OCR
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AS GCE APPLIED SCIENCE

G623/01/INSERT Cells and Molecules

PLAN FOR AN INVESTIGATION

INSERT

INFORMATION FOR CANDIDATES

- The abstracts on pages 2 and 3 of this insert are to give you some background that you might find helpful in planning for the task that follows. Not all the information included will be directly relevant and you are expected to select the information that is relevant to the task.
- This document consists of **4** pages. Any blank pages are indicated.

'Biofuels from Microalgae'

It is no secret that biofuels made from food crops such as corn and palm oil have driven up food prices and depleted rainforests, often without reducing net greenhouse emissions. Some species of microalgae are more than 50 percent lipid. Others are mainly starch, making them a potentially high-yielding source of either biodiesel or bioethanol, with no net contribution to atmospheric CO_2 levels.

The main advantages of these algal species are their higher photosynthetic efficiency and fast growth rates. Some species can metabolise nutrients in sewage, raising the appealing prospect of producing fuel while treating sewage. They are aquatic, but can grow in salty or brackish (slightly salty) water so they do not have to compete for the land and water needed to grow food crops.

Three types of microalgae – *Scenedesmus species, Chlorella vulgaris* and *Chlamydomonas reinhardtii* – efficiently convert nutrients to fuel on a diet of municipal waste water, while happily living in its harsh, salty environment. In a laboratory test, it took just three days for the algae to use 99 percent of the ammonia, 88 percent of the nitrate and 99 percent of the phosphates in a broth resembling that from a domestic sewage treatment plant, turning themselves into rich sources of fuel even as they purified the water.

The process has two phases. During the first three days, the algae produce lipids. Then, once the waste water is depleted of nitrogen and phosphates, the algae respond to starvation by turning their reserve nutrient stores into even more lipids.

After six days, the algae can be harvested. A mechanical pressing method is used to extract the oil. This can be converted into biodiesel, leaving behind biomass that could be composted, fed into an anaerobic digester to make methane, or sold as a feedstock to make ethanol.

‘Halophytic green algae for carbon recycling and biofuel production’

Microalga *Dunaliella salina* is a halophilic unicellular green alga. Two of the most important traits of interest are *Dunaliella’s* ability to produce high levels of oil and its remarkable ability to grow in extreme saline environments (up to 5.5 M sodium chloride, $NaCl$). In addition, it has considerable commercial value as a reliable potential feedstock for biofuel production, especially for regions with low quality salt water.

Dunaliella salina belongs to the same family as the green alga *Chlamydomonas reinhardtii.* However, it has several striking structural and physiological differences. Remarkably, *Dunaliella* enhances its photosynthetic activity in response to high salinity, whereas in most higher plants, salinity stress inhibits photosynthesis. Increasing salinity can also increase the fatty acid chain length and degree of overall unsaturation. *D. salina* also has a unique osmoprotection system. It does not have a normal cell wall but rather a less rigid mucin layer, allowing it to inhabit a broad range of salinities. *D. salina* appears to protect itself from osmotic shock and potential lysis by producing high concentrations of glycerol as an osmotic stabiliser. *D. salina* also produces high concentrations of carotenoids under high light and salinity conditions as a protectant against photo-oxidative stress. Most importantly, *D. salina* and related species have lipid and fatty acid compositions similar to plants and thus can serve as suitable feedstocks for biofuel production.