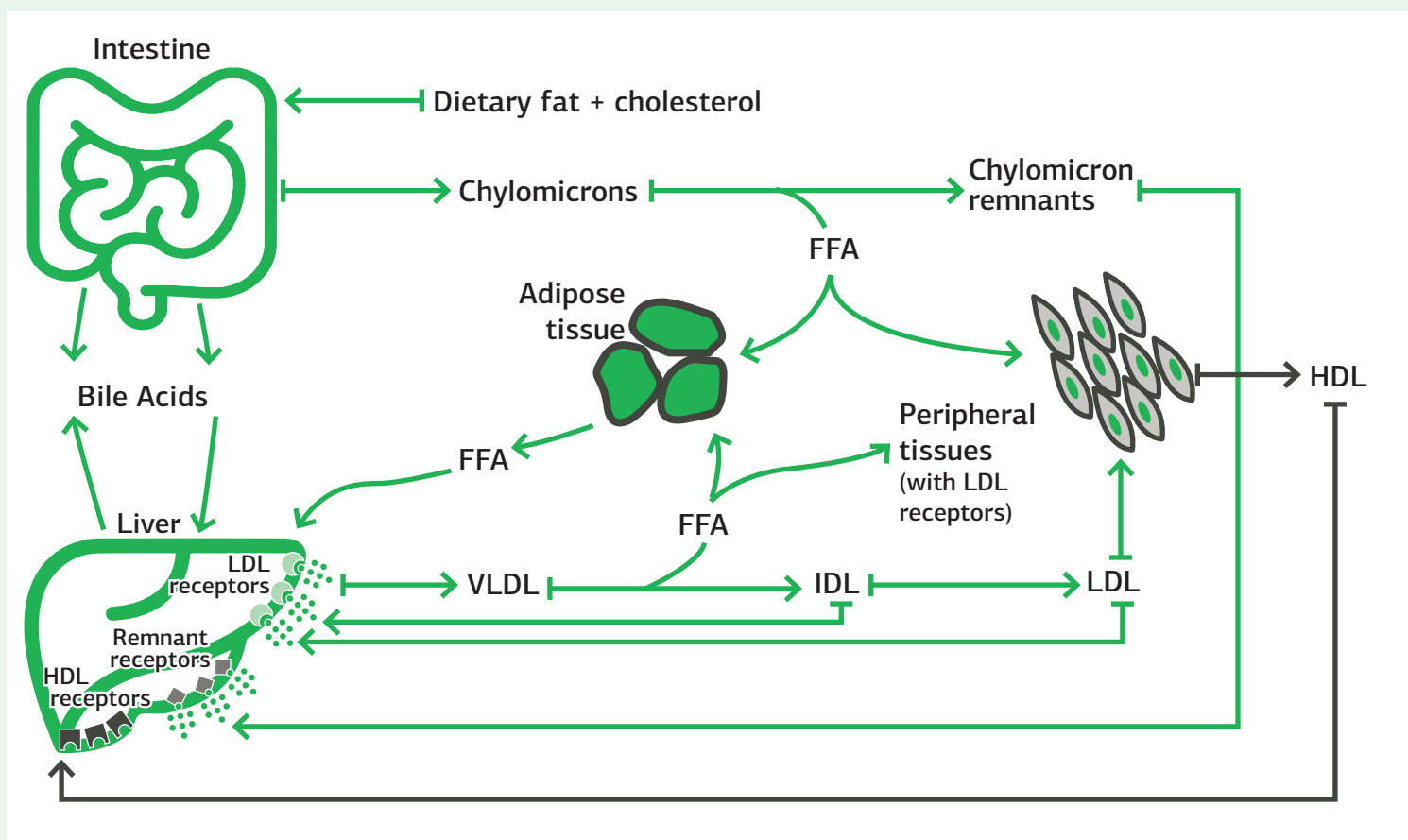


## Take Care of Your Liver and Your Liver Will Take Care of You

The liver plays an important role in carbohydrate metabolism, balancing blood glucose levels, and lipoprotein synthesis and metabolism.<sup>1</sup>



### How Does Impaired Liver Functioning Affect Health?

A dysfunctional liver fails to adequately regulate metabolic homeostasis of glucose, usually as a result of insulin resistance, glucose intolerance, and type 2 diabetes. Insulin resistance and elevated levels of insulin in the blood (compared to corresponding glucose levels) are key factors in the relationship between diabetes and liver disease.

Metabolic syndrome is a risk factor for non-alcoholic fatty liver disease which is frequently associated with type 2 diabetes.<sup>1</sup>

Maintaining a healthy liver is important for reducing your risk of these diabetes-associated conditions as well as improving overall glucose homeostasis and optimizing lipoprotein metabolism.

### UNDERSTANDING A HEALTHY LIVER AND HEALTHY LIPID LEVELS

#### High-density lipoprotein (HDL):

clears cholesterol from the body through the liver, potentially preventing plaque build-up in the arteries

#### Low-density lipoprotein (LDL):

carries cholesterol to the arteries, contributing to plaque build-up; associated with coronary artery disease

**Very low-density lipoprotein (VLDL):** carries triglycerides to tissues and eventually becomes LDL; associated with higher risk of heart disease

**LDL particle size:** value describing size and density of LDL particles, which varies; small particle size associated with diabetes and metabolic syndrome

**Triglyceride (TG):** type of fat found in the bloodstream derived from unused calories as a source of shared energy

## METABOLIC SYNDROME

### What is Metabolic Syndrome?

There are various definitions of Metabolic Syndrome (MetS). Essentially, it is a group of metabolic conditions that are major risk factors for the development of heart disease and type 2 diabetes.

The US National Cholesterol Education Program's Adult Treatment Panel III describes MetS as the presence of three or more of the following metabolic disorders:<sup>1</sup>

- 1 Central obesity reflected by increased waist circumference** (≥102 cm for men, ≥88 cm for women) | High fat levels in the abdominal region pose a greater risk for heart disease than in other areas of the body.<sup>2</sup>
- 2 Hypertension** (Systolic and diastolic blood pressure ≥ 130/85 mmHg) High blood pressure threatens the integrity of artery walls in the heart, increasing the risk for plaque buildup, which can lead to heart disease.<sup>2</sup>



- 3 Dyslipidemia** (HDL < 40 mg/dL for men, < 50 mg/dL for women, or TGs ≥ 150 mg/dL) High levels of triglyceride or low-density lipoprotein or low levels of high-density lipoprotein increases risk of heart disease.<sup>2</sup>
- 4 Insulin Resistance** (fasting blood glucose ≥ 110 mg/dL) Consistently high levels of fasting blood glucose is a sign of diabetes and increases the risk of heart disease.<sup>2</sup>

### Factors Contributing to MetS Development

The increasing prevalence of MetS (and other health challenges) is due largely to low-quality diets common in the United States. Americans in general have more access to a greater abundance of calorie-dense, nutrient-poor diet choices than their ancestors did.<sup>3</sup> Specifically, the Standard American Diet (SAD) is low in vegetables, fruits, and whole grain — but high in added sugars, saturated/trans fats, and sodium intake.<sup>4</sup>

In addition, chronic inflammation is one underlying cause of MetS and associated with chronic diseases such as cardiovascular disease and type 2 diabetes.<sup>2</sup>

#### How Nutrients Help Manage MetS

Several nutrients provide support for MetS management, including: protein (i.e. low glycemic index special protein blends), fiber, mono- and polyunsaturated fatty acids (i.e. omega-3 fatty acids), flavonoids, magnesium, phytonutrients in specialty crops (i.e. avenanthramide in select oats).

- Increased fiber intake helps with weight loss and affects appetite; not surprisingly, fiber intake is linked to lower levels of obesity and lower risk for MetS and heart disease.<sup>5-8</sup>
- Magnesium intake is associated with blood pressure management, and bioactive flavonoids from plants are associated with reduced risk of heart disease deaths.<sup>10-12</sup>
- Omega-3 fatty acid intake addresses dyslipidemia and its connection to MetS. These polyunsaturated fatty acids have been shown to decrease unhealthy cholesterol levels.<sup>9</sup>
- Consumption of whole grain oats has long been connected to supporting healthy glucose metabolism and metabolic health due to soluble and insoluble fiber content.
- Lastly, select nutrients are also important for stabilizing the underlying systems, such as B vitamins, vitamins C, D, and E.

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**The Omega-3 Advantage**

Two types of fatty acids, monounsaturated (MUFA) and polyunsaturated (PUFA), can improve metabolic parameters like blood pressure, lipid profiles, and insulin sensitivity. Both types of fat have also been studied to reduce inflammation, although the evidence base is stronger between reduced inflammation and PUFAs, like omega-3 fatty acids.

The Standard American Diet (SAD) usually contains more MUFAs than PUFAs, making it particularly important for the average individual to focus on consuming more PUFAs. Saturated fats and MUFAs can be synthesized in the liver, but omega-3 and omega-6 PUFAs are essential fatty acids that are good for health — they cannot be synthesized in the body.<sup>8</sup> Thus, it is necessary to obtain omega-6 and omega-3 fatty acids from the diet.<sup>8</sup> Thus, it is necessary to obtain omega-6 and omega-3 fatty acids from the diet.

Increasing omega-3 fatty acid intake through dietary choices and/or supplementation can be effective at improving the omega-6 to omega-3 ratio, which is optimally around 2:1 or

4:1. However, with a disproportionate amount of omega-6 consumption compared to omega-3 consumption in modern American diets, the ratio can be as high as 20:1.<sup>8</sup> The more optimized the ratio, the more health benefits that can be gleaned, including improved cardio-metabolic parameters.<sup>8</sup>

Omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) help to lower triglyceride levels by reducing synthesis and secretion from the liver. EPA and DHA can also support healthy blood pressure by stimulating the dilation of small arteries.<sup>8</sup>

Additionally, EPA and DHA improve cardio-metabolic parameters in a few key ways<sup>8</sup>

- Address plaque buildup in arteries by reducing levels of cytokines and adhesion molecule levels near the artery wall
- Increase size of LDL, as low LDL particle size is associated with risk for heart disease
- Reduce steatosis in non-alcoholic

**Polyphenols, Metabolic Syndrome, and Glucose Management**

Polyphenols found in plants may be beneficial for addressing metabolic syndrome and improving glucose management. Dietary polyphenols influence digestion, absorption, and metabolism of starch and sucrose, which are important dietary carbohydrates primarily digested in the upper gastrointestinal (GI) tract.<sup>1</sup>

Polyphenols support homeostasis in carbohydrate metabolism by balancing the glycemic response following a meal as well as fasting blood sugar levels. Polyphenols also influence insulin secretion and sensitivity. Additionally, studies show that polyphenols inhibit two enzymes vital for metabolizing glucose from dietary carbohydrate:  $\alpha$ -amylase and  $\alpha$ -glucosidase. They slow down glucose release and absorption, and ultimately reduce high blood sugar following a meal.<sup>1</sup>

Polyphenol involvement in glucose homeostasis is linked to prevention of insulin resistance, metabolic syndrome, and type 2 diabetes.<sup>1</sup> Accordingly, individuals at risk of type 2 diabetes are encouraged to eat more plant foods, which are rich sources of polyphenols.

Regulation of specific bitter receptor signaling may reduce the prevalence of risk factors associated with metabolic syndrome and glucose management. For example, bitter constituents found in whole grain oats bind to human bitter receptors in the mouth and throughout the GI tract. Additionally, beta-glucan is the main soluble fiber component of oats and contributes to its low glycemic index. With a low glycemic index, foods are digested and absorbed slower, causing a minimal rise in blood glucose levels.

**SOURCES OF OMEGAS**

**Sources of Omega-6**

- Common cooking oils (i.e. corn, safflower)
- Pork, chicken, beef, dairy products, eggs
- Grains
- Other grain-fed animal products



**Sources of Omega-3**

- Fatty fish (i.e. salmon, anchovy)
- Fish oils
- Walnuts
- Flax, hemp, and chia seeds



**PLANT-BASED FOODS PROVIDING RICH SOURCES OF POLYPHENOLS STUDIED EXTENSIVELY IN THE CONTEXT OF METABOLIC SYNDROME AND TYPE 2 DIABETES:**



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