Algae! The Answer to Our Food, Pharmaceutical and Energy Needs?

Abstract

Our world is constantly searching for new energy sources and new mass food supplies due to the constant high demand and so a decrease in their supplies and the answer could be...algae! Algae have the potential to help solve some of these problems. In order to achieve this, however they must be produced at an accelerated rate, and we're hoping to find out how. We will do this by finding the optimum growth conditions required by the algae and understanding some of their vital growth requirements. This includes the need for a symbiotic relationship with bacteria which may supply Vitamin B12 to the algae. Our experiments will measure the algal growth in different conditions so we can find if algae needs symbiotic conditions to grow fastest.

Funding Statement

Royal Society Partnership Grant

Introduction

Micro-algae (microscopic plants) are *unicellular* species that are quite unfamiliar to most people.[1] Many readers will be unaware about an innovative plan that has the possibility to change our future and energy forever. We are a group of year 12 students taking part in a project in collaboration with AlgaeCytes – a biotechnology company based in Sandwich, Kent, UK. We aim to accelerate the production of high value products from algae by carrying out this investigation.

Algae are a potential source of fuel for the future as they can produce many natural oils and can become a rather useful renewable source to help replace natural oil, which is a non-renewable fuel[2].

Algae could also produce active bio-ingredients and proteins for healthcare[3]. They are already being used as food throughout the world, and could become more popular in the western world, lowering demand and strain on our current food supplies. Currently algae are being used as bulking or gelling agents in the food industry by using *algal strains*, since they are capable of producing high levels of carbohydrates especially polysaccharides. The fact that algae can use phosphates and nitrates from recovered waste process water from food and beverage factories also make it very economical and environmentally friendly. It also means the factories can meet EU and USA legislation for water quality discharge. This all shows the huge future benefits for algae and so illustrates the benefits of our investigation.

See our glossary below for explanations of the words in italics.

Our experiment *(still work-in-progress):*

Our hypothesis is that algae will grow at an optimum rate in *symbiotic* conditions. This means "helper bacteria" are needed for the algae to grow optimally because they may be providing B12 to the algae, a vitamin vital to growth. (Algae are unusual in their requirement of Vitamin B12 as higher plants do not require it at all.) Vitamin B12 is also known as cobalamin and is an organic micronutrient uniquely made by bacteria. The algae may be dependent for their *metabolism* for this.

Method:

Our aim is to grow four separate samples of algae each under different conditions in order to investigate the best conditions for growth. A *centrifuge* was used to separate the algae.

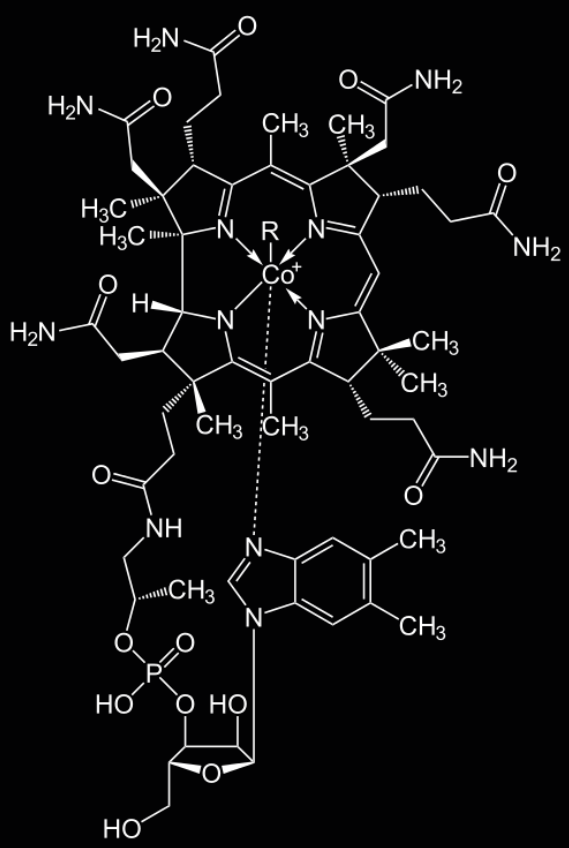
1. One will be washed three times to remove all bacteria and create the cleanest conditions to see how that will affect algal growth. It may show that algae actually need only a small amount of bacteria to grow.

2. The second will be washed once and spun in a centrifuge so that bacteria will still be present in this sample. We expect that this algal culture will grow well as the bacteria present may be providing Vitamin B12 to the algae.

3. The third sample of algae will be washed and spun three times to remove bacteria but Vitamin B12 will be added as a supplement. This is to see whether Vitamin B12 is the factor being supplied

Figure 1 (Above): Micro-algae[4]

Figure 2 (Below): Cobalamin[4]



by the bacteria and hence why it is growing so well and would provide an answer as to why algae would need bacteria to grow.

4. The fourth and final sample of bacteria will also be washed three times and antibiotics will be added to remove all bacteria present to give axenic conditions for the algae to grow – this is a culture where only one single species is present. This will also give a clear indicator as to whether bacteria are needed.

Experiments on each flask will be repeated to increase the reliability of our results, and strict adherence to *aseptic* technique will reduce the risk of anomalous results.

To determine the growth of the algae we will measure the cell density every week for 8 weeks using a haemocytometer. This is a microscopic grid that provides an easy counting system. Using mathematical methods, the algal density will be determined and results will be displayed as a growth curve.

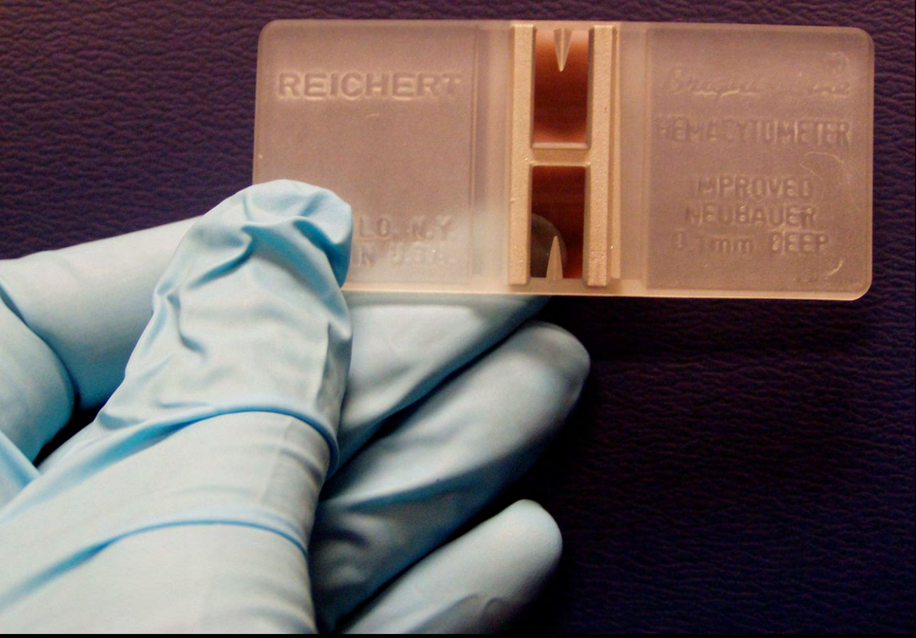


Figure 3: Haemocytometer[5]

We will also monitor the presence of bacteria in the cultures at the beginning and end of the algal growth period. A sample from each culture will be serially diluted and each diluted sample will be spread on an agar plate. After incubation, this will allow us to count the number of colonies. As each colony originates from a single cell, the original number of viable bacteria in the original culture can be determined using mathematical methods.

Summary:

With this project we hope to show that algae are dependent on a symbiotic relationship with bacteria to grow at an optimal rate and therefore cannot grow as quickly in an axenic environment. Furthermore we hope to show that it is Vitamin B12 that the bacteria are providing for the bacteria. Watch this space: we'll report back to Young Scientists Journal!

Glossary

- unicellular - a single-celled organism
- algal strain -a strain is a genetic variant or sub-type of a species
- symbiotic - a close and long-term relationship between two or more different organisms
- metabolism - life-sustaining chemical reactions within an organism
- centrifuge - lab equipment which spins samples at high speed causing less dense components to move to the centre
- aseptic - techniques conducted in sterile conditions

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References

1. Wikipedia
2. Scott, S. A.; Davey, M. P.; Dennis, J. S.; Horst, I.; Howe, C. J.; Lea-Smith, D. J.; Smith, A. G. (2010). "Biodiesel from algae: Challenges and prospects". Current Opinion in Biotechnology 21 (3): 277–286
3. Tokuşoglu, O.; Uunal, M. K. (2003). "Biomass Nutrient Profiles of Three Microalgae: Spirulina platensis, Chlorella vulgaris, and Isochrisis galbana". Journal of Food Science 68 (4): 1144
4. Cobalamin (possible chemical form of Vitamin B12)

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The three authors are Genevieve Butt, Georgia Green and Lois Mitchell. They are all Year 12 students and are all studying A levels, including Biology, Chemistry and Maths or Physics. Genevieve and Georgia are interested in studying Natural Sciences and Lois has a particular interest in Environmental Science. They are part of a bigger group of fourteen Year 12 AS Biology students who have been working on the project. They started last November by practising some of the methods needed for the project and then began the actual project in January 2015.