

## CERAMIDES ARE ONE OF THE KNIGHTS IN SHINING ARMOUR ON SKIN BARRIER

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### ABSTRACT

Ceramides are a family of waxy lipid molecules. A ceramide is composed of sphingosine and a fatty acid joined by an amide bond. Sphingosine is a long-chain amino alcohol, the backbone of sphingolipids, featuring an 18-carbon backbone with two hydroxyl (-OH) groups, one amino (-NH<sub>2</sub>) group at carbon 2, and a Trans double bond between carbons 4 and 5, making it amphiphilic (both water-loving and fat-loving) and crucial for cell signalling and membrane structure. Ceramides are essential waxy lipids (fats) naturally in your skin, acting like "mortar" to hold skin cells ("bricks") together, forming a strong, protective outer barrier that keeps moisture in and irritants out. They are crucial for hydration, defence against environmental damage, and preventing dryness, but their levels decline with age or harsh conditions, making topical ceramide skincare products vital for replenishing them to maintain healthy, supple skin, suitable for sensitive types too.

**KEYWORDS:** skin layers, skin sub layers, hydrophilic, hydrophobic, ceramides and sphingolipid.

### INTRODUCTION

Human skin has three main layers: the outer Epidermis (waterproof barrier, color), the middle Dermis (strength, flexibility with collagen/elastin, glands, nerves, follicles), and the deepest Hypodermis (fat, cushion, insulation), with the epidermis further divided into five sublayers. Together, these layers protect the body, regulate temperature, and provide sensation.<sup>[1-4]</sup>

#### 1. Epidermis (Outer Layer)

Function: Waterproof barrier, produces skin tone (melanin), protects from germs, UV, and injury.

Sublayers (from bottom up).

Stratum Basale: Innermost, produces new skin cells.

Stratum Spinosum.

Stratum Granulosum.

Stratum Lucidum: Extra layer in thick skin (palms/soles).

Stratum Corneum: Outermost, dead, tough cells.

#### 2. Dermis (Middle Layer)

Function: Strength, flexibility, houses nerve endings, blood vessels, sweat/oil glands, hair follicles.

Sublayers: Papillary (top) and Reticular (bottom).

#### 3. Hypodermis (Deepest Layer)

Function: Fat and connective tissue for cushioning, energy storage, and heat insulation (shock absorber).

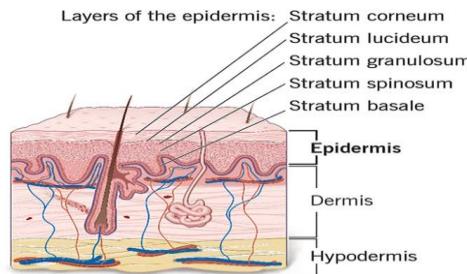


Figure-1: Anatomy of skin.

### What Ceramides Do For Your Skin

- Strengthens Skin Barrier: They are key components (30-40%) of the skin's outer layer (*stratum corneum*).
- Locks in Moisture: Prevents water loss, keeping skin hydrated and plump.
- Protects from External Threats: Shields against allergens, toxins, UV rays, and germs.
- Soothes & Calms: Helps reduce dryness and irritation, making them great for sensitive skin.

### Why You Might Need Them:

- Aging: Natural ceramide production decreases as you get older.

### Key structural features

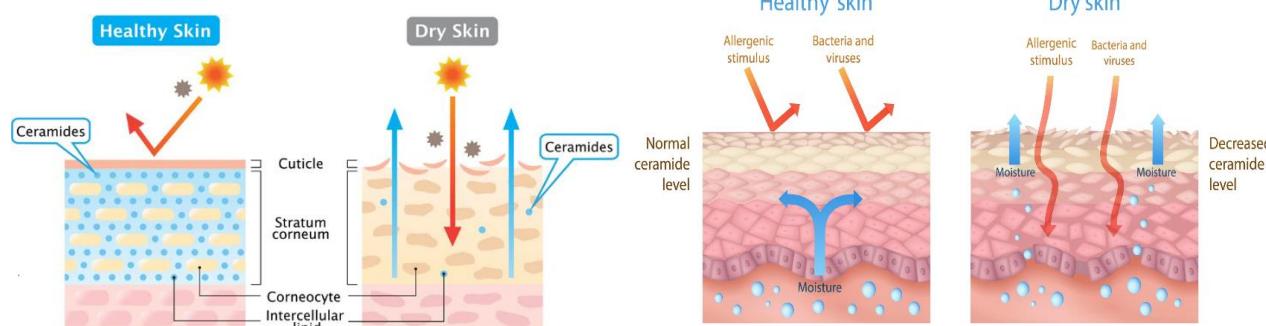


Figure-2: Healthy skin & Dry skin difference.

Backbone: A C18 (18-carbon) hydrocarbon chain.

### Functional Groups:

1. Hydroxyl (-OH) at C1 and C3.
2. Amino (-NH<sub>2</sub>) group at C2.
3. Unsaturation: A trans double bond (4E) in the hydrocarbon chain.
4. Chirality: Specific stereochemistry, typically (2S, 3R) configuration.

- Environmental Stress: Sun, pollution, and harsh weather deplete skin ceramides.
- Skin Conditions: Low ceramide levels are linked to issues like eczema (atopic dermatitis).

### How to Use Them

Look for Products: Find moisturizers, serums, or cleansers with "ceramide" in the ingredient list (e.g., Ceramide NP, EOP, AP).

Apply Damp Skin: Best applied after showering or washing, while skin is still damp, to lock in moisture.

Use Regularly: Aim for twice daily for best results.<sup>[5-8]</sup>

Check for Reactions: While generally safe, stop use if redness or itching occurs.



Figure-3: Backbone structure of ceramides.

Simplified breakdown: Imagine a long oily tail (the hydrocarbon chain) with a head containing two alcohol groups and an amino group, plus a kink from the double bond. This structure allows it to interact with both water and lipids, forming important signalling molecules and membrane components.

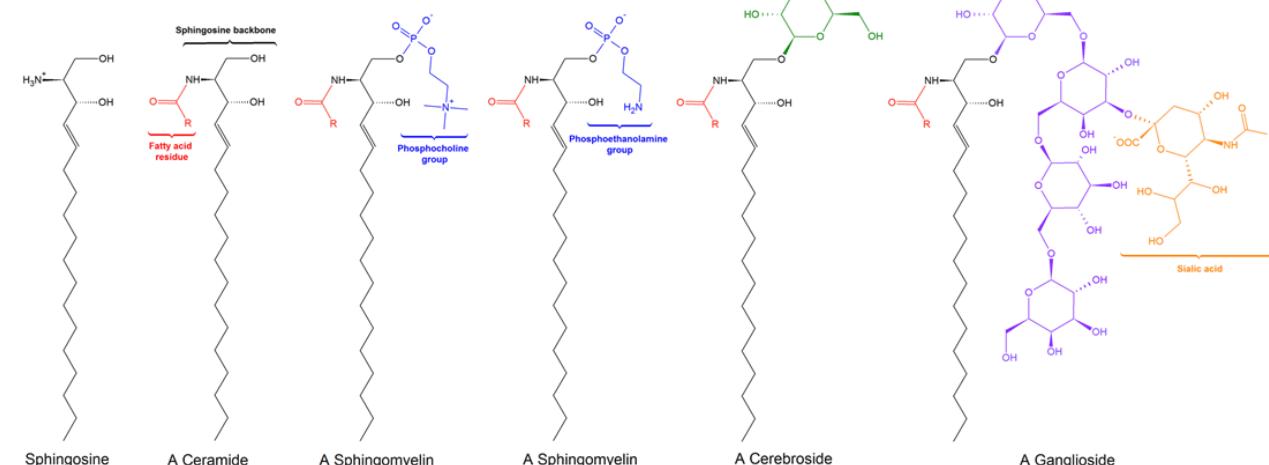


Figure-3: Backbone structure of ceramides.

Ceramides are found in high concentrations within the cell membrane of eukaryotic cells, since they are component lipids that make up sphingomyelin, one of the major lipids in the lipid bilayer. Contrary to previous assumptions that ceramides and other sphingolipids found in cell membrane were purely supporting structural elements, ceramide can participate in a variety of cellular signaling: examples include regulating differentiation, proliferation, and programmed cell death (PCD) of cells.

Sphingolipids are complex lipids featuring a sphingoid base (like sphingosine) backbone, an amide-linked fatty acid, and a polar head group (sugars, phosphate, or choline) attached to the base's C1-hydroxyl, creating an amphipathic molecule crucial for cell membranes, especially lipid rafts, and cell signaling. Unlike glycerophospholipids, they lack glycerol, instead using a long-chain amino alcohol (sphingoid base) with an amino group at C2 and hydroxyls at C1, C3, and sometimes C4, forming diverse structures like ceramides, sphingomyelins, and glycosphingolipids (gangliosides).<sup>[9-12]</sup>

#### Core Structure Components

1. Sphingoid Base: A long-chain amino alcohol (e.g., sphingosine or sphinganine) forming the backbone, distinguished by an amino group at C2 and hydroxyls.
2. Fatty Acid: Attached via a strong amide bond to the amino group (C2) of the sphingoid base, contributing to the hydrophobic tail.
3. Polar Head Group: A hydrophilic group attached to the C1 hydroxyl, defining the specific type of sphingolipid.

#### Major Classes

1. Ceramides: The basic unit, consisting of just the sphingoid base and fatty acid.
2. Sphingomyelins (Phosphosphingolipids): Contain a phosphorylcholine (or phosphoethanolamine) head group.
3. Glycosphingolipids: Head group is a sugar (carbohydrate).
4. Cerebrosides: One sugar (glucose or galactose).
5. Gangliosides: Complex oligosaccharide chains, often containing sialic acid, abundant in neuronal membranes.

#### Key Features & Functions

- Amphipathic: Both hydrophobic (fatty acid/base) and hydrophilic (head group) parts.
- Membrane Structure: Rich in lipid rafts, influencing membrane fluidity and protein organization, especially in nerve cells.

Signalling: Serve as bioactive molecules and precursors for signalling molecules like sphingosine-1-phosphate (S1P).

The word ceramide comes from the Latin **cera** (wax) and **amide**. Ceramide is a component of *vernix caseosa*, the waxy or cheese-like white substance found coating the skin of newborn human infants. Ceramides are crucial lipids that act as the "glue" holding skin cells together, forming a vital protective barrier that locks in moisture, prevents dryness, and shields skin from irritants, pollutants, and microbes, keeping it hydrated, smooth, firm, and healthy. They are essential for maintaining skin's strength, suppleness, and elasticity, with levels naturally declining with age, making topical ceramide products beneficial for restoring skin health and reducing signs of aging like fine lines.<sup>[13-16]</sup>

#### Functions of Ceramides.

- Hydration & Moisture Retention: They prevent Transepidermal Water Loss (TEWL), keeping skin plump and moisturized.
- Barrier Protection: They reinforce the skin's natural barrier, blocking environmental damage, allergens, and bacteria.
- Soothing & Calming: By locking in moisture, they relieve dryness, irritation, and flaky skin, often associated with eczema.
- Anti-Aging: Well-hydrated skin with a strong barrier appears firmer, smoother, and reduces the appearance of wrinkles.

Improved Texture: They contribute to softer, suppler skin by enhancing overall hydration and barrier function. Neither ceramides nor hyaluronic acid is inherently "better"; they serve different but complementary roles, with Hyaluronic Acid (HA) attracting water for plumpness and Ceramides locking that moisture in and repairing the skin's protective barrier, making both essential for healthy, hydrated skin, especially when used together. Choose HA for instant hydration and plumpness (good for dehydrated/oily skin) and Ceramides for barrier repair and long-term resilience (best for sensitive, dry, or aging skin), but the ideal is a combo product or layering.

#### Choose Hyaluronic Acid if

1. Your main goal is quick hydration and plumping.
2. You have dehydrated, dull, oily, or combination skin and need moisture without greasiness.
3. You want to smooth fine lines through moisture retention.

#### Choose Ceramides if:

1. Your skin feels sensitive, irritated, or compromised (like eczema/rosacea prone).
2. You need to strengthen your skin's barrier to prevent moisture loss.
3. You have dry, aging, or flaky skin that needs long-term repair.

#### The Best Approach: Use Both!

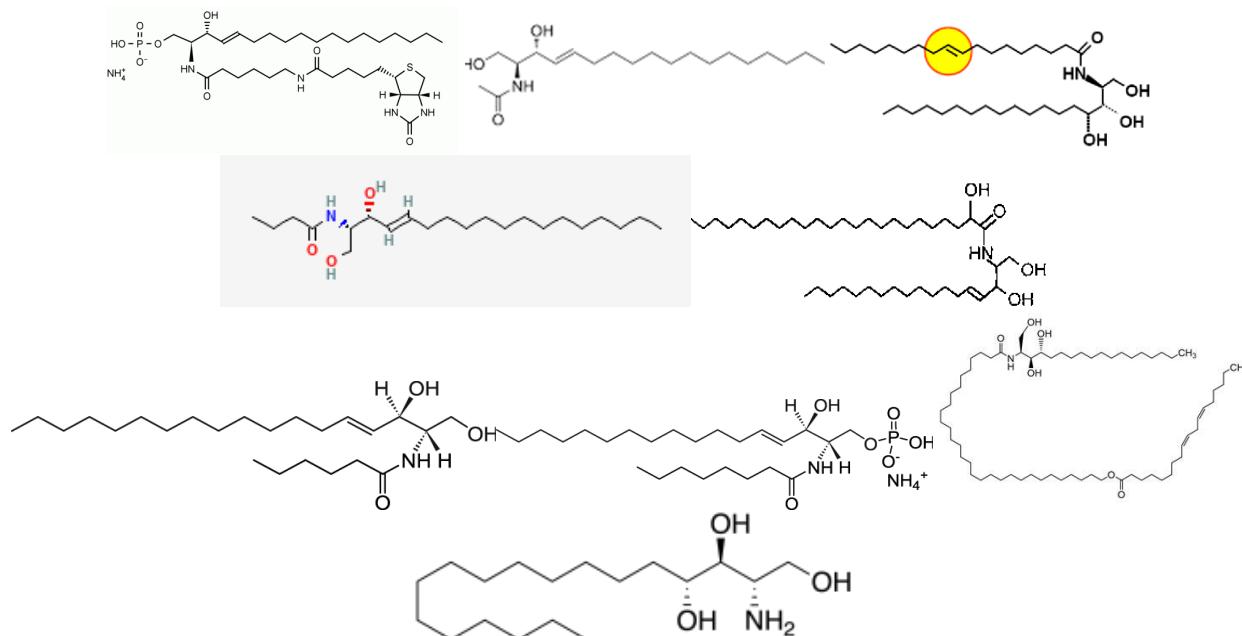
Layering: Apply an HA serum to damp skin for hydration, then seal it in with a ceramide-rich moisturizer to prevent evaporation and strengthen the barrier.

Combined Products: Many effective moisturizers and serums already contain both for a synergistic effect, offering both instant hydration and lasting protection.

All CeraVe skincare products contain 3 essential ceramides- type 1, 3 and 6-II. They work towards strengthening the skin's natural barrier, providing lasting moisture to the skin and preventing dryness and irritation. Ceramide III B differs from Ceramide III in that it has one unsaturated bond in its fatty acid chain. Ceramide III and Ceramide III B support the renewal of the skin's natural protective layer and form an effective barrier against moisture loss.

**Ceramide 1 (Ceramide EOS)** is a crucial lipid in the skin's outer barrier, known for its unique structure (omega-hydroxy fatty acid linked to sphingosine) that helps organize skin lipids, lock in moisture, maintain plumpness, and protect against dryness and external irritants, making it vital for healthy, hydrated skin, especially as we age or deal with conditions like eczema. It's a key component in cosmetic formulations for skin barrier repair and hydration.

It retains the moisture level and hydrates skin. Ceramides help decrease the transepidermal water loss that leads to inflamed and dry skin. They instead form a protective film on your skin that doesn't allow the water to evaporate, helping you keep your skin moisturized & plump.<sup>[17-19]</sup>



**Figure-4: Ceramide-1, Ceramide-2, Ceramide-3, Phytosphingosine skeleton.**

Key Functions & Characteristics.

- Skin Barrier Support: Forms part of the stratum corneum's complex lipid structure, essential for the skin's protective barrier.
- Moisture Retention: Its ability to hold water keeps skin hydrated, soft, and plump.
- Anti-Aging: Prevents moisture loss and maintains skin elasticity, combating dryness and signs of aging.
- Unique Structure: Contains linoleic acid attached to a long-chain omega-hydroxy acid, contributing to its role in skin organization.
- Cosmetic Ingredient: Found in moisturizers and serums to restore skin health, especially for sensitive or dry skin.

Related Compound: Ceramide 1-Phosphate (C1P)

- Bioactive Metabolite: A different molecule involved in cell signaling, inflammation, and cell survival, with both pro-inflammatory and anti-inflammatory roles.

**Ceramide-4, Ceramide-5, Ceramide-6, Ceramide-9,**

- Cellular Processes: Regulates cell growth, differentiation, migration, and apoptosis (cell death).
- Inflammation Mediator: Can activate pathways leading to the production of inflammatory molecules, relevant in conditions like asthma or inflammatory bowel disease (IBD).

**Ceramide 2** is an essential skin molecule that is able to capture and bind water required by the epidermis to remain supple, smooth and hydrated. This product is used in make-up products, skin and body care for dry and mature skin. It also fights against skin aging and preserves the skin's youth. Ceramide 2 provides restructuring function and maintains moisture and integrity of the cutaneous barrier. It is synthetic in origin.

Due to its versatile and skin-healing properties, ceramide 3 is found in a variety of skincare products, such as moisturizers, cleansers, serums, and eye creams. It is

particularly popular in formulations aimed at treating conditions like eczema, rosacea, and psoriasis.<sup>[20-22]</sup>

**Ceramide 3 (also known as Ceramide NP)** is a crucial lipid used in skincare to repair and strengthen the skin's protective barrier, preventing moisture loss and defending against irritants, making it ideal for dry, sensitive, or damaged skin (like eczema/psoriasis). It works by replenishing natural ceramides, locking moisture in, soothing redness, and improving skin smoothness and firmness, found in moisturizers, serums, and cleansers, often paired with glycerin for best results.

#### Key Uses & Benefits

- **Moisture Retention:** Forms a protective layer to stop water from evaporating, keeping skin hydrated.
- **Barrier Repair:** Replenishes skin lipids, repairing micro-damage and improving resilience.
- **Soothes Irritation:** Calms inflamed, flaky, or sensitive skin.
- **Anti-Aging:** Maintains skin elasticity and plumpness, reducing fine lines.
- **Protects Skin:** Shields against pollutants, allergens, and bacteria.

#### How to Use

- **In a Routine:** Use daily in moisturizers, serums, cleansers, or eye creams, even with other actives like retinol or vitamin C.
- **Pair with Glycerin:** Glycerin draws water in, while ceramides lock it down, creating a powerful hydration duo.
- **For Hair:** Helps flatten hair cuticles for shine and reduced frizz.

#### Product Examples

Moisturizers (e.g., Cetaphil Restoraderm)

Serums

Cleansers

Lipsticks (safe up to 10% concentration)

**Ceramide 4** aids in strengthening the skin's protective barrier, preventing moisture loss and maintaining skin elasticity.

Ceramides in cosmetics are essential lipids that mimic the skin's natural fats, acting as "mortar" between skin cells ("bricks") to form a strong, protective barrier that locks in moisture, keeps out irritants, soothes dryness, and promotes healthier, smoother, and more resilient skin, making them vital in moisturizers, cleansers, and barrier repair products, especially for dry or sensitive skin.

#### What Ceramides Do

**Strengthen Skin Barrier:** They make up over 50% of the skin's outer layer, holding cells together to prevent moisture loss and shield against environmental damage (toxins, allergens).

**Hydrate & Soothe:** By preventing water loss, they keep skin hydrated, reducing dryness, flakiness, and irritation, and soothing sensitive skin.

**Promote Healthy Skin:** They support the skin's structure, flexibility, and function, leading to a smoother complexion and preventing issues like itching or inflammation.

#### Why They're Used in Cosmetics

**Replenish Naturally Lost Ceramides:** Skin's natural ceramide levels decrease with age and environmental stress (hot showers, harsh weather), so cosmetic application helps replenish them.

**Treat Skin Conditions:** Deficiencies are linked to eczema (atopic dermatitis) and psoriasis, making ceramide products beneficial for barrier repair.

**Work with Other Ingredients:** They balance ingredients like Retinol (for renewal) by providing foundational comfort and barrier support, and pair well with Hyaluronic Acid to manage oil production.

#### Types & Where to Find Them

**Ingredient Names:** Look for "Ceramide NP," "Ceramide EOP," "Ceramide AP," "Phytosphingosine," or "Sphingosine" on labels.

**Product Types:** Found in cleansers, moisturizers (AM/PM lotions), serums, and lotions designed for dry or sensitive skin.

**Natural Sources:** Plant oils like wheat germ, rice bran, and jojoba oil contain ceramide-like compounds that support skin barrier function.



Figure-5: Ceramides in cosmetics.

**Ceramide 5 AS** is a skin care ingredient used mainly for its hydration and barrier repair benefits. It's part of a larger group of ceramides (natural moisturizing factors that are found in skin) including ceramide NG and ceramide AP. You might be familiar with this ingredient under the names ceramide 4 and ceramide 5.

**Ceramide 6 (or Ceramide VI, Ceramide 6-II, Ceramide AP)** is a specific type of lipid crucial for skin health, supporting barrier function, hydration, and cell turnover, often found in moisturizers, while CerS6 (Ceramide Synthase 6) is the enzyme that produces certain ceramides, linked to inflammation and kidney disease, making it a target for therapies. In skincare, it helps fortify the skin's protective layer, preventing moisture loss, and is beneficial for aging or dry skin. Omega 6 ceramides, rich in linoleic acids, rebuild and reconstitute the lipid matrix for increased firmness and elasticity. Ceramides are lipids that are found naturally in the uppermost layer of skin and comprise of over 50% of our skins composition.

### Sphingosine



### Ceramide

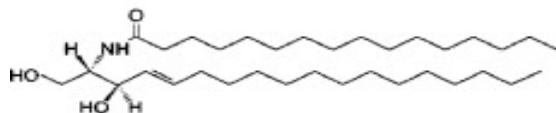


Figure-6: Sphingosine structure.

#### How to Use (Skincare)

Look for it in moisturizers, serums, and other barrier-repair products.

It's generally safe and effective for daily use on all skin types, including sensitive skin, to maintain a healthy complexion.

#### Ceramide 6 (specifically)

Ceramide 6-II or Ceramide AP) is a popular skincare ingredient that helps strengthen the skin's protective barrier, improve hydration, soothe irritation, and support cell turnover, making it great for dry, sensitive, eczema-prone, or aging skin by repairing damage and locking in moisture. You use it in moisturizers, serums, and cleansers to restore skin health and protect against environmental stressors.<sup>[23-25]</sup>

#### Key Uses & Benefits

- **Barrier Repair:** Reinforces the skin's natural lipid barrier, reducing moisture loss (TEWL).
- **Hydration:** Locks in moisture, keeping skin soft, plump, and hydrated.
- **Soothes Sensitivity:** Calms inflamed, red, or distressed skin, ideal for conditions like rosacea or eczema.

#### In Skincare & Cosmetics

- **Barrier Support:** Helps rebuild the skin's lipid barrier, improving its ability to retain moisture.
- **Cell Turnover:** Promotes normal skin cell shedding (desquamation).
- **Moisture Retention:** Keeps skin soft, plump, and hydrated, combating dryness associated with aging or conditions like eczema.

**Common Names:** Also known as Ceramide VI, Ceramide 6-II, or Ceramide AP (N-acyl phytosphingosine).

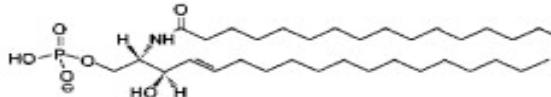
#### In Biology & Medicine.

- **Ceramide Synthase 6 (CerS6):** An enzyme that produces specific ceramides (like C16-ceramide).
- **Kidney Disease:** Upregulated in diabetic kidney disease and other conditions, potentially triggering inflammation by activating immune pathways.
- **Cancer Research:** Short-chain ceramides (like C6) have shown anti-tumor effects, inducing cell death and inhibiting proliferation.

### Sphingosine-1-P



### Ceramide-1-P



- **Supports Cell Turnover:** Helps normalize skin's natural shedding process (desquamation).
- **Anti-Aging:** Maintains skin suppleness and elasticity as you age, preventing dryness.

#### How to Use

- **Product Types:** Look for it in moisturizers, serums, lotions, and even face washes.
- **Application:** Apply after serums (like hyaluronic acid) onto slightly damp skin to lock in hydration, both morning and night for very dry skin, or evening for lighter use.
- **For All Skin Types:** Gentle and non-comedogenic, making it suitable for acne-prone skin too, especially when combined with other actives like retinoids.

Ceramide 6 (CER6) isn't a single molecule but refers to ceramides formed by acylating phytosphingosine with an alpha-hydroxy fatty acid (AHFA), creating a complex skin lipid with specific stereochemistry (2S, 3S, 4R) and structural features like an unsubstituted carbonyl at C3, influencing its biological roles in skin barrier function, antioxidant activity, and cell signalling. The structure varies greatly depending on the specific AHFA chain length, but always involves a phytosphingosine base

linked to an AHFA, forming unique interactions within the skin's lipid matrix.

#### Key Structural Features

- **Phytosphingosine Backbone:** Derived from sphingosine, but with an added hydroxyl group at C4.
- **Alpha-Hydroxy Fatty Acid (AHFA):** The fatty acid attached at the C2 position has a hydroxyl group on the alpha-carbon (next to the carbonyl), differentiating it from common ceramides.
- **Stereochemistry:** Natural human CER6 has a specific (2S, 3S, 4R) configuration, crucial for skin function.
- **Nomenclature:** Often called Ceramide 6 II (now retired/rename as Ceramide AP), or simply Ceramide 6 (CER6).

#### Structural Variations

- **Chain Lengths:** The fatty acid chain (e.g., 16:0, 24:0) and the phytosphingosine chain (e.g., 18 carbons, d18:1) vary, leading to diverse CER6 structures (e.g., d18:1/16:0).
- **Polymorphism:** Different CER6 structures exhibit various physical forms (polymorphs) and interact differently with cholesterol and other skin lipids, affecting membrane fluidity.

#### Biological Significance

- **Skin Barrier:** A vital component of the skin's intercellular lipid matrix, contributing to its water retention and protection.
- **Cell Signalling:** Induces apoptosis (cell death) and scavenges reactive oxygen species (ROS), playing roles in inflammation and cell regulation.

In essence, think of CER6 as a specialized ceramide class with an added hydroxyl on its fatty acid, giving it unique properties for skin health and cellular signalling, with specific isomers being the most biologically active.

**Ceramide 7** ( $C_{42}H_{83}NO_5$ ) is a specific type of ceramide, a lipid with a backbone of a sphingoid base (like sphingosine) linked to a fatty acid via an amide bond, but this "Ceramide 7" seems to refer to a very long-chain (C24) fatty acid (tetracosanamide) attached to a hydroxylated sphingoid base (phytosphingosine/4-hydroxysphinganine), forming a complex phytoceramide, crucial for skin barrier function and cell signalling, differing from simpler Ceramides by its specific long chains and hydroxyl groups, influencing membrane structure and cellular processes like apoptosis. **Core Structure Sphingoid Base:** A long-chain amino alcohol (e.g., sphingosine, sphinganine, or phytosphingosine). **Fatty Acid:** A long chain (typically 14-26 carbons) attached to the amino group of the sphingoid base. **Linkage:** An amide bond connects the fatty acid to the sphingoid base. **Ceramide 7 Specifics** (based on PubChem and DrugBank data) **Formula:**  $C_{42}H_{83}NO_5$ . **Type:** It's a Phytoceramide, meaning its

sphingoid base is 4-hydroxysphinganine (phytosphingosine). **Fatty Acid:** It has a long, saturated fatty acid chain, often specified as a tetracosanamide (C24) in some contexts, with hydroxyl groups.

**Key Feature:** Contains multiple hydroxyl groups (at C1, C3, and the 4-position of the base) and a trans double bond (at C4-C5) in the sphingoid backbone, plus the N-linked fatty acid, making it highly polar and influential in lipid packing. **Function Skin Barrier:** Vital for organizing the lipid matrix in the stratum corneum, controlling water loss. **Cell Signaling:** Acts as a second messenger, regulating cell growth, programmed cell death (apoptosis), and senescence. In essence, Ceramide 7 is a highly specific, complex phytoceramide with long fatty acid chains and hydroxylated backbones, contributing significantly to skin health and cellular communication.

**Ceramide 8** (C8) structure refers to a ceramide with a short, 8-carbon fatty acid chain, attached via an amide bond to a sphingoid base (like sphingosine or dihydrosphingosine), forming a lipid essential for skin barrier function, with the "8" specifically indicating the fatty acyl length, differing from common long-chain ceramides (C16, C24) but still playing a role in skin health.

#### Basic Ceramide Structure

- **Sphingoid Base:** A long-chain amino alcohol (typically 18 carbons, like sphingosine).
- **Fatty Acid:** A fatty acid (the "8" in Ceramide 8 means an 8-carbon fatty acid).
- **Amide Linkage:** The fatty acid attaches to the amino group (C2) of the sphingoid base.
- **Hydroxyl Groups:** The sphingoid base has hydroxyl groups (OH) at C1 and C3, and often a trans double bond between C4 and C5 (d18:1).

**Ceramide 8 (C8) Structure Details: Shorter Chain:** Instead of the typical longer fatty acids (C24, etc.), C8 has a short-chain fatty acid (e.g., octanoic acid).

**Classification:** It's often denoted as Cer (d18:1/8:0) or similar, indicating an 18-carbon base with one double bond and an 8-carbon (0 unsaturations) fatty acid.

**Function:** While long-chain ceramides are key for skin structure (*stratum corneum*), shorter ones like C8 are also found and their decrease is linked to increased water loss, showing their importance in maintaining skin integrity and hydration.

In essence, Ceramide 8 is a specific type of ceramide with a very short fatty acid component, part of a broader family of lipids crucial for cell membranes and skin barrier function.

**Ceramide 9** (Cer 9) isn't a single, fixed molecule but refers to a specific.

type of complex ceramide found in skin's stratum corneum, characterized by its unique headgroup structure (often an epoxy-hydroxy or related form) attached to a fatty acid and sphingoid base, differing from simpler ceramides by having a modified, often oxygenated, acyl chain, crucial for forming stable lipid structures and barrier function, unlike basic ceramide structures.

#### Basic Ceramide Structure (The Backbone)

All ceramides share a core structure

- Sphingoid Base: A long-chain amino alcohol (like sphingosine, phytosphingosine).
- Fatty Acid: A long-chain fatty acid.
- Amide Bond: Links the fatty acid to the sphingoid base.

What Makes Ceramide 9 Unique (The "9"): The number 9 (Cer 9) in skin biology often refers to specific, complex ceramides that are essential for the skin's barrier, especially in the outermost layer (*stratum corneum*).

Modified Acyl Chains: Cer 9 often involves fatty acids that are hydroxylated (have extra -OH groups) or have epoxy groups (like in "epoxy-hydroxy ceramides"), creating a unique, highly polar headgroup.

Protein-Bound: Some of these complex ceramides (like P-O ceramides or P-EO ceramides) become covalently linked to skin proteins, stabilizing the entire skin barrier structure.

Complex Assembly: These complex ceramides, along with cholesterol and free fatty acids, form highly ordered lamellar sheets, like a brick-and-mortar structure, that lock in moisture and keep irritants out.

In essence, Ceramide 9 isn't just C18:0/16:0 (a simple type), but a more elaborate ceramide with added oxygenation/epoxidation, enabling deeper integration and stability within the skin's lipid matrix, say researchers at the National Institutes of Health (NIH).

Analogy: Think of basic ceramides as building blocks, while Ceramide 9s are specialized, reinforced blocks that create stronger, more intricate structures for superior skin protection, note researchers at Creative Proteomics.

**Phytosphingosine** is a natural lipid (sphingoid base) vital for skin health, acting as a building block for ceramides, reinforcing the skin barrier, and offering anti-inflammatory and antimicrobial benefits, making it great for acne and irritated skin. Found in plants, fungi, and animals, it helps with skin repair, hydration, and protecting against environmental damage, often used in cosmetics for anti-aging and barrier support.

#### Key Functions & Benefits

**Skin Barrier Support:** Stimulates ceramide production, crucial lipids that keep skin hydrated and protected.

**Anti-inflammatory:** Calms redness and irritation, beneficial for acne and conditions like eczema.

**Antimicrobial:** Fights acne-causing bacteria (like *P. acnes*).

**Hydration:** Reduces transepidermal water loss (TEWL).

**Immune Regulation:** Acts as an immune regulator in skin.

#### In Skincare

**Usage:** Found in serums, moisturizers, eye creams, and makeup.

**Compatibility:** Generally safe and compatible with most ingredients, but patch testing is always wise for sensitive skin.

**Daily Use:** Can typically be used daily for soothing and hydrating effects.

#### Chemical Nature

**Type:** A sphingoid base, a component of more complex sphingolipids in the skin.

**Structure:** A [(2S,3S,4R)-2-Aminooctadecane-1,3,4-triol] 2-amino-1,3,4-triol, distinct from sphingosine (which has a double bond) and sphinganine. Sphinganine (D18:0) is an 18-carbon amino alcohol forming the backbone of sphingolipids, featuring two hydroxyl (-OH) groups and one amino (-NH<sub>2</sub>) group on its saturated chain, differing from sphingosine by lacking a double bond, acting as a key precursor for complex lipids like ceramides, essential for cell structure and signaling. Its structure is (2S,3R)-2-aminoctadecane-1,3-diol, a hydrophobic molecule crucial for membrane integrity, especially in neural tissues. **Key Structural Features:** Backbone: An 18-carbon (C18) aliphatic chain. **Functional Groups:** An amino group (-NH<sub>2</sub>) at C2 and two hydroxyl groups (-OH) at C1 and C3 (hence, diol). **Saturation:** It's a sphinganine, meaning it's fully saturated, unlike sphingosine (D18:1), which has a double bond at C4-C5.

**Stereochemistry:** Typically has a specific (2S,3R) configuration.

**Role in Biology:** Precursor: Synthesized from serine and palmitoyl-CoA, it's acylated to form dihydroceramide, a step before ceramide formation.

**Lipid Building Block:** Serves as the fundamental backbone for all sphingolipids, vital for cell membranes and signal transduction.

**Chemical Representation:** Formula: C<sub>18</sub>H<sub>39</sub>NO<sub>2</sub>.

#### CONCLUSION

Ceramides (pronounced "sair-uh-mydes") are fats or lipids that make up about 50% of your epidermis, which is the outer layer of your skin. "Natural ceramides are those found in the skin of humans and other animals," "Synthetic ceramides are human-made and commonly used in skin care products."

**Types of ceramides:** There are 12 types of ceramides, but these are the three most common ones typically found in over-the-counter serums, moisturizers, lotions, toners and creams.

Ceramide 1, or ceramide EOS

Ceramide 3, or ceramide NP  
Ceramide 6-II, or ceramide AP

When it comes to ceramides for skin health, many products advertise front and center that they feature ceramides. You can also check ingredient labels.

#### Ceramide benefits

Replenishes your skin barrier: Your skin barrier is your top layer of skin, made up of dead cells, proteins, fats and lipids, including natural ceramides. "Ceramides are part fatty acid and part amino acid and are able to be the grout that keeps the building blocks of the skin together and functioning as a barrier between the inside and outside world. "Using skin care products with added ceramides can restore optimal levels of these lipids."

Locks in moisture: Keeping your skin moisturized is important for everyone, but it becomes especially critical as you age. With time, your skin becomes thinner and less elastic, which causes it to lose moisture more easily than in your younger years. But ceramides help lock in moisture to keep your skin soft and plump. "Aging and certain skin conditions, like eczema, involve decreased ceramide levels, which can result in dehydrated or itchy skin. "Products with ceramides help keep your skin healthy and hydrated."

Helps protect your skin: Think about your skin barrier as a suit of armour, blocking bad stuff from getting through to the delicate living organism underneath. And ceramides are one of the knights in shining armour that do the hard work of keeping it safe. To maximize your skin health, pair this lipid with other good-for-you ingredients in your skin care products. They work well with/.

Emollients, which form a film on your skin and help relieve dryness and itchiness.

Humectants, which draw in moisture by attracting and binding water to your skin.

Occlusives, which lock in moisture and hydration but don't dissolve in water.

But what does that mean for you, exactly? To help figure it all out, Dr. Kassouf shares some specific ingredients that work well with ceramides. Look for:

Dimethicone  
Colloidal oatmeal  
Glycerin  
Hyaluronic acid  
Shea butter

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