Figure 11.1

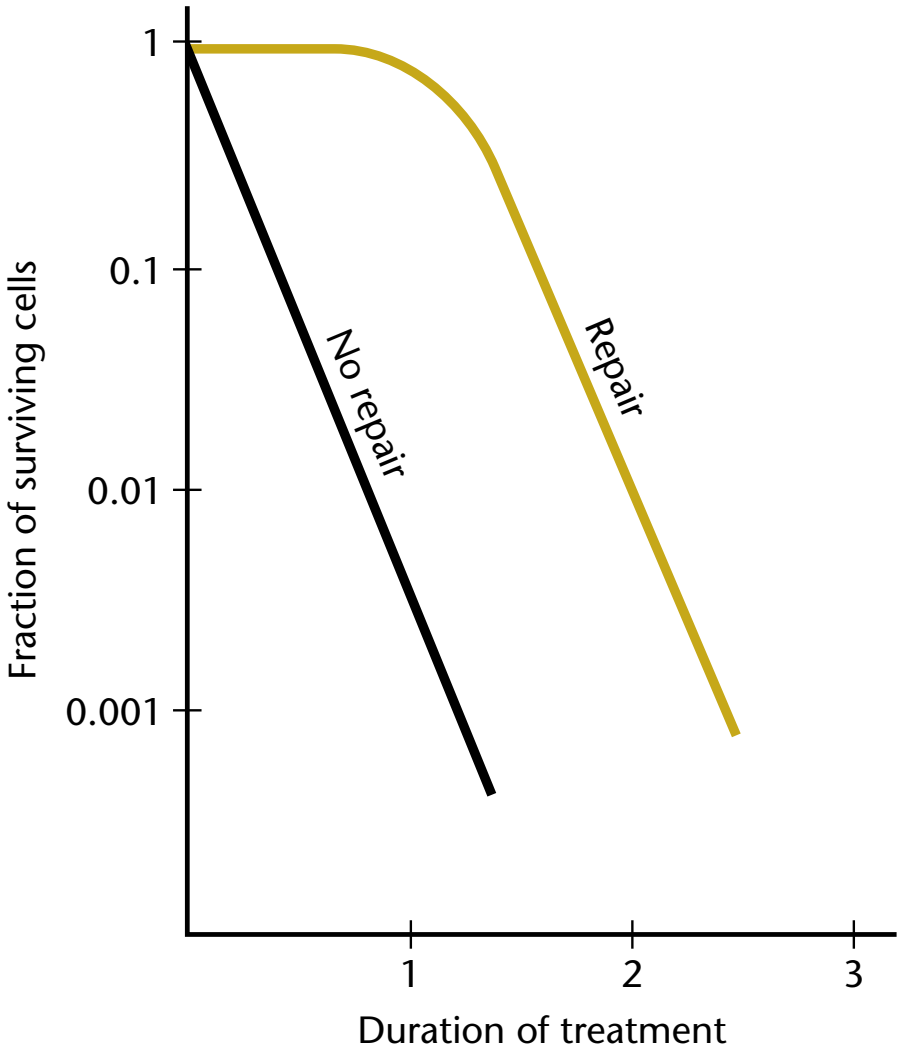

1
0.1
0.01
0.001
Fraction of surviving cells
No repair
Repair
1
2
3
Duration of treatment

Figure 11.2

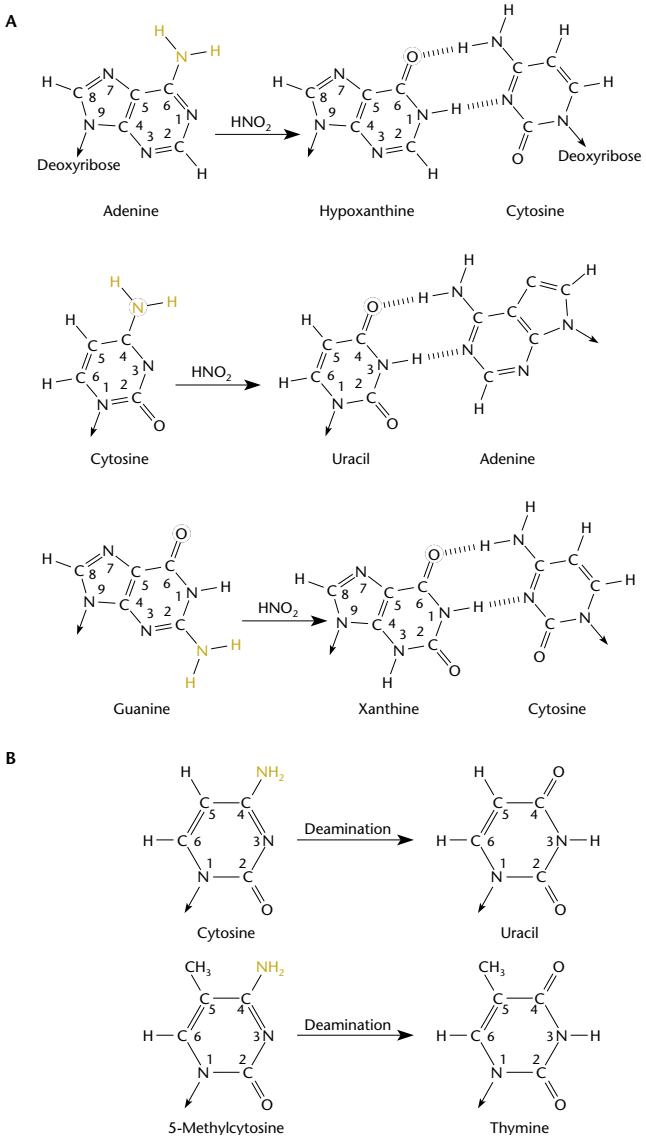

A
Deoxyribose
HNO2
Adenine
Hypoxanthine
Cytosine
Deoxyribose
HNO2
Cytosine
Uracil
Adenine
HNO2
Guanine
Xanthine
Cytosine
B
Deamination
Cytosine
Uracil
Deamination
5-Methylcytosine
Thymine

Figure 11.3

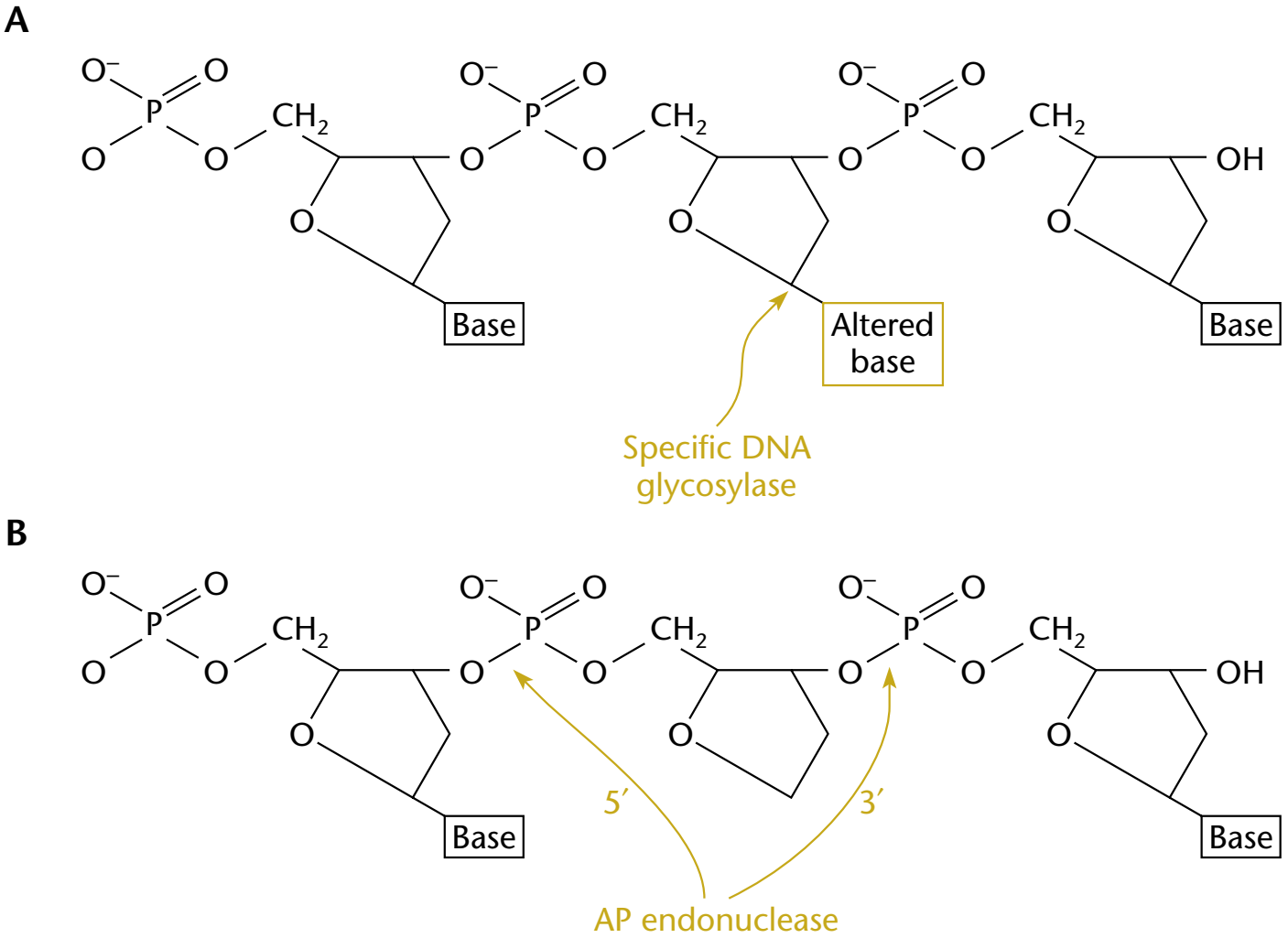

A
Base
Altered base
Base
OH
Specific DNA glycosylase
B
Base
5′
3′
Base
OH
AP endonuclease

Figure 11.4

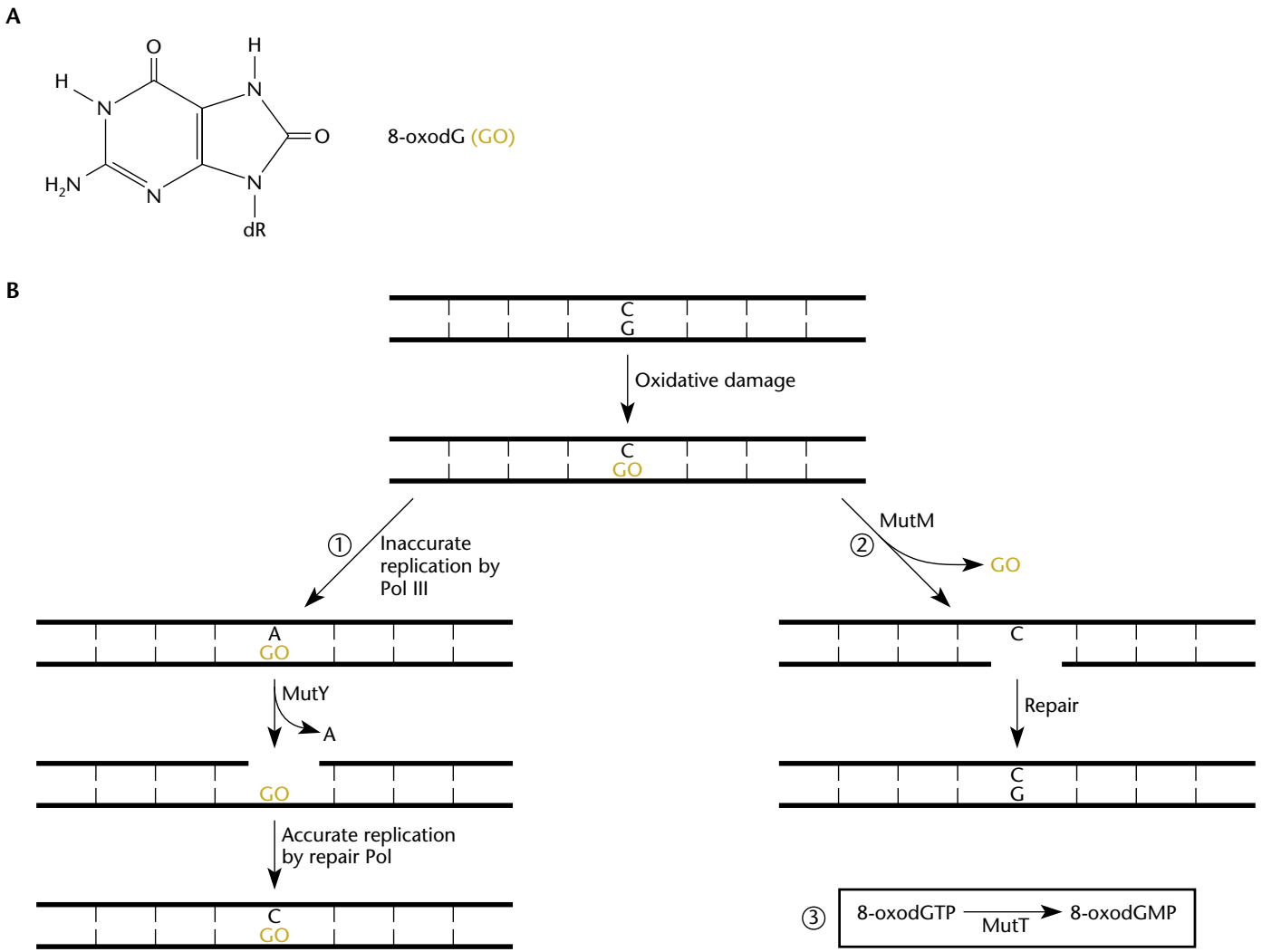

A
8-oxodG (GO)
B
C
G
Oxidative damage
C
GO
① Inaccurate replication by Pol III
② MutM
GO
A
GO
MutY
A
GO
Accurate replication by repair Pol
C
GO
C
Repair
C
G
③ 8-oxodGTP
MutT
8-oxodGMP

Figure 11.5

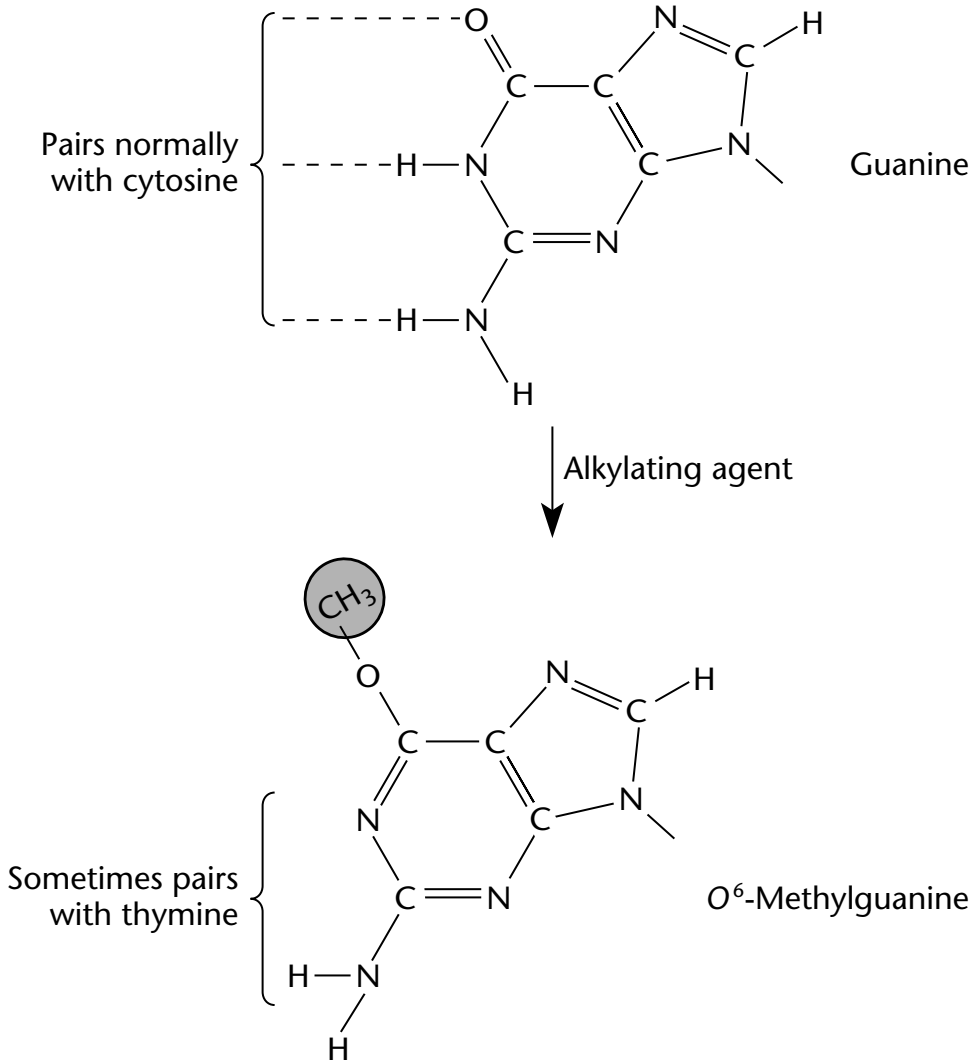

Pairs normally with cytosine
Guanine
Alkylating agent
Sometimes pairs with thymine
O⁶-Methylguanine

Figure 11.6

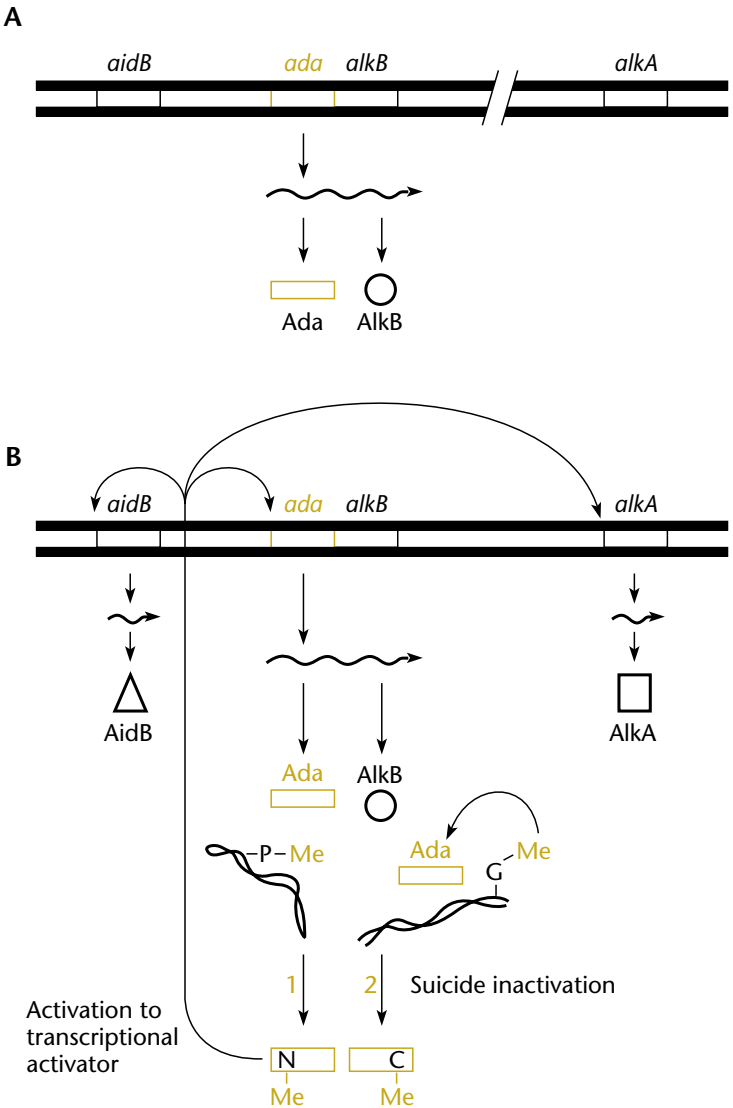

A
aidB
ada
alkB
alkA
Ada
AlkB
B
aidB
ada
alkB
alkA
AidB
AlkA
Ada
AlkB
P–Me
Ada
Me
G
1
2
Suicide inactivation
Activation to transcriptional activator
N
C
Me
Me

Figure 11.7

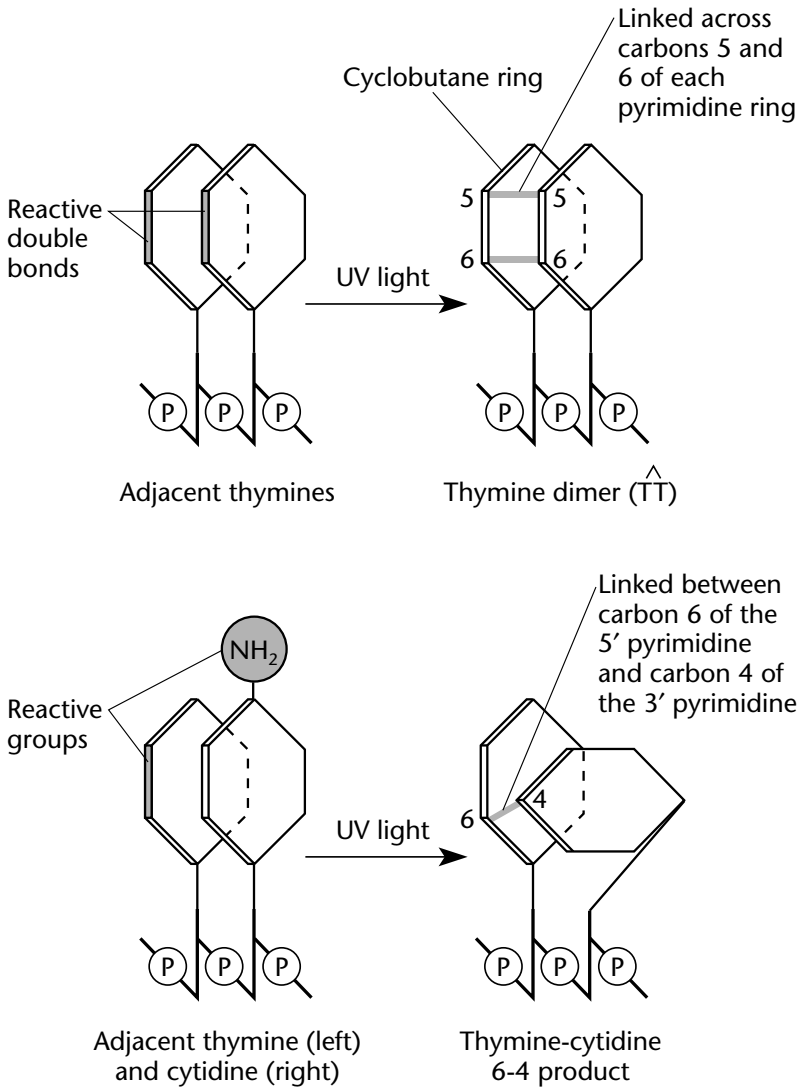

Linked across carbons 5 and 6 of each pyrimidine ring
Cyclobutane ring
Reactive double bonds
UV light
5
6
5
6
P
P
P
P
P
P
Adjacent thymines
Thymine dimer (TT)
Linked between carbon 6 of the 5′ pyrimidine and carbon 4 of the 3′ pyrimidine
NH2
Reactive groups
UV light
6
4
P
P
P
P
P
P
Adjacent thymine (left) and cytidine (right)
Thymine-cytidine 6-4 product

Figure 11.8

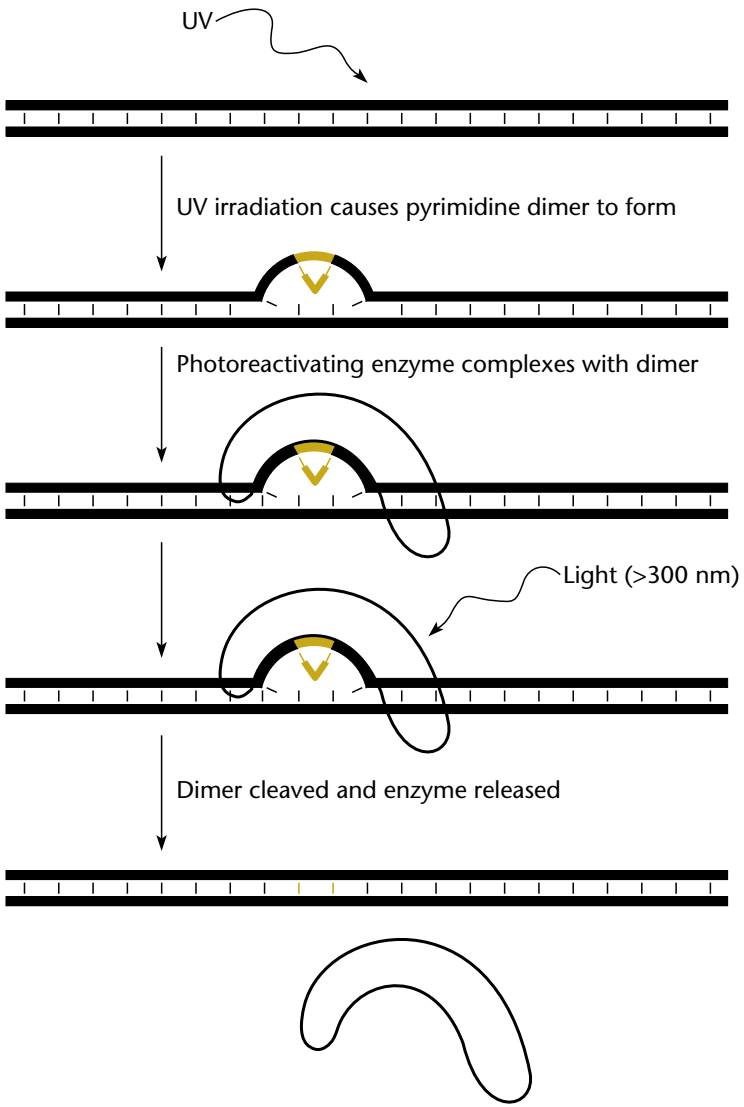
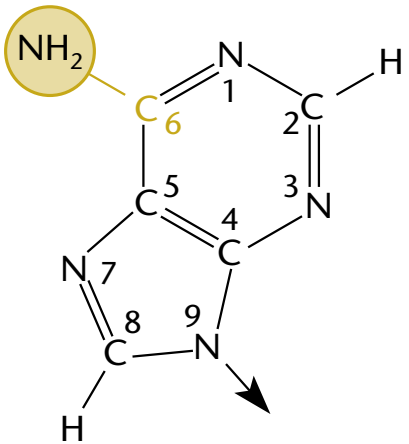
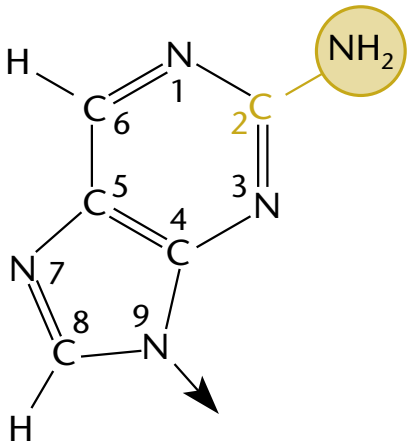

UV
UV irradiation causes pyrimidine dimer to form
Photoreactivating enzyme complexes with dimer
Light (>300 nm)
Dimer cleaved and enzyme released

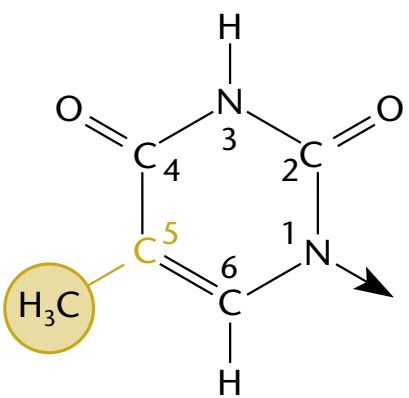
Figure 11.9



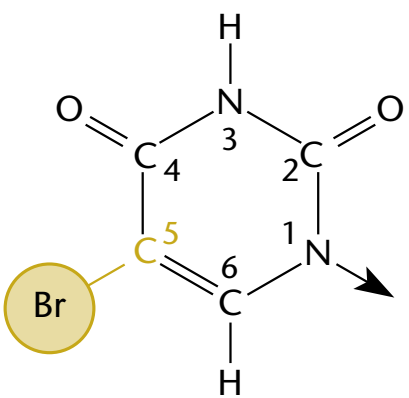
A



2-AP



T



5-BU

Figure 11.10

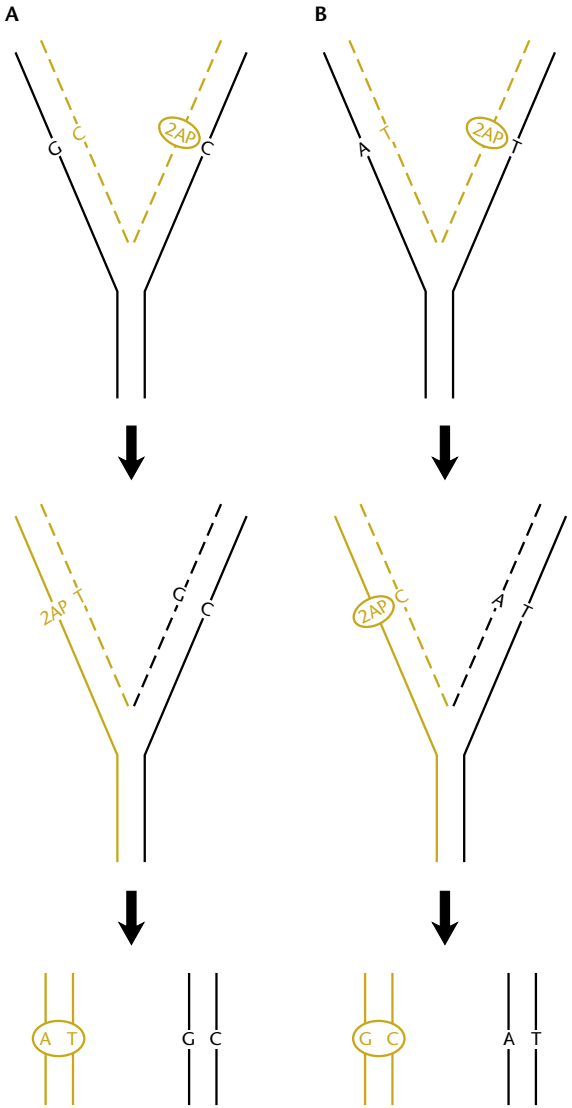


Figure 11.11

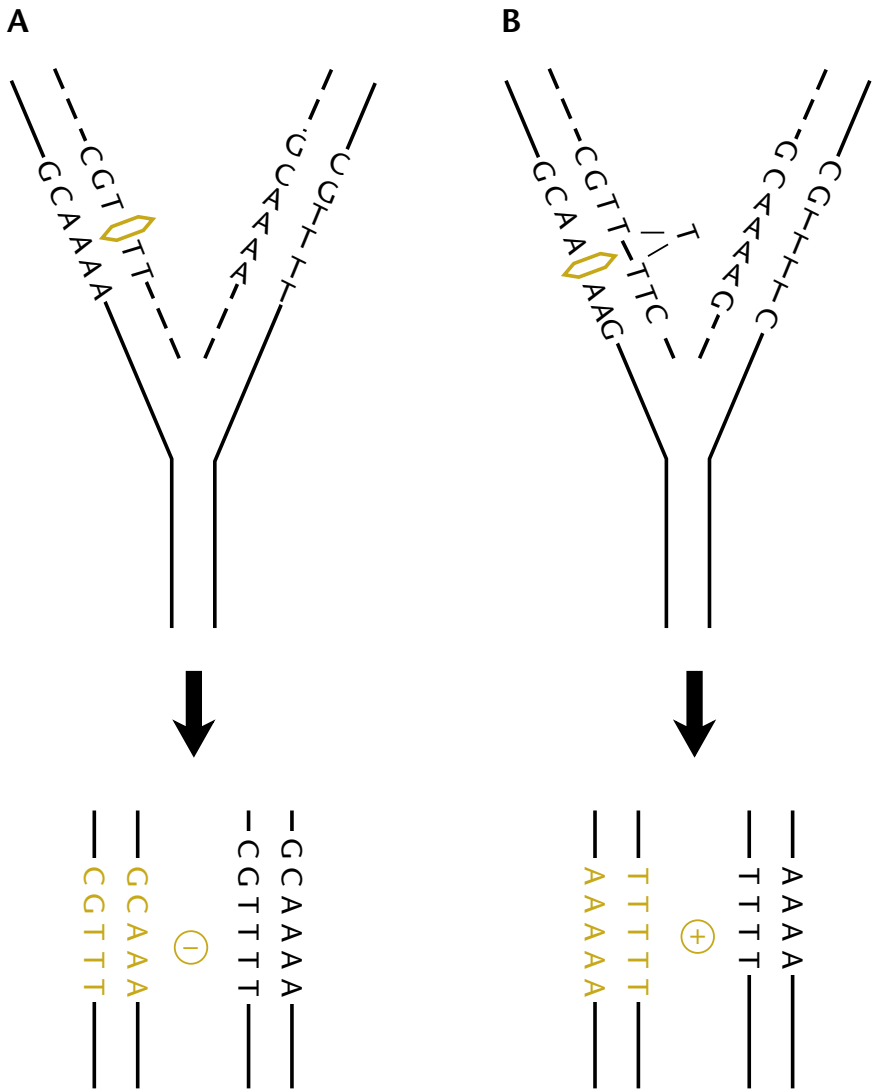


Figure 11.12

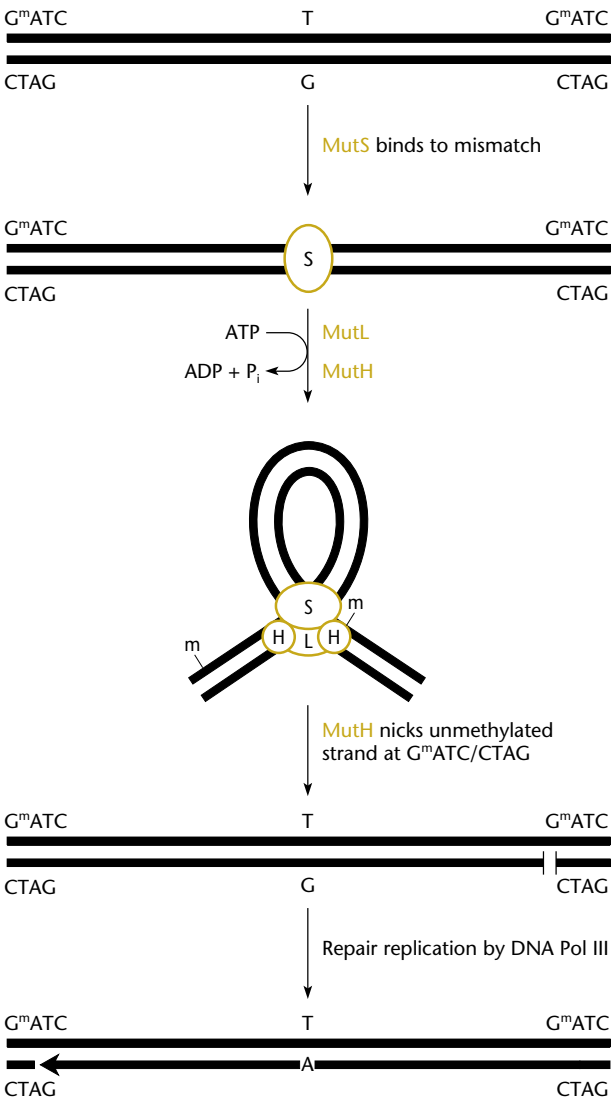

G^mATC
T
G^mATC
CTAG
G
CTAG
MutS binds to mismatch
G^mATC
S
G^mATC
CTAG
CTAG
ATP
ADP + P_i
MutL
MutH
S
m
H
L
H
m
MutH nicks unmethylated strand at G^mATC/CTAG
G^mATC
T
G^mATC
CTAG
G
CTAG
Repair replication by DNA Pol III
G^mATC
T
G^mATC
A
CTAG
CTAG

TABLE 11.1 Genes involved in the UvrABC endonuclease repair pathway

Gene	Function of gene product
uvrA	DNA-binding protein
uvrB	Loaded by UvrA to form a DNA complex; nicks DNA 3′ of lesion
uvrC	Binds to UvrB-DNA complex; nicks DNA 5′ of lesion
uvrD	Helicase II; helps remove damage-containing oligonucleotide
polA	Pol I; fills in single-strand gap
lig	Ligase; seals single-strand nick

Figure 11.13

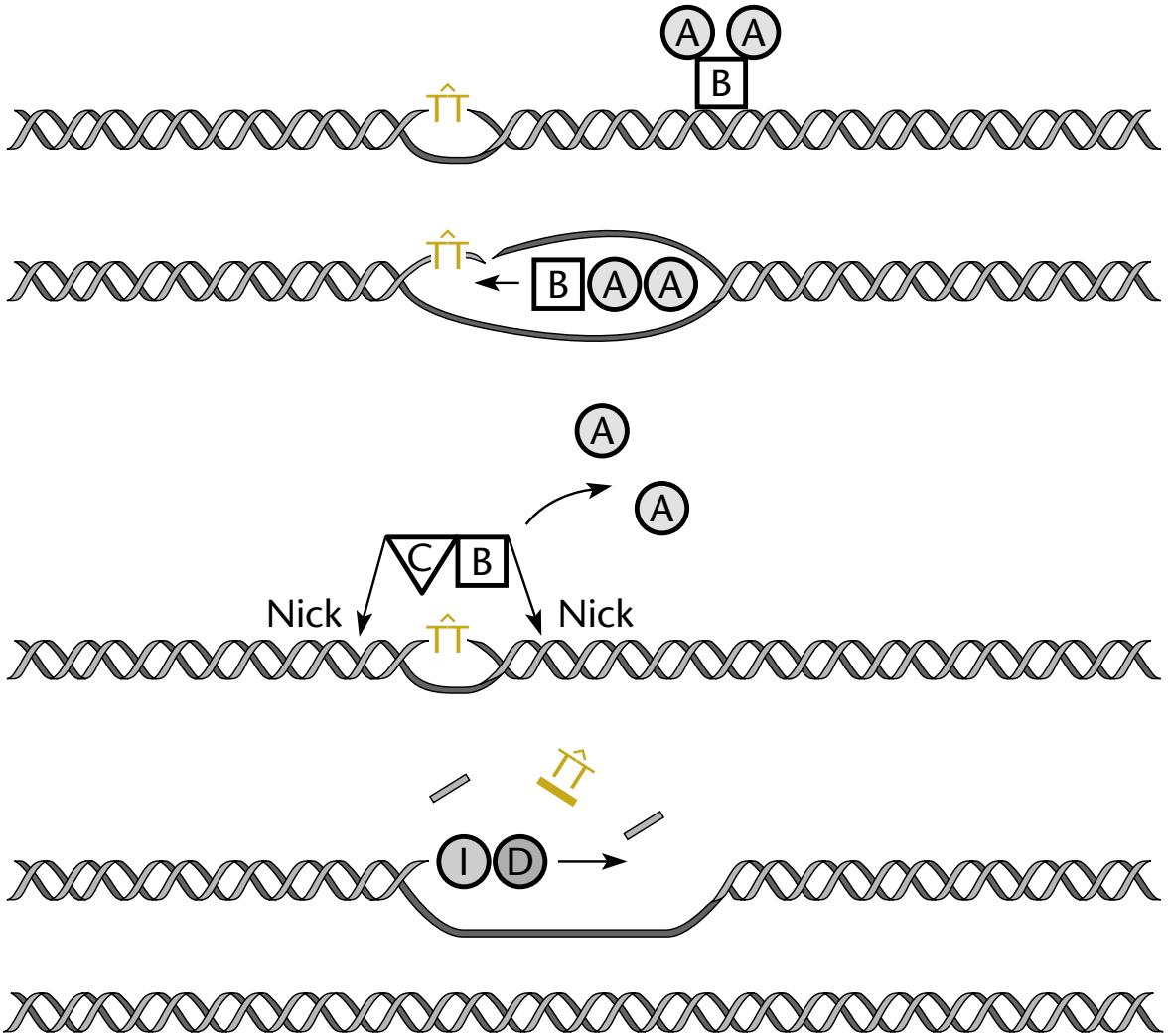


Figure 11.14

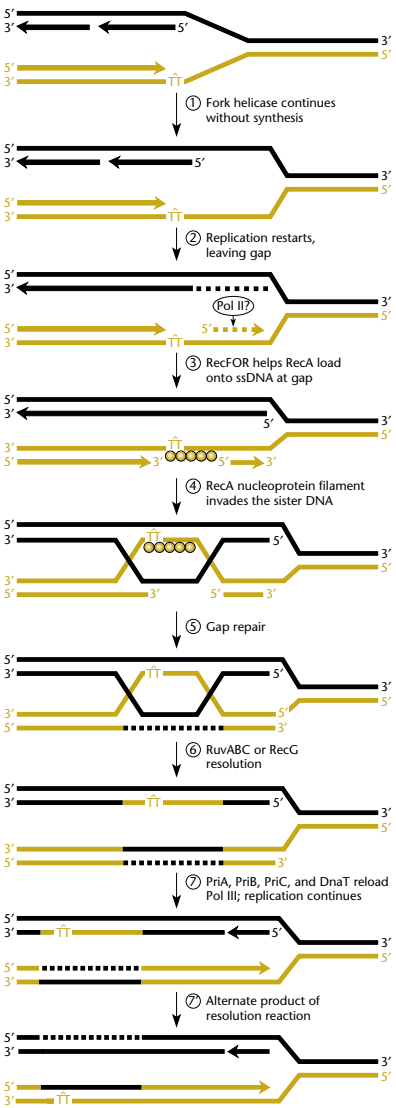

① Fork helicase continues without synthesis
② Replication restarts, leaving gap
Pol II?
③ RecFOR helps RecA load onto ssDNA at gap
④ RecA nucleoprotein filament invades the sister DNA
⑤ Gap repair
⑥ RuvABC or RecG resolution
⑦ PriA, PriB, PriC, and DnaT reload Pol III; replication continues
⑦ Alternate product of resolution reaction

Figure 11.15

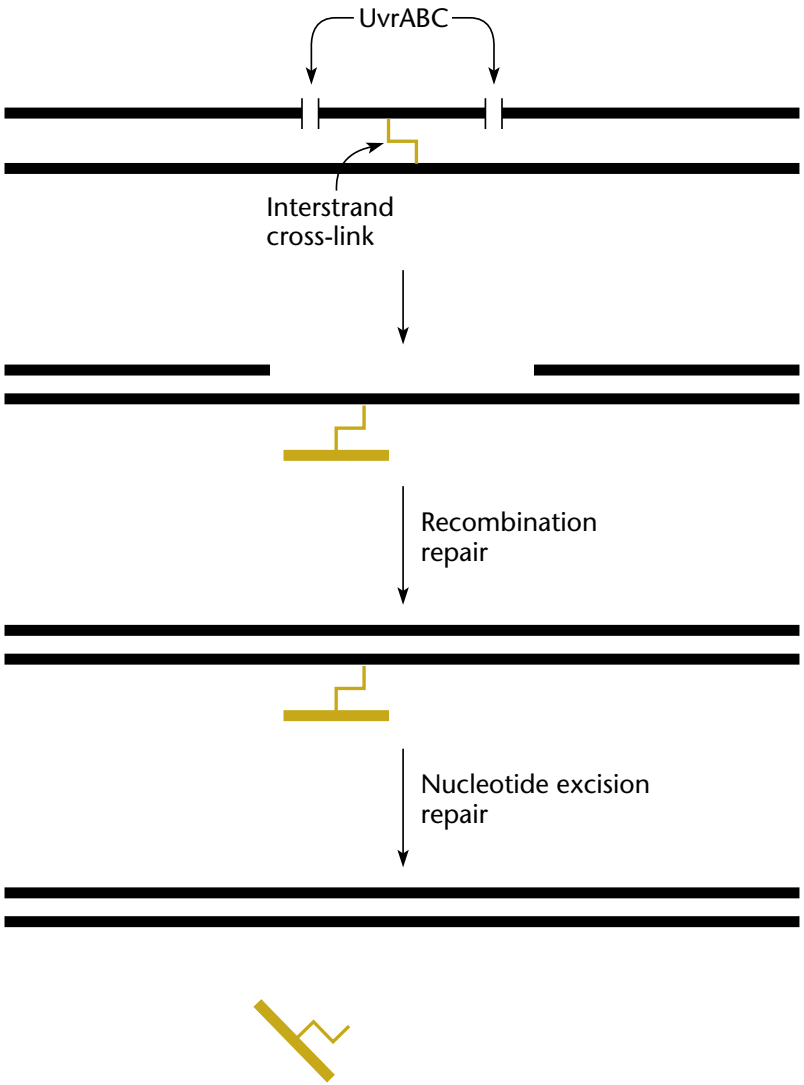

UvrABC
Interstrand
cross-link
Recombination
repair
Nucleotide excision
repair

Figure 11.16

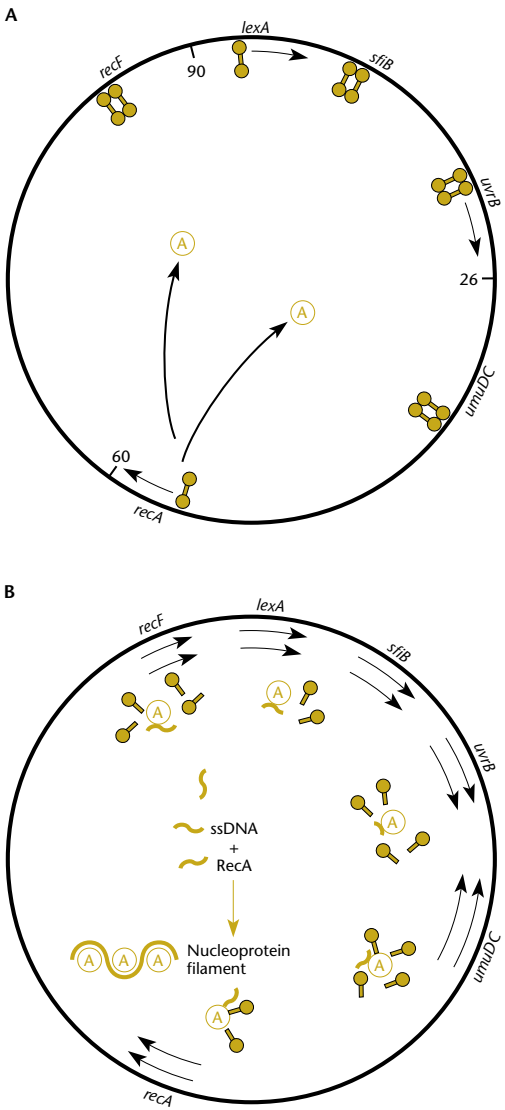

A
lexA
recF
90
sfiB
uvrB
26
umuDC
60
recA
B
recF
lexA
sfiB
uvrB
ssDNA
+
RecA
Nucleoprotein
filament
umuDC
recA

Figure 11.17

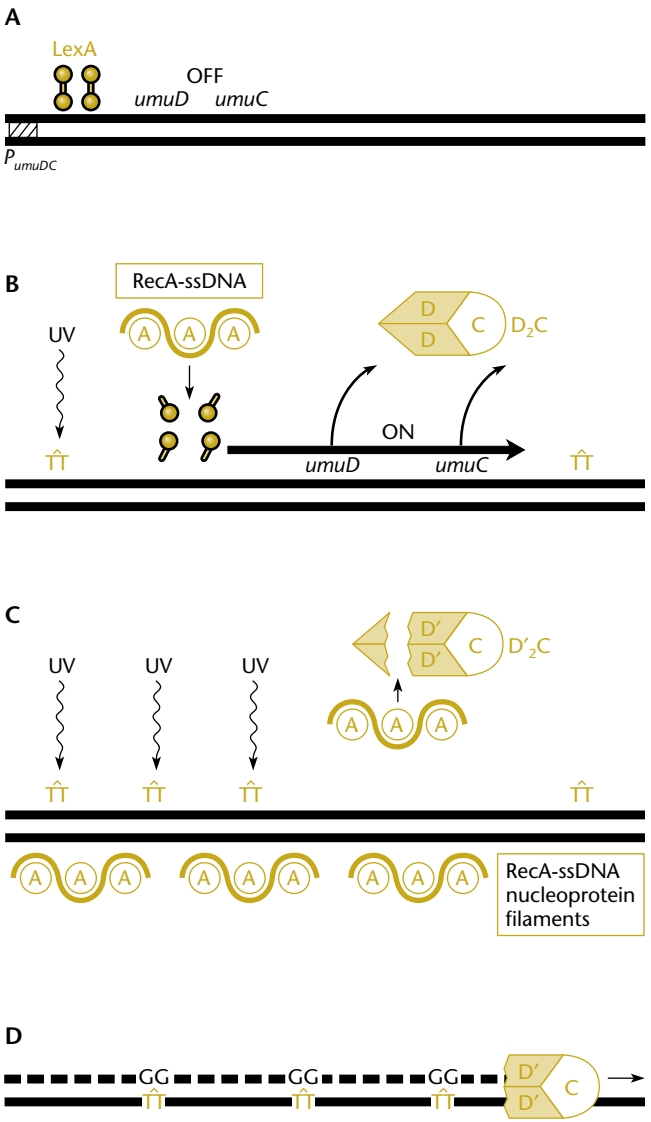

A
LexA
OFF
umuD umuC
P umuDC
B
RecA-ssDNA
UV
A A A
D D C D2C
ON
umuD umuC
C
UV UV UV
D′ D′ C D′2C
A A A
RecA-ssDNA nucleoprotein filaments
D
GG GG GG
D′ D′ C

Figure 11.18

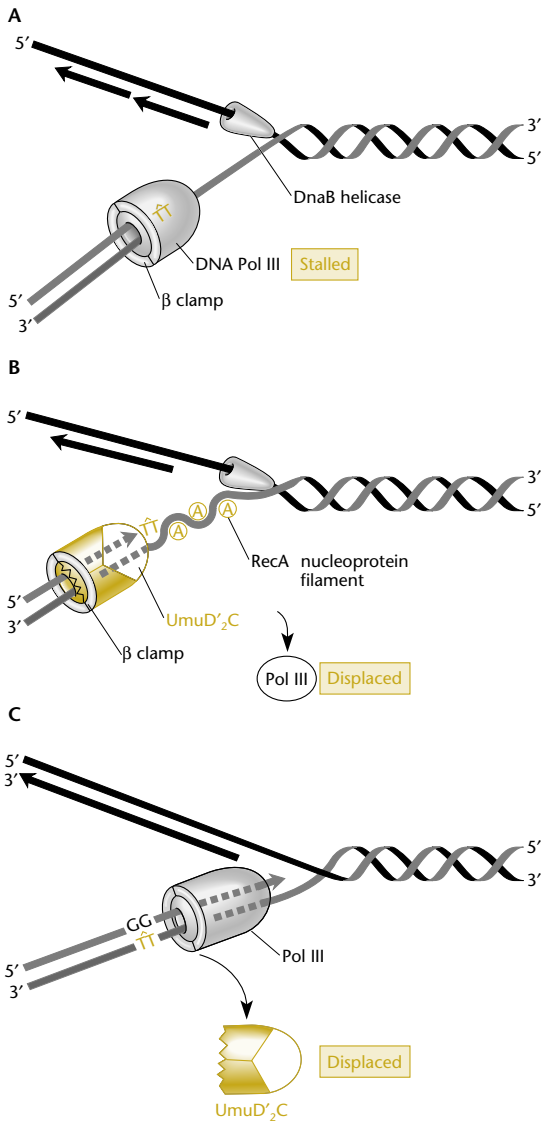

A
5′
3′
5′
DnaB helicase
DNA Pol III
Stalled
β clamp
5′
3′
B
5′
3′
5′
RecA nucleoprotein filament
UmuD′2C
5′
3′
β clamp
Pol III
Displaced
C
5′
3′
5′
3′
GG
Pol III
5′
3′
Displaced
UmuD′2C

Table 11.2

TABLE 11.2 Genetic pathways for damage repair

Repair mechanism	Genetic loci	Function
Methyl-directed mismatch repair	*dam*	DNA adenine methylase
	mutS	Mismatch recognition
	mutH	Endonuclease that cuts at hemimethylated sites
	mutL	Interacts with MutS and MutH
	uvrD (*mutU*)	Helicase
Very short patch repair	*dcm*	DNA cytosine methylase
	vsr	Endonuclease that cuts at 5′ side of T in TG mismatch
"GO" (guanine oxidizations)	*mutM*	Glycosylase that acts on GO
	mutY	Glycosylase that removes A from A:GO mismatch
	mutT	8-OxodGTP phosphatase
Alkyl	*ada*	Alkyltransferase and transcriptional activator
	alkA	Glycosylase for alkylpurines
Nucleotide excision	*uvrA*	Component of UvrABC
	uvrB	Component of UvrABC
	uvrC	Component of UvrABC
	uvrD	Helicase
Base excision	*xthA*	AP endonuclease
	nfo	AP endonuclease
Photoreactivation	*phr*	Photolyase
Recombination repair	*recA*	Strand exchange
	recBCD	Helicase and nuclease at double-strand breaks
	recFOR	Recombination function
	ssb	Single-stranded DNA-binding protein
SOS system	*recA*	Coprotease
	lexA	Repressor
	umuDC	Translesion synthesis (Pol V)
	dinB	Mutagenic polymerase (Pol IV)

TABLE 11.3 Bacteriophage T4 repair enzymes

Repair enzyme	Host analog
DenV	UV endonuclease of *M. luteus*
UvsX	RecA
UvsY	RecOR
UvsW	RecG
gp46/47 exonuclease	RecBCD recombination repair
gp49 resolvase	RuvABC recombination repair
gp59	PriA

Figure 11.19

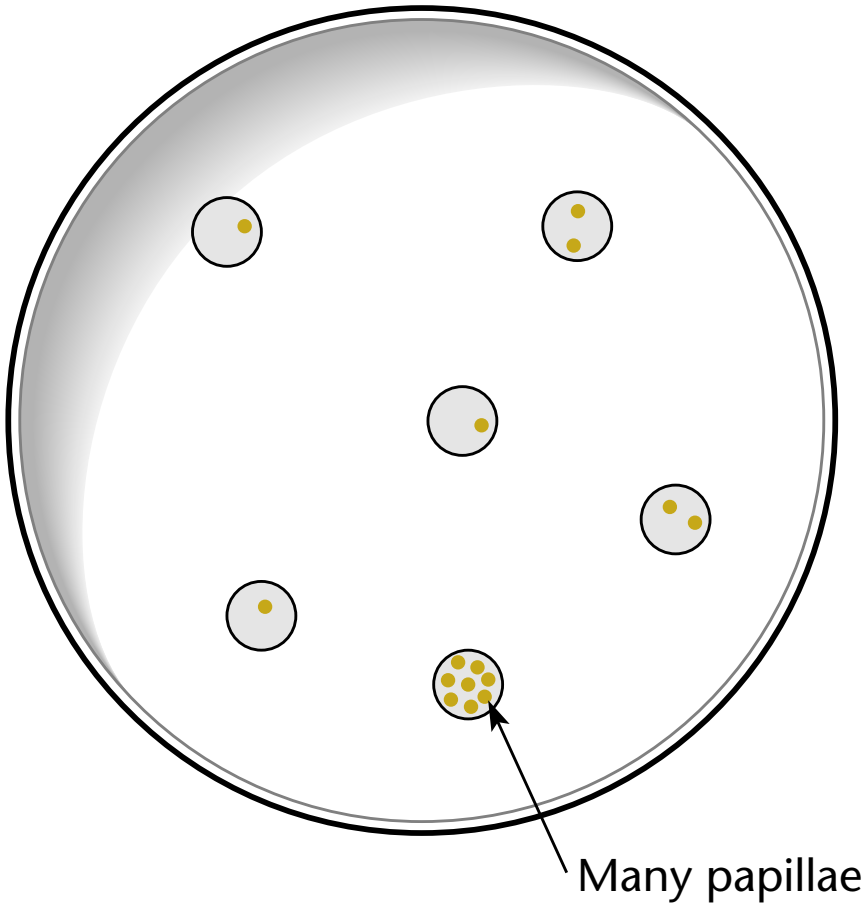


Figure 11.20

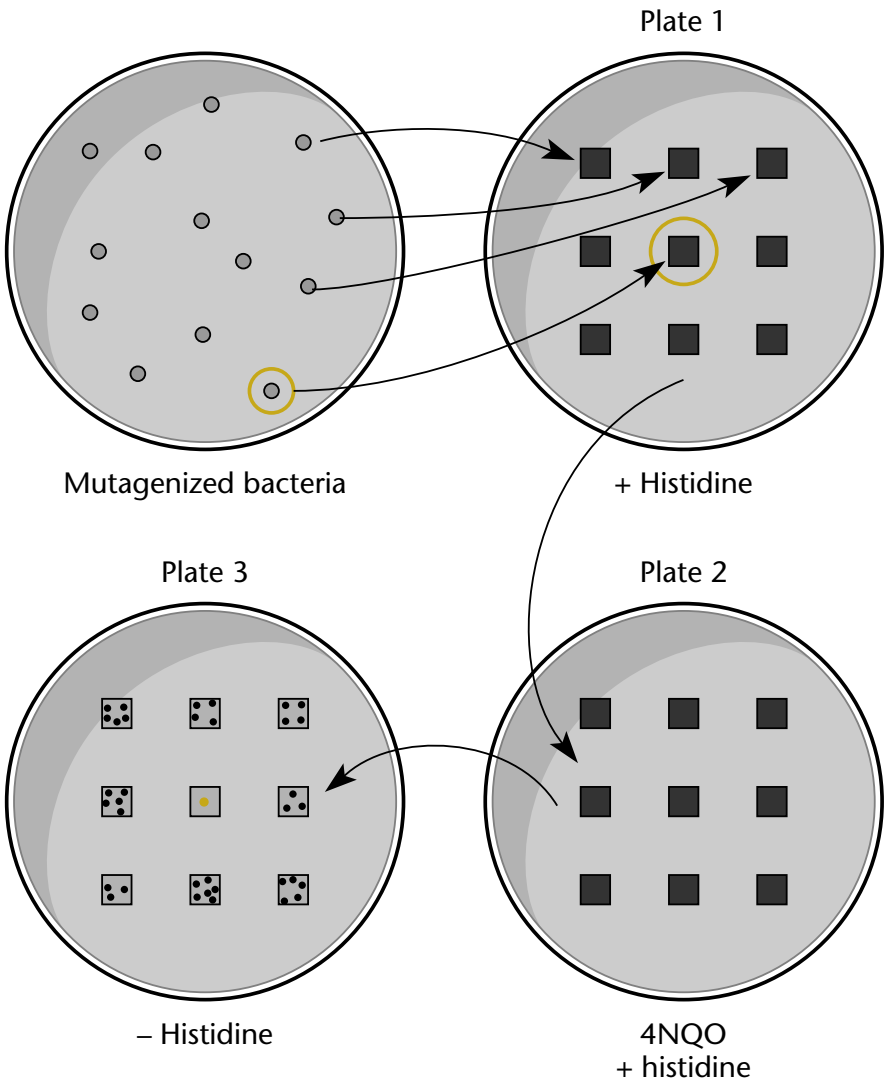


Plate 1
Mutagenized bacteria
+ Histidine
Plate 3
Plate 2
– Histidine
4NQO
+ histidine