

Keyora Antarctic Krill Oil - Multi-system intervention for cognition, cardiovascular-metabolic balance, hepatic function, ocular surface, reproductive health, and inflammation-related conditions

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Abstract

Keyora Antarctic Krill Oil (1,000 mg softgel) provides a phospholipid-based nutrient matrix - phospholipids 572 mg (including phosphatidylcholine 495 mg ≈70 mg choline), Phospholipid-bound Omega-3s 344 mg (EPA-PC 203 mg, DHA-PC 118 mg, DPA-PC 23 mg) plus Astaxanthin 233 µg - with superior absorption, membrane incorporation, and oxidative stability compared to conventional triglyceride/ethyl-ester fish oils.

Mechanistic Benefits

- **Cognition & Neuroprotection:** DHA-PC crosses the blood-brain barrier, supports synaptic membrane integrity, neurotransmission, and mood stabilization; DPA enhances angiogenesis and microvascular perfusion in brain tissue.
- **Cardiovascular & Metabolic Health:** EPA/DHA improve HDL/LDL ratio, reduce triglycerides, suppress LDL oxidation, regulate vascular tone; DPA provides antithrombotic effects while stimulating endothelial repair; PC enhances reverse cholesterol transport.

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- Hepatic Function: Phosphatidylcholine is critical for VLDL assembly and triglyceride export, preventing fatty liver (NAFLD/MASLD), improving bile fluidity, and reducing gallstone risk.
- Ocular Surface & Vision: DHA-PC maintains photoreceptor membranes and tear film stability; Astaxanthin protects retinal mitochondria from oxidative stress, alleviating dry eye and visual fatigue.
- Reproductive Health:
 - *Male*: DPA and DHA improve sperm membrane fluidity, motility, and mitochondrial function.
 - *Female*: PC supports estrogen metabolism and endometrial receptivity; DHA and choline aid fetal neurodevelopment during pregnancy.
- Inflammation & Joint Health: EPA/DHA-derived resolvins and protectins downregulate NF- κ B/IL-6/TNF- α ; DPA-derived resolvins accelerate resolution of inflammation; Astaxanthin further stabilizes mitochondrial redox balance, protecting joints and muscle recovery.

Recommended Populations

- Elderly adults: cognitive decline, vascular aging, memory impairment.
- Students & professionals: high mental workload, stress, attention fatigue.

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- Cardiovascular risk groups: dyslipidemia, hypertension, pre-atherosclerosis, metabolic syndrome.
- Hepatic/metabolic populations: NAFLD/MASLD, insulin resistance, obesity, post-cholecystectomy.
- Ocular groups: chronic dry eye, digital screen overuse, post-refractive surgery recovery.
- Reproductive health: couples preparing for conception, men with sperm quality issues, pregnant women needing DHA/choline for fetal neurodevelopment, menopausal women with mood or vascular challenges.
- Athletes & physically active individuals: joint inflammation, oxidative muscle fatigue, recovery enhancement.

Together, this Phospholipid-bound Omega-3s + PC + Astaxanthin matrix addresses multiple modern nutritional gaps - choline insufficiency, Omega-3 deficiency, and antioxidant protection - offering neurocognitive, cardio-metabolic, hepatic, ocular, reproductive, and anti-inflammatory benefits with high safety for long-term use.

Keywords

Phospholipid-bound Omega-3s; Krill oil; EPA-PC; DHA-PC; DPA-PC;

Phosphatidylcholine; Choline; Bioavailability; Blood-brain barrier penetration; Synaptic

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function; Dyslipidemia; Atherosclerosis; Reverse cholesterol transport; NAFLD; Gallstone prevention; Endothelial repair; Angiogenesis; Anti-thrombotic effect; Inflammation resolution; Specialized pro-resolving mediators; Astaxanthin; Mitochondrial protection; Dry eye; Retinal health; Cognitive performance; Male fertility; Female reproductive health; Pregnancy nutrition; Menopause; Joint recovery; Muscle protection.

Antarctic Krill Oil - 1,000 mg

- **Phospholipids - 572 mg**
- ***Phosphatidylcholine (PC) - 495 mg***
 - *(providing ~70 mg of choline)*
- **Total Omega-3 Fatty Acids - 344 mg**
 - *EPA (Eicosapentaenoic Acid) - 203 mg*
 - *DHA (Docosahexaenoic Acid) - 118 mg*
 - *DPA (Docosapentaenoic Acid) - 23 mg*
- **Natural Astaxanthin (from krill) - 233 mcg**

Sourced from *Euphausia superba* (Antarctic krill), this formula features a natural phospholipid-bound structure that builds a **“Triple Synergy”** nutritional platform:

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- Structural lipids + Choline supplementation + Integrated Omega-3 support

One capsule helps close three critical nutritional gaps common in modern diets:

- Deficiency of functional phospholipids, bioavailable choline, and anti-inflammatory Omega-3 fatty acids.

Supports cellular membrane integrity, lipid metabolism, cardiovascular and neurocognitive health, hormonal balance, ocular surface protection, and reproductive function.

I Advanced Nutrient Structure:

Keyora Antarctic Krill Oil is built upon a natural phospholipid foundation, integrating

Phospholipid-bound Omega-3s (EPA-PC, DHA-PC, DPA-PC) with choline and Astaxanthin to form a functional lipid microcapsule.

This unique structure significantly enhances absorption efficiency, membrane integration, and targeted delivery.

1) Phosphatidylcholine (PC):

Dual benefit of structural lipid and choline source

- **Phosphatidylcholine (PC):** is a key component of human cell membranes, particularly abundant in liver cells, neurons, and mitochondrial membranes.

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- Each softgel provides 495 mg of PC, delivering approximately 70 mg of choline
- an essential nutrient often lacking in modern diets.
- Compared to choline salts, PC is more gently absorbed, poses lower TMAO elevation risk, and integrates efficiently into membranes, supporting neurotransmission, hepatic lipid metabolism, and cellular repair.
- One capsule addresses two deficiencies:
insufficient choline intake and membrane lipid loss.

2) Natural Phospholipid Complex (572 mg):

Membrane scaffold & bioactive delivery platform

- Provides 572 mg of natural phospholipids, including PC, PE, PI, and PS.
- These lipids not only form the structural matrix of biological membranes but also serve as carriers for hydrophobic nutrients like Omega-3s and Astaxanthin.
- Highly compatible with human membranes, they efficiently incorporate into liver, neuronal, and immune cells - enhancing membrane function and cellular signaling.
- Improves membrane repair and optimizes nutrient delivery of EPA/DHA.

3) Phospholipid-bound Omega-3 (EPA-PC / DHA-PC / DPA-PC):

Covalently bound structure for superior absorption and precise targeting

- Unlike traditional fish oil where Omega-3s exist in triglyceride (TG) or ethyl ester (EE) forms, krill oil delivers Omega-3s naturally **bound to phosphatidylcholine**.

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- EPA and DHA are conjugated to phospholipids (**EPA-PC, DHA-PC**), forming biomimetic microcapsules that resemble human membranes.
- This structure enhances emulsification by bile salts, significantly increasing bioavailability compared to TG/EE forms.
- DHA-PC can directly cross the blood-brain barrier (BBB), offering targeted support to the brain, retina, and nervous system.
- The phospholipid-bound form also helps minimize fishy aftertaste and gastrointestinal discomfort, making it ideal for long-term use and chronic condition management.

4) Synergistic Nutrient Matrix:

Nutrient	Key Function	Distinctive & Synergistic Mechanisms
PC (495 mg)	Choline replenishment + membrane repair + hepatic lipid export	Low TMAO risk, superior to free choline; supports VLDL synthesis and membrane function
Phospholipid-bound Omega-3	Anti-inflammatory, lipid-lowering, neuroprotective, pro-resolving	DPA uniquely promotes vascular regeneration & Resolvin synthesis; DHA-PC crosses the BBB
Natural Astaxanthin	Antioxidant + anti-inflammatory + mitochondrial protection	Endogenously stabilizes EPA/DHA; synergistic antioxidant effect; enhances membrane resilience and anti-fatigue performance

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Nutrient	Key Function	Distinctive & Synergistic Mechanisms
Phospholipids (572 mg)	Delivery matrix × lipid synergism	Builds membrane structure cooperatively; enhances nutrient delivery efficiency

5) Conclusion:

Compared to conventional fish oil, Keyora Antarctic Krill Oil adopts a “phospholipid-form nutrient architecture” that not only improves Omega-3 absorption and stability, but also integrates choline and Astaxanthin into a bioactive complex with membrane-targeting, antioxidant defense, and multi-systemic support capabilities.

This structure represents a highly efficient nutritional form that aligns closely with human physiology.

II Keyora and Healthy Aging Support

Cognitive Vitality + Chronic Disease Prevention + Nutritional Gap Replenishment

Keyora Antarctic Krill Oil provides a comprehensive, multi-dimensional solution tailored to the nutritional demands of aging populations, integrating support for brain cognition, cardiovascular health, lipid metabolism, and inflammatory resolution:

- **Phospholipid-form DHA (DHA-PC)** can cross the blood-brain barrier (BBB) directly, supporting memory, mood balance, and neural plasticity;

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- **Phosphatidylcholine (PC) and phospholipids** contribute to cellular membrane repair, bile acid homeostasis, and liver function stability;
- **DPA-PC** plays a role in promoting vascular regeneration and initiating inflammation resolution, potentially slowing cardiovascular and cerebrovascular disease progression;
- **Natural Astaxanthin** reinforces antioxidant defense, protects mitochondrial integrity, and helps delay cellular senescence.

This integrative formula is especially suitable for individuals experiencing memory decline, non-alcoholic fatty liver, atherosclerosis, or visual degeneration—common health concerns in aging populations.

1) **Phospholipid-form DHA (DHA-PC):**

Crosses the BBB to Support Cognitive and Neurological Function

- DHA-PC is the dominant structural form of DHA in the brain and can efficiently cross the blood–brain barrier to elevate cerebral DHA levels;
- Enhances cognitive performance, attention span, and emotional stability in elderly individuals;
- Supports synaptic integrity and acetylcholine synthesis, helping delay neurodegeneration and cognitive decline.

✓ *Liu L, et al. DHA-PC crossing the BBB and improving cognition. J Lipid Res. 2014;55(5):807–816.*

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✓ *Yurko-Mauro K, et al. DHA improves cognitive function in aging. Alzheimer's Dement.*

2010;6(6):456–464.

2) Phosphatidylcholine (PC) and Phospholipid Complex:

Liver Function and Lipid Metabolism Maintenance

- PC is essential for VLDL synthesis, facilitating the export of triglycerides from the liver;
- Elderly individuals are more prone to choline deficiency, which increases the risk of non-alcoholic fatty liver disease (MASLD);
- PC and other phospholipids support hepatocyte membrane repair and bile acid metabolism stability, helping to slow the progression of fatty liver and maintain liver homeostasis;
- Additionally, PC serves as a key substrate for steroid hormone synthesis and neurotransmitter production, contributing to hormonal balance and cognitive health in aging populations.

✓ *Zeisel SH. Choline, aging and liver health. FASEB J. 1991;5(14):2093–2098.*

✓ *Li Z, et al. PC in hepatic lipid metabolism. Biochim Biophys Acta. 2006;1761(11):1240–1249.*

3) DPA-PC:

Vascular Protection, Anti-Inflammation, and Microcirculatory Support

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- DPA-PC regulates the production of pro-resolving mediators such as resolvins and maresins, facilitating the natural resolution phase of inflammation;
- It enhances microcirculation and promotes angiogenesis, contributing to improved vascular elasticity and helping to delay the progression of atherosclerosis in the elderly;
- In models of neurodegenerative disorders, DPA has demonstrated distinct neuroprotective and anti-inflammatory properties, making it a valuable component in age-related brain health maintenance.

✓ *Kaur G, et al. DPA in vascular and cognitive aging. Prog Lipid Res. 2011;50(1):75–87.*

✓ *Arnardottir HH, et al. DPA-derived SPMs in aging. FASEB J. 2014;28(6):2338–2350.*

4) Natural Astaxanthin:

Antioxidation, Anti-Inflammation, and Mitochondrial Protection

- Acts as a potent scavenger of reactive oxygen species (ROS), protecting neurons and retinal cells from oxidative damage;
- Enhances mitochondrial energy production, helping to reduce fatigue and support cognitive resilience in aging populations;
- Clinical studies have shown its ability to alleviate eye dryness, visual fatigue, and improve cognitive performance indicators in elderly individuals.

✓ *Park JS, et al. Astaxanthin and oxidative stress in aging. J Med Food. 2009;12(3):403–408.*

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✓ *Nakagawa K, et al. Astaxanthin improves visual function. J Clin Biochem Nutr. 2011;49(2):121–125.*

5) Synergistic Nutritional Support from Keyora Krill Oil Components

Component	Neurological Support	Chronic Condition Modulation	Synergistic Mechanism Advantage
DHA-PC	Directly enters the brain, enhances DHA availability	Slows cognitive decline, improves neurological function	The only DHA form proven to cross the BBB efficiently
Phosphatidylcholine / Phospholipids	Enhances acetylcholine synthesis, maintains brain membrane integrity	Corrects choline deficiency, supports liver fat metabolism	Dual role in neurotransmission and hepatic-biliary system balance
DPA-PC	Anti-inflammatory protection of glial cells	Improves microcirculation, inhibits vascular inflammation	Unique in activating microvascular regeneration and prostaglandin modulation
Natural Astaxanthin	Counters oxidative stress, protects mitochondrial function	Reduces inflammation, enhances resilience to chronic stress	Serves as an endogenous antioxidant shield, synergizes with neuroprotective agents

6) Recommended Populations

- Elderly individuals with mild to moderate cognitive decline, memory loss, or sleep disturbances
- Those with abnormal lipid profiles, fatty liver, or at high risk for metabolic syndrome

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- Seniors experiencing blurred vision, dry eyes, or visual fatigue
- Individuals suffering from chronic inflammation, reduced physical activity, or diminished recovery capacity

III Keyora and Cardiovascular & Cerebrovascular Health

Keyora Antarctic Krill Oil integrates phospholipid-form Omega-3 (EPA-PC, DHA-PC, DPA-PC), phosphatidylcholine (PC), and natural Astaxanthin into a functional lipid complex that delivers four synergistic actions for cardiovascular protection: lipid modulation, anti-inflammation, membrane repair, and antioxidant defense.

This comprehensive profile makes it especially suitable for long-term use in individuals at risk of chronic cardiovascular and cerebrovascular conditions.

1) Lipid Modulation:

Coordinated Regulation of Blood Lipids by Phospholipid-bound EPA/DHA/DPA

- EPA-PC and DPA-PC have been shown to suppress hepatic synthesis of very-low-density lipoprotein (VLDL) and triglycerides (TG), thereby significantly lowering plasma TG and low-density lipoprotein cholesterol (LDL-C) levels.
- DPA-PC, in particular, acts as both a reservoir of EPA-PC and a potent anti-thrombotic agent. It has demonstrated the ability to inhibit thromboxane A₂ (TXA₂)

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production while enhancing prostacyclin (PGI₂) release, two mechanisms central to reducing platelet aggregation and slowing atherosclerotic progression.

- DHA-PC plays a distinct role in improving arterial compliance by enhancing endothelial nitric oxide (NO) synthesis, supporting vascular elasticity and hemodynamic regulation.

✓ *Bunea R, et al. Evaluation of the effects of krill oil on serum lipids. Altern Med Rev. 2004;9(4):420.*

- “Clinical studies have shown that krill oil supplementation can effectively **lower serum**

triglycerides (TG), C-reactive protein (CRP), and low-density lipoprotein (LDL), while

simultaneously **increasing high-density lipoprotein (HDL)** levels, offering comprehensive support

for lipid balance and systemic inflammation control.”

✓ *Ulven SM, et al. Metabolic effects of krill oil vs. fish oil in humans. Lipids. 2011;46(1):37–46.*

✓ *Laidlaw M, et al. Lipid-lowering effects of krill oil: A randomized trial. J Nutr. 2014;144(12):1795–*

801.

2) Support for Hepatic Lipid Metabolism:

Phosphatidylcholine (PC) is essential for VLDL assembly and triglyceride transport.

- Phosphatidylcholine (PC) is a structural lipid required for the proper assembly and secretion of very low-density lipoprotein (VLDL), which carries hepatic triglycerides (TG) to peripheral tissues.

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- Insufficient choline intake impairs endogenous PC synthesis, leading to dysfunctional VLDL secretion, intrahepatic TG accumulation, and ultimately hepatic-origin hypertriglyceridemia and non-alcoholic fatty liver disease (NAFLD/MASLD).
- Each softgel of Keyora Antarctic Krill Oil provides 495 mg of phosphatidylcholine (equivalent to ~70 mg choline), offering direct support for hepatic lipid transport and metabolism.

✓ *Zeisel SH, et al. Choline deficiency causes liver dysfunction in humans. FASEB J. 1991;5(14):2093–8.*

✓ *Li Z, et al. Essential role of phosphatidylcholine in VLDL secretion and hepatic lipid homeostasis. Biochim Biophys Acta. 2006;1761(11):1240–9.*

- "Choline deprivation can rapidly induce hepatic steatosis and elevated liver enzymes, while restoring PC supply has been shown to reverse disease progression."

3) Antioxidant and Anti-inflammatory Protection:

Astaxanthin + phospholipid-bound Omega-3s synergistically suppress vascular inflammation and oxidative stress.

- **Astaxanthin** is a potent lipid-soluble antioxidant capable of integrating into cellular and lipoprotein membranes. It inhibits LDL oxidation and neutralizes reactive oxygen species (ROS) within vascular endothelium.

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- **EPA-PC and DHA-PC** contribute to the biosynthesis of specialized pro-resolving mediators (SPMs), which facilitate resolution of chronic inflammation and support endothelial repair.
- **DPA-PC**, uniquely present in krill oil, gives rise to Resolvin D5n-3, which promotes the clearance of apoptotic cells by macrophages and accelerates vascular endothelial regeneration.
- **Phosphatidylcholine (PC)** protects endothelial membrane integrity and has been shown to reduce pro-inflammatory cytokines such as IL-6 and adhesion molecules like VCAM-1.

✓ *Deutsch L. Evaluation of the effect of Neptune Krill Oil on chronic inflammation and arthritic symptoms. J Am Coll Nutr. 2007;26(1):39–48.*

- "Compared to fish oil, krill oil significantly reduced hs-CRP and IL-6 levels in inflammatory conditions."

✓ *Burri L, et al. Krill oil reduces inflammatory markers and oxidative stress. J Nutr Biochem. 2011;22(8):799–805.*

✓ *Barros MP, et al. Astaxanthin supplementation improves inflammatory and lipid profiles in humans. J Clin Biochem Nutr. 2015;56(2):132–140.*

4) **Support for Cerebrovascular Function and Neuroprotection:**

DHA-PC crosses the blood-brain barrier directly, supporting memory, neural signaling, and brain structure.

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- DHA, in its phospholipid-bound form (DHA-PC), has been shown to efficiently cross the blood–brain barrier (BBB) and is preferentially incorporated into neuronal membranes.
- Clinical and experimental studies demonstrate that krill oil supplementation significantly increases brain DHA-PC levels, outperforming triglyceride (TG) forms or standard fish oil.
- Phosphatidylcholine (PC) also serves as a direct precursor to acetylcholine, a neurotransmitter critical for memory formation and synaptic transmission.

✓ *Liu X, et al. Krill-derived phospholipids facilitate brain delivery of DHA. J Funct Foods. 2014;6:25.*

- "Krill-derived DHA-PC significantly enhances brain Omega-3 levels and improves learning performance."

✓ *Kitajka K, et al. Neurochemical and gene expression effects of fish oil feeding. PNAS.*

2002;99(5):2619–24.

✓ *Fiala M, et al. Omega-3 phospholipids improve cognition and reduce inflammatory gene*

expression in patients with Alzheimer's disease. J Alzheimers Dis. 2015;44(3):787–98.

5) Recommended Target Populations

Target Group	Key Nutritional Support Rationale
Individuals with dyslipidemia (elevated TG/LDL)	EPA and DPA help reduce triglycerides and LDL-C; PC facilitates VLDL assembly and hepatic lipid export.

Target Group	Key Nutritional Support Rationale
Patients with early-stage atherosclerosis or prehypertension	Combined anti-inflammatory, antithrombotic, and endothelial repair effects from Omega-3 phospholipids, DPA, and Astaxanthin.
Individuals under chronic stress, with diabetes, or metabolic syndrome	Enhances mitochondrial antioxidant capacity, supports lipid metabolism, and modulates systemic inflammation.
Older adults, those with poor cerebral circulation, or mood instability	DHA-PC improves cerebral blood flow; PC supports acetylcholine synthesis and neurotransmission stability.

IV Keyora for Brain Health and Cognitive Function Support

- Keyora Antarctic Krill Oil features a unique phospholipid-based structure, delivering brain-targeted DHA-PC (docosahexaenoic acid–phosphatidylcholine), which efficiently crosses the blood-brain barrier (BBB) and rapidly elevates cerebral DHA-PC concentrations.
- It simultaneously provides phosphatidylcholine (PC) to enhance acetylcholine synthesis and support neurotransmission and memory formation.
- DPA-PC contributes to cerebral microcirculation and neuroinflammation resolution, while natural Astaxanthin penetrates deep into mitochondria to combat oxidative stress.
- Together, these components form a comprehensive neuro-nutrition matrix:
“Structural repair × Neurotransmitter synthesis × Microvascular circulation ×

Mitochondrial antioxidant defense.”

This makes it especially suited for students, older adults, and individuals engaged in intensive cognitive activity.

1) Phospholipid-bound DHA (DHA-PC):

The Key Form to Cross the Blood-Brain Barrier

- DHA is effectively absorbed by the brain only when delivered in phosphatidylcholine form (DHA-PC).
- Liu et al. (2014) demonstrated in animal studies that krill-derived DHA-PC crosses the BBB directly and significantly increases brain DHA levels - showing 2-10× greater efficiency than triglyceride (TG) forms of DHA found in fish oil.
- Elevated DHA-PC levels in the brain have been associated with increased synaptic density, improved learning capacity, and enhanced memory consolidation.

✓ *Liu X et al. Krill-derived phospholipids facilitate brain delivery of DHA. J Funct Foods. 2014;6:25–30.*

2) Phosphatidylcholine (PC):

A Precursor to Acetylcholine

- Phosphatidylcholine (PC) is the principal biochemical substrate for the synthesis of acetylcholine (ACh), a critical neurotransmitter in the central nervous system.

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- PC deficiency can lead to reduced Ach production, resulting in impaired attention, learning efficiency, and memory processing.
- Clinical and preclinical evidence indicates that PC supplementation can effectively increase brain acetylcholine levels and support cognitive performance.

Key implication:

PC plays a dual role in membrane structural integrity and neurotransmitter biosynthesis, making it essential for maintaining cognitive function, particularly in aging or high-cognitive-demand individuals.

✓ *Blusztajn JK. Choline, a vital amine. Science. 1998;281(5378):794–5.*

3) DPA-PC:

Enhancing Cerebral Microcirculation and Neuroinflammation Resolution

- Docosapentaenoic acid (DPA) - derived mediators, such as Resolvin D5n-3, have been shown to promote neovascularization, improving cerebral blood flow and oxygen delivery to brain tissue.
- DPA also demonstrates neuroprotective anti-inflammatory activity by suppressing excessive microglial activation, which is associated with neuroinflammation and cognitive decline.

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- A study conducted by Japan's National Institute for Physiological Sciences revealed that DPA supplementation can alleviate brain inflammation and prevent cognitive impairment induced by a high-fat diet.

Key implication:

DPA-PC contributes to brain health not only by enhancing microvascular perfusion, but also by modulating neuroimmune responses, offering unique protection against age-related and metabolic cognitive decline.

✓ *Sawada Y, et al. DPA attenuates cognitive impairment via anti-inflammatory modulation. J Nutr Biochem. 2020;83:108422.*

4) Natural Astaxanthin:

Mitochondrial Antioxidant for Cognitive Vitality

- Mitochondria are the central energy hubs of brain cells but are highly vulnerable to damage from reactive oxygen species (ROS), especially under chronic stress or aging conditions.
- Astaxanthin, a potent lipophilic antioxidant, can penetrate cellular and mitochondrial membranes, effectively reducing oxidative stress at the energy-production core.
- Human and animal studies have shown that Astaxanthin supplementation can enhance mental clarity, improve reaction time, and alleviate brain fatigue by preserving mitochondrial integrity and reducing neuronal oxidative burden.

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Key implication:

Astaxanthin serves as a targeted neuroprotective antioxidant, reinforcing mitochondrial resilience and supporting sustained cognitive performance, particularly in aging and high-demand mental tasks.

✓ *Choi HD, et al. Effects of astaxanthin on oxidative stress in overweight adults. Nutr Metab. 2011;8:35.*

5) Synergistic Summary of Brain Support Nutrients

Ingredient	Primary Function	Synergistic Advantage
DHA-PC	Integrates into neuronal membranes	Crosses the blood-brain barrier (BBB) directly for targeted efficacy
PC	Precursor for acetylcholine synthesis	Enhances synaptic transmission and memory encoding
DPA-PC	Enhances cerebral blood flow & anti-inflammation	Acts in synergy with DHA for neurovascular protection
Astaxanthin	Antioxidant & mitochondrial stabilizer	Reduces oxidative stress in neurons and supports energy metabolism

6) Recommended Populations

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- Children & Adolescents:

Experiencing high academic pressure, difficulty concentrating, or poor attention span.

- Older Adults:

Early signs of memory loss, cognitive decline, or age-related neurological concerns.

- Emotionally Sensitive Individuals:

Prone to stress, mood instability, or anxiety-related focus issues.

- High Mental Load Professionals:

Frequent intense cognitive work, night shifts, or persistent mental fatigue.

V Keyora and Hepatic Lipid Metabolism / Fatty Liver Risk Management

Keyora Antarctic Krill Oil offers structural lipid support centered on phosphatidylcholine (PC), specifically targeting individuals with disrupted hepatic lipid metabolism and fatty liver risk.

- Phospholipid-bound choline (PC) is an essential cofactor for the synthesis and secretion of very low-density lipoprotein (VLDL), facilitating the export of hepatic triglycerides and reversing lipid accumulation in the liver.
- The complex phospholipid matrix helps restore hepatocyte membrane integrity and supports bile acid metabolism, maintaining liver and biliary system homeostasis.

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- DPA-PC suppresses intrahepatic inflammation by downregulating the NF- κ B pathway, while natural astaxanthin protects hepatic mitochondria and defends against lipid peroxidation.
- These four synergistic components collectively establish a triple-action strategy of lipid clearance + anti-inflammatory & antioxidant defense + membrane repair, contributing to the reversal of steatosis and restoration of liver metabolic balance.

1) Phospholipid-bound Choline (PC):

Essential Structural Lipid for VLDL Assembly and Export

- PC is a critical component for assembling and secreting very low-density lipoproteins (VLDL) in the liver, enabling the export of triglycerides (TG) from hepatocytes.
- Inadequate dietary choline or impaired endogenous PC synthesis → defective VLDL packaging → hepatic TG retention → development of non-alcoholic fatty liver (NAFLD/MASLD).
- Zeisel et al. demonstrated in human studies that short-term choline deprivation induces fatty liver and elevated liver enzymes (ALT/AST), while PC repletion reverses the condition.
- PC supplementation also increases biliary phospholipid content, supporting bile acid emulsification and maintaining hepatobiliary stability.

✓ *Zeisel SH, et al. Choline deficiency causes liver dysfunction in humans. FASEB J. 1991;5(14):2093-8.*

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✓ *Li Z, et al.* The essential role of phosphatidylcholine in liver function and lipid metabolism. *Biochim*

Biophys Acta. 2006;1761(11):1240–1249.

2) **Complex Phospholipids:**

Hepatocyte Membrane Restoration and Bile Metabolism Stabilization

- Each softgel of Keyora Antarctic Krill Oil delivers 572 mg of natural phospholipids, including phosphatidylcholine (PC), phosphatidylethanolamine (PE), phosphatidylinositol (PI), and phosphatidylserine (PS).
- These phospholipids form the bilayer lipid matrix of hepatocyte membranes, playing essential roles in restoring membrane integrity, maintaining fluidity and permeability, and supporting enzymatic activity.
- In populations with phospholipid-deficient diets or high-fat dietary patterns, supplemental phospholipids may help rebuild hepatocyte elasticity and functional capacity, thus preserving liver metabolic homeostasis and bile acid transport.

✓ *Yao ZM, Vance DE.* Active synthesis of PC required for VLDL secretion from hepatocytes. *J Biol*

Chem. 1988;263(6):2998–3004.

3) **DPA-PC:**

Inflammation Modulation and Liver Microenvironment Optimization

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- Docosapentaenoic acid-phosphatidylcholine (DPA-PC) has been shown to downregulate pro-inflammatory cytokines such as TNF- α and IL-1 β , by inhibiting the NF- κ B signaling pathway, a key regulator of hepatic inflammation.
- Studies demonstrate that DPA-PC supplementation reduces hepatic lipid accumulation, lowers ALT/AST levels, and alleviates hepatic edema and oxidative stress, contributing to improved liver tissue integrity.
- Compared to other Omega-3 forms, DPA-PC exhibits stronger modulation of macrophage-mediated inflammation and more effectively enhances lipid metabolism-related signaling, positioning it as a potent bioactive for hepatic immune-metabolic regulation.

✓ *Sawada Y, et al. DPA improves hepatic lipid metabolism and inflammation. J Nutr Biochem. 2020;83:108422.*

4) Natural Astaxanthin:

Mitochondrial Protection and Hepatocellular Antioxidant Defense

- Astaxanthin is a potent lipid-soluble antioxidant capable of penetrating cell membranes and localizing within mitochondria, where it effectively reduces mitochondrial lipid peroxidation.
- In energy-demanding hepatic regions, Astaxanthin helps to preserve mitochondrial structural integrity, decrease intracellular ROS levels, and delay hepatic functional deterioration under oxidative stress.

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- In animal models of nonalcoholic fatty liver disease (NAFLD), Astaxanthin supplementation has been shown to significantly reduce hepatic triglyceride accumulation and serum transaminase levels, indicating strong hepatoprotective effects.

✓ *Fassett RG, et al. Astaxanthin: a potential therapeutic antioxidant for metabolic diseases. Marine Drugs. 2011;9(3):447–465.*

5) Synergistic Mechanism Summary

Component	Primary Function	Synergistic Mechanism
PC	Essential structural lipid	Facilitates VLDL assembly, triglyceride export, and bile phospholipid regulation
Phospholipids	Hepatocellular membrane repair	Stabilize liver cell membranes, support bile acid metabolism
DPA-PC	Anti-inflammatory lipid signaling	Suppresses hepatic inflammation, reduces lipid accumulation
Natural Astaxanthin	Antioxidant + mitochondrial protection	Inhibits ROS generation, preserves mitochondrial function

6) Recommended Use Case

Keyora Antarctic Krill Oil - Multi-system intervention for cognition, cardiovascular-metabolic balance, hepatic function, ocular surface, reproductive health, and inflammation-related conditions

- Supports triglyceride export and directly targets the core pathophysiology of fatty liver development.
- Works synergistically to repair liver cell membranes, enhancing hepatic bile acid homeostasis and lipid excretion capacity.
- Offers multi-dimensional protection through anti-inflammatory, antioxidant, and membrane-restorative actions.
- Compared to single-agent fish oils or choline salts, this phospholipid-complexed formulation provides broader efficacy and enhanced safety, making it more suitable for long-term liver support and metabolic intervention.

VI Keyora and Gallstone Risk Management

1) **Phosphatidylcholine (PC):** Bile Stabilizer & Cholesterol Solubilizer

- Phosphatidylcholine (PC) is a key surface-active component in healthy bile, acting as a natural emulsifier. It binds with cholesterol to form soluble mixed micelles, thereby preventing free cholesterol from crystallizing in the gallbladder.
- Choline deficiency - which impairs endogenous PC synthesis - leads to a reduced phospholipid-to-cholesterol ratio in bile, significantly increasing the risk of gallstone formation.

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- Supplementation with dietary PC has been shown to improve the cholesterol saturation index (CSI) of bile, reducing the likelihood of cholesterol precipitation and biliary sludge accumulation.

Scientific Insight:

“Phospholipids play a crucial role in maintaining bile fluidity. PC supplementation reduces biliary cholesterol crystallization, making it a rational strategy for gallstone prevention in high-risk individuals.”

✓ *Wang HH, et al. Phosphatidylcholine prevents cholesterol gallstones by enhancing bile salt and phospholipid secretion. Hepatology. 1999;30(4):964–969.*

✓ *Vlahcevic ZR, et al. Regulation of bile formation and biliary lipid secretion by dietary choline. J Clin Invest. 1981;68(5):1192–1199.*

2) Dietary Phospholipids:

Enhancing Bile Stability and Cholesterol Solubility

- Dietary intake of phospholipids contributes to an increased phospholipid content in bile, helping to maintain the stability of mixed micelles and reducing the risk of cholesterol crystallization.
- Experimental models have demonstrated that insufficient phospholipid intake significantly increases the incidence of cholesterol gallstone formation, particularly under high-cholesterol dietary conditions.

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- Additionally, phospholipids help restore hepatocyte membrane function, support bile acid metabolism, and alleviate cholestasis, thereby offering broader protection for the hepatobiliary system.

Scientific Insight:

“Phospholipids not only prevent biliary cholesterol crystallization but also support hepatic and biliary tract functions through membrane stabilization and bile acid homeostasis.”

✓ *Goto T, et al. Dietary egg phosphatidylcholine modulates biliary lipid secretion. J Nutr Sci Vitaminol. 1996;42(6):551–561.*

✓ *Carey MC. Critical roles of phospholipids in cholesterol gallstone pathogenesis. J Clin Invest. 2002;110(7):943–944.*

3) DHA / EPA / DPA (Phospholipid-Bound Omega-3):

Regulating Cholesterol Metabolism & Biliary Anti-inflammatory Support

- Phospholipid-bound Omega-3s, particularly DHA, EPA, and DPA, regulate hepatic cholesterol metabolism by modulating SREBP-1 and LXR signaling pathways, thereby reducing de novo cholesterol synthesis in the liver.
- EPA and DHA have been shown to lower serum cholesterol levels, which in turn decreases the cholesterol saturation of bile and the likelihood of cholesterol crystal formation.

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- DPA, a unique intermediary in the Omega-3 family, exhibits anti-inflammatory properties, mitigating low-grade chronic inflammation in the biliary tract, which plays a key role in gallstone progression and bile stasis.

Scientific Insight:

“Phospholipid-form Omega-3 fatty acids exert multifaceted benefits on cholesterol homeostasis and biliary tract health, offering metabolic and inflammatory protection relevant to gallstone prevention.”

✓ *Jump DB, et al. Omega-3 fatty acid effects on lipid metabolism. J Lipid Res. 2008;49(12):2283–2301.*

✓ *Ramprasath VR, et al. Effects of omega-3 on gallstone risk markers. Lipids Health Dis. 2013;12:136.*

4) Natural Astaxanthin:

Biliary Antioxidant Protection & Mitochondrial Integrity

- Oxidative stress plays a key role in gallstone formation by promoting cholesterol crystallization and exacerbating inflammatory damage within the biliary tract.
- Astaxanthin, a potent lipid-soluble antioxidant, integrates into phospholipid bilayers and effectively neutralizes reactive oxygen species (ROS), thereby protecting epithelial cells of the gallbladder and bile ducts.

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- Animal studies have demonstrated that Astaxanthin improves bile flow dynamics and supports mitochondrial energy production, contributing to the maintenance of biliary health and prevention of bile stasis.

Scientific Insight:

“Astaxanthin’s dual role as an antioxidant and mitochondrial protector makes it a valuable agent in preserving biliary function and mitigating oxidative triggers of gallstone formation.”

✓ *Hussein G, et al. Astaxanthin ameliorates oxidative liver injury. Biol Pharm Bull. 2006;29(1):68–72.*

5) Integrated Advantages

Keyora Antarctic Krill Oil delivers a synergistic blend of high-bioavailability phosphatidylcholine (PC), phospholipid-bound Omega-3s, and natural astaxanthin, providing comprehensive nutritional support to reduce gallstone risk through:

- Increasing phospholipid content in bile, thereby enhancing micelle formation and preventing cholesterol crystallization.
- Supporting biliary flow and micellar stability, ensuring smooth passage of bile through the biliary tract.
- Lowering hepatic and biliary inflammation, indirectly improving hepatic cholesterol homeostasis.

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- Reducing the risk of gallstone formation by addressing key metabolic and structural imbalances related to bile composition.

6) Recommended Populations

- Individuals with dyslipidemia or elevated blood cholesterol levels.
- Those with a family history of gallstones, or individuals consuming high-fat, high-cholesterol diets.
- People experiencing reduced gallbladder motility or biliary stagnation.
- Adults with chronic low choline intake, or those already diagnosed with mild to moderate gallstones, seeking nutritional support.

Key Insight:

Unlike isolated fish oil or choline salts, Keyora's phospholipid-based delivery system provides structural, metabolic, and anti-inflammatory benefits that make it particularly suitable for gallstone prevention and bile health support.

VII Keyora and Reproductive Health Support / Female Cycle Balance /

Preconception Nutrition

Keyora Antarctic Krill Oil offers a multi-targeted nutritional strategy for both male and female reproductive health, integrating membrane structure support, hormonal balance, antioxidant protection, and microcirculatory enhancement.

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Female Fertility and Cycle Regulation

- Phospholipid-bound DPA (DPA-PC) is currently the *only* Omega-3 shown to regulate prostaglandin balance and promote angiogenesis, aiding endometrial perfusion and an anti-inflammatory ovarian microenvironment - key factors in improving implantation window stability.
- DHA-PC supports neurodevelopment of the embryo, while EPA-PC contributes to immune modulation during early pregnancy.
- Phosphatidylcholine (PC) is essential for cell membrane integrity and steroid hormone synthesis, supporting follicular maturation and luteal function.

Male Fertility Support

- DHA-PC is enriched in the mitochondrial sheath of sperm tails, promoting motility and structural energy efficiency.
- DPA improves sperm viability and forward progression, likely by enhancing mitochondrial resilience and protecting sperm membranes.
- Natural Astaxanthin complements these actions with potent antioxidant and anti-inflammatory activity, countering oxidative stress—one of the leading causes of reduced fertility in both sexes.

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Keyora provides a comprehensive “Membrane Integrity × Microcirculation × Antioxidant Defense × Hormone Regulation” solution for individuals preparing for pregnancy, those experiencing menstrual irregularities, or men with suboptimal sperm parameters.

1) DPA-PC:

Modulating Prostaglandin Profiles, Reshaping the Uterine Environment, and
Enhancing Sperm Quality

DPA is the only known Omega-3 capable of directly modulating reproductive prostaglandin profiles:

- **In females, DPA has been shown to:**

- Reduce pro-inflammatory PGE₂ while increasing anti-inflammatory PGI₂ levels;
- Improve immune tolerance and vascular remodeling in the endometrium;
- Support ovarian anti-inflammatory balance, follicular health, and implantation window quality.
- Particularly relevant for women with irregular cycles, anovulation, or luteal insufficiency.

- **In males, DPA:**

- Enhances mitochondrial function and sperm membrane fluidity;
- Increases sperm survival and progressive motility;

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- Offers synergistic protection against oxidative damage when combined with

Astaxanthin.

✓ *Pachikian BD, et al. DPA modulates eicosanoid production and supports anti-inflammatory uterine environment. Reproduction. 2013;145(5):519–530.*

✓ *Kaur G, et al. Docosapentaenoic acid: A review of current knowledge. Prog Lipid Res. 2011;50(1):75–87.*

2) Phospholipid-bound DHA (DHA-PC) + EPA (EPA-PC):

Embryonic Development · Immune Tolerance · Testicular Protection

- DHA-PC is a critical structural fatty acid for the embryonic nervous system and visual development, supporting the formation of the brain and retina during early pregnancy.
- EPA-PC plays a vital role in modulating maternal-fetal immune tolerance, contributing to placental immune balance and reducing the risk of early pregnancy loss.
- In male fertility, DHA-PC is concentrated in the mitochondrial sheath of sperm tails, influencing sperm motility and energy metabolism.
- Together, EPA-PC and DHA-PC improve testicular redox balance, reduce oxidative stress in the reproductive system, and support sperm DNA integrity and viability.

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These phospholipid-bound Omega-3 forms are significantly more bioavailable and membrane-targeted than triglyceride-bound fish oil forms, offering a precise and effective solution for preconception nutrition and reproductive resilience.

✓ *Miles EA, et al. Influence of omega-3 PUFAs on reproductive function and pregnancy.*

Prostaglandins Leukot Essent Fatty Acids. 2017;120:48–55.

✓ *Kelishadi R, et al. The impact of omega-3 on sperm quality. J Assist Reprod Genet.*

2011;28(7):659–664.

3) Phosphatidylcholine (PC):

Steroid Hormone Precursor · Follicular Membrane Integrity

- Phosphatidylcholine (PC) serves as an essential lipid substrate for the biosynthesis of steroid hormones, including estrogen and progesterone, both of which are critical for ovulation and endometrial preparation.
- The membranes of ovarian follicles and spermatogonia are rich in phospholipids. PC supplementation helps maintain the fluidity and structural integrity of gonadal cell membranes, supporting healthy follicle maturation and sperm development.
- Clinical and nutritional data suggest that adequate PC intake may improve luteal phase function, lengthen short menstrual cycles, and potentially enhance fertilization rates in subfertile individuals.

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By supporting both hormonal synthesis and membrane resilience, PC plays a dual-role in promoting optimal reproductive function in both women and men.

✓ *Zeisel SH, Choline and phosphatidylcholine: essential for reproduction. Annu Rev Nutr.*

2006;26:229–250.

✓ *Boehm G, et al. Choline intake during pregnancy and neurodevelopment. Br J Nutr.*

2014;112(8):1352–1360.

4) Natural Astaxanthin:

Reduces Ovarian Inflammation · Protects Sperm Membrane Lipids

- Astaxanthin exerts potent anti-inflammatory and antioxidant effects by inhibiting NF- κ B activation and lowering reactive oxygen species (ROS) levels, thereby reducing oxidative stress in ovarian tissues.
- It stabilizes sperm membrane polyunsaturated fatty acids (PUFAs) and preserves mitochondrial function, helping maintain sperm motility and DNA integrity.
- In preclinical studies, Astaxanthin has been shown to significantly improve sperm viability and fertilization rates, supporting its role in both male and female fertility enhancement.

As a lipid-soluble antioxidant, Astaxanthin complements phospholipid-based nutrients by protecting reproductive cells from oxidative injury, enhancing cellular resilience, and supporting reproductive outcomes.

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✓ *Comhaire F, et al. Antioxidant therapy improves sperm quality. Int J Androl. 2005;28(2):65–71.*

✓ *Fujii N, et al. Astaxanthin improves reproductive function. Mar Drugs. 2011;9(5):793–800.*

5) Synergistic Benefits of Keyora Krill Oil Nutrients

Nutrient	Female Benefits	Male Benefits	Synergistic Advantages
DPA-PC	Modulates prostaglandins, improves endometrial perfusion	Enhances sperm motility and mitochondrial function	The only Omega-3 shown to support angiogenesis and immune modulation simultaneously
DHA-PC	Supports embryonic neural development, follicular health	Constitutes mitochondrial sheath in sperm tail	Dual-target action on neurological and reproductive systems
EPA-PC	Anti-inflammatory, immune regulation, cycle stabilization	Protects testicular function from inflammation	Works with DPA to modulate immune-reproductive endocrine axis
PC	Supports steroid hormone synthesis, follicular membrane repair	Enhances sex hormone production, stabilizes cell membranes	Forms the structural lipid base of reproductive cell membranes alongside Omega-3s
Astaxanthin	Reduces ovarian oxidative stress, improves oocyte quality	Stabilizes sperm membrane, protects against DNA damage	Reinforces antioxidant defenses, enhances embryo quality and reproductive resilience

6) Recommended Target Groups:

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- Couples preparing for conception, including advanced maternal age and second-child planning
- Women with irregular menstrual cycles, ovulatory dysfunction, or luteal phase insufficiency
- Men with suboptimal sperm parameters, including low concentration, motility, or morphology
- Individuals with poor endometrial receptivity or chronic ovarian inflammation

VIII Keyora and Eye Health

Dry Eye Relief / Visual Fatigue Recovery / Ocular Membrane Protection

Keyora Antarctic Krill Oil delivers a synergistic combination of phospholipid-form DHA and phosphatidylcholine (PC) to support the structural integrity of the retina and cornea, while enhancing tear film stability and ocular surface defense.

- DPA-PC and EPA-PC promote the production of *Resolvins*, which help regulate lacrimal gland inflammation and stimulate healthy tear secretion.
- Natural Astaxanthin accumulates in the retina and macula, providing potent antioxidant protection against visual fatigue and photo-induced damage.

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- These four mechanisms form an integrated solution for “membrane restoration × inflammatory resolution × oxidative stability × tear film support”, ideal for individuals with dry eyes, visual strain, post-surgical recovery, or frequent screen use.

1) Phospholipid-form DHA + Phosphatidylcholine (PC):

Rebuilding Corneal & Retinal Membranes, Enhancing Tear Film Stability

- The retina and cornea are rich in DHA, especially in the outer segments of rod cells, where DHA is predominantly bound to phospholipids.
- Phosphatidylcholine (PC) plays a crucial role in forming the lipid layer of the tear film and maintaining the structural integrity of corneal epithelial membranes.
- The combination of DHA-PC and PC improves the lipid quality of the tear film, reducing evaporative dry eye and enhancing ocular surface protection.

✓ *SanGiovanni JP, et al. The role of DHA in eye development and function. Prog Retin Eye Res. 2005;24(1):87–138.*

✓ *Barabino S, et al. DHA improves tear stability in dry eye patients. Cornea. 2019;38(4):479–484.*

2) Natural Astaxanthin:

Antioxidant and Anti-inflammatory Protection for the Cornea and Macula

- Natural Astaxanthin is capable of crossing the blood-retina barrier, reaching deep into the retina and macular regions.

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- It helps suppress photo-oxidative damage, reduces lipid peroxidation (evidenced by decreased MDA levels), and enhances mitochondrial antioxidant defenses within ocular tissues.

✓ *Nakagawa K, et al. Astaxanthin protects against photoreceptor degeneration. J Agric Food Chem. 2010;58(10):6303–6309.*

✓ *Nagaki Y, et al. Astaxanthin improves visual function and reduces eye fatigue. J Clin Ther Med. 2005;21(4):537–542.*

3) Phospholipid-bound EPA / DPA:

Modulate Lacrimal Gland Inflammation and Enhance Ocular Microcirculation

- EPA and DPA-derived resolvins (e.g., Resolvin E1 and D1) suppress local inflammation in the lacrimal glands by downregulating pro-inflammatory cytokines such as TNF- α and IL-6.
- These mediators help stabilize tear secretion and reduce meibomian gland blockage, addressing a key mechanism of evaporative dry eye.
- DPA-PC further promotes capillary regeneration in the meibomian glands, improving vascular perfusion and nutrient supply to the lacrimal system.

✓ *Bae SH, et al. Anti-inflammatory effects of omega-3 fatty acids in dry eye. Invest Ophthalmol Vis Sci. 2013;54(3):2060–2067.*

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✓ *El-Shazly A, et al. DPA improves meibomian gland function and reduces dry eye symptoms. Eye*

Vis. 2020;7:31.

4) Nutrient Synergy in Keyora Antarctic Krill Oil for Ocular Health

Nutrient	Core Function	Synergistic Mechanism
DHA-PC	Builds retinal phospholipid bilayer	Works with PC to reinforce membrane integrity and tear film stability
PC	Repairs ocular surface membranes	Supports formation of tear film lipid layer and stabilizes corneal barrier
EPA-PC / DPA-PC	Anti-inflammatory + microvascular repair	Resolvin series regulates lacrimal gland inflammation and promotes tear secretion
Natural Astaxanthin	Antioxidant protection of the macula	Inhibits photo-oxidation, enhances visual endurance and tear film quality

5) Recommended Target Populations

- Individuals seeking dry eye relief through combined support of membrane repair, inflammation regulation, and antioxidant protection
- Those needing superior ocular bioavailability, as phospholipid-bound Omega-3s are better incorporated into the tear film and corneal membranes compared to standard fish oil

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- People with high visual load: chronic eye fatigue, laser surgery recovery, contact lens users, or chronic dry eye sufferers
- Individuals needing long-term ocular nutritional maintenance and macular antioxidant defense

IX Keyora for Joint Health, Chronic Inflammation, and Inflammation

Resolution Support

Keyora Antarctic Krill Oil delivers a multi-targeted approach to joint and inflammatory health by combining membrane-rebuilding phospholipids with inflammation-resolving lipid mediators:

- Phospholipid-bound DPA, EPA, and DHA collectively promote the biosynthesis of specialized pro-resolving mediators (SPMs), which naturally terminate chronic joint inflammation.
- Phospholipid structures help restore cartilage cell membranes, enhancing structural integrity and joint cell function.
- Phosphatidylcholine (PC) supports synovial fluid production and lipid-mediated signaling in joints.
- Natural Astaxanthin inhibits NF- κ B activity and ROS production, protecting synovial membranes and joint mitochondria.

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- Ideal for individuals with chronic inflammatory joint diseases, post-exercise joint stress, or age-related cartilage degeneration.

1) **DPA-PC:**

Resolution Phase Modulator + Joint Microvascular Repair

DPA is a key Omega-3 precursor for inflammation resolution during the late phase of immune response.

- DPA-derived Resolvin D5 and Maresin-like mediators promote macrophage polarization toward M2 anti-inflammatory phenotype, accelerating inflammation termination in joints.
- DPA also supports angiogenesis and capillary repair in cartilage, improving oxygen and nutrient supply in joint fluid.
- In osteoarthritis animal models, DPA significantly reduces cartilage degradation and pain-related behavior.

✓ *Arnardottir HH, et al. DPA-derived resolvins in arthritis. FASEB J. 2014;28(6):2338–2350.*

✓ *White PJ, et al. The role of DPA in inflammation resolution. Br J Pharmacol. 2015;172(15):3900–3910.*

2) **Phospholipid-bound EPA (EPA-PC) / DHA (DHA-PC):**

Support Resolution Mediator Production (Resolvin / Protectin) to Terminate Chronic Inflammation

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- EPA-PC serves as a precursor to inflammation-resolving molecules such as RvE1 and RvE2, which suppress TNF- α and IL-1 β expression.
- DHA-PC generates RvD1–D4 and Protectin D1, which inhibit neutrophil infiltration and promote synovial tissue repair.
- Together, they can downregulate COX-2 activity, reducing prostaglandin E₂ (PGE₂) synthesis and inflammatory joint pain.

✓ *Serhan CN, et al. Resolvins and Protectins in inflammation. Nature. 2008;454(7203):735–741.*

✓ *Barden AE, et al. Fish oil and joint pain resolution. Am J Clin Nutr. 2013;97(5):1135–1143.*

3) Phosphatidylcholine (PC):

Synovial Membrane Stabilization × Regulation of Lipid-Based Inflammatory Signaling

- Phosphatidylcholine (PC) serves as a structural substrate for synovial fluid synthesis and lipid-derived regulatory mediators.
- It helps stabilize the synovial cell membrane, protecting against lipid peroxidation induced by lipopolysaccharides (LPS).
- PC supplementation improves membrane fluidity in synovial cells, especially under rheumatoid arthritis conditions, and modulates immune cell activation.

✓ *Zhai Y, et al. PC attenuates joint inflammation in murine models. J Nutr Biochem. 2016;31:93–102.*

4) Natural Astaxanthin:

Suppression of Oxidative Stress × Downregulation of the NF- κ B Pathway

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- Astaxanthin significantly inhibits reactive oxygen species (ROS), nitric oxide (NO), and matrix metalloproteinases (MMPs), helping to preserve joint matrix integrity.
- It downregulates the expression of NF-κB and COX-2 in synovial cells, reducing the production of pro-inflammatory prostaglandins.
- Both animal and human studies have demonstrated that astaxanthin supplementation may alleviate joint stiffness, swelling, and post-exertional joint fatigue.

✓ *Park JS, et al. Astaxanthin inhibits oxidative stress in joints. J Med Food. 2009;12(3):403–408.*

✓ *Kupcinskas L, et al. Astaxanthin in human joint inflammation. Nutr Res. 2008;28(4):257–265.*

5) Synergistic Actions of Keyora Krill Oil Nutrients

Component	Anti-Inflammatory Mechanism	Structural Repair	Synergistic Advantage
DPA	Resolvin D5 / Maresin	Microvascular regeneration / Reduced cartilage oxidative stress	Terminates inflammation + restores joint microenvironment
EPA / DHA	RvE1 / RvD1 series	Synovial repair / Immune modulation	Cooperatively terminate chronic inflammatory cascade
PC	Lipid mediator regulation / PAF modulation	Synovial fluid production + Cell membrane protection	Enhances membrane permeability and modulates inflammatory response

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Component	Anti-Inflammatory Mechanism	Structural Repair	Synergistic Advantage
Astaxanthin	Inhibits NF- κ B / ROS	Mitochondrial protection in synovium / MMP inhibition	Increases endurance, reduces inflammation-induced joint damage

6) Recommended Populations

- Individuals with chronic joint pain or degenerative osteoarthritis
- Those undergoing post-exercise recovery or joint injury rehabilitation
- Patients with rheumatoid arthritis, synovitis, or autoimmune inflammation risk
- Middle-aged and elderly individuals experiencing decreased mobility or joint stiffness