dsm-firmenich

Health expectancy series

Part 1: The science of aging well

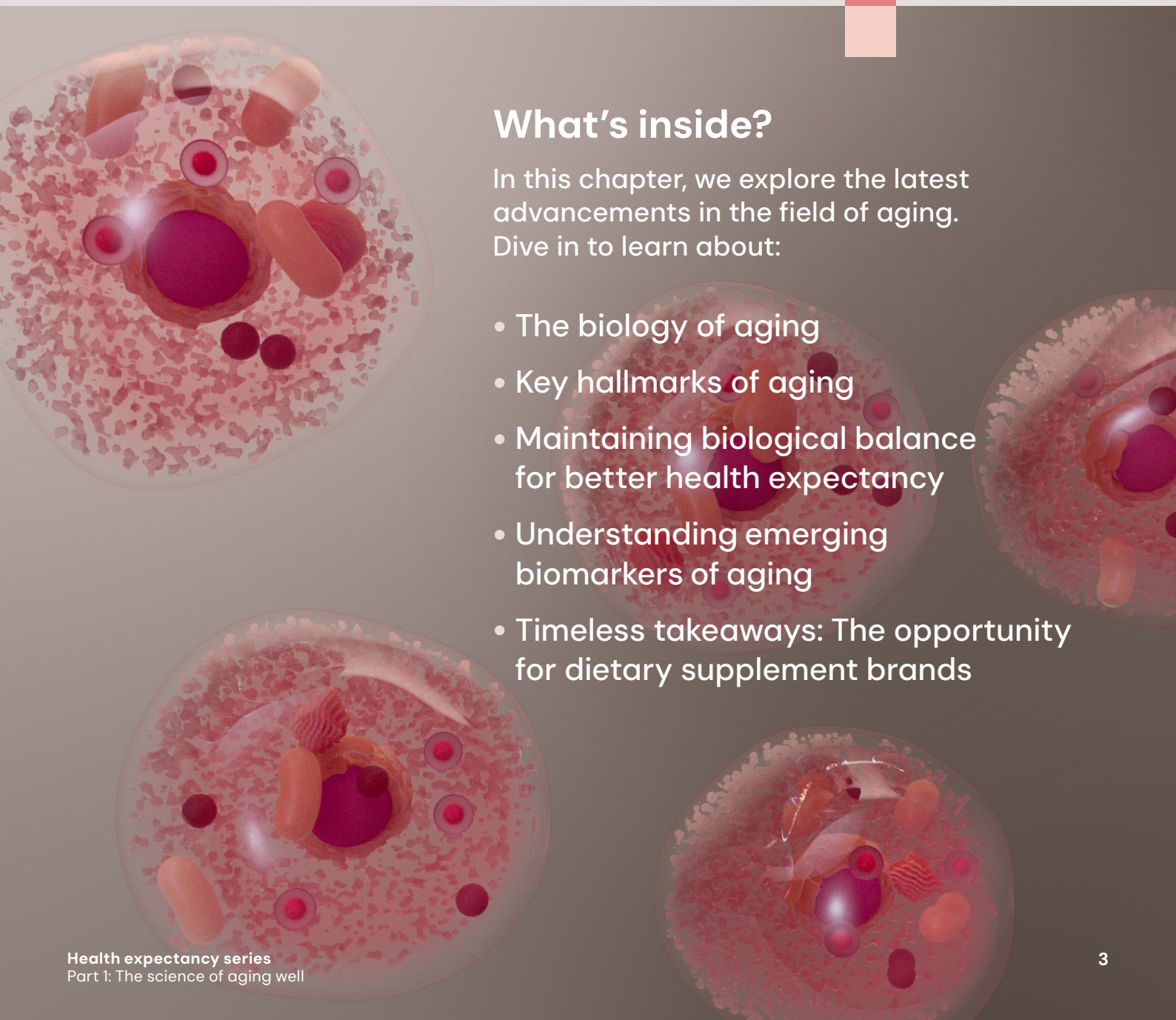
Introduction to the building blocks of aging and maximizing health expectancy

The population is living longer, but not always healthier. Today, most of us will spend our last 10 years of life battling ill health.[1] However, addressing this is key if we want to live vibrant and fulfilling lives, even into senior years.[2] Yet, as a society, we question, "How long will I live?", when we should be asking: **"How can I remain healthy for longer?"**

Enter nutritional supplements. New, cutting-edge research shows that it is possible to increase our health expectancy, i.e., the number of years we live in good health, by targeting the processes of aging at a cellular and system level—making our senior years not just longer, but some of our best.

As part of a three-part series, we dive into the challenge of aging, share breakthrough nutritional research in this field, and reveal how a new approach to innovation can support greater health expectancy. This first whitepaper explores the biological mechanisms behind aging, examines the key hallmarks of this process, and spotlights the opportunity to develop supplements for health expectancy.

10 years of life are marked by illness and disease that could be avoided



What's inside?

In this chapter, we explore the latest advancements in the field of aging. Dive in to learn about:

- The biology of aging
- Key hallmarks of aging
- Maintaining biological balance for better health expectancy
- Understanding emerging biomarkers of aging
- Timeless takeaways: The opportunity for dietary supplement brands

The biology of aging

Aging is a complex process that occurs at a biological, cellular, and systemic level. Some age-related changes are harmless, such as graying hair. Whereas others can impact us significantly, like reduced sensory function, decreased capacity for daily activities, and heightened susceptibility to frailty, disability, and chronic disease.

The link between aging and health

"Aging is not a disease, but advancing age is a major risk factor for disease. Additionally, many diseases accelerate the aging process. We see for instance that as life expectancy rises globally, there is a higher prevalence of chronic degenerative conditions, notably non-communicable diseases (NCDs) like cardiovascular disease, neurodegenerative diseases, cancer, and diabetes.

By slowing the process of aging, it may therefore be possible to reduce the burden of age-related disease and increase health expectancy—that is, living well for longer. However, to create effective interventions that support vitality with age, it is essential to first understand the aging process and factors that determine who ages 'well' or who is more susceptible to age-related disease."

Gabriele Civiletto
Associate Principal Scientist,
DS, HNC at dsm-firmenich

Benefits of health expectancy interventions

- Support health, wellbeing, and independence
- Improve quality of life in advancing years
- Reduce the burden of disease

Identifying key hallmarks of aging

Scientists have identified key mechanisms that contribute to the process of aging—and these mechanisms have now been unified under a concept known as the hallmarks of aging.

The hallmarks of aging model is a conceptual framework that describes the biochemical changes that occur in organisms as they age. Research has found that the process of aging currently involves 12 hallmarks (Figure 1), and these hallmarks interact in complex ways to drive the aging process.[3,4] However, this field is rapidly evolving, and new hallmarks continue to emerge.

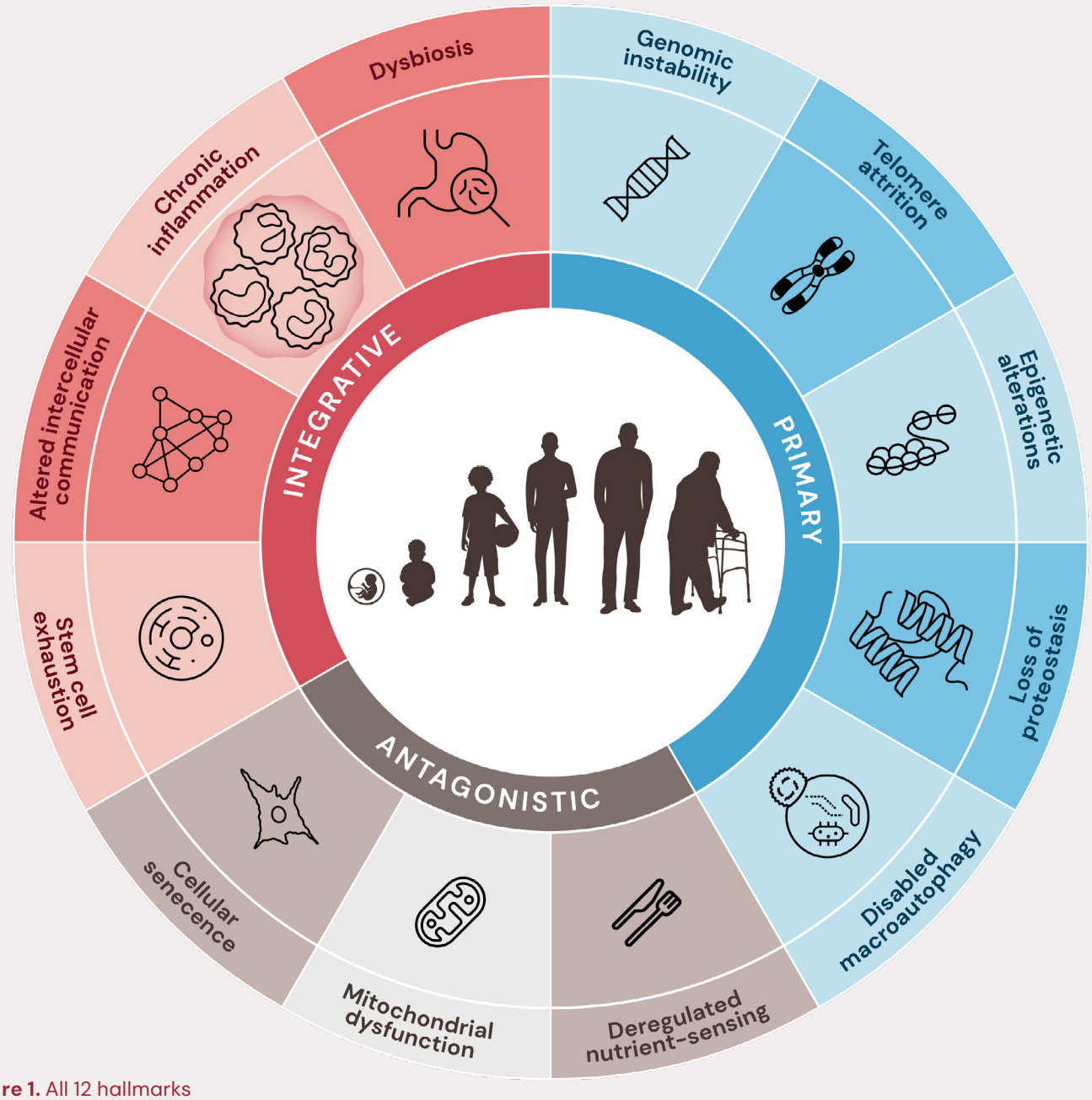


Figure 1. All 12 hallmarks are considered fundamental processes that contribute to the aging of cells and organisms.[4]

These hallmarks are split into three main categories: primary hallmarks (which cause damage), antagonistic hallmarks (the body's response to damage), and integrative hallmarks (the end results of aging).

The general aging process involves:

1. **Damage to DNA, protein and organelles** (structures inside cells that help them function, like the mitochondria or nucleus) **build up in cells over time**, initiating the aging process.
2. **The body's response to this damage**, like cellular repair and growth, is helpful when we're young but **can become harmful as we age**. For example, senescence, a process that stops damaged cells from growing, is beneficial early in life for healthy growth, but can increase the risk of age-related diseases in senior years.
3. Integrative hallmarks are the result of the earlier two stages and lead to the **decline in bodily functions** we associate with aging. These changes can affect entire systems, like the microbiome.

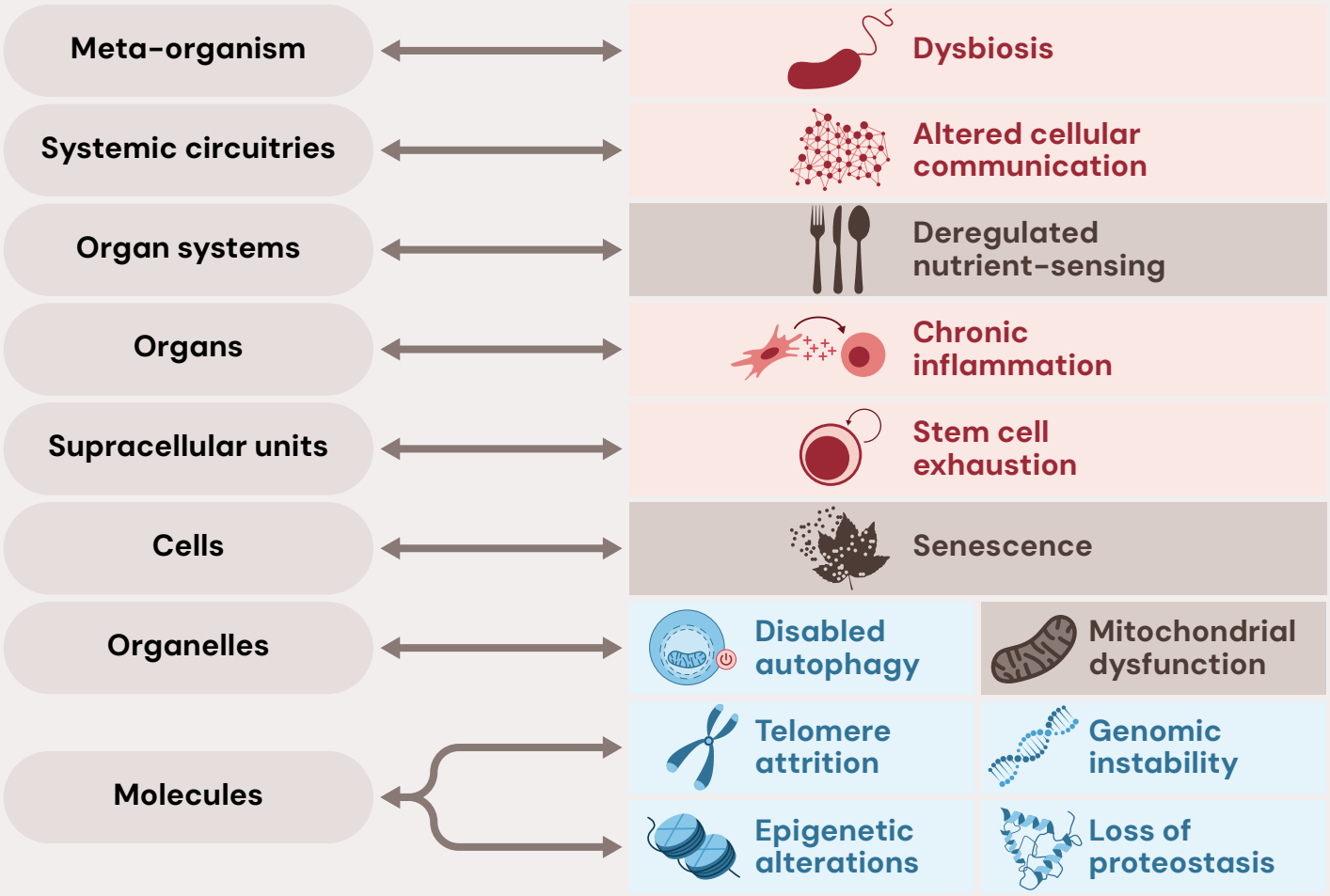
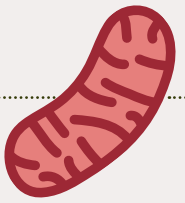


Figure 2. These hallmarks explain the various ways aging occurs at the cellular and molecular levels.[4]

A deep dive into aging hallmarks...

Of the 12 hallmarks of aging, dsm-firmenich identifies four as key for enabling effective nutritional interventions. These four hallmarks hold significant potential for promoting health expectancy—and could be targeted to develop the next generation of health expectancy solutions.

1



Mitochondrial dysfunction

The mitochondria—or 'powerhouse' of the cell—are energy-producing structures within human cells. They generate adenosine triphosphate (ATP), a molecule that cells use as a source of energy.

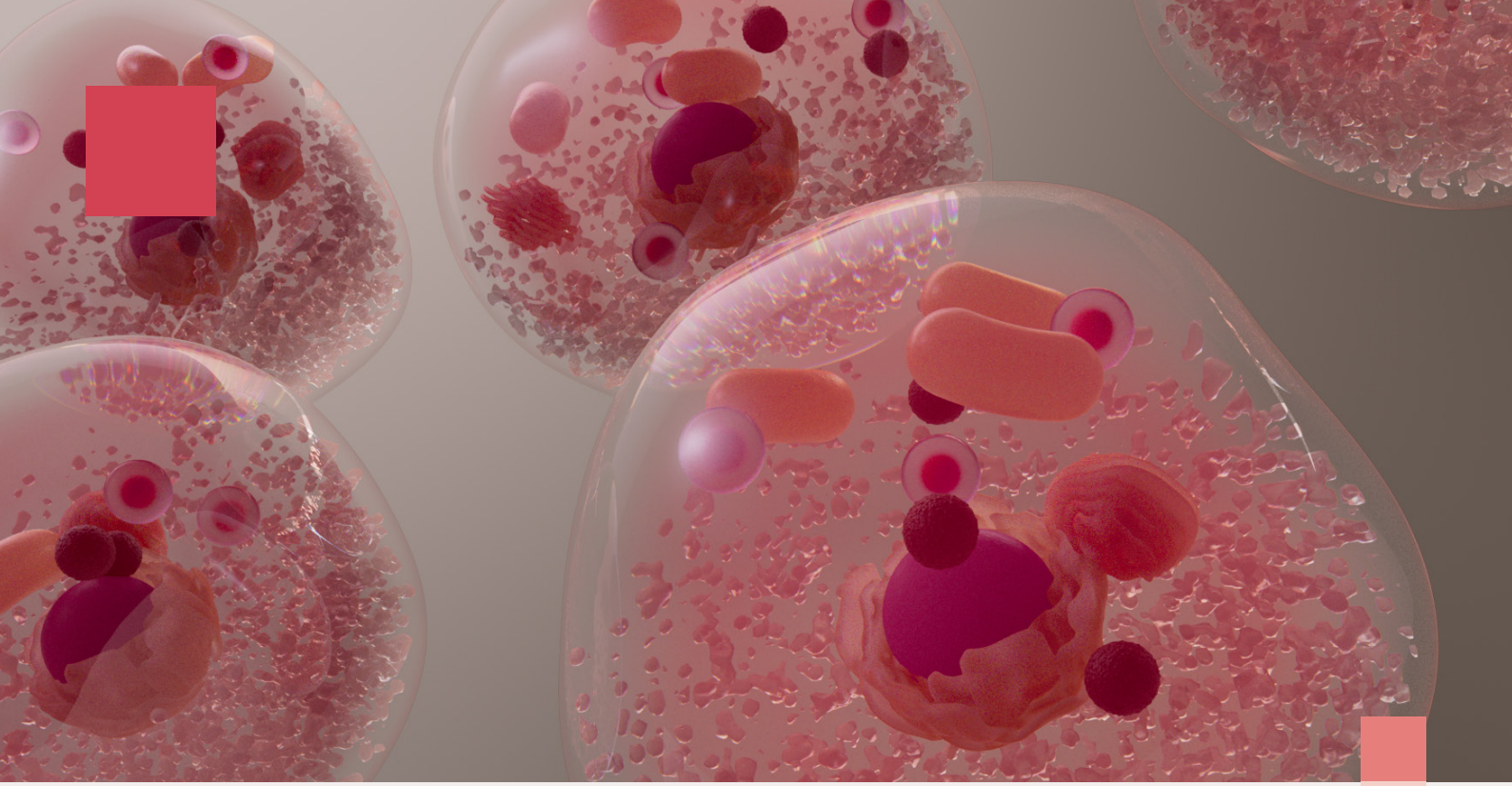
Mitochondrial dysfunction occurs when these essential organelles fail to produce enough energy, manage oxidative stress appropriately, and regulate cell function properly, leading to cellular damage, aging and various diseases.[5,6] The impact of mitochondrial dysfunction can be particularly prominent in tissues and organs that require a lot of energy, like the brain, heart, and muscles. This is why mitochondrial dysfunction often contributes to age-related diseases, like neurodegenerative disorders, cardiovascular diseases, metabolic syndrome, and some types of cancers.

2

Cellular senescence

Cellular senescence is a process in which cells lose function—including the ability to divide and replicate—but continue to secrete molecules that damage neighboring cells.[7,8] This process is a natural part of aging and acts as a protective mechanism to prevent damaged or stressed cells from proliferating, which could lead to cancer.

However, as these senescent cells accumulate and build up over time, they can contribute to aging and age-related diseases. This is because senescent cells create a pro-inflammatory environment—leading to chronic inflammation. Damaging secretions from these cells can also affect the surrounding tissue microenvironment, leading to tissue dysfunction, impaired regeneration and ultimately, the deterioration of organ systems.



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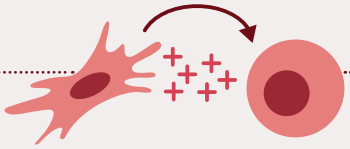
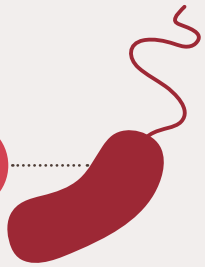


Chronic inflammation

Chronic inflammation—often referred to as inflammaging—is a prolonged and persistent inflammatory response in the body. Unlike acute inflammation, which is a short-term and beneficial response to injury or infection, chronic inflammation is a slow, ongoing process that can damage tissues and organs.

Chronic inflammation accelerates cellular aging because it increases oxidative stress, which can damage cellular components (like DNA, proteins, and lipids) and disrupt normal cell processes, thus influencing decline in tissue function.[9] It is also linked to the development and progression of age-related diseases, like Alzheimer's disease, type 2 diabetes, cancer, arthritis, and cardiovascular diseases.

4



Gut microbial dysbiosis

A normal gut microbiota is essential for various bodily functions, including digestion, immune system regulation, and even mood and cognitive function. Microbial dysbiosis occurs when there is an imbalance or disruption in the normal composition and function of the gut microbiota.[10]

Several factors, such as aging, poor diet, chronic stress, antibiotic use, and lack of physical activity, disrupt the balance and diversity of the gut microbiota. This microbial dysbiosis has significant implications for aging, not only accelerating the aging process but also contributing to the onset of age-related diseases. This happens because dysbiosis triggers chronic, low-grade inflammation in the body, impairing immune function and causing metabolic dysfunctions, like insulin resistance, obesity, and type 2 diabetes.[11]

Maintaining biological balance for healthier aging

Health depends on the body's ability to maintain internal balance (homeostasis) while dealing with stress and recovering afterward.

Throughout our lives, stressors—like poor diet, smoking, infection, environmental toxins, sleep deprivation, physical inactivity, and chronic psychological stress—contribute to oxidative stress and inflammation, which cause cellular damage. However, as we age, homeostasis is disrupted across all levels—molecular, cellular, tissue, and whole organism—and there is a breakdown of processes that usually regulate our response to environmental changes.

With this breakdown, the ability to recover from stresses decreases and the capacity to adapt and return to a balanced state weakens as we get older. This leads to an increased vulnerability towards diseases associated with aging.

Understanding emerging biomarkers of aging

The goal of aging research is to find and test ways to extend health expectancy in humans. To help with this, developing new biomarkers that can measure biological age and the speed of aging is crucial. These biomarkers should ideally track age-related changes from the cellular level to the whole body, providing a reliable measure of biological age that can predict when someone might develop a disease.

Traditional biomarkers, like fitness levels, gait speed, and cognitive function, measure physical performance but often lack predictive power for aging. However, advances in big data and machine learning have led to the creation of more complex biomarkers, like 'aging clocks', which measure biological age using data from epigenetics, gene expression, proteins, and metabolism.

Among modern biomarkers, epigenetic clocks are the most advanced and can even predict overall mortality risk. These clocks have shown that certain lifestyle changes, like diet and exercise, can reduce biological age. Why does this matter to supplement brands? It means that we can now accurately measure the effectiveness of health expectancy solutions—including nutritional supplements.

Timeless takeaways:
The health expectancy opportunity for nutrition brands

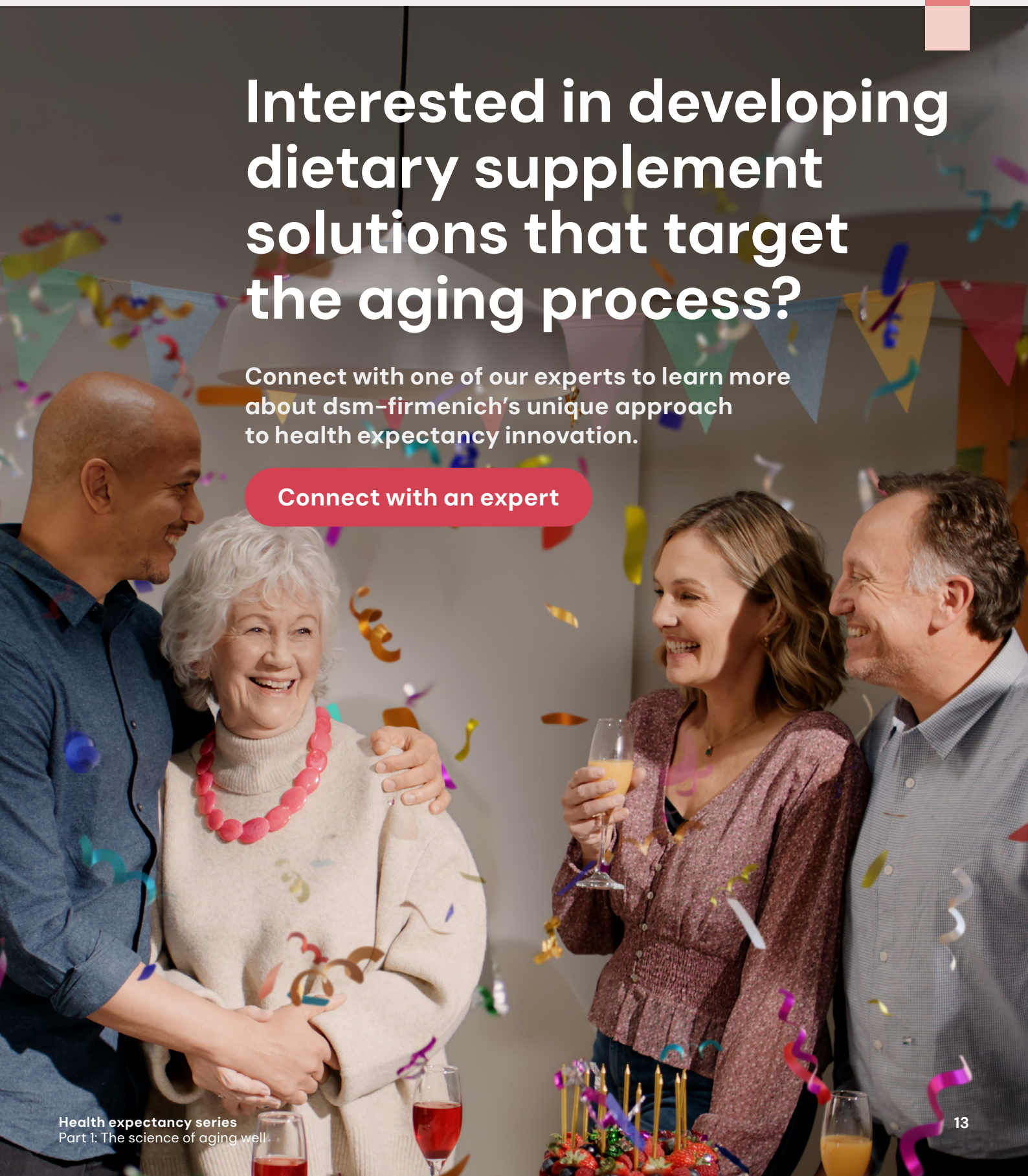
1. The current medical system treats each age-related disease separately. While this is helpful, new research is focused on reducing chronic diseases by addressing the underlying mechanisms of the aging process.

2. However, aging is complex. It has become clear that addressing just one aspect of the aging process is unlikely to be effective.

3. To effectively slow aging and increase health expectancy, it is critical to understand how the different aspects of aging are connected and address them in a unified way.

4. Due to the preventable nature of NCDs and their strong connection with aging, one approach is to understand how nutrients and bio-actives can modulate homeostasis and the hallmarks of aging—tapping into this knowledge to inform supplement innovation.

In the next chapter of this three-part series, we will delve into the influence of nutrition on aging processes and how dietary supplement brands can harness the power of nutrients and other compounds, like phytochemicals, to increase quality of life and function in advancing years.



Interested in developing dietary supplement solutions that target the aging process?

Connect with one of our experts to learn more about dsm-firmenich's unique approach to health expectancy innovation.

Connect with an expert

It's time to increase the health expectancy of the human race.

Together, we can elevate health expectancy and transform the lives of billions of people globally.

Our health expectancy offering is rooted in foundational scientific aging theories and bolstered by a multifaceted approach to evidence generation—with a portfolio of cutting-edge ingredients at the core to deliver life-enhancing benefits.

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