Sport Plus+

Hormone Metabolism & Methylation

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NUTRIGENOMIX®

PERSONALIZED SPORT
NUTRITION & PERFORMANCE
REPORT

Hello Caroline:

Nutrigenomix is pleased to provide you with your Personalized Sport Nutrition and Performance Report based on your individual genetic profile. Your recommendations are based on the most current evidence-based scientific research that has been published in peer-reviewed journals and reviewed by our team of world-renowned experts in the field of nutrigenomics.

Our laboratory has used state-of-the-art genetic testing procedures to analyze your DNA sample. We examined your genetic code to determine how your genes can influence recommendations related to weight management, body composition, cardiometabolic health, food intolerances, eating habits, various performance-related elements and injury risk. Based on these results, we developed a series of nutrition and performance-related recommendations that are aligned with your genetic profile and gathered additional genetic insights for you and your healthcare provider to consider. As new discoveries in the field of nutrigenomics are made, you will have the opportunity to access this information to further fine-tune your personalized nutrition and training plan.

You and your healthcare or fitness professional can now use the personalized recommendations contained in this report to help you optimize dietary and other performance-related strategies for achieving athletic excellence. You can create a plan to maximize your genetic potential to give you an edge above the competition by starting to *eat according to your genes!*

Ahmed El-Sohemy, PhD
Chief Scientific Officer

The Science Behind Nutrigenomix

One man's food is another man's poison – Lucretius

Nutrition is a key factor that contributes to success in sport. The foods, fluids and supplements you choose in training and competition will impact your performance, adaptations to training, body composition, and risk of illness or injury. Whether you are a weekend warrior or an Olympian, in competitive sports an athlete's nutritional strategies are vital to athletic success. Dietary and supplement strategies in both training and competition should be individually assessed and guided. Knowing about your genes and following tailored sport nutrition guidelines aligned with your personal genetic profile can assist you in optimizing athletic performance while decreasing injury risk.

Over the past decade, there has been growing recognition of the importance of how genes influence our nutritional status, which directly impacts our health and performance. The human genome consists of about 25,000 genes and virtually all can exist in different forms. The variations in our genes make us unique from one another. Genetic variation determines not only the color of our eyes and hair, but how we metabolize and utilize the foods, nutrients and supplements we ingest. Nutrigenomics is the science that applies genomic information and advanced technologies to uncover the relationship between genes, nutrition and human health. Sport Nutrigenomics takes this a step further and aims to help athletes gain an edge in training and competition by maximizing their genetic potential. The term nutrigenomics refers to both the study of how the food, beverages and supplements we consume affects our genes and how our genes can influence our body's response to what we consume.

Different versions of a gene can make us respond differently to certain components in food such as the lactose in milk, the gluten in bread, the caffeine in coffee, along with the carbohydrates, fats, proteins, vitamins and minerals found in various foods. We are all familiar with people who are lactose intolerant or cannot eat gluten. These differences between individuals can be explained by gene variations within the population. Through decades of science and research we have learned that genetic variations in the population and between individuals affect a wide variety of responses to key components of the human diet. For instance, some individuals may gain health, body composition or performance benefits from limiting their consumption of caffeine or saturated fat or increasing their intake of vitamin D or protein, while others can follow the general recommendation for either or both. Your best performance diet depends on the specific variants you have for these nutrient-related genes. Understanding your genetic profile and its implications on your unique response to the foods, supplements and beverages you consume, will provide you with the tools needed to adopt the best dietary strategies for optimal athletic performance.

The science of how specific genes change how we respond to dietary components enables us to use nutrition to its fullest potential to optimize athletic performance. These personalized diets can enhance an individual's nutritional status and empower them to better focus on the nutrition they need to support optimal health and performance. General dietary recommendations or the one-size-fits-all approach to nutritional advice will limit individuals from reaching their full genetic potential. By tailoring an athlete's nutritional needs to their genetic profile, the benefits of nutrition for optimal health and athletic performance can be maximized.

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Summary of Results

Nutrient Metabolism

Dietary Component	Gene, rs Number	Risk Variant	Your Variant	Your Risk	Recommendations
Vitamin A	BCMO1, rs11645428	GG	GG	Elevated	Focus on consuming preformed sources of vitamin A.
Vitamin B_{12}	FUT2, rs601338	GG or GA	GA	Elevated	Focus on consuming bioavailable sources of vitamin B12.
Vitamin C	GSTT1, rs2266633	Del	Ins	Typical	Meet the RDA for vitamin C daily.
Vitamin D	CYP2R1, rs10741657	Algorithm	GA	Elevated	Consume 1000 IU (25 mcg) vitamin D daily.
	GC, rs2282679		GG		
Vitamin E	COMT, rs4680	GG	GA	Typical	Meet the RDA for vitamin E daily from food sources rich in vitamin E.
Folate	MTHFR, rs1801133	CT or TT	TT	Elevated	Meet the RDA for folate daily.
Choline	MTHFD1, rs2236225	Algorithm	GG	Elevated	Meet the Adequate Intake (AI) level for choline daily.
	PEMT, rs12325817		CG		
Calcium	GC, rs7041	Algorithm	TG	Elevated	Consume 1200 mg of calcium daily.
	GC, rs4588		CA		
Iron Overload	SLC17A1, rs17342717	Algorithm	CC	Low	Follow the recommendations provided in the Low Iron Status section.
	HFE, rs1800562		GG		
	HFE, rs1799945		CC		
Low Iron Status	TMPRSS6, rs4820268	Algorithm	GA	Elevated	Meet the RDA for iron and consume sources of vitamin C with iron-rich foods.
	TFR2, rs7385804		CA		
	TF, rs3811647		AA		

Food Intolerances and Sensitivities

Dietary Component	Gene, rs Number	Risk Variant	Your Variant	Your Risk	Recommendations
Lactose	MCM6, rs4988235	CC or CT	CT	Slightly Elevated	Limit dairy intake if you experience gastrointestinal symptoms.
Gluten	HLA, rs2395182	Algorithm	GT	Medium	Medium risk for gluten intolerance.
	HLA, rs7775228		TT		
	HLA, rs2187668		CT		
	HLA, rs4639334		GG		
	HLA, rs7454108		TT		
	HLA, rs4713586		AA		
Caffeine	ADORA2A, rs5751876	TT	CT	Typical	Follow the recommendations provided by the CYP1A2 gene section of this report.

Cardiometabolic Health

Dietary Component	Gene, rs Number	Risk/ Response Variant	Your Variant	Your Risk/ Response	Recommendations
Caffeine	CYP1A2, rs2472300	GA or AA	AA	Elevated	Monitor performance after caffeine intake, and limit intake to 200 mg/day.
Whole Grains	TCF7L2, rs12255372	TT or GT	GT	Elevated	Consume most grain products as whole grains.
Sodium	ACE, rs4343	GA or AA	AA	Elevated	Limit sodium intake to the Adequate Intake level.
Omega-6 and Omega-3 Fat	FADS1, rs174547	CC or CT	TT	Typical	Meet the RDA for omega-6 LA fat and omega-3 ALA fat.
Physical Activity	LIPC, rs1800588	TT or CT	CT	Enhanced	Aim for 150 to 300 min/week of cardio and at least 2 days/week of muscle-strengthening activities.

Weight Management and Body Composition

Dietary Component	Gene, rs Number	Response Variant	Your Variant	Your Response	Recommendations
Physical Activity	FTO, rs9939609	Algorithm	AA	Enhanced	Aim for at least 30-60 mins/day of cardio activity, 6 days/ week, and muscle-strengthening activities at least 2 days/ week.
	ADRB2, rs1042713		GG		
Energy Balance	UCP1, rs1800592	GG or GA	GA	Diminished	To increase leanness, aim for a daily energy deficit of 10-20% from your current energy needs plus an additional 150 kcal.
Protein	FTO, rs9939609	AA	AA	Enhanced	Consume 25-35% of energy from protein or 1.6-2.0 g/kg body weight.
Total Fat	TCF7L2, rs7903146	TT	CC	Typical	Consume 20-35% of energy from fat.
Saturated Fat	APOA2, rs5082	CC	TC	Typical	Limit intake of saturated fat to no more than 10% of energy.
Saturated and Unsaturated Fat	FTO, rs9939609	TA or AA	AA	Enhanced	Limit intake of saturated fat to no more than 10% of energy. Consume at least 5% of energy from polyunsaturated fat.
Monounsaturated Fat	PPARγ2, rs1801282	GG or GC	CC	Typical	Aim for a balance of saturated, monounsaturated and polyunsaturated fats to meet your total daily fat intake.

Eating Habits

Dietary Component	Gene, rs Number	Risk/ Response Variant	Your Variant	Your Risk/ Response	Recommendations
Fat Taste Perception	CD36, rs1761667	GG or GA	AA	Typical	Your ability to sense the fatty taste of foods is typical.
Sugar Preference	GLUT2, rs5400	CT or TT	CT	Elevated	You have a high preference for sugar.
Eating between Meals	MC4R, rs17782313	CC or CT	TT	Typical	Your tendency to eat between meals is typical.

Exercise Physiology, Fitness and Injury Risk

Dietary Component	Gene, rs Number	Risk/ Response Variant	Your Variant	Your Risk/ Response	Recommendations
Motivation to Exercise	BDNF, rs6265	AA or AG	AA	Enhanced	You have an enhanced innate motivation to exercise.
Exercise Behavior	CYP19A1, rs2470158	Algorithm	GG	Typical	You have a typical likelihood of engaging in physical activity.
	LEPR, rs12405556		GT		
Power and Strength	ACTN3, rs1815739	TC or CC	CC	Ultra	You have a genetic advantage to excel in power sports.
Endurance	NFIA-AS2, rs1572312	Algorithm	CC	Typical	Your endurance potential is typical.
	ADRB3, rs4994		TT		
	NRF2, rs12594956		CA		
	GSTP1, rs1695		AG		
	PGC1a, rs8192678		AA		
Muscle Damage	ACTN3, rs1815739	TC or TT	CC	Typical	Meet general guidelines for warming up and cooling down.
Pain	COMT, rs4680	GG or GA	GA	Enhanced	You have an enhanced pain tolerance and therefore tend to experience less pain.
Bone Mass	WNT16, rs2707466	TC or CC	TC	Elevated	You have an elevated risk for low bone mass.
Achilles Tendon Injury	COL5A1, rs12722	CT or TT	CC	Typical	You have a typical risk for Achilles tendon injury.

2in5

People with Risk Variant

Your Results

Gene	Marker
BCMO1	rs11645428

Risk Variant	Your Variant
GG	GG

Your Risk

Elevated

only when vitamin A intake is low

Recommendation

Since you possess the GG variant of the BCMO1 gene, it is important for you to meet the RDA for vitamin A. Consuming foods that are higher in preformed active vitamin A can help you to meet your needs more easily. These foods include fish, liver, eggs, and dairy products. Meeting your recommendations for vitamin A will help to support healthy immunity, vision, and reproductive health. It will also act as an antioxidant when consumed in the form of beta-carotene (plant-sources). Women should aim for 700 mcg RAE/day and men should aim for 900 mcg RAE/day.

Focus on consuming preformed sources of vitamin A.

Vitamin A (Beta-Carotene)

Vitamin A is a fat-soluble vitamin that is important for eye health and vision, thus playing a role in optimizing hand-eye coordination and visual precision, which are key determinants of performance in many sports. Vitamin A also contributes to a strong immune system to support an athlete's demanding training and competition schedule. Beta-carotene is a precursor of active vitamin A and is an antioxidant found in certain fruits and vegetables that are orange-red in color. Beta-carotene can be converted to preformed vitamin A (retinol) in the body to exert its biological functions. Research shows that individuals with the GG version of the BCMO1 gene are inefficient at converting beta-carotene to active vitamin A.* These individuals are considered low responders to dietary beta-carotene so consuming enough active vitamin A can help ensure circulating levels of active vitamin A are adequate to support vision, immunity and reproductive functions.

*Lietz G et al. Single nucleotide polymorphisms upstream from the b-carotene 15,15'-monoxygenase gene influence provitamin A conversion efficiency in female volunteers. Journal of Nutrition. 2012;142:161S-5S.

BCMO1

Beta-carotene mono-oxygenase 1 (BCMO1) is an enzyme that plays a key role in the conversion of beta-carotene into the active form of vitamin A. Beta-carotene is the plant form of vitamin A. Individuals who possess the GG version of the BCMO1 gene are inefficient at converting beta-carotene into the active form of vitamin A. These individuals need to ensure they are consuming adequate amounts of vitamin A, particularly preformed vitamin A.

Sources of Vitamin A

	High in Preformed Vitamin A	Amount (mcg RAE)
Pumpkin, canned (1/2 cup)		1010
Carrots, cooked (1/2 cup)		650
Sweet potato, boiled without skin (1/2 medium)		600
Light tuna (75g)	✓	530
Spinach, boiled (1/2 cup)		500
Butternut squash (1/2 cup)		410
Goat cheese, hard (50g)	✓	240
Eggs (2 large)	✓	220
Mackerel (75g)	✓	190

Source: Health Canada's Nutrient Value of Some Common Foods and Dietitians of Canada Food Sources of Vitamin A

Vitamin B_{12}

Vitamin B_{12} (cobalamin) is important for normal brain and nervous system functioning. Vitamin B_{12} is also associated with red blood cell (RBC) formation and aerobic capacity. Megaloblastic anemia results from vitamin B_{12} deficiency and is associated with elevated homocysteine, and results in general feelings of fatigue and weakness. Megaloblastic anemia limits the blood's oxygen carrying capacity, thus reducing its availability to cells, which may negatively impact aerobic performance. Being deficient in vitamin B_{12} is also associated with pallor (pale skin) and irritability. Research shows that some individuals are at a greater risk than others for vitamin B_{12} deficiency based on the FUT2 gene.* Since animal products are the primary sources of vitamin B_{12}, individuals following a vegetarian diet are at an even greater risk of vitamin B_{12} deficiency.

*Hazra A et al. Common variants of FUT2 are associated with plasma vitamin B12 levels. Nature Genetics. 2008 Oct;40(10):1160-2.

FUT2

The fucosyltransferase 2 (FUT2) enzyme is encoded by the fucosyltransferase 2 gene and is involved in vitamin B_{12} absorption and transport between cells. Variants of this gene have been linked to low blood levels of vitamin B_{12} especially when consuming a vegetarian diet. However, for individuals with the risk variant, consuming adequate vitamin B_{12} can help reduce the risk of vitamin B_{12} deficiency.

Sources of Vitamin B_{12}

	Amount (mcg)
Clams, boiled or steamed (5 large)	59.0
Oysters, boiled or steamed (6 medium)	14.7
Atlantic herring (75g)	14.0
Fortified nutritional yeast (1 Tbsp)	3.9
Ground beef, lean (75g)	2.2
Fortified plant-based beverage (1 cup)	2.2
Atlantic salmon (75g)	2.1
Lamb (75g)	1.7
Soy 'burger' patty (1)	1.7
Eggs, hard boiled (2)	1.1

Source: Health Canada's Nutrient Value of Some Common Foods and http://nutritiondata.self.com

4in5

People with Risk Variant

Your Results

Gene	Marker
FUT2	rs601338

Risk Variant	Your Variant
GG or GA	GA

Your Risk

Elevated

only when vitamin B12 intake is low

Recommendation

Since you possess the GG or GA variant of the FUT2 gene, you have an elevated risk for vitamin B12 deficiency. It is, therefore, important for you to meet the RDA for vitamin B12 of 2.4 mcg daily. You should focus on eating foods with a high bioavailability of vitamin B12 (foods with a form of vitamin B12 that your body uses more effectively). Meat and fish products have a higher bioavailability than eggs or plant sources of vitamin B12, including soy products or fortified plant-based milks and meat alternatives. If you follow a vegetarian or vegan diet, you are at an even greater risk for vitamin B12 deficiency and depending on your food choices, a supplement may be warranted.

Focus on consuming bioavailable sources of vitamin B12.

1in5

People with Risk Variant

Your Results

Gene	Marker
GSTT1	Ins or Del

Risk Variant	Your Variant
Del	Ins

Your Risk

Typical

Recommendation

Since you possess the Ins variant of GSTT1, there is no increased risk of vitamin C deficiency, and supplementation is discouraged, as it may be potentially counter-productive to training. Therefore, following the RDA guidelines for vitamin C is sufficient for you. The RDA for vitamin C is 75 mg per day for women and 90 mg per day for men. Smokers require an additional 35 mg per day. Citrus fruits and juices, strawberries, tomatoes, red and green peppers, broccoli, potatoes, spinach, cauliflower and cabbage are examples of foods that are good sources of vitamin C.

Meet the RDA for vitamin C daily.

Vitamin C

Vitamin C is an essential nutrient and a powerful antioxidant. This water soluble vitamin can aid in the reduction of exercise-induced free-radical production, which can damage healthy tissues and cause premature fatigue during exercise. Vitamin C also aids in the absorption of non-heme (plant) iron, supports immune function and is required for the formation of collagen, a protein used to make skin, connective tissue, and blood vessels, along with supporting bone and tissue repair. However, too much vitamin C as a supplement may interfere with an athlete's adaptations to exercise training. Research has shown that the amount of vitamin C absorbed into the blood can differ between people even when the same amount is consumed. Some people do not process vitamin C from the diet as efficiently as others and are at a greater risk of vitamin C deficiency. Two recent studies* have shown that the ability to process vitamin C efficiently depends on a gene called GSTT1.

*Cahill LE et al. Functional genetic variants of glutathione S-transferase protect against serum ascorbic acid deficiency. American Journal of Clinical Nutrition. 2009;90:1411-7.
Horska A et al. Vitamin C levels in blood are influenced by polymorphisms in glutathione S-transferases. European Journal of Nutrition. 2011;50:437-46.

GSTT1

The GSTT1 gene produces a protein for the glutathione S-transferase enzyme family. These enzymes play a key role in the utilization of vitamin C. The GSTT1 gene can exist in one of two forms. The insertion ("Ins") form is considered functional while the deletion ("Del") form is not functional. The different versions of this gene influence the way vitamin C is utilized in the body. A deletion version of the gene results in a reduced ability to process vitamin C. This means that people who possess the deletion version (Del) will have lower blood levels of vitamin C at a given level of vitamin C intake compared to people who possess the insertion version (Ins) of the gene.

Sources of Vitamin C

	Amount (mg)
Red pepper (1 pepper)	216
Strawberries (1 cup)	96
Pineapple (1 cup)	92
Brussels sprouts (1 cup)	90
Orange juice (1 cup)	86
Broccoli (1 cup)	82
Grapefruit (1 fruit)	78
Mango (1 fruit)	75
Kiwi (1 fruit)	70

Source: TACO (UNICAMP), Canadian Nutrient File and USDA Nutrient Database

Vitamin D

Vitamin D is essential to calcium metabolism and increasing calcium absorption. Low levels of vitamin D are associated with decreased bone mineral density and an increased risk of stress fractures. Vitamin D also seems to play an important role in heart health, immune function, neuromuscular function, and may help in muscle growth and recovery after damaging exercise. Vitamin D can be synthesized by the skin from UV light or it can be obtained from the diet. Vitamin D deficiency is diagnosed by measuring the most common form of vitamin D in the blood, which is 25-hydroxy vitamin D. Research shows that variations in the CYP2R1 and GC genes can affect your risk for low circulating 25-hydroxyvitamin D levels.*

*Slater NA et al. Genetic Variation in CYP2R1 and GC Genes Associated With Vitamin D Deficiency Status. Journal of Pharmacy Practice. 2015:1-6.
Wang TJ et al. Common genetic determinants of vitamin D insufficiency: a genome-wide association study. Lancet. 2010;376:180-88.
Wilson-Barnes SL et al. Effects of vitamin D on health outcomes and sporting performance: Implications for elite and recreational athletes. Nutrition Bulletin. Open Access https://doi.org/10.1111/nbu.12413

CYP2R1 & GC

Vitamin D 25-hydroxylase is the key enzyme that activates vitamin D from its preformed type, which is obtained through sun exposure and the diet. This enzyme is encoded by the CYP2R1 gene and a variant of this gene has been associated with an increased risk of low circulating levels of vitamin D. The GC gene encodes the vitamin D-binding protein, which binds vitamin D and transports it to tissues. A variant in this gene has also been associated with an increased risk of low circulating levels of vitamin D.

Sources of Vitamin D

	Amount (IU)
Sockeye salmon (75g)	680
Whitefish (75g)	448
Sardines, canned in oil (1/2 can)	254
Rainbow trout (75g)	192
Smoked salmon (40g)	168
Halibut (75g)	144
Fortified plant-based beverage (1 cup)	124
Arctic char (75g)	112
Milk (1 cup)	104
Orange juice, fortified with vitamin D (1/2 cup)	50

Source: Health Canada's Nutrient Value of Some Common Foods and Canadian Nutrient File

6in7

People with Risk Variant(s)

Your Results

Genes	Markers
CYP2R1 GC	rs10741657 rs2282679

Risk Variant	Your Variants
Algorithm	GA GG

Your Risk

Elevated

only when vitamin D intake is low

Recommendation

Since you possess one or more elevated risk variants, you are at an increased risk for low circulating vitamin D levels, so getting enough vitamin D is important. Aim for 1000 IU (25 mcg) vitamin D per day. This can help to maintain and/or improve your bone health, muscle and brain function, immunity, and heart health. Since it may be challenging to get enough vitamin D in the diet, supplementation may be beneficial. Do not exceed 2000 IU (50 mcg) per day without first having your blood levels of vitamin D assessed and monitored by a healthcare professional.

Consume 1000 IU (25 mcg) vitamin D daily.

1in4

People with Risk Variant

Your Results

Gene	Marker
COMT	rs4680

Risk Variant	Your Variant
GG	GA

Your Risk

Typical

Recommendation

Since you possess the AA or GA variant of the COMT gene, current research shows that there is no elevated cancer risk associated with vitamin E supplementation. In fact, those who possess the AA variant of the COMT gene have a slightly lower cancer risk when taking vitamin E supplements. However, since an effective and safe dose of vitamin E in the form of supplements has not yet been established for cancer protection, increasing intakes of vitamin E rich foods is recommended. Therefore, aim to meet the vitamin E RDA of 15 mg per day (21 IU/day) through food sources only. Good food sources of vitamin E include almonds, sunflower seeds, sunflower oil, hazelnuts, and grapeseed oil. Consult your healthcare provider before taking vitamin E-containing supplements.

Meet the RDA for vitamin E daily from food sources rich in vitamin E.

Vitamin E

Vitamin E is a fat-soluble antioxidant essential for building a strong immune system and supporting skin and eye health, and it may also help to reduce exercise-induced free radical damage. Most vegetable oils, such as sunflower, canola and flaxseed oil, are good sources of vitamin E. Nuts and seeds are also great sources. Given its antioxidant properties, there has been much interest in the role for vitamin E supplementation in cancer prevention. While some studies have shown a protective effect of vitamin E supplementation on cancer risk, others have reported increased risk with higher vitamin E supplementation.* The discrepancy in findings across studies may be partly related to genetic variants that modify the risk associated with vitamin E supplementation. Scientists have reported a genetic variant in COMT may modify the risk associated with vitamin E supplementation.

*Hall KT et al. COMT and Alpha-Tocopherol Effects in Cancer Prevention: Gene-Supplement Interactions in Two Randomized Clinical Trials. J Natl Cancer Inst. 2019 doi: 10.1093/jnci/djy204

COMT

The COMT gene produces an enzyme called catechol-O-methyltransferase, which helps detoxify both substances produced by the body and environmental compounds such as drugs and harmful toxins. Variations in the COMT gene impact the enzyme activity of COMT, and research shows that this genetic variation may modify the way individuals respond to vitamin E supplementation as it relates to risk of cancer. Among individuals with the GG variant, a slightly increased cancer risk was observed with vitamin E supplementation compared to placebo. By contrast, those with the GA variant experienced no risk or benefit, and individuals with the AA variant had a slightly reduced cancer risk following vitamin E supplementation.

Sources of Vitamin E

	Amount (mg)
Almonds (1/4 cup)	9.3
Sunflower seeds, roasted (1/4 cup)	8.5
Sunflower oil (1 Tbsp)	5.7
Hazelnuts, dry roasted (1/4 cup)	5.2
Avocado (1/2 fruit)	4.0
Peanut butter (2 Tbsp)	2.9
Peanuts, dry roasted (1/4 cup)	2.6
Flaxseed oil (1Tbsp)	2.4
Canola oil (1 Tbsp)	2.4
Halibut (75g)	2.2
Eggs (2 large)	1.0

Source: Health Canada's Nutrient Value of Some Common Foods

Folate

Folate is a water-soluble B vitamin that is necessary for cell growth and development. Low blood levels of folate have been associated with increased risk of heart disease and stroke via high homocysteine levels. Intense physical activity has also been shown to raise homocysteine levels, therefore training athletes may have an increased risk especially if coupled with folate deficiency. Research has shown that the amount of folate absorbed into the blood can differ between individuals even when the same amount of folate is consumed. Some people do not utilize dietary folate as efficiently as others and are consequently at a greater risk of folate deficiency. Studies* have shown that an individual's ability to process dietary folate efficiently depends on a gene called MTHFR.

*Solis C et al. Folate Intake at RDA Levels Is Inadequate for Mexican American Men with the Methylenetetrahydrofolate Reductase 677TT Genotype. Journal of Nutrition. 2008 ;138 :67-72.
Guinotte CL et al. Methylenetetrahydrofolate Reductase 677C T Variant Modulates Folate Status Response to Controlled Folate Intakes in Young Women. Journal of Nutrition. 2003;133 :1272-1280.
Currò M, Di Mauro D, Bruschetta D, D'Amico F, Vecchio M, Trimarchi F, Ientile R, Caccamo D. Influence of MTHFR polymorphisms on cardiovascular risk markers in elite athletes. Clin Biochem. 2016 Jan;49(1):183-5

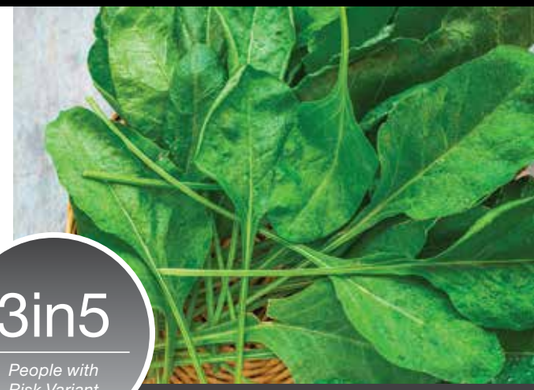
MTHFR

The MTHFR gene produces methylenetetrahydrofolate reductase (MTHFR), which is a vital enzyme for folate usage in the body. MTHFR converts folate obtained from the diet to an active form of the nutrient that can be used by the body at the cellular level. Variations in the MTHFR gene determine the way individuals can utilize dietary folate. Those people who have the CT or TT variant of the gene have reduced MTHFR enzyme activity and are at greater risk of folate deficiency when folate intake is low, compared to those with the CC variant.

Sources of Folate

	Amount (mcg)
Lentils, cooked (3/4 cup)	265
Edamame (soybeans) (1/2 cup)	190
Spinach, cooked (1/2 cup)	130
Asparagus (6 spears)	128
Chickpeas (3/4 cup)	119
Black beans (3/4 cup)	108
Artichoke, boiled (1/2 cup)	106
Kale, raw (1 cup)	100
Avocado (1/2 fruit)	81

Source: Canadian Nutrient File and USDA Nutrient Database



3in5

People with Risk Variant

Your Results

Gene	Marker
MTHFR	rs1801133

Risk Variant	Your Variant
CT or TT	TT

Your Risk

Elevated

only when folate intake is low

Recommendation

Since you possess the TT or CT variant of the MTHFR gene, there is a greater risk of folate deficiency if the RDA is not met on a daily basis. Ensure that folate intake is at least 400 mcg per day in order to reduce the risk of deficiency. Foods that are naturally high in folate include lentils, romano beans, black beans, white beans, okra, asparagus, spinach, and other leafy greens. Enriched ready-to-eat cereals, bread, and bread products are also good sources of folate. A folate supplement may be warranted if adequate intakes through dietary sources cannot be achieved.

Meet the RDA for folate daily.

3in5

People with Risk Variant(s)

Your Results

Gene	Markers
MTHFD1 PEMT	rs2236225 rs12325817

Risk Variant	Your Variants
Algorithm	GG CG

Your Risk

Elevated

only when choline intake is low

Recommendation

Since you possess one or more of the risk variants you have a greater risk of choline deficiency if your choline intake is low. Therefore, it is important to meet the Adequate Intake (AI) level of 425 mg/day for women or 550 mg/day for men. Do not exceed the tolerable upper limit (UL) of 3.5 g/day. Foods rich in choline include meat, poultry, dairy products and eggs, as well as legumes, broccoli, brussels sprouts and quinoa. In addition, ensuring your level of dietary folate recommendations are met also helps lower your risk of choline deficiency (refer to the Folate section for your specific recommendations).

Meet the Adequate Intake (AI) level for choline daily.

Choline

Choline plays numerous roles in the body. This essential nutrient is involved in multiple metabolic pathways, and is needed for the production of acetylcholine, a neurotransmitter implicated in memory, mood, and muscle control. A reduction in the release of acetylcholine may contribute to the development of fatigue and exercise performance impairment. Choline is found in all cells of the body, providing a vital structural component to cell membranes. Choline can also impact early brain development and regulate the function of genes or how they are "expressed". Although some choline is produced by the body, dietary sources of choline are necessary to meet daily needs. Athletes experience muscle damage through high volume and high intensity training. A deficient or suboptimal status of choline may place additional stressors on an athlete's ability to recover, repair and adapt to their given training stimulus. Research also shows that variation in the MTHFD1 and PEMT genes also impact dietary choline needs.*

*Ganz AB, Shields K, Fomin VG, Lopez YS, Mohan S, Lovesky J, et al. Genetic impairments in folate enzymes increase dependence on dietary choline for phosphatidylcholine production at the expense of betaine synthesis. FASEB Journal: Official Publication of the Federation of American Societies for Experimental Biology. 2016;30(10):3321-33.
Kohlmeier M, da Costa K, Fischer LM, Zeisel SH. Genetic variation of folate-mediated one-carbon transfer pathway predicts susceptibility to choline deficiency in humans. Proc Natl Acad Sci U S A. 2005 Nov 1;102(44):16025-30.
da Costa K, Kozyreva OG, Song J, Galanko JA, Fischer LM, Zeisel SH. Common genetic polymorphisms affect the human requirement for the nutrient choline. FASEB J. 2006 Jul;20(9):1336-44.
Jager R, Purpura M, Kingsley M. Phospholipids and sports performance. J Int Soc Sports Nutr. (2007) 4:5. doi: 10.1186/1550-2783-4-5

MTHFD1 & PEMT

Methylene tetrahydrofolate dehydrogenase (MTHFD1) encodes an enzyme responsible for folate (also known as vitamin B9) metabolism. Choline's function is tightly linked to the metabolism of folate, as both share overlapping roles in the same metabolic pathways. Individuals who carry the A allele of the MTHFD1 gene are at higher risk of developing clinical signs of choline deficiency when choline intakes are very low in comparison to those who have the GG genotype. In addition, the phosphatidylethanolamine N-methyltransferase (PEMT) gene encodes a protein that allows the liver to produce choline. Individuals with the CG or CC variants of the PEMT gene are at a higher risk of experiencing clinical signs of choline deficiency compared to those with the GG variant if choline intake is low. Meeting the Adequate Intake (AI) for choline is especially important for individuals with the risk variants of these genes.

Sources of Choline

	Amount (mg)
Egg (1)	147
Soybeans (1/2 cup)	107
Chicken breast (85g)	72
Ground beef (85g)	72
Atlantic cod (85g)	71
Shiitake mushrooms, cooked (1/2 cup)	58
Baked potato (1 large)	57
Wheat germ (2 Tbsp)	51
Kidney beans (1/2 cup)	45

Source: National Institutes of Health

Calcium

Calcium is important for growth, maintenance and repair of bone tissue. It is also involved in maintenance of blood calcium levels, regulation of muscle contraction, nerve conduction, and normal blood clotting. In order to absorb calcium, we also need adequate vitamin D intake (refer to the vitamin D section for your specific recommendations). Inadequate dietary calcium and vitamin D increase the risk of low bone mineral density and stress fractures. Low energy intakes and menstrual dysfunction in female athletes along with low vitamin D and calcium intakes further increase the risk of stress fractures. Research now shows that some people do not utilize dietary calcium as efficiently as others and this may depend on variations in the GC gene.*

*Fang Y et al. Vitamin D binding protein genotype and osteoporosis. Calcif Tissue Int. 2009;85:85-93.

GC

The GC gene encodes the vitamin D-binding protein, which binds vitamin D and then transports it to various tissues. Since vitamin D is needed for the absorption of calcium, this binding protein can impact calcium levels in the body and, therefore, bone fracture risk. Research shows that two variations in the GC gene are associated with an increased risk of bone fractures when calcium intake is low.

Sources of Calcium

	Amount (mg)
Low-fat cheddar cheese (50g)	450
Yogurt, plain (3/4 cup)	330
Skim milk (1 cup)	325
Fortified soy or rice beverage (1 cup)	320
Tofu, firm (150g)	235
Canned salmon, with bones (75g)	210
Sardines, canned in oil (1/2 can)	200
Kefir, plain (3/4 cup)	185
Edamame (soybeans) (1/2 cup)	130
Spinach, boiled (1/2 cup)	130

Source: Health Canada's Nutrient Value of Some Common Foods

4in5

People with Risk Variant(s)

Your Results

Gene	Markers
GC	rs7041 rs4588

Risk Variant	Your Variants
Algorithm	TG CA

Your Risk

Elevated

only when calcium intake is low

Recommendation

Based on your GC gene, you have an increased risk for bone fractures if your calcium intake is below 1200 mg per day. Meeting intakes of 1200 mg per day will bring your elevated risk down to typical. Adults 19-50 years old should not exceed 2500 mg calcium per day and adults over 50 should not exceed 2000 mg per day. Aim to meet your recommended daily intake of calcium through dietary sources. Calcium supplementation should not exceed 250 mg per day unless otherwise advised by your healthcare provider.

Consume 1200 mg of calcium daily.

1in150

People with Risk Variant(s)

Your Results

Genes	Markers
SLC17A1 HFE HFE	rs17342717 rs1800562 rs1799945

Risk Variants	Your Variants
Algorithm	CC GG CC

Your Risk

Low

Recommendation

Since you do not possess any risk variants for iron overload, you have a low risk for iron overload. Follow the recommendations given in the next section for Low Iron Status.

Follow the recommendations provided in the Low Iron Status section.

Iron Overload

Hemochromatosis is a condition where the body absorbs too much iron (i.e. iron “overload”) and can result in liver disease, arthritis and heart conditions. If you have a high risk for iron overload it is important to monitor your iron intake and blood markers of iron status such as ferritin, hepcidin or transferrin saturation. There are two main types of dietary iron: heme and non-heme iron. Non-heme iron is found in certain plant products and is not absorbed as effectively as heme iron, but vitamin C can substantially increase the absorption of non-heme iron. Hereditary hemochromatosis is an iron overload condition that is linked to variations in the HFE or SLC17A1 genes.* Interestingly, the prevalence of genetic variation in the HFE and SLC17A1 genes, leading to iron overload, is much higher in elite level athletes compared to the general population.** While this genetic variation appears to have a favorable impact on performance, it is important for athletes with a medium or high risk to avoid iron supplementation as this could lead to severe organ dysfunction.

*Allen KJ et al. Iron-overload-related disease in HFE hereditary hemochromatosis. New England Journal of Medicine. 2008;358:221-30.
Pichler I et al. Identification of a common variant in the TFR2 gene implicated in the physiological regulation of serum iron levels. Human Molecular Genetics. 2011;15:1232-40.
**Semenova EA et al. The association of HFE gene H63D polymorphism with endurance athlete status and aerobic capacity: novel findings and a meta-analysis. Eur J Appl Physiol. 2020

HFE & SLC17A1

The human hemochromatosis protein is encoded by the HFE gene and variations in the gene sequence have been linked to iron overload. The SLC17A1 gene is located near the HFE gene and variations in SLC17A1 have also been linked to iron overload. The HFE protein functions to regulate iron uptake in the small intestine. Those with elevated risk variants need to be careful not to consume too much iron and should have their blood markers of iron monitored. This test detects approximately 95% of cases of iron overload.

Sources of Iron

Sources of Heme Iron	Sources of Non-Heme Iron
Beef	Almonds
Chicken	Chickpeas
Fish	Parsley
Organ meats	Spinach
Shrimp	Tofu
Veal	White beans

Low Iron Status

Iron is an essential mineral that plays a fundamental role in processes related to sport and exercise performance and immune function. Iron is required in the formation of red blood cells, which transport oxygen in the body. It is also a component of certain enzymes and proteins, which are essential for energy production and optimizing physical performance. Low iron status is determined by measuring certain blood markers such as ferritin, hepcidin or transferrin. Low iron stores can lead to anemia, which is associated with fatigue, weakness, shortness of breath, dizziness and reduced aerobic capacity. Low iron status, even in the absence of anemia, can cause fatigue and poor performance. Many athletes are at higher risk of low iron stores than the general population. Several genes can impact the risk of having low iron status including TMPRSS6, TFR2, and TF.*

*Pichler I et al. Identification of a common variant in the TFR2 gene implicated in the physiological regulation of serum iron levels. Human Molecular Genetics. 2011;15:1232-40.
Benyamin B et al. Variants in TF and HFE explain approximately 40% of genetic variation in serum-transferrin levels. Am J Hum Gen. 2009;84:60–65.

TMPRSS6, TFR2 & TF

The TMPRSS6 gene codes for the protein matriptase-2, which affects hepcidin levels that help to regulate iron balance. The transferrin receptor 2 (TFR2) gene codes for the TFR2 protein, which helps iron to enter into cells. The transferrin (TF) gene codes for the protein transferrin, which is mainly responsible for transferring iron in the body. Together, variations in these genes can impact the risk of low iron status.

Sources of Iron

	Amount (mg)
Chicken liver (75g)	9.8
White beans, canned (1 cup)	8.0
Pumpkin seeds (2 Tbsp)	5.2
Spinach, boiled (1/2 cup)	3.4
Tofu, firm (1/2 cup)	3.0
Tahini (2 Tbsp)	2.7
Ground beef, extra lean (100g)	2.7
Chickpeas (3/4 cup)	2.4
Almonds (1/4 cup)	1.5
Lean ground chicken (75g)	1.2

Source: Health Canada’s Nutrient Value of Some Common Foods

2in5

People with Risk Variant(s)

Your Results

Genes	Markers
TMPRSS6 TFR2 TF	rs4820268 rs7385804 rs3811647

Risk Variants	Your Variants
Algorithm	GA CA AA

Your Risk

Elevated

only when iron intake is low

Recommendation

You are at an increased risk for low iron status. To minimize your risk for low iron, meet the RDA for iron and consume food sources of vitamin C with non-heme iron-containing foods to increase iron absorption. Focus on foods with a high bioavailability such as animal products (heme iron) and cooked spinach. Although iron supplementation might be warranted, too much iron can be toxic and can also result in reduced exercise performance. Therefore, the decision to use iron supplements should carefully consider blood work assessment and the supervision of a healthcare professional. Men aged 19 years and older and women over 50 should aim for 8 mg/day. Women 19-50 years old should aim for 18 mg/day. Those following plant-based diets may need higher intakes.

Meet the RDA for iron and consume sources of vitamin C with iron-rich foods.

Your Results

Gene	Marker
MCM6	rs4988235

Risk Variant	Your Variant
CC or CT	CT

Your Risk

Slightly Elevated

Lactose

Lactose is a naturally occurring sugar found in dairy products. When lactose is properly digested, it is broken down into two different sugar molecules: glucose and galactose. Lactase is the enzyme needed to break down lactose. Some people do not produce any, or enough lactase. Because of this, lactose passes through the intestines undigested. When this occurs, gut bacteria in the intestines ferment the lactose, which produces gas that leads to bloating and cramps, and causes water to enter the intestine quickly leading to diarrhea. These are the uncomfortable symptoms associated with lactose intolerance. Some people who do not digest lactose cannot tolerate any dairy products, while others can tolerate small amounts of lactose. When dairy is consumed with a meal there can be minor symptoms or no symptoms at all, but consuming dairy on its own (especially fluid milk) can result in more severe symptoms.

Lactose Intolerance

Individuals who are lactose intolerant cannot digest lactose. When lactose is not digested, it can cause uncomfortable symptoms such as stomach upset, gas, bloating, and/or loose stools. These symptoms can develop as early as one hour after you consume lactose-containing products. Typically, individuals with lactose intolerance may have to consume a lactose-free or lactose-reduced diet for life or consume dairy products with a meal to reduce the impact of lactose on the gastrointestinal system. Sometimes you can train your body to produce more lactase enzyme by gradually introducing lactose into your diet. Some lactose intolerant individuals can tolerate up to 12 g of lactose per day, which is equivalent to 1 cup of milk. Spreading out your intake over the course of a day and/or consuming lactose-containing foods with meals can help improve tolerance. Your risk for lactose intolerance depends in part on the MCM6 gene. Sometimes you can develop short-term lactose intolerance when you are sick.

MCM6

MCM6 is part of the MCM complex that helps to regulate the expression of the LCT gene, which encodes lactase, the enzyme that plays a role in breaking down lactose. Variations in this gene can impact your ability to break down lactose, impacting your risk for lactose intolerance. Individuals who possess the CC or CT variant may produce some lactase, but in limited amounts. Individuals with the CC or CT variant have been shown to be at an increased risk for low calcium intake and blood calcium levels.* This particular variant in MCM6 may not predict lactose intolerance risk for individuals who are not of European descent.

*Enattah NS et al. Identification of a variant associated with adult-type hypolactasia. Nature Genetics. 2002;30:233-7.
Koek et al. The T-13910C polymorphism in the lactase phlorizin hydrolase gene is associated with differences in serum calcium levels and calcium intake. Journal of Bone and Mineral Research. 2010;25(9):1980-7.
Dzialanski et al. Lactase persistence versus lactose intolerance: Is there an intermediate phenotype? Clinical Biochemistry. 2015. doi: 10.1016/j.clinbiochem.2015.11.001.

9in10 East Asians — *People with Risk Variant*

9in10 African Americans — *People with Risk Variant*

7in10 Caucasians — *People with Risk Variant*

Nutrition Considerations with a Lactose-Free Diet

Research shows that individuals who consume a lactose-free diet are at a greater risk of inadequate calcium and vitamin D intake compared to individuals who can tolerate lactose.* Calcium and vitamin D are important for building and maintaining strong bones and teeth, and reducing the risk of low bone density and stress fractures that often occur in athletes, especially females with menstrual cycle dysfunction. If you have lactose intolerance, you can still get enough calcium and vitamin D in the diet through fortified plant-based milk alternatives such as soy, almond, and oat. Calcium and vitamin D are not added to all plant-based milk alternatives, so be sure to read the label to check that the products you are choosing have been "fortified with calcium and vitamin D."

*Koek et al. The T-13910C polymorphism in the lactase phlorizin hydrolase gene is associated with differences in serum calcium levels and calcium intake. Journal of Bone and Mineral Research. 2010;25(9):1980-7.

Sources of Lactose

	Amount (g)
Cow's milk (1 cup)	12
Goat's milk (1 cup)	11
Flavoured milk (1 cup)	10
Buttermilk (1 cup)	9
Yogurt (3/4 cup)	7
Frozen yogurt (1/2 cup)	5
Ice cream (1/2 cup)	5
Cottage cheese (1/2 cup)	3
Sour cream (1/4 cup)	2
Hard cheese, example: Parmesan (50g)	<1

Source: Dietitians of Canada, Food Sources of Lactose

Recommendation

Since you possess the CT variant of the MCM6 gene, you have a slightly elevated risk of experiencing lactose intolerance symptoms after consuming lactose. If you experience gastrointestinal symptoms after consuming lactose-containing foods, try avoiding lactose and monitor your symptoms. Some lactose intolerant individuals can tolerate up to 12 g of lactose per day, which is equivalent to 1 cup of milk. Spreading out your intake over the day and/or consuming lactose-containing foods with meals can help improve tolerance. To help meet your calcium and vitamin D needs, aim to include 1 serving of dairy, if tolerated, and 1-2 calcium- and vitamin D-fortified lactose-free milk or dairy alternatives such as soy or almond beverages daily.

Limit dairy intake if you experience gastrointestinal symptoms.

Your Results

Gene	Markers
HLA	rs2395182 rs7775228 rs2187668 rs4639334 rs7454108 rs4713586
Risk Variants	**Your Variants**
Algorithm	GT TT CT GG TT AA

Your Risk

Medium

Gluten

Gluten is a protein found in wheat, barley, rye and products made from these grains. Some oats also contain gluten. Many foods that contain gluten provide fibre from whole grains and can be an excellent source of vitamins and minerals. However, for some people, gluten can cause severe digestive problems leading to nutrient malabsorption, anemia and many serious health problems. Several nutrient deficiencies are common in athletes with undiagnosed celiac disease, especially iron deficiency. Iron deficiency can significantly impair athletic performance since iron plays a large role in enhancing muscle function and work capacity. Gastrointestinal distress, or stomach upset, can also impair performance, so for athletes with gluten intolerance, following a strict gluten-free diet is crucial.

Celiac Disease & Gluten Sensitivity

Celiac disease represents the most severe form of gluten intolerance and affects about 1% of the population. People with celiac disease require a gluten-free diet for life. Non-celiac gluten sensitivity (NCGS) is a milder form of gluten intolerance that may affect 5% of the population. Individuals with NCGS often experience diarrhea, abdominal pain, fatigue and headaches when they consume gluten-containing foods. However, these adverse effects of gluten in individuals who do not have celiac disease are poorly understood and NCGS remains controversial.*

*Tonutti E and Bizzaro N. Diagnosis and classification of celiac disease and gluten sensitivity. Autoimmunity Reviews. 2014;13:472-6.

HLA

The HLA genes produce a group of proteins called the human leukocyte antigen (HLA) complex, which are responsible for how the immune system distinguishes between the body's own proteins and foreign, potentially harmful proteins. Research has shown that the HLA genes are the most important genetic predictor of gluten intolerance. Approximately 99% of people with celiac disease and 60% of those with non-celiac gluten sensitivity* have the DQ2 or DQ8 risk version of HLA, compared to only 30% of the general population. Six variations in the HLA genes can be used to classify individuals into predefined risk groups for gluten intolerance. Risk prediction is based upon a scale of low, medium or high risk.

*Mark Wolters VM and Wijmenga C. Genetic background of celiac disease and its clinical implications. American Journal of Gastroenterology. 2008;103:190-5.
Sapone A et al. Divergence of gut permeability and mucosal immune gene expression in two gluten-associated conditions: celiac disease and gluten sensitivity. BMC Medicine. 2011;9:23.
Monsuur AJ et al. Effective detection of human leukocyte antigen risk alleles in celiac disease using tag single nucleotide polymorphisms. PLoS ONE. 2008;3:e2270.

70% of People — *Low Risk*

20% of People — *Medium Risk*

10% of People — *High Risk*

Nutrition Considerations when Following a Gluten-Free Diet

Gluten-free foods include all unprocessed vegetables, fruit, dairy products, meat, fish, poultry, nuts, legumes, seeds, fats and oils. Gluten-free grains include rice, quinoa, corn, buckwheat, amaranth, and millet. For individuals who need to follow a gluten-free diet, foods to avoid include any products that are made with wheat, rye, barley or triticale. Pure oats should be consumed in moderation if tolerated, while regular oats (which contain wheat) should be avoided. For the vast majority of the population, consuming a gluten-free diet is unnecessary. Processed gluten-free products often have more calories, sodium, added sugar and fat and fewer nutrients compared to their gluten-containing counterparts. Despite a lack of evidence supporting the benefits of a gluten-free diet for athletic performance in individuals without celiac disease, athletes are more likely than the general population to follow a gluten-free diet. For athletes without celiac disease, adherence to a gluten-free diet is often unnecessary and can make it more difficult to meet their nutritional needs, especially for carbohydrates.

Sources of Gluten

Major Sources of Gluten	Hidden Sources of Gluten
Bread	Salad dressing
Pasta	Pudding
Cereal	Imitation crab meat
Crackers and chips	Vegan meat substitute
Oats*	Potato chips
Baked goods	French fries
Malt	Soup stock cubes
Soy sauce	Chocolate and candy
Gravy	Processed meat
Barley or wheat based-beer	Canned soup
Vinegars	Instant rice
Wheat - incl rye, spelt and barley	Ice cream

*Pure oats do not contain gluten; however, oats are often cross-contaminated with gluten-containing grains

Recommendation

You have a medium risk for developing celiac disease however this does not mean you have celiac disease. Speak to your healthcare professional if you experience diarrhea, steatorrhea, cramps, flatulence, fatigue or joint pain while consuming gluten-containing foods, or if you have a family member with celiac disease. Major dietary sources of gluten include bread, pasta, cereal and any baked goods made with wheat, barley or rye. It is not recommended that you immediately attempt to remove gluten from your diet, as eliminating gluten may interfere with the accuracy of celiac disease diagnostic tests.

Medium risk for gluten intolerance.

1in5

People with Risk Variant

Your Results

Gene	Marker
ADORA2A	rs5751876

Risk Variant	Your Variant
TT	CT

Your Risk

Typical

Recommendation

Since you possess the CT or CC variant of the ADORA2A gene, you have a typical risk for an increase in feelings of anxiety after caffeine consumption. Aim to follow your DNA-based caffeine intake recommendations for the CYP1A2 gene included in your report.

Follow the recommendations provided by the CYP1A2 gene section of this report.

Caffeine

Anxiety

Many commonly consumed foods and beverages, such as coffee, tea, soft drinks and chocolate, as well as functional beverages such as energy drinks, contain caffeine. There are also hidden sources of caffeine found in pain medications, weight loss supplements, as well as chocolate or coffee-flavored beverages and food products. Caffeine is widely used to promote wakefulness and vigilance, reduce sleepiness and mitigate fatigue related to various shift-work occupations or athlete travel and competition across time zones. In the brain, the effects of caffeine are primarily due to its blocking action of adenosine, a neuromodulator that increases drowsiness and builds up over the day as bedtime approaches. Athletes that are more prone to general or performance anxiety may increase their risk for feelings of anxiety depending on their level of caffeine use and which variant of the ADORA2A gene they possess. A common variation in the ADORA2A gene contributes to the differences in subjective feelings of anxiety after caffeine ingestion*, especially in those who are habitually low caffeine consumers.**

*Childs E eta al. Association between ADORA2A and DRD2 polymorphisms and caffeine-induced anxiety. Neuropsychopharmacology. 2008 Nov;33(12):2791-800
Alsene K et al. Association between A2a receptor gene polymorphisms and caffeine-induced anxiety. Neuropsychopharmacology. 2003 Sep;28(9):1694-702.
**Rogers PJ, et al. Association of the anxiogenic and alerting effects of caffeine with ADORA2A and ADORA1 polymorphisms and habitual level of caffeine consumption. Neuropsychopharmacology. 2010. (9):1973–1983.

ADORA2A

The ADORA2A (adenosine A2A receptor) gene encodes one of the main receptors for adenosine. Adenosine has many functions in the body, including promoting sleep and calmness and suppressing arousal. Caffeine blocks adenosine receptors, resulting in the stimulating effects of coffee, tea, chocolate and other caffeinated food products and supplements. Individuals who possess the TT variant of the ADORA2A gene are more sensitive to the stimulating effects of caffeine and experience greater increases in feelings of anxiety after caffeine intake than do individuals with either the CT or CC variant.

Athletic Performance

Supplementation with caffeine has been shown to acutely enhance many aspects of exercise performance, including aerobic and muscular endurance, some aspects of anaerobic performance as well as a wide range of sport-specific actions. Although coffee is one of the most significant sources of caffeine, many athletes use caffeine supplements in the form of capsules, tablets, pre-workout formulas, energy drinks and caffeinated gels and chews. Research shows that 2-6 mg of caffeine per kg of body mass is beneficial for many but not all athletes and exercisers. Caffeine can influence cardiovascular health as well as athletic performance differently between individuals. Specifically, the cardiovascular health and endurance performance effects of caffeine depend on an individual's variant of the CYP1A2 gene.*

*Guest N et al. Caffeine, CYP1A2 Genotype, and Endurance Performance in Athletes. Med Sci Sports Exerc. 2018; 50:1570-1578.
Womack CJ et al. The influence of a CYP1A2 polymorphism on the ergogenic effects of caffeine. J Int Soc Sports Nutr. 2012 Mar 15;9(1):7. doi: 10.1186/1550-2783-9-7.
Cornelis et al. Coffee, CYP1A2 genotype, and risk of myocardial infarction. Journal of the American Medical Association. 2006;295:1135-41.

CYP1A2

The CYP1A2 gene produces an enzyme called cytochrome P450 1A2 (CYP1A2), which is the main enzyme responsible for breaking down caffeine in the body. Variations in the CYP1A2 gene affect the rate at which caffeine is broken down, which determines the impact of caffeine on cardiovascular health and athletic performance. Individuals who possess the GA or AA variant of CYP1A2 break down caffeine more slowly and are at greater risk of high blood pressure and heart attack when caffeine intake is high. These individuals do not appear to experience endurance performance benefits from caffeine. Furthermore, caffeine may diminish endurance performance in individuals with the AA variant. Those who have the GG variant actually have a lower risk of heart disease with moderate coffee consumption. Caffeine is also more effective at improving endurance performance in athletes with the GG variant.

Sources of Caffeine

	Amount (mg)
Coffee (1 cup)	100
Energy drinks (1 cup)	80
Espresso (1 shot)	85
Black tea (1 cup)	50
Green tea (1 cup)	45
Cola (1 can)	26
Chocolate, dark (40g)	27
Decaf coffee, espresso, tea (1 cup)	0-15
Herbal tea (1 cup)	0

Source: Canadian Nutrient File and USDA Nutrient Database

1in2

People with Risk Variant

Your Results

Gene	Marker
CYP1A2	rs2472300

Risk Variant	Your Variant
GA or AA	AA

Your Risk

Elevated

only when caffeine intake is high

Recommendation

Since you possess the AA or GA variant of the CYP1A2 gene, you are a slow metabolizer of caffeine and are less likely to benefit from the endurance performance-enhancing effects of caffeine. Additionally, there is an increased risk of high blood pressure and heart attack if you are consuming more than 200 mg of caffeine per day. Limit caffeine consumption to no more than 200 mg per day in order to reduce your risk of heart disease. If you have the AA variant, monitor your response to caffeine in training and competition as caffeine may worsen your performance. Caffeine occurs naturally in coffee, tea, cocoa, kola and guarana. It is also manufactured synthetically and added to cola, energy drinks, and certain over the counter cold remedies.

Monitor performance after caffeine intake, and limit intake to 200 mg/day.

1in2

People with Risk Variant

Whole Grains

Whole grains are a low glycemic index carbohydrate that contain more fibre than refined grains. They also contain more essential micronutrients such as folic acid, magnesium and vitamin E. Years of research have demonstrated that whole grains may help reduce the risk of several diseases, particularly type 2 diabetes. Scientists have more recently shown that the benefits of consuming whole grains may be particularly important among individuals who have a variant in the TCF7L2 gene.*

*Cornelis MC et al. TCF7L2, dietary carbohydrate, and risk of type 2 diabetes in US women. American Journal of Clinical Nutrition. 2009;89:1256-62.

Your Results

Gene	Marker
TCF7L2	rs12255372

Risk Variant	Your Variant
GT or TT	GT

Your Risk

Elevated

only when whole grain intake is low

Recommendation

Since you possess the TT or GT variant of the TCF7L2 gene, there is an increased risk of developing type 2 diabetes if your whole grain consumption is low. Replacing high glycemic index carbohydrates in the diet with low glycemic index carbohydrates may help to reduce this risk. The food replacement table provides you with some ideas for whole grain products that can replace high glycemic index carbohydrates. Be mindful that whole grains are high in fiber and consuming excess fiber too close to your training session or competition can lead to gastrointestinal upset and impairments to performance. Try to consume high-fiber foods well after exercise or at least 3-4 hours before exercise.

Consume most grain products as whole grains.

TCF7L2

The TCF7L2 gene produces a protein called transcription factor-7 like 2 (TCF7L2). This protein, in turn, affects how the body turns on or off a number of other genes. The interaction of these proteins and genes is complex, and not yet fully understood. However, the TCF7L2 gene is one of the most consistent predictors of the likelihood of developing type 2 diabetes. People who possess the high risk GT or TT variant of the gene are at greater risk of developing type 2 diabetes. Yet, recent studies have shown that consuming whole grain foods can reduce the risk of type 2 diabetes in individuals who carry the GT or TT variant of the TCF7L2 gene.

Replace these foods...	with these foods..
White bread, bagels, pitas	100% whole grain bread, bagels and pitas
White rice	Brown or wild rice, quinoa
White pasta	100% whole wheat pasta or brown rice pasta
High sugar cold cereals	Oatmeal or 100% whole grain cold cereal
White flour baked goods	100% whole wheat flour baked goods

Sodium

Sodium is an essential micronutrient that regulates blood pressure and blood volume. Most people consume more sodium than the body requires. However, sodium requirements may be higher in athletes who sweat considerably during training than for the general public. The major adverse effect of excess sodium intake is elevated blood pressure, which predisposes to hypertension and heart disease. However, some individuals do not experience as great an increase in blood pressure in response to excess sodium intake as others. Research shows that the effect of sodium intake on blood pressure is influenced by variations in a gene called ACE.*

*Poch E et al. Molecular basis of salt sensitivity in human hypertension: Evaluation of renin-angiotensin-aldosterone system gene polymorphisms. Hypertension. 2001;38:1204-9.

ACE

The ACE gene directs the body to produce the angiotensin-converting enzyme (ACE), which is known to play a role in regulating the response of blood pressure to sodium intake. Studies have shown that a person's blood pressure response to excess sodium intake is dependent on which variant of the ACE gene they possess. Those who have the GA or AA variant of the ACE gene are at a greater risk of experiencing elevated blood pressure when higher amounts of sodium are consumed than those possessing the GG variant of the gene.

Sources of Sodium

	Amount (mg)
Ramen noodles, with flavour (1 package)	1760
Bagel with ham, egg and cheese	1260
Canned soup (1 cup)	1130
Ham (75g)	1040
Pickle (1 medium)	830
Tomato sauce, canned (1/2 cup)	650
Feta cheese (50g)	560
Chips (1 small bag)	390
Cold cereal (1 cup)	350
Bread (1 slice)	230

Source: Canadian Nutrient File and USDA Nutrient Database

7in10

People with Risk Variant

Your Results

Gene	Marker
ACE	rs4343

Risk Variant	Your Variant
GA or AA	AA

Your Risk

Elevated

only when sodium intake is high

Recommendation

Since you possess the AA or GA variant of the ACE gene, there is an increased risk of elevated blood pressure when sodium intake is high. Limiting sodium consumption to the Adequate Intake (AI) level of 1500 mg per day should help to reduce the risk. However, if you frequently sweat heavily during training or competition, causing sodium losses, your sodium requirements may be higher. The AI is equivalent to 3⁄4 teaspoon of salt per day, which includes sodium that is found naturally in food as well as salt that is added during processing and preparation.

Limit sodium intake to the Adequate Intake level.

1in2

People with Risk Variant

Your Results

Gene	Marker
FADS1	rs174547

Risk Variant	Your Variant
CC or CT	TT

Your Risk

Typical

Recommendation

Since you possess the TT variant of the FADS1 gene, your HDL cholesterol levels are likely not impacted by the level of dietary omega-6 LA or your balance of omega-6 LA to omega-3 ALA intake. Meet the guidelines for healthy adults. Individuals should aim to consume between 5-10% of energy from omega-6 LA and between 0.6-1.2% of energy from omega-3 ALA. Limit intakes of omega-6 LA coming from baked goods, fried foods and other processed foods. For cooking, baking and salad dressings choose canola oil, which is an excellent source of omega-3 ALA. Other foods rich in omega-3 ALA include flax and chia seeds.

Meet the RDA for omega-6 LA fat and omega-3 ALA fat.

Omega-6 and Omega-3 Fat

Higher consumption of polyunsaturated fats (PUFAs) is associated with reduced risk of cardiovascular disease. PUFAs include both omega-6 fat, such as linoleic acid (LA), and omega-3 fat, such as alpha-linolenic acid (ALA). Since our bodies cannot make omega-6 LA and omega-3 ALA, these essential fats must be obtained from our diets. However, consuming too much omega-6 LA and too little omega-3 ALA may have adverse health effects. Studies have shown that a gene involved in the metabolism of these PUFAs can adversely impact levels of HDL cholesterol ("good cholesterol") when dietary omega-6 LA intake is high,* or when the ratio of omega-6 LA to omega-3 ALA is too high.**

*Lu Y et al. Dietary n-3 and n-6 polyunsaturated fatty acid intake interacts with FADS1 genetic variation to affect total and HDL-cholesterol concentrations in the Doetinchem Cohort Study. American Journal of Clinical Nutrition. 2010; 92:258–65.
Dumont J et al. Dietary linoleic acid interacts with FADS1 genetic variability to modulate HDL-cholesterol and obesity-related traits. Clinical Nutrition. 2018;37:1683-1689.
**Hellstrand S et al. Intake levels of dietary long-chain PUFAs modify the association between genetic variation in FADS and LDL-C. Journal of Lipid Research. 2012; 53: 1183–1189.

FADS1

The FADS1 gene directs the production of an enzyme called fatty acid desaturase 1. This enzyme converts omega-6 LA and omega-3 ALA to longer-chain PUFAs that participate in inflammatory and immune responses, which are key to muscle recovery and general health. Compared to those with the TT variant, individuals who have the CC or CT variant of the gene have lower levels of HDL cholesterol when consumption of omega-6 LA is high. Among those with the CC or CT variant, increasing the proportion of dietary omega-3 ALA to omega-6 LA promotes higher levels of HDL cholesterol.

Sources of Omega-6 and Omega-3 Fats

	Omega-3 ALA (g)	Omega-6 LA (g)
Chia seeds (1 Tbsp)*	1.9	0.6
Flaxseeds (1 Tbsp)*	1.6	0.4
Canola oil (1 Tbsp)*	1.3	2.7
Walnuts (1/4 cup)	0.9	11
Edamame (1/2 cup)*	0.3	1.5
Salmon (75g)*	0.3	0.2
Sardines (75g)*	0.2	0.1
Corn oil (1 Tbsp)	0.2	7.3
Wheat germ cereal, toasted (1 Tbsp)*	0.1	0.4
Tahini (1 Tbsp)	0.1	3.5
Safflower Oil (1 Tbsp)	0.01	1.8
Sunflower Seeds (1/4 cup)	0.01	2.7
Sunflower Oil (1 Tbsp)	0.01	4

*Helps achieve a higher balance of omega-3 ALA to omega-6 LA Source: Canadian Nutrient File

Physical Activity

for Cardiometabolic Health

Physical activity has important benefits for mental health, physical fitness, optimal body composition and the prevention of many chronic diseases. Indeed, exercise improves the function of your heart, lungs and blood vessels, and it also has beneficial effects on blood lipids. Scientists have demonstrated that the LIPC gene influences blood levels of HDL cholesterol (the "good" cholesterol). Research also shows that physical activity raises HDL cholesterol to a greater degree among individuals who have a particular variant of the LIPC gene, compared to those who do not.*

*Grarup et al. The -250G>A promoter variant in hepatic lipase associates with elevated fasting serum high-density lipoprotein cholesterol modulated by interaction with physical activity in a study of 16,156 Danish subjects. Journal of Clinical Endocrinology and Metabolism. 2008;93:2294-2299.
Ahmad et al. Physical Activity Modifies the Effect of LPL, LIPC, and CETP Polymorphisms on HDL-C Levels and the Risk of Myocardial Infarction in Women of European Ancestry. Circulation: Cardiovascular Genetics. 2011;4:74-80.

LIPC

The hepatic lipase gene, also known as LIPC, encodes an enzyme that plays a key role in blood lipid metabolism. LIPC helps transport HDL cholesterol to the liver, where further lipid processing takes place. Large studies conducted in both men and women show that a genetic variant in LIPC impacts the way HDL cholesterol levels increase in response to physical activity. Generally, individuals who are physically active tend to have higher HDL cholesterol concentrations than those who are sedentary. However, even among those who are physically active, individuals who carry the TT or CT variant in the LIPC gene display an enhanced HDL-raising response when engaging in physical activity, resulting in higher HDL cholesterol than individuals without this variant.

Types of Cardiovascular Activities

Moderate-Vigorous Intensity	
Swimming	Race walking, jogging, running
Briskly walking, hiking (5 km/hour or faster)	Tennis
Cycling	Water Aerobics

Types of Muscle-Strengthening Activities

Lifting weights	Working with resistance bands
Bodyweight training	Push-ups, plyo-jumps
Higher intensity yoga and Pilates	Core training

1in3

People with Response Variant

Your Results

Gene	Marker
LIPC	rs1800588

Response Variant	Your Variant
TT or CT	CT

Your Response

Enhanced

when physical activity is high

Recommendation

Since you possess the CT or TT variant of the LIPC gene, you have an enhanced HDL cholesterol-raising response from physical activity. Engage in 150 to 300 minutes of moderate-to-vigorous intensity exercise per week. This can be met through 30 to 60 minutes of moderate-to-vigorous intensity aerobic exercise five days per week in bouts of 10 minutes or more. This will ensure that you reap the benefits of physical activity not only for your cholesterol levels, but also body composition, weight management, mental health, blood pressure, bone health, blood sugar, and many other health-related factors. You should also include muscle strengthening activities at least 2 days per week.

Aim for 150 to 300 min/week of cardio and at least 2 days/week of muscle-strengthening activities.

3in10

People with Response Variant

Your Results

Genes	Markers
FTO ADRB2	rs9939609 rs1042713

Response Variant	Your Variants
Algorithm	AA GG

Your Response

Enhanced

when physical activity is high

Recommendation

Since you possess the enhanced response variants of the FTO and/or ADRB2 gene, you have an enhanced weight loss response from participation in higher levels of physical activity. Your physical activity recommendations, therefore, are to include at least 30-60 minutes/day of moderate-vigorous cardiovascular activity in bouts of 10 minutes or more, over at least 6 days of the week. You should also include muscle strengthening activities at least 2 days per week. These activities should involve major muscle groups. By meeting these physical activity recommendations, you are more likely to increase your lean mass, decrease your fat mass and decrease your body weight.

Aim for at least 30-60 mins/day of cardio activity, 6 days/week, and muscle-strengthening activities at least 2 days/week.

Physical Activity

for Weight Loss

Physical activity has important benefits for mental health, physical fitness, weight maintenance and the prevention of many chronic diseases. Cardiovascular or endurance exercise such as brisk walking, running, swimming and cycling improve the function of your heart, lungs and blood vessels. Resistance-training or muscle conditioning exercises improve muscle strength and power as well as bone health and include activities such as weight-lifting or higher intensity yoga and Pilates. Most forms of physical activity are beneficial; however, some individuals can achieve greater weight loss or fat loss than others based on the amount and type of physical activity they perform. Research shows that variants in the FTO gene can impact an individual's metabolic response to physical activity.* Indeed, physical activity can reduce the effects of the FTO gene on risk of overweight and obesity by as much as 75%.** In addition, a variant in the ADRB2 gene influences how much body fat you lose in response to cardiovascular exercise.***

*Andreasen et al. Low physical activity accentuates the effect of the FTO rs9939609 polymorphism on body fat accumulation. Diabetes. 2008;57:95-101.
**Reddon et al. Physical activity and genetic predisposition to obesity in a multiethnic longitudinal study. Scientific Reports. 2016;6:1-10.
***Garenc et al. Effects of 2-Adrenergic Receptor Gene Variants on Adiposity: The HERITAGE Family Study. Obesity Research. 2003;11:612-618.

FTO & ADRB2

The FTO gene is also known as the 'fat mass and obesity-associated gene', and has been consistently shown to impact weight management and body composition. The FTO gene's role in the body is related to metabolic rate, energy expenditure and energy balance. It is also expressed in regions of the brain that are involved in the regulation of energy intake. Current research shows that specific physical activity recommendations can substantially help with weight loss and weight maintenance in individuals with certain variants of the FTO gene.* The ADRB2 gene encodes the Beta-2-Adrenergic Receptor, which belongs to a family of molecules that are involved in the fight-or-flight response to stress and response to substances like adrenaline. ADRB2 contributes to the breakdown and mobilization of fat cells, and its activity increases during exercise. A large study of obese, sedentary individuals found that variation in the ADRB2 gene predicted fat loss in response to cardiovascular exercise. Women who carried two copies of a specific ADRB2 variant had an enhanced response to a cardiovascular exercise program, losing over three times more body fat than women who had a typical response.**, ***

*Rodrigues et al. A single FTO gene variant rs9939609 is associated with body weight evolution in a multiethnic extremely obese population that underwent bariatric surgery. Nutrition. 2015;31:1344-50.
**Garenc et al. Effects of Beta-2-Adrenergic Receptor Gene Variants on Adiposity: The HERITAGE Family Study. Obesity Research. 2003;11:612-618.
***Lagou et al. Lifestyle and Socioeconomic-Status Modify the Effects of ADRB2 and NOS3 on Adiposity in European-American and African-American Adolescents. Obesity. 2011;19:595-603.

Energy Balance

Energy is used to fuel all functions in the body. A calorie is a commonly used unit of measurement to quantify energy, which comes from the foods, beverages and sport supplements consumed. The body uses this energy to complete essential processes such as digestion, breathing, brain function and maintaining a normal body temperature. The energy expended during these essential processes is referred to as the Resting Metabolic Rate (RMR). Total energy output, on the other hand, is the sum of the RMR plus energy burned during physical activity. Consuming less energy and/or expending more energy can lead to weight loss. Athletes creating an energy deficit to lose fat mass must also consider factors such as current training demands when calculating appropriate daily energy requirements. RMR can vary substantially between individuals, and can result from differences in muscle mass, weight, age and genetics. Research shows that variation in the UCP1 gene affects RMR.*

*Nagai N et al. UCP1 genetic polymorphism (-3826A/G) diminishes resting energy expenditure and thermoregulatory sympathetic nervous system activity in young females. Int J Obesity. 2011;35:1050-5.

UCP1

Uncoupling protein 1 (UCP1) is found in fat tissue and is involved in metabolic processes that create energy and then release it in the form of heat. The UCP1 gene is important for regulating normal body temperature and can impact RMR. Research shows that individuals with the GG or GA variants tend to have lower RMRs compared to individuals with the AA variant. As such, they need to consume less energy to maintain regular bodily functions.

Sources of High Energy Foods

	Amount (calories)
Pizza with pepperoni and cheese (1/2 of 12")	660
Fish, battered, fried (1 piece)	590
Meat and vegetable pie (1 individual pie)	450
Mixed nuts, roasted (1/2 cup)	410
Carrot muffin (1 medium)	340
Avocado (1 fruit)	320
Cheeseburger (1)	320
Donut, chocolate covered (1)	270
French fries (20-25)	240
Croissant (1)	230

Source: Health Canada's Nutrient Value of Some Common Foods

2in5

People with Response Variant

Your Results

Gene	Marker
UCP1	rs1800592

Response Variant	Your Variant
GG or GA	GA

Your Response

Diminished

Recommendation

Since you possess the GG or GA variant of the UCP1 gene, your daily RMR may be about 10% (or 150 kcal) lower compared to those who have the AA variant of the UCP1 gene. This 10% decrease is based on an average RMR of 1500 kcal per day, which may be higher or lower than your RMR. Therefore, to lose fat mass it may be helpful to reduce daily energy intake or increase energy expenditure through additional exercise, by an amount equal to 10-20% of your estimated energy needs plus an additional 150 kcal. For example, an individual consuming 2000 kcal per day for weight maintenance may choose an energy deficit of 200 kcal, plus an additional 150 kcal deficit per day, which totals a 350-kcal deficit for weight loss. These values will depend on several factors including physical activity levels, and time needed to reach your goal.

To increase leanness, aim for a daily energy deficit of 10-20% from your current energy needs plus an additional 150 kcal.

1in5

People with Response Variant

Your Results

Gene	Marker
FTO	rs9939609
Response Variant	**Your Variant**
AA	AA

Your Response

Enhanced

when protein intake is high

Recommendation

Since you have the AA variant of the FTO gene, you have an enhanced fat loss response from consuming a moderate-to-high protein diet. A moderate-to-high protein diet can be beneficial since it can help you lose fat mass, enhance weight loss, and improve your ability to maintain an optimal body composition and lean physique. Aim to consume 1.6-2.0 grams of protein per kilogram of body weight or approximately 25-35% of energy from protein as part of a controlled energy diet. Note that for larger athletes or those with higher energy intakes due to heavy training and/or high energy expenditures the grams per kilogram recommendations remain the same, but protein as a percent (%) may decrease markedly.

Consume 25-35% of energy from protein or 1.6-2.0 g/kg body weight.

Protein

Protein is an essential nutrient for muscle growth and repair, wound healing, healthy hair, skin and nails and proper immune function. Both endurance and power/strength athletes need adequate protein to build strength and repair damaged muscle tissue that occurs during regular training. Protein has also been shown to regulate appetite by filling you up and allowing you to feel more satisfied with fewer calories. For athletes at risk of carrying excess fat mass or unable to easily achieve their desired lean physique, a high protein diet can help with achieving and maintaining a lean physique over both the short-term and long-term.*

*Zhang X et al. FTO genotype and 2-year change in body composition and fat distribution in response to weight-loss diets: The POUNDS LOST trial. Diabetes. 2012;61(11):3005-11.

FTO

The FTO gene is also known as the 'fat mass and obesity-associated gene' since it can impact weight management and body composition. This gene's role in the body is related to your metabolism, energy expenditure and energy balance. It is also expressed in regions of the brain that are involved in the regulation of energy or food intake. Current research shows that specific dietary and exercise recommendations can substantially help with fat loss and weight maintenance in individuals with certain variants of the FTO gene.

Sources of Protein

	Amount (g)
Chicken breast (75g)	25
Extra lean ground beef (75g)	23
Tofu, regular, extra firm (150g)	21
Salmon, baked (75g)	20
Cottage cheese (1/2 cup)	15
Lentils (3/4 cup)	14
Chickpeas (3/4 cup)	9
Skim milk (1 cup)	9
Almonds (1/4 cup)	8
Whole egg (1)	6

Source: Health Canada's Nutrient Value of Some Common Foods

Total Fat

Fat is an essential part of a healthy diet, provides energy in aerobic type exercise, and is needed for the absorption of the fat-soluble vitamins A, D, E, and K. Fat provides more than double the amount of calories as carbohydrates or protein on a gram per gram basis. The total amount and types of fats that you choose may play a role in how effective your dietary strategies are for fat loss and achieving an optimal body composition for your sport. In general, unsaturated fats are heart-healthier than saturated or trans fats. The TCF7L2 gene is involved in body weight regulation and body composition. Research shows that individuals who possess the TT variant of TCF7L2 experience greater weight loss when they consume lower-to-moderate fat diets, in comparison to when they consume higher fat diets. For those with the CC or TC variant, there is no difference in weight loss based on the amount of fat consumed, although lower total energy intakes are needed to create a calorie deficit.*

*Grau K et al. TCF7L2 rs7903146-macronutrient interaction in obese individuals' responses to a 10-wk randomized hypoenergetic diet. American Journal of Clinical Nutrition. 2010;91:472-9.
Mattei J et al. TCF7L2 genetic variants modulate the effect of dietary fat intake on changes in body composition during a weight-loss intervention. American Journal of Clinical Nutrition. 2012;96:1129-36.

TCF7L2

The TCF7L2 gene produces a protein called transcription factor-7 like 2. This protein affects how the body turns on or off a number of other genes. Research shows that for individuals who possess the TT variant of the TCF7L2 gene, the amount of fat in the diet can significantly impact body composition (lean/muscle mass vs. fat mass) as well as the risk for being overweight or obese. Furthermore, possessing the TT variant puts you at an increased risk for insulin resistance (reduced ability to control blood sugars) when your total fat intake is high. Consuming a low-to-moderate fat intake can help facilitate weight loss in individuals with the TT variant, which can in turn help with reducing insulin resistance.

Sources of Fat

	Amount (g)
Bacon (75g)	32
Macadamia nuts (1/4 cup)	26
Cheddar cheese (50g)	17
Butter (1 Tbsp)	16
Olive oil (1 Tbsp)	14
Swiss cheese (50g)	14
Pistachios (1/4 cup)	14
Lean beef mince (75g)	11
Goat cheese (50g)	11
Yoghurt, 2-4% M.F. (3/4 cup)	8
Sockeye salmon (75g)	8

Source: Health Canada's Nutrient Value of Some Common Foods

1in10

People with Response Variant

Your Results

Gene	Marker
TCF7L2	rs7903146
Response Variant	**Your Variant**
TT	CC

Your Response

Typical

Recommendation

Since you possess the CC or TC variant of the TCF7L2 gene, you have a typical weight loss response based on your fat intake. However, to help ensure that you are consuming a healthy, well-balanced diet, consume 20-35% of your total daily energy needs from fat as part of an energy-restricted diet.

Consume 20-35% of energy from fat.

1in7

People with Response Variant

Saturated Fat

Saturated fats, such as those found in red meat and baked goods have long been associated with health conditions such as diabetes, cardiovascular disease and obesity. However, the connection between saturated fats and obesity, has been poorly understood. In the past, scientists could not explain why certain people seemed prone to obesity when consuming a diet high in saturated fats, but others were less susceptible. A number of studies* have now shown that the effect of saturated fat on high levels of body fat and obesity can be influenced by variations in a gene called APOA2.

*Corella D et al. APOA2, dietary fat, and body mass index: replication of a gene- diet interaction in 3 independent populations. Archives of Internal Medicine. 2009;169:1897-906.

Your Results

Gene	Marker
APOA2	rs5082
Response Variant	**Your Variant**
CC	TC

Your Response

Typical

Recommendation

Since you possess the typical risk variant of the APOA2 gene, aim to meet the general guidelines for limiting saturated fat intake to less than 10% of total energy intake, in order to reduce the general risk of other associated health issues such as cardiovascular disease. Foods high in saturated fat include fatty meats (lamb, pork and beef), processed meats (bacon, salami), butter, cheese, fried foods and coconut and palm oils often found in processed foods and baked goods. Suitable alternatives low in saturated fat include olive and vegetable oils, lean meats, low-to-moderate fat dairy products, fish, and plant protein sources such as beans, lentils, nuts/seeds or plant-based proteins such as soy beverages and tofu.

Limit intake of saturated fat to no more than 10% of energy.

APOA2

The APOA2 gene directs the body to produce a specific protein called apolipoprotein A-II, which plays an important role in the body's ability to utilize different kinds of fat. Scientists now understand that there are different variations in the APOA2 gene present in the human population and that these different versions of the gene interact with saturated fat in unique ways to influence energy balance and ultimately the risk of high body fat levels and obesity. Those people who have the CC variant of the gene are at a higher risk of developing high body fat levels and obesity when consuming a diet high in saturated fats than those possessing the TT or TC variant of the gene.

Sources of Saturated Fat

	Amount (g)
Short ribs (75g)	11
Cheddar cheese (50g)	10
Ice cream, premium (1/2 cup)	11
Butter (1 Tbsp)	8
Salami (75g)	8
Regular ground beef, cooked (75g)	7
Cheeseburger (single patty)	6
Muffin (1 small)	5
French fries (20-25)	5
Homogenized milk (1 cup)	5

Source: Canadian Nutrient File and USDA Nutrient Database

Saturated and Unsaturated Fats

There are two main types of dietary fats: saturated and unsaturated. Saturated fats are primarily found in animal-derived foods such as fatty meats, cheese, butter and other whole milk dairy as well as prepared foods such as pizza, baked goods and many desserts. For athletes, it is important to focus on calories that are contributing to health and performance, while minimizing calories that play less of a role in your performance diet. Saturated fats should be limited in an athlete's diet since they are not necessary to improve health or performance and are only needed in very small amounts. Unsaturated fats, such as those found in olive oil, almonds and grape seed oil, may help to decrease the risk of many chronic diseases. Current research shows that variation in the FTO gene can impact the response to saturated and unsaturated fat. For individuals with the AA or TA variant, a high intake of unsaturated fat, and low intake of saturated fat in the diet can help facilitate weight loss, decrease fat stores around the abdomen and decrease the risk for obesity.*

*Phillips CM et al. High dietary saturated fat intake accentuates obesity risk associated with the fat mass and obesity-associated gene in adults. Journal of Nutrition. 2012;142:824-31.

FTO

The FTO gene is also known as the 'fat mass and obesity-associated gene' since it can impact weight management and body composition. This gene's role in the body is related to metabolic rate, energy expenditure and energy balance. It is also expressed in regions of the brain that are involved in the regulation of energy intake. Current research shows that specific dietary and exercise recommendations can substantially help with weight loss and weight maintenance in individuals with certain variants of the FTO gene.

Sources of Mono and Polyunsaturated Fat

Monounsaturated Fat	**Amount (g)**
Macadamia nuts (1/4 cup)	20
Almond butter (2 Tbsp)	12
Olive oil (1 Tbsp)	10
Canola oil (1 Tbsp)	8
Peanut butter (2 Tbsp)	8
Polyunsaturated Fat	**Amount (g)**
Flaxseed oil (1 Tbsp)	10
Grape seed oil (1 Tbsp)	10
Sunflower oil (1 Tbsp)	9
Soybean oil (1 Tbsp)	8
Brazil nuts (1/4 cup)	7

Source: Health Canada's Nutrient Value of Some Common Foods

3in5

People with Response Variant

Your Results

Gene	Marker
FTO	rs9939609
Response Variant	**Your Variant**
TA or AA	AA

Your Response

Enhanced

when saturated fat intake is low and polyunsaturated fat intake is high

Recommendation

Since you have the TA or AA variant of the FTO gene, you can enhance your weight loss by limiting saturated fat intake to less than 10% of total energy intake and consuming the rest of your recommended daily fat intake from unsaturated fats. Your intake of polyunsaturated fats should be at least 5% of your total energy intake, and the rest should come from monounsaturated fats. This can further help to decrease your risk of having too much fat mass resulting in suboptimal body composition for peak athletic performance. This will help you to achieve the desired intake of protein, carbohydrates and unsaturated fats to maintain a high-quality performance diet while reducing your general risk for other associated health issues such as cardiovascular disease.

Limit intake of saturated fat to no more than 10% of energy. Consume at least 5% of energy from polyunsaturated fat.

1in4

People with Response Variant

Your Results

Gene	Marker
PPARγ2	rs1801282
Response Variant	**Your Variant**
GG or GC	CC

Your Response

Typical

Recommendation

Since you possess the CC variant of the PPARγ2 gene, consuming more monounsaturated fats will not necessarily help to facilitate weight loss and lower your body fat percentage. However, for heart health, you should aim for a balance of saturated, monounsaturated and polyunsaturated fats to meet your total daily fat intake recommendation.

Aim for a balance of saturated, monounsaturated and polyunsaturated fats to meet your total daily fat intake.

Monounsaturated Fat

Monounsaturated fats such as those found in olive oil, almonds and avocados have been associated with a reduced risk for heart disease and add many beneficial nutrients to your performance diet. Monounsaturated fats can help reduce 'bad' (LDL) cholesterol levels and may also help increase 'good' (HDL) cholesterol. Research shows that these fats can help facilitate weight loss and reduce body fat levels in some individuals based on their PPARγ2 gene.*

*Garaulet M et al. PPARγ Pro12Ala interacts with fat intake for obesity and weight loss in a behavioural treatment based on the Mediterranean diet. Molecular Nutrition and Food Research. 2011;55:1771-9.

PPARγ2

The PPARγ2 gene is involved in the formation of fat cells. This gene is mainly found in fat tissue. Because of its involvement in the formation of fat, PPARγ2 can impact weight management and body composition. Specifically, individuals who have the GG or GC variant of the gene tend to experience greater weight loss and lose more body fat, compared to those with the CC variant, when they consume a diet high in monounsaturated fats.

Sources of Monounsaturated Fat

	Amount (g)
Macadamia nuts (1/4 cup)	20
Almond butter (2 Tbsp)	12
Olive oil (1 Tbsp)	10
Canola oil (1 Tbsp)	8
Peanut butter (2 Tbsp)	8
Sesame oil (1 Tbsp)	6
Pumpkin and squash seeds, dried (1/4 cup)	5
Soybeans, boiled (3/4 cup)	3
Hummus (1/4 cup)	2

Source: Health Canada's Nutrient Value of Some Common Foods

Fat Taste Perception

Food intake is largely determined by our taste perceptions and preferences for certain foods and beverages. The way that we perceive the taste of fatty foods is particularly important because our intake of fats can affect heart health and body composition. Fat is needed to absorb certain vitamins including vitamins A, D, E, and K. It provides 9 calories per gram, which is more than double the calories in a gram of protein or carbohydrate. Research shows that our preference for fatty foods can vary depending on which version of the CD36 gene we have.*

*Melis M, Sollai G, Muroni P, Crnjar R, Barbarossa IT. Associations between orosensory perception of oleic acid, the common single nucleotide polymorphisms (rs1761667 and rs1527483) in the CD36 gene, and 6-n-propylthiouracil (PROP) tasting. Nutrients 2015; 7(3): 2068-84.
Pepino MY et al. The fatty acid translocase gene CD36 and lingual lipase influence oral sensitivity to fat in obese subjects. Journal of Lipid Research. 2012;53:561-6.

CD36

The cluster of differentiation 36 (CD36) gene is also known as fatty acid translocase. It is found on the surfaces of many cells, including taste bud cells in the tongue, and is involved in the transport of fat from the blood. Several studies have now linked variations in the CD36 gene to differences in the perception of the taste and texture of fats and oils. 'Super tasters' tend to be able to detect the taste of fats and oils at lower levels than 'low tasters.'

Sources of High Fat Foods

	High in Healthy (Unsaturated) Fat	Amount (g)
Cheddar cheese (50g)		17
Avocado (1/2 fruit)	✓	15
Olive oil (1 Tbsp)	✓	14
Butter (1 Tbsp)		12
Chips (20-25)		12
Hamburger (1)		12
Croissant (1)		12
Salmon (75g)	✓	9
Ice cream (1/2 cup)		8
Homogenized milk (1 cup)		8

Source: Health Canada's Nutrient Value of Some Common Foods

7in10

People with Response Variant

Your Results

Gene	Marker
CD36	rs1761667
Response Variant	**Your Variant**
GG or GA	AA

Your Response

Typical

Recommendation

Since you possess the AA variant of the CD36 gene, you are a 'low taster' of fats. This means that you require greater amounts of fat in your food to be able to detect the taste of fats. In comparison, those who are 'super tasters' are better able to detect the taste of fats at lower levels. Consuming too much fat, and the wrong types of fats (saturated vs. unsaturated) can increase the risk of obesity and cardiometabolic disease. Refer to the Total Fats section of your report for your recommended daily intake of fats.

Your ability to sense the fatty taste of foods is typical.

1in4

People with Risk Variant

Your Results

Gene	Marker
GLUT2	rs5400

Risk Variant	Your Variant
CT or TT	CT

Your Risk

Elevated

Recommendation

Since you possess the CT or TT variant of the GLUT2 gene, you are at an increased risk of over-consuming sugar and may be more likely to enjoy sweet foods and beverages. Aim for less than 5% of your total daily energy intake from added sugar. There are key times when consuming simple sugars, such as those found in sports beverages, gels or chews can benefit athletic performance. For example, when high-intensity training is sustained for more than 60 minutes, sugar-containing foods and beverages can help to prevent depletion of muscle glycogen stores and maintain blood sugar levels. This can have a positive impact on performance. However, too much added sugar can lead to cardiometabolic disease and increased fat mass, which may hinder athletic performance.

You have a high preference for sugar.

Sugar Preference

Sugar intake is partly determined by our sweet taste preference and cravings for certain foods and beverages. There is considerable variability in individuals' preferences and cravings for sweet foods and beverages. There are many factors that may impact your preference for sugary foods including the age that you are first introduced to sweets, and psychological associations between consuming these foods and certain life experiences or emotions. In addition to 'pleasure-generating' signals in the brain given off in response to eating or drinking something sweet, there are specialized areas in the brain that regulate both food intake and glucose (sugar) levels in the body. Research has shown that your intake of sweet foods can be determined by a genetic variant that regulates blood glucose levels in your body. People who carry the variant associated with higher sugar intake are also at higher risk of dental caries (cavities).

GLUT2

Glucose transporter type 2 (GLUT2) is involved in regulating glucose (sugar) in the body. The expression of this gene has been found in areas of the brain that are involved in controlling food intake. Individuals who possess the TT or TC variant of this gene seem to have a greater preference for sweet foods and beverages and are more likely to over-consume sugar.* In addition, those who have the variant associated with higher sweet food intake, have also been shown to have a higher risk of dental caries.** For many athletes, longer training sessions, races and competitions often require sugar-containing sports drinks, gels, or chews to meet fuel needs. However, for optimal health, it is important to limit added sugars in your regular diet.

*Eny KM et al. Genetic variant in the glucose transporter type 2 is associated with higher intakes of sugars in two distinct populations. Physiol Genomics. 2008;33(3):355-60.
**Kulkarni GV et al. Association of GLUT2 and TAS1R2 genotypes with risk for dental caries. Caries Research. 2013; 47:219-25

Sources of High Sugar Foods

	Amount (g)
Iced cappuccino (2 cups)	56
Cola (1 can)	36
Citrus juice, frozen, diluted (1 cup)	32
Sports beverage (2 cups)	28
Caramels (40g)	26
Milk chocolate (50g)	26
Maple syrup (2 Tbsp)	24
Jellybeans (10 beans)	20
Popsicle (75g)	10
Jam (1 Tbsp)	10

Source: Health Canada's Nutrient Value of Some Common Foods

Eating between Meals

Eating between meals (i.e. snacking) can be beneficial if snacks are healthful and the extra calories are not in excess of those needed to maintain a healthy weight. Healthy snacks can assist with regulating blood sugar levels and weight, curb food cravings and provide fuel and recovery needs during training. However, for many busy athletes, snacking is often an unhealthy habit due to snack-food choices and/or excessive calorie intake beyond one's needs. For your overall health and wellness, it is important to manage emotional eating, and focus on more healthful snacking when you feel hungry or need fuel to train or compete. Some reasons for emotional eating may include boredom, habit (i.e. eating in front of the television), stress, frustration, anxiety or loneliness. Scientists have also now discovered that variations in the MC4R gene are associated with the likelihood of eating between meals driven by the desire to eat more or less frequently depending on your genotype.*

*Stutzmann F et al. Common genetic variation near MC4R is associated with eating behaviour patterns in European populations. Int J Obes. 2009;33:373-378.

MC4R

The MC4R gene codes for the melanocortin 4 receptor, which is found in the hypothalamus region of the brain. This is an area of the brain that controls hunger and appetite. The MC4R gene plays an important role in appetite regulation and hunger cues. Research shows that individuals with the CC or CT version of the MC4R gene are more likely to eat between meals often and have a heightened appetite.

Replace these foods...	with these foods..
Chips	Whole wheat pita with hummus
Muffin	Whole wheat English muffin with peanut butter
Ice cream with toppings	Low-fat yogurt with fresh berries
Trail mix with added oils or sweets	Fibre-rich cereal with milk/alternative
'Veggie' chips	Fresh vegetables with low-fat dip
Pasta salad	Mixed salad topped with chickpeas
Nachos and cheese dip	Whole wheat crackers with low-fat cheese
Potato chips	Natural popcorn
Pizza slice	Half a turkey sandwich with veggies

2in5

People with Risk Variant

Your Results

Gene	Marker
MC4R	rs17782313

Risk Variant	Your Variant
CC or CT	TT

Your Risk

Typical

Recommendation

Since you possess the TT variant of the MC4R gene, you have a typical risk for eating between meals. To maintain a healthy metabolism, avoid going longer than six hours without eating during the day. Monitor and respond to hunger cues, which may include a lack of energy, mood changes, stomach growling, weakness, dizziness, or having a headache. Choose healthy snacks that are not excessive in calories.

Your tendency to eat between meals is typical.

1in3

People with Response Variant

Your Results

Gene	Marker
BDNF	rs6265

Response Variant	Your Variant
AA or AG	AA

Your Response

Enhanced

Implications

Since you possess the AA or AG variant of the BDNF gene, you are more likely to experience greater enjoyment and positive mood changes from exercise or training. You also tend to perceive your exertion level during exercise to be lower than individuals with the GG variant. These responses to exercise result in a heightened motivation to exercise and greater likelihood that you will continue to follow your training regime. Therefore, you are at a genetic advantage when it comes to motivation to begin or continue regular exercise.

You have an enhanced innate motivation to exercise.

Motivation to Exercise

Your attitude toward exercise and the effect it has on your mood can greatly impact your training and performance. Research shows that individuals who possess the AA or AG variant of the BDNF gene are more likely to experience positive mood changes from exercise and training. They also perceive their effort and exertion level as lower during exercise compared to individuals who possess the GG variant,* which can help to enhance training and, therefore, benefit performance during competition. These factors impact motivation to train. Enhanced motivation to exercise can have a multitude of physical and psychological benefits including improvements in body fat levels, blood sugars, blood pressure, blood lipid profiles, and mental health and attitude.

*Bryan A et al. A transdisciplinary model integrating genetic, physiological, and psychological correlates of voluntary exercise. Health Psychol. 2007;26:30-39.
Caldwell Hooper A et al. What keeps a body moving? The brain-derived neurotrophic factor val66met polymorphism and intrinsic motivation to exercise in humans. J Behav Med. 2014;37(6):1180-92.

BDNF

The brain-derived neurotrophic factor is a protein that is encoded by the BDNF gene. This protein works in regions of the brain to influence the nervous system, musculature, and blood vessels, all of which are important to exercise. Because of the complexity of mental stamina and the psychological response to exercise, the BDNF gene is only one of many possible genetic factors that may influence responses to exercise and future exercise behavior. Nevertheless, research shows that those with the AA or AG variant of the BDNF gene derive greater enjoyment or pleasure and improvements in mood from exercise and a lower perception of effort during exercise compared to those without this variant.

Exercise Behavior

Following a strength and endurance training program can lower blood pressure, lower blood sugars, improve cholesterol levels, decrease depression and improve mood, among many other positive outcomes. Research shows that genetic differences influence the likelihood of engaging in physical activity. The CYP19A1 and LEPR genes have been identified as being key contributors to one's probability of participating in physical activity/training.*

*De Moor MH et al. Genome-wide association study of exercise behavior in Dutch and American adults. Med Sci Sports Exerc. 2009;41:1887-95.

CYP19A1 & LEPR

The CYP19A1 gene helps to make the enzyme aromatase, which is involved in hormone conversion. The exact physiological pathway by which this gene impacts exercise behavior is unknown. However, current research shows that those who have the AA or GA variant of the CYP19A1 gene are more likely to exercise compared to those with the GG variant. The LEPR gene helps to make the leptin receptor protein, which helps to regulate body weight. The precise relationship between variations in the LEPR gene and exercise behavior may stem from this gene's involvement in regulating energy balance. Those who have the TT or GT variant of the LEPR gene are more likely to participate in physical activity compared to those who have the GG variant.

1in12

People with Response Variant

Your Results

Genes	Markers
CYP19A1 LEPR	rs2470158 rs12405556

Response Variant	Your Variants
Algorithm	GG GT

Your Response

Typical

Implications

Based on your LEPR and CYP19A1 variants, you have a typical likelihood of engaging in physical activity. Athletes should be mindful of maintaining regular exercise during the entire year. To sustain your active lifestyle, set monthly SMART (specific, measurable, attainable, realistic, timely) goals and consider using mental imagery; these can further enhance your motivation. Having an exercise partner can also enhance your likelihood of participating in physical activity.

You have a typical likelihood of engaging in physical activity.

Your Results

Gene	Marker
ACTN3	rs1815739

Response Variant	Your Variant
CC or TC	CC

Your Response

Ultra

Implications

Since you possess the CC variant of the ACTN3 gene, you have the highest possible genetic advantage to excel in strength and power-based activities as determined by this gene. Strength/resistance exercises are important for strengthening bones, muscle and connective tissue, reducing injury risk and improving athletic performance. Aim to participate in strength/resistance training at least two days per week.

You have a genetic advantage to excel in power sports.

Power and Strength

Strength training and resistance exercise are considered a fundamental part of all athletes training programs, including those involved in endurance, team and strength/power sports. The benefits of strength and resistance training in both competitive and recreational athletes have been well documented and include improvement in athletic performance, reduced risk of injury and positive impacts to muscle, bone and connective tissue. Strength/resistance exercises also help to maintain or achieve a lean physique and an ideal body composition for optimal sport performance. Different forms of strength/resistance exercises include free weights, weight machines, resistance bands and your own body weight. Research shows that the ACTN3 gene plays a major role in your genetic predisposition to excelling in strength and power-based activities.*

*Ma F et al. The association of sport performance with ACE and ACTN3 genetic polymorphisms: a systematic review and meta-analysis. PLoS One. 2013;8:e54685.

ACTN3

There are two types of muscle fibers: slow twitch and fast twitch. Both fiber types are needed in all sports and exercises, however there will be a higher use and demand for one fiber type versus the other depending on the sport. Fast twitch muscle fibers contract with greater speed and force, which are needed for short bursts of intense activities including sprinting, jumping and acceleration and change of direction in team sports. Slow twitch fibers contract for longer periods and at lower intensities and are used in activities such as longer distance endurance sports like cross-country skiing, running, swimming and cycling.
The ACTN3 gene encodes the alpha-actinin-3 protein, which is only expressed in fast twitch muscle fibers. Therefore, certain variations in this gene can be beneficial for exercises or sports requiring strength and power. In particular, individuals with the CC variant of ACTN3 are more likely to excel at power or strength-based sports. Those with the TC variant have a slightly enhanced power and strength potential.*

*Garton and North. The effect of heterozygosity for the ACTN3 null allele on human muscle performance. Med Sci Sports Exerc. 2015 [Epub ahead of print].

Endurance

Endurance sports include running, cycling, swimming, rowing, dancing and many team sports. These sports require effort over a longer sustained period of time as opposed to shorter duration anaerobic sports requiring large bursts of power. Your VO2 max or maximal aerobic capacity is a measurement of the maximum amount of oxygen that your body is able to process during 1 minute of exercise and is a marker of physical fitness. A higher VO2 max generally results in a performance advantage when it comes to endurance sports, although many factors play a role. Research shows that there are several genes that impact your genetic predisposition to excelling in endurance sports.* In some of these genes, certain versions of the gene have also been shown to improve your endurance capacity in response to endurance training more effectively and to a greater magnitude, compared to other versions of the gene.**

*Ahmetov I et al. Genome-wide association study identifies three novel genetic markers associated with elite endurance performance. Biol Sport. 2015;32(1):3-9. doi:10.5604/20831862.1124568.
Santiago C et al. Trp64Arg polymorphism in ADRB3 gene is associated with elite endurance performance. British Journal of Sports Medicine. 2011;45:147-9.
**Zarebska A et al. The GSTP1 c.313A>G polymorphism modulates the cardiorespiratory response to aerobic training. Biol Sport. 2014;31:261-266.
He et al. NRF2 genotype improves endurance capacity in response to training. Int J Sport Med. 2007; 28:717-721.
Stefan et al. Genetic Variations in PPARD and PPARGC1A Determine Mitochondrial Function and Change in Aerobic Lifestyle Intervention. J Clin Endocrinol Metab. 2007; 92: 1827-1833.

NFIA-AS2, ADRB3, NRF2, GSTP1 & PGC1a

NFIA-AS2, ADRB3, NRF2, GSTP1 and PGC1a are all involved in physiological processes that impact your endurance abilities. Individuals with the CC variant in the NFIA-AS2 gene tend to have greater VO2 max, which is advantageous for endurance exercise. Variations in the ADRB3 gene are more common among world-class endurance athletes compared to non-athlete controls. The NRF2 gene plays an important role in the production of mitochondria, the power houses of the cell, and those with the AA variant improve their endurance in response to exercise training. Variation in the GSTP1 gene is also associated with differences in VO2 max responses to aerobic training and individuals with the GG and GA variants have greater improvements. Finally, the GG variant of the PGC1a gene is associated with improved aerobic fitness in response to endurance training. Together, these genes can predict your genetic advantage for excelling in endurance activities and sports.

Your Results

Genes	Markers
NFIA-AS2 ADRB3 NRF2 GSTP1 PGC1a	rs1572312 rs4994 rs12594956 rs1695 rs8192678

Response Variants	Your Variants
Algorithm	CC TT CA AG AA

Your Response

Typical

Implications

Based on your DNA, your endurance potential is typical. You may need to increase your training to a greater extent than an individual with a genetic advantage to achieve the same level of cardiovascular fitness. Aim to get 150 to 300 minutes of moderate-to-vigorous intensity exercise per week. Your goals and detailed training recommendations are sport-specific and should be reviewed with your coach or trainer.

Your endurance potential is typical.

7in10

People with Risk Variant

Your Results

Gene	Marker
ACTN3	rs1815739

Risk Variant	Your Variant
TC or TT	CC

Your Risk

Typical

Implications

Since you possess the CC variant of the ACTN3 gene, you have a typical susceptibility to muscle damage after strenuous or unaccustomed exercise. When starting a new exercise program ensure you take necessary precautions like warming up and cooling down, and gradually increase exercise intensity over time. Rest and recovery are also important – if you experience extreme soreness after a workout, take a break from working that muscle group until it is no longer sore. It is also important to ensure adequate intakes of protein for muscle repair and consume plenty of antioxidant-rich plant foods such as fruits, vegetables, nuts and seeds.

Meet general guidelines for warming up and cooling down.

Muscle Damage

Delayed onset muscle soreness (DOMS) is commonly experienced in the days following unaccustomed or strenuous exercise, and it is characterized by tender, stiff muscles which also cause a temporary reduction in strength and range of motion. DOMS is a result of exercise-induced muscle damage, which at low levels is a positive stimulus for muscle growth and increased strength. However, excessive damage or inadequate recovery may cause persistent and unnecessary soreness which can impede strength gains and increase the risk of developing over-use injuries. DOMS is caused by oxidative stress, inflammation, and muscle protein degradation. There is considerable variability in an individual's response to muscle-damaging exercise, due to factors such as age, exercise history and genetics. Research shows that variation in the ACTN3 gene influences one's susceptibility to muscle damage after prolonged, strenuous or unaccustomed exercise.* The type of activity inducing the greatest muscle damage is most often high-intensity resistance or power-type exercise.

ACTN3

The ACTN3 gene encodes the alpha-actinin-3 protein, which plays a key role in the contraction of fast-twitch or power-type muscle fibres during short bursts of intense activities, such as sprinting or lifting heavy objects. Genetic variation in ACTN3 affects the expression of the resulting protein in fast-twitch fibres, and individuals who carry at least one copy of the T variant produce a lower functioning ACTN3 protein that has been linked to increased risk of muscle damage. For example, a recent study showed that experienced endurance athletes with the TC or TT variant had higher levels of markers of muscle damage after a competitive marathon than individuals with the CC variant, and a similar trend was observed in a study where healthy young men performed knee extension exercises, working the quadriceps, in a laboratory setting.**

*Del Coso et al. ACTN3 genotype influences exercise-induced muscle damage during a marathon competition. European Journal of Applied Physiology. 2017;117:409–416.
**Vincent et al. Protective role of alpha-actinin-3 in the response to an acute eccentric exercise bout. Journal of Applied Physiology (1985). 2010;109:564-573.

Pain

Pain is an unpleasant feeling triggered by the nervous system that can be mild to severe, and athletes are often exposed to both acute and chronic pain through high intensity training as well as recovery from heavy training. Pain tolerance refers to the maximum amount of pain that someone can withstand. Pain threshold refers to the point where you begin to feel pain that causes discomfort to the extent that it becomes difficult for you to withstand. It is a threshold at which you cannot continue to exercise or train at a certain intensity due to an intolerable level of discomfort. There are substantial differences in the way, or the degree to which people feel pain. Overall, men tend to have higher pain tolerances than women. Research now shows that variations in the COMT gene also impact how we feel and perceive pain.*

*Zubieta et al. COMT val[sup158]met genotype affects μ-Opioid Neurotransmitter Responses to a Pain Stressor. Sci. 2003:299:1240-1243.
Tammimäki A, Männistö PT. Catechol-O-methyltransferase gene polymorphism and chronic human pain: a systematic review and meta-analysis. Pharmacogenet Genomics. 2012;22(9):673-91.

COMT

The Catechol-O-methyltransferase (COMT) gene is involved in pathways in the body that process pain signals. Because of this, researchers have studied how variations in this gene can impact our perception of pain. Studies show that the COMT gene is a significant predictor of pain tolerance. Specifically, individuals with the GG or GA variant tend to experience less pain compared to those with the AA variant.

3in4

People with Response Variant

Your Results

Gene	Marker
COMT	rs4680

Response Variant	Your Variant
GG or GA	GA

Your Response

Enhanced

Implications

Since you possess the GG or GA variant of the COMT gene, you have enhanced pain tolerance, which can be beneficial for training and performance. To increase your pain tolerance even further, try practicing deep breathing, and changing negative thoughts to positive thoughts when you are undergoing pain. For example, when you are training, try to shift your focus away from the discomfort you may be feeling in your muscles, and focus on how the intensity is preparing you to push yourself during competition. Getting yourself accustomed to feelings of discomfort by pushing yourself during your training sessions more often may help you to decrease pain perception over time.

You have an enhanced pain tolerance and therefore tend to experience less pain.

4in5

People with Risk Variant

Your Results

Gene	Marker
WNT16	rs2707466

Risk Variant	Your Variant
CC or TC	TC

Your Risk

Elevated

Implications

Since you possess the CC or TC variant of the WNT16 gene, you have an elevated risk for low BMD and bone fracture. Exercise protocols that produce high mechanical forces in the skeleton can increase bone density and strength. For example, sports such as basketball and volleyball, or fitness classes that include running or jumping can all help to improve bone density. In addition, resistance exercise using your own body weight, free weights or machines has been shown to strengthen bones. Daily activities such as running up stairs, carrying heavy groceries or gardening also help to maintain bone strength. Aim to engage in both weight-bearing and resistance exercises most days of the week. Be sure to seek expert guidance before trying new or more challenging exercises. It is also important to ensure adequate intakes of protein, calcium, vitamin D and antioxidants for optimal bone health.

You have an elevated risk for low bone mass.

Bone Mass

Osteoporosis and osteopenia are common bone diseases that occur more often in older adults but can develop at any age. Both involve a deterioration of tissue, resulting in low bone mineral density (BMD) and compromised bone strength. Osteoporosis can develop without any signs or symptoms and is characterized by low BMD and a high risk of bone fracture. Osteopenia is also characterized by reduced BMD and can predict later development of osteoporosis and fracture risk. Low bone mineral density in athletes, regardless of their age, is associated with stress fracture injuries. Menstrual dysfunction, in addition to low energy intake, can also increase a female athlete's risk for bone and stress fractures. The rate of bone loss is influenced by factors such as nutrition and exercise, with some forms of exercise slowing the rate of loss and even increasing BMD and bone strength. Genetic variation also contributes to differences in BMD levels across individuals. Research shows that a genetic variant in the WNT16 gene is associated with a greater risk of low BMD and increased risk of fracture.*

*Zheng et al. WNT16 influences bone mineral density, cortical bone thickness, bone strength, and osteoporotic fracture risk. PLOS Genetics. 2012:8; e1002745.

WNT16

WNT16 encodes a protein belonging to the WNT family of genes, which is involved in the regulation of bone formation. WNT16 has been associated with bone mass and structure across all life stages, and it is an important determinant of BMD, bone strength, and risk of fracture. Individuals who possess the CC or TC version of the WNT16 gene are predisposed to having a lower BMD and higher risk of bone fracture, compared to those with the TT variant. It is particularly important for individuals with the CC or TC variant to engage in weight-bearing exercises and to ensure they consume adequate amounts of protein, vitamin D and calcium, which are essential nutrients for bone health.

Types of Weight Bearing Activities

Walking	Running
Hiking/trekking	Tennis
Jogging	Team Sports

Types of Resistance Activities

Lifting weights	Working with resistance bands
Using weight machines	Push-ups
Squats	Lunges

Achilles Tendon Injury

Your Achilles tendon starts at the bones in your heels and continues up to your calf muscles. It is one of the largest and strongest tendons in the human body. This tendon gives you the ability to point your toes and extend your foot. Unfortunately, injuries to the Achilles tendon are common. They typically arise from training exercises that require a sudden surge of energy such as plyometric training and uphill sprinting, and are more common in athletes compared to the general population. Symptoms of an Achilles tendon injury include extreme pain, tenderness, swelling, or stiffness along the back of your foot and above your heel. Your risk of developing an Achilles tendon injury depends in part on the COL5A1 gene.*

*September AV et al. Variants within the COL5A1 gene are associated with Achilles tendinopathy in two populations. Brit J Sport Med. 2009;43:357–365.

COL5A1

The COL5A1 gene directs the body to produce a protein called collagen alpha-1(V) chain, which plays an important role in the creation of collagen. Collagen is the protein that is used to make connective tissues in the body. Given the role of the COL5A1 gene in the creation of connective tissue, scientists have studied the link between this gene and Achilles tendon injury risk. Research has shown that individuals with the CT or TT variant of COL5A1 gene have a higher risk for developing an Achilles tendon injury.

Dynamic Stretching Warm-up

Side lunges	Warrior pose
Heel raises	Tip-toe walking
Walking lunges with rear leg extension	Mountain climbers

Lower Leg Strengthening Exercises

Seated calf raises	Weighted toe raises
Standing calf raises	Anterior tibialis isometrics

Higher Risk Exercises for Achilles Tendon

Box jumping	Hill sprints
Plyometrics	Sled pushes

4in5

People with Risk Variant

Your Results

Gene	Marker
COL5A1	rs12722

Risk Variant	Your Variant
CT or TT	CC

Your Risk

Typical

Implications

Since you possess the CC variant of the COL5A1 gene, you have a typical risk of developing an Achilles tendon injury. To decrease your risk, be mindful of exercises requiring a surge of energy or overextension of this tendon through certain exercises such as plyometrics and uphill running. Preventive measures also include additional stretching of your calf muscles and increasing the duration of your warm up and cool down during exercise sessions.

You have a typical risk for Achilles tendon injury.

Additional Genetic Insights for Health and Wellness

The table below includes genetic markers that provide additional insights for health and wellness. These insights come from research studies on genetic variation and its association with health-related outcomes, such as the association for a genetic marker with having a higher level of a nutrient circulating in the blood. This section differs from the previous sections in the report, which focus on genetic markers that modify the way we respond to diet or exercise to impact health outcomes. Therefore, currently, no personalized diet or fitness recommendations are given for the markers in the following table. Talk to your healthcare provider about general strategies you can implement to optimize your health given these additional health-related insights.

	Gene, rs Number	Gene Function	Risk/ Response Variant	Your Variant	Your Risk/ Response	Implications
Nutrients						
Magnesium	TRPM6, rs11144134	TRPM6 is a magnesium transporter	TT or CT	CT	Elevated	You have an elevated risk of low levels of magnesium.
Zinc	SLC30A3, rs11126936	SLC30A3 is a zinc transporter	CC	CC	Elevated	You have an elevated risk of low levels of zinc.
Starch	AMY1, rs4244372	AMY1 is a salivary starch enzyme	AA	AT	Typical	Your ability to metabolize starch is typical.
Vitamin E	Intergenic – rs12272004	APOA5 is a component of HDL	CC or CA	CA	Elevated	You have an elevated risk of low vitamin E levels.
Inflammation and Antioxidant Capacity						
Adiponectin	ADIPOQ, rs17366568	Adiponectin is an anti-inflammatory hormone	GA or AA	GA	Diminished	Your levels of adiponectin are likely to be diminished.
Interleukin 6	IL6, rs1800795	IL6 is an inflammation biomarker	GG or GC	GG	Elevated	Your levels of interleukin 6 are likely to be higher than normal.
Superoxide Dismutase 2	SOD2, rs4880	SOD2 is an antioxidant	TT or CT	CT	Diminished	Your SOD2 enzymatic activity, which affects antioxidant capacity, is diminished.
Nitric Oxide	NOS3, rs1799983	NOS3 is involved in producing antioxidants	GT or TT	GG	Typical	Your plasma nitric oxide levels are likely to be typical.
Eating Habits						
Hunger	NMB, rs1051168	NMB regulates eating behaviour	TT	GT	Typical	You have a typical susceptibility to hunger.

	Gene, rs Number	Gene Function	Risk/ Response Variant	Your Variant	Your Risk/ Response	Implications
Weight Management						
Maintenance of Long-Term Weight Loss	ADIPOQ, rs17300539	Adiponectin regulates fat metabolism and insulin sensitivity	AA or AG	GG	Typical	You have a typical risk of regaining weight after weight loss.
Sleep and Lifestyle						
Short Sleep Duration	CLOCK, rs1801260	CLOCK regulates the circadian rhythm	CC or TC	TT	Typical	You have a typical risk of short sleep duration.
Alcohol Sensitivity	ALDH2, rs671	ALDH2 is involved in alcohol metabolism	AA or AG	GG	Typical	You have a typical sensitivity to the effects of drinking alcohol.
Cardiometabolic Health						
Total Cholesterol	APOA5, rs662799	APOA5 is a component of HDL	CC or TC	TT	Typical	You have a typical risk of high total cholesterol.
LDL Cholesterol	ABCG8, rs6544713	ABCG8 is involved in cholesterol transport	TT or CT	CC	Typical	You have a typical risk of high LDL cholesterol.
HDL Cholesterol	ABCA1, rs1883025	ABCA1 is involved in cholesterol transport	TT or TC	CC	Typical	You have a typical risk of low HDL cholesterol.
Triglycerides	ANGPTL3, rs10889353	ANGPTL3 is involved in regulating lipid metabolism	AA or CA	AA	Elevated	You have an increased risk of high triglycerides.
Fasting Glucose	ADCY5, rs11708067	ADCY5 is involved in insulin secretion	AA or GA	AA	Elevated	You have an increased risk for high fasting glucose.
Insulin	IRS1, rs2943641	IRS1 is involved in insulin signaling	CT or CC	CT	Elevated	You have an increased risk for high insulin concentrations.
Injury						
Rotator Cuff Injury	MMP1, rs1799750 MMP3, rs3025058	MMP1 and MMP3 are involved in tissue remodeling	Algorithm	GG DelA	Elevated	You have an elevated risk of having a rotator cuff injury.

Hormone Metabolism and Methylation

The table below shows genetic markers that provide additional insights for health and wellness. Included are markers that affect the function of enzymes involved in the metabolism of important hormones such as estrogen and androgens and detoxification of their by-products. Also included are markers that affect the function of enzymes involved in DNA methylation, a crucial process for adequate cell development. This section differs from previous sections in the report, which focus on genetic markers that modify the way we respond to diet or exercise to impact health outcomes. Currently, no personalized diet or fitness recommendations are given for the markers in the following table. Talk to your healthcare provider about general strategies you can implement to optimize your health given these additional insights.

Enzyme	Gene, rs Number	Risk Variant	Your Variant	Your Risk	Implications
Hormone Metabolism					
Cytochrome P450 17A1	CYP17A1, rs743572	AG or GG	AG	Elevated	You have an elevated risk of high estrogen levels.
Aromatase	CYP19A1, rs10046	CT or TT	CC	Typical	You have a typical risk of elevated estrogen levels, and an increased estrogen:androgen ratio.
Cytochrome 1B1	CYP1B1, rs1056836	GC or GG	GC	Medium	You have a medium risk of tissue damage due to estrogen by-products.
UDP-Glucuronosyl-transferase 2B15	UGT2B15, rs1902023	TG or GG	TT	Typical	You have a typical risk of high dihydrotestosterone (DHT) levels.
Mitochondrial Superoxide Dismutase 2	SOD2, rs4880	CT or TT	CT	Elevated	You have an elevated risk of cell oxidative damage.
Catechol-O-Methyltransferase	COMT, rs4680	GA or AA	GA	Medium	You have a medium risk of high dopamine levels.
Glutathione S-transferase P1	GSTP1, rs1695	AG or GG	AG	Medium	You have a medium risk of tissue damage due to a moderate rate of estrogen clearance.
Glutathione S-transferase T1	GSTT1, rs2266633	Del	Ins	Typical	You have a typical risk of tissue damage due to a higher rate of estrogen clearance.

Enzyme	Gene, rs Number	Risk Variant	Your Variant	Your Risk	Implications
Methylation					
Methionine Reductase	MTR, rs1805087	GG or AG	AG	Elevated	You have an elevated risk for high homocysteine levels, and an elevated risk for low circulating folate.
Methionine Synthase Reductase	MTRR, rs1801394	AG or GG	AG	Elevated	You have an elevated risk for high homocysteine levels, and an elevated risk for low circulating folate.
Methylene-Tetrahydrofolate Reductase A	MTHFR (A1298C), rs1801131	AC or CC	AC	Elevated	You have an elevated risk for high homocysteine levels, and an elevated risk for low circulating folate.
Methylene-Tetrahydrofolate Reductase B	MTHFR (C677T), rs1801133	CT or TT	TT	Elevated	You have an elevated risk for high homocysteine levels, and an elevated risk for low circulating folate.

International Science Advisory Board

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Dr. Ahmed El-Sohemy is a Professor and Associate Chair and held a Canada Research Chair in Nutrigenomics at the University of Toronto. He is also the founder of Nutrigenomix Inc., serves as the company's Chief Science Officer and is Chair of the company's International Science Advisory Board. Dr. El-Sohemy obtained his PhD from the University of Toronto and completed a postdoctoral fellowship at Harvard. He has published in the top scientific and medical journals with almost 200 peer reviewed publications and has given more than 300 invited talks around the world. He is currently Editor-in-Chief of the journal Genes & Nutrition, serves on the editorial board of 10 other journals, and has served as an expert reviewer for more than 30 different scientific and medical journals and 12 research granting agencies. He has been a member of international expert advisory panels and scientific advisory boards of several organizations. Dr. El-Sohemy is the recipient of several awards for excellence in research by the American College of Nutrition, the Canadian Society for Nutrition and the American Nutrition Association.

Sara Mahdavi, RD, MSc, PhD

Dr. Sara Mahdavi is a clinical scientist and holds a clinical instructor and research appointment with the Department of Community and Family Medicine at the University of Toronto. Dr. Mahdavi received her doctorate from the Faculty of Medicine at the University of Toronto in the field of gene-environment interactions and cardiometabolic disease. She has been practicing clinical dietetics over the last decade at several hospitals as well as private practices. Dr. Mahdavi has been an invited speaker at medical conferences and for government agencies. She has published over a dozen original scientific articles in top medical journals, has been an invited reviewer for several clinical journals and serves on the editorial board of the Canadian Journal of Kidney Health and Disease. Dr. Mahdavi's clinical research and practice have varied from early insulin sensitivity to kidney disease, rare genetic disorders, and innovative dermatological interventions.

Lynnette R Ferguson, D.Phil. (Oxon.), DSc

Dr. Lynn Ferguson is Program Leader of Nutrigenomics New Zealand. She obtained her D.Phil. from Oxford University working on DNA damage and repair. After her return to New Zealand, she began working as part of the Auckland Cancer Society Research Centre, using mutagenicity testing as a predictor of carcinogenesis. In 2000, she took on a 50% role as Head of a new Discipline of Nutrition at The University of Auckland. She has recently been investigating the interplay between genes and diet in the development of chronic disease, with particular focus on Inflammatory Bowel Disease. As Program Leader of Nutrigenomics New Zealand she is working with a range of others to bring nutrigenomics tools to the New Zealand science scene. She has supervised more than 30 students and has more than 300 peer reviewed publications. Dr. Ferguson serves as one of the managing Editors for Mutation Research: Fundamental and Molecular Mechanisms of Mutation, as well as on the Editorial Boards of several other major journals.

J. Bruce German, PhD

Bruce German is the Director of the Foods for Health Institute at the University of California Davis, and is Professor of Food Science and Technology (http://ffhi.ucdavis.edu/). Dr German received his PhD from Cornell University and joined the faculty at the University of California (Davis) in 1988. In 1997, he was named the first John E. Kinsella Endowed Chair in Food, Nutrition and Health. His research interests in personalized nutrition include the structure and function of dietary lipids, the role of milk components in food and health and the application of metabolic assessment to personalizing diet and health. Dr German has published more than 350 papers and holds a number of patents related to various technologies and applications of bioactive food components. The research articles from his lab rank in the top 5 most cited in the field.

David Jenkins, MD, DSc, PhD

Dr. Jenkins earned his MD and PhD at Oxford University, and is currently a Professor in both the Departments of Medicine and Nutritional Sciences at the University of Toronto. He is also a staff physician in the Division of Endocrinology and Metabolism and the Director of the Clinical Nutrition and Risk Factor Modification Center, St. Michael's Hospital. Dr Jenkins has published over 300 peer reviewed articles and given hundreds of invited talks around the world. He has served on numerous international committees to set guidelines for the treatment of diabetes and most recently on the new joint United States-Canada DRI system (RDAs) of the National Academy of Sciences. His team was the first to define and explore the concept of the glycemic index of foods and demonstrate the breadth of metabolic effects of viscous soluble fibre. He has received many national and International awards in recognition of his contribution to nutrition research. Dr Jenkins currently holds a Canada Research Chair in Nutrition and Metabolism.

Jose Ordovas, PhD

Jose M. Ordovas is Professor of Nutrition and Director of the Nutrigenomics Laboratory at the United States Department of Agriculture, Human Nutrition Research Center on Aging at Tufts University in Boston. After obtaining his PhD from the University of Zaragoza, Spain, he completed postdoctoral work at Harvard, MIT and Tufts University. Dr Ordovas' major research interests focus on the genetic factors predisposing to cardiovascular disease and their interaction with environmental factors. Dr Ordovas has published ~700 articles in peer reviewed journals, and written numerous reviews and edited 5 books on nutrigenomics. He has been an invited speaker at hundreds of International meetings all over the world and is currently a member of the Institute of Medicine's Food and Nutrition Board (National Academies). He serves as Editor for Current Opinion in Lipidology (Genetics Section), and on the Editorial Board of numerous journals. Dr. Ordovas is a Member of Honor of the Spanish Society of Atherosclerosis and has received other awards for his contributions to the field of nutrigenomics.

Ben van Ommen, PhD

Dr. Ben van Ommen is Director of the Nutrigenomics Organization (NuGO) and Principal Scientist at TNO, one of the largest independent research organizations in the area of nutrition world-wide. He is also Director of the TNO systems biology program and leading the activities on nutrigenomics, nutritional systems biology, personalized health and personalized medicine. His research applies systems biology to metabolic health and metabolic disease, focusing on understanding all relevant processes involved in maintaining optimal health and causing specific disease sub-phenotypes, developing new biomarkers and treatment strategies.

Nanci S. Guest, PhD, RD, CSCS

Dr. Nanci Guest is a registered dietitian (sport specialty), certified personal trainer and a certified strength and conditioning specialist, and she has been working in private practice in this field for two decades. She completed her doctoral degree in the area of nutrigenomics and athletic performance at the University of Toronto. She obtained her BSc in agriculture and dietetics, and her MSc in nutritional sciences with a sport focus at the University of British Columbia. Dr. Guest has published her research in top journals, presented at international conferences and has given dozens of invited talks around the world. She also teaches advanced sport nutrition courses at the college level. Dr. Guest is a global consultant to professional and amateur athletes and teams, and she was also involved in creating past athlete nutrition guidelines for the International Olympic Committee. She was the Head Dietitian at both the Vancouver 2010 Olympics and the Toronto 2015 Pan Am games and served as a consultant to a variety of international athletes in preparation for the past four London, Sochi, Rio and PyeongChang Olympics.