

Livelli di Organizzazione del DNA

Il DNA contenuto nelle cellule è organizzato in strutture fisiche note come **cromosomi**.

Distinguiamo cromosomi virali, procariotici ed eucariotici.

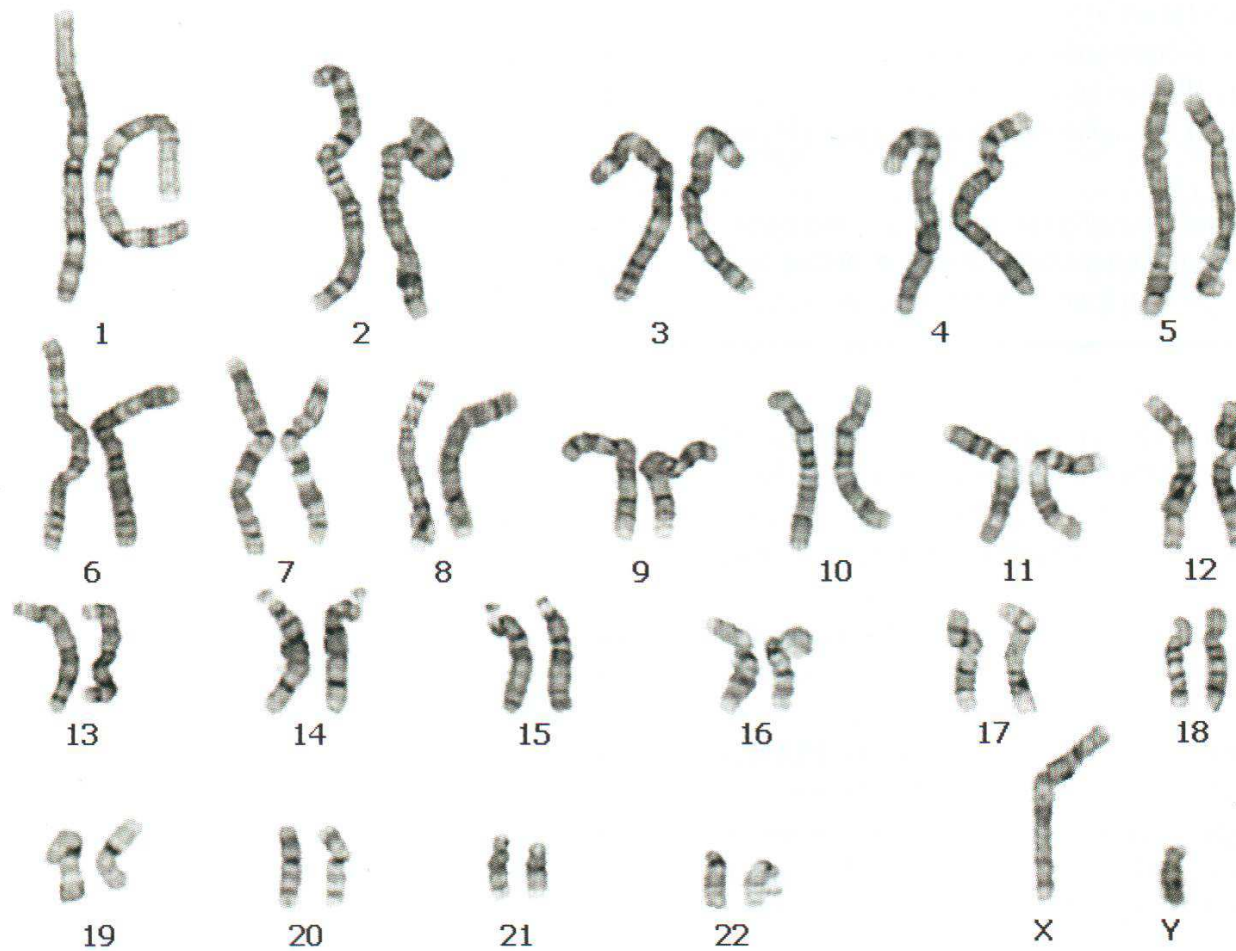
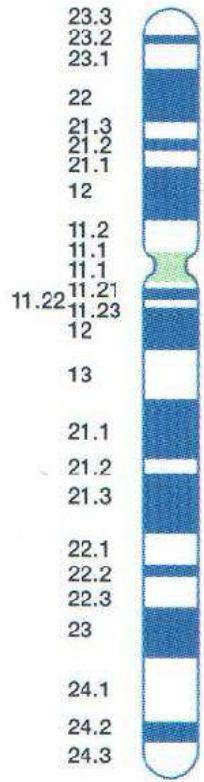


Figure 2.14. G-banded prometaphase karyogram of mitotic chromosomes from lymphocytes of a normal male at between 550 and 850 bands per haploid set.

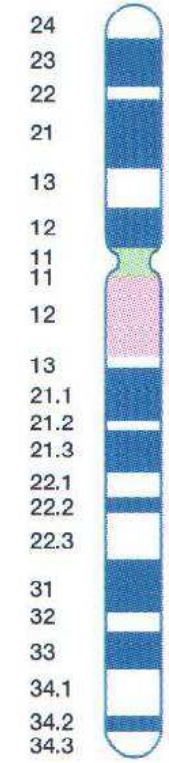
Compare with the idealized ideograms in *Figure 2.15*. Overall lengths of metaphase chromosomes range between 2 and 10 μm ; the DNA of the cell, if stretched out, would be about 2 m long. Reproduced from Cross and Wolstenholme (2001). In *Human Cytogenetics: Constitutional Analysis*, 3rd Edn (ed. D. E. Rooney). Reproduced by permission of Oxford University Press.

Il cromosoma eucariotico è costituito da **una singola** molecola (lunghissima) di DNA a doppia catena, lineare, cui si trovano associate proteine.

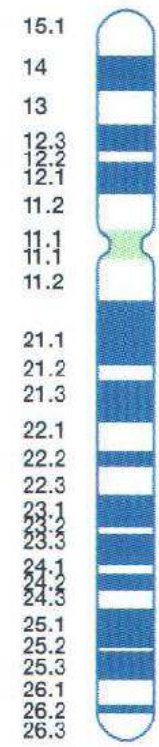
Il complesso di DNA e proteine associate al cromosoma si chiama **cromatina**.



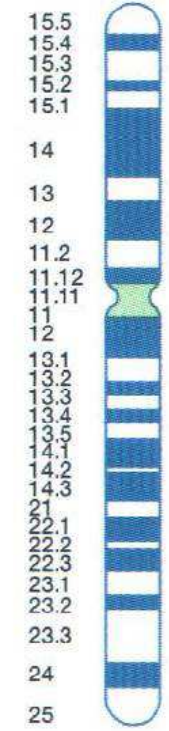
8



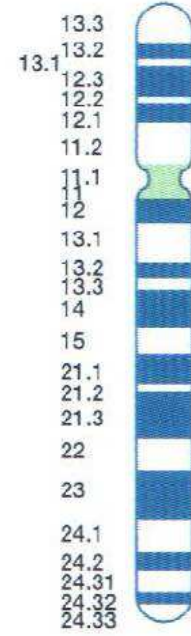
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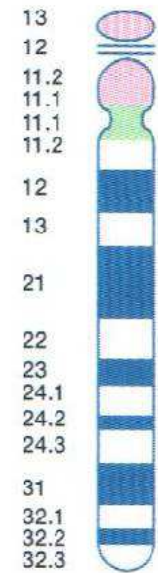
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La classe più abbondante di proteine associate ai cromosomi è rappresentata dagli **istoni**.

Altre proteine associate ai cromosomi, dette proteine **non-istoniche**, includono proteine che legano il DNA. **SMC**.

Gli **istoni** sono proteine basiche, presenti nelle cellule eucariotiche.

Si conoscono le seguenti proteine istoniche:

H2A, H2B, H3, H4 (**core histones**)

H1 (**linker histone**)

TABELLA 5.4 Le principali proteine istoniche.

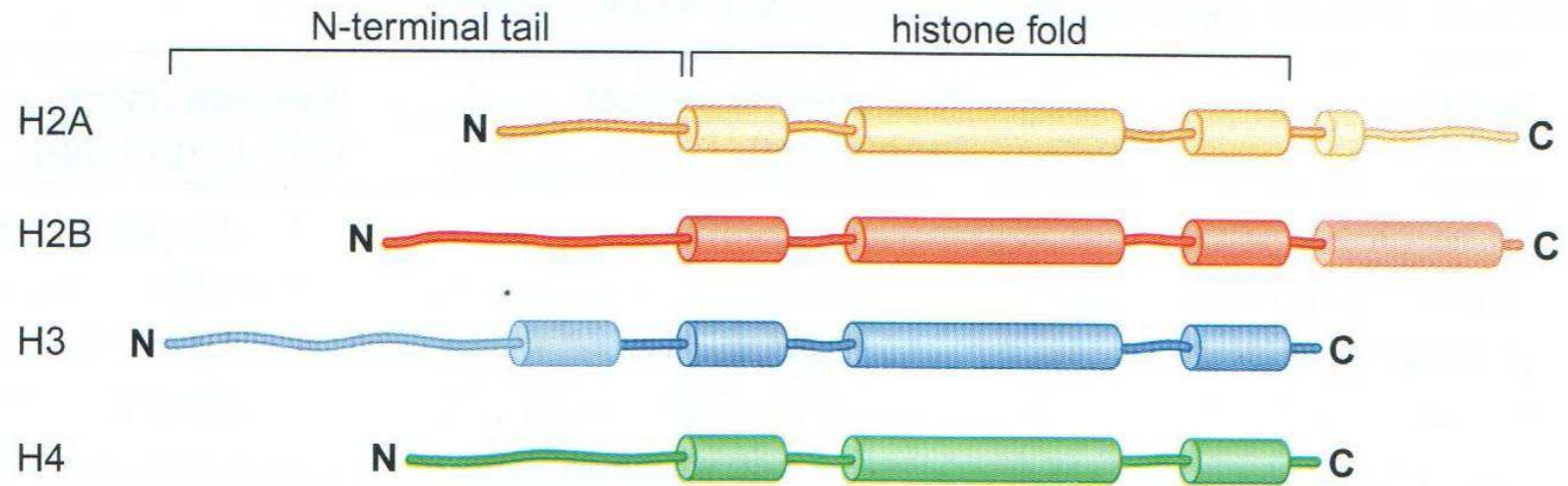
Istone ^a	Peso Molecolare	Numero di amino acidi	Percentuale di Lys + Arg
H1	22,500	244	30.8
H2A	13,960	129	20.2
H2B	13,774	125	22.4
H3	15,273	135	22.9
H4	11,236	102	24.5

^a I dati sono riferiti a istoni di coniglio (H1) e bovini.

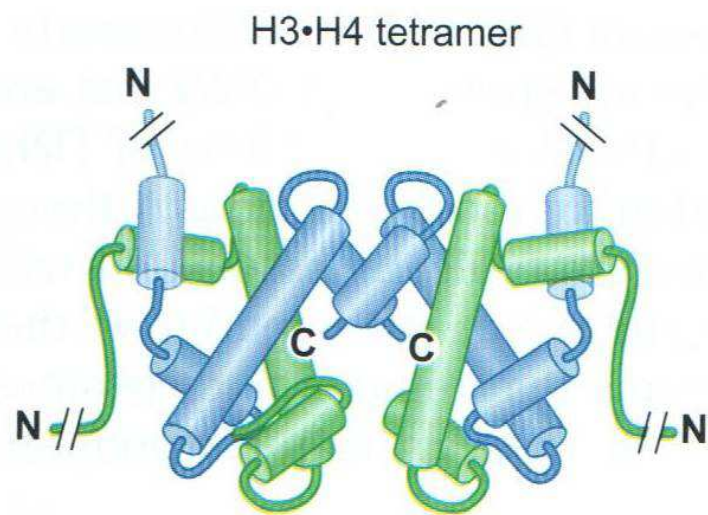
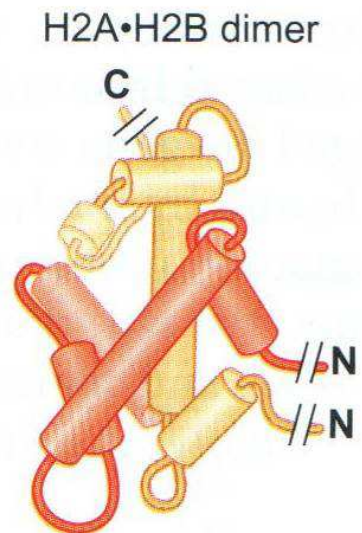
Sono proteine evolutivamente **altamente conservate**.

Gli istoni si trovano regolarmente associati al DNA a formare delle strutture note come **nucleosomi**.

a



b



L'assemblaggio del nucleosoma ha inizio con la formazione di un tetramero H3-H4.

Il tetramero H3-H4 si lega al dsDNA.

Il tetramero H3-H4, legato al DNA, richiama due copie del dimero H2A-H2B per completare l'assemblaggio del nucleosoma.

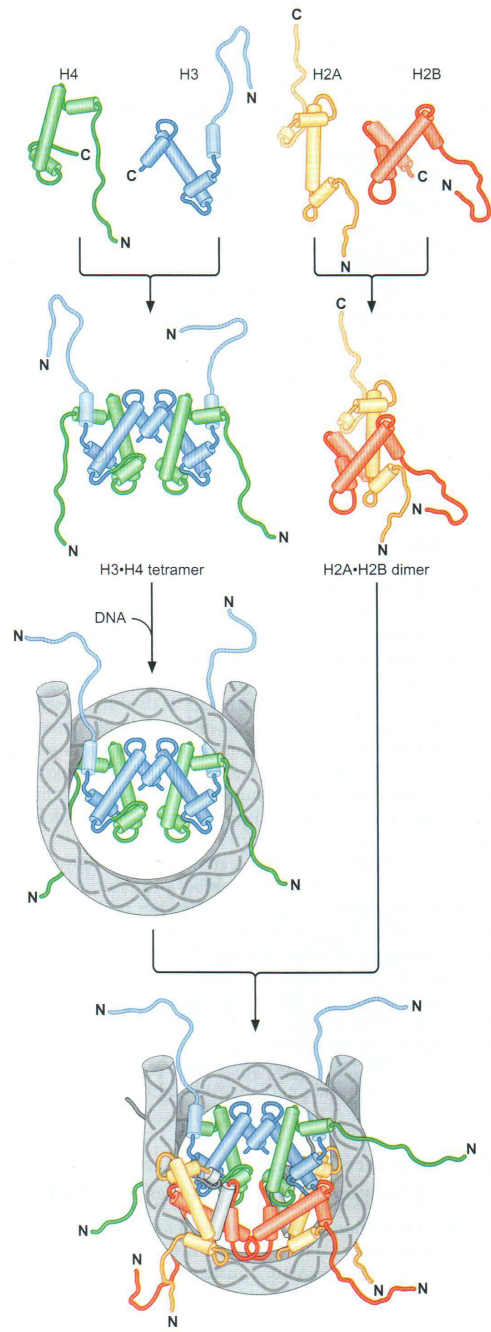
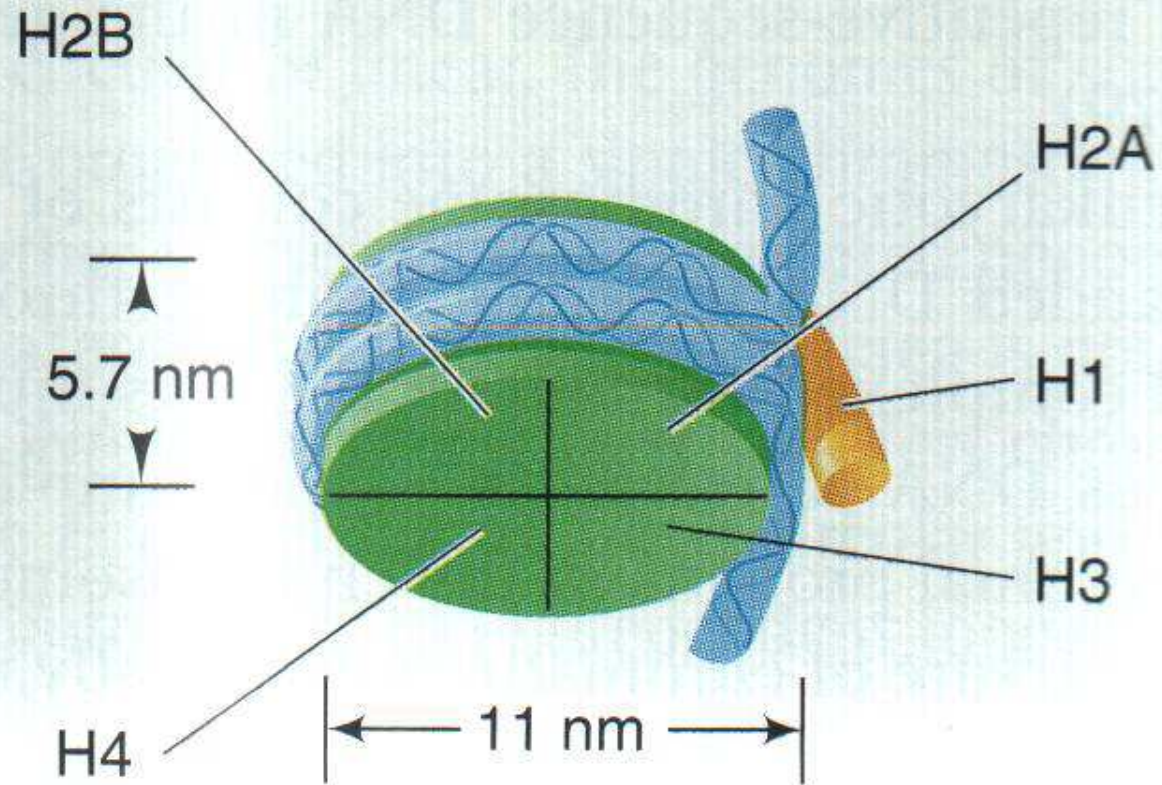
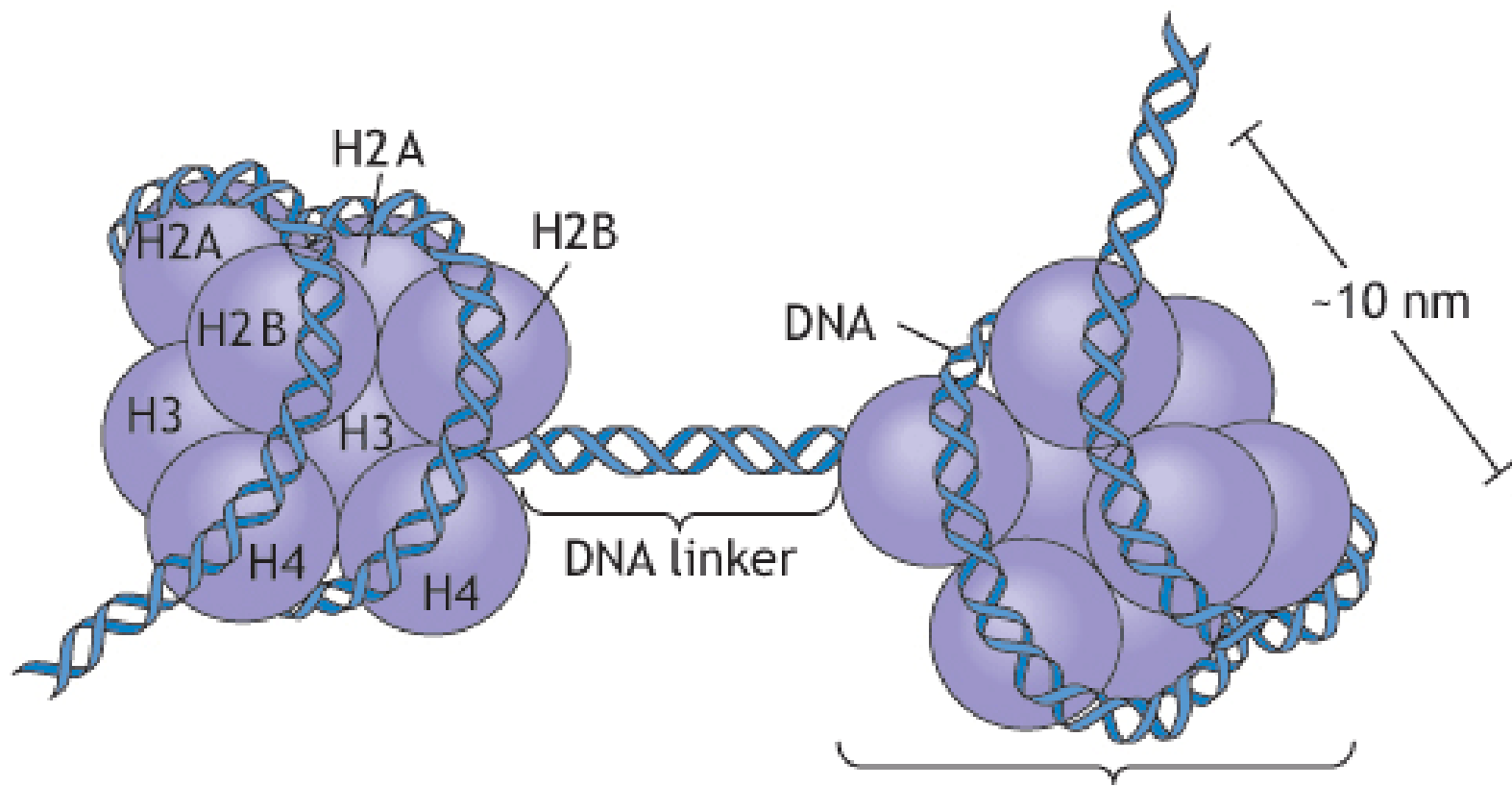


Figure 8.17

A possible nucleosome structure.





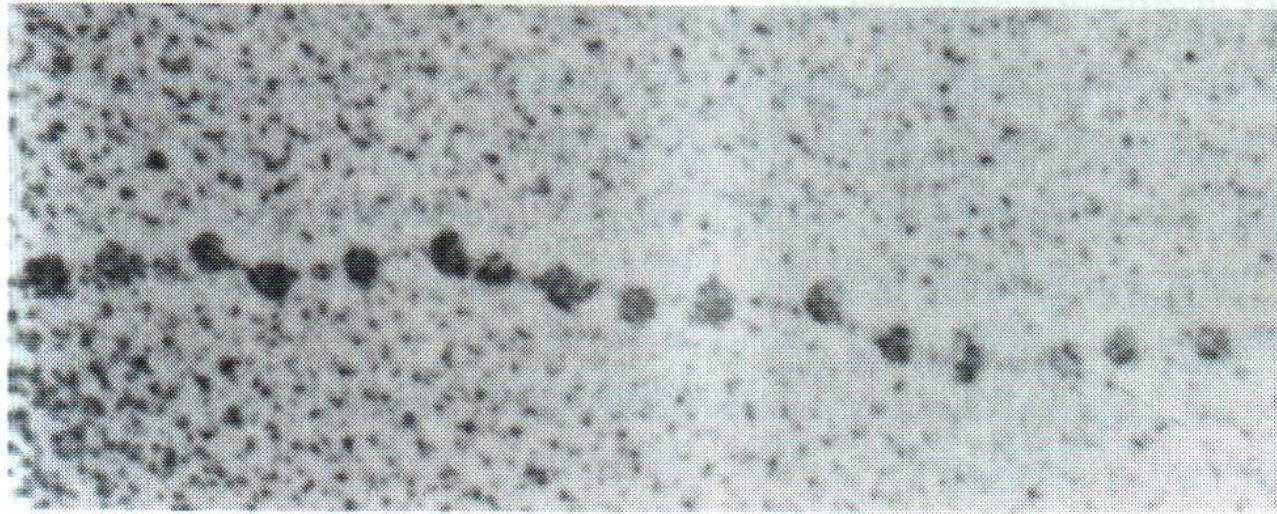
Nucleosoma (8 molecole di istoni + 146 coppie di nucleotidi di DNA)

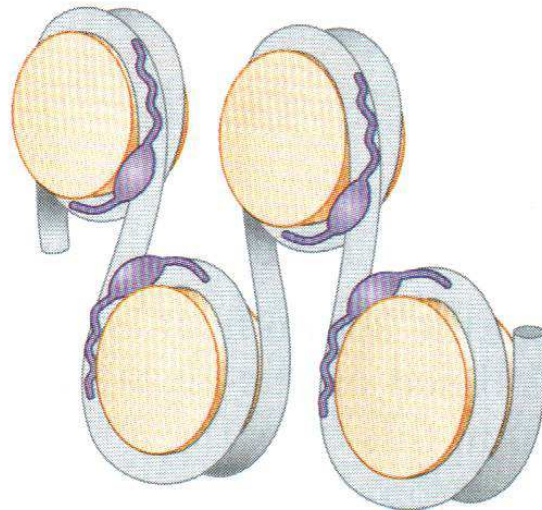
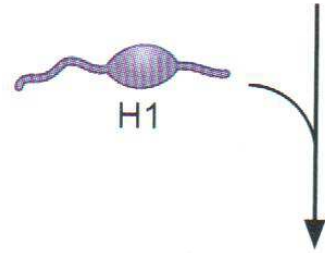
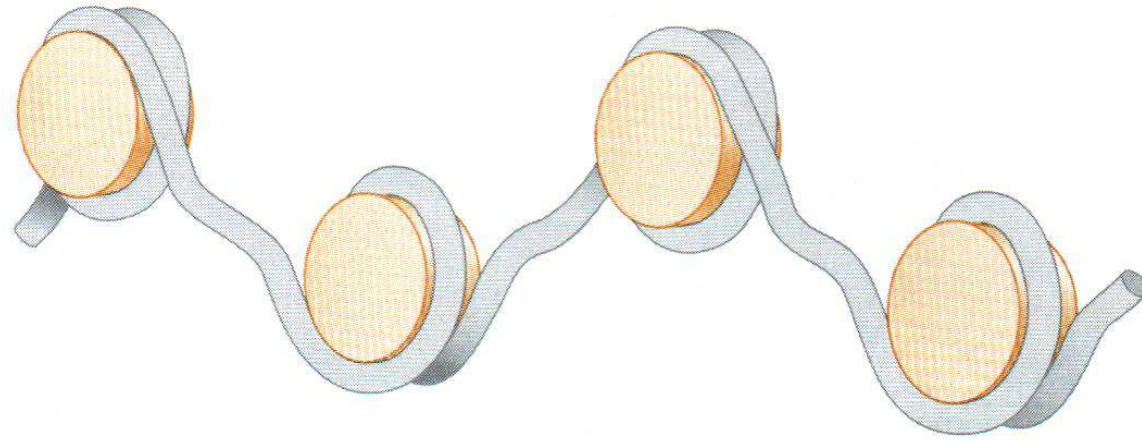
“Beads-on-a-string”
form of
chromatin

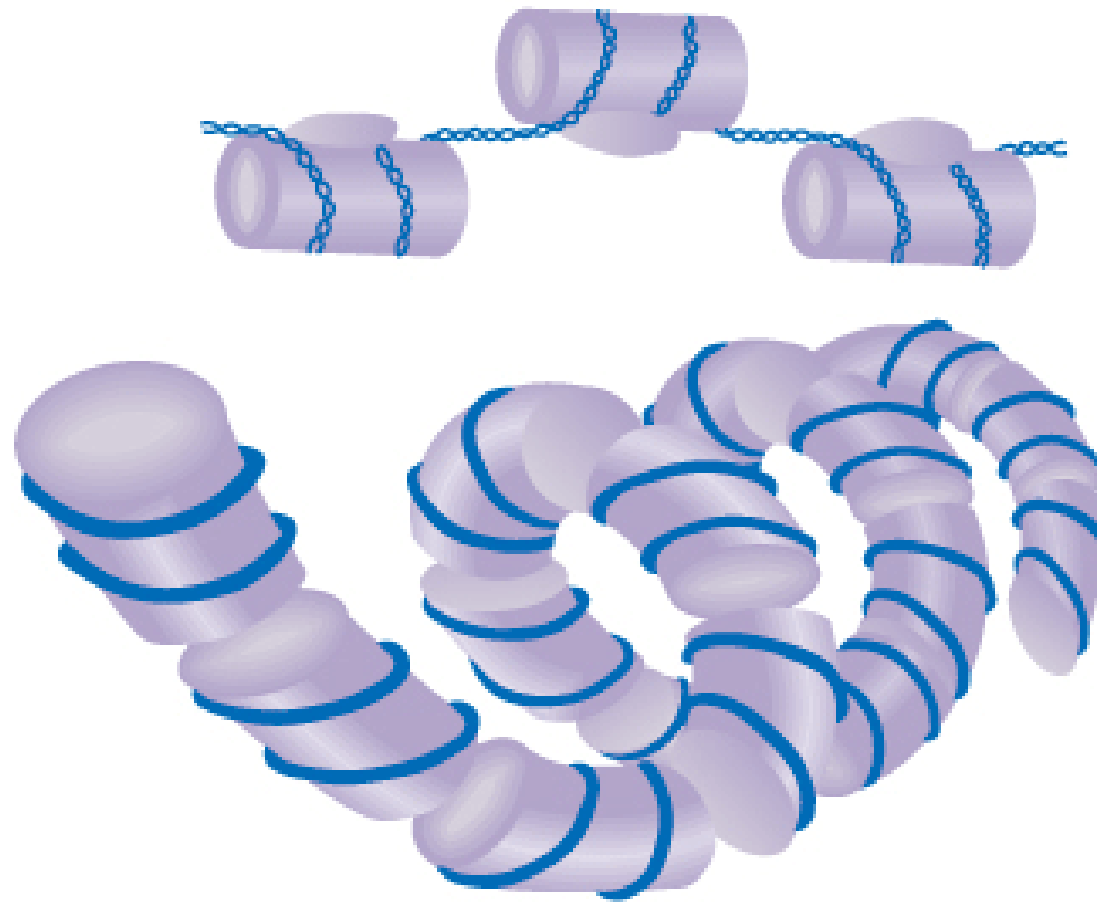


Figure 8.19

Electron micrograph of unraveled chromatin showing the nucleosomes in a “beads-on-a-string” morphology.

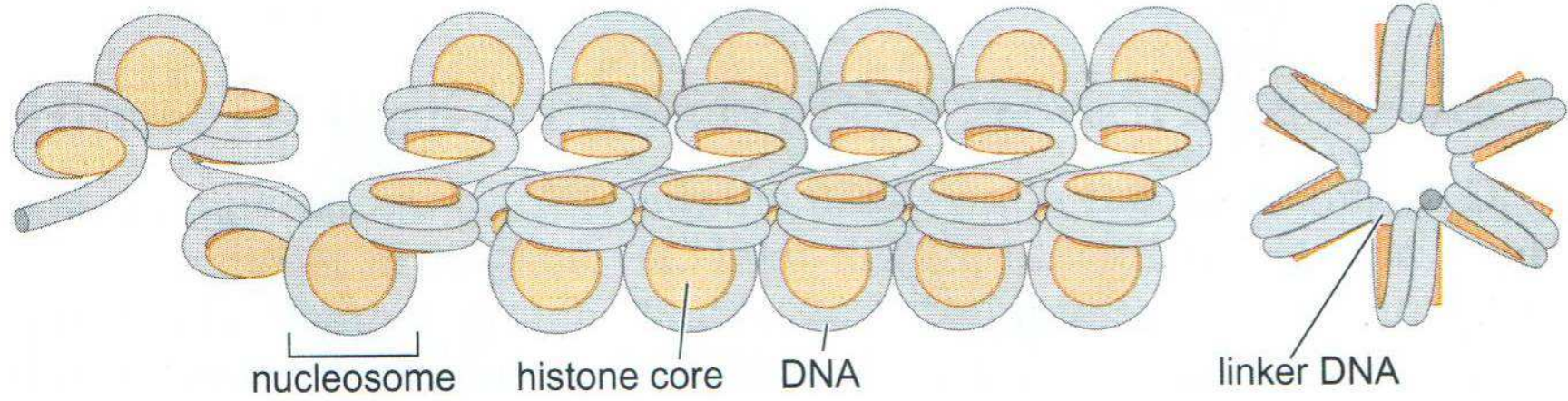




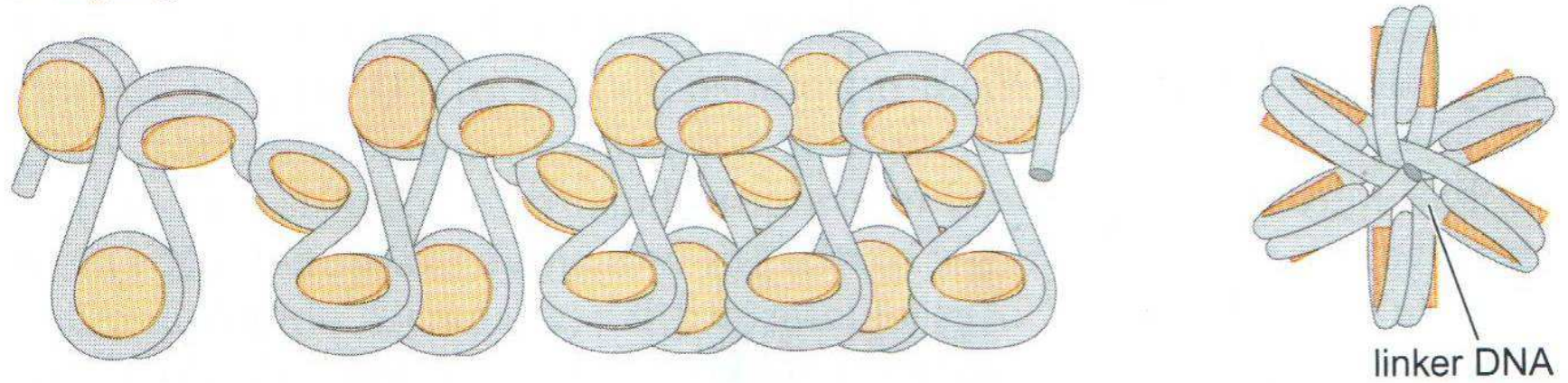


■ **FIGURA 1.61** **La fibra di 30 nm: il solenoide.** L'avvicinamento delle perle fa sì che si formi una struttura nella quale i nucleosomi sono impacchettati a formare un'elica irregolare a zig zag.

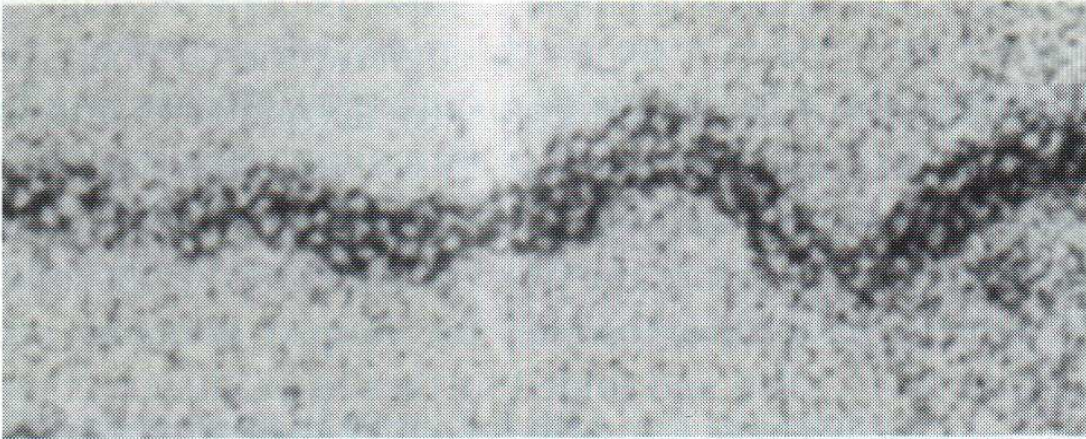
a solenoid



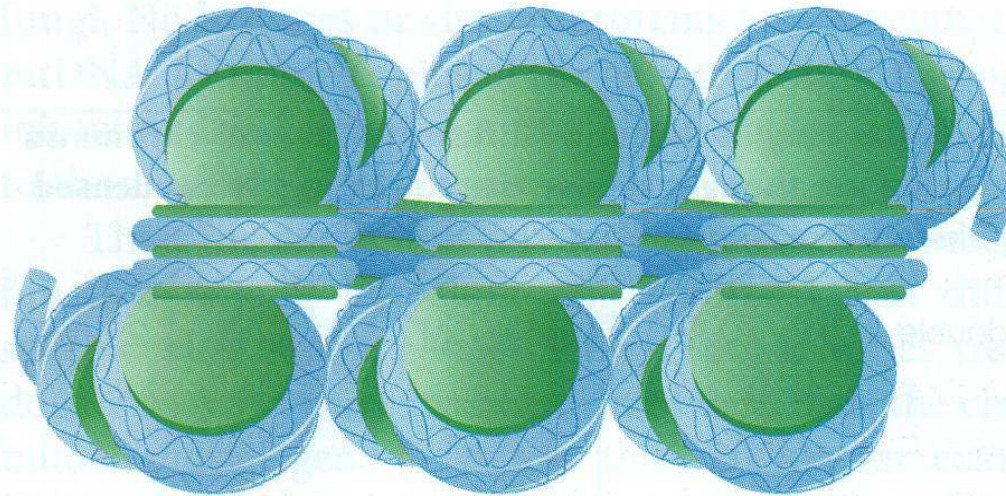
b zigzag



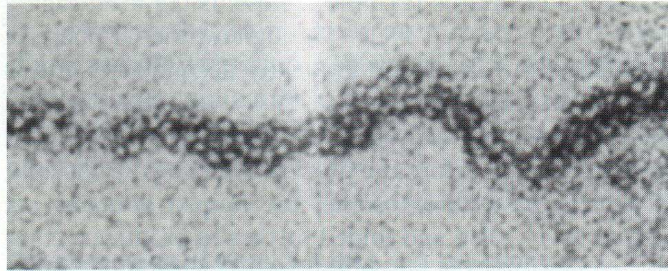
a)



b)



a)



b)

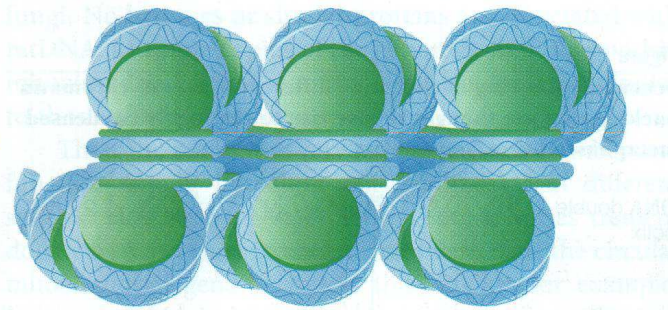
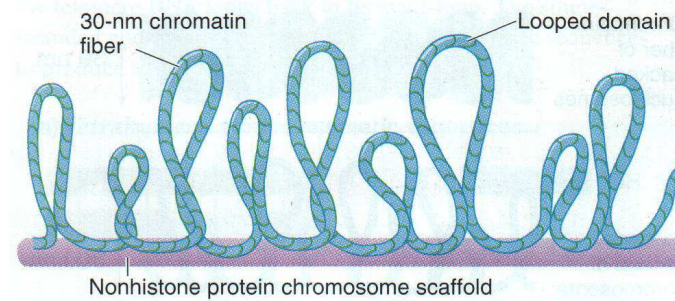
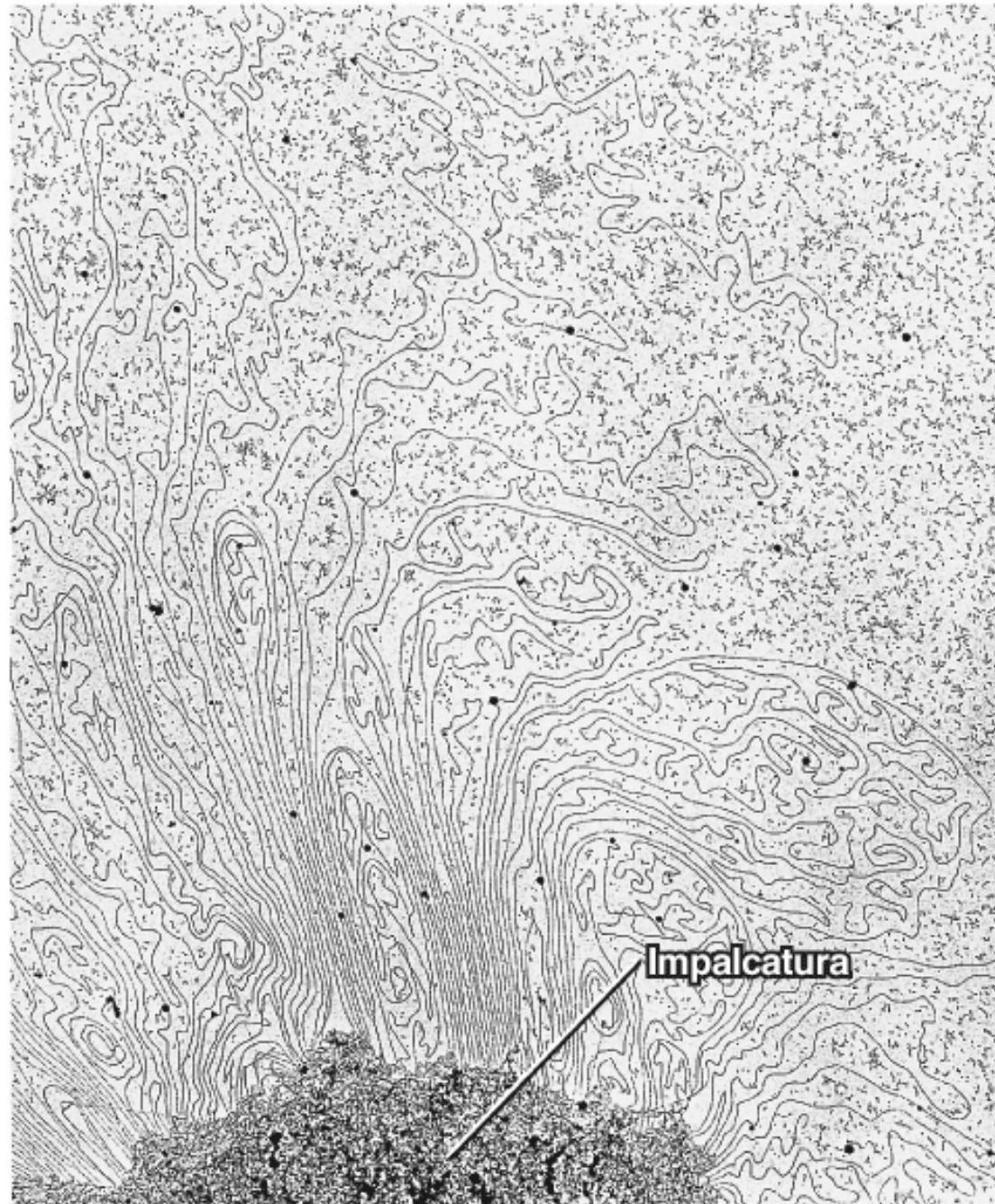


Figure 8.21

Schematic model for the organization of 30-nm chromatin fiber into looped domains that are anchored to a nonhistone protein chromosome scaffold.



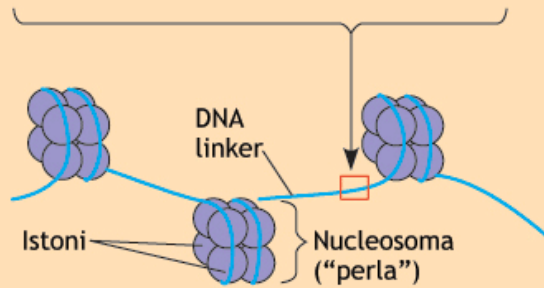
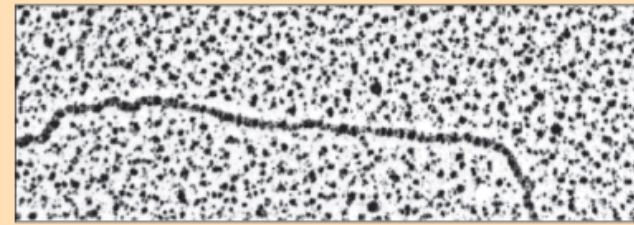






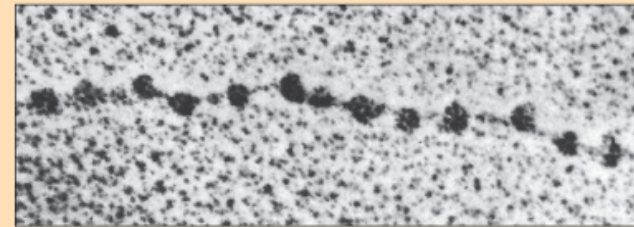
DNA a doppia elica

2 nm

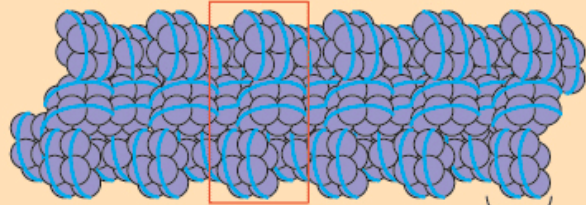


Istoni
DNA linker
Nucleosoma ("perla")

10 nm



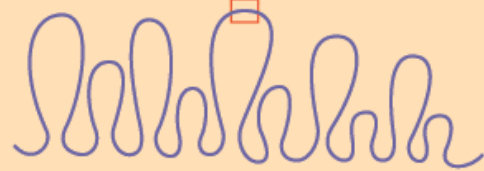
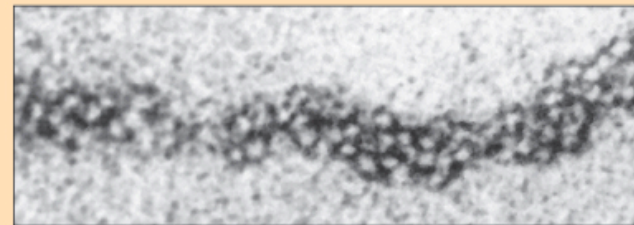
a) Nucleosomi ("collana di perle")



b) Fibra di cromatina di 30 nm

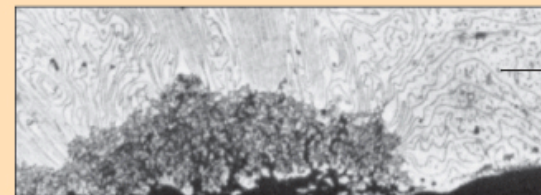
Nucleosoma

30 nm

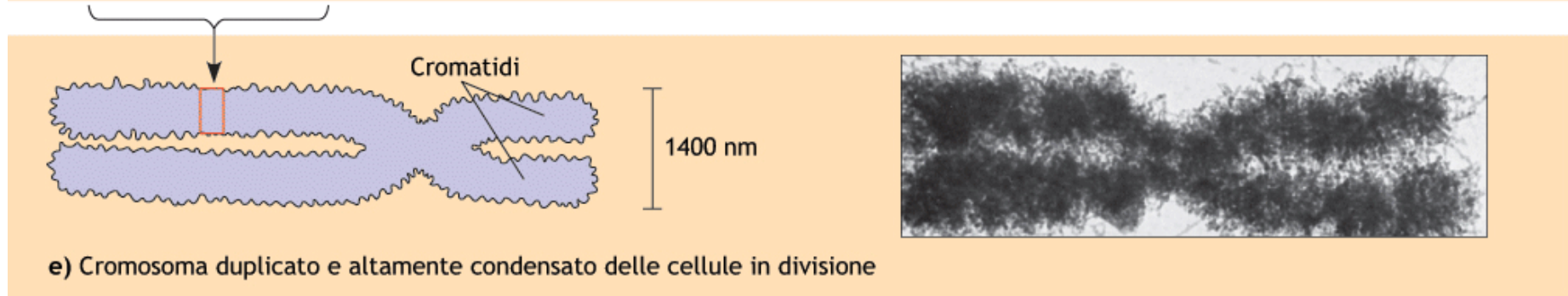
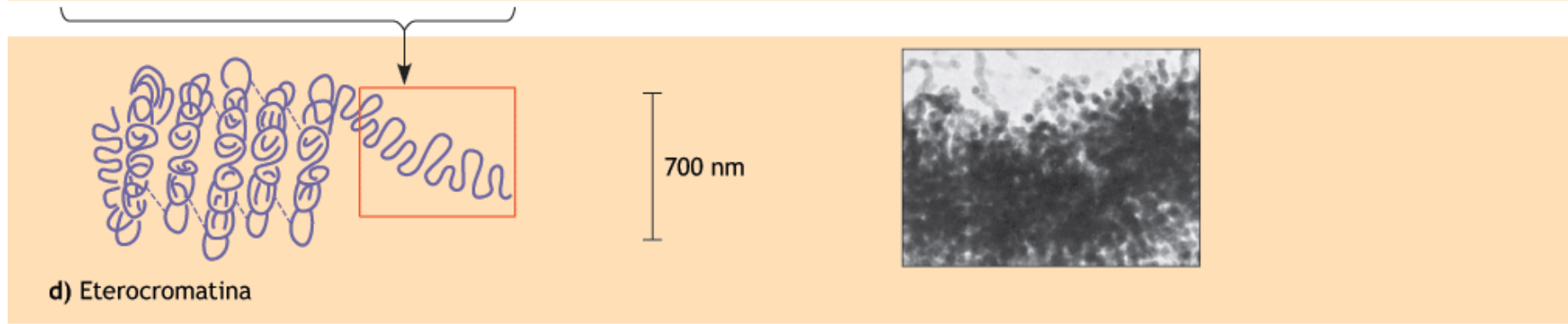
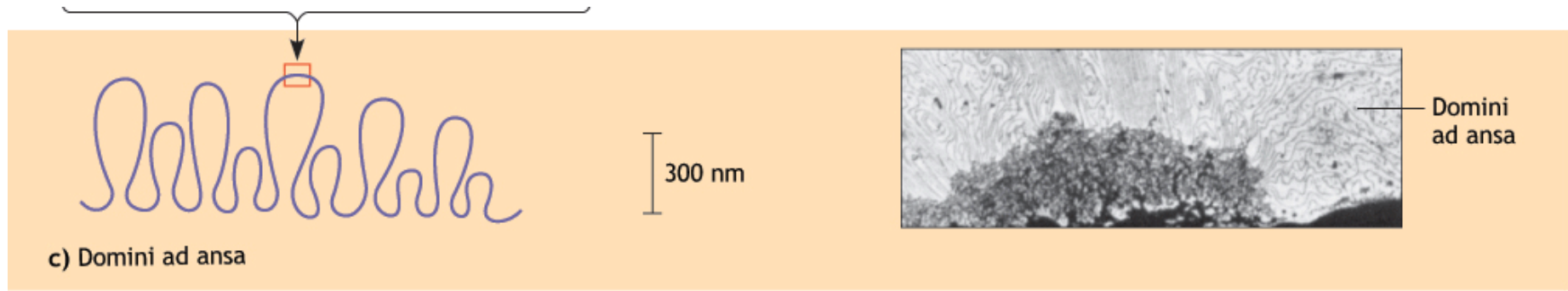


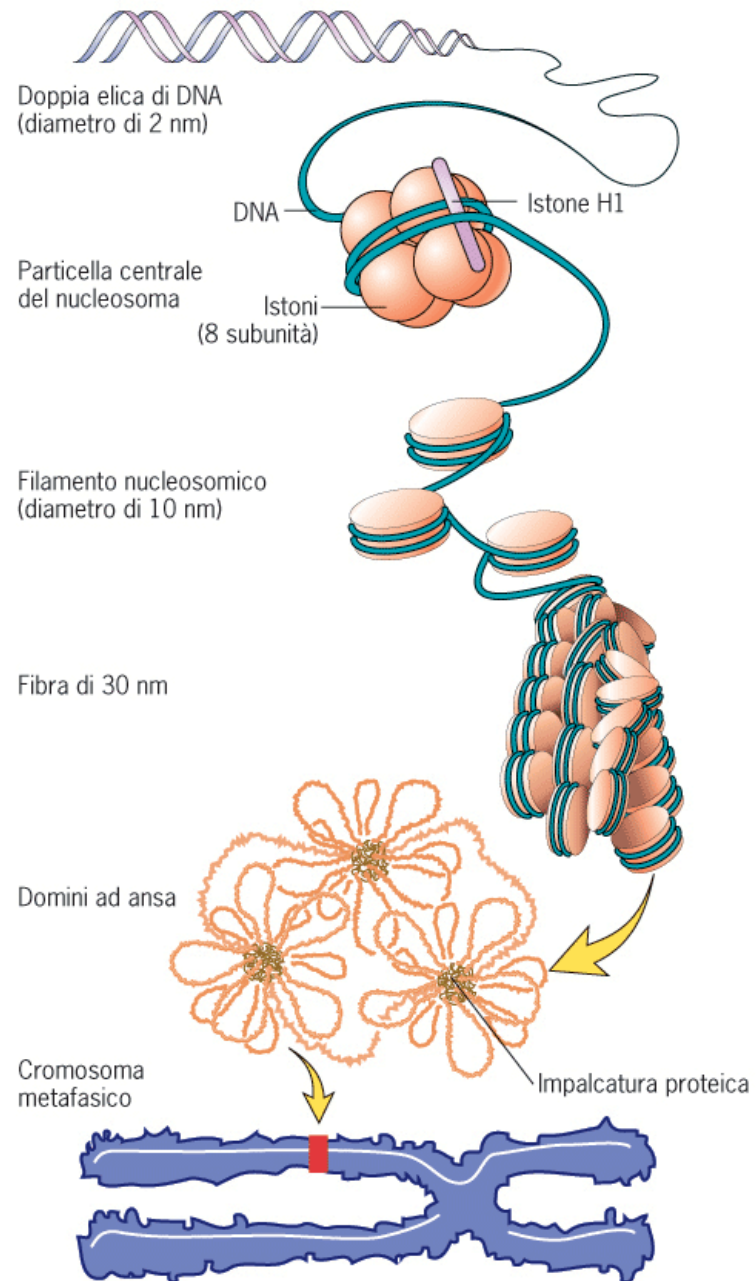
c) Domini ad ansa

300 nm



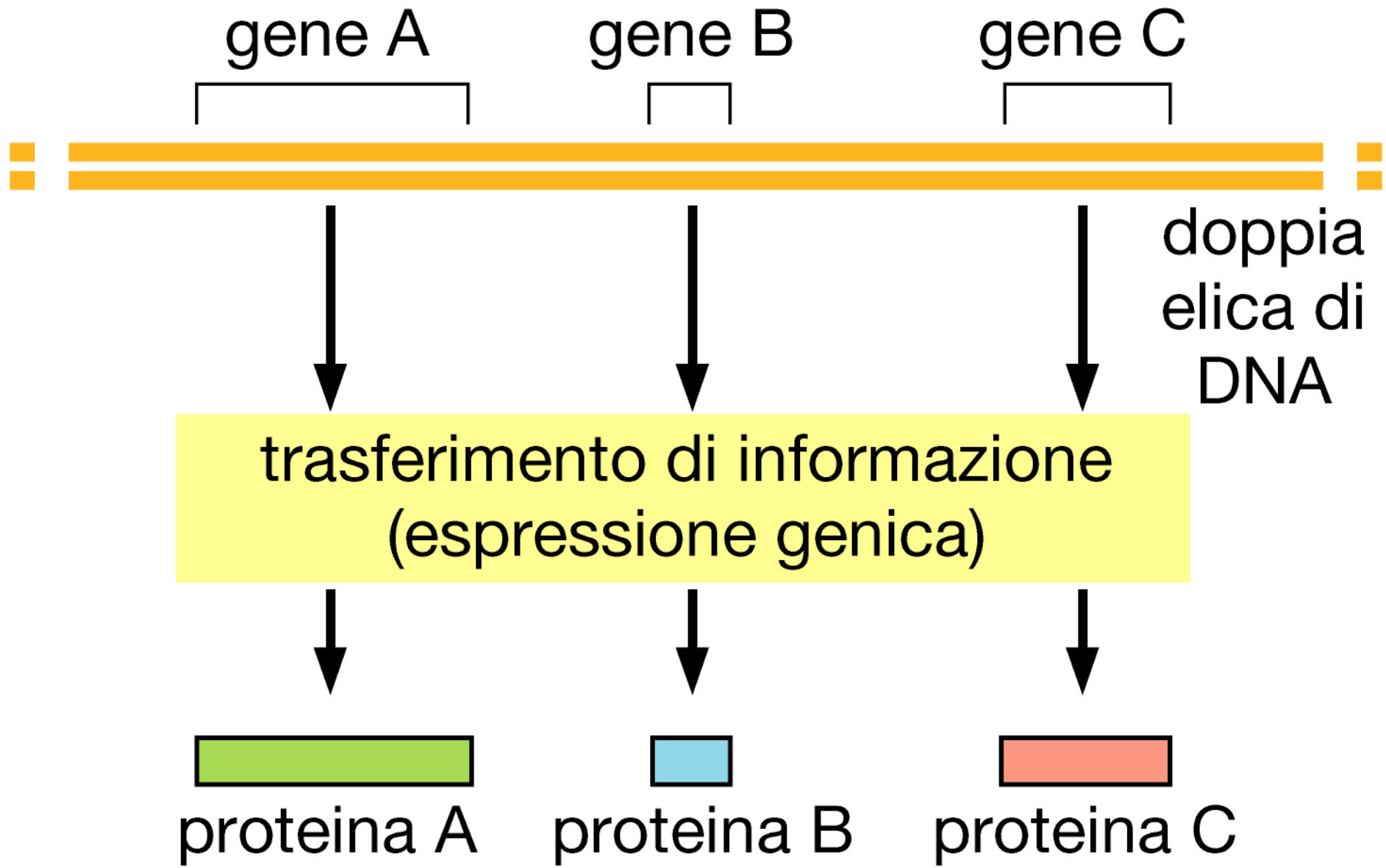
Domini ad ansa

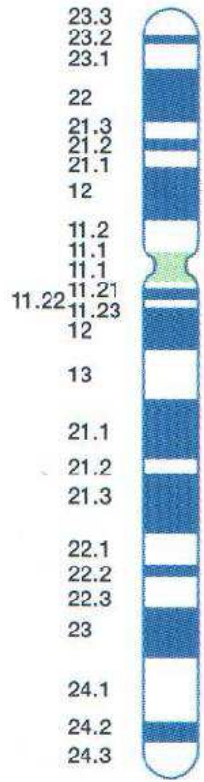




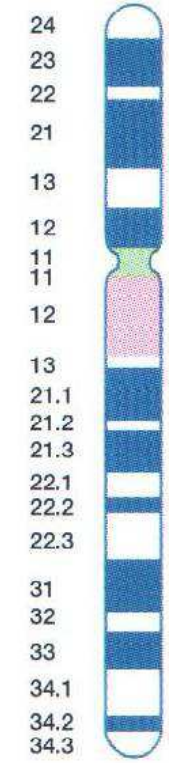
Funzioni dei cromosomi

- Forma compatta che consente al DNA di localizzarsi all'interno della cellula
- Sui cromosomi si trovano i **geni**, localizzati in punti specifici detti **loci**
- Il **genoma** comprende l'informazione genetica totale posseduta dall'organismo

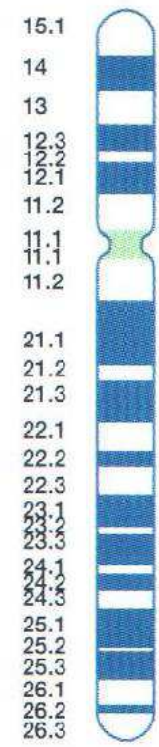




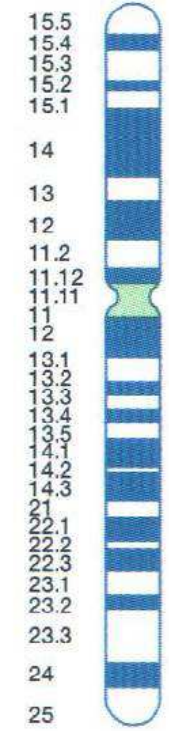
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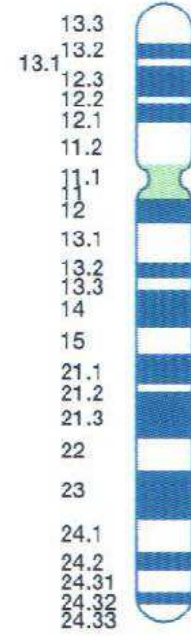
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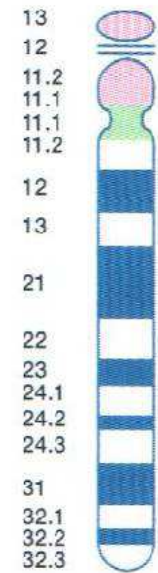
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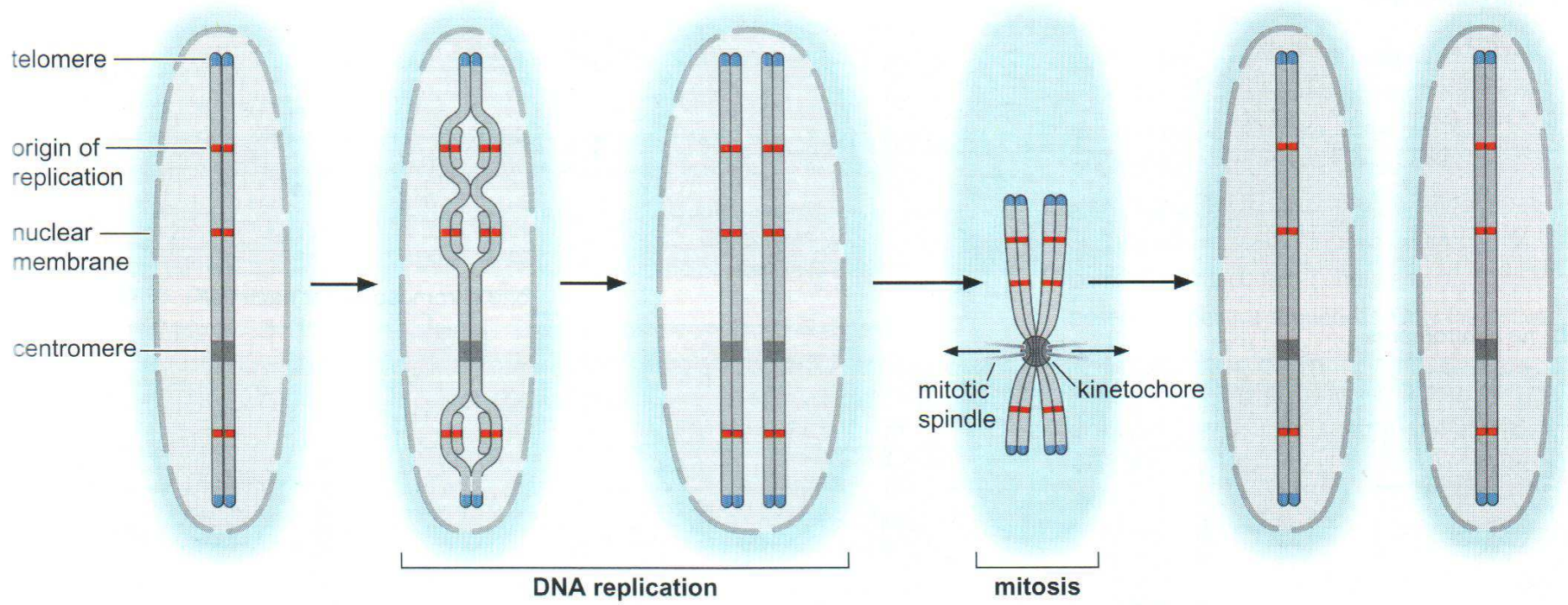
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Funzioni dei cromosomi

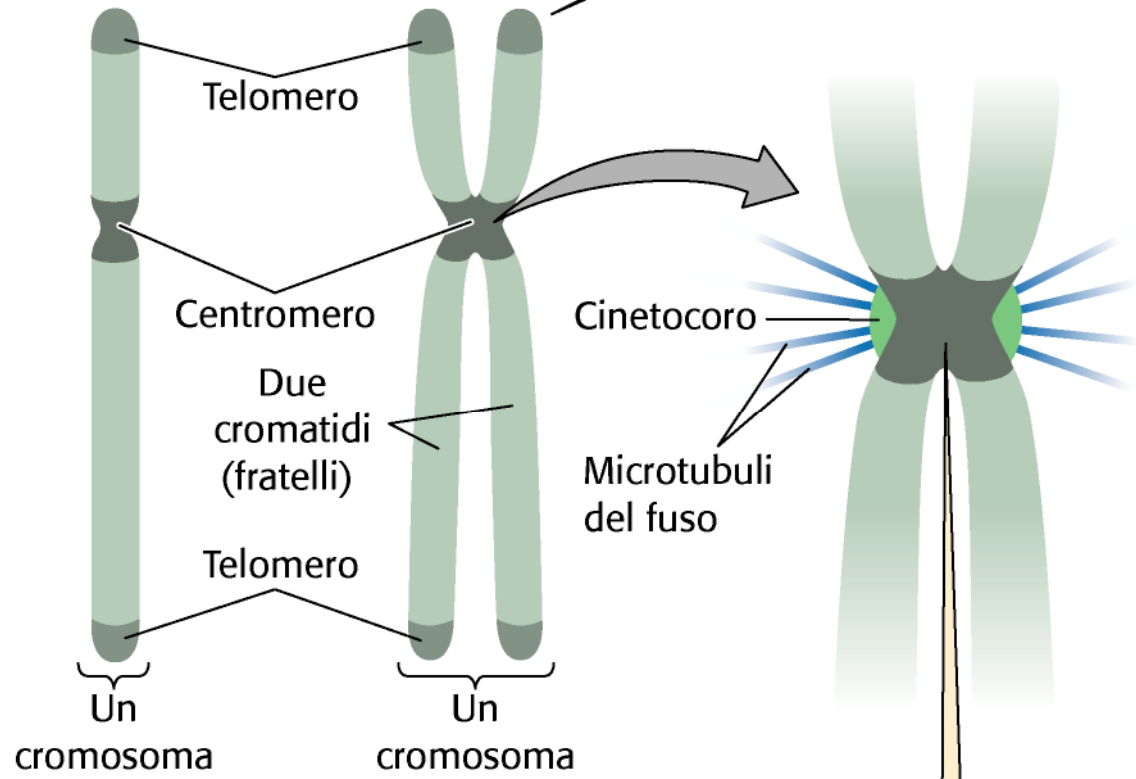
- Protezione e stabilità del DNA (e quindi dell'informazione). **Telomeri.**
- Duplicazione dell'informazione. **Origine di replicazione.**
- Trasmissione efficiente alle cellule figlie durante la divisione cellulare. **Centromero.**



In alcuni momenti un cromosoma è costituito da un singolo cromatide...

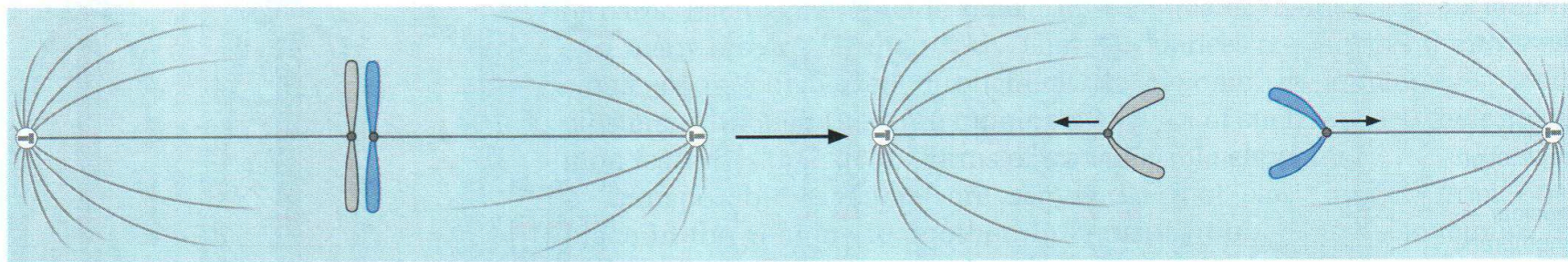
...in altri è formato da due cromatidi (fratelli).

I telomeri rappresentano le estremità stabili dei cromosomi.



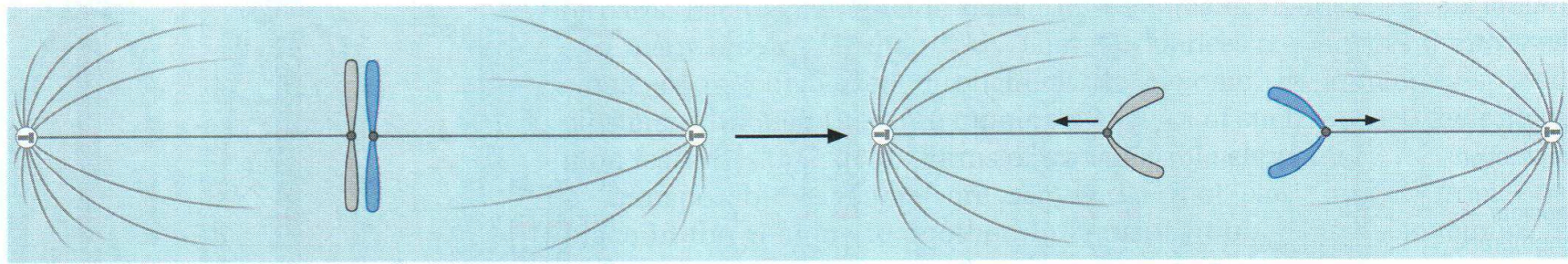
Il centromero è una regione contratta del cromosoma in cui si forma il cinetocoro e a cui si attaccano i microtubuli del fuso.

a one centromere



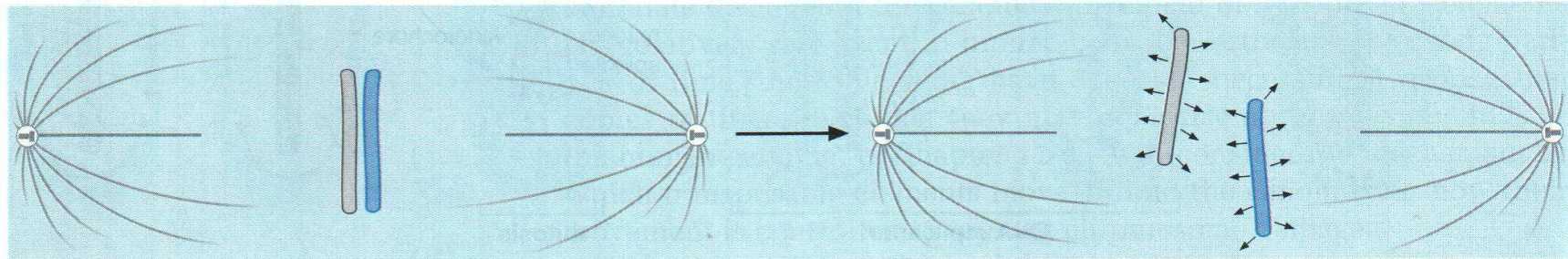
one chromosome for each cell

a one centromere



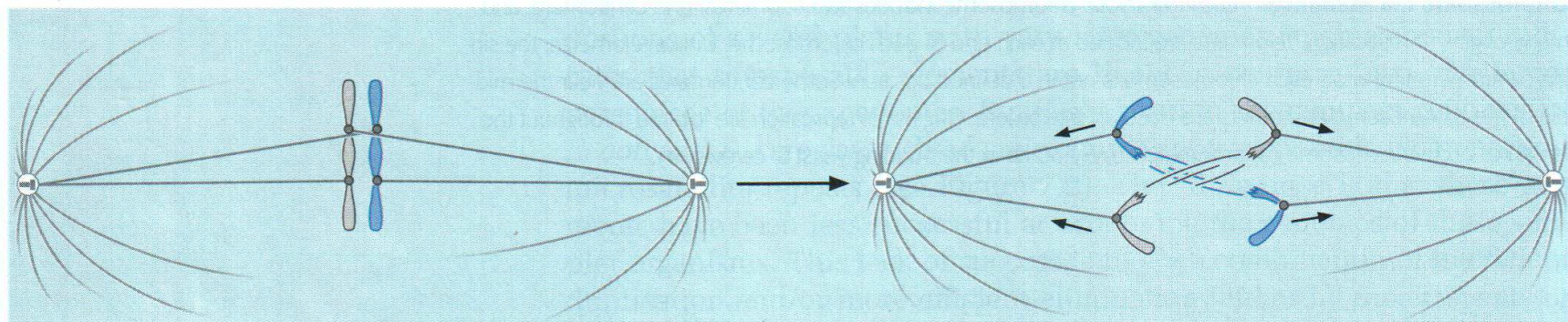
one chromosome for each cell

b no centromeres

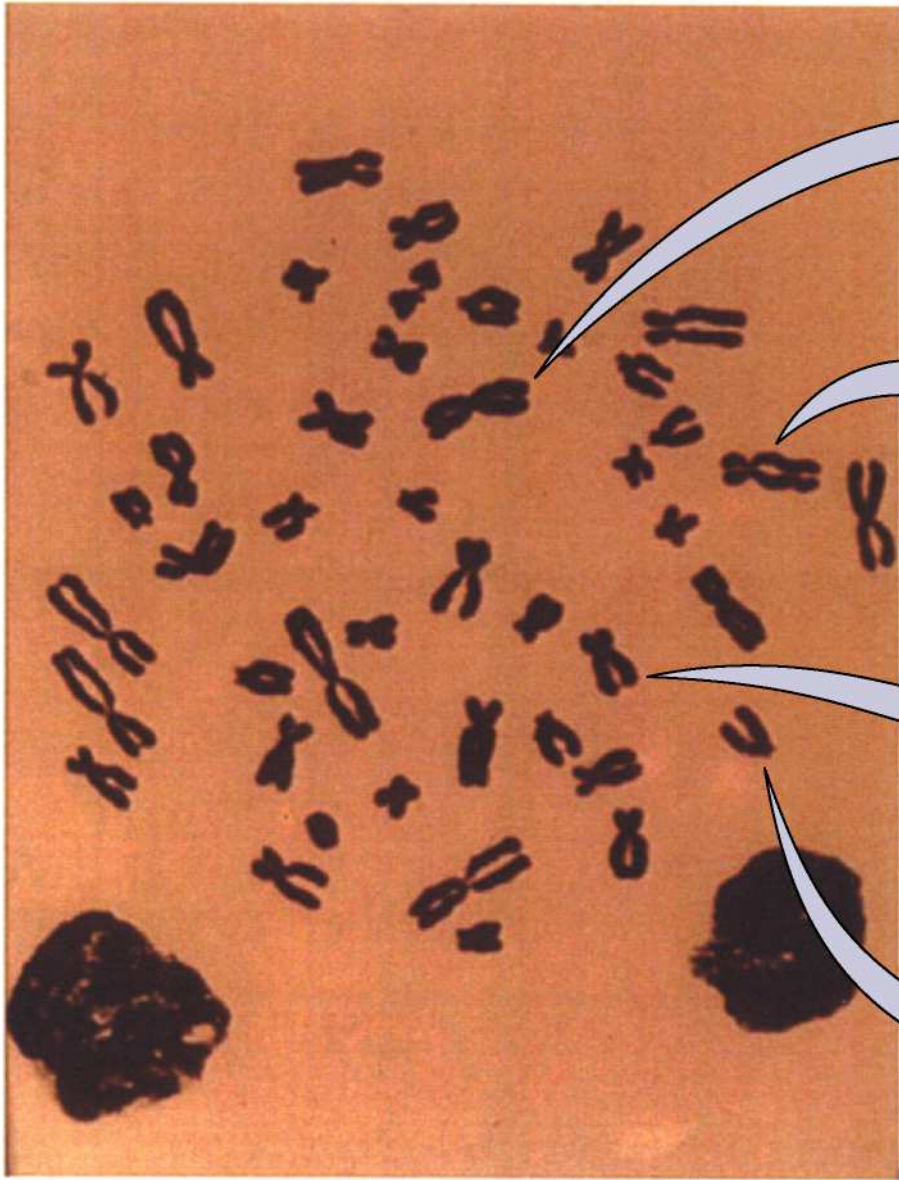


random segregation of chromosome

c two centromeres



chromosome breakage
(due to more than one centromere)



Metacentrico



Submetacentrico



Acrocentrico



Telocentrico



(A)



(B)

Cromosoma Procariotico



Concetto chiave

A differenza degli organelli delle cellule eucariotiche, quelli delle cellule procariotiche non sono racchiusi da membrane.

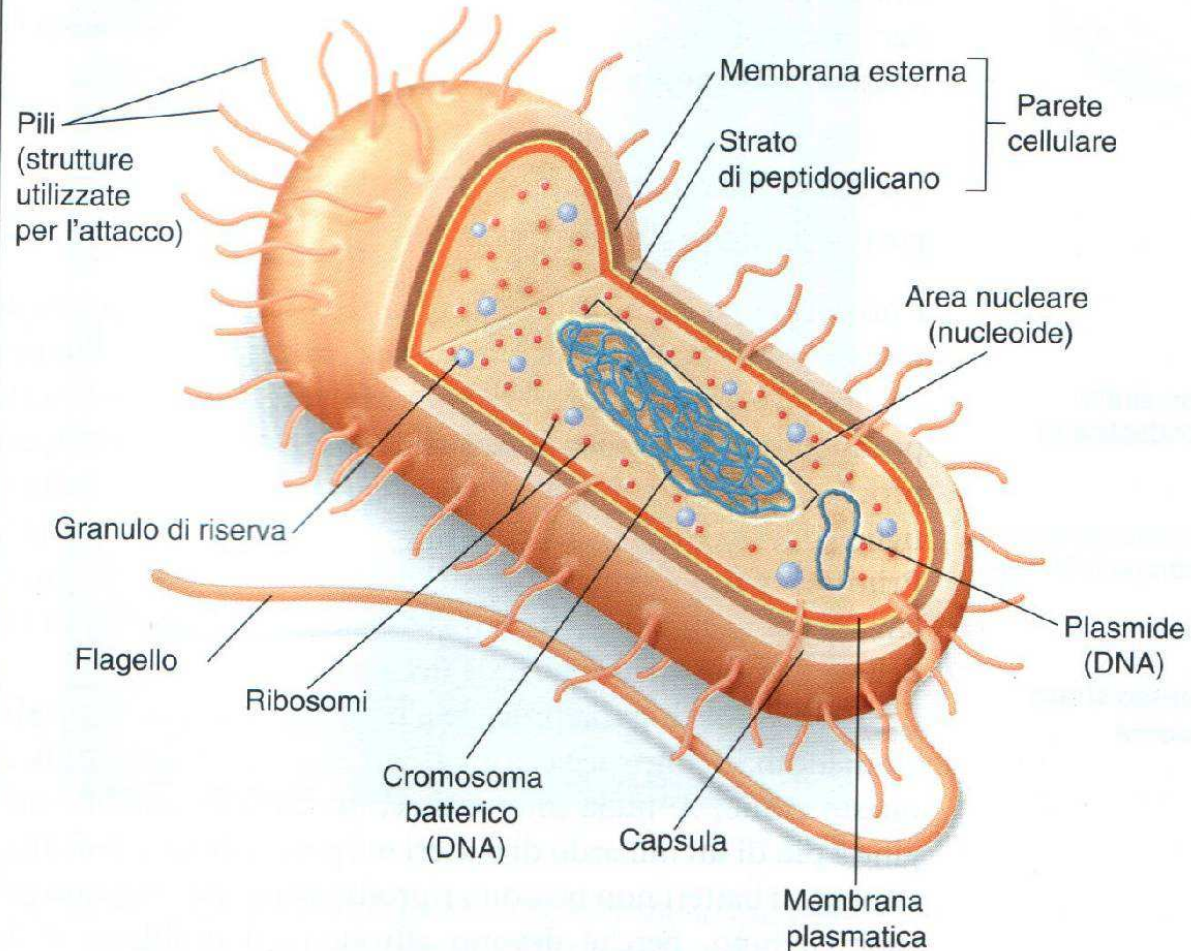


Figura 19-9 Struttura di una cellula procariotica

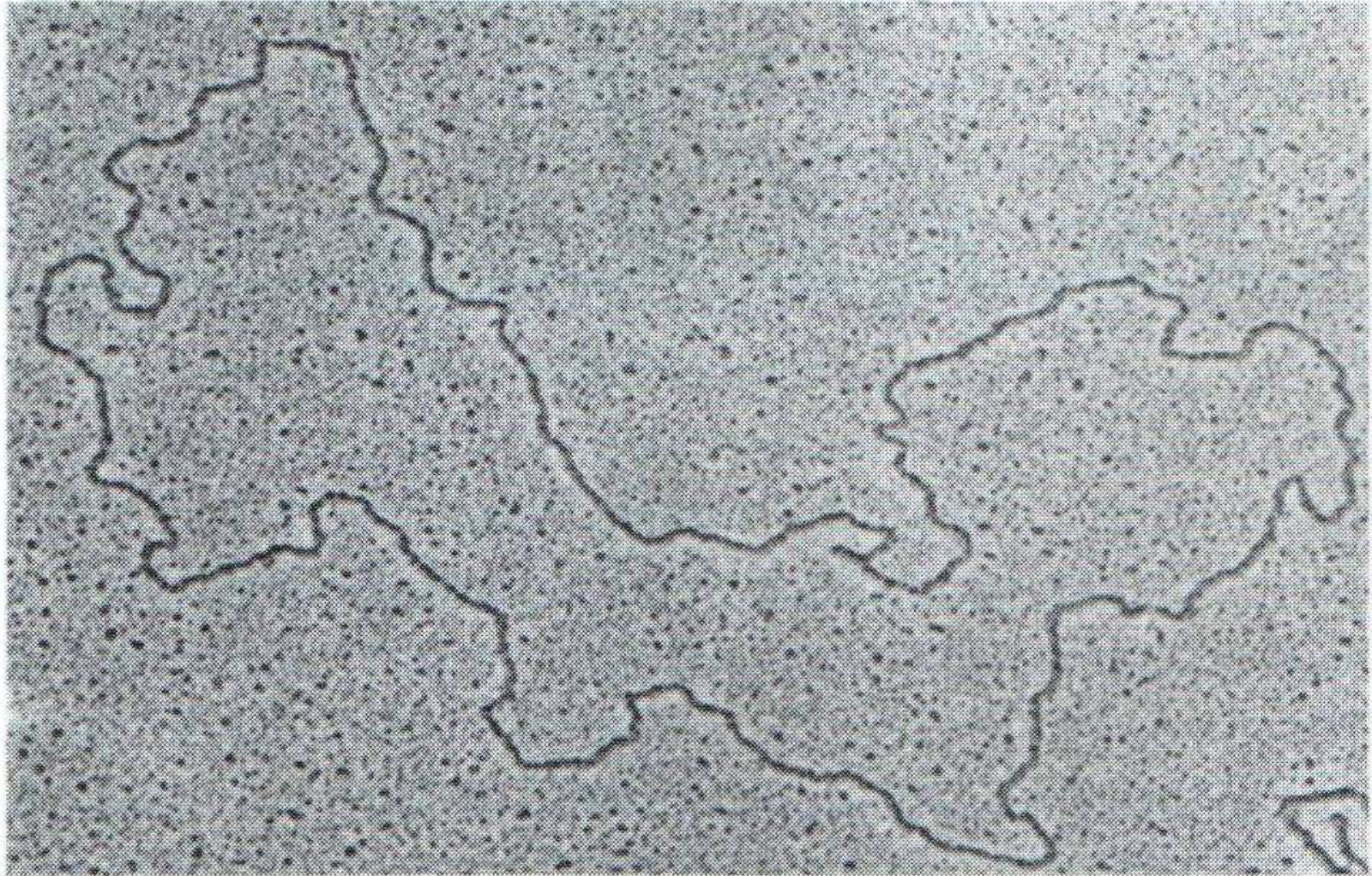
Questo bacillo è un batterio gram-negativo (discusso nel testo).
Si noti l'assenza di un involucro nucleare che avvolga il DNA del batterio.

Il cromosoma procariotico si trova in una regione cellulare nota come **nucleoide**, non racchiuso da membrana.

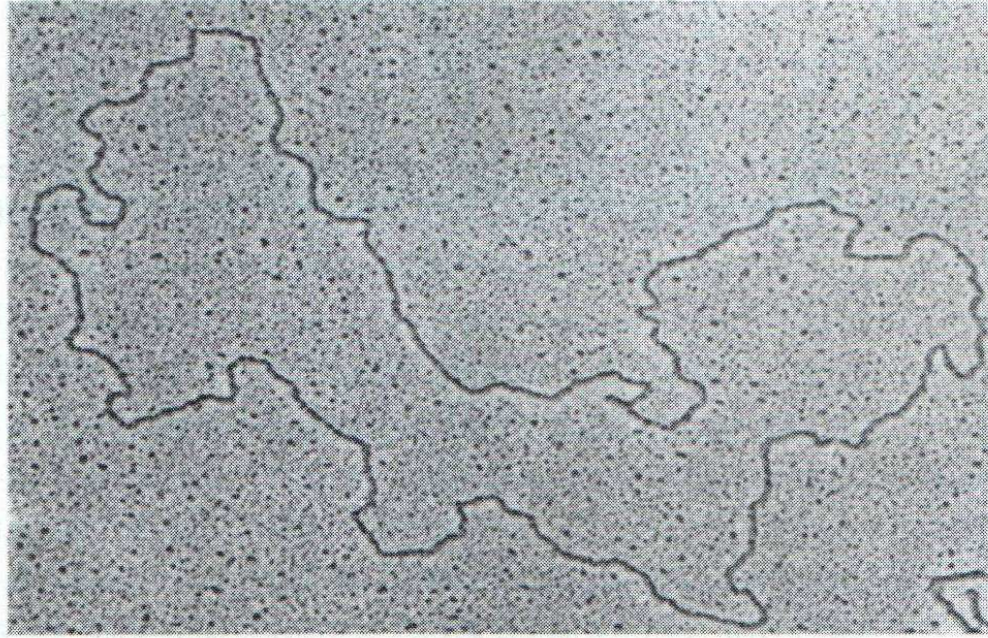
I procarioti hanno un unico cromosoma costituito da DNA a doppia catena, circolare, covalentemente chiuso.

Il cromosoma batterico è spiralizzato (**supercoiled**).

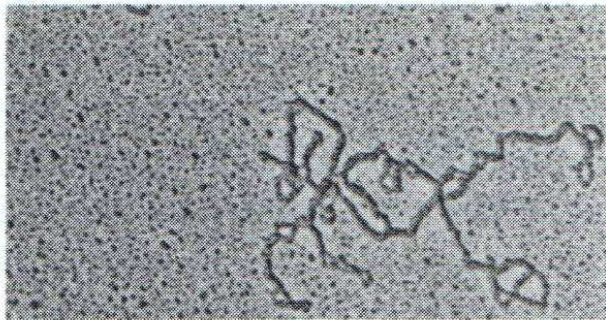
a)



a)



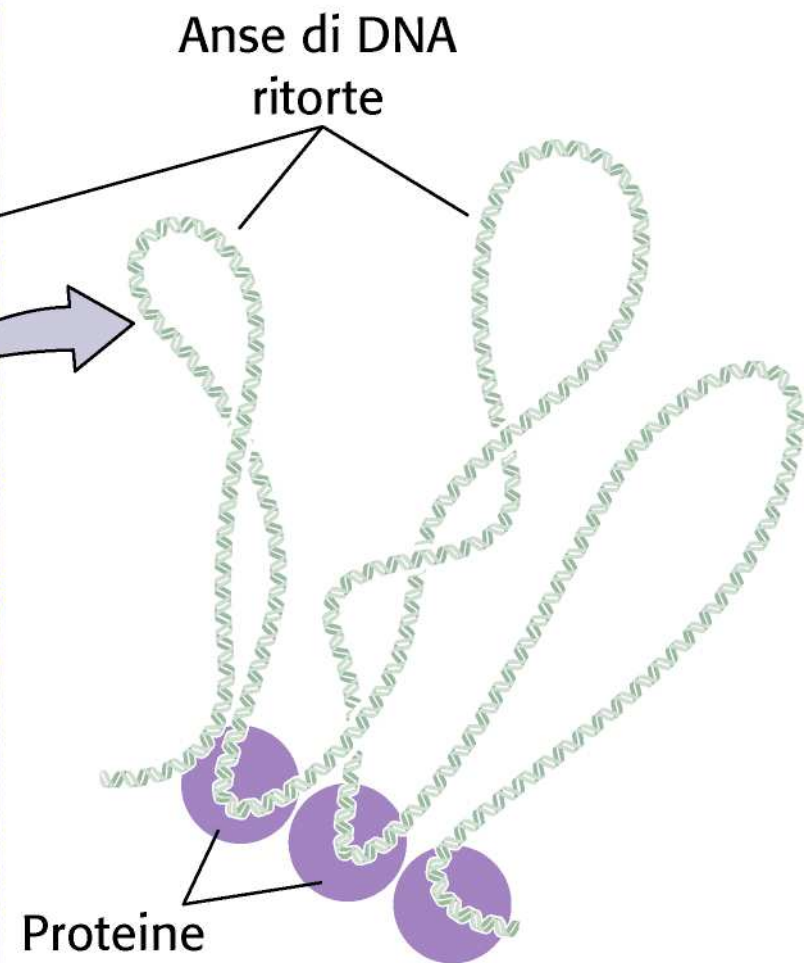
b)

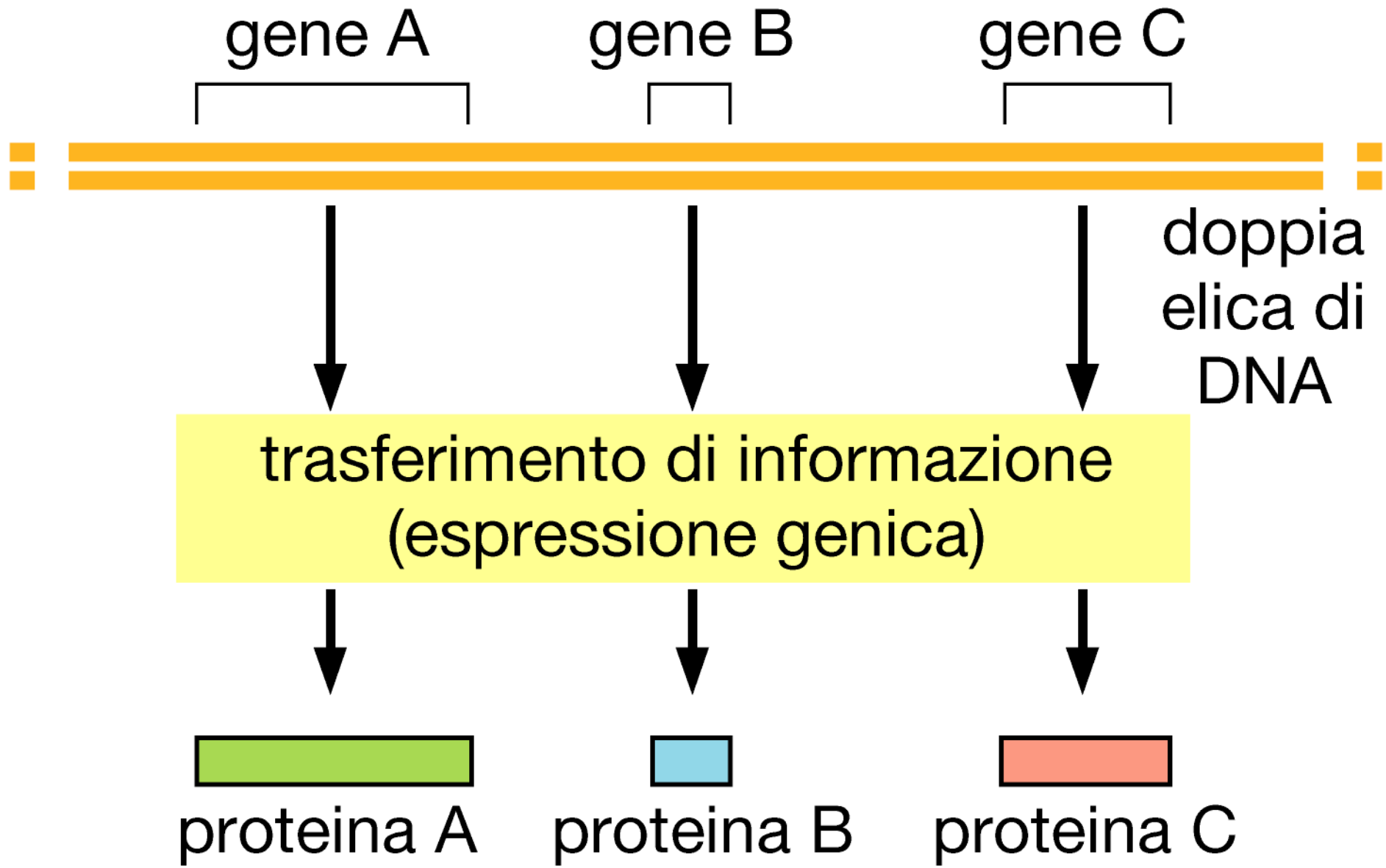


(a)



(b)





Concetto chiave

A differenza degli organelli delle cellule eucariotiche, quelli delle cellule procariotiche non sono racchiusi da membrane.

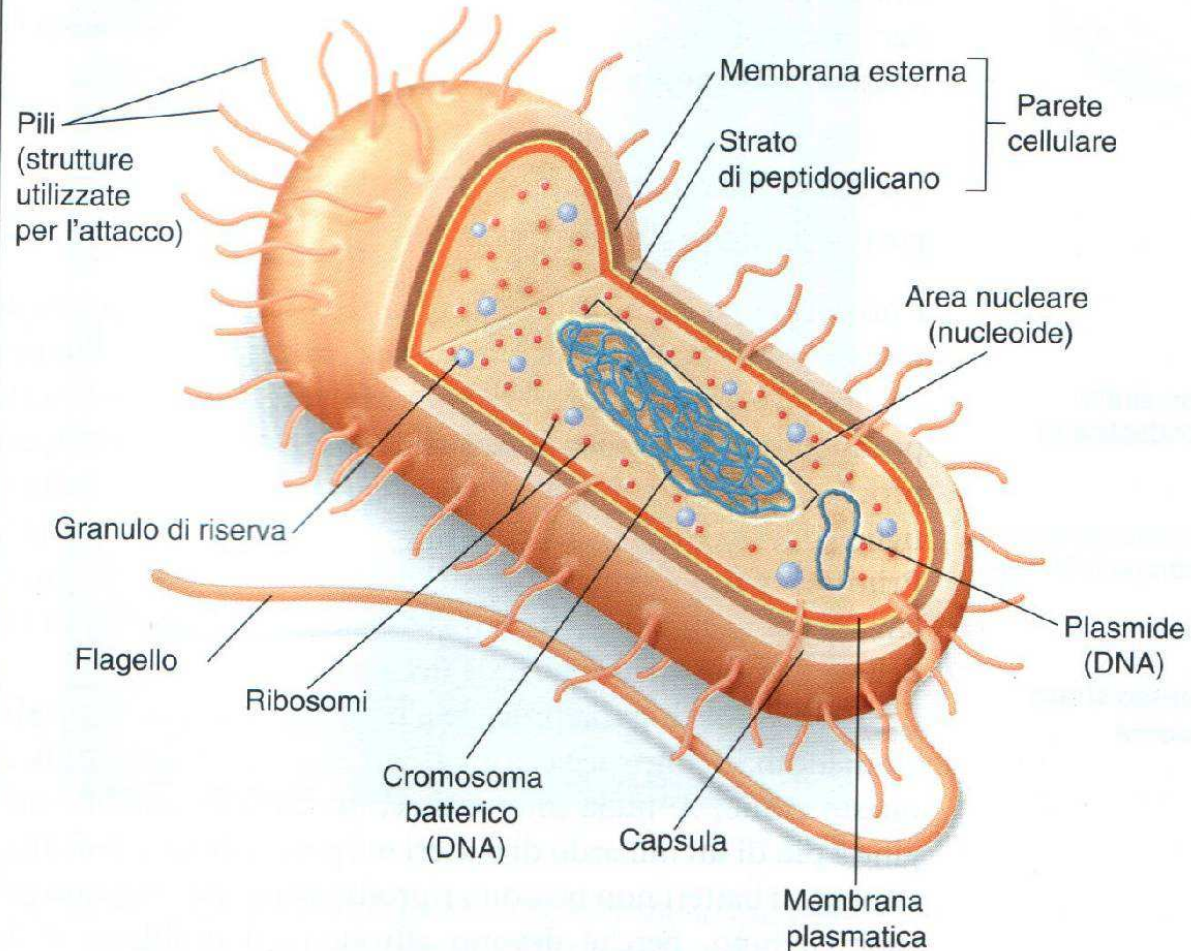


Figura 19-9 Struttura di una cellula procariotica

Questo bacillo è un batterio gram-negativo (discusso nel testo).
Si noti l'assenza di un involucro nucleare che avvolga il DNA del batterio.

Cromosoma Virale

Il materiale genetico dei virus può essere costituito da DNA a doppia elica, DNA a singola elica, RNA a doppia elica, RNA a singola elica.

Il cromosoma virale può presentarsi in forma lineare oppure in forma circolare.

Es: il batteriofago virulento T2 presenta DNA a doppia catena, lineare. Il batteriofago virulento Φ X174 presenta DNA a singola catena, circolare.

RNA monofilamento



DNA monofilamento



DNA circolare
a filamento doppio



RNA a filamento doppio



DNA circolare
monofilamento



DNA a filamento doppio



DNA a filamento doppio
con terminali chiusi covalentemente



DNA a filamento doppio
con proteina terminale
legata covalentemente



Table 6–2 Viruses That Cause Human Disease

VIRUS	GENOME TYPE	DISEASE
Herpes simplex virus	double-stranded DNA	recurrent cold sores
Epstein-Barr virus (EBV)	double-stranded DNA	infectious mononucleosis
Varicella-zoster virus	double-stranded DNA	chicken pox and shingles
Smallpox virus	double-stranded DNA	smallpox
Hepatitis B virus	part single-, part double-stranded DNA	serum hepatitis
Human immuno- deficiency virus (HIV)	single-stranded RNA	acquired immunodeficiency syndrome (AIDS)
Influenza virus type A	single-stranded RNA	respiratory disease (flu)
Poliovirus	single-stranded RNA	infantile paralysis
Rhinovirus	single-stranded RNA	common cold
Hepatitis A virus	single-stranded RNA	infectious hepatitis
Hepatitis C virus	single-stranded RNA	non-A, non-B type hepatitis
Yellow fever virus	single-stranded RNA	yellow fever
Rabies virus	single-stranded RNA	rabies
Mumps virus	single-stranded RNA	mumps
Measles virus	single-stranded RNA	measles