Chapter 44
Integrated Omics and Mutation in Algae

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ABSTRACT

Algae importance is spectacularly increasing in many biotechnological applications, such as human food, animal feed, biofuels, bioplastics, bioremediation, pharmaceuticals, and cosmetics. With the widespread use of "omics" technologies over the past two decades, recent advanced research attempts to understand the pathways of the promising algae species by whole genomes sequencing (genomics) and revealing lipid pathways (lipidomics), microarray to study all RNA transcripts (transcriptomics), all protein sets produced by the algal cell (proteomics). DNA alteration as classical mutagenesis caused a random mutation such as ethyl methane-sulfonate as chemical mutagenic and ultraviolet radiation as a physical mutagenic. On the other hand, the CRISPR-Cas9 modern technique is used to genetically engineer a protein with maximum editing efficiency. Incorporating omics and mutations techniques helps to thoroughly understand the systems biology of algae in the new era called integrated omics.

INTRODUCTION

Algae are photosynthetic cell factories capable of converting light energy into chemical energy in the form of biomass and numerous natural products, and therefore, they occupy the main base level in food chains as primary producers. For this reason, algae are considered the main food for fish, aquatic organisms, and protozoa. Algae contain high-value compounds such as carotenoids, proteins, fatty acids, carbohydrates, and solidifying agents such as carrageenan and alginate. These bioproducts used in different applications as biofuels, biofertilizers, antimicrobial compounds and biomedical applications (AlProl & Elkatory, 2022; Alsenani et al., 2020; Beaumont et al., 2021; Eltanahy & Torky, 2021; Lina M. González-González, Eltanahy, & Schenk, 2019; Lina María González-González et al., 2018).

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Algae, whether micro or macro, are considered one of the oldest autotrophic organisms present on the Earth's surface, and they are credited with forming oxygen resulting from the photosynthesis process to maintain the ecosystem and prevent global warming and the increase in carbon dioxide in the atmosphere. Furthermore, the interest in using algae began a long time ago in different cultures as a source of food and alternative medicine in ancient civilizations. With the increase in technology and development in scientific research, discoveries related to these algae increased with the isolation of nova species of algae from promising and virgin wild environments and the possibility of benefiting in the manufacturing of food for human or animal feed and pharmaceutical industries as well as biofuels production and wastewater treatment and bioremediation.

It is indisputable that the field of algal biotechnology has some interesting challenge points from the scientific community and despite of the presence of many algal products in the market, full potential of algae is hardly tapped due to some limitations in scaling up algal cultivation for industrial production including the difficulty of obtaining high biomass accompanied with high desirable metabolites production, issues in harvesting and downstream processing and lack of the ease of adaptation to both biotic and abiotic stress factors by algal strain in addition to bioprospecting for more promising strains with distinctive traits, raising the specific growth rate of isolated species, or inducing the algal cell productivity of high-value biological components through changes in the culture nutritional and environmental conditions (Mosey, Douchi, Knoshaug, & Laurens, 2021; Pierobon et al., 2018) while with the emerge of the omics era, other solutions such as breeding, sexual hybridization, mutation and genetic and metabolic engineering present a more controlled promising alternatives (Gan, Lim, & Phang, 2016).

INTEGRATED OMICS

Integrated-omics, multi-omics, pan-omics, poly-omics and trans-omics are different names for the study of two or more omics data sets in order to support the analysis of the data and the huge results produced by different omics analyzes (Krassowski, Das, Sahu, & Misra, 2020). Also, how to use them to explain metabolic pathways and visualize the biological mechanism of algae growth and an accurate understanding of how different physical and chemical factors affect the environment algae influence its various metabolic processes, as well as changing the bioactive metabolic compounds. Although omics techniques have been considered somewhat modern techniques during the past two decades, most of the early research was mainly concerned with the medical fields and pathogenic bacteria because of their impact on human health and the possibility of using them in the pharmaceutical industries (Jamers, Blust, & De Coen, 2009) in addition to the very high costs of the analysis, which were not available in many research laboratories at that time. Over time, these omics techniques became cheaper in price, and with the development of next-generation sequencing techniques and the issuance of many types of equipment that could perform these analyzes, the use of omics techniques blowout to start the era of phycology omics.

The use of omics techniques such as genomics, transcriptomics, proteomics, and metabolomics in recent years has provided a huge amount of information about the biological systems inside the algal cell to reach a complete understanding of systems biology, which is known as the interaction between components of biological systems. Unfortunately, these data individually depict an effect on only one level inside the cell, which does not give a comprehensive picture of what happens more accurately in the metabolic pathways. Therefore, it was necessary to develop more comprehensive systems that de-

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