Protein Foods Initiative Committee
Shirin Panahi, PhD
David W.L. Ma, PhD
Robert Bertolo, PhD
Alison Duncan, PhD, RD
Rajavel Elango, PhD
Stuart Phillips, PhD
James House, PhD
Melissa Fernandez, PhD, RD
Sophie Desroches, PhD, RD
Andrea Grantham, CNS Executive Director
The objective of the **Protein Foods Resource Document** is to increase knowledge and awareness of trainees, nutrition communicators, health professionals and non-governmental organizations on the definition of protein foods, various types of protein foods (e.g. animal- and plant-based sources), quantity of protein in different foods, and how to include them in the diet. This resource is intended to be a comprehensive reference with consistent messages and information that will be used to tailor resources for different contexts and populations. It includes the following sections:

I. What are protein foods and why do we need protein in the diet?
II. Why is protein important?
III. What are processed protein foods?
IV. How much protein do we need? How can we include protein foods in the diet?
V. Are protein recommendations different for physically active individuals?
VI. What are the key protein allergens?
VII. What are the impacts of protein foods on our planet?
VIII. What are the key messages for consumers?

**Key terms**

*Acceptable Macronutrient Distribution Range (AMDR)*
*Allergens*
*Animal-based proteins*
*Appetite control*
*Canada’s Food Guide*
*Complete proteins*
*Digestible indispensable amino acid score (DIAAS)*
*Environmental impact*
*Incomplete proteins*
*Indispensable amino acids*
*Insect-based proteins*
*Lean muscle mass*
*Net protein utilization (NPU)*
*Plant-based proteins*
*Processed protein foods*
*Protein digestibility-corrected amino acid score (PDCAAS)*
*Protein blend foods*
*Protein powders*
*Protein complementation*
*Pulses*
*Recommended Dietary Allowance (RDA)*
*Resistance training*
*Sarcopenia*
*Satiety*
*Supplements*
*Whey protein*
I. What are protein foods and why do we need protein in the diet?

Proteins from food contain 20 amino acids, nine of which are indispensable (i.e. cannot be synthesized by the human body and must be supplied by the diet): histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. Protein is found in most foods, but it is only present in a limited group of foods in higher amounts. Major sources include both animal-based (e.g. meat, poultry, fish, eggs, dairy) and plant-based (e.g. pulses, soy foods, nuts and seeds) proteins. Grains (e.g. whole grain breads, rice, quinoa, barley, oats), despite their minimal protein content, still contribute protein to the diet due to their higher levels of consumption. Within each protein source is a complex mixture of proteins that can affect physiology in different ways.

Protein is necessary to maintain protein homeostasis for adults and for growth and development in children and in pregnancy. When assessing protein foods, both the quality and quantity of the sources are important. Protein quality is characterized by its digestibility (i.e. ability of protein to be digested, absorbed and retained by the body) and its indispensable amino acid content that is needed to support physiological processes specific to life stage (e.g. growth, development, pregnancy). To assess quality, the net protein utilization (NPU) of a food may be used. This is the percentage of protein contained in a food that is retained in the body after a food has been consumed. However, the protein digestibility-corrected amino acid score (PDCAAS) or the digestible indispensable amino acid score (DIAAS) are more common measures. Proteins that contain all nine indispensable amino acids at levels that meet or exceed needs are considered complete proteins (e.g. those in animal-based sources and in some plant-based sources such as soy) while those proteins that are insufficient in one or more amino acids that limit physiological function (e.g. some plant-based sources) are incomplete proteins. Plant-based proteins are less digestible than animal proteins possibly due to the different structures and characteristics of plant versus animal proteins and are deficient in certain indispensable amino acids (e.g. lysine in cereals). Thus, protein quality is a function of protein digestibility, amino acid content, and the resulting amino acid availability to support gain and maintenance of muscle mass and metabolic function. The most practical way to obtain all indispensable amino acids is by combining a variety of protein sources (e.g. combining pulses and grains) during the day. This is referred to as protein complementation.

II. Why is protein important?

Dietary protein is a macronutrient and source of energy providing 4 kcal/gram. Beyond its nutritional role as a source of energy and amino acids for protein synthesis and maintaining lean muscle mass, protein is important in the regulation of food intake, glucose and lipid metabolism, blood pressure, bone metabolism and immune function (Figure 1). Several studies have shown that consuming a diet higher in protein improves waist circumference, blood pressure, and blood triglycerides, while also increasing satiety leading to better appetite control, regulation of body weight and promotion of lean muscle mass. These health effects are also dependent on the source of protein and on the overall calories in the diet. Thus, the benefits of protein are achieved when energy (calorie) intake is also balanced. For example, observational studies have shown
that plant-based proteins and certain animal-based protein sources such as dairy products improve glycemic control, reduce the risk for type 2 diabetes and improve markers of cardiometabolic health. Consuming more plant-based proteins also implies consuming more vegetables, which are associated with cardiovascular benefits. In children, adequate protein consumption is important for growth and development. There is, however, insufficient evidence for benefits of higher protein intake on blood pressure, insulin sensitivity or blood lipids in children.

III. What are processed protein foods?

Processed protein foods have been subject to various processing methods that alter the food from their original state. Some processed protein foods (e.g. frozen chicken fingers, sweetened dairy products, deli meats, vegetable burgers) that contain higher amounts of sodium, saturated fats and added sugars, should be consumed in limited quantities. Processing may include:

- methods such as curing, canning, cooking, isolating, combining, packaging or pasteurizing;
- the addition of other ingredients to the food, such as preservatives, flavours, nutrients, and other food additives or substances approved for use in food products, such as sodium, added sugar and saturated fat;
- the addition of ingredients that may reduce, increase, or leave unaffected the nutritional characteristics of raw foods such as meats;
- various processing techniques such as fermentation, concentration and extraction that have been used to facilitate the integration of proteins in food products, to extend shelf-life and improve their nutritional values;
- certain methods such as pasteurization of milk that help to create safe and convenient dairy products, while other types of processing, such as drying, canning, freezing, concentrating and fermenting, help preserve and retain nutrients and extend shelf-life.
Some animal-based proteins derived from muscle and other tissues (e.g. collagen, gelatin, and beef plasma protein) and plant proteins (e.g. pulses) are used as functional ingredients in food processing. Plant protein can also be found in a fibrous form called textured vegetable protein (TVP). TVP is traditionally produced from soy flour from which proteins are isolated. It is mainly a low-calorie and low-fat meat alternative and functions as a meat analog in vegetarian hot dogs, hamburgers, and chicken patties. Protein blend foods are also gaining popularity and include foods that contain both animal- and plant-based sources of protein and are potential alternatives for individuals who wish to reduce intake of animal-based proteins. Examples include blended burgers (e.g. beef and pea protein isolate) and sausages (e.g. turkey and mushroom). However, it is important to guide consumers to incorporate whole plant-based protein foods such as pulses (e.g. lentils, chickpeas, kidney beans) into their habitual diets, as much as possible, instead of turning to convenient, but highly processed plant-based foods (e.g. meatless burgers, meat-free chicken nuggets, flexburgers), which can be higher in nutrients of concern (i.e. nutrients that should be limited), including added sodium, saturated fats and added sugars and may also contain a long list of ingredients.

The introduction of processing techniques has also sparked the sports supplement marketplace with derivative animal- and plant-based products such as whey, casein, and soy proteins. Individually, these products vary in quality and applicability to certain populations. The most common protein supplement, whey protein, the by-product of cheese making, has been studied extensively in individuals with type 2 diabetes and obesity, older adults and athletes. It is a high quality protein due to its amino acid content (i.e. high in leucine) and rapid digestibility. Furthermore, plant-based protein powders such as soy protein, which are mostly free of components such as dietary fibre have digestibility rates similar to those of animal-based proteins. The use of protein supplements will depend on the needs and goals of each individual. Since food ingredients are not typically consumed in isolation, sources of high quality animal proteins such as whey may be consumed in dairy products such as milk and yogurt, while soy protein may be consumed in soy products such as tofu or soy beverages.

A more novel source of protein also gaining popularity is insect-based protein which serves as an alternative for animal-based protein. For example, the protein, vitamin and mineral content of mealworms is suggested to be similar to that in fish and meat. Insects such as crickets already form a traditional part of many regional and national diets, although consuming insects is not a common component of Western diets. Insects are often consumed whole, but can also be processed into granular or paste forms to be used in various food products. Attitudes towards the consumption of insects appears to be mixed; however, because of their nutrient composition, accessibility and quick growth rates, they can offer an inexpensive and efficient way to reduce food insecurity and improve the quality of traditional diets among vulnerable individuals.

IV. How much protein do we need? How can we incorporate protein foods into the diet?

How much daily protein one requires depends on life stage, health status, body weight, goals (e.g. weight loss, muscle gain), and level of physical activity. The current Recommended Dietary Allowance (RDA) for protein is estimated, from nitrogen balance, at 0.8 g protein from high
quality sources/kg of body weight per day for adults of all ages, except pregnant and lactating women\textsuperscript{17}. The RDA for protein intake is the minimum intake to prevent deficiency. The **Acceptable Macronutrient Distribution Range (AMDR)** for protein is broad at 10\% to 35\% of total daily energy intakes\textsuperscript{17}. The higher RDA for children and youth is between 0.85-1.1 g/kg of body weight per day, depending on age, and is extrapolated from the adult RDA\textsuperscript{17}. Children who are involved in sports or are regularly active may require additional protein although this quantity is currently not known. Though the RDA is the same for all adults, there is increasing evidence that older adults require more dietary protein than the RDA to maintain optimal physical function, prevent sarcopenia, help maintain basal metabolic rate, and maintain bone health and cardiovascular function\textsuperscript{18-21}. Protein intakes between 1.2-2.0 g/kg of body weight or higher for older adults have been recommended depending on health status and goals\textsuperscript{22-24}. During pregnancy, protein requirements vary depending on the stage of gestation; early stages require 1.2 g/kg of body weight per day while later stages require 1.5 g/kg of body weight per day \textsuperscript{25}.

**Example:** A woman of 50 kg (110 pounds) should consume 40 g of protein per day (50 kg x 0.8 g/kg body weight per day). This could be provided by a variety of protein foods such as two cups (500 mL) of cow’s milk (18 g of protein), 3/4 cup (175 mL) of chickpeas (11 g of protein) and half a serving (50 g) of chicken (12 g of protein)\textsuperscript{1}.

**TABLE 1** Protein food source, serving size and quantity.

<table>
<thead>
<tr>
<th>Protein Food</th>
<th>Serving Size</th>
<th>Protein (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow’s milk (2% M.F.)</td>
<td>250 mL</td>
<td>8.1</td>
</tr>
<tr>
<td>Cheese (cheddar)</td>
<td>30 g</td>
<td>6.9</td>
</tr>
<tr>
<td>Yogurt (plain, 2% M.F.)</td>
<td>175 g</td>
<td>6.1</td>
</tr>
<tr>
<td>Beef (lean)</td>
<td>100 g</td>
<td>28.6</td>
</tr>
<tr>
<td>Chicken breast (skinless)</td>
<td>100 g</td>
<td>28.9</td>
</tr>
<tr>
<td>Egg</td>
<td>100 g</td>
<td>12.4</td>
</tr>
<tr>
<td>Fish (salmon)</td>
<td>100 g</td>
<td>25.1</td>
</tr>
<tr>
<td>Tofu</td>
<td>100 g</td>
<td>17.7</td>
</tr>
<tr>
<td>Grains (rice)</td>
<td>30 g</td>
<td>2.6</td>
</tr>
<tr>
<td>Pulses (dry)</td>
<td>100 g</td>
<td>21.4</td>
</tr>
<tr>
<td>Nuts</td>
<td>30 g</td>
<td>6.1</td>
</tr>
<tr>
<td>Seeds</td>
<td>30 g</td>
<td>5.8</td>
</tr>
<tr>
<td>Peanut Butter</td>
<td>15 g</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Dietary guidelines such as the 2019 **Canada’s Food Guide**\textsuperscript{26} support consumption of a variety of protein foods such as pulses, nuts, seeds, tofu, fortified soy beverages, fish, shellfish, eggs, poultry, lean red meat including wild game, lower fat milk, yogurts and kefir and cheeses lower in fat and sodium (Table 1). Plant-based, animal-based, and highly processed sources of protein foods are not equivalent in nutritional quality and consumers may lack the knowledge to select the best combination of foods to optimize nutritional quality. It is important to choose nutrient-rich protein foods and eat a variety of protein-rich foods from various sources (animals and plants) for optimal nutrient intakes. Individuals who primarily follow plant-based diets must consider both the quantity and quality of protein to ensure optimal protein intake. Soy foods are high-quality sources of protein; however, many grain (e.g. rice) or nut-based (e.g. almond) beverages contain little protein and may contain excess free sugars. Notably, low-protein nut beverages should not replace milk or fortified soy beverages for children in the first few years of life due to the lower content of calcium and vitamin D. Individuals who desire to obtain all their protein from plant sources (i.e. vegans) must consume a variety of vegetables, fruits, grains, and pulses to ensure intake of all essential amino acids, vitamins, and minerals.
There are many ways to incorporate protein foods in the diet. To include more plant-based protein foods in the diet, soups, salads, entrées and desserts that include pulses can be prepared (e.g. bean and chickpea burrito, vegetarian chili, lentil salad, bean brownies), homemade trail mix may be prepared by combining whole grain cereals with a handful of nuts (e.g. almonds, pistachios, walnuts) and seeds (e.g. pumpkin seeds, sunflower seeds), and hummus (i.e. a chickpea spread) may be used in sandwiches or as dips and consumed with vegetables. Animal-based proteins such as low-fat yogurt may be consumed as snacks and used in cooking and as substitutes for sauces. Eggs (e.g. boiled) may also be consumed as snacks or part of meal (e.g. sandwiches, salads). It is important to encourage consumers to choose and prepare foods that have little to no added sodium, added sugars or saturated fat and to compare nutrition facts tables among food products to search for options that are lower in these nutrients. Healthy methods to prepare food is also encouraged such as baking, grilling, roasting, poaching, draining extra fat after cooking, trimming visible fat from meats, removing skin from poultry prior to cooking and limiting the quantity of sauces, butter or gravy. Canada’s Food Guide suggests several protein sources to choose from (Table 2).

**TABLE 2 Protein foods and recommendations.**

<table>
<thead>
<tr>
<th>Protein Food</th>
<th>Canada’s Food Guide Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pulses</strong> (e.g. beans, peas, lentils)</td>
<td>• dried beans, peas and lentils to soak and cook at home&lt;br&gt;• low sodium canned beans, peas and lentils, or rinse and drain them to reduce the amount of sodium</td>
</tr>
<tr>
<td><strong>Nuts and seeds</strong> (e.g. almonds, pumpkin seeds)</td>
<td>• dry roasted nuts and seeds without added sugars, fat (oils) and sodium (salt)&lt;br&gt;• peanut butter or other nut butters that list peanuts or nuts as the only ingredient with little to no added sodium, sugars, saturated fat</td>
</tr>
<tr>
<td><strong>Fish and shellfish</strong> (e.g. salmon)</td>
<td>• canned fish with little to no added sodium&lt;br&gt;• fresh or frozen fish and shellfish that has not been breaded, battered or deep-fried</td>
</tr>
<tr>
<td><strong>Lean meats</strong> (e.g. chicken, beef)</td>
<td>• skinless poultry and lean cuts of meat such as round and loin&lt;br&gt;• fresh or frozen meat and poultry without rich sauces&lt;br&gt;• meat prepared with little or no added sodium or saturated fat</td>
</tr>
<tr>
<td><strong>Milk and dairy products</strong> (e.g. plain yogurt)</td>
<td>• low fat cheeses&lt;br&gt;• unsweetened lower fat yogurt&lt;br&gt;• unsweetened lower fat milk</td>
</tr>
<tr>
<td><strong>Soy products and fortified soy beverages</strong> (e.g. tofu)</td>
<td>• low sodium soy products&lt;br&gt;• unsweetened fortified soy beverages</td>
</tr>
<tr>
<td><strong>Eggs</strong></td>
<td>• hardboiled or poached eggs&lt;br&gt;• eggs with little to no added sodium or saturated fat</td>
</tr>
</tbody>
</table>
V. Are protein recommendations different for physically active individuals?

Muscle growth occurs only when exercise and nutrition are combined. According to the American College of Sports Medicine, Academy of Nutrition and Dietetics, and Dietitians of Canada, the recommendation for physically active individuals is 1.2–2.0 g/kg of body weight per day with intakes toward the higher range depending on duration, type and intensity of the activity\(^2\). This will help to optimize recovery from training and to promote the growth and maintenance of lean mass when caloric intake is sufficient. While active individuals may require protein intakes higher than the RDA, most active Canadian children and youth have habitual protein intakes that exceed these recommendations\(^2\). Protein intake should be spaced throughout the day and after workouts. Most physically active individuals may obtain the recommended amount of protein through food alone, without the use of supplements. **Protein powders** and supplements may be convenient, particularly for athletes immediately following training, however, they are not necessary. Protein supplementation combined with **resistance training** may have stronger benefits in older adults in preventing age-related muscle mass attenuation and loss of leg strength compared with resistance training alone\(^2\). Therefore, nutrition supplements and exercise strategies such as the combination of protein supplementation and resistance training, may be used to improve both physical activity and the health of older individuals.

VI. What are the key protein allergens?

A food allergy is defined as an immune system-mediated adverse reaction to food proteins\(^3\). Allergy to many key proteins within foods is prevalent. It is estimated that 6% of young children and 3-4% of adults in Canada are affected by food allergies\(^3, 4\). Allergies may include skin, respiratory, gastrointestinal, cardiovascular and other symptoms such as headaches and anxiety. The most common food allergens\(^3\) are found in:

- peanuts, tree nuts (almonds, Brazil nuts, cashews, hazelnuts, macadamia nuts, pecans, pine nuts, pistachios, and walnuts) and sesame seeds
- milk
- eggs
- fish, crustaceans and molluscs
- soy, wheat and triticale
- sulphites
- mustard

There is also the potential for new protein sources (i.e. insect proteins, certain new pulse proteins such as pea protein isolate) to cause allergic reactions. At the moment there is no cure for food allergies; however, management of food allergies focuses on avoidance, recognition and treatment (i.e. epinephrine in the case of severe reactions), and nutritional support. Products with allergen-free claims or those listing key allergens (e.g. soy, milk, wheat and eggs) on labels are commonly found in grocery stores, and many schools have careful guidelines about what students can bring for snacks and lunches. More options in presenting proteins to consumers can play a role in providing alternatives to those that may be allergic.
VII. What are the impacts of protein foods on our planet?

When considering the effect of various protein foods on nutrient density and human health, it is also important to consider the **environmental impact** of these foods. Not all foods have an equal impact and production of greenhouse gas emissions associated with food production, processing, transport and retail, tend to be higher with animal-based foods (e.g. red meat) compared with plant-based foods (e.g. pulses)\textsuperscript{33}. It is also important to note, however, that agriculture is only one component of greenhouse gas emissions. There remains disagreement among experts on the extent of agriculture on the total environmental impact as the contribution of other sectors (e.g. cars, planes, industry) is also significant. Over the years, life cycle assessment has been progressively viewed as a concept for ensuring a transition to more sustainable production and consumption patterns by assessing agricultural systems, food processing, manufacturing and food waste management activities\textsuperscript{34}. While dietary guidelines currently do not include aspects of sustainability including greenhouse gas emissions, water and land usage\textsuperscript{34}, to help reduce the impact on the environment, consuming more plant-based foods may be one way to help protect the planet.

VIII. What are the key messages for consumers?

- Major sources of protein foods include both animal-based (e.g. meat, poultry, fish, eggs, dairy) and plant-based (e.g. pulses, soy foods, nuts and seeds) proteins
- When assessing protein foods, both the **quality** and **quantity** of the sources are important
- To obtain all indispensable amino acids from most plant-based protein foods, eat a variety of protein sources (e.g. pulses and cereals) during the day
- Protein needs depend on life stage, health status, body weight, goals, and physical activity
- Protein supplements may be convenient (e.g. for athletes), but are not necessary
- Choose and prepare foods that have little to no added sodium, added sugars or saturated fat and consume less processed foods
- In the case of allergies to various food proteins, pay attention to allergen-free claims and the listing of key allergens (e.g. soy, milk, wheat and eggs) on labels and refer to school guidelines for foods students can bring for snacks and lunches
- To help reduce the impact on the environment, consuming more plant-based foods such as whole grains, pulses, nuts, and seeds is recommended
# References


