genetic make-up

know your DNA and improve training results

by Kris Abbey B. Ed (Phys Ed & Sci)

We often embark on a training program knowing very little about our physicality other than what we see in the mirror or feel in our body when we exert ourselves. Technology now exists - at an affordable price - that enables us to know about our physical make-up right down to our DNA. Through a simple saliva test, we can uncover hidden information that is vitally important to help set our training goals. Once you know your genetic profile, you can train accordingly, making it easier to reach your goals.

IN THE GENES

In 1909, Danish botanist Wilhelm Johanssen coined the word 'gene' for the hereditary unit found on a chromosome. Nearly 50 years earlier, Gregor Mendel had characterised hereditary units as 'factors', or observable differences that were passed from parent to child. Today, we know that a single gene consists of a unique sequence of DNA that provides the complete instructions to make a protein. Genes instruct each cell to make discrete sets of proteins at just the right times, and it is through this specificity that our 'uniqueness' arises.

Genetics shape us in many ways, including our potential to excel in sports. Training, diet and other factors naturally play a big role in developing and reaching our potential, but you definitely have a head start if you have certain genes that permit you to excel. The most simple example of this is having the 'height genes', making you much more suited to sports like basketball, netball or AFL football, but less likely to be a successful jockey!

HOW GENETICS INFLUENCE RESPONSE TO TRAINING

You may have the genetic potential to be a champion athlete, but if you have a poor diet and lifestyle and don't exercise, you're unlikely to achieve that potential. On the other hand, you may have limited genetic potential, yet find ways to compensate and become a high achiever. Genetics have a large influence over strength, muscle size and composition (fast or slow twitch), lung capacity, flexibility and, to some extent, endurance. They have less influence over balance, agility, reaction time and accuracy.

Your genes also determine how your body responds to training, diet and other external factors. Training increases cardiac efficiency, but the extent of this increase depends upon your genetics. Research on aerobic endurance shows that some people respond more positively to training than others. So even if you have a low genetic potential for endurance, you may respond well to training and develop your potential more completely than someone with genetic 'talent' who doesn't respond to training.

While it is more likely that elite athletes are blessed with great genetics, even recreational athletes can make the most of their ability through optimal conditioning, good nutrition and a positive mental attitude. You can further enhance your results by doing what is most suited to your DNA profile.

ONE SIZE DOES NOT FIT ALL

Two people may follow an identical diet and training program, yet have totally different results. Chalk this up to genes! People inherit variations in their genes and even slight variations can have a profound effect on how your body responds to diet and exercise.

Genes are segments of DNA, which is found in all your cells. DNA is essentially a chemical database for your body, telling it how to behave and interact on a cellular level. A basic gene can have many different forms, such as the normal variations of the gene that determines specific hair colour.

Similarly, your genes determine how complex chemical reactions play out within your body. A particular gene may dictate how your body metabolises a certain food. Some people might have a slight variation in that gene. As with the hair colour gene, the variation in this gene is perfectly normal. But just as you may end up with a different hair colour, you also may end up reacting differently to a particular diet and training program if you have that genetic variation.

Today, a handful of tests are available that can detect some of these genetic variations and predict how you're likely to respond to certain training methods.

DISCOVERING YOUR DNA

There are numerous benefits to doing a DNA test. Aside from knowing your DNA make-up to best devise a training strategy that will deliver maximum results, it is also useful for your long-term health. Knowing what conditions you are genetically predisposed to allows you to adjust your lifestyle to reduce the risk of that condition manifesting in the future. For example, since heart disease is hereditary in my family, I keep myself fit and don't have a diet high in saturated fats. Knowing your health blueprint allows you to be proactive, rather than reactive, when it's often too late!

GeneElite™ is a company that specialises in DNA testing for the fitness industry. Their test identifies and assesses variations in 15 genes related to cardiovascular health, fat metabolism, bone health, antioxidation, VO^2 max and fitness, inflammation and recovery. The test involves a simple cheek swab, and within several weeks you receive a report outlining the results on the genes (and their variations) that are assessed. The 15 genes tested play an important role in body fat metabolism, lean body mass development, recovery and nutrition.

Body Fat Metabolism

ADRδ-2 (Lipid Metabolism)

The human body is composed of lean tissue, such as muscle, bone and organs, that is metabolically very active, and fatty tissue that is metabolically less active. The minimum body fat considered safe and acceptable for good health is 5% for males and 12% for females. Once men creep up over 25%, and women over 32%, there is a dramatic increase in illness and disease.

Adrenaline activates the breakdown of fats, which is influenced by exercise and so regulates body weight. Adrenaline works by activating a molecule called the beta-2 adrenergic receptor (ADRδ-2). A variation in the ADRδ-2 gene in females is associated with reduced fat oxidation during exercise, higher BMI and higher fat mass. In sedentary obese males, the normal gene causes a slightly higher increase in fat accumulation. However, in non-obese males and obese males who exercise, the variation in the ADRδ-2 gene causes a reduction in fat loss. The 20% of the population who have this variation need to work a little harder at maintaining a healthy weight.

PPARγ2 (Insulin Sensitivity)

Visceral fat is the fat that is found deep in your abdomen and surrounding organs. It is metabolised into free fatty acids, which travel to your liver to be converted into cholesterol. If the amount of fatty acids in your liver is too high, it can result in over-production of cholesterol and insulin resistance. Insulin resistance lead to the onset of Type II diabetes. Over-production of cholesterol leads to the blockage of blood vessels, leading to a higher risk of cardiovascular disease. Both diseases are common in obese people.

Peroxisome Proliferator-Activated Receptor gamma 2 (PPARγ2) plays a key role in regulating fat metabolism and glucose turnover (insulin sensitivity). PPARγ2 activity in visceral fat causes fatty acid mobilisation into the blood vessels that travel to your liver. A variation in the PPARγ2 gene results in reduced activity. This results in a lower metabolism of visceral fat, so carriers are potentially protected from Type II diabetes and cardiovascular disease. (Over 70% of the population have the variation). However, there is no safe form or level of obesity.

Lean Body Mass Development

ACE (Cardiovascular Health & Insulin Sensitivity)

The cardiovascular system ensures that the blood carrying the necessary nutrients and oxygen to sustain your cells reaches all areas of your body. It does this by pumping blood at pressure through a system of blood vessels. The need for more blood is achieved by increasing the pressure of the system, which involves increasing your heart's beating rate and reducing the diameter of your arteries. However, a constant elevation in pressure, due to narrowing of the arteries, can have a serious impact on your health. This narrowing can occur due to build-up of cholesterol, plaque formation or increased nerve activity. Constantly having your cardiovascular system under great pressure can result in coronary heart disease (reduced blood supply to the heart), myocardial infarction (heart attack) or stroke. The angiotensin converting enzyme (ACE) is involved in the narrowing of blood vessels. A variation in the ACE gene leads to an over-production of the enzyme. (35% of the population have the variation). This in turn can lead to unregulated narrowing of blood vessels, the overgrowth of heart tissue (myocardial hypertrophy) and insulin resistance. The combination of these can result in high blood pressure, heart disease and Type II diabetes.

eNOS-3 (Cardiovascular Health)

A good supply of oxygenated blood to muscles during exercise allows muscles to expend more energy over a longer period of time, thus increasing performance. VO^2 max is the maximum amount of oxygen you can use in one minute per kilogram of body weight. Fitter athletes have higher VO^2 max values. VO^2 max is affected by the ability of the cardiovascular system to transport oxygenated blood to muscles. Nitric oxide relaxes the muscle cells of the arteries and prolongs vasodilation (widening of blood vessels), inhibits platelet formation (artery blockages) and activates new growth of blood vessels, allowing a good supply of oxygenated blood to muscles. Endothelial nitric oxide synthase (eNOS) is a key enzyme involved in the synthesis of nitric oxide. A variation in the eNOS-3 gene results in reduced nitric oxide production. This in turn results in reduced VO^2 max, lowering sporting performance.

MTHFR (Cardiovascular Health)

The enzyme methylene tetrahydrofolate reductase (MTHFR), along with B vitamins, is involved in the metabolism of homocysteine. High levels of homocysteine have been associated with coronary heart disease, deep vein thrombosis, pulmonary embolism and stroke. A variation in this MTHFR gene is associated with an accumulation of homocysteine. (55% of the population have the negative variation).

HIF-1 (Cardiovascular Health)

Angiogenesis is the production of new blood vessels, while erthropoiesis is the production of new red blood cells. Both increase the supply of oxygenated blood to the body's tissues. HIF-1 is a

molecule that is activated during periods of low oxygen, initiating the processes of angiogenesis, erthropoiesis and metabolism. A variation in the HIF-1 gene causes an increase in the amount of angiogenesis, erthropoiesis and metabolism. This may positively affect VO^2 max during and after training improving performance.

MCT-1 (Muscle Health)

Lactate is a product generated from the breakdown of glucose during the process of anaerobic metabolism and is produced in high quantities during exercise. Lactate formed in the muscles during exercise is transported to the liver through the bloodstream, where it is neutralised in the presence of oxygen. However, during high intensity or prolonged exercise, when oxygen levels are inadequate, lactic acid levels in the muscles and bloodstream rise, making blood more acidic. Deficiencies in the transport of lactate in muscle can result in muscle cramping and fatigue, compromising performance. Monocarboxylate transporter-1 (MCT-1) is involved in the removal of lactate from the muscles. A symptomatic deficiency in lactate removal can result in muscle injury during exercise and heat exposure. A negative variation in the MCT-1 gene results in lactate transport rates that are 60-65% of normal. (50% of the population have the variation).

Col1A1 (Bone Density)

Bone gives the skeleton the necessary rigidity to function as an attachment and lever for muscles, and supports the body against gravity. During childhood, adolescence and early adulthood, large amounts of calcium and other substances are added to bone, making it stronger. From the age of 30, the amount of bone mass reduced as the amount of calcium and other substances that are removed is greater than the amount added. Type 1 collagen is a structural protein found in bone. Type 1 collagen is made up of three components and variations in the balance between these components affects bone quality and mass. A genetic variation in the type 1 collagen (Col1A1) gene increases the level of one of the three components resulting in an imbalance in the composition of type 1 collagen, having a negative impact on bone density. (10% of the population have the variation).

Recovery

TNFα & IL-6 (Inflammation)

Inflammation is the response to damage of living tissue. Proteins, fluid and cells from local blood vessels migrate into the damaged area to mediate local immune responses and encourage healing. If an infective agent, such as bacteria, is present in the damaged area, it can be destroyed by the immune response. The damaged tissue can be broken down and partially liquefied, and the debris removed from the site of damage. However, if the process of inflammation becomes over-reactive, the defensive actions become damaging, causing pain and slowing the healing process. Tumour necrosis factor alpha (TNFα) and interleukin 6 (IL-6) activate many of the substances and molecules involved in inflammation. A negative variation in the TNFα (30% of the population have this variation) or IL-6 gene (50% of the population have this variation) results in an over-stimulation of the inflammation process. This can result in a number of common disorders, including cardiovascular disease, joint pain, asthma and prolonged healing.

MnSOD (Antioxidation)

The oxygen we breathe, our consumption of alcohol, cigarette smoke, exposure to the sun's radiation and high intensity exercise all form reactive molecules known as free radicals. Free radicals can attack DNA, protein, fats and other cellular molecules in our body, which can potentially lead to cardiovascular disease, chronic inflammation and accelerated ageing. Our body's defence system against free radicals includes the enzyme manganese superoxide dismutase (MnSOD), which converts the free radicals to non-harmful molecules. MnSOD is also involved in DNA repair. A variation in the MnSOD gene results in 30-40% reduced antioxidation, hampering the body's ability to reduce the number of free radicals. (50% of the population have the variation).

Nutrition

CYP1A1, GSTP1, GSTT1 & GSTM1 (Antioxidation & Detoxification)

When we eat, drink, breath and take medication, our bodies accumulate harmful substances present in the food, environment and drugs called xenobiotics. Xenobiotics are found in many common foods and medication including caffeine (coffee), codeine (pain relief), steroids (eg. cortisone for treatment of inflammation), nicotine, alcohol, enzene (eg. from pollution) and polycyclic aromatic hydrocarbons (chemicals produced from frying, char grilling and barbequing). Over-accumulation of xenobiotics can lead to health problems including headaches, muscle and joint pain, fatigue, allergy or flu-like symptoms, inflammation, chronic mucous production, sleep disturbances and an inability to concentrate.

Our bodies must be able to efficiently remove these toxic substances before they can do us significant harm. The liver is the primary organ that carries out this process of detoxification, rendering the toxic substances less harmful and allowing them to be removed from our bodies. Other parts of the body that carry out detoxification include the skin, lungs, kidneys and colon, the areas exposed to xenobiotics.

The process of detoxification - converting fat-soluble xenobiotics to water-soluble molecules that can be flushed from our bodies - involves two phases. During phase I, the xenobiotics are metabolised into free radicals that can damage cells and generate oxidative stresses in the body, so over-activity of phase I enzymes can have a negative effect on health. A variation in the CYP1A1 gene (10% of the population have the variation) causes a 50% increase in free radical production. In the second phase of detoxification, the free radicals are neutralised and made water-soluble so they are easy to remove from the body. The enzymes GSTP1, GSTT1 and GSTM1 are involved. Variations in the GSTP1 (60% of the population have the variation) or the absence of the GSTT1 (25% of individuals) or GSTM1 (45% of individuals) gene may result in an accumulation of toxic substances in the body, leading to the health problems mentioned above.

According to Dr Valin Reja, molecular biologist and head scientist at GeneElite, "By refining your program, with the support of your health and fitness professional, you can capitalise on your genetic advantages, while targeting and compensating for your genetic challenges. A DNA analysis is valuable and permanent insight into your health and achieving desired reults."

MY STORY

I was fortunate enough to undergo the GeneElite test and now have a comprehensive report outlining my genetic profile. It's almost like looking into a crystal ball, seeing what conditions I'm more at risk of developing. This is invaluable knowledge and very motivating to do something proactive for my long-term health.

Armed with my results, I have enlisted the services of one of the best personal trainers around to help me set and achieve specific goals. Simon Stininato of Alltraffic Lifestyle & Fitness Professionals is at the forefront of DNA testing and analysis. He is also involved in training PTs in its use and implications, so I know I'm in good hands. Simon uses GeneElite testing for most of his clients. "It allows me to help clients reach their goals sooner. As a personal trainer, it is another service we can offer clients while ensuring they get results which keeps them coming back. It is a useful tool to have when designing a program specific to client's needs. I still perform fitness tests on all of my clients and combine the results from the fitness test with their DNA report to generate a highly individualised, goal-oriented diet and exercise plan. Knowing someone's DNA takes a lot of the guesswork out of developing a suitable program, so you don't stand around scratching your head when a client doesn't respond."

Over the next few issues, I'll share my test results and the program Simon has devised for me. So far, so good. I can't thank Simon or the good folk at GeneElite enough for the knowledge I have gathered so far. If you would like more information about DNA testing, visit www.excelgene.com.

DNA (Deoxyribonucleic Acid)
A DNA molecule consists of a long chain of nucleotides that are composed of deoxyribose (a 5-carbon sugar), a phosphate group linked to the bases (nucleotides) and adenine, thymine, cytosine and guanine. Within cells, DNA is organised into structures called chromosomes. The set of chromosomes within a cell make up a genome. DNA contains the genetic code that controls the production of proteins in living organisms. DNA determines the structure, function and behaviour of the cell. An important property of DNA is that it can replicate itself. This is critical when cells divide because each new cell needs to have an exact copy of the DNA present in the old cell.

Gene
A sequence of DNA that controls a particular cell function by governing the synthesis of a specific protein.

Genetic Disorder
A hereditary condition that results from a defective gene or chromosome.

Genetic Marker
A sequence of DNA that has a known location on a chromosome and is known to be associated with a particular gene or trait. Some genetic markers are associated with certain diseases, and detecting these genetic markers in the blood can determine whether someone is at risk of developing the disease. They are also used as a reference point for mapping other genes.

Chromosome
A threadlike component in cells that consists of a single, long molecule of DNA coated with proteins. Genes are carried on the chromosomes. Each cell in the human body has 46 chromosomes in its nucleus.