



# dnamind

optimal health for life

Welcome

Example2 Example1

to your dna mind report

Date of Birth: 01 Jan 2001

Date Reported: 18 Nov 2022

Sample Number: 12345678

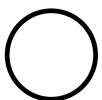
Referring Practitioner: Private

## Introduction

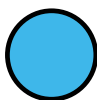
From your DNA sample we have used a process called the Polymerase Chain Reaction (PCR), which copies the DNA of your genes many times over so that we can generate sufficient quantities to analyse your genetic material. We then identify unique DNA sequences in some of your genes. Certain changes (polymorphisms) in these genes have been studied in detail, with evidence that correlates these polymorphisms with an individual's risk of developing certain chronic disease conditions or altered metabolic processes. Having identified the presence or absence of these polymorphisms, we are able to qualitatively assess particular areas of health risk related to the specific genes. To make a holistic assessment of health risks, environmental factors (diet and lifestyle) need to be considered in conjunction with the accompanying genetic profile.

## How to read your results

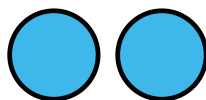
You will find your genetic results in the following pages. On the left side you will see the gene name and description as well as your specific result and an explanation. The impact can be identified by the following:



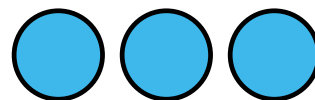
No Impact



Low Impact



Moderate Impact



High Impact



Beneficial Impact

# Introduction to DNA Mind

DNA Mind tests for genetic variations associated with changes in key biological areas that affect mental health. Weaknesses in these areas, together with environmental factors, increase risk for development of disorders related to mental health. The areas of mental health reported in DNA Mind include: Neurodegenerative disorders, mood regulation, and addictive behaviour.

## **N** Neurodegenerative disorders

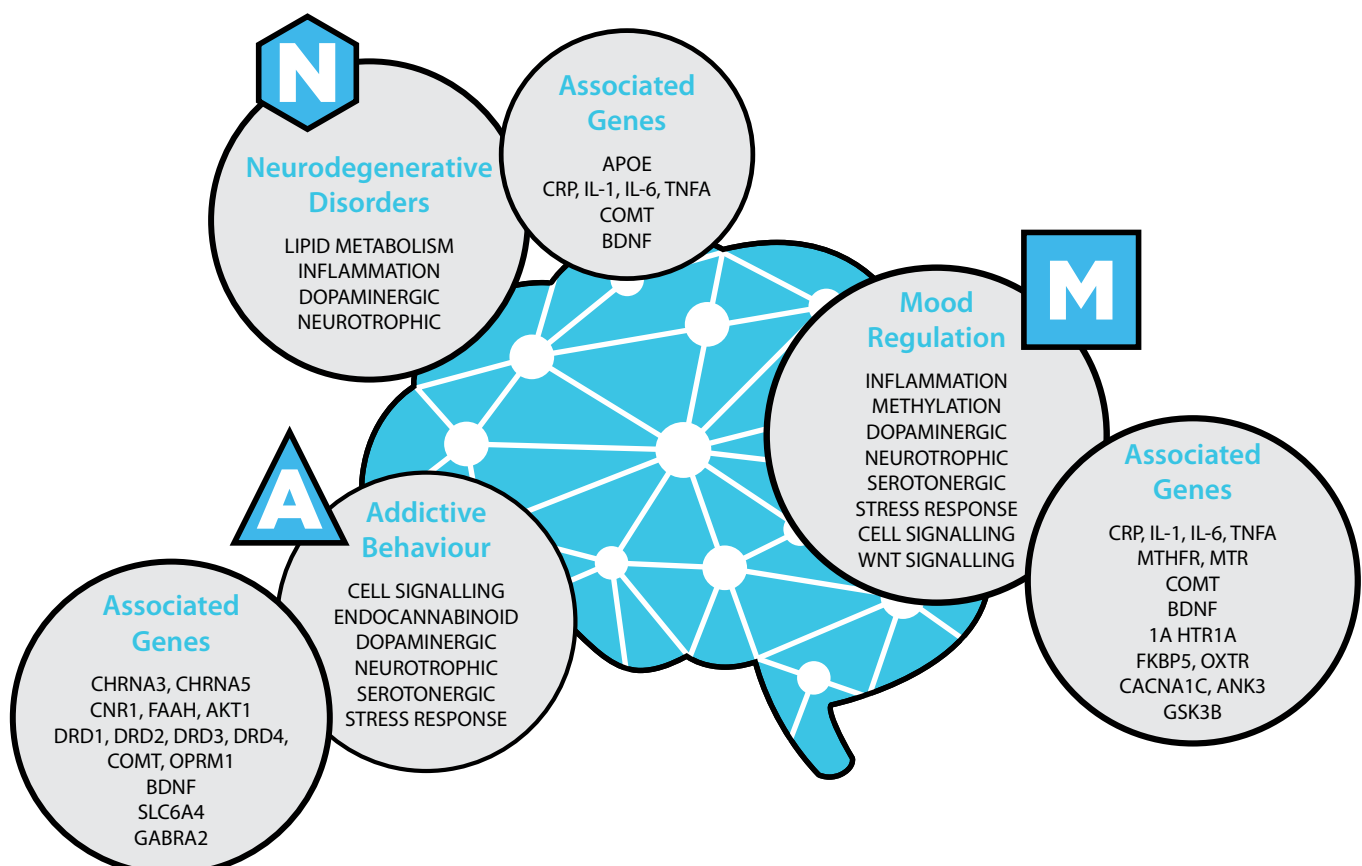
Mild cognitive impairment (MCI) causes a slight, but noticeable and measurable decline in cognitive abilities, including memory and thinking skills. Individuals with mild cognitive impairment are at an increased risk of developing Alzheimer's Disease (AD) or another dementia. Altered functioning of specific biological areas have been related to increased risk of MCI as well as late-onset AD.

## **M** Mood regulation

Mood disorders are psychological disorders that are characterized by the elevation or lowering of an individual's mood, to the extent that it can interfere with everyday life for an extended period of time. The specific mood areas reported on include bipolar, depression, anxiety and post-traumatic stress disorder.

## **A** Addictive behaviours

Addictive behaviour can manifest in a number of disorders, which are complex in their aetiology and are influenced by both genetic and environmental factors. Genetics and addictive areas of association include behavioural disorders such as eating disorders (binge eating), 'adrenaline seeking', and risk-taking behaviour. Substance use disorders include risk for alcohol, nicotine, cannabis and opioid dependence. This area will also report on psychosis response from cannabis use.



## Summary table of results

| Biological Area  | Gene Name | Genetic Variation | Your Result | Impact |   |   |
|------------------|-----------|-------------------|-------------|--------|---|---|
|                  |           |                   |             | N      | M | A |
| Lipid metabolism | APOE      | E2/E3/E4          | E3/E3 E3/E2 |        |   |   |
| Inflammation     | CRP       | G>A               | GG          |        |   |   |
|                  | IL1-A     | 4845 G>T          | GG          |        |   |   |
|                  |           | -889 C>T          | TC          |        |   |   |
|                  | IL1-B     | 3954 C>T          | CC          |        |   |   |
|                  |           | -511 A>G          | GG AA       |        |   |   |
|                  | IL1-RN    | 2108 C>T          | TT          |        |   |   |
|                  | IL-6      | -174 G>C          | CC          |        |   |   |
| TNFA             | -308 G>A  | GG                |             |        |   |   |
| Methylation      | MTHFR     | 677 C>T           | CT          |        |   |   |
|                  |           | 1298 A>C          | AA          |        |   |   |
|                  | MTR       | 2756 A>G          | AG          |        |   |   |
| Wnt Signalling   | GSK3B     | C>G               | CG          |        |   |   |
|                  |           | A>C               | AC          |        |   |   |
|                  |           | G>A               | AG          |        |   |   |
| Stress Response  | FKBP5     | C>T               | CT          |        |   |   |
|                  | OXTR      | G>A               | AA          |        |   |   |
| Cell Signalling  | AKT1      | T>C               | CT          |        |   |   |
|                  | ANK3      | A>G               | AG          |        |   |   |
|                  |           | C>T               | CT          |        |   |   |
|                  | CACNA1    | G>A               | AG          |        |   |   |
|                  | CHRNA3    | G>A               | GG          |        |   |   |
|                  | CHRNA5    | Asp398Asn         | GG          |        |   |   |
| Dopaminergic     | COMT      | Val158Met         | GG          |        |   |   |
|                  | DRD1      | T>C               | TT          |        |   |   |
|                  |           | C>T               | TT          |        |   |   |
|                  | DRD2      | Taq1A/2A          | TC          |        |   |   |
|                  | DRD3      | Ser9Gly           | TT          |        |   |   |
|                  | DRD4      | -521 C>T          | CC          |        |   |   |
|                  | OPRM1     | Asn40Asp          | GG          |        |   |   |
| Endocannabinoid  | CNR1      | T>C               | TT          |        |   |   |
|                  | FAAH      | 385 C>A           | AC          |        |   |   |
| GABAergic        | GABRA2    | T>C               | CT          |        |   |   |
| Neurotrophic     | BDNF      | Val66Met          | TT          |        |   |   |
| Serotonergic     | 1A HTR1A  | -1019 C>G         | CC          |        |   |   |
|                  | SLC6A4    | A>C               | CC          |        |   |   |

## Lipid metabolism

Apolipoprotein E is an important protein in the lipid metabolism pathway and has been implicated as the major gene target for risk of Late Onset Alzheimer's Disease (LOAD). ApoE plays multiple roles in the pathogenesis of LOAD; affecting A $\beta$  deposition, Tau phosphorylation and neurofibrillary tangle formation, as well as neuro-inflammation. It should be noted that environmental factors are also important risk mediators of LOAD.

### APOE E2/E3/E4

APOE encodes Apolipoprotein E, a lipid-transporting protein functioning in both the periphery and the central nervous system. It is involved in multiple biological processes related to AD development and progression. Two SNPs on APOE results in three possible isoforms. The isoform affects the structure and function of apoE including binding to lipids, receptors and A $\beta$ .

#### YOUR RESULT: E3/E3 E3/E2

The APOE E3/E3 genotype is the most common in the general population and encodes a 'normal' protein. The APOE E2 allele leads to a change in the apolipoprotein function, such that it is associated with increased antioxidant capacity. The APOE E2 allele may also possibly increased expression of a protective proton pump that mediates the concentration of neurotransmitters into synaptic vesicles, thus playing a crucial role in synaptic transmission

Carriers of the APOE E3/E3 genotype are considered to have the 'neutral' genotype, and are not associated with increased risk for cognitive decline. The APOE E2 allele may exert a protective effect against development of LOAD. When compared to individuals with the APOE E3/E3 genotype, APOE E2 allele carriers have reduced risk of developing LOAD. ApoE E2 carriers have also been positively associated with cognitive functions in aging.

## Inflammation

Neuroinflammation is recognised as one of the potential mechanisms mediating the onset of a broad range of psychiatric disorders, where studies have shown that abnormal inflammatory responses can result in altered behavioural responses and cognitive deficits. Variations in genes encoding pro-inflammatory cytokines, together with environmental factors, may increase risk for chronic low- grade inflammation and development of psychiatric diseases, including neurodegenerative and mood disorders.

Considering inflammation plays a key role in the pathogenesis of psychiatric disorders, anti-inflammatory therapies may play a critical role in their management.

### CRP rs1205 G>A

CRP, encoding C-reactive protein, is an acute phase protein and a marker of inflammation. It's levels are increased with IL-6 secretion by macrophages and T cells.

#### YOUR RESULT: GG

The G allele increases expression of CRP, which is associated with higher levels of CRP in the serum. The G allele has also been associated with AB deposition in the brain.

The G allele increases predisposition to disorders related to chronic inflammation. The G allele has been associated with an increased risk for cognitive decline. Focus on lifestyle interventions to decrease inflammation, including increasing intake of omega 3 fatty acids.

## IL-1: IL-1A, IL1-B & IL-1RN

IL-1 has been increasingly implicated as an important leverage point in the inflammatory cascade, and IL-1 expression is therefore key in the pathogenesis of several chronic diseases. The biological activity of IL-1 involves the two agonists – IL-1alpha (IL-1A) and IL-1beta (IL-1B), specific IL-1 receptors, and an IL-1 receptor antagonist (IL-1RN), which is a negative regulator of the pro-inflammatory response. Certain genetic variations in IL-1A, IL-B and IL-1 RN lead to a more active inflammatory response, and have been associated with increased risk for a number of chronic diseases.

### YOUR RESULT:

Individuals carrying variations in IL-1A, IL-1B or IL-1RN have a more active inflammatory response and can be considered to have increased IL-1 activity. This has been linked to increased risk for chronic, low-grade inflammation and predisposition with a number of mental health disorders.

Individuals with increased IL-1 activity are at increased risk for neuro-inflammatory disorders, including cognitive decline and mood disorders specifically depressive disorder. The association is modulated by the presence of an environmental trigger such as psycho-social stress. Increase intake of nutrients known to inhibit secretion of pro-inflammatory markers. These include omega 3 fatty acids, curcumin, ginger, and phytonutrient rich foods including certain berries that contain compounds such as resveratrol, anthocyanins and dehydro-ascorbate.

## IL-6 -174 G>C

Interleukin 6 is a pro-inflammatory cytokine that plays a crucial role in inflammation and regulates expression of CRP.

### YOUR RESULT: CC

The C allele of this functional SNP has been associated with raised IL-6 and CRP concentrations and has been associated with increased risk for chronic, low-grade inflammation.

The IL-6 C allele is associated with increased risk for cognitive decline as well as mood disorders, especially when exposed to psychosocial stressors and a pro-inflammatory environment. The risk associated with the C allele is further pronounced in smokers. Individuals with the C allele should follow a diet to reduce inflammation that includes increasing n-3 fatty acids, decreasing saturated fatty acids, and increasing dietary antioxidants. A healthy weight and avoidance of all smoking is also imperative in managing inflammation.

## TNFA -308 G>A

Tumour necrosis factor- $\alpha$  (TNF $\alpha$ ) is a proinflammatory cytokine, secreted by both macrophages and adipocytes and has been shown to alter whole body glucose homeostasis.

### YOUR RESULT: GG

No variant was detected at the -308 G>A locus. The TNFA GG genotype is the wild type, and has been associated with normal expression of TNFA.

Individuals carrying the GG genotype have not been associated with increased risk for mental health disorders such as cognitive decline and depressive disorder.

## Methylation

Methylation involves the process of creating methyl groups that can be added to a molecule, or substrate, and plays an essential role in the production of neurotransmitters. In order for methylation reactions to be completed, specific amounts of B-vitamins are required. B-vitamins are nutrients that are derived from the diet. Poor methylation function due to enzymatic deficiencies as well as low levels of B-vitamins have been associated with increased risk of mood disorders.

## MTHFR

Methylene tetrahydrofolate reductase, encoded by MTHFR, catalyzes the conversion of 5,10-methylenetetrahydrofolate to 5-methyltetrahydrofolate, which is a co-substrate for homocysteine remethylation to methionine. Reduced enzyme activity, due to function-reducing polymorphisms, results in the impairment of homocysteine metabolism and the folate cycle, leading to a decreased ability to synthesise important neurotransmitters.

## MTHFR 677 C>T

### YOUR RESULT: CT

The MTHFR 677 CT genotype results in a 30% reduction in enzyme function and is associated with risk of higher homocysteine levels and a decreased ability to synthesise neurotransmitters.

The MTHFR 677 CT genotype results in a 30% reduction in enzyme function and is associated with risk of increased homocysteine levels and mood disorders, including depressive disorder, when B-vitamin intake, and folate levels, are low. T allele carriers may have increased B-vitamin, specifically folate, requirements. Consider the use of methyl folate if clinically indicated.

## MTHFR 1298 A>C

YOUR RESULT: **AA**

The MTHFR 1298 AA genotype is associated with normal enzyme activity. Consider activity of the enzyme due to the MTHFR 677 C>T SNP.

No variant was detected for this SNP, and the AA genotype is not associated with any increased risk for mood disorders.

## MTR 2756 A>G

MTR encodes methionine synthase, which is responsible for the regeneration of methionine from homocysteine, using 5-methyltetrahydrofolate as its essential co-factor. This enzyme is dependent of methylcobalamin, and forms part of the S-adenosylmethionine (SAMe) biosynthesis and regeneration cycle.

YOUR RESULT: **AG**

The G allele is associated with increased methionine synthase enzymatic capacity.

Carriers of the G allele, specifically the GG genotype, have increase susceptibility for depressive disorder especially when there is low vitamin B12 status. Ensure adequate intake of vitamin B12, as well as all B-vitamins that support methylation.

## Wnt Signalling

Wnt signaling pathways are a group of signal transduction pathways made of glycoproteins that pass signals into a cell through cell surface receptors. The Wnt signaling pathway regulates critical aspects of cell fate determination, cell migration, cell polarity, neural patterning and organogenesis during embryonic development.

### GSK3B

GSK3B encodes the B-isoform of glycogen synthase kinase 3, which is expressed abundantly in the central nervous system and has been implicated in several neuropsychiatric disorders, including bipolar and major depressive disorder. It is an important target protein of several anti-depressants, including lithium, and upregulation of GSK3B is associated with increased risk for mood disorders.

### GSK3B rs334555 C>G, rs11925868 A>C, rs11927974 G>A

#### YOUR RESULT: **Upregulated**

The genotype combination is associated with upregulated GSK3B.

Individuals carrying this combination of gene variations on GSK3B have been linked with an increased susceptibility for mood disorders including depressive disorder, as well as an earlier age of onset for depressive disorder.

## Stress response

Stress exposure is known to precipitate mental disorders, however, even though stress is part of daily life, there is large interindividual variability that exists in the development of stress-related psychopathology. An important marker of stress sensitivity is hypothalamus–pituitary–adrenal (HPA)-axis function, and variation in stress-induced cortisol responses may predict differences in neural vigilance processing during stress exposure.

Oxytocin also plays an important role in stress a management, and genetic variation in the oxytocin receptor gene (OXTR) has been implicated in anxiety, depression and related stress phenotypes.

### FKBP5 rs1360780 C>T

The FK506 binding protein, encoded by FKBP5, acts as a co-chaperone that modulates not only glucocorticoid receptor activity in response to stressors but also a multitude of other cellular processes in both the brain and periphery. Notably, the FKBP5 gene is regulated via complex interactions among environmental stressors, FKBP5 genetic variants, and epigenetic modifications of glucocorticoid-responsive genomic sites.

#### YOUR RESULT: **CT**

The T allele has been associated with significantly higher FKBP5 levels and is linked to differences in glucocorticoid receptor (GR) sensitivity. The SNP has also been shown to alter the extent of mRNA and protein induction following GR activation.

The CT genotype has been reported to interact with prior lifetime trauma and/or stress to increase the risk for depression and post-traumatic stress disorder. The SNP provides diagnostic insight for management of individuals exposed to an environmental stressor. Individuals who carry the risk variant may require more intensive follow up after exposure to an environmental stressor.



## OXTR rs53576 G>A

Oxytocin is a peptide hormone and neuropeptide that is involved in the regulation of mood, anxiety and social biology. It plays a role in social bonding, sexual reproduction in both sexes, and during and after childbirth. The protein encoded by the OXTR gene belongs to the G-protein coupled receptor family and acts as a receptor for oxytocin. Its activity is mediated by G proteins which activate a phosphatidylinositol-calcium second messenger system.

**YOUR RESULT: AA**

The A allele is associated with a change in OXTR function such that there is decreased sensitivity to social cues, especially in a stressful environment.

Individuals who are A allele carriers may have decreased ability to manage stressful situations and may respond negatively to environmental stressors.

## Cell signalling

Genes encoding proteins involved in cell signalling are important in ensuring normal cell-to-cell communication among nerve cells (neurons), neuronal survival, and the formation of memories. Cell-signalling proteins also serve important roles in activating the release of specific neurotransmitters and hormones.

Calcium and sodium signalling controls many neurological functions, including neurotransmitter release and regulation of excitatory signalling in the brain. Disruptions in these pathways have been linked to altered mood regulation, specifically bipolar disorder.

## AKT1 rs2494732 T>C

AKT1 encodes one of 3 closely related serine/threonine-protein kinases (AKT1, AKT2 and AKT3) and is important in regulating many processes including metabolism, proliferation, cell survival, growth and angiogenesis. AKT1 SNPs have been linked to paranoia and psychosis with cannabis use.

**YOUR RESULT: CT**

The AKT1 TC genotype is possibly associated with altered gene function.

Individuals with the TC genotype may have a slightly increased risk for paranoia in response to cannabis use.

## ANK3

ANK3 encodes Ankyrin-3, which plays a key role in sodium channel functioning and regulation of excitatory signalling. The gene has been linked to conditions characterised by mood instability.

### ANK3 rs1938526 A>G

YOUR RESULT: **AG**

The ANK3 AG genotype has been linked to mildly increased excitatory signalling

Individuals carrying the ANK3 G allele have been associated with an increased risk for bipolar disorder. If clinically indicated, and in context, moderation of excitatory signalling can be achieved via the use of omega-3 fatty acids and/or mood stabilisers.

### ANK3 rs10994336 C>T

YOUR RESULT: **CT**

The ANK3 CT genotype has been linked to increased excitatory signalling.

Individuals carrying the ANK3 T allele have been associated with an increased risk for bipolar disorder. If clinically indicated, and in context, moderation of excitatory signalling can be achieved via the use of omega-3 fatty acids and/or mood stabilisers.

### CACNA1C rs1006737 G>A

The CACNA1C gene belongs to a family of genes that provide instructions for making calcium channels. CACNA1C encodes a subunit of L-type voltage gated Calcium Channel, involved in excitatory signaling in the brain, and has been linked to conditions characterised by mood instability.

YOUR RESULT: **AG**

The CACNA1 AG genotype is mildly associated with altered brainstem volume and increased CACNA1 excitatory signalling.

The A allele is associated with a predisposition to depressive and bipolar disorder. Methods to decrease excitatory signalling, such as ensuring adequate omega-3 FA intake, as well as the use of mood stabilisers, may be used if clinically indicated.

## CHRNA3 rs16969968 G>A

CHRNA3 encodes the nicotinic acetylcholine receptor alpha 3 subunit. The encoded protein is a ligand-gated ion channel that likely plays a role in neurotransmission and release of neurotransmitters after exposure to a stimulant such as with nicotine intake.

YOUR RESULT: **GG**

The GG genotype is associated with normal receptor function.

This genotype shows no increased risk for a high number of cigarettes smoked per day.

## CHRNA5 Asp398Asn / D398N

CHRNA5 encodes the nicotinic acetylcholine receptor alpha 5 subunit. The encoded protein is a ligand-gated ion channel that likely plays a role in neurotransmission and release of neurotransmitters after exposure to a stimulant such as with nicotine intake.

YOUR RESULT: **GG**

The GG genotype is associated with normal receptor function.

Individuals with the GG genotype do not show an increased susceptibility for nicotine dependence.

## The dopaminergic pathway and dopamine response

Dopamine is an excitatory neurotransmitter in the catecholamine family that is synthesized in the brain, and is responsible for modulating reward and pleasure. Dopamine actions include areas of reward, cognition, working memory, and motor coordination. Alterations in dopamine production, breakdown, and receptor function may increase susceptibility to cognitive decline, altered mood regulation and addictive behaviour disorders, including risk for substance abuse, risk-seeking behaviour and binge eating disorders.

### COMT Val158Met

COMT, encoding the catechol-O-methyl transferase enzyme, is responsible for methylation of catecholamines, thereby regulating dopamine (DA) levels primarily in the prefrontal cortex. The COMT Val158Met SNP strongly determines enzyme function, and has been associated with differences in neural processes underlying cognitive output and breakdown of excitatory neurotransmitters.

#### YOUR RESULT: GG

The COMT GG (Val158Val) genotype is associated with increased COMT activity and thus accelerated breakdown of excitatory catecholamines including dopamine and may lead to generally lower dopamine levels.

The COMT GG (Val158Val) genotype is associated with increased COMT activity and thus lower dopamine levels. COMT GG genotype carriers may be at increased risk for brain and cognitive deficits, including executive functioning. Higher lifestyle activities, such as being social, engaging in novel information processing activities, may protect from the COMT risk genotype effect. The GG genotype may also lead to alterations in the reward circuitry pathway, predisposing toward addictive behaviour due to lower dopamine levels. Ensure adequate nutrition to provide for dopamine precursors and manage behaviour accordingly.

### DRD1

DRD1 encodes the D1 subtype of the dopamine receptor, which is the most abundant dopamine receptor in the central nervous system. D1 receptors regulate neuronal growth and development, mediate some behavioral responses, and modulate dopamine receptor D2-mediated events. Dopamine D1 Receptor is involved in regulation of dopamine release in accumbens.

### DRD1 rs4532 T>C

#### YOUR RESULT: TT

Due to the C to T substitution that occurs on this SNP, it may act in inhibiting it receptor translation, changing the functionality of the DRD1 receptor.

This SNP has shown significant association with alcohol dependence and associated disorders including bipolar disorder, novelty seeking, behavioural persistence and harm avoidance characterized as anticipatory worry, fear of uncertainty, and shyness. The TT genotype is associated with increased risk for heavier alcohol use in alcoholism, as well as a greater susceptibility to nicotine dependence. The T allele has also been linked to impulse control behaviours, such as gambling, hypersexuality, compulsive shopping and compulsive eating.

## DRD1 rs5326 C>T

YOUR RESULT: **TT**

The TT genotype is associated with altered DRD1 translation.

DRD1 TT individuals have increased risk for cocaine and heroin dependence and, with regards to heroin addiction, TT carriers were found to develop to heroin-dependency more rapidly compared to those without the homozygous genotype.

## DRD2 Taq1A/2A

DRD2 encodes the D2 subtype of the dopamine receptor, which is integral in the reward-circuitry pathway. The gene has been linked to co-morbid substance use disorders as well as risk seeking and binge eating behaviour.

YOUR RESULT: **TC**

The T allele is associated with a reduced number of dopamine binding sites in the brain.

Individuals with the TC genotype are associated with an increased risk for compulsive and risk-seeking behaviours, as well as co-morbid substance use disorders (alcoholism and opioids), and binge eating behaviour. Having insight to individuals at higher risk for dependence may assist with appropriate intervention strategies and management.

## DRD3 Ser9Gly

DRD3 encodes the D3 subtype of the dopamine receptor. This receptor is localized to the limbic areas of the brain, which are associated with cognitive, emotional, and endocrine functions.

YOUR RESULT: **TT**

The TT genotype is linked to normal DRD3 activity.

The TT genotype has not been linked to increased risk for addictive behaviour.

## DRD4 -521 C>T

DRD4 encodes the D4 subtype of the dopamine receptor, which is integral in the reward-circuitry pathway. The gene has been linked to novelty seeking, substance dependence vulnerability, as well as ADHD.

**YOUR RESULT: CC**

The CC genotype is associated with normal receptor function.

Individuals carrying the CC genotype may have a higher predisposition toward novelty seeking behaviour.

## OPRM1 Asn40Asp (118 A>G)

OPRM1 encodes the mu opioid receptor (MOR), which is the principal target of endogenous opioid peptides and opioid analgesic agents such as beta-endorphin and enkephalins. MOR also has an important role in dependence to other drugs of abuse, such as nicotine, cocaine, and alcohol via its modulation of the dopamine system.

**YOUR RESULT: GG**

The OPRM1 GG genotype alters  $\mu$  opioid receptor availability, and produces a threefold increase in  $\beta$ -endorphin binding affinity and potency.

OPRM1 GG individuals are associated with a greater risk for alcoholism and opioid dependence and may also experience stronger cravings. Individuals with the GG genotype may also have increased pain sensitivity. Compared to AA genotype, the variant (G) is also well established in showing more positive treatment response for alcoholism with naltrexone. Having insight to risk for opioid and alcohol dependence may assist with early intervention and appropriate therapeutic management.

## Endocannabinoid pathway

Cannabinoids, principally delta-9-tetrahydrocannabinol ( $\Delta^9$ -THC) & synthetic analogs, are psychoactive ingredients of marijuana. Cannabinoids bind to central cannabinoid (CB1) receptors where they mimic the effects of endogenously produced cannabinoids. Studies suggest that cannabinoids increase dopamine (DA) activity in the nucleus accumbens (Nac) and prefrontal cortex (PFC) by activating CB1 receptors in the ventral tegmental area (VTA), which increase DA neuronal firing and burst rates.

In this panel, genetic variants will be reported on that have been shown to increase risk for dependence on cannabis as well as other illicit substances.

### CNR1 rs2023239 A>G

CNR1 gene encodes 1 of 2 cannabinoid receptors. Cannabinoids, principally delta-9-tetrahydrocannabinol (THC) bind to central cannabinoid, or CB1, receptors, in which it mimics the effects of endogenously produced cannabinoids. The gene has a role in modulating endocannabinoid and DA-mediated reward signaling.

YOUR RESULT: **TT**

The TT genotype is associated with normal CNR1 function and thus normal reward signalling in this area.

The TT genotype does not confer increased risk to addictive behaviour or dependence on comorbid substances and cannabinoids.

### FAAH 385 C>A

FAAH encodes Fatty Acid Amide Hydrolase, which is an enzyme that is expressed in the brain and liver.

It de-activates N-arachidonoyl-ethanolamine, an endogenous central cannabinoid 1 agonist. FAAH plays an important role in pain, depression, appetite, and inflammation, and has been shown to be associated with risk for substance abuse.

YOUR RESULT: **AC**

The AC genotype is not associated with any significant change in enzyme function.

The AC genotype is not linked to increased risk for addictive disorders.

## The GABAergic pathway

Externalising behaviour is considered to be a strong predictor of early-onset substance use and substance use disorder in adulthood and, the GABAergic pathway has been implicated in this behaviour.

Gamma-aminobutyric acid (GABA) is a neurotransmitter that is expressed predominantly in the central nervous system and is the major inhibitory neurotransmitter. Neuronal activity in the brain is regulated by excitatory inputs and inhibitory activity, including GABAergic inhibitory activity. Stimulation of the inhibitory GABAergic activity, either by endogenous ligands or certain drugs such as benzodiazepines, results in sedation, amnesia and ataxia, while attenuation of the GABAergic system leads to arousal, anxiety, restlessness, insomnia and exaggerated reactivity.

### GABRA2 rs279858 T>C

GABRA2 encodes the gamma-aminobutyric acid receptor subunit alpha-2. GABA is the major inhibitory neurotransmitter in the mammalian brain where it acts at GABA-A receptors, which are ligand-gated chloride channels. Chloride conductance of these channels can be modulated by agents such as benzodiazepines (BZDs) that bind to the GABA-A receptor, where stimulation of the inhibitory GABAergic activity results in sedation, amnesia and ataxia.

#### YOUR RESULT: CT

The CT genotype is associated with normal receptor function, and does not have an altering effect on the GABA-ergic pathway.

The CT genotype has not been linked to externalising behaviour or increased risk for addictive disorders.



## The neurotrophin pathway

Neurotrophins are a family of trophic factors involved in differentiation and survival of neural cells. The neurotrophin family consists of nerve growth factor (NGF), brain derived neurotrophic factor (BDNF), neurotrophin 3 (NT-3), and neurotrophin 4 (NT-4). Function and signalling of neurotrophin plays an important role for neural development and additional higher-order activities such as learning and memory.

### BDNF Val66Met

BDNF, encoding brain derived neurotrophic factor, is a member of the nerve growth factor family of proteins. It is believed to promote many aspects of brain development, such as neuronal cell survival, differentiation, migration, dendritic arborization, synaptogenesis, and plasticity. It is proposed that this gene may take part in the regulation of the stress response and in the biology of neurodegenerative and mood disorders. The gene has also been linked to a number of addictive behaviours, including binge eating disorder.

#### YOUR RESULT: **TT**

The presence of the met (T) allele results in a 25% reduction in activity-dependent secretion of BDNF in the central nervous system (CNS).

Individuals with the met (T) allele have been associated with increased risk for cognitive decline. Low BDNF levels in the cerebral spinal fluid may be a predictor of future cognitive decline in healthy older subjects, and higher levels may decrease risk. In risk was however modulated by regular participation of 'higher lifestyle activities'. The T allele also predisposes to mood disorders such as depressive disorder and anxiety related disorders, especially after psycho-social stress exposure. Stress management interventions are important for these individuals. In terms of addictive behaviours, T allele carriers have greater susceptibility toward behaviours of addiction, including binge eating and bulimia, as well as harmful substance use (cocaine) and 'fear-seeking' behaviour. Increasing expression of BDNF has been achieved with engaging in regular aerobic exercise.

## The serotonergic pathway

Serotonin, or 5-hydroxytryptamine, is a monoamine neurotransmitter that is derived from tryptophan. Serotonin is primarily found in the gastrointestinal tract, as well as blood platelets, and the central nervous system (CNS) and is an important modulator of mood; contributing toward feelings of well-being and happiness. The involvement of serotonin neurotransmission in learning and memory formation via the serotonin receptors may play a modulatory role in the behavioural effects induced by many psychostimulants, providing further understanding of the mechanisms underlying the formation and retrieval of drug-associated memories. Low levels of serotonin are associated with mood disorders, including depression.

### 1A HTR1A -1019 C>G

Serotonin 1-A (5-HT1A) receptors are critical regulators of the serotonin system. Serotonin receptor HTR1A is a G protein coupled receptor that mediates negative feedback inhibition of serotonergic neurons and signalling in limbic brain regions, including the amygdala.

**YOUR RESULT: CC**

The CC genotype is associated with unaltered 5-HT1A activity.

Individuals with the CC genotype are associated with a decreased stress response compared to those carrying the G allele.

## SLC6A4 -rs1042173 A>C

SLC6A4 encodes Solute Carrier Family 6 Member 4, which is an integral membrane protein that transports the neurotransmitter serotonin from synaptic spaces into presynaptic neurons, terminating the action of serotonin and recycling it in a sodium-dependent manner. This protein is a target of psychomotor stimulants, such as amphetamines and cocaine.

### YOUR RESULT: CC

The CC genotype is reported to have higher SLC6A4 expression.

CC genotype individuals do not confer increased risk to addiction related disorders and are also not associated with a heavier alcohol consumption status.

