FOREVERGREEN

THE TRUTH ABOUT
MARINE PHYTOPLANKTON

Jacques Cousteau once said, "The future of nutrition is found in the oceans." What did he mean? How could the nutrients found in the ocean possibly be more beneficial than those found on land? To better understand the value of marine nutrients, we first must understand a few key principals about marine phytoplankton.

For the first part of this discussion, an understanding of a few terms will help simplify what is an intricate process. For years scientists have studied various forms of ocean nutrients using terminology that to them is somewhat interchangeable; however, as these nutrients have found their way to our shelves companies have continued to use certain terms as though they were still in the lab.

Below is a list of common terms followed by a brief summary of how access to the nutrition from the ocean can greatly enhance our health and well being.

Definition of essential terms:

Biome: A **biome** is a major group of distinctive plant and animal communities. A biome is made up of ecosystems. There are two fundamental classifications of biomes:

1. Terrestrial (land) biomes and
2. Aquatic (water) biomes

Aquatic biomes: The organisms responsible for primary production in all aquatic ecosystems are known as "phytoplankton." These miraculous microscopic organisms not only form the base of life in our oceans, but also produce up to 90% of the oxygen in our atmosphere.

Notice we did not use the term "plankton" or "algae". This is where an interchanging of terms usually creates confusion among many consumers. "Algae" is one of the most misused terms in the consumer markets partly because in science, the term "algae" can refer to any plant in a wet environment without true roots or leaves. With such a broad definition as "wet environment" distinctions between marine, freshwater or even land based algal growths are often misrepresented. Often the terms "microalgae" and "macroalgae" are used in an attempt to distinguish between microscopic organisms such as phytoplankton and larger organisms such as seaweed or kelp. Although these terms have helped, much confusion still exists.

A good rule of thumb states that all phytoplankton are classified as microalgae, but not all microalgae occur in phytoplankton. As you will read below, there are roughly a dozen different classes of phytoplankton. Just as "algae" has a broad definition, so does phytoplankton. Among the various classes of phytoplankton you find marine, freshwater and terrestrial based species. So, just because someone labels a product microalgae or phytoplankton the reality of what they are using is usually different.

Algae: **Algae** (singular *alga*) encompass any aquatic organisms capable of photosynthesis. Algae range from single-cell organisms to multicellular organisms, some with fairly complex form and (if marine) called seaweeds. All lack leaves, roots, flowers, seeds and other organ structures that characterize higher land based plants. The US Algal Collection is represented by almost 300,000 specimens. Most common forms of algae are known as:

Green Algae: Only about 10% of green algae are marine species, most live in freshwater. Green algae are more closely related to the green land plants than any other group of algae. They have the same photosynthetic system as land based plants. There are more species of green algae found in warm tropical oceans than in cooler temperate seas. The structure of green algae ranges from single-celled forms to multi-cellular sheets. The most common green alga is *Chlorella*.

Red Algae: The red algae are a large group, about 5000 - 6000 species of mostly multicellular, marine algae, including many notable commercial seaweeds.

Blue-Green Algae: **Cyanobacteria** (Greek: *kyanós* = blue + bacterium) is a division of Bacteria that obtain their energy through photosynthesis. They are often still referred to as blue-green algae, although they are in fact more like bacteria. The most common commercial blue-green alga is *Spirulina*.

Yellow-Green Algae: Yellow-green algae generally live in freshwater, but some are found in marine and soil habitats. They vary from single-celled organisms to simple colonial forms. Unlike other algae, their chloroplasts do not contain fucoxanthin, which accounts for their lighter color. Several species have shown to provide a very poor food source for immediate consumers because they were readily ingested but were very poorly digested.

Brown Algae: Brown algae are a large group of mostly marine multicellular algae, including many seaweeds of colder Northern Hemisphere waters. They play an important role in marine environments both as food, and for the habitats they can form. Worldwide there are about 1500 - 2000 brown seaweed species. Most brown algae contain the pigment fucoxanthin, which is responsible for the distinctive greenish-brown color that gives them their name.

Sea Vegetables: Sea vegetables are marine macroalgae, more commonly known as seaweeds. Macroalgae differ from microalgae primarily by their larger size, which is chiefly a function of a more complex cellular organization. These algae comprise three Classes – Brown (Phaeophyta), Red (Rhodophyta), and Green (Chlorophyta) based on their pigment composition. The general public is probably most familiar with kelps and other brown seaweeds that can form extensive forests along the coastline.

Plankton: The name **plankton** is derived from the Greek word "planktos", meaning "wanderer" or "drifter". While some forms of plankton are capable of independent movement and can swim up to several hundred meters in a single day, their position is primarily determined by currents in the body of water they inhabit. By definition, organisms classified as "plankton" are unable to resist ocean currents. Plankton is primarily divided into broad functional groups:

1. **Phytoplankton**
2. **Zooplankton**

This scheme divides the plankton community into broad producer and consumer groups.

Phytoplankton: The name comes from the Greek terms, *phyton* or "plant" and *planktos*, meaning "wanderer" or "drifter". Phytoplankton is microscopic plants that live in the ocean, freshwater and other terrestrial based water systems. There are many species of phytoplankton, each of which has a characteristic shape, size and function. Marine species of phytoplankton grow abundantly in oceans around the world and are the foundation of the marine food chain. Marine Phytoplankton is the producing (autotrophic) component in the ocean.

There are fourteen classes of phytoplankton. Each class of phytoplankton contains unique attributes in size, cell structure, nutrients and function. The following is a list of the classes with a brief description:

Classes of Phytoplankton
Bacillariophyceae (diatoms) – 100,000 species in 250 genera, passive floating, silicon cell walls, chain-forming
Chlorophyceae (green algae) – 2,500 species in 350 genera, self-propelled, green pigmentation
Chrysophyceae (chrysomonads) – 1,000 species in 120 genera, self-propelled, golden-brown pigmentation
Cryptophyceae (cryptomonads) – 60 species in 20 genera, self-propelled, tear drop shape
Cyanophyceae (blue-green algae) – predominantly tropical, either filamentous or coccoid, photosynthetic bacteria
Dictyophyceae (silicoflagellates) – only a few species, self-propelled, silicon skeleton
Dinophyceae (dinoflagellates) – 4,000 species in 550 genera, self-propelled, some species form "red tides"
Euglenophyceae (euglenoids) – 800 species in 43 genera, self-propelled, pliable, green pigmentation
Eustigmatophyceae (yellow-green algae) – very small, self-propelled, large "eyespot", high pigment concentration
Prasinophyceae (prasinomonads) – 120 species in 13 genera, self-propelled, heart shape
Prymnesiophyceae (prymnesiomonads) – 500 species in 50 genera, self-propelled, calcium carbonate scales
Raphidophyceae (chloromonads) – < 20 species, self-propelled, yellow-brown pigmentation
Rhodophyceae (red algae) – few microalgal species, usually benthic, red pigmentation
Xanthophyceae (yellow-green algae) – 600 species in 90 genera, most are fresh-water or terrestrial

Ecosystem: An ecosystem is a naturally occurring collection of all living organisms in a biome; every plant, insect, aquatic animal, bird, or land species forming a complex web of interdependency. Within an ecosystem an action taken at any level in the food web has a potential domino effect on every other occupant of that system.

Food Chain: A food chain is a linear pathway from one organism to another. There is one organism per level. They usually start with a primary producer and end with a top consumer. Here is an example of a food chain:

phytoplankton → copepod → fish → squid → seal → orca

In this example, phytoplankton—autotrophs by virtue of their ability to photosynthesize—are the base of the food chain. It is always the case that numbers and mass decrease from the base of the chain to the top. In other words, the number and mass of phytoplankton are much greater than the number and mass of copepod's being supported by the phytoplankton. Viewed another way, 90% of the organism's energy source is lost in each level of consumption.

Photosynthesis: Photosynthesis (photo=light, synthesis=putting together), generally, is the creation of energy from light, carbon dioxide and water, with oxygen as a waste product. It is arguably the most important process known; nearly all life depends on it. It is an extremely complex process, comprised of many coordinated biochemical reactions. It occurs in higher plants, algae, some bacteria, and many protists, organisms collectively referred to as photoautotrophs (photo=light, auto=self, trophe=nutrition).

Primary Producers: All life on earth is directly or indirectly reliant on primary production. Primary production is the production of organic compounds from atmospheric or aquatic carbon dioxide, principally through the process of photosynthesis. The organisms responsible for primary production are known as primary producers or autotrophs (auto=self, trophe=nutrition), and form the base of the food chain. In terrestrial biomes, these organisms are mainly plants, while in aquatic biomes phytoplankton are primarily responsible.

Consumer: A consumer is an organism that is incapable of making its own food from light or inorganic compounds, and feeds on organisms or the remains of other organisms to get the energy necessary for survival. A consumer is known as a heterotroph (heterone = (an)other and trophe = nutrition) in the food chain. All animals as well as humans are consumers (heterotrophic) and therefore must obtain their nutrition from another consumer (heterotroph) or a producer (autotroph).

SUMMARY

Eating closer to the base of the food web (primary producers), transfers more energy and nutrients to you. As we learned in our definitions, there are at least fourteen classes of phytoplankton. Some of the classes are commonly found in marine environments while others are freshwater based or terrestrial based. We also learned that a general classification of microalgae does not necessarily mean the same as phytoplankton; while all phytoplankton are microalgae, not all microalgae occur in phytoplankton.

The base of all marine food chains is marine phytoplankton. Diatoms (Bacillariophyceae) are especially important, as they are estimated to contribute up to 45% of the total oceanic primary production (Mann, D.G. 1999, The species concept in diatoms, Phycologia 38, 437-495). Many of the over 100,000 diatom species flourish in temperate ocean conditions, but generally three diatoms prevail – Skeletonema, Thalassiosira, and Chaetoceros. These prevailing diatoms utilize the nutrient-rich ocean water and in conjunction with photosynthesis their microscopic cells contain high concentrations of essential nutrients.
Access to these highly concentrated nutrients has been through the natural progression of the food chain. However, for humans a direct link to these nutrients is difficult because of several factors:

Growing: Many species can grow in artificial seawater, though their growth is not usually optimal because some micro-nutrient is missing or even too abundant. Natural seawater, on the other hand, contains a complete suite of buffered elements in suitable proportions forming the best possible base for growing marine phytoplankton. It is common practice in research laboratories to use artificial seawater for experiments. Scientists do this to control the environment when they want to measure the effects of specific parameters they might be studying (e.g., effects of light levels on growth). Controlling the growth environment using photobioreactors (enclosed growth chambers) provides limitations of expense and large scale production.

Harvesting: In order to shorten the food chain and allow humans direct access to the base oceanic nutrients found in marine phytoplankton, you need to extract microscopic organisms. Most commercial facilities and research laboratories harvest phytoplankton using centrifugation. Other extraction processes are sometimes used but are not as cost-effective. New facilities and technologies are required to efficiently break the cellular structures of these microscopic organisms and deliver the highly concentrated nutrients with minimal loss.

Digesting: Many scientific studies have focused on the ability of consumers to not only ingest but digest primary producers. Most marine and freshwater phytoplankton have either a siliceous or cellulose outer membrane. While many products may be ingestible, many microalgae products simply can not be digested by humans. The ability to breakdown cellulose is not possessed by mammals. Typically, this ability is possessed only by certain bacteria which are often the flora on the gut walls of cows and sheep, or by fungi, which in nature are responsible for cycling of nutrients.

The group of phytoplankton known as the diatoms create their cell walls from silicic acid. Relative to the cellulose cell walls produced by other groups, silica cell walls require less energy to generate (approximately 8%), a major saving of overall cell energy (Raven, J. A. (1983). Biol. Rev. 58, 179-207), and an explanation for higher growth rates in diatoms (Furnas, M. J. (1990). J. Plankton Res. 12, 1117-1151). This difference in cellular membrane structure from all other alga forms enhances the importance of the diatom class of marine phytoplankton.

So what does this all mean for the ability to consume at the base of the marine food chain? First, we must realize that because of the over processed state of our foods, the closer we can eat to the primary producers the higher the quality of the nutrients we will receive. Access and digestibility of these tiny microorganisms are key factors in actually providing our systems with these highly potent and effective nutrients.

Second we must understand that "algae" and "phytoplankton" are broadly defined terms encompassing numerous species. Remember, all phytoplankton are classified as microalgae, but not all microalgae are found in phytoplankton. The richest source of primary production in the marine food chain is the marine phytoplankton class known as diatoms. These microscopic organisms account for 45% of the primary production in our oceans.

Third, in order for humans to gain access to the highly effective and potent nutrients, the issue of digestibility is crucial. If we can ingest but not digest, it does not matter how nutritious or how much we consume or systems will be left empty. Algae and phytoplankton with cellulose walls are not digestible by our systems. Unlike most algae and phytoplankton species, diatoms contain a silica cell wall which allows this specie to conserve its energy during growth preserving nutrients for its consumers.

Finally, there is a difference in the growth of any algae or phytoplankton in its natural ocean state verses a freshwater or manmade state. Freshwater and artificial seawater simply do not contain the amount or breadth of nutrients that are found in our oceans. Additionally, strains of algae cultured over many generations potentially suffer from mutations. Contamination in a natural environment can be controlled without robbing consumer of vital natural nutrients and growth patterns. The marine food chain has thrived for millions of years without bioreactors and manipulated growing processes.

Below we have listed some of the products that claim to use marine phytoplankton. Upon careful review you can see how some of the common misconceptions and misuses of terms lead to confusion.

COMPARISON OF PHYTOPLANKTON AND ALGAE PRODUCTS

Spirulina is blue-green algae and therefore is actually classified as Cyanobacteria. It is a simple, one-celled form of algae that grows in warm freshwater environments. Even though *Spirulina* is distantly related to the kelp algae, it is not a sea plant. The freshwater ponds and lakes it favors are notably more alkaline than ordinary lakes and cannot sustain any other forms of microorganisms. Spirulina is much like terrestrial plants except that it does not have a cellulose cell wall.

Chlorella is a form of unicellular green algae found in still, freshwater; soil, or bark of trees. Chlorella has a strong cell wall that prevents its native form from being adequately broken down and absorbed by the human digestive system and so special processing is required to break its cell wall.

Kelp are large macroalgae (seaweeds), belonging to the brown algae. Despite their appearance they are not grouped with the normal aquatic or land plants. Kelp grows in underwater forests (kelp forests) in clear, shallow, oceans, requiring water below about 20 °C; it offers a protection to some sea creatures, or food for others. Of the more common algae products currently on the market Kelp is correctly classified as a marine algae.

Alpha 3 CMP™ (Condensed Marine Phytoplankton) is a unique nutrient-rich blend of marine phytoplankton harvested from the pristine temperate coastal waters of the Pacific Northwest. What makes these temperate waters an exceptional cauldron of life is the way in which ocean tides interact with fresh water, creating turbulence that draws even more deep water nutrients and supporting a diverse array of marine phytoplankton species. National Geographic, (Aug. 2006). The proprietary patent pending process harvests natural seawater, capturing the marine phytoplankton in million-liter tanks. This is the only known product to take natural marine phytoplankton communities containing a complete suite of marine trace elements in proportion to those found naturally in human tissue. Throughout this unique growing and harvesting process, quality control and testing is employed to ensure the highest quality product, providing assurance that no pathogens, toxins, heavy metals or contamination has occurred to the natural marine phytoplankton. The concentrated paste contains a variety of over 200 species (primarily from the larger, nutrient-rich *Bacillariophyceae* classification commonly known as diatoms). Through the harvesting process the Company's patent pending proprietary technology breaks down the cellular walls, separating the silicate walls and releasing the nutrients that are otherwise encapsulated. This process, unlike any other known to man today, makes the nutrients immediately bioavailable. The raw paste at this point contains approximately 85% water. It next goes to a state-of-the-art phytopharmaceutical production facility, licensed and certified GMP (Good Manufacturing Processes) by Health Canada, where it is further concentrated, passing through the highest standard quality assurance procedures (sanitized and stabilized) to certify Alpha 3 CMP™ safe for human consumption.

FrequenSea™ by Forever Green™ is a super food, exclusively employing the nutrient benefits found in Alpha 3 CMP™ for the network marketing industry. Combining the whole-food nutrition from both land and sea, FrequenSea™ utilizes organic ingredients known to re-awaken the body's natural healing power. In addition to the Alpha 3 CMP™, the following ingredients contribute to the amazing synergy of FrequenSea™:

Frankincense Essential Oil: An ancient healing art considered sacred in the Middle East and once more valuable than gold, it has been used for centuries to enhance the immune system, fight infections, and improve your mood as it relieves stress.

Ginger and Nutmeg: These well known spices aid the circulatory system and digestive tracts, contain strong anti-parasitic values and are rich antioxidants.

Aloe Vera: This "miracle plant" is anti-pyretic (reduces heat), anti-puritic (soothes itching), naturally hypo-allergenic with a perfect pH balance, revitalizes and improves tissue function at the cellular level, and moisturizes without closing off oxygen that is crucial to the repair process as it replaces lost fluids.

Astaxanthin: This is one of the most potent biological antioxidants extracted from marine micro-algae. These natural compounds are important nutrients and protectants for the skin and contribute to whole body health. Astaxanthin nourishes the eyes, brain and central nervous system, increases strength and endurance, boosts the immune system, protects cells and mitochondrial membranes from oxidative damage, and supports a healthy cardiovascular system.

Rose: Clinical research shows that plant concentrates have the highest frequency of any natural substance. The higher the frequency, the more effective the plant is in warding off bacteria, viruses and fungus. Rose emits the highest frequency (320MHz). While roses have long been associated with soothing fragrances that calm the body, mind and spirit with relaxing waves of positive energy, they also contain high amounts of Vitamins A and C, improve circulation, aid in liver detoxification, and provide an additional source of anti-inflammatories.

A.M.P. ™ Process: Forever Green uses an exclusive, proprietary extraction process called Aqueous Molecular Partitioning (AMP) that allows the CO_2-extracted plant materials to become water soluble, making it instantly bio-available in the body. This process preserves the essential oils, resins and all the powerful antioxidant-rich phyto nutrients of the whole plant without the use of heat or nutrient-harming solvents.

FrequenSea™ is an amazing ionic whole-food tonic, containing practically all the elements necessary to sustain a healthy life. Perfect in its organic composition, Hugo Rodier, M.D. calls it "Mother Earth's Milk." Nature obviously provides the ultimate food source, offering the micro nutrients necessary for cellular regeneration with the ability to detoxify our bodies of unnatural contaminants. The body is a self-healing mechanism and will perform miracles when we learn to honor its intelligence. Nothing honors the body like the proprietary FrequenSea™.