

part 1

UNDERSTANDING VEGETARIANISM

01 DEFINITIONS

According to the International Vegetarian Union (IVU), vegetarianism is a diet derived from plants, including mushrooms, algae, and salt, and excluding any animal meat (e.g., beef, poultry, pork, fish, seafood), with or without the use of dairy products, eggs and/or honey.

The common feature of all types of vegetarian diets is the **absolute exclusion of any type of animal meat**. Additionally, based on the exclusion of other food groups or lifestyle-related elements, the diet is given different nomenclatures:

- **Ovo-lacto vegetarian**: a vegetarian who consumes eggs, milk, and dairy products.

- **Lactovegetarian**: a vegetarian who does not consume eggs but consumes milk and dairy products.

- **Ovovegetarian**: a vegetarian who does not consume dairy products but uses eggs.

- **Strict vegetarian**: a vegetarian who does not consume any animal-sourced products.

- **Vegan**: an individual who adopts a strict vegetarian diet but also excludes the use of any animal products for other purposes, such as clothing (wool, leather, and silk) or cosmetics tested or that contain ingredients of animal origen, and the use of animals for entertainment, sports, and research.

> The IVU recommends a diet without any animal product (strict vegetarian or vegan), as an excelent way to provide many benefits for animals, people, and the environment.

The term **"vegan diet"** is used in **scientific publications** as a **synonym for "strict vegetarian diet"**. Although the diet is strictly vegetarian and veganism also involves non-dietary aspects, this nomenclature is valid from a medical and nutritional point of view.

> Thus, in the description of articles cited in this Guide, we use the term "vegan diet", as typically used in the medical and nutritional literature.

With the **industrialization of food production**, highly processed foods with ingredients originating exclusively from the plant kingdom have become available. The foods are accepted and often frequently consumed by many strict vegetarians who do not have health concerns as their main reason for adopting vegetarianism. To aid in health assessments following adoption of a vegan diet, the term plant-based diet is thus used.

- **Plant-based diet**: The original term **whole food plant-based diet** was created in 1980 by Dr. Thomas Colin Campbell to differentiate between healthy and unhealthy (with refined cereals and processed foods) strict vegetarian diets. For some authors, the plant-based diet is a strict vegetarian diet that relies on natural and minimally processed foods, and based on fruits, vegetables, whole grains, pulses, seeds, herbs, and spices and excluding any type of animal product (meat, eggs and dairy products).

> **The IVU defines the term plant-based diet or whole food plant-based diet** as a diet based on whole or minimally processed foods, which may include small amounts of salt and added vegetable oil, and that excludes all animal-sourced products (such as meat, eggs, dairy products, and honey).

The term has been increasingly used in the literature, with a certain flexibility in scientific studies to also include small amounts of animal-derived products, for the purpose of comparing dietary patterns and interventions, since from a nutritional and health perspective, small inclusions of these products may not affect the final analytical outcomes.

Although the term plant-based diet was coined as a synonym of a healthy strict vegetarian diet, the **food industry** has incorporated this term and defined it as "foods made from plants that contain no animal-derived ingredients". Within this concept, there is room to produce food items lacking fiber and other salutary components that are intrinsic to plant-based food *in natura*, while adding other components such as hydrogenated fat, sugar and added oil, as well as food dyes and other food additives.

It is important to be aware that the positive health effects of adopting a plant-based diet are attributed to the scientific concept (of unprocessed food) and not to the way the industry does, because it drastically changes the original composition of the foods *in natura*.

Thus, it is important, when designing a scientific study or interpreting the existing ones, to check the concept used by the researcher so as to determine more accurately the effects of the intervention against what would be expected in a typical plant-based profile. It is possible that in a near future, the term **whole food plant-based diet** will have to be used to remove any ambiguities about this dietary pattern.

- **Semivegetarian, pescatarian, flexitarian, reducitarian, and pollotarian** refer to an individual who consumes mostly a vegetarian diet but may include meat in their meals up to three meals per week, according to most authors, though this frequency can vary based on each study's criteria. Although this individual **is not a vegetarian**, the nomenclature and group are used in research studies since individuals in this category enable investigating a dietary pattern (low meat consumption) that is intermediate between that of omnivores and vegetarians.

- **Macrobiotic** designates a type of diet that **may or may not be vegetarian**. Macrobiotic is a specific type of diet based on whole grains, with a unique and distinguished philosophical lifestyle. The macrobiotic diet, unlike vegetarian diets, has specific indications regarding the proportion of the food groups to be used. These proportions vary and may or may not include meat (usually white). Macrobiotics does not recommend the use of milk, dairy products, and eggs.

In addition to these classifications, there are individuals who follow a raw food diet (**raw foodists**), regardless of whether they are vegetarians. These individuals consume food that is not heated above 42°C, also known as a **live diet**.

Frugivores consume raw or cooked fruits and vegetables, in addition to pulses. In the context of fruits, the view is botanical, not nutritional. **Frugivores are vegans**.

The most common dietary pattern in the world today is **omnivore; theoretically**, these individuals **eat any type of food**, whether animal or plant.

The **nomenclature used** may give the false idea that it is possible to determine the nutritional status of the person who follows a specific diet. However, there are omnivores who do not eat vegetables and fruits, ovo-lacto-vegetarians who rarely eat dairy products and eggs and strict vegetarians who eat processed or whole foods, among many other possibilities.

Thus, from a populational standpoint, the **nomenclature** may help to screen possible deficiencies and excesses in groups with similar dietary profiles but can **never define an individual's nutritional status**. A strict vegetarian diet may be more varied than an omnivorous diet or vice versa.

02
REASONS LEADING TO VEGETARIANISM

There are several reasons that lead individuals to become vegetarians. Here, we list the most common ones.

Ethics

The perception that animals are sentient beings (capable of suffering or feeling pleasure and happiness) leads many individuals to not want to participate in any practice that causes animals pain or suffering, which may include their use as food, clothing, cosmetics, etc.

Health

Several studies associate positive health effects with greater consumption of foods of plant origin and restricted consumption of foods of animal origin. The adoption of a vegetarian diet for this reason also includes the feeling of well-being that some individuals report when not eating meat or animal-derived foods. In the section on health, we will briefly address the results of studies on this topic.

Environment, sustainability

Information on the subject is gaining increasing space in scientific publications. Due to the importance of the topic, we delve deeper into the subject at the end of this section (Threat to Planetary Health).

Family

The adoption of this type of diet by parents, spouses and family members influences some people to also adopt it.

Spiritual and religious

Religions such as Adventism, Spiritism, Hinduism, Jainism, Zoroastrianism and Buddhism often advocate the adoption of a vegetarian diet.

Yoga

Individuals who practice yoga often adopt a vegetarian diet based on energy-related, ethical or health principles. Yogi principles include Ahimsa or nonviolence, which also applies to animals.

Philosophy

For various philosophical reasons, some individuals choose not to eat meat and often animal byproducts (eggs, milk, and cheese).

Dislike of taste

It is not uncommon to refuse to eat meat due dislike of its taste.

03

THREAT TO PLANETARY HEALTH: IMPACT OF ANIMAL FOOD CONSUMPTION

In the current context of global health, where food demand is increasing, and resources are becoming scarcer we need to pay attention to the type of food we consume.

The topic “environmental nutrition” emerges as a new subject that combines our knowledge on nutrition with its impact on the planet. As consumers who care about environmental preservation, we can direct what we choose to buy in order to reduce the negative impact that it may cause to the environment.

The IVU encourages the practice of environmental nutrition as a form of integrated health.

Within this context, the EAT-Lancet Commission on Food, Planet, Health was created, bringing together 37 scientists to answer the following question: can we feed a future population of 10 billion people a healthy diet within planetary boundaries?

In the ETA-Lancet report, it was made explicit that a healthy diet for people and the planet must be based on the consumption of plant foods, minimizing the use of animal products. It was recommended that to achieve this goal by 2050, there must be a doubling of the consumption of plant foods and a greater than 50% reduction in the consumption of certain foods, such as red meat and added sugar. A diet that relies on plants with low animal food intake confers improved human health and environmental benefits.

The next four subsections provide data compiled by Dr. Cynthia Schunk, coordinator of the IVU Department of Global Health, for a comprehensive view on the subject.Dentro desse contexto, foi criada a comissão EAT-Lancet sobre Alimentos, Planeta e Saúde, que reuniu 37 cientistas para responder à pergunta: como alimentar uma futura população de 10 bilhões de pessoas com uma dieta saudável dentro dos limites do planeta.

3.1. Dietary choices and environmental sustainability

Food systems intricately link human health and environmental sustainability; however, they are currently threatening both. We are approximately 8 billion humans on this planet but raise and slaughter nearly 80 billion land animals – and an even greater number of aquatic animals – every year for use as food. Raising livestock is a highly inefficient means of producing food: farmed animals consume much more food than they produce. On average, approximately ten times more calories are used to feed farm animals than those available in their meat. Biologically, this energetic inefficiency is to be expected, since most of the calories, protein and other nutrients that an animal consumes are not converted into meat but are used instead to keep the animal alive (for locomotion, maintenance of body temperature, tissue repair, among multiple other metabolic functions). Energy is also lost in the form of waste.

Due to the low energy efficiency typical of meat, egg and dairy production, large areas of land (many of which high-grade arable land) are needed as pasture, or to produce animal feed. Currently, almost two thirds of all soybeans, maize, barley, and about a third of all grains are used as feed for animals. In general, the livestock industry uses over 80% of the arable land on the planet, even though animal- sourced foods provide only 18% of the calories consumed globally.

Naturally, livestock farming exerts an enormous pressure on every ecosystem on Earth, leading to habitat loss and waste of natural resources that could otherwise be used more efficiently. Not surprisingly, the consumption of meat (both land and aquatic animals) is considered one of the main drivers of the current sixth mass extinction on this planet.

The draining of rivers, lakes, and other freshwater bodies to irrigate land used to grow crops used as animal feed also has a major impact on **water resources**. Meat production in water-stressed areas is indeed a major competitor with other uses of water, including those needed for the proper maintenance of ecosystems.

Water and soil pollution are also major outputs of the livestock sector. Animals, obviously, generate waste. In intensive animal operations, the enormous volume of waste (manure) produced by thousands of animals is often untreated, as the costs of proper management are prohibitive to many farmers or can be often worked around with faulty legislation and deficient enforcement. Be it by direct discharge, infiltration or runoff, livestock waste contaminates the ground and surface water with pathogens, drug residues and excessive levels of organic matter. This can in turn favor the proliferation of algae and bacteria, which by consuming the oxygen available in the environment make it unsuitable for other organisms. Similarly, the major impact of livestock production on greenhouse gas emissions is well established.

3.2. Looking forward

Population growth and a rising demand for animal products will further intensify existing pressures on land, water, and other natural resources. It is estimated that if dietary patterns are left unchecked, over 1 billion hectares of arable land (the size of the entire European continent) would be needed, with simultaneous increases in deforestation and loss of natural capital. This scenario is unsustainable.

Fortunately, there is a great potential to mitigate the environmental challenges ahead of us through changes in consumption patterns, as the amount of land and natural resources required to sustain plant-based diets is substantially lower than that required to sustain existing (omnivorous) dietary patterns. Vegetarian diets have been shown to be much more sustainable per unit of weight, per unit of energy, or per protein weight than diets including animal-sourced foods across multiple environmental indicators.

The IVU recognizes the heavy environmental footprint of animal food production, and that a shift towards plant-based nutrition is one of the most promising means to promote a healthy, safe, and sustainable future for all.

3.3. Pandemics and infectious disease epidemics

Over the last century, pandemics and epidemics with pandemic potential predominantly had their origins in the contamination of humans with pathogens from butchered wild animals, or in wild pathogens cultured in animals living in intensive and modern animal farming systems. This was the case, for example, of the Ebola outbreaks, the 2002-2003 SARS epidemics, the swine flu (H1N1pdm) pandemic of 2009 and multiple avian flu outbreaks. In the latter cases, poultry and swine made the genetic bridge between the wild virus and the virus that spread in the human population.

Livestock species now constitute more biomass than all wild mammals combined, harboring a much larger number of zoonotic viruses than their wild relatives. Importantly, domesticated species such as chicken, pigs and cattle act as intermediate or amplifier hosts where pathogens can evolve and spill over into humans. Pigs, having receptors for avian, swine, and human influenza viruses, are regarded as ideal mixing vessels for the emergence of influenza viruses with pandemic potential, as was the case in the 2009/H1N1pdm pandemic. Similarly, intensive poultry farming has made highly pathogenic avian influenza pervasive, with most reassortments and conversion events from low pathogenic to highly pathogenic strains (that is, viral strains that have a higher lethality) reported in commercial poultry farms.

Indeed, many of the ideal conditions for the emergence of highly pathogenic viruses are present in modern animal farming systems. For example, the maintenance of large populations of animals at high stocking densities in closed environments promotes the development of high levels of pathogenicity in multiple ways. First, by facilitating the rapid animal-to-animal movement of multiple viral strains. Additionally, viruses are faced with hosts that are incredibly susceptible to infection, where pathogens can multiply rapidly to high levels. Moreover, immunosuppression induced by chronic stress, whereby individuals lose partially the immune response that protects them against infection, is well documented. Although modern facilities have biosecurity protocols in place, the large scale of the organic outputs of these systems, the dependence on multiple players in the production chain, the transport of live animals nationally and across borders, and the possibility of contamination of the final products makes those measures insufficient. Additionally, poor compliance with biosecurity has been shown to be endemic in the industry. The borderless nature of zoonotic diseases often means that a biosecurity risk in one place is a biosecurity risk everywhere.

3.4. Antimicrobial resistance

The emergence of antimicrobial-resistant bacteria is currently deemed as one of the biggest threats to global health. Pathogens that cause serious medical problems, or complications from these conditions

– such as tuberculosis, sexually transmitted diseases, urinary tract infections, pneumonia, and hospital infections – have now become resistant to a wide range of antibiotics. About 700 thousand deaths per year already occur due to antibiotic-resistant infections, with an estimated 10 million deaths per year due to antibiotic-resistant infections in 2050 (more than cancer or diabetes) considering the current levels of dependence on animal-sourced products.

Although part of the problem is the overuse of antibiotics by the human population, most antibiotics (over 70%) sold in the world are not used in humans, but in animals raised as a source of food, predominantly in intensive animal farming systems. In these systems, antimicrobials are widely administered to all animals (regardless of their health status) to promote their growth or prophylactically, to ensure the survival of farmed animals (often very susceptible to infectious diseases) until the end of the production cycle. Antimicrobial-resistant bacteria have been isolated in several food-producing animals and derived animal food products sold in supermarket chains in multiple countries.

The IVU recognizes that animal farming systems represent an unacceptable level of threat to public health, and advocates that a transition towards safer methods of food production is at the core of protecting the well-being of current and future generations.

04
VEGETARIANISM AROUND THE WORLD

A study published in 2010 estimated the number of existing vegetarians in the world to be 1.5 billion people, of who only 75 million are vegetarian by choice and 1.425 billion by necessity. In this estimate, those who do not eat meat because they do not have the financial means would probably do so if their situation changed.

Among countries, **India** has the highest prevalence of vegetarians, with **40% of its population** defined as such.

According to an American telephone survey conducted by Gallup, **5%** of 1,033 adults reported being **vegetarians,** and **3%** reported being **vegans**. Among individuals, vegetarianism was more commonly adopted by those under 50 years of age (7-8%) than by older people (2-3%).

It is estimated that the number of vegans in the United States has grown by 600%, from a population of approximately 4 million people in 2014 to approximately 19.6 million in 2017.

In **Switzerland**, at least **2.5%** of the population is vegetarian, among whom **10%** is **vegan**.

In **Brazil**, based on data from 2018 from Intelligence in Research and Consulting (IRC) previously known as IBOPE (Institute of Public Opinion and Statistics), which surveyed individuals over 16 years of age, **14%** reported being **vegetarian,** and **55%** of Brazilians would **consume more vegan products** if such information was indicated on packaging. In the study, 63% of the Brazilians said they would like to reduce their meat consumption. The vegetarian population, compared with that in the previous survey conducted in 2012**, increased by 75%** in metropolitan areas. In 2021, research done by IRC in Brazil pointed out that 46% of the population do not consume meat once a week by choice and 32% of the people interviewed choose a vegan choice when that option is promoted by the restaurant.

Plant-based products that replace animal-based products have grown steadily in recent years. These data represent not only the increase in the number of vegetarians but also in the number of people interested in **reducing the consumption of animal products** and **increasing that of vegetables**.

Plant-based products are currently the main sales drivers of the retail market, and their sales have **grown almost 2.5 times faster than total food sales**. Data published in April 2021 in the United States show that the sale of these substitute products grew 27% last year, from 5.5 billion dollars in 2019 to 7 billion dollars in 2020. In addition, sales, in dollars, of plant-based foods grew 43% in the past two years. Plant-based milk today accounts for 15.2% of all dollar sales for milk. Plant-based milk alone accounts for 35% of the plant-based foods sold in the retail market.



part 2

EFFECTS ON HEALTH

The vegetarian diet is not a single diet model followed by people in an identical way. More, or less, healthy choices can be made, and this directly impacts the results obtained, either in terms of nutrient intake or disease prevention and treatment.

However, the choice of plant-based foods in their natural and whole form and the abstention or reduction in the consumption of animal foods has important metabolic impacts to the body.

The focus of this guide is dietary planning, not examining the relationship between vegetarianism and disease prevention and treatment, as the latter is material for another work. Nevertheless, we briefly describe the main findings for different health conditions studied. In this part of the guide, we begin with a discussion of the potential effects of healthy eating and end by presenting important studies on the main chronic noncommunicable diseases.

01
POTENTIAL FOR DISEASE PREVENTION AND TREATMENT THROUGH A VEGETARIAN DIET

The use of whole, **plant-based foods**, as **advocated by the IVU** to obtain the greatest benefits from consuming a vegetarian diet, substantially increases the consumption of fiber and phytochemicals, positively modulates microbiota (population of gut bacteria), and reduces the consumption of all negative elements present in animal products, which we will address later. Next, we will provide a brief synopsis of the action of these compounds.

1.1. Fibers

Fibers are carbohydrate molecules that the body is unable to process. They are usually derived from plant-derived polysaccharides, with several positive health benefits. A well-planned vegetarian diet contains a considerable amount of fiber because it will be based on **natural and whole foods**.

Fiber consumption by Americans and Europeans is approximately one-third lower than the recommended level. It is also low worldwide, i.e., under 20 g per day, when the recommended intake is 25-29 g/day.

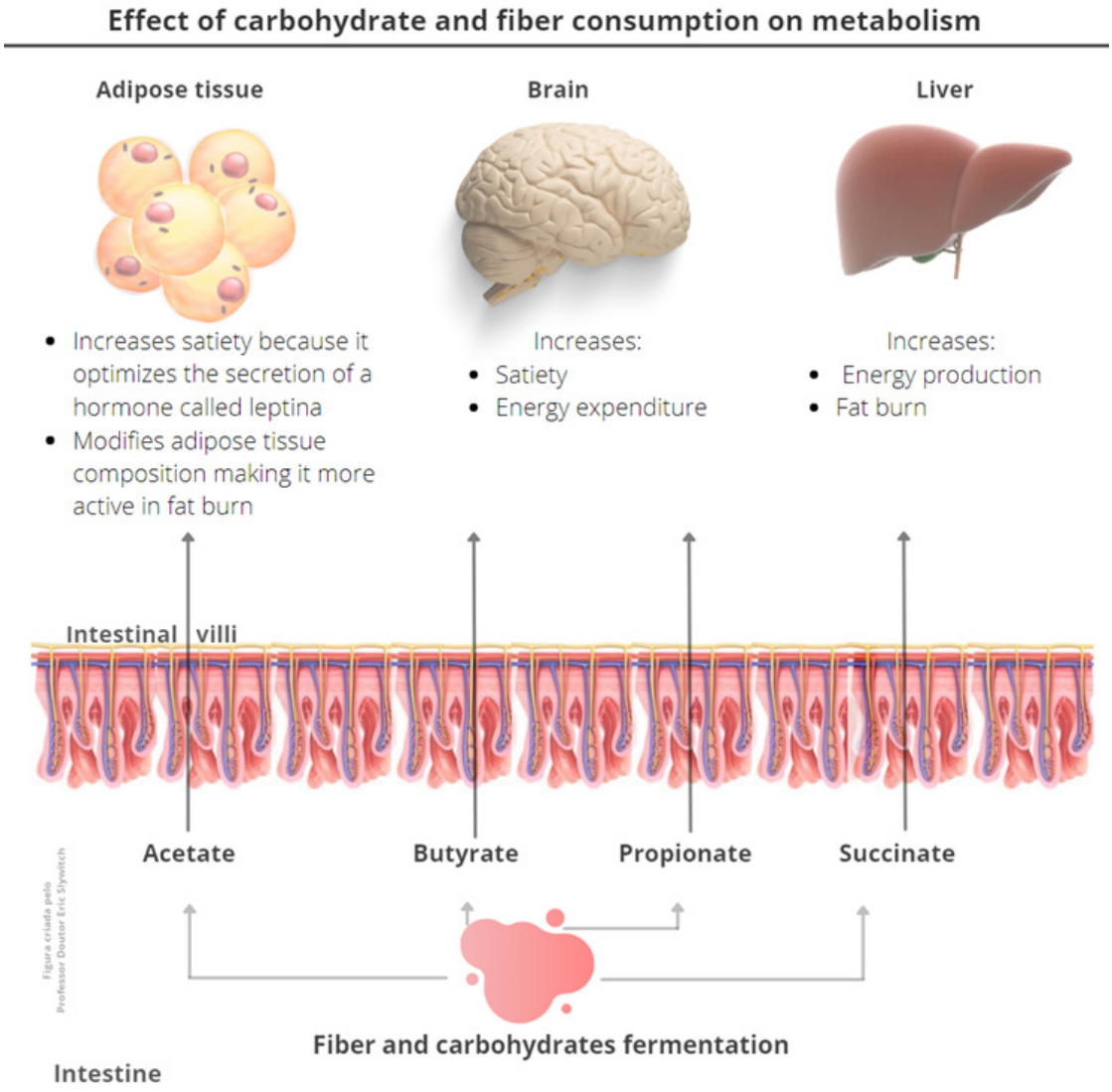
Fibers reduce gastric emptying of the stomach (which increases satiety); its viscosity slows down the traffic in the small intestine (which favors the slower absorption of nutrients, including glucose, and reduces the so-called glycemic index of the food) and leads to the

formation of a more voluminous and softer fecal bolus (which improves constipation). Its effect on blood glucose (“blood sugar”) control is remarkable.

Because it binds with various intestinal compounds, fiber (especially soluble ones, with a greater ability to dissolve in water) increase the excretion of cholesterol through the feces, even if you do not consume food rich in cholesterol (because our bile ducts release cholesterol daily in the intestine, and, once it is reabsorbed, it returns to the blood). Fibers provide the elements for bacterial fermentation, and this feeds the gut bacteria, which, in return, generate multiple benefical compounds for the body. These benefits include lowering the cholesterol level, increasing calcium absorption (in the large intestine), optimizing the immune response, nourishing the intestinal cells themselves, providing extra protection for the intestines to block bacteria from crossing into the blood, and by reducing the pH inside the large intestine they hinder the proliferation of bacteria that may cause diseases.

For every **10g of fiber increase** (of any type), the **risk of cardiovascular disease is reduced by 9%**, of **coronary disease by 11%** and all **cancers by 6%.** The effect of fiber in the prevention of colon and rectal cancer is fully proven.

Fiber fermentation by gut bacteria produces substances (acetate, butyrate, propionate, and succinate) that have many positive metabolic effects. See the figure below:



1.2. Gut microbiota

The **microbiota** has been the subject of many studies, from which there are important results that pertain to the vegetarian diet. A brief summary of these aspects is provided in the box below.

Brief summary of the microbiota.

Gut bacteria can produce several products that can either be beneficial or harmful to our body.

Beneficial bacteria usually feed on carbohydrates and fiber, as these are the foods, they are able to utilize as nutrients. So, when food contains carbohydrates and fiber, these bacteria increase their population and produce various substances that help to positively regulate many body functions.

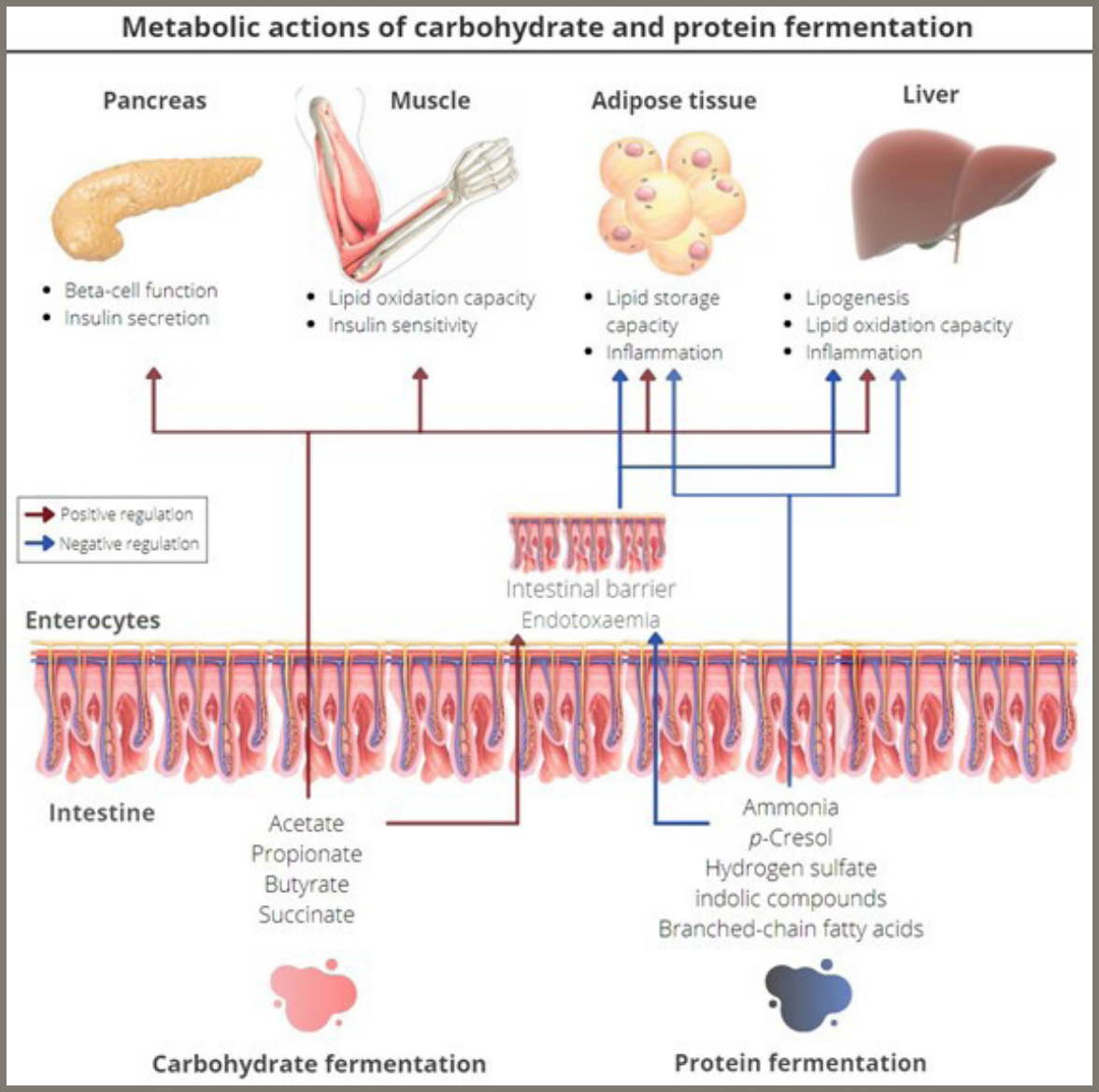
On the other hand, the greater consumption of proteins and fats (especially saturated fats found in coconut and palm oil, butter, curd, meat, eggs, and dairy products), starve the good bacteria, as they cannot feed on these elements. At the same time, the population of well-fed bad bacteria increases, and, with it, the production of harmful substances also increases.

The balance between bacteria, with the intention of having a great amount and a good diversity of good bacteria, has the ability to reduce the level of inflammation in the body, improves the action of insulin produced in the pancreas and optimizes the body's ability to burn fat, modulate the formation of neutrotransmitters, reduce the level of cholesterol, among many other functions already discovered. Protein fermentation produces substances that are harmful to our body, such as ammonia, p-Cresol, hydrogen sulfate, indole compounds and branched-chain fatty acids.

Note in the figure how different substances affect positively (red lines), helping the body to function well, or negatively (blue lines), impairing the functioning of various body functions.

Thus, when food contains carbohydrates and fiber, these bacteria increase their population and produce various elements that help to positively balance our bodily functioning.

Figure 2.1. Metabolic actions of carbohydrate and protein fermentation



The use of plant-based foods with little or no cooking provides more substrate for gut bacteria to use.

An ultra-processed diet, devoid of fiber, provides full absorption of nutrients in the small intestine, leaving nothing for intestinal bacteria to feed on.

This can lead to dysbiosis, which is the reduction of intestinal bacteria and their variety, which causes various health problems for the host.

The studies are very clear in showing that the adoption of a plant-based diet has a positive effect on the microbiota by optimizing the greater diversity of strains (different types of bacteria), reducing the amount of most harmful bacteria, decreasing the level of inflammation, and producing more compounds that are beneficial to health.

From a cardiovascular point of view, in addition to the previously mentioned inflammatory effects, there are two other important points to be considered: its effect on cholesterol and on the formation on TMAO (which will be discussed later, in another topic).

Several strains of bacteria isolated from the intestine or feces can convert cholesterol that has reached the intestine into coprostanol, which is poorly absorbed by the intestine and is eliminated in the feces. This helps to reduce the level of cholesterol in the body.

1.3. Antioxidants, phytochemicals and phytosterols

Oxidants are a type of compound that may cause harm to our bodies. To protect ourselves, we count on the antioxidants that our bodies produce plus the ones that we obtain through the food we consume. The accumulated aggression of oxidants leads to the emergence of all known chronic diseases, such as diabetes, cardiovascular disease, various types of cancer, in addition to aging and cellular dysfunction.

Regarding the protective compounds present in a plant-based diet, a study analyzed the total antioxidants in more than 3,100 foods, beverages, spices, herbs, and supplements used worldwide and found that there **is 64.27 times more antioxidants in foods originating from the plant kingdom than in foods originating from the animal kingdom**. This is highly significant!

A diet with one portion of meat and three portions of dairy products provides approximately 500-kcal from foods with low antioxidant content (0.18 mmol/100 g). In a 1,500-kcal diet for women, this is equivalent to 33.3% of the diet consisting of foods with low antioxidant content. Replacing these animal products with vegetables substantially increases the intake of antioxidants and provides many positive health effects, as this is a protective factor against the development of all chronic non-communicable diseases.

Several studies also show that vegetarians have higher blood levels of antioxidants than non-vegetarians.

In addition, plants produce several compounds with remarkable positive actions on the human body: such as the phytochemicals. These are chemical substances produced by plants that help us with various body reactions, such as vasodilation, liver cleansing (detoxification) and antiviral defense.

When plants are threatened by insects or predators, the production of phytochemicals that protect the plant increases. Organic cultivation promotes plants with a higher content of polyphenols, silicic acid, and vitamin C, for example. Phytosterols are plant-derived lipid elements found in unrefined vegetable oils, such as oilseed (sesame, sunflower, soybean, macadamia, almond) and olive oils. Its consumption brings several health benefits by modulating the inflammatory and antioxidant response and presenting an antiulcer, immunomodulatory, antibacterial, and antifungal effect. Its cardiovascular effect is recognized; these substances can reduce the level of total cholesterol and LDLc (the "bad" fraction of cholesterol).

1.4. Exclusion of animal products

The exclusion of meat and animal derivatives brings, by itself, a significant reduction in the consumption of various compounds harmful to health such as **saturated fat**, **heme iron**, **advanced glycation and lipoxidation end-products**, carnitine, phosphatidylcholine and choline (precursors for the formation of trimethylamine N-oxide or **TMAO**), in addition to **chemical compounds with carcinogenic action used in the preservation of these products,** such as nitrites, which react with amines and amides in the gut and become N-nitrous compounds, nitrosamines and nitrosamides. We will explain it all in this guide.

In addition, the exposure of meat to **high temperatures** leads to the formation of substances known to be carcinogenic (that cause cancer) such as heterocyclic amines and polycyclic aromatic hydrocarbons. The presence of N-glycolylneuramic acid in meat (especially red meat) increases the body's inflammatory response (a condition that favors the emergence of chronic non-communicable diseases such as diabetes, cardiovascular disease, and various types of cancer).

In addition, animal products are devoid of fiber and phytochemicals, while also having a macronutrient composition based on fats and proteins, with none or low carbohydrate content. Let's understand more about the effect of these substances on the human body.

1.5. Saturated fat

Saturated fats are abundant in all products of animal origin (butter, cream cheese, meats, eggs, and cheeses). In vegetable sources, they are found in greater concentration in coconut oil, palm oil, and red palm oil.

Increased consumption of saturated fat increases the production of a substance called TNF-α (tumor necrosis factor alpha), which has an inflammatory effect on the body. It also raises levels of "bad" cholesterol (LDL) and can negatively affect glycemic control (blood sugar levels).

Their effect on gut bacteria is also detrimental.

This effect is more pronounced when intake exceeds 10% of the kilocalories ingested.

1.6. Advanced glycation and lipoxidation end-products

Advanced glycation end products (AGEs) are substances formed by the combination of proteins or lipids with sugars, usually subjected to high temperatures resulting in the formation of very harmful compounds. The formation of AGEs also occurs within the body when there is hyperglycemia (increased blood glucose), as is the case in people with diabetes, because there is more glucose to chemically react with the circulating products.

The formation of AGEs is directly linked to the mechanisms that lead to the development of various diseases such as diabetes and its complications (retinopathy, neuropathy), neurological disorders (Parkinson's and Alzheimer's disease), atherosclerosis, hypertension, kidney disease, rheumatoid arthritis, bone remodeling disorders, tumor growth, metastases, and other degenerative diseases.

Glycation can also occur in **products that are cooked, i.e., fried, roasted, or microwaved**, and especially during **caramelization**. These processes provide enhanced flavor and aroma to preparations. Advanced lipoxidatin end products (ALEs) are produced

in large quantities in animal foods due to their high protein and fat content. The higher the intake of these products, the greater their absorption. Their effects are as harmful as those of AGEs.

The consumption of foods not subjected to high temperature processes is important to avoid the ingestion of AGEs and ALEs.

1.7. Trimethylamine N-oxide (TMAO)

Another current highlight is the growing number of studies on **the formation of TMAO** by gut bacteria (microbiota) from an omnivorous diet.

Figure 2.4 – Trimethylamine N-oxide (TMAO) formation and its consequences

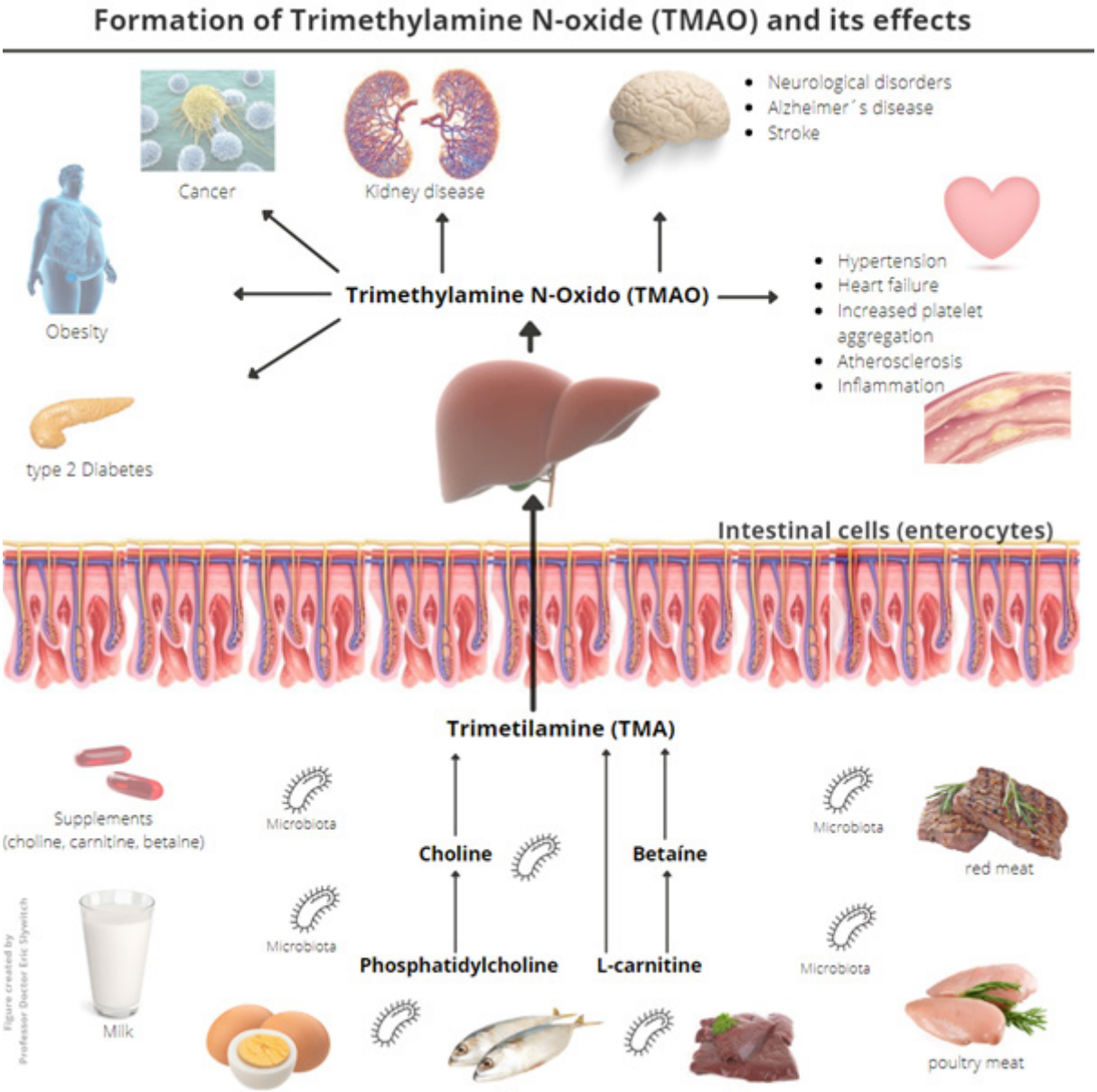


Figure created by Professor Doctor Eric Slywitch

The formation of TMAO depends on a sequence of events:

1. Substrate ingestion for its formation

The substances required for TMAO production are primarily present in animal products and include carnitine, phosphatidylcholine and choline, betaine, dimethylglycine, and ergothioneine.

The major sources of **phosphatidylcholine** and consequently TMAO are **eggs, liver, milk, meat (red and poultry), and fish.**

Red meat is rich in **carnitine** (one of the main TMAO precursors), whereas **beef** and other meats (e.g., **poultry**), **liver, fish, and egg yolk** are rich in **choline.** Choline is also present in **supplements** and **medications**. In the plant kingdom, choline is less concentrated.

Betaine is more present in **plants.**

2. Metabolization by gut bacteria

Gut bacteria, through enzymes, can convert these ingested substances into TMA (trimethylamine). However, this metabolization will depend on the type of bacteria we have in our gut, which changes considerably according to what we eat. A strict vegetarian diet, consisting of foods rich in fiber, favors the proliferation of bacteria that are unable, or have a reduced capacity, to produce TMA.

Because of this, **vegetarians have a reduced ability to produce TMA.**

3. Absorption and production of TMAO in the liver

Após absorvido, o TMA é transformado, pelo fígado, em TMAO.
Como vegetarianos produzem menos TMA, eles têm menos TMAO.

4. Effects of TMAO on the body

TMAO exerts deleterious effects on human metabolism and is associated with increased **cardiovascular risk**, **heart failure, stroke**, **neurological disorders, intestinal inflammation, chronic kidney disease, and mortality from all causes.** Elevated TMAO levels are also associated with **Alzheimer's disease**, **obesity,** and increased mortality from **type 2 diabetes.**

This substance, TMAO, is soon to be listed in medical guidelines as posing a risk for the development of cardiovascular disease, in the same way as LDL cholesterol.

1.8. Action of heat on meat

Heating red meat (mammalian meat) leads to the production of mutagenic substances (carcinogens) that contribute to an increased risk of colon and rectal cancer. In some forms of meat preparation, the concentration of carcinogenic substances can increase more than 100-fold. Table 2.1 explains each preparation.

Table 2.1 - Explains each preparation

Substance	Where it is found	Comments
N-nitrous compounds (NOCs)	Cured meats*	Classified as group 1 mutagenic (carcinogenic, beyond scientific doubt). Their level in feces is 10 times higher in omnivores than in vegetarians.
Heterocyclic aromatic amines (HCAs)	Well-done meats, including chicken	Found in large quantities mostly in meat cooked at high temperature.
Polycyclic aromatic hydrocarbons (PAHs)	Smoked meats and meats cooked over an open flame	Classified as group 1 mutagenic (carcinogenic, beyond scientific doubt). When they drip, the fat and juice of the meat grilled directly on an open fire creates a flame. This flame contains PAHs, which adhere to the surface of the meat. In the liver, PAHs form carcinogenic compounds. PAHs are also present in tobacco and appear to contribute to lung cancer. They are also found in vehicle exhaust fumes.
Heme iron	Animal meats, especially red meat	Accelerates the formation of free radicals (compounds aggressive to human health) in the gastrointestinal tract.

* A meat preservation process achieved by adding salt, color fixing compounds (nitrates and/or nitrites), sugar and/or spices

The formation of HCAs and PAHs varies based on the type of meat, the cooking method, and the cooking level (rare to well-done). Regardless of the type of meat cooked, the formation of HCAs and PAHs is enhanced when the temperature is higher than 149 °C (300 °F), and this occurs when grilling, pan frying, or when cooking directly on an open flame. Meats cooked for longer periods tend to form more HCAs. As an example, well-done, grilled, or barbecued chicken and steak have high concentrations of HCAs. Cooking methods that expose meat to smoke or carbonization contribute to the formation of PAHs.

The role of these meats in cancer has been widely studied; we will discuss it later in the section on cancer.

1.9. N-glycolylneuraminic acid (Neu5Gc)

In addition to the aforementioned compounds, **N-glycolylneuraminic acid (Neu5Gc)**, which is abundant in red meat, is also noteworthy. Neu5Gc is not biosynthesized by humans but is bioavailable in ingested meat and incorporated into human tissues, promoting the formation of anti-Neu5Gc antibodies, which cause chronic **inflammation** leading to the formation of free radicals (aggressive compounds that attack and cause damage to cells). This mechanism contributes to **carcinogenesis** and **tumor progression.**

1.10. Heme Iron

Heme iron has several negative effects on metabolism, and we will present systematic reviews and meta-analyses of this compound in the chapter on iron.

02
PESTICIDES

The use of **pesticides in agriculture** began in the **1920s** and, at that historical moment, little was known about their possible health effects. During World War II (1939–1945), pesticides were used as **chemical weapons,** and subsequently, their production was increased.

In Brazil, in 1975, the National Development Plan (Plano Nacional de Desenvolvimento-PND), responsible for opening the country to pesticide trade, instituted the inclusion of a defined pesticide quota for each loan needed and required farmers to purchase pesticides with farm credit resources. This requirement, added to manufacturers' advertising, led to the increased and widespread use of pesticides in Brazil.

In the context of human health, exposure to pesticides, at any level, is harmful and is **associated with various diseases**, such as **hypersensitivity, cancer**, **asthma,** and **hormonal disorders**. It can also cause **congenital defects** and **low birth weight** and lead to **death**. Organochlorine pesticides also appear to be associated with **Parkinson's disease**.

In the food production process, plants use soil (including its nutrients, water, and microorganisms) and solar energy for development. Animals obtain their nutrients and energy from plants, other animals, or both. With population growth, **polyculture was replaced by monoculture,** and **synthetic chemical fertilizers and pesticides** were introduced; the use of **antibiotics**, **vitamins** and **minerals** became the **basis of global livestock farming**. **Confined animal farming requires large-scale planting**, usually in **monoculture**, for animal feeding. In the United States, the production of 1 kg of meat requires 10 kg of grains for animal feeding, more than 8,000 liters of water, approximately 8,000 kilojoules (1,910.7 kcal), 150 g of fertilizers, **7 g of pesticides** and 21 square meters of land. As animals spend much of their energy for their own use, livestock is considered an inefficient form of resource use, with approximately **89%** biomass loss over the life of the animal, as explained in the "Threat to planetary health" chapter. The resources needed for the production of 1 kg of kidney bean protein and 1 kg of beef protein is shown in Table 2.2.

Table 2.2 - Resource requirements to produce 1 kg of protein from kidney beans or beef

The production of 1 kg of beef protein compared to that of 1 kg of kidney bean requires:
18x larger planting area
10× more water
12× more fertilizer
9× more fuel
10× more pesticide

Pesticides are used in the **production of plant and animal foods**. For plants, they are used to combat and prevent the multiplication of insects, a condition favored by large-scale monoculture. For **animals**, pesticides are used in the **prevention and treatment of parasitic diseases.** In addition, most **agricultural production is used as animal feed**, and the pesticides present in plants are consumed by animals. Because they are primary or secondary consumers and due to their high body fat content, animals accumulate residues from some pesticides throughout their lifetime. As the top of this food chain, when humans consume animal fat, they ingest these xenobiotics in a concentrated form.

The use of pesticides was estimated at 3.5 million tons worldwide in 2020.

The countries that used pesticides the most and their estimated consumption per kilogram per inhabitant in the period from 2010 to 2014 are shown in Table 2.3.

Table 2.3 - Pesticide use by country

Country	Pesticide use in kg/inhabitant
Japan	18.98
China	10.45
Mexico	7.87
Brazil	6.17
Germany	5.12
France	4.86
United Kingdom	4.03
United States	3.89
India	0.26

These agents can remain active in the environment for long periods and affect the entire ecosystem, represent a major risk to public health and require monitoring and surveillance of water, soil, food and air.

Pesticides are classified as insecticides, herbicides, and fungicides (Figure 2.5).

The compounds widely used in crop and livestock farming belong to four distinct groups: organophosphates, organochlorines, carbamates and pyrethroids. Their intake by humans occurs through the **consumption of animal and plant foods**.

Organochlorines are widely used in **crops and cattle** to **treat ectoparasites**. These compounds are extremely **fat-soluble** (which enables them to be deposited in the adipose tissue of animals) and exhibit slow degradation and accumulation capacities in the environment (they can remain **in the soil for more than 30 years**) and in living beings. Human contamination occurs directly (by respiratory, cutaneous, or digestive pathways) or through the food chain. However, the **main route of contamination** is the **consumption of foods that contain high amounts of fat**. The use of organochlorines in countries such as Brazil is restricted to combating ants (Aldrin) and to public health campaigns (DDT and BHC).

A **review study** evaluated **pesticide residues in cow milk** from 1970 to 2002. According to the authors, the presence of such residues may occur through the consumption of contaminated pastures and feed or by ectoparasite treatment with pesticides, applied in noncompliance with good agricultural practices. The study showed that although their use is prohibited in several countries, **organochlorines** are still **detected in milk**, albeit in progressively smaller amounts across the years. In almost all the countries studied, **contamination reached 100% of the samples** at various times.

Table 2.4 shows the results of studies conducted in several countries that monitored pesticide residues in animal product samples (adapted from reference).

Table 2.4 - Pesticide residues animal product samples

Product of animal origin	Pesticide found	Samples with detected residues
Raw milk	Carbamates Organophosphates	93,8%
Cheese	Organochlorines	100%
Pasteurized milk	Organochlorines	95%
Milk, cheese, butter and yogurt	Organochlorines	20.6%
Meat products under federal inspection	Organochlorines	96.9% in the raw material 97.7% in the processed product
Hot dog sausage	Organochlorines Polychlorinated biphenyls	Samples with a level below that established by the law
Eggs Chicken Beef	Organochlorines	28% 20% 49%
Fish Mollusks Crustaceans	Organochlorines Polychlorinated biphenyls	100%

In Brazil, several studies have identified many contaminated watersheds. More than ten years after the use of DDT was banned, contamination was still found in all broiler breeders in a region of Rio de Janeiro, along with the contamination of eggs destined for human consumption.

A study conducted between 1993 and 1995 in Hong Kong to evaluate the level of organochlorines in cow milk samples detected DDE and BHC at amounts that exceeded the maximum allowed by regulatory bodies, even though China banned the use of these compounds in 1983, i.e., 10 years before the study.

An earlier study (published in 1983) evaluated **breast milk** samples from women who consumed a lactovegetarian diet (18 samples), an omnivorous mixed diet (20 samples) and a diet containing Baltic fatty fish (11 samples). The **lowest levels** of the various evaluated pesticides were found in the **lactovegetarian group,** whereas the highest were found in women who ate fatty fish.

In 1998, a study conducted in India (Punjab) evaluated **food samples collected in markets** every three months for a period of one year. The results showed contamination by

DDT and BHC higher than that reported in industrialized countries. **Fatty foods** (milk and its derivatives, oils and fats, meats, eggs and cheeses) were **responsible for 85% of the total DDT ingested**, while **BHC was found to be more distributed** among the various analyzed foods.

The highest human contamination by organochlorines comes from the consumption of meat and animal-derived products.

Another study evaluated the pesticide residues ingested by the general population of France in groups of omnivores, lactovegetarians, ovo-lacto vegetarians, pesco-lacto vegetarians and vegans. The maximum daily theoretical intake, based on the maximum residual level, was calculated as a percentage of the acceptable daily intake. Among the 421 pesticides studied, 48 were at a level above the acceptable level for at least one of the groups. **Meat and eggs** were the foods most responsible for the high ingestion of **organochlorines**, which, for Aldrin, reached 348% of the acceptable daily intake in the general population compared to 146% to 183% in the vegetarian group. The **vegetarian diet** left its practitioners more exposed to **other pesticides**.

A 2016 study from Israel evaluated the **intake of pesticides** (organophosphates and carbamates) in **vegetarian** and vegan diets in which foods produced in an **organic or conventional system** were consumed. The data were compared with the results of the Israel Biomonitoring Study (IBS). The evaluation was performed by identifying the **urinary concentration** of pesticide residues in 42 participants from a vegetarian community (Amirim), and 24-h recall dietary data were requested from the participants. **Vegetarians exhibited higher urinary levels** of pesticide residues than the previously evaluated population. **Vegetarians whose diet consisted of more than 25% of organic products had significantly fewer pesticides measured in the urine**. The authors concluded that the **consumption of organic foods** may offer some **protection** against increased exposure to **organophosphate pesticides in vegetarians**.

A study published in 2021 evaluated exposure to **25 pesticide residues** in different diets, including omnivorous (n = 33,018), pesco-vegetarian (n = 555), ovo-lacto vegetarian (n = 501) and vegan (n = 368), that included **organic or conventional** plant-based foods. The evaluation was performed using the foods consumed. Two scenarios were evaluated: 100% conventional foods or 100% organic foods. The highest exposure found was to imazalil, a fungicide. In general, **vegetarians were the least exposed to the pesticides** studied. The consumption of products from conventional agriculture led to greater exposure to pesticides. The authors concluded that despite the high consumption of vegetables, vegetarians were less exposed to synthetic pesticides than were omnivores due to the greater propensity to **consume organic products.**

The IVU recommends the consumption of foods from organic production. In the absence of access to organic products, fruits, vegetables, and other plant foods should not be excluded from the diet because studies are consistent in showing positive effects on human health, even when these products are not derived from organic production.

03
CHRONIC NONCOMMUNICABLE DISEASES

Because this guide is focused on nutrition, we do not intend to delve into each disease in detail, but we want to provide an overview of the research on the subject.

The main examples of chronic non-communicable diseases are cardiovascular diseases, diabetes and the various types of cancer. These are called non-communicable diseases because they cannot spread from one person to another, as is the case with viral and bacterial agents. It is worth remembering that in some types of cancer, such as cervical cancer, a viral factor (in this case, HPV – human papilloma virus) can act as a triggering factor, and thus they are outside the scope of non-communicable diseases.

Study results depend on the type or design of the study performed. Each study type provides specific answers to specific questions.

Note that it is not enough for a diet to be considered "vegetarian" for us to know its health outcomes, because the term "vegetarian" only tells us that individuals do not eat meat. It does makes a difference to know what individuals eat, whether the diet consists of fresh or highly processed foods, whether fiber consumption is adequate, whether or not saturated or hydrogenated fat is added to the diet, in addition to lifestyle habits other than eating. There are many studies evaluating these variables.

We will divide this chapter into systematic reviews/meta-analyses and controlled studies.

3.1. SYSTEMATIC REVIEWS AND META-ANALYSES

Systematic reviews and meta-analyses are considered studies with the highest level of evidence from a scientific point of view; for this reason, we created this section in this chapter. In this type of review, all studies on the subject are compiled using the researchers' filter criteria to assess the results of the total body of studies. However, it should be mentioned that if the studies of origin have any flaws, the final conclusions are affected. In the context of a vegetarian diet, many problems may occur because the criteria used by different authors may vary, e.g., individuals who eat meat or use processed and refined foods being classified by some authors as consuming a plat-based diet.

In summary, these studies show that:

– There was a reduction in overall mortality among vegetarian populations, and Adventists showed the greatest reduction. In this group, there was a 32% reduction in overall mortality, 40% reduction in ischemic heart disease (partial or complete blockage of the arteries supplying the heart muscle with blood), and 29% reduction in cerebrovascular disease.

– Cholesterol levels are significantly reduced. The adoption of a vegetarian diet is considered an effective non-pharmacological option in the management of dyslipidemia (an imbalance in the amount of lipids in the blood, in this case due to an elevated cholesterol level). The combination of the studies shows that a vegetarian diet may lead to a reduction in LDL levels greater than 35%, i.e., it is as effective as drug treatment.

- A plant-based diet showed a greater effect on the level of inflammation associated with obesity. Inflammation is a response of the body to injury, and several things can injure us such as sleep deprivation, poorly planned physical activity, and excess body fat, which lead to the production of substances that are very harmful to our body.

– In non-obese individuals, a vegetarian diet led to a reduction in inflammation as measured by various inflammatory markers.

– The adoption of a vegetarian diet is associated with a 25% reduction in cardiovascular diseases and 15% reduction in total cancer. All studies show a reduction in cardiovascular mortality, but they were not unanimous about the reduction of cancer.

– In individuals with high blood pressure, the adoption of a vegan diet without caloric restriction resulted in a significant decrease in blood pressure.

– A comprehensive review of the available systematic reviews and meta-analyses concluded that vegetarian diets were associated with an 11% reduction in negative health outcomes; among Adventists, there was a 28% reduction. The review authors concluded that a vegetarian diet is associated with a positive effect on the lipid profile and a reduction in the risk of negative health outcomes such as diabetes, cardiovascular disease, and cancer risk, and that vitamin B_{12} supplementation should be investigated.

It is worth mentioning that the most evident effect observed in Adventist populations probably reflects the adoption of a healthier vegetarian diet, which is what we advocate in this Guide.

3.2 CONTROLLED STUDIES

In terms of comparing the effects of vegetarian diets with omnivore diets, the most reliable comparison is made using a **well-planned vegetarian diet** and a **well-planned omnivore diet.** There are studies in the literature with this approach investigating individuals with diabetes, cardiovascular disease, and cancer. In all studies, a vegan diet (consisting of whole foods) yielded the best outcomes. There are also some interesting studies on obesity.

3.2.1 Diabetes

In patients with diabetes, glycemic control, as well as lipid profile control, weight reduction, reduction in the dose of drugs used, and the level of body inflammatory markers measured was much better in individuals who followed a vegan diet than an omnivorous diet, even though carbohydrate intake was higher in the vegan diet. Importantly, one study followed-up the same individuals for 74 weeks and found that the results were maintained over that time. The effect of a plant-based diet on glycemic control is comparable to that of drug treatment.

Due to the quality of evidence in diabetes research, **the Consensus Statement by the American Association of Clinical Endocrinologists and American College of Endocrinology** on the type 2 diabetes management algorithm, published in January 2020, recommends that nutrition for these patients should allow maintenance of optimal weight, caloric reduction (if overweight), and a **plant-based diet** with a predominance of vegetable unsaturated fatty acids.

3.2.2 Cardiovascular diseases

Estudo de revisão sobre cholesterol

In the context of cardiovascular diseases, the results are even more striking. Studies repeatedly show a reduction in cholesterol levels in vegetarians and even more so in vegans. A review of 27 controlled trials showed a reduction in LDL ("bad" cholesterol) levels greater than 35%, which is comparable to the reduction induced by drugs (statins) used to lower cholesterol.

Estudo sobre redução de placas de ateroma

In the field of cardiovascular disease, a study by Dean Ornish was a major milestone in understanding the potential benefits of plant-based nutrition for patients with coronary disease. He recruited omnivorous individuals with moderate-to-severe coronary heart disease, randomly assigned them to one of two groups, and followed them for one year. Thus, 28 individuals were allocated to consume a plant-based diet associated with lifestyle interventions, whereas 20 control individuals followed an omnivorous diet and the usual care recommendations by the American Heart Association for heart disease patients. The study was published in 1990 and in 1998 another study was published showing the effects of the intervention at five years of follow-up. In the plant-based diet group, there was a 7.9% regression in the narrowing of blood vessels (7.9% less obstruction), whereas coronary atherosclerosis progressed in the omnivorous diet group (27.7% progression).

Given the wealth of studies and positive results, the diets recommended by the **American College of Cardiology** and **American Heart Association** are the DASH (Dietary Approaches to Stop Hypertension) diet, Mediterranean diet, and **plant-based** diet. The common element of all these diets is more abundant consumption of whole plant foods and a reduction in dietary fat.

3.2.3 Cancer

The evaluation of the effect of diet on cancer is complex because different cancer types have different promoting factors and evolutionary patterns.

From the prevention standpoint, based on scientific evidence for each cancer type, it is important to apply precautionary principles. These include the behaviors described in Table 2.6 (taken from).

Table 2.6 — Precautionary principles in cancer prevention

Limit or avoid dairy products to reduce the risk of prostate cancer.
Limit or avoid alcohol to reduce the risk of cancers of the mouth, pharynx, larynx, esophagus, colon, rectum, and breast.
Avoid red and processed meats to reduce the risk of cancers of the colon and rectum.
Avoid grilled, fried and broiled meats to reduce the risk of cancers of the colon, rectum, breast, prostate, kidneys, and pancreas.
Consume soy products during adolescence to reduce the risk of breast cancer in adulthood and reduce the risk of recurrence and mortality for women previously treated for breast cancer.
Consume fruits and vegetables to reduce the risk of several common forms of cancer.

The consumption of plant-based foods has a protective effect in cancer prevention, and for plant-based foods to represent a higher proportion in meals, there must be a simultaneous reduction in animal product consumption.

On October 26, 2015, the International Agency for Research on Cancer, a sector of the World Health Organization, had 22 experts evaluate more than 800 studies that investigated the carcinogenic effect of processed and unprocessed meat consumption. **Processed meat** (meat subjected to salting, curing, fermentation, smoking and other processes to enhance flavor or improve preservation) was classified as Group 1, i.e., there is sufficient evidence to classify it as **carcinogenic to humans**. For every 50 g of processed meat consumed daily, the risk of colorectal cancer increases by 18%. **Unprocessed red meat** (defined as unprocessed mammalian meat, including beef, veal, pork, lamb, mutton, horse and goat) was classified as Group 2A (**probably carcinogenic** to humans).

To illustrate the research on this subject in controlled trials, which is the focus of this part of the chapter, we will focus on prostate and breast cancer, the most common cancers in men and women, respectively. We begin with a brief review of these studies, followed by studies that applied a plant-based diet.

Several studies and meta-analyses have investigated the relationship between the consumption of **milk and dairy products** and **prostate cancer**, an increased risk of **mortality from prostate cancer**, and the **progression of prostate cancer**.

One study recruited 93 volunteers with **prostate cancer** who refused to undergo conventional treatment, which made it possible to randomize the groups without the bias of surgical interventions, hormone deprivation therapy, or radiotherapy. Half of participants adopted a plant-based diet, in addition to lifestyle changes, similarly to the study that showed a reduction in cardiovascular disease, because the two studies are by the same author. The omnivorous diet group followed the recommendations by the health professionals who treated them. In the plant-based diet group, none of the patients underwent treatment, because **there was no increase in PSA (diagnostic marker for prostate cancer) or disease progression** based on magnetic resonance imaging (MRI), but treatment was necessary for six patients in the omnivorous diet group. Significantly, **the PSA level decreased by 4%** in the plant-based diet group and **increased by 6% in the omnivorous diet group**. The

growth of prostate cancer cells was significantly **inhibited: almost eight times more in the plant-based diet group** than in the experimental group (**70% versus 9%, respectively**). The authors concluded that the proposed lifestyle, which included a plant-based diet, may affect the progression of low-grade prostate cancer in men.

Regarding breast cancer, there is still controversial evidence among some studies regarding the effect of dairy consumption. However, in the context of the treatment of estrogen-dependent breast cancer, there are important considerations to be made.

Approximately **60% to 70% of the total animal-derived estrogen** present in the human diet comes from the consumption of milk and dairy products. Cows produce milk up to 220 days of gestation, a period in which the increase in **estrogen is 33 times the normal value**. The free estrogen (estradiol) content in milk ranges from 1.0 to 2.4 pg/mL, and the serum estradiol found in women ranges from 2.0 to 266 pg/mL. The **amount of active estrogen absorbed via dairy consumption is uncertain**. From the perspective of **estrogen-dependent breast cancer**, where a reduction in the amount of circulating estrogen is pursued, either by reducing ovarian production or via drug therapy, the **recommendation is to restrict milk consumption until further studies are conducted about its safety**.

In the context of **breast cancer** treatment, a critical review was published in 2017, providing guidelines for this condition. For **animal products** (meat, eggs, and low-fat dairy products), the recommendation is to restrict their **consumption to once or twice a week**.

A **narrative review** published in 2018 on advising women undergoing **breast cancer** treatment states that the evidence suggests **following a plant-based diet** for general health as a whole after diagnosis. In addition, as 35% of deaths in women with breast cancer result from cardiovascular disease, this approach has a protective effect.

In 2021, a study of over 1,000 women showed that participants with breast cancer (350 newly diagnosed women matched with 700 apparently healthy women (control group)). The association of the overall plant-based diet index with breast cancer was evaluated, with one group classified as following a healthy vegetarian diet and the other an unhealthy diet. After controlling for confounding factors, the participants with the best dietary pattern showed a **67% lower** probability of breast cancer than those who had the worst dietary pattern. Women who had the worst dietary pattern were 2.23 times more likely to have breast cancer. **Higher adherence to a healthy plant-based diet was associated with a greater protective effect against breast cancer**.

3.2.4 Obesity

The results of population studies generally indicate that vegetarians, compared with omnivores, have a lower BMI throughout life. An example of this finding is reported in the European Prospective Investigation into Cancer and Nutrition (EPIC-Oxford), in which 65,429 men and women aged 20 to 97 were evaluated, of whom 33,883 were omnivores, 10,110 were fish eaters, 18,840 were ovo-lacto vegetarians and 2,596 were vegan. The results showed that throughout life, both vegan men and women had a lower BMI (within normal weight) than omnivores (who were overweight in part of their lives). Ovo-lacto vegetarians and semivegetarians maintained an intermediate BMI between the two groups.

However, **body weight reacts to the energy intake and expenditure** of the individual, and dietary choices make a difference in the final caloric intake. A diet consisting of highly processed and low-fiber foods may lead to a higher BMI than an omnivorous diet consisting of unprocessed and fiber-rich foods. In addition, the increased consumption of industrialized products offered to the vegan public may contribute to the intake of foods with higher caloric density and favor weight gain if their consumption is not controlled.

Another factor to be considered is the **caloric density of foods**. With a caloric value of 4 kcal/g, carbohydrates and protein have a lower caloric density than fat (9 kcal/g). In addition, foods rich in carbohydrates, due to osmotic factors, have more added water, which makes them more voluminous. Foods rich in fat, which is hydrophobic, do not contain significant amounts of water.

Due to these characteristics, fruits, leafy vegetables, starchy vegetables, other vegetables, legumes, and cereals are foods that require the intake of a larger volume to obtain more kilocalories. Conversely, oils, nuts, meats, eggs and dairy products provide high amounts of energy at a lower volume.

Based on this principle, **low-fat plant-based diets** (including those excluding oils, avocado and nuts), as designed in some studies, allow **free caloric intake and lead to significant weight loss** in individuals with overweight or obesity, even when compared to calorie-restricted omnivorous diets.

A vegetarian diet may lead to weight loss, weight maintenance or obesity. It all depends on food preparation, lifestyle, and an individual's metabolic composition. Low-fat, high-carbohydrate vegan diets (consisting of whole foods), without calorie restriction, favor weight loss due to the lower caloric density intake.

3.2.5 Anorexia nervosa

Given questions regarding eating disorders with the adoption of a vegetarian diet, we included this topic in the chapter, even though it is not part of the evaluation of controlled studies.

Anorexia nervosa is a disease that has **three essential characteristics:** persistent restriction of caloric intake; intense fear of gaining weight or persistent behavior that prevents weight gain; and disturbance in perception of one's own weight or shape. Its manifestation may involve only eating restrictions or binge eating followed by purging (autoinduced vomiting or the use of laxatives, diuretics or enemas).

In 1987, a study evaluated 116 patients with anorexia nervosa and found discourse about vegetarianism in 54.3%. In **only 6.3%** of the assessed cases was the adoption of **vegetarianism** made before **disease onset**.

The greater concern with a healthy diet, which consequently brings health benefits, creates in some researchers the erroneous idea that vegetarians have eating disorders. This conceptual error is seen in studies in the indexed literature.

As meat is a caloric food with a high fat content, it is natural for individuals with anorexia nervosa, at some point, to avoid it, as well as various other caloric foods (pasta, yellow cheeses, and sweets). **Vegetarianism is a consequence of choice in the disease and not a cause of it**.

Discourse that underweight is achieved by adopting a vegetarian diet is a cause for concern and important for the detection of anorexia nervosa, because eating this type of diet does not lead to excessive thinness, except in case of nutrition errors, consuming diseases, or anorexia nervosa as the primary cause.

Eating a vegetarian diet does not lead to anorexia nervosa, but people with this condition can use discourse about vegetarianism to justify their low weight and hide the disease from others.

my notes