

MEIOTIC DRIVE

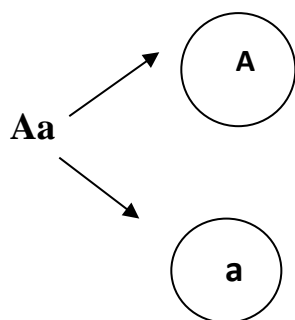
(A form of genetic Selection)

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DEFINITION/ CHARACTERISTICS

- As per the Mendelian principles, heterozygotes (Aa) will produce allele **A** and **a** bearing gametes in equal proportions (1:1)



- Any mechanism that disrupts this 1:1 ratio of segregation results in non-random assortment of alleles/ chromosomes into gametes, causing “**segregation distortion**”. The phenomenon is known as “**Meiotic drive**.”
- Meiotic drive occurs when gametes that carry a particular allele exhibit preferential transmission/ survival.
- A meiotic drive system consists of two genetically linked loci- **a driver** and **its target**.
- The meiotic driver is a **selfish** genetic element that prevents the formation of functional gametes that do not have its copy.
- In other words, it favours its own transmission at the expense of alternative alleles.

Examples:

- The Segregation Distortion (SD) complex in *Drosophila melanogaster* is a best studied system of meiotic drive.
- It includes two loci- Segregation distorter or Sd (the driver) and the Responder or Rsp (the target) which are tightly linked on 2nd chromosome.
- The SD system acts in males through **sperm killing**.
- The Sd locus has two alleles, **Sd** (mutant, causing segregation distortion) and **Sd⁺** (wild, causing no segregation distortion).
- The Rsp locus also has two alleles, **Rsp^s** (wild and sensitive) and **Rspⁱ** (mutant and insensitive).
- In males, when one homologue contains Sd and **Rspⁱ** alleles together, and **Sd⁺** and **Rsp^s** on another homologue, more than 95% of sperms produced are found to carry Sd and **Rspⁱ** alleles.
- In other words, Instead of being present in 50% of the offspring of these males, the chromosome bearing Sd and **Rspⁱ** alleles (the killer chromosomes) are found in almost all.
- The mutant Sd allele produces a truncated protein that kills sperm carrying sensitive allele **Rsp^s** at responder locus.
- In this case, the chromosomes of affected sperms **fail to condense** properly and so, maturation of these cells will not occur.

The table summarizes the four possible combinations of alleles and their effects.

	Rsp^s	Rspⁱ
Sd	The product of Sd acts on sensitive responder on the some chromosome. Result: a suicidal chromosome	Responder locus protects this chromosome against the product of Sd . Result: a killer chromosome
Sd⁺	Responder locus is sensitive. Result: the chromosome is killed when Sd bearing sperms are present.	Responder locus protects this chromosome. Result: No segregation distortion, even when Sd bearing sperms present.

- Meiotic drive also occur in certain races of *Drosophila pseudobscura*, causing males to produce gametes mostly bearing X- chromosome (due to degeneration of Y- chromosome during anaphase II followed by an extra division of X- chromosome).

Conclusion:

- Deviation from 1:1 ratio of segregation due to preferential survival of gametes with particular alleles/chromosomes will certainly affect the state of genetic equilibrium in the population.
- Genes that cause meiotic drive are widespread in nature. They have been reported in species as diverse as mosquitoes, corn, mice, Lily, tobacco, wasp, rye and grasshopper.
- In every case, the meiotic drives system involves a complex of loci including a driver gene and a target gene analogous to **Sd** and **Rsp** in *Drosophila*.
