



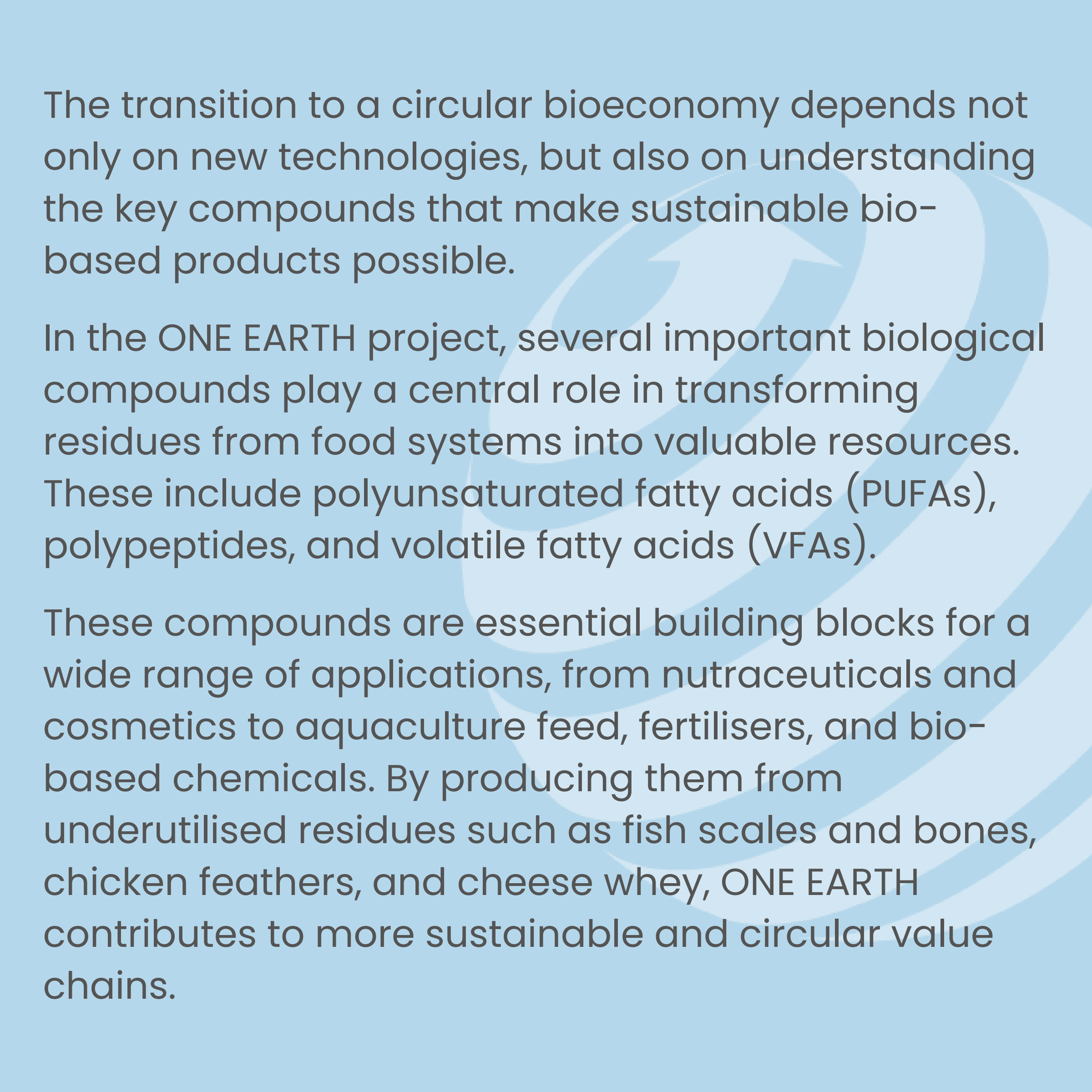
Key Compounds in the ONE EARTH Project



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The transition to a circular bioeconomy depends not only on new technologies, but also on understanding the key compounds that make sustainable bio-based products possible.

In the ONE EARTH project, several important biological compounds play a central role in transforming residues from food systems into valuable resources. These include polyunsaturated fatty acids (PUFAs), polypeptides, and volatile fatty acids (VFAs).

These compounds are essential building blocks for a wide range of applications, from nutraceuticals and cosmetics to aquaculture feed, fertilisers, and bio-based chemicals. By producing them from underutilised residues such as fish scales and bones, chicken feathers, and cheese whey, ONE EARTH contributes to more sustainable and circular value chains.



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Polyunsaturated Fatty Acids (PUFAs)



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Polyunsaturated fatty acids (PUFAs) are a group of essential fatty acids that play an important role in human and animal health. They are called “polyunsaturated” because their chemical structure contains multiple double bonds.

Among the most well-known PUFAs are omega-3 and omega-6 fatty acids. These compounds are essential nutrients, meaning that the human body cannot produce them in sufficient amounts and they must be obtained through diet.

PUFAs contribute to several biological functions, including maintaining cell membrane integrity, supporting cardiovascular health, and playing a role in inflammatory and immune responses. Long-chain omega-3 PUFAs such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are particularly important for brain development and function.

Because of their nutritional importance, PUFAs are widely used in food supplements, aquaculture feed, and functional food products.



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Why PUFAs Matter



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Polyunsaturated fatty acids are essential components of healthy diets for both humans and animals. Long-chain omega-3 PUFAs such as EPA and DHA are linked to several health benefits, including support for cardiovascular health and normal brain and eye development.

For this reason, PUFAs are widely used in a range of sectors. In human nutrition they are incorporated into dietary supplements and fortified foods. In aquaculture they are crucial for producing nutritionally balanced fish feed, ensuring that farmed fish maintain the same nutritional quality as wild fish.

PUFAs are also increasingly used in cosmetics and personal care products due to their moisturizing and skin-protective properties.

As global demand for nutritious food and sustainable feed continues to grow, ensuring a reliable and sustainable supply of PUFAs is becoming increasingly important.



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Where PUFAs Come From Today



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Today, the main commercial source of long-chain omega-3 PUFAs is fish oil obtained from marine fish species such as anchovies, sardines, and mackerel.

These fish accumulate omega-3 fatty acids by feeding on microalgae at the base of marine food chains. As a result, fish oil has traditionally been the primary source of EPA and DHA used in food supplements and aquaculture feed.

However, global demand for omega-3 fatty acids has increased significantly in recent decades due to growing awareness of their health benefits and expanding aquaculture production.

Because marine resources are finite, reliance on fish-derived omega-3 fatty acids raises concerns about long-term sustainability and pressure on marine ecosystems.



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The Sustainability Challenge for PUFAs



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The growing global demand for omega-3 fatty acids presents an important sustainability challenge.

Fish oil production depends on wild marine fish stocks, particularly small pelagic fish species that play an important ecological role in marine food webs. Although many fisheries are well managed, increasing demand for omega-3 fatty acids has raised concerns about pressure on marine ecosystems and long-term supply stability.

At the same time, aquaculture is expanding rapidly and requires large amounts of omega-3 fatty acids to maintain the nutritional quality of farmed fish.

For these reasons, researchers and industry are actively exploring alternative and sustainable sources of PUFAs, including microbial fermentation and algae-based production systems.

Developing these alternative sources is essential for supporting the future of sustainable food systems and the circular bioeconomy.



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Biotechnology for Sustainable PUFAs



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Biotechnology offers promising pathways to produce polyunsaturated fatty acids without relying on marine fish stocks.

One of the most promising approaches involves cultivating microorganisms such as microalgae or certain oleaginous microbes that naturally produce omega-3 fatty acids. In controlled biotechnological processes, these organisms can convert organic substrates into valuable compounds such as EPA and DHA.

Because fish obtain omega-3 fatty acids from algae in marine ecosystems, producing PUFAs directly from algae or microbial systems replicates this natural pathway while reducing pressure on marine resources.

These technologies are increasingly being explored within the framework of the circular bioeconomy, where biological residues and industrial side streams can serve as feedstocks for sustainable bioproduction.

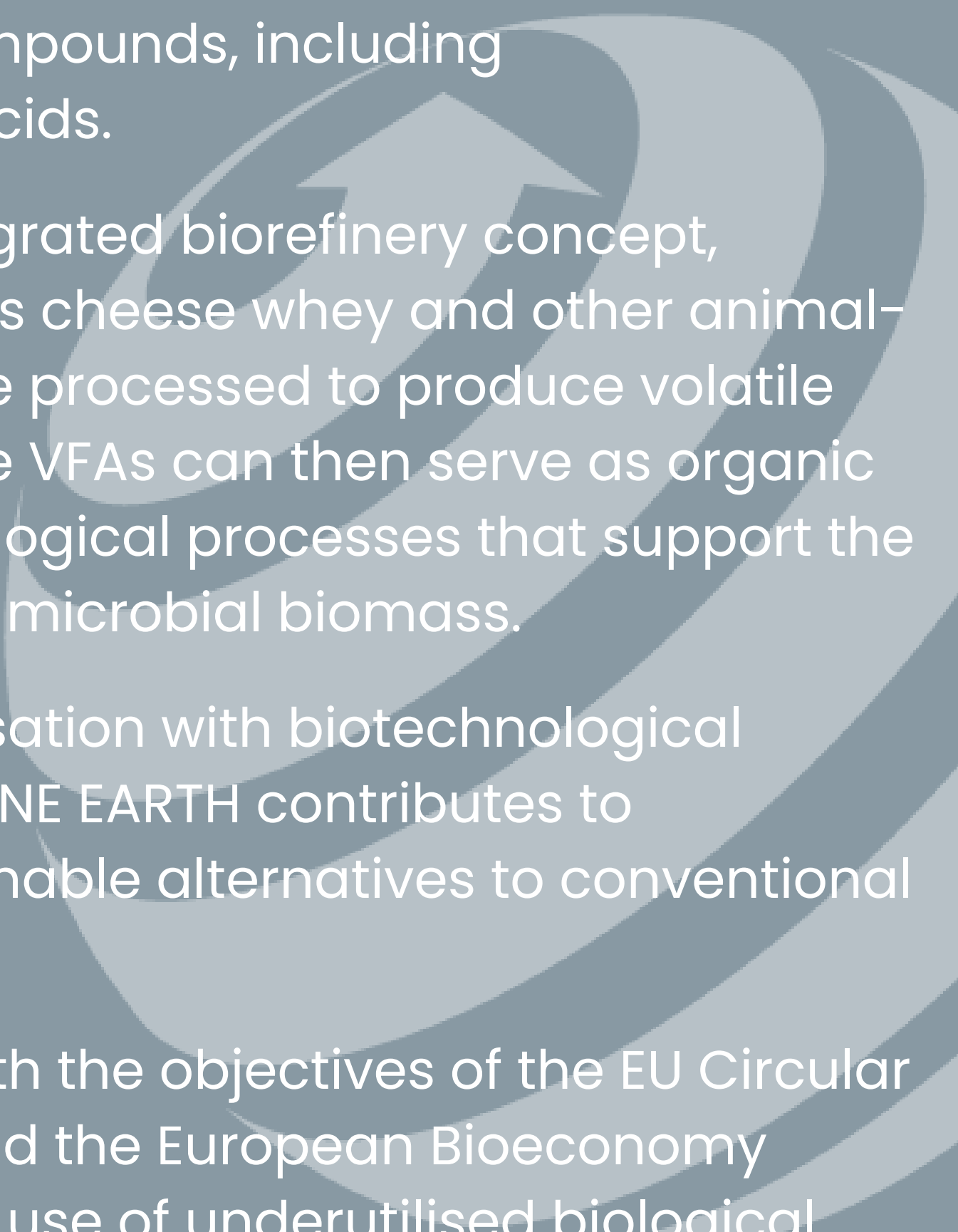


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ONE EARTH Producing PUFAs from Residues



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The ONE EARTH project explores how residues from animal-based food systems can be transformed into valuable bio-based compounds, including polyunsaturated fatty acids.

Within the project's integrated biorefinery concept, organic residues such as cheese whey and other animal-derived by-products are processed to produce volatile fatty acids (VFAs). These VFAs can then serve as organic precursors in biotechnological processes that support the production of PUFA-rich microbial biomass.

By linking residue valorisation with biotechnological production pathways, ONE EARTH contributes to developing more sustainable alternatives to conventional PUFA production.

This approach aligns with the objectives of the EU Circular Economy Action Plan and the European Bioeconomy Strategy, promoting the use of underutilised biological resources to create high-value products for food, feed, cosmetics, and other sectors.



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Volatile Fatty Acids (VFAs)



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Volatile fatty acids (VFAs) are short-chain organic acids that play an important role in microbial metabolism and industrial biotechnology.

These compounds are naturally produced by microorganisms when they break down organic matter in environments where oxygen is limited. This microbial process occurs in many natural systems as well as in engineered biological reactors.

Because VFAs are intermediate molecules in microbial metabolism, they can serve as building blocks for the production of many bio-based compounds.

For this reason, VFAs are increasingly recognised as important molecules for developing sustainable biotechnological production systems and circular bioeconomy solutions.



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VFAs as Platform Molecules



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Volatile fatty acids (VFAs) are often described as platform molecules, meaning they can be converted into a wide range of valuable products through biological or chemical processes.

In modern biorefineries, VFAs can serve as carbon sources for microorganisms that produce microbial oils, bio-based chemicals, and other high-value biomolecules.

Because these compounds can be produced from organic residues and side streams, they offer an opportunity to transform underutilised resources into valuable ingredients for food, feed, and industrial applications.

As interest in sustainable production grows, VFAs are becoming increasingly important intermediates in the development of circular bio-based value chains.



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Producing VFAs from Residues



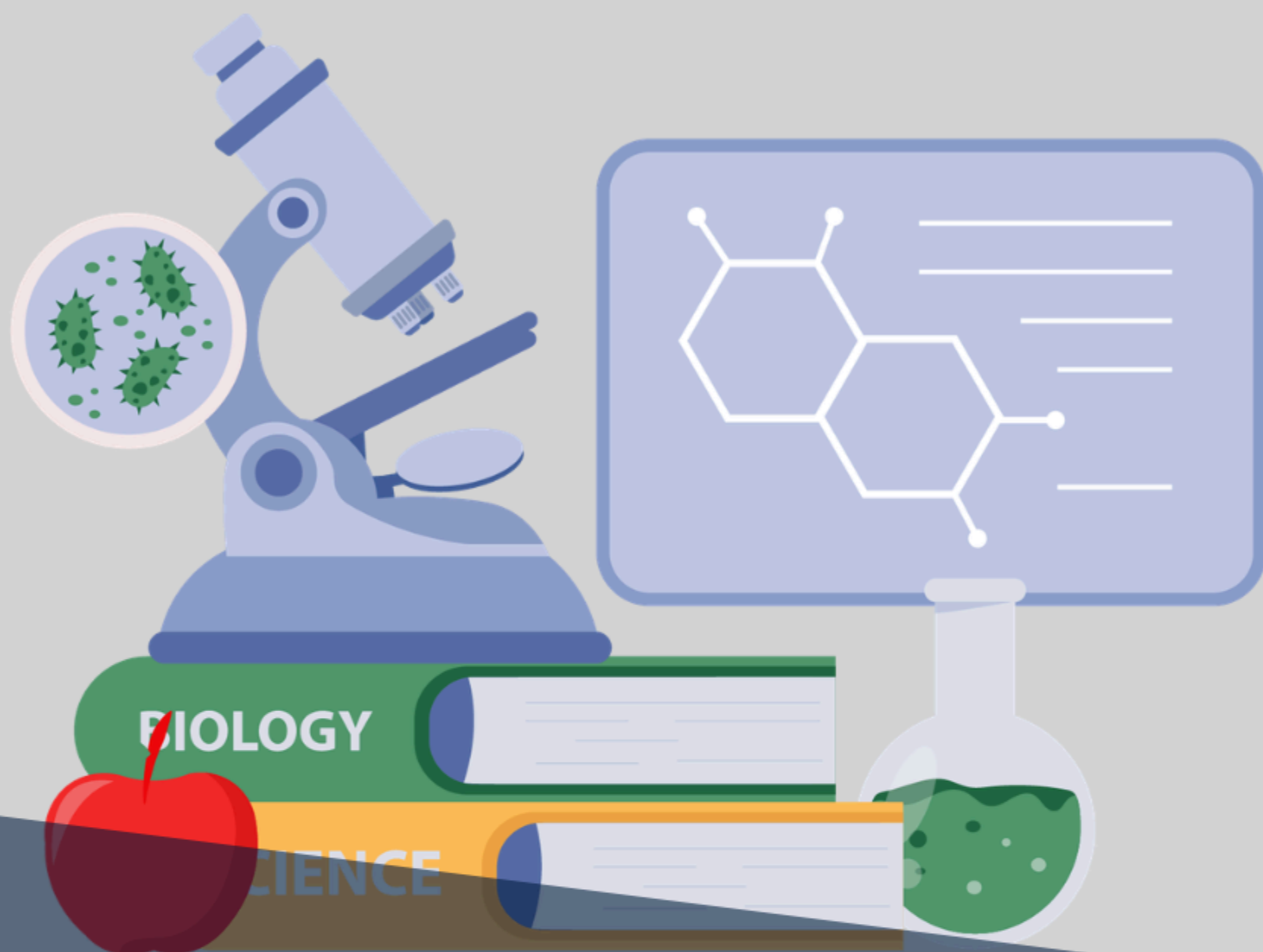
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Volatile fatty acids (VFAs) can be produced through anaerobic fermentation, a microbial process in which microorganisms break down organic matter in the absence of oxygen.

This process can convert a wide range of organic materials, including food processing by-products and agricultural residues, into mixtures of VFAs.

Anaerobic digestion systems are already widely used across Europe for managing organic waste streams, providing an existing infrastructure that can also support biotechnological production of VFAs.

By converting biological residues into valuable intermediate molecules, VFA production supports the transition toward resource-efficient and circular bioeconomy systems.



The Carboxylate Platform



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Volatile fatty acids (VFAs) are central to what scientists call the Carboxylate Platform, a concept that focuses on converting organic residues into valuable chemicals through microbial processes.

In this approach, organic materials are first fermented into mixtures of volatile fatty acids.

These VFAs can then be used as building blocks to produce a wide range of bio-based products, including biofuels, microbial oils, polymers, and other chemicals.

By enabling the conversion of biological residues into valuable resources, the Carboxylate Platform demonstrates how biotechnology can support the circular bioeconomy and more sustainable industrial systems.



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VFAs Enabling Circular Biorefineries



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One of the key advantages of Volatile fatty acids (VFAs) is that they can be produced from underutilised biological residues, including organic side streams from agriculture and food processing.

These VFAs can then serve as carbon sources for microorganisms that produce valuable biomolecules such as lipids, proteins, and other bio-based ingredients.

This concept forms the basis of integrated biorefineries, where biological residues are converted into multiple products through interconnected biological and chemical processes.

Such systems support the goals of the EU Circular Economy Action Plan and the European Bioeconomy Strategy, which promote efficient resource use and sustainable bio-based production.



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ONE EARTH Producing VFAs from Residues



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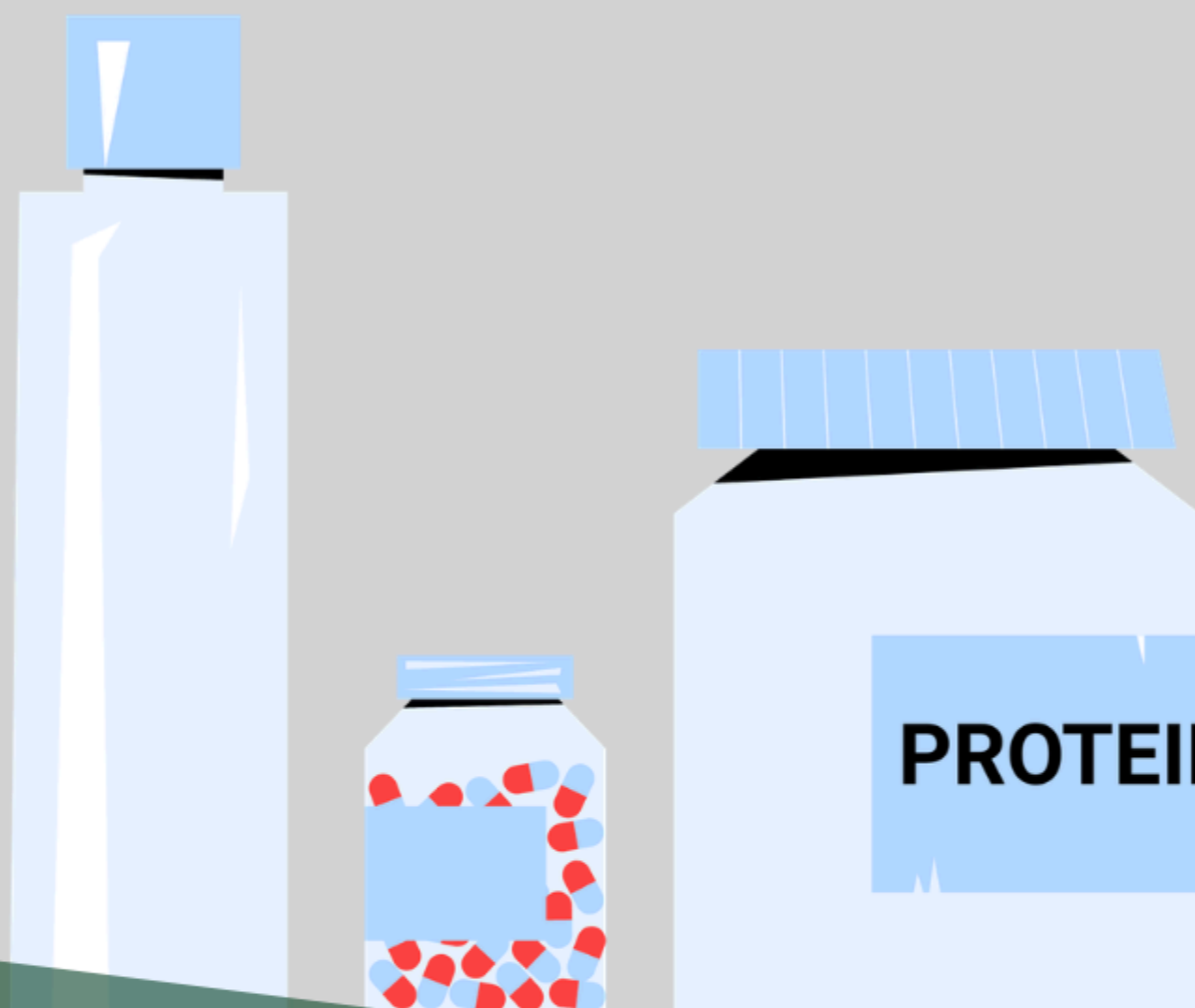


In the ONE EARTH project, volatile fatty acids (VFAs) are key intermediate molecules within the project's integrated multi-purpose biorefinery concept.

Residues from animal-based food systems, including fishery residues, poultry by-products, and cheese whey, are processed through microbial fermentation to produce VFAs.

These VFAs can then serve as organic precursors for further biotechnological processes, including the production of valuable compounds such as polyunsaturated fatty acids (PUFAs).

By linking residue valorisation with biotechnological production pathways, ONE EARTH contributes to the development of circular value chains that transform underutilised biological resources into sustainable bio-based products.



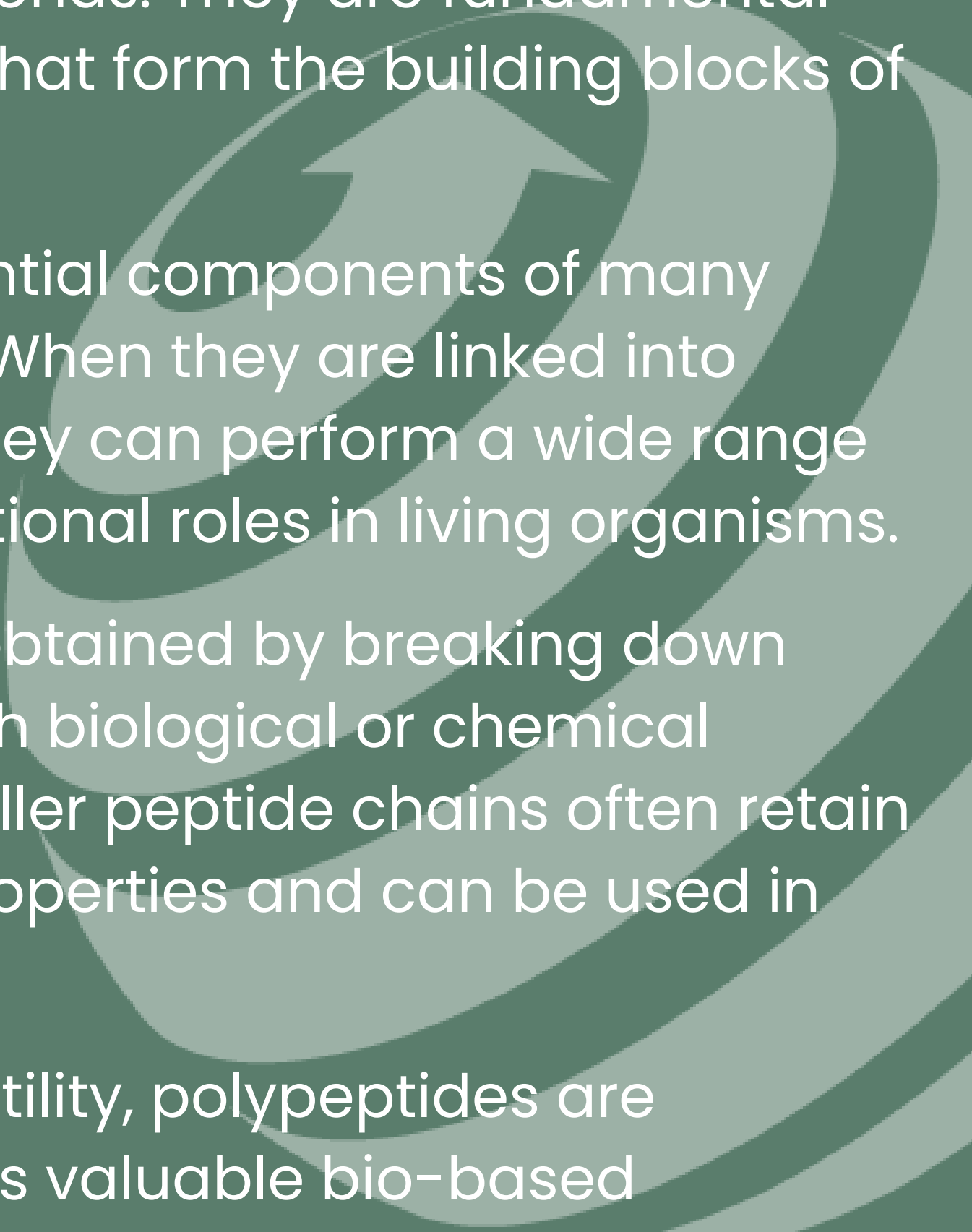
Polypeptides



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Polypeptides are chains of amino acids linked together by peptide bonds. They are fundamental biological molecules that form the building blocks of proteins.

Amino acids are essential components of many biological processes. When they are linked into polypeptide chains, they can perform a wide range of structural and functional roles in living organisms.

Polypeptides can be obtained by breaking down larger proteins through biological or chemical processes. These smaller peptide chains often retain valuable biological properties and can be used in various applications.

Because of their versatility, polypeptides are increasingly studied as valuable bio-based compounds for food, feed, cosmetics, and industrial uses.



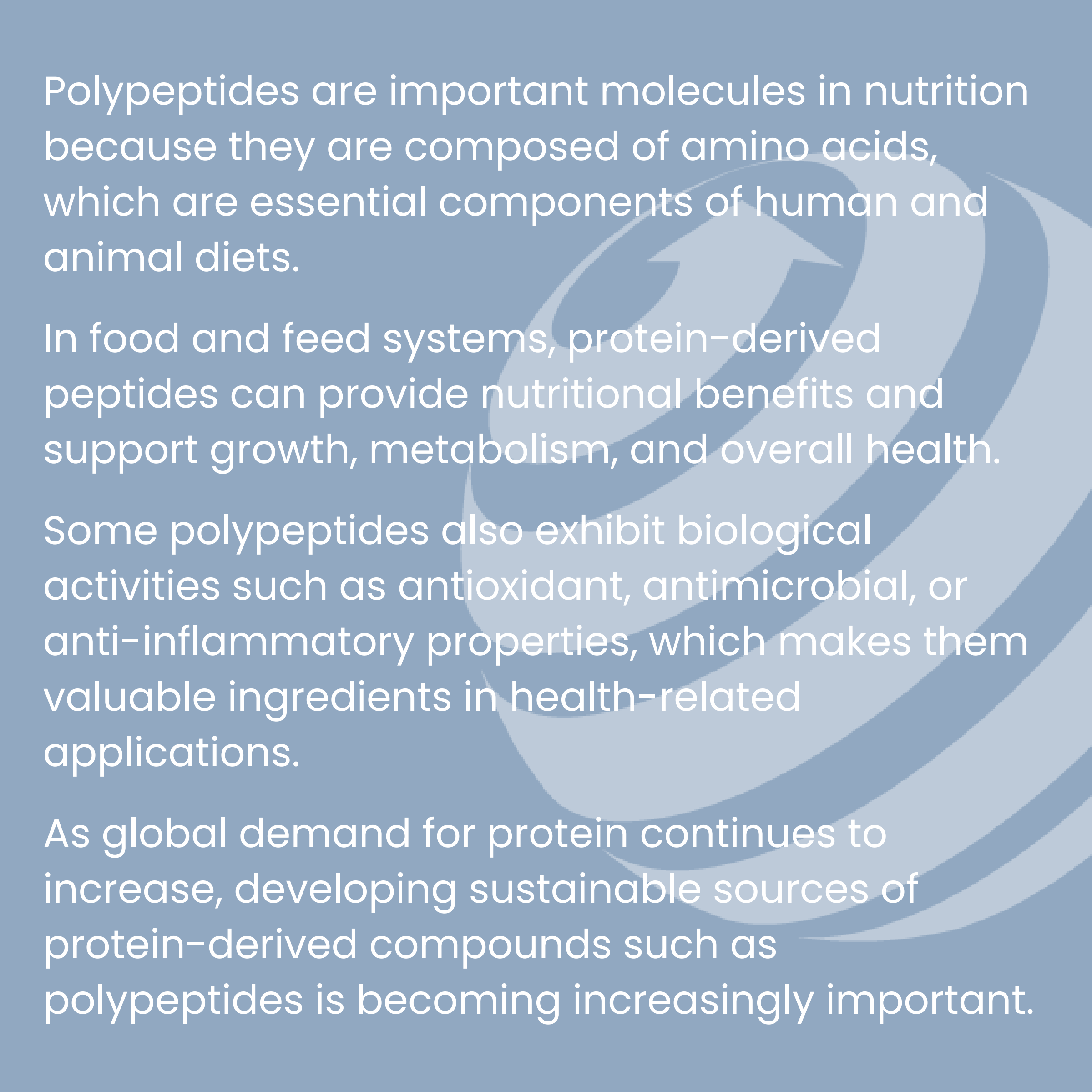
Why Polypeptides Matter



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Polypeptides are important molecules in nutrition because they are composed of amino acids, which are essential components of human and animal diets.

In food and feed systems, protein-derived peptides can provide nutritional benefits and support growth, metabolism, and overall health.

Some polypeptides also exhibit biological activities such as antioxidant, antimicrobial, or anti-inflammatory properties, which makes them valuable ingredients in health-related applications.

As global demand for protein continues to increase, developing sustainable sources of protein-derived compounds such as polypeptides is becoming increasingly important.



Polypeptides from Biological Residues



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Many biological residues from food systems are rich in proteins that can serve as sources of polypeptides.

Fish processing residues such as bones and scales contain collagen and other structural proteins that can be converted into valuable peptides.

Poultry by-products such as feathers are composed mainly of keratin, a durable structural protein that can also be broken down into peptide fractions through specialised processing methods.

Dairy by-products such as cheese whey contain soluble proteins that can be transformed into bioactive peptides through enzymatic processes.

By recovering protein fractions from these residues, it becomes possible to transform underutilised biological materials into valuable resources.



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Producing Polypeptides Through Biotechnology



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Polypeptides can be produced through several technological approaches that break down larger proteins into smaller peptide chains.

One common method is enzymatic hydrolysis, where specific enzymes are used to break peptide bonds in proteins in a controlled way.

Microbial fermentation can also contribute to protein conversion processes, where microorganisms help degrade complex proteins into smaller molecules.

These processes allow researchers to obtain peptide fractions with specific functional properties that can be used in different industries.

Biotechnology therefore plays an important role in transforming protein-rich residues into valuable bio-based ingredients.

A glass jar filled with a thick, white cream is the central focus. In the background, a purple ribbon is elegantly draped. The entire scene is set against a soft, light pink background. A semi-transparent dark grey banner is positioned across the lower half of the image, serving as a backdrop for the title text.

Applications of Polypeptides



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Polypeptides have a wide range of potential applications in different sectors.

In food systems, peptides derived from proteins can be used as nutritional ingredients or functional food components.

In aquaculture and animal nutrition, protein hydrolysates can provide valuable amino acids that support growth and health.

In cosmetics, certain peptides are used in skincare formulations because they can help maintain skin hydration and structure.

Polypeptides can also serve as components in bio-based materials and chemical formulations, contributing to the development of sustainable products.



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ONE EARTH Producing Polypeptides from Residues



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The ONE EARTH project investigates how protein-rich residues from animal-based food systems can be transformed into valuable bio-based compounds.

Materials such as fishery residues, poultry by-products, and cheese whey contain significant amounts of proteins that can be processed to obtain polypeptides.

Through biotechnological and enzymatic processes, these proteins can be converted into peptide fractions that can be used as ingredients in food, feed, cosmetics, and other applications.

By integrating protein recovery into its multi-purpose biorefinery concept, ONE EARTH contributes to developing circular value chains that transform residues into high-value bio-based products.

This approach supports the objectives of the EU Circular Economy Action Plan and the European Bioeconomy Strategy, promoting sustainable use of biological resources.



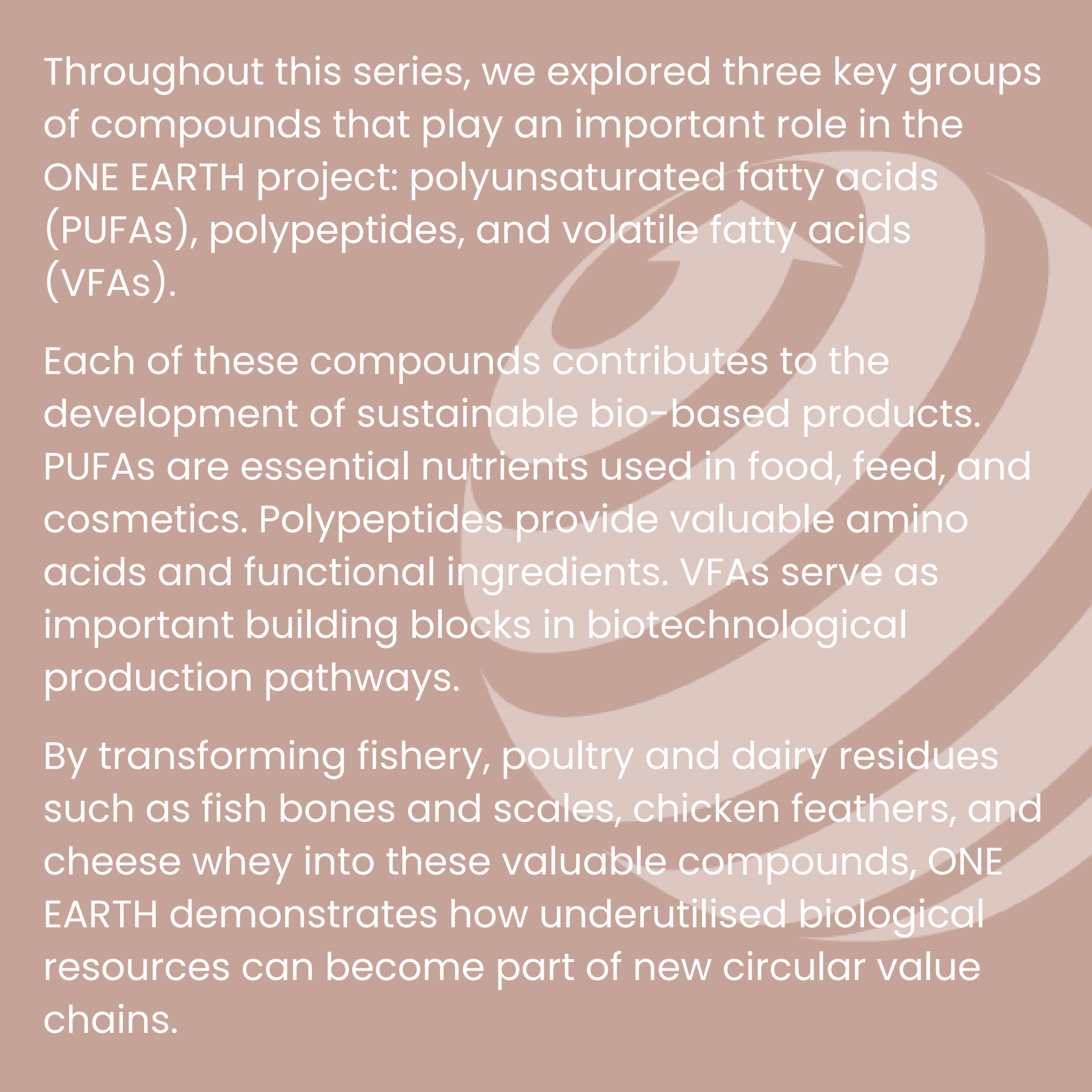
Key Compounds in the ONE EARTH Project



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Throughout this series, we explored three key groups of compounds that play an important role in the ONE EARTH project: polyunsaturated fatty acids (PUFAs), polypeptides, and volatile fatty acids (VFAs).

Each of these compounds contributes to the development of sustainable bio-based products. PUFAs are essential nutrients used in food, feed, and cosmetics. Polypeptides provide valuable amino acids and functional ingredients. VFAs serve as important building blocks in biotechnological production pathways.

By transforming fishery, poultry and dairy residues such as fish bones and scales, chicken feathers, and cheese whey into these valuable compounds, ONE EARTH demonstrates how underutilised biological resources can become part of new circular value chains.