MATERNAL EFFECT

Moumita Pal, Zoology Dept., Raniganj Girls College

The embryo is formed when a female gamete unites with a male gamete. In the vast majority of species, the female gamete is physically larger than the male gamete and provides the cytoplasm for the developing embryo. Within this cytoplasm there are factors that were released by the nuclear genes of the female. Those factors may have specific effects upon the developing embryo. Those phenotypes that are controlled by factors present in cytoplasm of female but encoded by nuclear genes are known as maternal effect.

So, it is a phenomenon where the phenotype of an organism is determined not only but the environment it experience and its genotype, but also by the environment and genotype of its mother. In genetics maternal effects occur where an organism shows the phenotype expected from the genotype of the mother, irrespective of its own genotype, sometimes due to the mother's messenger RNA or proteins to the egg. It can also be caused by the maternal environment independent of genotype, sometimes controlling the size, sex or behavior of the offspring's

EXPLANATION WITH EXAMPLE.....

The classic phenotype which exhibits maternal effect is coiling of snail Limnaea. The shell coiling of this snail is of two types---- right handed or dextral and left handed or sinistral. The coiling phenotype that is seen in the offspring is controlled by the genotype of the mother. As the specific coiling producing protein i.e. dextral protein, is only available in the cytoplasm of mother's gamete. The nuclear control over left handed or right handed coiling can be interpreted by analyzing the outcome up to F3 generation. The following crosses were made between pure line snail, and the following result was seen.



CROSS 1

CROSS 2

Parents coil (male)	Right coil (female) x Left coil (male)	Left coil (female) x right
F1	All right coil	All left coil
F2	All right coil	All right coil
F3	3 Right coil: 1 left coil	3 right coil: 1 left coil

These results at first glance appear to be at odds with Mendel's laws. First, the F1 phenotype is not same for both cases. With other experiments, the results of reciprocal crosses were equivalent, but with this experiment it appears that the female controls the phenotype. Yet, the F2 appears to contradict this hypothesis because the left and right coiled F1 individuals produced all right progeny. Furthermore, the 3:1 Mendelian ratio is not seen in the F2, but rather appears in the F3 generation.

The F3 ratio of 3 rights: 1 left for both crosses suggests that right coiled shells are dominant to left coiled shells. If this is the case, then we can assign the following genotypes

- Right coiled shell : DD
- Left coiled shell : dd

The next observation is that the phenotype of the F1 generation is always that of the female parent. One hypothesis would suggest that the genotype of the female controls the genotype of the offspring. Can these results be confirmed in the subsequent generations? If the genotypes we assigned to the parent are correct, then the genotype of F1 individual from each cross are Dd (from DD x dd and dd x DD). If the female genotype does control the phenotype of its offspring, then we would predict that all the F2 snails would have right coils. This is the exact result that is seen. But what would the genotypes of the F2 snails be? If we inter-mate snails with the genotype Dd the genotypic ratio should be 3 D to 1dd. These genotypes would not be expressed as a phenotype until the F3 generation. These are the result that we obtained. A general conclusion from all traits that express a maternal effect is that the normal Mendelian ratio is expressed one generation than expected.

Cytological analysis of developing eggs has provided the explanation of above mentioned result, the genotype of the mother determines the orientation of the mitotic spindle during the second cleavage mitotic division in the zygote, and this in turn controls the direction of the shell coiling of the offspring.

Picture Reference: <u>http://bio3400.nicerweb.com/Locked/media/ch09/maternal_effect-</u> Limnaea_coiling.html