Gene Transfer

- Genetic material is transferred between bacteria
- Donor→Recipient
  - Donor= original source of DNA
- Plasmid or linear DNA
  - Plasmid DNA: can replicate autonomously
  - Linear DNA: can integrate by homologous, non-homologous or site-specific integration

Mechanisms of gene transfer

- Transformation
- Conjugation
  - Plasmids
  - Conjugative transposons
- Transduction
  - Generalized
  - Specialized

Fate of transferred DNA

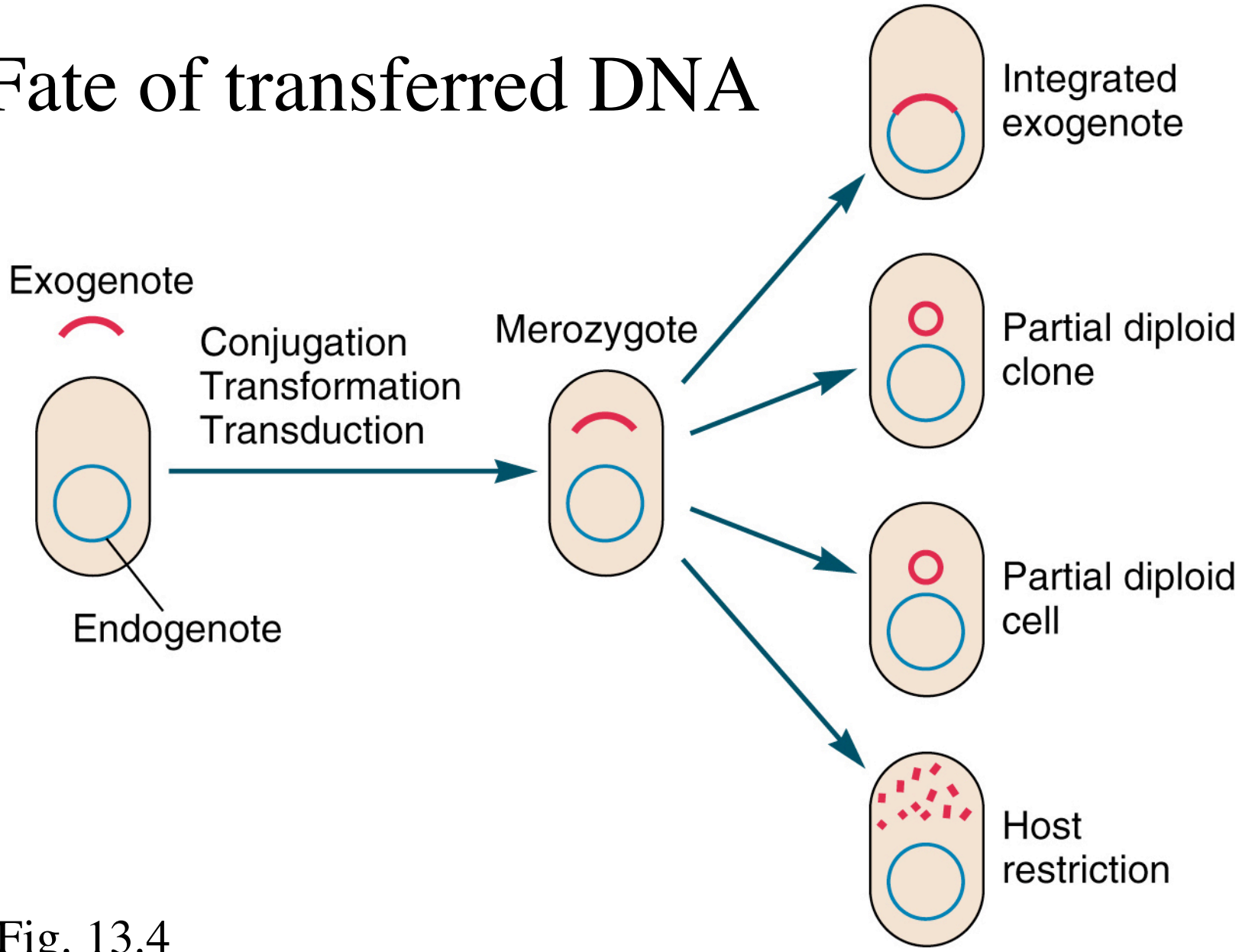


Fig. 13.4

Transformation of linear DNA

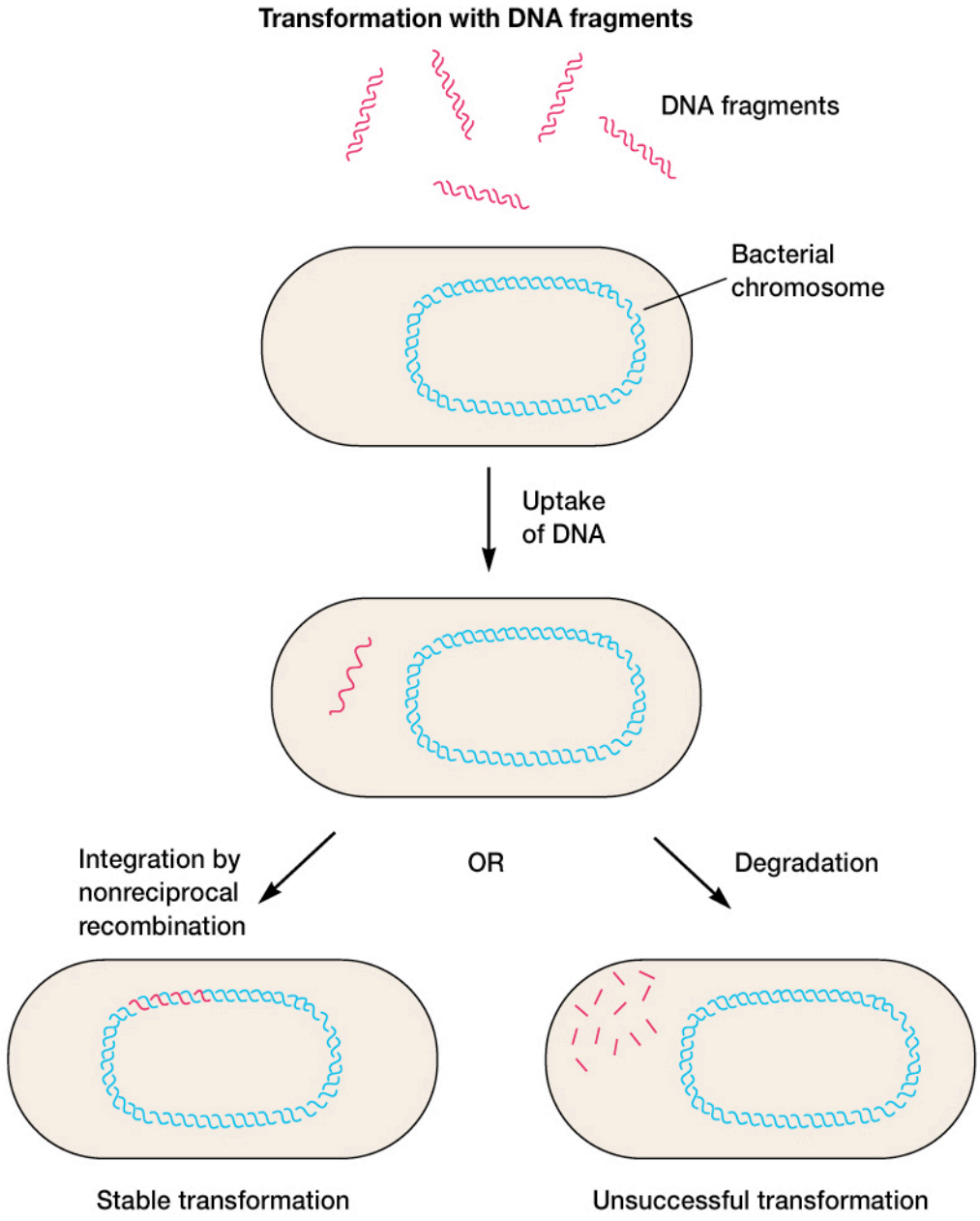
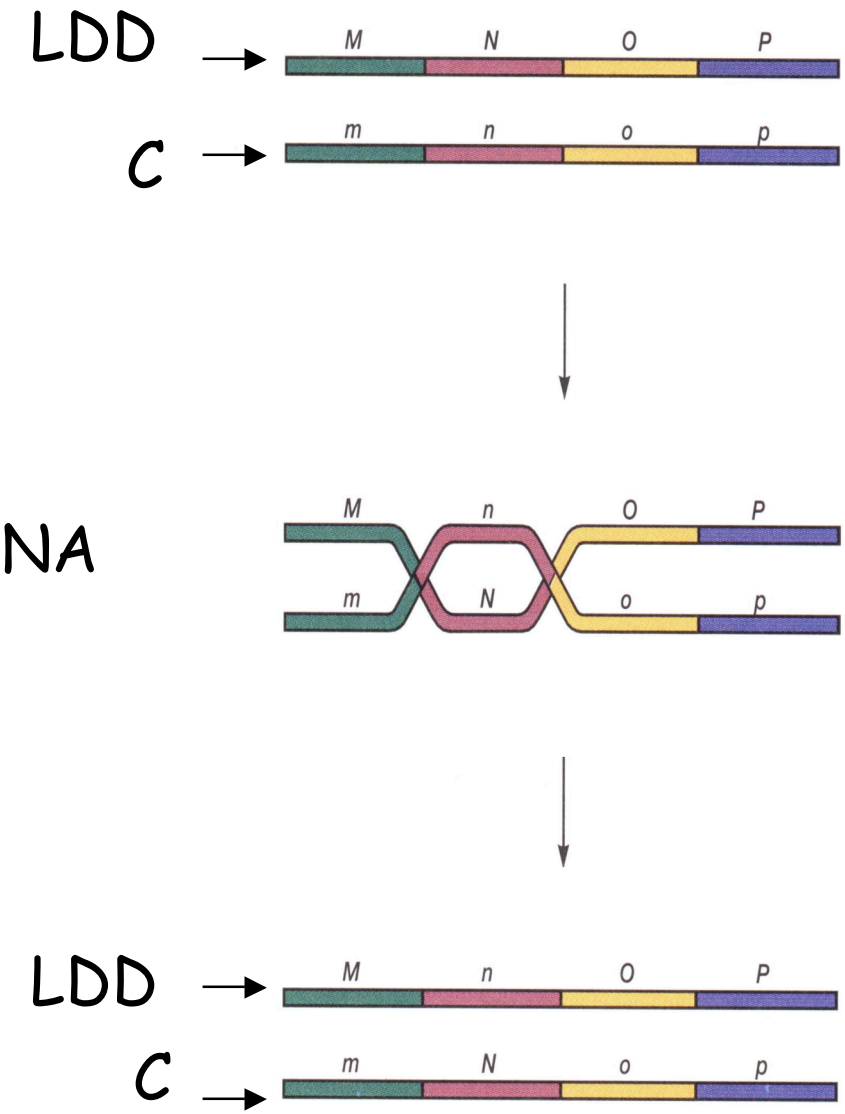


Fig. 13.16

Homologous recombination

LDD= Linear Donor DNA

C=Chromosome



Based on Fig. 14.1

Mechanism of transformation in *S. pneumoniae*

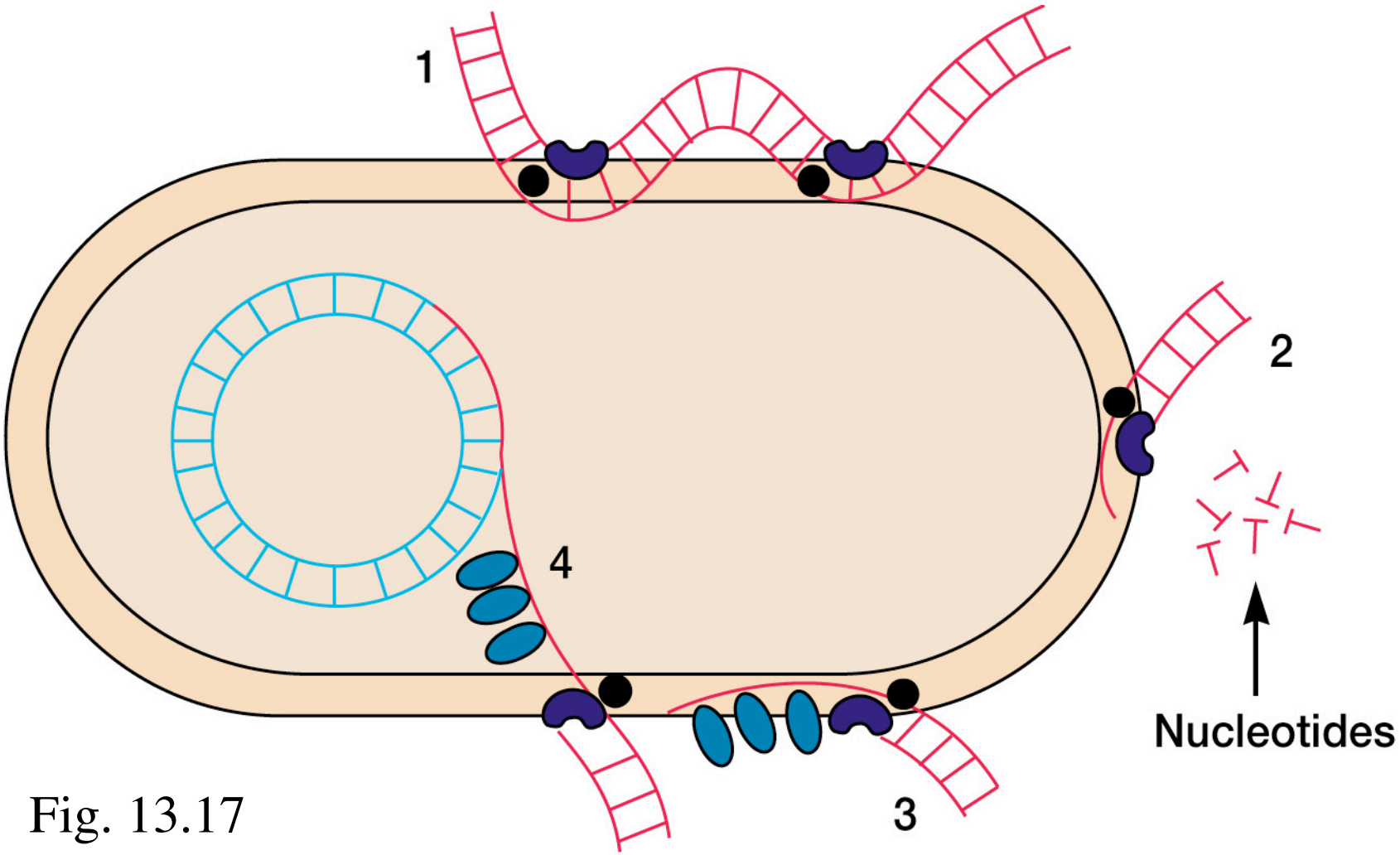


Fig. 13.17

Transformation of plasmid DNA

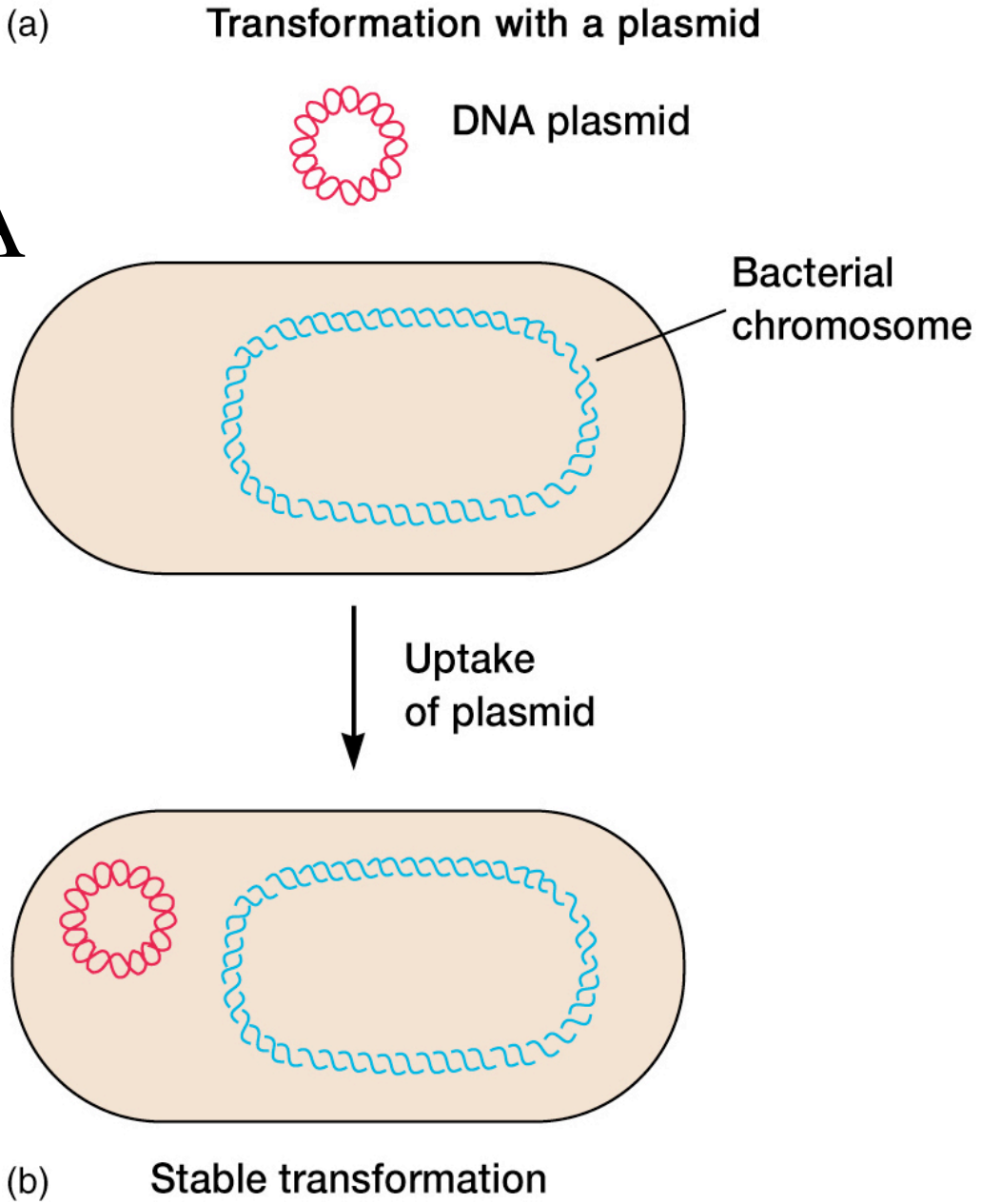


Fig. 13.16

Conjugation

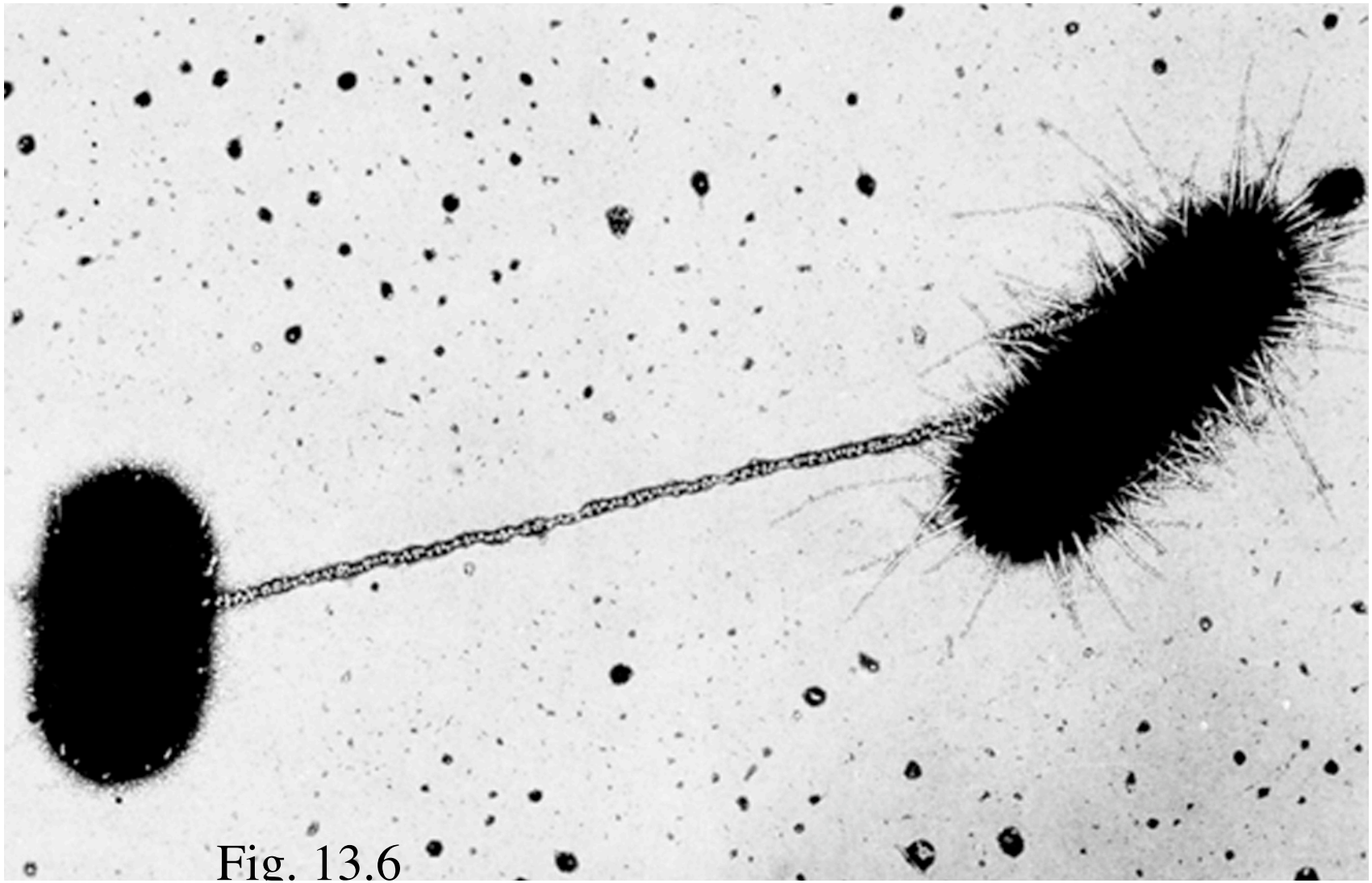
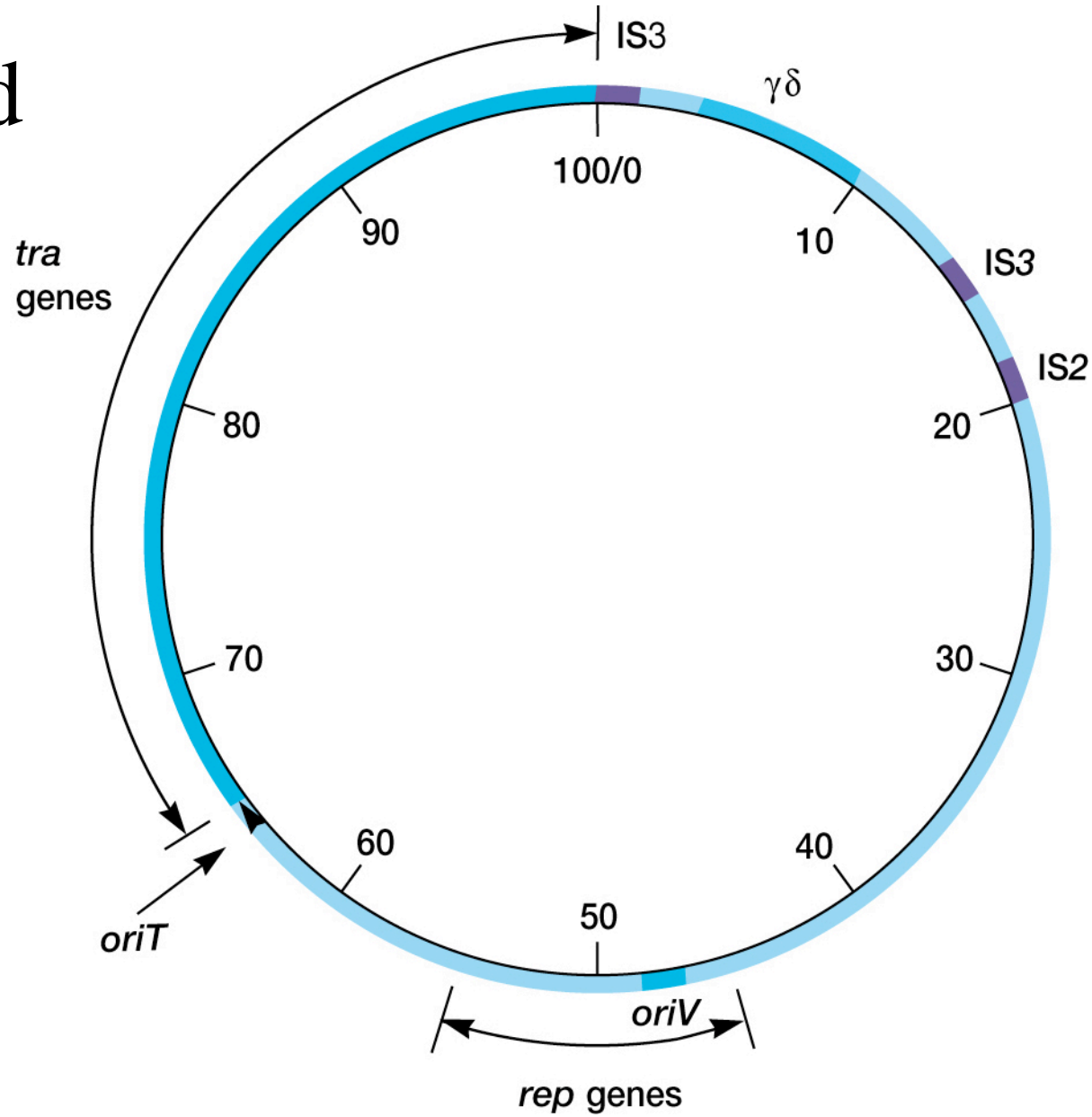


Fig. 13.6

F plasmid


IS3
γδ
100/0
10
IS3
IS2
20
30
40
50
60
70
80
90
tra
genes
oriT
oriV
rep genes

Conjugation of F Factor

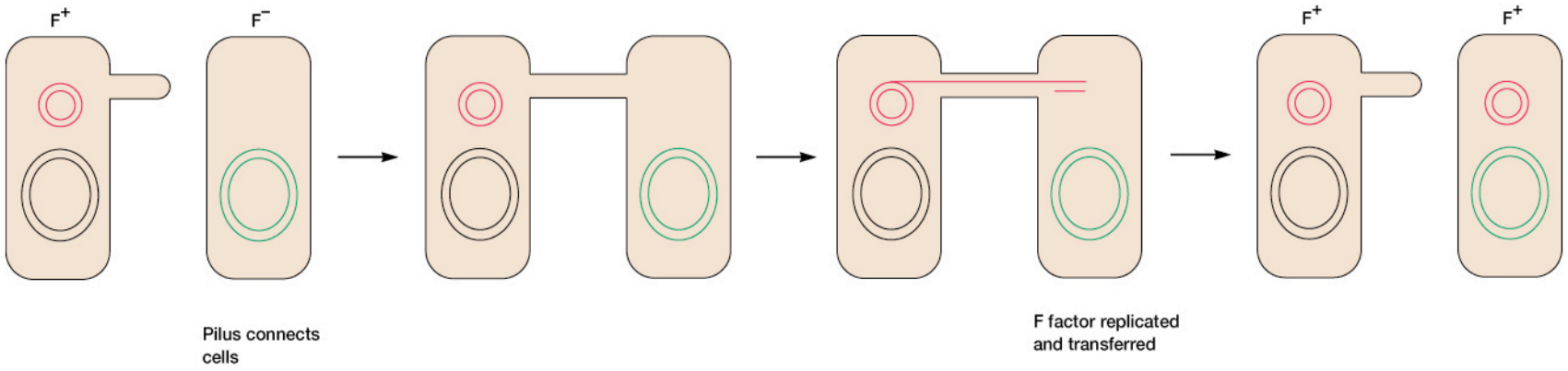


Fig. 13.14

Site-specific integration of F plasmid

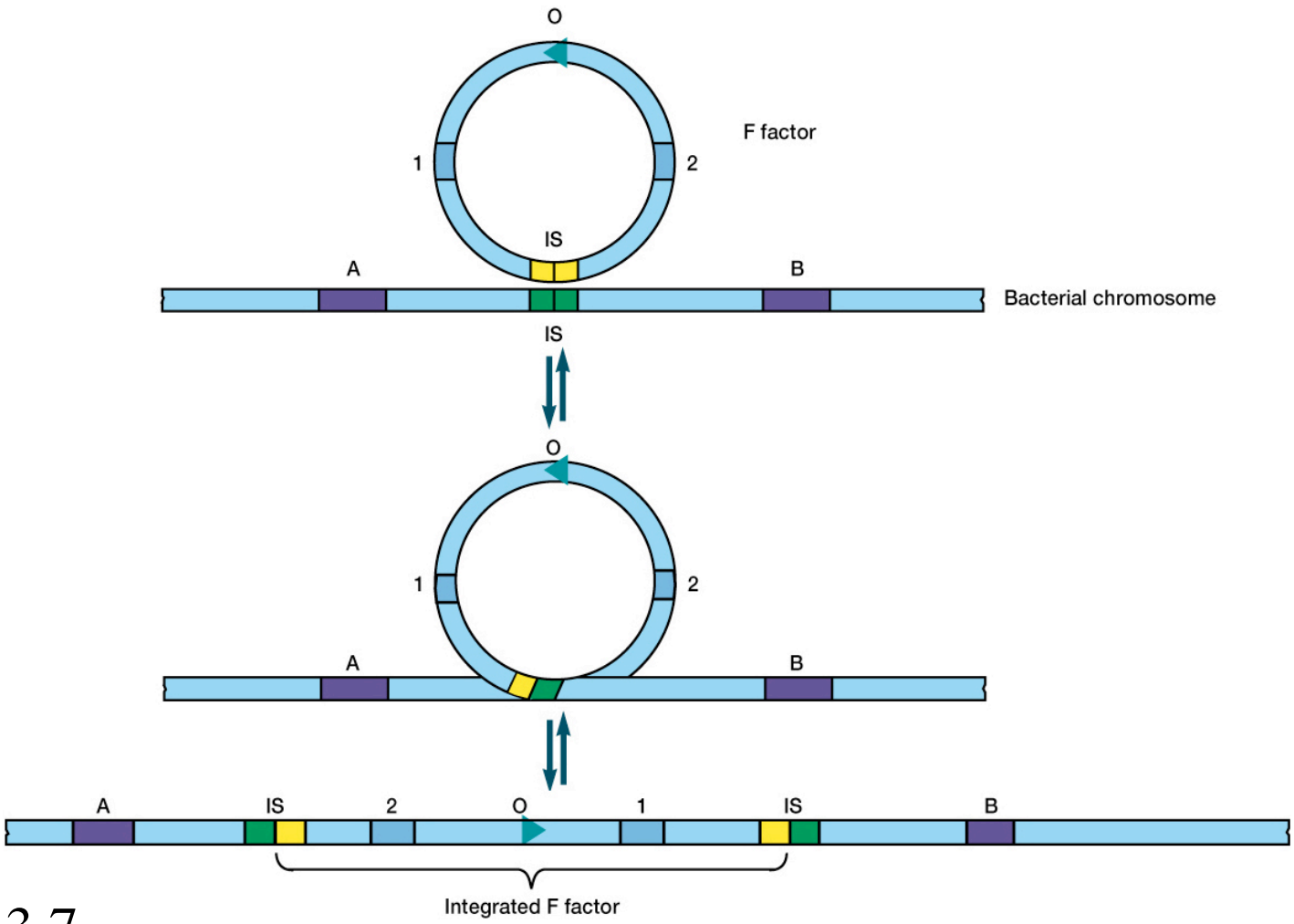


Fig. 13.7

Hfr transfer

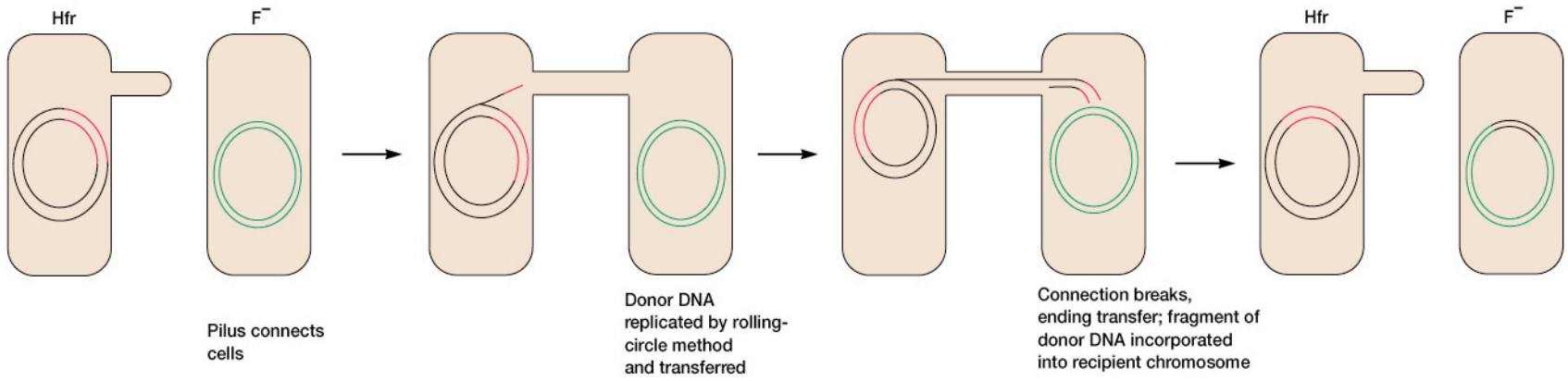


Fig. 13.14

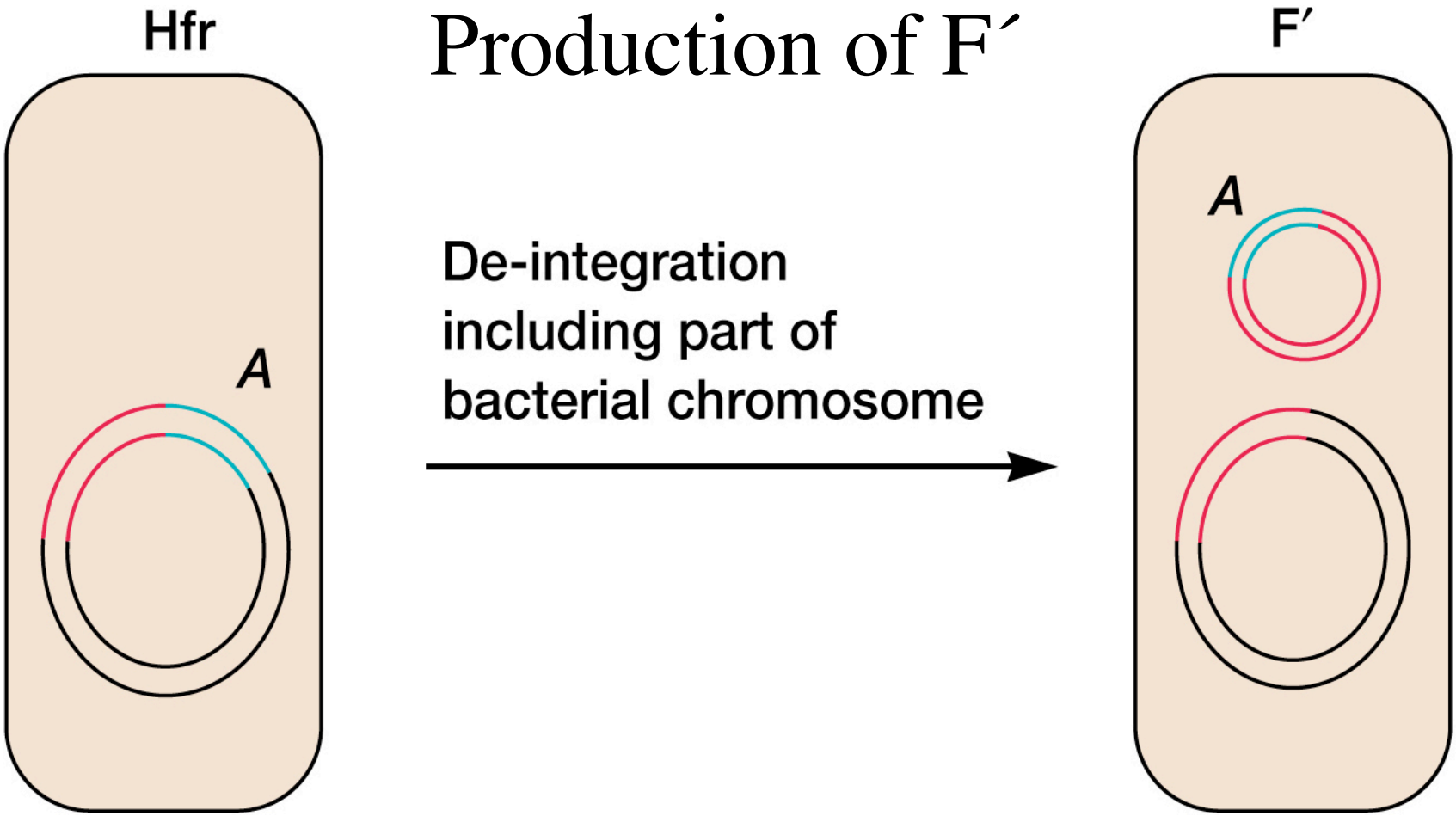

Production of F´
Hfr
A
De-integration
including part of
bacterial chromosome
F′
A

Fig. 13.15

F´ conjugation

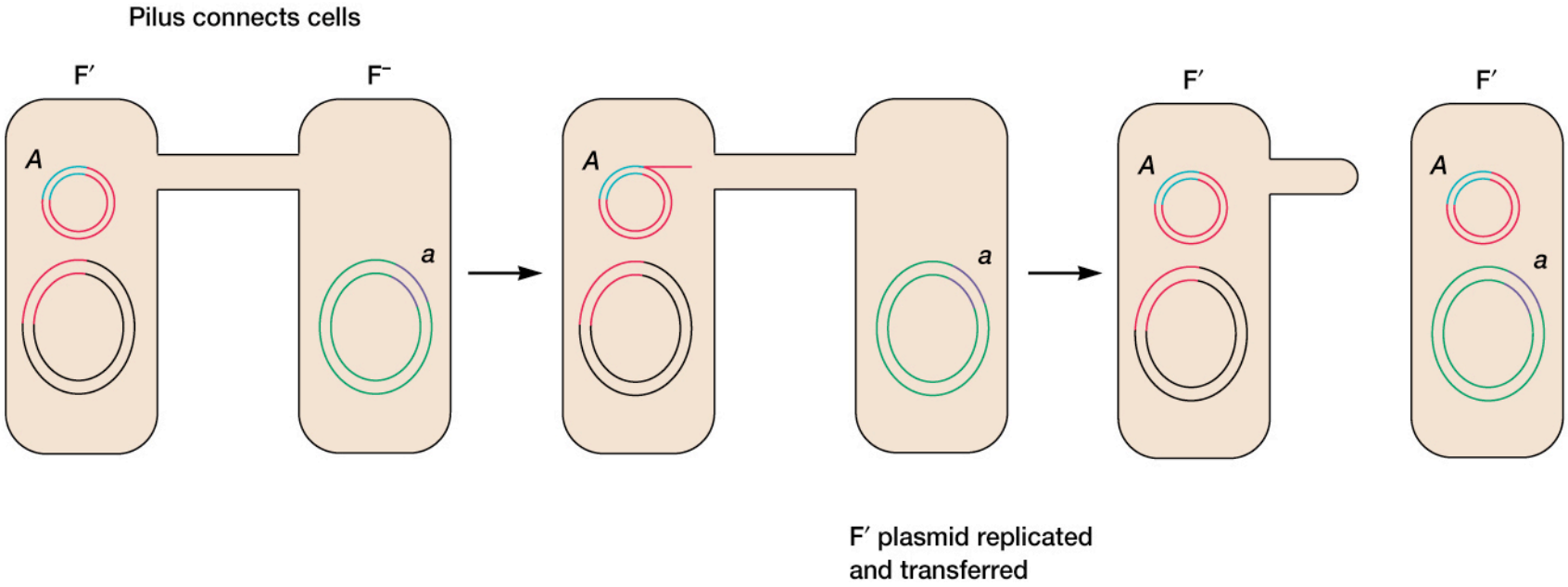


Fig. 13.15

Plasmid types

Table 13.1 Major Types of Plasmids

Type	Representatives	Approximate Size (kbp)	Copy Number (Copies/Chromosome)	Hosts	Phenotypic Features[a]
Fertility Factor[b]	F factor	95–100	1–3	*E. coli, Salmonella, Citrobacter*	Sex pilus, conjugation
R Plasmids	RP4	54	1–3	*Pseudomonas* and many other gram-negative bacteria	Sex pilus, conjugation, resistance to Ap, Km, Nm, Tc
	R1	80	1–3	Gram-negative bacteria	Resistance to Ap, Km, Su, Cm, Sm
	R6	98	1–3	*E. coli, Proteus mirabilis*	Su, Sm, Cm, Tc, Km, Nm
	R100	90	1–3	*E. coli, Shigella, Salmonella, Proteus*	Cm, Sm, Su, Tc, Hg
	pSH6	21		*Staphylococcus aureus*	Gm, Tm, Km
	pSJ23a	36		*S. aureus*	Pn, Asa, Hg, Gm, Km, Nm, Em, etc.
	pAD2	25		*Enterococcus faecalis*	Em, Km, Sm
Col Plasmids	ColE1	9	10–30	*E. coli*	Colicin E1 production
	ColE2		10–15	*Shigella*	Colicin E2
	CloDF13			*Enterobacter cloacae*	Cloacin DF13
Virulence Plasmids	Ent (P307)	83		*E. coli*	Enterotoxin production
	K88 plasmid			*E. coli*	Adherence antigens
	ColV-K30	2		*E. coli*	Siderophore for iron uptake; resistance to immune mechanisms
	pZA10	56		*S. aureus*	Enterotoxin B
	Ti	200	ted into it	*Agrobacter tumefaciens*	Tumor induction
Metabolic Plasmids	CAM	230		*Pseudomonas*	Camphor degradation
	SAL	56		*Pseudomonas*	Salicylate degradation
	TOL	75		*Pseudomonas putida*	Toluene degradation
	pJP4			*Pseudomonas*	2,4-dichlorophenoxyacetic acid degradation
				E. coli, Klebsiella, Salmonella	Lactose degradation
				Providencia	Urease
	sym			*Rhizobium*	Nitrogen fixation and symbiosis

Mobile elements

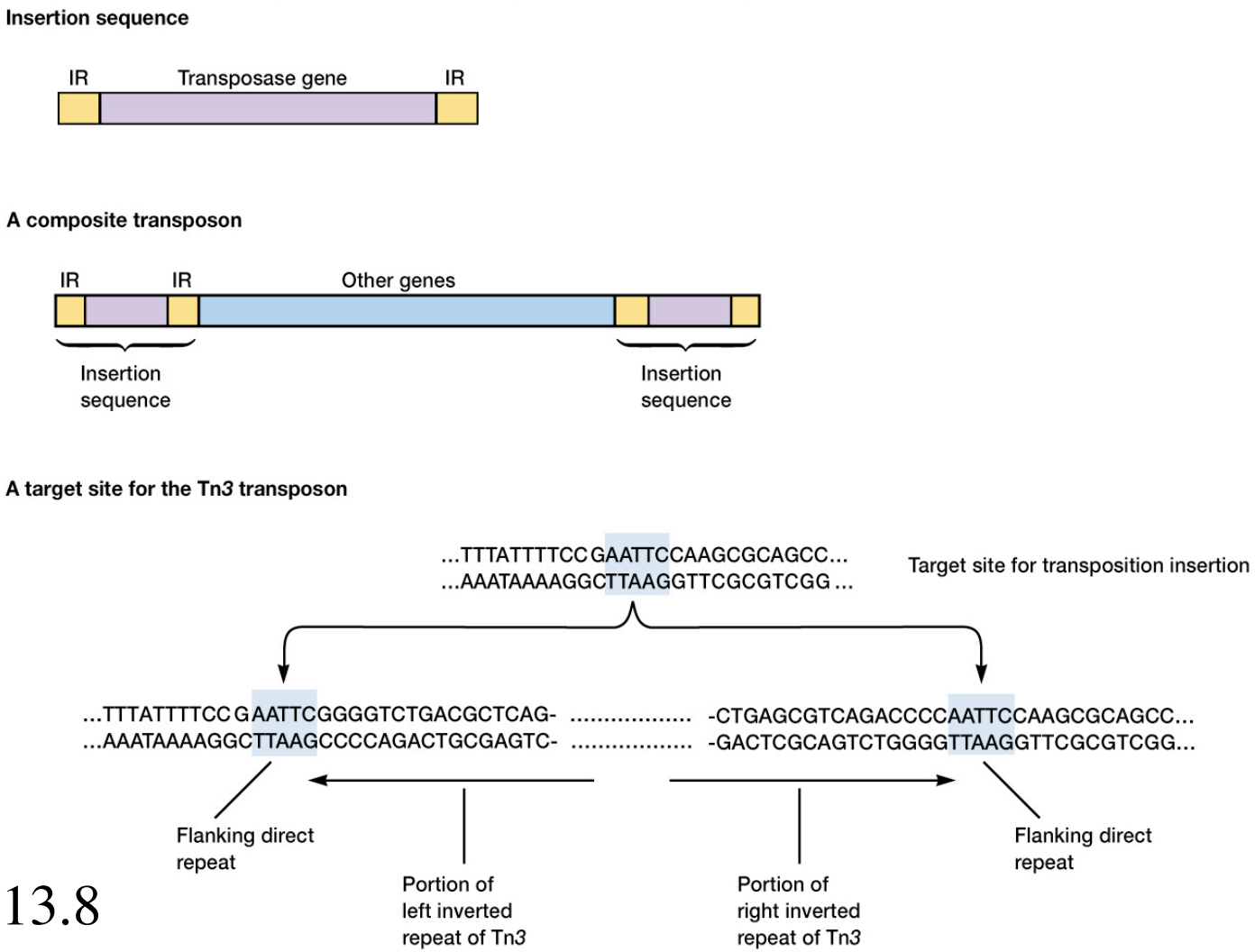


Fig. 13.8

Transposition

- Inserts randomly into chromosome or into plasmid
- Direct repeats found at ends
- Replicative when transposes
- Relatively stable at site of insertion
- Can cause varying effects due to insertion
- Some are conjugative, those that aren't can be moved by other mechanisms

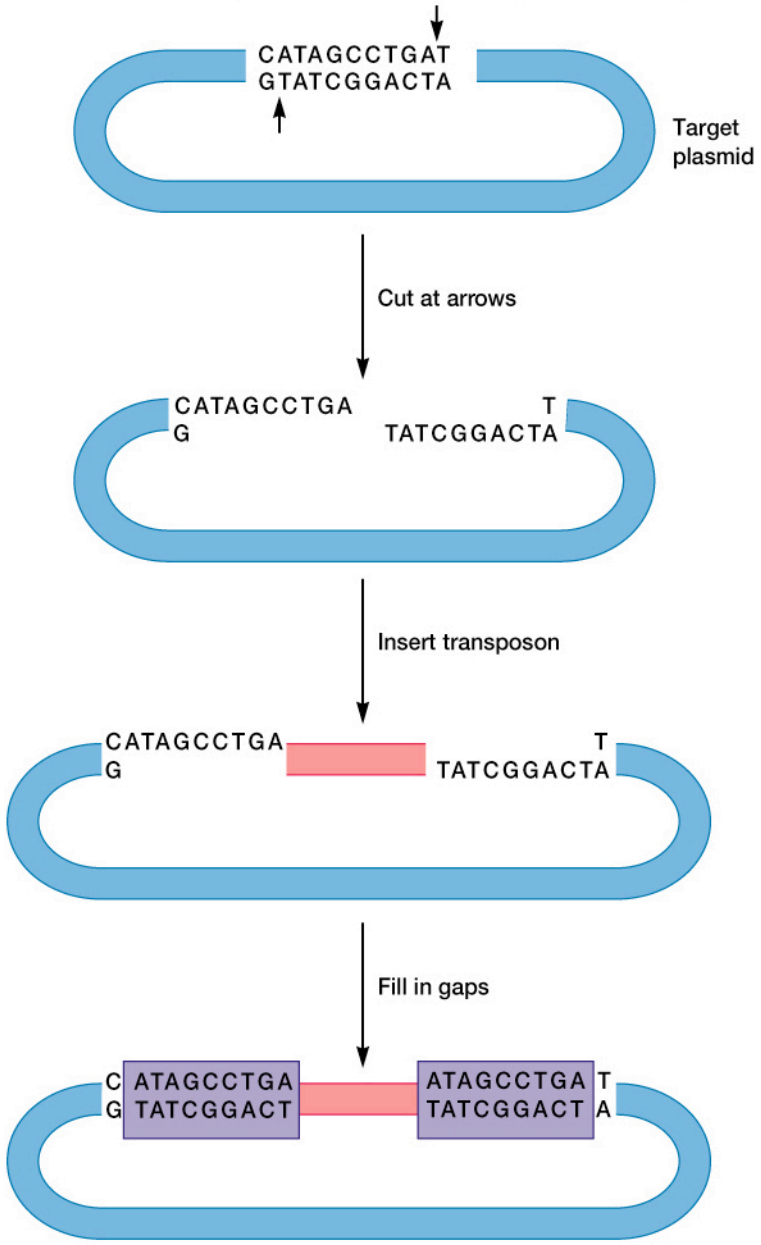


Fig. 13.9

Properties of Transposons

Table 13.3 The Properties of Selected Composite Transposons

Transposon	Length (bp)	Terminal Repeat Length	Terminal Module	Genetic Markers[a]
Tn*3*	4,957	38		Ap
Tn*501*	8,200	38		Hg
Tn*951*	16,500	Unknown		Lactose utilization
Tn*5*	5,700		IS*50*	Km
Tn*9*	2,500		IS*1*	Cm
Tn*10*	9,300		IS*10*	Tc
Tn*903*	3,100		IS*903*	Km
Tn*1681*	2,061		IS*1*	Heat-stable enterotoxin
Tn*2901*	11,000		IS*1*	Arginine biosynthesis

[a]Abbreviations for antibiotics and metals same as in table 13.1.

R plasmids and transposons

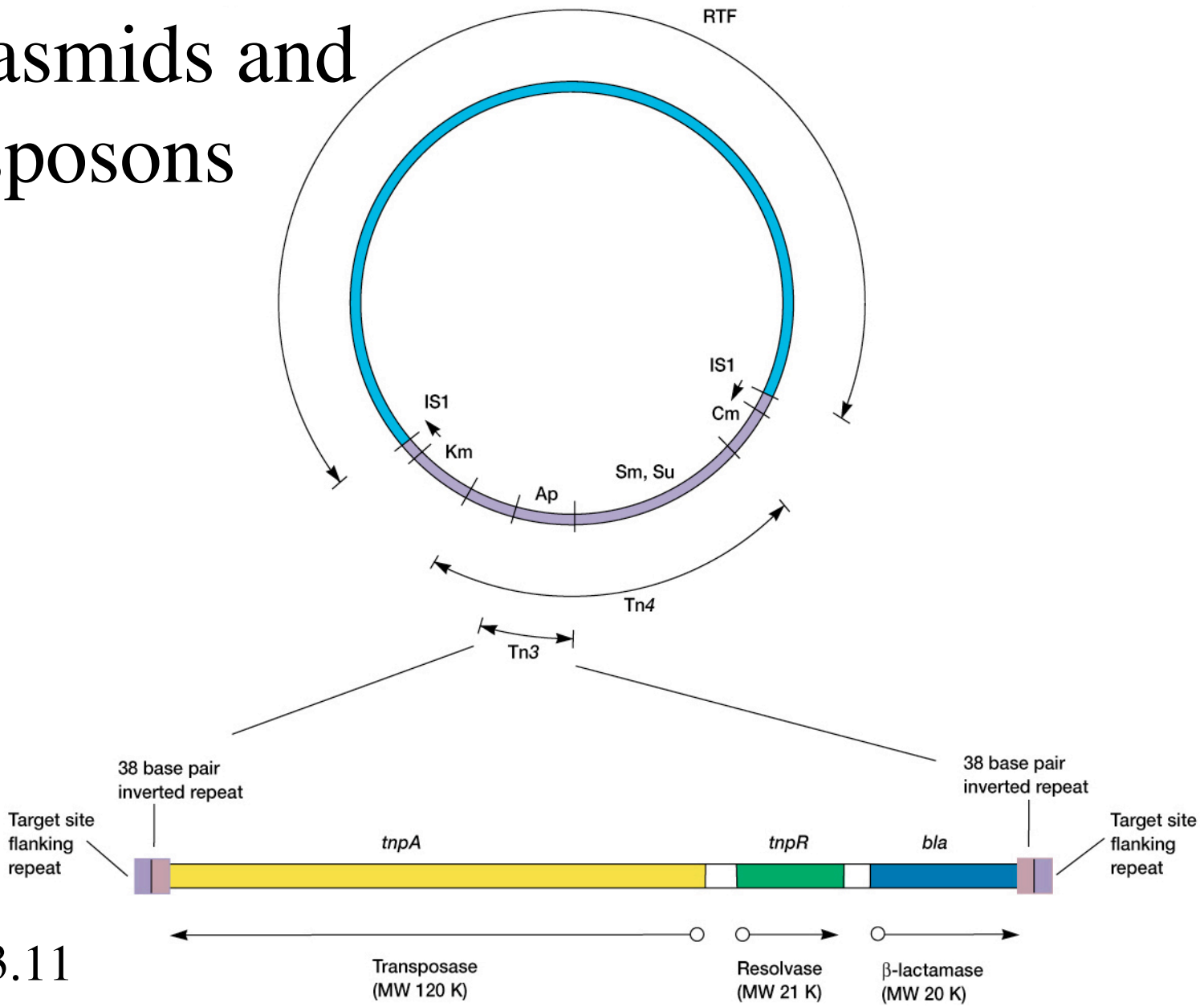


Fig. 13.11

Lambda Phage Genome

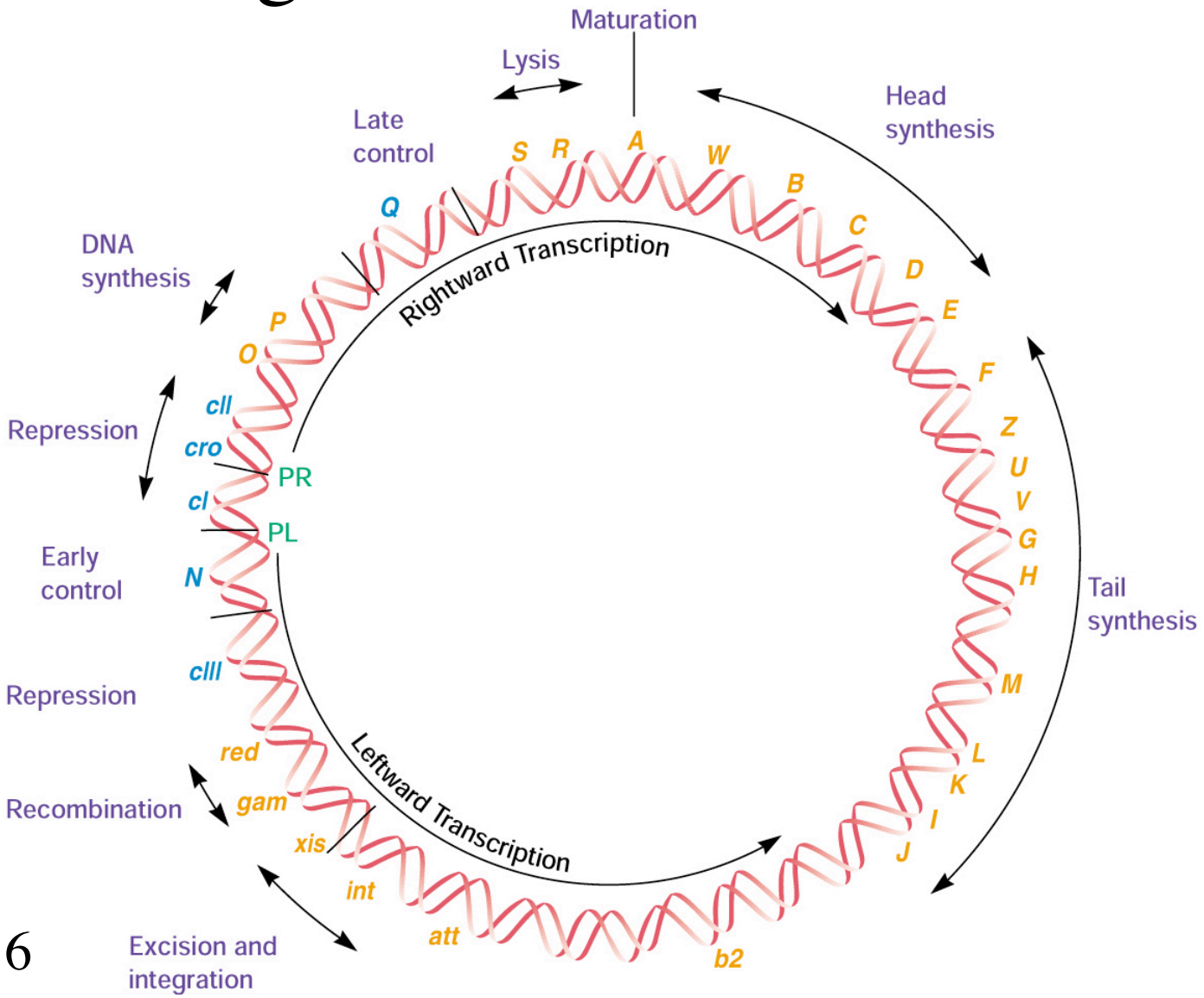


Fig. 17.16

Phage attachment and DNA injection

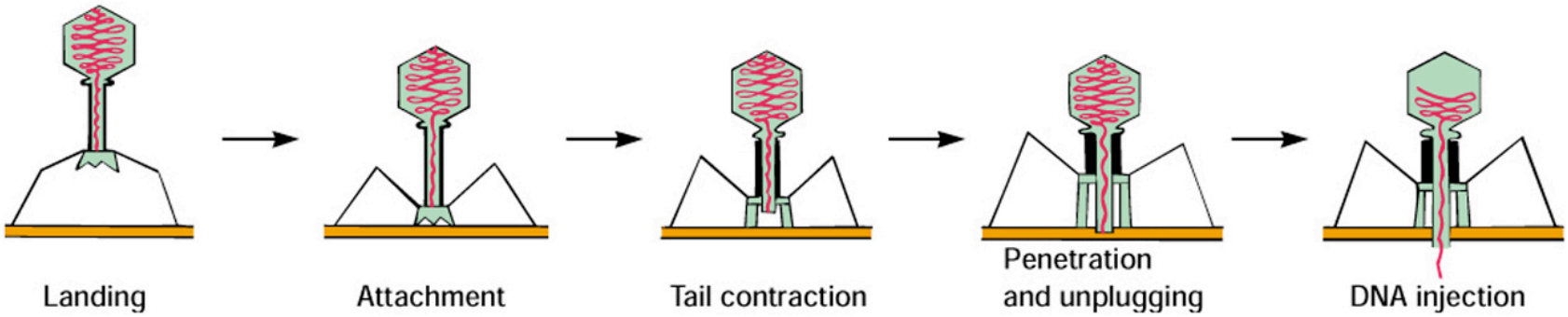


Fig. 17.3

Lytic and lysogenic viral life cycles

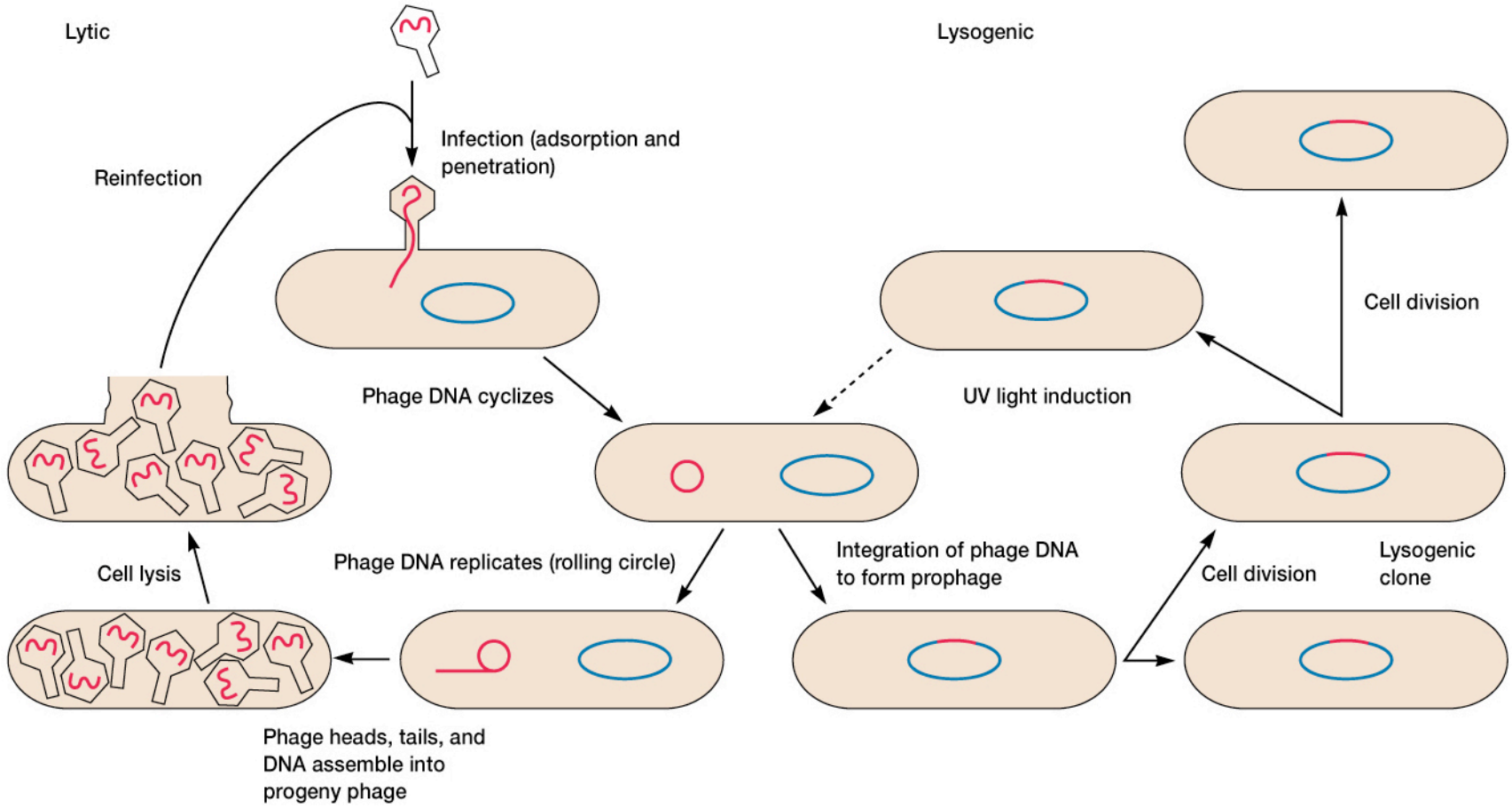


Fig. 13.18

Generalized transduction

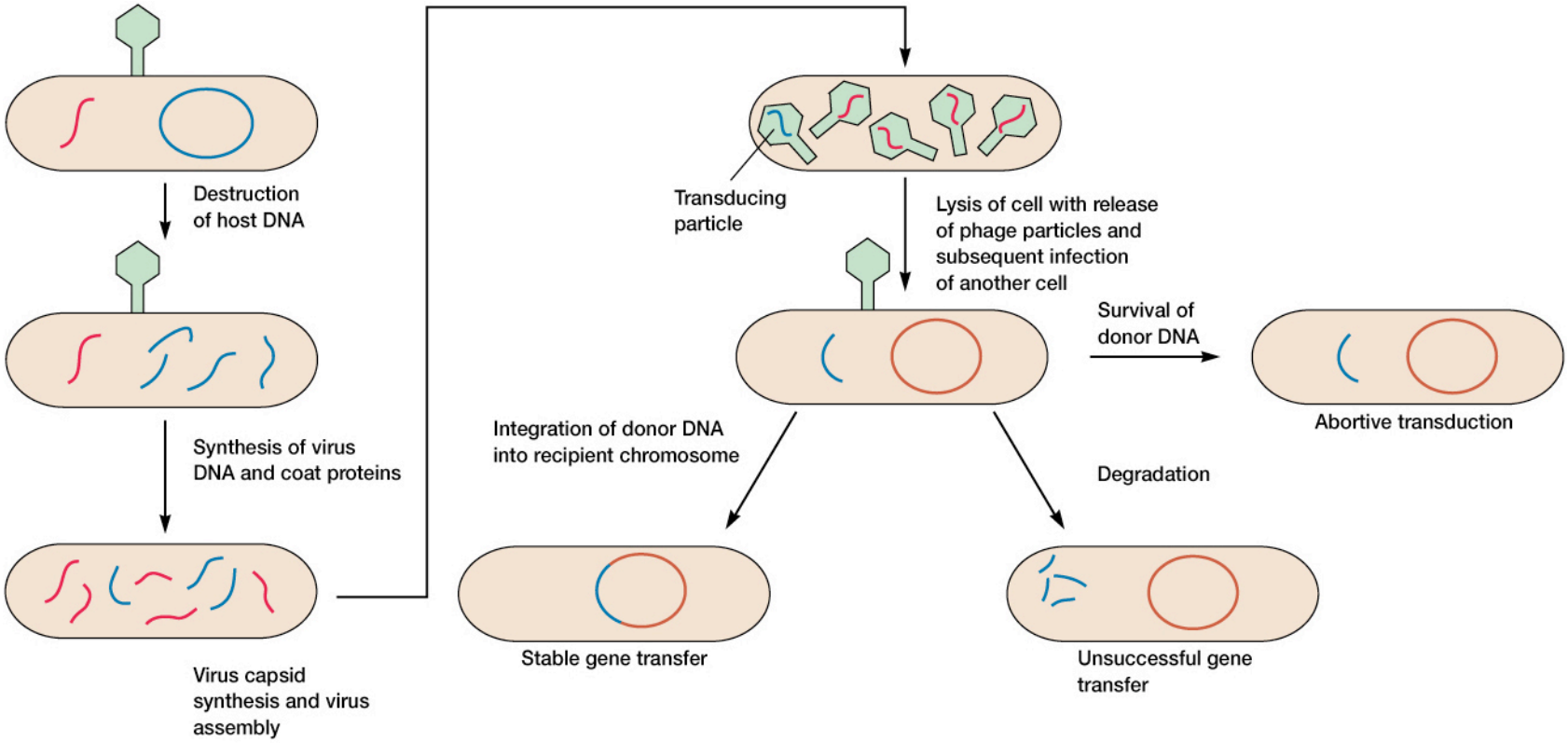


Fig. 13.19

Specialized transduction

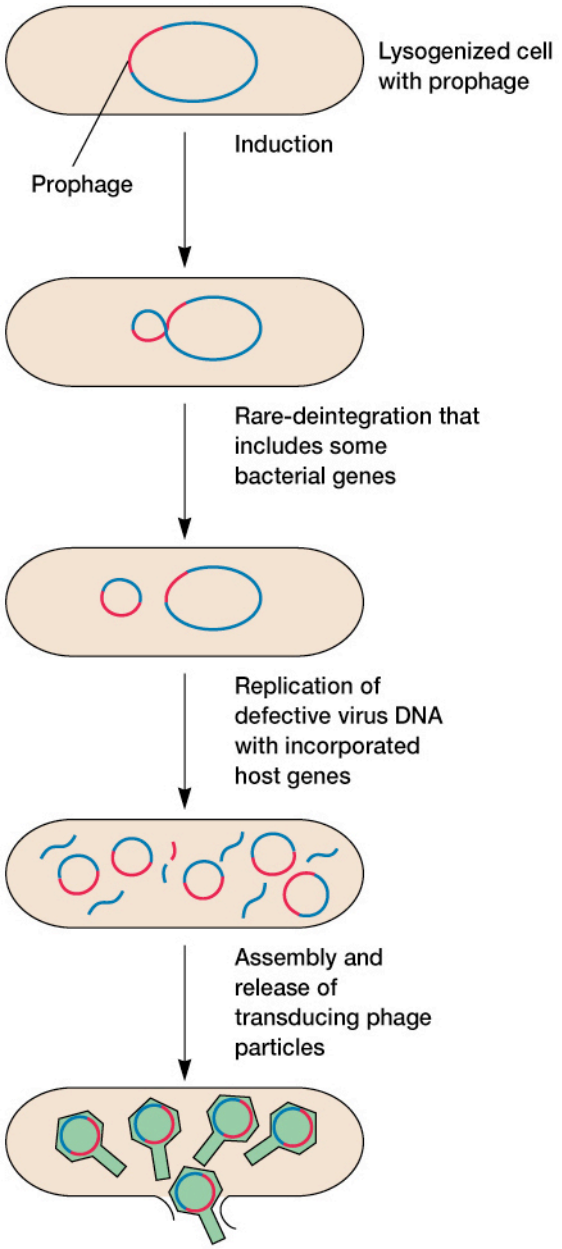
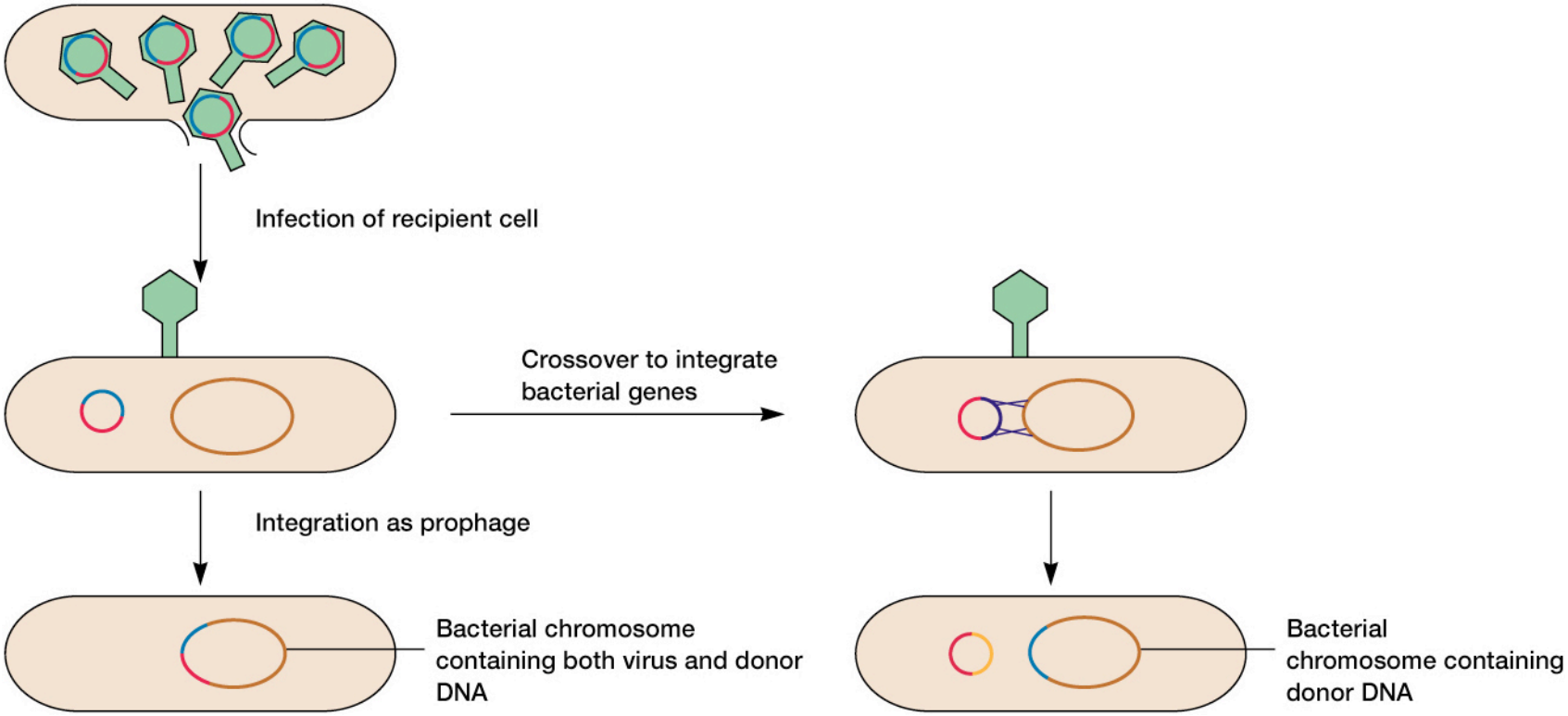
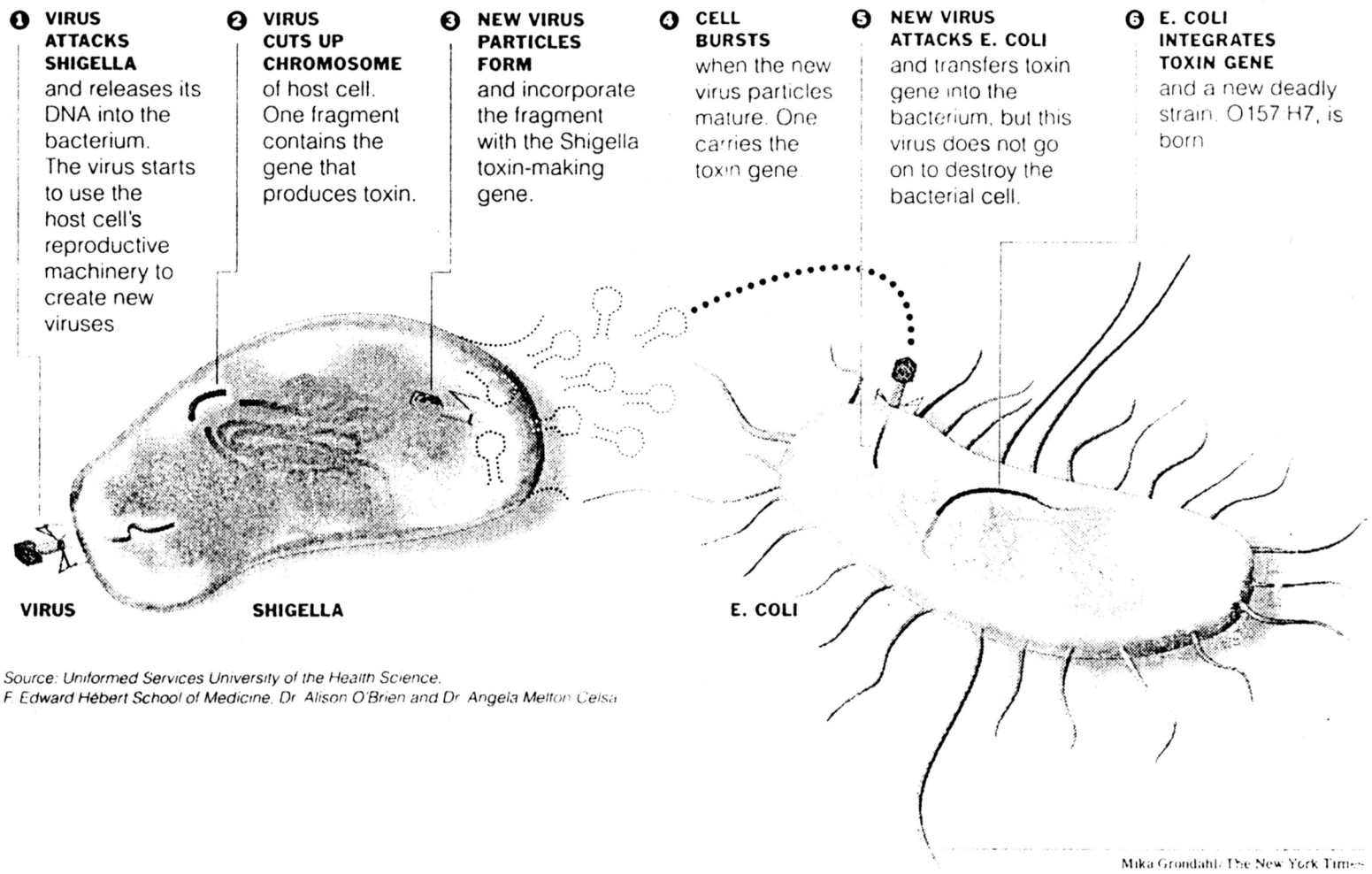


Fig. 13.20

Specialized transduction



Origin of *E. coli* O157:H7

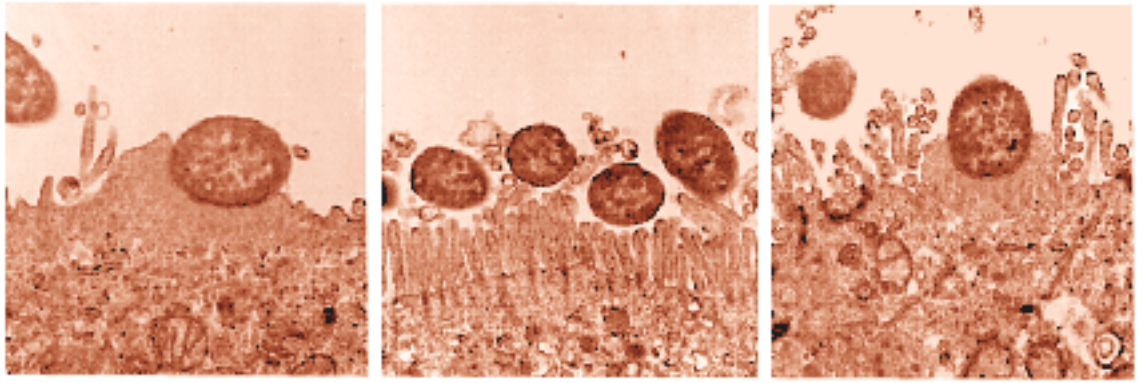


Specialized transduction in pathogenesis

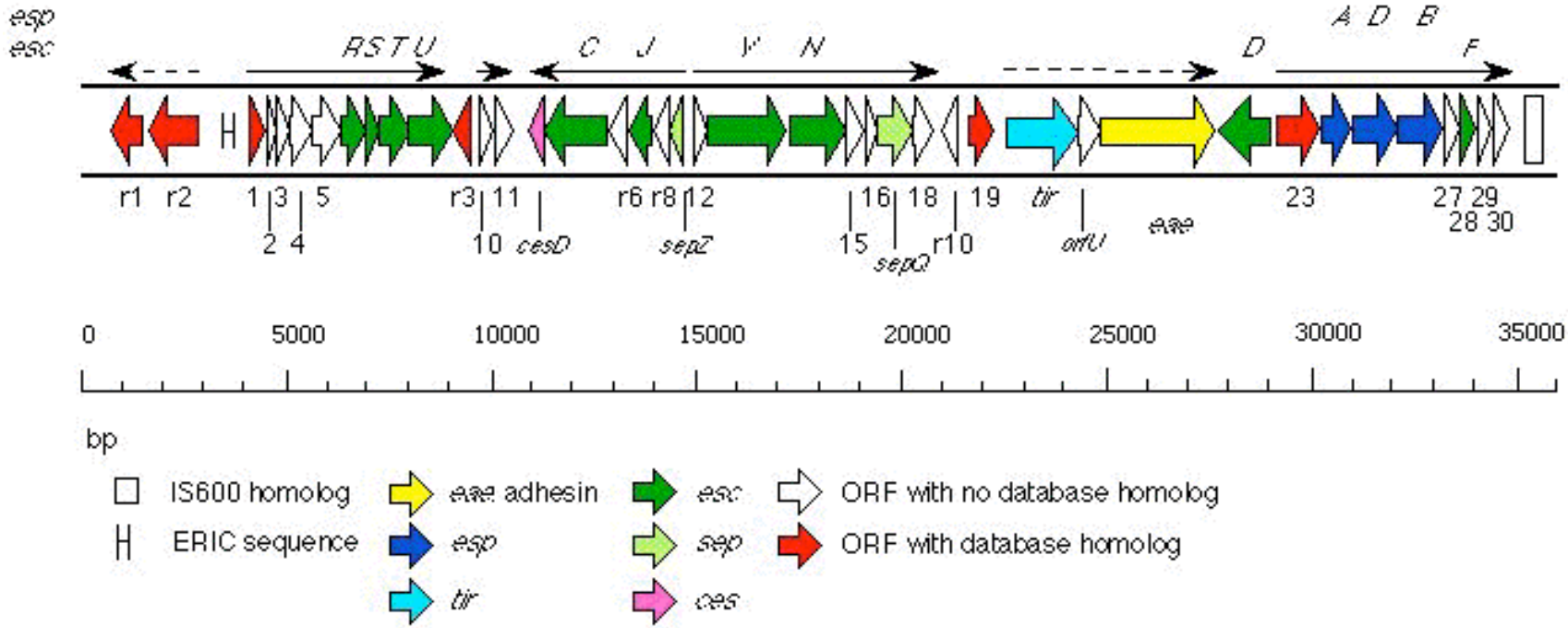
•**Bacterium**	**Phage**	**Gene Product**	**Phenotype**
•*V. cholerae*	CTX phage	cholera toxin	cholera
•*E. coli*	lambda phage	shigalike toxin	hemorrhagic diarrhea
•*C. botulinum*	clostridial phages	botulinum toxin	botulism
•*C.diphtheriae*	corynephage beta	diphtheria toxin	diphtheria
•*S. pyogenes*	T12	erythrogenic toxins	scarlet fever

Pathogenicity Island (PAI)

- Large segment of DNA (30-100 kb)
- Chromosomally encoded
- In pathogenic, but not non-pathogenic genera
- Clusters of virulence genes
- Found in *Salmonella*, *Escherichia*, *Yersina*, *Helicobacter*, *Listeria*



The locus of enterocyte effacement (LEE) of E2348/69



Evidence for gene transfer in PAIs

- Similarity in gene sequences for some PAI genes
  - Type IV pili, A-B subunit toxins
- GC content different than rest of chromosome
- Often inserted at tRNA loci
  - Phage mediated insertion
  - Phage IR73 inserts at conserved TTCGA
- Contain plasmid and insertion sequence elements