The Health Nugget

To the 3rd and 4th Generations

Through the magnifying glass of epigenetics, we saw last month how environmental factors can modify the very expression of DNA, in rats at least. Epigenetics means "control above genetics." It has opened up an understanding of how modifications of gene activity can occur and be passed down to successive generations, without an actual mutation or change in the DNA blueprint. Lest we conclude this only happens in animals, consider 19th century northern Sweden.

Hugging the North Pole, the county of Norbotten experienced extreme cycles of feast and famine in the 1800s. Preventive-health specialist, Dr. Lars Olov Byrgen, of the Karolinska Institute in Stockholm, researched the effect of such extremes on the children and grandchildren of the few who lived in Norbotten during this time period. Byrgen wanted to know, "Could parents' experiences early in their lives somehow change the traits they passed on to their offspring?"[1] Initially, his ideas may have sounded preposterous, but Byrgen's research proved anything but crazy.

Thanks to his Swedish Royal Majesty the King, accurate regional harvest records had been kept during that era. After going over both agricultural and human records, Byrgen discovered that males who—during times of feast—consumed an overabundance of food as pre-pubescent boys, had children and grandchildren who died decades earlier. Diabetes was prevalent in this group as well. Amazingly, the grandchildren of those who endured lean times during the same period of life lived longer and were less likely to die of cardiovascular disease. The data he uncovered suggested that, "overeating as a youngster could initiate a biological chain of events that would lead one's grandchildren to die decades earlier than their peers did."[2] The effects of food availability were observable across three generations!

The fact that the amount of food consumed altered life expectancy in grandchildren is extremely interesting. However, the question and underlying question is, how could that have been inherited? Science's conventional dogma is that DNA carries all our heritable information and that nothing an individual does in their lifetime will be biologically passed to their children. But this theory doesn't explain what took place in Sweden. While the modern Swede may never even have met his grandparents, his epigenomes remembered them.

Last month we defined the epigenome as the cellular material that sits outside the genome, responsible for determining cell type, activity and gene expression. The function of the epigenome is quite sensitive to environment: nutritional components, chemicals, toxins and even mothering. "Put simply, and as bizarre as it may sound, what you eat or smoke today could affect the health and behavior of your great-grandchildren. Epigenetics introduces the concept of free will into our idea of genetics."[3]

Byrgen, with fellow researchers, used the Avon Longitudinal Study of Parents and Children (ALSPAC) to make an interesting discovery. Of 14,024 fathers studied in England, 166 began smoking before age 11. This is when males are about to begin manufacturing sperm. The years around puberty are a critical time period for environment to impact the DNA of future posterity, just as we saw in northern Sweden. The body mass of the children born to the early smokers was significantly higher than other boys by age nine. Their future risk of obesity, health problems and earlier death is much higher.[4] The children did not ask for this weakness. The bad

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hand dealt to them, while not a defective blueprint, is theirs as the result of their father's choices.

Genetic determinism has in some degree fostered a sense of powerlessness and seeming inability to alter our course. We have seen some diseases just run up family trees like devouring termites. We figure that if grandfather, father and brother had prostate cancer, it's our destiny. It could be looked upon as a generational curse. Epigenetic influences however, do not always veer down. Through them generational blessings are possible too.

Agouti mice carry the agouti gene, which makes them yellow, fluffy, diabetes- and cancer-prone, obese rodents. Agouti mothers give birth to agouti babies, bequeathing the generational curse. Researchers Randy Jirtle, a professor of radiation oncology at Duke University, and his postdoctoral student Robert Waterland, wanted to know if they could alter the heritage of the doomed. By simply changing the mother's diet, Jirtle and Waterland were able to seemingly erase the agouti gene. Instead of giving birth to yellow, fat babies, out popped brown, slender, healthy pups minus the tendency to cancer and diabetes. Before conception, female mice were fed a diet supplemented with vitamin B12, folic acid, betaine and foods rich in methyl donors. Methyl donors are chemical groups that can alter DNA expression.

"After being consumed by the mothers, the methyl donors worked their way into the developing embryos' chromosomes and onto the critical agouti gene. The mothers passed along the agouti gene to their children intact, but thanks to their methyl-rich pregnancy diet, they had added to the gene a chemical switch that dimmed the gene's deleterious effects. 'It was a little eerie and a little scary to see how something as subtle as a nutritional change in the pregnant mother rat could have such a dramatic impact on the gene expression of the baby,' Jirtle says. 'The results showed how important epigenetic changes could be.'"[5]

DNA methylation is one way in which genes are epigenetically modified. It is a process in which a methyl chemical group (CH3) attaches to a gene or to surrounding proteins and as a result modifies its expression. This can result in thousands of different readings of that gene. Remember those stressed out rats from last month? Scientists discovered that a lack of being licked in infancy resulted in a lack of methyl groups in certain areas of the brains. When methyl groups were injected into these areas, the stressed-out fully-grown rats became calm.

Methylation is just one chemical reaction. There are others. Combined, they are the real movers and shakers of our genetic blueprint. Environmental influences can turn on the switch or shut it down. The switches can be knocked off or regained. What incredible value this places on our lifestyle and our environment.

You and I did not pick our genes. We may have inherited a generational curse. The good news is that it is not irreversible. That which has been turned on, can be turned off and vice versa. It is possible to send to our offspring a genetic code free of the skeleton in the closet.

Scripture says, "In those days they shall say no more, the fathers have eaten a sour grape, and the children's teeth are set on edge" (Jeremiah 31:29). Whatever the generational curse, God has the specific plan and all the power needed to reverse it. He doesn't want to "visit" and keep witnessing (revisiting) "the iniquity of fathers on the children and on the grandchildren to the third and fourth generations" (Exodus 34:6-8, NAS).

[1]Cloud, John. Why Your DNA Isn't Your Destiny. Time. 1/6/10.http://www.time.com/time/health/article/0,8599,1951968-1,00.html.
[2]Ibid.
[3]Watters, Ethan. DNA is Not Destiny. Discover.11/22/06. http://discovermagazine.com/2006/nov/cover.
[4]Sex-specfic, male-line transgenerational responses in humans. European Journal of Human Genetics (2006) 14, 159– 166.
[5]Watters, Ethan. DNA is Not Destiny. Discover.11/22/06. http://discovermagazine.com/2006/nov/cover.
[6]White, Ellen. *Counsels on Health*, p. 37.

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