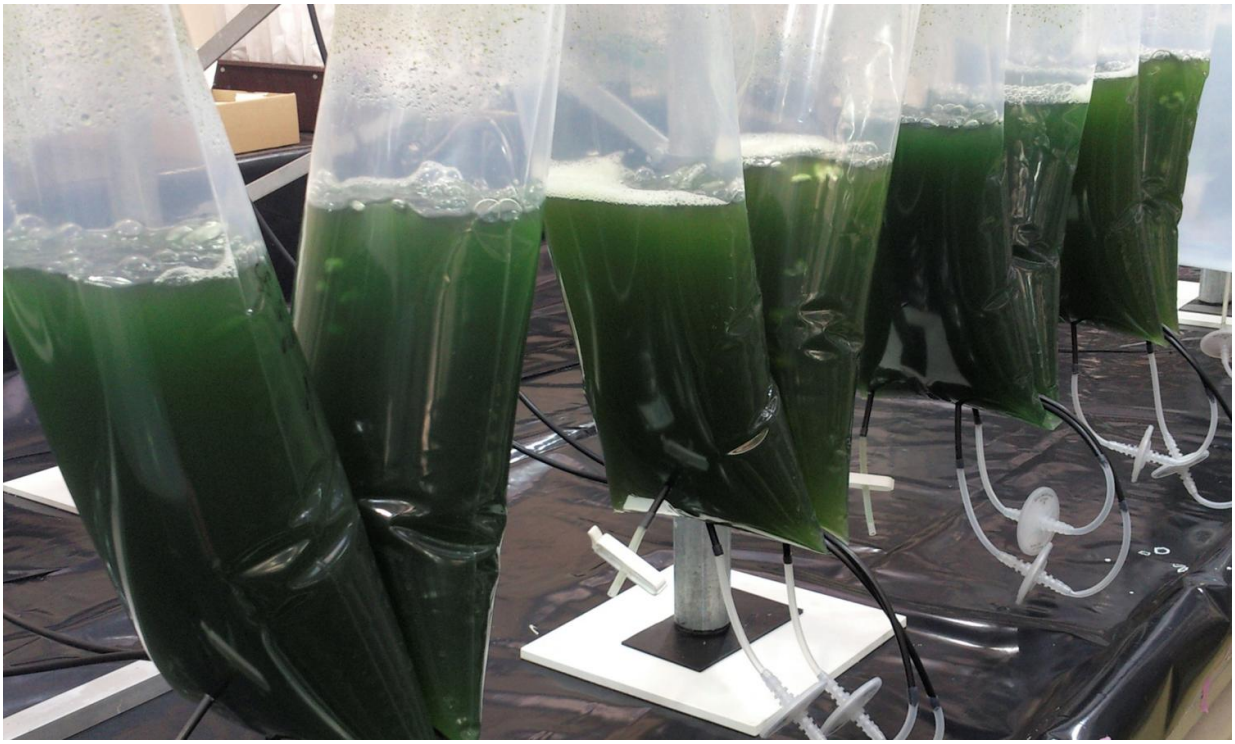
Modified microalgae converts sunlight into valuable medicine

May 20 2016, by Johanne Uhrenholt Kusnitzoff



The microalgae cultures are able to grow rapidly using waste water and light. Credit: Photo: Department of Plant and Environmental Sciences, University of Copenhagen

A special type of microalgae can soon produce valuable chemicals such as cancer treatment drugs and much more just by harnessing energy from the sun. The team of scientists from Copenhagen Plant Science

Centre at University of Copenhagen has published an article about the discovery in the scientific journal Metabolic Engineering.

Researchers from Copenhagen Plant Science Centre at University of Copenhagen have succeeded in manipulating a strain of microalgae to form complex molecules to an unprecedented extent. This may pave the way for an efficient, inexpensive and environmentally friendly method of producing a variety of chemicals, such as pharmaceutical compounds.

"So basically, the idea is that we hijack a portion of the energy produced by the microalgae from their photosynthetic systems. By redirecting that energy to a genetically modified part of the cell capable of producing various complex chemical materials, we induce the light driven biosynthesis of these compounds," says Post Doc Agnieszka Janina Zygadlo Nielsen, who along with colleagues Post Doc Thiyagarajan Gnanasekaran and PhD student Artur Jacek Wlodarczyk has been the main researcher behind the study.

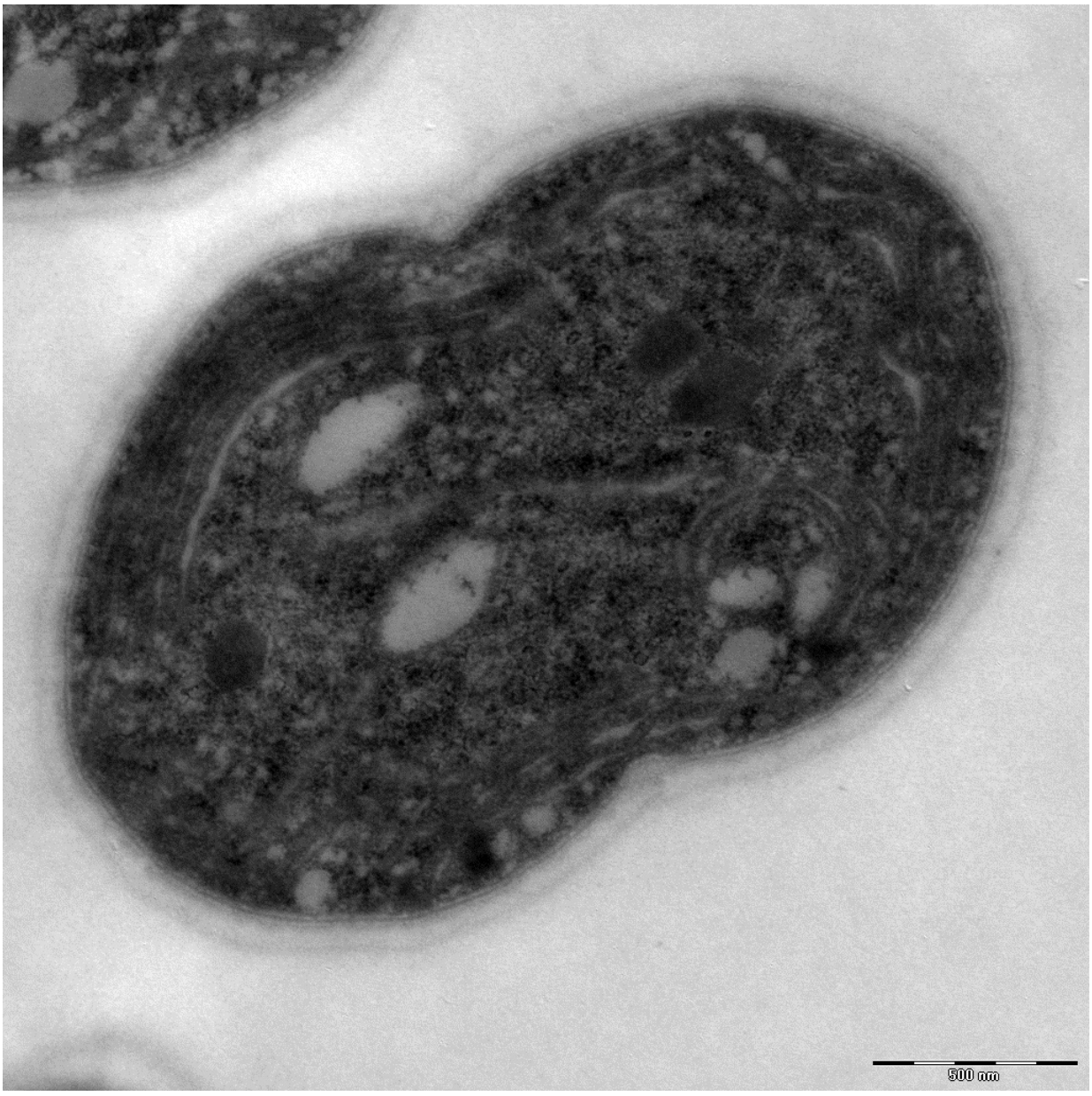
The researchers have as such modified microalgae genetically to become small chemical factories with a build in power supply. According to the research team's study, this basically allows sunlight being transformed into everything ranging from chemotherapy or bioplastics to valuable flavor and fragrance compounds.

As Agnieszka Janina Zygadlo Nielsen describes, the problem with many of these substances today is namely that they are extremely expensive and difficult to make, and therefore produced only in small quantities in the medicinal plants.

"A cancer drug like Taxol for instance is made from old yew trees, which naturally produce the substance in their bark. It is a cumbersome process which results in expensive treatments. If we let the microalgae run the production this problem could be obsolete," she explains.

Sustainable production from wastewater

Thiyagarajan Gnanasekaran clarifies that the method can be run sustainably and continuously, and that this is what makes it even more spectacular compared to present methods.



The researchers have enabled unicellular mikroalgae like this one to produce a variety of chemical structures. Credit: Department of Plant and Environmental Sciences, University of Copenhagen

"Our study shows that it is possible to optimize the enzymatic processes in the cells using only sunlight, water and CO2 by growing them in transparent plastic bags in a greenhouse. Theoretically, the water could be replaced with sewage water, which could make the process run on entirely renewable energy and nutrient sources. Recycling wastewater from industry and cities to produce valuable substances would surely be positive," he points out.

Agnieszka Janina Zygadlo Nielsen adds:

"If we can create a closed system that produces the valued chemicals from water, sunlight and CO2, it would be a fully competitive method compared to the ones used today, where it is primarily extracted from plants or yeast and *E. coli* bacteria producing the substances. In theory it should be cheaper on the long run to use our method than adding the large quantities of sugar that the conventional yeast and *E.coli* cultures amongst other things need to function."

A method with revolutionizing perspectives

However, the research team emphasizes that the method using genetically modified microalgae has its limitations at present time. As Thiyagarajan Gnanasekaran points out, the microalgae use much of the harnessed sunlight to keep their own metabolic processes running:

"It is difficult to produce large quantities of the desired compounds in microalgae because they have to use a large amount of the produced

energy for themselves, since they are fully photosynthetic organisms. Exactly for this reason, it makes good sense to have them produce the particularly valuable substances which are cost effective to produce in relatively small quantities at a time, as for instance medicine."

However, according to the team the expanding methods and genetic tools for microalgae are likely to overcome these limitations within near future.

More information: Artur Wlodarczyk et al, Metabolic engineering of light-driven cytochrome P450 dependent pathways into Synechocystis sp. PCC 6803, *Metabolic Engineering* (2016). DOI: 10.1016/j.ymben.2015.10.009

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