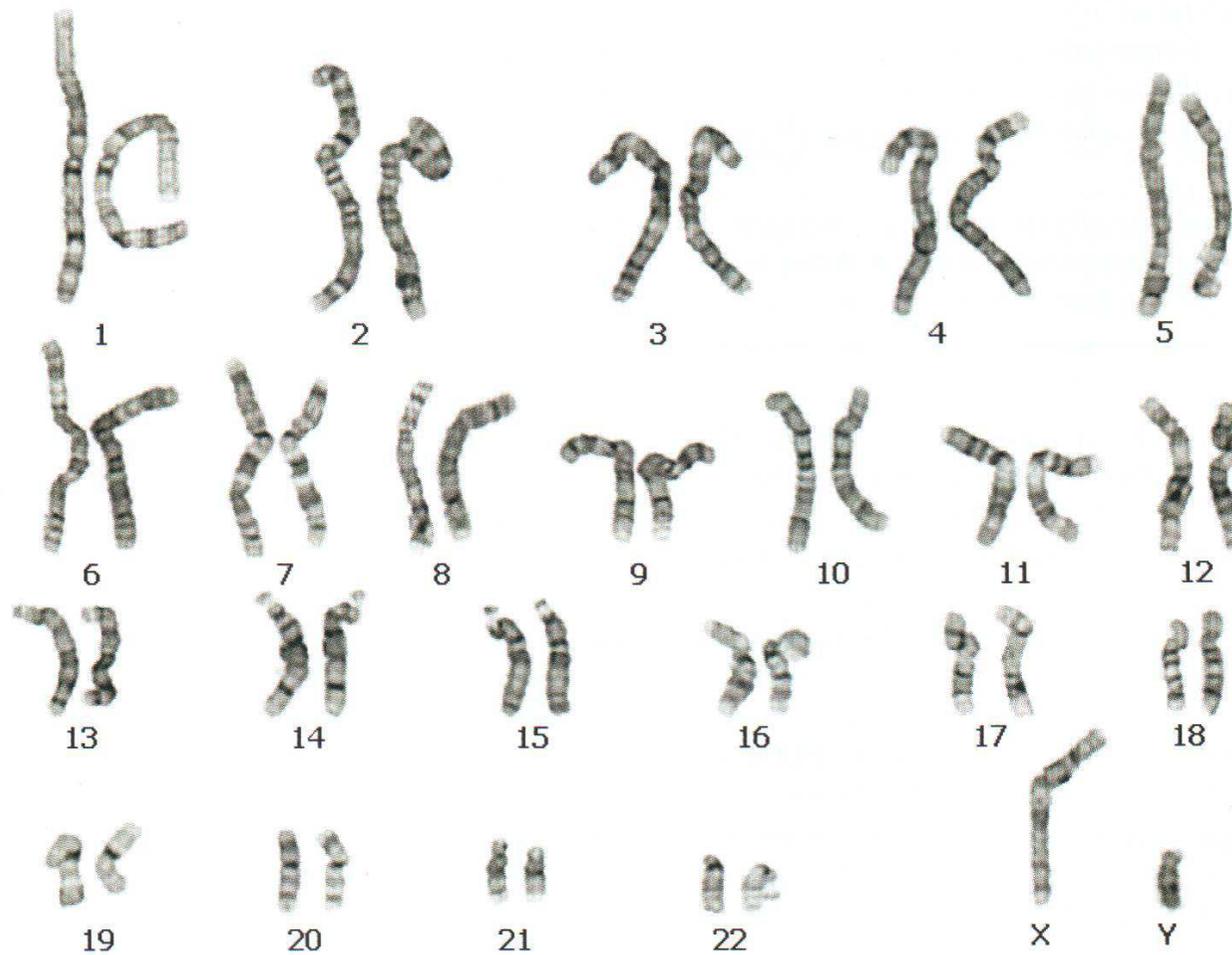


# **Livelli di Organizzazione del DNA**

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

Distinguiamo cromosomi virali, procariotici ed eucariotici.

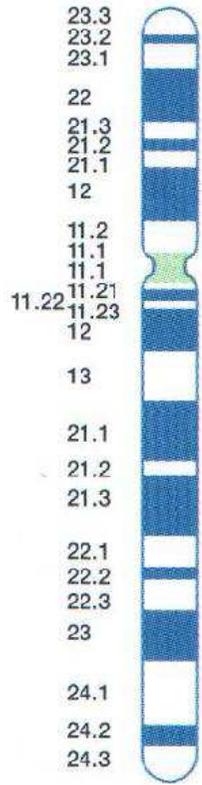


**Figure 2.14. G-banded prometaphase karyogram of mitotic chromosomes from lymphocytes of a normal male at between 550 and 850 bands per haploid set.**

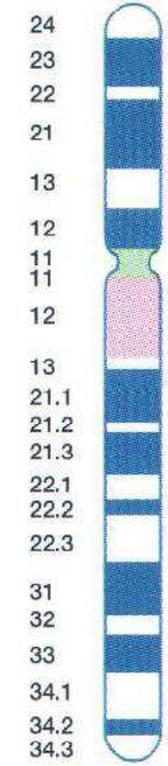
Compare with the idealized ideograms in *Figure 2.15*. Overall lengths of metaphase chromosomes range between 2 and 10  $\mu\text{m}$ ; the DNA of the cell, if stretched out, would be about 2 m long. Reproduced from Cross and Wolstenholme (2001). In *Human Cytogenetics: Constitutional Analysis*, 3rd 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.

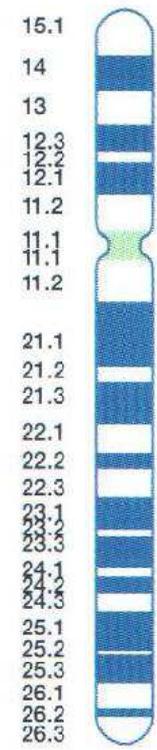
Il complesso di DNA e proteine associate al cromosoma si chiama **cromatina**.



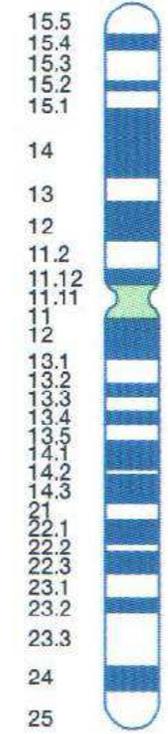
8



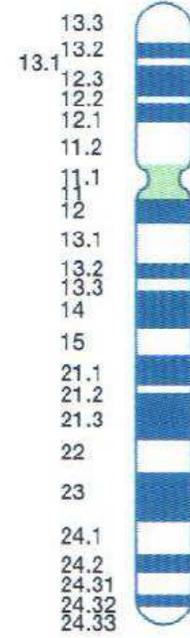
9



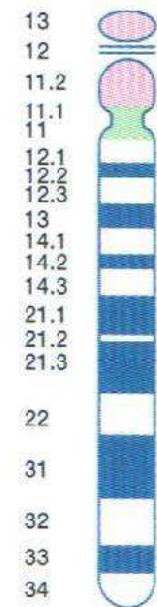
10



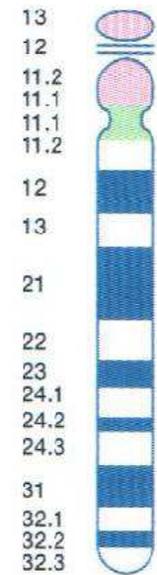
11



12



13



14



15

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.

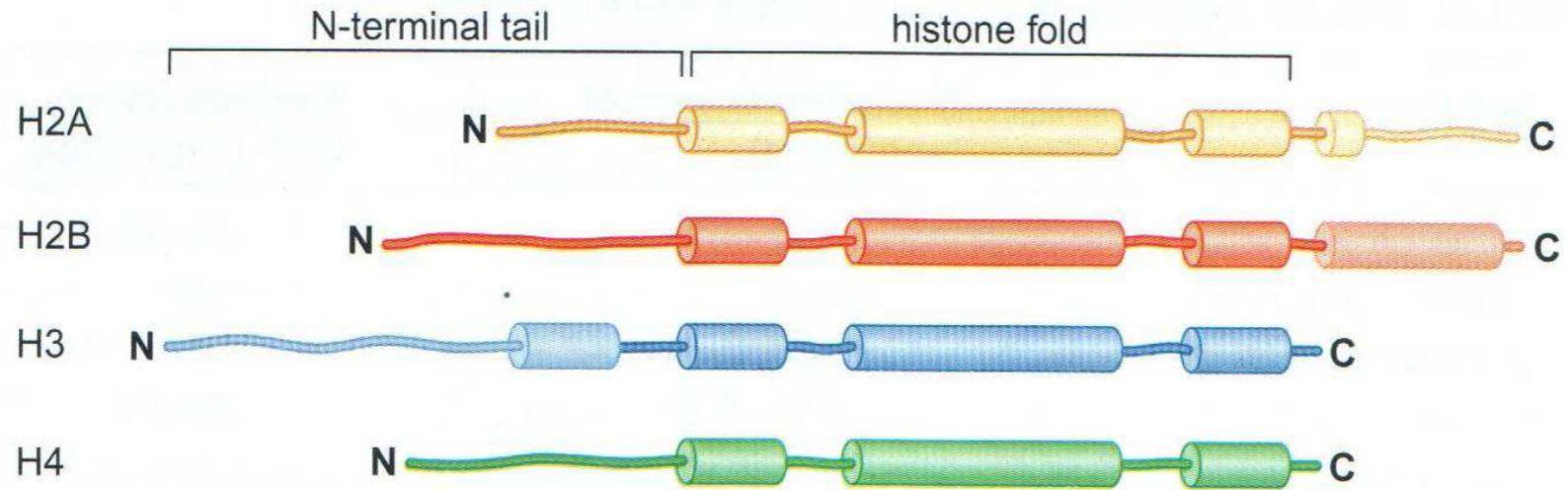
<b>Istone <sup>a</sup></b>	<b>Peso Molecolare</b>	<b>Numero di amino acidi</b>	<b>Percentuale di Lys + Arg</b>
H1	22,500	244	30.8
H2A	13,960	129	20.2
H2B	13,774	125	22.4
H3	15,273	135	22.9
H4	11,236	102	24.5

<sup>a</sup> I dati sono riferiti a istoni di coniglio (H1) e bovini.

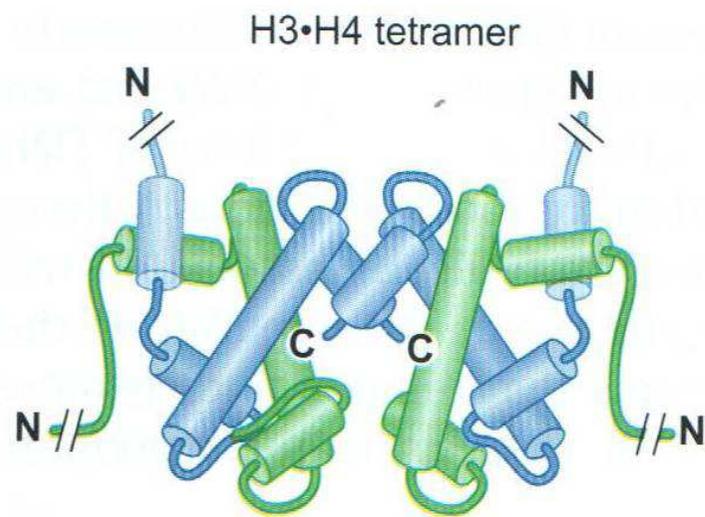
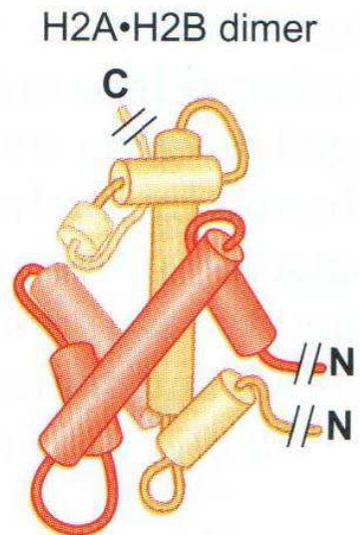
Sono proteine evolutivamente **altamente conservate**.

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

**a**



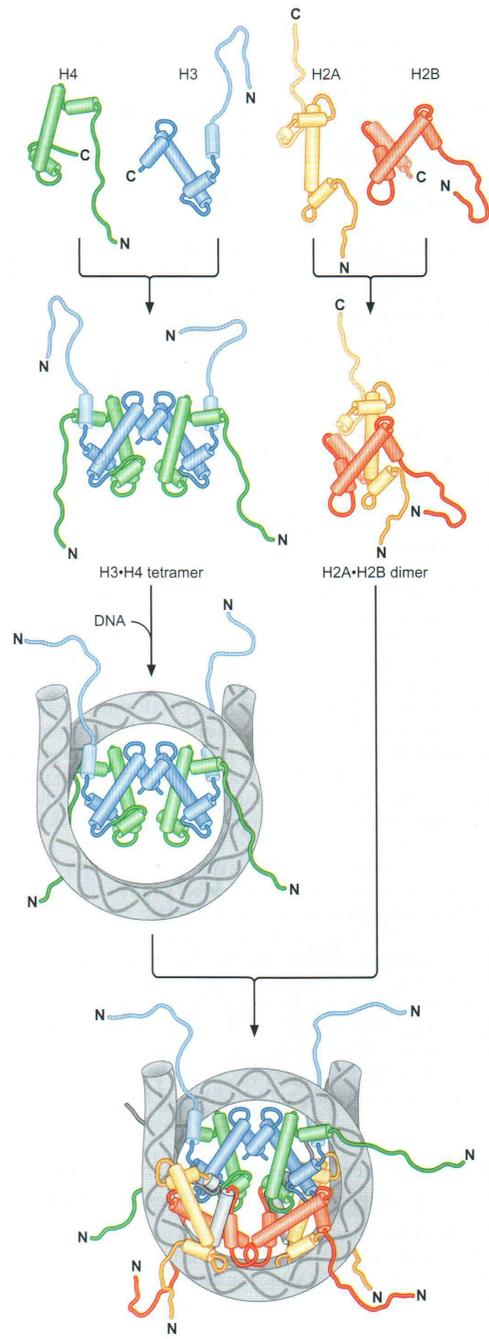
**b**



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

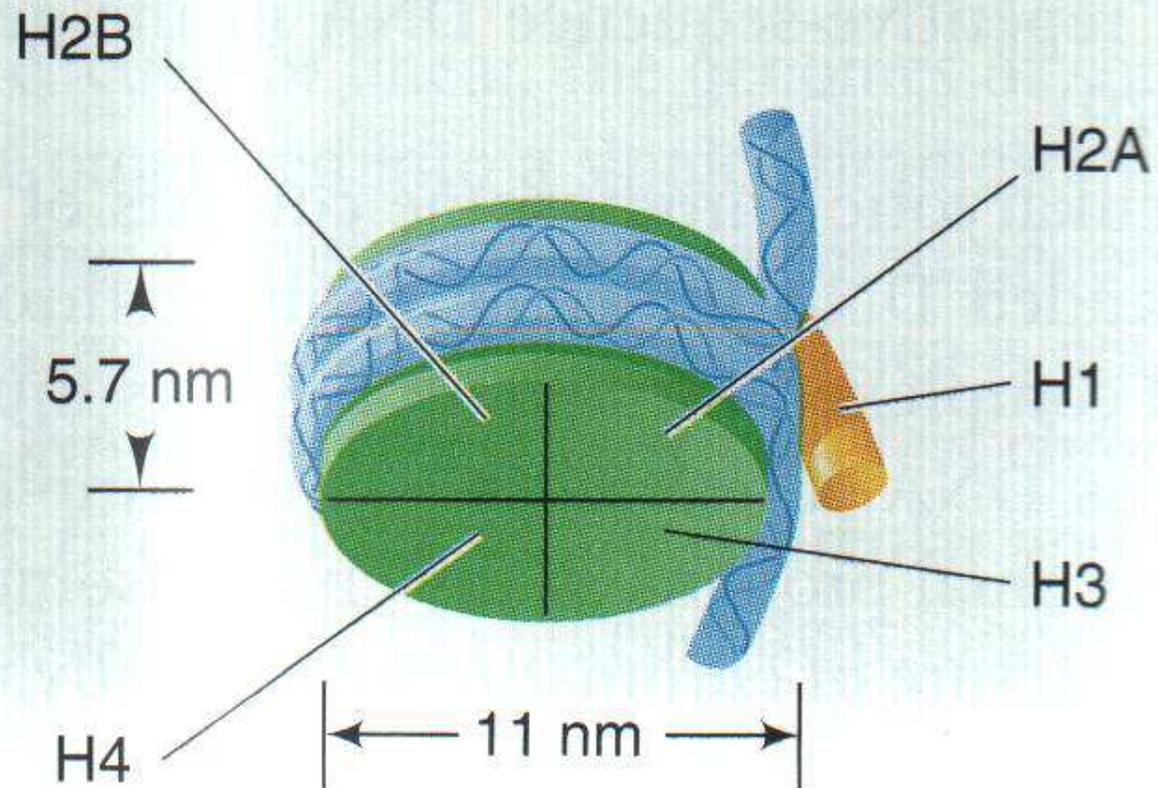
Il tetramero H3-H4 si lega al dsDNA.

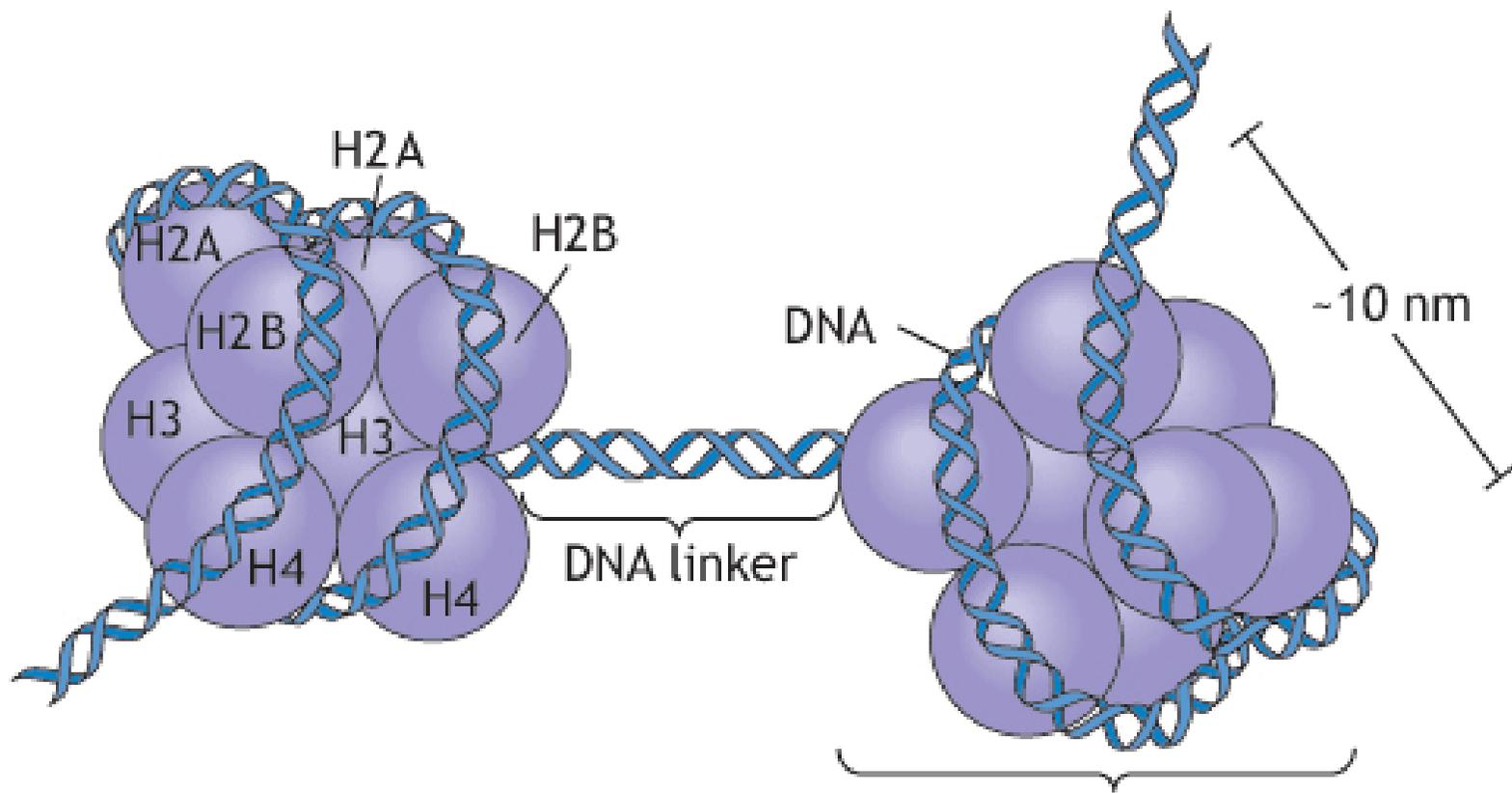
Il tetramero H3-H4, legato al DNA, richiama due copie del dimero H2A-H2B per completare l'assemblaggio del nucleosoma.



**Figure 8.17**

**A possible nucleosome structure.**





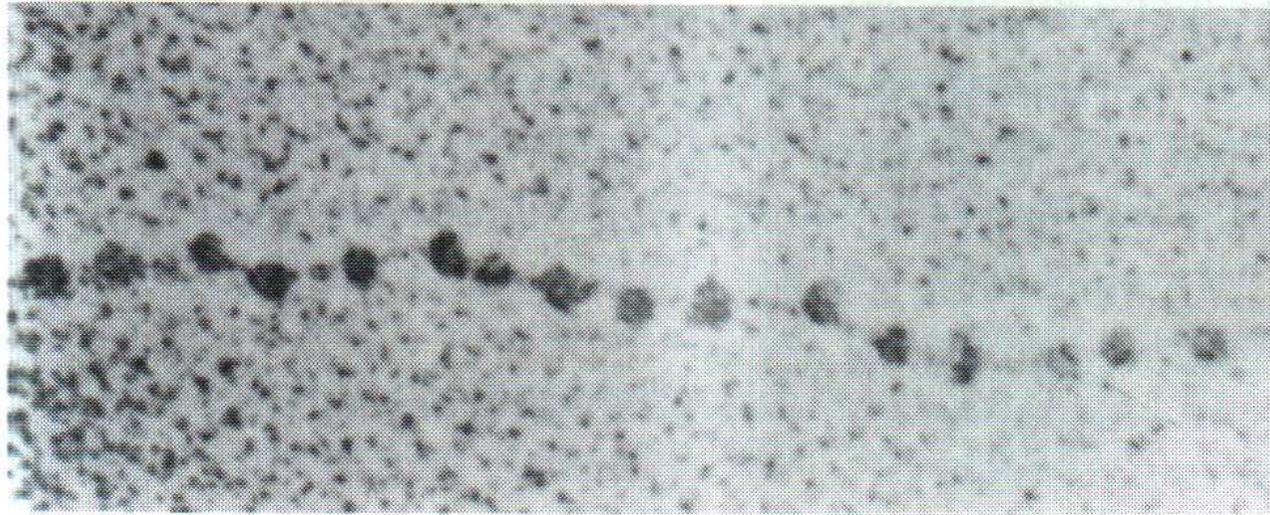
Nucleosoma (8 molecole di istoni + 146 coppie di nucleotidi di DNA)

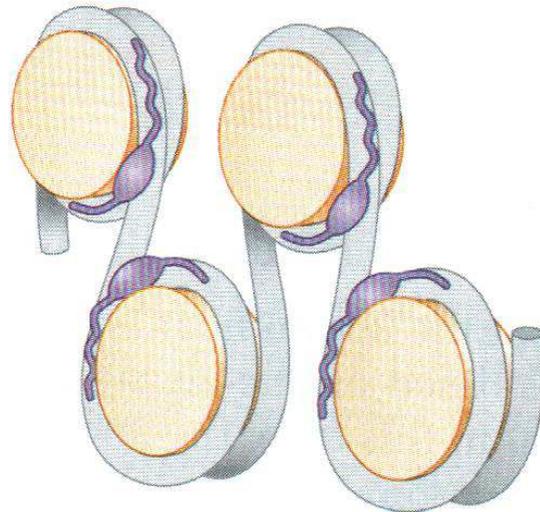
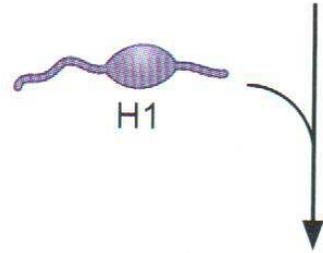
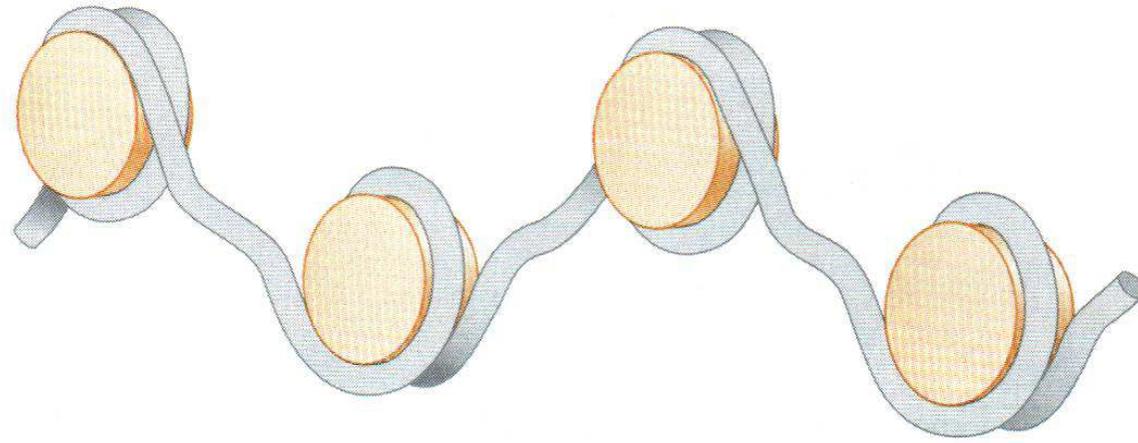
“Beads-on-a-string”  
form of  
chromatin

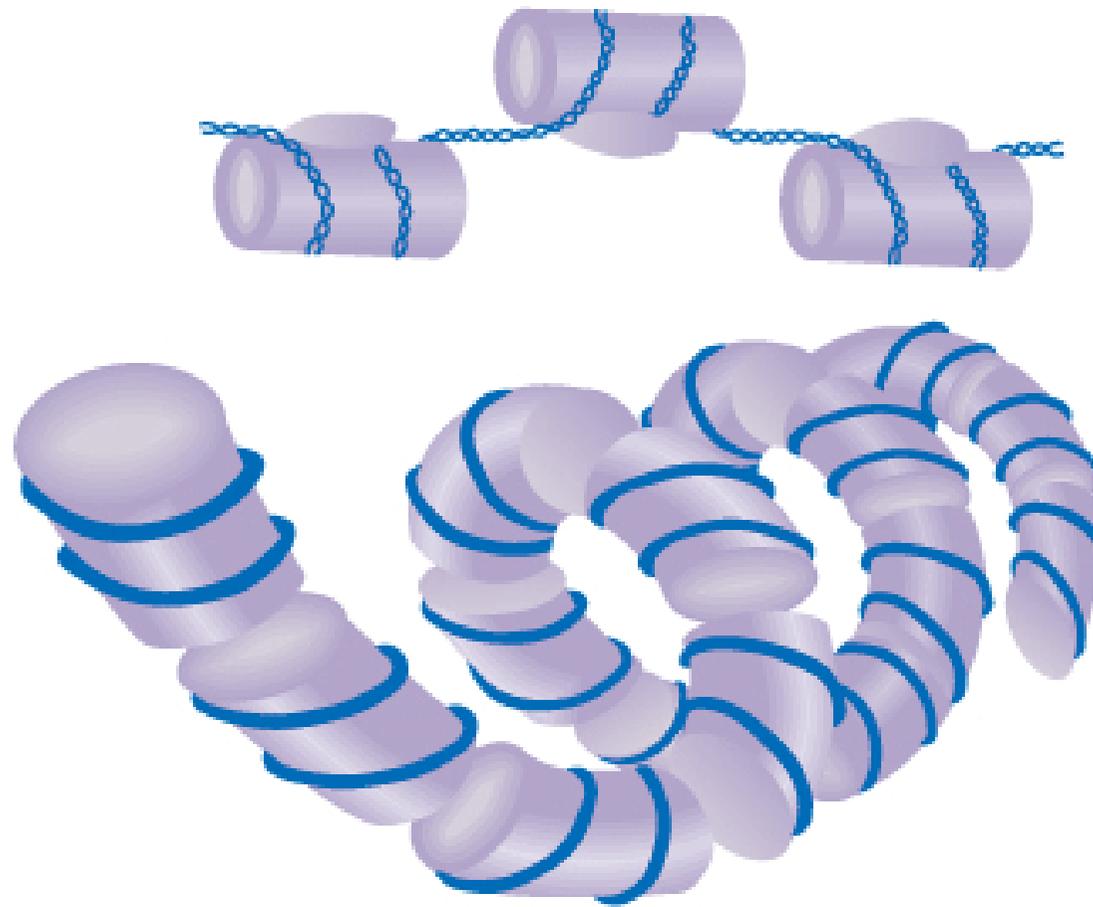


**Figure 8.19**

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

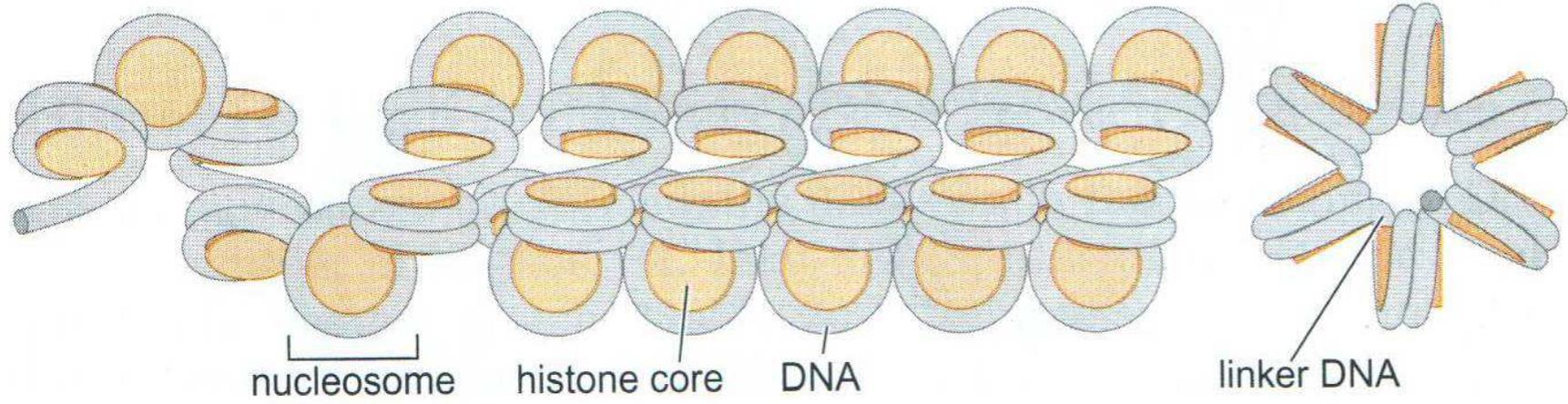




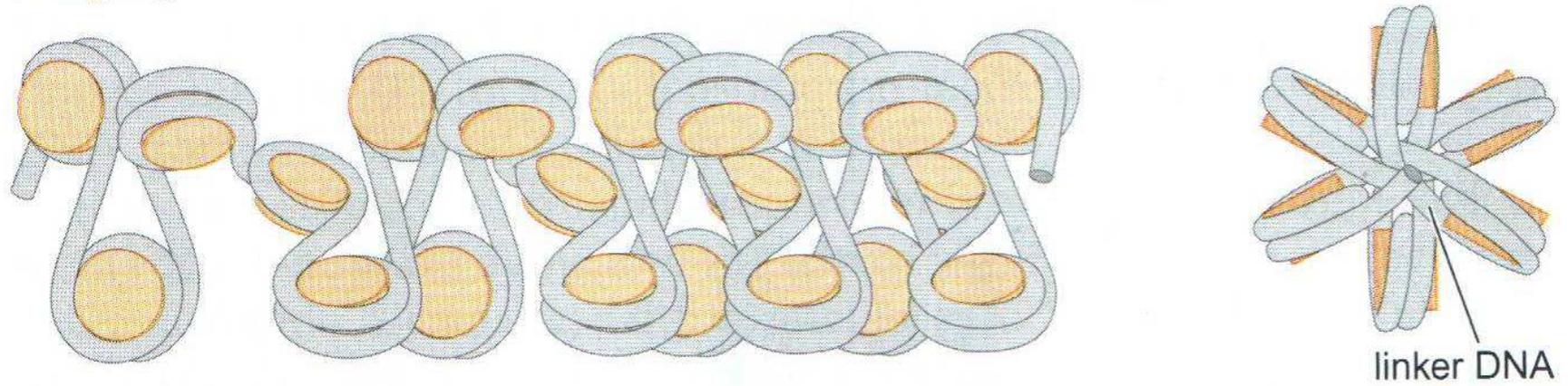


■ **FIGURA 1.61** **La fibra di 30 nm: il solenoide.** L'avvicinamento delle perle fa sì che si formi una struttura nella quale i nucleosomi sono impacchettati a formare un'elica irregolare a zig zag.

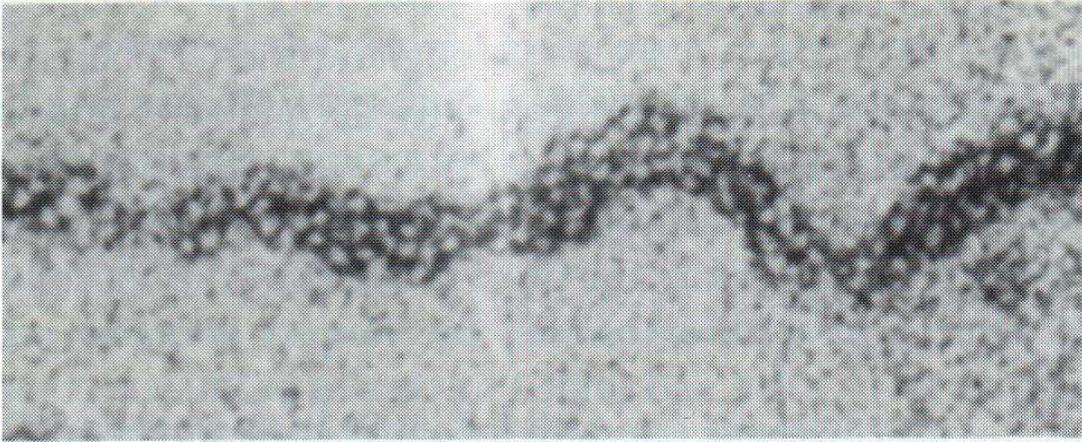
**a** solenoid



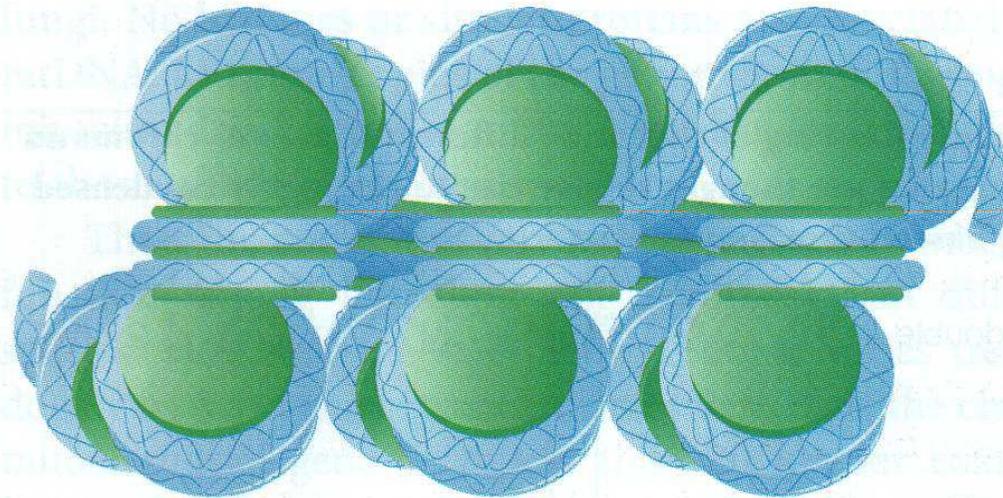
**b** zigzag



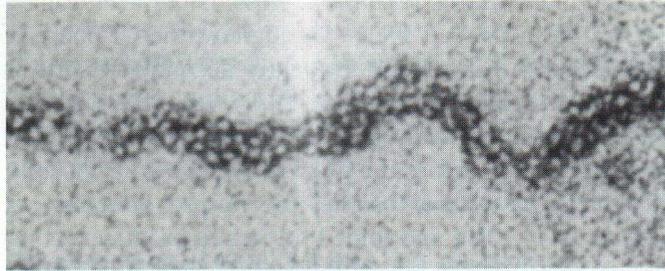
a)



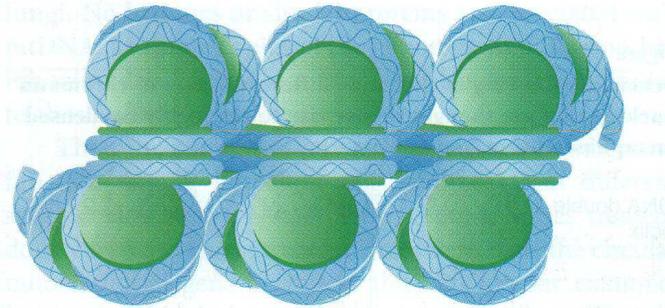
b)



a)

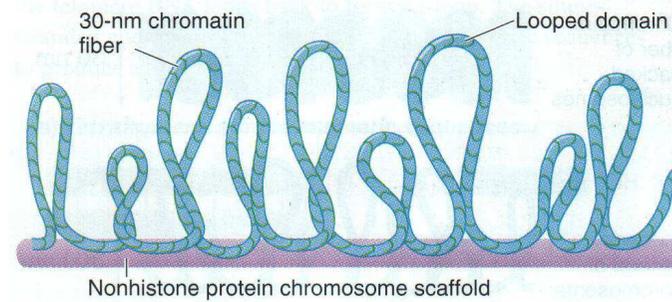


b)

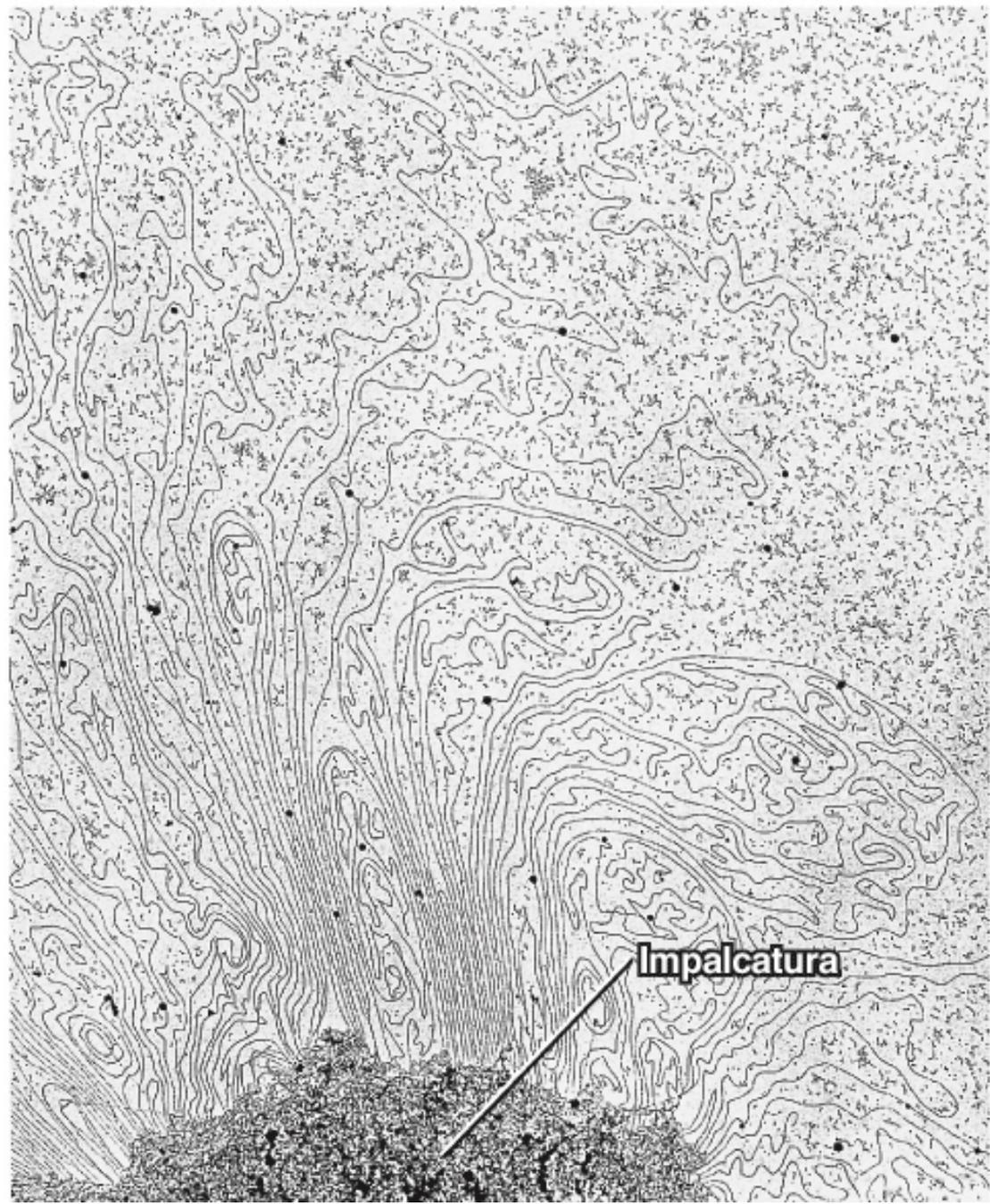


**Figure 8.21**

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





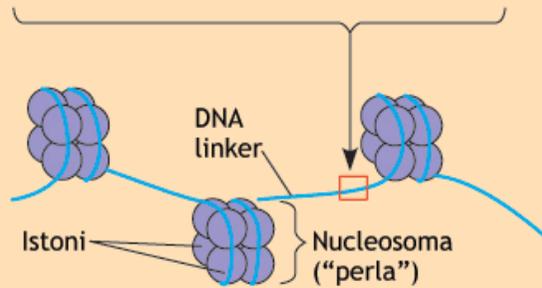
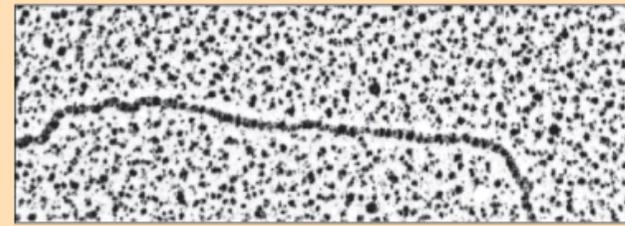


**Impalcatura**

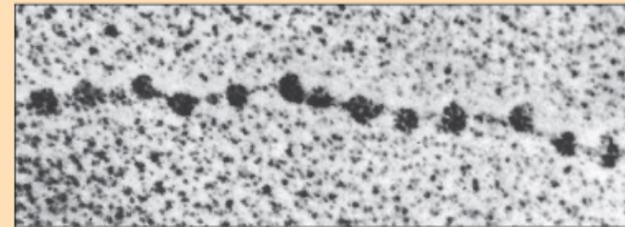


DNA a doppia elica

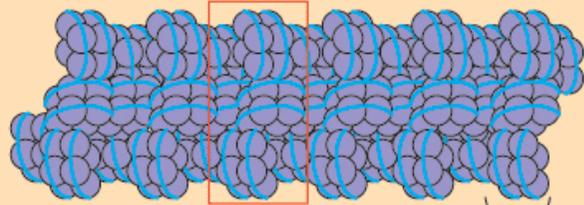
2 nm



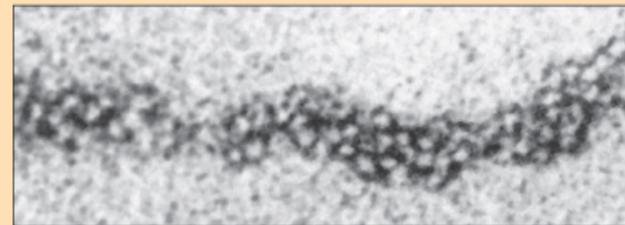
10 nm



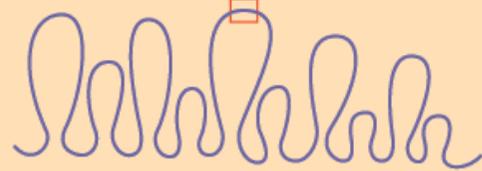
a) Nucleosomi ("collana di perle")



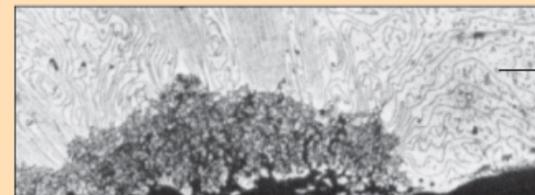
30 nm



b) Fibra di cromatina di 30 nm

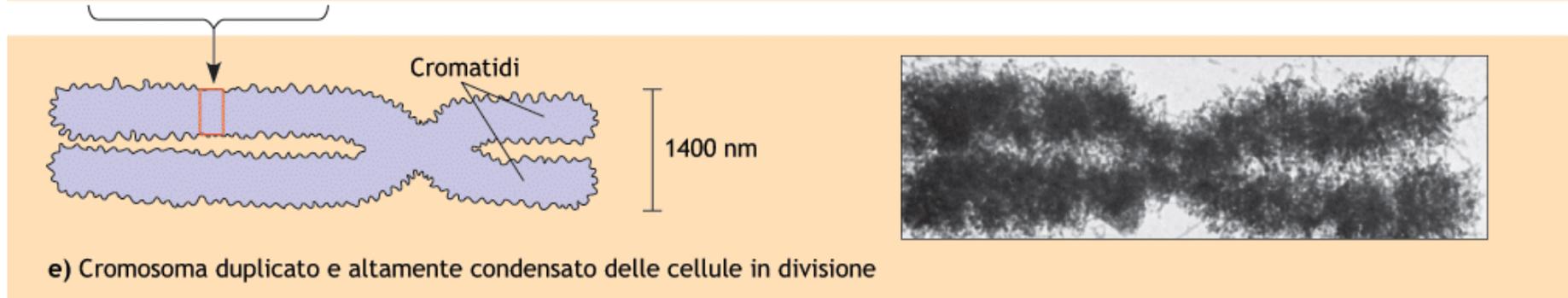
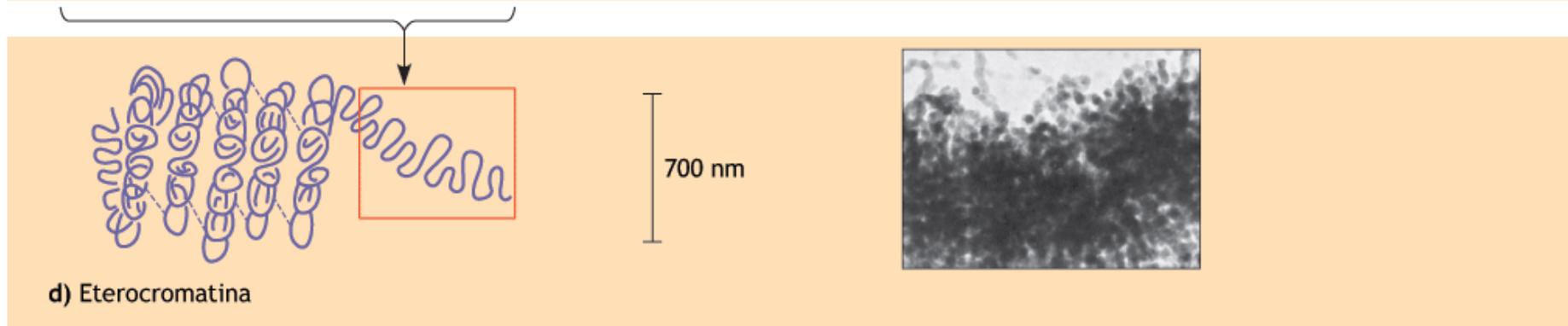
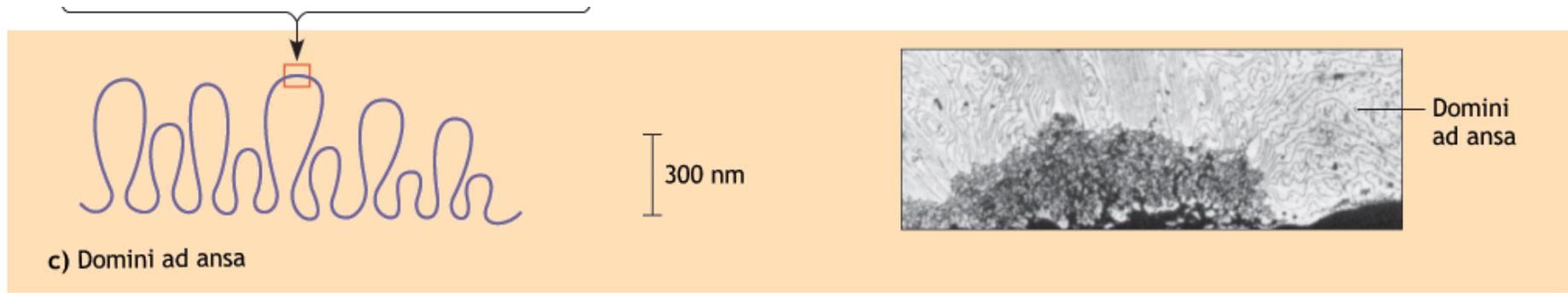


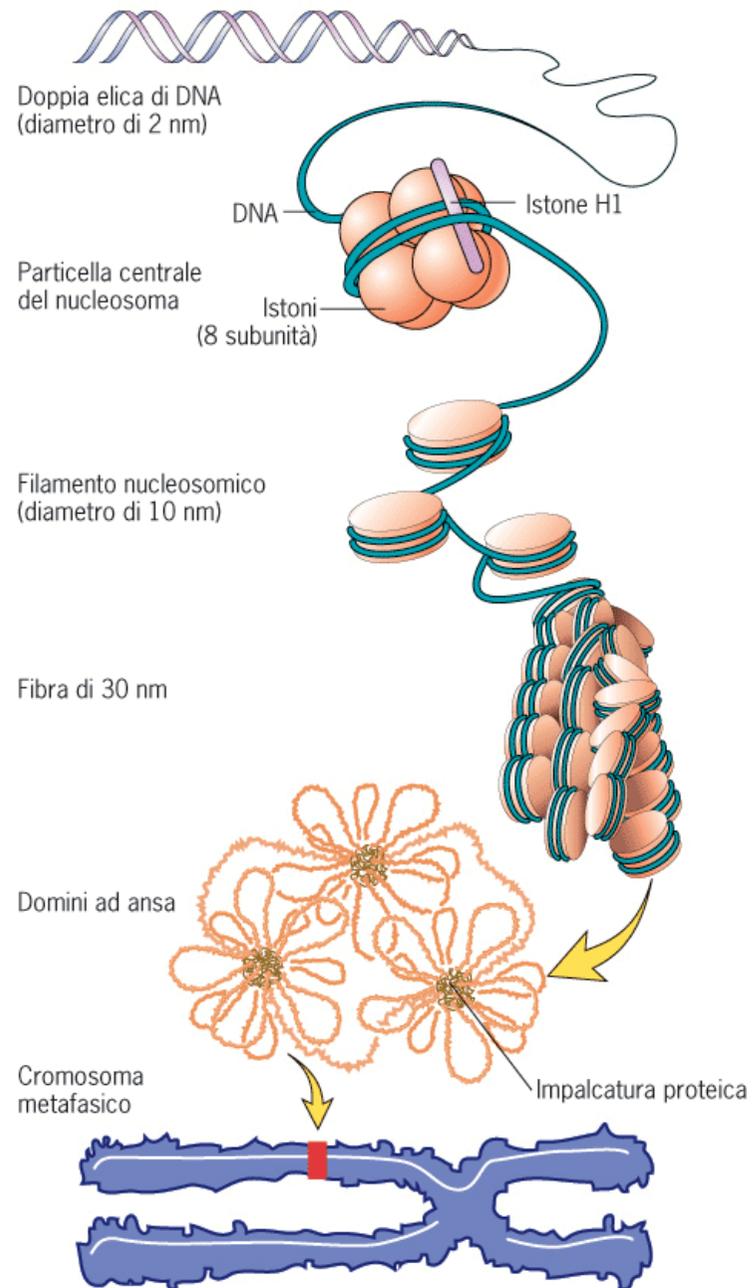
300 nm



Domini ad ansa

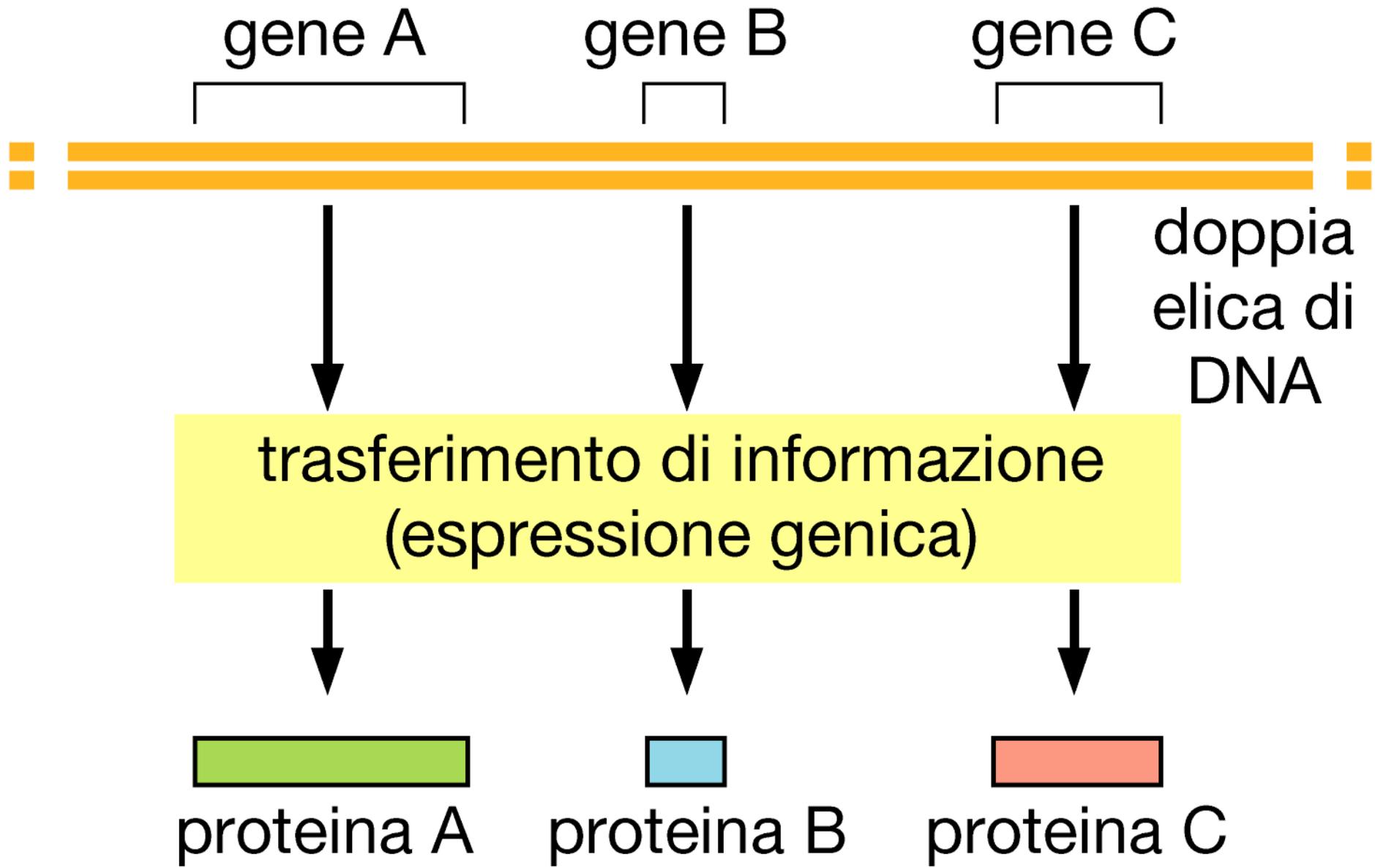
c) Domini ad ansa

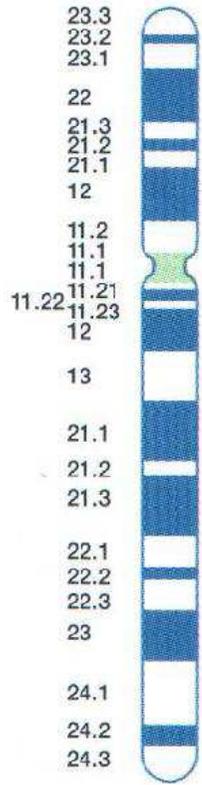




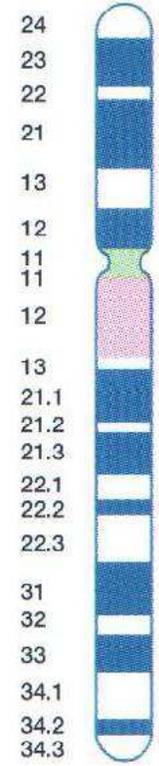
# Funzioni dei cromosomi

- 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

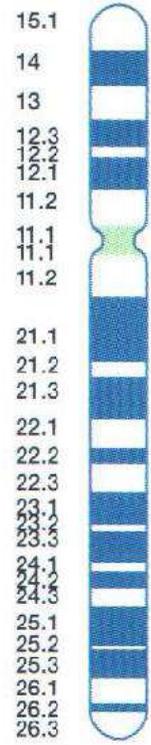




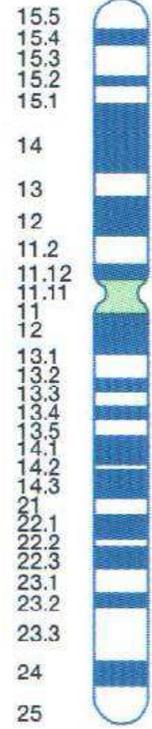
8



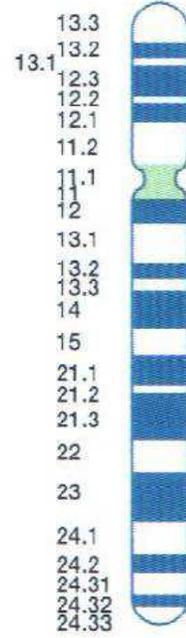
9



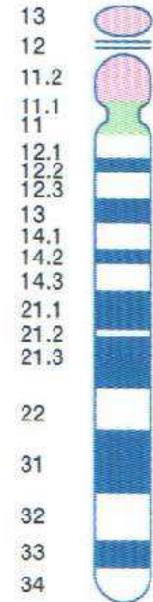
10



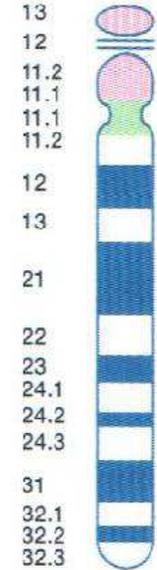
11



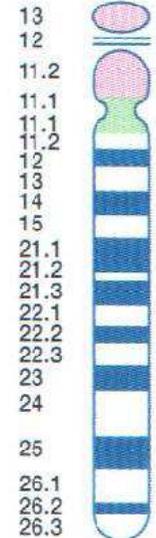
12



13



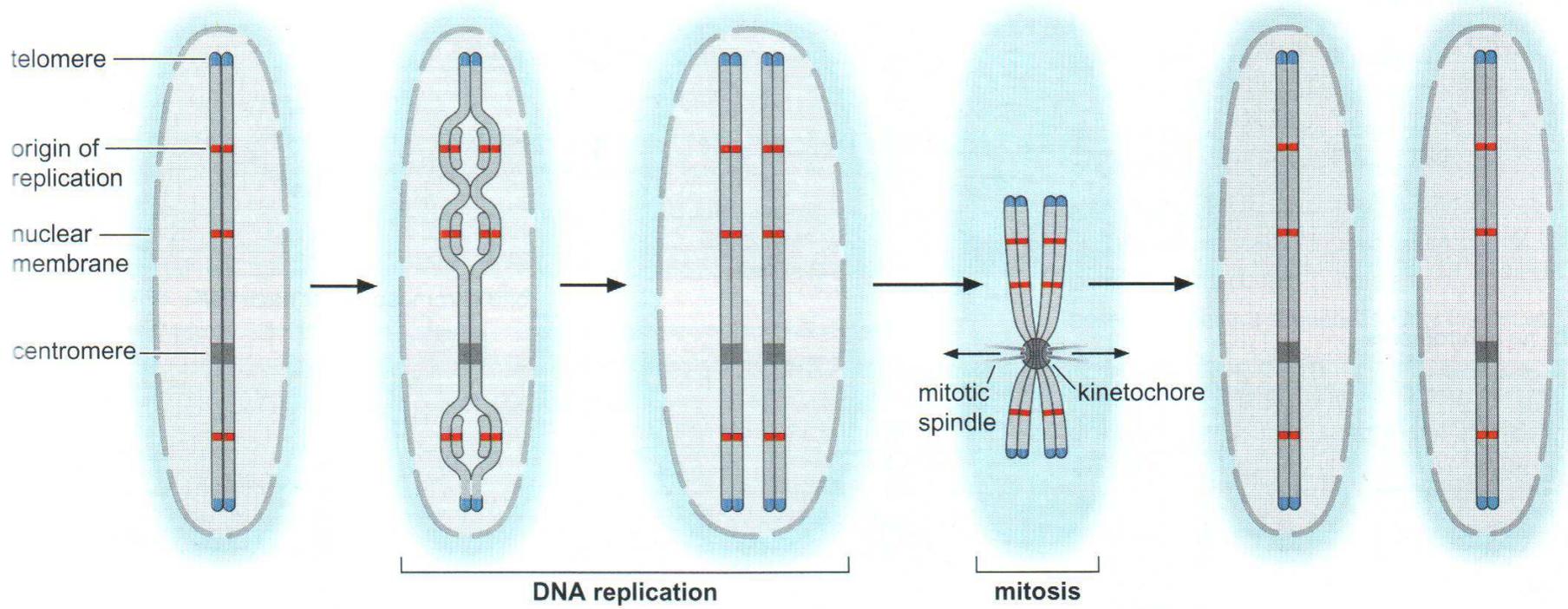
14



15

# Funzioni dei cromosomi

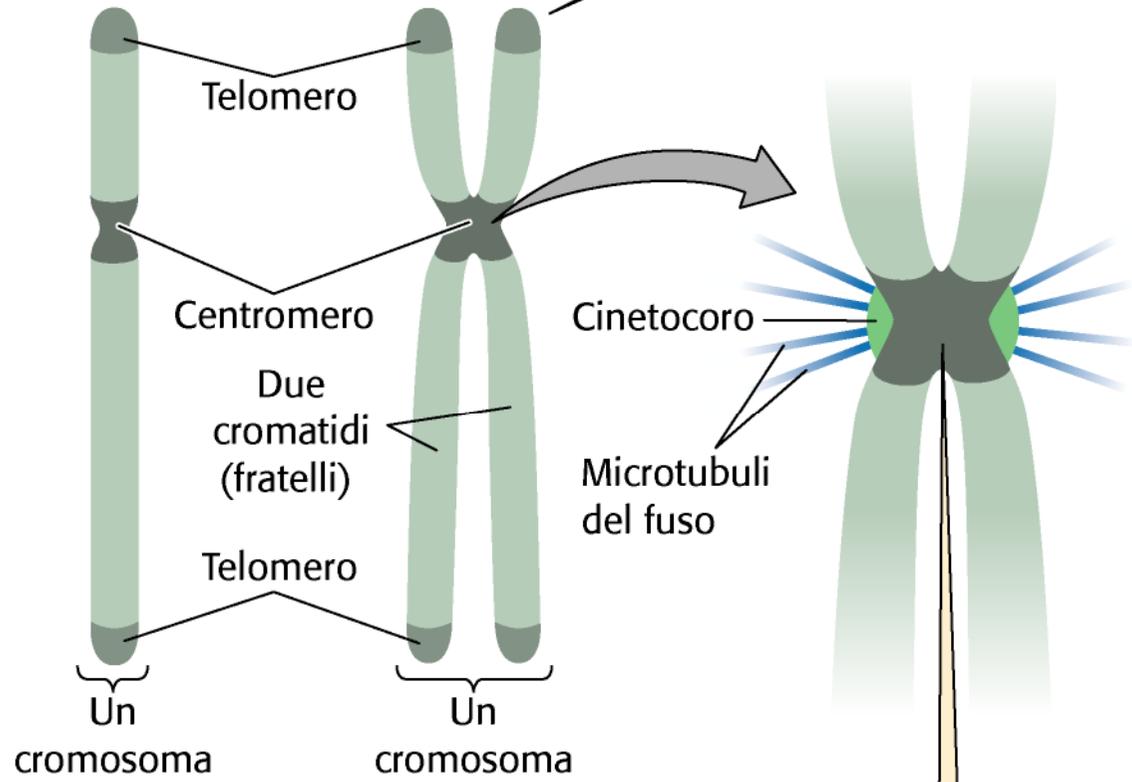
- Protezione e stabilità del DNA (e quindi dell'informazione). **Telomeri.**
- Duplicazione dell'informazione. **Origine di replicazione.**
- Trasmissione efficiente alle cellule figlie durante la divisione cellulare. **Centromero.**



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

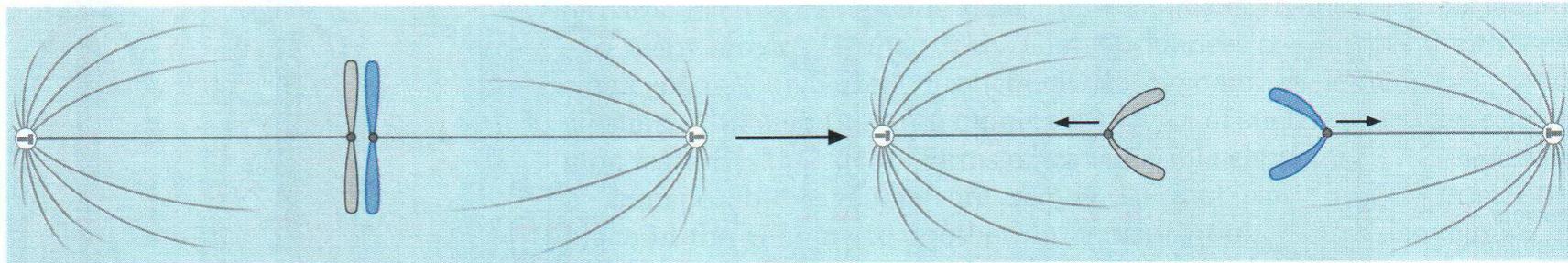
...in altri è formato da due cromatidi (fratelli).

I telomeri rappresentano le estremità stabili dei cromosomi.



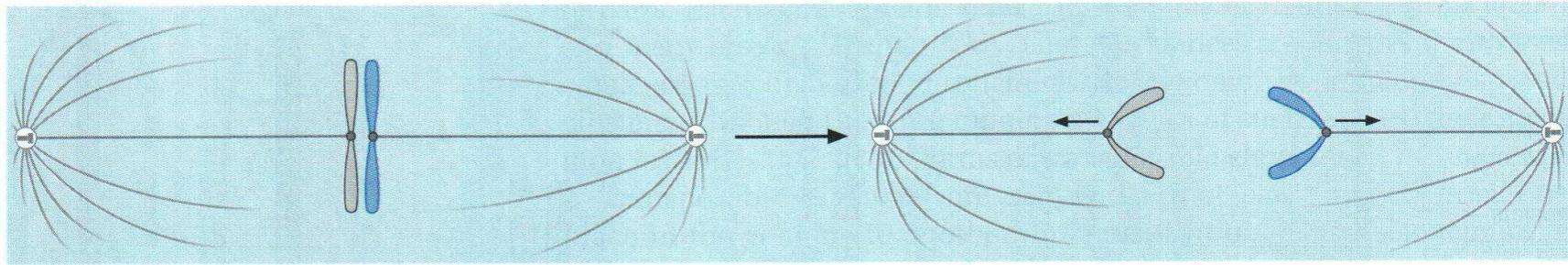
Il centromero è una regione contratta del cromosoma in cui si forma il cinetocoro e a cui si attaccano i microtubuli del fuso.

**a** one centromere



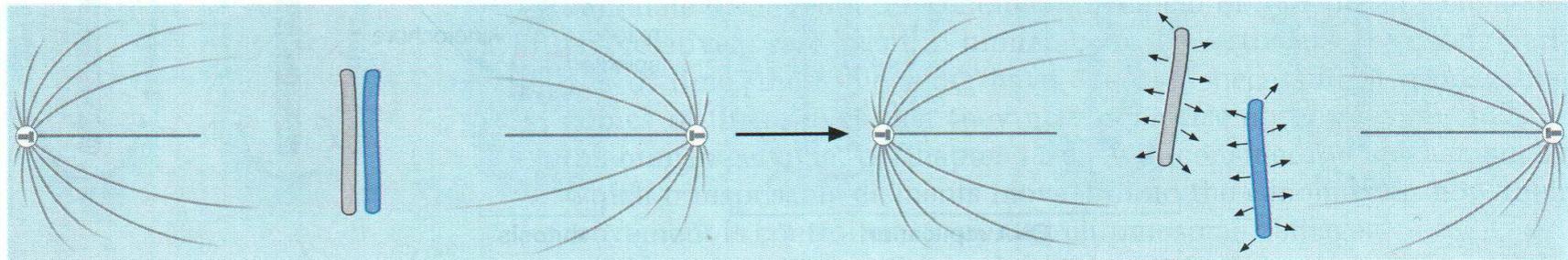
one chromosome for each cell

**a** one centromere



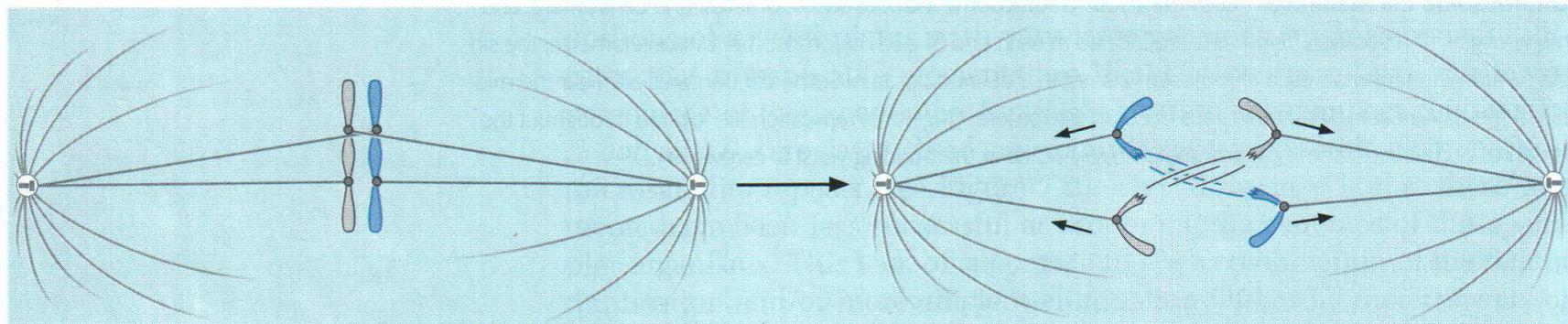
one chromosome for each cell

**b** no centromeres

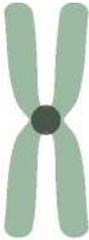
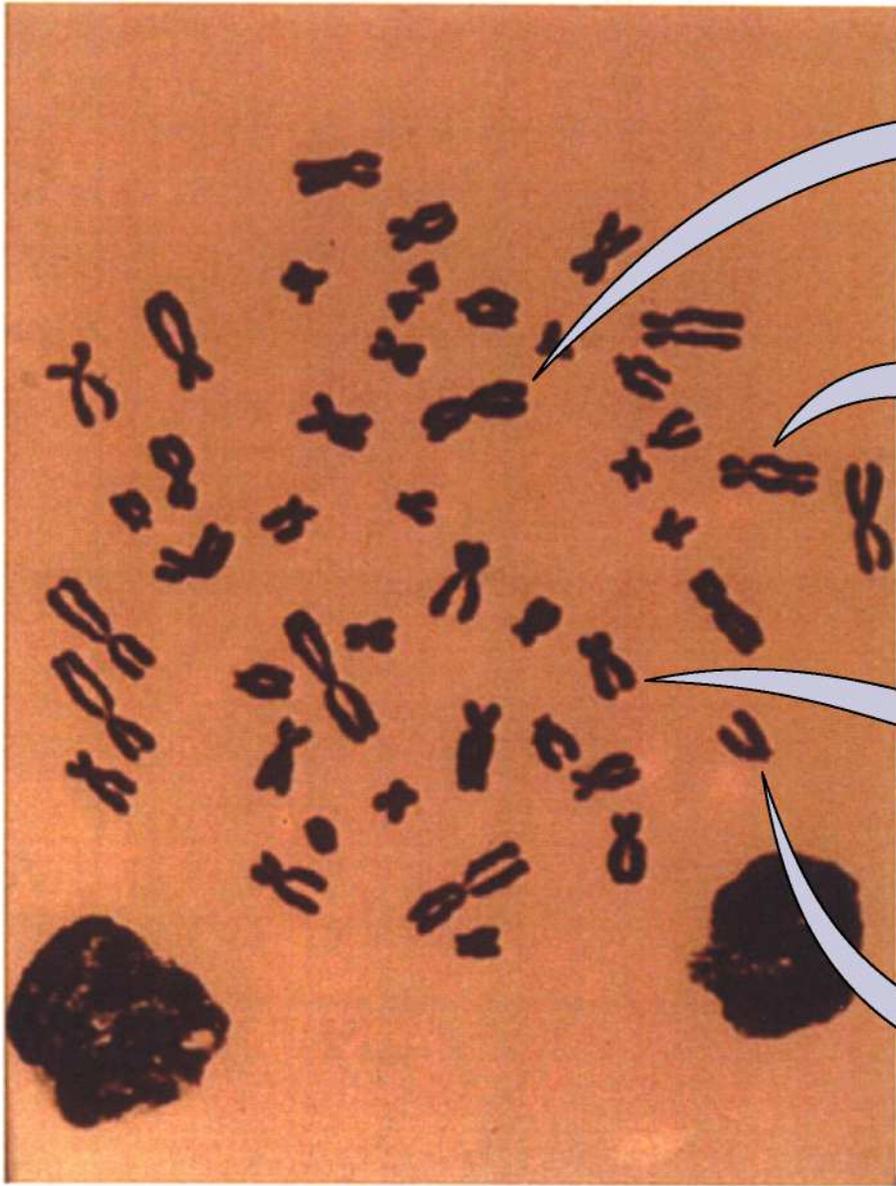


random segregation of chromosome

**c** two centromeres



chromosome breakage  
(due to more than one centromere)



Metacentrico



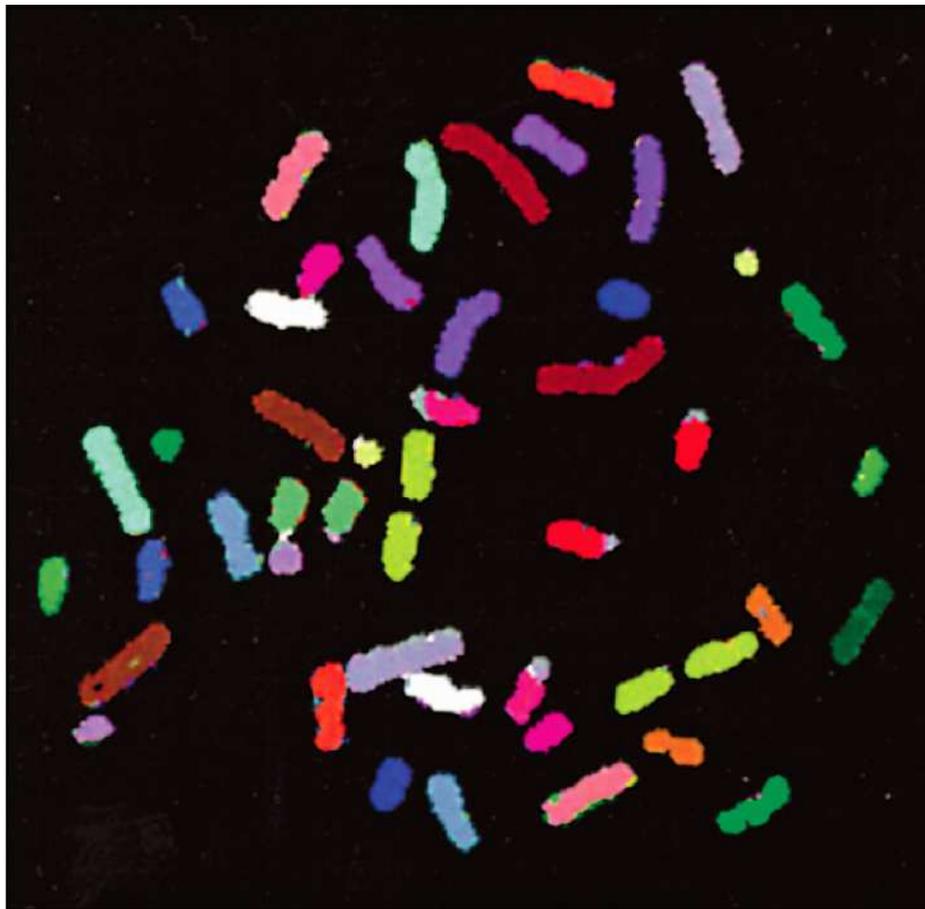
Submetacentrico



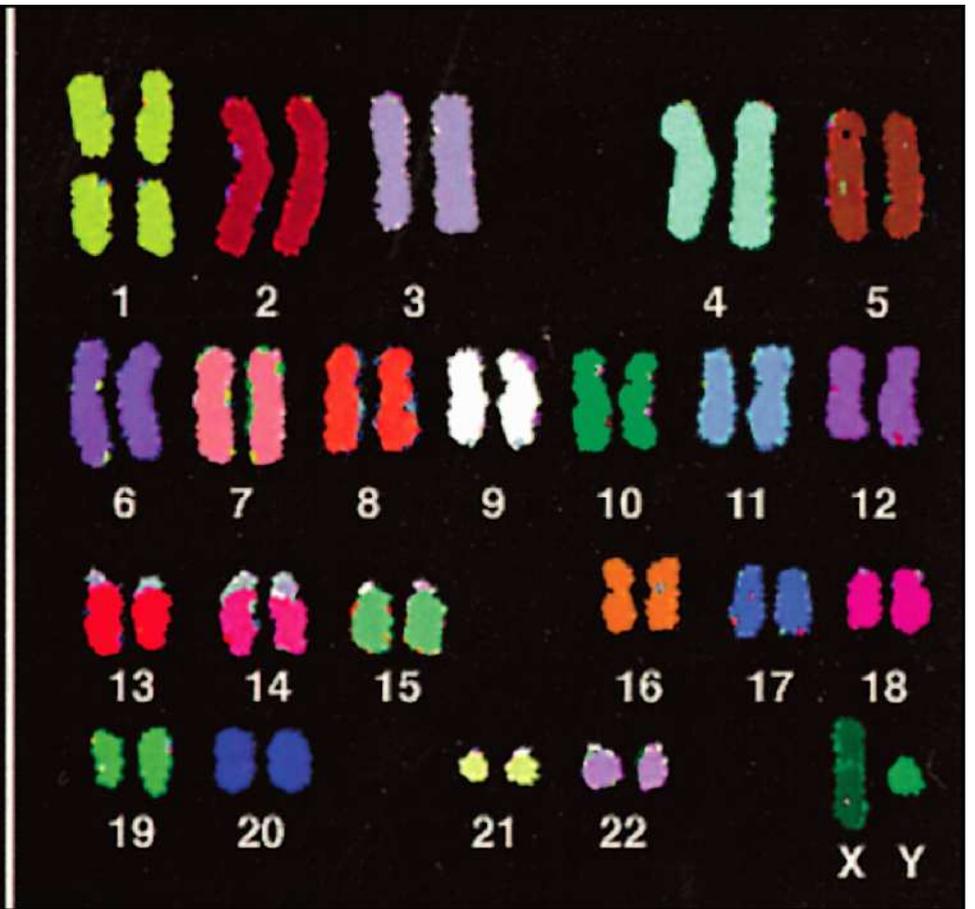
Acrocentrico



Telocentrico



(A)



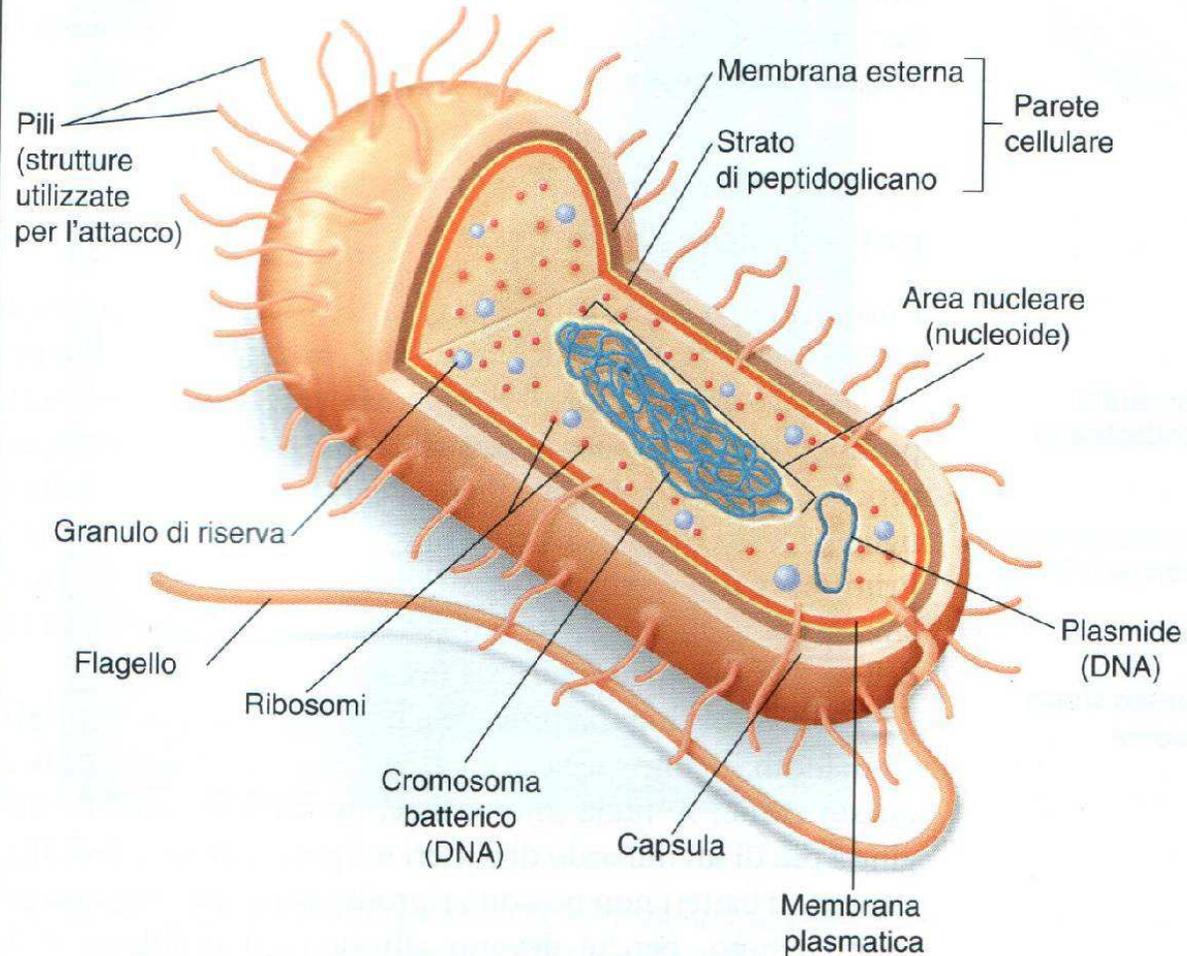
(B)

# 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

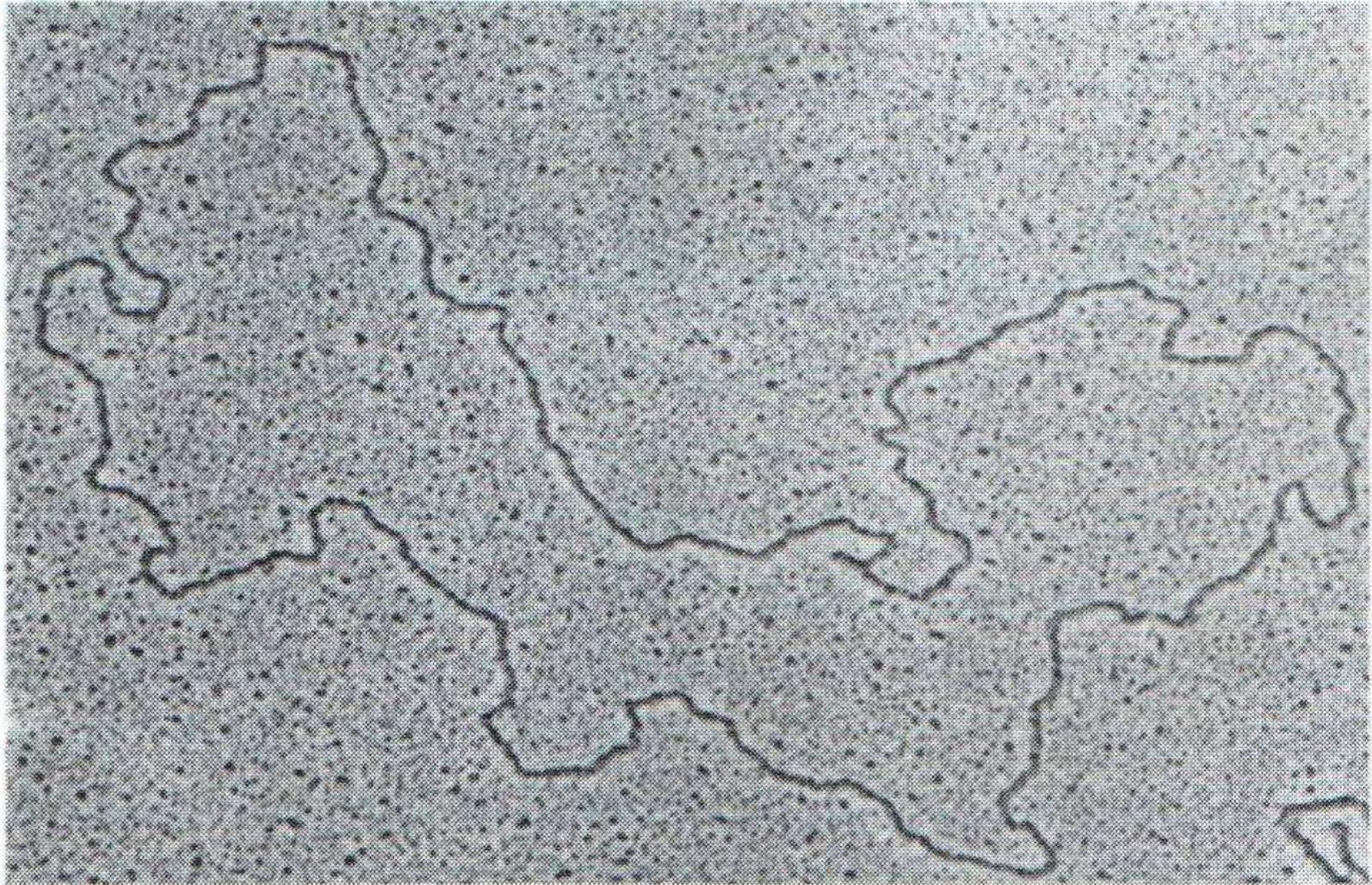
Questo bacillo è un batterio gram-negativo (discusso nel testo).  
Si noti l'assenza di un involucro nucleare che avvolga il DNA del batterio.

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

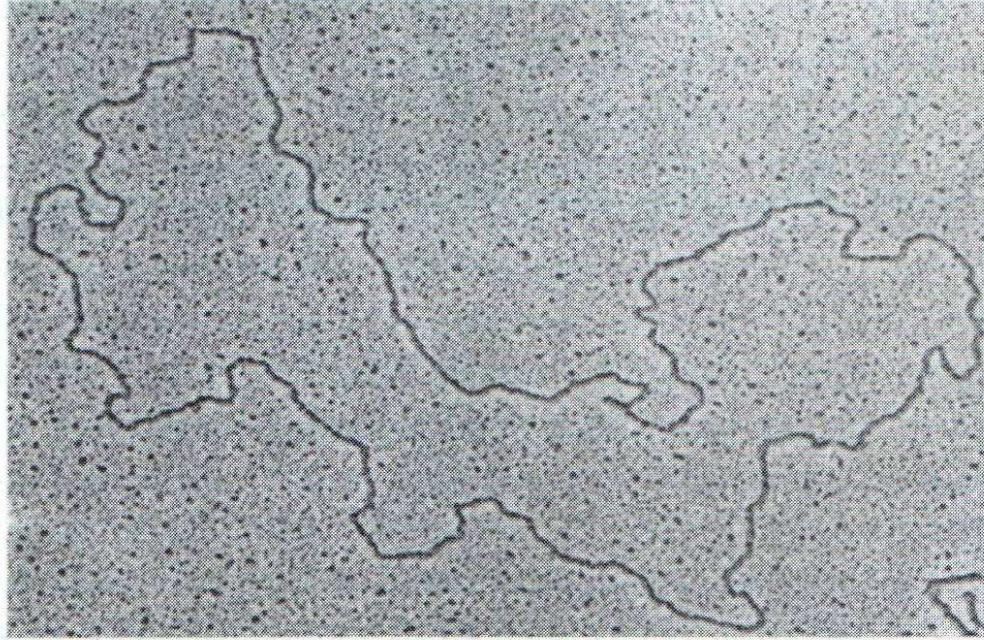
I procarioti hanno un unico cromosoma costituito da DNA a doppia catena, circolare, covalentemente chiuso.

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

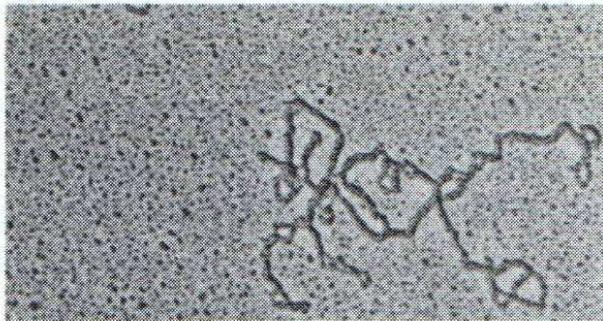
a)



a)



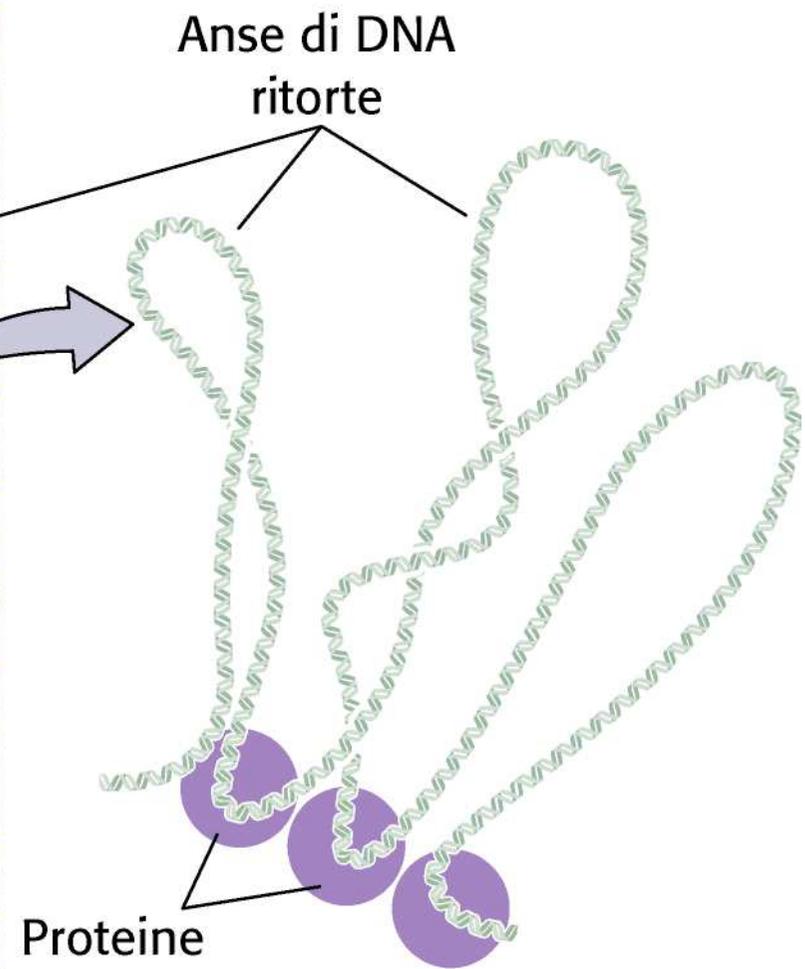
b)



**(a)**

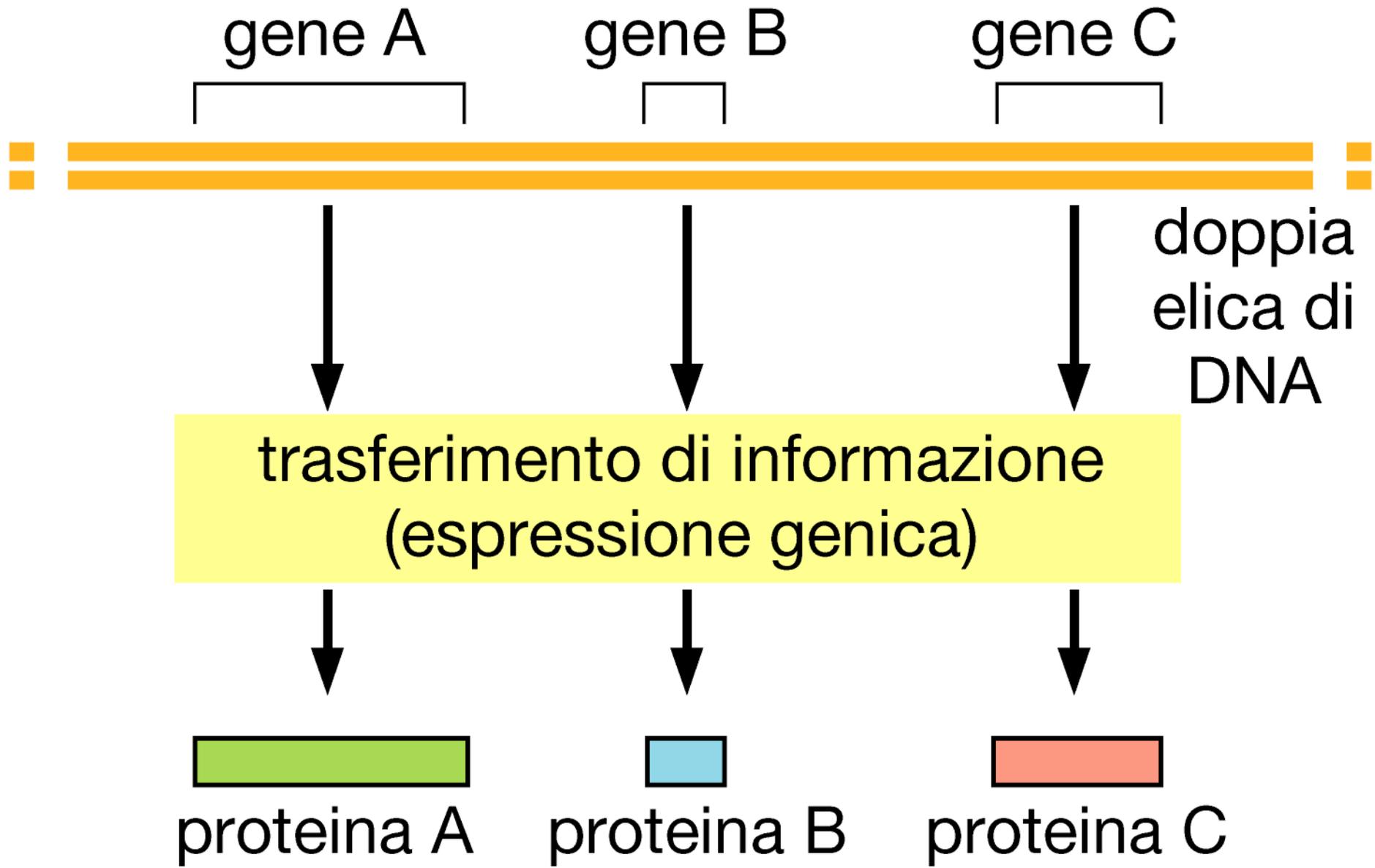


**(b)**



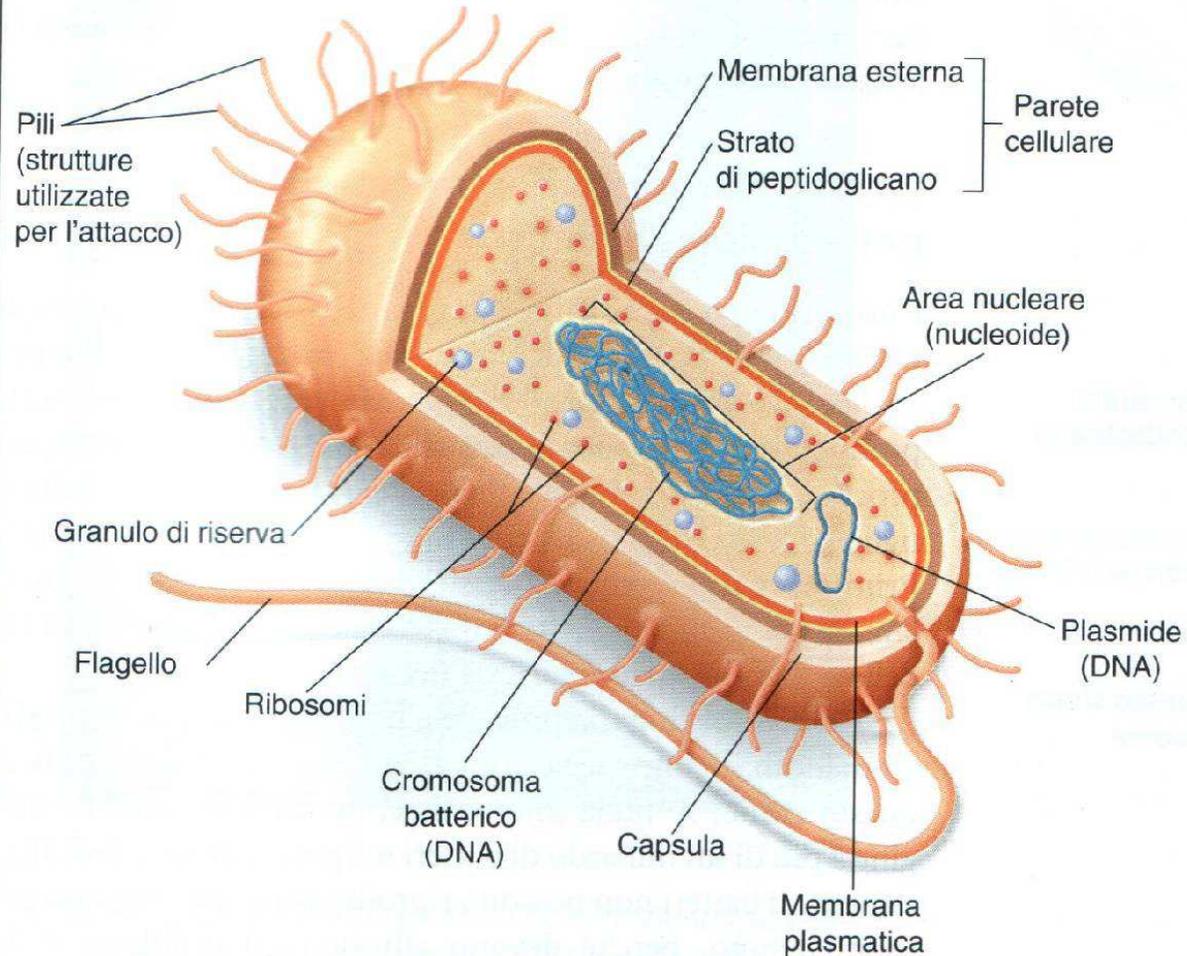
Anse di DNA  
ritorte

Proteine



### 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  $\Phi$ 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