

NON-DISJUNCTION

(in *Drosophila* and Human)

Q.How Calvin Bridges's work related to Thomas Hunt Morgan?

When Morgan crossed his original white-eyed male with homozygous red-eyed females, all 1237 of the progeny had red eyes, except for three white-eyed males. As already mentioned, Morgan attributed these white-eyed F1 males to the occurrence of further mutations. However, flies with these unexpected phenotypes continued to appear in his crosses. Although uncommon, they appeared far too often to be due to mutation. Calvin Bridges, one of Morgan's students, set out to investigate the genetic basis of these exceptions.

Q.Give a brief note on Nondisjunction and the Chromosome Theory of Inheritance. Q,Arrange a cross to justify nondisjunction and the chromosome theory of inheritance.

Experiment:

- i) Bridges found that, when he crossed a white-eyed female (X^wX^w) with a red-eyed male (X^+Y), about 2.5% of the male offspring had red eyes and about 2.5% of the female offspring had white eyes (**Figure 6a**).
- ii) In this cross, every male fly should inherit its mother's X chromosome and should be X^wY with white eyes.
- ii) Every female fly should inherit a dominant red-eye allele on its father's X chromosome, along with a white-eyed allele on its mother's X chromosome.
- iii) All the female progeny should be X^+X^w and have red eyes.

Result:

The appearance of red eyed males and white-eyed females in this cross was therefore unexpected.

Explanation:

- i) Bridges hypothesized that, occasionally, the two X chromosomes in females fail to separate during anaphase I of meiosis. Bridges termed this failure of chromosomes to separate **nondisjunction**.
- ii) When nondisjunction occurs, some of the eggs receive two copies of the X chromosome and others do not receive an X chromosome (**Figure 6b**).
- iii) If these eggs are fertilized by sperm from a red-eyed male, four combinations of sex chromosomes are produced.
- iv) When an egg carrying two X chromosomes is fertilized by a Y-bearing sperm, the resulting zygote is X^wX^wY . Sex in *Drosophila* is determined by the X:A ratio (**Table 1**).
- v) In this case the X:A ratio is 1.0, so the X^wX^wY zygote develops into a white-eyed female.
- vi) An egg with two X chromosomes that is fertilized by an X-bearing sperm produces X^wX^wX , which usually dies.
- vii) An egg with no X chromosome that is fertilized by an X bearing sperm produces X^+O , which develops into a red eyed male.
- viii) If the egg with no X chromosome is fertilized by a Y-bearing sperm, the resulting zygote with only a Y chromosome and no X chromosome dies.
- ix) Rare nondisjunction of the X chromosomes among white-eyed females therefore produces a few red-eyed males and white eyed females, which is exactly what Bridges found in his crosses.

Inference:

- i) Bridges's hypothesis predicted that the white-eyed females would possess two X chromosomes and one Y and that red-eyed males would possess a single X chromosome.
- ii) To verify his hypothesis, Bridges examined the chromosomes of his flies and found precisely what he predicted.
- iii) The significance of Bridges's study was not that it explained the appearance of an occasional odd fly in his culture but that he was able to predict a fly's chromosomal makeup on the basis of its eye-colour genotype.
- iv) This association between genotype and chromosomes gave unequivocal evidence that sex-linked genes were located on the X chromosome and confirmed the chromosome theory of inheritance.

