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Title: The potential of microalgae for the development of innovative technologies for the protection and preservation of the environment

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Introduction

Biotechnology has become a fundamental tool to study the biochemistry and functionality of microalgae for biomass production, and it has been found that they have higher photosynthetic performance than plants and algae, resulting in higher biomass production capacity with high nutrient and lipid content (Lu *et al*., 2021; Araújo *et al.*, 2021; Liu and Benning, 2013). Therefore, they have attracted the interest of many researchers who are looking for alternatives and solutions to various environmental pollution problems, both air and water, using simple, economical and efficient processes, in addition to the recycling of residuals and the production of clean energy (Cheirsilp *et al.*, 2023). Intensive cultivation of microalgae can contribute to the reduction of CO_2 emissions from power plants, consume inorganic nitrogen and phosphorus (Bernard, 2011; Benemann, 2003), recycle pollutants present in water or air and adsorb them for the production of biomass that acts as a completely environmentally friendly biofuel (Cheirsilp et al., 2023; Silambarasan *et al*., 2020;; Hernández and Labbé, 2014), making them an excellent option as an energy source for the future (Subhash *et al*., 2013; Bernard, 2011).

This review presents the most relevant information on microalgae, from the components of their cellular structure and the functions they perform, to understanding the processes and favorable conditions for their cultivation, which lead to the production of certain biomass components that are of high value for some specific industries. Also included are the advances in biotechnology that have allowed the development of new technologies and the benefits associated with their low cost. This information is complemented by recent research demonstrating the potential of microalgae in the areas of health, environment, energy and food production

Methodology

Investigation on different repositories, platforms, specialized books, magazines and articles of comprehensive information on the research of various industrial products and in the case of the microalgae market, for example:

Persistence Market Research (PMR, 2021)

Creative UASLP

Handbooks on line

Elsevier

Springer

ECORFAN

Chemosphere

Results

Structure of microalgae

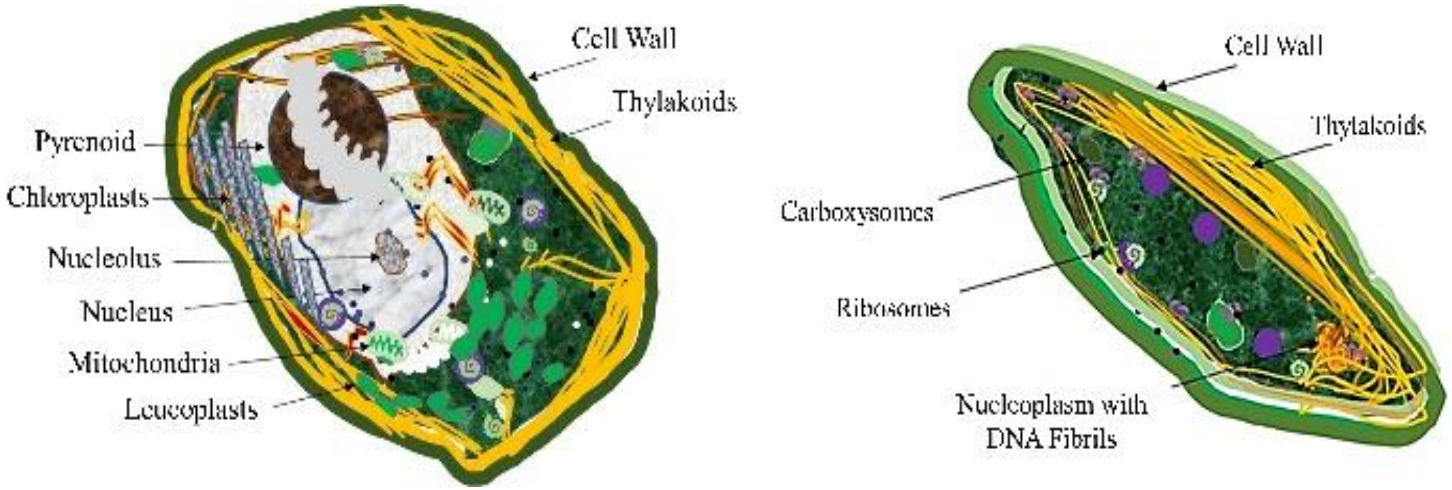

Figure 1 Structures of microalgae: a) *Chlorella vulgaris* and a cyanobacterium, b) *Synechococcus sp*. (Images based on micrographs by M.R. Palandri in Richmond, 2004).

Figure 2 Conditions that favor photosynthesis by microalgae and consequently the production and storage of sugars and oils, as well as the effect on the pH of the water in which they are cultivated, Authors' Image

Microalgae cultivation

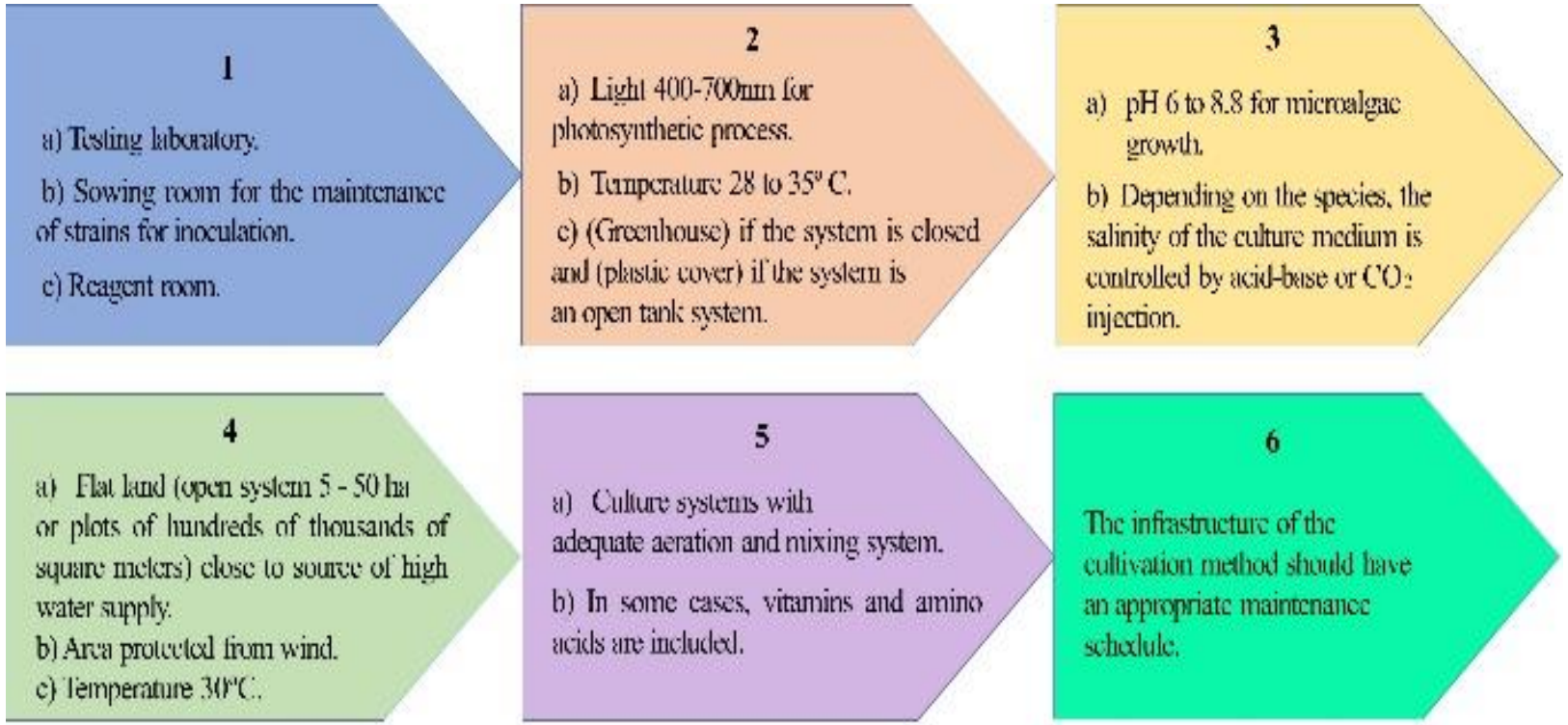

Figure 3 Requirements for efficient microalgae cultivation, Authors' Illustration**.**

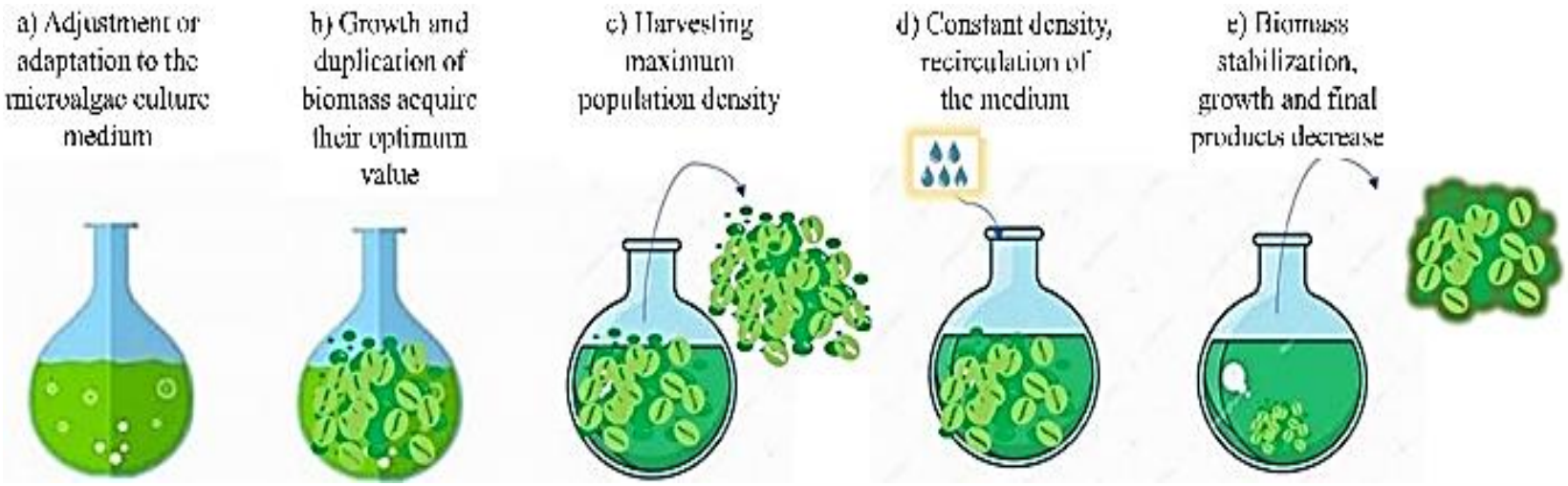

Figure 4 Growth stages of microalga, Author's Illustration.

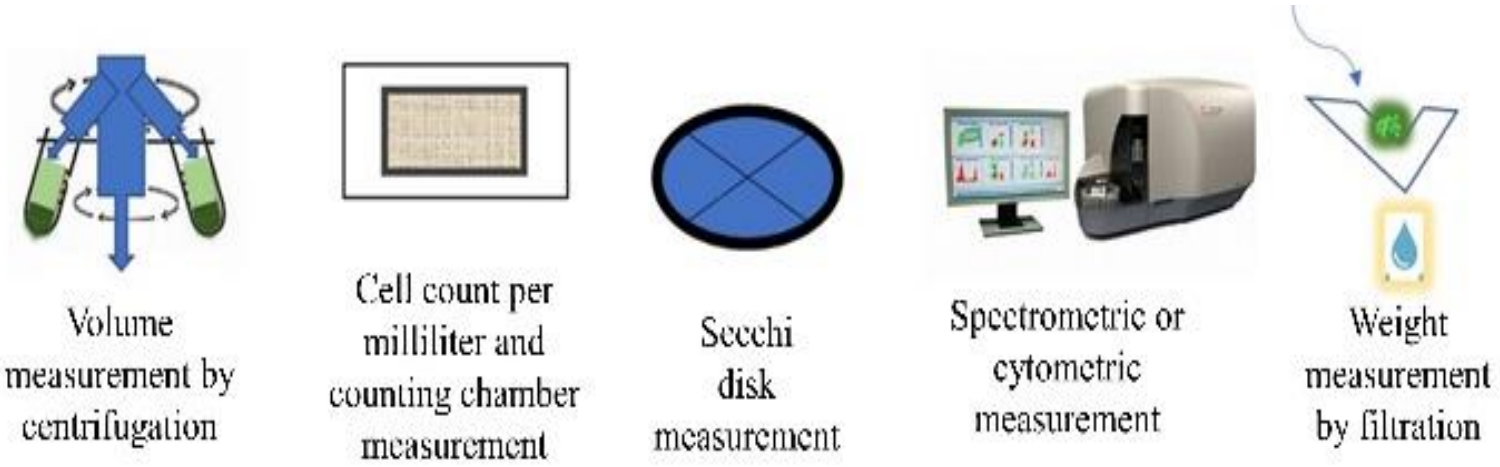

Figure 5 Direct and indirect methods to measure microalgae growth, Authors' Image**.**

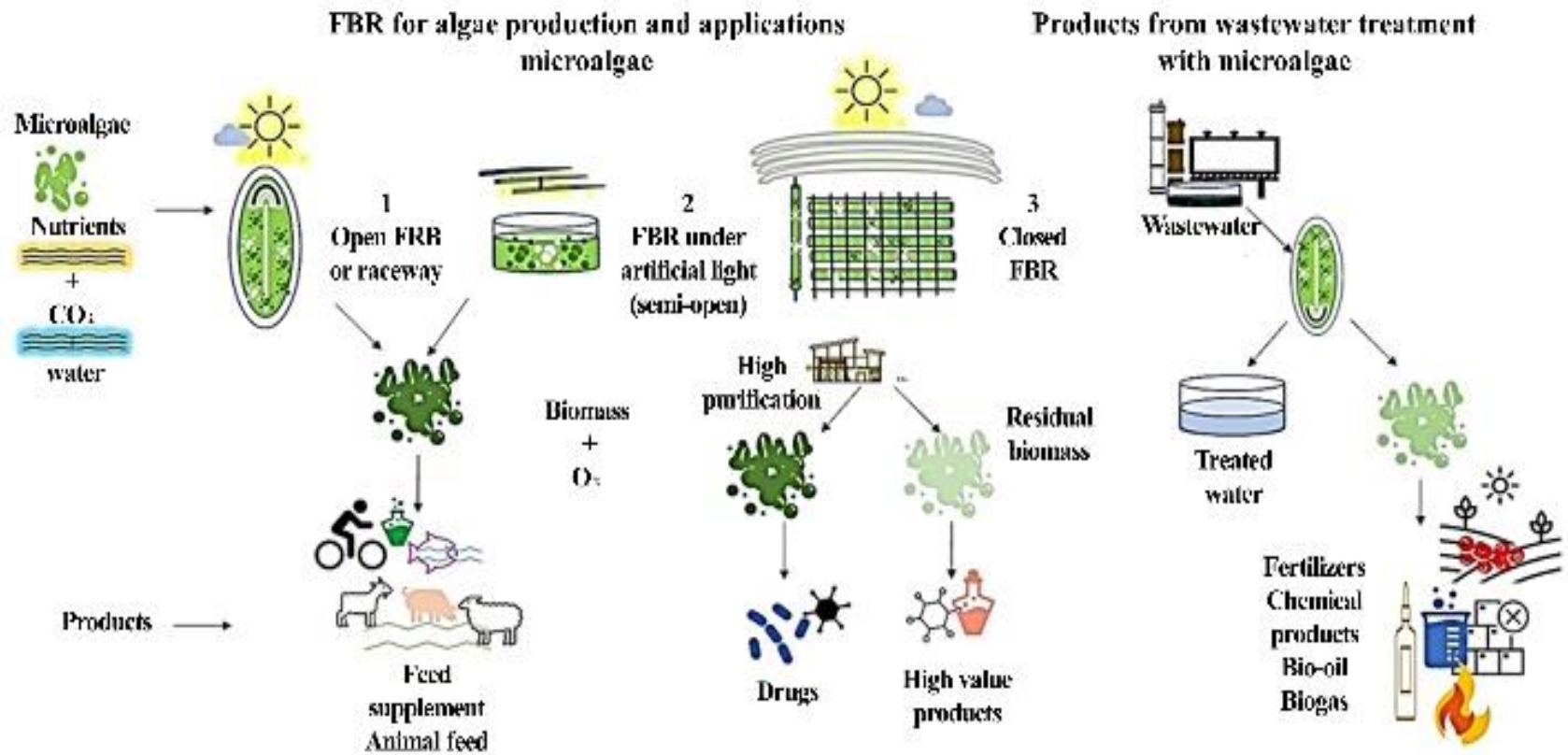

Figure 6 Microalgae production methods and their applications, Authors' Illustration.

Conclusions

This review presents the latest advances in research on microalgae of different species for their intensive cultivation and use in the fields of health, energy and environment, as well as the regulatory constraints that limit their production and use in different countries.

In addition, some opportunities are identified for the research of different species of microalgae that have not been studied in depth, in order to assess the potential of these organisms that could trigger the creation of new technologies and innovations to improve human quality of human life, especially in aspects related to the care of the environment.

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