female Albino mice (young mice – at the age of 6-8 weeks, weighing 20-22 g; aging mice – at the age of 8-9 months, weighing 30-34 g).

The results showed that aging mice exhibited decreased viability and increased necrotic and apoptotic death of ovarian granulosa cells (GCs). An increase in the content of 2-thiobarbituric acid active products in the liver tissue was revealed. There was a decrease in serum ceruloplasmin levels, but at the same time a slight increase in reduced glutathione levels in liver homogenate. There was also an increase in the metabolic activity of neutrophils. The use of Ge citrate had a cytoprotective effect on the viability of GCs, reducing their necrotic and apoptotic death. In addition, the administration of Ge citrate contributed to a significant reduce of lipid peroxidation, regulation of antioxidant defense, as well as a decrease in the functional activity of inflammatory effector cells, which was confirmed by a decrease in the activation of oxygen-independent and oxygen-dependent metabolism of neutrophils in the peripheral blood of aging mice.

Thus, the results obtained in aged female mice showed that Ge citrate exhibits an antioxidant effect, preventing the development of oxidative stress and improving the viability of ovarian cells. The data obtained indicate the feasibility of further study of Ge citrate and the prospects of its use for the correction of age-related changes aimed at reproductive health maintaining.

The biological role of *Chlamydomonas reinhardtii* in industrial biotechnology

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Microalgae constitute a diverse group of eukaryotic unicellular organisms that are of interest for pure and applied research. Owing to their natural synthesis of value-added natural products microalgae are emerging as a source of sustainable chemical compounds, proteins and metabolites, including but not limited to those that could replace compounds currently made from fossil fuels.

For the model microalga, *Chlamydomonas reinhardtii*, this has prompted a period of rapid development so that this organism is poised for exploitation as an industrial biotechnology platform. Highly advanced industrial biotechnology systems using bacteria and yeasts were established in a classical metabolic engineering manner over several decades.

Chlamydomonas reinhardtii offers potential as a host for the production of high value compounds for industrial biotechnology. Synthetic biology provides a mechanism to generate generic, well characterised tools for application in the rational genetic manipulation of organisms: if synthetic biology principles were adopted for manipulation of *C. reinhardtii*, development of this microalga as an industrial biotechnology platform would be expedited.

Industrial biotechnology employs biological systems, mainly microbes, for the production of commodities. Today these range from fuels, to platform chemicals, and many high-value products, including a vast range of therapeutics and pharmaceuticals. IB has its origins in fermentation practices for beer, wine and breadmaking, but as microbiology emerged as a science, the ability to control these technologies proceeded in parallel, and led to many important compounds being made this way.

A noteworthy example is penicillin from the fungus Penicillium notatum, as well as several other naturally occurring antibiotics from soil bacteria. The advent of genetic manipulation enabled the optimisation of biological production systems and enormously expanded the portfolio of compounds that could be produced by IB, including the ability to produce human insulin and growth hormone as recombinant proteins, avoiding the side effects of use of animal forms of the hormones. Today, as well as pharmaceuticals, products from IB are an everyday feature of life, from vegetarian cheeses made with recombinant rennet, to plastics made from platform chemicals, to enzymes in washing powders.

Synthetic biology draws on principles first employed in the electronics field, and aims to create or (re)design complex biological circuits, networks or whole

organisms in a rational way, combining computational models with assembly of standard or modularised components, to create useful outputs. Synthetic biology is characterised by an iterative workflow of continuous improvement, with generated knowledge informing subsequent rounds of design. The basis is the use of standard parts for the design and engineering of novel biological systems, in this example DNA sequences such as promoters, terminators or introns.

These parts or pathways may be described as orthogonal, that is they are transferrable between different cellular hosts with little/no impact on function. They may be insulated, so they are unaffected by host cell metabolism, while an approach may be said to lead to abstraction, allowing design at higher levels of complexity because work builds upon well characterised inputs. This makes knowledge transferable, as a combination of elements that lead to a predetermined expression level of a transgene could be employed in subsequent studies to drive the expression of other transgenes.

The aim is that, once sufficiently well characterised, the design process no longer needs to consider individual DNA parts. Instead these may be combined into expression cassettes or devices with novel but predictable outputs. This will allow the field to progress more efficiently by building directly upon work that preceded it.

Microalgae are of interest to academic and commercial stakeholders due to their unique biology, which encompasses facets of bacterial and yeast systems, and their potential as a biotechnology platform. Although the microalgal research field is less well developed than for the former organisms, the model green alga, *C. reinhardtii*, is positioned for development as an IB platform. It is evident that the major limitation now lies in our capacity to engineer *C. reinhardtii* efficiently. By taking a synthetic biology approach, progress within the field should be accelerated.