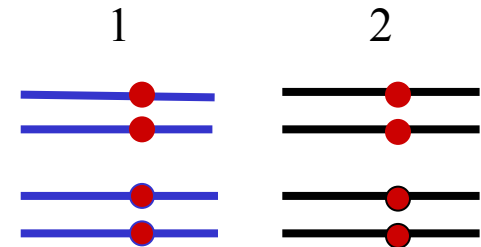


Autopolyploids

Polyploids in which all the chromosomes come from the same species

3x = Autotriploid

4x = Autotetraploid



- ✓ Increased cell size relative to diploid progenitors
- ✓ Decrease in the ratio of cell surface to cell volume
- ✓ Increase in size of pollen grains
- ✓ Increase in size of stomatal guard cells
- ✓ Cell-division cycle is prolonged
- ✓ Slower growth rate and later plant maturity
- ✓ Possible increase in size of flowers, fruits, and seeds

Autopolyploids

The most likely natural cause of polyploidy in plants is the formation of unreduced ($2n$) gametes in diploid individuals.

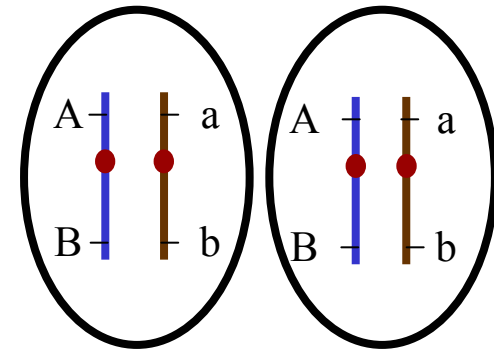
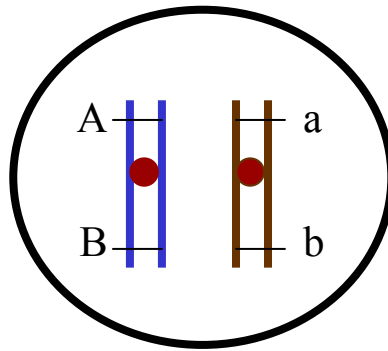
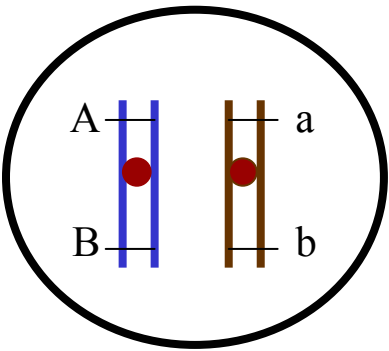
Some causes of unreduced gamete formation are:

- ✓ Chromosome doubling in premeiotic cell
- ✓ An incomplete type of first meiotic division known as first-division restitution (FDR)
- ✓ An incomplete type of second meiotic division known as second-division restitution (SDR)
- ✓ Chromosome doubling after meiosis
- ✓ Development of a somatic cell in the ovule into a $2n$ gamete

First-Division Restitution (FDR)

Failure of spindle formation results in nuclear membrane reforming around the chromosomes without movement to opposite poles

Normal disjunction at second division of meiosis



Meiotic prophase

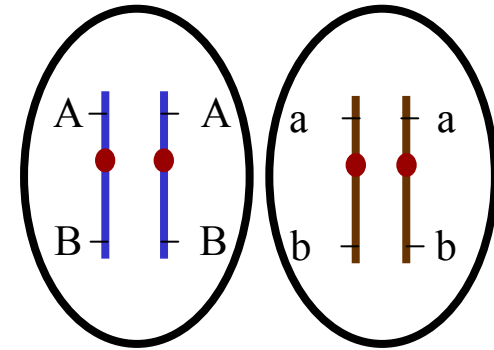
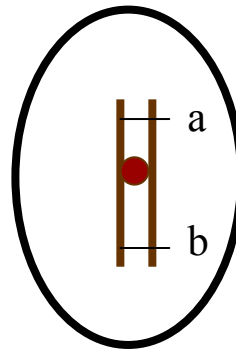
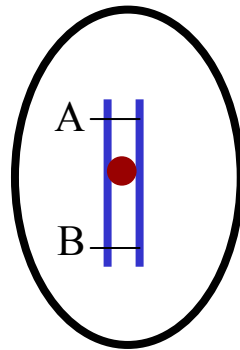
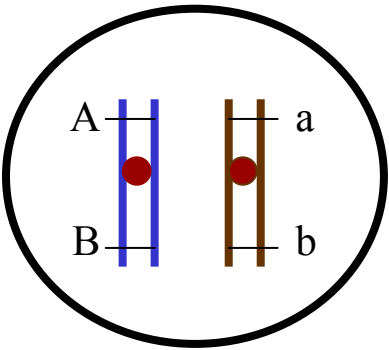
Product of FDR
Telophase I

Both gametes are AaBb

Second-Division Restitution (SDR)

Normal separation of
homologous
chromosomes

Separation of sister
chromatids occurs during
meiosis II, but no cell plate
is formed at the end

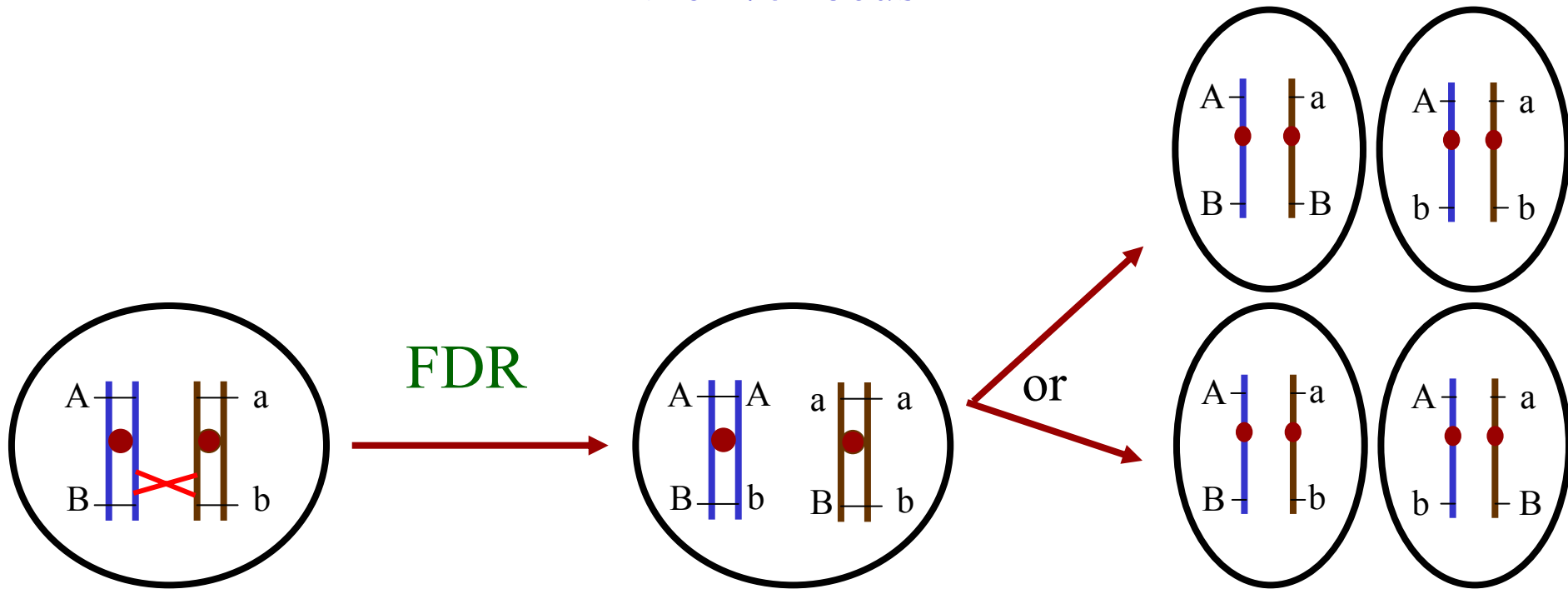


Meiotic
prophase

Telophase I

Products of SDR
Gametes recovered
are 1AABB: 1 aabb

Results of FDR after a single crossover between the centromere and the *B/b* locus



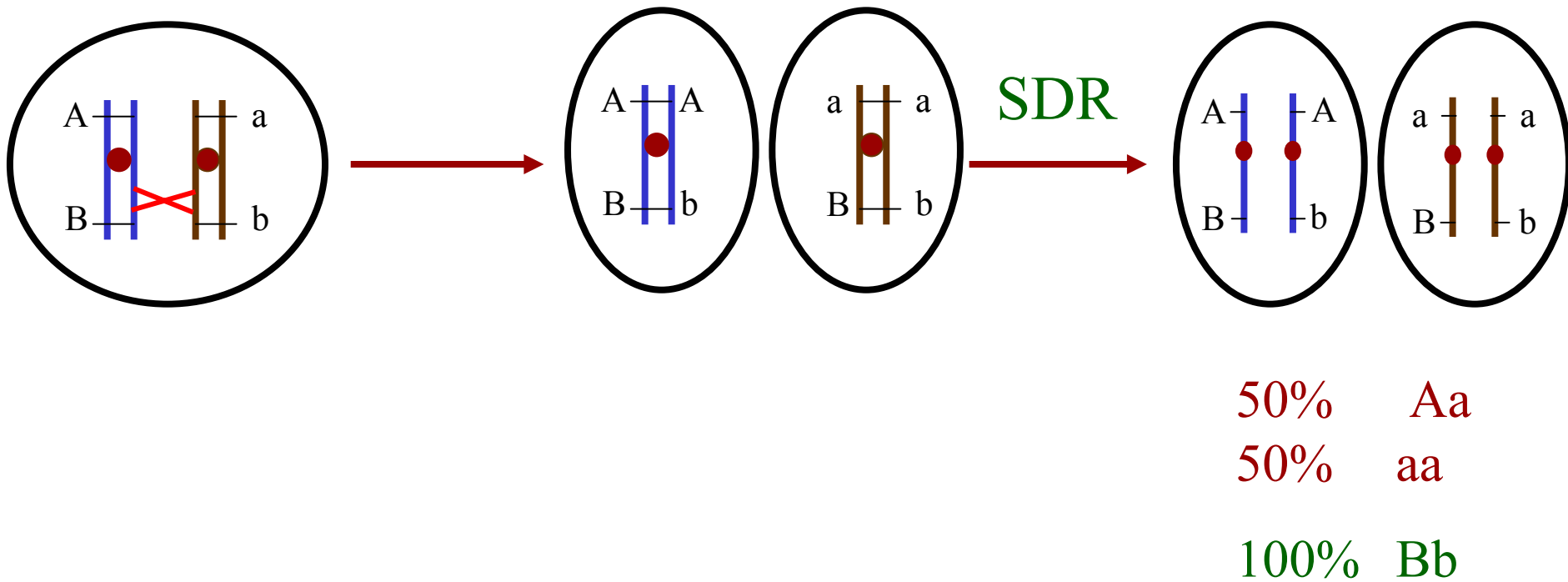
100% *Aa*

50% *Bb*

25% *BB*

25% *bb*

Results of SDR after a single crossover between the centromere and the *B/b* locus



Meiotic behavior of autopolyploids

Fertility of autopolyploids

- ✓ Fertility measured by seed set and/or normal pollen, is usually lower in newly induced autotetraploids than the parental diploids
- ✓ Selection of plants with higher fertility over 10-19 generations was accompanied by a decrease in quadrivalents and increase in bivalents (diploidization)
- ✓ Autotriploids are typically highly sterile due to preponderance of gametes with unbalanced chromosome numbers
- ✓ Autopolyploids above tetraploids usually lack the vigor and fertility to be maintained
- ✓ Most naturally occurring autopolyploids are perennials with some type of asexual propagation, so seed propagation can be bypassed when high sterility is a problem
- ✓ Ploidy levels up to 12 times the basic number exist in *Rubus* species (raspberries and blackberries) and some ferns (*Pteridophytes*)

Chromosome segregation in autopolyploids

Possible genotypes in an autotetraploid

AAAA

Quadruplex

AAAa

Triplex

AAaa

Duplex

Aaaa

Simplex

aaaa

Nulliplex

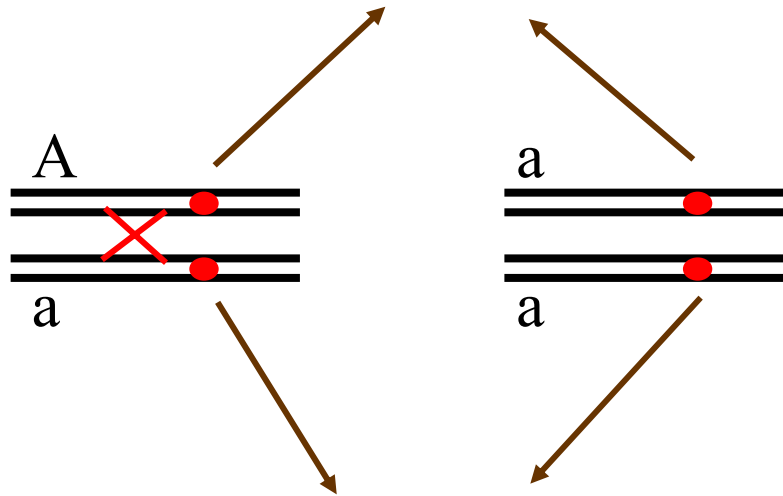
Chromosome segregation in autopolyploids

Random chromosome assortment :

Quadrivalents are never formed

Locus in question far enough from the centromere to allow chiasma formation

Sister chromatids at this locus can never end in the same gamete



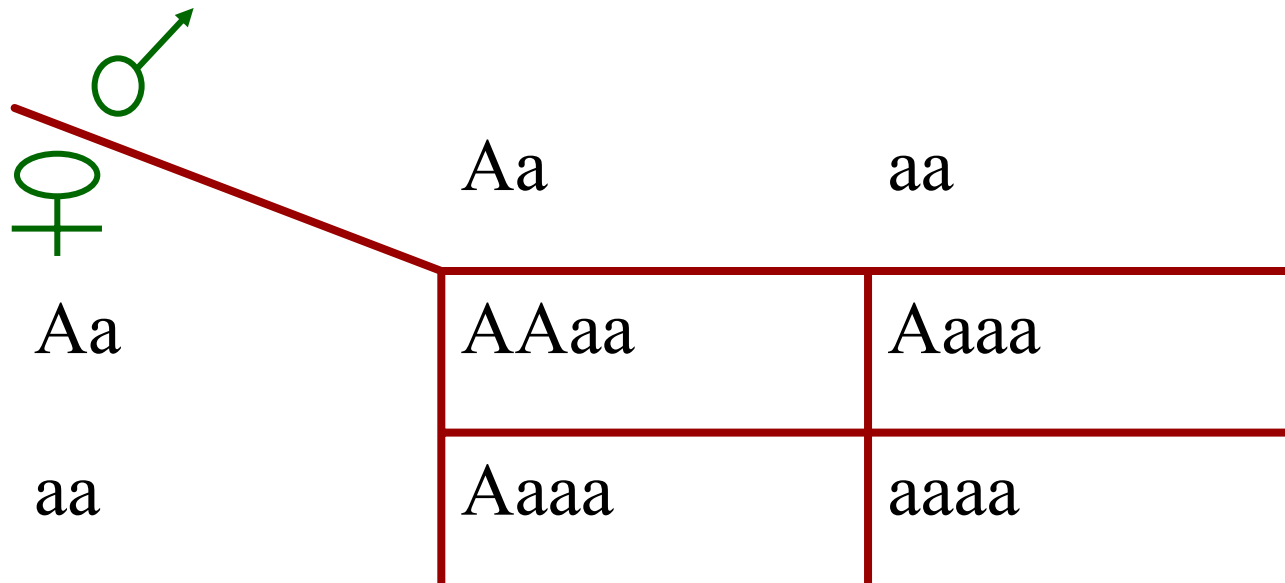
- ✓ The centromeres will always pass to the same pole at anaphase I and separate at anaphase II
- ✓ The dominant alleles will not appear in the same gamete

Chromosome segregation in autopolyploids

Random chromosome assortment (Quadrivalents are never formed):

Gametic ratio: $1Aa:1aa$

Zygotic expectation from selfing Aaaa



$3 A_ _ _ : 1 aaaa$

Chromosome segregation in autopolyploids

Random chromatid assortment:

Quadrivalents are formed

Locus in question far enough from the centromere to allow chiasma formation

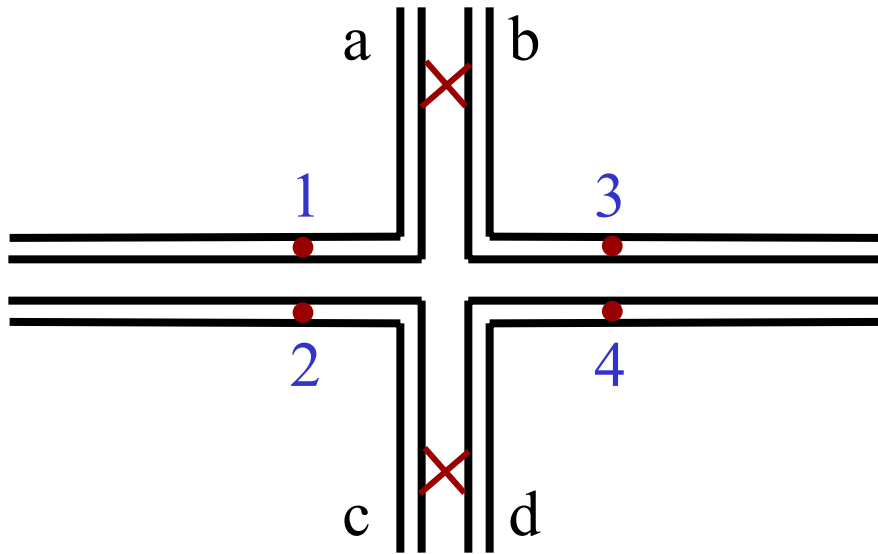
Sister chromatids never end in the same gamete

- ✓ When quadrivalent formation is complete and 50% crossing over occurs between the centromere and the locus, the partition of chromatids to gametes will be random.
- ✓ Requirements for double reduction (requires that after crossing over between the centromere and gene marker in adjacent chromosomes, these chromosomes go to the same pole at anaphase I):

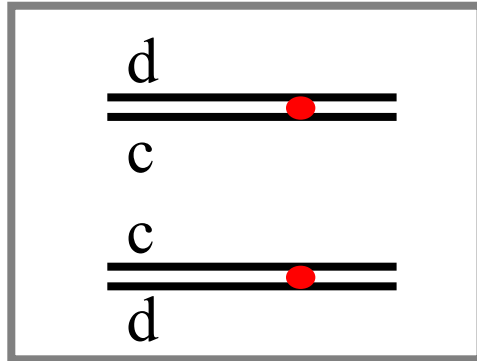
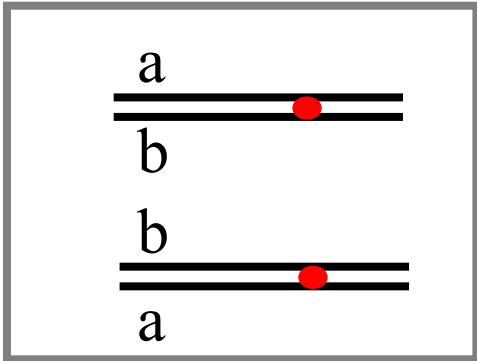
Chromosome segregation in autopolyploids

Random chromatid assortment (Quadrivalents are formed):

- ✓ Requirements for double reduction (requires that after crossing over between the centromere and gene marker in adjacent chromosomes, these chromosomes go to the same pole at anaphase I):
 1. Multivalent formation
 2. Crossover between the gene and the centromere
 3. Two pairs of chromatids resulting from crossing over must pass to the same pole at anaphase I
 4. Random separation of chromatids at anaphase II



Anaphase I



Anaphase II

