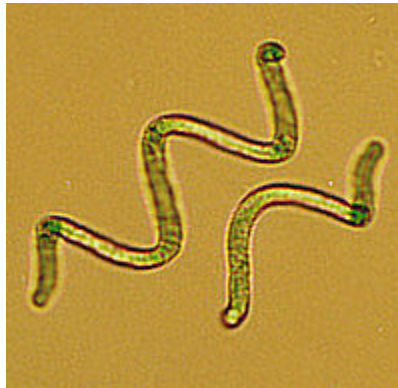


# Spirulina

## Spirulina



## Scientific classification

Domain: [Bacteria](#)

Phylum: [Cyanobacteria](#) = [Chroobacteria](#)

Order: [Oscillatoriales](#)

Family: [Phormidiaceae](#)

Genus: *Arthrospira*

## Species

About 35.

- *Arthrospira maxima*
- *Arthrospira platensis*

**Spirulina** is the common name for human and animal food supplements produced primarily from two species of cyanobacteria: *Arthrospira platensis*, and *Arthrospira maxima*. These and other *Arthrospira* species were once classified in the genus *Spirulina*. There is now agreement that they are a distinct genus, and that the food species belong to *Arthrospira*; nonetheless, the older term Spirulina remains the popular name.

Spirulina is cultivated around the world, and is used as a human dietary supplement as well as a whole food and is available in tablet, flake, and

powder form. It is also used as a feed supplement in the aquaculture, aquarium, and poultry industries.

### ***Biology***

Spirulina are free-floating filamentous cyanobacteria characterized by cylindrical, multicellular trichomes in an open left-hand helix. Spirulina occurs naturally in tropical and subtropical lakes with high pH and high concentrations of carbonate and bicarbonate. *A. platensis* occurs in Africa, Asia and South America, whereas *A. maxima* is confined to Central America.

### ***History***



An illustration from the Florentine Codex showing how the Aztecs harvested Spirulina off lakes by skimming the surface with ropes and then drying the algae into square cakes that would be eaten as a nourishing condiment.

Spirulina is believed to have been a food source for the Aztecs and other Mesoamericans until the 16th-century; its harvesting from Lake Texcoco and subsequent sale as cakes is described by one of Cortés' soldiers. The Aztecs called it Tecuitlatl, meaning stone's excrement. Spirulina was found in abundance at the lake by French researchers in the 1960s, but there is no reference to its use there as a daily food source after the 16th century. The first large-scale Spirulina production plant, run by Sosa Texcoco, was established there in the early 1970s.

Spirulina may have an even longer history in Chad, as far back as the 9th century Kanem Empire. It is still in daily use today, dried into cakes called Dihé, which are used to make broths for meals, and also sold in markets. The Spirulina is harvested from small lakes and ponds around Lake Chad.

## ***Cultivation***

Most cultivated spirulina is produced in open-channel raceway ponds, with paddle-wheels used to agitate the water. The largest commercial producers of spirulina are located in the United States, Thailand, India, Taiwan, China, Pakistan and Myanmar.

## ***Nutrients and other chemicals***

### **Protein**

Spirulina contains an unusually high amount of protein, between 55% and 77% by dry weight, depending upon the source. It is a complete protein, containing all essential amino acids, though with reduced amounts of methionine, cysteine, and lysine when compared to the proteins of meat, eggs, and milk. It is, however, superior to typical plant protein, such as that from legumes.

### **Essential fatty acids**



Spirulina tablets

Spirulina is rich in gamma-linolenic acid (GLA), and also provides alpha-linolenic acid (ALA), linoleic acid (LA), stearidonic acid (SDA), eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA), and arachidonic acid (AA).

### **Vitamins**

Spirulina contains vitamin B1 (thiamine), B2 (riboflavin), B3 (nicotinamide), B6 (pyridoxine), B9 (folic acid), vitamin C, vitamin D, and vitamin E.

## **B12**

The bioavailability of vitamin B12 in Spirulina is in dispute. Several biological assays have been used to test for the presence of vitamin B12. The most popular is the US Pharmacopoeia method using the *Lactobacillus leichmannii* assay. Studies using this method have shown Spirulina to be a minimal source of bio-available vitamin B12. However, this assay does not differentiate between true B12 (cobalamin) and similar compounds (corrinoids) that cannot be used in human metabolism. Cyanotech, a grower of spirulina, claims to have done a more recent assay, which has shown Spirulina to be a significant source of cobalamin. However, the assay is not published for scientific review and so the validity of this assay is in doubt. The American Dietetic Association and Dietitians of Canada in their position paper on vegetarian diets state that spirulina can not be counted on as a reliable source of active vitamin B12.

## **Minerals**

Spirulina is a rich source of potassium, and also contains calcium, chromium, copper, iron, magnesium, manganese, phosphorus, selenium, sodium, and zinc.

## **Photosynthetic pigments**

Spirulina contains many pigments including chlorophyll-a, xanthophyll, beta-carotene, echinenone, myxoxanthophyll, zeaxanthin, canthaxanthin, diatoxanthin, 3'-hydroxyechinenone, beta-cryptoxanthin, oscillaxanthin, plus the phycobiliproteins c-phycoyanin and allophycocyanin.

## ***Evidence of health and healing effects***

Despite existing research supporting Spirulina's health and healing properties, detractors claim that these are frequently overstated by

Spirulina advocates. Conversely, Spirulina advocates have accused health food detractors of dismissing all such claims without acknowledging this research. Many positive claims are based on research done on individual nutrients that Spirulina contains, such as GLA, various antioxidants, etc., rather than on direct research using Spirulina. What follows is research on the health and healing effects of Spirulina. In vitro research (e.g., studying cells in a petri dish) may suggest the possibility of similar results in humans but, due to the drastically different conditions of the research, provides only hints at the potential for human effects. Animal research can also provide evidence of potential human effects. Human research focuses on actual effects in humans - however, the validity and reliability of the research depends on the design of the study. The strongest evidence comes from well designed and controlled clinical trials, which are one type of human research study.

### **In vitro research**

Spirulina extract inhibits HIV replication in human T-cells, peripheral blood mononuclear cells (PBMC), and Langerhans cells.

### **Animal research**

Spirulina helps prevent heart damage caused by chemotherapy using Doxorubicin, without interfering with its anti-tumor activity. Spirulina reduces the severity of strokes and improves recovery of movement after a stroke; reverses age-related declines in memory and learning; and prevents and treats hay fever.

A study on the metabolism of mice indicates that it has little effect on their metabolism, and therefore probably that of humans too.

### **Human Research**

Spirulina is effective for the clinical improvement of melanosis and keratosis due to chronic arsenic poisoning; improves weight-gain and corrects anemia in both HIV-infected and HIV-negative undernourished children; and protects against hay fever.

A 2007 study found that 36 volunteers taking 4.5 grams of spirulina per day, over a six week period, exhibited significant changes in cholesterol and blood pressure:

- (1) lowered total cholesterol;
- (2) increased HDL cholesterol;
- (3) lowered triglycerides;
- (4) lowered systolic and diastolic blood pressure.

However, as this study did not contain a control group, researchers can not be confident that the changes observed are due totally - or even partially - to the effects of the Spirulina Maxima as opposed to other confounding variables (i.e., history effects, maturation effects, demand characteristics).

Spirulina has also been found to be clinically effective against allergic rhinitis, a condition that can lead to chronic sinusitis.

### ***Organic Certification***

Until recently, much spirulina was certified organic. In 2002, the USDA's National Organic Standards Board voted to disallow the use of Chilean nitrate. They granted a three-year window to spirulina producers, which expired in 2006. As a result, leading spirulina manufacturers have stopped labeling their spirulina as organic, citing safety concerns of nitrate alternatives. However a company based in India, Parry Nutraceuticals, started producing organic Spirulina meeting revised USDA requirements as of March 2006, using a vegetarian source of nitrogen and phosphorous.

Recently, Hash Biotech Labs, in Northern India, has joined forces with IIMSAM and The United Nations, in producing organic spirulina<sup>1</sup> and is providing it to the malnourished in developing countries and as a premium product in developed countries. Hash BioTech Labs is the only

company in India endorsed by IIMSAM (Intergovernmental Institution for the use of Micro-algae Spirulina Against Malnutrition).

The United Nations World Food Conference in 1974 lauded Spirulina as the 'best food for the future'. Recognizing the inherent potential of Spirulina in the sustainable development agenda, several Member States of the United Nations came together to form an intergovernmental organization by the name of IIMSAM, which aspires to build a consensus with the UN Member States, international community and other stakeholders to make Spirulina a key driver to eradicate malnutrition, achieve food security and bridge the health divide throughout the world.

Spirulina has been proposed by both NASA (CELSS) and the European Space Agency (MELISSA) as one of the primary foods to be cultivated during long-term space missions. NASA considers Spirulina an ideal food to grow on space stations and has researched the possibility of using it on long-term space flights. It will become one of the first foods grown on the new Space Station when it is completed. It is one of the most efficient, oxygen-generating foods known.

### **What is Spirulina Algae?**

Spirulina is a microscopic freshwater plant, an aquatic micro-vegetable/organism composed of transparent bubble-thin cells stacked end-to-end forming a helical spiral filament.

Spirulina is microscopic blue - green algae that exist as a single celled organism turning sunlight into life energy.

It is one of the first life forms designed by nature more than 3.6 billion years ago. Spirulina contains billions of years of evolutionary wisdom in its DNA and is an offspring of earth's first photosynthetic life forms.

Under the microscope, Spirulina is a blue-green color and has the appearance of a spiral of long thin threads. Spirulina is blue - green algae. It is a simple, one-celled form of algae that thrives in warm, alkaline freshwater bodies. The name 'spirulina' is derived from the Latin word for

'helix' or 'spiral'; denoting the physical configuration of the organism when it forms swirling, microscopic strands.

Spirulina is exceedingly adaptable and occurs in a wide variety of environments including fresh water, tropical springs, saltwater and salt pans.

Spirulina is full of nutrients and very easily digested. Commercially, Spirulina is available as a powder, tablet and capsule or added to foods and health tonics.

There are many forms of valuable algae and in the last 40 years Spirulina has been singled out for its nutritional properties. Long before it became a favorite of the health food industry, Spirulina was eaten regularly by North Africans and Mexicans centuries ago. Now many people around the globe realize that Spirulina is a powerful food with huge potential as a whole food source, medicine and biochemical resource.

A great deal of research has concentrated on the cultivation and harvesting of what is affectionately referred to as 'the green'. It has been described as 'probiotic' and a 'superfood'.

The cultivation of Spirulina has also brought interest because, as with most micro algae, Spirulina is extremely adaptable, often thriving in extreme conditions. With its rich nutritional goodness and ability to grow in adverse conditions, Spirulina has a huge potential to be a food source that will help feed and nourish the world's population.

As a plant, Spirulina is incredibly rich containing a balance of nutrients that make it virtually a 'whole food' capable of sustaining life without the need for other foods.

Spirulina provides vitamins, many minerals, essential amino acids, carbohydrates and enzymes. Spirulina is at least 60% vegetable protein, which is predigested by the algae, making it a highly digestible food. It is higher in protein than any other food. Its outstanding nutritional profile also includes the essential fatty acids, GLA fatty acid, lipids, the nucleic



acids (RNA and DNA), B complex, vitamin C and E and phytochemicals, such as carotenoids, chlorophyll (blood purifier), and phycocyanin (a blue pigment), which is a protein that is known to inhibit cancer.

Spirulina is being developed as the 'food of the future' because of its amazing ability to synthesize high-quality concentrated food more efficiently than any other algae. Most notably, Spirulina is 65 to 71 percent *complete* protein, with all essential amino acids in perfect balance. In comparison, beef is only 22 percent protein.

Spirulina has a photosynthetic conversion rate of 8 to 10 percent, compared to only 3 percent in such land-growing plants as soybeans.

Spirulina also provides high concentrations of many other nutrients - amino acids, chelated minerals, pigmentations, rhamnose sugars (complex natural plant sugars), trace elements, enzymes - that are in an easily assimilable form.

Even though it is single-celled, Spirulina is relatively large, attaining sizes of 0.5 millimeters in length. This is about 100 times the size of most other algae, which makes some individual Spirulina cells visible to the naked eye. Furthermore, the prolific reproductive capacity of the cells and their proclivity to adhere in colonies makes Spirulina a large and easily gathered plant mass.

The algae are differentiated according to predominating colorations, and are divided into blue-green, green, red and brown. Spirulina is one of the blue-green algae due to the presence of both chlorophyll (green) and phycocyanin (blue) pigments in its cellular structure.

Even though Spirulina is distantly related to the kelp algae, it is not *a sea* plant. However, the fresh-water ponds and lakes it favors are notably more alkaline - in the range of 8 to 11 pH than ordinary lakes and cannot sustain any other forms of microorganisms. In addition, Spirulina thrives in very warm waters of 32 to 45 degrees C (approximately 85 to 112 degrees F), and has even survived in temperatures *of 60 degrees C* (140 degrees F)

Certain desert-adapted species will survive when their pond habitats evaporate in the intense sun, drying to a dormant state on rocks as hot as 70 degrees Centigrade (160 degrees F). In this dormant condition, the naturally blue-green algae turns a frosted white and develops a sweet flavor as its 71 percent protein structure is transformed into polysaccharide sugars by the heat.

Some scientists speculate that the ‘manna’ of the wandering Israelites, which appeared miraculously on rocks following a devastating dry spell and was described as tasting ‘like wafers made with honey’ may have been a form of dried, dormant Spirulina.

This ability of Spirulina to grow in hot and alkaline environments ensures its hygienic status, as no other organisms can survive to pollute the waters in which this alga thrives. Unlike the stereotypical association of microorganisms with ‘germs’ and ‘scum’, Spirulina is in fact one of the cleanest, most naturally sterile foods found in nature.

Its adaptation to heat also assures that Spirulina retains its nutritional value when subject to high temperatures during processing and shelf storage, unlike many plant foods that rapidly deteriorate at high temperatures.

Spirulina is also unusual among algae because it is a ‘nuclear plant’ meaning it is on the developmental cusp between plants and animals. It is considered somewhat above plants because it does not have the hard cellulose membranes characteristic of plant cells, nor does it have a well-defined nucleus. Yet its metabolic system is based on photosynthesis, a process of direct food energy production utilizing sunlight and chlorophyll, which is typical of plant life forms.

In essence, Spirulina straddles that fork in evolutionary development when the plant and animal kingdoms differentiated. Thus it embodies the simplest form of life. In contrast, other algae such as Chlorella have developed the hard indigestible walls characteristic of plants.

This form of aquaculture represents one of the solutions needed to produce food while restoring the planet.

### **How is it grown?**

Spirulina thrives in natural alkaline lakes. Spirulina farming is part of the new era of ecological agriculture. The key component in the production of Spirulina is sunlight and attention is given to measurement of temperature and oxygen levels.

Because pesticides and herbicides would kill many microscopic life forms in a pond, algae scientists have learned how to balance pond ecology without the use of these harmful substances.

The spirulina production involves three major steps, viz., cultivation, harvesting and processing. Selected strains are used for cultivation of alga in specially constructed ponds. Constant agitation of water is one of the important parameters in cultivation of spirulina. Agitation of algal culture is necessary to keep nutrients evenly dispersed and also to expose all the cells to sunlight. The algal biomass is carefully harvested using specially made filters to recover biomass. The washed biomass is dried and is pulverized to get desired particle size and packed appropriately.

### ***Spirulina cultivation Ponds***



### ***Product Profile***

Extensive testing by scientist worldwide have shown Spirulina to be the most powerful and well-balanced source of nutrition on the planet. NASA found it to be an excellent, compact space food for astronauts (1 kg. of Spirulina is equivalent to 1000 kgs. of assorted vegetables).

Spirulina has very rich protein content (upto 70%). This protein is a complete protein containing 18 of the 22 amino acids that body needs. This ensures proper utilization and assimilation of the food a person eats. Also, it has zero cholesterol.

Unstable molecules called the free 'Radicals' are generated in every human body as a result of normal metabolic processes. These can lead to ailments like cancer, arthritis, cataracts and premature ageing. The 'Anti-Oxidants' like Vitamins A, E, and minerals like Zinc and Selenium effectively neutralise these free radicals; Spirulina is the world's only source of all these nutrients.

Spirulina also contains Gamma Linolenic Acid (GLA), which dissolves the fat deposits in blood vessels. These deposits are the reason behind a majority of heart ailments. Moreover, it actively helps in decreasing bad cholesterol, especially in cases of higher initial levels.

Spirulina helps combat problems like diabetes, anaemia malnutrition and various degenerative diseases.

Several studies have shown regular intake of Spirulina helps to improve hemoglobin levels in both animal and human subjects. Apart from contributing the required iron, Spirulina also supplies folic acid and vitamin B12 - needed by anaemic persons - making it a wholesome nutritional support.

Furthermore, the micronutrients and enzymes present also contribute to the better assimilation of the nutrition from the food ingested thus making it as a bio-enhancer. The capability of Spirulina through several helpful factors for better assimilation of the nutrients from the average diet of pregnant women leads to better health of their babies.

## **Use**

Spirulina is a simple cyanobacterium. It has been effectively promoted as a natural health and slimming food in the market. Studies show that spirulina at a particular level indicated immense progress in anemia, diabetes, healing of wounds and lowering of cholesterol.

- Protein supplement : in diets for malnourished children and adults
- Protein supplement : in feeds for poultry, cattle, pig and aquaculture
- Health food
- Food colourant
- Medicine in therapeutic preparation
- Enriching the feed in sericulture

Spirulina is a rich source Gamma Linolenic Acid (GLA), which is the 'miracle' ingredient of Spirulina. GLA is an essential fatty acid that has been shown very helpful in the relief of joint pain.

### ***Spirulina's Nutritional Analysis***

#### ***Proteins:***

The blue - green algae and Spirulina in particular, have a primitive structure with few starch storage cells and cell membrane proliferation, but rich amounts of ribosomes, the cellular bodies that manufacture protein. This particular arrangement of cellular components allows for rapid photosynthesis and formation of proteins. The lack of hard cellular walls assures that Spirulina protein is rapidly and easily assimilated by consuming organisms.

Spirulina is approximately 65 to 71 percent protein, depending on growing conditions. These proteins are biologically complete, which means they provide all eight essential amino acids in the proper ratios.

Most plant foods are not complete proteins because they usually lack one or more amino acids.

Unfortunately, the body cannot store amino acids in anticipation of deficient ones eventually arriving in subsequent meals. To synthesize protein for the body's repair and maintenance, all dietary protein factors must be present simultaneously or the amino acids are wasted.

Furthermore, even if complete protein is consumed, digestive difficulties can prevent assimilation of all needed elements. Spirulina provides all the required amino acids, and in a *form* that is five times easier to digest than meat or soya protein.

*These eight essential amino acids are found in Spirulina:*

- *ISOLEUCINE* (4.13 %): Required for optimal growth, intelligence development and nitrogen equilibrium in the body used to synthesize other non-essential amino acids.
- *LEUCINE* (5.8%): Stimulator of brain function, increases muscular energy levels.
- *LYSINE* (4.0%): Building block of blood antibodies strengthens circulatory system and maintains normal growth of cells.
- *METHIONINE* (2.17%): Vital lipotropic (fat and lipid metabolizing) amino acid that maintains liver health. An anti-stress factor, it calms the nerves.
- *PHENYLALANINE* (3.95%): Required by the thyroid gland *for* production of thyroxine, which stimulates metabolic rate.
- *THREONINE* (4.17%): Improves intestinal competence and digestive assimilation.
- *TRYPTOPHANE* (1.13%): Increases utilization of B vitamins, improves nerve health and stability of the emotions. Promotes sense of *calm*.
- *VALINE* (6.0%): Stimulates mental capacity and muscle coordination.

*These are the non-essential amino acids supplied by Spirulina:*

Spirulina supplies ten of the twelve non-essential amino acids. 'Non-essential' does not mean that these amino acids are not needed by the body, but merely indicates that the body can synthesize them by itself if it needs to do so, provided the appropriate nutritional building blocks are available.

Nevertheless, the body is better served if these excellent protein components are readily and totally available in dietary sources, since all the amino acids must be on hand as the cells manufacture enzymes, proteins, hormones, brain chemicals and the other products of metabolism. Of the thousands of biochemical substances acting and interacting in the human body, not one is derived from a vacuum; the body is ultimately dependent upon nutrient intake for all of its functions.

- *ALANINE (5.82%)*: Strengthens cellular walls.
- *ARGININE (5.98%)*: Important to male sexual health as seminal fluid is 80 percent arginine. Also helps detoxify the blood.
- *ASPARTIC ACID (6.34%)*: Aids transformation of carbohydrates into cellular energy.
- *CYSTINE (0.67%)*: Aids pancreatic health, which stabilizes blood sugar and carbohydrate metabolism. Has been used to alleviate some symptoms of food allergy and intolerance.
- *GLUTAMIC ACID (8.94%)*: With glucose, one of the principal fuels for the brain cells. Has been used to reduce the craving for alcohol and stabilize mental health.
- *GLYCINE (3.5%)*: Promotes energy and oxygen use in the cells.
- *HISTIDINE (1.08%)*: Strengthens nerve relays, especially in the auditory organs. Has been used to reverse some cases of deafness.
- *PROLINE (2.97%)*: A precursor of glutamic acid.
- *SERINE (4.0%)*: Helps form the protective fatty sheaths surrounding nerve fibers.
- *TYROSINE (4.60%)*: Slows aging of cells and suppresses hunger centers in the hypothalamus. Can be synthesized from phenylalanine. Involved in proper coloration of hair and skin, including protection from sunburn.

### *Minerals:*

Although proteins are the building blocks of life, many trace minerals can profoundly affect health and metabolism.

The waters Spirulina favors are so saturated with minerals deposited from ancient soils and mountains that no other plants can live there. Because Spirulina thrives in such alkaline waters, it incorporates and synthesizes many minerals and derivative compounds into its cell structure.

Transformed into natural organic forms by Spirulina, minerals become chelated with amino acids and are therefore more easily assimilated by the body. Many times people have ingested large amounts of inorganic minerals without benefit to health because the body does not know what to do with these incompatible forms. In fact, evidence is accumulating that the inorganic minerals can block absorption of the organic forms, leading ultimately to mineral deficiency diseases.

Spirulina contains essential minerals and trace elements absorbed from its growth medium into chelated, easily absorbed forms:

- *POTASSIUM (15,400 mg/kg):* A crucial mineral that regulates body electrolyte balance. Deficiency can cause heart arrest, hypertension, adrenal exhaustion and muscular collapse.
- *CALCIUM (1,315 mg/kg):* The most abundant mineral in the body, it is especially important to bone and dental health, but is also involved in neural transmissions to the muscles. Spirulina supplies about as much calcium, gram for gram, as milk.
- *ZINC (39 mg/kg):* The pivot point of over thirty vital enzymatic reactions, with profound effects on mental health, skin tone, prostate function and healing capacity.
- *MAGNESIUM (1,915 mg/kg):* Deficiency can lead to spasmodic muscle disorders, including cardiac irregularities. Helps assimilation of vitamin C, B vitamins and proteins.
- *MANGANESE (25 mg/kg):* Activates enzyme systems, along with zinc. Promotes activity of neurotransmitter acetylcholine, and helps stabilize blood sugar.



- *SELENIUM (0.40 ppm)*: Originally believed to be a toxic heavy metal, but now known to be necessary for health. It retards aging, harmful oxidation and free radical formation, reduces the toxic effect of carcinogens, and improves cardiac efficiency.
- *IRON (580 mg/kg)*: Promotes formation of hemoglobin, the oxygen-carrying blood pigment found in healthy red blood cells. Iron deficiency is most common among women in their reproductive years.
- *PHOSPHORUS (8,942 mg/kg)*: The second most abundant mineral in the human body, it is found in practically every cell. Functions with calcium to maintain bone density. Helps to digest carbohydrates and the B vitamins niacin and riboflavin.

### *Vitamins:*

Spirulina supplies several of the vitamins that all living beings need to carry on metabolic processes:

- *PYRIDOXINE or B6 (3 mg/kg)*: Involved in breakdown and assimilation of protein. Protects cardiac health, reduces edema and stabilizes female hormone levels. Dr. Carl Pfeiffer has demonstrated that B6, together with the mineral zinc, can cure some forms of schizophrenia.
- *BIOTIN (0.4 mg/kg)*: An enzyme that carries CO<sub>2</sub> during certain biochemical reactions involved in carbohydrate metabolism. Also acts as a co-enzyme in the assimilation of other B-complex vitamins. Biotin is destroyed by eating raw egg whites and some kinds of raw fish.
- *COBALAMIN or B12 (2 mg/kg)*: The most difficult of all vitamins to obtain from vegetable sources. A B12 deficiency results in pernicious anemia, nerve degeneration, premature senility, pronounced fatigue and mental illnesses resembling schizophrenia.
- *PANTOTHENIC ACID (11 mg/kg)*: The 'stress' vitamin, used by the adrenal glands, along with cholesterol and vitamin C, to manufacture cortisone and other steroids in response to physical and mental stress. Deficiency encourages sensitivity to allergy,

- infection and degenerative diseases such as arthritis and rheumatism. Ulcers and hypoglycemia have also been associated with shortage of this vitamin.
- *FOLIC ACID (0.5 mg/kg)*: Essential to proper hemoglobin formation in red blood cells. Deficiency results in anemia, poor growth, skin pigmentation disorders and premature graying of the hair.
  - *INOSITOL (350 mg/kg)*: Vital lipotropic nutrient that sustains liver health and helps detoxify carcinogens, particularly excess female hormones. Helps normalize blood cholesterol levels. With choline, inositol is used by the liver to manufacture lecithin. Inositol is the second most abundant vitamin in the body, after niacin. Recent studies indicate that inositol, with biotin, reduces loss of scalp hair.
  - *NIACIN (118 mg/kg)*: Also known as nicotinic acid and niacinamide, which is an alternative form, niacin is essential to mental health. Dr. Abram Hoffer, a renowned pioneer in orthomolecular psychiatry, has completely relieved schizophrenic symptoms using niacin. The Physicians' Desk Reference, a pharmaceutical text used by doctors when prescribing medication, recognizes niacin as an effective cholesterol lowering agent.
  - *RIBOFLAVIN or B2 (40 mg/kg)*: The most common vitamin deficiency is that of riboflavin and results in cataracts, failing vision, watery eyes and uncontrollable eczema.
  - *THIAMINE or B 1 (55 mg/kg)*: A co-enzyme in the breakdown of dietary carbohydrate. Maintains levels of glucose in the blood. Deficiency results in weakness, cardiac damage, abdominal distention and poor oxygenation. Severe shortage results in death; critical toxemia develops from unmetabolized carbohydrate fragments.
  - *TOCOPHEROL or vitamin E (190 mg/kg)*: Spirulina contains more vitamin E per gram than pure wheat germ. This nutrient protects heart and vascular health, promotes oxygenation of cells, and retards aging.

### *Carotenoids:*

Some substances in plant foods are not true vitamins, but provide the precursors from which the body can then synthesize the appropriate vitamins. The carotenoid compounds of Spirulina are of this nature, since they are used to produce vitamin A.

True vitamin A is found in the pre-formed state only in animal sources, such as liver. This is the form of vitamin A sometimes associated with toxicity and overdose, since it is fat-soluble and is not readily excreted from the body.

In contrast, the carotenoid complexes found in vegetable foods are converted to vitamin A only as it is needed, thus minimizing the dangers of toxicity. Spirulina and other algae are a primary source of vitamin A precursors - it is from algae carotenoids that fish livers derive and concentrate vitamin A.

Spirulina contains the yellow/orange pigments cryptoxanthine and beta-carotene from which vitamin A can be made. Two units of carotene will normally yield one unit of complete vitamin A, if required by the body. Spirulina contains 4,000 mg/kg carotenoids in these forms:

- *Alpha-carotene -- traces*
- *Beta-carotene -- 1,700 mg/kg*
- *Xanthophyllis -- 1,000 mg/kg*
- *Cryptoxanthin -- 556 mg/kg*
- *Echinenone -- 439 mg/kg*
- *Zeaxanthin -- 316 mg/kg*
- *Lutein -- 289 mg/kg*

### ***Enzymatic pigments:***

While the protein, mineral and vitamin value of Spirulina is impressive, this minute organism is also rich in pigments that are bio-chemically important to life. Without pigments, organisms could not synthesize many of the enzymes necessary for balancing metabolism.

## *Chlorophyll*

The most visible pigment in *Spirulina* is chlorophyll, a green molecule common to plants. It releases ions when struck by the energy of sunlight. These free ions proceed to stimulate the biochemical reactions that form proteins, vitamins and sugars.

Chlorophyll is sometimes called 'green blood' because of its similarity to the hemoglobin molecule found in human blood cells. In fact, both are constructed of almost identical molecular structure called pyrrole rings, and both substances are chemically known as 'porphyrin pigments' by scientists.

The difference is that chlorophyll contains a magnesium ion at its core, while hemoglobin contains an iron molecule. Magnesium imparts a green color to the chlorophyll molecule and is involved in synthesis of other materials, while iron gives hemoglobin a red coloration and changes the function of the porphyrin molecule to respiration and breakdown of materials.

It is believed that if chlorophyll is ingested with sufficient iron, the magnesium can be displaced to yield a hemoglobin molecule. Experiments in Japan have demonstrated that *Spirulina* has a marked positive effect on anemia, possibly due to the conversion of chlorophyll into hemoglobin. Of course, the high nutrient density of *Spirulina*, especially the blood-building vitamins B12 and folic acid and the amino acids, are also useful in treating cases of anemia.

Chlorophyll has other positive benefits to the body. It increases peristaltic action and thus relieves constipation, and also normalizes the secretion of digestive acids. It soothes the inflammation and reduces the excess pepsin secretion associated with gastric ulcers.

During World War II, the drying action of chlorophyll and its antiseptic qualities made it a common first-aid measure to prevent festering of wounds. In addition, chlorophyll soothes swelling and promotes granulation, the process that regenerates new tissue over injuries.

Chlorophyll appears to promote regeneration of damaged liver cells, and also increases circulation to all the organs by dilating blood vessels. In the heart, chlorophyll aids in transmission of nerve impulses that control contraction. The heart rate is slowed, yet each contraction is increased in power, thus improving the overall efficiency of cardiac work.

### *Phycocyanin*

The pigment which gives Spirulina its blue cast is phycocyanin, found in concentrations of about 7 percent, compared to the percent chlorophyll content most commonly found. Phycocyanin is related to the human pigment bilirubin, which is important to healthy liver function and digestion of amino acids.

### *Porphyrin*

Another important pigment is porphyrin, a red compound that forms the active nucleus of hemoglobin. Related to this structure is the polypyrrole molecule of B12, which is essential to the formation of healthy red blood cells.

These and several lesser pigments such as *phycoerythrin*, *tetrapyrrole*, *phytonadione* and other *carotenoids* are not just the 'color' of living organisms, but are used to carry on metabolic processes throughout the body. Without them, enzymatic reactions would be reduced until cellular disintegration occurred.

### *Fats, sugars, salts and calories:*

It is probably hard to imagine that a concentrated source of nutrients such as Spirulina is not also loaded with fats, starches and calories. Amazingly, Spirulina is only 7 percent lipid, and most of that is in the form of essential fatty acids that promote cholesterol normalization. The essential fatty acids sometimes called vitamin F, include linoleic, linolenic and arachidonic acid. They are used by the body to manufacture Prostaglandins, the hormonal regulators of blood pressure and capillary resilience.

The essential fatty acids are involved in respiration in all the cells, and are especially important to oxygen transport. They affect the health of the hair, skin and nails, and help break up cholesterol in the blood stream. *They are not dangerous fat but are absolutely vital to health.*

Spirulina contains very little starch or sugar. What carbohydrate it supplies, roughly 10 to 15 %, is primarily in the form of rhamnose and glycogen. These two polysaccharides are easily absorbed by human cells with minimal intervention by insulin. Hence, Spirulina sugars provide speedy energy, without taxing the pancreas or precipitating hypoglycemia.

From a caloric standpoint, Spirulina nutrition is economical. There are only approximately 3.9 calories per gram of protein obtained from Spirulina. You would have to consume about 65 calories of beef to obtain a gram of protein. The average 500 mg tablet of Spirulina contains only one to two calories!

Some people are concerned about sodium in their diets, and have therefore avoided seaweed foods such as nori, wakami and kombu. These kelp foods are very nutritious, but they do contain significant sodium amounts. Spirulina avoids the sodium problems of algae that grow in the sea, yielding only 0.206 mg of sodium per tablet. Most hypertension patients are restricted to 2,000 mg or less of sodium per day; Spirulina has such small amounts of sodium that no danger is presented to persons on a salt-restricted diet.

### ***Modern dietary needs.***

The benefits of Spirulina in today's society are becoming too great not to take notice of as life for many gets busier and busier, a lot of diets are dictated by the time you have available for eating, from the rushed breakfast, to the small break in the working day. This leaves many people sold on convenience foods which can be prepared in an instant, which are often high in fats, sugars and carbohydrates, and low in protein, natural nutrients and fibre. To receive the supply of nutrients to assist the body to function at optimum levels, larger volumes of nutritionally empty foods are consumed. Convenience foods typically increase body fat, raise

cholesterol levels, and contribute to digestive and health challenges in later years.

The human digestive system, when bombarded with over-processed fatty foods, does not extract enough quality nutrients. The body is continually starving for more nutrients, triggering appetite and compulsive overeating disorders.

You must learn to work with your body, not against it. People should be using spirulina for a dietary supplement as part of the transform in their health and vitality. Spirulina is a very concentrated natural food. Many are using it as a dietary supplement and a complete food. For those who lead busy lives it is ideal.

- *Does not need to be chewed, ideal food on the run.*
- *Prepared in seconds*
- *Highly concentrated for easy nutrient absorption*
- *High quality protein*

As part of a wholesome natural food diet, spirulina can help bring body fat back to a healthy level. Many people use it along with a low carbohydrate diet and exercise to achieve their results. Taking it one hour before meals can help satisfy your body's appetite. It is not an appetite suppressant in any way, and contains no drugs or chemicals that trick the body. It is simply super concentrated, easily digested natural nutrition. With digestion being the largest process occurring in the body the less work the body has to do to extract the nutrients from the food, the more it can spend using them on repair, growth and vital functions. Exactly what the body needs.

### ***More about Spirulina***

It is a whole-food, not a concentrate, not an extract. It is detoxifying. A person can not eat too much and overdose on Spirulina. It contains more bio-chelated organic iron than any other whole-food. Bio-chelated means that the iron will easily be assimilated into the body. Spirulina has 58 times the iron of raw spinach and 28 times that of raw beef liver.

It contains more beta-carotene than any other whole food. Beta-carotene determines how our cells communicate with one another. Beta carotene opens the membrane communication channels of cancerous and pre-cancerous cells, allowing the body to signal the cancerous cells to stop dividing. Therefore, foods rich in beta carotene may not only be able to prevent but also reverse cancers.

Research as demonstrated that beta-carotene can lower cholesterol, treat wounds and reduce the size of tumors. Natural beta-carotene is far superior to synthetic, both chemically and physically. It absorbs better into the body than synthetic and it will NOT build up in the body and become toxic. There are NO toxic side effects.

It is the richest source of natural antioxidants of any whole-food source. It contains every natural known antioxidant including zinc, manganese, selenium and copper, the amino acid methionine, vitamin E, vitamins B-1 and B-6, the amino acid methionine and of course, beta-carotene. It is rich in chlorophyll, much richer than wheat grass and alfalfa.

Spirulina contains more Gamma Linolenic Acid (GLA) than any other whole-food source.

Phycocyanin, which is the natural blue pigment of Spirulina, is NOT found in any other food on the planet.

Glycolipid, which is found in Spirulina, has been found to be active against the AIDS virus (Boyd et al 1989).

Spirulina is a rich, natural source of phenylalanine-slimmers; Spirulina effectively suppresses the appetite. Its whole food nutrition facilitates low-calorie dieting without the energy draining and health destroying nutritional deficiencies that are the downfall of most weight-loss programs. Spirulina satisfies hunger because it fulfills the body's nutritional and biochemical needs.

Virtually all multiple vitamin/mineral supplements today are laboratory-synthesized chemical compounds. Yet, according to internationally



acclaimed author and nutritionist Dr. Paavo Airola: *“It is wisest and safest to take vitamins and minerals in the form of food supplements where they occur in their natural form and strength, and in combination with all of the other nutritive factors such as enzymes and trace elements, for optimum assimilation and biological activity.”*

Fitness enthusiasts, body-builders, professional coaches and competitive athletes are reporting increased energy, enhanced endurance and other exciting performance improvements with Spirulina. Spirulina promotes health in many ways. It powerfully protects from oxidant stress and strongly supports the immune system and a healthy inflammatory response. Scientific studies suggest it may be especially good for the brain, heart, immune system and more; so you can meet life’s challenges.

Spirulina produces all its nutrients by harvesting sunlight. It gathers and transforms sunlight into green and blue pigments that make it blue green algae. The blue is an amino acid group found only in Spirulina called phycocyanin, which accounts for its high concentration of vegetarian protein. The green in Spirulina is chlorophyll, one of the best natural detoxifiers known.

Spirulina is an extremely high energy food. It contains all the B vitamins, which are synonymous with high energy. Energy derived from whole foods such as Spirulina and Chlorella are natural and will never leave you flat after their nutrients have been consumed by the body. Scientific studies world-wide have demonstrated the incredible health properties of spirulina.

Water, nitrogen, phosphorus, carbon dioxide and sunlight are all that is needed to produce Spirulina, one of the most nutritionally packed foods in the world, an absolutely astounding array of enzymes and other nutrients. It is extremely easy to grow and takes less room per cubic centimeter than any other crop known, yielding an enormous amount of nutrition.

*Spirulina is a Whole Food*

Most vitamins on the market are comprised of laboratory-synthesized chemical compounds rather than natural sources. Virtually all vitamins are mix and match amalgams of extracts and concentrates, some of which can accumulate in the body and become toxic if they are fat soluble. The other problem with the mix and match vitamin approach is that vitamin companies are trying to duplicate nature, which can never be done. Spirulina is a balanced natural whole food. Its minerals and vitamins are naturally bio-chelated, meaning they are wrapped in amino-acids for excellent assimilation by the body. It contains over 100 synergistic nutrients and is nature's richest and most complete source of total organic nutrition. Spirulina is a completely natural, and therefore superior, approach to nutrition. It is also much more economical than most mass produced vitamins!

### *Spirulina: a Powerful Nutraceutical*

The human body is perfectly capable of healing itself if it is provided with the necessary vitamins, minerals, enzymes and other nutrients it needs. There are many foods that have healing and preventative health qualities, but none possess such powerful and wide-ranging and diverse group nutrients as Spirulina. Spirulina provides the body with the proper nutrients it needs so it can heal itself.

Over 2000 different enzymes are critical for good health, and to weather digestive or metabolic disorders. Spirulina has been scientifically demonstrated to increase the reproduction of lacto-bacilli, the bacteria that digests our food. Spirulina has a cleansing effect that works first on the digestive system and then on the blood and entire of body after several months of use. It also contains SOD (Super Oxide Dismutase). This essential enzyme is crucial to the body's ability to assimilate amino acids (protein). Without its presence in the body, we are unable to create the 10,000's of long, complex chains of amino acids known as protein.

Spirulina has 3 times the Vitamin E than that of raw wheat germ and its biological activity is 49% greater than synthetic vitamin E. It has 25 times the Beta-Carotene than raw carrots. Unlike the preformed vitamin A of

synthetics and fish liver oils, beta-carotene is completely nontoxic even in mega doses.

*Spirulina is Alkaline and helps balance your body's pH*

It is important that we maintain a balance body pH of ideally about 7.3 - 7.45, which is about neutral. However because of our poor diet of junk food, fast food, over-cooked, processed foods, especially soft drinks (the worst is cola), which have a pH of 2.7. This is several thousand times more acidic than our bodies.

This is important because all diseases start and live and thrive in an acidic environment and do not live well in an alkaline environment. Thus it follows we have to keep ourselves as alkaline as possible. Becoming too alkaline is rare but not unheard of.

Cancer rates have risen steadily until now that fully one third of all people in the United States will get cancer in their lifetime! The rise of fast, junk and processed foods matches those of rising cancer rates. Forty years ago, cancer in children was almost unheard of. Now they have entire hospital wards given over to children with cancer. We are too acidic! May be that is why we are getting sick!

## **Spirulina Content**

A breakdown in nutritional terms of a few of the most commonly available supplements reveals an impressive comparison.

General Composition of Spirulina	
Protein	60%
Carbohydrates	19%
Lipids	6%
Minerals	8%
Moisture	7%
VITAMINS	
Beta-carotene	10 mg

Vitamin A (100% as Beta-Carotene)	15,030 IU
Vitamin B1 (Thiamin)	102 mcg
Vitamin B2 (Riboflavin)	99 mcg
Vitamin B3 (Niacin)	621 mcg
Vitamin B6	13.2 mcg
Vitamin B12	6.6 mcg
Inositol	2.04 mg
Biotin	0.969 mg
Folic Acid	0.9 mcg
Pantothenic Acid	12 mcg
<b>FATTY ACIDS</b>	
<i>Omega 6 Family</i>	
Gamma Linolenic (GLA)	30 mg
Essential Linolenic	33 mg
Dihomogamma Linolenic	1.59 mg
<i>Omega 3 Family</i>	
Alpha Linolenic	0.0435 mg
Docosahexaenoic (DHA)	0.0435 mg
<i>Monoenoic Family</i>	
Palmitoleic	5.94 mg
Oleic	0.51 mg
Erucic	0.072 mg
<b>MINERALS</b>	
Calcium	12 mg
Magnesium	14.4 mg
Iron	3.18 mg
Phosphorous	31.2 mg
Potassium	45.6 mg
Sodium	21.9 mg
Manganese	78 mcg
Zinc	36 mcg
Boron	30 mcg
Copper	3 mcg
Molybdenum	3 mcg

PHYTONUTRIENTS	
Beta-carotene 9- <i>cis</i>	1.60 mg
Beta-carotene 13- <i>cis</i>	0.51 mg
Beta-carotene 15- <i>cis</i>	0.12 mg
Beta-carotene all- <i>trans</i>	7.80 mg
Zeaxanthin	0.95 mg
Chlorophyll	23.70 mg
Total carotenoids*	14 mg
Phycocyanin	333 mg
Superoxide Dismutase**	2640 units
*Includes alpha carotene, beta cryptoxanthin & others.	
**Reported as units Ferric S.O.D.	