# Mating in budding yeast

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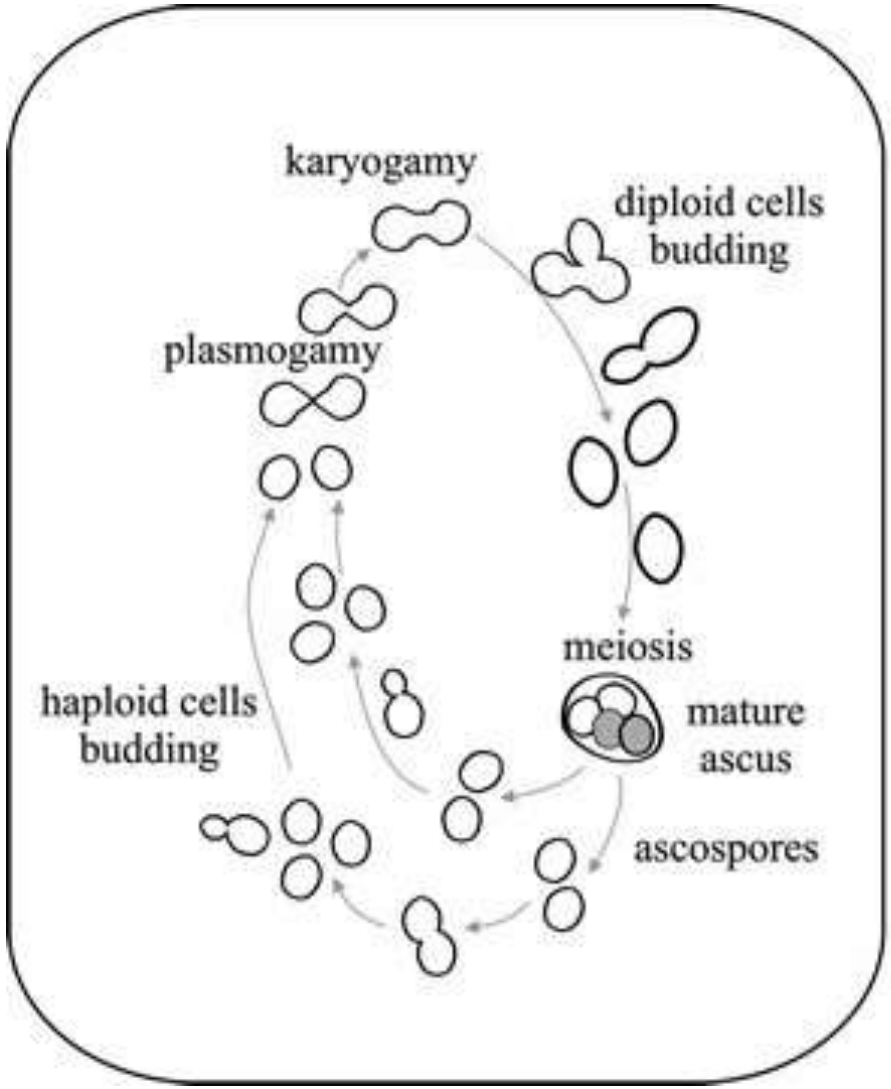

karyogamy
diploid cells budding
plasmogamy
meiosis
haploid cells budding
mature ascus
ascospores

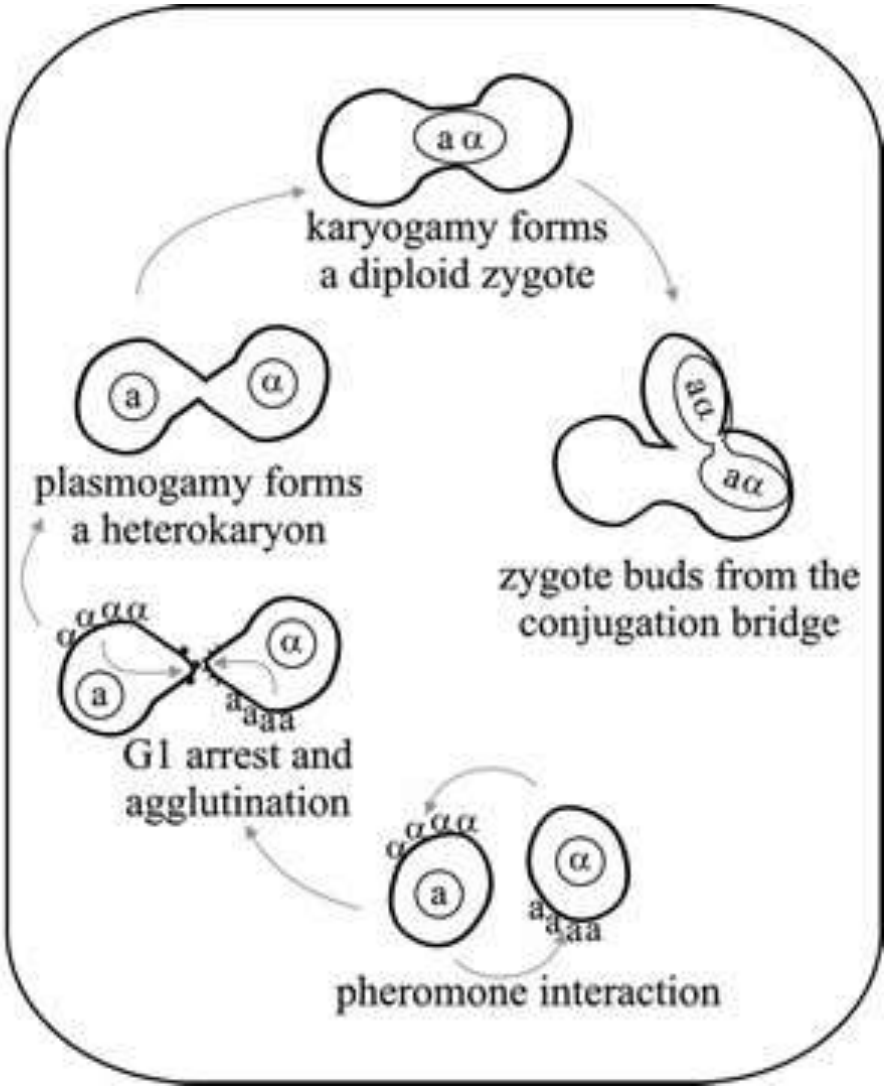

a α
karyogamy forms a diploid zygote
a
α
plasmogamy forms a heterokaryon
aα
aα
zygote buds from the conjugation bridge
G1 arrest and agglutination
pheromone interaction

**Figure 17.1** Mating type controls several activities.

| | *MATa* | *MATα* | *MATa/MATα* |
|---|---|---|---|
| Cell type | **a** | α | **a**/α |
| Mating | yes | yes | no |
| Sporulation | no | no | yes |
| Pheromone | **a** factor | α factor | none |
| Receptor | binds α factor | binds **a** factor | none |

α-factor

$NH_2$-Trp-His-Trp-Leu-Gln-Leu-Lys-Pro-Gly-Gln-Pro-Met-Tyr-COOH

a-factor

$NH_2$-Tyr-Ile-Ile-Lys-Gly-Val-Phe-Trp-Asp-Pro-Ala-Cys-$COOCH_3$

**Fernesylation**
**Carboxylation**

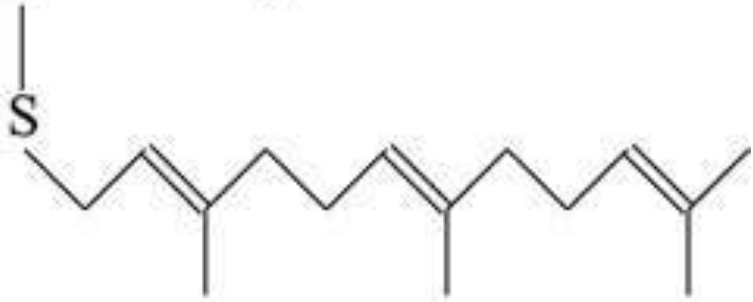
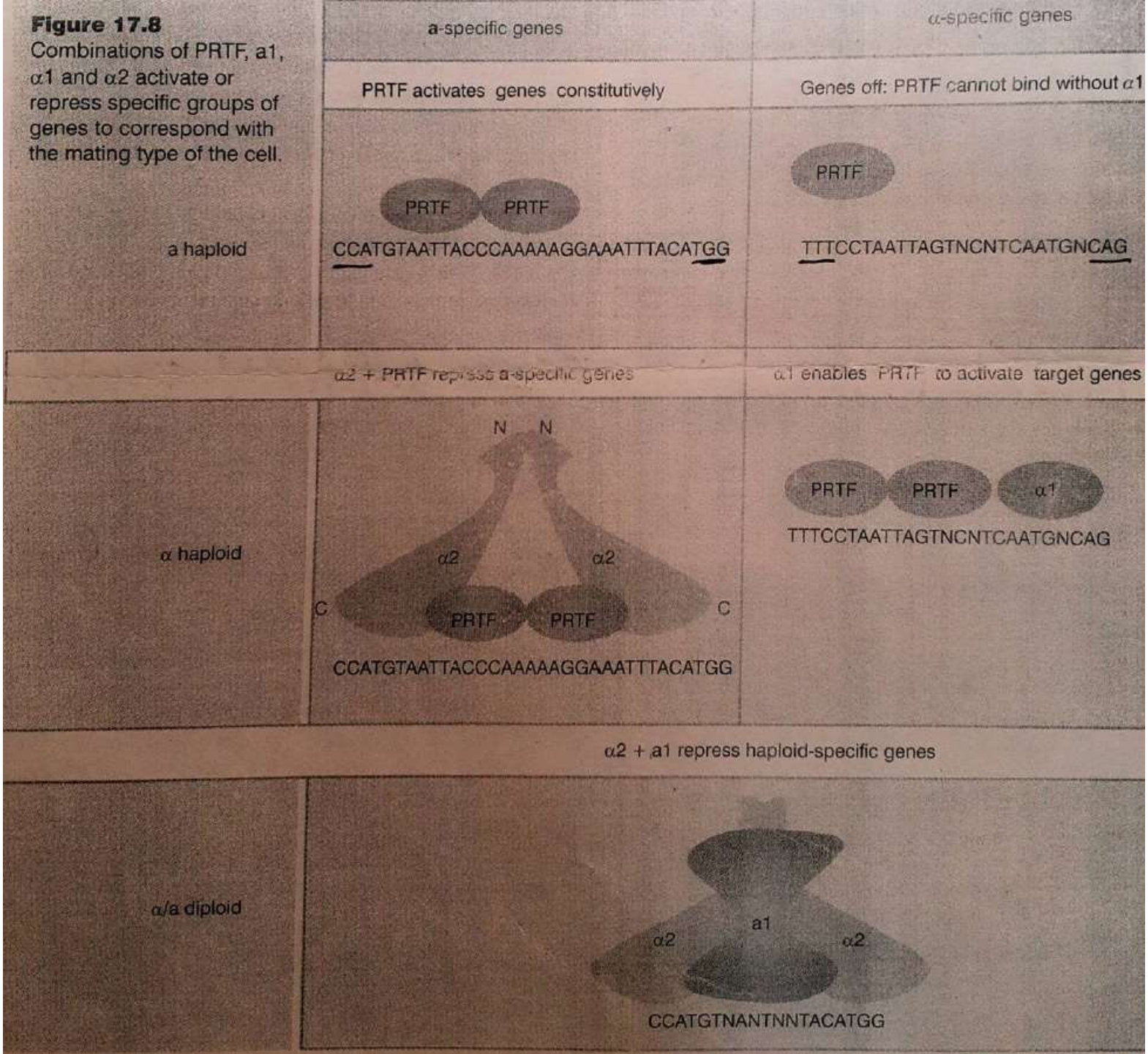


**Figure 17.8**
Combinations of PRTF, a1, α1 and α2 activate or repress specific groups of genes to correspond with the mating type of the cell.



coupled to.

The most common mechanism used in such path-

**Figure17.2** *Overview*: the yeast life cycle proceeds through mating of *MAT***a** and *MAT*α haploids to give heterozygous diploids that sporulate to generate haploid spores.

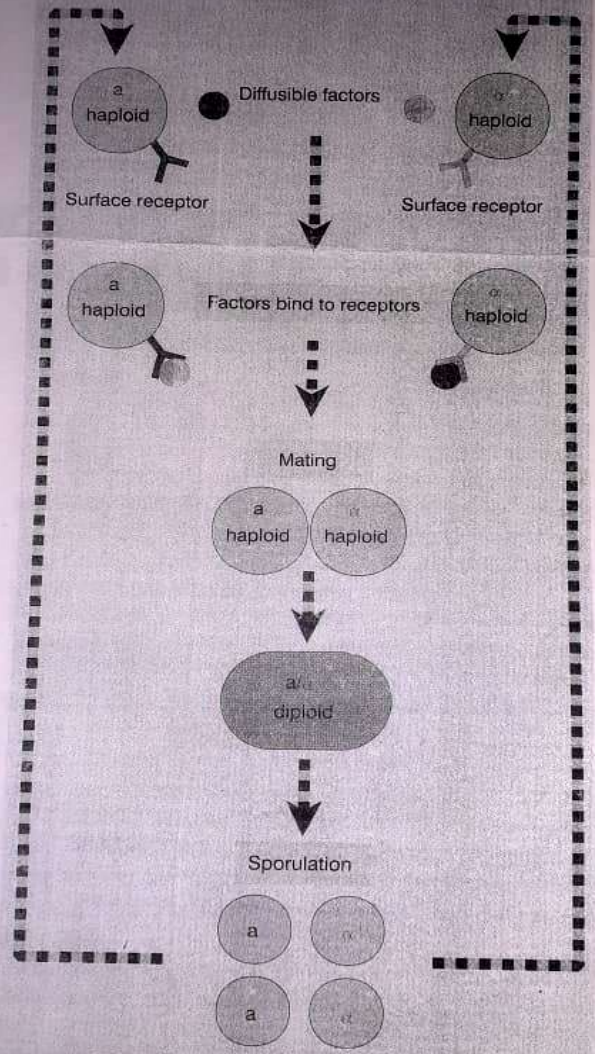
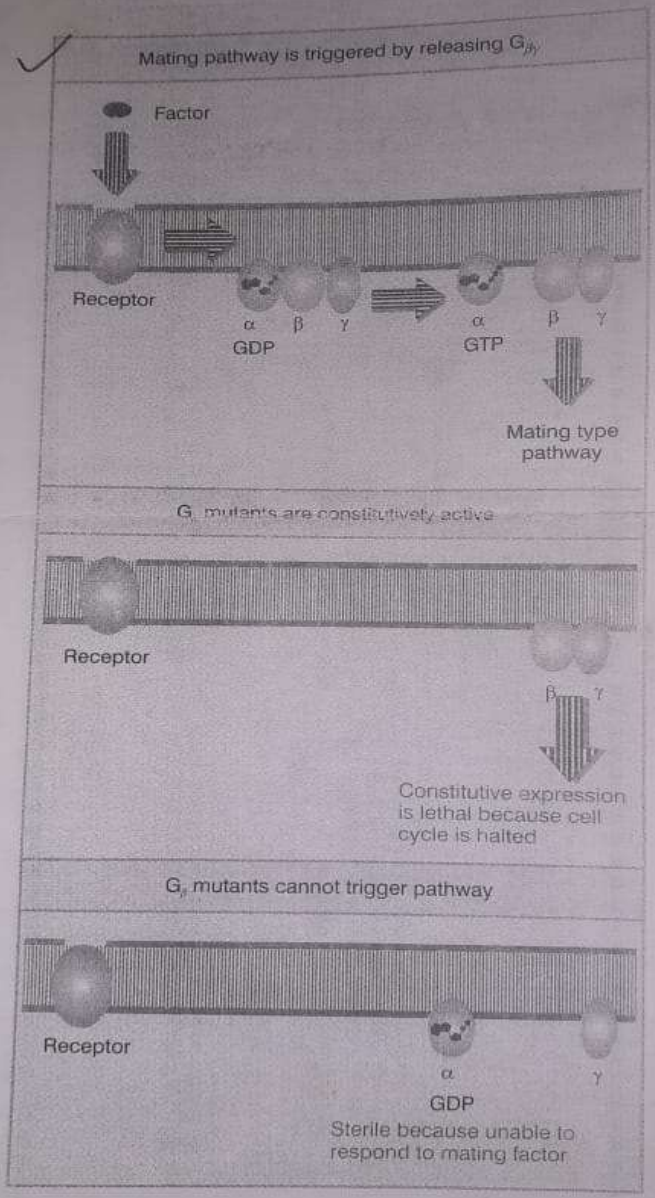
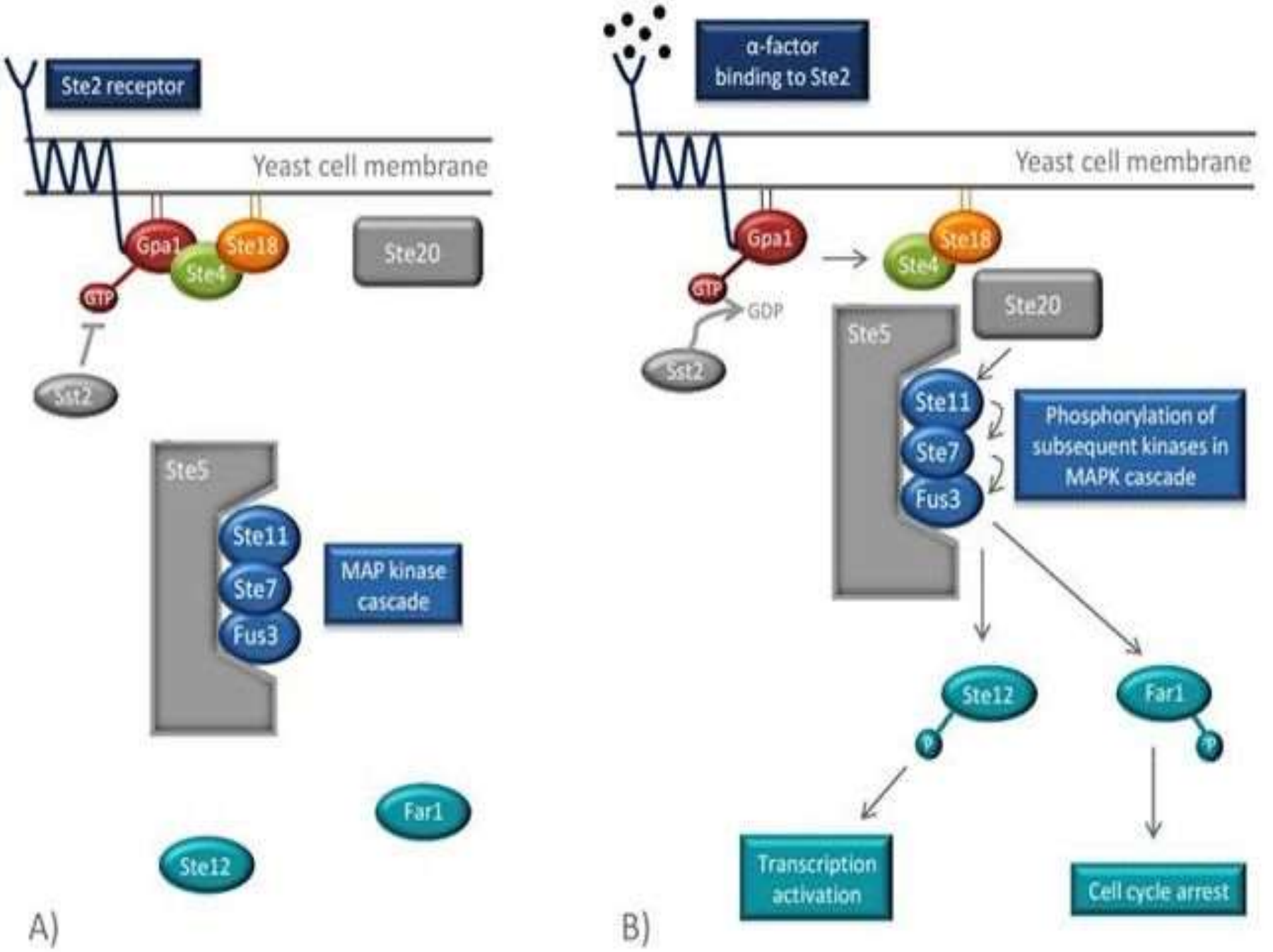
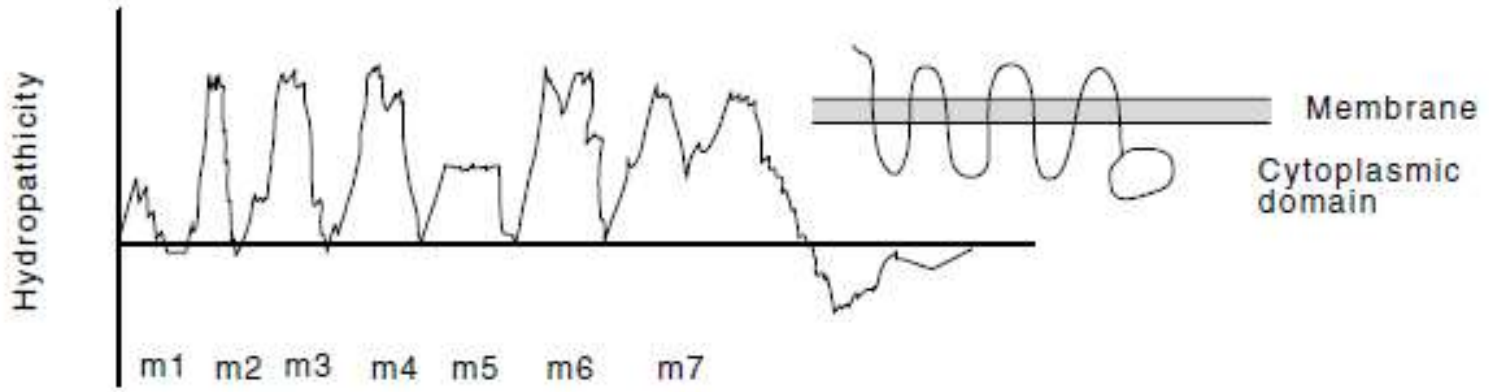



**Figure 17.3** Either **a** or α factor/receptor interaction triggers the activation of a G protein, whose βγ subunits transduce the signal to the next stage in the pathway.




Ste2 receptor
Yeast cell membrane
Gpa1
Ste18
Ste4
GTP
Ste20
Sst2
Ste5
Ste11
Ste7
Fus3
MAP kinase cascade
Far1
Ste12
A)
α-factor binding to Ste2
Yeast cell membrane
Gpa1
Ste18
Ste4
GTP
GDP
Ste20
Sst2
Ste5
Ste11
Ste7
Fus3
Phosphorylation of subsequent kinases in MAPK cascade
Ste12
Far1
P
P
Transcription activation
Cell cycle arrest
B)

# Isolation of sterile mutants



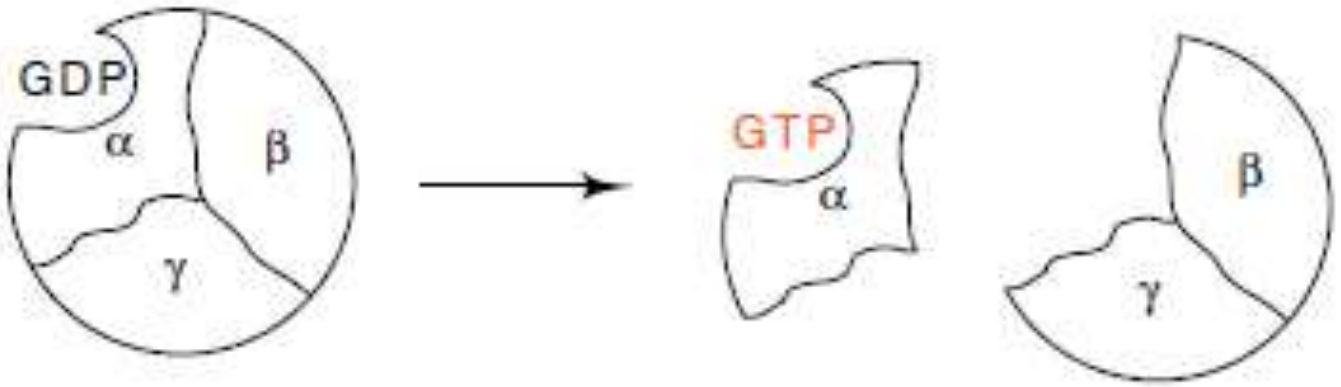
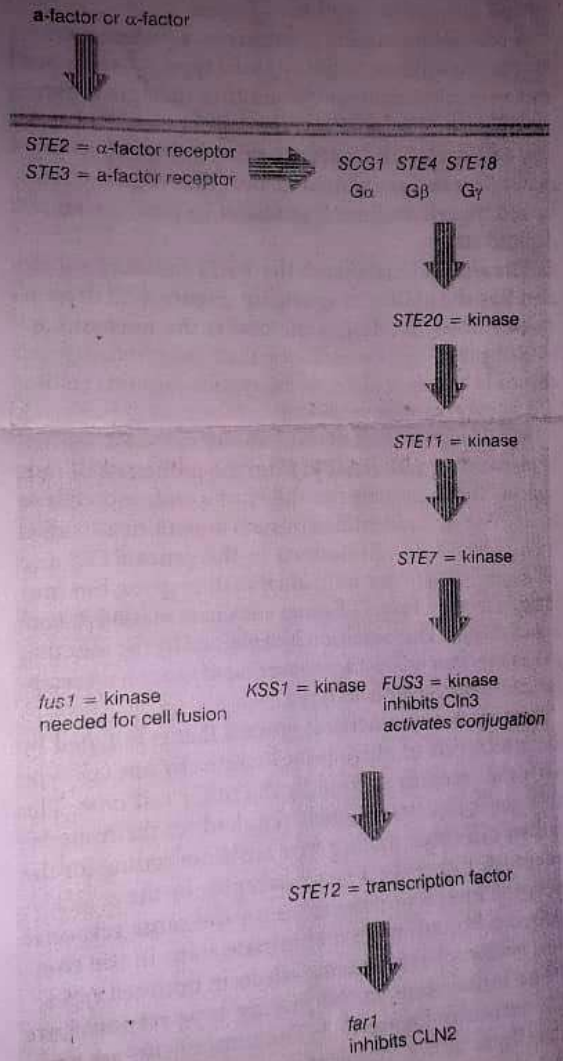
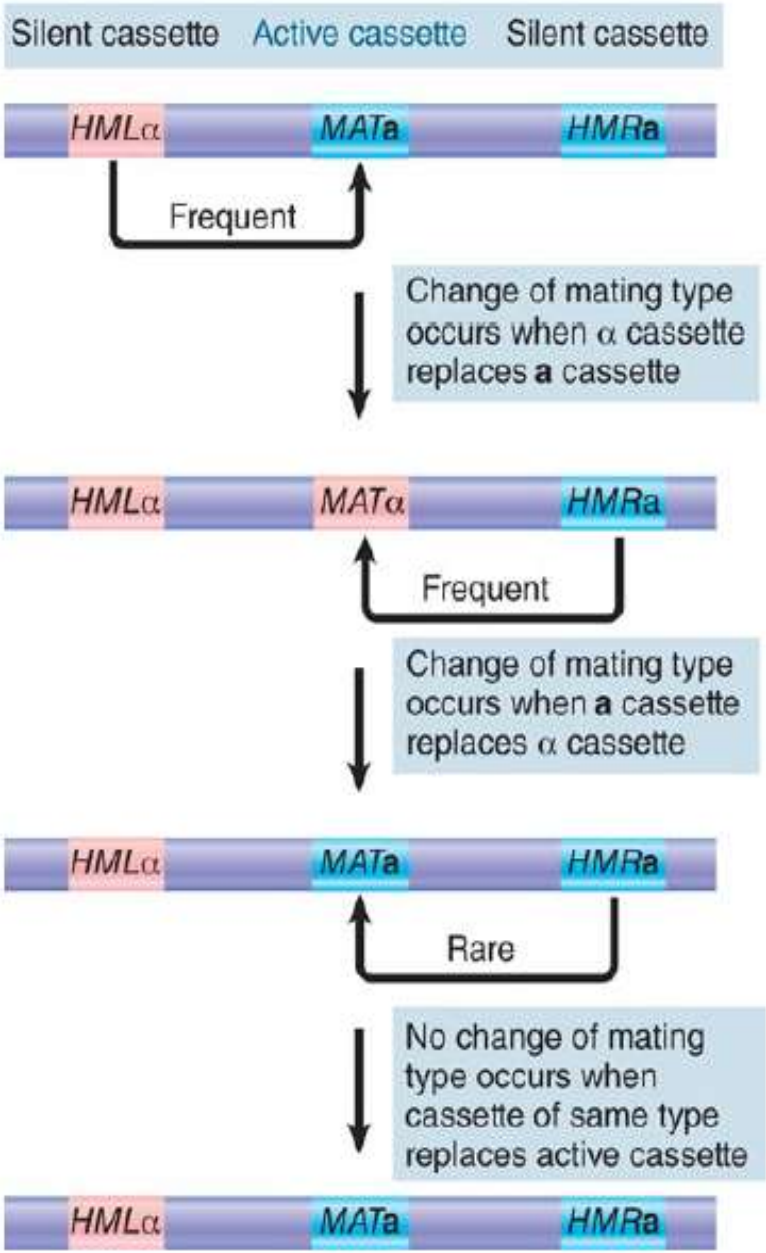
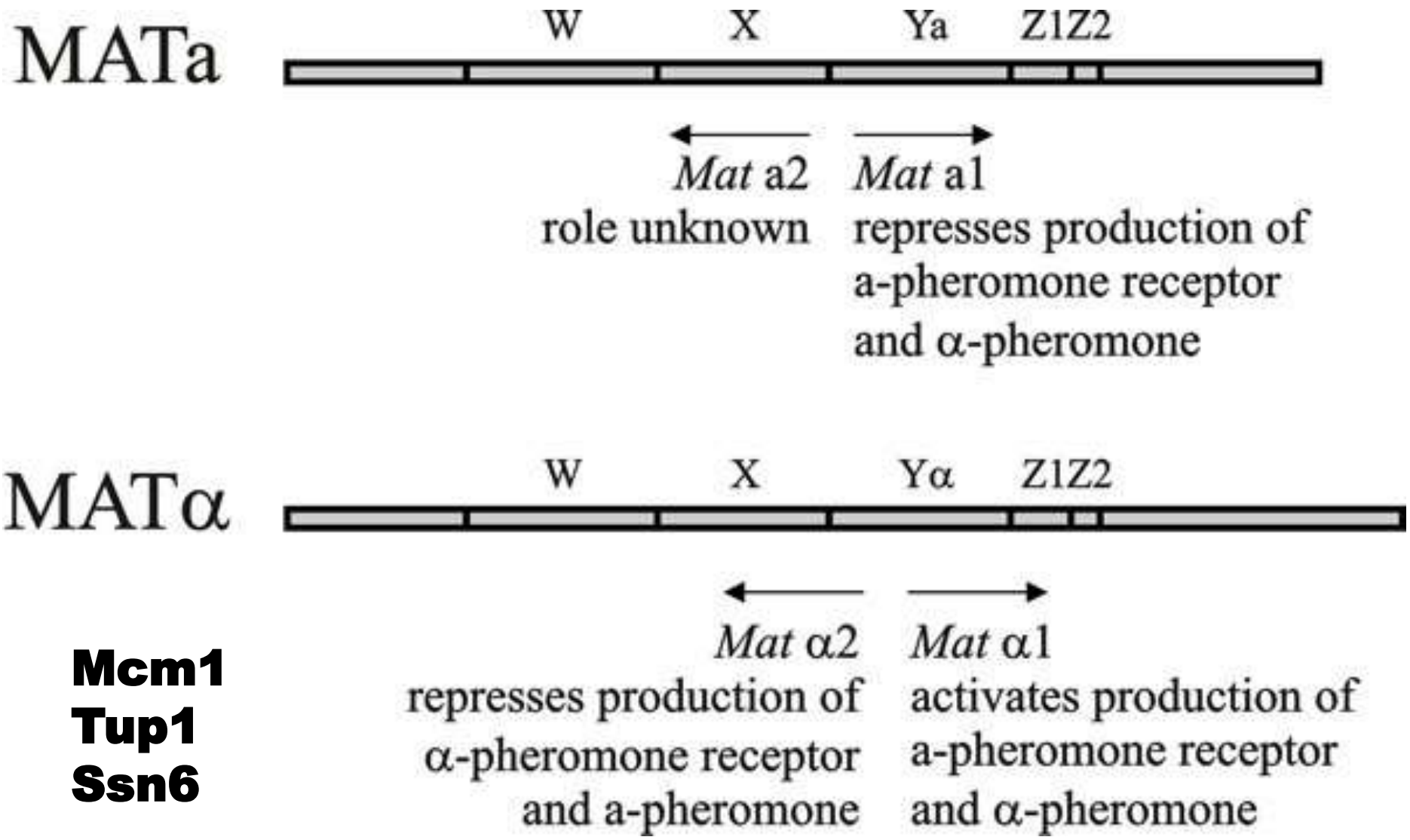



**Figure 17.4** The same mating type response is triggered by interaction of either pheromone with its receptor. The signal is transmitted through a series of kinases to a transcription factor; there may be branches to some of the final functions.

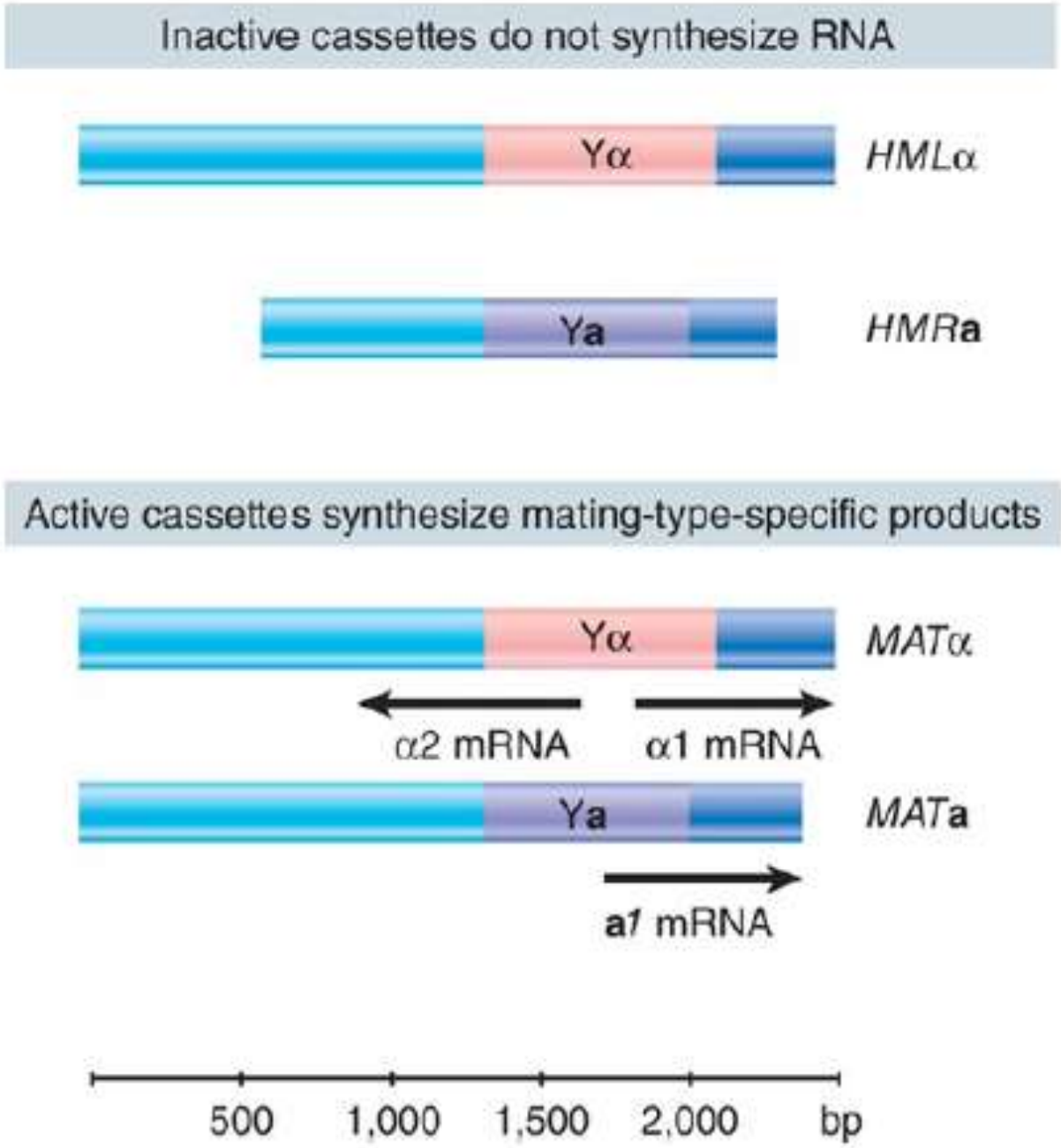




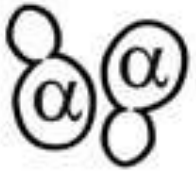

**Mcm1**
**Tup1**
**Ssn6**

**If MAT is entirely deleted, haploid cells mate identically to MATa cells (that is, the MATa phenotype is the default phenotype), because a-specific genes are constitutively expressed in the absence of Matα2 and α-specific genes are not transcribed in the absence of Matα1.**

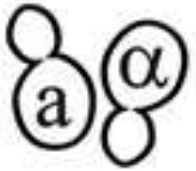

Inactive cassettes do not synthesize RNA
Yα
HMLα
Ya
HMRa
Active cassettes synthesize mating-type-specific products
Yα
MATα
α2 mRNA
α1 mRNA
Ya
MATa
a1 mRNA
500
1,000
1,500
2,000
bp

Original mother cell is mating type α


Budding produces a daughter cell and mother and daughter bud again

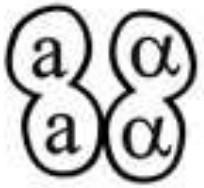



Mother switches to mating type a, but the first daughter cannot switch until it has budded

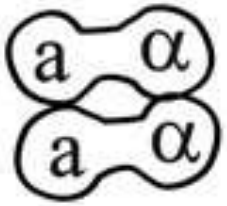


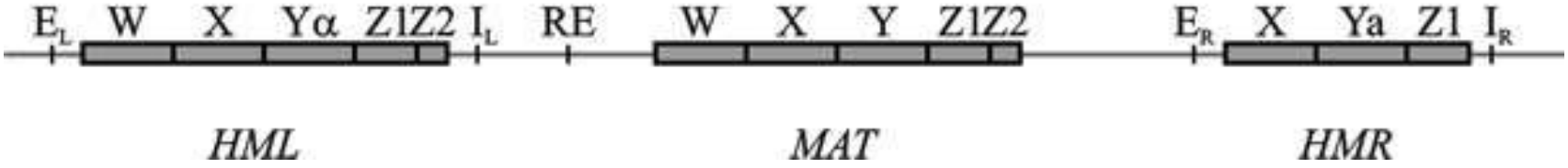

**Ash1**

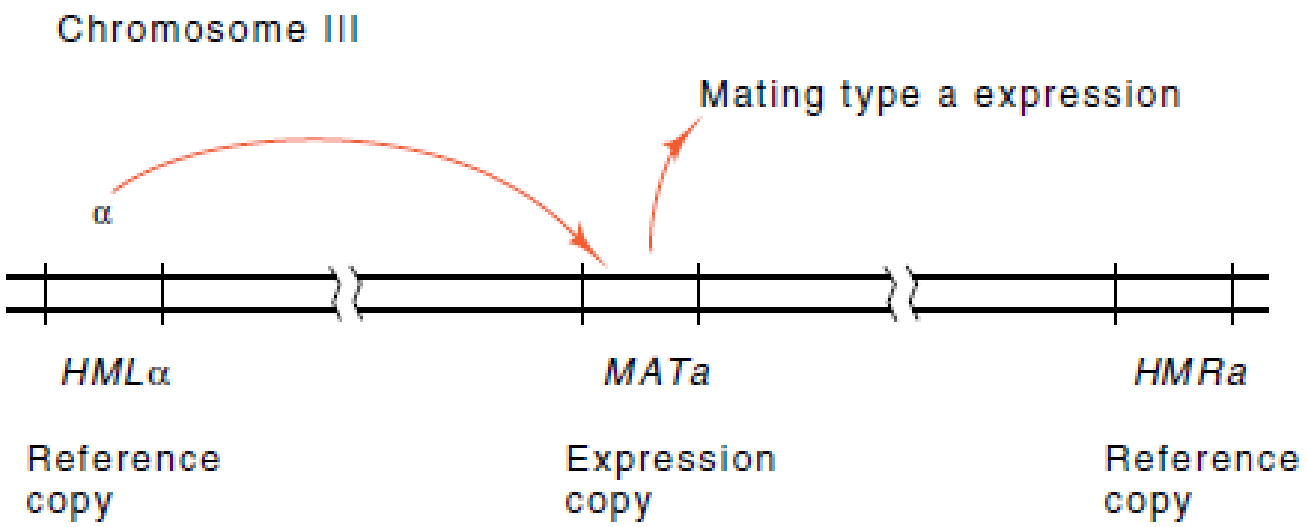
As a result of the switch, mother and second daughter are both mating type a, first daughter and its bud are both mating type α

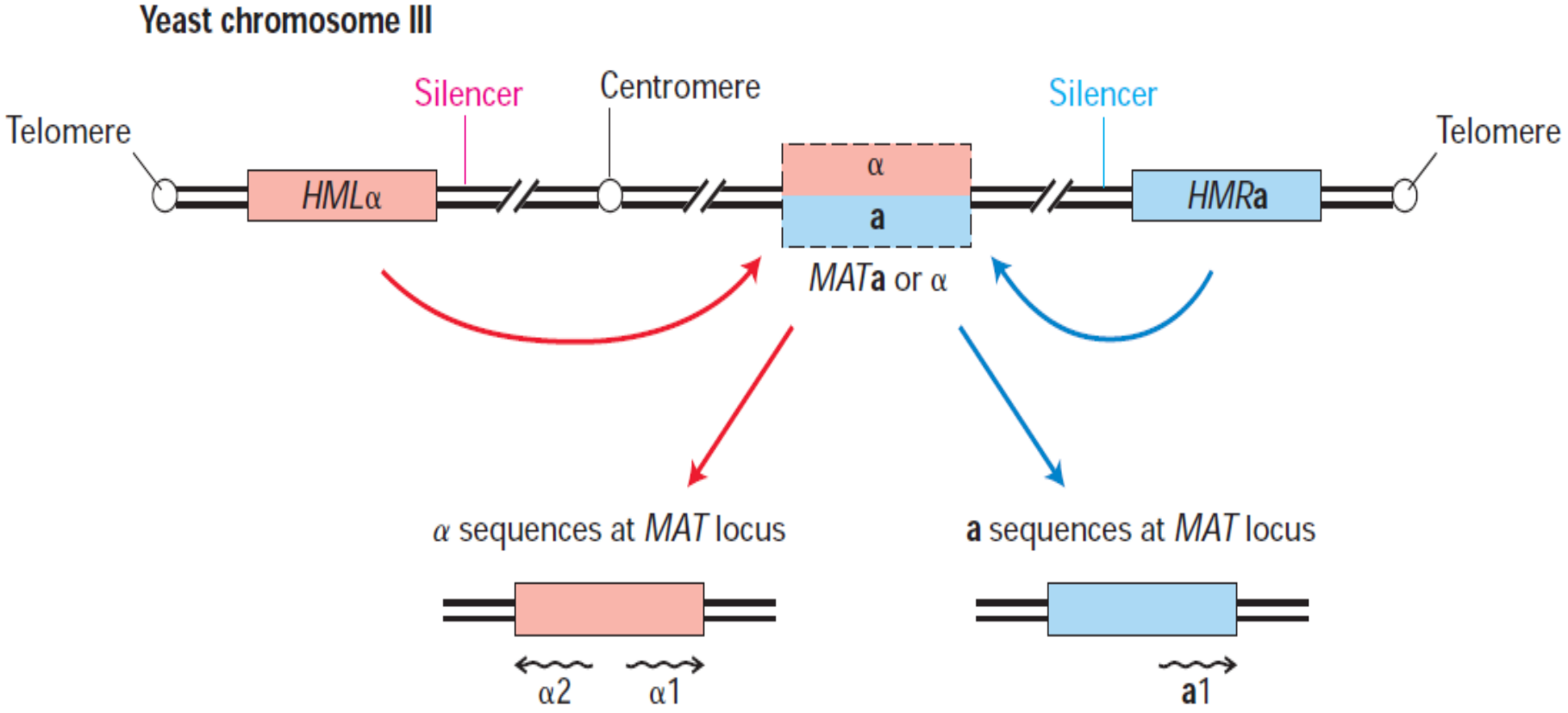


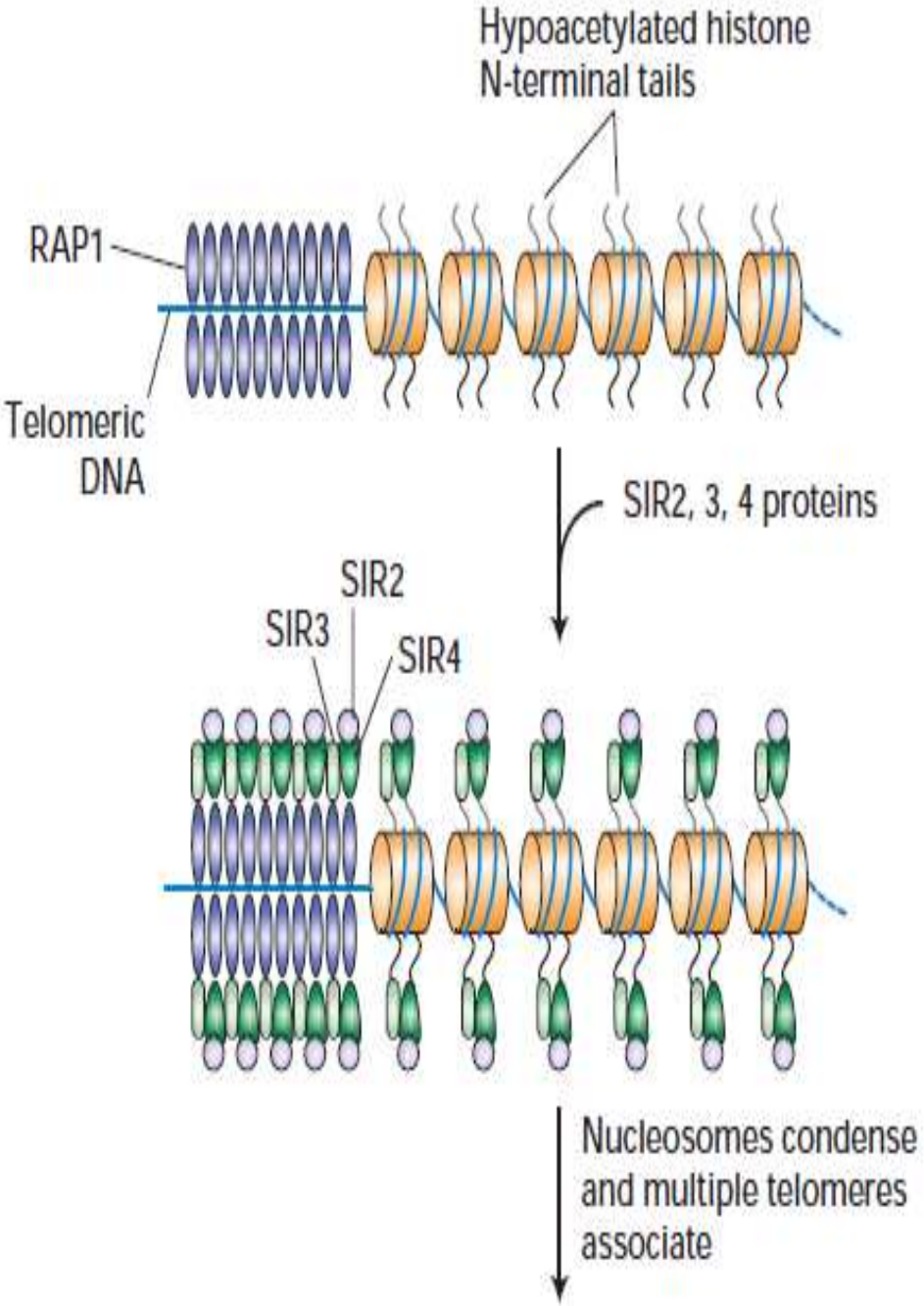

compatible cells mate to form zygotes

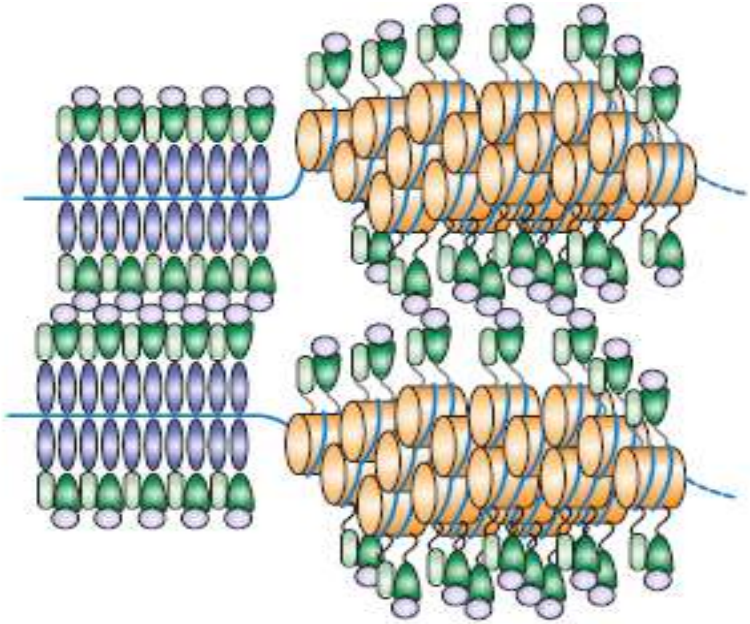


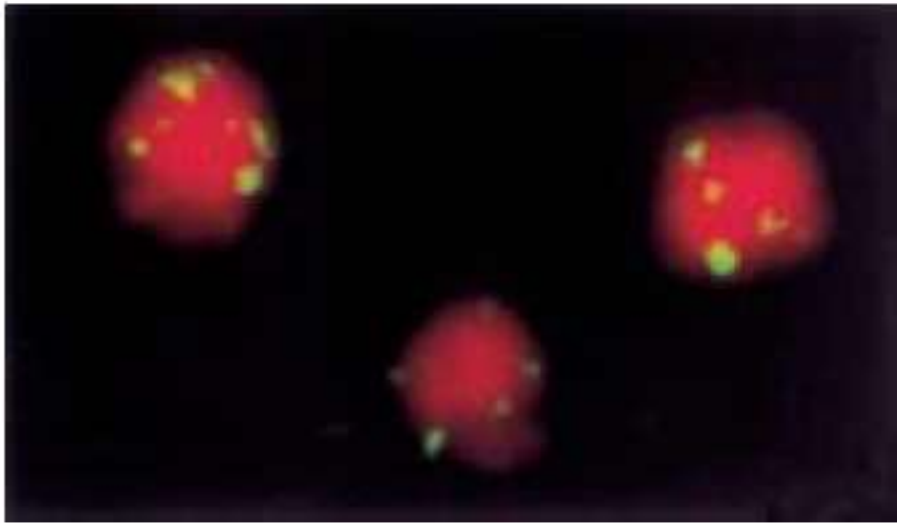

Chromosome III
Mating type a expression
α
HMLα
MATa
HMRa
Reference copy
Expression copy
Reference copy

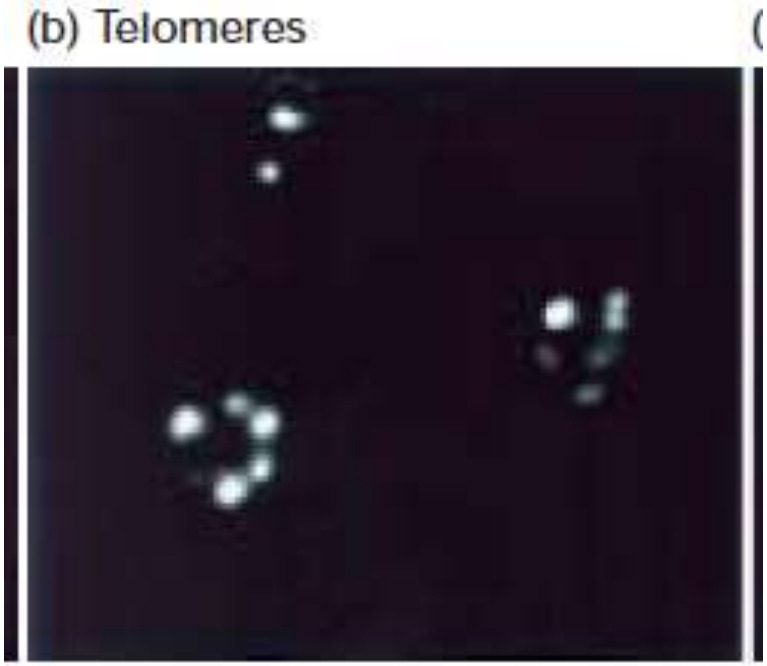

Yeast chromosome III
Telomere
Silencer
Centromere
Silencer
Telomere
HMLα
α
a
HMRa
MATa or α
α sequences at MAT locus
a sequences at MAT locus
α2
α1
a1

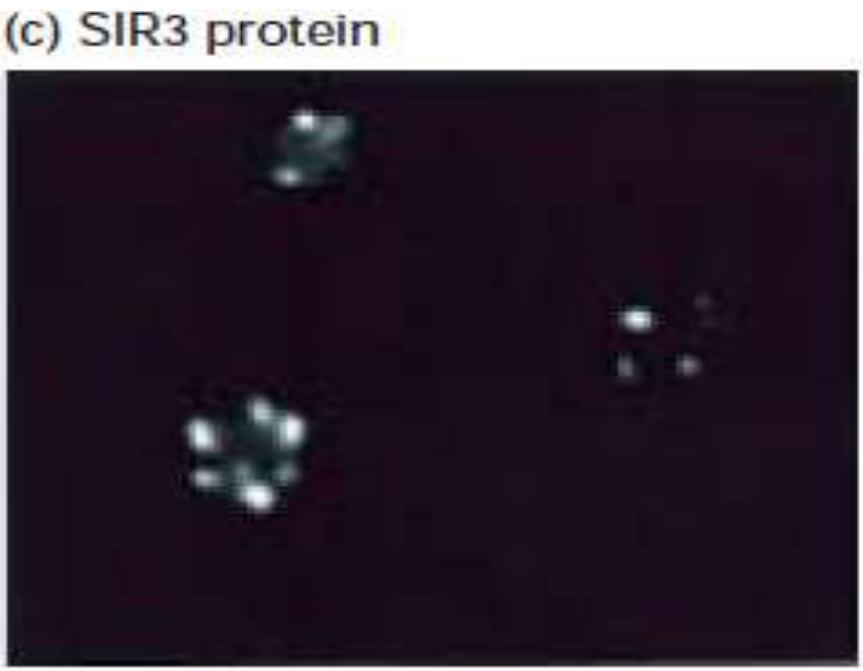


(a) Nuclei and telomeres






**MAT switching depends:**

**1. Unexpressed/ cryptic storage loci in HMRa and HMLα: SIR, RAP1, heterochromatinisation**

**2. Programmed creation of site sp. ds break in MAT locus only**

**3. Previously divided cell can switch mating type (lineage sp. Control)**

**4. Inhibition of DNA repair mechasnisms.**

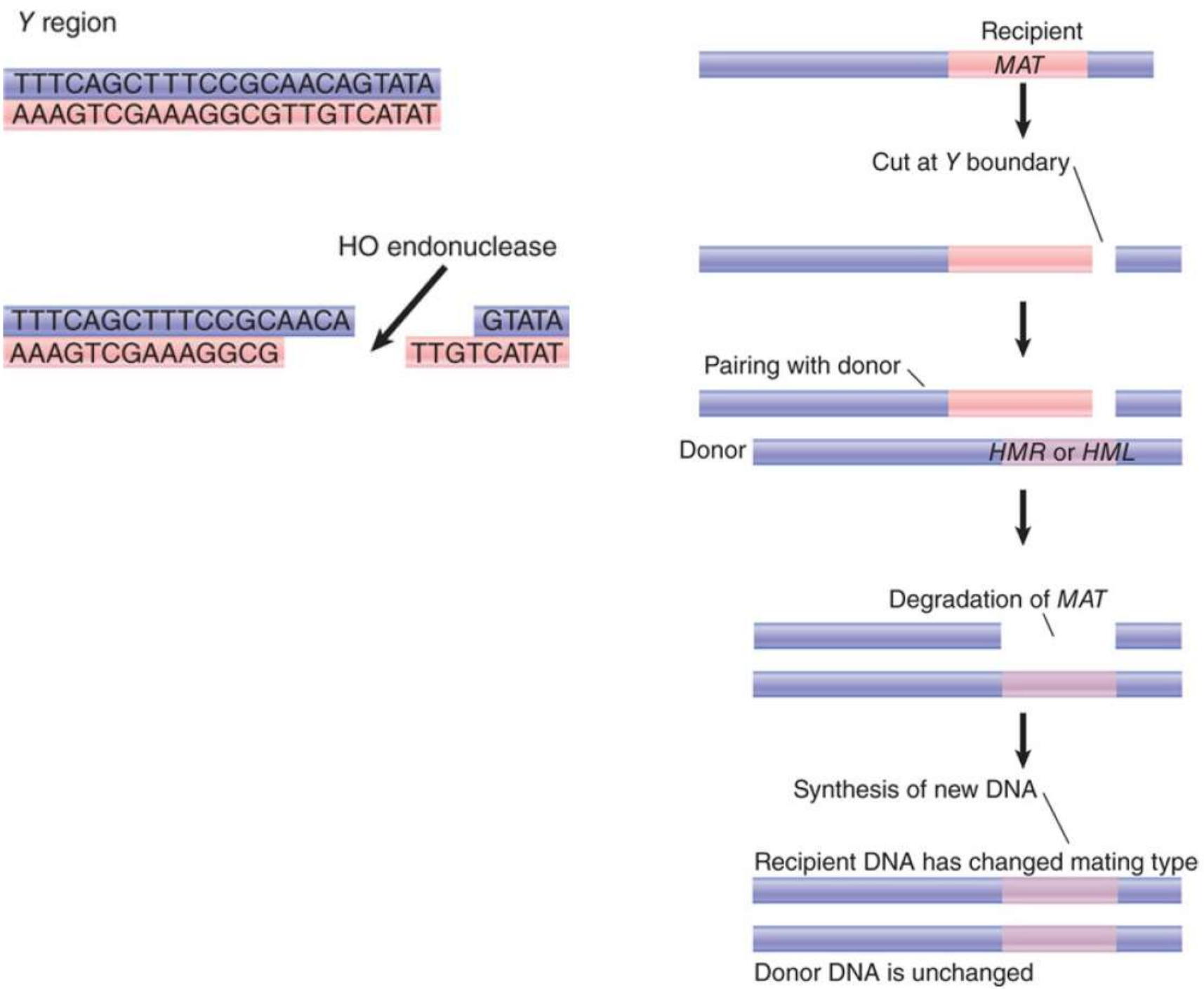
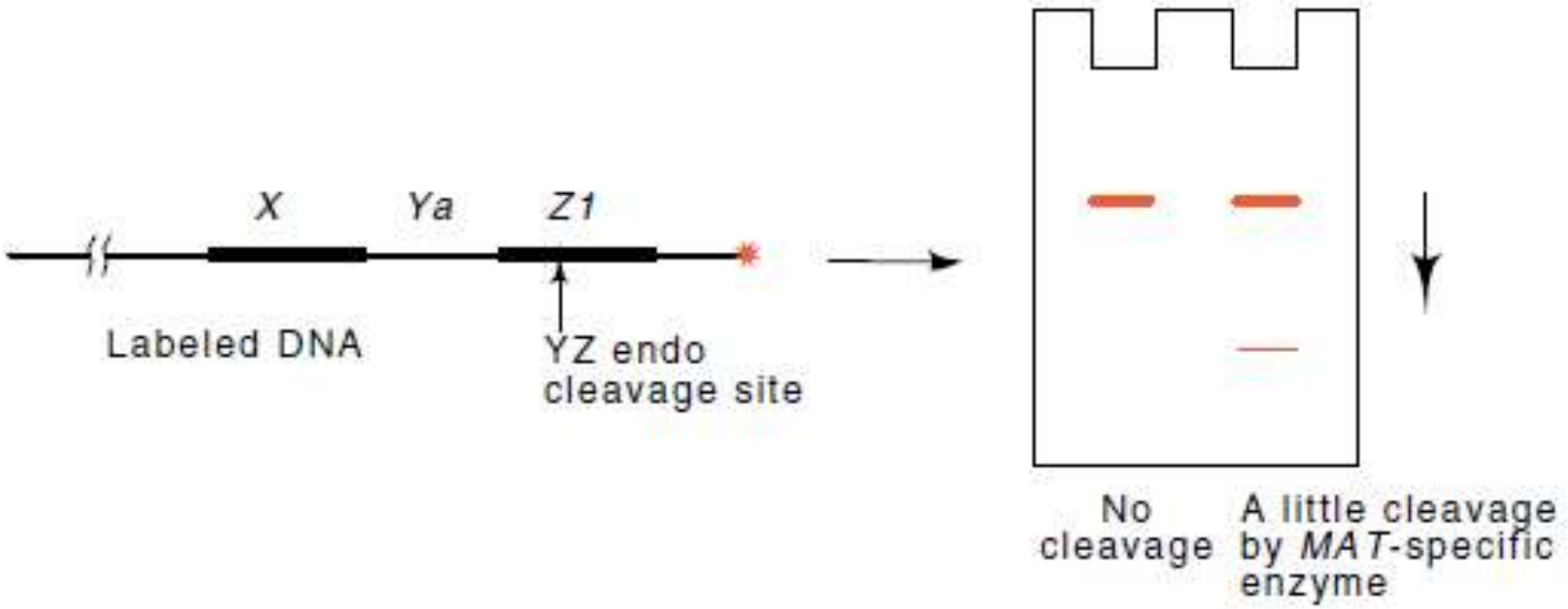
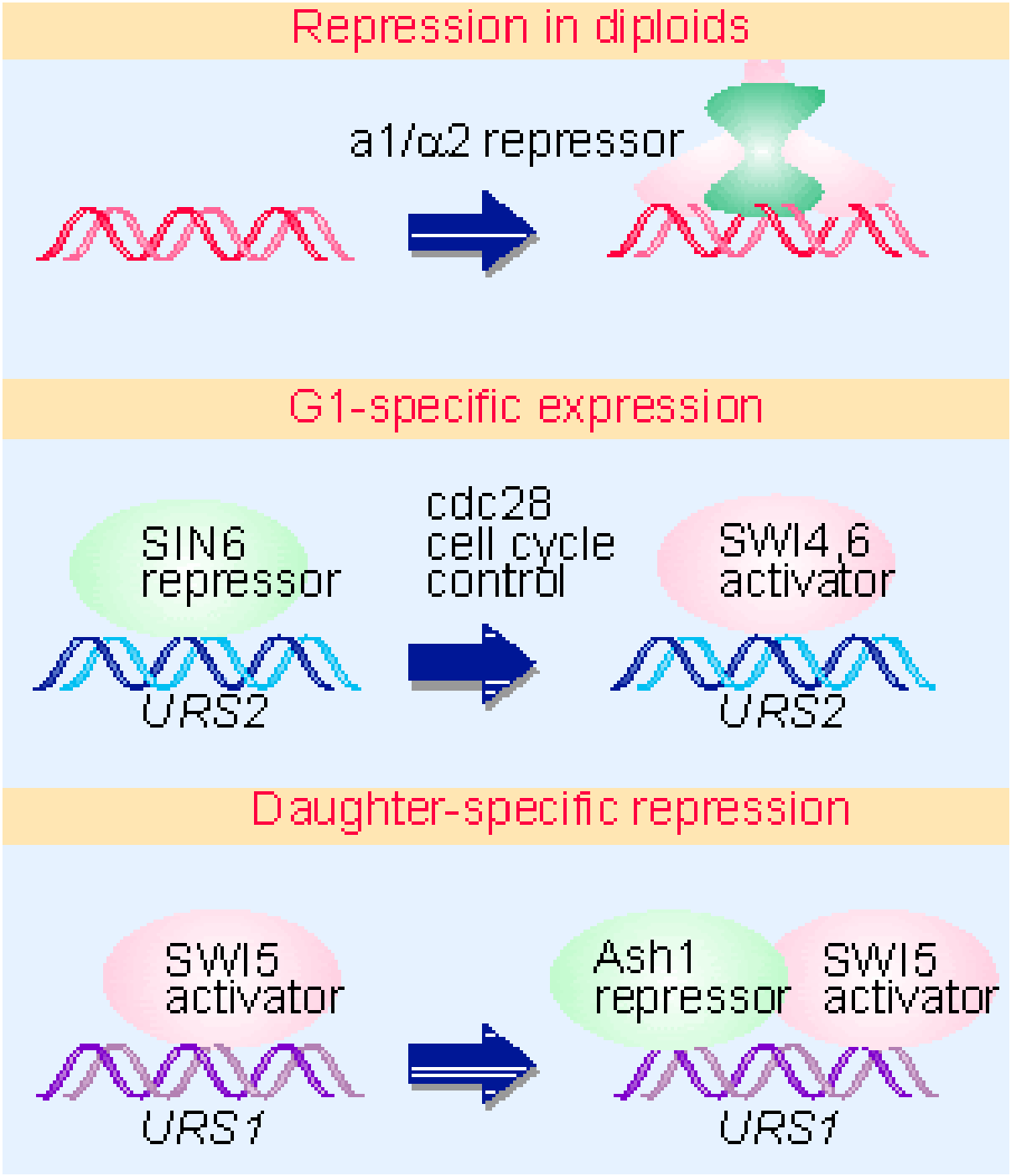

Y region
TTTCAGCTTTCCGCAACAGTATA
AAAGTCGAAAGGCGTTGTCATAT
HO endonuclease
TTTCAGCTTTCCGCAACA
AAAGTCGAAAGGCG
GTATA
TTGTCATAT
Recipient
MAT
Cut at Y boundary
Pairing with donor
Donor
HMR or HML
Degradation of MAT
Synthesis of new DNA
Recipient DNA has changed mating type
Donor DNA is unchanged

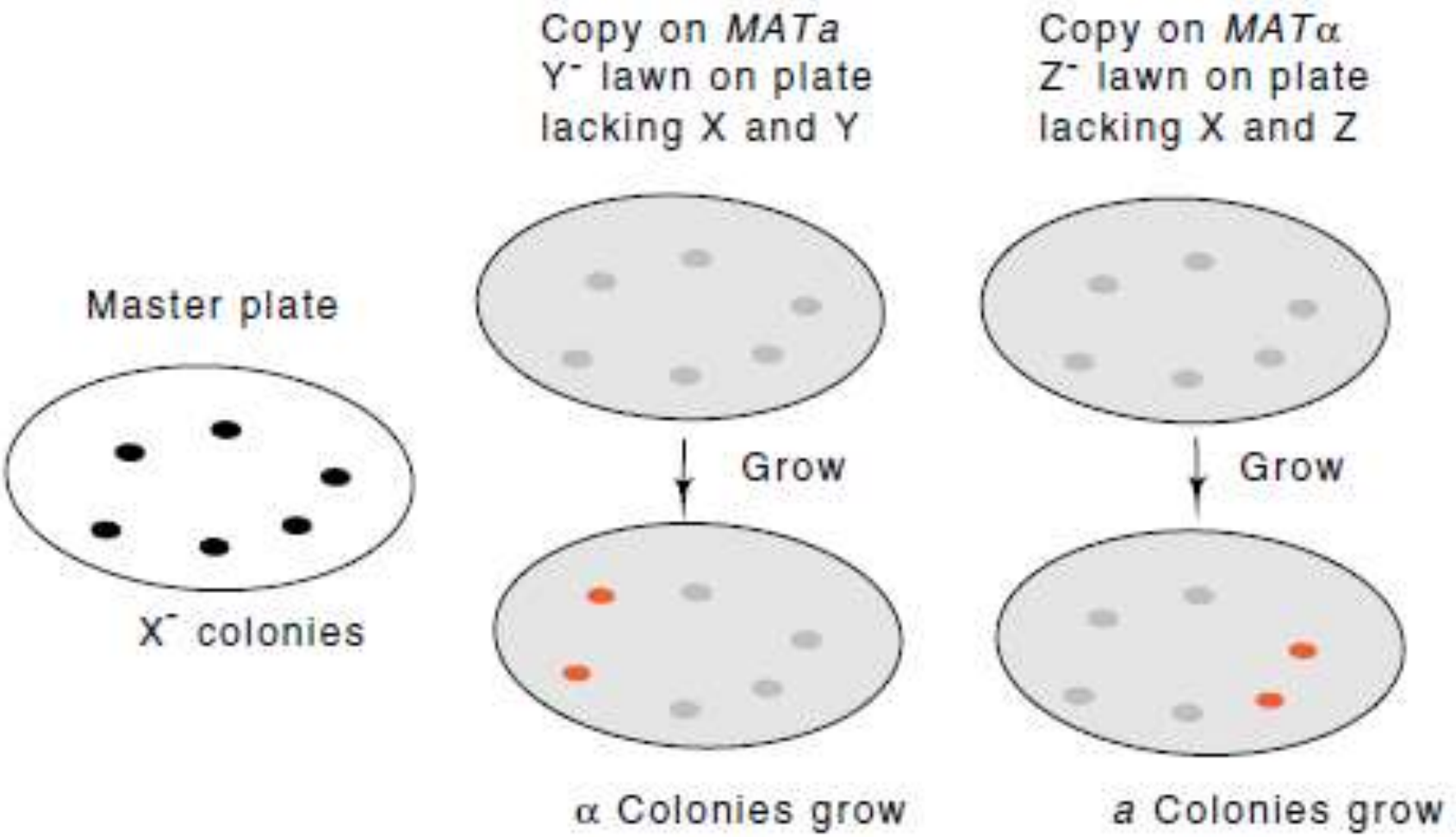
**Figure 16.14** A sensitive scheme for detecting an endonuclease that cleaves specifically in *MAT* sequences.



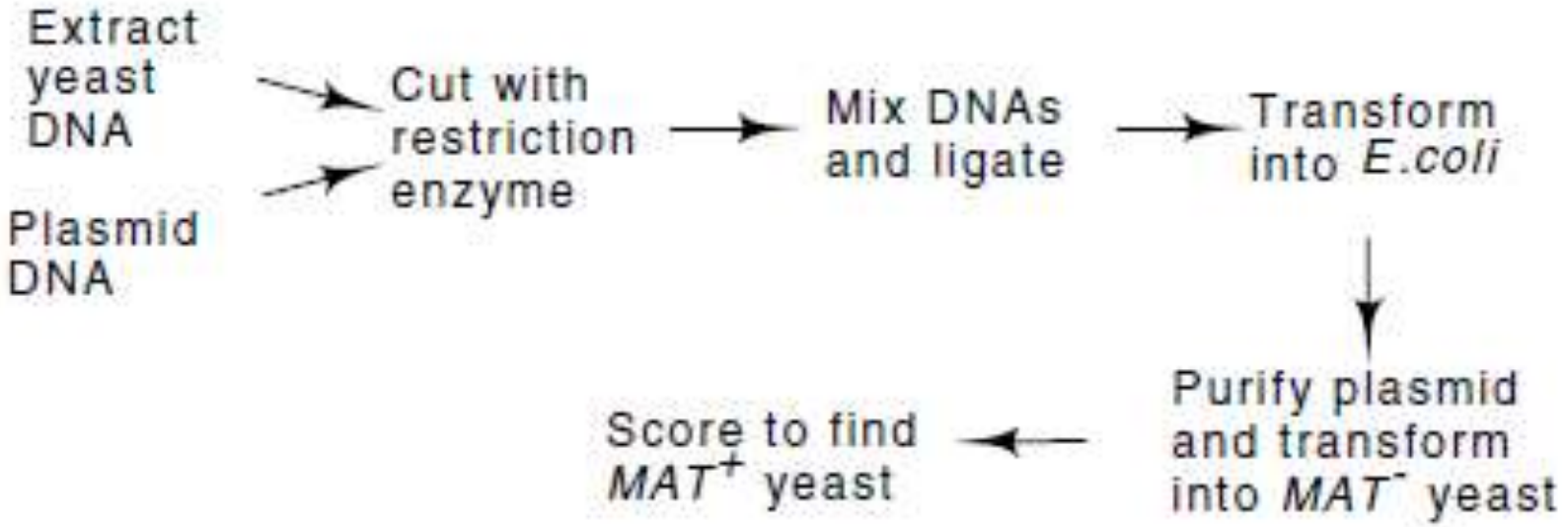



**Regulation of HO endonuclease**

# Detection of mating types



# Cloning the mating type loci in yeast cells



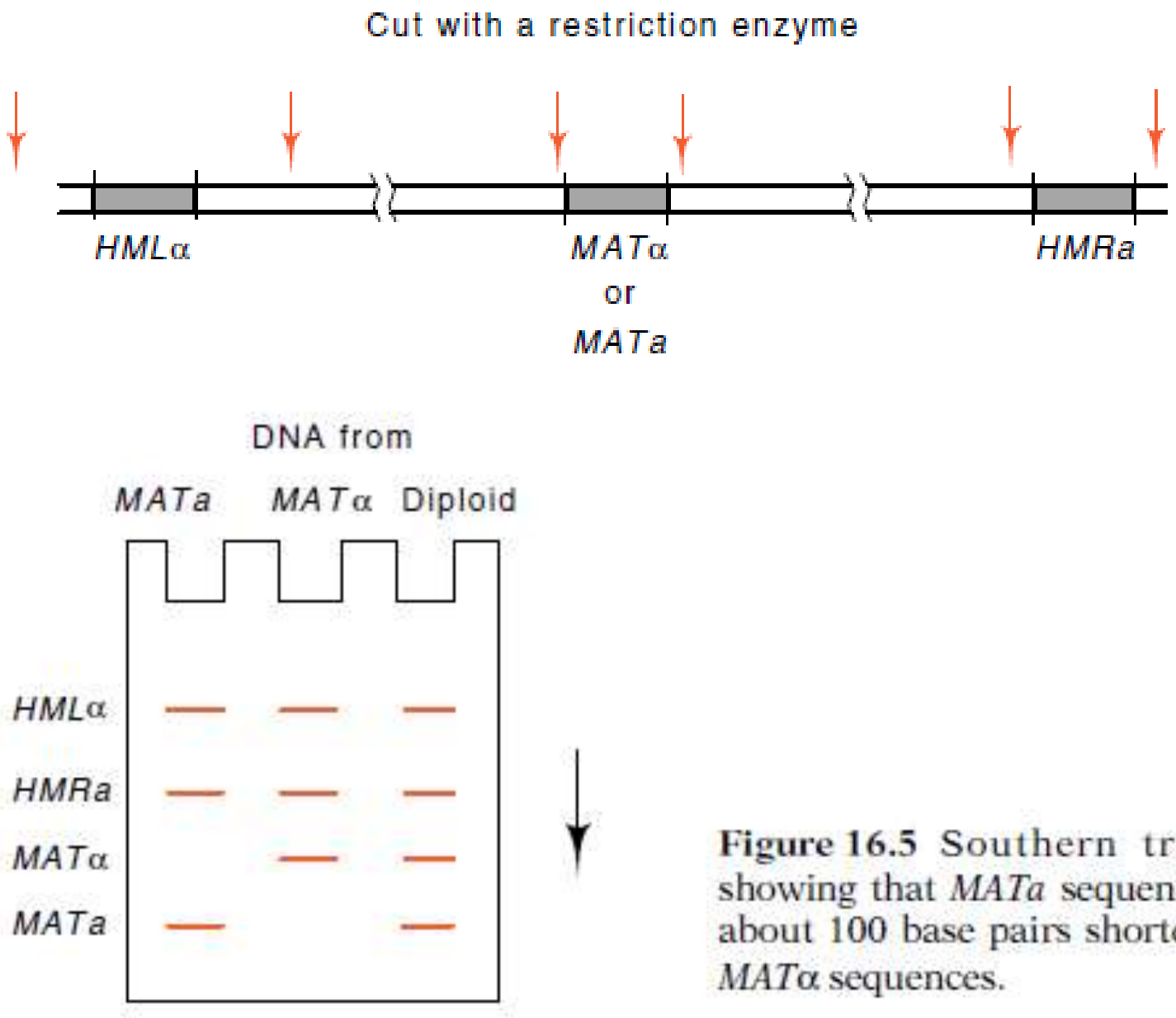
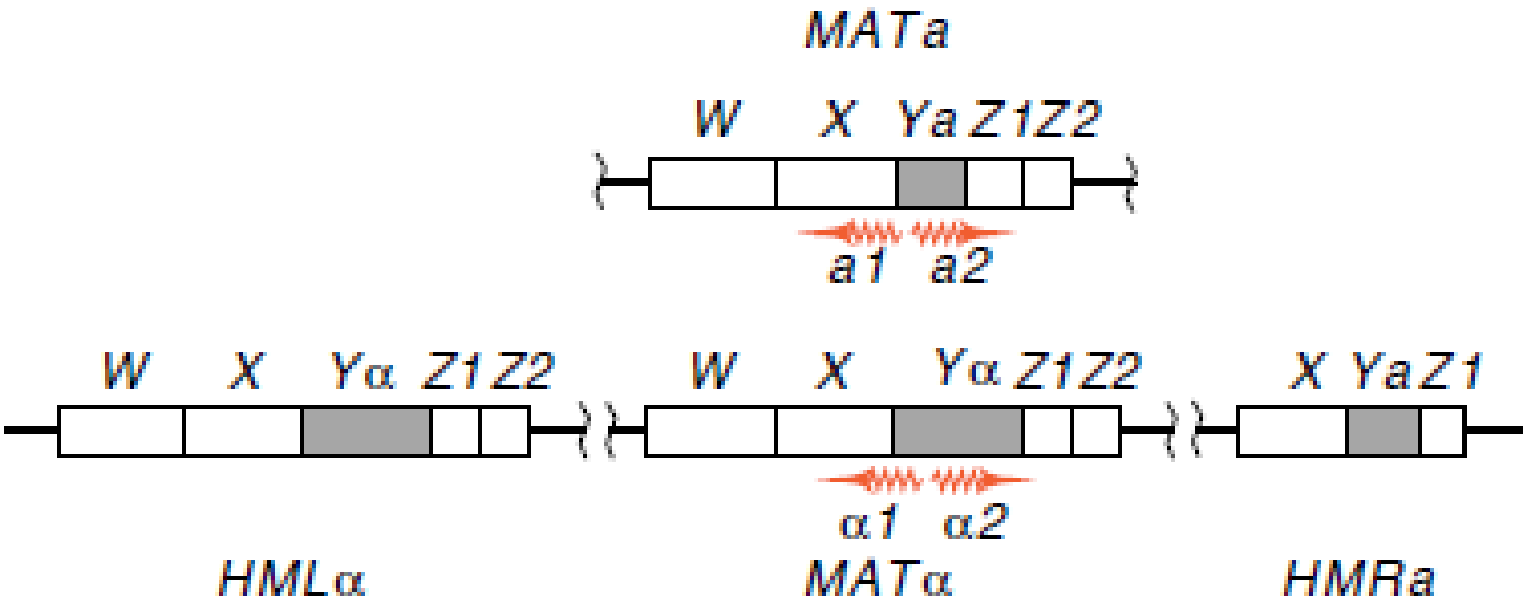
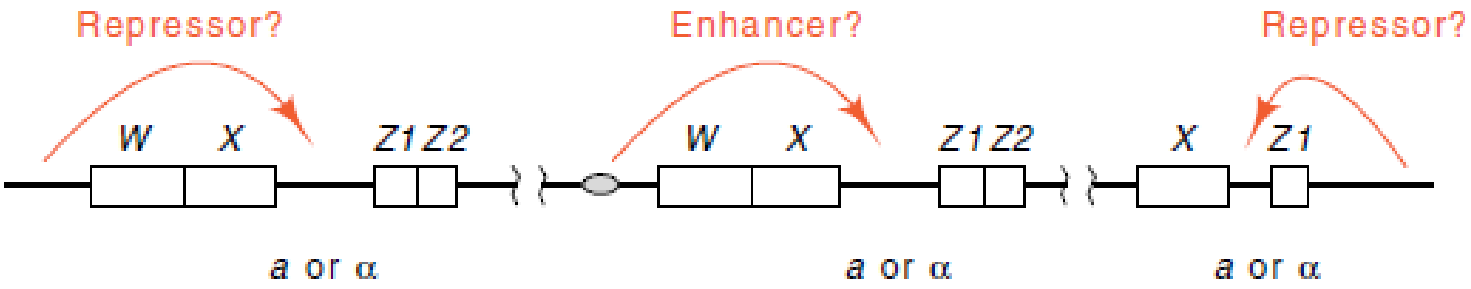
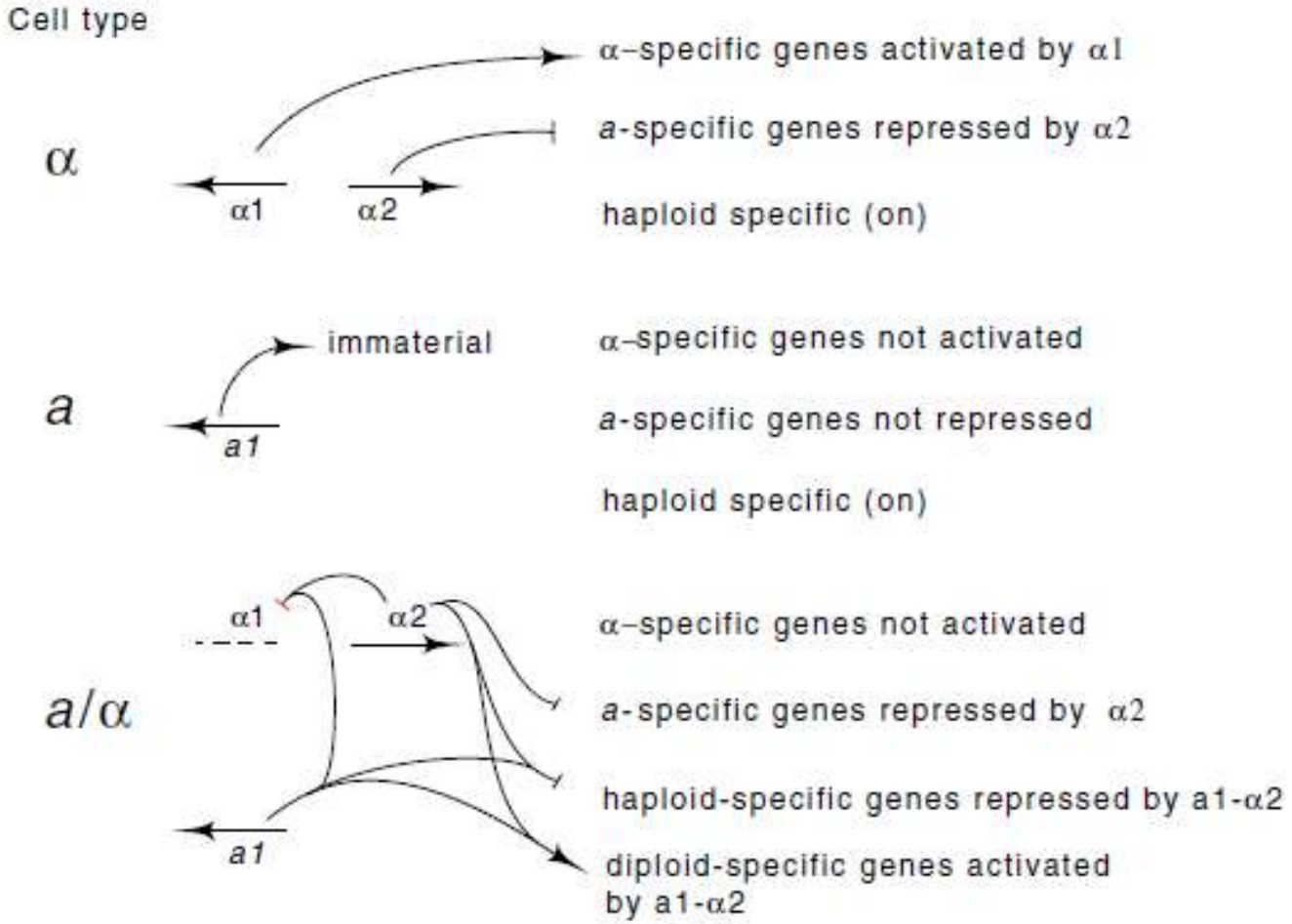



**Figure 16.5** Southern transfer showing that *MATa* sequences are about 100 base pairs shorter than *MATα* sequences.




**Why no a2? No mutations have been found in the a2 region and the a2 transcript lacks a good open reading frame preceded by an AUG codon**


Repressor?
Enhancer?
Repressor?
W
X
Z1 Z2
W
X
Z1 Z2
X
Z1
a or α
a or α
a or α


Cell type
α
α1
α2
α–specific genes activated by α1
a-specific genes repressed by α2
haploid specific (on)
a
immaterial
a1
α–specific genes not activated
a-specific genes not repressed
haploid specific (on)
a/α
α1
α2
a1
α–specific genes not activated
a-specific genes repressed by α2
haploid-specific genes repressed by a1-α2
diploid-specific genes activated by a1-α2

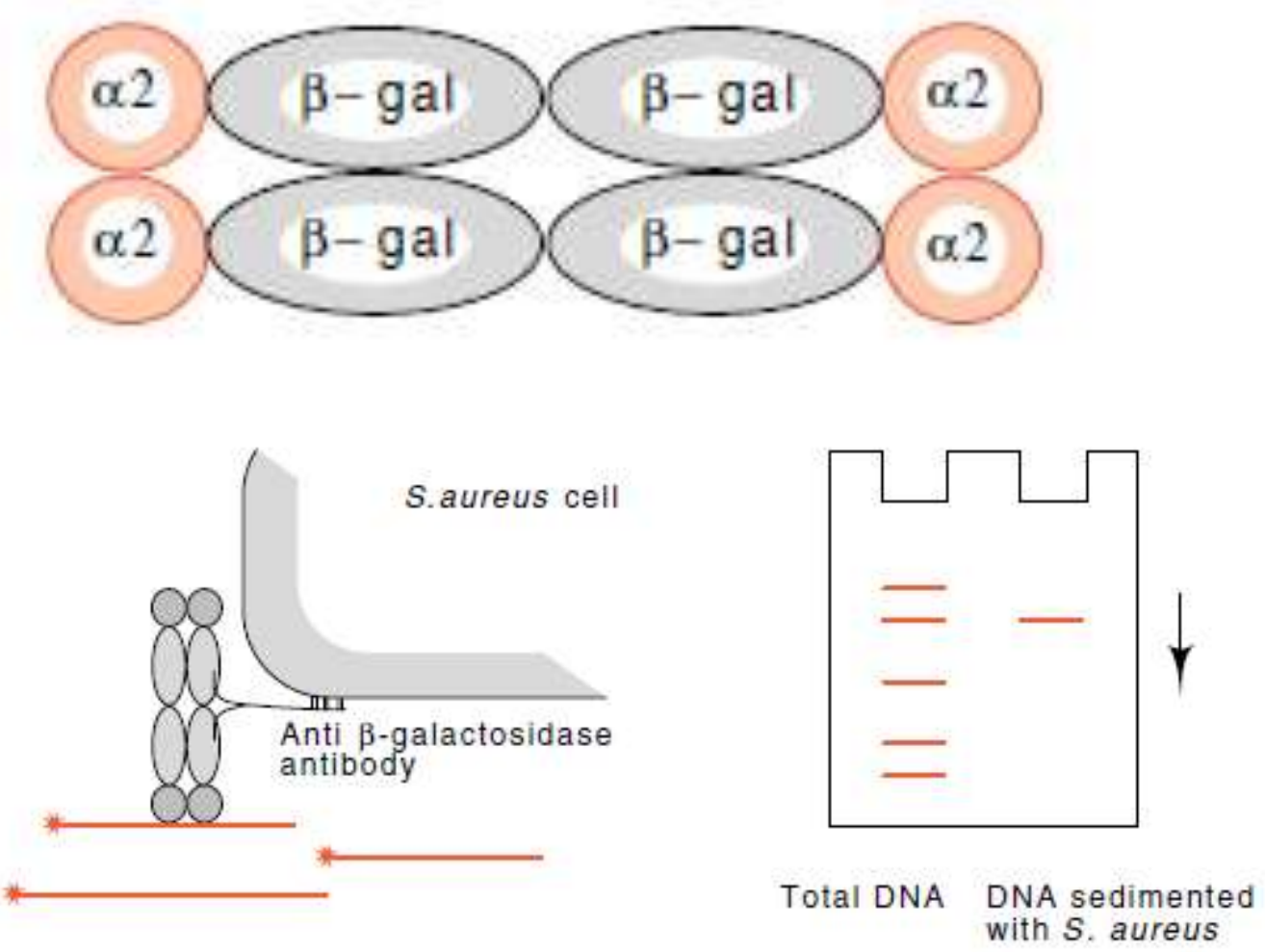



**Figure 16.11** Antibody against β-galactosidase that binds to *Staphlococcus aureus* cells can couple α2 protein bound to DNA carrying the α2 specific sequence. The specific DNA can then easily be separated from other DNA fragments. The selectivity can be displayed by electrophoresis and autoradiography of the radioactive DNA fragments.

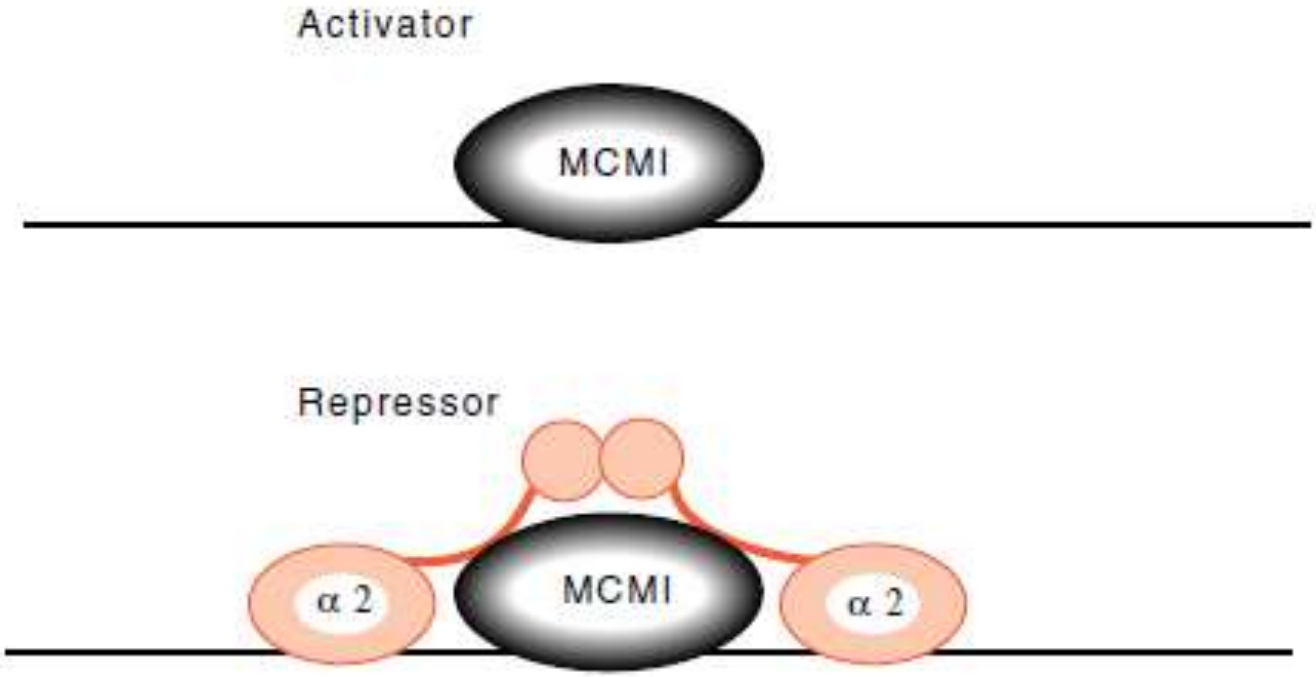



**Figure 16.12** The MCM1 protein functions as an activator when alone, and as a repressor when it is flanked by the α2 protein.

**Figure 16.9** Cells can be made to switch mating type with the loss of repression at *HM* loci if they possess an a1⁻ allele at *MAT* and cannot transfer copies from *HML* or *HMR* to *MAT*. As a result they switch from constitutively expressing *a* type genes to repressing these genes and expressing genes activated by *α1*.