The Role of Phytoplanktons in the Environment and in Human Life, a Review

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Phytoplankton is microscopic organisms that lie in watery environment and make their own food from sunlight through photosynthesis. Phytoplanktons are the core producers and major role play to the food web. They produce the similar amount of biomass of CO_2 as all terrestrial plants combined. Several environmental factors, many of which are currently undergoing significant changes as a result of human-caused global warming, control phytoplankton productivity. Generally, ocean ecosystem is based on phytoplankton. It contributes about half of the world's primary production, and diverse phytoplankton taxa play distinctive roles in the earth biogeochemical cycles, biological pump, ocean food chain, bioindicator, food industry and drugs. In the present paper an effort has been made to give broad review of literature on phytoplankton. This review clearly indicates that such research is necessary and emphasis the urgency of present work. The recent review highlights the value of phytoplankton in our lives and environment.

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1. Introduction

Phytoplankton is uniqueness nourished autotrophic member of the plankton group, necessary in ocean and freshwater ecosystems. They obtain energy through photosynthesis, living in oceans and lakes surface layers that are well-lit. Phytoplanktons is differ from terrestrial plants in that they are dispersed across a border surface area, are less seasonally variable, and have a higher rate of turnover than less. This makes them respond rapidly to climate variation on a global scale. Phytoplanktons are crucial universal carbon cycle, accounting 50% of all photosynthetic activity in the planets and oxygen production. Important groups include diatoms, cynobacteria, and dinoflagellates. The majority of phytoplankton is too small to be seen separately, except when they are present in large quantities, some diversity may be able to be seen as colored patches on the water surface because of several species have additional pigments and cells that contain chlorophyll.

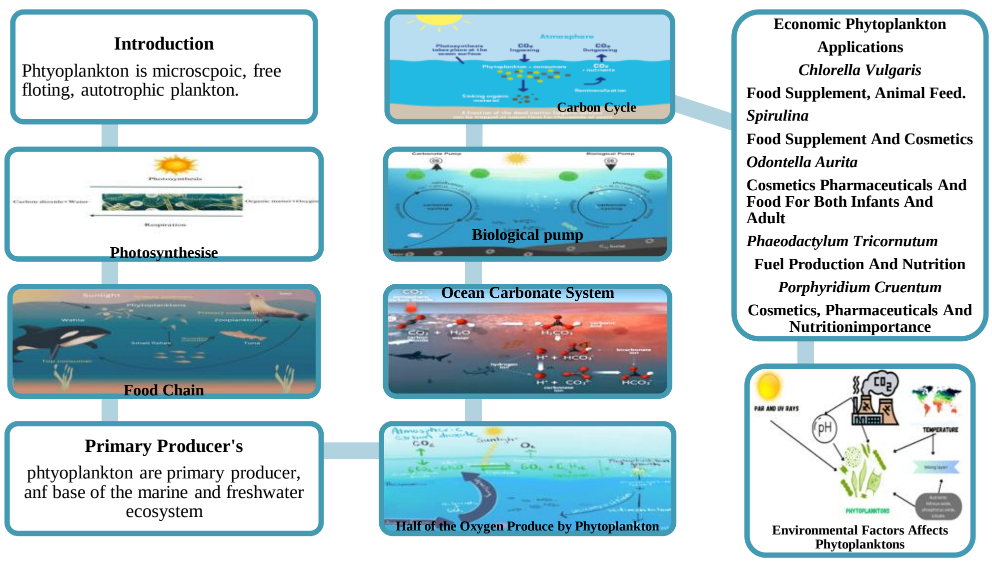

Figure 1: Mind Map for the review paper

2. Photosynthesis

Photosynthesis by phytoplankton is a highly significant activity. It is the nucleus of the entire marine food chain and the main source of oxygen in the atmosphere. Because it removes enormous amounts of carbon dioxide from the atmosphere through photosynthesis (fig.2), phytoplankton also plays a significant part in controlling the global climate. Furthermore, changes in temperature, nitrogen levels, and other significant oceanographic parameters can be tracked using phytoplankton, which is a potent indicator of ocean health. The energy that higher trophic level creatures from phytoplankton photosynthesis, which is a significant source of energy for ocean ecosystems. In order to preserve the wellbeing of our planet and its inhabitants for a number of generations, it is crucial to comprehend the significance of this process. Through fluorescence, oxygen evaluations, and the production of pigments like chlorophyll a, phytoplankton photosynthesis can be measured. While oxygen measurements assess the amount of oxygen formed by the phytoplankton during photosynthetic activity, fluorescence measurements measure the amount of light that the phytoplankton emits when they are exposed to various light sources. Chlorophyll a, a pigment created by al phytoplankton during photosynthetic activity is what is measured by pigment measurements. The fundamental benefit of utilizing fluorescence to monitor phytoplankton photosynthesis is that it is that it is non-invasive and allows for real-time monitoring of photosynthesis variations. In a variety of light regimes and nutrient concentrations, fluorescence can also quantify photosynthesis. This is a perfect way to measure photosynthesis in varying environmental circumstances.

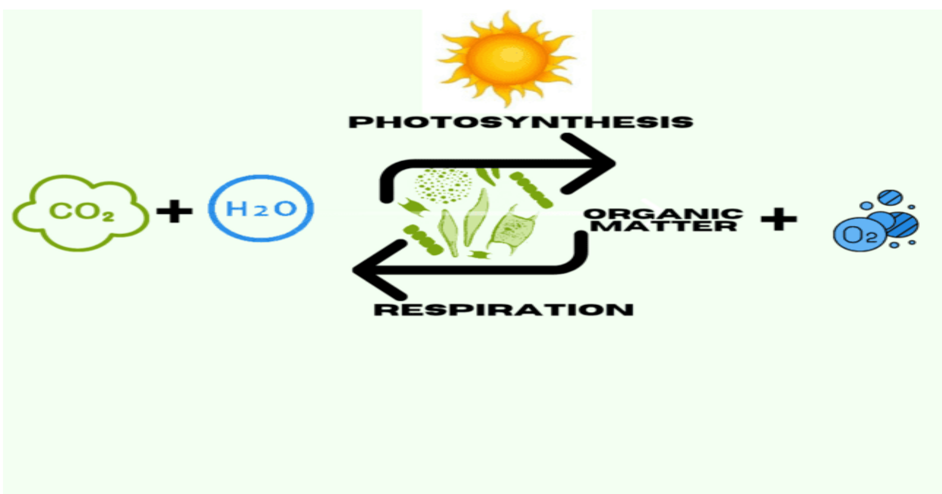

Figure 2: Photosynthesis process by Phytoplankton

3. Food Chain

The aquatic food chains foundation, phytoplanktons are microscopic floating organisms whose ecology is influenced by both biotic and abiotic factors [1]. Aquatic ecosystems biomass pyramids are inverted compared to terrestrial ones. Mostly, the biomass of consumers for example zooplankton (shrimplike creature), small fish and mackerel, (secondary consumer), Tuna (tertiary consumers), and shark (quatemary consumer) bigger than primary producer's (fig. 3). This occurs because a little mass of phytoplankton, the minuscule primary producers of the ocean, may produce a lot of primary matter quickly due to their rapid growth and reproduction. Defiantly, many important terrestrial main producers, like reproduction and growth in older forests are slow, need a substantially bigger mass to achieve equal pace of the primary output. The biomass majority of marine animals are made up of zooplankton because of this inversion. Zooplankton, are primary consumers, and key streak between which represent best part of the marine food web's primary produces, and reminder of the food chain. Phytoplankton that dies before being eaten travels across the euphotic zone as marine snow and settles into the ocean's surface. Approximately 2 billion tons of carbon dioxide (CO_2) into the ocean annually removes by phytoplankton, leading the ocean turn into sink of (CO_2), all of sequestered carbon storing about 90% [2]. About half of the earth's oxygen produced via the ocean, with it holds 50 times as much carbon dioxide as atmosphere does [3]. Understanding an ecosystem food chain and how its impacts the flow of energy minerals and minerals. By turning inorganic chemicals into organic chemicals, phytoplankton produces biomass on a self-replicating autographically [29]. As the foundation of the marine food web, phytoplankton supports every other aquatic life in the water. In the marine food chain, microbial loop is the second important mechanism. These cycles destroys Achaea and marine bacteria, remineralizes organic and inorganic material, and reuse the products also in the pelagic food web or by deposition as marine sediment on the bottom [4].

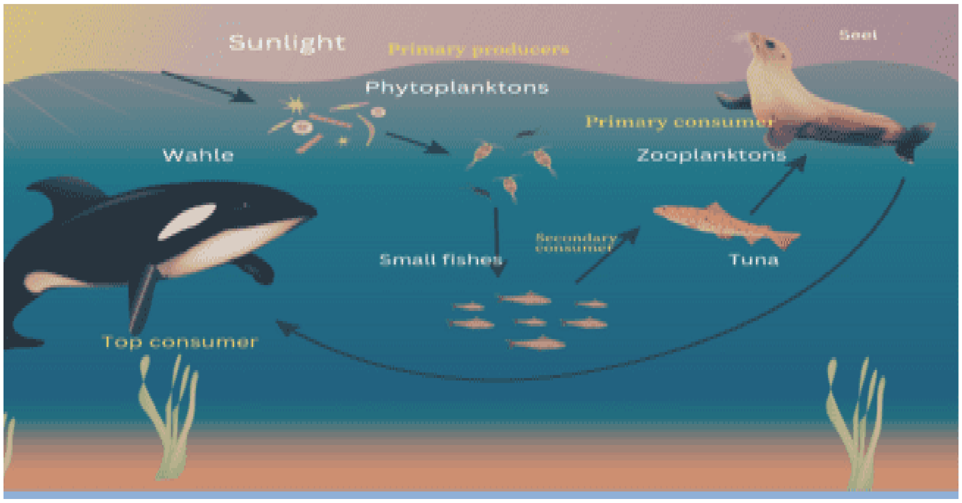

Figure 3: The ocean food chain

4. Primary Producers

Primary productivity basically defined as the ratio of phytoplankton biomass to phytoplankton growth rate, as the amount of organic substance generated per unit area per unit time [5]. Marine primary producers are important to the dynamic's food webs, biogeochemical cycles, and marine fishes [6, 7]. Phytoplankton serves as the foundation of the marine food web, making them the main producers [8]. A chlorophyll-a, is a pigment that all phytoplankton have in common, but they also have other auxiliary pigments such chlorophyll-b and chlorophyll-c with photosynthetic carotenoids [9, 10]. These pigments achieve solar energy; change into the high-energy organic compounds from and water CO_2. These chemicals energy growth with creating essential building blocks such pigments, and nucleic acids, amino acids, lipids, proteins, polysaccharides. Gross primary production is the result of photosynthetic activity; net primary production is the result of the variation between respiration and gross primary production. The process of respiration absorbed the free of CO_2 through photosynthesis, resulting in a netting fixation of the inorganic carbon into autotropic biomass. Phytoplankton makes up the Ocean's around half of the world's net primary output [11]. Primary producers functions such as biological pump to remove carbon to the surface by sinking the fixed organic matter [12]. Their by playing a global role in climate change.

5. Carbon Cycle

Phytoplanktons produce oxygen and take up carbon dioxide from the ocean's water during photosynthesis. They allowed the oceanic carbon dioxide more absorbed through the atmosphere by eliminating CO_2 from the water (fig.4). The biosphere is so reliant on phytoplankton that a decline in their population can have an impact on the earth temperature. The more phytoplankton present, the more atmospheric carbon dioxide may dissolve in the water. The less carbon dioxide there is in the atmosphere, it is a green house gas. Despite their significance, phytoplankton only lives one to two days. They disintegrate upon death, carrying enormous volumes of carbon dioxide. The ocean floor serves as a repository for phytoplankton and is the phytoplankton and is the richest place on the earth for carbon dioxide.

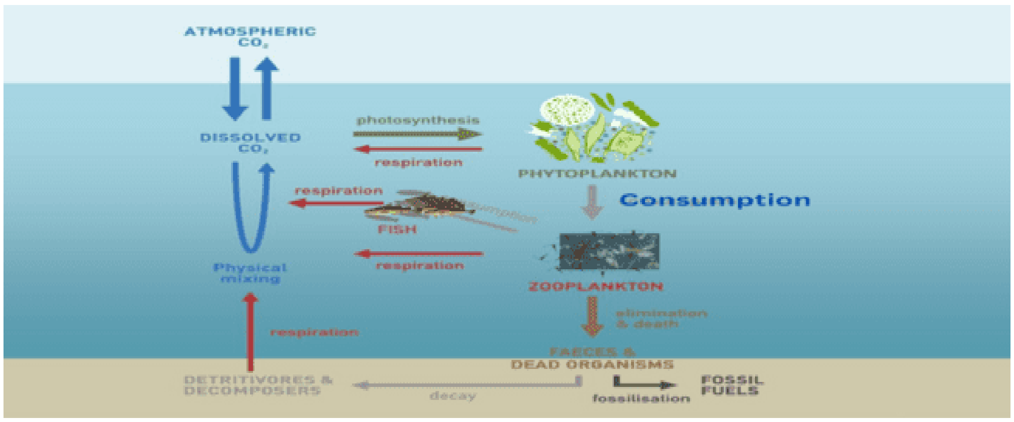

Figure 4. They allow the ocean to absorb more carbon dioxide through the atmosphere by eliminating CO_2 from the water.

6. Biological Pump

In addition to chemical reactions, biological activities, through the biological carbon pump, regulate the ocean's intake of CO_2. Organic matter is created n the surface layer by phytoplankton using carbon dioxide and UV-rays. Some of these particles descend to deeper strata and disintegrate within the water. In this approach, the biological pump (fig.4) tends to reduce the level of CO2 at surface of the ocean's, which promotes uptake from the atmosphere. Ocean has a significant potential to absorb CO_2, which lowers the atmospheric concentration of CO_2 and introduces carbon atoms to the ocean system. Lots of molecules that enter the water's surface also spread reverse to the atmosphere over comparatively small occasion. But several carbon atoms from these initial carbon dioxide molecules continue to exist into the water used for tens thousands to a few million years. Carbon atoms able to conserved millions of the years but some of them finally to the bottom of the ocean sediment. The ocean nature mediated elimination of carbon to the atmosphere, additional to the core of the ocean and biological pump known as sediments on the seafloor [13]. It is a biologically arbitrate mechanism that causes carbon to be stored into the ocean, distant from the land and atmosphere. The ocean carbon pump contains a physical and biological component. The movement of organic material, mostly produced by phytoplankton during photosynthesis, is a function of the wider oceanic carbon cycle. This is a component of the larger deep-sea carbon cycle that is reliable for the cycling of organic material formed primarily through photosynthesis and the cycling of $CaCO_3$ produced via certain organisms like mollusks as shells (Carbonate Pump) and plankton (fig.5)[14]. Climate and life on earth are fundamentally influenced by the element carbon. It can move inside and outside of the mesosphere, cryosphere, atmosphere, biosphere, and hydrosphere. The carbon cycle on earth refers to this flux of carbon. The cycling of other elements and compounds is likewise closely related to it. The ocean is an essential part of the carbon cycle on the earth, helping to control the level of carbon dioxide in the atmosphere. On the center of the marine carbon cycle is biological pump, collection of the mechanisms to transport organic carbon to the deep sea to surface [15]. The portion of primary generated organic matter that escapes degradation of the euphotic zone and carry on exported from water surface to support, the biological pump depends on carbons is carried against the slope of dissolve inorganic carbon (DIC) from the deep ocean surface as a result of it being mineralized in the ocean’s interior and becoming inorganic carbon. Physical adding and transit of the dissolve and particulate organic carbon (POC), straight migration of the organisms (fish and zooplankton), and gravity settle of the particle organic carbon all contribute to this transfer [16, 17, 18].

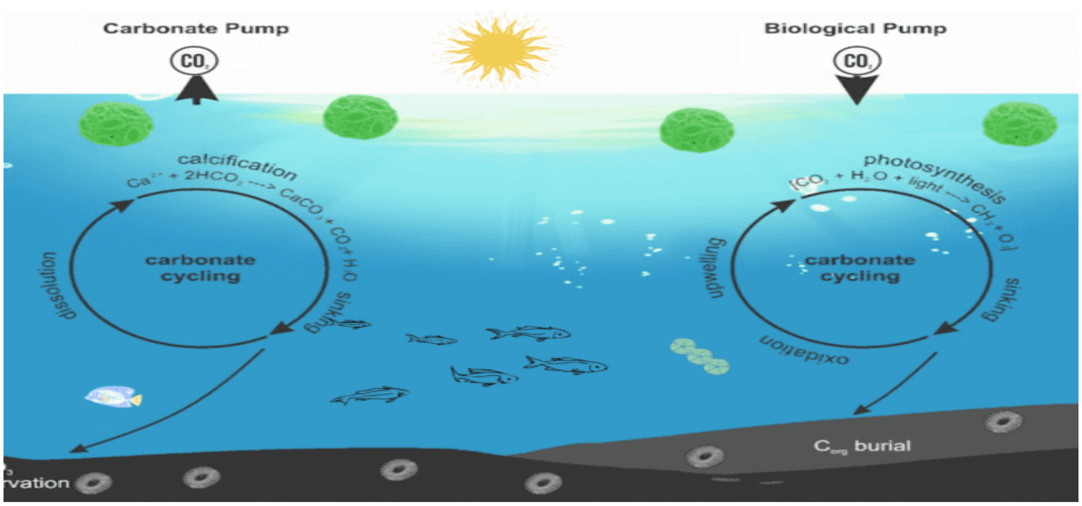

Figure 5. Biological pump and Carbonate Pump

7. Ocean Carbonate System

Coral, oysters, clams, lobsters, and other marine animals use the ocean's carbonate system to from their shells. Pump for ocean carbonate system for the oceanic carbonate chemistry of the marine nature contains a huge number of dissolve chemicals, which is particularly essential to the ocean carbon cycle and creatures are live in that create shells. Biological pump and the ocean carbonate system work together to move carbon to deep sea deposits, somewhere, and it is store up over incredibly lifelong times. Once carbon dioxide dissolved in the ocean, it initial mixing with the water molecules and a number of the reversible chemical expansion to the result in the formation of bicarbonate, hydrogen and carbonate ($H^+CO_3^-$,H^+, and CO_3^{2-}) ions. In particular, calcium ions (Ca^{2+}) and carbonate ions (CO_3^{2-}) combine to the calcium carbonate ($CaCO_3$); (fig.6) marine creatures place a specific emphasis on these ions. Calcium carbonate is used by animals that from the inner skeletons, shells, and plates, including pteropods, lobsters coral, oysters, ocean urchins, and several kinds of plankton.

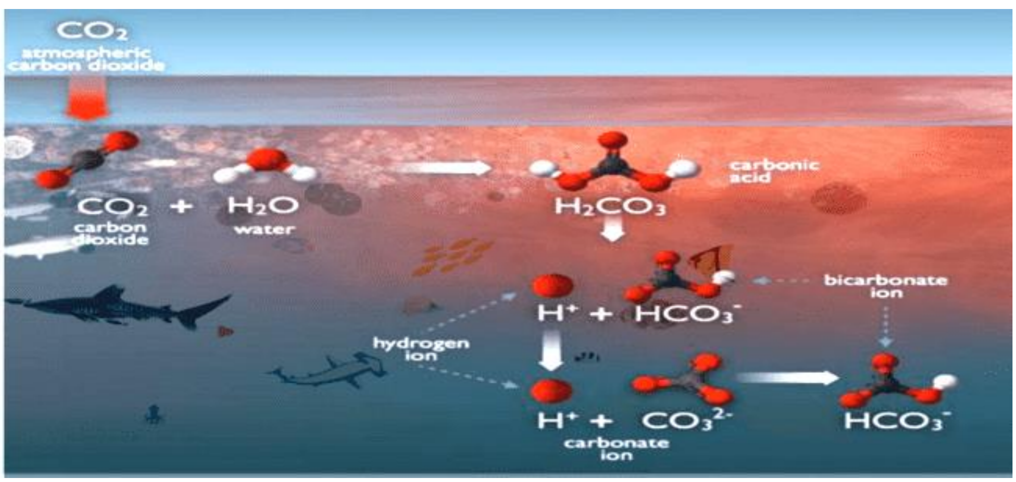

Figure 6. Ocean Carbonate ($CaCO_3$**)** System

8. Half of the Oxygen in the atmosphere produces by Phytoplankton

Despite the fact that trees, bushes, grasses, and other land plants are naturally thought of as our main sources of oxygen, phytoplankton really generates as much as all of these plants together. Chlorophyll, a substance found in phytoplankton, is responsible for converting carbon dioxide into the chemicals that make their bodily tissue by absorbing sun energy. Because oxygen is produced as a consequence of this process (fig.7), plankton is not only a crucial food source for marine life and, by extension, people, but they also allow us to breathe.

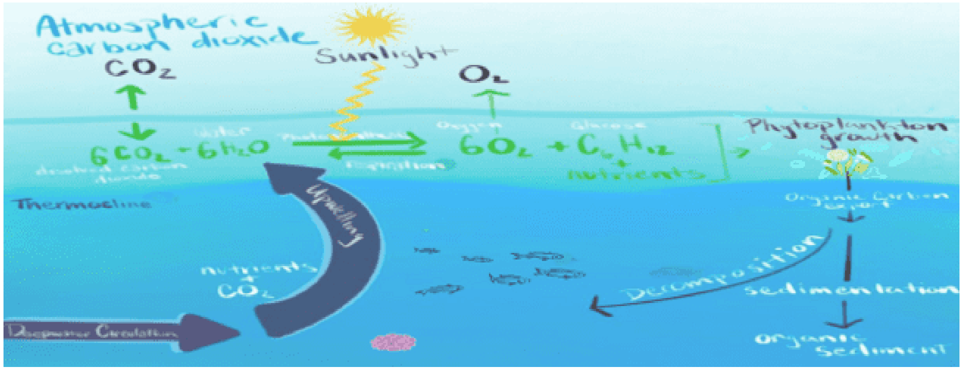

Figure 7: Phytoplankton produces half of the oxygen in the atmosphere

9. Economic Importance of Phytoplankton

Phytoplankton has used their collection in the agriculture and can also be main resource of earnings. Phytoplanktons are generally used as food supplements and play a very important part in both animal and human food. Phytoplankton is making use in the drugs manufacturing. Further 50% of all pharmaceuticals in medical use around the global are natural materials and derivative, and more than 60% of cancer treatment accepted is of natural derivation [52, 53, 54, 55]. They also, verified to be appropriate used for produce vaccines the source of bioactive secondary metabolites, such as positions, that may be the most new is phytoplankton. They exhibit anti-cancer, anti-inflammatory, antifungal, anti-abiotic, anti-viral, and other actions that can be used in medication development and treatment [56, 57, 58, 59]. Table (1) gives outlook phytoplanktons and their uses in different industries:

Table 1: Phytoplanktons and their uses.

Phytoplankton	Applications
Chlorella vulgaris	Animal feed, and Food supplement,
Spirulina	Food supplement, Cosmetics
Odontella aurita	Food for both infants and adult, and Cosmetics pharmaceuticals
Phaeodactylum tricornutum	Food nutrition and Fuel production
Porphyridium cruentum	Pharmaceuticals, nutrition, and Cosmetics

Cosmetic

Promoting glowing beautiful skin owing to its high bioflavonoid content, which promotes to healthy skin by remove impurity and accumulates in riboflavin and our skin cells, which is also known to decrease free radicals damaging our skin cells.

Diabetes

Supports healthy glucose levels both phenylalanine and chromium are renowned for reducing sugar cravings and helping to normalize blood sugar levels.

Improve Cardiovascular Strength

A very good source of Super Oxide Dismutase (SOD), omega 3 fatty acids and amino acid, all of the confirmed to carry a strong cardiovascular system.

Improve Immune System

The ocean phytoplanktons are rich in bioflavonoid, alanine, vitamin E, and beta-carotene all of which contain have a quick immune system-boost effect.

Regeneration of Cells

Marine phytoplankton's exceptional capacity to fortify cell membranes and promote cell regeneration is one of its most significant advantages [30]. The Federal Government principal organization scientific investigation into various miscellaneous medical and healthcare organizations, practice, describes the vitamins contained in ocean phytoplanktons are especially in human, cell membranes need to move out their functions. Starting discovery are human plasma, fluid that surrounds cell membranes, shares a lot in common with sea water in terms of chemical composition.

Improve Mental Health/decrease Symptoms of Depression

Nucleic acids, DHA, Omega-3 fatty acids, EPA, phenylalanine, magnesium and proline, are all abundant. Phytoplankton is an excellent vegetarian food source. Phytoplanktons are fantastic assistance used for brain tissues and be capable of greatly increase memory, psychological sharpness, and mood.

Improve Eye Sights

Marine phytoplankton is high in beta-caroten, which is identified shield human eyes cornea. Also significantly enhancing visual function is marine phytoplankton.

Promotes Joint Health

Phytoplanktons high manganese content can help to increase joint mobility, while pantothenic acid and omega-6 fatty acids support to protect joint health.

Support a Healthy Liver

The nutrient L-arginine which is present in marine phytoplankton, has been shown to ameliorate fatty liver decrease, increases blood flow, and maybe boost blood flow to the liver where it was previously constrained.

Consists of vital trace minerals

A predictable 80% of the Americans suffer from a deficiency in some essential trace elements. Marine phytoplankton is a great resource of all the trace minerals into the body requirements, majority of bioavailable from. According to the findings, an excess reliance on food supplies from the land can result in micronutrient and trace mineral shortages. A healthy human system must have iconic trace minerals.

Detoxifying substance

One of the best sources of Super Oxide Dismutase (SOD), which are identified to be the most useful heavy metal detoxifying catalyst are marine phytoplanktons in term of bioavailability. Primary functions of marine phytoplankton in the ocean are oxygenation and detoxification of our blood plasma, which is the liquid part of our blood.

10. Phytoplankton as Bioindicator

Phytoplanktons are crucial primary producers that are highly responsive to their physical surroundings [18]. Environmental Changes can affect the phytoplankton community's diversity, in abundance, diversity, and dominance of species in their environments [19]. Therefore, monitoring phytoplankton populations can be a reliable methods for evaluate the level of pollution in the water bodies in biomonitoring studies [20-21]. Because of their structure and function, Phytoplanktons perform the appropriate indicator and can be used to quantitative changes in water quality across vast geographic areas [20]. Phytoplanktons are supportive indicator of water quality and have been used for successful study of the water pollution [22, 23, 24, 25]. The relationship between an algal population growth rate, photosynthesis and concentration of the nutrient in the water body.

The relationship between the rate of growth and each of these factors can be affected by contaminations, for example instance radiance might be filtered and absorbed by industrial effluents if it is colored or includes suspended materials, which would slowing the development. A Decreasing of light causes a drop in the rate of ammonia and nitrate uptake by marine phytoplankton [26, 27].

11. Environmental Factors Affect Phytoplankton Diversity

Despite making up only about 1% of the total biomass of plants, phytoplankton performs 50% world's photosynthetic carbon dioxide fixation and 50% oxygen production [30]. In contrast to terrestrial plants, marine phytoplanktons is spread across a larger surface area, is subject to less seasonal change, and has considerably faster turnover rates than trees (days versus decades) [30]. Therefore, while evaluating the contributions of phytoplankton to carbon fixation and forecasting how this output can fluctuate in response to perturbations, these properties are crucial. Cycles of phytoplankton blooms, which are impacted by both bottom-up managing and climate change, make it difficult to predict how primary productivity will be influenced. Accessibility to essential nutrients, vertical mixing, and top-down control (such as grazing and viruses) is a few example. [31, 30, 32, 33, 34, 35]. A rise in temperature, increase solar radiation, and freshwater inputs into surface water all serve to further the stratification of the ocean and, as a result, decrease the upwelling of nutrients from deep water, surface, reducing primary production (fig .8). [30, 36, 37]. In contrast, higher carbon dioxide amount boost phytoplanktons primary production, except simply in conditions where nutrient availability is not constrained [38, 39, 40, 41]. Some studies have suggested that there has been a decrease in the overall density of oceanic phytoplankton over the past century (fig.7), [42], but these finding have been contested due to the lack of long-term phytoplankton data, methodology variations, data generation, and significant annual and decadal fluctuations in phytoplanktons productivity [43, 44, 45]. In additional research points to global increases during marine phytoplanktons productivity [46] with modification into the particular geographic or else definite phytoplanktons species [47, 48]. There are contradictory hypotheses of altering the mixing pattern, variation in nutrients delivery, and production trends in Antarctic Regions, despite the fact that the global Sea Ice Index is declining [49], the result, could effect during more light diffusion, the atmosphere possibly additional primary production [50]. Uncertainly exists on how phytoplankton biodiversity affects by human-caused climate change. Should greenhouse gas emission continue to climb to high levels by 2100. Some phytoplankton models predict increase in richness, or the number of unique species within a given area. Ocean temperatures rising are linked to this rise in plankton variety. Along with changes in species richness, it is anticipated that the distribution of phytoplankton would move closer to the earth's poles. Due to phytoplankton, such movement might make threats on ecosystems. Zooplankton eats them, which keeps fishes alive. This change in phytoplankton distribution may also reduce their capacity to store carbon from human-related emissions. Phytoplankton alteration caused by human anthropogenic activities has an effect on economic and natural system [51].

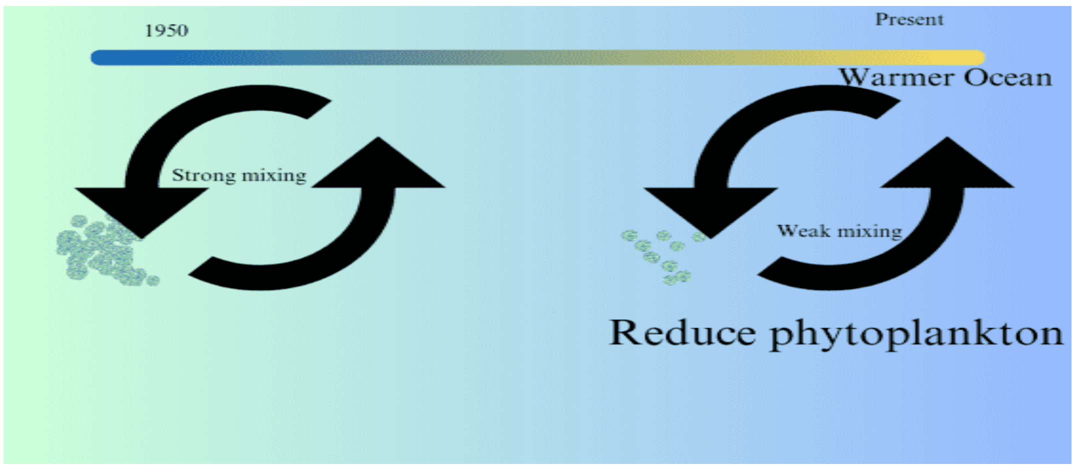

Figure 8: Reduce phytoplankton and increase ocean temperature,

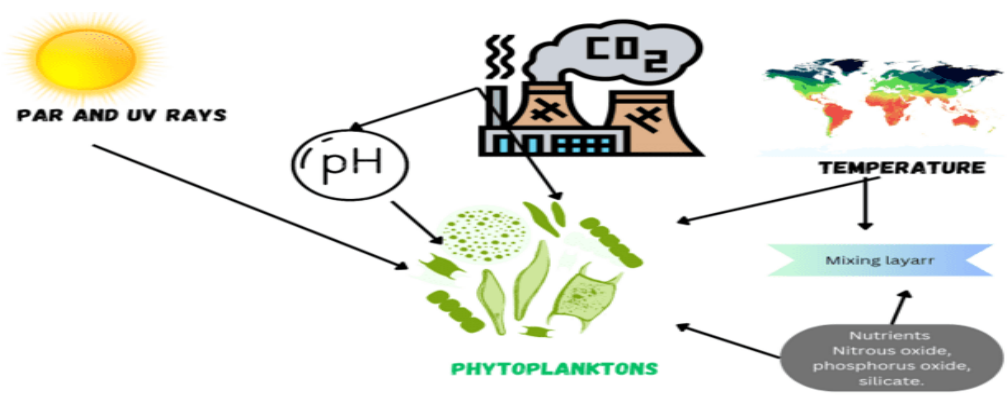

Figure 9: Environmental factors that's affect phytoplanktons

12. Conclusions

Phytoplankton is important for maintaining the ocean food chain. The ocean food chain and human societies that rely on the water for food and a living could be significantly impacted by the disappearance of these microscopic organisms. For phytoplankton to survive, concerns including ocean acidification, nutrient pollution, and global warming must be addressed. Reduce greenhouse gas emissions, nutrient pollution control, and the preservation of coastal ecosystems are just a few steps that must be taken to protect phytoplankton population. By implementing these actions, we can guarantee the survival of phytoplankton and the wellbeing of the entire ocean food chain, carbon cycle, carbonate system, biological pump, carbonate pump and photosynthesis.

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