Novel Algae Bioreactors for Nitrogen and Phosphorus Removal

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Introduction
Agricultural fields contain high concentrations of nitrogen (N) and phosphorus (P) due to modern agricultural practices (e.g., use of chemical fertilizers). These N and P would leach from agricultural fields to nearby rivers and lakes by runoff water, which can cause eutrophication in the water bodies. Agricultural runoff water from the upper Midwest States, including Minnesota, is considered to be a major source of the dead zone in the Gulf of Mexico (a hypoxic water environment where no organisms can survive). Therefore, efforts must be made to reduce N and P leaching from agricultural fields.

Objective
The hypothesis of this study is that algae and denitrifying bacteria can co-exist in granular sludge. In algae granules, algae could assimilate N and P and provide fixed carbon to denitrifiers. In the anaerobic area of the granules, denitrifiers could reduce NO3- using organic carbon provided by algae. The goal of my UROP project is to develop algae-denitrifiers granules in a bioreactor setting, which can be used to simultaneously reduce N and P from agricultural runoff water.

Method

![Diagram of the method]

**Process 1:** Photosynthesis (Needs light and Oxygen)
- \( \text{O}_2 \) (gen. from water)
- \( \text{CO}_2 \)
- C (fix C, organic C works as the electron donor for denitrification)

**Process 2:** Denitrification (Needs electron donor and anaerobic (low-oxygen) condition)
- \( \text{NO}_3^- \) (oxidation)
- \( \text{NH}_4^+ \)

**Process 1+3:** algae bioreactor
**Process 2+4:** non-algae bioreactor

Data and Discussion

- **Conclusion and Future Work**
  - **Conclusion:** The granules were stable in the bioreactor, which favors the N and P removing process. However, the removing rates of nitrate, nitrite and phosphate were not stable based on the IC (ion chromatography) testing and may be influenced by factors like algae density, initial media concentration and intensity of the air pump.
  - **Future work:** Improve the accuracy of measuring methods and get more data of the bioreactor; Compare different data, like pH and nitrate removing rate, to improve the efficiency of bioreactor.
  - **Ultimate Goal:** Combine algae and non-algae bioreactors together to develop an algae-denitrifiers bioreactor, which can be used to simultaneously reduce N and P from agricultural runoff water.