



# DNA and Epigenetic Profiling

2020-21

# The Decision Problem

Poor health is becoming an epidemic - we must start to focus on prevention, rather than just clinical solutions which are costly and may not address an underlying health issue.

## Facts\*

- 30% of absenteeism in the workplace is caused by stress, anxiety or depression –of which 92% have weight issues, are inactive or have a poor diet.
- 40% suffer from a musculoskeletal disorder (i.e. low back pain, lower limb problems, neck and shoulder problems). The higher the weight, the greater the prevalence.
- Nutrition is very important and yet few people understand exactly what is good for them, often making food choices based on habit or convenience.
- Digestive problems rank high in short term absenteeism. The underlying issues are often the same as those for cardiac, diabetes and cancer.
- Increased strength and conditioning and flexibility are particularly important for the ageing workforce (40 yrs)

## Decision Problem

The decision problem that Muhdo is looking to address is the key areas that can lead to a person being absent from work and/ or having to make a claim on their private medical insurance. These include:

- Stress, depression and anxiety
- Ailments and non-critical illness
- Non-contact (i.e. avoidable) physical injury

\*Study performed by Healthcare Risk Management on 22,000 UK people

# Muhdo Health Ltd

Muhdo is a genomics company that offers DNA and epigenetic profiling. While you are born with a fixed genetic makeup which can be analysed using our simple DNA saliva test, we can also analyse your epigenetic gene expression over time through periodic saliva testing. This enables us to calculate an extensive range of areas that you can track over time including your biological age, hearing, memory, eyesight and inflammation. The focus on inner health over external appearance sits at the heart of preventative healthcare. Muhdo can help at every stage of life from pregnancy, infancy, adolescence, adulthood and old age.

## DNA and Epigenetics Combined with Lifestyle Markers

Muhdo is able to understand how your day-to-day diet affects your body at a cellular and genetic level through the science of nutrigenomics. We do this by combining your DNA profile, which stays the same over time, together with a process called epigenetics, which refers to the changes in your gene expression. This is impacted by changes in your lifestyle, diet and environment.

By utilising your mobile phone to collect key lifestyle data and periodic saliva samples, we can measure your epigenetic gene expression. We can then both monitor and improve your inner health over time by providing you with hyperpersonalised health, nutrition and lifestyle recommendations aligned to your genetic profile and your health goal.

Understanding your genetics can help improve your mental health enabling you to enhance your cognitive function, creativity, working memory and reading comprehension. Muhdo can also help reduce stress, anxiety, depression, illness and even prevent injury based on your genetic code.



**"Our vision is the mass personalisation of preventative and curative healthcare through epigenetics. Prevention is better and cheaper than cure and inspiring people to develop healthy long-term habits is good for them and good for society. We need to focus more on internal health and democratise genetic knowledge so people can make informed decisions about their wellbeing."**

**Nathan Berkley**  
CEO OF MUHDO

# Muhdo Health Methodology

Muhdo understands that we all come with a set of unique genetic predispositions, but our lifestyle and environments will affect those same genetic traits and either dilute or accentuate them through a process called methylation and epigenetics.

Your epigenetic clock will help us to predict your biological age otherwise known as your phenotypical age or PhenoAge based on methylation points on your DNA.

DNA methylation (DNAm) is a process where tiny chemical markers called methyl groups will attach to one of the four nucleotide bases on your DNA (adenine [A], cytosine [C], guanine [G], or thymine [T]). As we naturally age these methyl groups will either hypo (low) or hyper (high) methylate regions across your genome, which will then affect how specific genes and biological processes function, such as your eye sight, hearing and memory.

Chronological ageing is as predictable as night follows day, your date of birth and age cannot be altered. Whereas our biological age (Phenoage) and the rate to which we age is a different matter entirely, with your ability to respond, alter and adapt to your internal and external environment thanks to epigenetics.

By simply having “Good genes” offers no guarantees to our health and wellbeing, nor does it on living to 100. Muhdo helps to simplify the fact that epigenetics is the intersection between genetics, nutrition, and environment and how diet, micronutrients, exercise and sleep can all change the expression of our genes - all at a touch of a button.

For the most part there will be two things that you will keep with you for the majority of your life, your mobile phone and your health. And as the symbiosis between humans and AI moves every closer and at an exponential rate, the realisation that the synergy between man and machine could possibly be the panacea for improving our health and longevity.

Muhdo's allows each of our users the ability to understand their genetic and epigenetic blueprint, but to then be able to see how their day to day lives such as their diet, exercise, sleep and environment are affecting them at a genetic and cellular level.

The main question and the key to epigenetics is that if we only look at one of these areas, we miss the influence and power of the others.

# Why do a genetic profile test?

As humans, we each have between 20,000 and 25,000 genes. Most genes are the same in all of us, but there will be differences in less than one percent of them, which is what makes us unique.

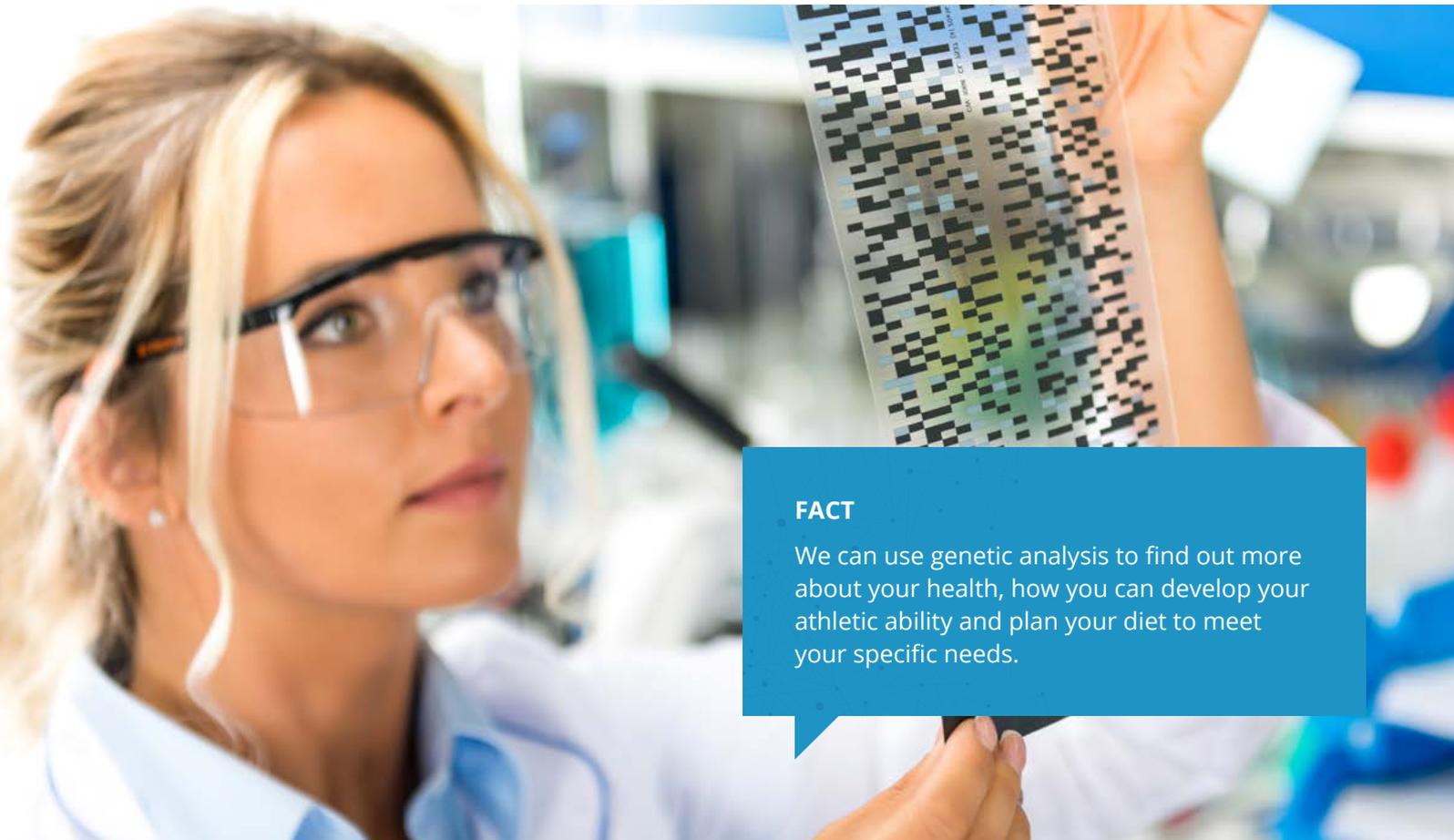
The science of genetics is helping us to understand what these small differences mean. Research has shown that your genes affect how you respond to your surroundings and experiences.

Tiny variations can affect how your muscles form and behave, how your body uses the major food groups and whether you are likely to lack certain vitamins or minerals.

That's why genetic testing is becoming increasingly popular and useful. A genetic test is very easy to do. Usually all that is needed is a saliva sample.

Your whole genetic story will be in your sample. The sample is analysed in a laboratory and then experts in sports science, nutrigenomics and health, who understand all the current research, interpret the results for you.

If you are interested in the details you can find out more at <https://www.ncbi.nlm.nih.gov/snp/>



## FACT

We can use genetic analysis to find out more about your health, how you can develop your athletic ability and plan your diet to meet your specific needs.

# What are genes and DNA?

A gene is a basic building block for all living things. Through your genes you inherit traits from your parents that are easy to see, like the colour of your eyes and hair, while others, like your blood type, are less obvious.

Each gene is made up of DNA (deoxyribonucleic acid) Like a recipe in a cookery book, your DNA provides the instructions needed to build and maintain all the different parts of your body.

DNA is like a set of chains - some long, some short  
- made up of four different types of molecules (nucleotides) that, for ease, are labelled A, C, G, and T.

A variation in the position of just one of these nucleotides in a DNA chain could make a difference to how your body works.

These variations are called SNPs (single nucleotide polymorphism - pronounced 'snip'). It is these differences that we look for in genetic testing and research.

## FACT

Even though identical twins technically have the same DNA, the genetic equivalent of 'typing mistakes' can take place in their genetic code as cells grow and are copied.

# How can genetic analysis help me?

Knowing that you will have variations in your DNA is the starting point. Genetic analysis can identify these tiny differences.

For this information to be useful to you, it is also important to understand what you want to achieve in terms of your health, fitness and lifestyle.

Then we can interpret your options and actions you can take.

See Paul's example on the right

Paul



1

Paul has a variant in a gene that means conversion of beta-carotene into usable vitamin A will be poor.

2

As a vegetarian Paul is likely to struggle to get enough vitamin A, even with plenty of yellow, red and leafy green vegetables at meal times.

3

On average Paul's conversion will be almost a third lower than most people. Amongst other things, vitamin A is important for Paul's immune system.

4

Eating additional good sources of vitamin A, such as dairy food and perhaps taking a dietary supplement can help Paul to keep healthy.

# How can genetic profiling help with fitness and exercise?

Around the world researchers, doctors, healthcare providers and many big businesses are exploring genetics to help find cures for diseases.

As their understanding of genetics grows, they are also discovering a lot about how the human body works.

This information is now making a real difference to our approach to fitness and exercise.

This is where the experts come in to interpret and use this information to help you.

[See Sarah's example on the right](#)



1 Sarah is a keen runner.

2 We know that the genes that affect blood pressure may also affect the rate at which blood and oxygen go to Sarah's muscles. This is called vasodilation.

3 We can use our understanding of these genes to help Sarah plan a programme that includes plenty of endurance training, as vasodilation will affect aerobic work.

# How can DNA testing help with highlighting health predispositions?

We will all be genetically predisposed to various health conditions, such as bone mineral density, high blood pressure and type 2 diabetes.

Knowing which ailments you are more prone to developing will allow you to put in place certain lifestyle changes that should mitigate some of these risk factors.

You must also remember that nature as well as nurture are both important factors that contribute towards developing a particular ailment.

See Jon's example on the right

1 Jonathan has been suffering from mild arthritis and low energy levels for a number of years.

2 Understanding his genetic predispositions to certain health factors such as inflammation, bone and joint health to which vitamins and minerals that he'll need to include in his diet has proved extremely useful.

3 It has allowed him to tweak his lifestyle slightly, removing the danger foods as well as incorporating the vitamins that he was missing.

4 Following a few easy and simple steps has helped Jonathan alleviate some of his symptoms.



Jon  
↙

# How about diet and nutrition?

We all know that eating a balanced diet is important for our health.

Still, each year, millions of people use weight loss products, slimming aids, plans and diets that just can't be maintained.

Understanding your genetics is the key to having a safe, sustainable diet that is tailored for your individual needs and how you respond to certain food groups.

**Your unique genetic code can give you answers to important dietary and nutritional questions, such as:**

- Are you extra sensitive to weight gain with simple carbohydrate intake?
- Should your fat intake be lowered, or even increased?
- How well do you use protein?
- Will unsaturated fats actually decrease your fat mass, even if your calories increase?



# Why choose Muhdo?

At Muhdo we're committed to giving you the most comprehensive DNA profile available with our accurate, state of the art laboratories and science. We do this by analysing over 1,000 snips (genetic variants) and providing you with 300 reports tailored to your DNA.

We don't look at your ancestry as we believe that your future health is more important. Whatever your health objective is our interactive app will give you all the information you need right at your fingertips!

So even if your goal is fat loss, muscle building, fitness & endurance or general health & wellbeing, Muhdo is with you every step of the way - because your health matters.

- The World's first Epigenetic tracking test
- Global leaders in DNA and bio-marker science
- We provide 300 reports on over 1,000 analysed snips (genetic variants)
- Hyper-personalised nutrition and training plan
- Use your genetic make-up to meet your health goals

 Eddie Hall  
World's Strongest Man 2017  
Muhdo Ambassador



# What does a Muhdo DNA test analyse for you?

## Diet and nutrition:

Find a healthy, sustainable diet specifically designed for you through a better understanding of your responses to protein, fats, carbohydrates and calorie restriction. Your overall health can be significantly improved when you understand your risks for deficiencies in vitamins A, B6, B9, B12, and D as well as minerals such as magnesium and selenium.



## Fitness and exercise:

Improve your overall fitness with a better understanding of your capacity for the following: power; endurance; flexibility; increased muscle size (muscle hypertrophy); lactate threshold; oxygen use (VO2 max); respiration (ATP) recovery rate; injury recovery rate; lean body mass; and power to weight ratio.



## Health and wellbeing:

Our analysis can also highlight your genetic predisposition for a variety of health conditions such as bone mineral density, risks for type 2 diabetes, obesity, hypertension and infection risk from colds/flu.



## Psychology:

Find out more about your body's dopamine response, which can affect behaviour, cognition and motivation. And as to whether you are a worrier or warrior or sit nicely in between?



# App User Guide

The aim of this section is to help guide you through your genetic results while supporting your learning and understanding of the information provided. We will go through the mobile app so you have knowledge of its full functionality. By the end you will be able to create an action plan and make any required changes to achieve your goals.

## Genetic results and outcomes

The following information relates to how we've arrived at the health conclusions and your specific results.

Firstly, we look at a panel, or set of genes, and small reference points on each gene called 'snips' providing a polygenic analysis for a specific predisposition such as Muscle Power or Vitamin D metabolism.

With each gene and snip having been heavily researched with at least 5 peer reviewed studies.

We then weight each snip and the most relevant studies according to a variety of factors such as, the University or institution where it was conducted, number of participants in each study and the year it was submitted.

An extremely important point to remember is that we also look at 1,000 snips. This provides both more detail and crucially more accuracy with our conclusions/results than other DNA profiles. This increased accuracy allows us to make more informed recommendations for you.



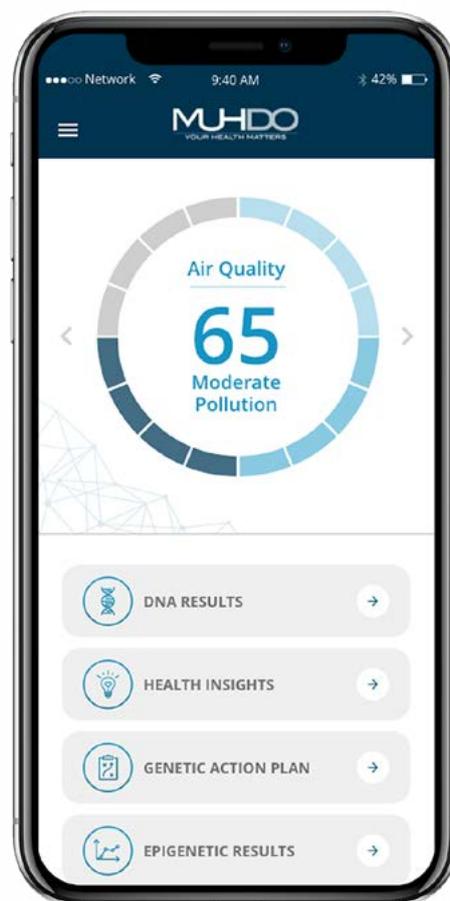
# The Muhdo App

## Main screen has the following functions:

- **Pollution Index** - This is based on where you are in the world and is linked to GPS through your phone. We are able to provide recommendations to reverse the effects of pollution, especially through nutrition.
- **Sleep Index** - This is linked to when you last used your phone at night to when you use it in morning. It will cover hours of sleep and can link to the sleep mode.

## Top left burger menu contains:

- Home page
- Profile & Preferences
- Questionnaire
- Kit ID Information
- Account Details



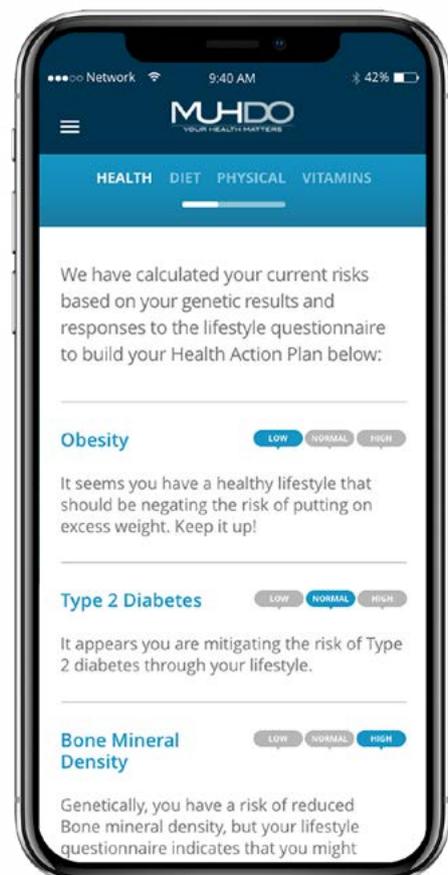
# The Muhdo App

## Genetic Overview:

- Identifies your key genetic information.
- It is broken down in to 6 different areas:
  - Diet/weight concerns
  - Vitamin deficiencies
  - Physical health risks
  - Physical health gifts
  - Health warnings
  - Sleep issues
- Each area will provide you with up to 3/4 key points.

## Genetic Action Plan:

- Once you have completed a questionnaire the app will produce an Action Plan. The questionnaire is to identify key points about you including, lifestyle, training, nutrition, vitamins, minerals, supplements and medication.
- The Action Plan is broken down into 4 key areas which include:
  - Diet
  - Vitamins
  - Physical
  - Health
- The actions are calculated via your current risk level based on your genetics and responses to the questionnaire.



# The Muhdo App

## DNA results

Once you have gone through the Genetic Overview and Genetic Action Plan you can take a deeper look in to your DNA results. To begin, however, you will need to choose what your health objective is.

## Health Modes

Select one of our 4 health modes:

- **Fitness and Endurance** - Caters to those who are actively running or out on their bikes, to those taking part in different sports each weekend and looking to improve their fitness levels.
- **Build Muscle** – Suited for those who want to build lean muscle mass as quickly as their genetics allow.
- **Weight Loss** – Aims to improve the ability of your body to burn any unwanted fat. It will also provide you with more information that will allow to maintain your ideal bodyweight.
- **Health & Wellbeing** – Focused on those looking to get a little healthier and not really in to going to the gym or running a 10k.

Once you have made your selection, which you can change at any time, all the information will recalibrate automatically to help you maximise that particular goal. (profile & preferences)

## Key Data

You Key Data will have your macro breakdown and key DNA results showing some of the most relevant areas of interest.



**Fitness & Endurance**



**Build Muscle**



**Weight Loss**



**Health & Wellbeing**

# The Muhdo App

## The Core Health Areas

Then we have 5 further areas displayed at the top of the screen, which are titled:

## Health Modes

Select one of our 4 health modes:

- Vitamins
- Diet
- Health
- Psychology
- Physical

We will now delve deeper in to these areas to allow you to fully understand the thought process behind the data.



## Vitamins

This panel is probably one of the most important to read through and fully understand, as vitamins & minerals form the back bone for our health.

Having a nutrient deficiency will affect your body's ability to perform a whole variety of important metabolic functions, which can eventually lead to disease and illness creeping in.

We also need to remember that having a specific outcome, whether that be No Genetic Risk, Normal Genetic Risk or having a possible Increased Risk should only be used as a guide.

We look at 12 micro nutrients consisting of vitamins, minerals and essential fatty acids – a few of which are titled below.

As well as 5 sports supplements to see if they'd be beneficial for you to take, or if you'd be better off spending your money on something else.

## Potassium

Having No Genetic risk in Potassium, for instance, is just an indicator that you should be fine absorbing potassium as long as you are eating a balanced diet which contains potassium.

## Magnesium & Calcium

Magnesium and calcium have a Ying/Yang type of relationship, with regards to muscle contractions and being turned on or off will dramatically affect your training or exercise.

As half the world's population is deficient in Magnesium, is it any wonder that many of the negative health connotations associated with deficiency are so prevalent. These include muscle fatigue and weakness, high blood pressure, osteoporosis, anxiety and depression, hormonal regulation and sleep issues.

## Omega 3

Increasing Omega 3 levels, if you're at risk of deficiency, will help reduce inflammation and improve recovery rates significantly. They are also extremely effective at reducing DOMS (delayed onset muscle soreness), which you may encounter after completing a particularly strenuous run or session.

Omega 3 fatty acids are extremely important to your health and offer a variety of benefits to both your body and brain. Omega 3 can also help combat the pro-inflammatory response seen from diets higher in grains, vegetable oils and processed foods, which are all high in Omega 6 fatty acids. A diet high in Omega 3 could also help minimise the effect of systemic inflammation which is one of the leading causes of cardiovascular and heart disease.

## Diet

The next panel looks at your diet, and how effectively you process macro nutrients such as Saturated and unsaturated fats, your protein and sugar response, and whether you are more likely to be a sweet or bitter taster.

Then we look at your likelihood to snack, metabolic rate, fat distribution, YoYo diet response, and if you are more likely to be lactose intolerant.

In many instances you are what you eat, so understanding your ability to breakdown and process their food will go a long way to them achieving their goals.

### Proteins:

- Proteins are used to repair worn out tissue
- Are used to build new tissue
- Can be used as an energy source
- Make up a large percentage of essential body fluids
- Aid in the blood transport of key nutrients such as vitamins, minerals, fats, etc.

### Carbohydrates

There are 3 types of carbohydrates: sugar, starch and fibre. Carbs provide the main source of energy for the body. We need to also look to see whether they are simple or complex carbohydrates, as that will be a measure of how quickly your body can break them down and release the glucose into the blood stream.

Having a diet high in simple carbohydrates has many negative health connotations associated with it such as, increased inflammation, diabetes and obesity. You should always opt for complex carbohydrates, which contain fibre and starch. Complex carbs take longer to get broken down and be digested by your body, thus providing a more consistent energy source for a longer period of time.

For instance, having reduced risk of injury but having a higher risk of inflammation and or slower recovery can then increase the risk of you becoming injured if you aren't getting sufficient rest and/or eating a diet full of beneficial foods.

### Saturated fats

You're probably aware of the supposedly harmful effects of eating saturated fat, and that they are the quickest way to clog your arteries and ill health.

So it is important to understand how you cook your food, which is as important as which food you choose to eat. You'll need to be aware of the negative health effects that frying and char-grilling meat will have on saturated fat.

## Unsaturated fats

Unsaturated fats basically fall into 2 main groups, Mono and Polyunsaturated, and both are generally looked at as being healthier and more beneficial for you than saturated fats.

Like all fats, Monounsaturated fat has 9kcal/gram and can result in weight gain if excessive amounts are consumed.

They are found in a variety of foods such as, olive oil, nuts and seeds, and have many positive health benefits associated with them. These include protection from free radical build up from oxidation damage within the body, to improving insulin sensitivity and blood sugar control.

Polyunsaturated fats are found in both plant and animal sources, Alpha Linolenic Acid known as (Omega 3), Linoleic Acid known as (Omega 6) and Arachidonic acid (Omega 6).

Your body can synthesize all the fatty acids you will require from the essential fats, essential meaning your body cannot make them and you must get them from your diet.

It's extremely important to obtain these in the correct 1:1 ratios. Unfortunately, the western diet contains larger amounts of Omega 6, which is found in vegetable oil and processed foods - throwing this balance out.

This can result in increased inflammation and a reduction in immune function escalating your chances of ill health.



## Unsaturated fats

Vitamin D plays a pivotal role in exercise-induced muscle damage and recovery, as well as being crucial for the absorption of calcium into the bones. It is also essential for optimal hormone regulation and function, which goes hand in hand with testosterone levels and improvements to strength, speed, power and recovery.

Research is clearly demonstrating the importance of Vitamin D on our health; and unfortunately, Vitamin D deficiency affects almost 50% of the world's population.

Some of the elements contributing towards this include lifestyle factors such as, reduced outdoor activities and obesity. Environmental factors such as, living in the northern hemisphere, air pollution, poor dietary choices and genetic factors also play a large part.

Studies show that almost 10% of the human genome may be regulated by Vitamin D, so obtaining sufficient levels is crucial to your health, fitness and longevity.



## Health

Our Health section looks at a variety of health and disease parameters such as:

- Caffeine Sensitivity
- Bone Mineral Density
- Genetic Risk of Obesity
- Genetic Risk of Type 2 Diabetes
- Genetic Risk of Hypertension
- Genetic Risk of Infection Risk from Colds/Flu.

If you have an increased risk of illness it is important that you try to boost your vitamin and mineral intake. This should mainly be through food but could also be supplemented with Vitamin C, vitamin D and Zinc.

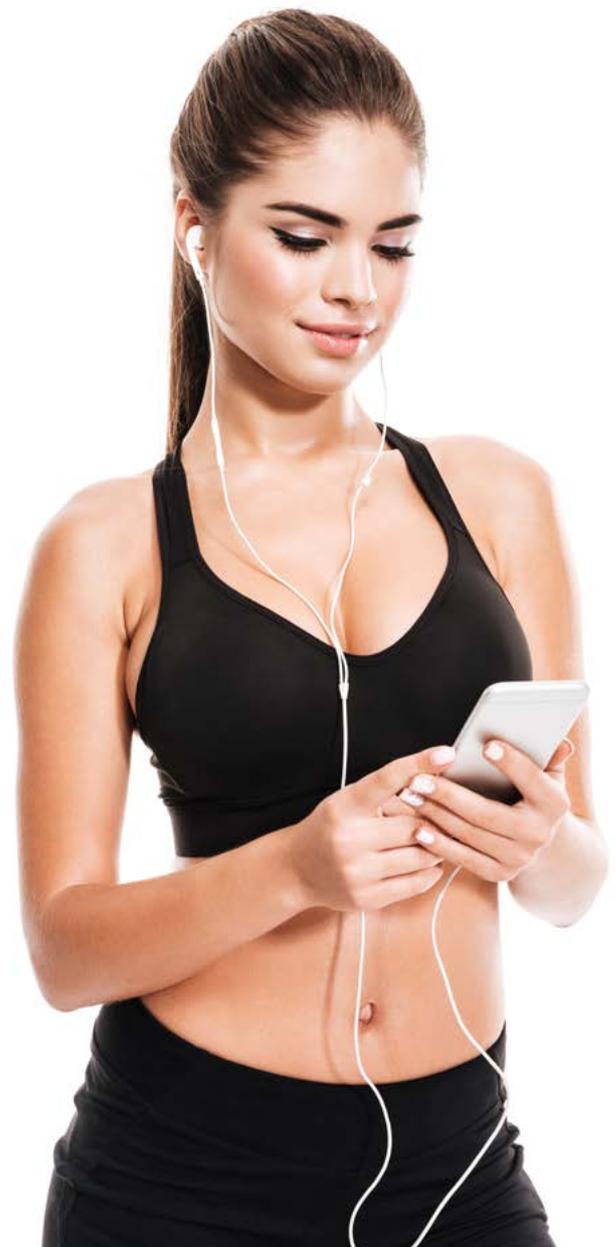
Please also remember that your results are just an indicator and that nature, as well as nurture, are both important factors that contribute towards developing a particular ailment.

Once you understand your genetic risk and predisposition you can put in place certain lifestyle changes that will hopefully mitigate some of these risk factors.

## Psychology

The last section looks at psychology and as to whether you are Worrier or Warrior.

We look at a specific gene that encodes for your stress response and ability to deal with stress. The Worrier may make better decisions and have a lower pain threshold. Whereas the Warrior is generally more aggressive with a higher pain threshold, but possibly making rash decision.



## Physical

The Physical panel looks at 11 areas:

- Muscle Power
- Muscle Stamina
- O2 Usage
- Anaerobic Threshold
- Recovery rate
- Muscle Mass
- Injury Risk
- Inflammation
- Lean Body Mass
- Power to weight ratio
- How effective exercise is on losing weight

Muhdo's Science Team consists of a range of current and ex-professional athletes from rugby, football and swimming.

Our "Physical" section contains detailed, technical information and is aimed towards people that are interested in training and working out to improve a specific goal.

Muscle Power and Muscle Stamina are the first that we can talk through and explain how they will possibly affect any programs that you follow.

## An Example: Cardiovascular

If you are looking to include cardiovascular work and your muscle power is scoring higher than your muscle stamina results, it would be more beneficial to incorporate a greater amount of high intensity interval training or HITT to improve performance and fat loss.

We can then also use the muscle power and muscle stamina areas to look at steady state activity as well as understanding your O2 usage and lactate threshold.

However, if your goal is to run a marathon for instance, you should still look to include a certain amount of power aspects to your training if your muscle power score is higher than your stamina. If your muscle stamina score is actually higher than your muscle power, then utilising pure steady state same intensity training over a long period of time and will most probably give the most benefit.



## Time Under Tension

We use muscle power and muscle stamina to calculate your "time under tension" for each set that you perform (i.e. how long each specific movement takes to complete).

Time under tension per set can be used for reps for each set.

For instance, an example would be when you perform a 30 second set, with each rep taking 3 seconds that would be 10 reps in total.

30s SET TUT = 10 REPS AT 3s PER REP  
(normal tempo 1s concentric, 2s eccentric)

If muscle power is greater than stamina, you will have to decrease the set time under tension and increase the load.

If muscle stamina is greater than power you will need to increase the set time under tension and decrease the load.

## An Example: Rep, time under tension

This will also relate to how many reps you will be performing.

Look at the 3 movements linked to muscle contraction; eccentric, isometric and concentric.

6 second rep  
Eccentric – 3s / isometric – 2s / concentric 1s

It is important to train all 3 muscle contractions.

You can then break this down to set TUT-  
35 – 45 secs. This equals 6 to 7 reps.



## Other areas with Physical

Let's briefly look at O2 Usage, Anaerobic Threshold and Recovery

### O2 Usage

Can be used as a marker to identify if you are gifted for endurance activities.

### Anaerobic Threshold

If you have a gifted outcome you can often train longer compared to those with a reading of normal.

This information could be beneficial for laying out how many sets you can perform, how long a training session could last, and how long a distance could be undertaken.

Using the Anaerobic Threshold marker will also help you calculate your "work to rest" ratios if designing interval, ladder or fartlek training.

### Recovery

The first aspect to understand from a recovery issue is how many days per week you should be training at a certain intensity to optimise your results.

If you have slow recovery you will be more suited and better off with less training days to prevent over training.

When it actually comes to training, if you are in the slow category you need to take more time in between sets as well as more time in between intervals to gain the most out of them.

**SLOW** = Less training days, and longer rest between sets/intervals

**FAST** = More training days, and quicker between sets/intervals

### A note to remember

A point to note is that you must always remember to look at your report in its entirety, as many areas will have a knock-on effect and can dramatically affect other areas.

For instance, having reduced risk of injury but having a higher risk of inflammation and or slower recovery can then increase the risk of you becoming injured if you aren't getting sufficient rest and/or eating a diet full of beneficial foods.

## Meal guide

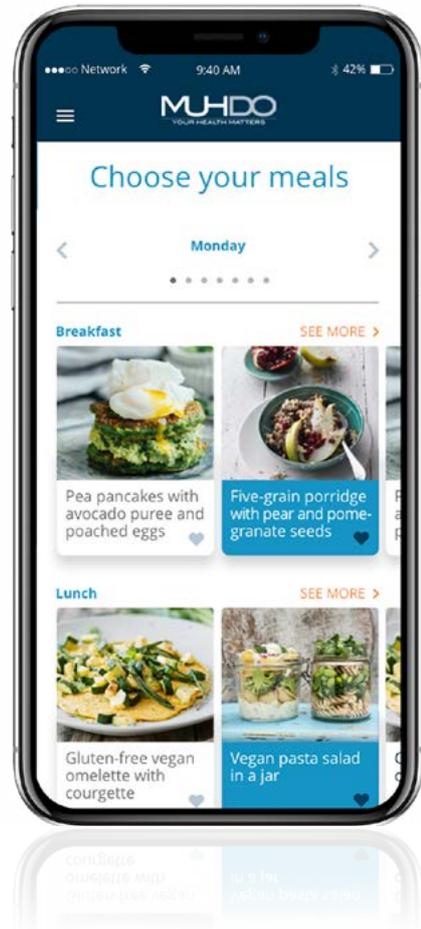
In order to augment your DNA results you are able to design a meal planner that can be accessed 24/7 through the app.

You will be requested to answer a few quick and easy questions to help us understand your daily life better, which will be linked with your DNA results to provide you with a personalised meal planner.

You will need to select meals from the suggestions for each day so the app can provide you with your full meal plan. You can save your favourite recipes and come back to them in 'My Favourites' at the top of page.

You also have a 'My Calories' section which suggests the macronutrient breakdown of possible calories per meal if you decide to design your own meal planner.

You can reset the meal planner in the top righthand corner by clicking on the icon.



## Training guide

Once you have read through your results, the next step is to go to the training guide. Within this section you will be provided with 4 different options:

- Genetic Workout Plan
- Warm Up / Cool Down
- Injury Prevention
- Wellness

## Workout Plan

This option will take you to an online consultation where you will be asked to answer a few quick and easy questions. Your answers will help us understand you better and will be linked with your DNA results to provide you with personalised training advice and planner.

## Warm Up / Cool Down

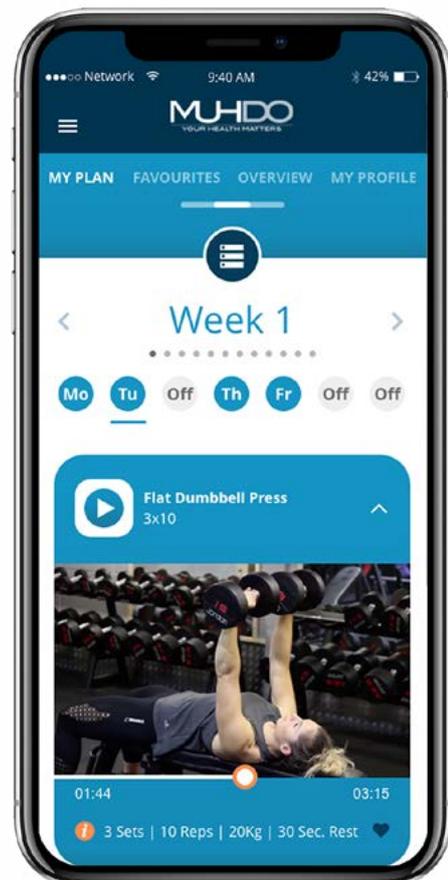
This area is not linked to your genetics but will provide you with different warm up exercises for upper body, lower body or full body. It will also provide you with exercises for foam rolling and static and dynamic warm up and cool down stretches.

## Injury prevention

This section includes exercises related to major joints and muscles in the body. You can use the workouts designed here or select certain exercises for injury prevention or rehab.

## Wellness

The Wellness option includes a variety of different exercise methods including yoga, functional training and more. It allows you access to a different range of activities so that you have other options than gym or sport. These areas are very effective to help with reducing stress and improving sleep.



## Overview

Across the top of the of the exercise section you will be able to go to your genetic workout plan, change your goal and you can "favourite" different workouts from other sections including injury prevention, warm up / cool downs and training from the wellness section. Finally, you will be provided with an overview. This will include different goals – strength, hypertrophy, endurance and cardiovascular training.

Within each area it will explain sessions per week, rest days, sets, reps, rest, time under tension and different training systems.



## Health insights

The following Health Insights provide greater insights into your genetics.

### Stress

Mental stress is a form of psychological pain and while it is mostly considered negative, it is often required and can be beneficial in helping athletes to reach their goals, improving motivation and aiding the body in adapting to a certain environment. Excessive psychological stress, however, is negative. Acutely, it can cause panic and chronic stress can eventually lead to psychological and physical harm. Stress is caused by an individual's perception of what is occurring around them (their environment), what they perceive to be occurring from others (external pressure) and internal emotions that might be deemed stressful to them.

### Dealing with Stress

The way we deal with stress is highly important. Methods to reduce stress may include breathing exercises, meditation, eating certain foods, going to the gym or for a run, yoga, etc. However, some people are more likely to keep themselves isolated when chronically stressed and research has shown that it is better to talk with others instead of going into isolation. There has also been some correlation between those who are more likely to isolate themselves and certain genetic variants. This insight also looks at stress in relation to pressure, memory, the heart and caffeine.



Stress Management



Eye Health



Gut Health



Heart Health



Anti-Ageing



Skin Health



Addiction



Mental Health



Sleep Management



Injury Prevention

## Sleep

Our genetics play a role in the development of sleep disorders, quantity and quality of sleep, and if we are more likely to stay up late, get up early, or have naps, etc. These areas show the importance of particular gene variants on your own sleep patterns. We also look in to whether you're a night owl, sleep duration, fragmented sleep, stress affecting sleep and caffeine affecting sleep.

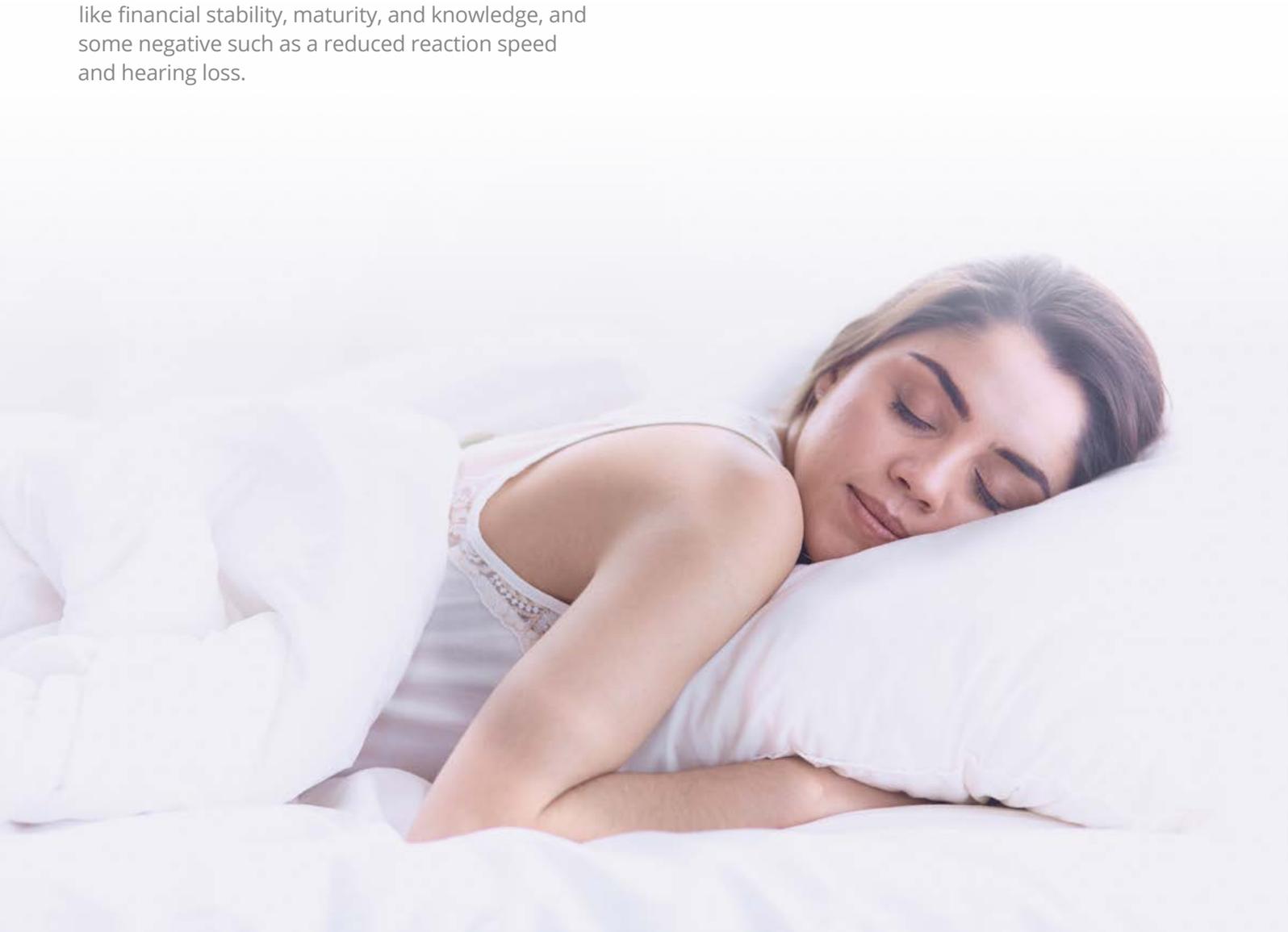
## Anti-ageing

Human ageing is often just represented in time and how many years the person has been alive. However, in reality, a multitude of aspects occur and should be considered when thinking about a person's age. Physical, psychological and social changes are all impacted. Some may be positive like financial stability, maturity, and knowledge, and some negative such as a reduced reaction speed and hearing loss.

## Keeping physically fit

Physical fitness is an aspect heavily associated with age, with many becoming less physically active as they get older. Some genetic variants linked to this process are faster or more pronounced and this aspect looks at these variants, highlighting potential interventions you can put in place.

Physical fitness is vital in the maintenance of good quality of life, mobility, muscle strength and bone strength. Each are related to physical activity and play a huge role in ageing well vs. ageing poorly. Other areas we look at are Cognition, testosterone, bone strength, pain, stress and ageing and skin and ageing.



## Injury Prevention

Injuries, also known as physical traumas, are damage to the body and are usually caused by external force. However, weakening of the body's defences can often lead to injury. Major trauma to the body can cause long lasting damage, paralysis, scarring and death; in fact, injuries are the sixth-leading cause of death in the world.

Some injuries are unavoidable. 30% of all major injuries come from transportation accidents, of which may be completely out of the individual's control. However, many injuries - especially sports injuries - occur due to a number of factors with major trauma being an instigator. Nevertheless, bone weakness, illness and even psychology are major contributing factors, along with overuse, which can lead to injury in its own right.

## Type of injury rehab

After an injury has occurred it is difficult to assess what is the best course of treatment and rehab to do. Even experts will disagree on the correct way to treat the same patient with the same injury. Different methods of rehab are often put across, such as rest, soft exercise, aggressive exercise, etc.

However, the response of treatment can come down to a number of factors, for instance environment, age, starting fitness level, type of injury, gender, diet, underlying illness and genetics. To help build a superior rehab plan, knowing certain gene variants takes one aspect out of the equation, however, you should always follow your medical professional's advice when it comes injury treatment and use the advice here for supplementary guidance.

Further areas we cover are: Lower back pain; bones and joints.

## Mental Health

There are a number of genetic variants that encode for areas that can affect your mental health.

## Attention

A useful insight associated with general cognitive aspects such as attention, which can help understand a person's natural focus and how a person responds to success.

Attention seems to be affected by a multitude of factors such as environmental upbringing, educational level, brain injury, drugs/alcohol, sleep, and food. Attention even seems to be affected by cultural differences, as well as inheritance - attention is affected by our genetics.

Areas covered in this mode are: Workaholic; focus; caffeine; memory and night productivity.

## Heart health

The heart health mode analyses the genes associated with potential risk factors associated with cardiovascular illness and pathology.

It will have the gene variances that can cause irregular heart rhythm, the risk of heart disease and factors associated with a general effect of certain environmental factors on the heart such as stress and caffeine. The insight will also look at potential genetic cholesterol issues. It can also influence a decision to remove or alter dosages of potential stimulants as pre-workouts. It can be useful to change exercises to potentially improve blood pressure and help with exercise choices that may increase blood pressure.

## Addiction

The addiction insight is a one-off that analyses genes associated with personality traits that may lead a person to being more prone to addictive chemicals or certain activities such as gambling or even exercise obsession.

## Gut health

Gut Health looks at gluten tolerance, which helps understand if you are at risk of celiac disease, which can help alter diets to better aid your overall health.

Gut Irritability analyses the genes associated with gut inflammation and would be useful in dietary changes to help reduce irritation with food choices, drink choices and superior nutrition.

Knowing if caffeine causes gut issues, and if stress is also associated, you can alter dosages or make lifestyle changes to help with general gut health.

## Skin health

The skin health looks at 3 key areas, Sun sensitivity, Gluten and skin as well as Betacarotene conversion. If you have skin conditions these insights could shed light on what foods maybe causing issues and what supplements can be usefully to mitigate the effect..

## Eye health

The eye health insight looks at 5 areas including sight degeneration and beta-carotene conversion.

## Muscle health

The muscle health insight has many useful reports, such as:

### MSTN

The MSTN gene can cause lower myostatin leading to increased strength and improved muscle mass. And in some cases, the variant can lead to decreased body fat percentage too.

### Testosterone

Testosterone is extremely important for a number of reasons. So if you have low levels, it is important to follow the advice provided to help with areas such as training, sleep and stress.

### Useful Reports

Other important aspects within the insight, like muscle pain, can better help influence a training plan, splitting muscle groups allowing for more recovery, improving diet protocols to help muscle healing.

The genes analysed in muscle health can help with choosing exercise regimes that are of alternating intensities to help mitigate risk factors.



## Epigenetics

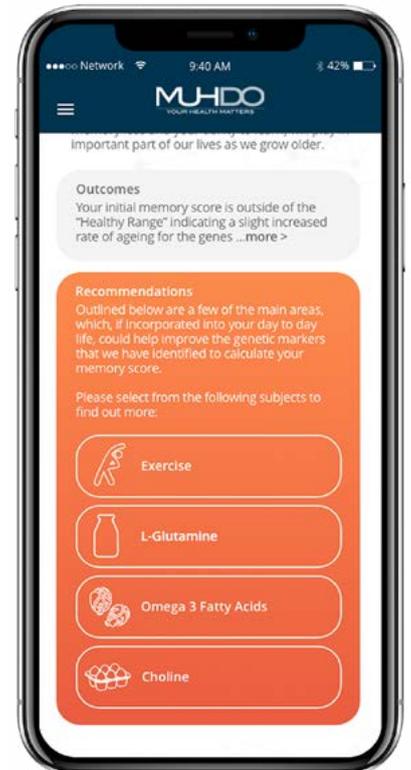
Epigenetics allows tracking of what were until recently invisible markers within the body that will change far earlier than blood markers, physical signs and symptoms. These markers can be early indicators of potential health issues, and by tracking them, preventative measures can be put in place to slow down or stop these processes. The great part is that multiple tests can track these changes.

Epigenetics allows for another marker that shows the benefits of exercise and correct nutrition. Whilst a healthy lifestyle can lead to improvements in

self-esteem, weight control and general health, epigenetic testing allows you to put a number against your success. Reducing your epigenetic age, improving your hearing age and memory score is empowering as you take control of your health. Epigenetics allows for further information on genes that are already analysed in the DNA test, this information is of a highly valuable nature as unlike the variants we test for in the DNA test, these markers are changeable.

## Epigenetic tracking

Coming soon



## PT Action Planner

The App will now provide you with a genetic overview and action plan based on an online consultation that your client has completed. You will then be able to produce a personalised action plan based on your goal and lifestyle.

Analyse the key points and identify the easy and quick wins, which can be achieved in a short period of time.

If you achieves smaller tasks and feel better, you will continue to maintain the correct habits, which will allow you to quickly move on to the next key point and closer to your goal.

We suggest setting a 12-week goal to achieve. This allows for weekly targets / landmarks to be ticked off along the way – cementing good habits.

Also, when introducing, changing or adapting a training plan, be mindful at all times of your health, how you feel, what mood you are in and if you are recovering appropriately.

If you have any specific questions that haven't been explained or addressed in this guide then please email [info@muhdo.com](mailto:info@muhdo.com) for further information or help.



# Our World Class Laboratory Partner

- CFR 21 part 11 approved software
- All samples are checked on receipt and registered
- Comprehensive sample management and tracking systems
- Access control, including tracking and alarms
- LIMS
- Daily data back-ups and back-up equipment
- Separate data archiving

Our Lab partner complies with IOS 17025:2005. The certification is applied to Illumina Infinium genotyping protocol ISO 17025:2017 Accreditation. It was one of the first companies in the world to implement the 2017 version.

We work with Illumina's state of the art automatization protocols including automated DNA extraction protocols. They use the following robotic systems in the process:

- LGC Octopure
- Tecan robots
- Multidrop system
- iScan autoloader
- Opentron OT-2



# Meet our Science Team



## Dr. Tanya Petrossian, PhD

Epigenetics Clinical Lead

Dr. Tanya Petrossian is a world leader in epigenetics and holds a PhD in Biochemistry & Molecular Biology. Dr. Petrossian made the groundbreaking discovery of the Methyltransferasome which led to her nomination by the National Institutes of Health to represent the United States in the 2010 Meeting of the Nobel Laureates. She is also pioneering the development of the first non-hormone therapeutic for endometriosis – the number one cause of infertility and disability in women during their reproductive years.



## Christopher Collins, MSST, CISSN

Co-Founder, Head of Physiology

Chris is an experienced coach, researcher and therapist who currently splits his time between the National Health Service (NHS) and commercial health research. He has graduated from Myerscough College, Edge Hill University and Queen Margaret University with degrees in Sports Therapy, Medical Imaging and Sports Specific Nutrition. He has worked with multiple professional football teams and corporate clients across three different hospital sites and designed multiple predictive health algorithms. He believes that genetic science holds the key for performance enhancement in athletes, engaging people with their health and predicting possible health problems before they occur.



## James Brown, BSc

Co-Founder and Nutrigenomics Director

James is an ex-professional rugby player representing Harlequins and England schools and has spent the last 20 years working as a sports and performance nutritionist. With a degree from St Mary's University, Twickenham, James provides regular monthly nutrition columns in a variety of health and fitness titles. James switched his attention to the world of genetics following the deaths of two of his younger cousins from cystic fibrosis in 2010. He gained his degree in Nutrigenomics from La Trobe University in 2015, and now provides a wealth of experience and knowledge with how our genes fully interact with our food, exercise, lifestyle and environment.



## Aire Allikas, MSc

Molecular Geneticist and Scientific Advisor

Aire has been a product manager in a global pharmaceutical company and project leader in a drug development company involved in the development of new cancer drugs. During the last five years she has been focused on lifestyle and nutritional genetics with her primary area of expertise being in the genetic factors of weight control. Aire has a degree in Genetics from the University of Tartu.



## Prof. Andres Valkna, PhD

Geneticist and Scientific Advisor, Associate Professor  
of Biomedicine and Genetics

Prof. Valkna has held positions in The Scripps Research Institute California, Stockholm University, Tallinn University of Technology and University of Tartu. He is a CSO in CCCR Cambridge and Celecure Group. Prof. Valkna is also a keen windsurfer and sportsman.

# Muhdo Science

## DNA

With significant funding into genome-based medicine, the science behind genetic testing has advanced at rocket speed. It's this research that has uncovered multiple associations between certain genes and human physical attributes. With our dedicated team of geneticists, sports scientists, nutritionists and physiologists, Muhdo conducts its own research to help move the industry forward, ensuring that our recommendations are accurate and relevant to consumers.

### Muhdo Science – Algorithms and Validation

Muhdo utilises algorithms to predict physiological outcomes based on certain genotypes. These types of algorithm are also applied to epigenetic science. We have developed a robust system to make sure the accuracy of our statements and recommendations are legitimate and backed up by science.

### Steps for Science

The Muhdo DNA product concentrates on a particular subset of 1,000 snips that affect our fitness characteristics, injury risks, micro and macro nutrient metabolism, mental health, sleep patterns and much more, in fact Muhdo creates 300 reports from the 1,000 snips analysed.

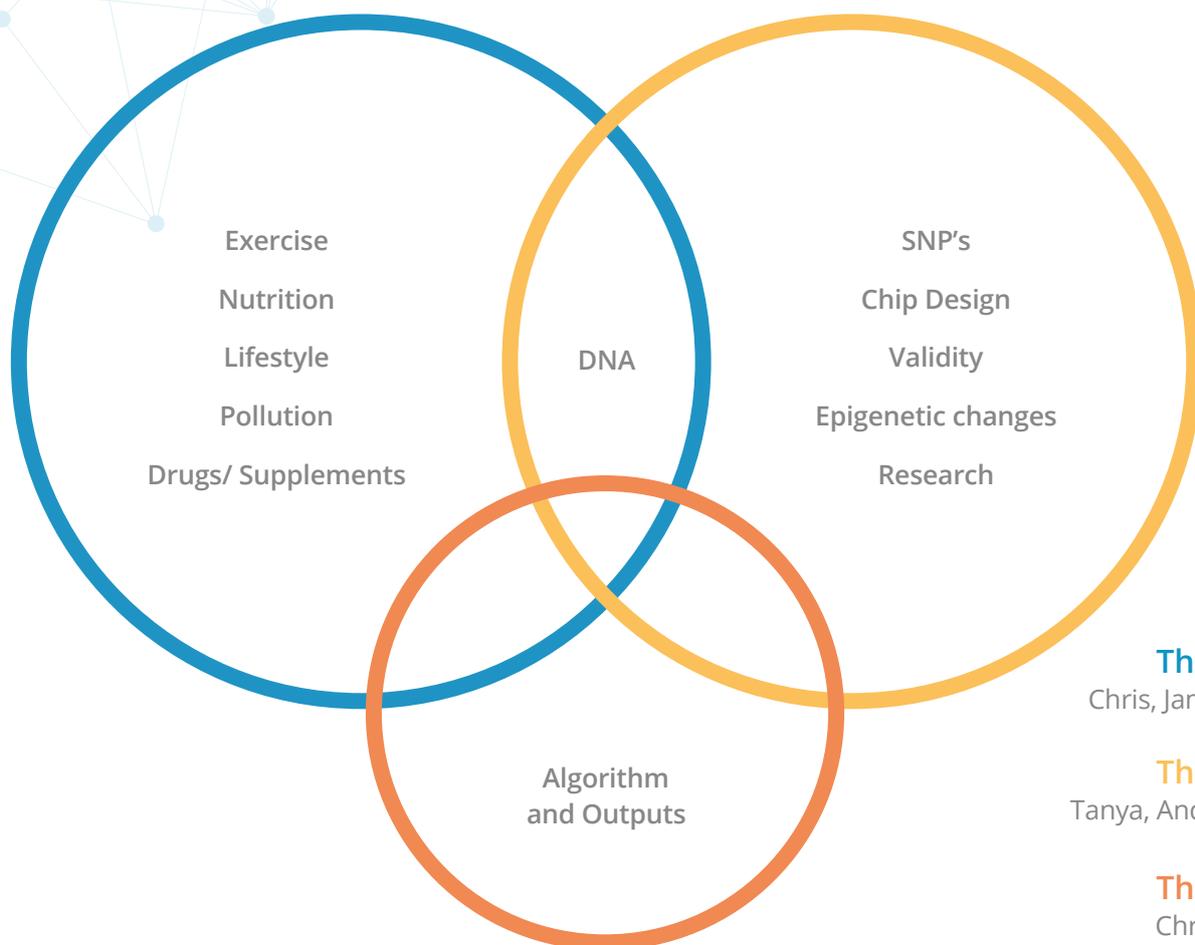
Approximately 2,000 genes encode for our unique identity and body makeup. Some define our external characteristics such as height, the colour of our eyes, and the shape of our nose. Whilst others (approximately 1,000) define our internal body make-up, such as how we metabolise foods, how efficiently we convert micronutrients, muscle strength and stamina, athletic gifts and injury risk.

Muhdo focuses on the 1,000 snips that make up our internal health. Our analysis gives deep insight into over 300 health and performance aspects ranging from fat burn, physical performance, mental health and anti-ageing. Muhdo collates hundreds of these papers and weights them accordingly to give us an extremely accurate and effective health platform to offer our customers. We analyse 1,000 of the most researched Single Nucleotide Polymorphisms (SNPs) that relate to nutrition, fitness and health. Each SNP requires at least five peer reviewed medical papers supporting the nutrigenomic conclusions before we incorporate it into our algorithms. This, along with a whole variety of positive testimonials from customers over the last three years gives us extreme confidence with the recommendations that our platform goes on to provide.

Finally, epigenetic testing is carried out by Muhdo's principal lead, Dr. Tanya Petrossian. The combination of solid genetic science and human interaction is key to designing a custom chip that is actually beneficial to the individual and sets the right base work for a custom algorithm design.

## Muhdo science – Algorithms and Validation

Muhdo utilises algorithms to predict physiological outcomes based on certain genotypes. These types of algorithm are also applied to epigenetic science, however, as these markers change, results are not fixed unlike the base pair algorithms. Muhdo has developed a robust system to make sure the accuracy of statements made are legitimate and can be backed up by science. Muhdo does not make finite statements on disease markers associated with congenital disease such as fragile X syndrome, trisomy, cystic fibrosis etc. although these markers may be analysed on the Muhdo custom chip set.



### The Team

Chris, James, Lucy

### The Team

Tanya, Andres, Aire

### The Team

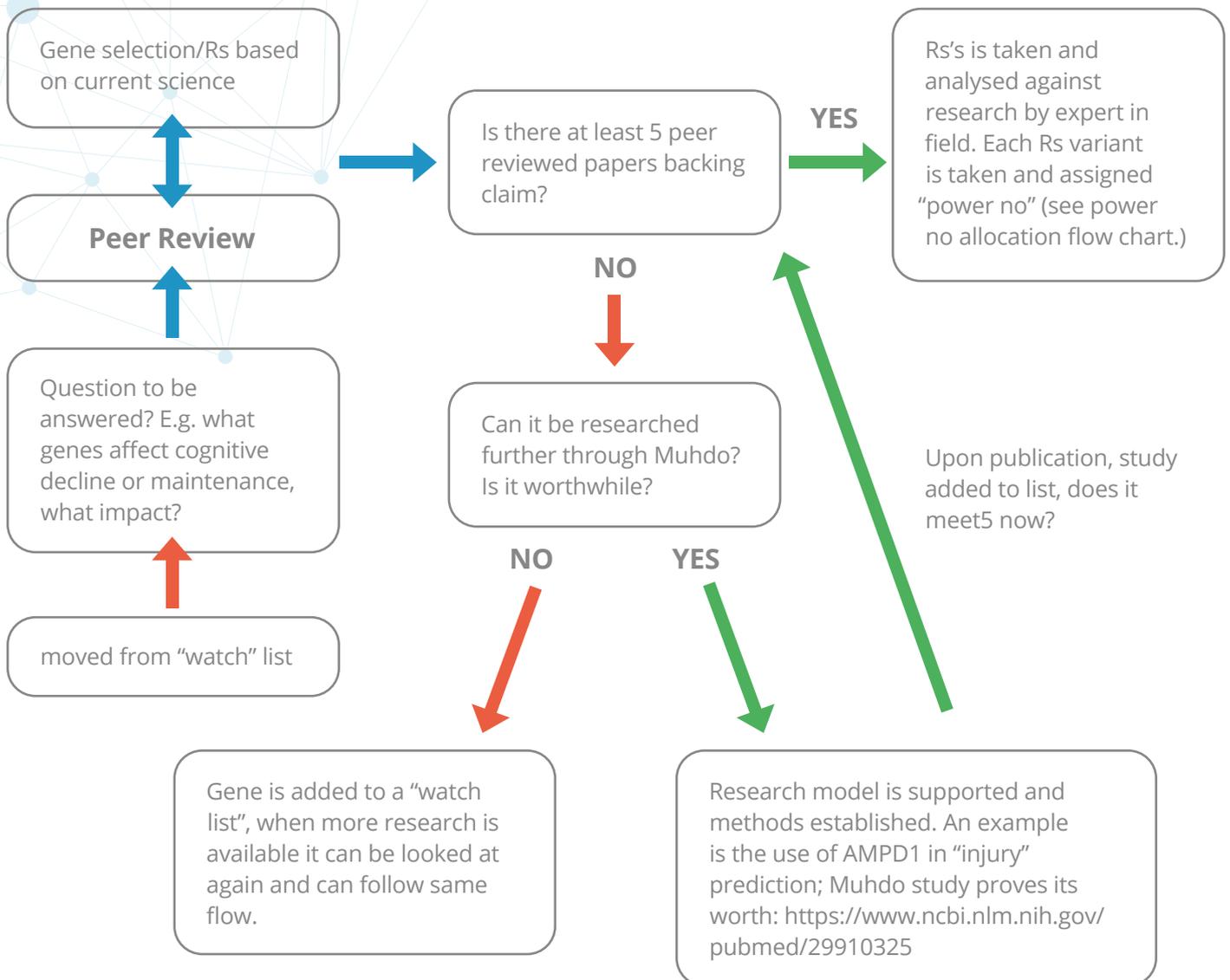
Chris, Andre

## Steps for science:

1. The 1,000 SNP's have been hand chosen by geneticists Prof. Andres Valkna and Aire Allikas and Christopher Collins, a physiologist and expert in the practical usage of genetics. In addition, exercise, nutrition and lifestyle input is provided by James Brown, Muhdo's Director of Nutrigenomics, Lucy Ellis, a Nutrition consultant and Wez Pooley, a qualified strength and conditioning coach and Master Trainer PT. Finally, epigenetic testing is carried out by Muhdo's principal lead, Dr. Tanya Petrossian. The combination of solid genetic science and human interaction is key to designing a custom chip that is actually beneficial to the individual. This then leads onto a custom algorithm design.

customers and provide value, such as: muscle stamina, muscle power, carbohydrate response, caffeine response etc. Our custom chip has 200+ aspects built in. Aspects must have five peer reviewed papers backing our recommendations. These must be of high calibre and be cited on PubMed or Researchgate.

## Algorithm Maker Flow Chart (Stage 1)



3. This leads the team to have an aspect built up from a set number of genotypes with at least five research papers backing any claims being made, i.e. muscle stamina – genes/SNPs chosen that are associated with muscle stamina must have five research papers backing up the choices of gene and variants.

## Muscle Stamina

rs1042713 / rs12722 / rs1815739 / rs4253778 / rs4343 / rs4994 / rs8192678 / rs17602729 / rs1801253 / rs2010963 / rs7181866 / rs680

The above table shows the SNPs chosen for the muscle stamina algorithm. The following are just some of the research papers backing each aspect - the full list can be obtained from the link on the final page of this document:

- <https://www.ncbi.nlm.nih.gov/pubmed/19553224?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/19565482?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4993135/>
- <https://www.ncbi.nlm.nih.gov/pubmed/28294290?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/18443036?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/24755981?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/29632650?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5969195/>
- <https://www.ncbi.nlm.nih.gov/pubmed/18043716?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/19422653?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3554644/>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4993135/>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2587487/>
- <https://www.ncbi.nlm.nih.gov/pubmed/11331279?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/19553224?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/22865486?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/17289909?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/12879365?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/20620111?dopt=Abstract>
- <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0060570>
- <https://www.ncbi.nlm.nih.gov/pubmed/19265027?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/16505069?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/23065660?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4885623/>
- <https://www.ncbi.nlm.nih.gov/pubmed/19544227?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/23681449?dopt=Abstract>
- <https://www.ncbi.nlm.nih.gov/pubmed/11028479?dopt=Abstract>
- [https://www.scitechnol.com/peer-review/resistance-training-recovery-and-genetics-ampd1-the-gene-for-recovery-acCT.php?article\\_id=5980](https://www.scitechnol.com/peer-review/resistance-training-recovery-and-genetics-ampd1-the-gene-for-recovery-acCT.php?article_id=5980)
- <https://www.ncbi.nlm.nih.gov/pubmed/25761735?dopt=Abstract>

# Muhdo Science

## Epigenetics Q&A

**Which cell type would the epigenetic profile be derived from? Because the DNA in all our cells is roughly the same, any cell type can be used but epigenetic profiles are generally quite cell type specific. Can an accurate and viable epigenetic profile be achieved without multiple biopsies on different cells to get a complete picture?**

Saliva. Please note that DNA/epigenome from saliva is mostly composed of blood cells (specifically white blood cells since red blood cells do not have DNA). Most of epigenetic research that has been conducted in the world to date have been performed in saliva or blood because it provides a great overview of the body's functioning as blood circulates to all organs of the body and is considered non-invasive. Both our results and the current scientific research from other academic labs confirm that saliva's results are very accurate and similar to blood results. Biopsies are not needed to gain a full picture because saliva/blood is able to give us a full picture of what is going on in the body.

### **What are we looking for within the epigenetic profile?**

Many different methods are utilized to analyze an epigenetic profile. A majority of the methodology (described below) follows an unbiased approach and/or includes scientific literature by other academic labs to confirm analysis. This is the most scientifically accurate methodology because that there are over 850,000 markers that are being analysed. Given the high number of markers, if we were to take a biased approach in analysis and only look at specific scientific markers, this could lead to placing significance on random data. We do not target specific loci unless there have been scientific articles that have already been published on the loci because using a non-adjusted p-value cut off of 0.05 (which, at a minimum would need to be adjusted by some correction value

such as Bonferroni for multiple comparison analysis). This would mean that there are 42,500 markers that could be mistaken as significant that truly are just random. Any loci or gene with a truly significant cut-off would appear in our analysis through the non-biased methods. To predict and calculate biological age, we are using published research. We have developed a Muhdo-specific aging algorithm using multiple regression analysis that is more accurate than the current Horvath algorithm.

### **Specific genes associated with biological age**

We run regression analysis with averaged epigenetic marker profile for each gene and then score each regression analysis based on  $r^2$  and adjusted/non-adjusted p/q values for the most significant associations of genes with age. We also perform this on an individual biomarker level. Genes/Biomarkers that score as highly significant are then ranked and only the most significant genes/biomarkers are analyzed. We then perform deep translational scientific analysis to relate the importance of the genes/biomarkers to human biology.

### **Literature-based associations:**

Specific loci and genes are analyzed and reported if they have been published in credible scientific journals and show similar trends within our own dataset.

### **Novel associations within our dataset:**

Mann Whitney analysis is used to compare different population and/or different lifestyle behaviors. Genes/Biomarkers are ranked via by adjusted p-values and translational analysis is then performed. Please note that Dr. Petrossian has worked on these strategies for over 15 years and was selected to represent the United States on behalf of the NIH at the Meeting of the Nobel Laureates for her work in this field. Her post-doctoral studies in this analysis under an international consortia hosted by Nobel Prize Winner Kurt Wuthrich.

## What is the concrete benefit to knowing something like biological age? Are there any medically proven steps that can be taken to offset these effects? Do we even really understand what biological age means?

Biological age is a very well-defined scientific term. It is not a loosely defined marketing term. To date there are 2,992 scientific publications on biological age and epigenetics, so it is very well characterized. Biological aging includes inability to fight cancer/disease, lack of functioning proteins, lack of energy production in the body, lack of nutrient function, loss of circadian rhythm, increased inflammation, loss of new cell regeneration, and many more factors. When proteins lose function, the body cannot carry out the necessary functions in the body – for instance, memory, eye sight, hearing, ability to properly digest nutrients, ability to metabolize sugars and fats, ability to fight disease, development of autoimmune diseases, etc.

In order to be a diagnostic or therapeutic company, we would need to obtain CE Mark and FDA Approval for every association which, in reality, is only done for companies that are diagnosing diseases like cancer because it is a very expensive and long process. Instead LDT (Laboratory developed test) that are not technically allowed to prescribe medically proven steps, but are allowed to relay very significant and actionable associations for the population. This is similar to most if not all genetic companies. We are able to outline associations that we find with different epigenetic profiles to different factors.

Examples include:

- Individuals who were more physically fit and who exercised more minutes per week have less epigenetic markers on BRCA and thus higher functioning BRCA genes. Lower functioning BRCA genes (like mutated BRCA) leads to breast cancer onset. Therefore, someone may choose to exercise to help prevent breast cancer onset.
- Populations with great memory may work out more often, therefore, someone can conclude that they should work out to help with their memory.

- Pollution may be associated with increased inflammation; therefore, some can decide to purchase air purifier at home.
- Individuals who eat more fish may be able to have higher functioning epigenetic profiles for their metabolism genes, so individuals may choose to eat more fish.

## What kinds of supplements could be used and what would their effects be?

There is a lot of data and scientific articles on lifestyle changes and epigenetic aging. We are able to provide insights into lifestyle changes beyond supplementation that a person can take by associations of data. This includes smoking, pollution, diet, exercise, stress, etc. Further research in this field is included at the end of this document.

## Will the user see any noticeable difference in their profile 6 months on when they are next profiled?

According to scientific literature, if lifestyle changes occur, the individual can see noticeable changes in their epigenome as early as 3 weeks after the change. Most research has been conducted with a 3-month interval window between samples after a lifestyle change occurred (i.e. diet change, exercise change) with noticeable and statistically significant change. Therefore, 6 months is ample time to measure a significant change.

# Stress, Illness and Injury

The table below is focused on stress, illness an injury.  
All our genetic outcomes are supported by peer  
reviewed medical papers.

## Stress    Illness    Injury

Statistics

Genetic Outcomes

Health Recommendations

# Stress Scientific Research

## Stress and Mental Health - Statistics

Mental health issues (including stress, depression, anxiety and more serious conditions such as manic depression and schizophrenia) resulted in 15.8 million days being lost (11.5%). <http://bit.ly/2RaXHfp>

Stress, anxiety and reported numbers of people with depression are all unfortunately on the rise, the below paper looks at how intrinsically important vitamin D is for regulating our hormones and mental health.

Vitamin D regulates serotonin the "Happy Hormone", which affects mental health and wellbeing <http://bit.ly/2v9gVJQ>

Stress, depression or anxiety and musculoskeletal disorders accounted for the majority of days lost due to work-related ill health, 12.8 million and 6.9 million respectively. ... <https://www.hse.gov.uk/statistics/dayslost.htm>

## Dealing with stress - Genetic Outcomes

1. Warriors versus worriers: the role of COMT gene variants.
2. Department of Mental Health and Psychiatry, University of Cape Town, South Africa.
3. Oct 2006
4. COMT gene
5. <https://www.ncbi.nlm.nih.gov/pubmed/17008817?dopt=Abstract>

## Vitamin D - Genetic Outcomes

1. Common genetic determinants of vitamin D insufficiency: a genome-wide association study.
2. Division of Cardiology, Department of Medicine, Massachusetts General Hospital, Boston
3. July 2010
4. Identifies individuals who have substantially raised risk of vitamin D insufficiency.
5. <https://www.ncbi.nlm.nih.gov/pubmed/20541252?dopt=Abstract>

# Illness Scientific Research

## Injury – lower back pain - Recommendations

1. Core Stability Training for Injury Prevention
2. Human Movement Program, Department of Interdisciplinary Health Sciences, Arizona School of Health Sciences, AT Still University
3. Nov 2013
4. Strength the core
5. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3806175/>

## Injury - Recommendations

1. Does Stretching Improve Performance? A Systematic and Critical Review of the Literature
2. Centre for Clinical Epidemiology and Community Studies, SMBD-Jewish General Hospital, Montreal, Quebec, Canada.
3. April 2004
4. Reduce risk of injury
5. <https://journals.lww.com/cjsportsmed/pages/articleviewer.aspx?year=2004&issue=09000&article=00004&type=Fulltext>

# Injury Scientific Research

## Vitamin D and Pain Management - Statistics

Musculoskeletal problems (including back pain, neck and upper limb problems) at 30.8 million days (22.4%).  
<http://bit.ly/2RaXHfp>

Back and muscle pain will be a major factor that contributes towards the estimated 137 millions work days lost to sickness and injury.

Vitamin D affects musculoskeletal pain, overview of 347 studies looking at vitamin D association with pain <http://bit.ly/2FwMLC9>

## Lower Back Pain - Genetic Outcome

1. Identification of a novel common genetic risk factor for lumbar disk disease.
2. Department of Medical Biochemistry, University of Oulu, Aapistie 7, 90220 Oulu, Finland.
3. April 2001
4. Identification of a common genetic risk factor for Lumbar disk disease
5. <https://www.ncbi.nlm.nih.gov/pubmed/11308397>

## Injury - Genetic Outcome

1. Knee osteoarthritis, lumbar-disc degeneration and developmental dysplasia of the hip--an emerging genetic overlap.
2. Musculoskeletal Research Group, Institute of Cellular Medicine, Newcastle University, 4th Floor, Catherine Cookson Building, The Medical School, Framlington Place, Newcastle upon Tyne, NE2 4HH, UK
3. April 2011
4. Genetic injury risk
5. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3132037/>

## Injury – Muhdo Paper - Genetic Outcome

<https://www.ncbi.nlm.nih.gov/pubmed/29910325>

# Muhdo Health Research

## Muhdo Health - Full Scientific Research Papers

Outlined below are links to a full list of peer reviewed medical papers, published by the top universities and research institutions in the world that have been used in our research and algorithms to generate genetic outcomes or health recommendations.

### Genetic Research List:

<https://www.muздо.com/dna-research-papers-genetics>  
This consists of a document containing over 1,500 links to papers.

### Nutritional Research List:

<https://www.muздо.com/dna-research-papers-nutrition>  
This consists of a document containing over 600 links to papers.

## Training, Strength & Conditioning List:

<https://www.muздо.com/dna-research-papers-activity>  
This consists of a document containing over 80 links to papers.

## Epigenetics & Biological Age

The method of age prediction is calculated by a process similar to Horvath's clock but with more accurate genes and biomarkers for saliva testing that have been discovered from more recent research. Please find below a link to our website that contains a report and a scientific poster that includes a few of the methods and biomarkers we use. It also includes a link to a further 20+ papers we use in our epigenetics product:

Epigenetics - Biological Age:  
<https://www.muздо.com/epigenetics-research-papers>



The following are just some of the research papers backing each aspect - the full list can be obtained from the link on the final page of this document:

<https://www.ncbi.nlm.nih.gov/pubmed/19553224?dopt=Abstract>  
<https://www.ncbi.nlm.nih.gov/pubmed/19565482?dopt=Abstract>  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4993135/>  
<https://www.ncbi.nlm.nih.gov/pubmed/28294290?dopt=Abstract>  
<https://www.ncbi.nlm.nih.gov/pubmed/18443036?dopt=Abstract>  
<https://www.ncbi.nlm.nih.gov/pubmed/24755981?dopt=Abstract>  
<https://www.ncbi.nlm.nih.gov/pubmed/29632650?dopt=Abstract>  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5969195/>  
<https://www.ncbi.nlm.nih.gov/pubmed/18043716?dopt=Abstract>  
<https://www.ncbi.nlm.nih.gov/pubmed/19422653?dopt=Abstract>  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3554644/>  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4993135/>  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2587487/>  
<https://www.ncbi.nlm.nih.gov/pubmed/11331279?dopt=Abstract>  
<https://www.ncbi.nlm.nih.gov/pubmed/19553224?dopt=Abstract>  
<https://www.ncbi.nlm.nih.gov/pubmed/22865486?dopt=Abstract>  
<https://www.ncbi.nlm.nih.gov/pubmed/17289909?dopt=Abstract>  
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