

Nutrigenomics? Epigenetics? The *must-know* buzzwords of 21st century health care

We've always held a fascination with our DNA, the huge library of genetic information stored in every one of the 50 trillion or so cells which make up the human body. The almost magical secrets stored in our DNA find themselves woven into television dramas and murder mysteries. It seems that a single hair or a lipstick smudge on a glass can be enough to accurately identify an individual! But can we utilise information about DNA to enhance our health?

Away from the screen and back to the real world, our fascination with DNA seems boundless. The fascination has been fostered by the remarkable work of a group of scientists who, just 10 years ago, finished mapping the entire human genome, an enormous undertaking which has led to a far deeper understanding of how our genes affect our health.

If we were to unravel the entire DNA in every cell in the human body, it would stretch from earth to the sun and back 70 times! This enormous library of information stores every little characteristic that makes you unique!

The **Human Genome Project** succeeded in cataloguing each of the 30,000 genes which reside in each cell of every human being; some of these 30,000 genes we share with other species on this planet – but our particular combination of genes defines us as uniquely human.

So why should we care?

Interesting as it is to know these facts about our DNA, what is more useful is the knowledge that can influence our genomes in ways that can improve our health. It is not so very long ago that we thought that the genes we were born with were '*cast in concrete*', never to be altered. So, if we saw that a long line of our older relatives all developed the same disease (for example heart disease), we would have assumed that we would be powerless to stop it developing in ourselves as well. What's been unfolding over the last decade is the exciting fact that we *DO* have significant control over our genome in ways we never thought possible. And this can translate to much better health for us all.

Working with DNA '*spelling mistakes*'.

Every time a human cell divides to produce two new cells, it has to copy the exact DNA from its 'library blueprint' into the two new cells. This should result in a perfect DNA copy in the new cells but for a variety of reasons, it may not be. In short, the copy process sometimes produces *spelling mistakes* - or *typos*! When a spelling mistake occurs in a gene, it may not make the gene worthless;

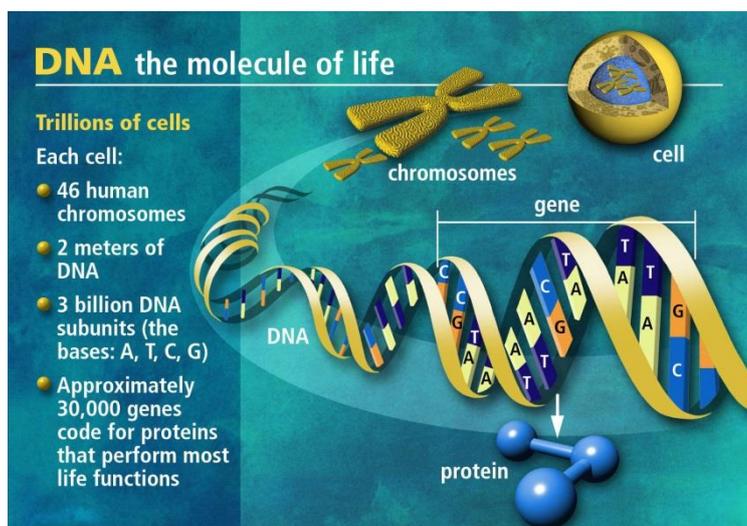


Figure 1. Lengths of coiled DNA are grouped into genes. Each gene carries the code that the cell uses to make a specific protein. Each of these proteins is essential for normal cell function.

more likely the DNA code produces a protein (usually an enzyme) which doesn't work as well as it should. So the job gets done but perhaps only at 70% of the expected efficiency.

Geneticists call these faulty genes 'SNPs', pronounced 'snips' (*single nucleotide polymorphisms*). We all have numerous SNPs and in part, this is what makes us each uniquely different. Some of these SNPs, such as toenail shape, don't affect one's health or wellbeing. On the other hand, if you have a SNP which prevents your blood vessels from relaxing as they should, you may develop high blood pressure and other cardiovascular abnormalities. This can be perplexing because you might be careful to eat well, exercise regularly and get enough rest – but still your blood pressure tends to be higher than normal.

Genome Profiling

New information about the human genome now makes it possible to have a sample of your DNA taken and selected genes tested for the presence of SNPs. One of the genes which is associated with the elasticity of the blood vessels is a gene known as eNOS (endothelial nitric oxide synthase). If you have an abnormal variant in the eNOS gene, you may be one of those whose blood pressure seems to defy all attempts to control it using a sensible lifestyle. The eNOS gene is also associated with the way blood clots in the vessels.

So how does this help me?

The rapidly-growing field of Nutrigenomics may provide solutions to help you to optimise the function of the variant genes. Certain foods are known to influence many common gene SNPs and so it is possible to select particular foods and/or nutrigenomically-active supplements to increase the expression of the abnormal genes towards normal.



Figure 2 Young broccoli sprouts as the highest source of nutrigenomically-active Sulforaphane

Nutrigenomically-active foods and supplements.

The word 'nutrigenomics' is derived from 'nutri' meaning food and 'genomics' referring to your genes. In other words; 'your food talking to your genes'. One of the most bioactive nutrigenomic food chemicals is a compound known as 'sulforaphane' which is released in abundance from certain forms of broccoli sprouts.

Sulforaphane (pr. Sul-4-a-fane) is capable of activating a molecular 'switch' in human cells and this switch

influences literally hundreds of genes, each of which is associated with the way human cells protect themselves. In fact, Australian scientists have developed special sulforaphane-yielding supplements which can be used to counter the effects of many abnormal gene SNPs. The advantage of a 100% whole broccoli sprout supplement over eating broccoli as a food is that a consumer can be certain of obtaining a predictable amount of sulforaphane which is easily destroyed by inappropriate handling.

Outdated and flawed 'antioxidant' theories

For 60 years, vitamin supplements such as vitamins C, E and others have been promoted as a way of activating the cell's defences. It was thought that disease and premature aging were caused by



exposure to free radicals in the environment. The simplistic notion that *'all free radicals are bad and all antioxidants are good'* has turned out to be quite simply wrong and yet this theory has driven mega-consumption of synthetic vitamin supplements without there being adequate evidence for their benefit, unless a frank deficiency exists.

Research over the past decade has clearly shown that 'free radicals' in fact act as signals to tell the cell to 'switch on' its own defence systems. What excessive amounts of antioxidant vitamins do is to mask these signals; as a result, the cell doesn't know that it should be switching on its defences and therefore remains unprotected from the threat of environmental damage.

Without a doubt, our new understanding of the power of Nutrigenomics opens doors to personalised health care we only dreamed about a decade ago. This is because we can activate our cells' own defence systems using particular food molecules in exactly the same way as Mother Nature does.

Bottom line on Nutrigenomics

Even though we may have inherited some defective genes from our parents, the expression of many abnormal gene variants can be improved by choosing certain foods that can restore more normal function of that gene. So, even if all the members of your family appear to have suffered the same illness, presumably due to inheriting one or more abnormal gene SNPs, our newer understanding of nutrigenomics enables us avoid developing that same disease by choosing foods or supplements known to improve the expression of the defective gene(s).

Epigenetics – “buzzword” number 2.

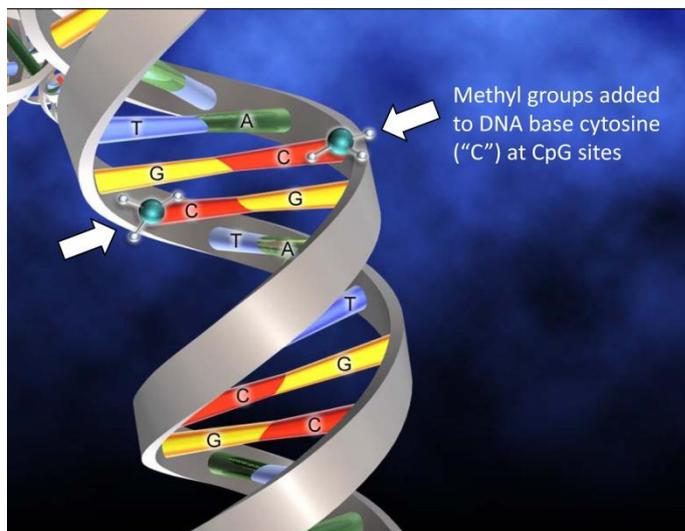


Figure 3 Methyl groups are like paper clips which can attach to the DNA and switch the gene 'on' or 'off'.

small molecular groups are like paper clips and that we can pin a paper clip onto part of the DNA; we can also remove it later without damaging the basic structure of the DNA.

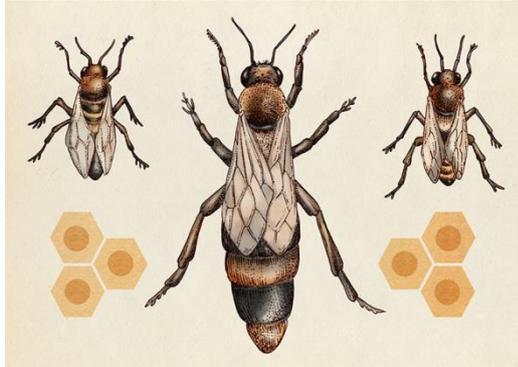
The most common form of 'paper clip' is a *methyl group* made up of one carbon and three hydrogen atoms. Such 'paper clips' can switch on certain genes and switch off others. In some cases, epigenetic changes are harmful as when Nature's protective *Tumour Suppressor gene* is switched off, a situation which occurs early in the development of most cancers. At other times, epigenetic changes can be beneficial and can be associated with our need to adapt to a changing environment.

Often used interchangeably with *'nutrigenomics'*, the word *'epigenetics'* is also associated with the way our genes are expressed, although different in its action.

As we saw earlier, SNPs occur when DNA makes the equivalent of 'spelling mistakes' in copying the code. In this way, the expression of the gene changes, so that the proteins produced from the defective code don't work as efficiently as they should if the error had not occurred.

Epigenetic changes also modify the way in which a gene is expressed – but in a different way. Let's imagine that certain

The Making of a Queen Bee – Epigenetics visibly at work



The most remarkable example of epigenetics at work is demonstrated in the way that a Queen Bee is ‘created’ by feeding a worker bee differently from the rest of the bees.

The bees make highly-nutritious Royal Jelly which is fed to just one bee who subsequently develops into a Queen Bee; such an extraordinary transformation simply as a result of the composition of the Royal Jelly.

Every one of the bees in the same hive carries genetically identical DNA. However, different bees in the hive have different roles as drones, nurses, workers and of course the one selected to be Queen. Even with identical DNA structure, the bees develop differently just because they are fed differently. It seems incredible that Royal Jelly can effect such epigenetic changes that a worker bee can not only become larger but also adopt a different role within the social hierarchy of the hive.

Epigenetics – the good and the bad

Epigenetics can have numerous effects, some desirable and others unwanted. Poor lifestyle choices such as smoking and excessive alcohol consumption can activate epigenetic changes in certain genes; disease becomes more likely and health and longevity less likely.

Most alarming is the fact that we can pass these epigenetic tags onto our offspring, so that our children and grand-children can be born with the same disease-promoting tendencies that we acquired in our younger years; this adds another dimension to the expression, *“the sins of the father.....”*

Epigenetics is also visibly at work when individuals survive famine. There have been several great famines in recorded history during which pregnant women survived and gave birth to apparently healthy offspring.

Because the surviving mothers were forced to adapt to lowered food intake, they carried epigenetic tags on their genes, the means by which they were able to adapt to their dire circumstances. When the children of those women were born with the same epigenetic markers, they quickly became overweight once they started to eat a normal diet; the epigenetic ‘memory’ of their cells behaved as though they were living in an environment of famine, behaving to conserve energy. Some scientists think that this carry-over effect from adaptation to past famines may be an added contributor to today’s obesity epidemic.



Fig. 4: Front cover of TIME magazine January 18, 2010

How does knowledge of nutrigenomics and epigenetics affect me?

The growing popularity of this paradigm is such that in January, 2010, TIME magazine featured it on its front cover. The Special Article entitled, “*Why Your DNA Isn’t Your Destiny*” sought to capture the enormous importance of this new concept in personalised health care. Its message was to convey the fact that no longer are we as individuals dealt a rigid genetic hand of cards at birth; instead, by modifying our environment and lifestyle choices, we can maximise the expression of our genes.

What is so profound is that every mouthful of food we consume contains compounds which engage in complex and intricate ‘*conversations*’ with our genes, modifying their expression for better...or for worse, depending on the foods we eat and the lifestyle choices we make.

From the very first contact a new baby has with its mother’s milk or colostrum, signals are being sent to the baby’s genome. There can be lifetime consequences to infants (and *their* offspring) who are fed over-processed foods early in life; changes to the child’s *epigenome* acquired during its lifetime can be passed down to subsequent generations.

Each of us in our pre-reproductive years has a huge responsibility to take care of the genome our children and grandchildren will inherit. Rather sobering, isn’t it, especially when our youthful pre-reproductive years are often spent abusing our bodies in ways that are pushing our cells to the absolute limit?

Nutrigenomics teaches us that food is so much more than a means of satisfying appetite; food is a library of complex chemical compounds continuously interacting with our DNA. Nutrigenomically-active substances are like the conductors of an orchestra, sending continuous subtle signals to the musicians so that the finished performance is perfectly-synchronised. Such is the magnificent and complex function of human cells. We are really only just beginning to comprehend their intricacies as we sit on the cusp of this exciting new paradigm in personalised health care.

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