Difference Between Cytoplasmic Inheritance and Genetic Maternal Effect

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Key Difference - Cytoplasmic Inheritance vs Genetic Maternal Effect

Chromosomal DNA is the main storehouse of genetic information in a cell. It is instrumental in deciding the phenotype of an offspring. However, there are instances where the phenotype of the offspring is similar to the maternal phenotype regardless of environmental effects or the genotype it bears. This indicates that there is DNA outside the nucleus which contributes to deciding the phenotype of the offspring. Scientists have discovered that it is mainly due to two phenomena named cytoplasmic inheritance and genetic maternal effect. Though chromosomes divide precisely into gametes during meiosis, the cytoplasm of gametes does not collect precisely into the zygote. Cytoplasmic inheritance and genetic maternal effects arise due to the contribution of more cytoplasm by female gamete into the resultant zygote during the syngamy. However, the cytoplasmic inheritance and genetic maternal effect are different from each other. The key difference between cytoplasmic inheritance and genetic maternal effect is that **cytoplasmic inheritance occurs due the genetic information stored in genes of some organelles such as mitochondria and chloroplasts present in the cytoplasm** while **genetic maternal effect occurs due to the mRNA and proteins received from the female gamete**.

What is Cytoplasmic Inheritance?

Mitochondria and chloroplast are two organelles present in cells which contain DNA other than chromosomal DNA. These organellar DNA carries genetic information and works independently or in collaboration with nuclear DNA (chromosomal DNA). Inheritance of characteristics from generation to generation by extrachromosomal /cytoplasmic/ organelle DNA is called cytoplasmic inheritance. There are a large number of examples which show the involvement of cytoplasmic DNA in controlling heredity traits of the organisms. Hence they are also known as cytoplasmic heredity units or cytoplasmic genes.

These plasma genes are mostly received by the egg cytoplasm rather than the sperm cytoplasm. Hence, cytoplasmic inheritance is considered as a maternal

inheritance phenomenon which influences the heredity characters. Though the cytoplasmic inheritance contributes to decide the characters of the offspring, reciprocal crosses do not result in the same phenotypes.

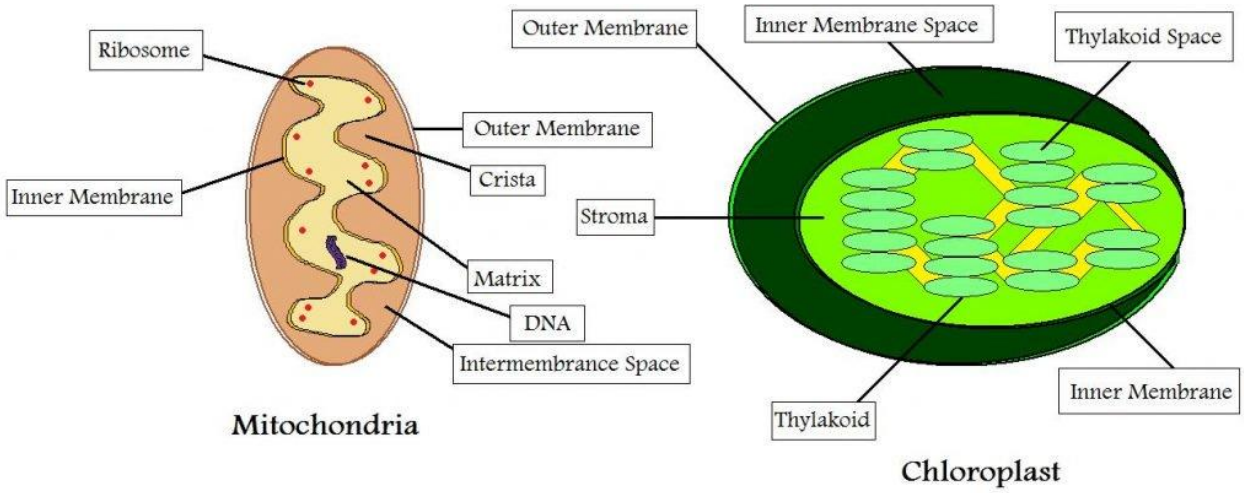

Figure 01: Mitochondria and Chloroplast

What is Genetic Maternal Effect?

Maternal effect is a situation which determines the phenotype of an offspring by the genotype of its mother, independent of the offspring genotype and environmental effect. In other words, the maternal effect is the casual influence of the maternal genotype on the phenotype of the offspring regardless of its genotype. It occurs due to the specific mRNA and proteins supplied by the mother to the zygote during embryo development. In many organisms, the embryo is initially inactive for the transcription. Hence the supply of mRNA and proteins from the maternal side is important. The maternal effect does not arise due to heredity units. It arises totally due to these molecules received from the maternal supply. Due to these maternal effects, two offspring may sometimes differ phenotypically from each other though they possess the same genotype. One individual may resemble the mother parent.

The properties of cytoplasm are mainly governed by nuclear genes. Thus, the maternal effect depends on the nuclear genes.

Maternal effect is an important process in ecology and evolution. It contributes to population dynamics, phenotypic plasticity, niche construction, life-history evolution and natural selection.

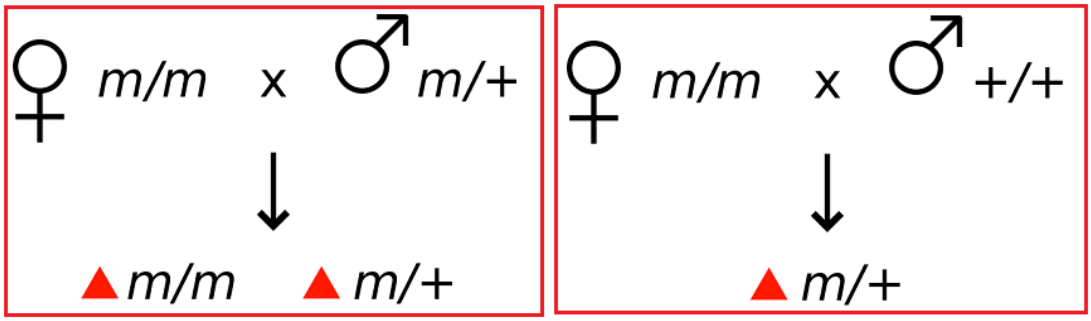

Figure 02: Genetic crosses involving a maternal effect recessive mutation

What is the difference between Cytoplasmic Inheritance and Genetic Maternal Effect?

Vegetative Propagation vs Spore Formation	
Cytoplasmic inheritance is the inheritance of characteristics due to the genetic information stored in cytoplasmic DNA or organelle DNA.	Genetic maternal effect is the phenomenon where offspring traits are decided by maternal factors such as mRNA and proteins.
Occurrence	
Cytoplasmic inheritance is a result of actual genes received from mitochondria, chloroplasts or any infective particle like a virus.	Genetic maternal effect is a result of mRNA or proteins received from the mothers' egg.
Involvement of Organelles	
Cytoplasmic inheritance is involved in essential organelles like chloroplasts and mitochondria.	Genetic maternal effect is not involved in organelles.
Dependence on Nuclear Genes	
Cytoplasmic inheritance is not dependent on nuclear genes	Genetic maternal effect may or may not dependent on nuclear genes.
Genetic Basis	
Cytoplasmic inheritance is due to actual genes.	Genetic maternal effect is due to gene products but not due to actual genes.

Summary - Cytoplasmic Inheritance vs Genetic Maternal Effect

Chromosomal DNA is considered as the sole genetic material of a cell. However several cellular organelles (mitochondria, chloroplasts) possess DNA which can influence the traits of the offspring. Some maternal products in the cytoplasm are also involved in deciding the traits of an offspring. Cytoplasmic inheritance and genetic maternal effect are two such situations. These two phenomena are caused due to the genes or factors inherited from the mothers' egg to the zygote. Maternal effect is a result of mRNA and proteins (gene products) received from the cytoplasm of the mothers' egg. Cytoplasmic inheritance is a result of genetic material in the mitochondria or chloroplasts or infective viruses. This is the main difference between cytoplasmic inheritance and genetic maternal effect. Offspring inherits the maternal traits regardless of its own genotype and the genes due to both these phenomena.

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APA: Difference Between Cytoplasmic Inheritance and Genetic Maternal Effect. (2017, June 05). Retrieved (date), from http://www.differencebetween.com/difference-between-cytoplasmic-inheritance-and-vs-genetic-maternal-effect/

MLA: "Difference Between Cytoplasmic Inheritance and Genetic Maternal Effect." *Difference Between.Com*. 05 June 2017. Web.

Chicago: “Difference Between Cytoplasmic Inheritance and Genetic Maternal Effect." *Difference Between.Com*. http://www.differencebetween.com/ difference-between-cytoplasmic-inheritance-and-vs-genetic-maternal-effect/ (accessed [date]).