

# **Chlorella - A Brief Review**

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*Chlorella*

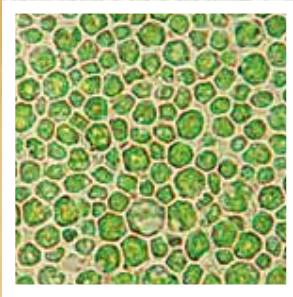
In recent years, scientific research has experienced a paradigm shift, abandoning the fallacy that is pervasiveness among human understanding in exchange for deferential submission to that of nature's knowledge and will. As evidenced by this shift, humans have been forced to better acknowledge the paths through which nature has chosen to subsist. In doing so, the "humbled exclusion" of our species from that of the natural world has since allowed for the development of sustainable practices in every aspect of modern scientific development. It's quite possible that the solutions to many, if not all, of the ecological problems created by humans, lie in the understanding and application of natural processes.



First described by Dr. Martinus Beijerinck in 1890, the genus *Chlorella* has become one of the most developmentally investigated groups of organisms in scientific history. Rightfully so, considering the processes through which have survived these organisms for over a billion years, serve as a blueprint for higher life as we know it. Utilizing only carbon dioxide, mineral water, and sunlight, these organisms harness the ability to produce oxygen and biomass at photosynthetic efficiencies beyond that of most forms of higher plant life. These attributes have driven many scientists to investigate the use of *Chlorella* species in developing sustainable solutions to

humanity's ever-growing need for food, fuel, and medicine. In doing so, researchers are ultimately left to answer one question, "Is it possible to implicate such basic units of life in the complexity of modern existence?" In the case of *Chlorella*, it is important to first understand the evolution of biological processes that have governed *Chlorella's* existence for so many years. This article will serve as a review of these evolutionary processes, exploring how they relate to modern life, and their implications in both scientific research and the public perception of "health" and "health practices" moving forward.

## Chlorella Beginnings



Since 1890, over 100 *Chlorella* species have been identified and classified in an often ambiguous process which has proved especially difficult for taxonomists, considering the overwhelming simplicity of *Chlorella* morphology. In 1961, Melvin Calvin used this simplicity to describe carbon dioxide assimilation in plants; a breakthrough which ultimately defined the parsimonious roles of light in photosynthesis and the carbon processes that govern the production of organic compounds in plants. To Melvin Calvin, and so many researchers, *Chlorella* represented the foundation on which most aerobic life is based. Which begs the question, where and when did *Chlorella* come to exist, and why is it still relevant today?

To classify *Chlorella* amongst modern interpretations of higher plant life would be a misnomer. *Chlorella* is actually a protist, a single-celled microscopic algae capable of producing its own food through photosynthesis in aquatic environments. Like most green algae in the division Chlorophyta, it is primarily composed of chlorophyll pigments. Its name, like chlorophyll, is derived from the Greek words 'chloros', meaning green, with the Latin 'ella' meaning small. Ranging in sizes as small as only a few micrometers in diameter, the round *Chlorella* cell consists of a mixture of chlorophyll a and chlorophyll b. This is not unlike the cells of higher plants, which rely on these same pigments in photosynthesis, leading many scientists to further implicate *Chlorella*, and many other Chlorophyta, as being ancestral to land plants. Green algae itself is believed to have evolved from prokaryotic organisms between 2500 and 1000 million years ago (Avagyan, 2010). Its stark morphological similarities to the outer wall structure of the 1450 million year old *Leiosphaeridia crassa* from Australia serves as one of many indications of an evolutionary shift of green algae into our modern interpretation of "Neochlorophyta", and other early representations of Chlorophyceae, during this span of time (Javaux et al., 2004). Despite this relatively broad range of estimation regarding the earliest representations of *Chlorella* species, there is no denying the ancient nature of this organism, and its role in shaping the world we know today. The implications of an evolutionary shift during this time period should serve as a reminder of the foundation on which our own existence came to develop and persist. It only makes sense that the molecular constituents of *Chlorella* biomass serve as the nutritional basis for what is considered "healthiest" to our species.



## Why *Chlorella*?



With thousands of algal protists to choose from, why has *Chlorella* become a staple for commercialized application? To answer this question, we must go back to the First World War, when German scientists sought to investigate *Chlorella* as a low-input source of protein for soldiers. *Chlorella*'s ability to produce nutrient packed biomass at rate efficiencies beyond that of most domesticatable crop species ultimately became the motivation behind this initial research. In only 12 hours of optimal conditions, *Chlorella* is capable of reproducing itself 4 times over, with over 50% of its biomass existing as protein. However, the incorporation of *Chlorella* in the human diet

quickly proved problematic. The same hardened cell wall often attributed with surviving these organisms for so many years, also prevents the cells from being adequately digested within the human body. Consequently, commercial interest in *Chlorella* applications quickly faltered following the end of World War II. The discovery of the Haber-Bosche process, and the production of synthetic fertilizer, set the groundwork for the agricultural revolution that would ultimately define exponential population growth in the 20th century. With such an abundance of food sources capable of now being easily produced cheaply and efficiently, *Chlorella* held little economic importance in developed and developing countries. Concomitantly, without an effective and fiscally efficient means of rendering *Chlorella* cells digestible, such applications in third world and undeveloped countries were also unfounded in their practicality to support life.

The revolution of modern medicine, once responsible for penicillin and the propulsion of human survival into exponential population growth, now serves to denounce the very dogma governing the laws of survival in ecology and evolution. Double-blind studies aimed at treating symptoms hold little relevance in our holistic understanding of the biological processes governing innate human health. The enhanced degree of variability among the diagnosis and treatment of non-terminal diseases in our modern world should serve as an indicator of the “optimal” health humans are pursuing, but never seem to reach. Occam’s Razor, otherwise known as the law of parsimony, points to a much simpler convergence of causes that have led to our dependence upon prescription medication. There is no denying the importance modern medicine has played in sustaining rapid population growth since the early 1900s. However, when straddling the line between a supportive and dependent use of prescription drugs, we are ultimately faced with the question, “How much is enough?”

**A**s a natural and holistic medicinal supplement, *Chlorella* has historically had little to offer in the way of clinical drug research. When approaching any one of the millions of health-symptoms impacting our everyday lives, it becomes less and less likely that *Chlorella* will be singularly attributed to any one of them in a double-blind research study. Rather, its role goes much deeper. To conduct research on such a vast array of “downstream” health benefits that may or may not be associated with *Chlorella* consumption would take the better part of the careers of countless people in food nutrition and drug health research. Studying the life-long benefits of a natural, and in many cases, un-patentable “drug”, within the framework of the complexity of modern human life across a broad population would take lifetimes, with little to be guaranteed in the way of commercial profit. Being that humans only live an upwards of a century, and patents only a few decades, it’s impractical to find commercial interest in something that is not only natural, but required to be taken as part of a healthy lifestyle. However, in studying the convergence of health effects attributed to the broad range of associated disorders in our immune system function, research has shown that *Chlorella* supports the body’s ability to take care of itself. By also humbling ourselves in our understanding of the human body, and the natural processes that have governed the preservation of our species for tens of thousands of years, *Chlorella* offers one of the best approaches to these solutions that we could ask for: helping the body do what it was built to do. Conversely, the paradoxical approaches presented in modern medicinal practice serve to question even the most basic laws of survival. If our body hadn’t the ability to take care of itself,



independent of prescription drug use, then humans would have went extinct a long time ago, due to an absence of significance in “evolutionary adjustment”. Our now “conscious adjustment” of how we can best support sustainability of life should begin and end with the acknowledgement of the body’s natural life processes, and what we can do to improve them every step of the way.

What we do know is that *Chlorella* contains numerous constituents clinically proven to be vital to proper human nutrition. *Chlorella* contains many vitamins and minerals including Vitamins A, B12, C & E; Iron, Magnesium, & Zinc; antioxidants such as beta-carotene; and high amounts of amino acids. However, the “magic” of *Chlorella* goes beyond nutrition alone. *Chlorella* exhibits powerful detoxification effects on the body. This can be attributed to its high levels of chlorophyll, which bind to many carcinogenic, toxic, and heavy metal compounds that make it in the bloodstream such as chlordecone, heterocyclic amines, dioxin, polychlorinated biphenyls, mercury, cadmium, and aflatoxin, excreting them as bodily waste (Lee & Rosenbaum, 1998). It has also been demonstrated to promote the turnover of bile acids in the liver, thereby suppressing cholesterol increases caused by high cholesterol diets (Sano et al., 1998). Despite an often-pervasive disinterest in the cause-effect benefits of proper nutrition, research has demonstrated the ability of *Chlorella* to reduce the severity of many disease symptoms. These include improvements in symptoms related to Ulcerative Colitis, Fibromyalgia Syndrome, and Hypertension. Common among these chronic conditions, is the inability of the body to regulate responses to the surrounding environment. This is especially true in cases of Ulcerative Colitis, where autoimmune responses are believed to trigger the body into attacking its own colon tissue (Ordonez et al., 2012). In fact, drugs issued as immunosuppressants in clinical practice to prevent organ rejection following transplants, such as rapamycin and cyclosporin, are often administered as a last resort for symptom reduction in severe cases of Ulcerative Colitis.



As someone that almost died from Ulcerative Colitis at a young age, when the connection between Ulcerative Colitis and autoimmune dysfunction is most prominent, I was given cyclosporin at the precipice of death, in a desperate attempt to prevent the need for removal of my colon. This proved in vain upon my having an allergic, or autoimmune rejection, to the very drug meant to curve an autoimmune attack. Upon waking up from surgery, staples now holding a 10-inch opening in my stomach together, I realized that science ultimately falters in truly understanding much of the systematic bodily functions bridging symptomatology and disease treatment. This is not a testament to the lack of

humanity's will or ability to understand and accomplish great things in medicine, but rather the overall approach we seek to take in our medicinal practices. I'd much rather believe that corporate interests fuel our dependence on prescription drug use, as the alternative causation of human ignorance in the finality of labeling synthetic drugs as the answer to chronic health conditions leaves little room for deferential submission to an almost incomprehensible holistic understanding of human bodily function. Regardless, a faltering of the public's faith in professional medicine is completely unwarranted, and should not be something any human should wish to be party to. There is no denying the success of modern medicine in delivering humanity into exponential population growth. Rather, the answer to the question of, "How much is enough" I believe lies in newfound approaches to bodily care at the individual level, independent of the statistics that ultimately govern



medicinal practices. There will always exist a ceiling to statistical test measures, where the individuality among cases will always succeed in preventing any single treatments from prevailing as "end all" cures. In acknowledgement of this, no longer should the mediums of clinical treatment warrant any substantiate separation of medicinal and holistic health practices. Clinical research, corporate drug development, and health insurance will continue to fuel human survival. However, the answer to your health, as well as your dependency on medicinal practices, is ultimately a function of your will and motivation to take control of your health, before a doctor must do so for you.

## Chlorella Moving Forward



**C**hlorella represents something that we do not yet fully understand, but should seek to utilize in preventative health assessment. The previously attributed roles of Chlorella when it comes to improving such complex and systematic health conditions point to its undeniable role in improving innate holistic health. We should not be so limited in our utilization of Chlorella, a billion-year old organism on which the very fabric of higher life is based, as what we understand about the complex morphology in our bodies is no doubt much less than our capacity to treat it. Rather, what we can acknowledge is the ability of Chlorella to improve health, where the complexity of symptom prevention often goes unrepresented in current human

health research. I am a firm believer that nature's ability to survive the human species warrants further application of practices that improve the body's natural ability to survive itself. An unnatural dependence upon the endless amounts of synthetic drugs used to treat chronic non-terminal illnesses is unfounded in its ability to support what we cannot claim to understand about long-term human benefits at the molecular level.

If long-term benefit and survival is our goal, we would be best suited in turning our attention to the human body, and the reasons behind its design with regards to the survival of our species in this planet's environment. Evolutionary adjustment already did the work for us. Would not our now conscience adjustment best be served in a foundation based upon what nature has already developed, of which we cannot, and may not ever, fully understand? Beneficial health practices will always begin with an assessment of our ability to survive, but perhaps the question we should be asking ourselves is, "Which is more likely to improve the quality of the human life-span: natural processes or prescription drugs?"

I believe answering that question will lead our society to further embrace the implications of diets incorporating natural supplements like Chlorella and the very constituents that have survived us longer than we can hope to imagine, through a mechanism we have since imagined to be much less.





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