

Maternal Effect: Snail Shell Coiling in Limnaea

1. What is Maternal Effect?

Maternal effect is a genetic condition in which the phenotype of the offspring is determined by the genotype of the mother. This happens because the egg cytoplasm contains maternal gene products (mRNA and proteins) deposited during oogenesis. These cytoplasmic determinants control early development.

2. Example: Shell Coiling in Snail (*Limnaea stagnalis*)

Snails show two types of shell coiling:

- Dextral (right-handed) – Dominant (D)
- Sinistral (left-handed) – Recessive (d)

3. Why Maternal Effect Occurs in Snail

The direction of the first cleavage divisions determines the shell coiling direction. Cleavage direction is controlled by cytoplasmic factors from the mother. Thus:

Mother's genotype → Offspring phenotype.

4. Cross Explanation

Cross 1:

DD (dextral mother) × dd (sinistral father)

Mother genotype DD → D-type cytoplasm.

Offspring genotype: all Dd.

Offspring phenotype: Dextral (because mother = DD).

Cross 2:

dd (sinistral mother) × DD (dextral father)

Mother genotype dd → d-type cytoplasm.

Offspring genotype: all Dd.

Offspring phenotype: Sinistral (because mother = dd).

5. F2 Generation

F1 (genotype Dd, phenotype sinistral due to maternal effect) is selfed:

Dd × Dd → genotypes: 1 DD : 2 Dd : 1 dd.

Phenotype of all F2 = Dextral (because phenotype depends on mother, and mother = Dd → dominant cytoplasm).

6. Summary Table

Mother Genotype | Offspring Genotype | Offspring Phenotype

DD → Dd → Dextral

$Dd \rightarrow DD, Dd, dd \rightarrow$ Dextral
 $dd \rightarrow Dd \rightarrow$ Sinistral

7. Key Points

- Maternal effect is not the same as maternal inheritance.
- Controlled by nuclear genes but expressed through cytoplasmic determinants.
- Classic example: Snail shell coiling.
- Phenotype lag: F1 reflects mother's genotype; F2 reflects F1 mother's genotype.

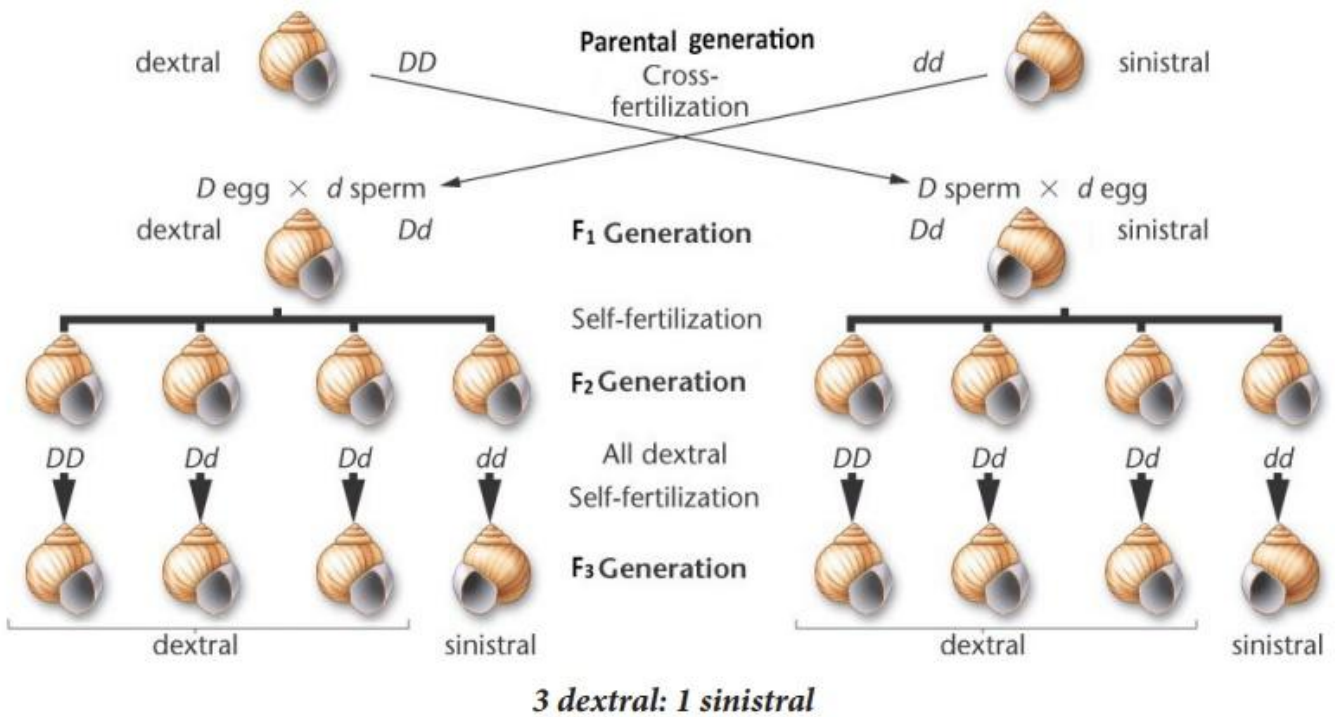


Fig. 4.11 Shell coiling in *Limnaea*