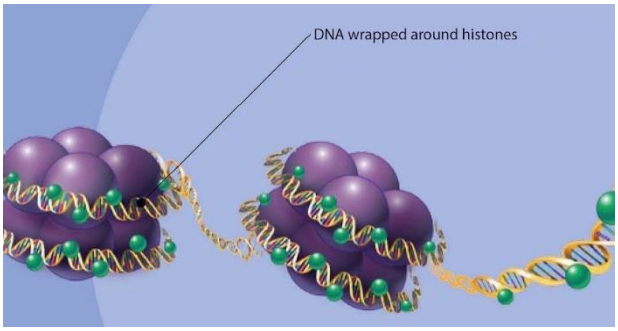
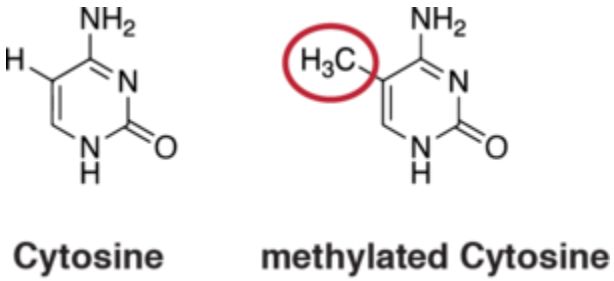
Biotechnology and Genetics Blog Post – Epigenetics

In 1942, the term "epigenetics" was first used by a British developmental biologist, named Conrad H. Waddington, who was also an embryologist and geneticist at the Cambridge University. The term was first used during the time when there was very little knowledge about genes and their hereditary roles. Epigenetic changes in an organism affect not the DNA, but the way how a cell reads genes. There are two main types of epigenetic modification: DNA methylation, and histone regulation. DNA methylation is when a methyl group (CH_3) is added to the nitrogen bases of the DNA structure, usually naturally by environmental factors, which then turns of the protein production of a certain gene, in other words, it turns the gene "off". The other type of epigenetic modification is histone regulation. Histones are proteins that the DNA wraps around tightly to make a spool-like shape. Without these histones, DNA would be too long to fit inside of cells. Often, if the histones "squeeze" the DNA too much, then the gene is unable to produce proteins. Epigenetics help release the tightness of the squeeze, allowing the DNA to produce more proteins, in other words, it turns the gene "on".



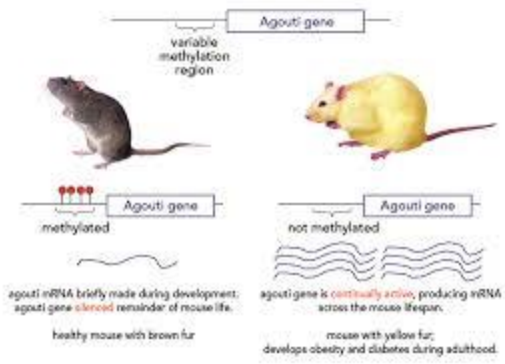
1 A close up image of DNA wrapping around the histone proteins.

The use of epigenetics has certainly grown over the years, as it can now be used as an alternative biotechnological strategy used to grow crops instead of genetically modified products. Genetically modified food has always been controversial, as many people believe that since the genes of the organisms have been either removed, or new one have been added, that it is not the same type of product anymore and that it can be dangerous for consumption. Scientists use epigenetics to "trick" the plant into thinking that it is growing in harder conditions, which makes it work harder to reproduce. By using epigenetics, scientists can modify the way a crop grows, tastes, looks, and much more without the need to remove or add any new genes. The reason that this form of biotechnology can be considered better than gene modification is because all that the scientists are doing are modifying the genes that the plants already have, not adding or removing any genes. Another reason why epigenetics is a good form of biotechnology is because it can help reduce stress and other mental or physical health problems. Stress has a possibility to create epigenetic changes, such as neurological problems in the offspring. Other lifestyle factors which could affect epigenetics are physical activity, diet, obesity, tobacco smoking, alcohol consumption, environment pollutants, and even work during night shifts. All of these little factors can cause such great problems. This is why these forms of epigenetics are best used. If everyone understood the dangers of epigenetic modification, there would be more motivation to do their best to maintain a healthier lifestyle. It is important to know why some environmental factors can affect genes and DNA, so that an organism does not need to have any unnecessary epigenetic modifications.



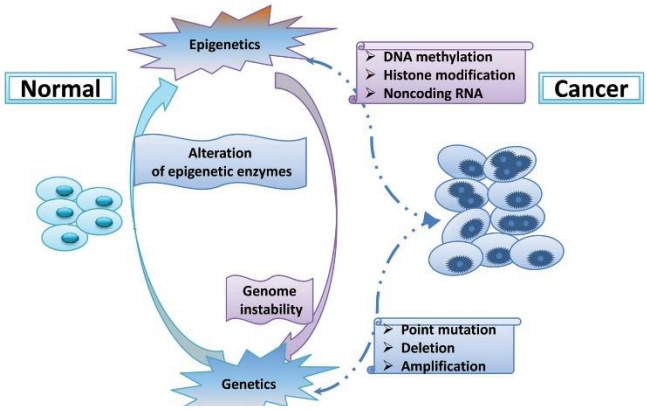
2 Example of cytosine that has undergone the DNA methylation process. Notice that the cytosine remains the same, only the methyl group has been added. No other modifications have been added.

One of the greatest advancements in epigenetics was the experiment that was performed in 2007. In the experiment, mice with the gene called *Agouti*, the gene that provides the yellow colour and diabetes (causing obesity and then rapid death) were used. The mice were fed food that contained the methyl group (CH_3) to be used as "markers" for the experiment. Amazingly, the offspring of these mice were born brown, slim, who did not suffer from the diabetes disease, and therefore were able to live for much longer than their parents. This happened because the *Agouti* gene still existed in the offspring's cells, but because the process of DNA methylation occurred, the gene was silenced. Therefore, scientists were able to come up with a conclusion that not only offspring can be interchanged depending on what their parents ate, but what their grandparents ate can change which genes are on or off as well. Another big advancement happened recently, in 2013, as scientist saw that when mice were fed a calorie-restrictive diet, their offspring showed the signs of delayed aging, because the diet of the parents helped decrease the levels of histones. This caused the genes that helped with delaying aging turn on.



3 Difference shown between mice with the Agouti gene showing versus mice with the gene turned off by DNA methylation.

Scientists have started to realize how epigenetics can change a lot about certain organisms. For example, scientists now think that epigenetics might play a role in the development of some cancers. Epigenetic modifications could cause a gene that suppresses tumors to turn off, and therefore a resulting possibility of cancer. This can also be explained by using the example of the gene that checks the growth of cells. If this gene is turned off it can also lead to cancer. It is still quite difficult for scientists to regulate this kind of gene activity, as usually the changes occur naturally, often from something as simple as a different diet. However, if an easier way to control this activity in the DNA will be invented, then controlling and experimenting with epigenetic modifications could have a huge utilization later in the future, which could even help reduce the risks of diseases, such as cancer.



4 There is a huge possibility that epigenetic advancements in biotechnology can help regulate some diseases, such as cancer.

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