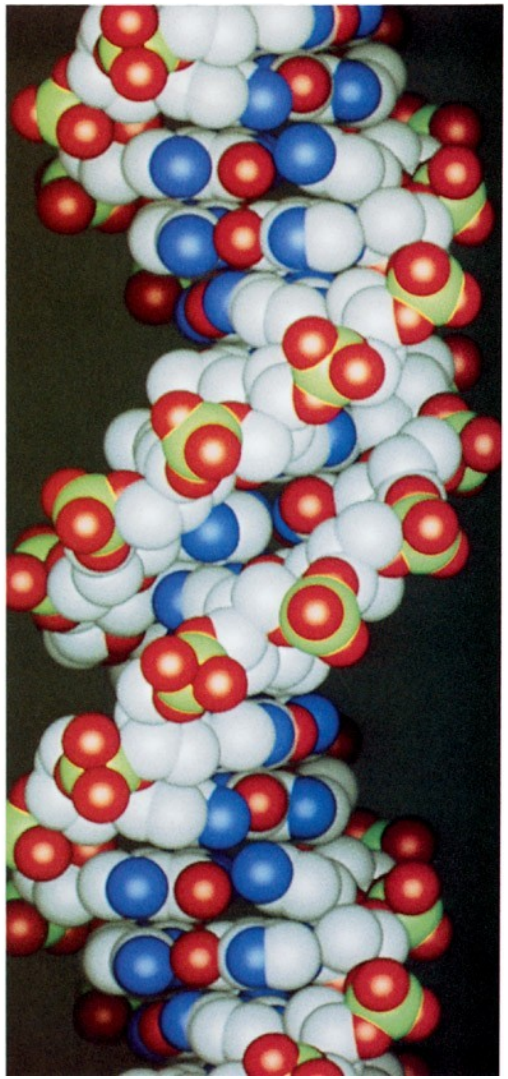


Formy DNA

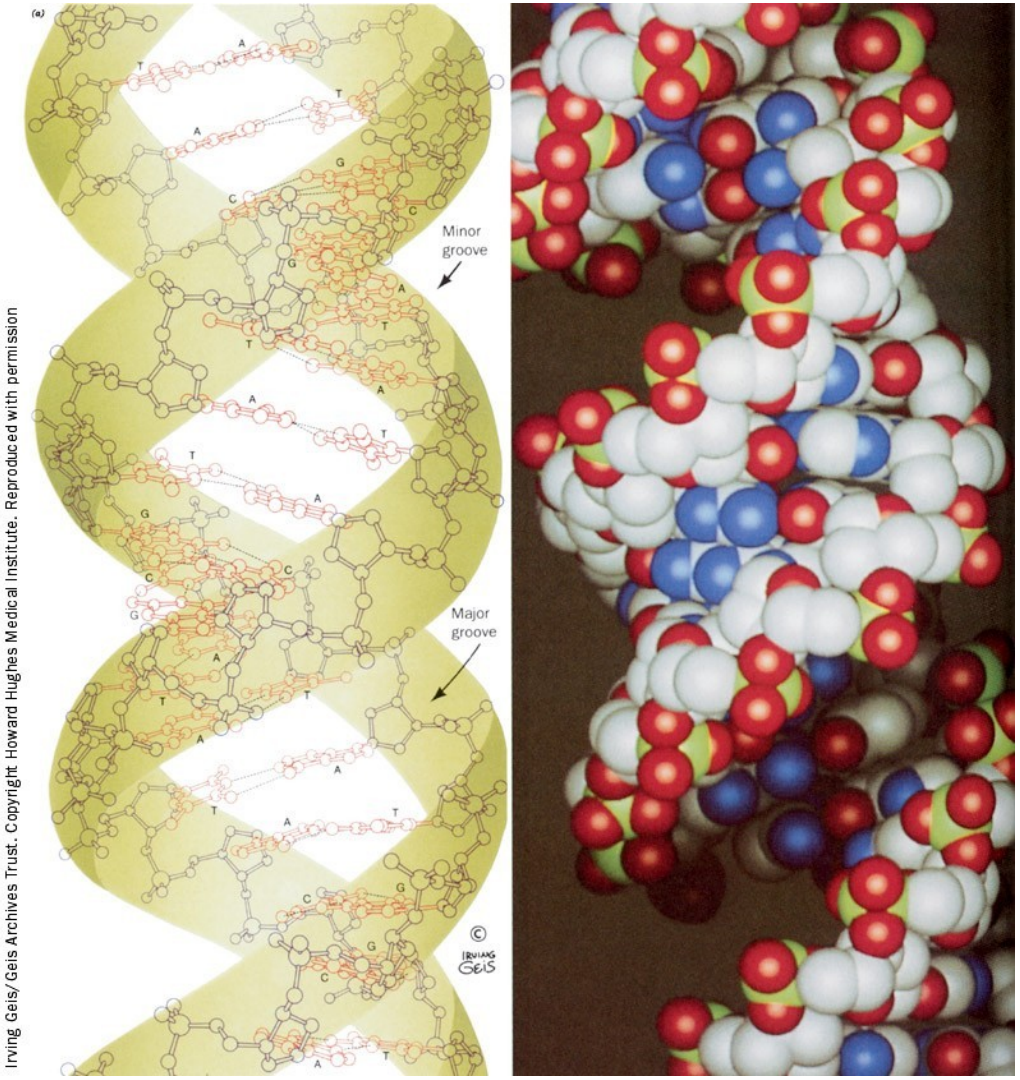
- B - DNA - nativní 92 % H_2O, Na^+
  pravotočivá - 10 párů bází na závit
- A - DNA - 75 % H_2O, rovina bází 20°
  pravotočivá - 11 párů bází na závit
- Z – DNA -d(CGCGCG)
  levotočivá - 12 párů bází na závit

B DNA

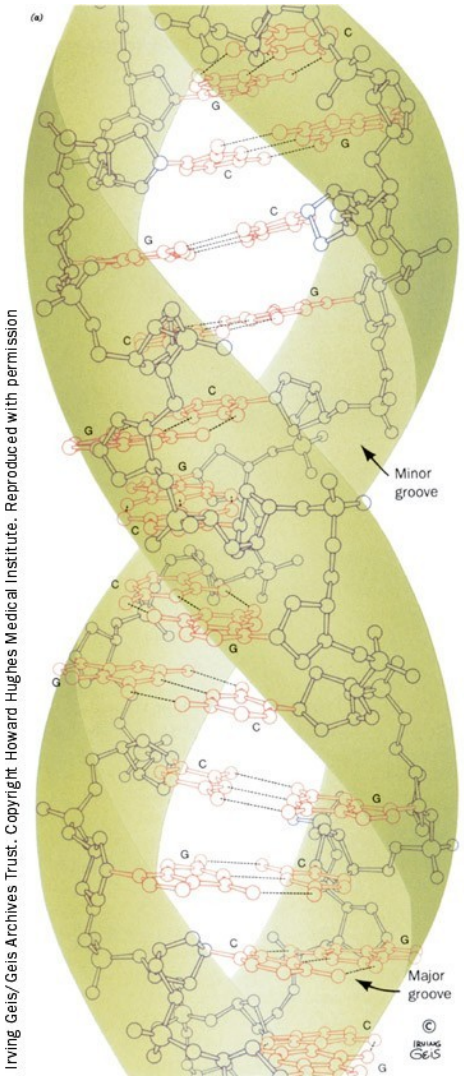

(a)
Minor groove
Major groove
Irving Geis/Geis Archives Trust. Copyright Howard Hughes Medical Institute. Reproduced with permission

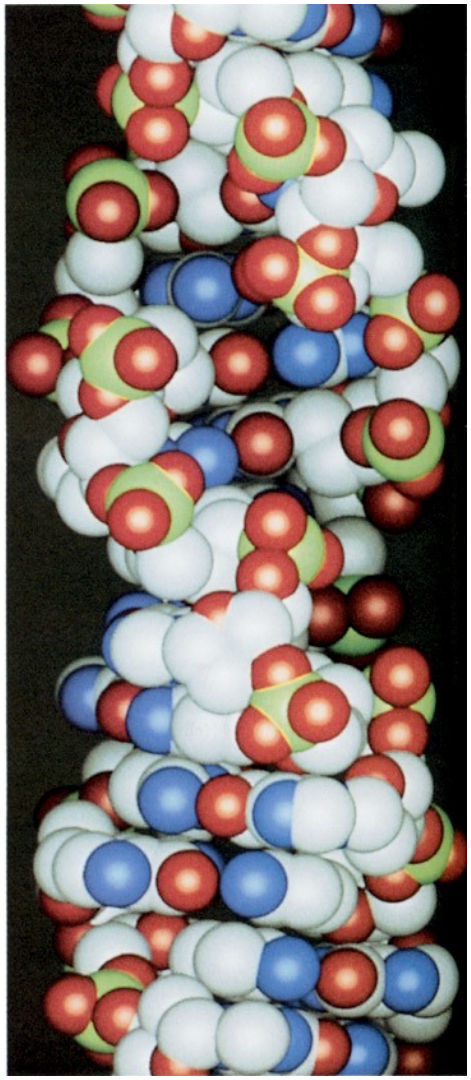


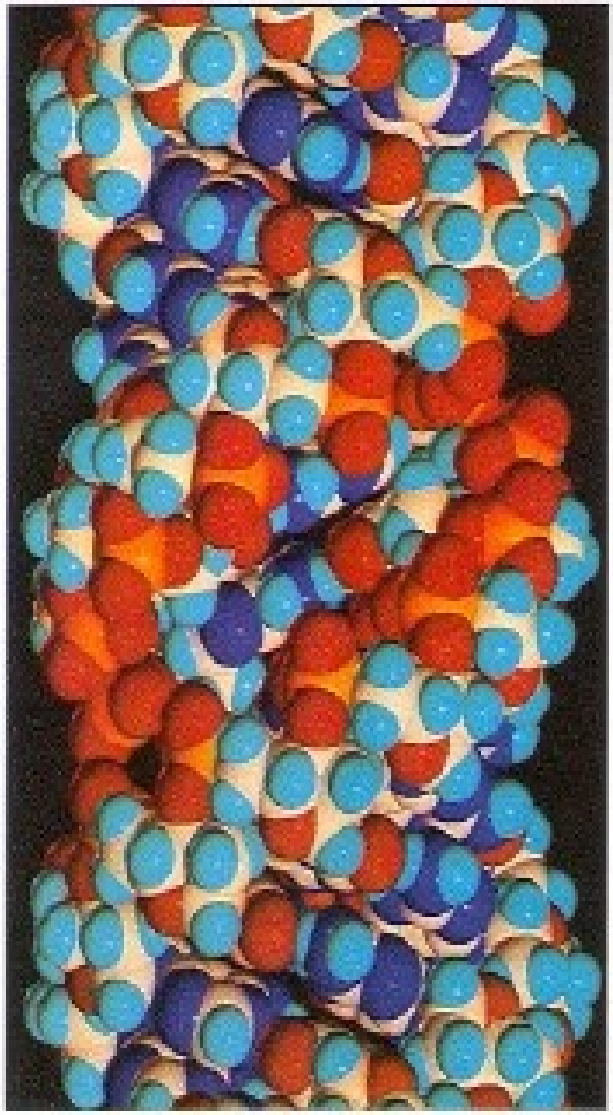
A DNA



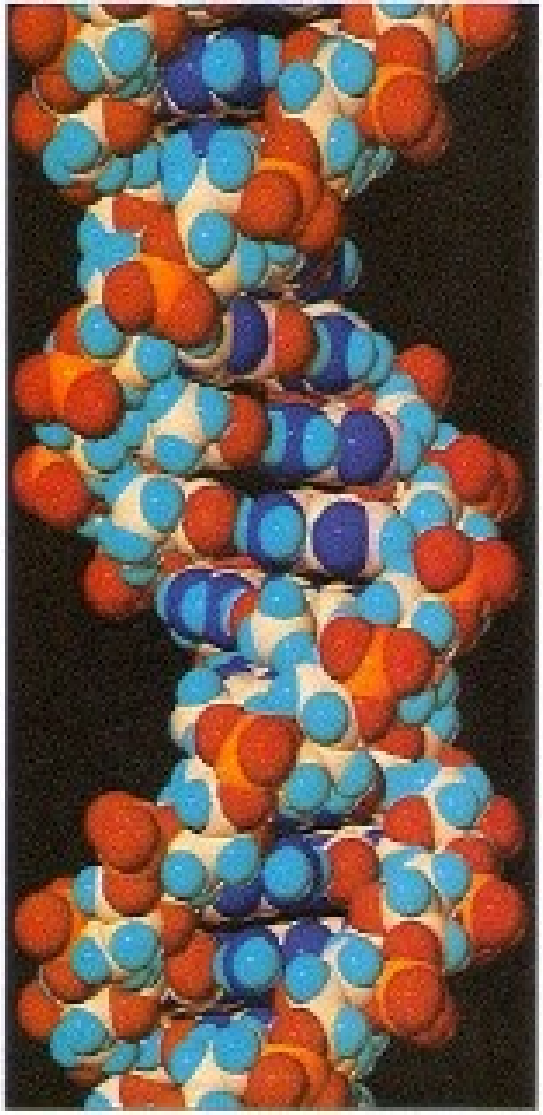
Z DNA



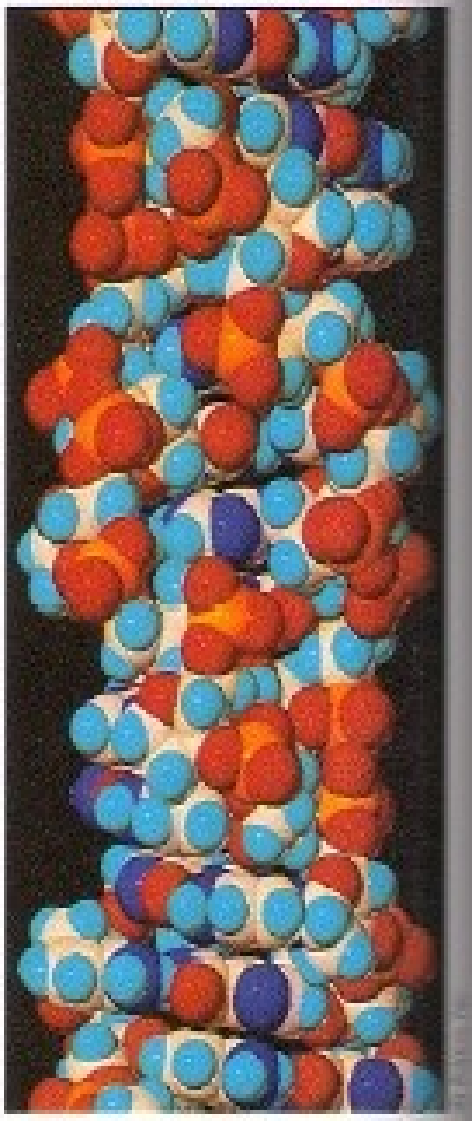




A-DNA

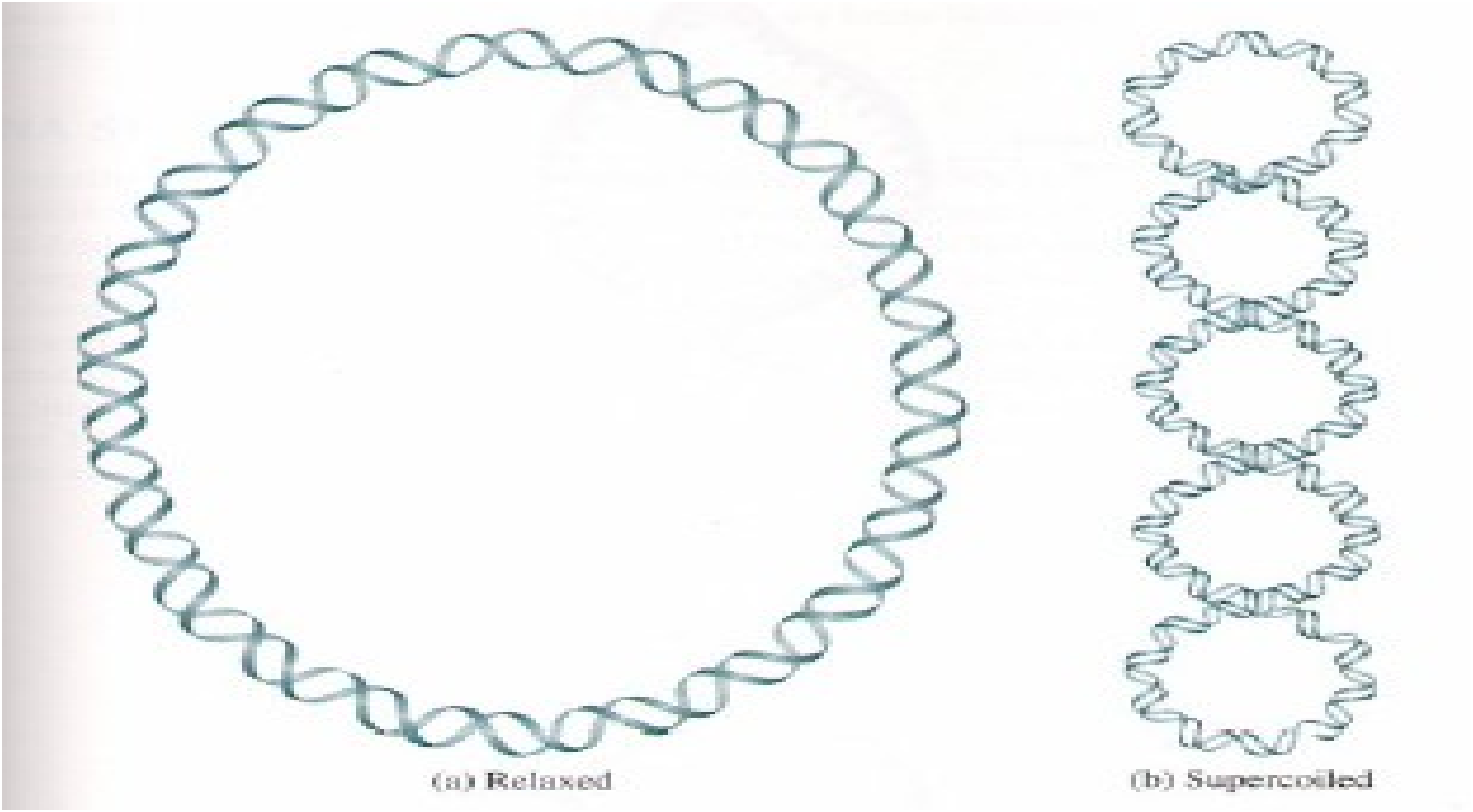


B-DNA

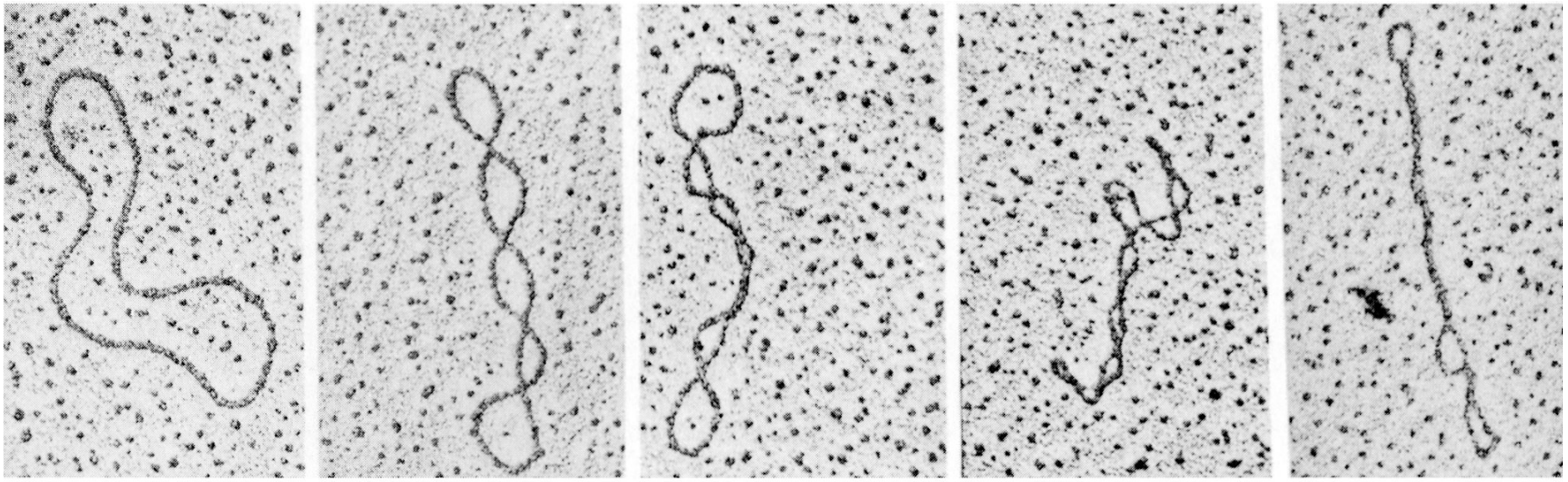


Z-DNA

Bakteriální DNA

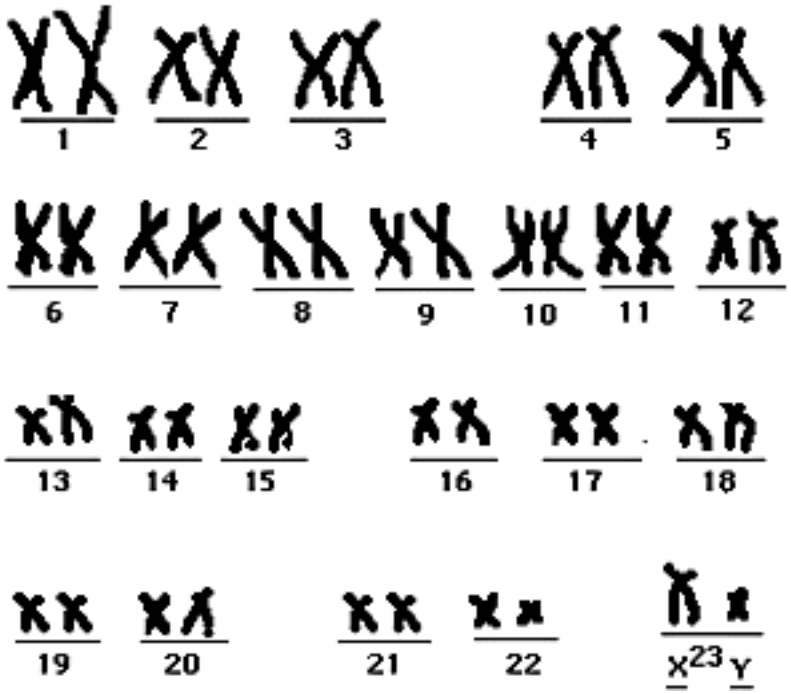


Bakteriální DNA

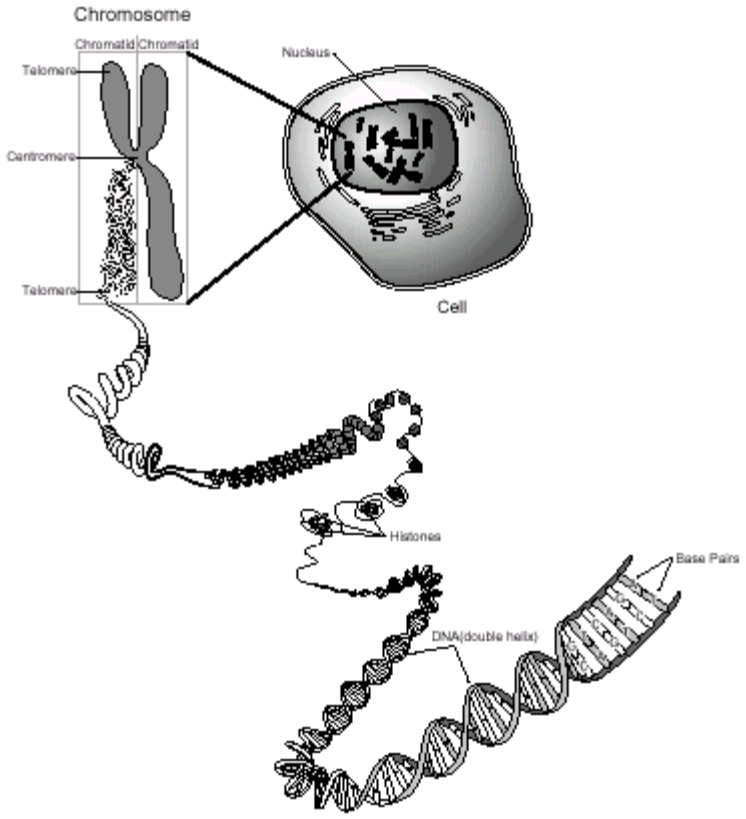


Electron micrographs by Laurien Polder. From Kornberg, A. and Baker, T.A., DNA Replication (2nd ed.), p. 36, W.H. Freeman (1992). Used with permission

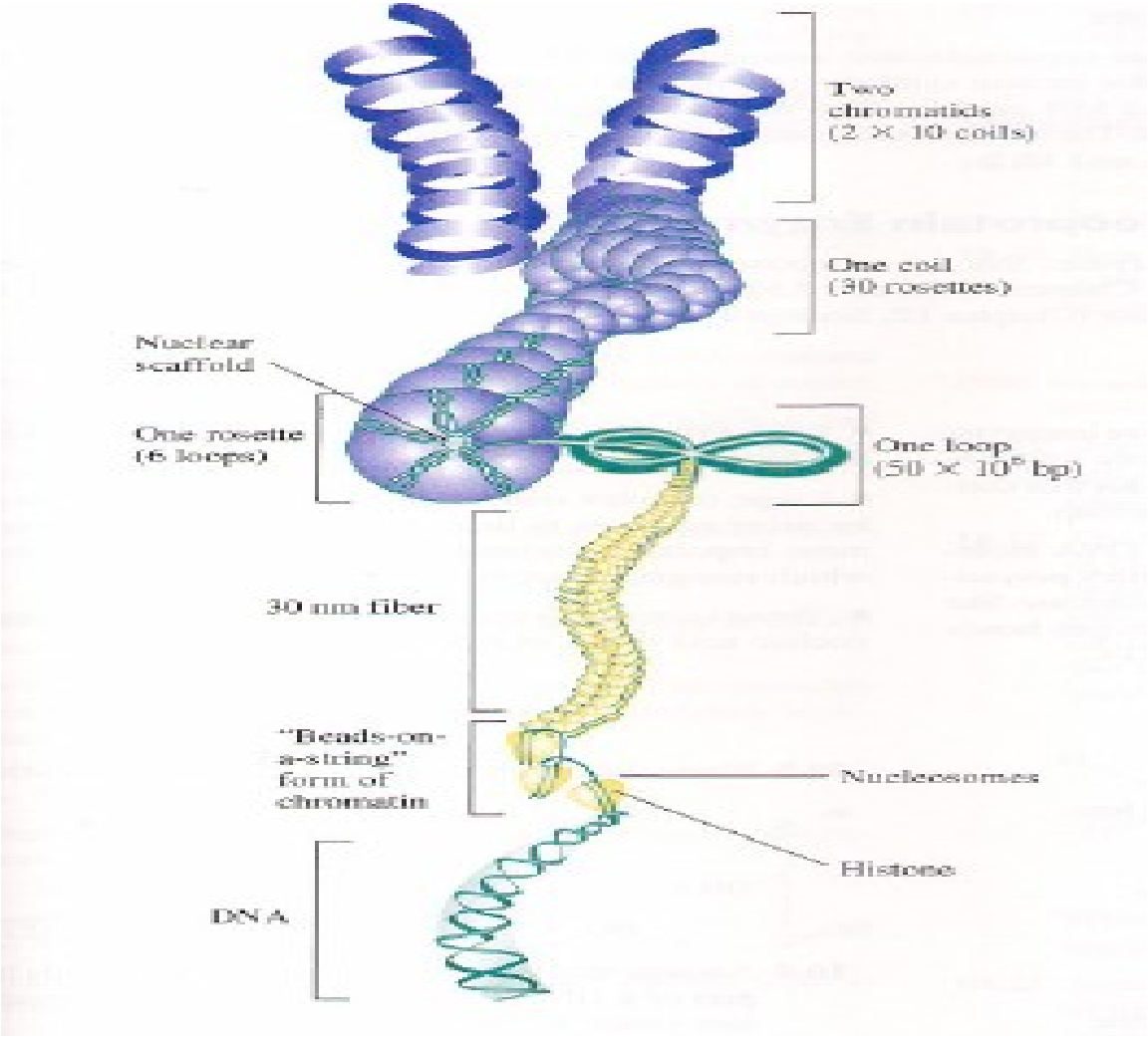
Lidské chromozomy



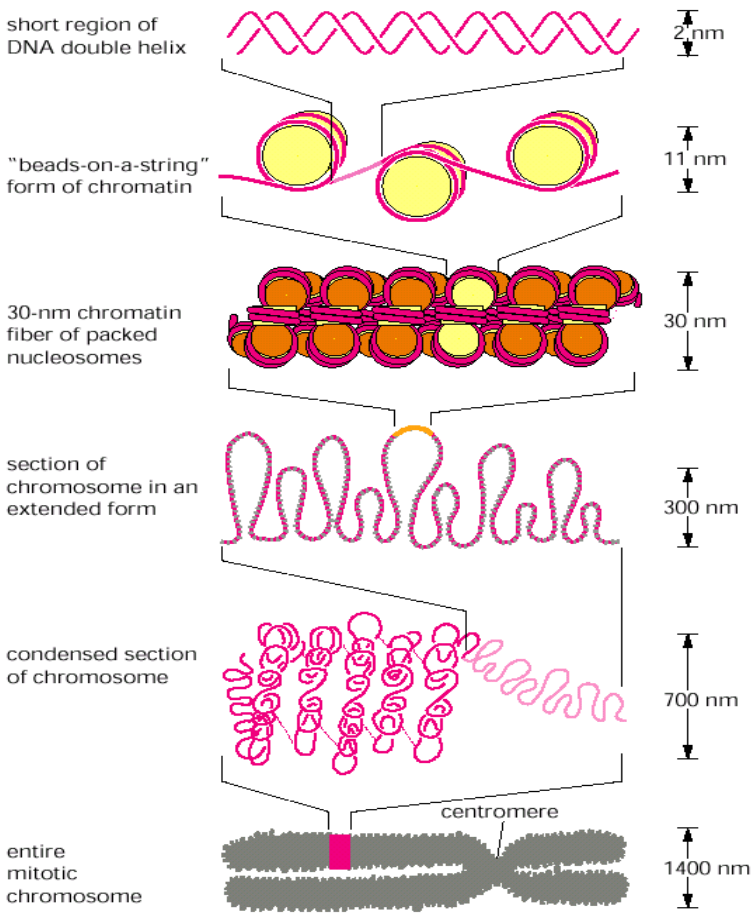
Chromozom


Chromosome
Chromatid
Chromatid
Telomere
Centromere
Telomere
Nucleus
Cell
Histones
Base Pairs
DNA(double helix)

Chromozom

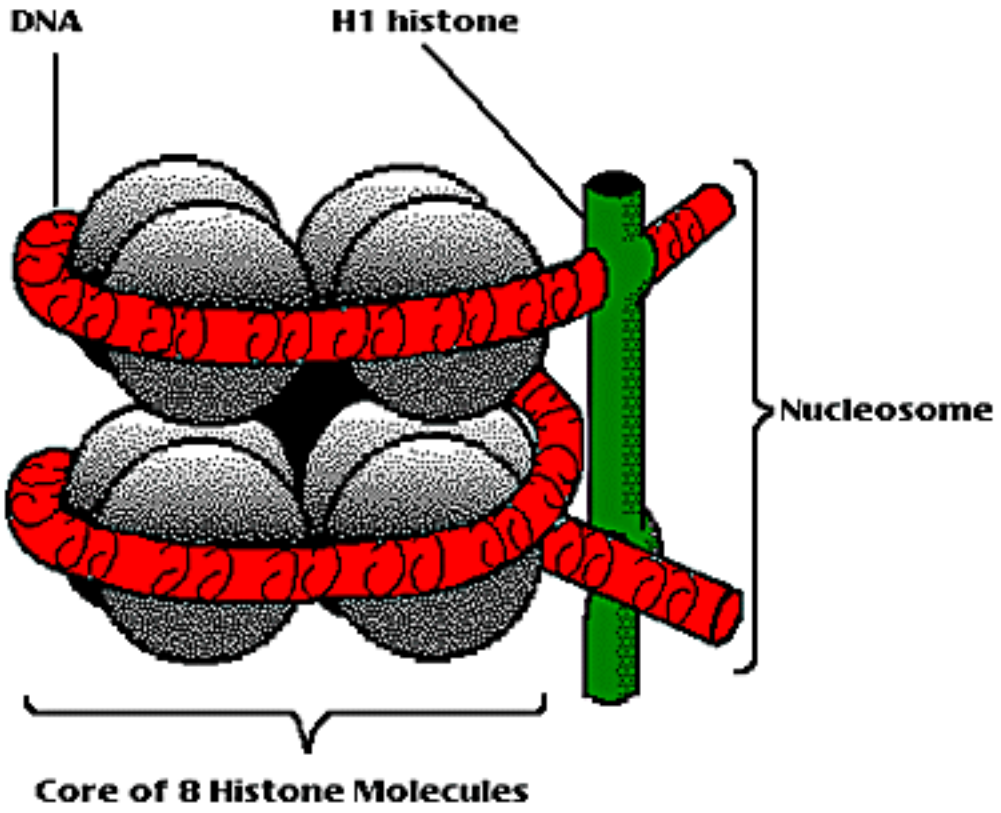

Two chromatids (2 × 10 coils)
One coil (30 rosettes)
Nuclear scaffold
One rosette (6 loops)
One loop (50 × 10³ bp)
30 nm fiber
"Beads-on-a-string" form of chromatin
Nucleosomes
Histone
DNA

Chromatin

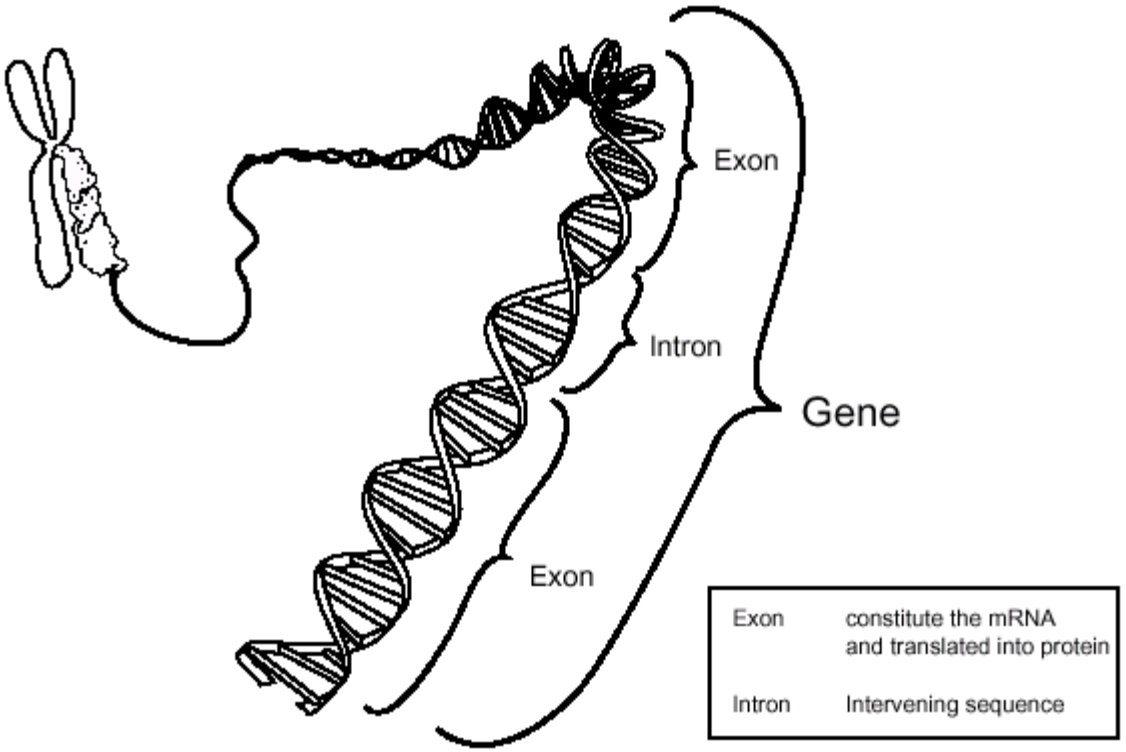


NET RESULT: EACH DNA MOLECULE HAS BEEN PACKAGED INTO A MITOTIC CHROMOSOME THAT IS 50,000x SHORTER THAN ITS EXTENDED LENGTH

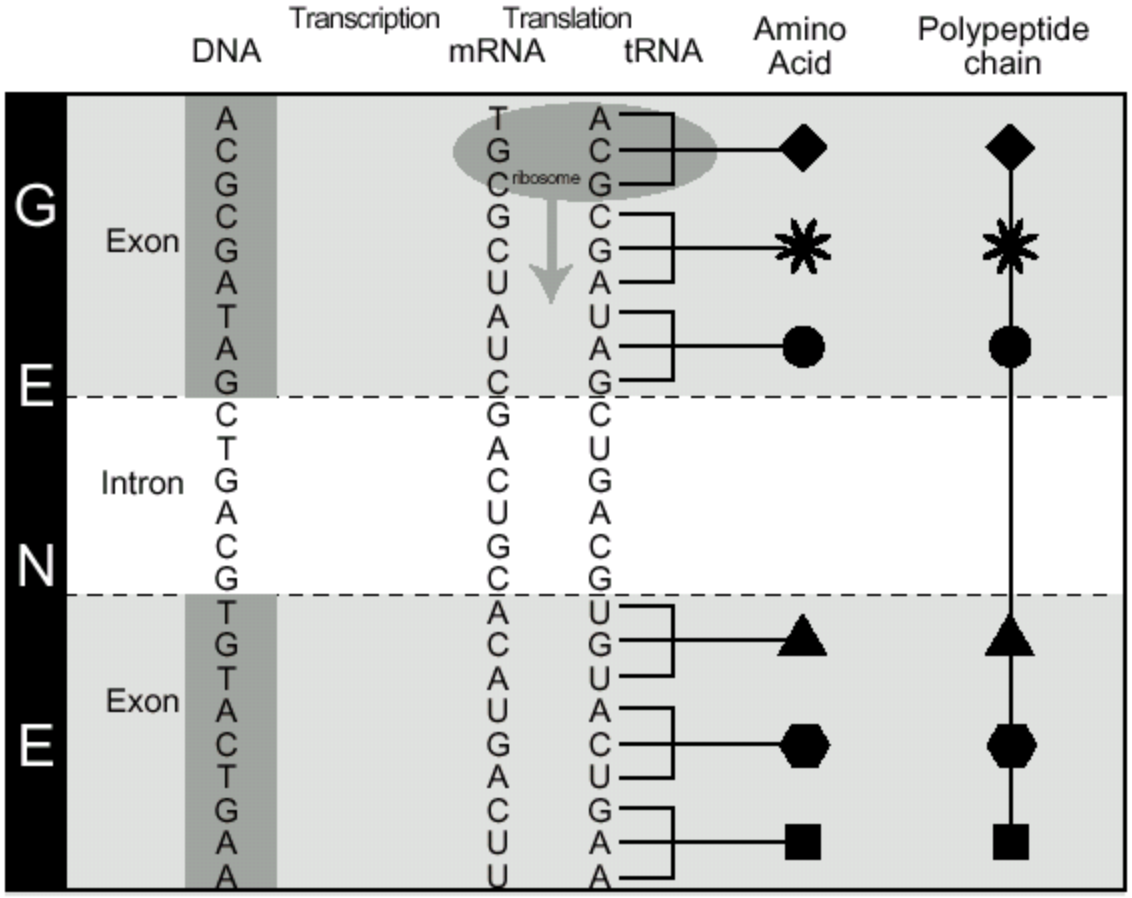
Nukleosom



Exon a intron



Exon a intron



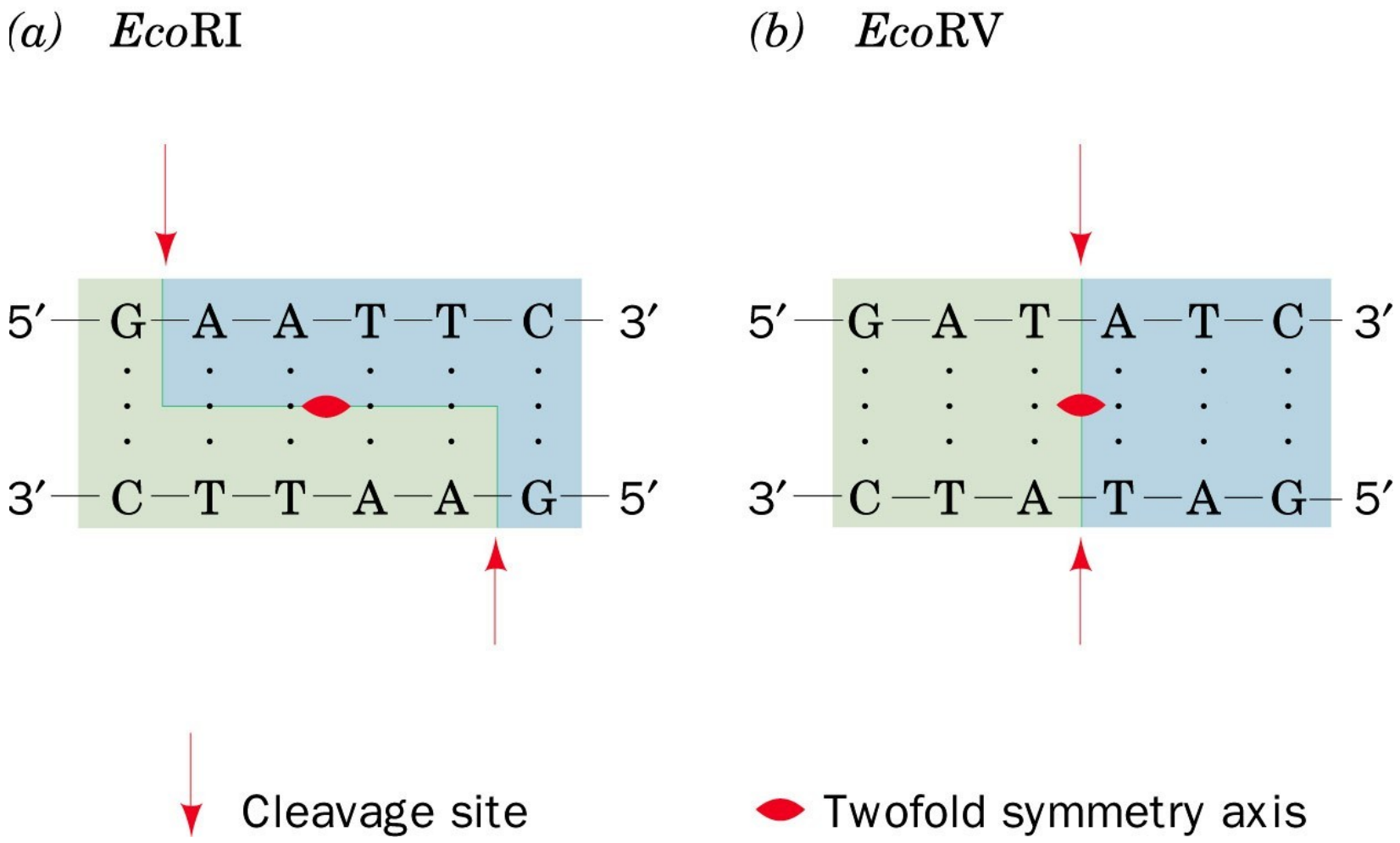
Stanovení sekvence DNA

- Restrikční enzymy
- Chemické štěpení – Maxam Gilbertovo metoda
- Enzymová metoda

Restrikční enzymy

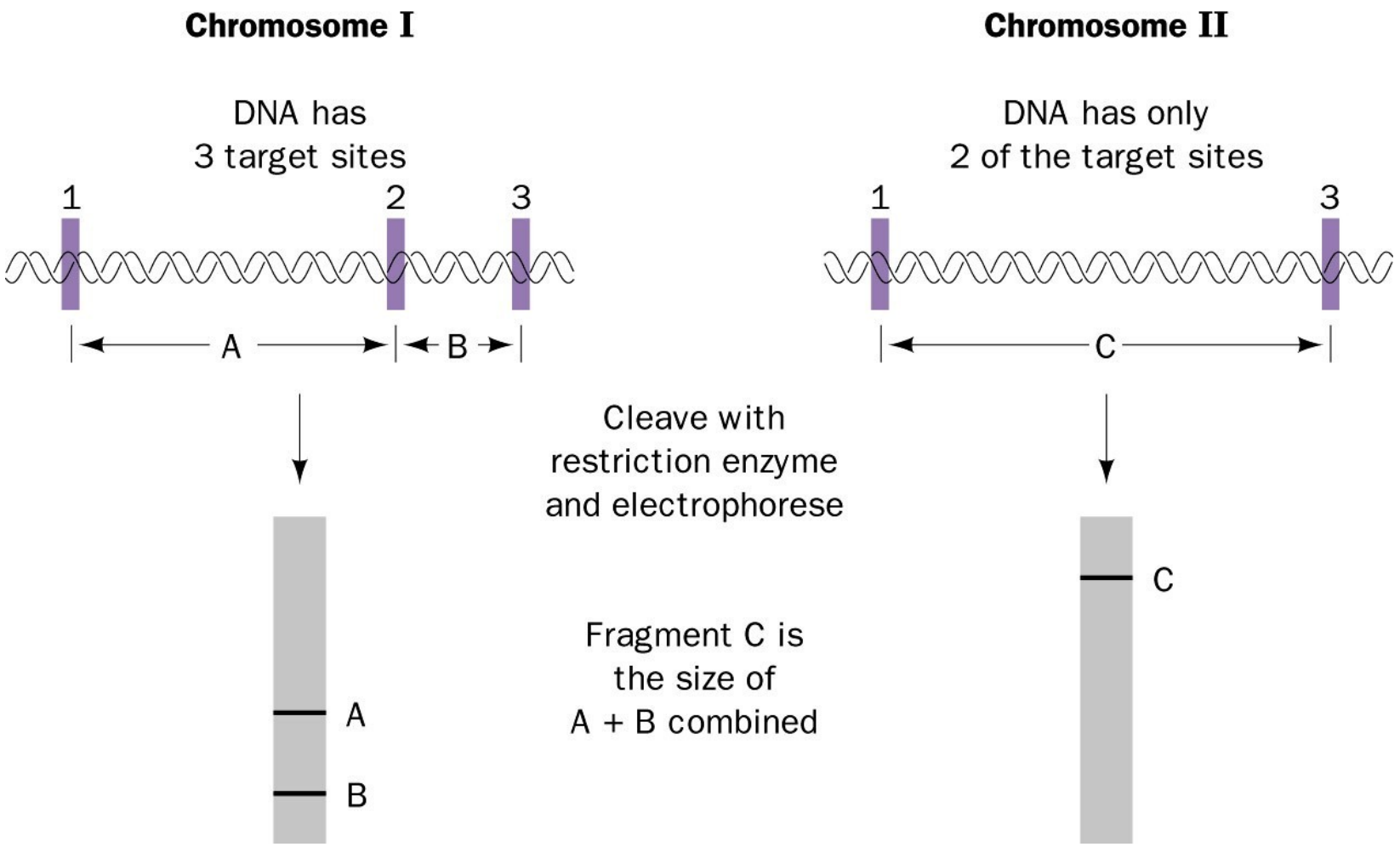
Enzyme	Recognition Sequence*	Microorganism
*Alu*I	AG↓C*T	*Arthrobacter luteus*
*Bam*HI	G↓GATC*C	*Bacillus amyloliquefaciens* H
*Bgl*I	GCCNNNN↓NGCC	*Bacillus globigii*
*Bgl*II	A↓GATCT	*Bacillus globigii*
*Eco*RI	G↓AA*TTC	*Escherichia coli* RY13
*Eco*RII	↓CC*(N)GG	*Escherichia coli* R245
*Eco*RV	GA*T↓ATC	*Escherichia coli* J62 pLG74
*Hae*II	RGCGC↓Y	*Haemophilus aegyptius*
*Hae*III	GG↓C*C	*Haemophilus aegyptius*
*Hin*dIII	A*↓AGCTT	*Haemophilus influenzae* R_d
*Hpa*II	C↓C*GG	*Haemophilus parainfluenzae*
*Msp*I	C*↓CGG	*Moraxella* species
*Pst*I	CTGCA*↓G	*Providencia stuartii* 164
*Pvu*II	CAG↓C*TG	*Proteus vulgaris*
*Sal*I	G↓TCGAC	*Streptomyces albus* G
*Taq*I	T↓CGA*	*Thermus aquaticus*
*Xho*I	C↓TCGAG	*Xanthomonas holcicola*

Restrikční enzymy



Restrikční enzymy

Restrikční enzymy



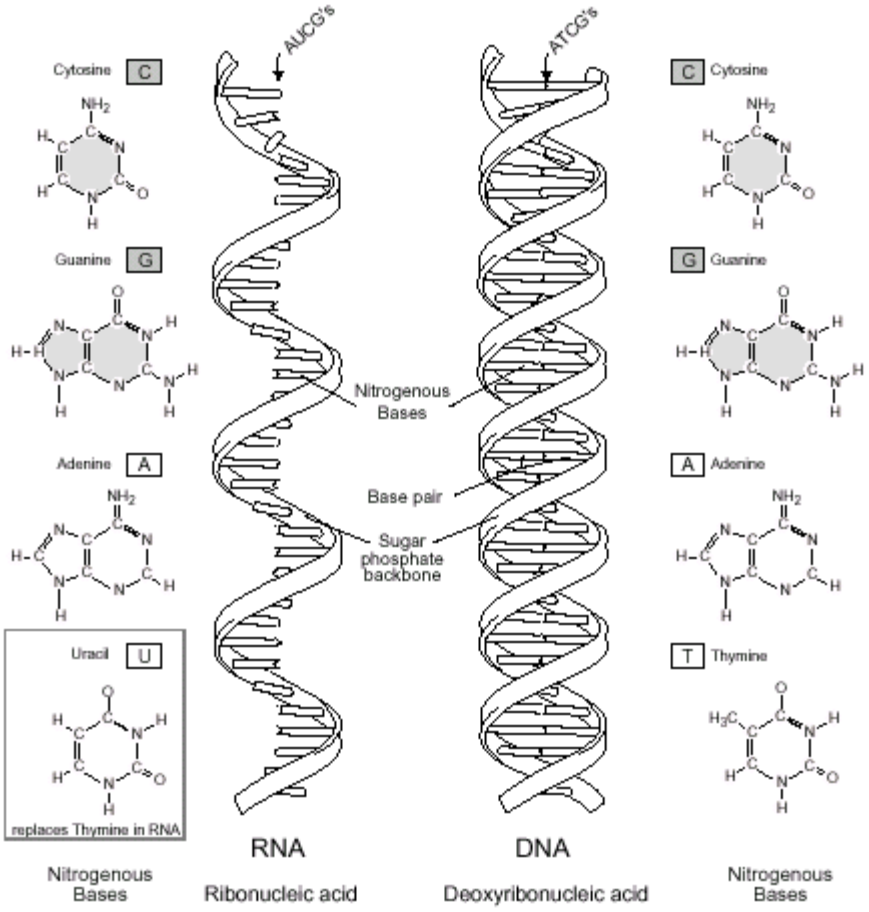
Maxam Gilbertova metoda

Maxam-Gilbertova metoda

- značení 5´konce ^{32}P
- specifické chemické štěpení
- elektroforéza

Maxam Gilbertova metoda

RNA versus DNA



Formy RNA

- mRNA – mediátorová, messenger,

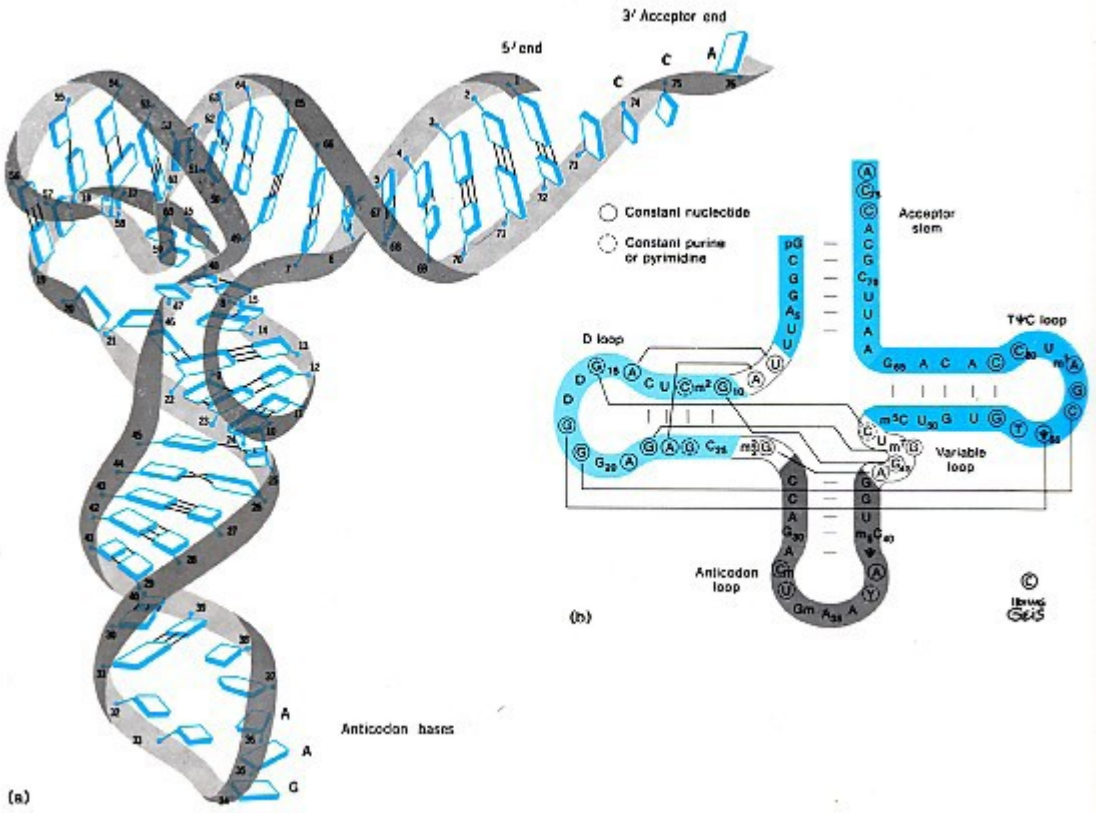
  informační – 5-10 %r

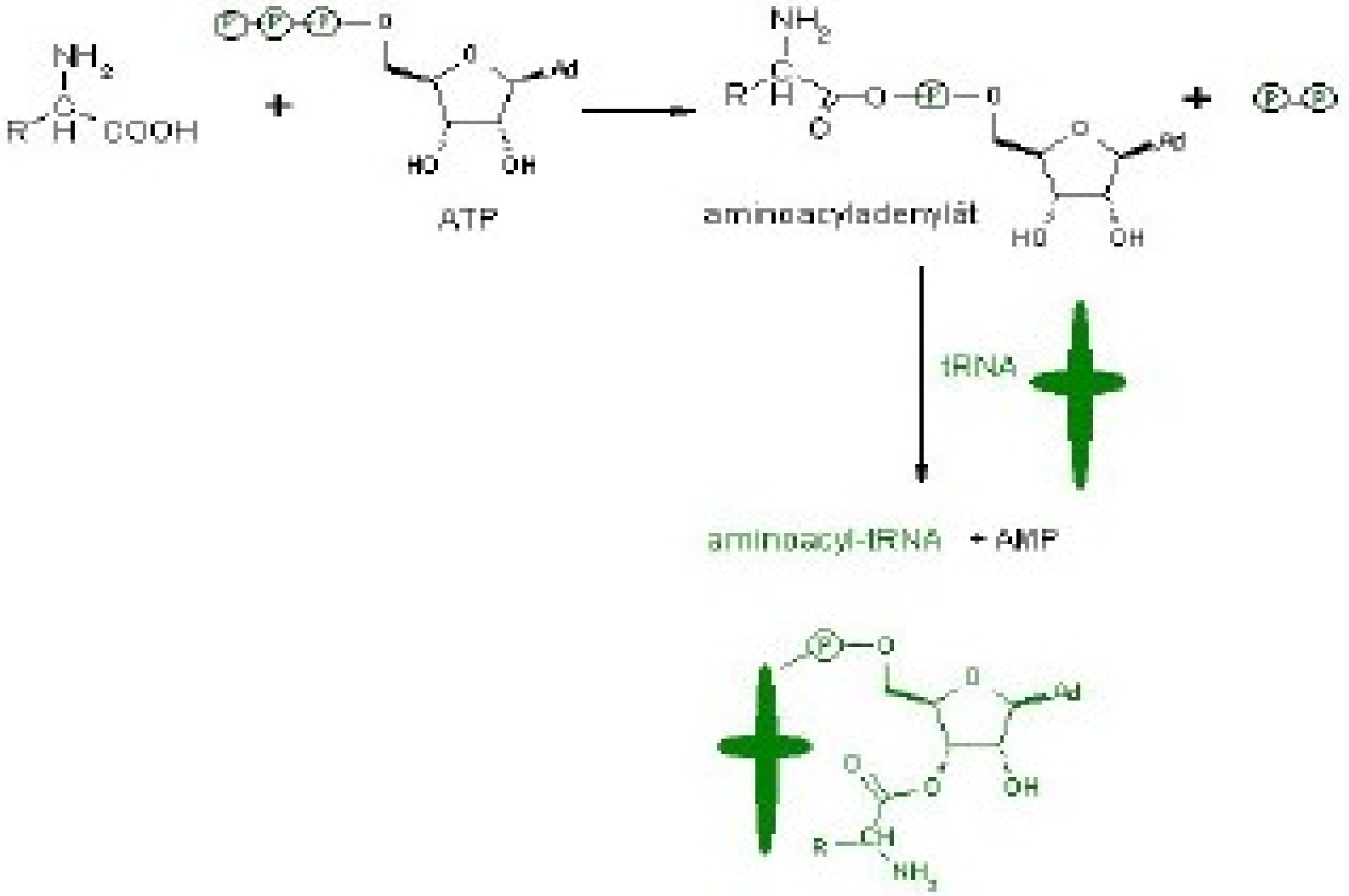
- RNA – ribosomální – 80 %

- tRNA – transferová, přenosová – 10-15 %

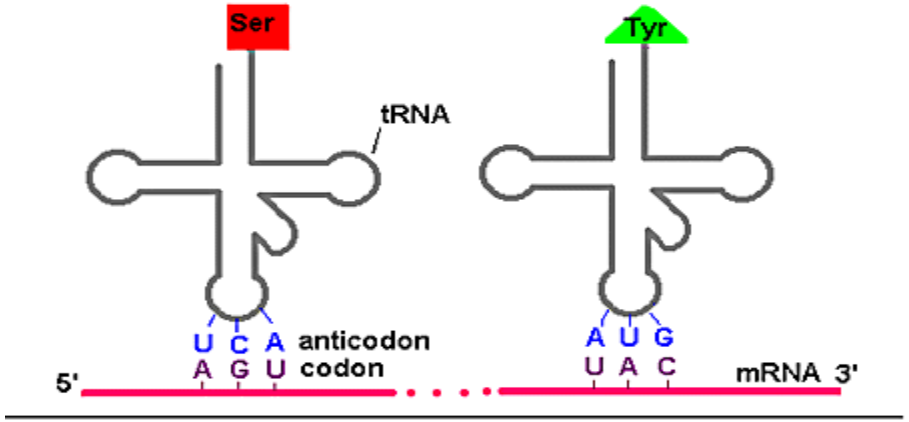
  60 tRNA

tRNA


3′ Acceptor end
5′ end
Constant nucleotide
Constant purine or pyrimidine
Acceptor stem
TψC loop
D loop
Variable loop
Anticodon loop
Anticodon bases
(a)
(b)


NH2
R
H
COOH
HO
OH
Ad
ATP
aminoacyladenylat
tRNA
aminoacyl-tRNA + AMP

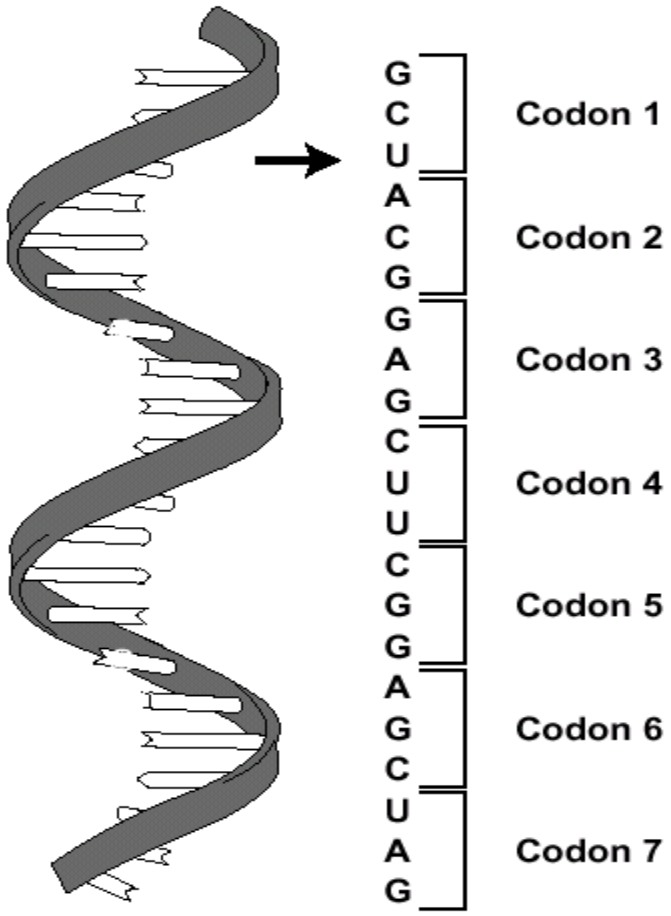
Genetický kod

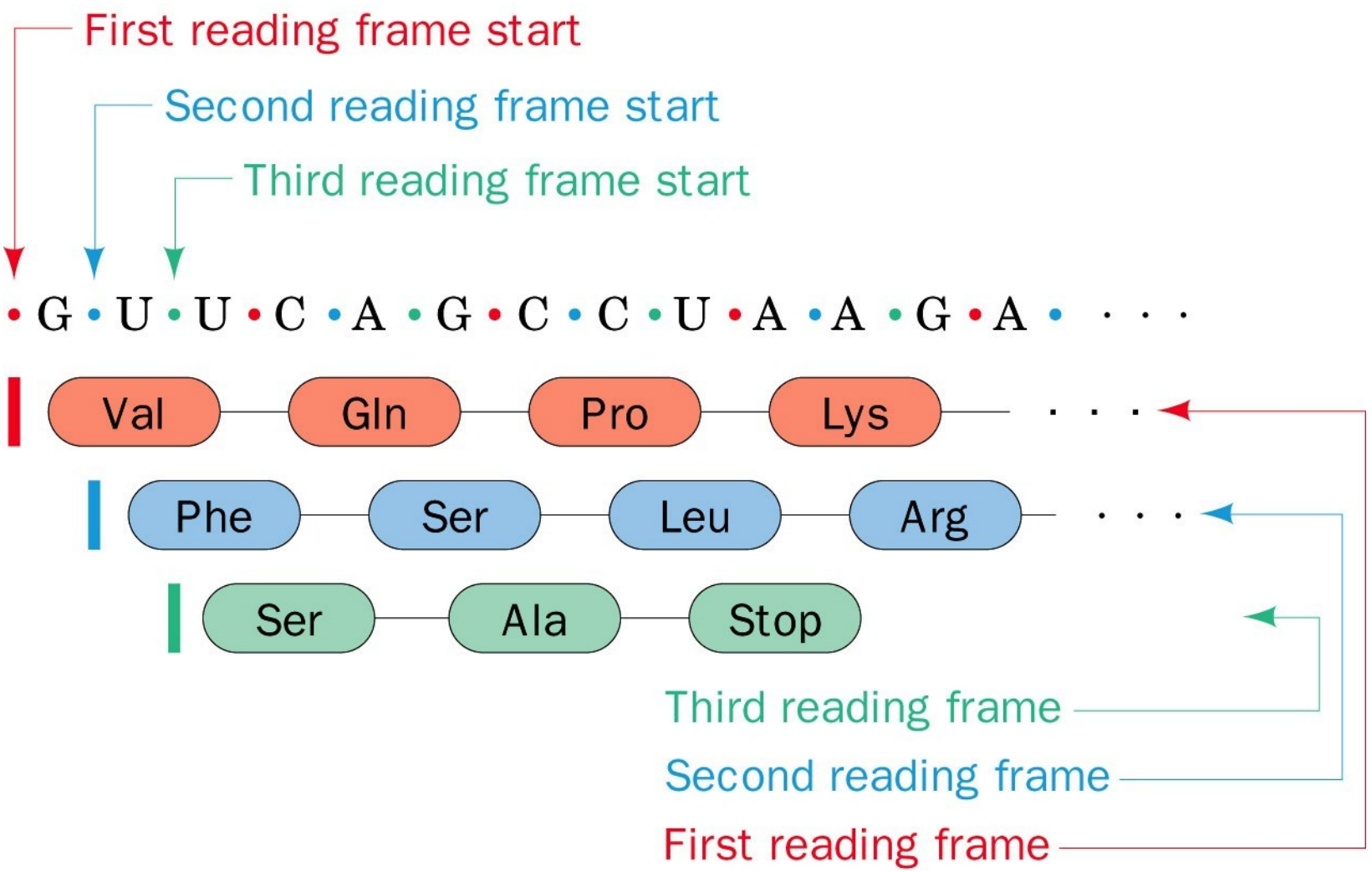


2nd base in codon

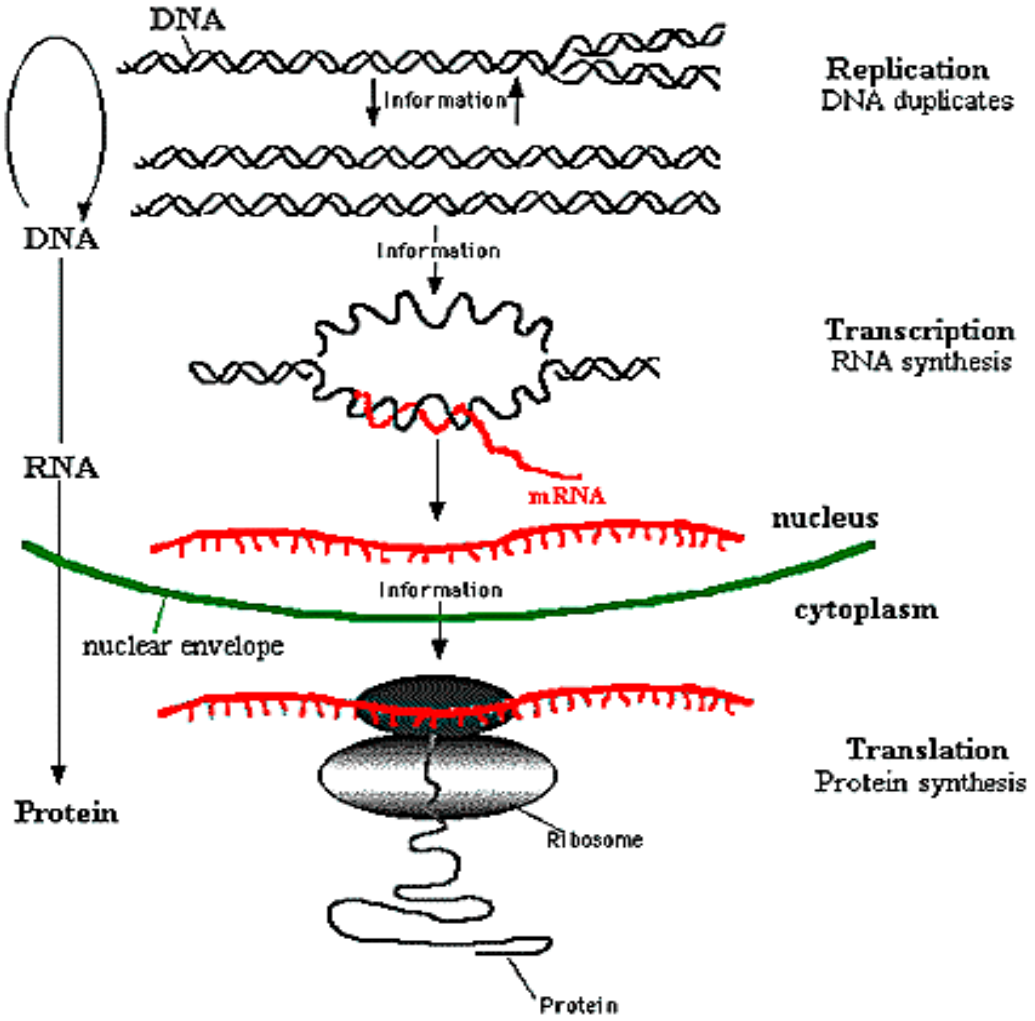
1st base in codon	U	C	A	G	3rd base in codon
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	STOP	STOP	A
	Leu	Ser	STOP	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val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

Kodón

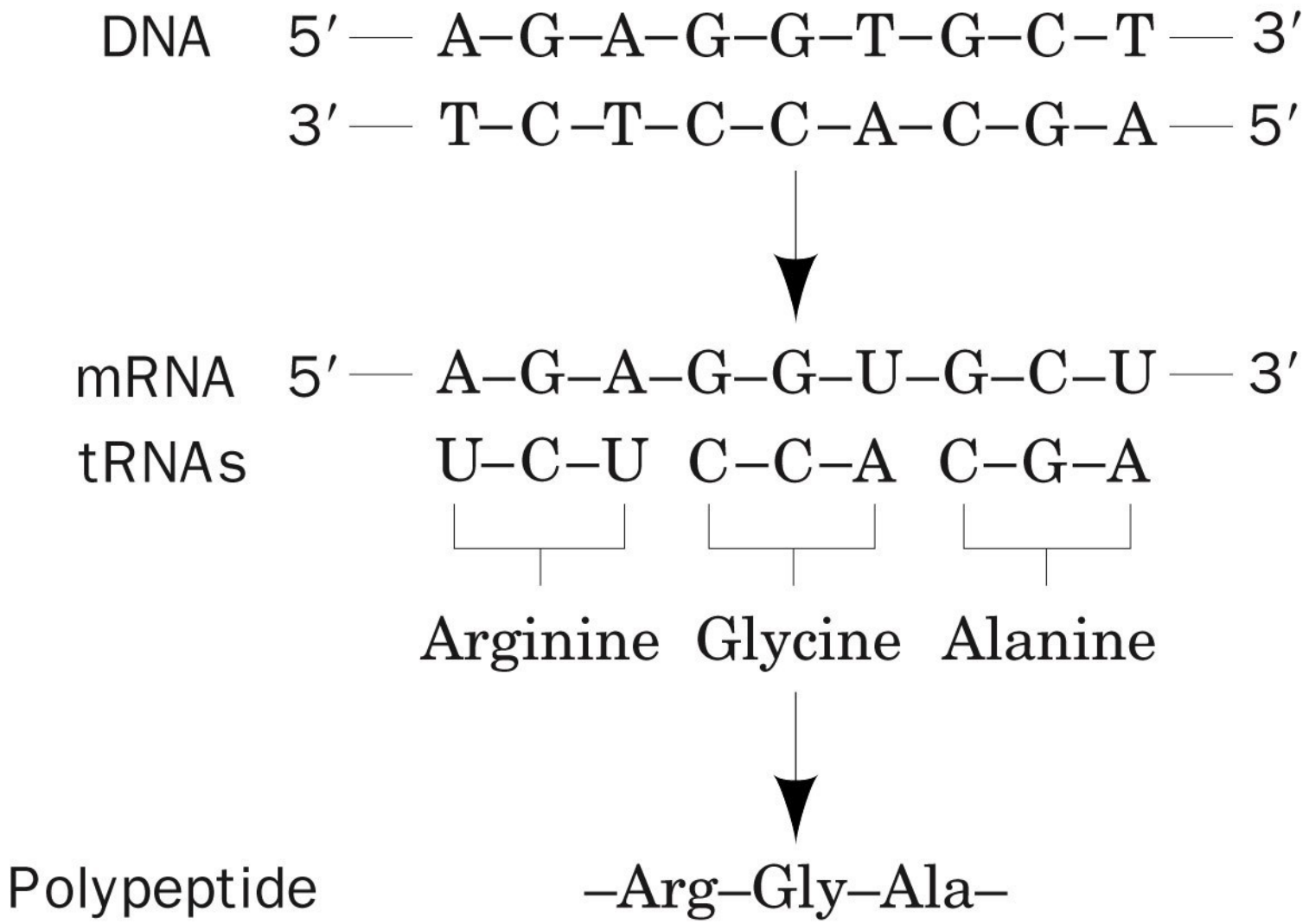

G
C
U
Codon 1
A
C
G
Codon 2
G
A
G
Codon 3
C
U
U
Codon 4
C
G
G
Codon 5
A
G
C
Codon 6
U
A
G
Codon 7


First reading frame start
Second reading frame start
Third reading frame start
• G • U • U • C • A • G • C • C • U • A • A • G • A • . . .
Val
Gln
Pro
Lys
. . .
Phe
Ser
Leu
Arg
. . .
Ser
Ala
Stop
Third reading frame
Second reading frame
First reading frame

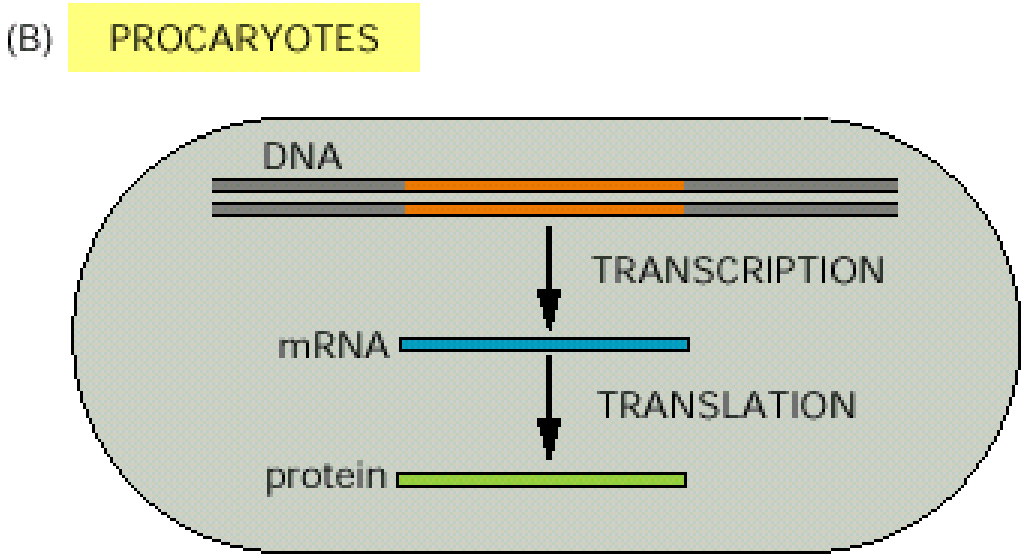
Centrální dogma mol.biologie



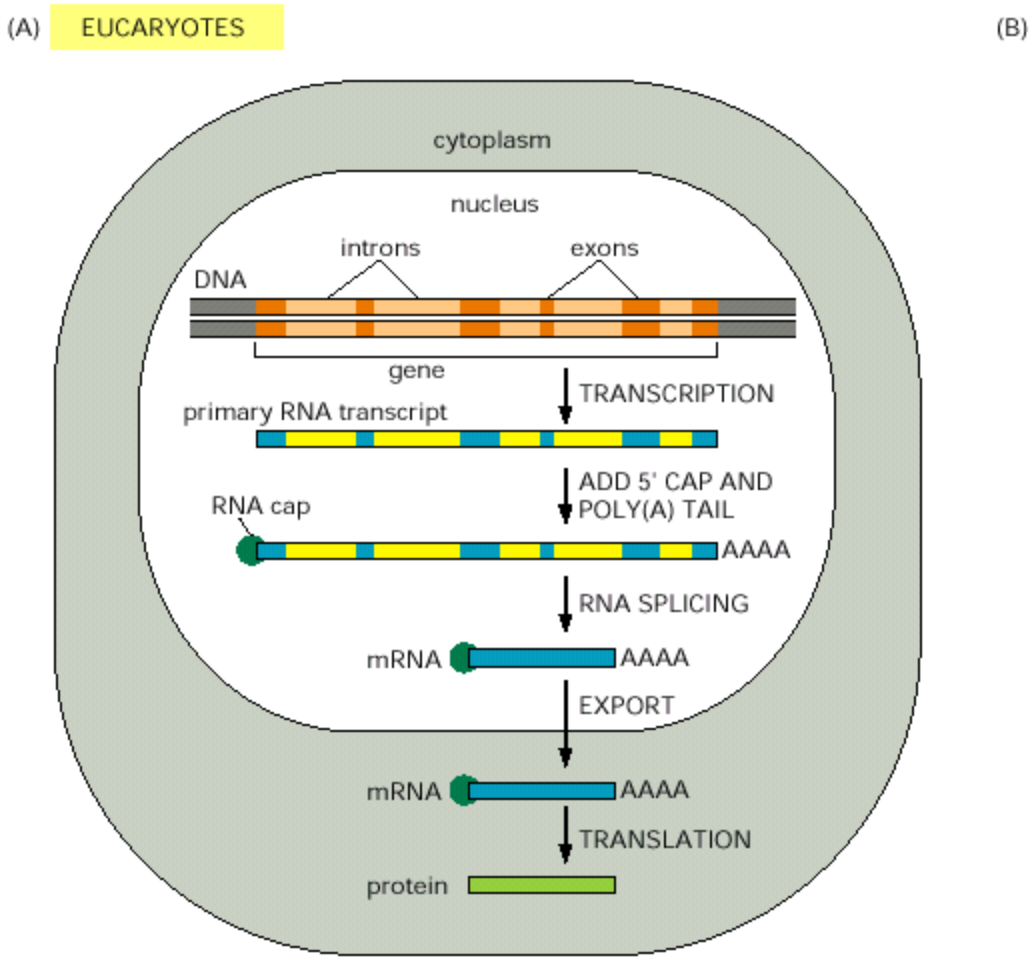
Centrální dogma mol.biologie



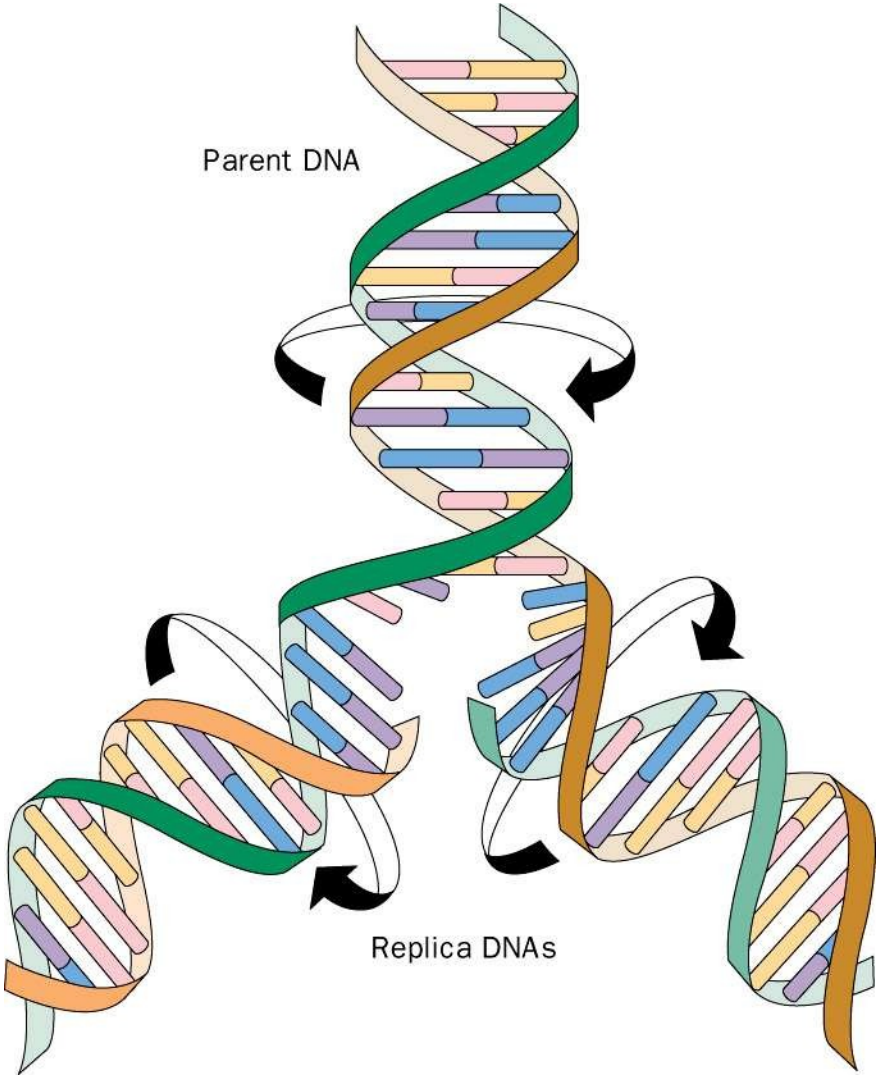
Prokaryota


(B)
PROCARYOTES
DNA
TRANSCRIPTION
mRNA
TRANSLATION
protein

Eukaryota


(A)
EUCARYOTES
(B)
cytoplasm
nucleus
introns
exons
DNA
gene
TRANSCRIPTION
primary RNA transcript
ADD 5' CAP AND
POLY(A) TAIL
RNA cap
AAAA
RNA SPLICING
mRNA
AAAA
EXPORT
mRNA
AAAA
TRANSLATION
protein

Replikace DNA



Replikace DNA

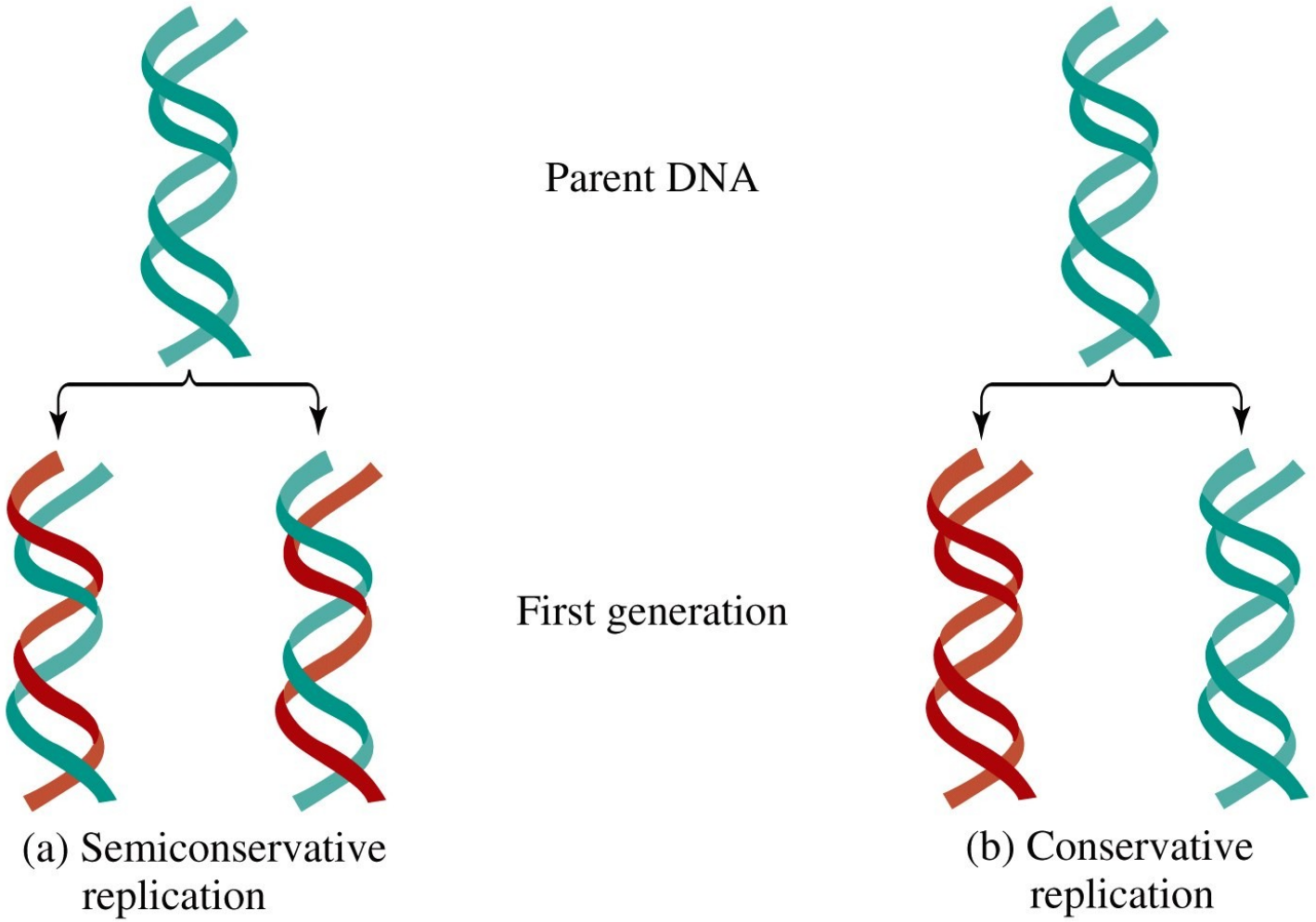


Figure 11-1 Concepts in Biochemistry, 3/e

Meselsonův a Stahlův experiment

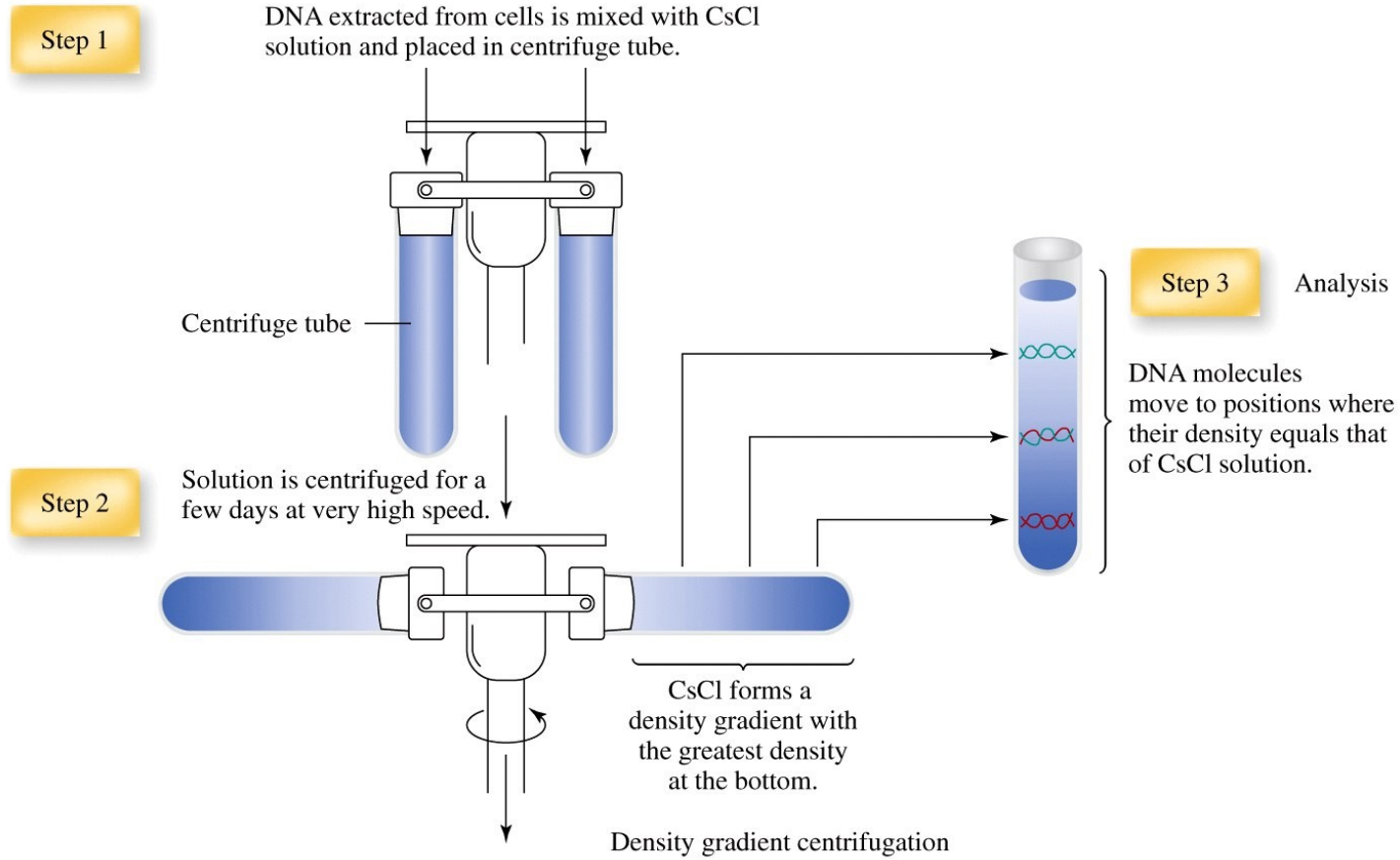
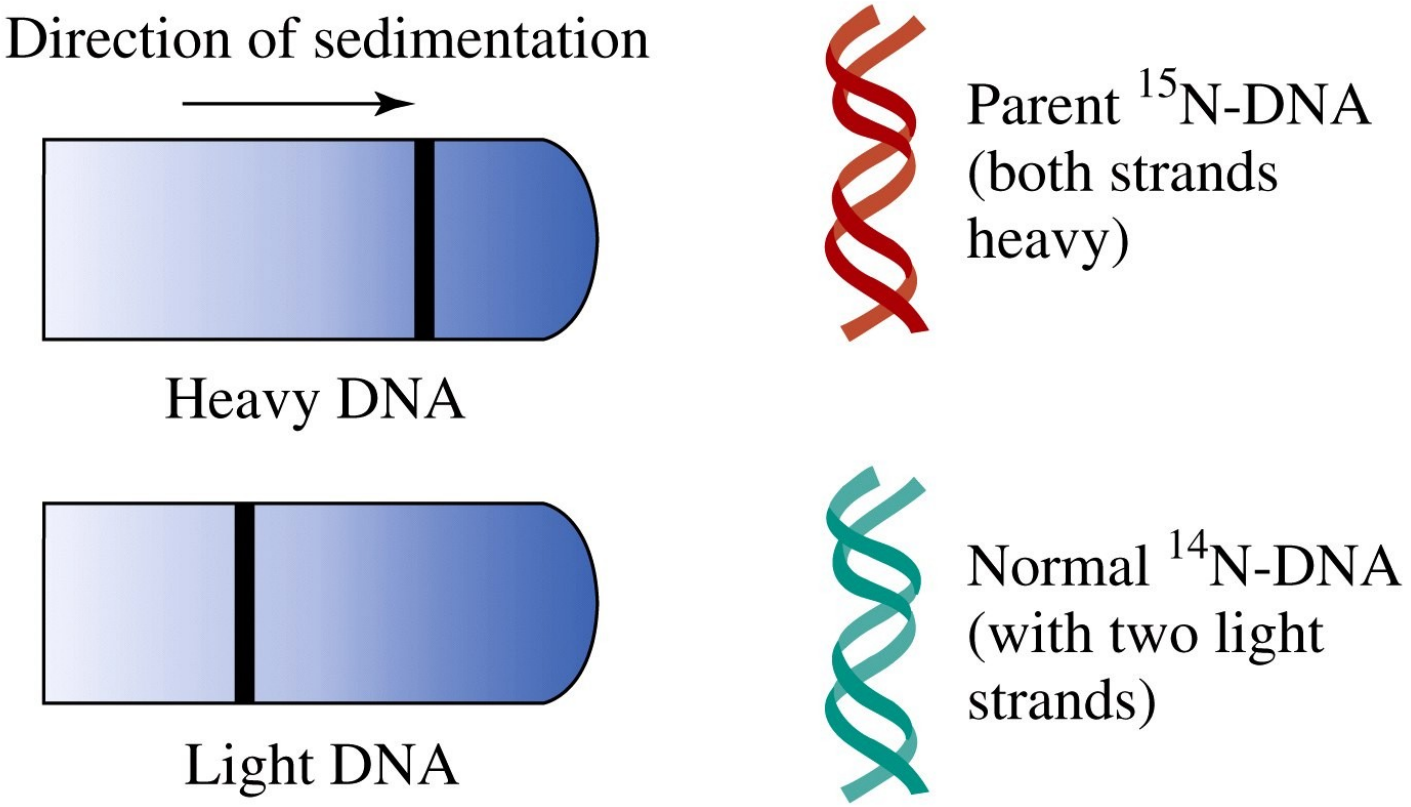


Figure 11-2a Concepts in Biochemistry, 3/e

Meselsonův a Stahlův experiment



Preliminary experiment

Figure 11-2b Concepts in Biochemistry, 3/e

Meselsonův a Stahlův experiment

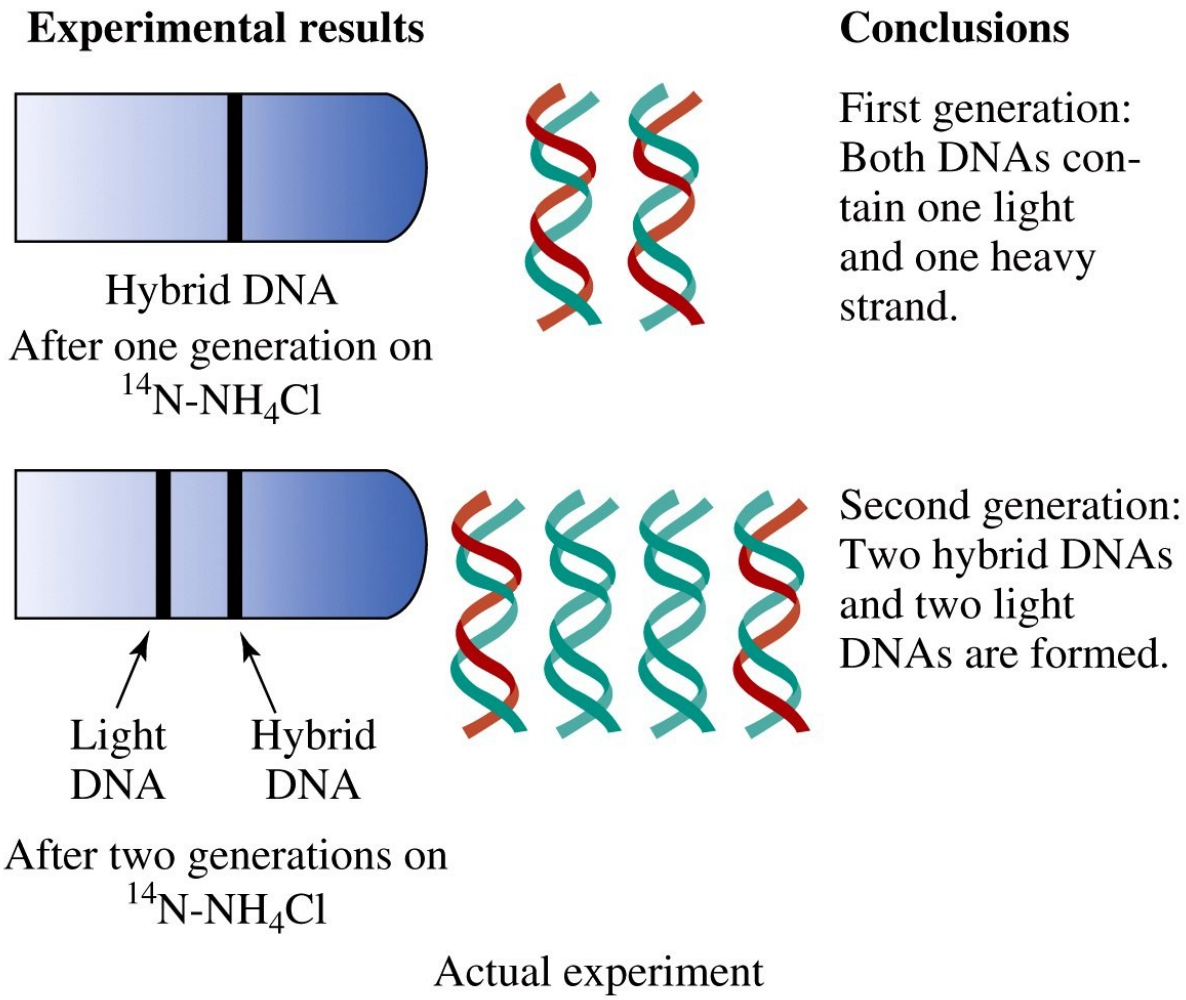
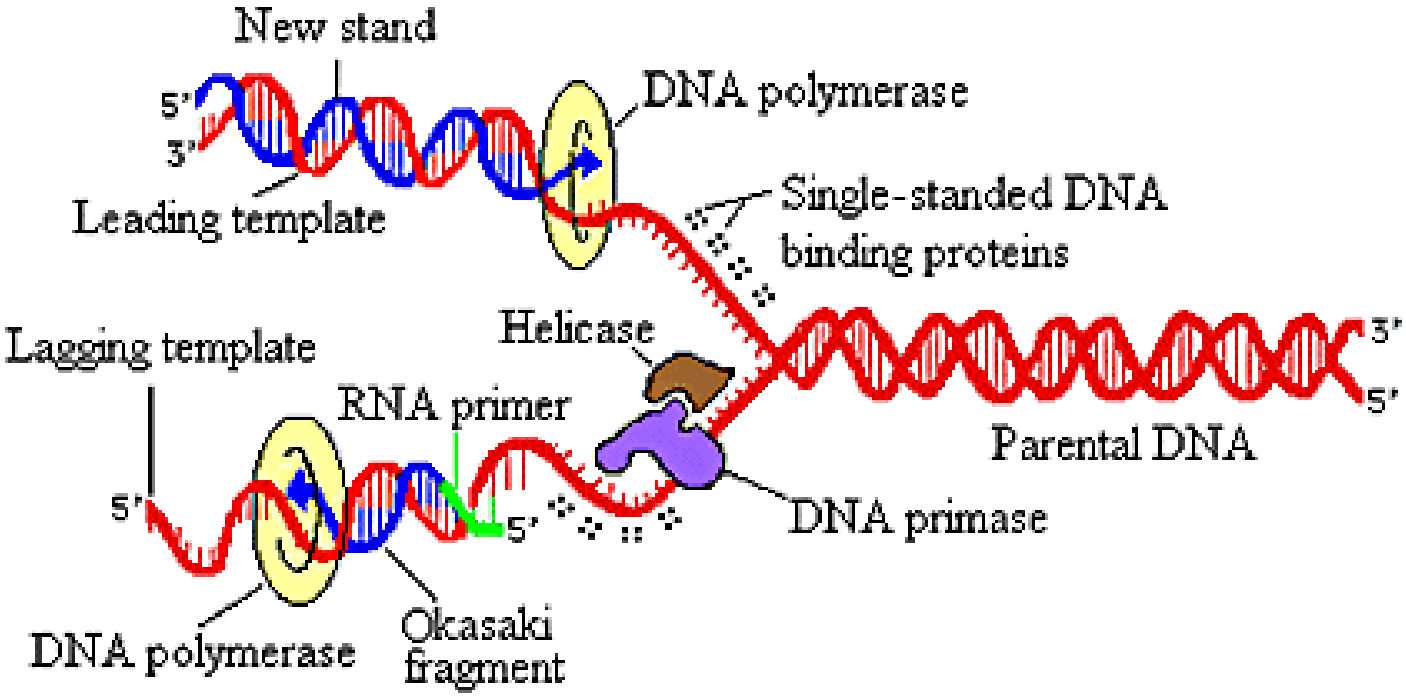


Figure 11-2c Concepts in Biochemistry, 3/e

Účast enzymů na replikaci



Účast enzymů na replikaci

Table 11.2

Proteins necessary for DNA replication in *E. coli*

Protein	Function
Helicase	Begins unwinding of DNA double helix
DNA gyrase	Assists unwinding
SSB proteins	Stabilize single strands of DNA
Primase	Synthesis of RNA primer
DNA polymerase III	Elongation of chain by DNA synthesis
DNA polymerase I	Removal of RNA primer and filling in gap with DNA
DNA ligase	Closes last phosphoester gap to form phosphodiester bond

Table 11-2 Concepts in Biochemistry, 3/e

Prokaryontní replikaci

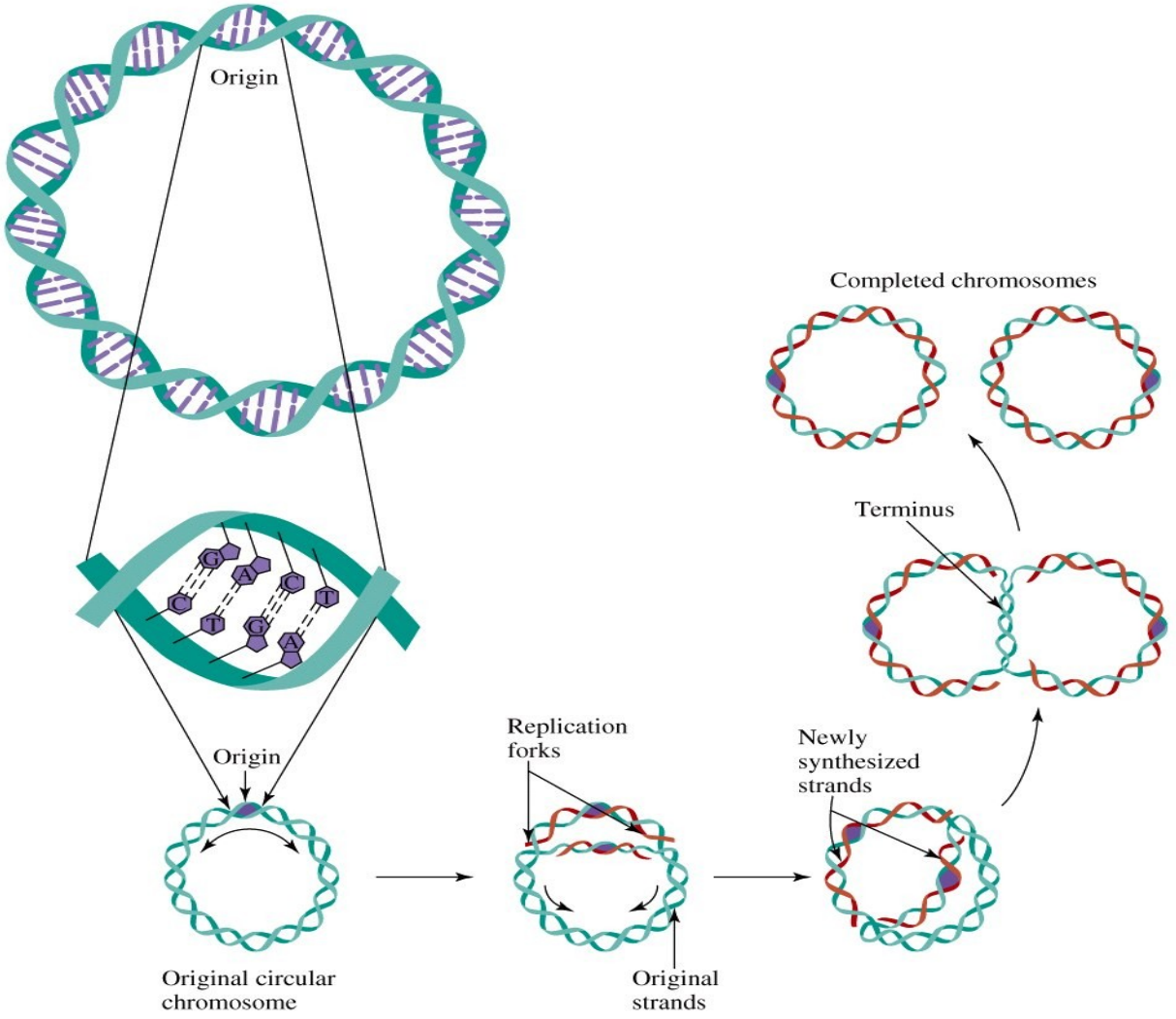
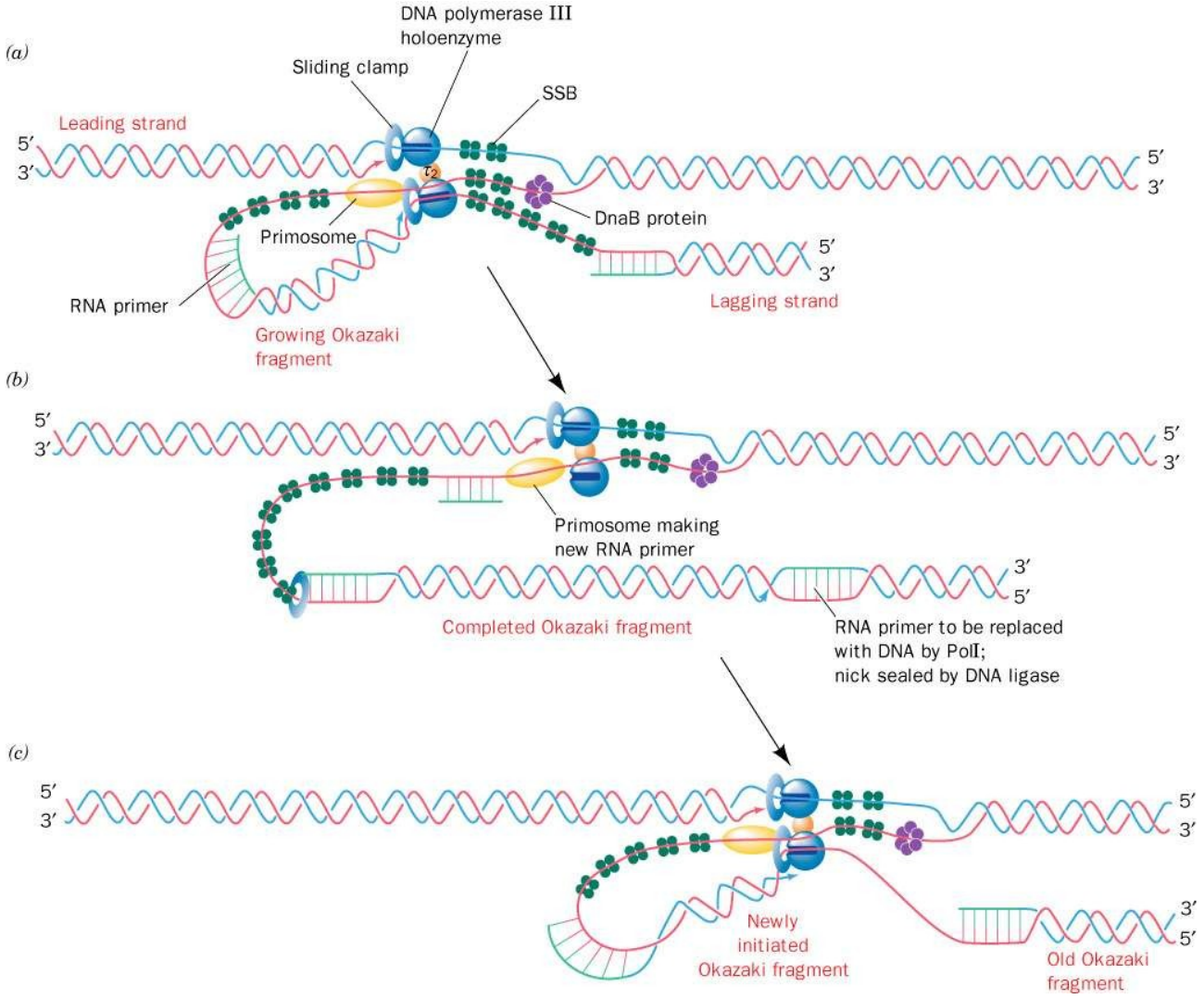


Figure 11-4 Concepts in Biochemistry, 3/e

Prokaryontní replikaci



Eukaryontní replikaci

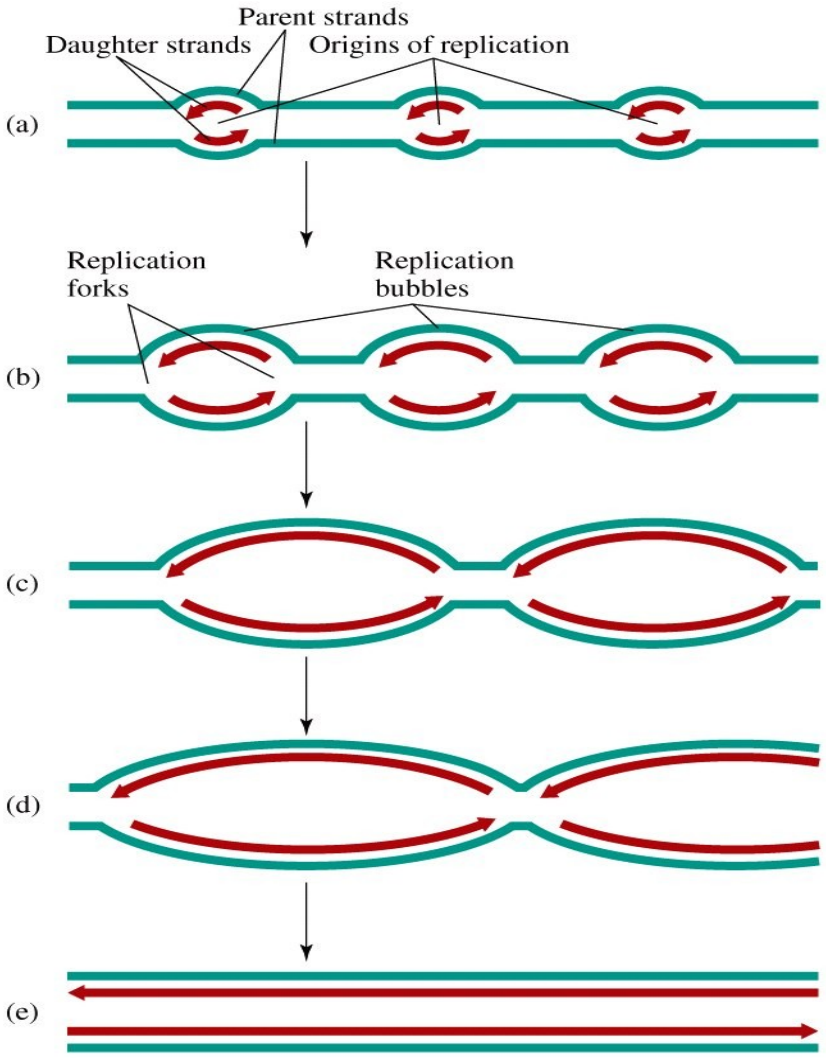
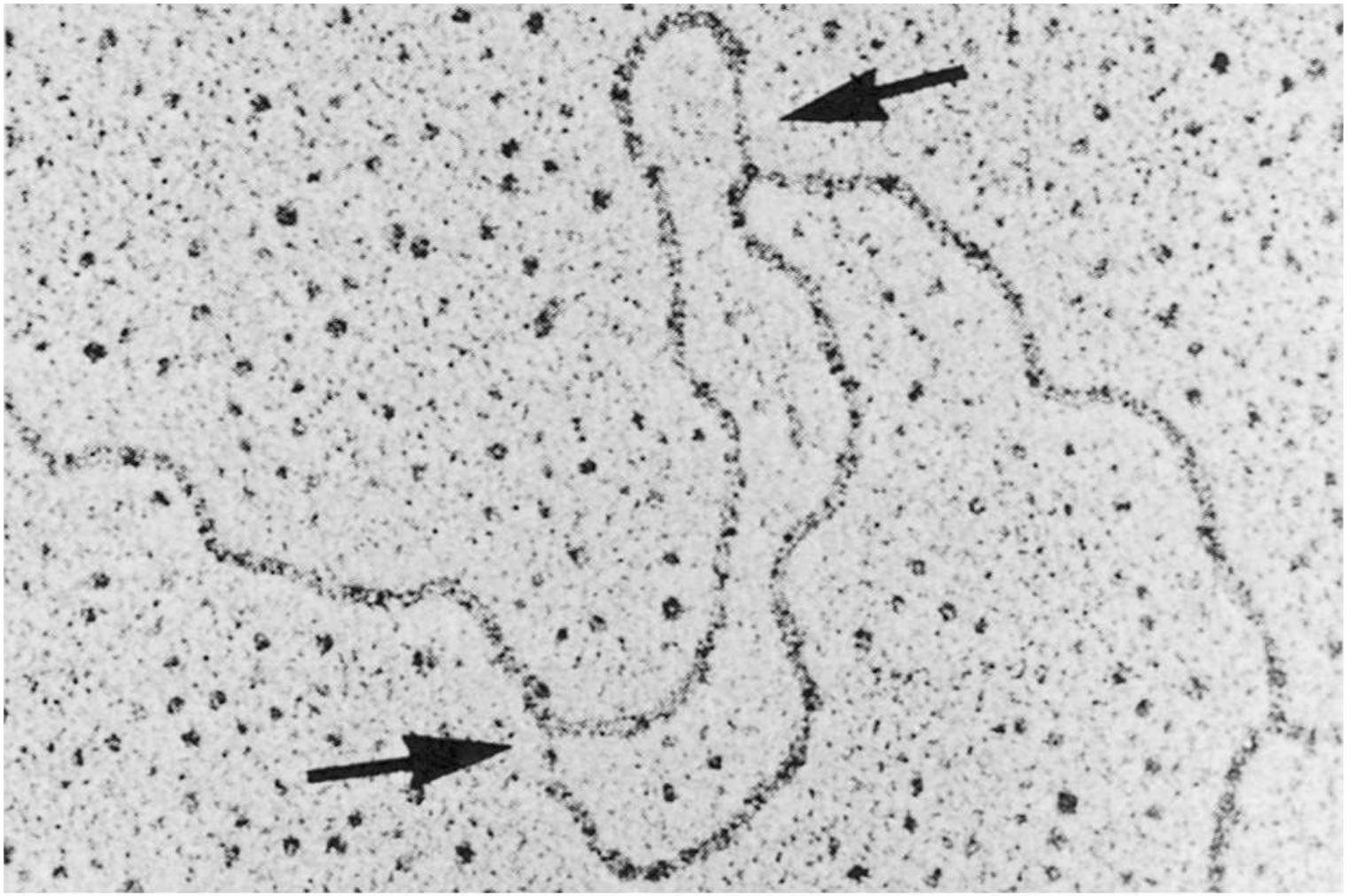
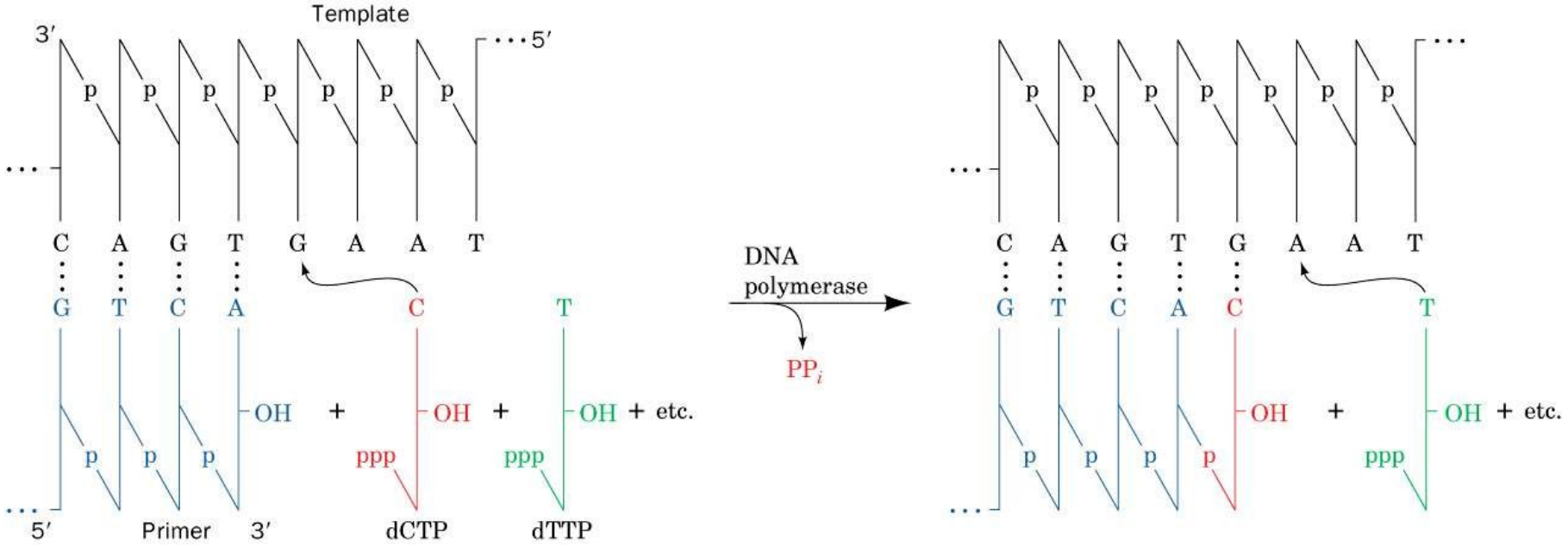


Figure 11-5 Concepts in Biochemistry, 3/e

Replikace u drosofily



From Kreigstein, H.J. and Hogness, D.S., *Proc. Natl. Acad. Sci.* **71**, 173 (1974)


Template
3′
5′
C A G T G A A T
G T C A
OH
C
OH
ppp
T
OH
ppp
+
+
+ etc.
5′
Primer
3′
dCTP
dTTP
DNA
polymerase
PP_i
C A G T G A A T
G T C A C
T
OH
ppp
+
OH + etc.

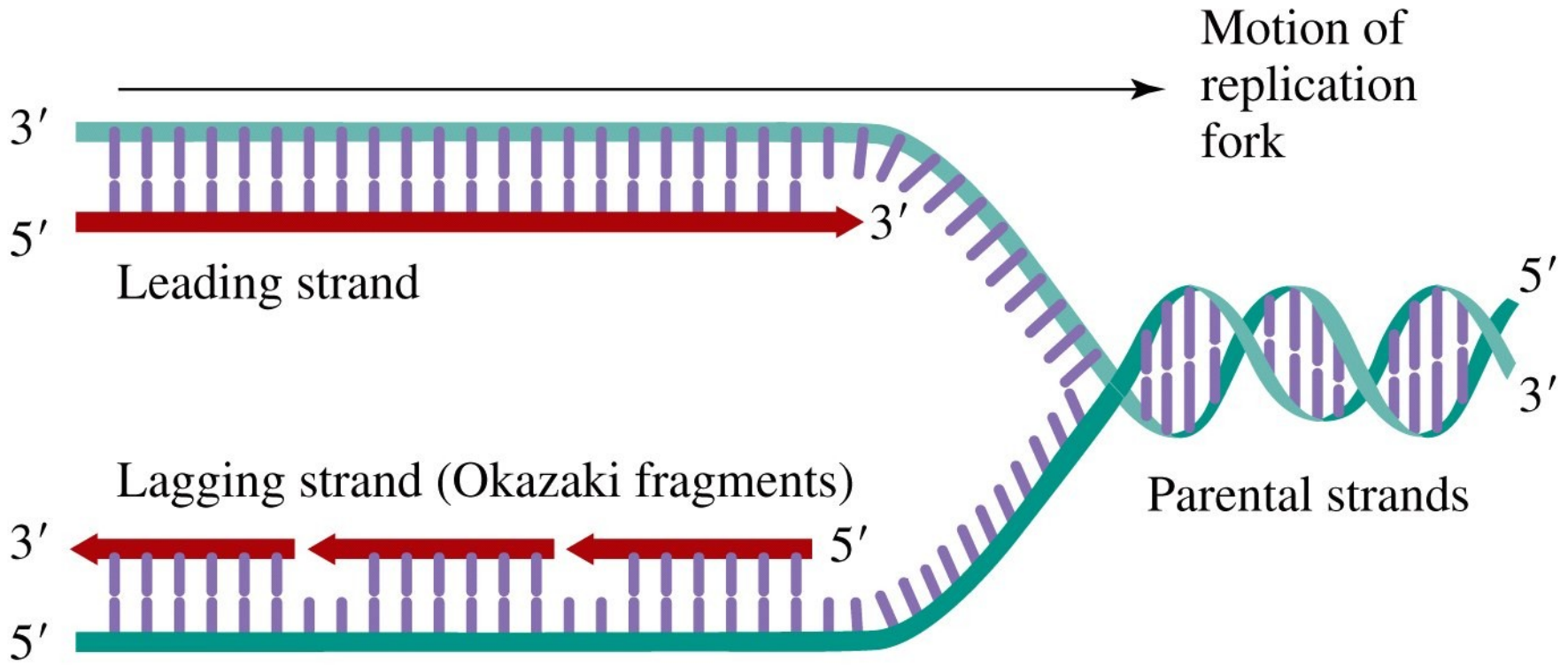


Figure 11-9 Concepts in Biochemistry, 3/e

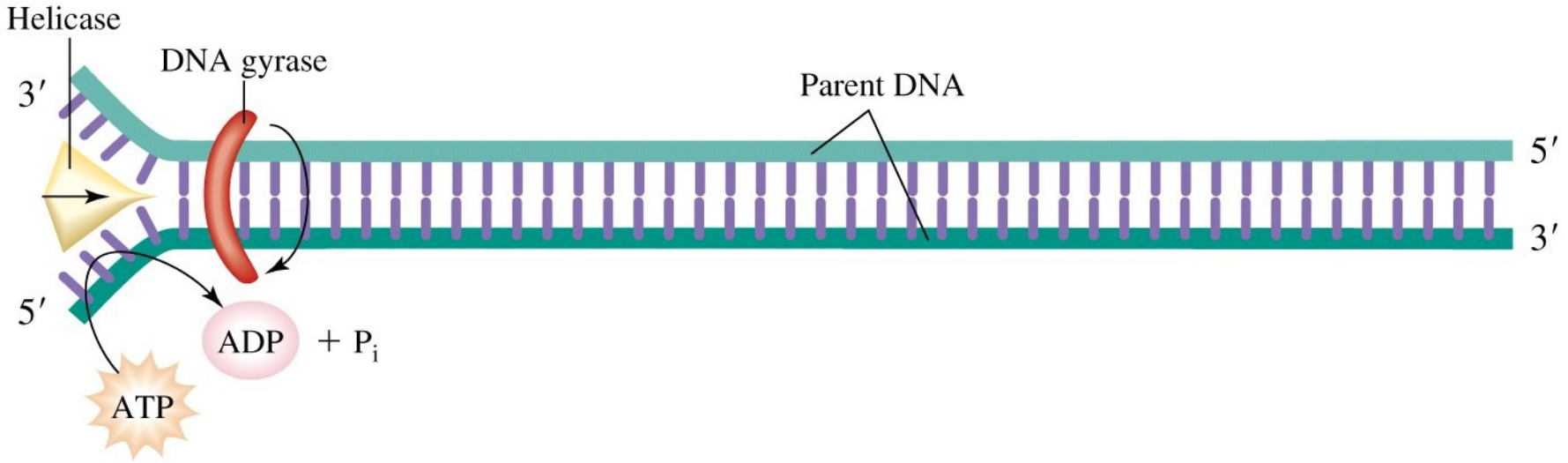


Figure 11-10a Concepts in Biochemistry, 3/e

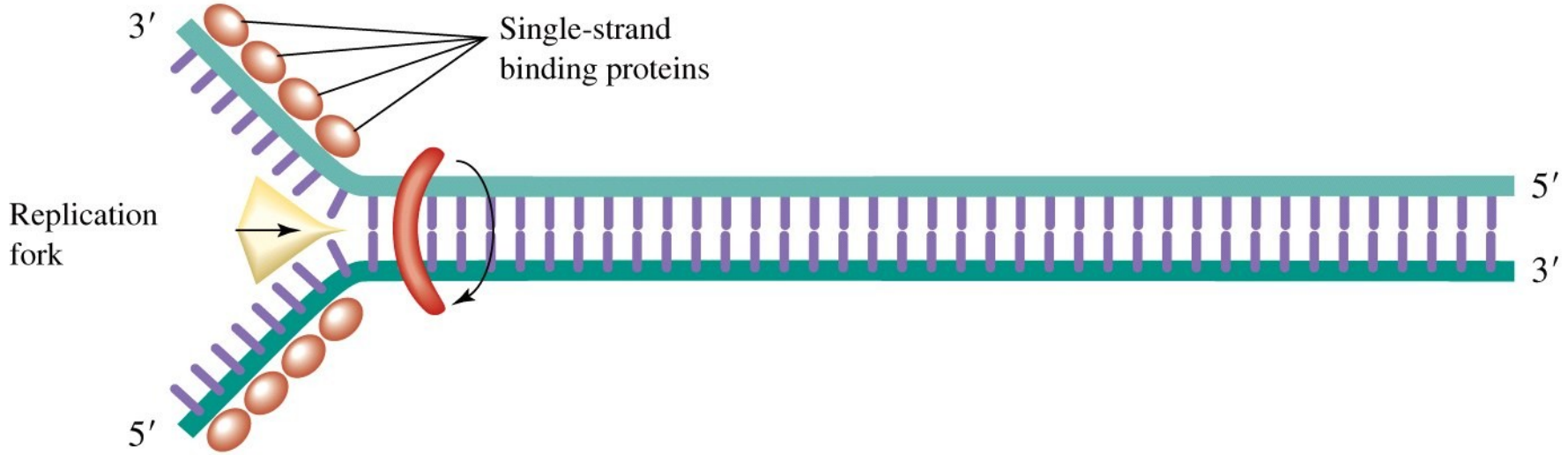


Figure 11-10b Concepts in Biochemistry, 3/e

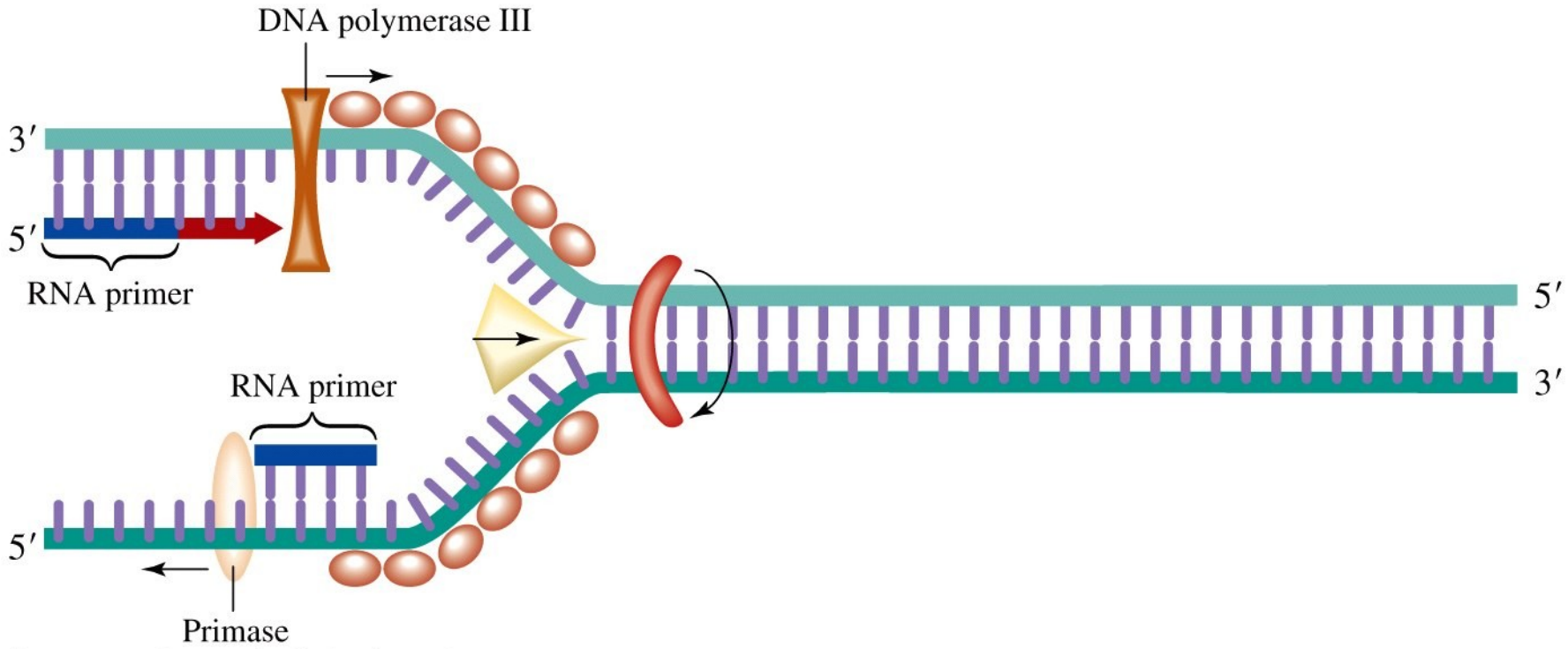


Figure 11-10c Concepts in Biochemistry, 3/e

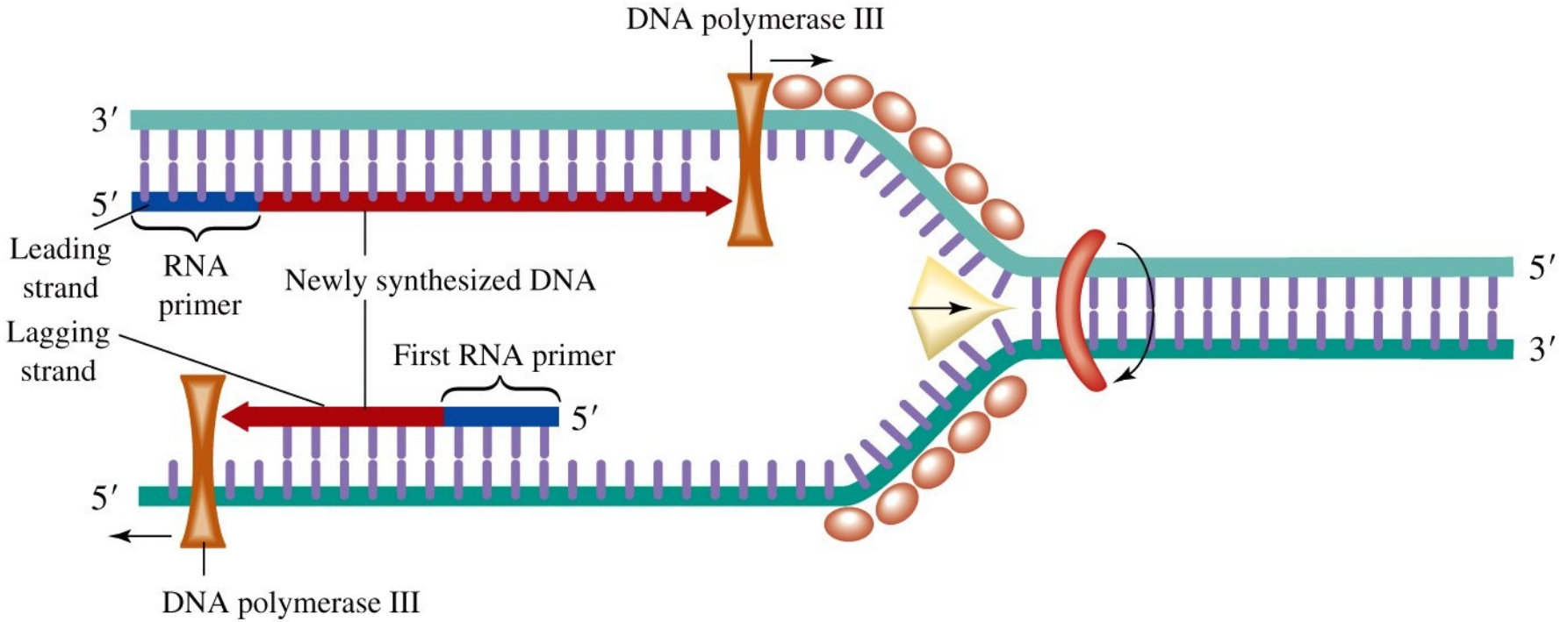


Figure 11-10d Concepts in Biochemistry, 3/e

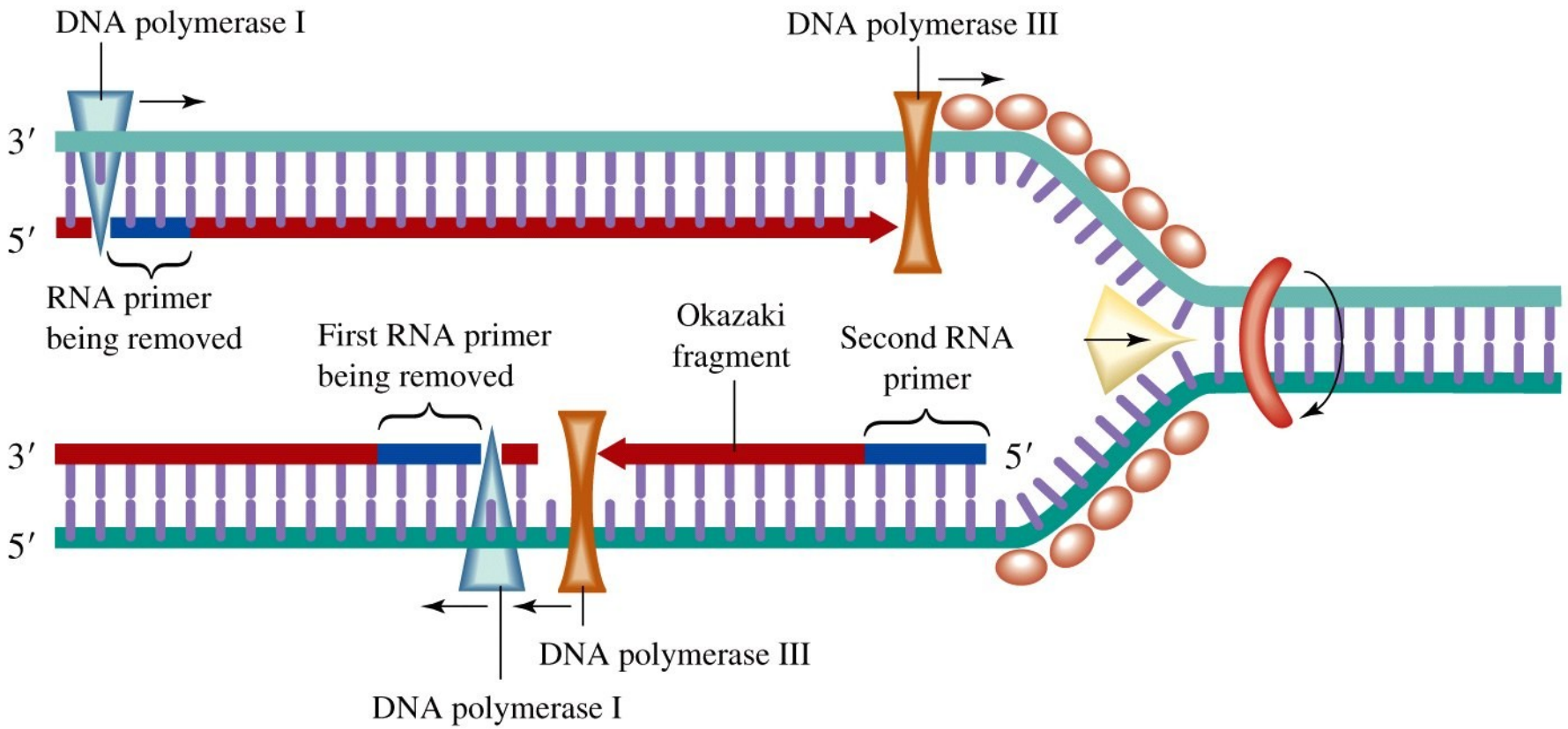


Figure 11-10e Concepts in Biochemistry, 3/e

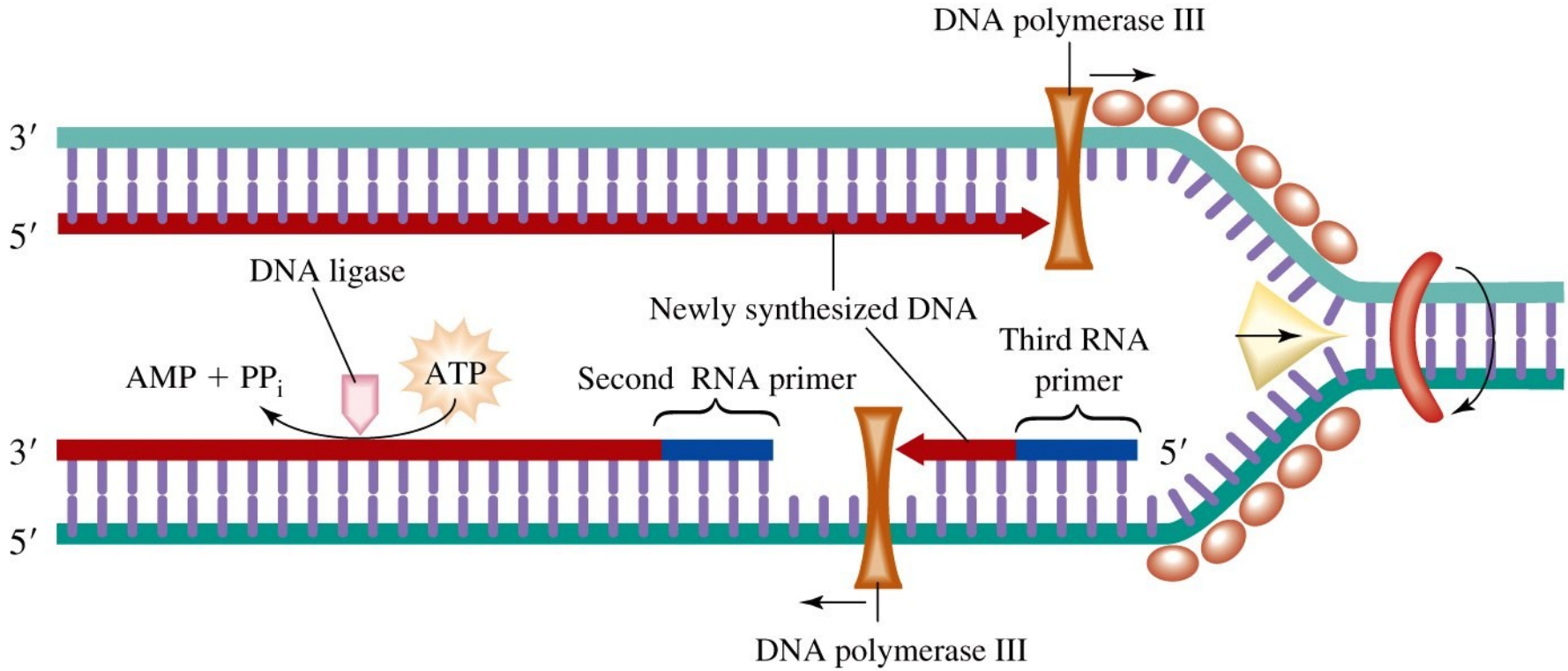
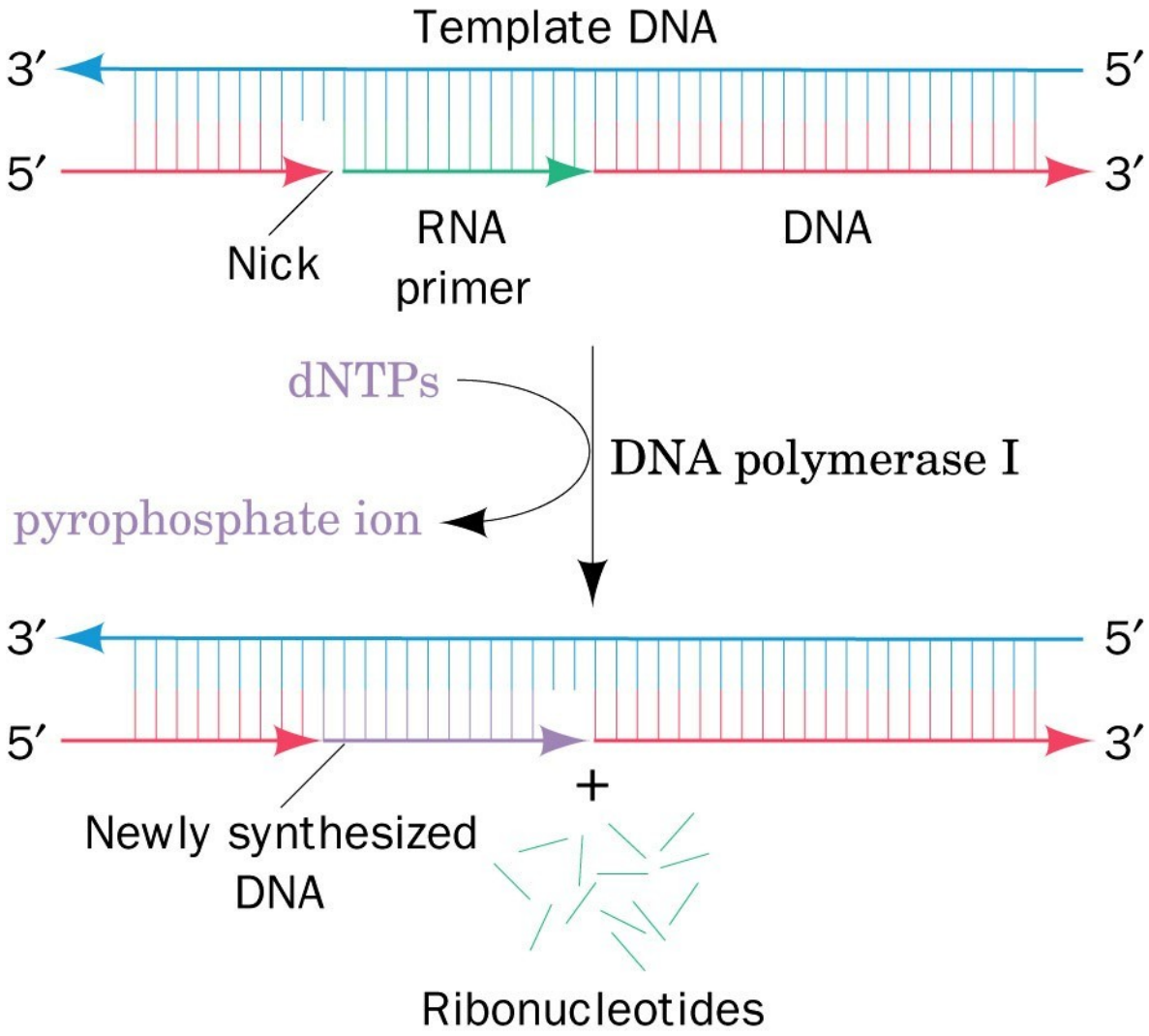
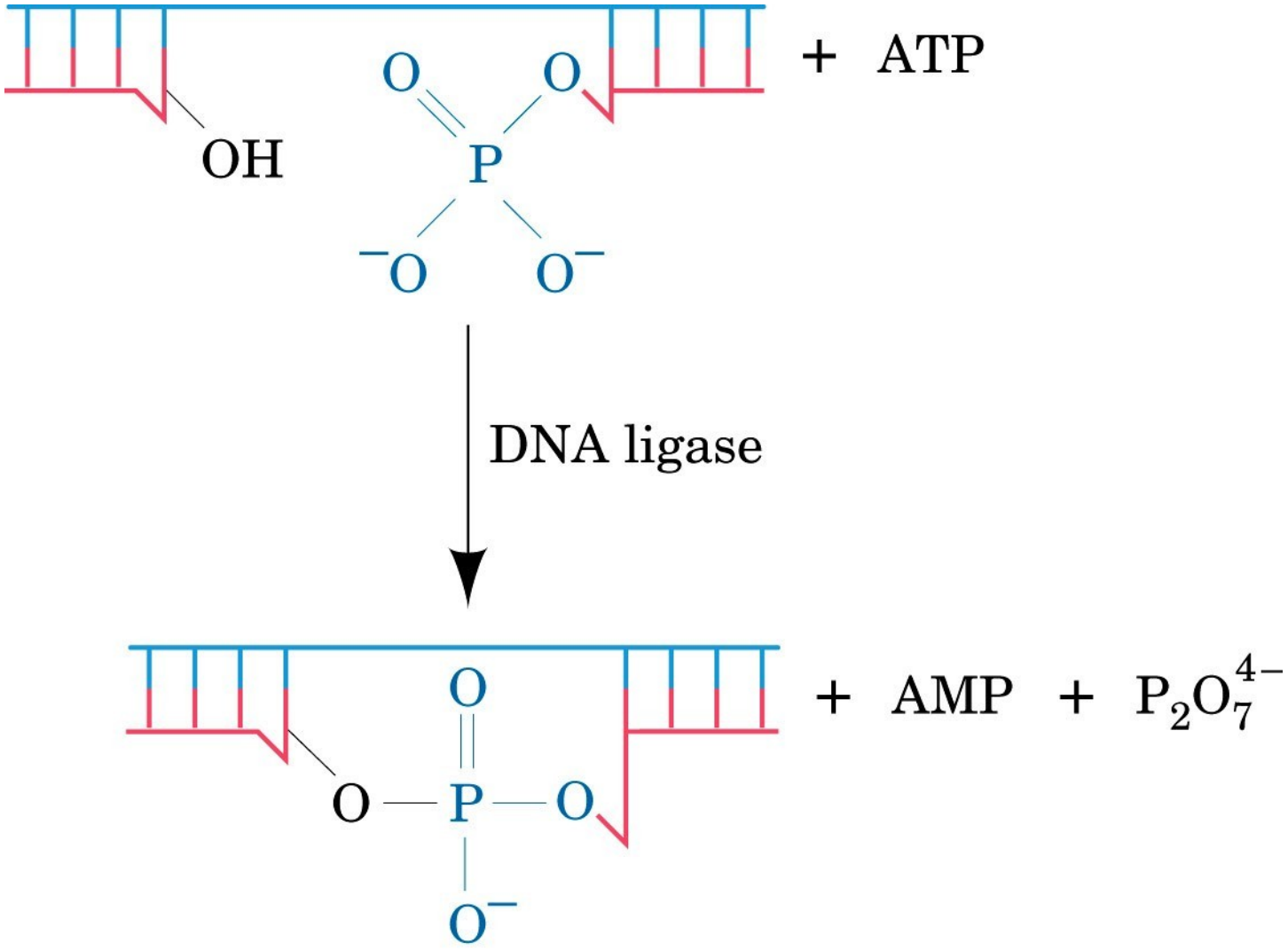


Figure 11-10f Concepts in Biochemistry, 3/e


Template DNA
3′
5′
5′
3′
Nick
RNA primer
DNA
dNTPs
DNA polymerase I
pyrophosphate ion
3′
5′
5′
3′
+
Newly synthesized DNA
Ribonucleotides


OH
O
O
P
⁻O
O⁻
+ ATP
DNA ligase
O
O — P — O
O⁻
+ AMP + $P_2O_7^{4-}$

Maxam Gilbertova metoda

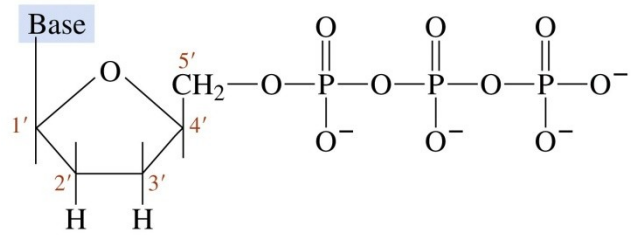


Figure 11-29 Concepts in Biochemistry, 3/e
© 2006 John Wiley & Sons

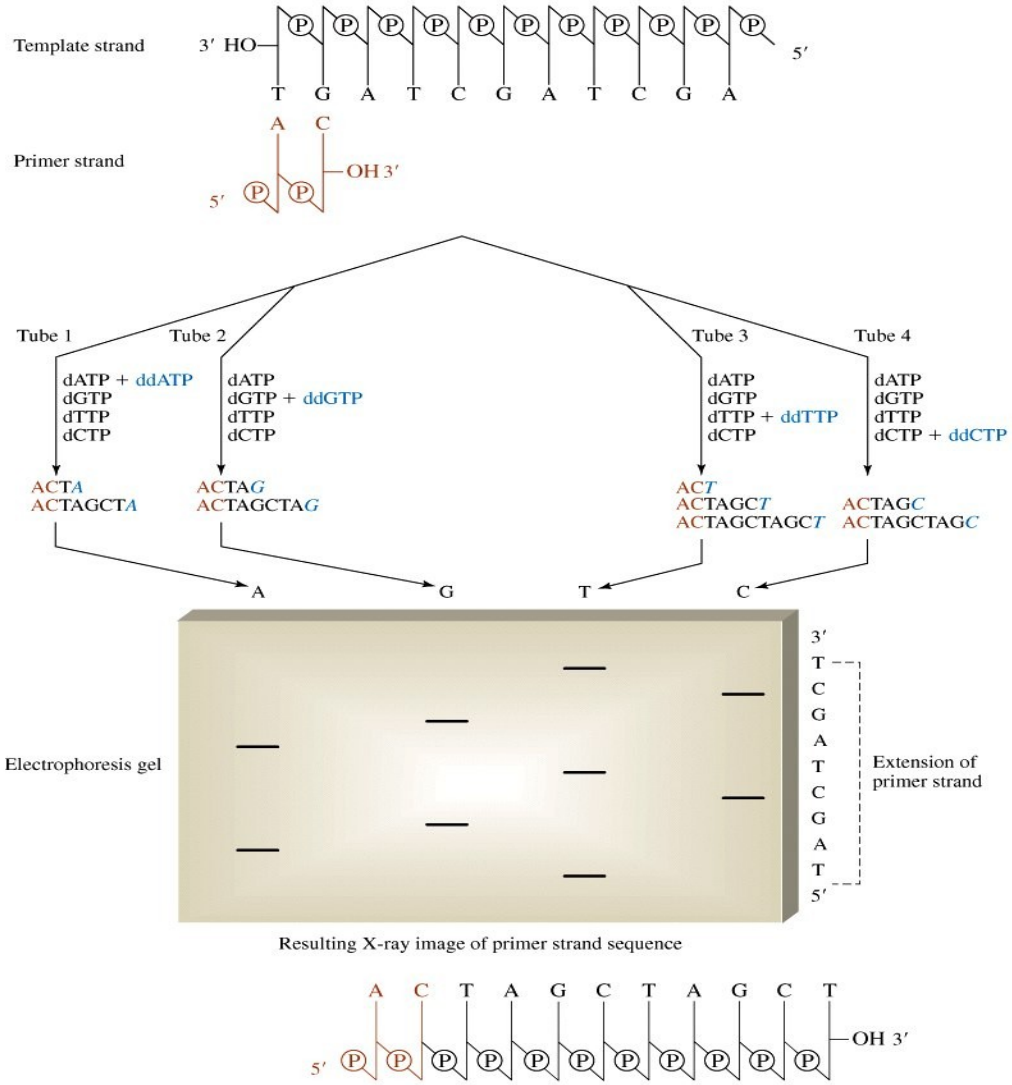
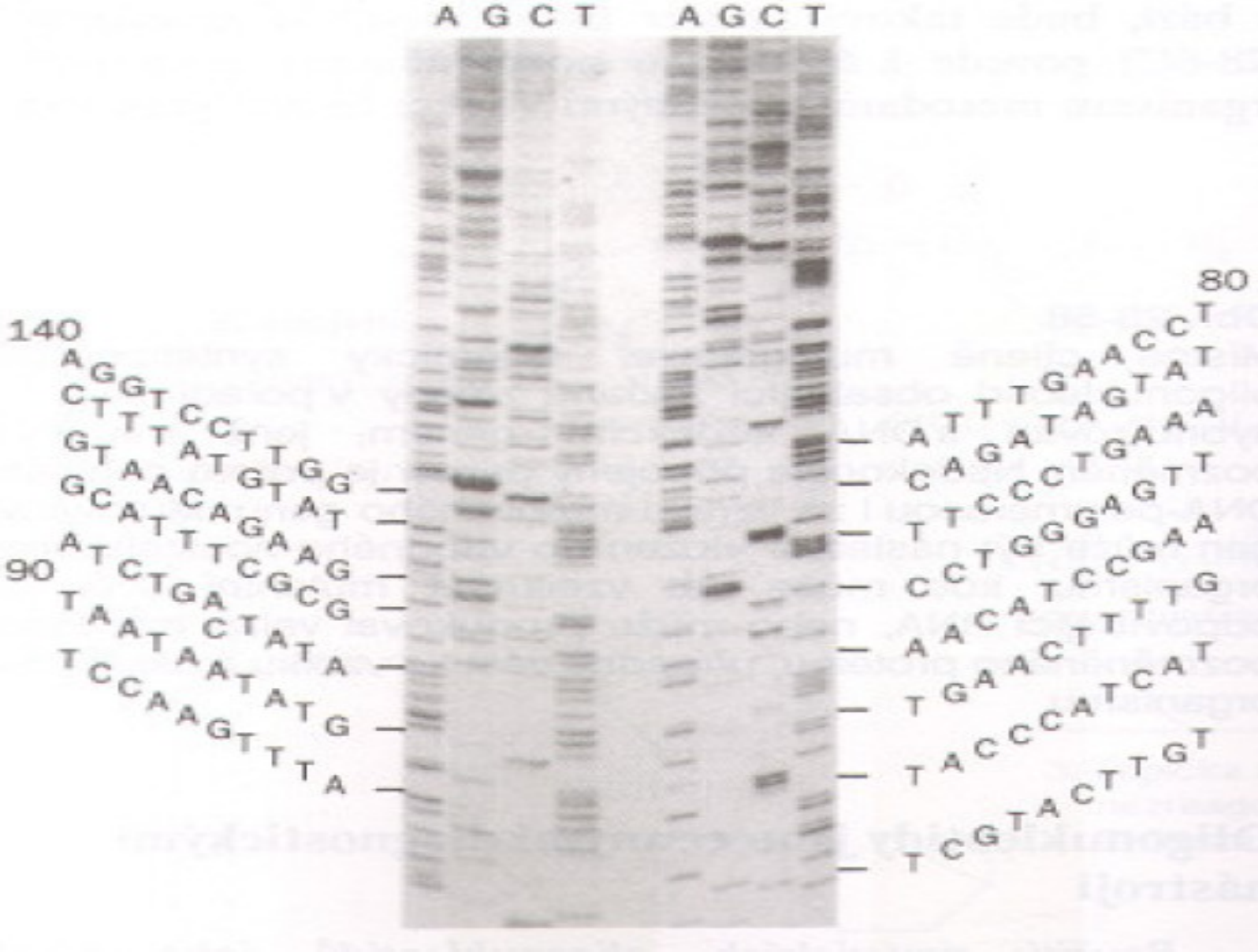
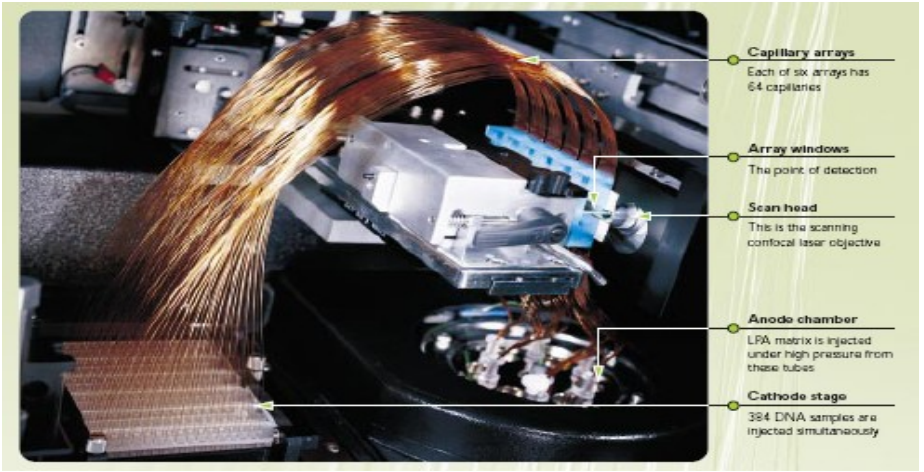
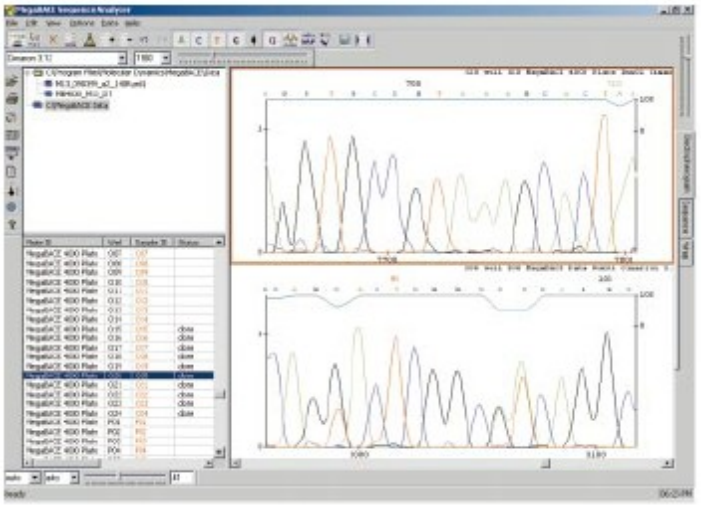


Figure 11-30 Concepts in Biochemistry, 3/e
© 2006 John Wiley & Sons


A G C T
A G C T
140
90
80

2003 - Projekt lidského genomu





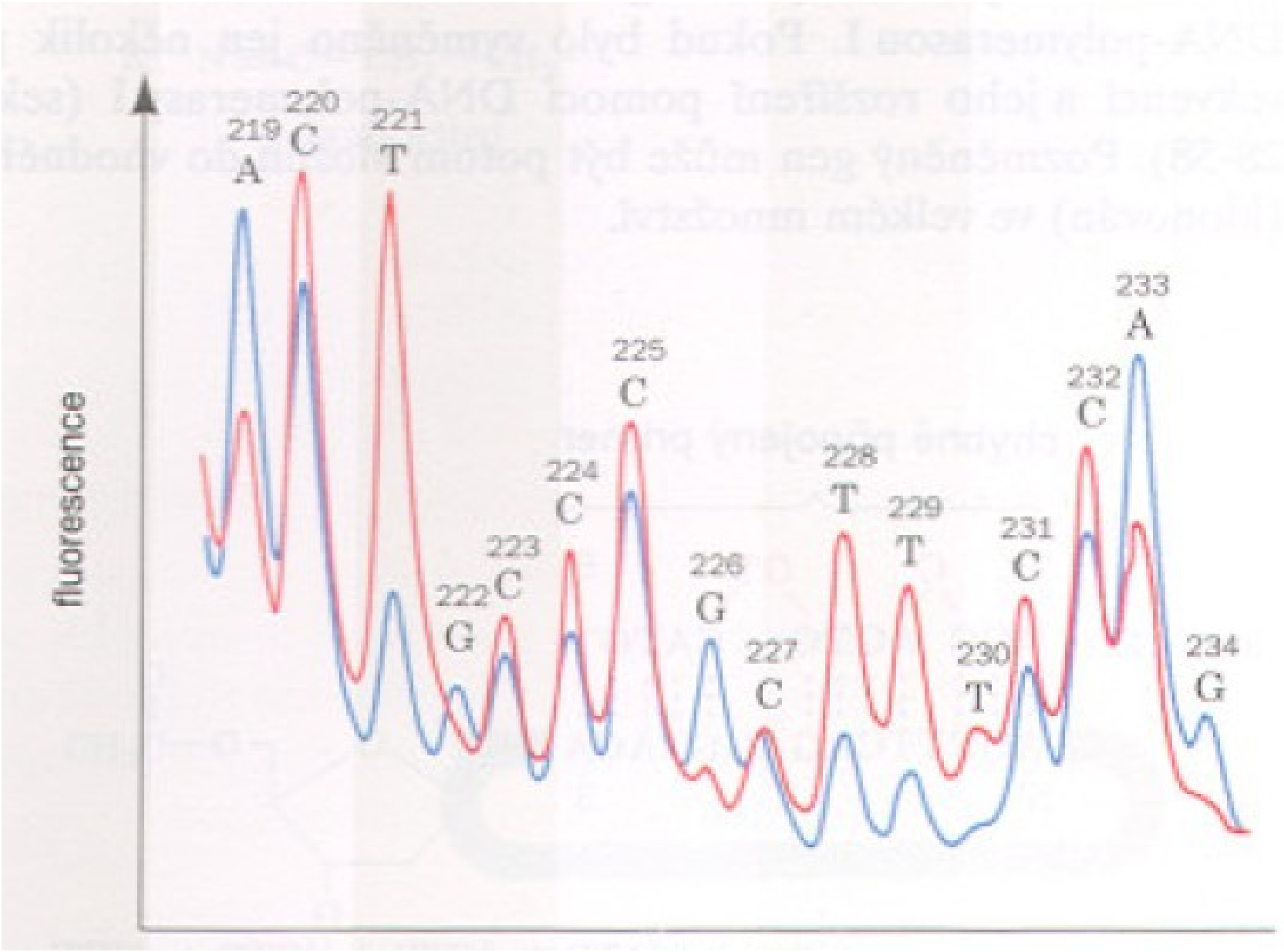
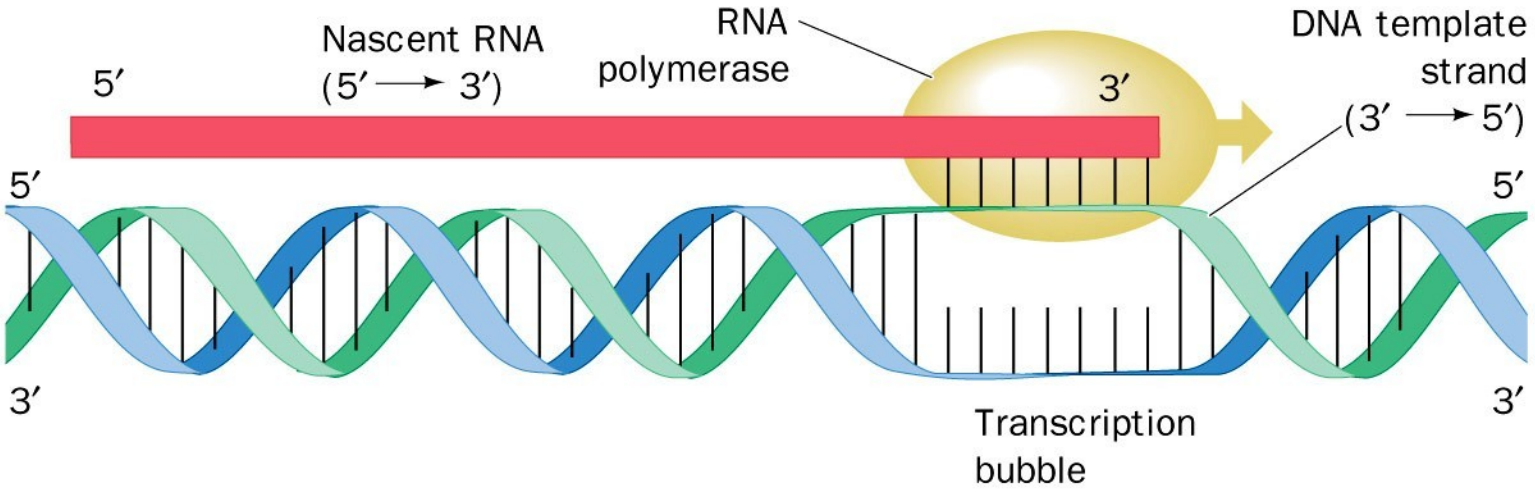

fluorescence
219 A
220 C
221 T
222 G
223 C
224 C
225 C
226 G
227 C
228 T
229 T
230 T
231 C
232 C
233 A
234 G

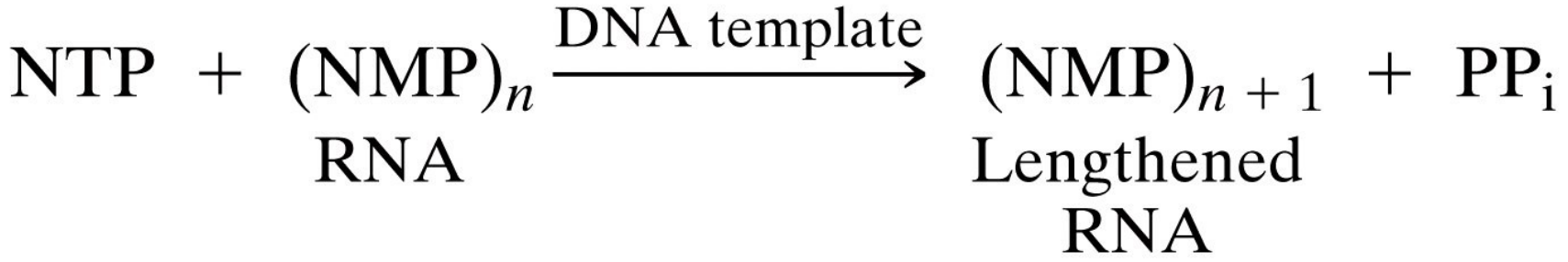
Table 13.3
Some Sequenced Genomes

Organism	Genome size (kb)	Number of Chromosomes
Mycoplasma genitalium (human parasite)	580	1
Borrelia burgdorferi (agent of Lyme disease)	1444	1
Haemophilus influenzae (human pathogenic bacterium)	1830	1
Mycobacterium tuberculosis (cause of tuberculosis)	4412	1
Escherichia coli (bacterium)	4639	1
Saccharomyces cerevisiae (yeast)	11,700	16
Drosophila melanogaster (fruit fly)	137,000	4
Oryza sativa (rice)	430,000	12
Homo sapiens (human)	3,200,000	23

Table 13-3 Concepts in Biochemistry, 3/e

Transkripce





Unnumbered figure pg337 Concepts in Biochemistry, 3/e

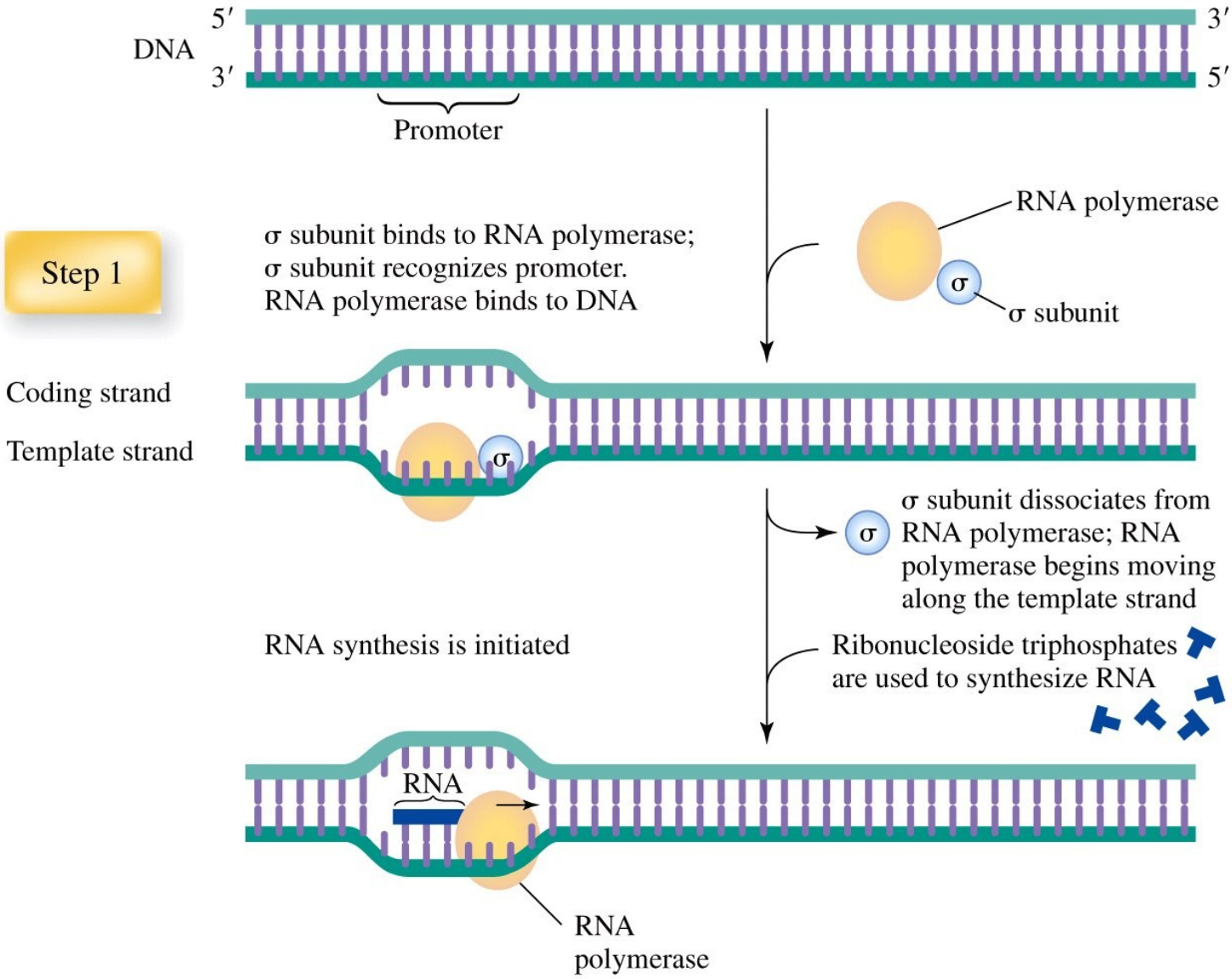


Figure 11-22 part 1 Concepts in Biochemistry, 3/e

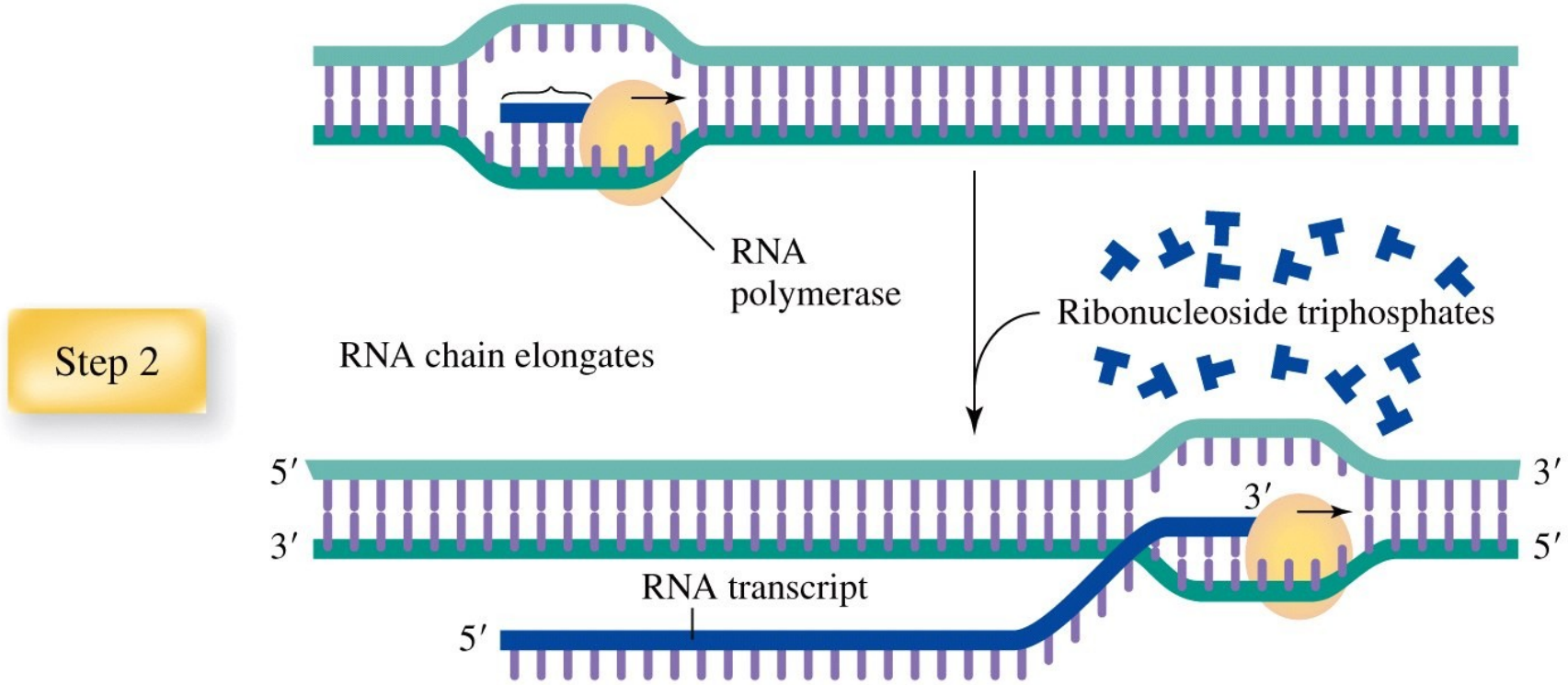


Figure 11-22 part 2 Concepts in Biochemistry, 3/e

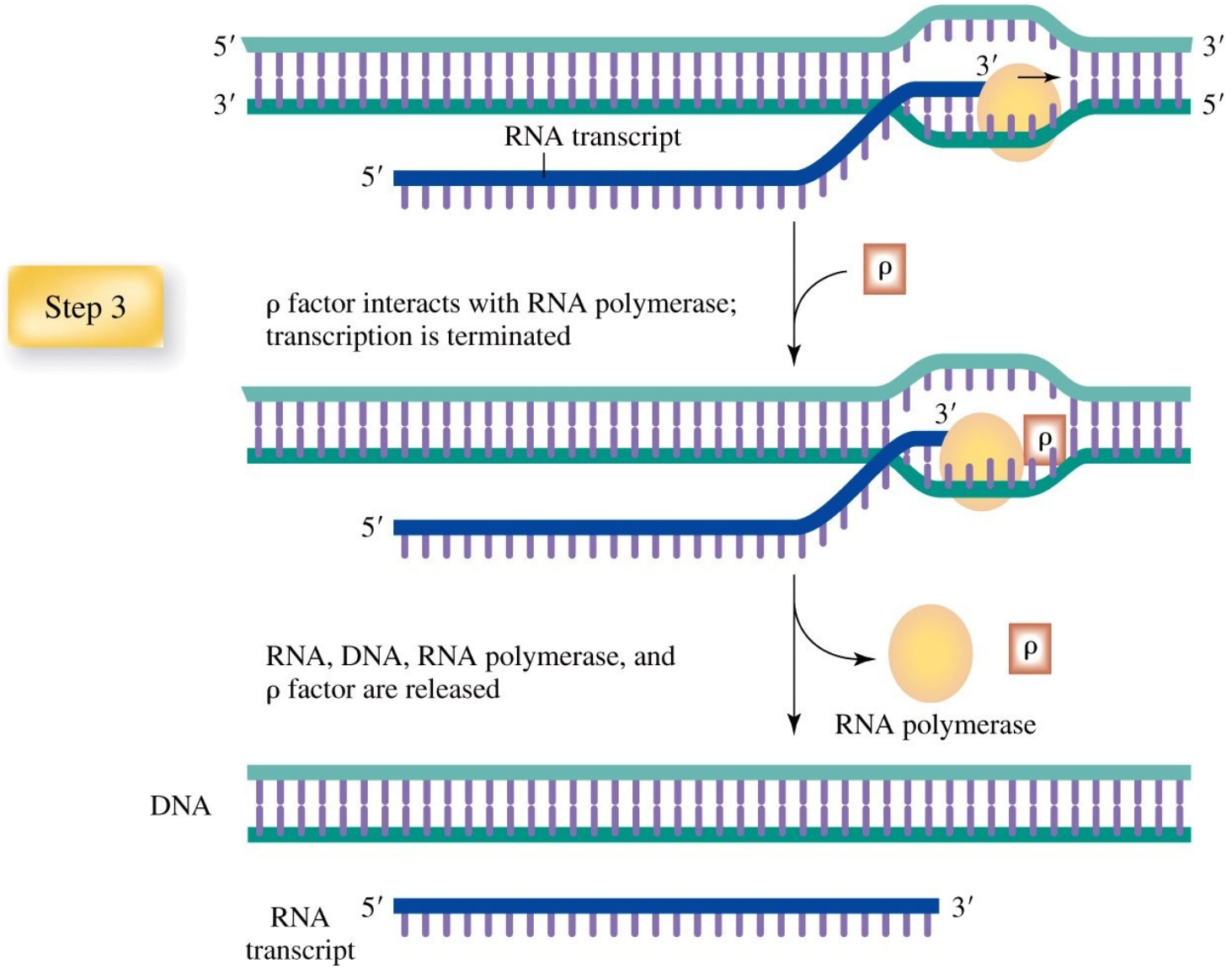
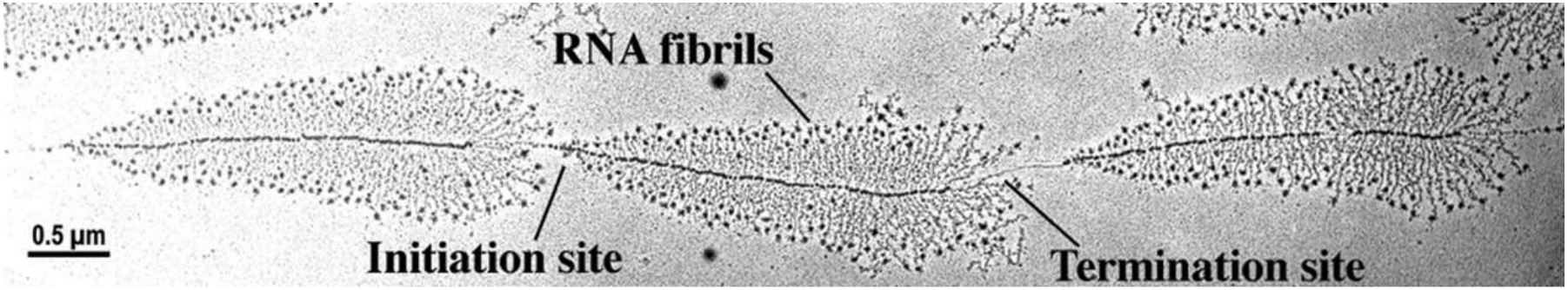
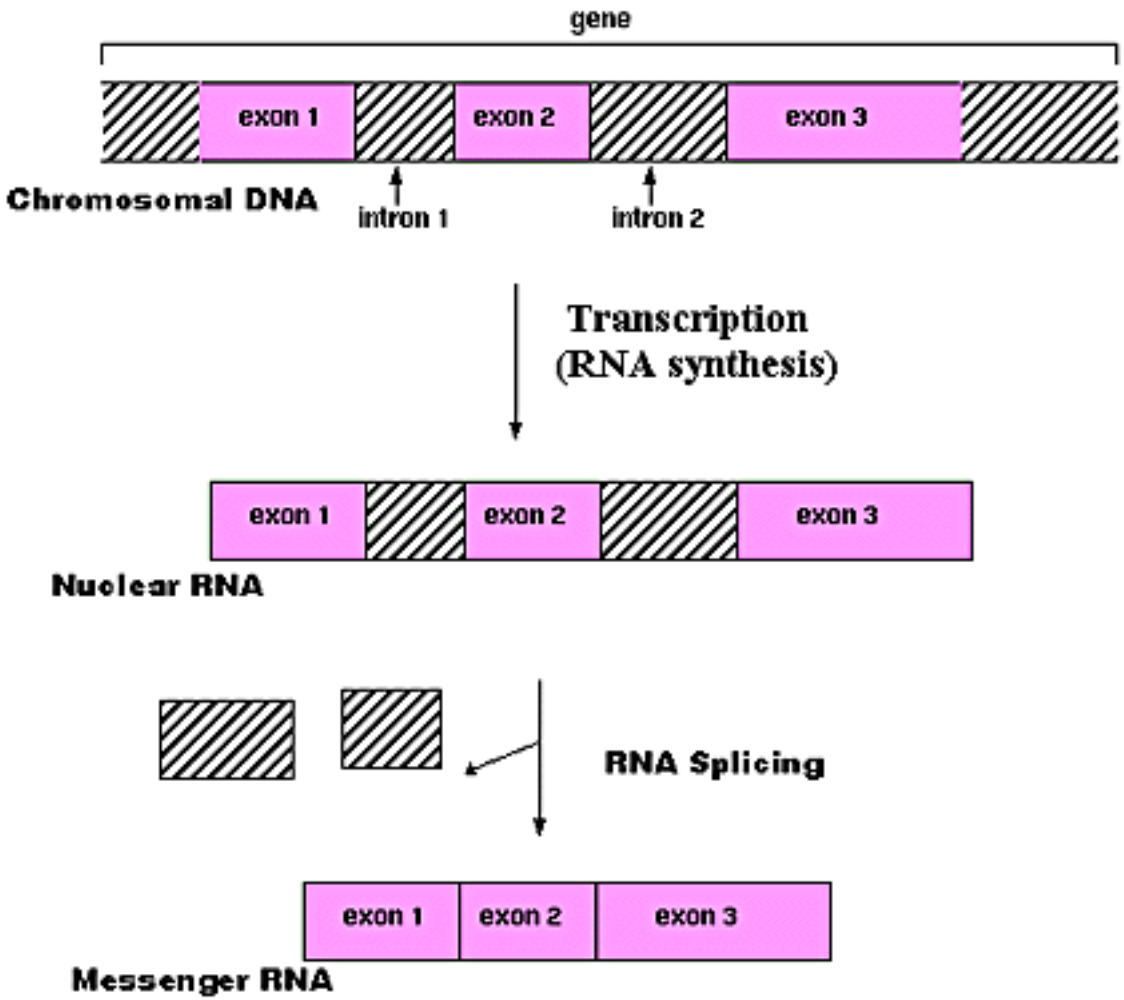


Figure 11-22 part 3 Concepts in Biochemistry, 3/e



Courtesy of Ulrich Scheer, University of Würzburg, Germany

Syntéza RNA


gene
exon 1
exon 2
exon 3
Chromosomal DNA
intron 1
intron 2
Transcription
(RNA synthesis)
exon 1
exon 2
exon 3
Nuclear RNA
RNA Splicing
exon 1
exon 2
exon 3
Messenger RNA

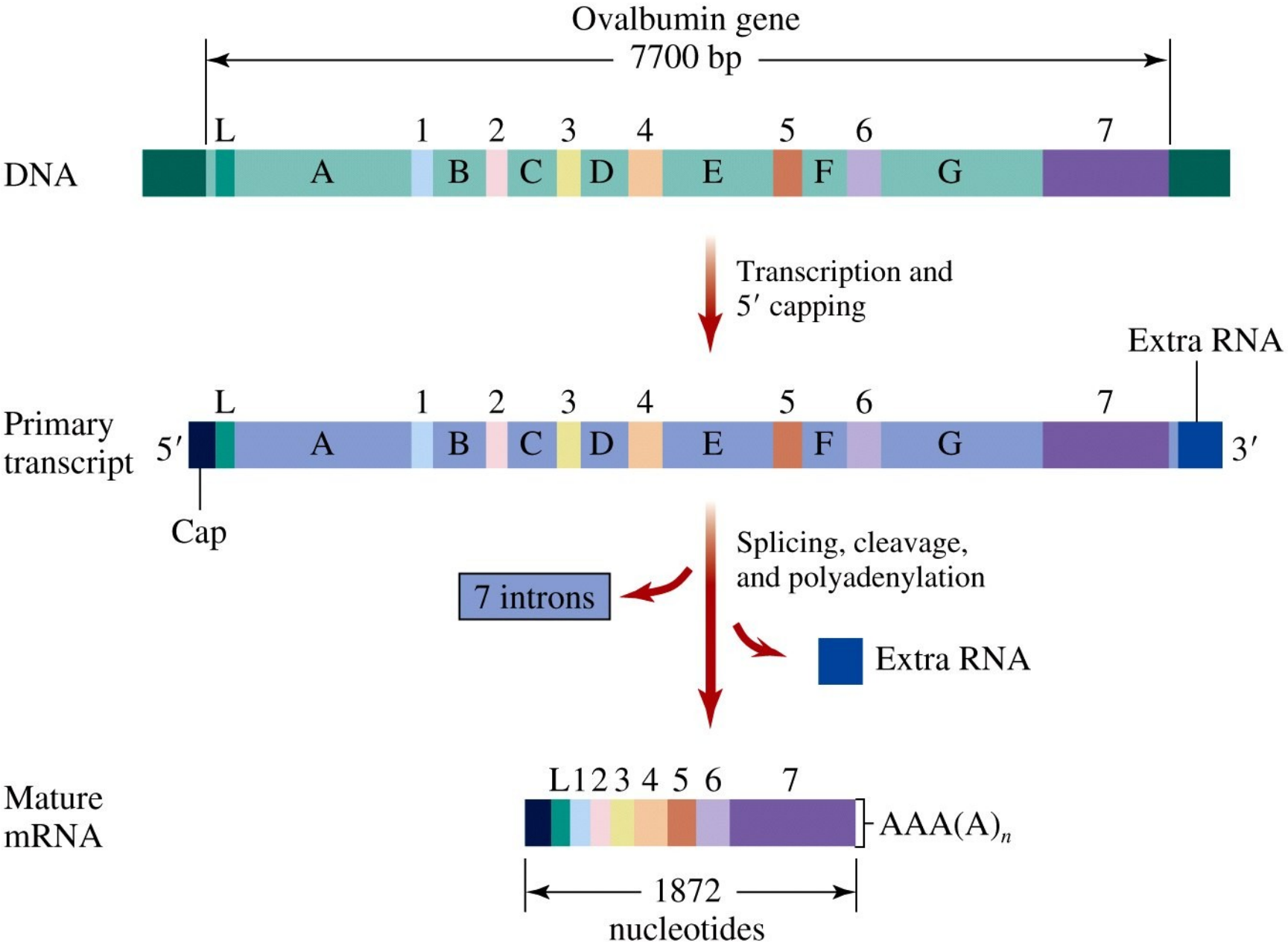
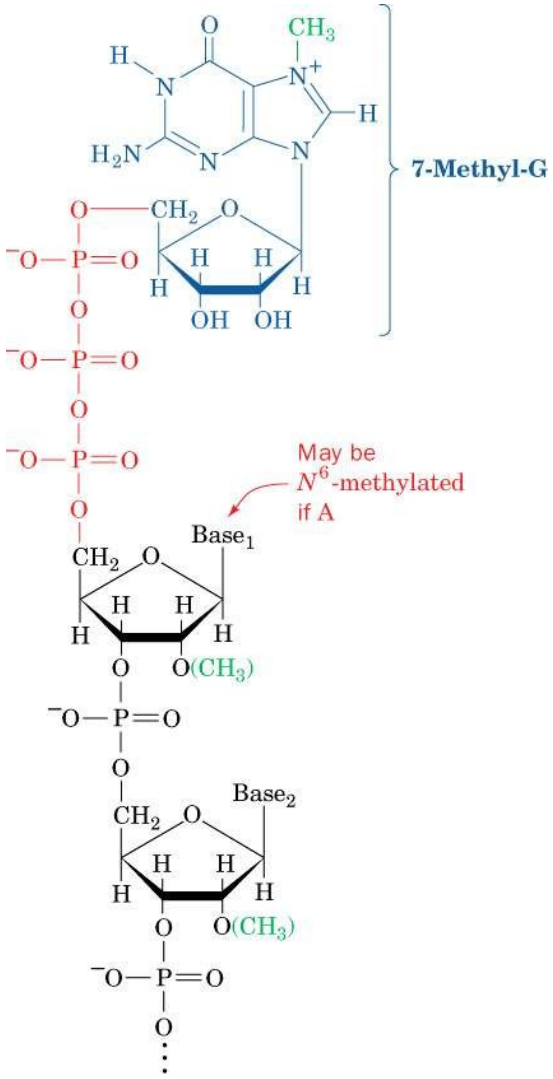
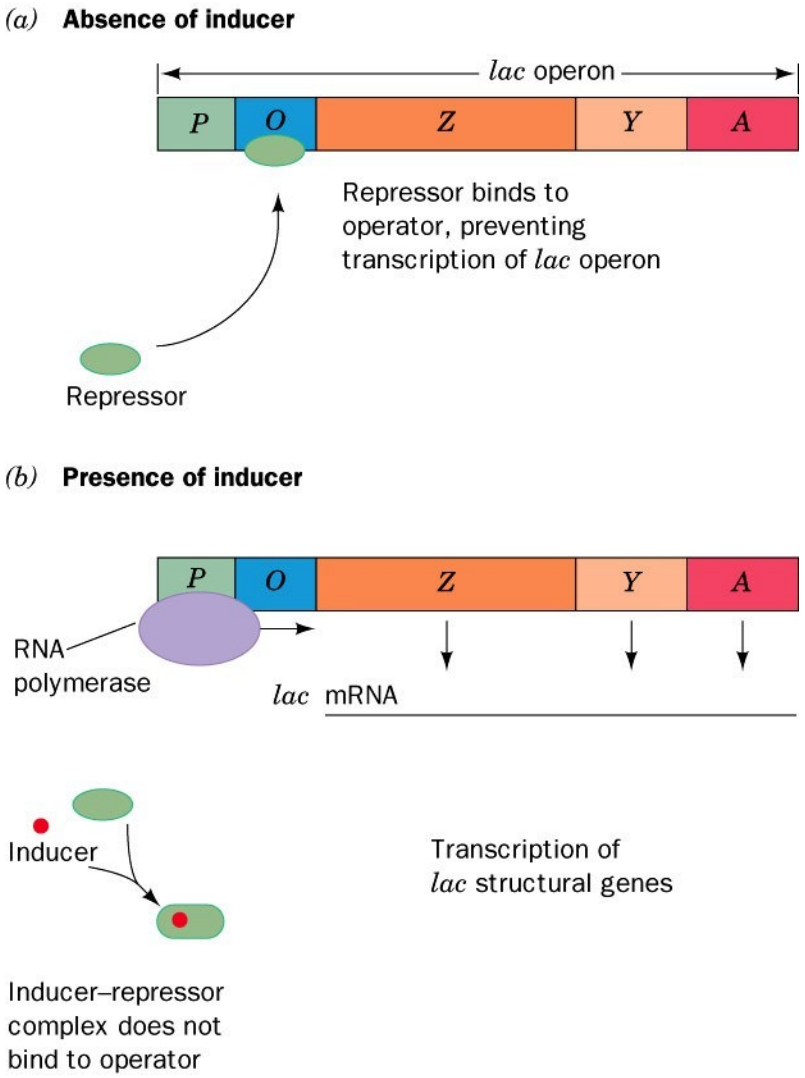


Figure 11-28 Concepts in Biochemistry, 3/e

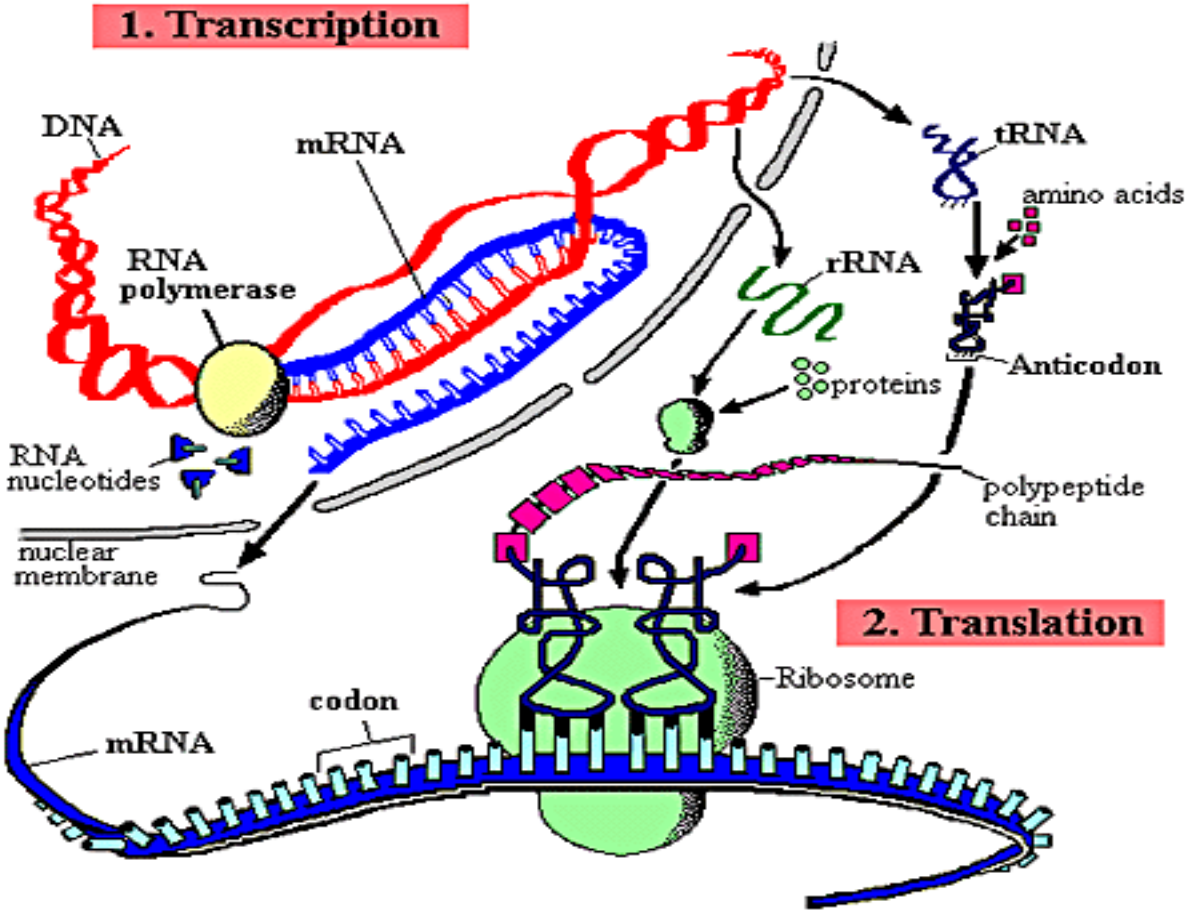
Cap

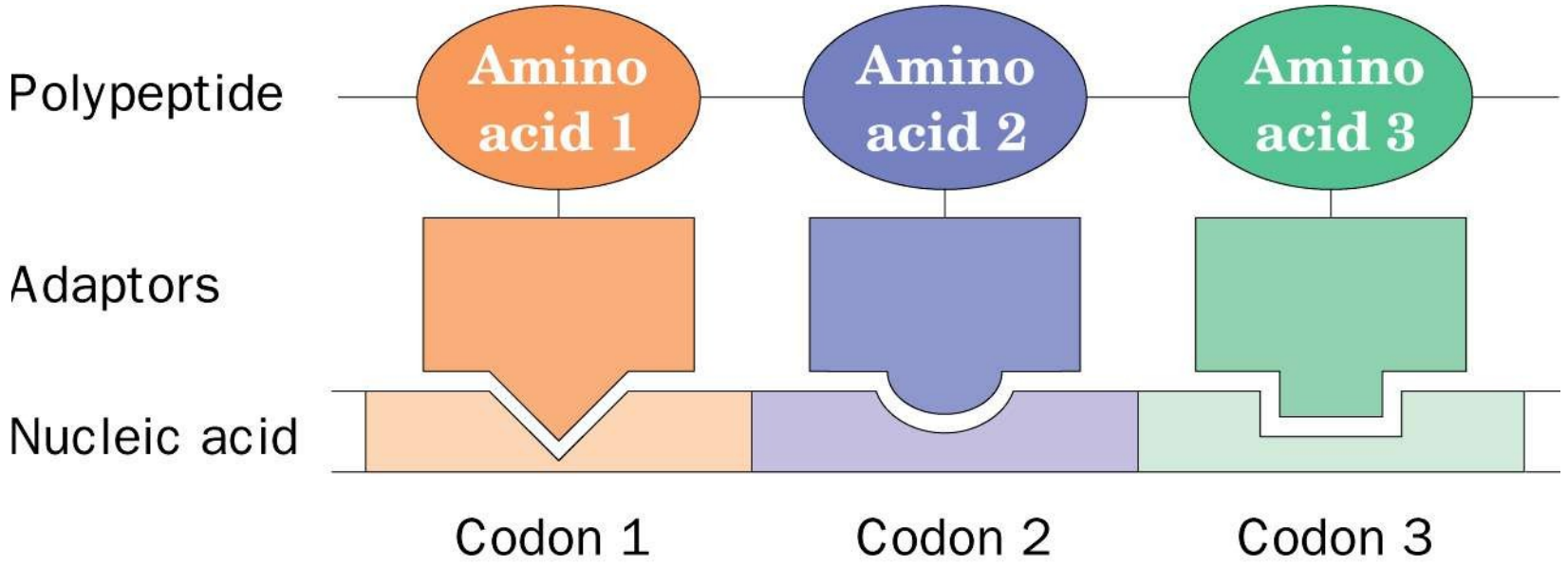


Regulace translace



Syntéza bílkovin




Polypeptide
Amino acid 1
Amino acid 2
Amino acid 3
Adaptors
Nucleic acid
Codon 1
Codon 2
Codon 3

Aktivace AMK

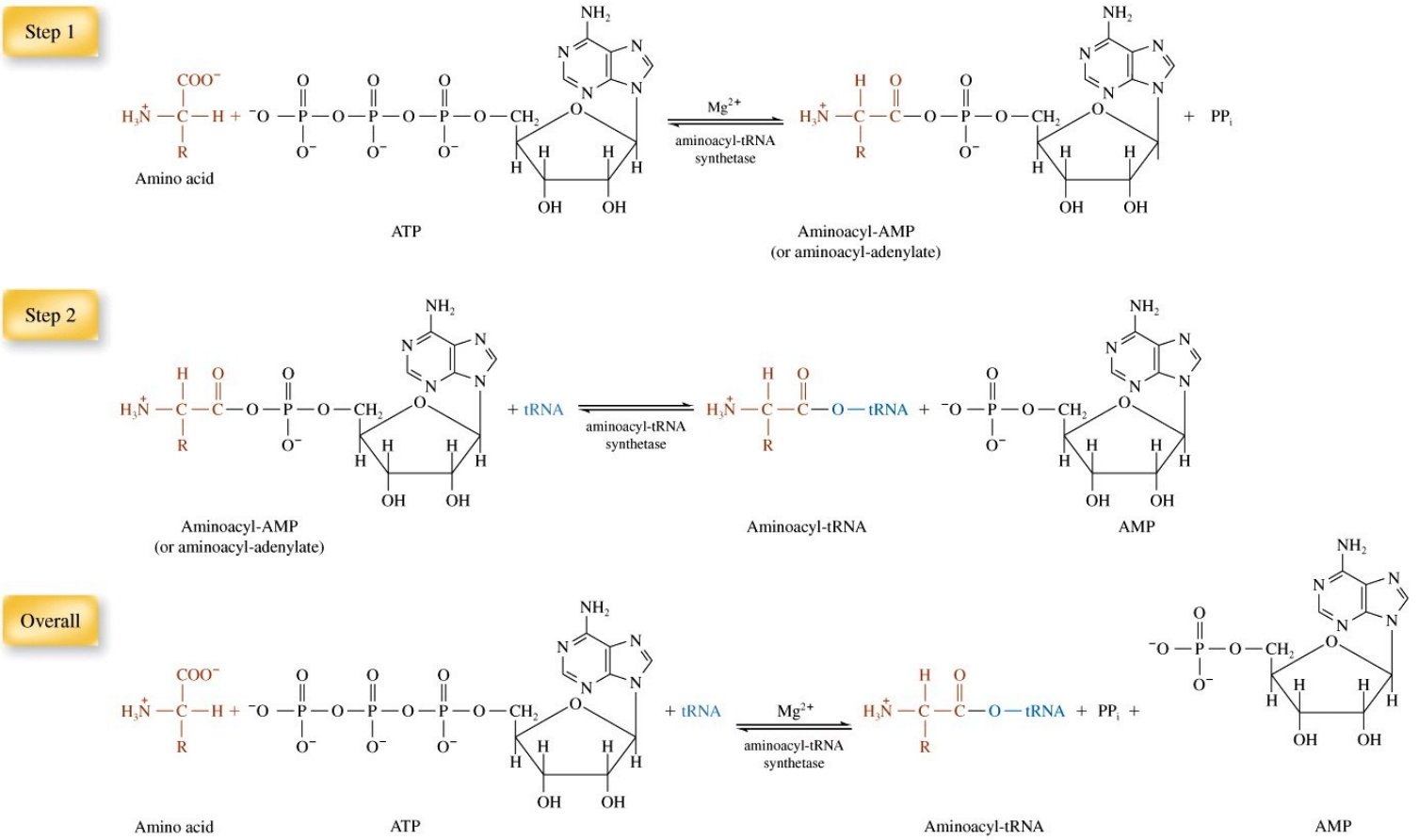


Figure 12-4 Concepts in Biochemistry, 3/e

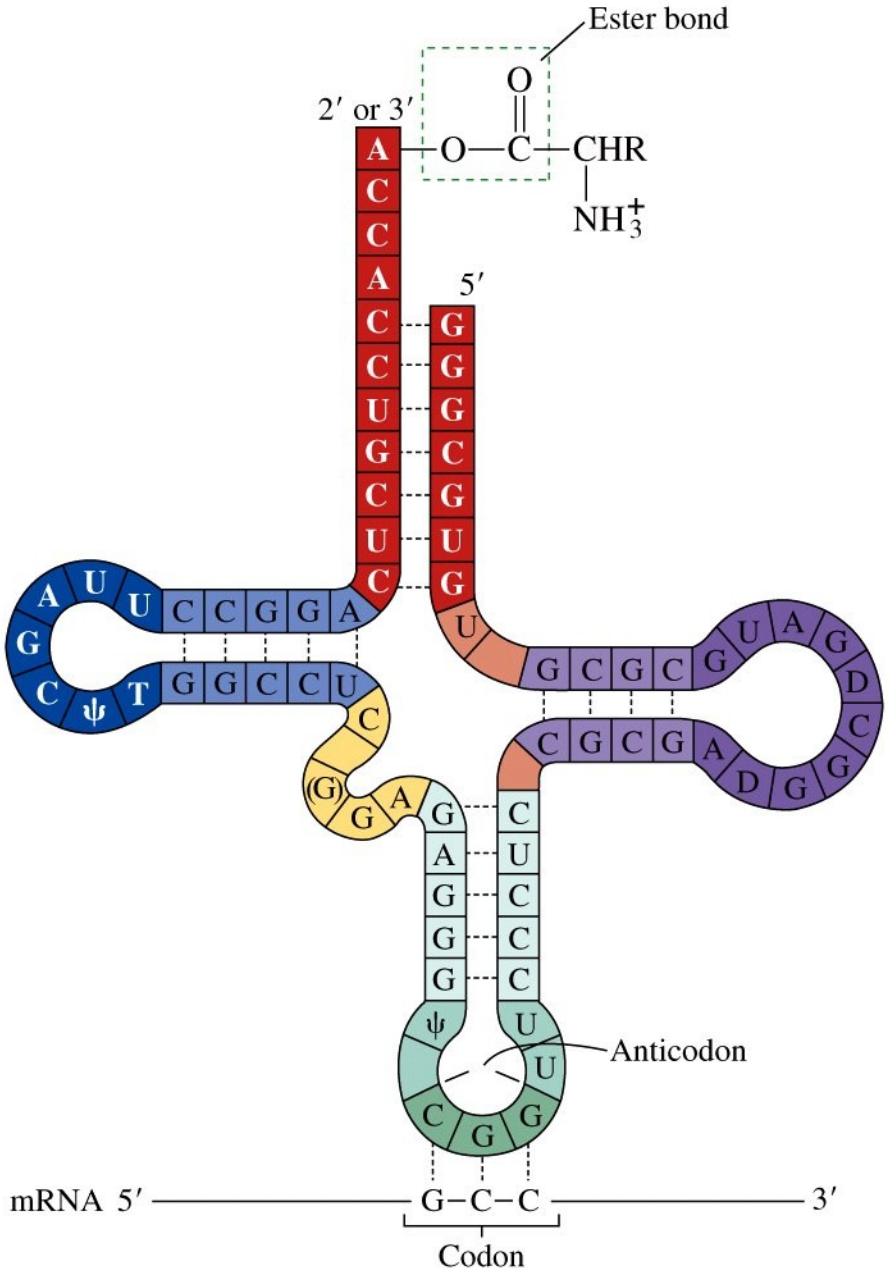
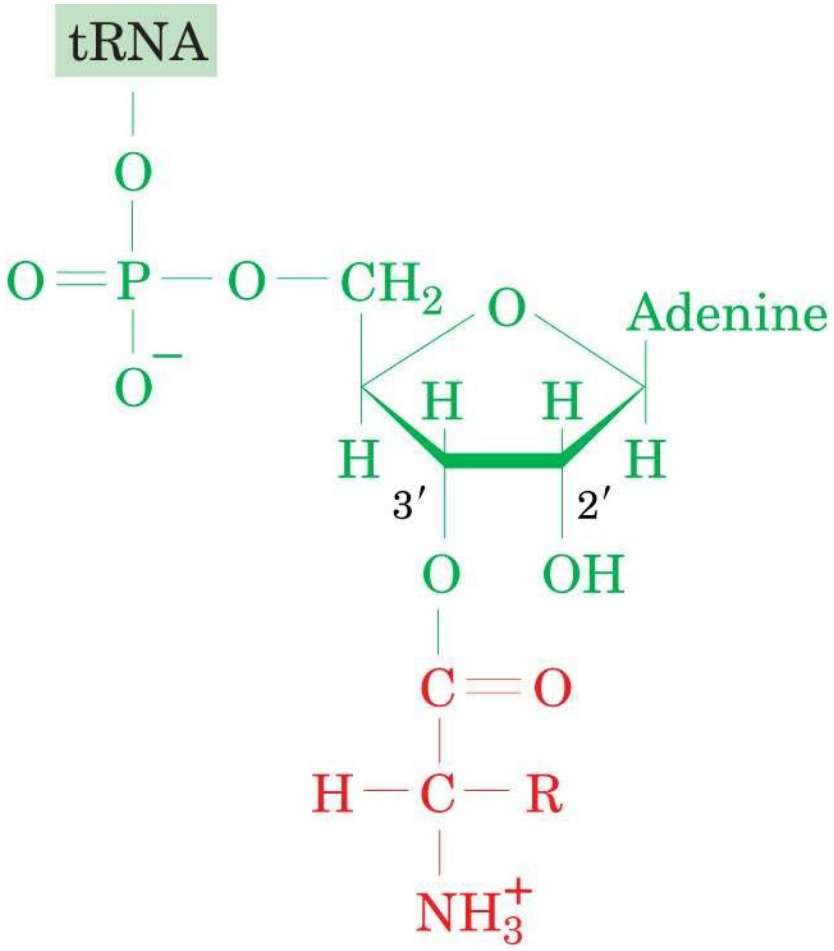
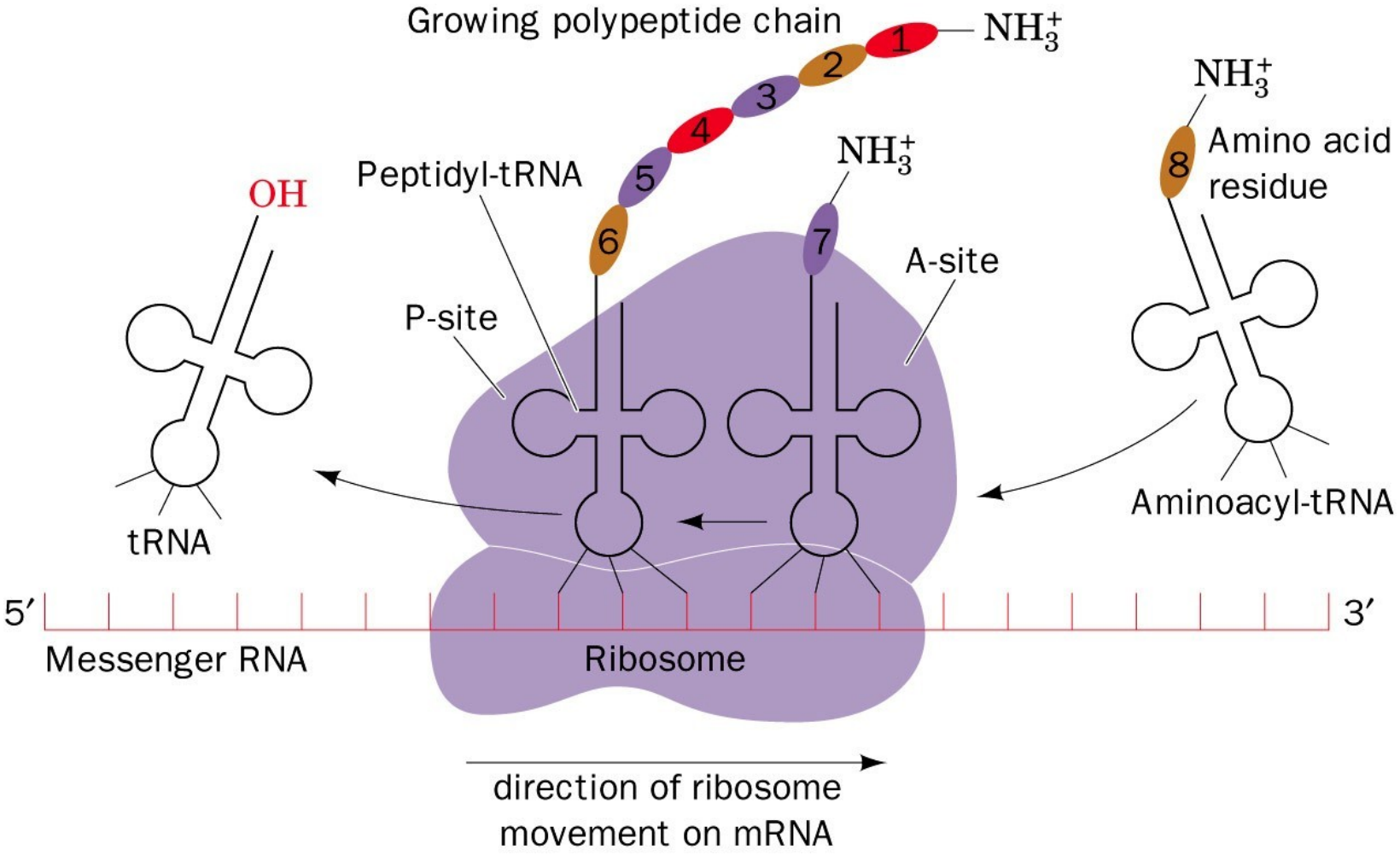


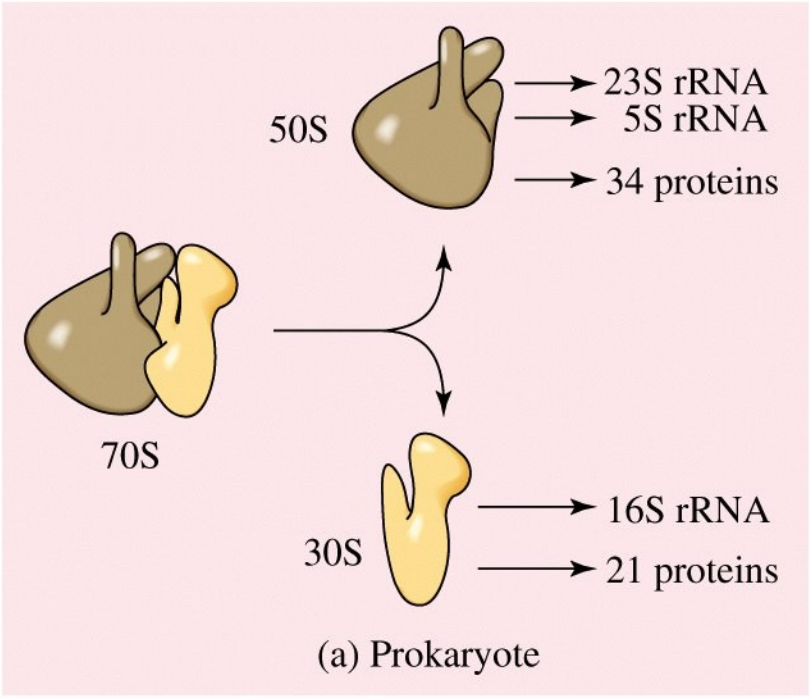
Figure 12-3 Concepts in Biochemistry, 3/e



Aminoacyl–tRNA


Growing polypeptide chain
NH_3^+
1
2
3
4
5
6
7
8
NH_3^+
Amino acid residue
Peptidyl-tRNA
OH
P-site
A-site
tRNA
Aminoacyl-tRNA
5′
3′
Messenger RNA
Ribosome
direction of ribosome movement on mRNA

Ribozomy



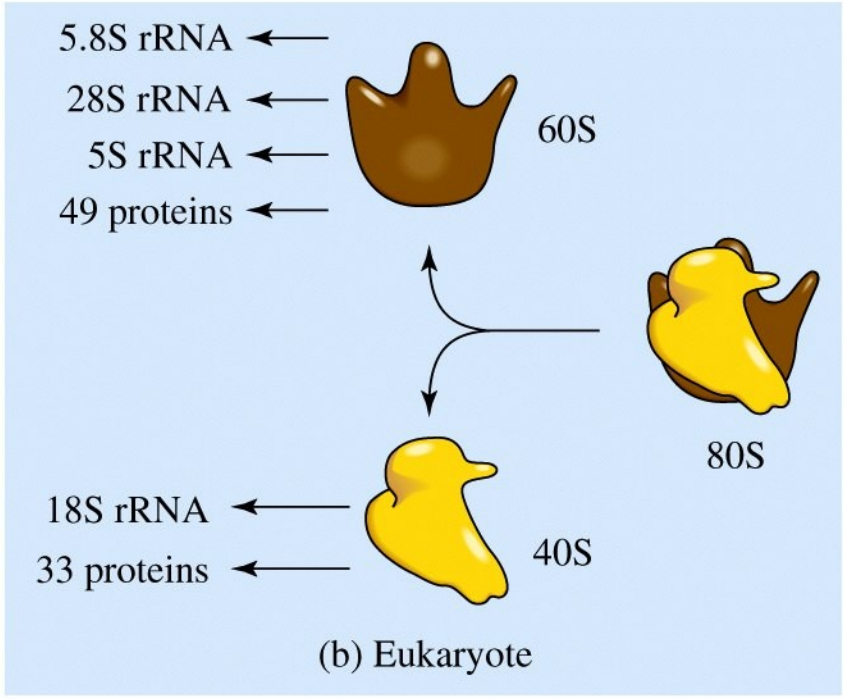
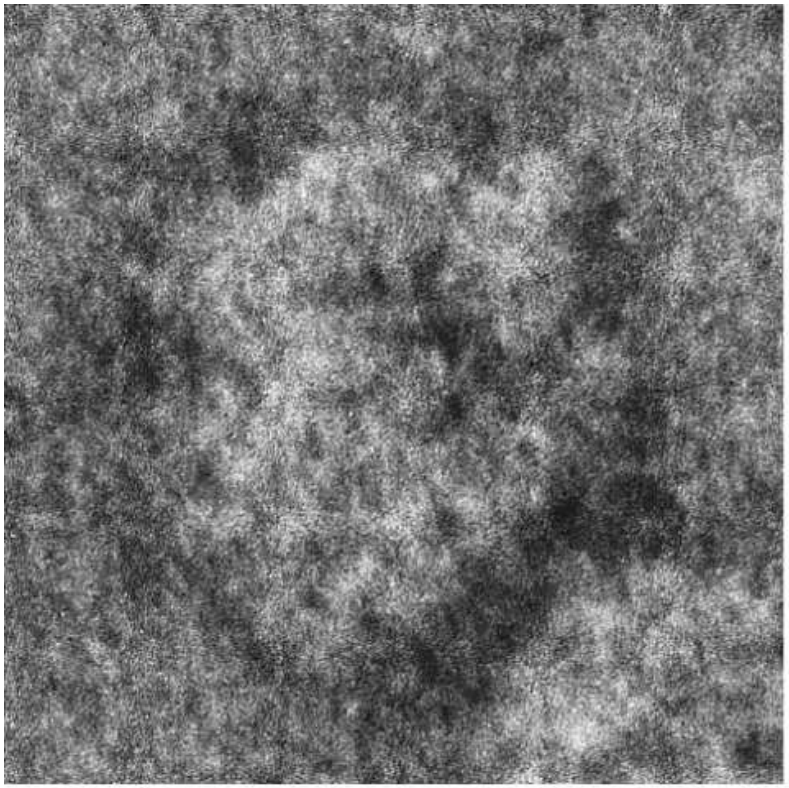
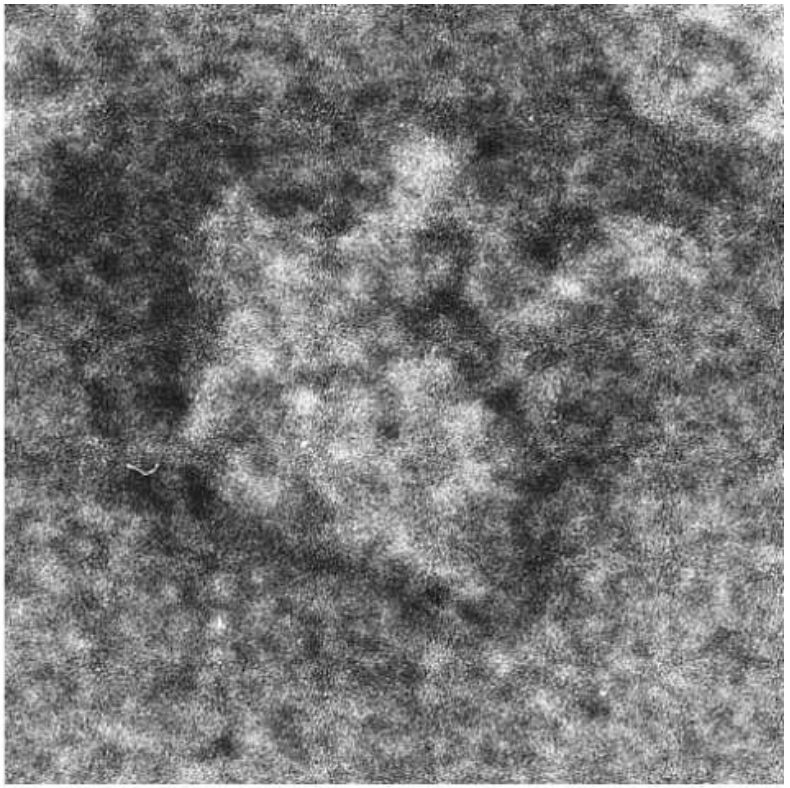


Figure 12-1 Concepts in Biochemistry, 3/e

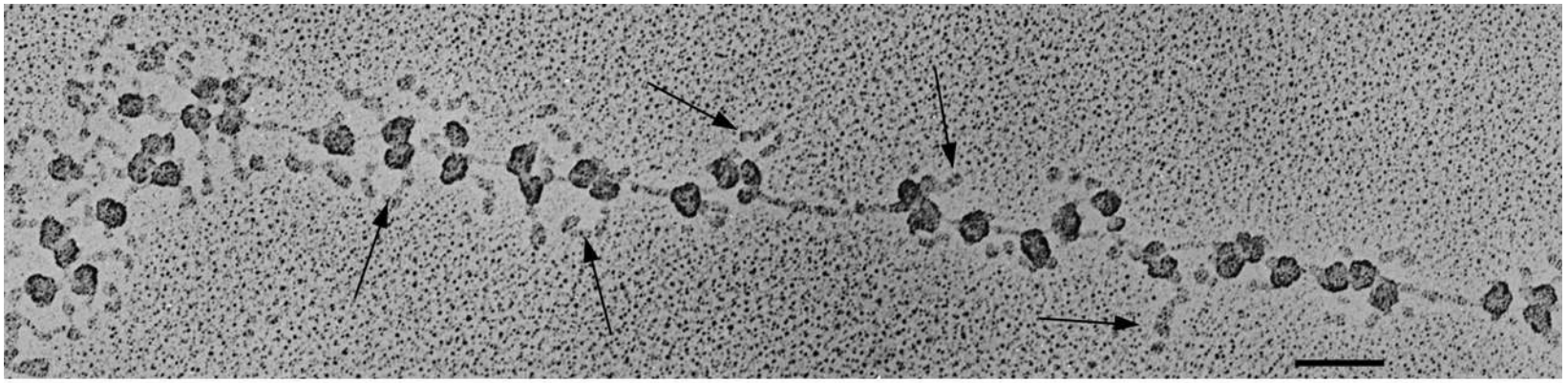
Ribozomy E.coli





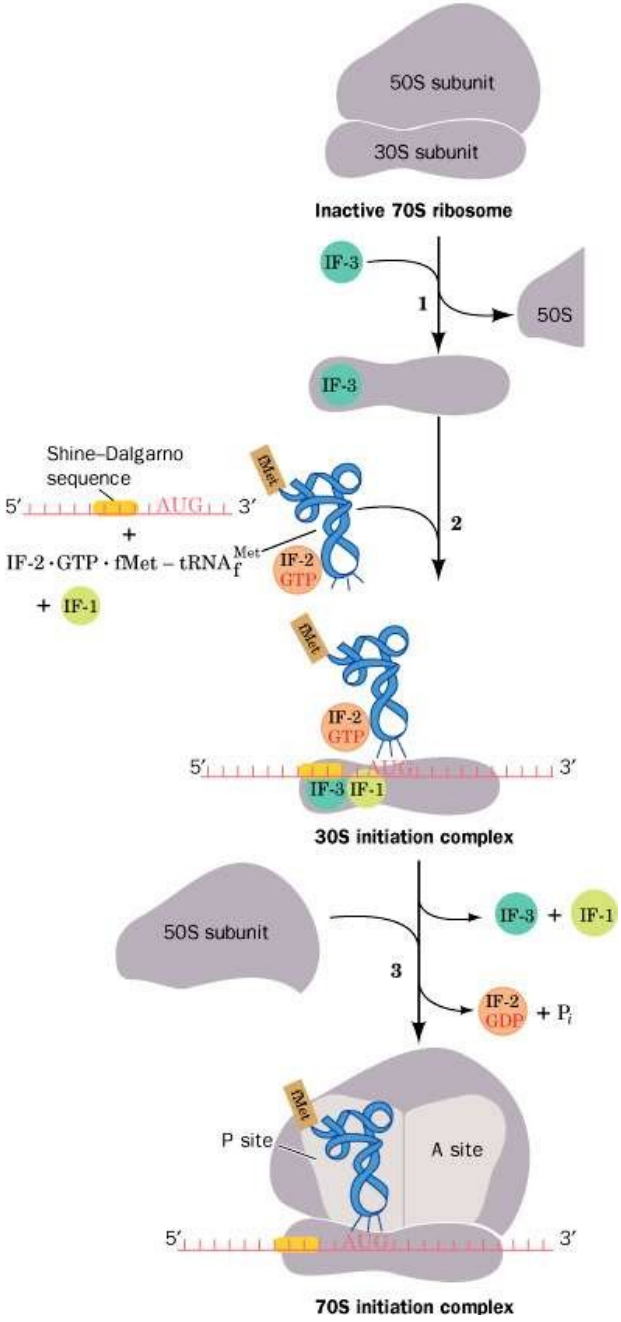
Courtesy of James Lake, UCLA

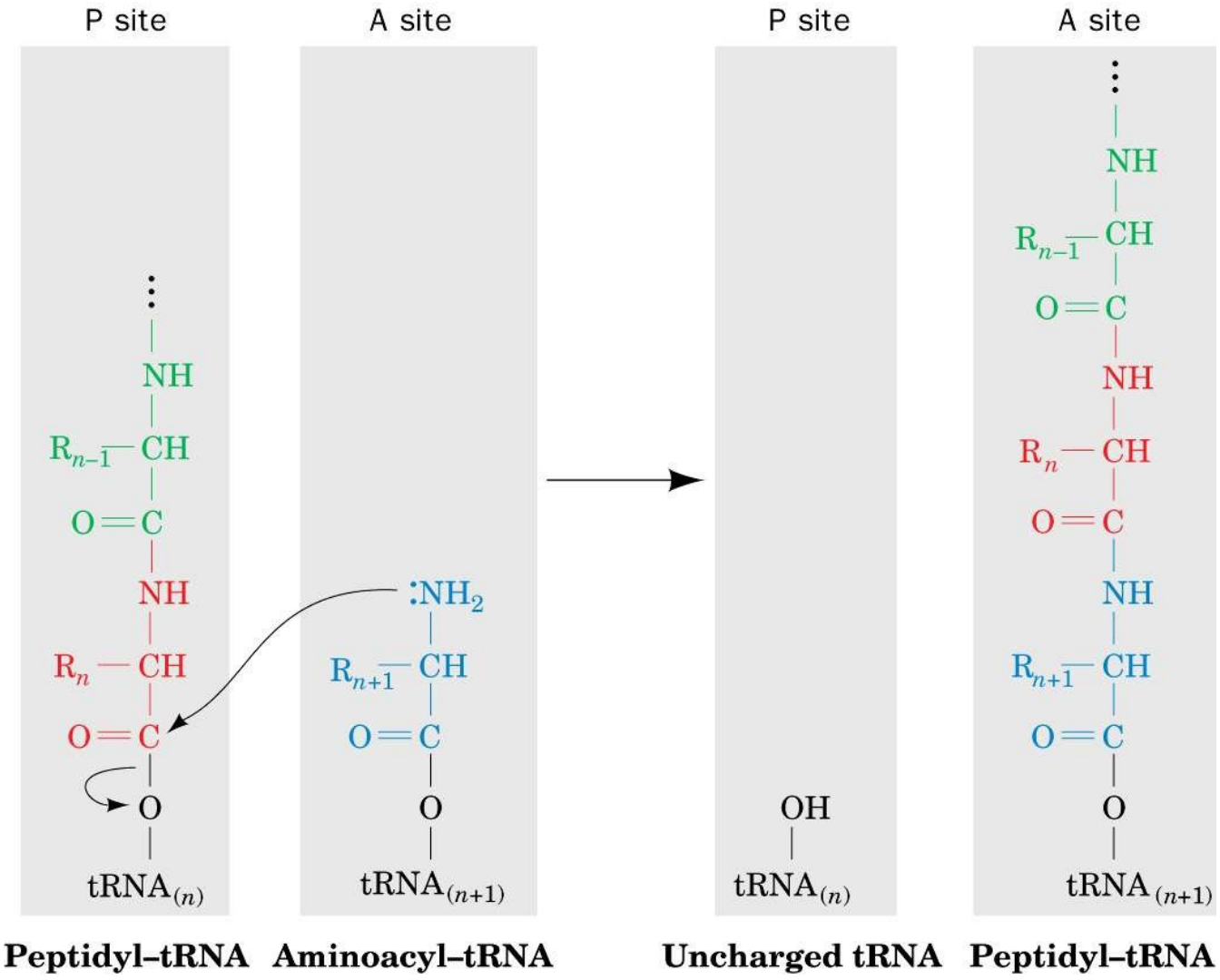
Polyribozomy *Bombyx mori*



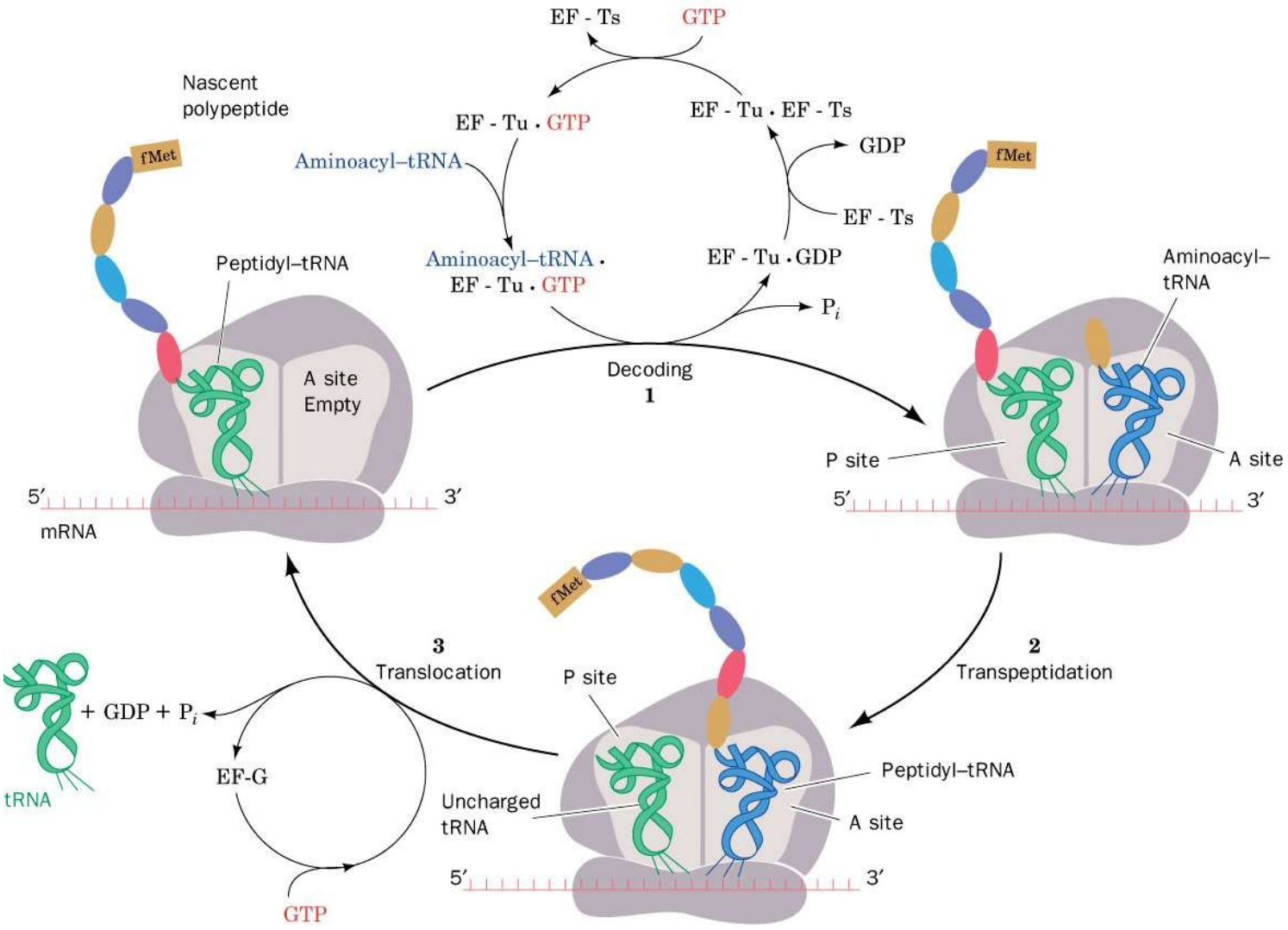
Courtesy of Oscar L. Miller, Jr. and Steven L. McKnight, University of Virginia

Inicializace

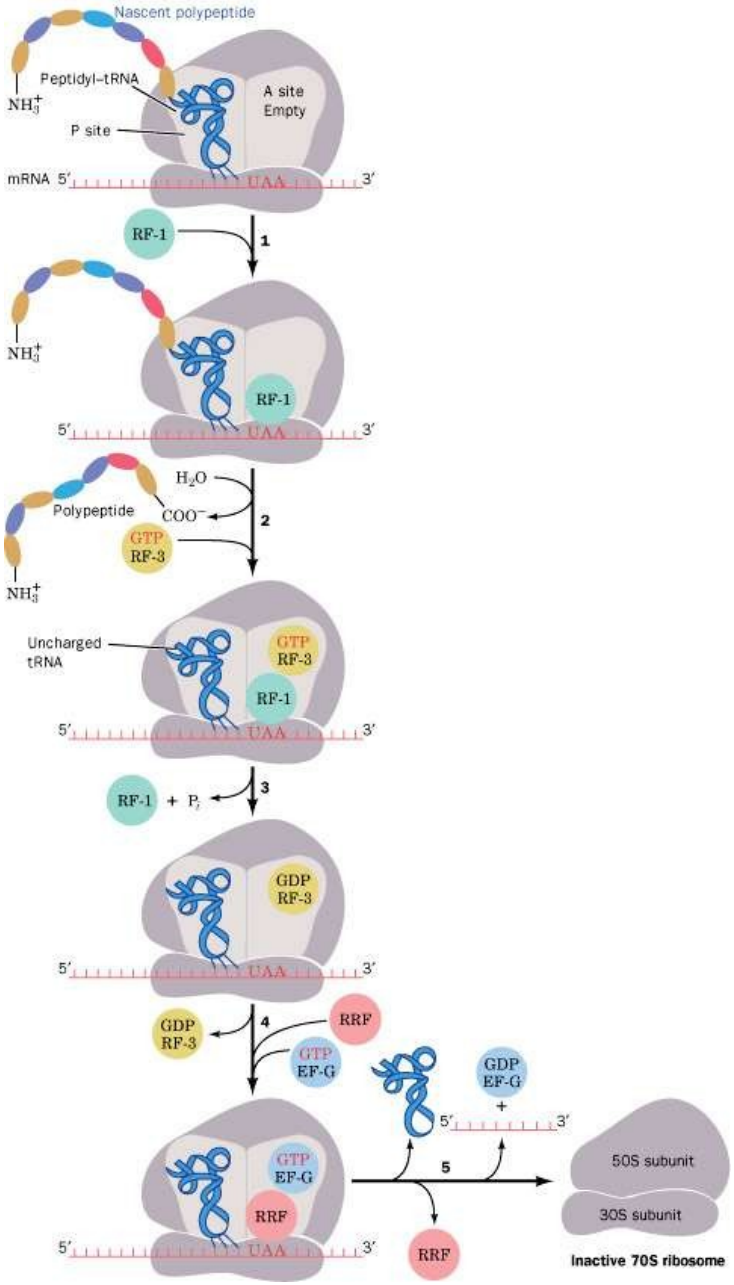



P site
A site
P site
A site
NH
R_{n-1} CH
O=C
NH
R_n CH
O=C
O
$tRNA_{(n)}$
$:NH_2$
R_{n+1} CH
O=C
O
$tRNA_{(n+1)}$
OH
$tRNA_{(n)}$
NH
R_{n-1} CH
O=C
NH
R_n CH
O=C
NH
R_{n+1} CH
O=C
O
$tRNA_{(n+1)}$
Peptidyl–tRNA
Aminoacyl–tRNA
Uncharged tRNA
Peptidyl–tRNA

Elongace


EF - Ts
GTP
Nascent polypeptide
EF - Tu · GTP
EF - Tu · EF - Ts
GDP
fMet
Aminoacyl–tRNA
EF - Ts
Peptidyl–tRNA
Aminoacyl–tRNA · EF - Tu · GTP
EF - Tu · GDP
Aminoacyl–tRNA
P_i
A site Empty
Decoding 1
P site
A site
5′
3′
mRNA
3 Translocation
2 Transpeptidation
+ GDP + P_i
tRNA
EF-G
Uncharged tRNA
Peptidyl–tRNA
GTP

Terminace


Nascent polypeptide
Peptidyl–tRNA
NH_3^+
A site
Empty
P site
mRNA 5′
UAA
3′
RF-1
1
Polypeptide
H_2O
COO^-
GTP
RF-3
2
Uncharged
tRNA
RF-1 + P_i
3
GDP
RF-3
RRF
GTP
EF-G
4
GDP
EF-G
+
5
50S subunit
30S subunit
Inactive 70S ribosome

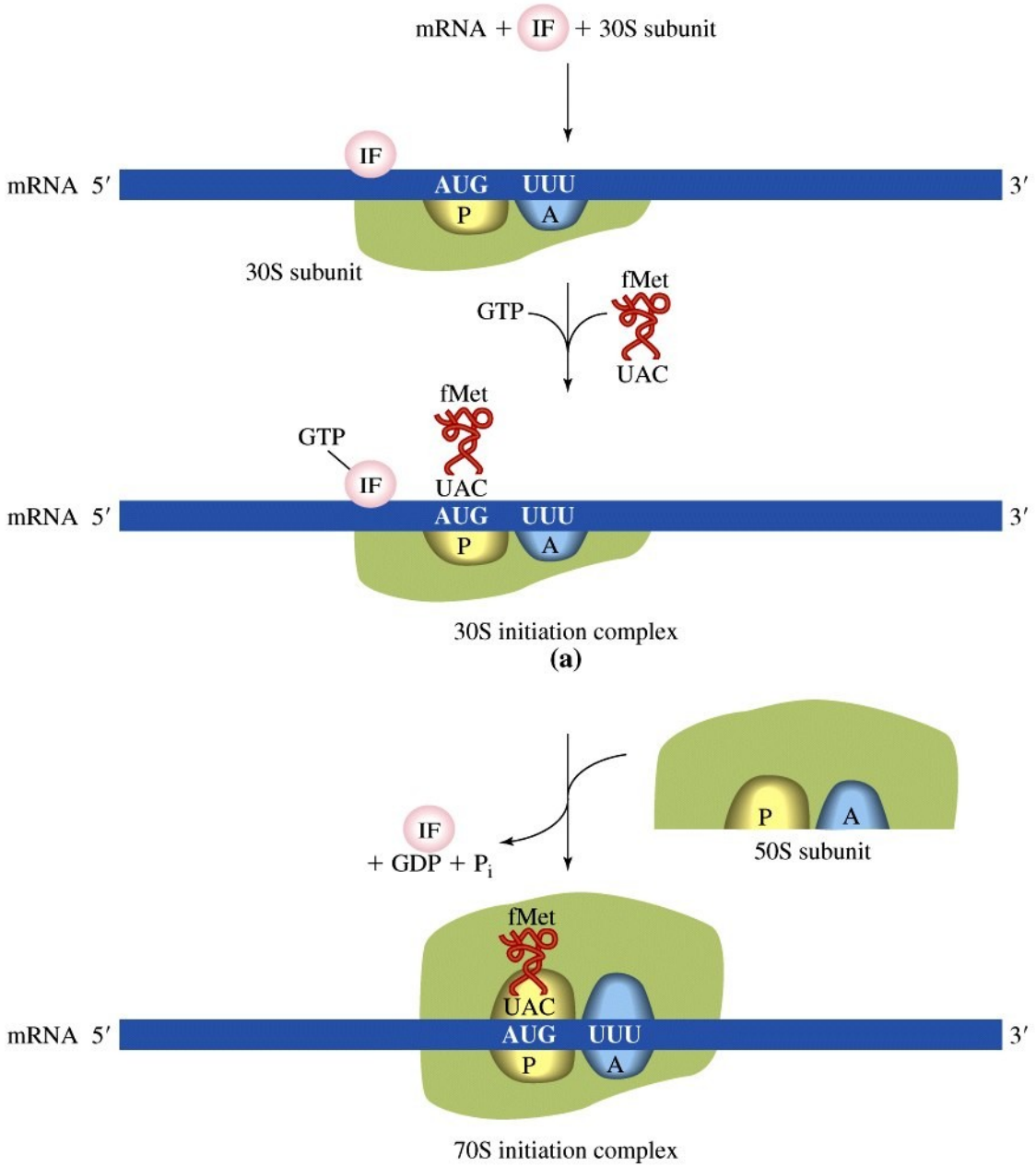


Figure 12-5a Concepts in Biochemistry, 3/e

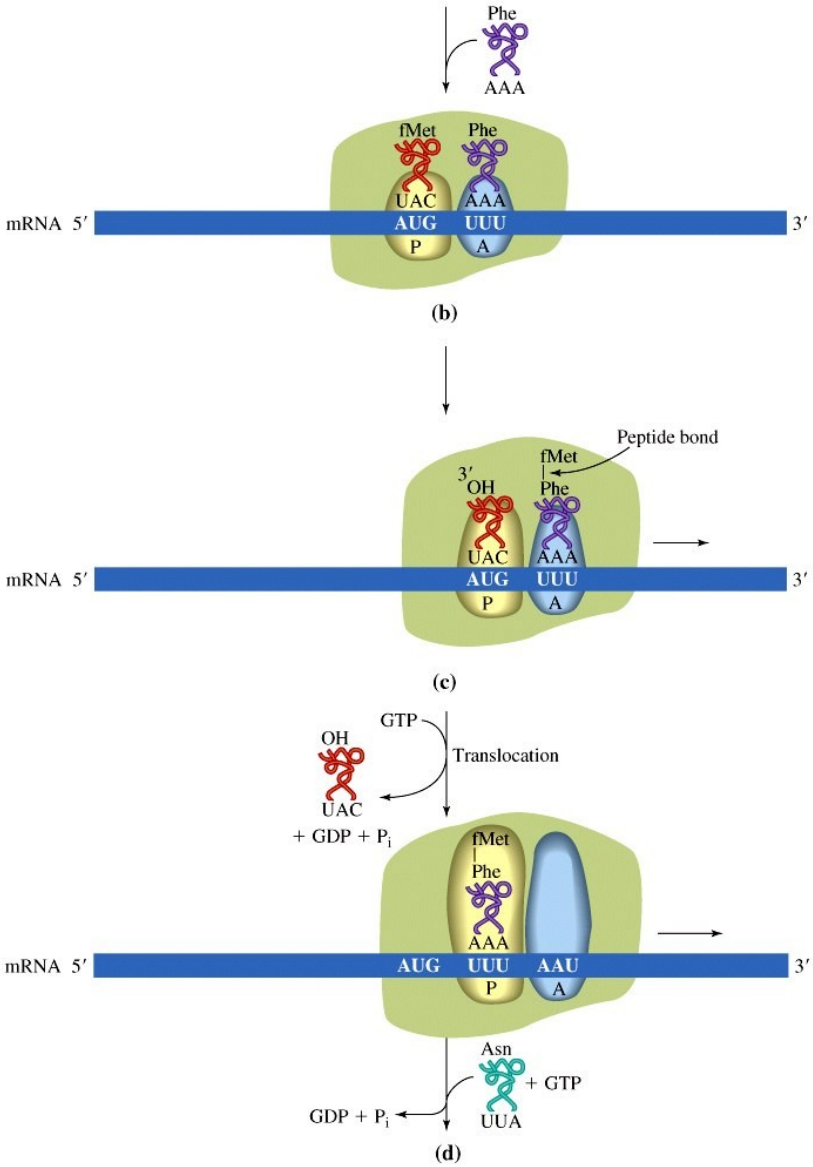


Figure 12-5b Concepts in Biochemistry, 3/e

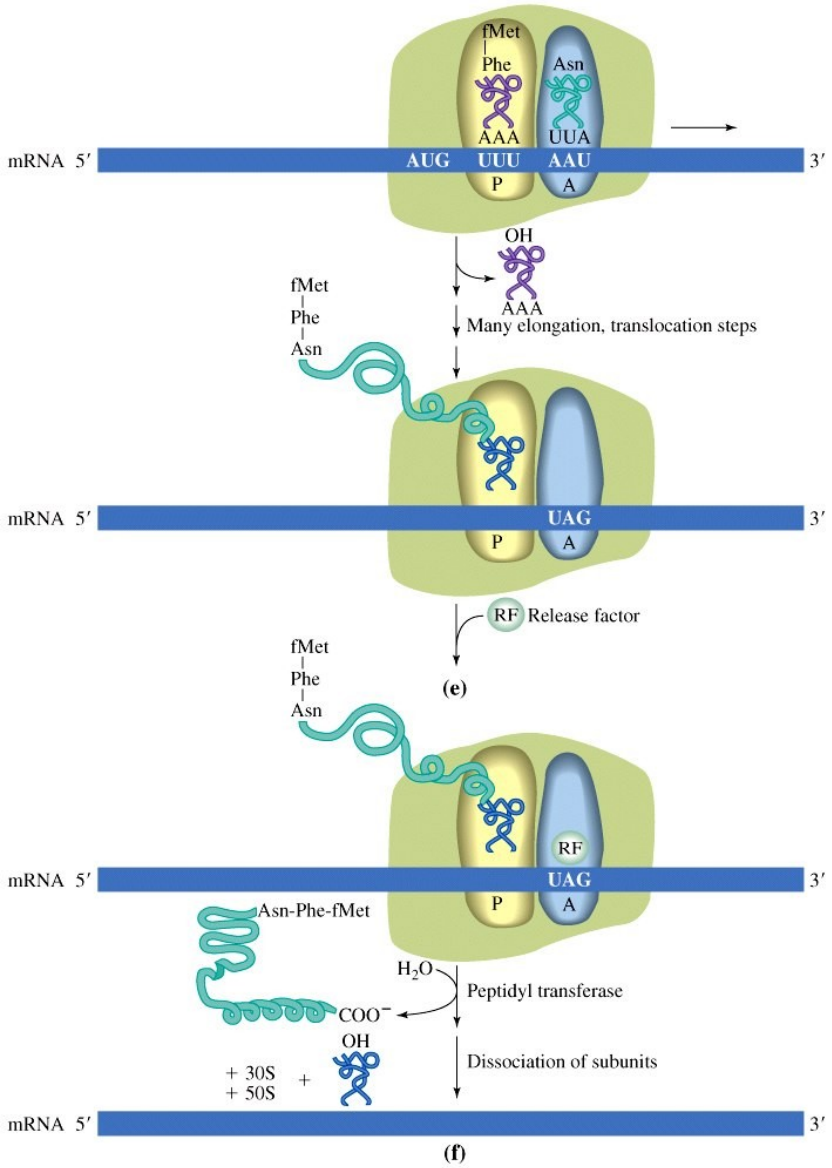


Figure 12-5c Concepts in Biochemistry, 3/e

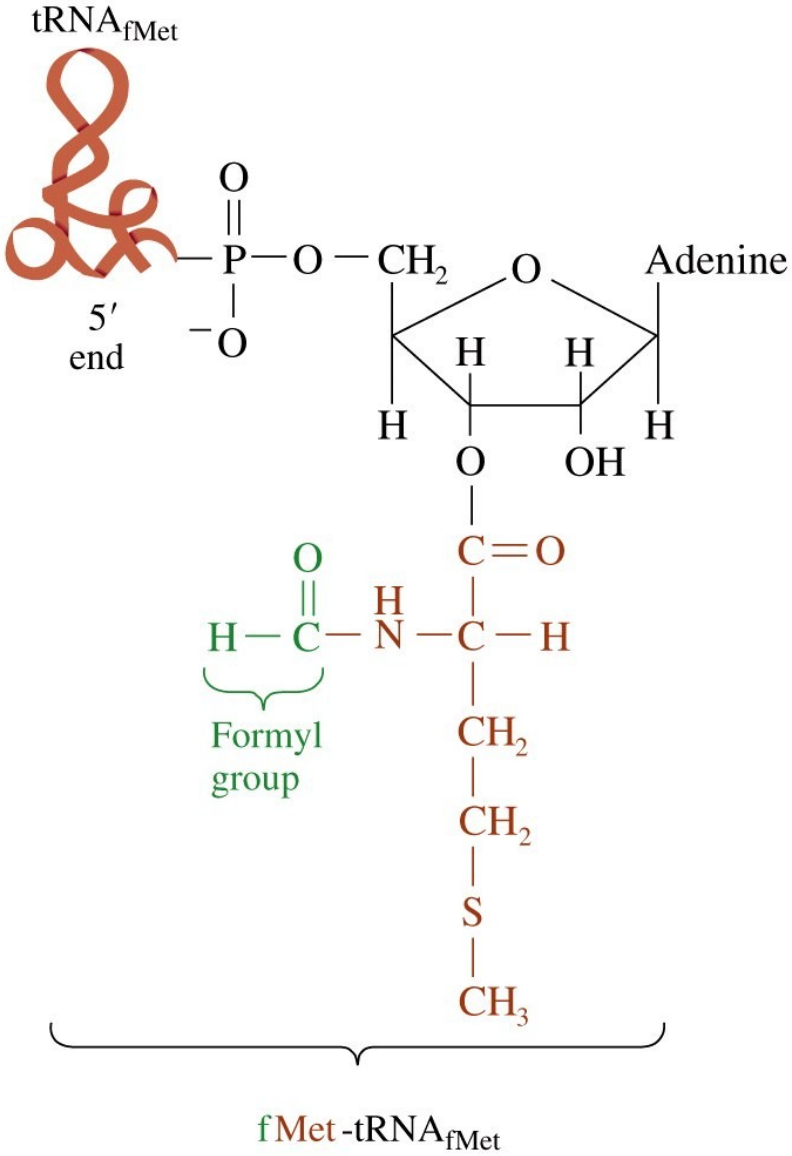


Figure 12-6 Concepts in Biochemistry, 3/e

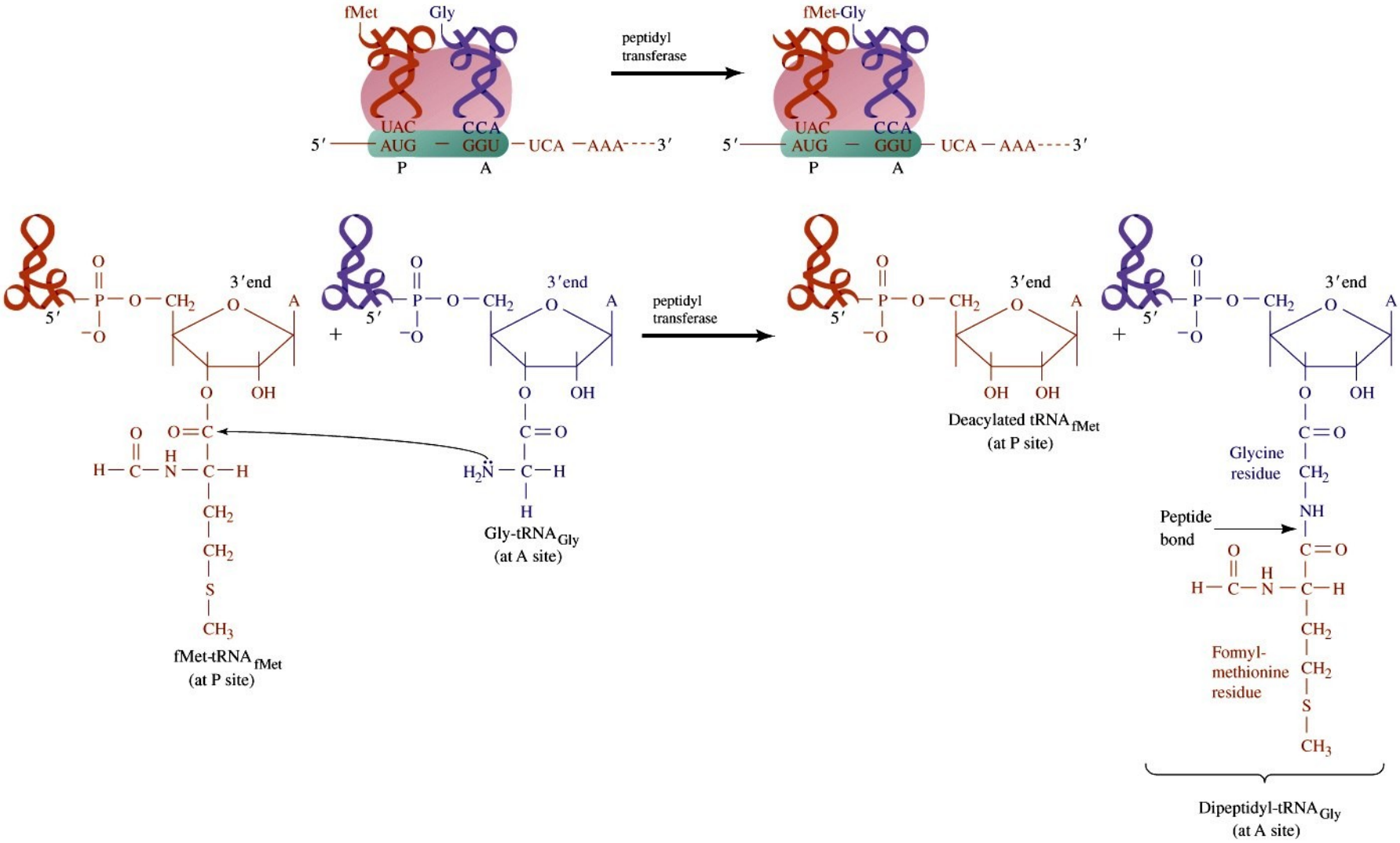


Figure 12-7 Concepts in Biochemistry, 3/e

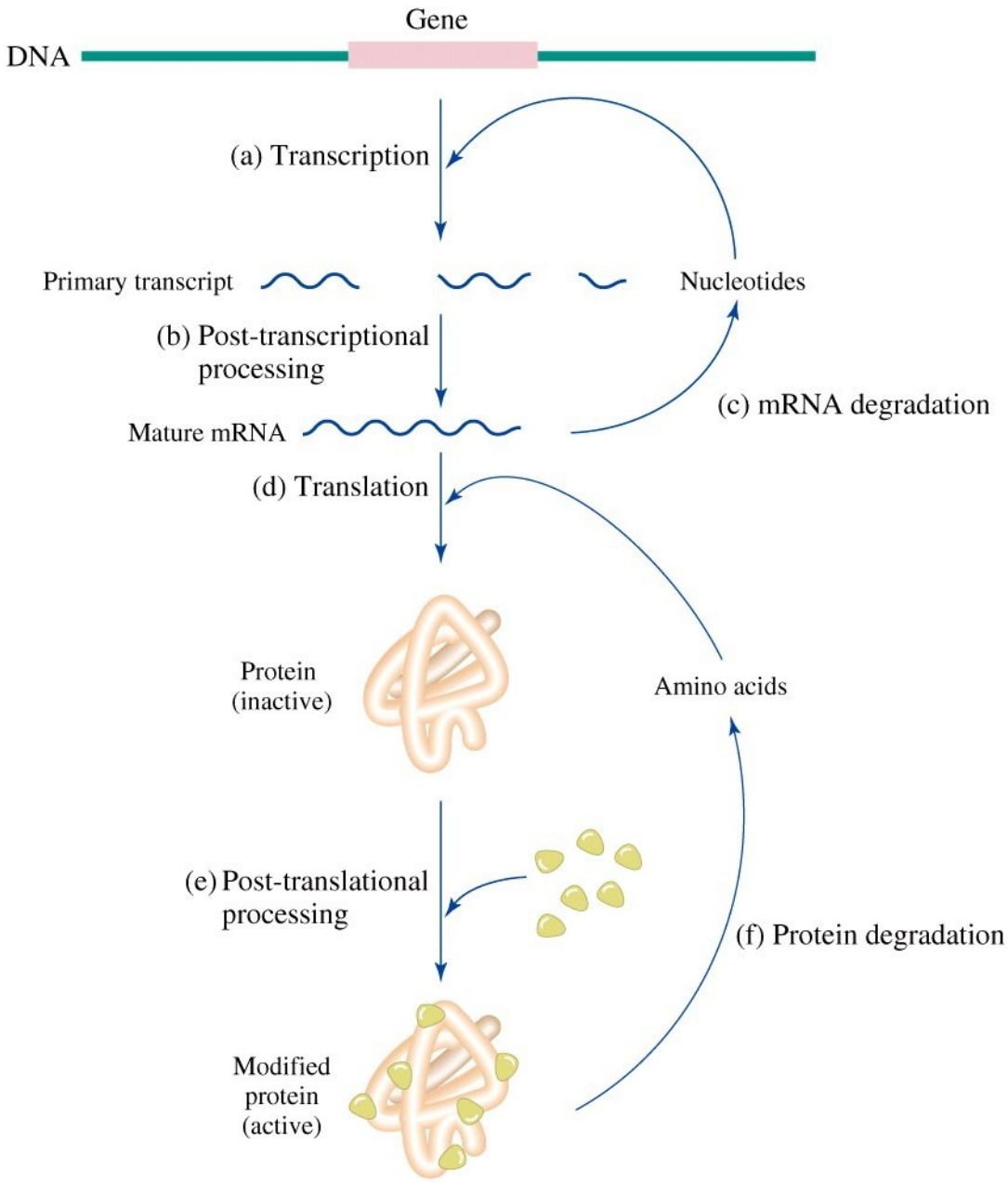


Figure 12-16 Concepts in Biochemistry, 3/e

Kontrola exprese genu

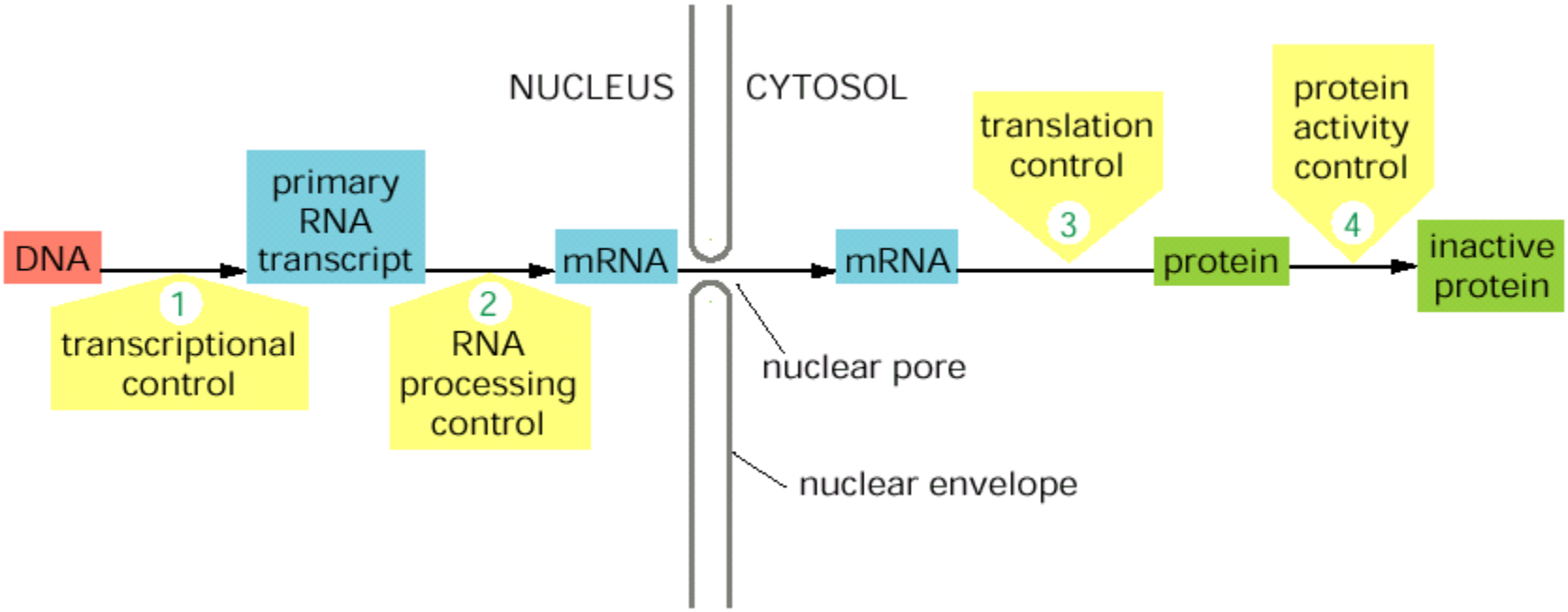
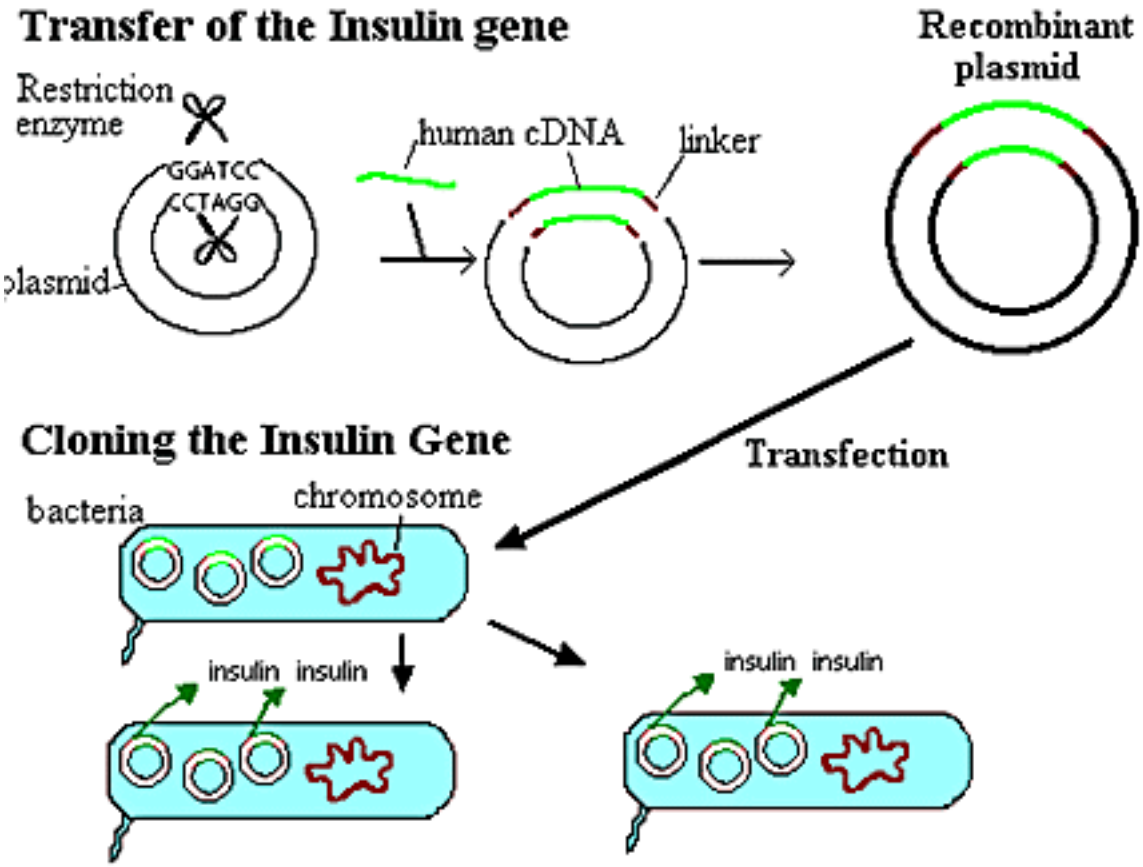


Table 12.4
Antibiotic inhibitors of protein synthesis

Antibiotic	Mode of Action
Puromycin	Causes early termination by mimicking the action of an aminoacyl-tRNA; acts on prokaryotes and eukaryotes
Streptomycin	Causes misreading of mRNA and inhibits initiation; acts on prokaryotes
Tetracycline	Binds to the A site of ribosomes and blocks entry of aminoacyl-tRNAs; acts on prokaryotes
Erythromycin	Binds to ribosome and inhibits translocation; acts on prokaryotes
Chloramphenicol	Binds to 50S subunit and inhibits peptidyl transferase; acts on prokaryotes
Cycloheximide	Inhibits translocation of eukaryotic peptidyl-tRNA
Linezolid	Blocks formation of 70S initiation complex in prokaryotes

Table 12-4 Concepts in Biochemistry, 3/e

Genetické inženýrství



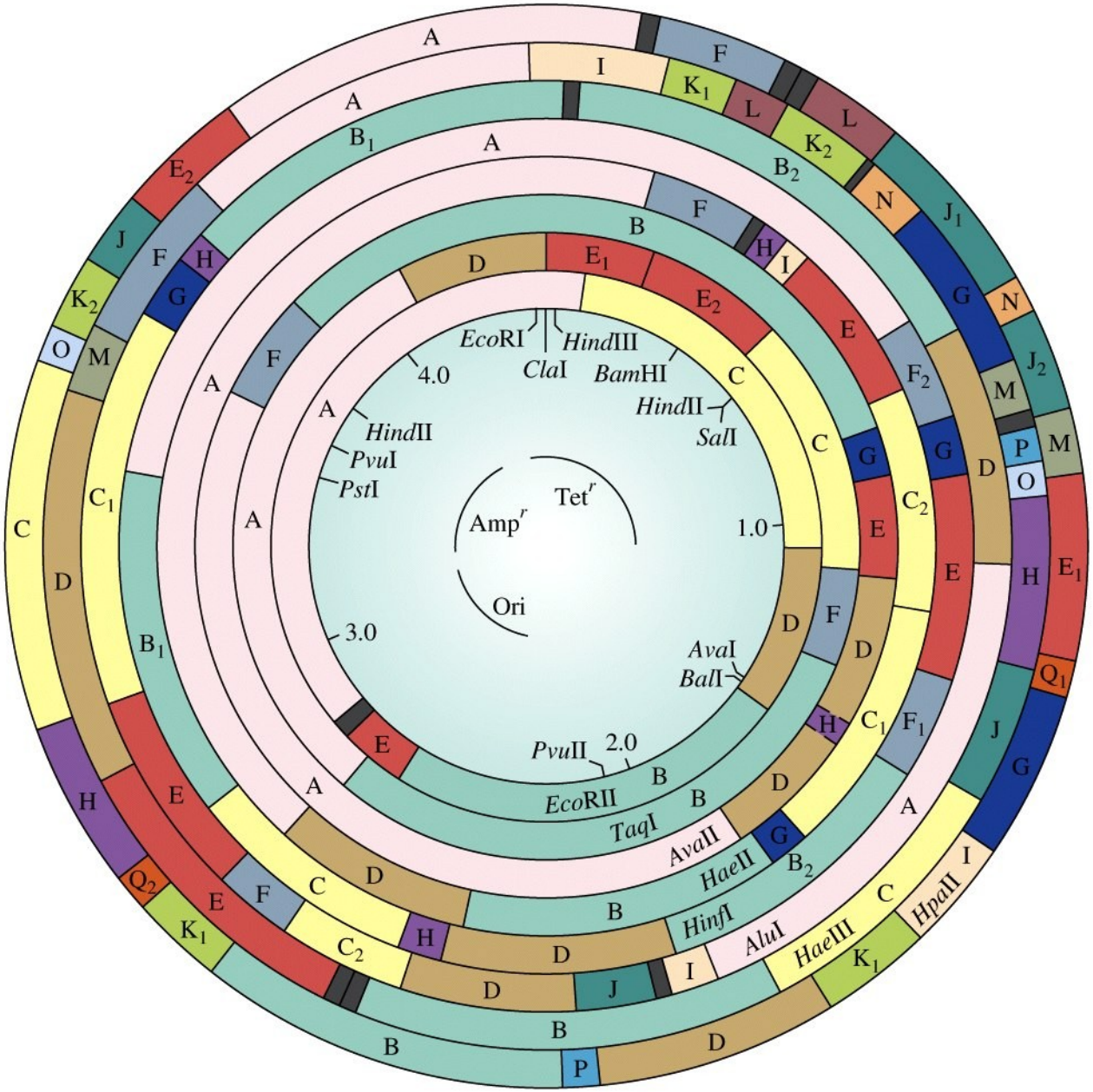


Figure 13-8 Concepts in Biochemistry, 3/e

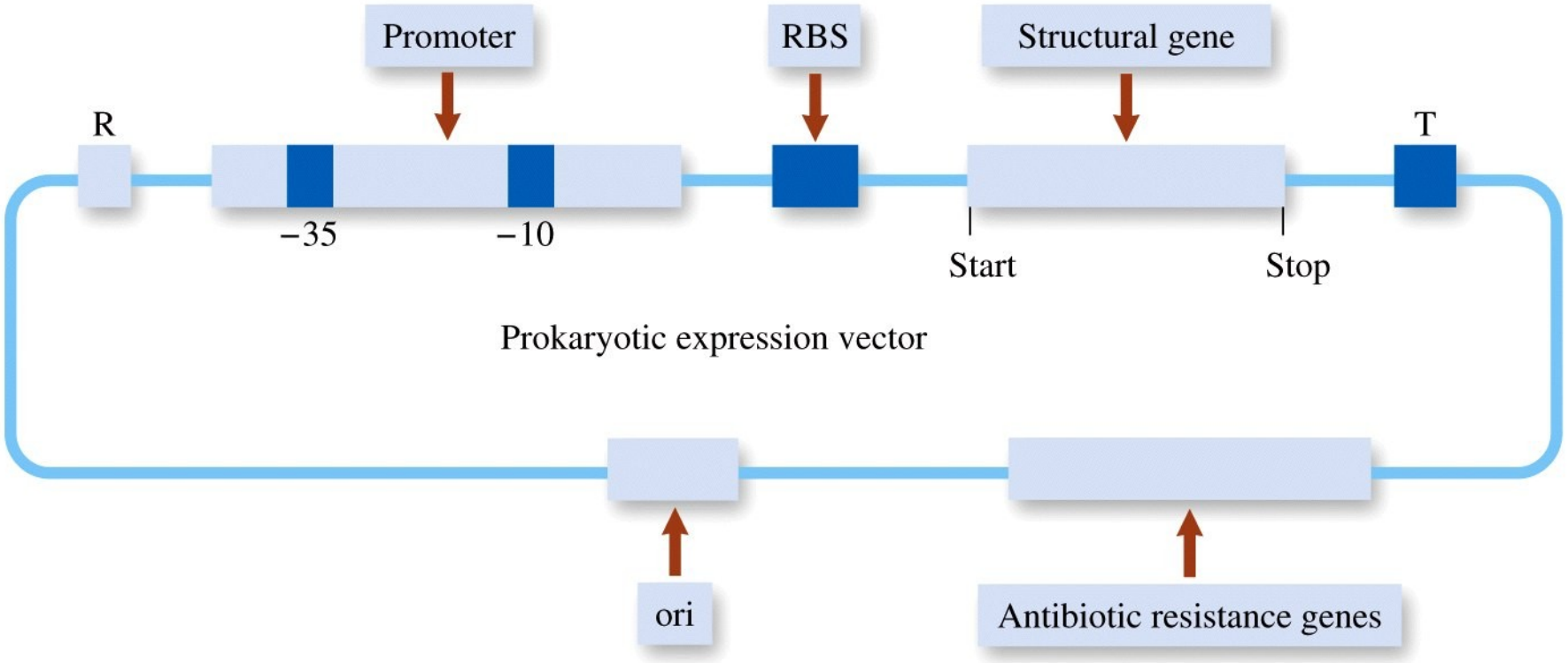
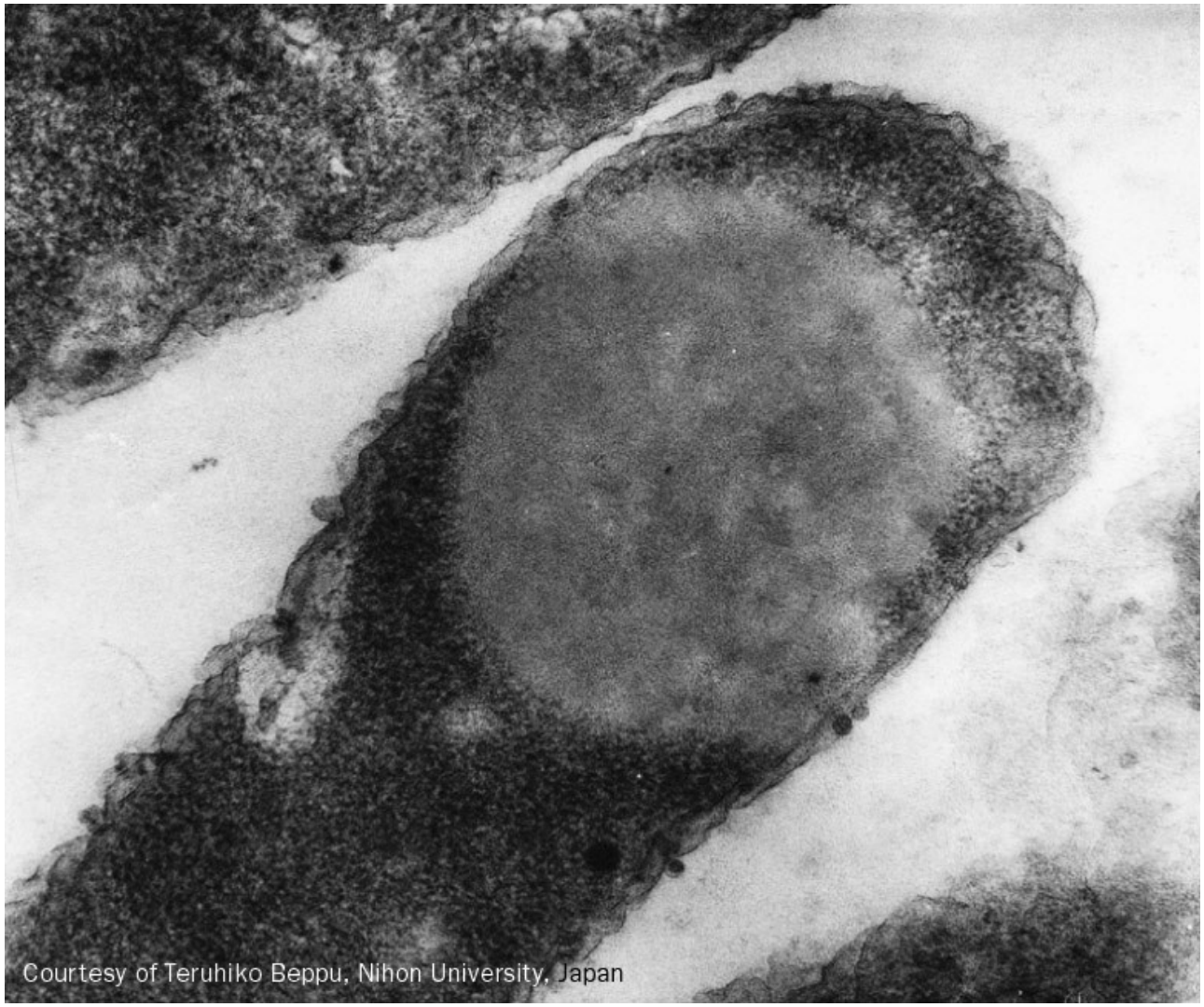
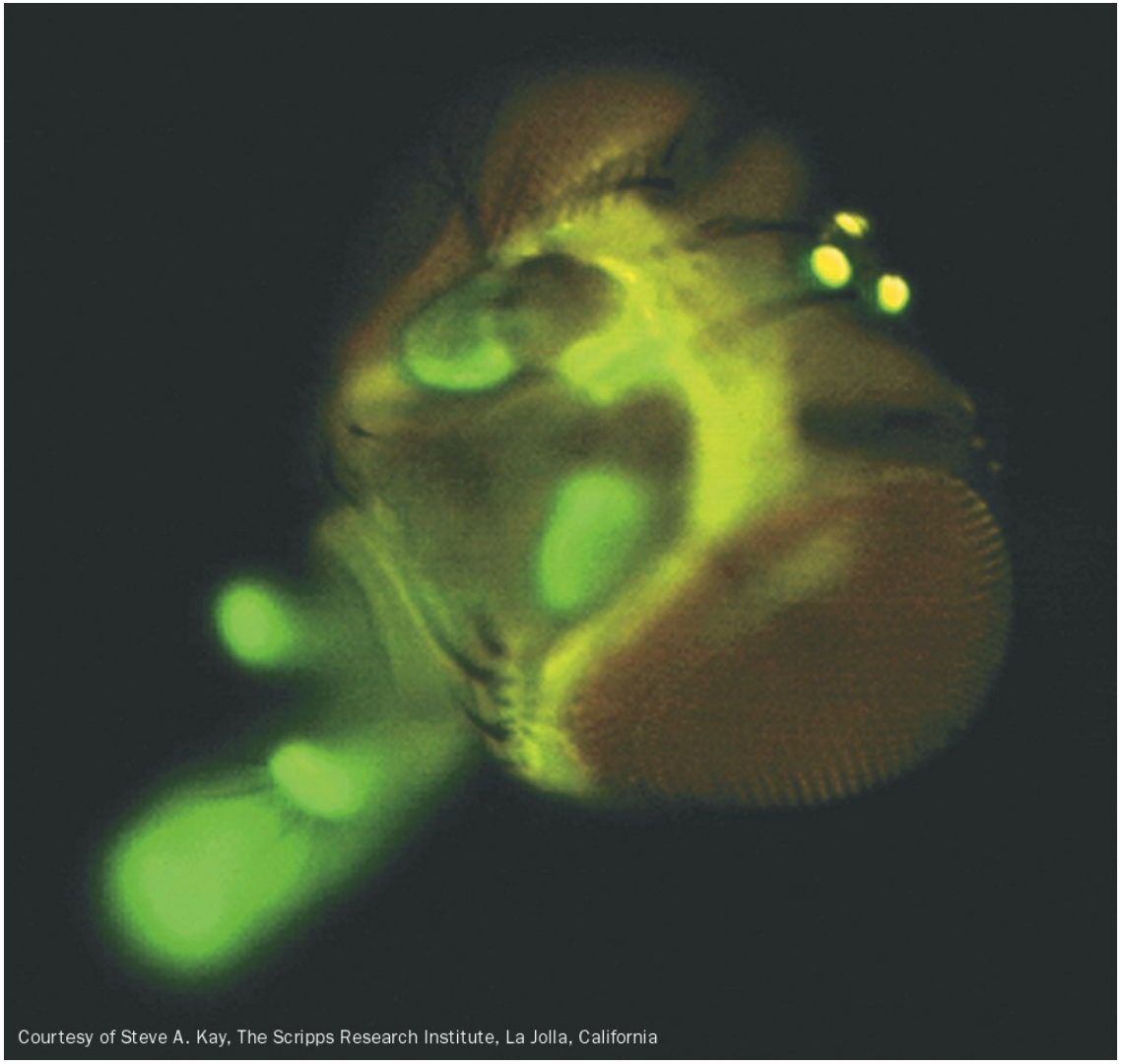


Figure 13-3 Concepts in Biochemistry, 3/e

Inklusní tělíska



Green Fluorescent Protein



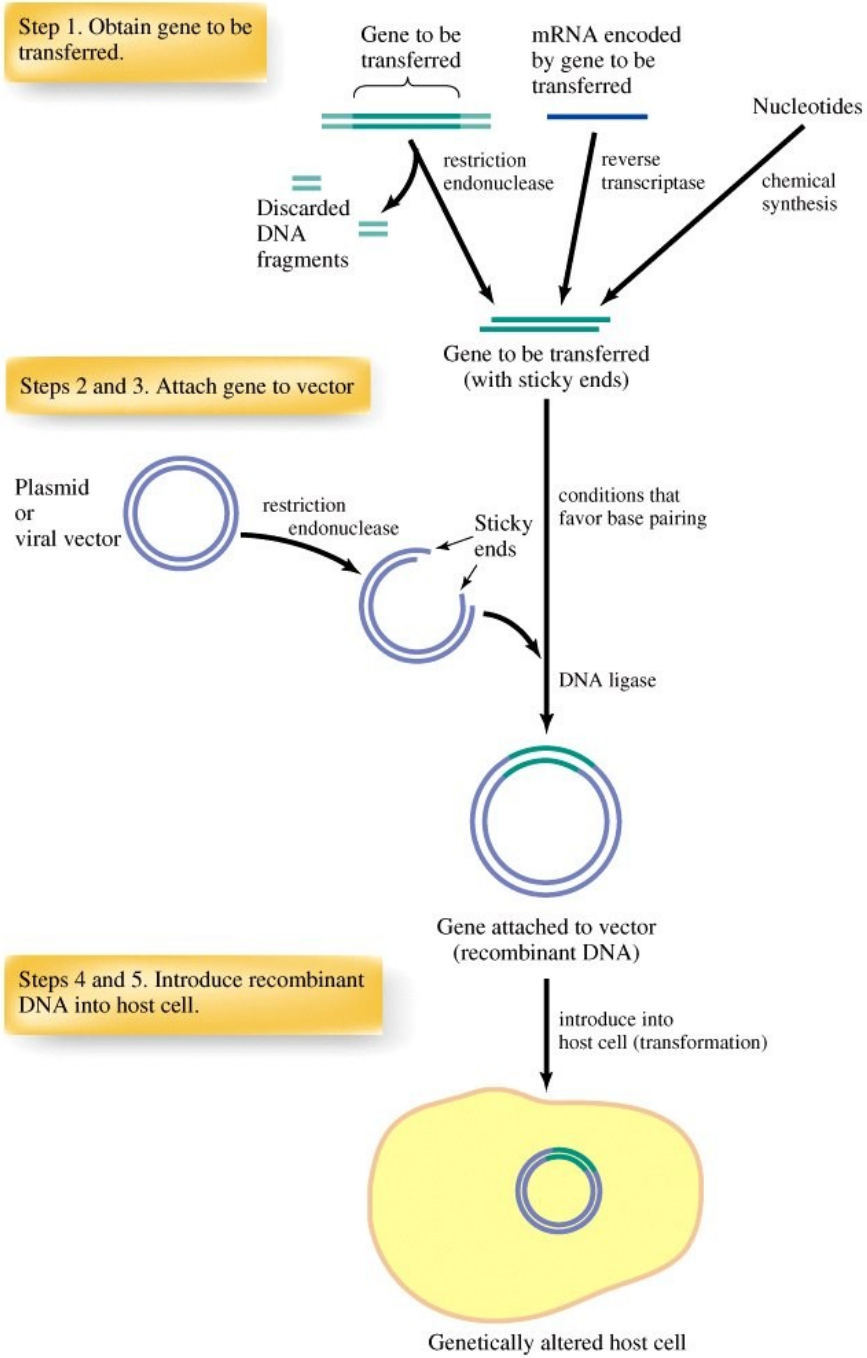


Figure 13-1 Concepts in Biochemistry, 3/e

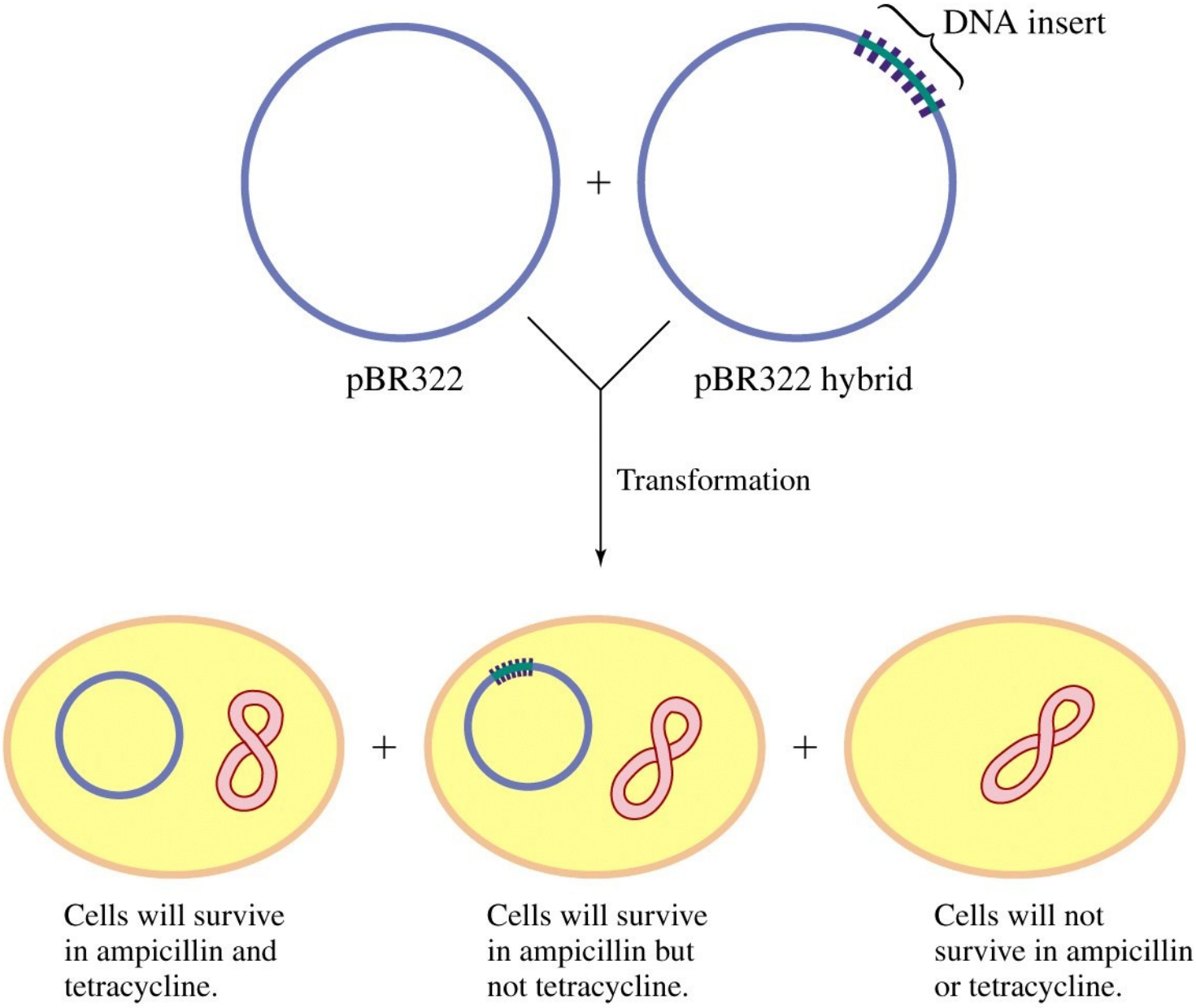


Figure 13-6 part 3 Concepts in Biochemistry, 3/e

Table 13.1
Recombinant proteins and their use

Protein	Use
Human insulin	Treatment of diabetes
Human somatotropin (growth hormone)	Treatment of dwarfism
Bovine somatotropin (BST)	Enhances milk production in dairy cattle
Porcine somatotropin	Enhances growth in pigs
Pulmozyme (DNase)	Treatment of cystic fibrosis
Tissue plasminogen activator (TPA)	Treatment of heart attack, stroke victims; dissolves blood clots
Erythropoietin	Stimulates erythrocyte production in anemia
Interferons	Antiviral agent; treatment of cancers
Atrial natriuretic factor	Reduces high blood pressure
Leptin	Treatment of obesity
Hepatitis B vaccine	Treatment of hepatitis
Herceptin	Monoclonal antibody to treat metastatic breast cancer
Superoxide dismutase	Destroys reactive oxygen species; treatment of arthritis

Table 13-1 Concepts in Biochemistry, 3/e

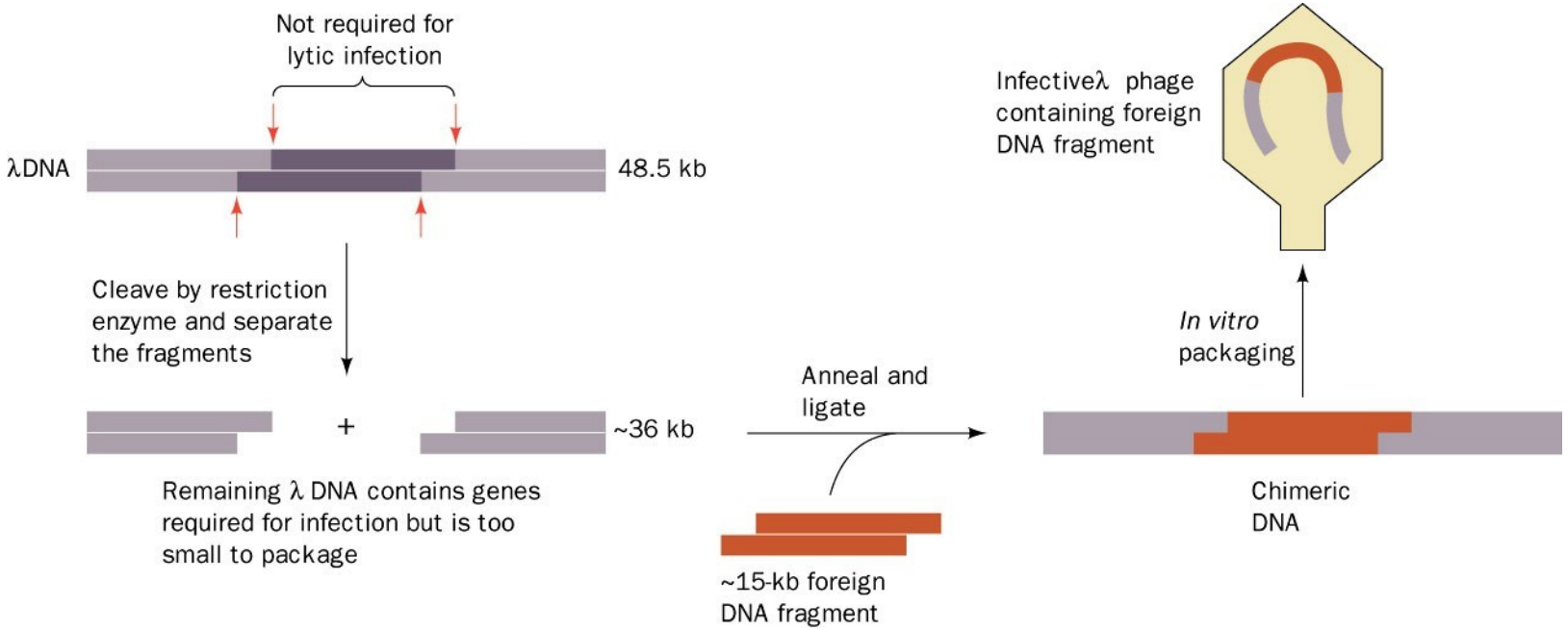

Not required for
lytic infection
λDNA
48.5 kb
Cleave by restriction
enzyme and separate
the fragments
+
~36 kb
Remaining λ DNA contains genes
required for infection but is too
small to package
Anneal and
ligate
~15-kb foreign
DNA fragment
Chimeric
DNA
In vitro
packaging
Infectiveλ phage
containing foreign
DNA fragment

Table 13.2

Human gene therapy projects currently in or preparing for clinical trials

Disease	Defective Protein, Gene, or Inserted DNA
Lesch-Nyhan syndrome	Hypoxanthine–guanine phosphoribosyl transferase (Section 19.5)
Amyotrophic lateral sclerosis (ALS, Lou Gehrig's disease)	Superoxide dismutase
Adrenoleukodystrophy (ALD)	Very long chain fatty acid synthetase transporting protein
Severe combined immunodeficiency (SCID)	Adenosine deaminase
β-Thalassemia	β-Globin, a polypeptide of hemoglobin
Familial hypercholesterolemia	Liver receptor for low density lipoprotein (LDL) (Section 18.5)
Hemophilia	Blood-clotting factors
Duchenne's muscular dystrophy	Dystrophin
AIDS	The gene to produce a ribozyme that cleaves HIV RNA
Inherited emphysema	α_1-Antitrypsin
Cystic fibrosis	A product that unclogs lung mucus is inhaled in a nasal spray
Cancer	E1A and p53 tumor suppressor genes

Table 13-2 Concepts in Biochemistry, 3/e

PCR Mullis

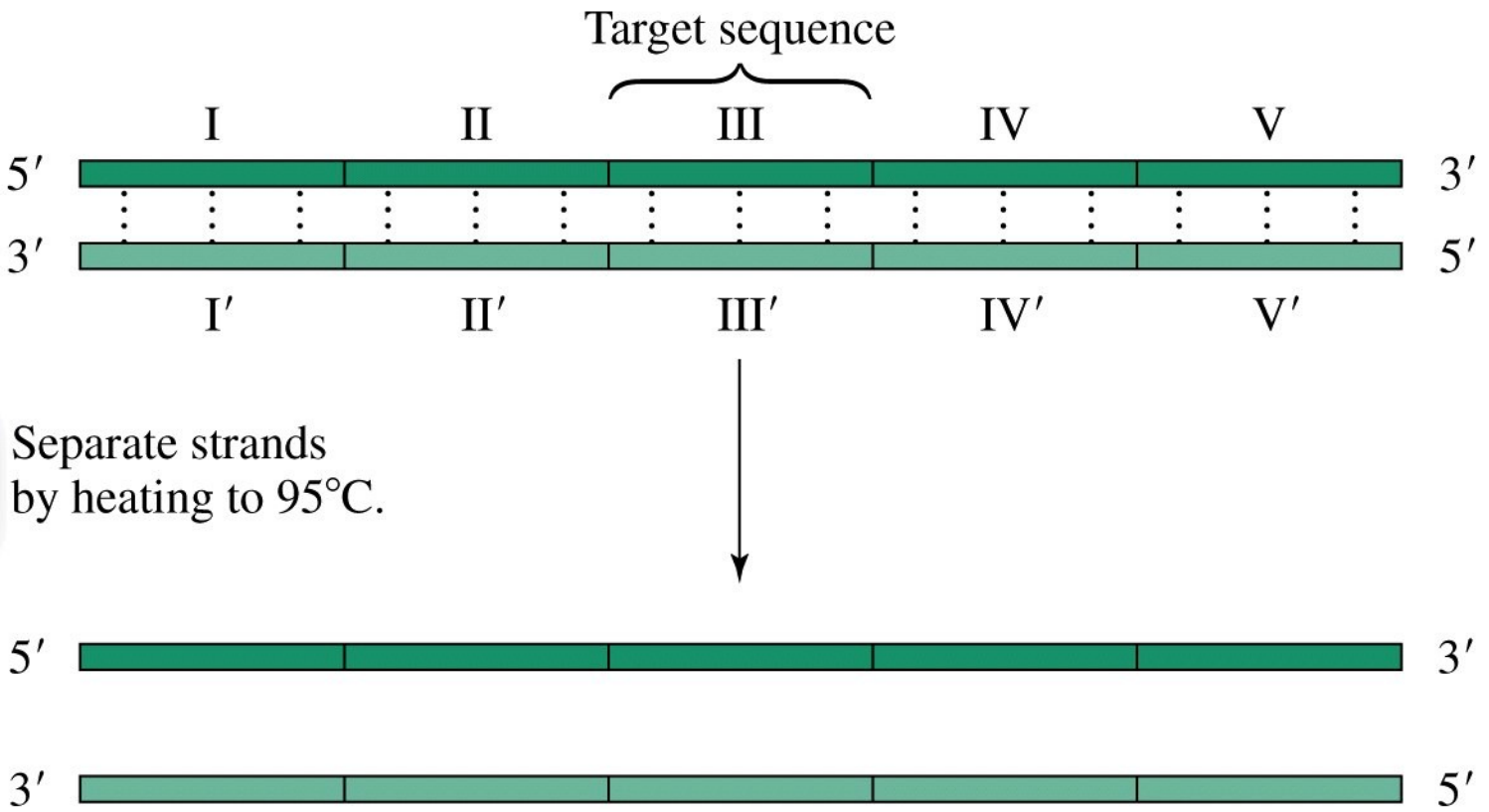


Figure 13-11 part 1 Concepts in Biochemistry, 3/e

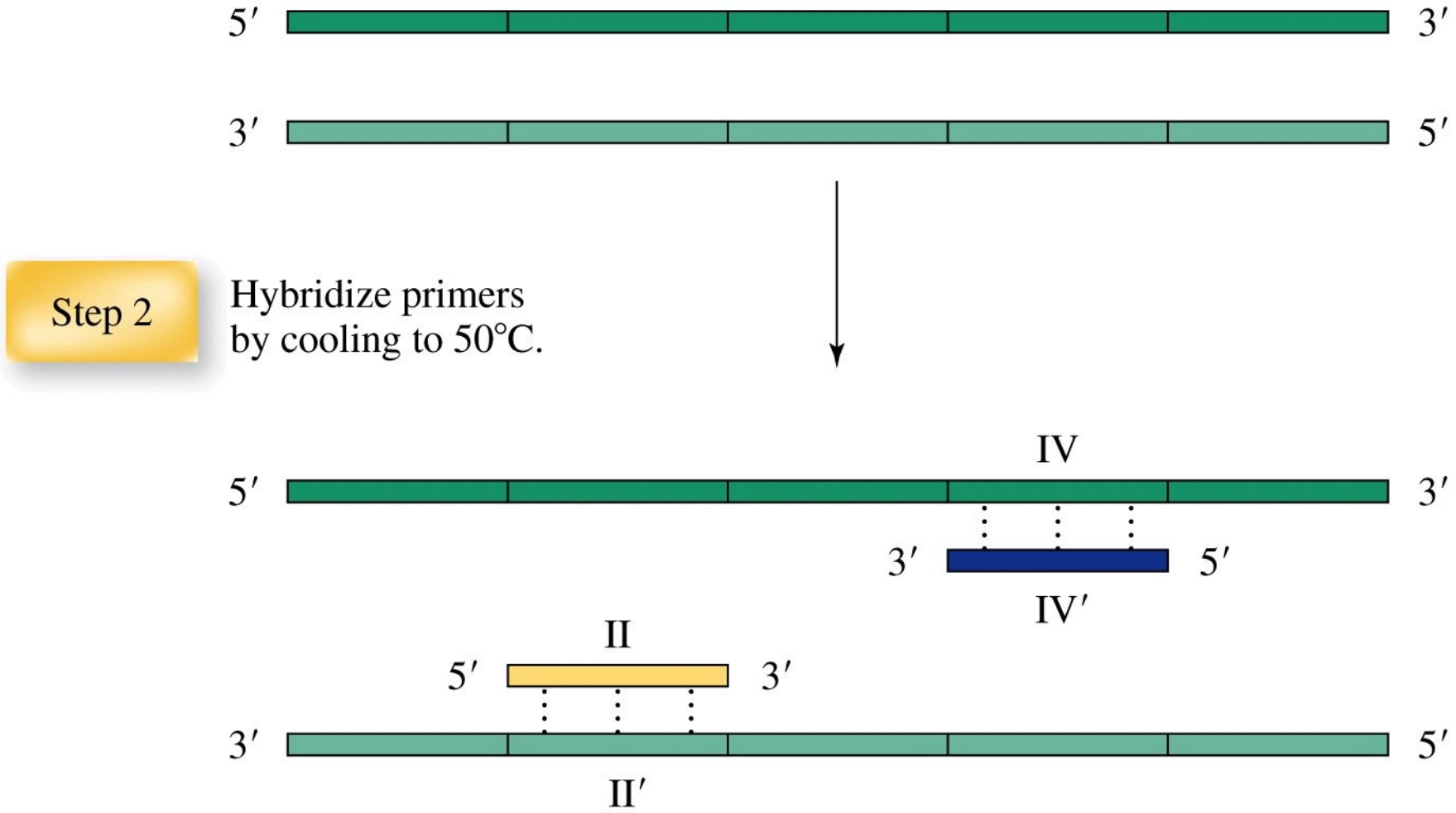


Figure 13-11 part 2 Concepts in Biochemistry, 3/e

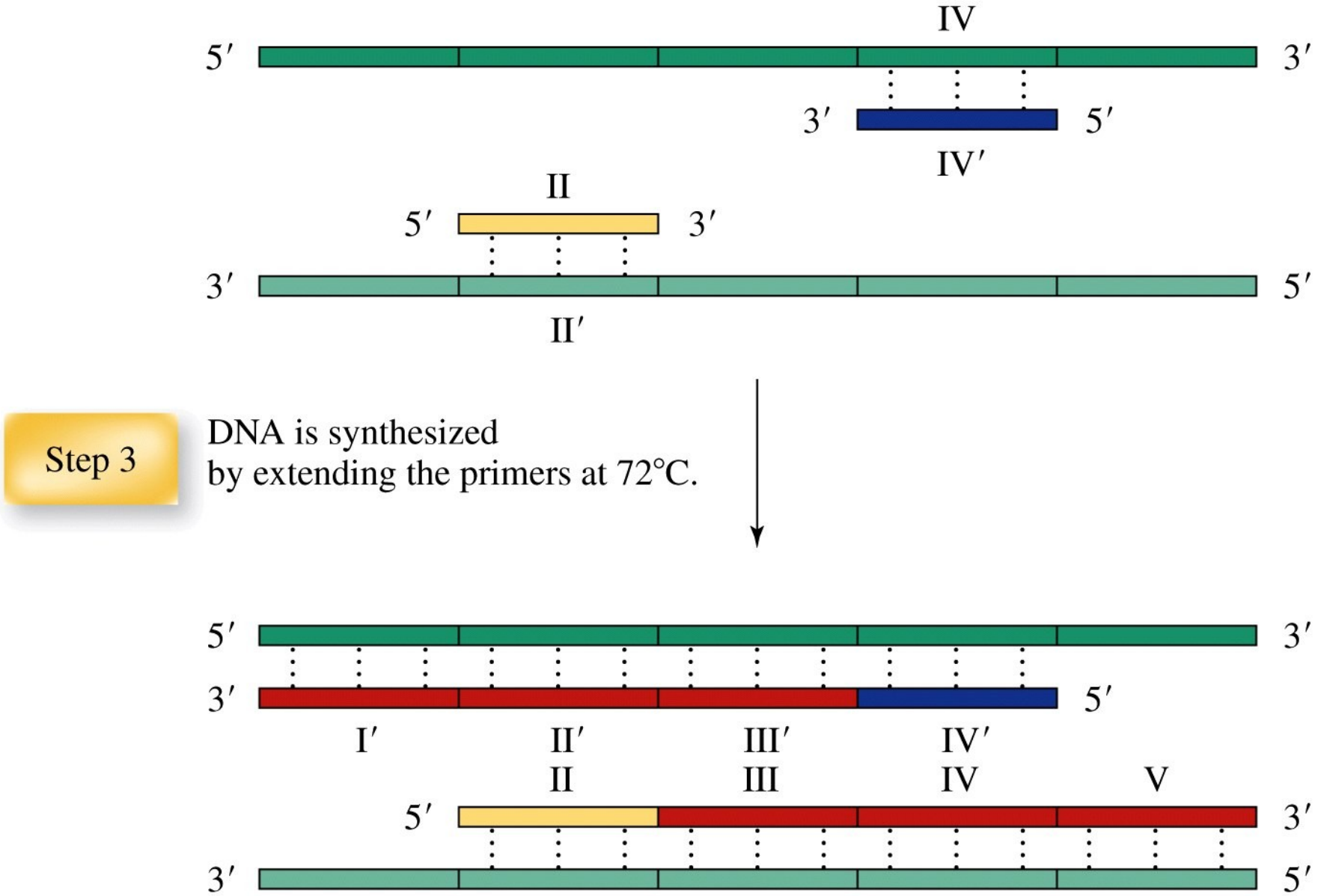
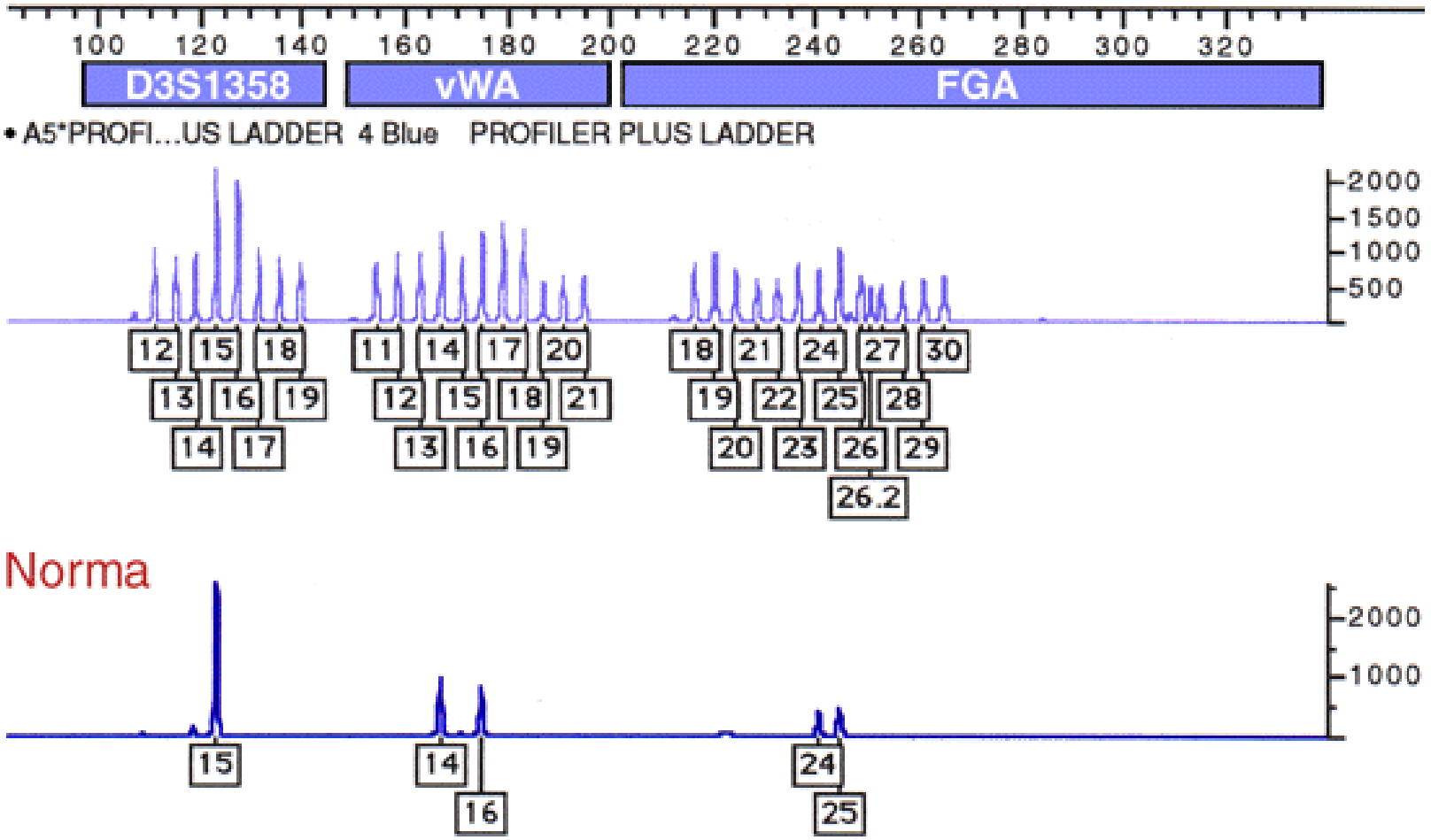


Figure 13-11 part 3 Concepts in Biochemistry, 3/e

Short tandem repeats



DNA Array


AFFYMETRIX
GeneChip®
Human Genome
U133 Plus 2.0
P/N: 520019
Lot #: 4010008
Exp. Date: 05/07/06
For Research Use Only
AFFYMETRIX
GeneChip®
Mouse Genome
430 2.0 Array
P/N: 520029
Lot #: 4015112
Exp. Date: 11/24/06
For Research Use Only