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# ALGAECOM NEWSLETTER

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## EDITORIAL

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## *Projects in ALGAECOM*

Christos Karamitros**,** joined ALGAECOM project as postdoctoral researcher in Enzyme Technology Laboratory, Department of Agricultural Biotechnology, Agricultural University of Athens (AUA), for 10 months. Below you can have an idea of Christos's project .

"***Antioxidant enzymes and their role in the detoxification of oxygen-derived free radicals*** ''

Proteins are biomacromolecules which are built by amino acids. In fact, proteins are polymers that result from the combination of twenty different amino acids which are connected by the so-called peptide bond. In cells, proteins are the final products of gene transcription and subsequent mRNA translation in ribosomes. Their synthesis is extraordinarily complex and is regulated by numerous factors, from which the majority of them remains unknown. Proteins play multi-functional roles in cells. They are carriers of cellular signals, thereby mediating numerous responses. For example, phosphorylation of certain proteins may promote specific protein-protein interactions and this, in turn, might regulate a whole metabolic pathway. Additionally, cells may produce proteins upon certain environmental stresses, in order to cope with non-ideal situations. This is particularly true for proteins with catalytic properties, the so-called enzymes. Enzymes are catalysts, which are able to catalyze chemical reactions with outstanding specificity and accuracy. Life could not exist without enzymes due to the fact that, the metabolic biochemical processes would need even years to occur, if at all! Therefore, enzymes are in charge of accurately controlling thousands of metabolic processes, thus sustaining life.

A particular class of enzymes, which play key metabolic roles in cells are the antioxidant enzymes. These enzymes are directly involved in the metabolism of dioxygen ($O_2$). In fact, $O_2$ is a toxic mutagenic gas which is highly oxidizing and combustible [1]. It is unique in that it is a relatively stable free radical having two unpaired electrons with parallel spins. This specific feature of dioxygen allows it to accept electrons one at a time and it is used as electron acceptor in numerous cellular "electron transport chains". The partial reduction of dioxygen leads to the formation of a series of reactive-oxygen species, the so-called ROS [2]. ROS are thought to be responsible for the damage of cellular macromolecules, tissue injury and dysfunctions and ultimately diseases [3]. Some examples include the damage of DNA, oxidation of amino acid residues in proteins, oxidative inactivation of enzymes by oxidation of co-factors as well as oxidation of fatty acids in lipids. Given the high reactivity of ROS and their wide involvement in numerous cellular pathways, organisms have developed through evolution enzyme-based, complex regulatory systems for the scavenging of ROS and the maintenance of homeostasis. Major mechanism from which partially reduced O2 species such as superoxide ($O_2^-$) and hydrogen peroxide ($H_2O_2$) are produced, is the mitochondrial ATP generation [4]. Both species react further with transitional metals resulting in the formation of reactive hydroxyl radicals (three electron reduction of O2). Another electron transport system that utilizes NADPH and produces nitric oxide (NO) as oxygen-derived free radical, is related to the activity of the enzyme nitric oxide synthase (NOS). This enzyme can additionally produce $O_2^-$, which ultimately reacts with NO leading to the formation of peroxynitrite (ONOO-). Peroxynitrite is a very strong oxidizing and nitrating species, that can cause severe damage to cellular macromolecules. Haloperoxidases are another example of oxidant-generating components that utilize $H_2O_2$ for the formation of a series of ROS, the so-called halous acids (HOX), which are important for host defense [5].

Based on what was mentioned above, it is evident that ROS are abundant in biological systems; and either they are byproducts of the main metabolism that need to be removed or they fulfill a particular role in favor of the cell (e.g. host defense). Cells are equipped with an arsenal of distinct enzymes which are in charge of the detoxification of oxygen-derived free radicals. The function of those enzymes is essential for the proper regulation of ROS steady-state levels. Such enzymes are Superoxide Dismutase (SOD), which scavenges $O_2^-$ to $H_2O_2$ , and this in turn, is scavenged by catalase to $H_2O$. Hydrogen peroxide can also be scavenged by two thiol-based systems, which in combination with the action of SOD and catalase form the major intracellular antioxidant pathways as shown in Figure 1. At this point, it must be underlined and highlighted the fact that, the action of SOD alone does not lead to full scavenging of oxygen-derived reactive species since it generates $H_2O_2$. Its action must be complemented either by the action of catalase or by the thiol-based systems. The generation and accumulation of ROS in cells results in the so-called oxidative stress, which is an imbalance between ROS and antioxidants with ROS being in excess. It is very important to mention that, despite the endogenous antioxidants which were briefly discussed above (SOD, catalase, glutathione peroxidase, glutathione reductase), exogenous molecules with antioxidant activity exist as well. Exogenous antioxidants (vitamins, trace elements, phytoantioxidants) cannot be synthesized by the cells, thus they must be supplemented exogenously to the body. Oxidative stress has been associated with numerous diseases in humans, including cancer [6]. Particularly, the risk of oxidative stress increases considerably with age and additionally, the endogenous antioxidants progressively decline over time. Therefore, aging is a perfect example of a natural process, which leads to a loss of adaptive cellular responses, thereby resulting in increased steady-state levels of oxidized substances. Consequently, prevention strategies relying on the supplementation of antioxidants are indispensable for the homeostasis of body. The protection of the skin entails particular concern given the fact that, the skin being a cutaneous barrier is constantly subjected to damage from the environment. Therefore, the study and characterization of sources which are enriched with endogenous antioxidants, are of primary concern for the researchers; particularly in the field of cosmetics with focus on the development of skin care products. Green algae is a great example of such source with high-added antioxidant value. They are unicellular, eukaryotic marine organisms that are able to conduct photosynthesis similar to plants. It is believed that green algae, like all eukaryotic photosynthetic organisms, have been originated from a primary endosymbiotic event where a prokaryotic photosynthetic cyanobacterium-like organism was engulfed and subsequently got stably integrated and evolved into all eukaryotic plants as we know them nowadays. It is well-documented that green algae are characterized by a high content of endogenous antioxidant enzymes. This characteristic is presumably associated with their natural growth conditions (high salinity, temperature variations), which have evolved green algae to cope with environmental stress and insults. This makes algae a very attractive target for antioxidants research, particularly for the development of high-added value antiaging cosmetics, given the well-established beneficial effects of such formulations on body [7].

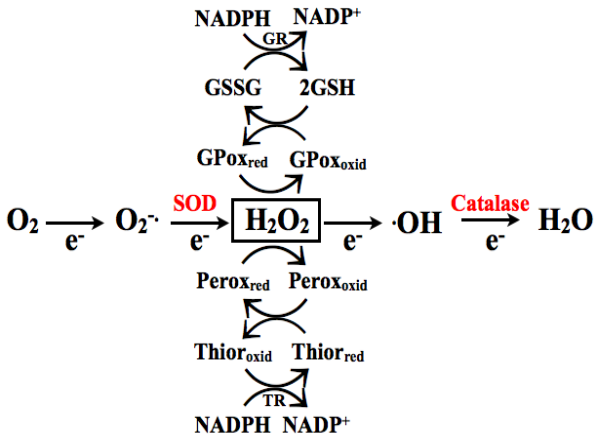


**Figure 1.** The diagram depicts the major endogenous antioxidant pathways which scavenge oxygen-derived reactive species. Molecular dioxygen ($O_2$) is partially and stepwise reduced by the addition of single electrons ($e^-$). The first addition results in the formation of superoxide ($O_2^{\cdot-}$), which is subsequently dismutated to hydrogen peroxide ($H_2O_2$) by Superoxide Dismutase (SOD). Hydrogen peroxide can have different fates: either it can be utilized by catalase, reaction which will lead to the formation of $H_2O$ or it can be scavenged by two thiol-based systems. The first thiol-based system is based on the function of glutathione peroxidase (GPox) and glutathione (GSH); glutathione is regenerated by glutathione reductase (GR) with the simultaneous oxidation of NADPH. The second thiol-based system is the thioredoxin (Thior) system, which relies on the function of peroxiredoxins (Perox) and ultimately the thioredoxin is recycled with concomitant oxidation of NADPH by thioredoxin reductase (TR).

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# 4th WORKSHOP

The 4th ALGAECOM workshop entitled ""Exploitation of microalgae diversity for the development of novel high added value cosmeceuticals " was held at Athens (Greece) from the 4th to the 8th of May 2015. It was organized by Agricultural University of Athens. First day of the workshop was a welcome day and an introduction to the infrastructure of Enzyme Technology, Molecular Biology/ Biochemistry laboratories in Agricultural University of Athens. On the second day, partners' representatives presented their work progress on AlgaeCom project. On the third day, laboratory demonstration occurred based on the preparation of microalgae extracts for subsequent *in vitro* testing introduced by Dr. Christos S Karamitros. On forth day, laboratory demonstration occurred based on *in vitro* testing of dermal cell lines introduced by Dr. Sophia Letsiou. On the last day, all partners discussed on the current results and on future perspectives.

Prof. Manolis Flemetakis, project leader of AlgaeCom project, opened the presentation session of the workshop by introducing all the representatives of all partners involved in AlgaeCom. All the representatives of the partners presented their current state of research.


Dr. Sophia Letsiou (APIVITA, Greece) presented an *In Vitro* approach for biological testing and functional evaluation of microalgae-based cosmeceutical ingredients

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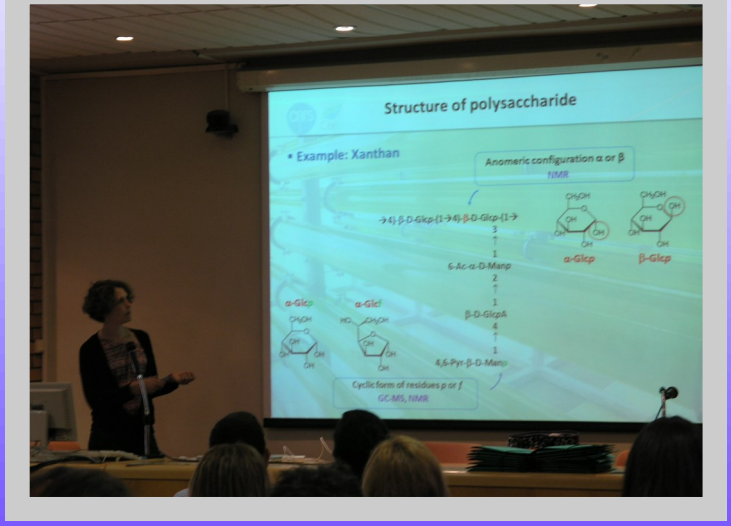


Dr. Tinaïg Le Costaouëc(Cermav-CNRS,France) presented the structure elucidation of *Phaeodactylum tricornutum* cell wall polysaccharide. Some results were also presented about the screening for new degrading enzymes realized in collaboration with Dr. Spyros Georgakopoulos.

Dr. Christos Karamitros (AUA, Greece) presented the high added value enzymatic content of microalgae of cosmeceutical importance.

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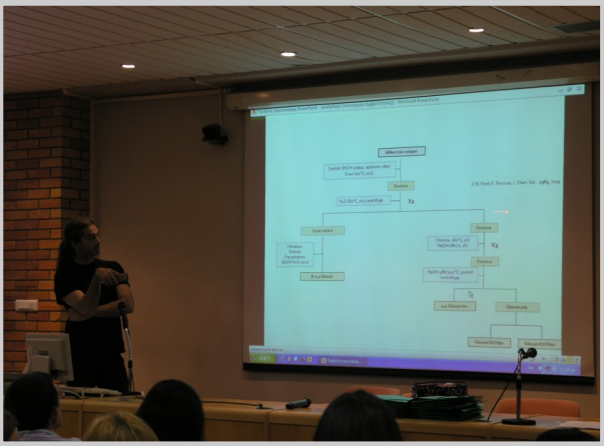

Dr. Spyros Georgakopoulos (APIVITA, Greece) presented extraction and characterization of *Nannochloropsis* storage and cell wall polysaccharides, with a special focus on polysaccharide characterization techniques.

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Dr. Carlos Infante (FITMAR,Spain) presented a summary of results obtained during the screening of the more than 350 strains (including both freshwater and marine strains) belonging to the cyanobacteria collection of the company in relation to ability to produce exopolysaccharides (EPS).