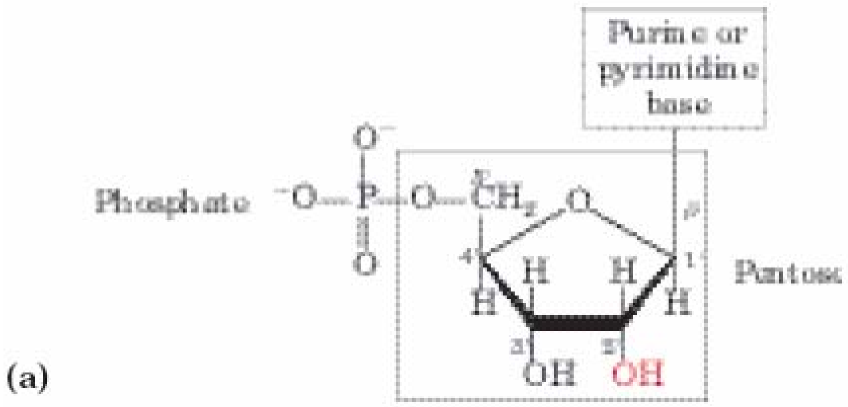
Nucleic acids

Molecular biology

نوکلئوتید

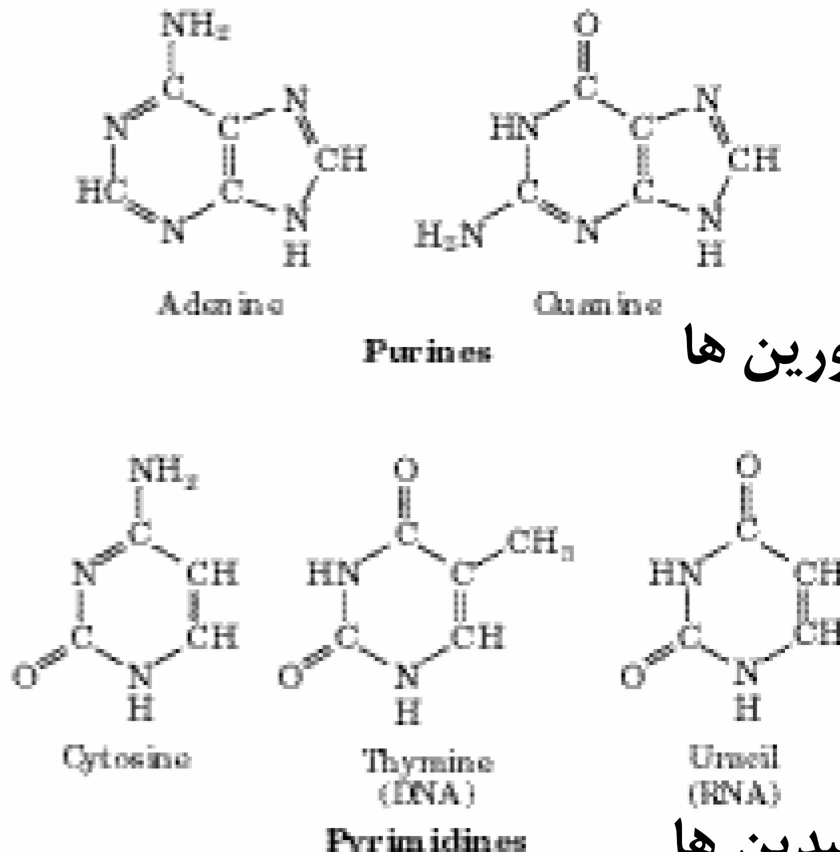
۱) باز نیتروژنی
۲) پنتوز
۳) فسفات



- ## نوکلئوزید

گروه فسفات ندارد

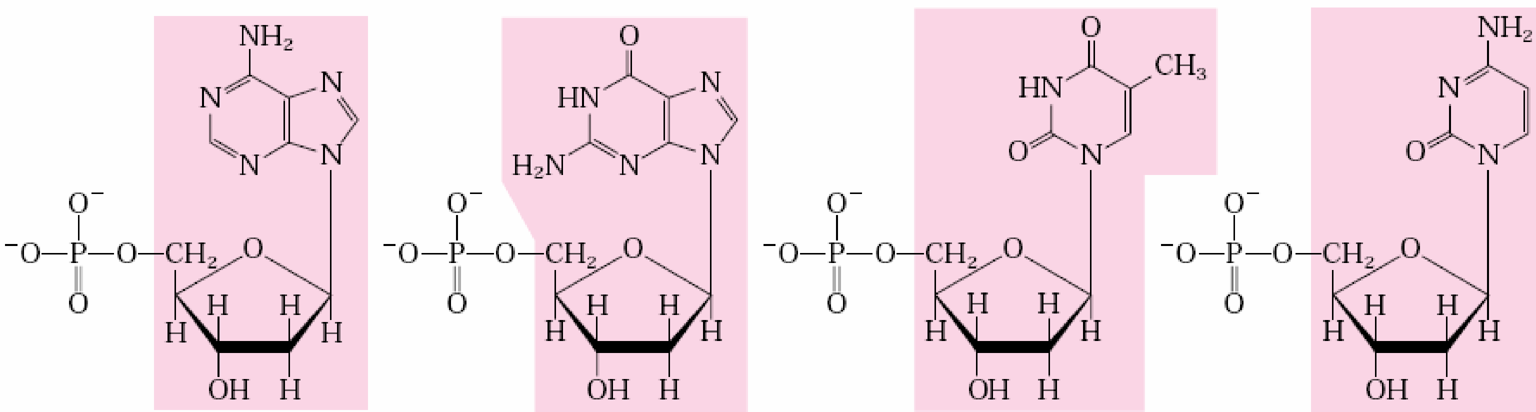
باز آلی



پورین ها

پریمیدین ها

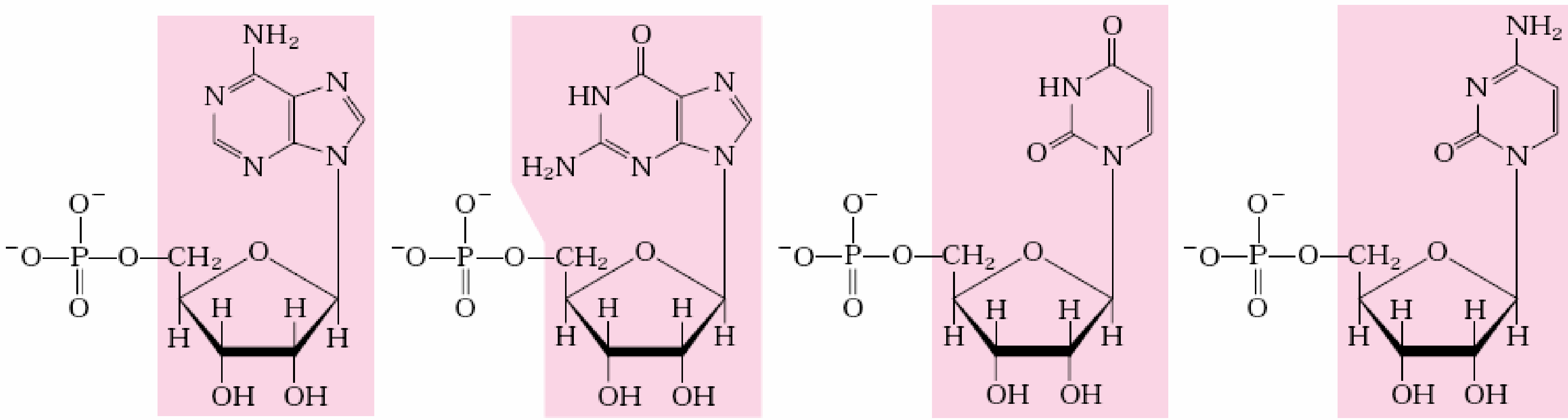
DNA



Nucleotide:	Deoxyadenylate (deoxyadenosine 5′-monophosphate)	Deoxyguanylate (deoxyguanosine 5′-monophosphate)	Deoxythymidylate (deoxythymidine 5′-monophosphate)	Deoxycytidylate (deoxycytidine 5′-monophosphate)
Symbols:	A, dA, dAMP	G, dG, dGMP	T, dT, dTMP	C, dC, dCMP
Nucleoside:	Deoxyadenosine	Deoxyguanosine	Deoxythymidine	Deoxycytidine

(a) Deoxyribonucleotides

RNA



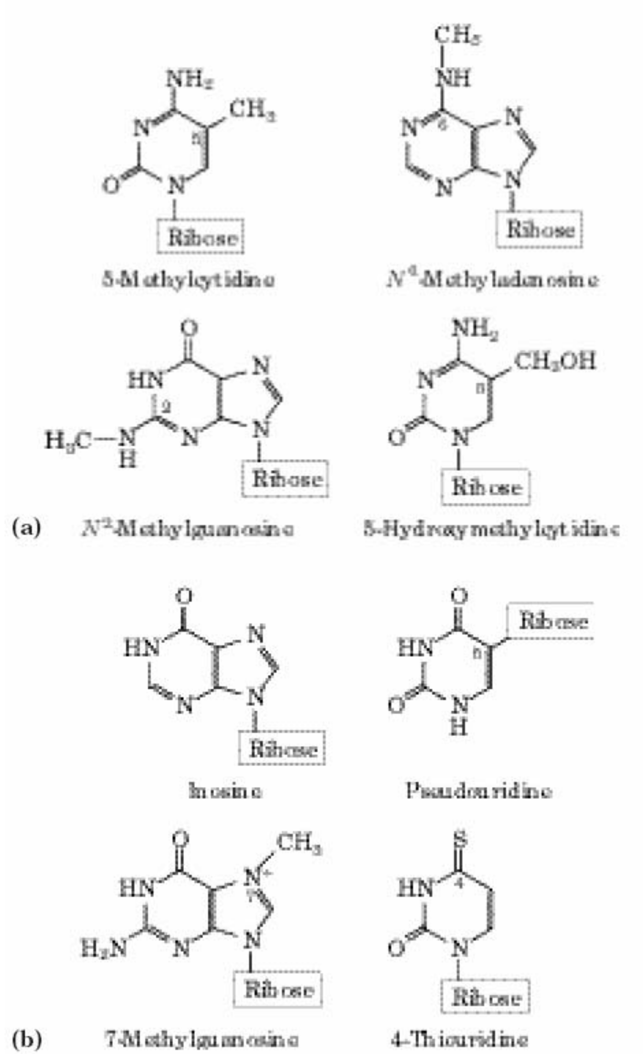
Nucleotide:	Adenylate (adenosine 5′-monophosphate)	Guanylate (guanosine 5′-monophosphate)	Uridylate (uridine 5′-monophosphate)	Cytidylate (cytidine 5′-monophosphate)
Symbols:	A, AMP	G, GMP	U, UMP	C, CMP
Nucleoside:	Adenosine	Guanosine	Uridine	Cytidine

(b) Ribonucleotides

اصطلاحات

TABLE 8-1 Nucleotide and Nucleic Acid Nomenclature

Base	*Nucleoside*	*Nucleotide*	*Nucleic acid*
Purines			
Adenine	Adenosine	Adenylate	RNA
	Deoxyadenosine	Deoxyadenylate	DNA
Guanine	Guanosine	Guanylate	RNA
	Deoxyguanosine	Deoxyguanylate	DNA
Pyrimidines			
Cytosine	Cytidine	Cytidylate	RNA
	Deoxycytidine	Deoxycytidylate	DNA
Thymine	Thymidine or deoxythymidine	Thymidylate or deoxythymidylate	DNA
Uracil	Uridine	Uridylate	RNA


5-Methylcytidine
N^6-Methyladenosine
(a)
N^2-Methylguanosine
5-Hydroxymethylcytidine
Inosine
Pseudouridine
(b)
7-Methylguanosine
4-Thiouridine

مونوفسفات های آدنوزینی

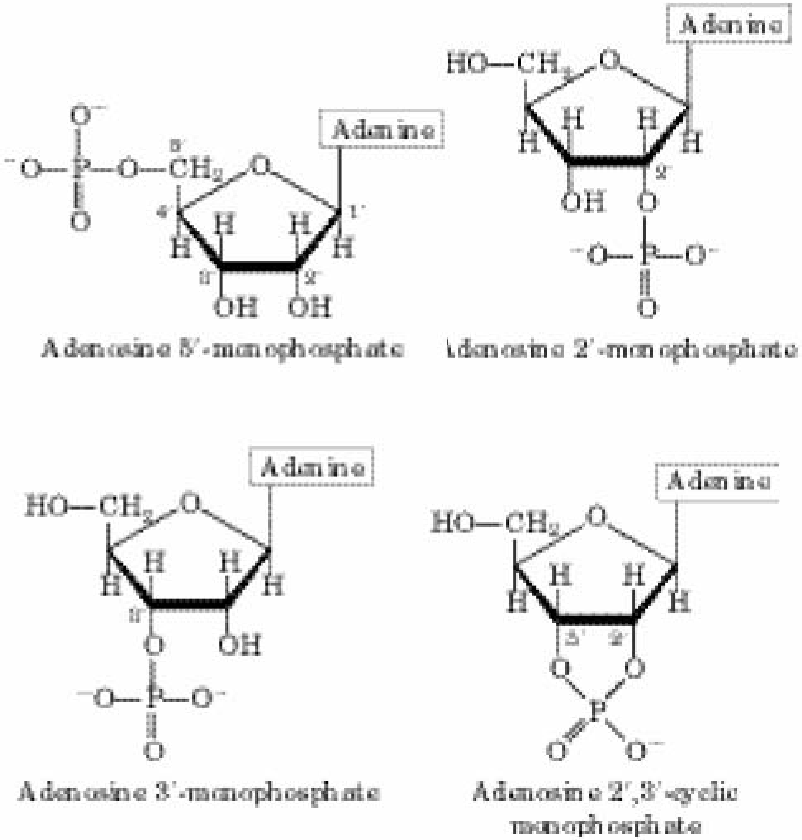


FIGURE 8–6 Some adenosine monophosphates. Adenosine 2′-monophosphate, 3′-monophosphate, and 2′,3′-cyclic monophosphate are formed by enzymatic and alkaline hydrolysis of RNA.

اتصالات فسفو دی استر

- الیگو نوکلئوتید
- پلی نوکلئوتید

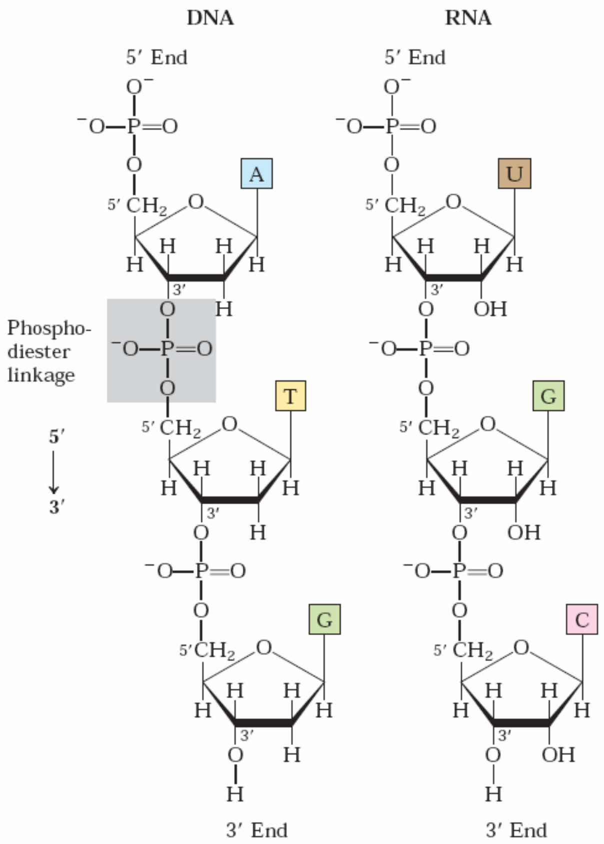
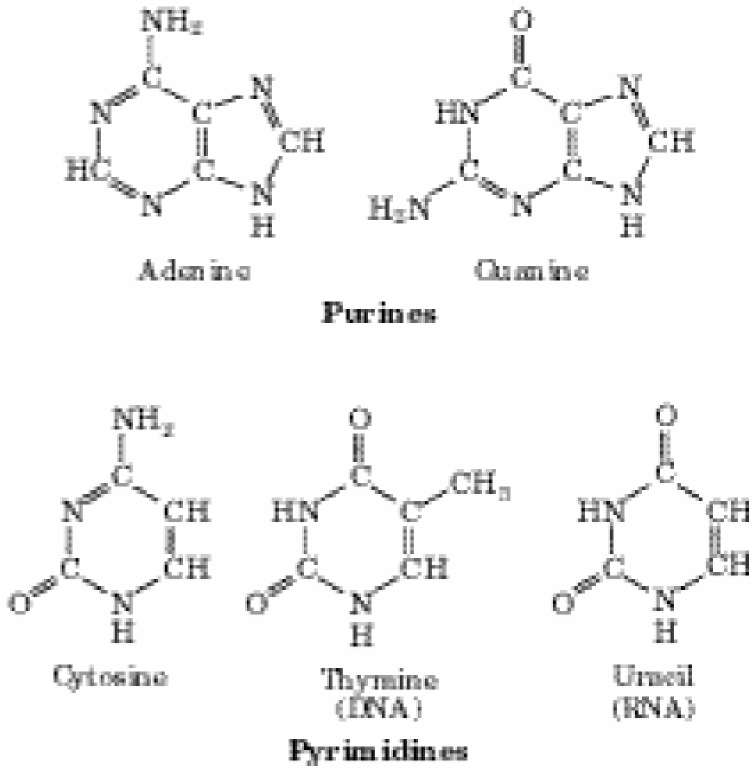


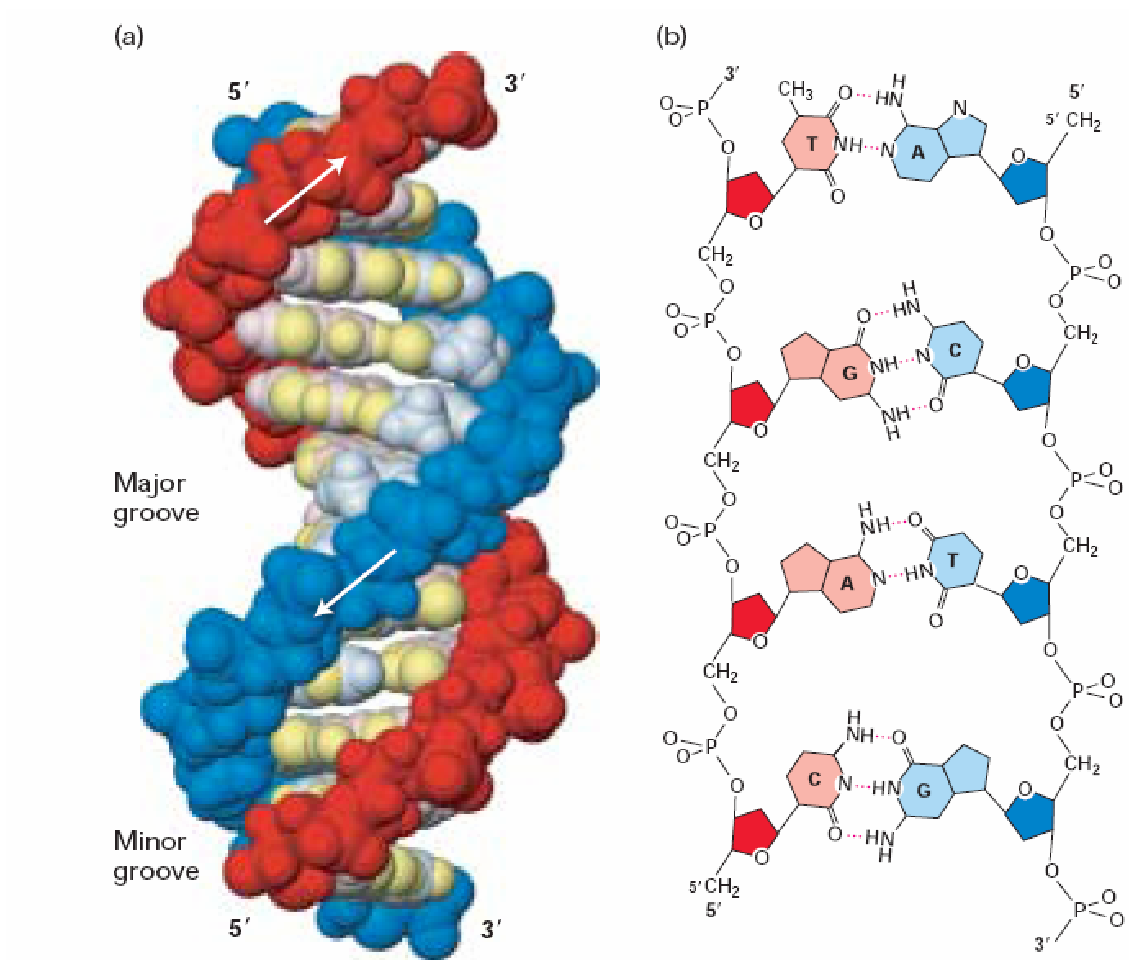
FIGURE 8–7 Phosphodiester linkages in the covalent backbone of DNA and RNA. The phosphodiester bonds (one of which is shaded in the DNA) link successive nucleotide units. The backbone of alternating pentose and phosphate groups in both types of nucleic acid is highly polar. The 5′ end of the macromolecule lacks a nucleotide at the 5′ position, and the 3′ end lacks a nucleotide at the 3′ position.

توتومریزاسیون

به دلیل رزونانس

- آمینو – ایمینو
- کتو – انول





▲ **FIGURE 4-3 The DNA double helix.** (a) Space-filling model ... are lined by potential hydrogen bond donors and acceptors

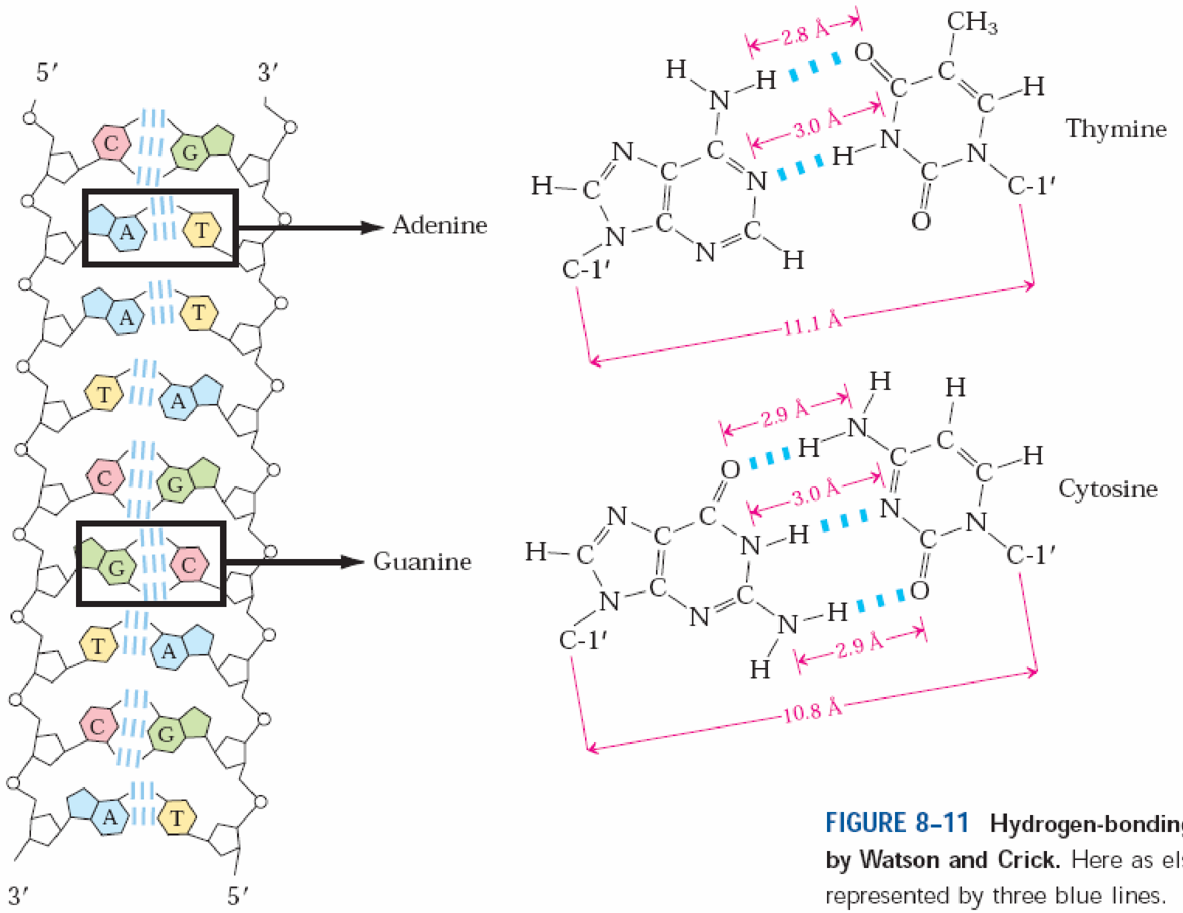


FIGURE 8–11 Hydrogen-bonding patterns in the base pairs defined by Watson and Crick. Here as elsewhere, hydrogen bonds are represented by three blue lines.

نتایج آزمایشات شارگاف

- ترکیب بازی DNA موجودات مختلف متفاوت است
- ترکیب بازی DNA در بافت های مختلف یک موجود مشابه است
- ترکیب بازی DNA با افزایش سن، تغییر تغذیه و یا تغییر محیط، تغییر نمی کند
- در تمامی مولکول های DNA داریم: A=T, C=G و در کل A+G= C+T

DNA مارپیچی (۱۹۵۰)

Rosalind Franklin,
1920–1958

Maurice Wilkins

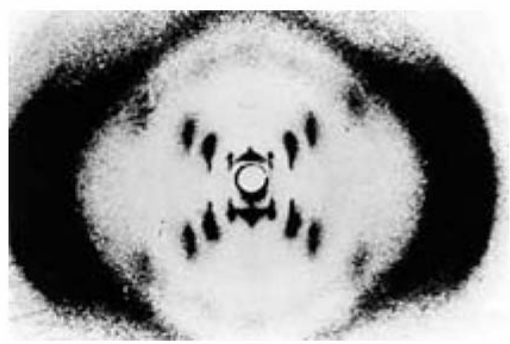
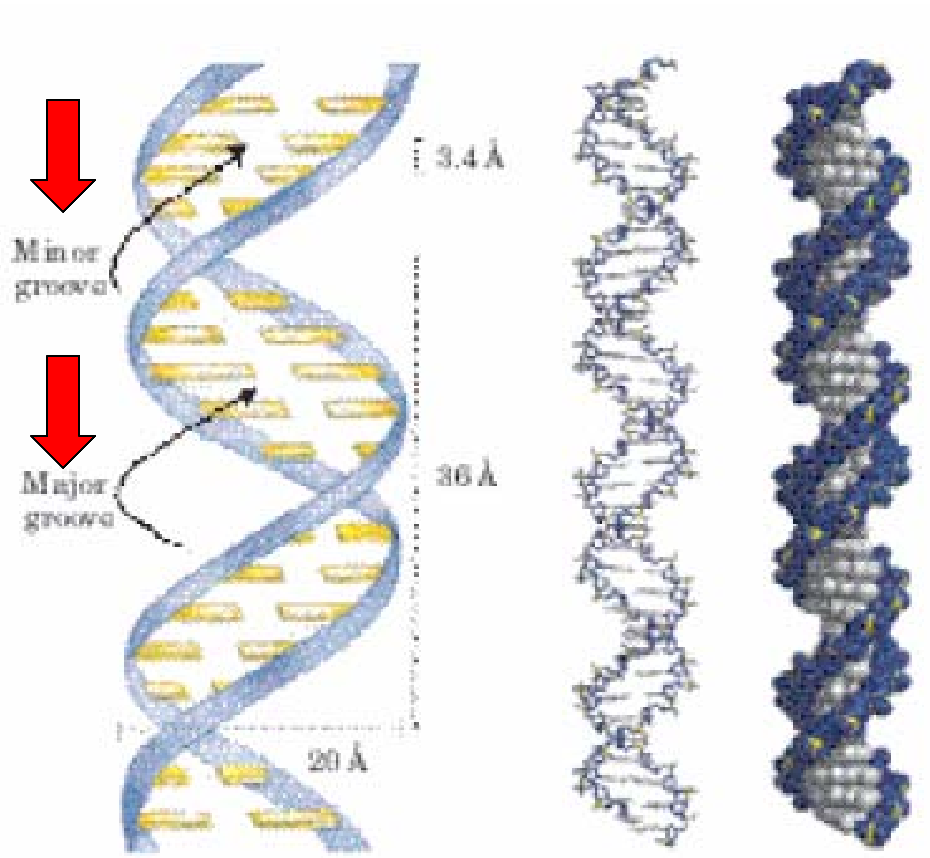


FIGURE 8–14 X-ray diffraction pattern of DNA. The spots forming a cross in the center denote a helical structure. The heavy bands at the left and right arise from the recurring bases.

مارپیچ دو رشته ای (۱۹۵۳)

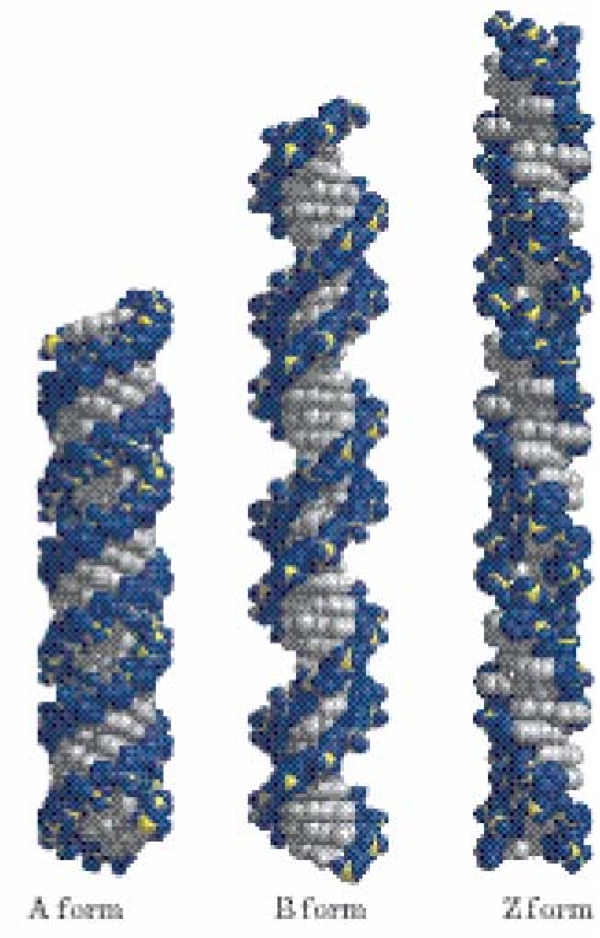
James Watson   Francis Crick



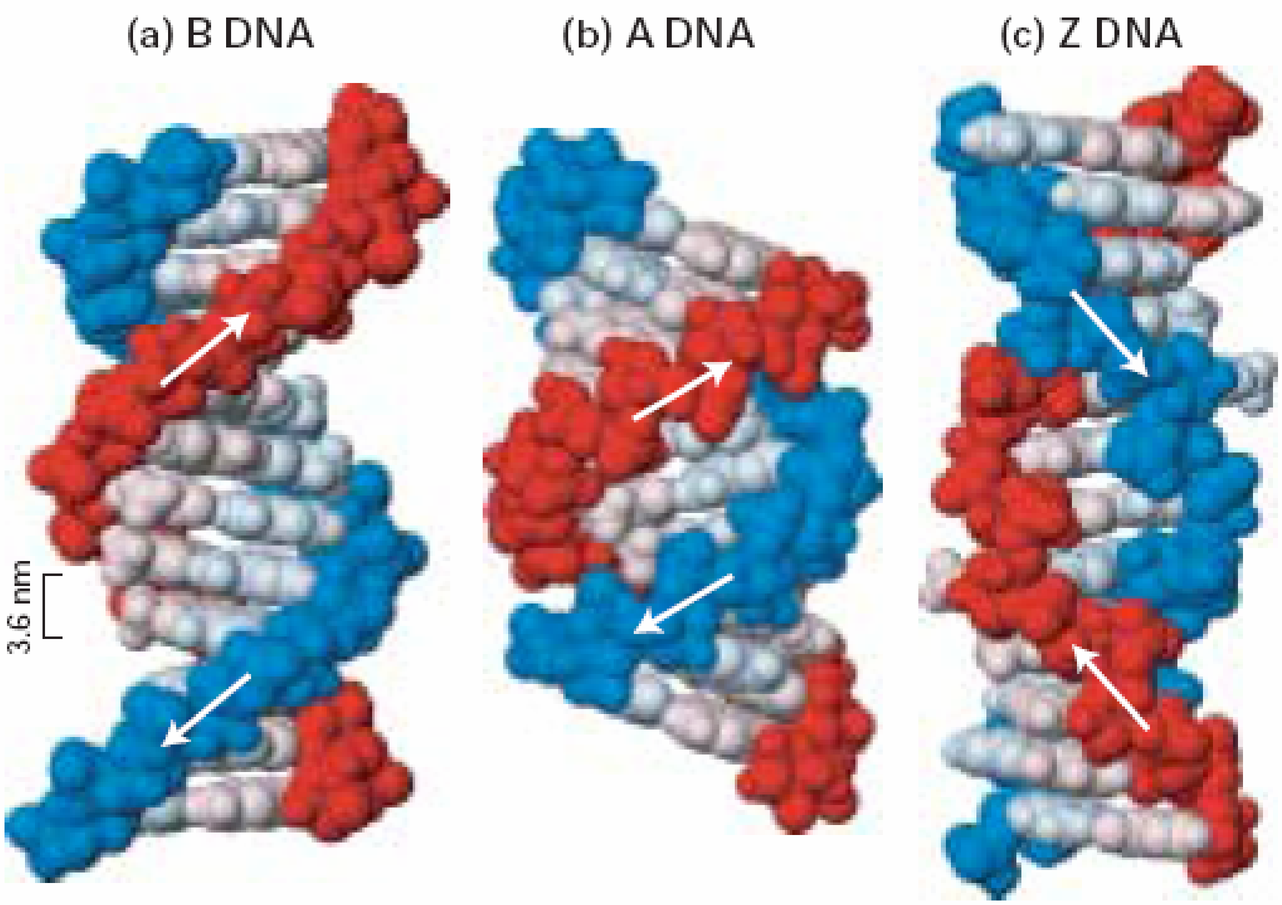
رشته ها:

- ❑جهت دار
- ❑موازی ناهمسو(antiparallel)
- ❑مکمل
  - oبسیار حایز اهمیت

فرم های فضایی DNA

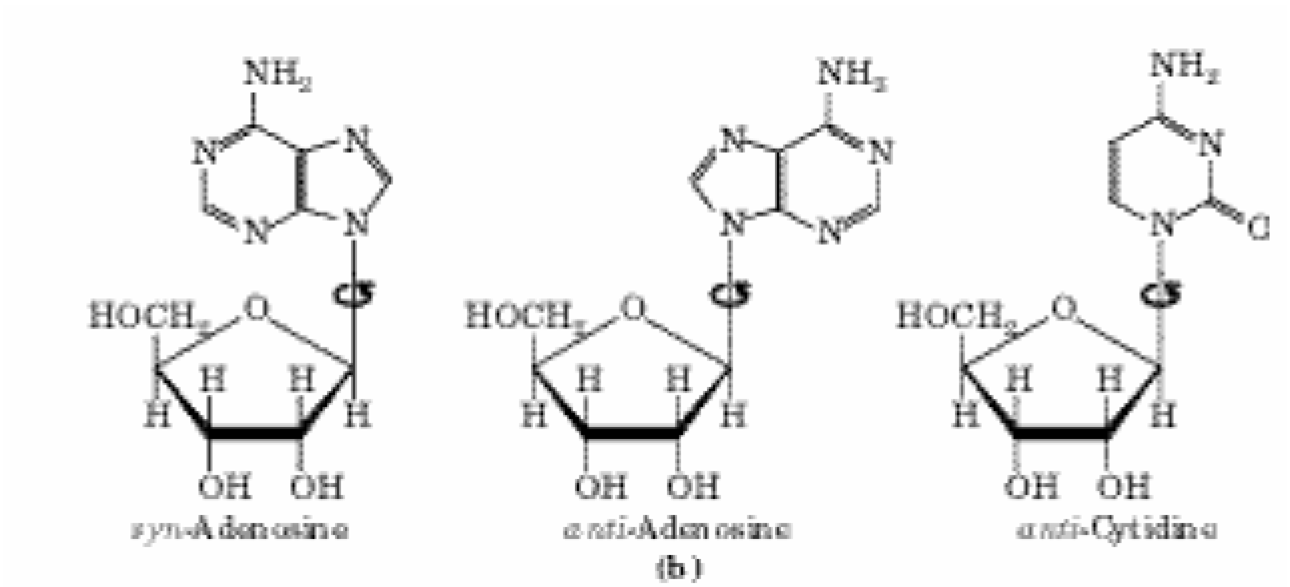


فرم های فضایی DNA



▲ **FIGURE 4-4 Models of various known DNA structures.**
The sugar-phosphate backbones of the two strands, which are

syn & anti



❑For purine bases in nucleotides, only two conformations with respect to the attached ribose units are sterically permitted, **anti** or **syn**.

❑Pyrimidines generally occur in the anti conformation.

مقایسه فرم ها

	A form	B form	Z form
Helical sense	Right handed	Right handed	Left handed
Diameter	~26 Å	~20 Å	~18 Å
Base pairs per helical turn	11	10.5	12
Helix rise per base pair	2.6 Å	3.4 Å	3.7 Å
Base tilt normal to the helix axis	20°	6°	7°
Sugar pucker conformation	C-3′ endo	C-2′ endo	C-2′ endo for pyrimidines; C-3′ endo for purines
Glycosyl bond conformation	Anti	Anti	Anti for pyrimidines; syn for purines

- A-DNA کوتاهتر و ضخیمتر از B-DNA
- در A-DNA شیار کوچک بزرگتر و توپرتر و شیار بزرگ باریکتر و عمیقتر از B-DNA
- Z-DNA کشیده تر و باریکتر از B-DNA
- در Z-DNA شیار بزرگ وجود ندارد و شیار کوچک یک شکاف عمیق

فرم های فضایی DNA

Whether A-DNA occurs in cells is uncertain, but there is evidence for some short stretches (tracts) of Z-DNA in both prokaryotes and eukaryotes. These Z-DNA tracts may play a role (as yet undefined) in regulating the expression of some genes or in genetic recombination.

Biochemistry, Nelson, 2004

ساختارهای وابسته به توالی

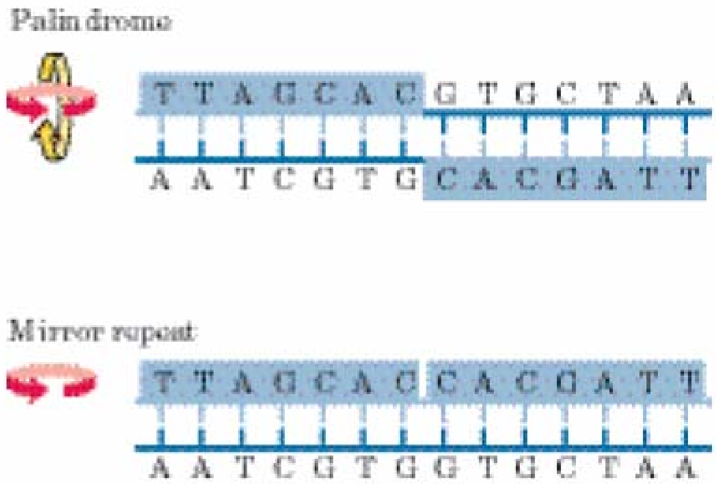


FIGURE 8–20 Palindromes and mirror repeats. Palindromes are sequences of double-stranded nucleic acids with twofold symmetry. In order to superimpose one repeat (shaded sequence) on the other, it must be rotated 180° about the horizontal axis then 180° about the vertical axis, as shown by the colored arrows. A mirror repeat, on the other hand, has a symmetric sequence within each strand. Superimposing one repeat on the other requires only a single 180° rotation about the vertical axis.

ساختارهای وابسته به توالی

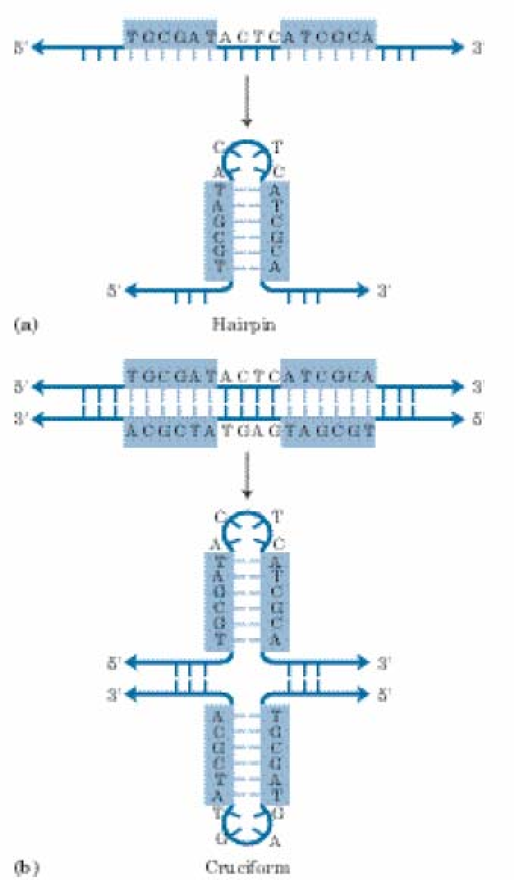


FIGURE 8–21 Hairpins and cruciforms. Palindromic DNA (or RNA) sequences can form alternative structures with intrastrand base pairing. **(a)** When only a single DNA (or RNA) strand is involved, the structure is called a hairpin. **(b)** When both strands of a duplex DNA are involved, it is called a cruciform. Blue shading highlights asymmetric sequences that can pair with the complementary sequence either in the same strand or in the complementary strand.

سه رشته ای و چهار رشته ای

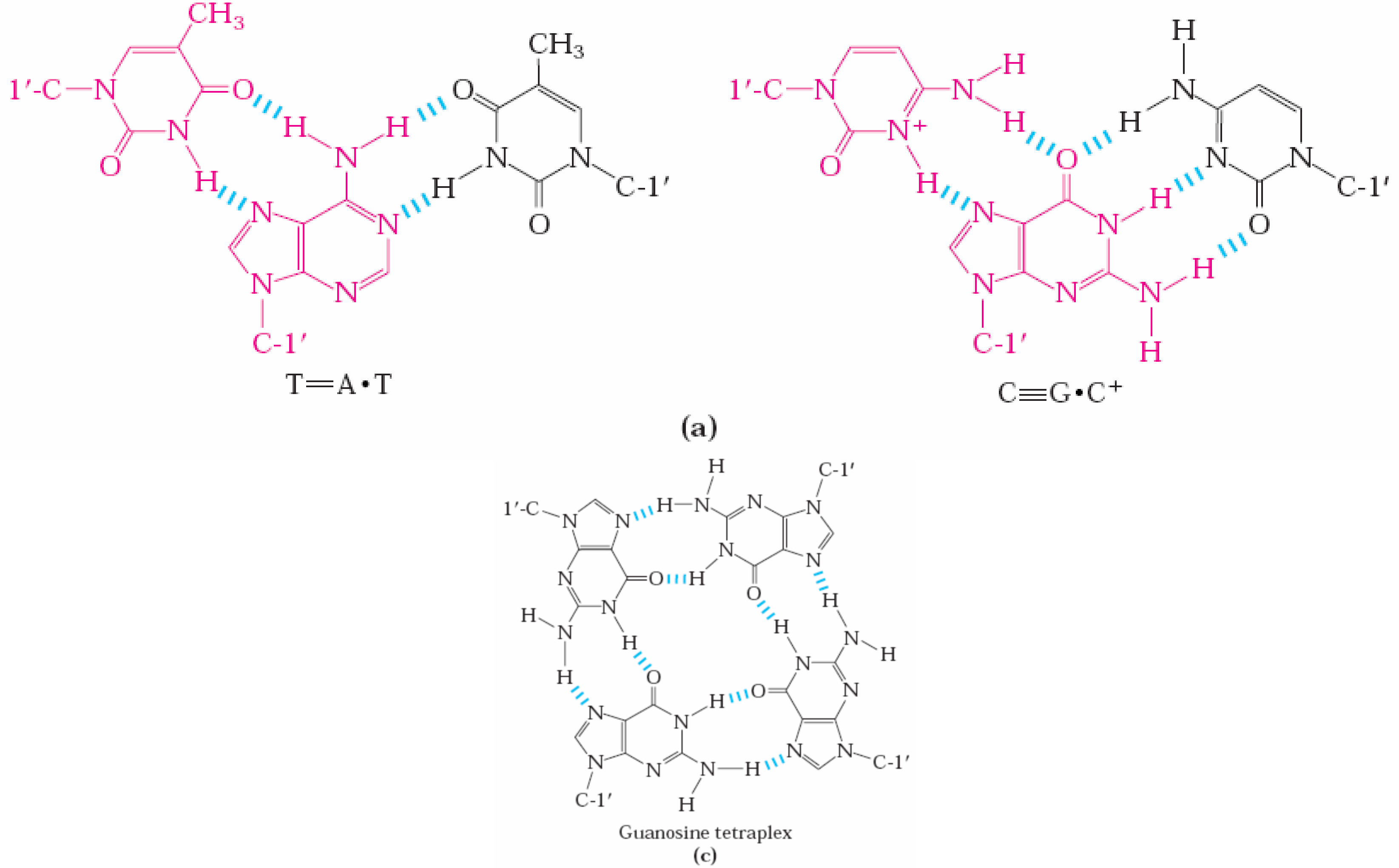


FIGURE 8–22 DNA structures containing three or four DNA strands.

زیست شناسی مولکولی مدرس:

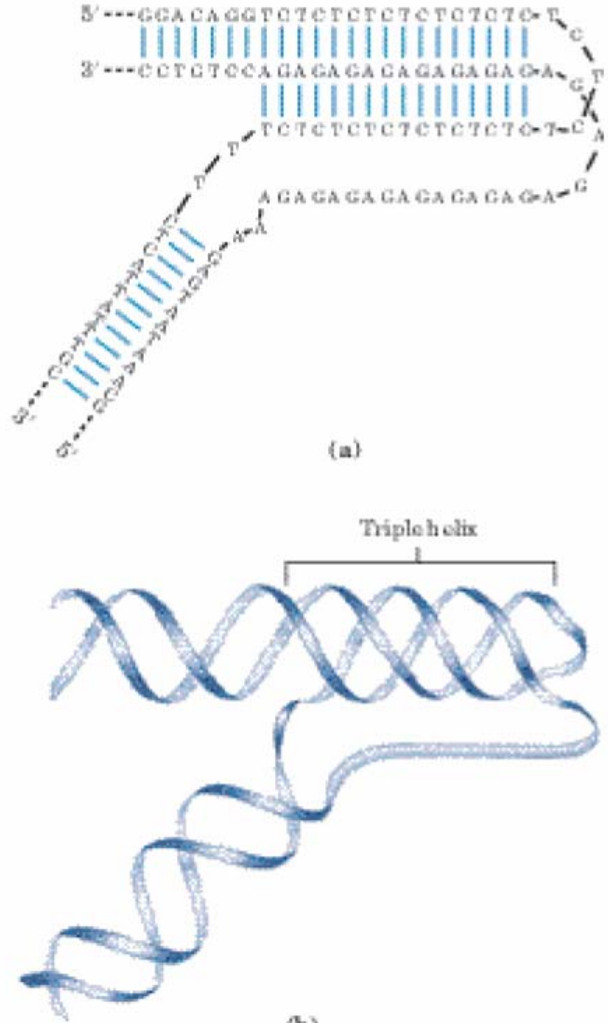


FIGURE 8–23 H-DNA. (a) A sequence of alternating T and C residues can be considered a mirror repeat centered about a central T or C.

زیست شناسی مولکولی مدرس: سید

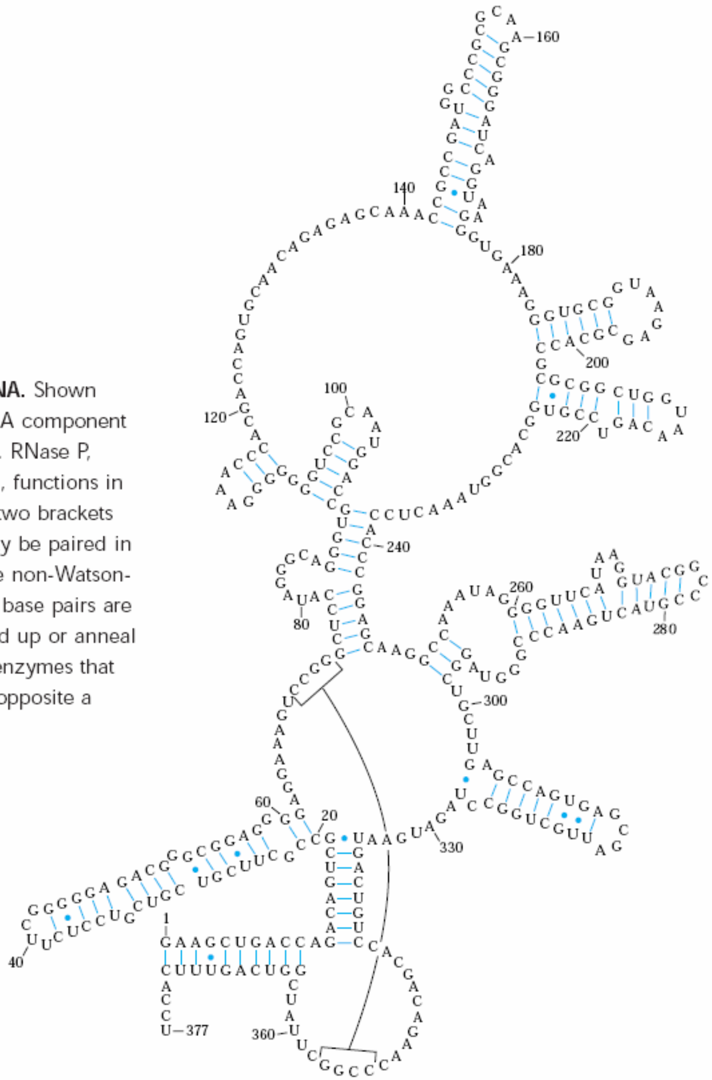
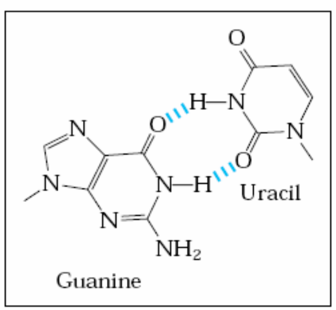


FIGURE 8–27 Base-paired helical structures in an RNA. Shown here is the possible secondary structure of the M1 RNA component of the enzyme RNase P of *E. coli*, with many hairpins. RNase P, which also contains a protein component (not shown), functions in the processing of transfer RNAs (see Fig. 26–23). The two brackets indicate additional complementary sequences that may be paired in the three-dimensional structure. The blue dots indicate non-Watson-Crick G═U base pairs (boxed inset). Note that G═U base pairs are allowed only when presynthesized strands of RNA fold up or anneal with each other. There are no RNA polymerases (the enzymes that synthesize RNAs on a DNA template) that insert a U opposite a template G, or vice versa, during RNA synthesis.



فراپیچش (supercoiling)

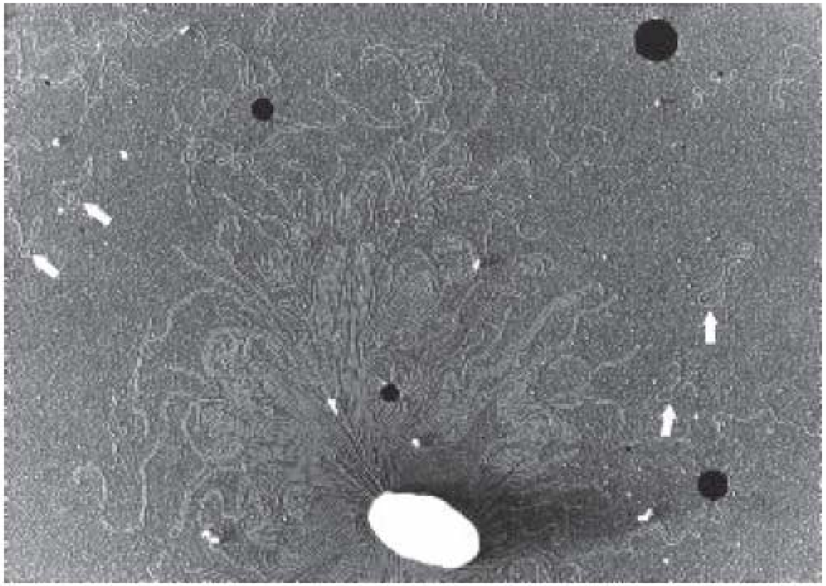


FIGURE 24–4 DNA from a lysed *E. coli* cell. In this electron micrograph several small, circular plasmid DNAs are indicated by white arrows. The black spots and white specks are artifacts of the preparation.

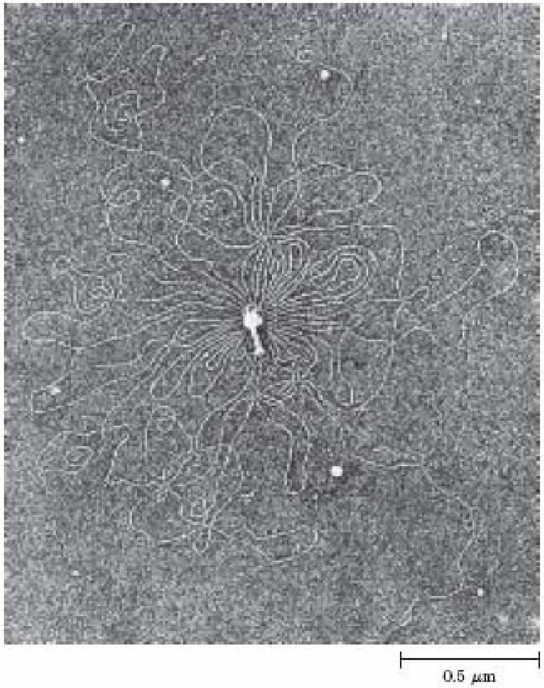


FIGURE 24–1 Bacteriophage T2 protein coat surrounded by its single, linear molecule of DNA. The DNA was released by lysing the bacteriophage particle in distilled water and allowing the DNA to spread on the water surface. An undamaged T2 bacteriophage particle consists of a head structure that tapers to a tail by which the bacteriophage attaches itself to the outer surface of a bacterial cell. All the DNA shown in this electron micrograph is normally packaged inside the phage head.

سوپرکویل

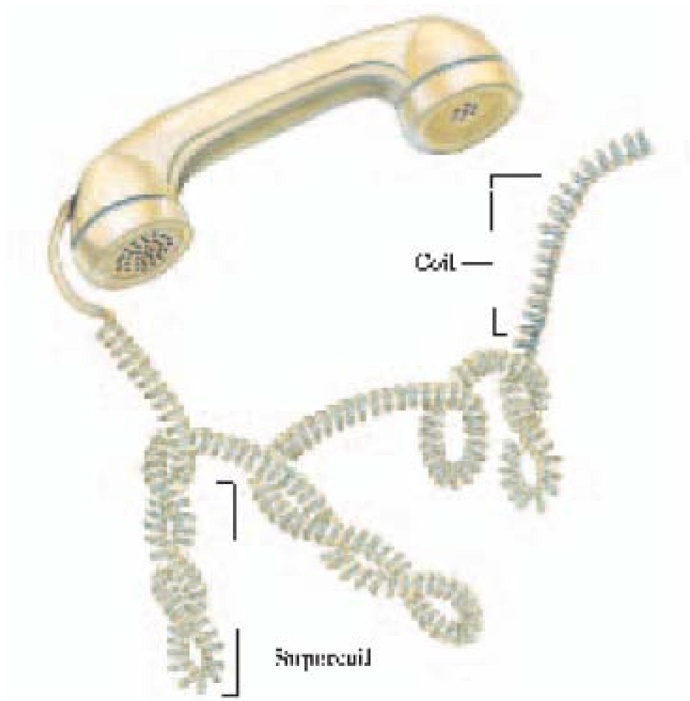


FIGURE 24–10 Supercoils. A typical phone cord is coiled like a DNA helix, and the coiled cord can itself coil in a supercoil. The illustration is especially appropriate because an examination of phone cords helped lead Jerome Vinograd and his colleagues to the insight that many properties of small circular DNAs can be explained by supercoiling. They first detected DNA supercoiling, in small circular viral DNAs, in 1965.

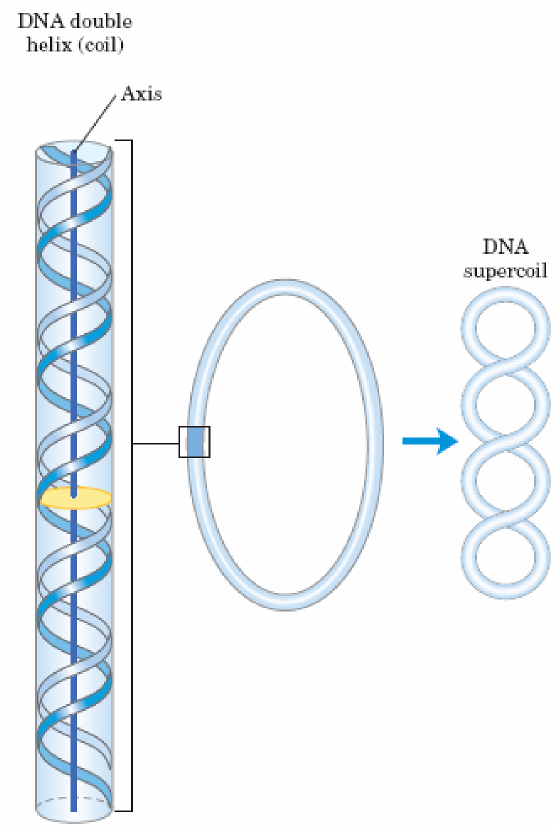


FIGURE 24–11 Supercoiling of DNA. When the axis of the DNA double helix is coiled on itself, it forms a new helix (superhelix). The DNA superhelix is usually called a supercoil.

سوپرکویل

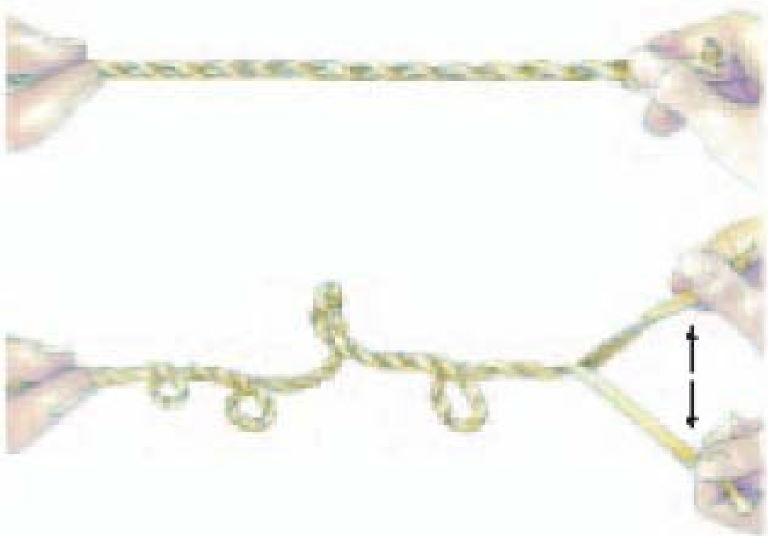


FIGURE 24–12 Supercoiling induced by separating the strands of a helical structure. Twist two linear strands of rubber band into a right-handed double helix as shown. Fix one end by having a friend hold onto it, then pull apart the two strands at the other end. The resulting strain will produce supercoiling.

سوپرکویل

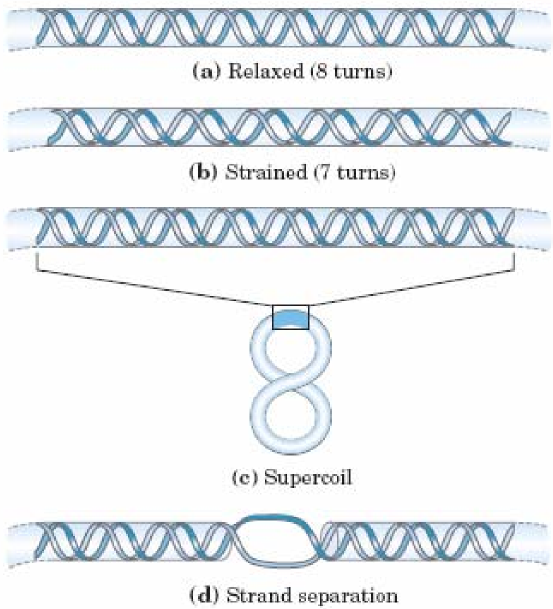


FIGURE 24–14 Effects of DNA underwinding. **(a)** A segment of DNA within a closed-circular molecule, 84 bp long, in its relaxed form with eight helical turns. **(b)** Removal of one turn induces structural strain. **(c)** The strain is generally accommodated by formation of a supercoil. **(d)** DNA underwinding also makes the separation of strands somewhat easier. In principle, each turn of underwinding should facilitate strand separation over about 10 bp, as shown. However, the hydrogen-bonded base pairs would generally preclude strand separation over such a short distance, and the effect becomes important only for longer DNAs and higher levels of DNA underwinding.

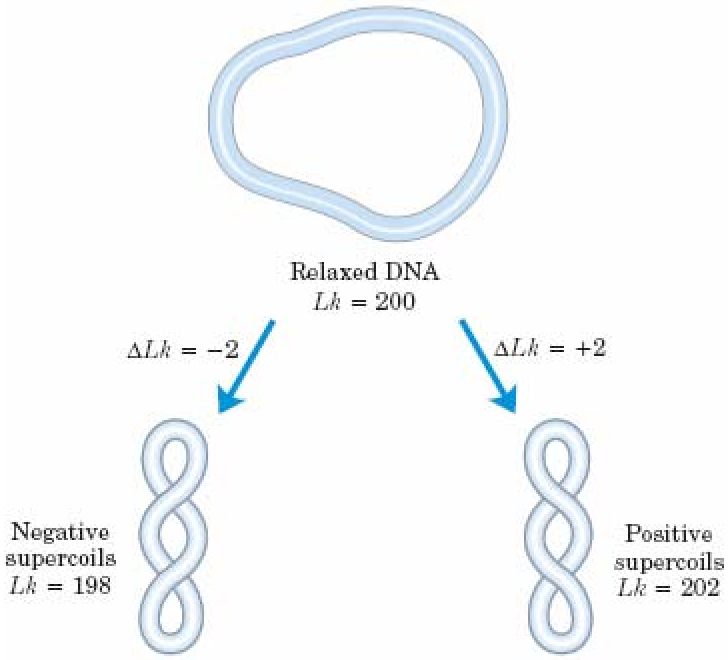


FIGURE 24–17 Negative and positive supercoils. For the relaxed DNA molecule of Figure 24–16a, underwinding or overwinding by two helical turns (Lk = 198 or 202) will produce negative or positive supercoiling, respectively. Note that the DNA axis twists in opposite directions in the two cases.

سوپرکویل

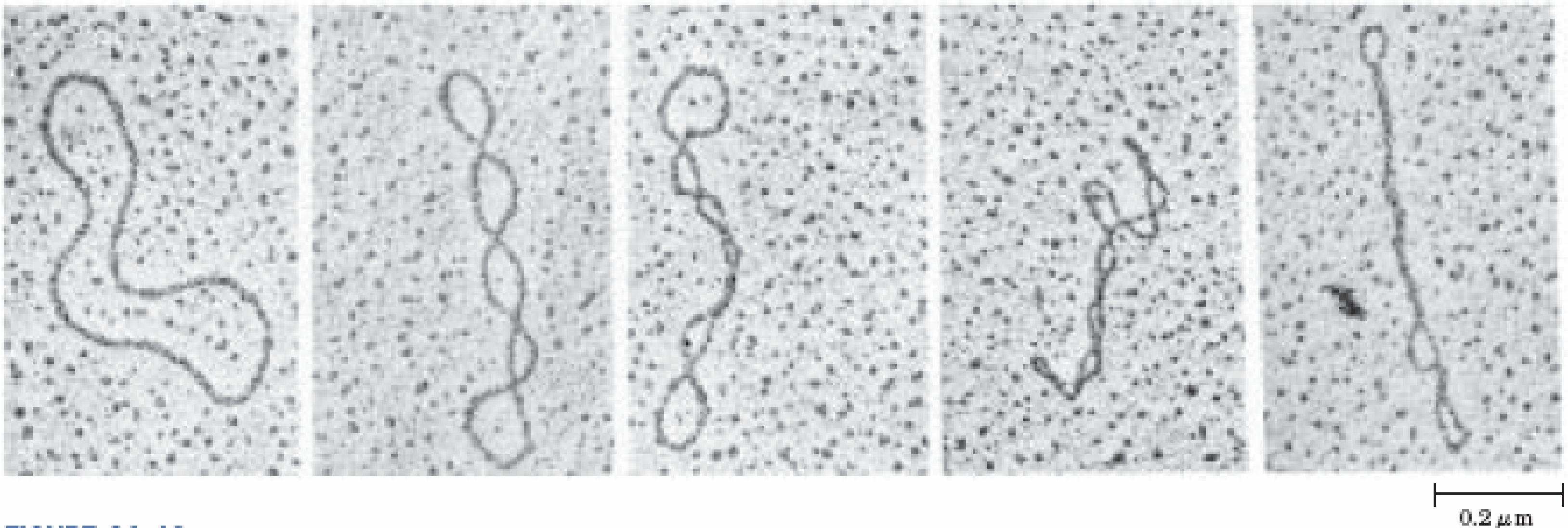
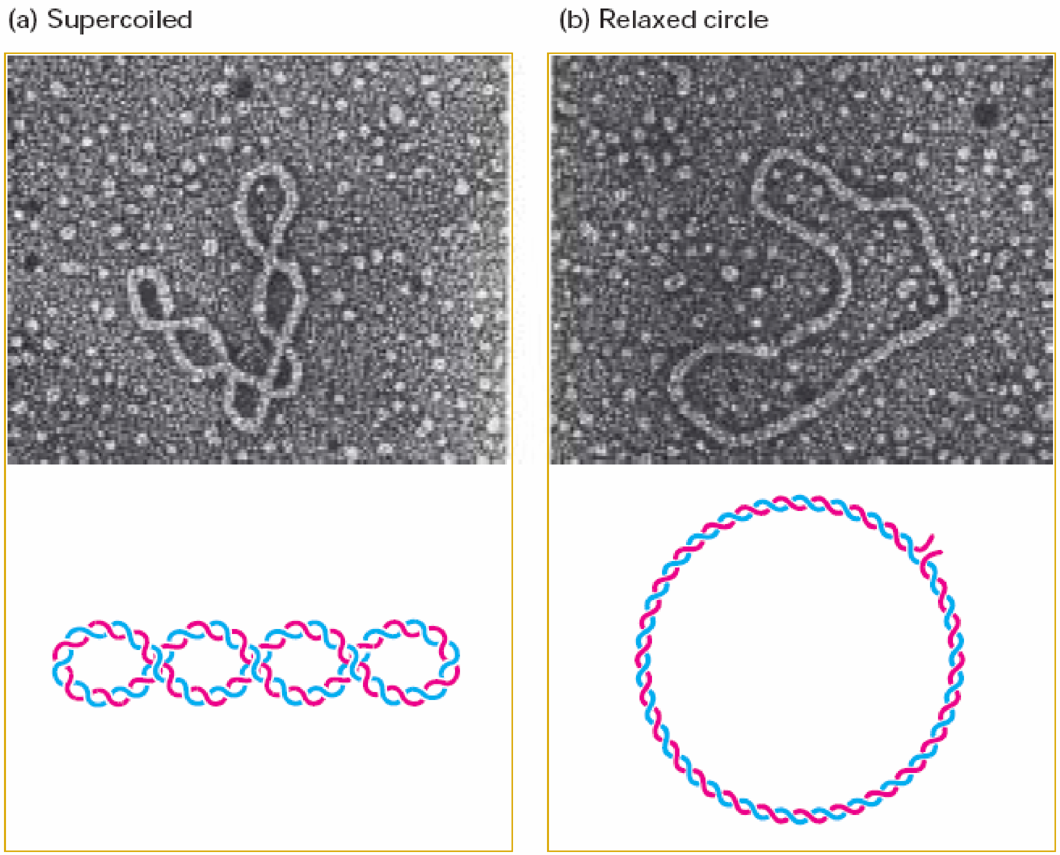


FIGURE 24-13 Relaxed and supercoiled plasmid DNAs. The molecule in the leftmost electron micrograph is relaxed; the degree of supercoiling increases from left to right.

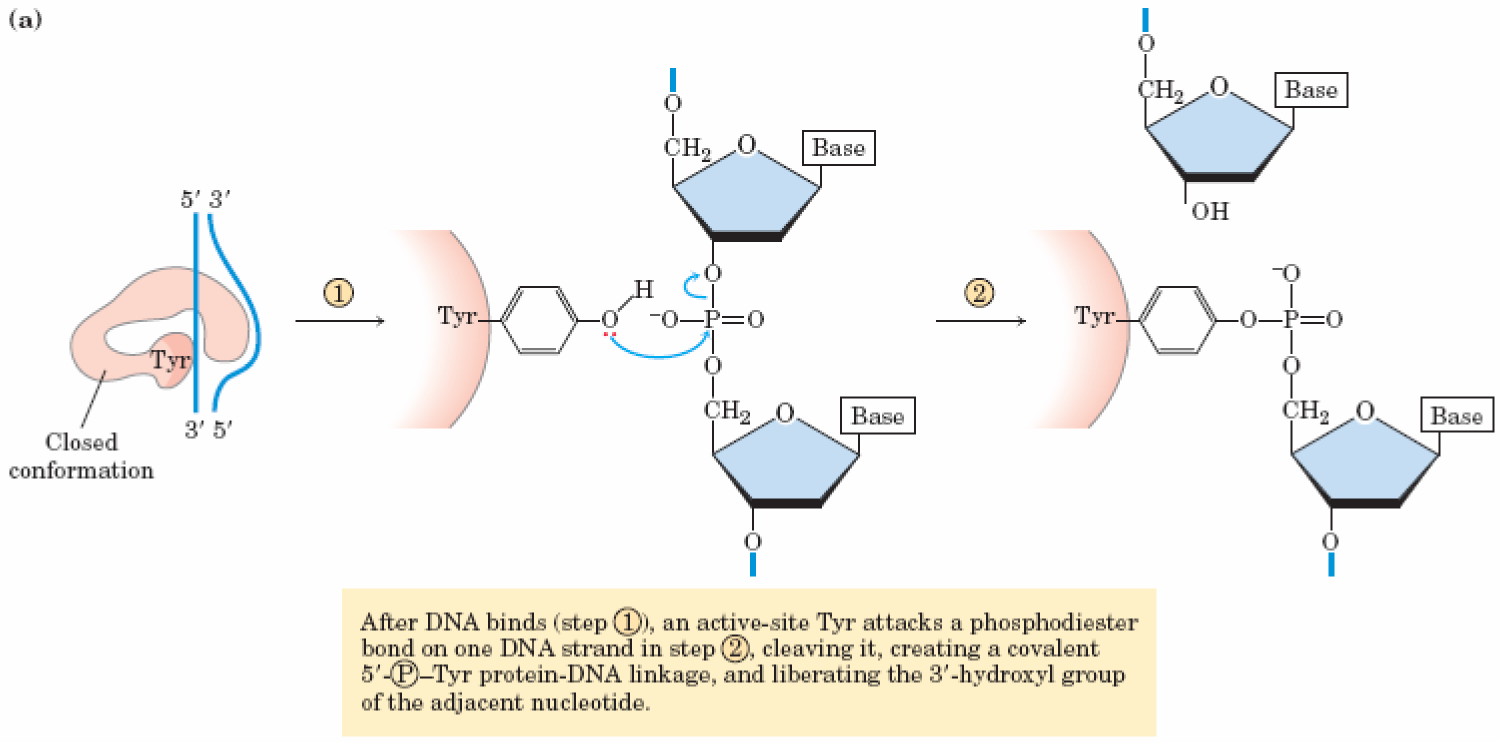
Relaxed = وقتی محور DNA هیچ خمیدگی بر روی خود نداشته باشد

سوپر کویل



◀ **EXPERIMENTAL FIGURE 4-7 DNA supercoils can be removed by cleavage of one strand.** (a) Electron micrograph of SV40 viral DNA. When the circular DNA of the SV40 virus is isolated and separated from its associated protein, the DNA duplex is underwound and assumes the supercoiled configuration. (b) If a supercoiled DNA is nicked (i.e., one strand cleaved), the strands can rewind, leading to loss of a supercoil. Topoisomerase I catalyzes this reaction and also reseals the broken ends. All the supercoils in isolated SV40 DNA can be removed by the sequential action of this enzyme, producing the relaxed-circle conformation. For clarity, the shapes of the molecules at the bottom have been simplified.

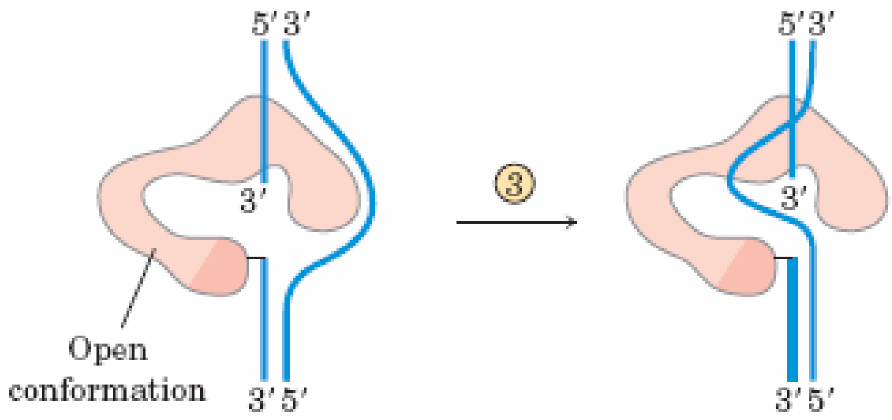
توپوایزومراز I



MECHANISM FIGURE 24–21 Bacterial type I topoisomerases alter linking number. A proposed reaction sequence for the bacterial topoisomerase I is illustrated. The enzyme has closed and open conformations. **(a)** A DNA molecule binds to the closed conformation and one DNA strand is cleaved. **(b)** The enzyme changes to its open conformation, and the other DNA strand moves through the break in the first strand. **(c)** In the closed conformation, the DNA strand is religated.

توپوایزومراز I

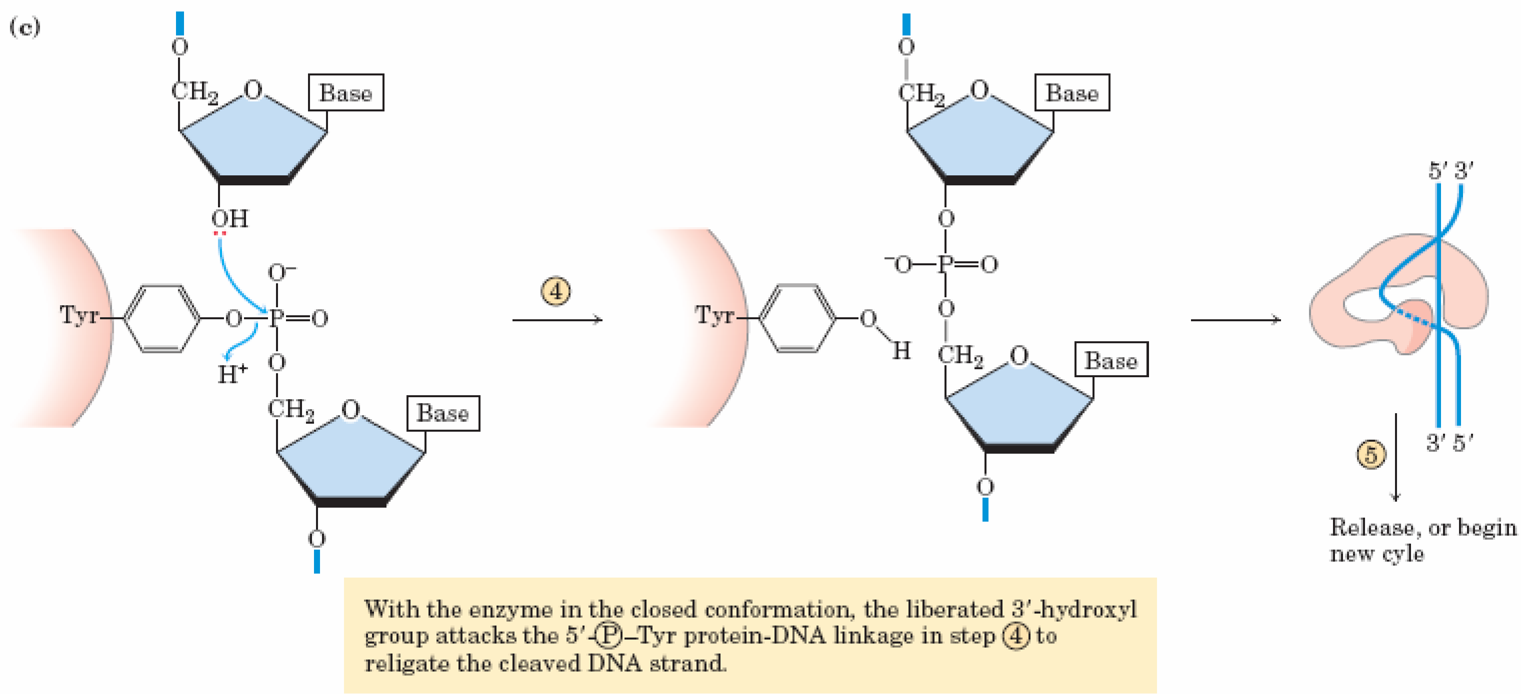
(b)



In step (3) the enzyme switches to its open conformation, and the unbroken DNA strand passes through the break in the first strand.

MECHANISM FIGURE 24–21 Bacterial type I topoisomerases alter linking number. A proposed reaction sequence for the bacterial topoisomerase I is illustrated. The enzyme has closed and open conformations. **(a)** A DNA molecule binds to the closed conformation and one DNA strand is cleaved. **(b)** The enzyme changes to its open conformation, and the other DNA strand moves through the break in the first strand. **(c)** In the closed conformation, the DNA strand is religated.

توپوایزومراز I



MECHANISM FIGURE 24–21 Bacterial type I topoisomerases alter linking number. A proposed reaction sequence for the bacterial topoisomerase I is illustrated. The enzyme has closed and open conformations. **(a)** A DNA molecule binds to the closed conformation and one DNA strand is cleaved. **(b)** The enzyme changes to its open conformation, and the other DNA strand moves through the break in the first strand. **(c)** In the closed conformation, the DNA strand is religated.

توپوایزومراز II

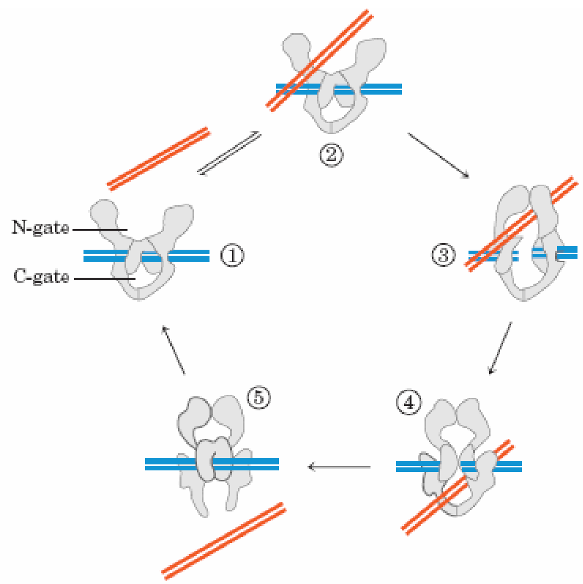
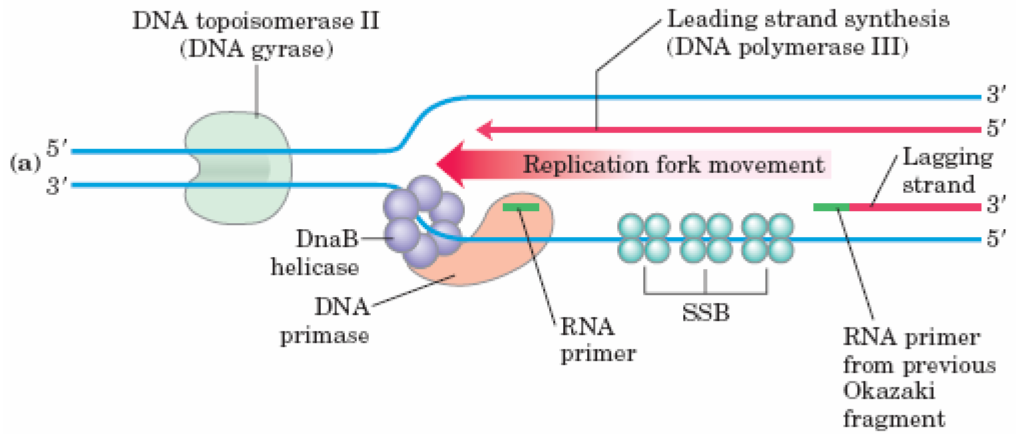


FIGURE 24–22 Proposed mechanism for the alteration of linking number by eukaryotic type IIA topoisomerases. ① The multisubunit enzyme binds one DNA molecule (blue). Gated cavities above and below the bound DNA are called the N-gate and the C-gate. ② A second segment of the same DNA molecule (red) is bound at the N-gate and ③ trapped. Both strands of the first DNA are now cleaved (the chemistry is similar to that in Fig. 24–20b), and ④ the second DNA segment is passed through the break. ⑤ The broken DNA is religated, and the second DNA segment is released through the C-gate. Two ATPs are bound and hydrolyzed during this cycle; it is likely that one is hydrolyzed in the step leading to the complex in step ④. Additional details of the ATP hydrolysis component of the reaction remain to be worked out.

توپوایزومراز II



بازهای تغییر یافته DNA

- ترمیم
- همانند سازی
- محافظت از DNA

آنزیم های موثر بر DNA

- نوکلئازها
  - اگزو
  - اندو

واسرشتی و بازسرشتی

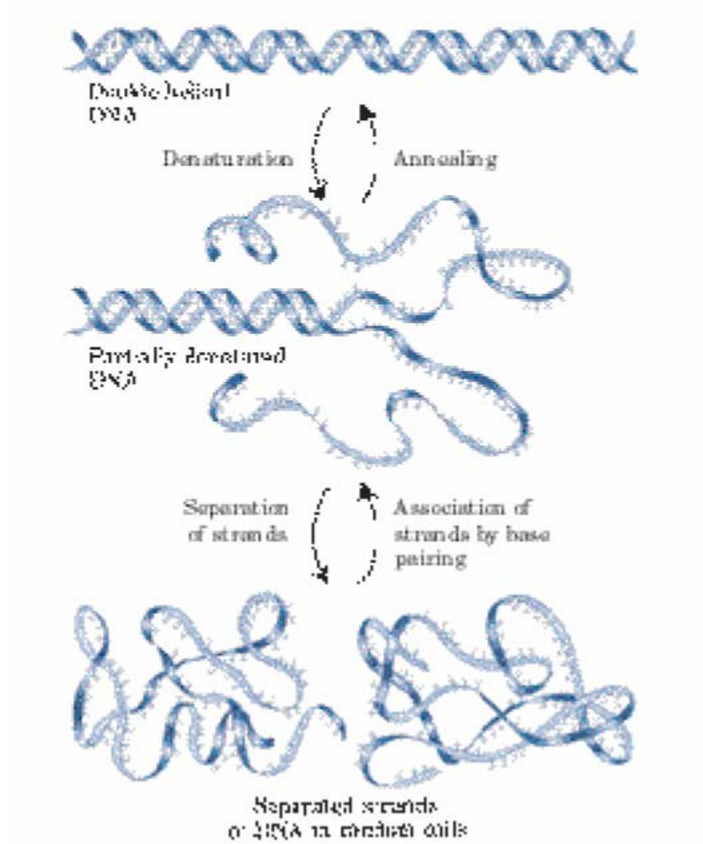


FIGURE 8–29 Reversible denaturation and annealing (renaturation) of DNA.

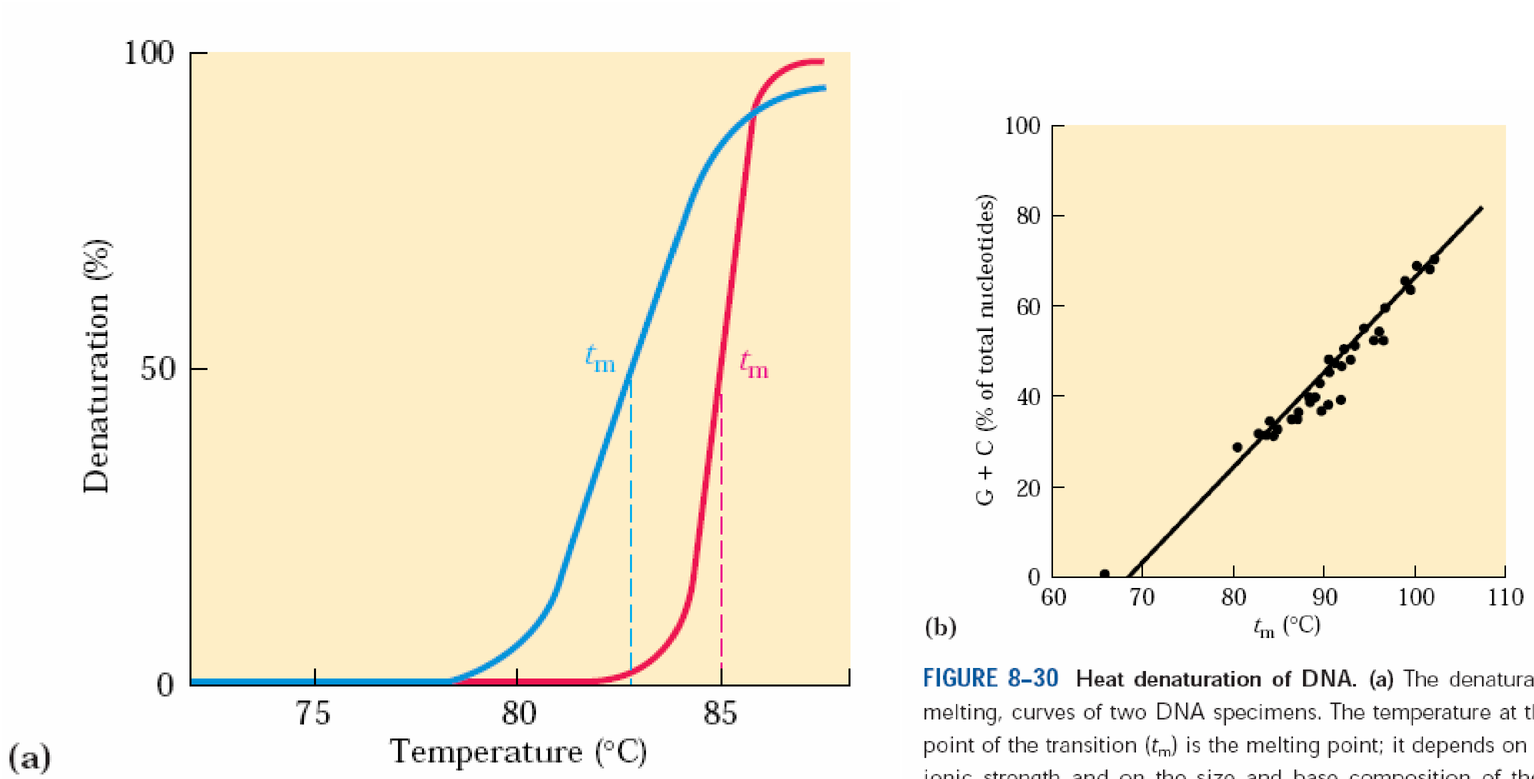


FIGURE 8–30 Heat denaturation of DNA. (a) The denaturation, or melting, curves of two DNA specimens. The temperature at the midpoint of the transition (t_m) is the melting point; it depends on pH and ionic strength and on the size and base composition of the DNA. **(b)** Relationship between t_m and the G≡C content of a DNA.

RNA

تفاوت با DNA:

- نوع قند
- U به جای T
- تک رشته بودن

هیدرولیز قلیایی RNA

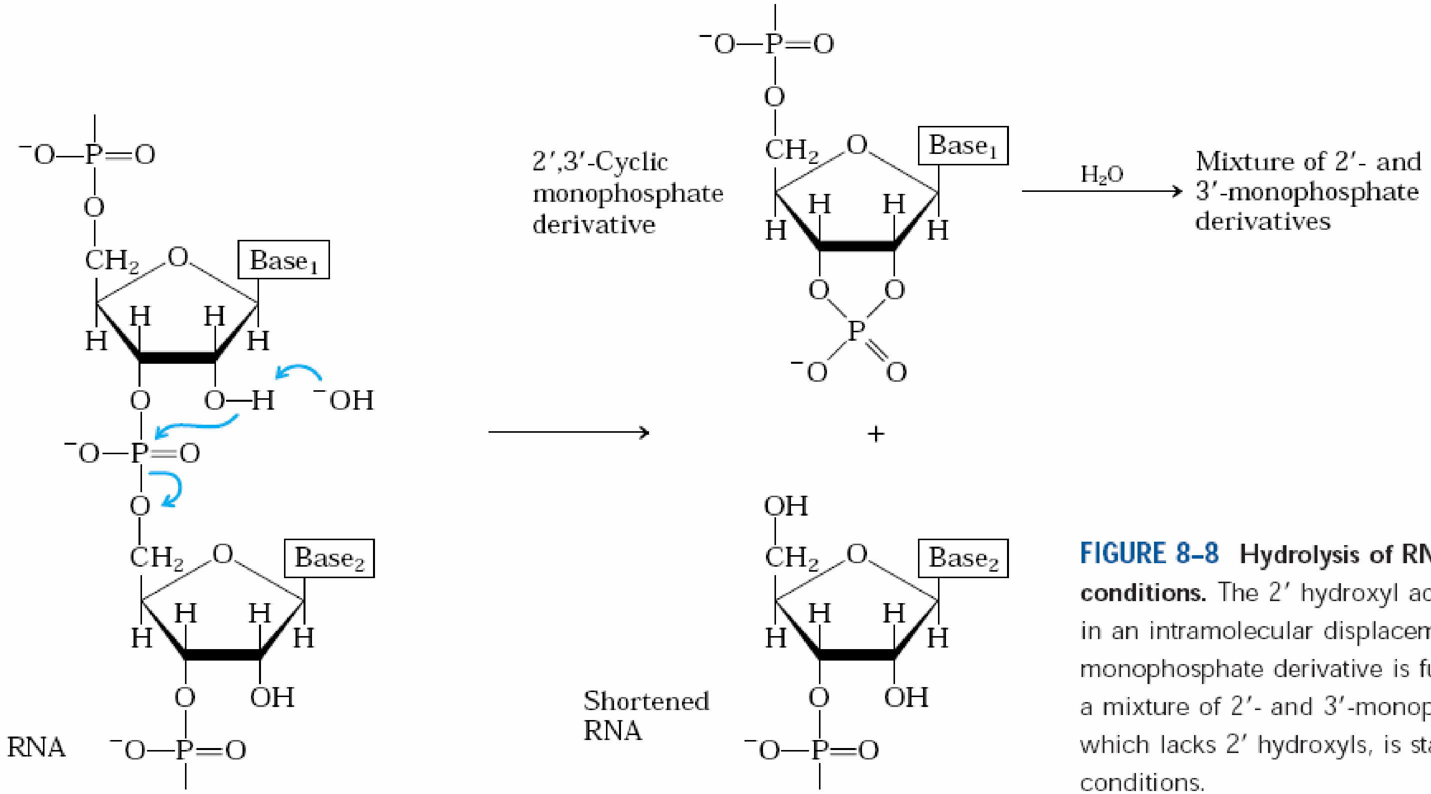


FIGURE 8–8 Hydrolysis of RNA under alkaline conditions. The 2′ hydroxyl acts as a nucleophile in an intramolecular displacement. The 2′,3′-cyclic monophosphate derivative is further hydrolyzed to a mixture of 2′- and 3′-monophosphates. DNA, which lacks 2′ hydroxyls, is stable under similar conditions.