Epigenetics: The Science of Change

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ABSTRACT

While most of the scientific research into disease, behavioral aspects, and environmental effects focuses on changes in DNA sequence, researchers have been more recently exploring the idea that gene function could be affected without changing the DNA sequence. By creating tags to change how genes can express themselves, Epigenetics may be the new answer to how environmental factors can alter gene functions in offspring and later lineage. For our project, we first will explore how epigenetic tags create these changes by the twin comparison experiments. Next, we want to explore how certain factors create epigenetic changes that affect early childhood development and possible life-long changes.

INTRODUCTION

Every cell in the human body has the same set of genes, however, the cells in our brain, eyes, hair, and skin look and behave different from each other.

In the case of identical twins, people often like to find out traits that two people who look the same do not have in common. Maybe one likes adventure, while the other prefers the couch, or one likes to paint but the other does not even know how to hold a paintbrush.

This study of how these differences come about and an interesting topic for researchers nowadays is called Epigenetics.

EPIGENETICS

- Epigenetics is the study of when a chemical compound binds to DNA, certain genes are activated or deactivated, selecting which proteins are made.
- In early life, epigenetic processes play a critical role in determining how cells will develop and specialize. These processes can be influenced by many factors, including diet, stress, aging, and environmental factors.
- Over time, the changes in the epigenetic pattern from environmental influences is what causes these differences.

Important Terms:

- Monozygotic Twins [MZ]
- CpG Sites
- Cytosine & Guanine
- CpG Islands
- Heritability

TWIN EXPERIMENTS

To further study Epigenetics, scientists needed a way to differentiate between altered gene expression.

- MZ twins are assumed to share almost 100% of their genetic variance. They are also useful in research as they share factors such as age, maternal effects, and early environmental factors.
- Researchers focus on CpG Islands, as a 1975 study on gene regulation showed that a reduced gene expression was from CpG methylation at the 5' regions [Figure 1]
- Illumina BeadChips are used to read the gene sequence [Figure 3]

For our focus, we researched using MZ twins to look at disease and epigenetic relations. The studies use sets of MZ twins, with one having a disease and the other not. Results have led to the identification of markers for cancer, psychiatric disorders, pain sensitivity, autoimmune diseases, and many more. In figure 2, bar graphs show what factors were identified in contributing to common diseases. For most of the diseases, environmental factors caused the most epigenetic changes.

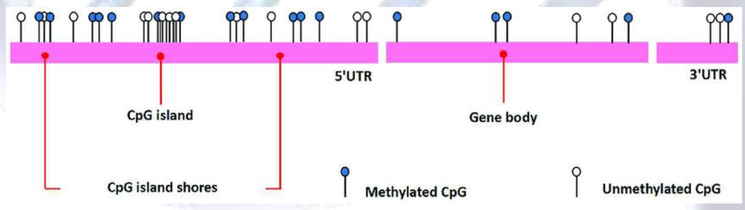

Figure 1. CpG Island

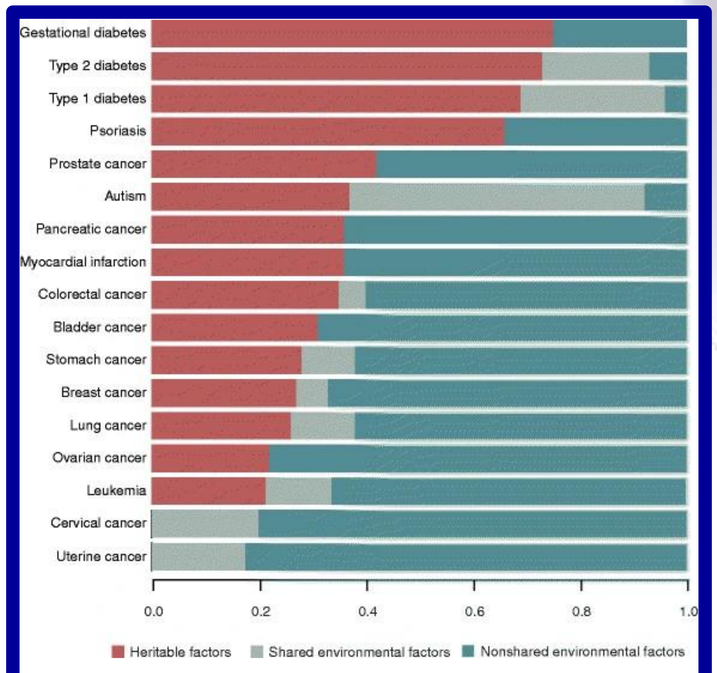

Figure 2. Heritable and environmental factors contributing to disease

Figure 3. Illumina BeadChip Array

These boards are used to process and image the genetic sequence in a sample collected from a twin

CONCLUSIONS

A grand majority of infectious diseases can affect us through genetics and environmental factors because of epigenetics. Nature vs. nurture is the debate for what truly affects raising children, and which is more important. Epigenetics is heavily involved with nurture side of things, and twins remove the nature side of things, as they are natures closest thing to clones without it being clones. Different early life experiences and different physical activities (such as one playing football and the other playing soccer) can truly demonstrate epigenetics effects on our lives.

FUTURE WORK

Cancer is one of the most deadly diseases of our time, and we hope to research further into it by exploring the topic with epigenetics in mind

- Cancer can be caused by outside sources (radioactive material exposure, exposure to nuclear weapons, or smoking)
- Epigenetics could help us determine how these types of cancer can occur
- Epigenetics could also help us try and figure out a way to prevent these types of cancer from manifesting in the first place
- It could also help explain why some people are more prone to cancer than others based on previous experiences

References

Castillo-Fernandez, Juan E, et al. "Epigenetics of Discordant Monozygotic Twins: Implications for Disease - Genome Medicine." *BioMed Central*, BioMed Central, 31 July 2014, https://genomemedicine.biomedcentral.com/articles/10.1186/s13073-014-0060-z.

"Epigenetics." *National Institute of Environmental Health Sciences*, U.S. Department of Health and Human Services, https://www.niehs.nih.gov/health/topics/science/epigenetics/index.cfm#:~:text=In%202005%2C%20a%20team%20of%20Italian%20researchers%20provided,epigenetic%20patterns%2C%20including%20DNA%20methylation%20and%20histone%20modifications.

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