How do your genes and the environment interact?

Most common diseases are a result of both your genes and your environment. Your environment can include personal choices, such as what foods you eat and how much you exercise, and external factors, such as stress, clean water, and air quality. Only a small number of diseases are a result of just a single mutation in a gene. Examples of these single-gene disorders are Huntington disease and Tay Sachs . Most diseases, especially common diseases, are a combination of your genetic risk and your environment. It is becoming difficult to group diseases into either purely 'genetic' or 'environmental' because most diseases are a little bit of both. For example, emphysema can be the result of both smoking and a disorder called alpha-1-AT deficiency . The field of research looking at gene-environment interactions (GxE) is growing.

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It is important to understand that most times your genes do not determine your health. Small differences in your genetic makeup mean that two people can respond differently to the same environmental exposure. Here are some ways that your genes and your environment can interact:

- **Mutagens** – Mutagens are pollutants in the environment that enter the body and directly change your DNA sequence. Example: The chemicals in cigarette smoke can cause cancer.
- **Gene-gene interactions** – Gene-gene interactions occur when pollutants in the environment do not change your DNA sequence, but rather cause a chain reaction that affects the functioning of one gene that then affects the functioning of another gene. Example: Regularly drinking way too much alcohol can cause a specific gene, TACE, not to produce enough of its protein. TACE protein is supposed to help the MTHFR gene make enough of its protein. Too little MTHFR protein changes the level of folate (another protein) in our blood, and low folate levels may cause depression.
- **Transcription factors** – Pollutants in the environment can indirectly affect the DNA sequence by altering transcription factors, which are responsible for starting the process of using genes to make proteins that are needed for different functions in the body. Example: Stress can change

the amount of proteins made by genes involved in your immune system and therefore, you may get sick more easily when you're stressed.

- **Epigenetics** – The environment can alter your health by affecting the proteins that turn genes on or off. Continue reading for more information on epigenetics. Example: half the genes that cause familial or inherited cancer are turned off when pollutants in the environment affect these proteins. Because they are turned off, these genes cannot suppress tumor formation or repair DNA.

Epigenetics

The epigenome is the primary location of gene-environment interactions and can be altered by the environment both directly and indirectly. It literally means "on top of or in addition to genetics," or basically factors outside of the genetic sequence. Epigenetic factors (most famously histone modification and DNA methylation) can switch genes on or off and determine what proteins are transcribed. They are involved in many normal cellular processes and epigenetic changes are a natural part of human development. Some changes, however, can lead to disease. Some of these abnormal changes can lead to diseases such as:

Cancer	Mental Retardation	Neurodevelopmental Disorders	Infertility
Cardiovascular Diseases	Type-2 Diabetes	Obesity	

Epigenetics and the Environment

Some environmental exposures and dietary factors can lead to abnormal changes in epigenetic pathways. Because epigenetic changes are subtle and cumulative, it is difficult to know the true causal relationship between epigenetics and the environment. Some factors that can lead to epigenetic changes include –

Heavy metals, such as Cadium	Vincolzolin, a widely used pesticide	Folate and methionine deficiencies	Cigarette smoke