
An investigation of Arctic algal and microbial species for use in bioremediation and generation of bioenergy products

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Project abstract:

Anthropogenic activities in the world today are causing a multitude of environmental harms, pollution chief among them; either by greenhouse gas emissions or by the deposition of toxic materials into local ecosystems. Pollution is continuously driven by two foremost and ever-increasing needs; first, for energy, and second, for industrial manufacture and processes, both required to support a still-growing human population. Our modern world is still fiercely reliant on fossil fuels; 80% of global energy demand is met by the use of oil, coal, and gas. Fossil fuels are exhaustible, and the emissions cause by their usage are widely established as the leading driver of climate change. Dramatically underscored in the latest IPCC Special Report; "...limiting global warming to 1.5°C would require 'rapid and far-reaching' transitions in land, energy, industry, buildings, transport, and cities. Global net human-caused emissions of carbon dioxide would need to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050. This means that any remaining emissions would need to be balanced by removing CO₂ from the air." Alternative fuel generation is a necessary response to the demand for clean energy, and it can be produced by the recycling of anthropogenic waste products via algal and microbial pathways. Thus, it is well within the capacity of human ingenuity to design closed-loop organic waste recycling systems that couple waste treatment to bioenergy production, thereby addressing both energy demand and the need for remediation of industry-related pollution. This research will explore the algal and microbial communities in existence within and in close proximity to wastewater generated by the Finnish paper pulp industry. Using data gathered regarding species diversity and chemical composition of wastewater, a bioreactor system will be designed and developed with the ultimate objective of maximising energy yield from otherwise unusable industrial waste. This system will provide the technical and biological foundation for widespread improvement of wastewater treatment and a novel type of biofuel generation in Finland. Additionally, though awareness of the environmental and climate issues driving this demand is already common in Finland, the utilisation of Finnish algae and/or microbes to treat Finnish waste, thereby cleaning Finnish water, and generating fuel products in Finland may have some influence on the ongoing efforts to divest from fossil fuels. This approach should be beneficial to local economies in the future, setting an example for similar systems

tailored to different environments around the world.

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Aineiston yleiskuvaus

1.1 Millaiseen aineistoon tutkimuksesi perustuu? Millaista aineistoa kerätään, tuotetaan tai käytetään uudelleen? Missä tiedostomuodoissa aineisto on?

The chemical and engineering research is based upon studies conducted in the Bhatnagar lab at UEF Kuopio. Material and data collected will be chemical profiles of pulp factory wastewater for use as grown media in a bioreactor system, and high throughput sequence data to characterise the algal, bacterial, and eukariotic communities already existing under these conditions. The sequence raw data will be processed and stored in standard open data formats e.g FastQ, Fasta, SAM and BAM.

1.2 Miten aineiston yhtenäisyys ja laatu varmistetaan?

Biological data will be produced by standardised microbial sampling and sample treatment methods with satisfactory replication, and by uniform sequencing and sequence analysis methods. Chemical data will be verified by use of multiple laboratory techniques, and adequate replication.

Eettisten periaatteiden ja lainsäädännön noudattaminen

2.1 Mitä eettisiä seikkoja aineistosi hallintaan liittyy (esim. arkaluonteisten tietojen käsittely, tutkittavien identiteetin suojaaminen ja tietojen jakamista koskevan suostumuksen hankkiminen)?

Not applicable to this project.

2.2 Miten aineiston omistajuuteen, tekijänoikeuksiin ja immateriaalioikeuksiin liittyviä asioita hallintaan? Estävätkö tekijänoikeudet, käyttöoikeudet tai muut rajoitukset aineiston käyttämisen tai jakamisen?

UEF claims ownership of all data created in research; agreements regarding ownership and intellectual property are made prior to commencing collaboration with other universities and/or industry partners.

Dokumentointi ja metatiedot

3.1 Miten dokumentoit aineistosi, jotta se on löydettävissä, saavutettavissa, yhteentoimivaa ja uudelleen käytettävissä sekä itseäsi että muita varten? Mitä metatietostandardeja, README-tiedostoja ja muuta dokumentaatiota käytät, jotta muut voivat ymmärtää ja käyttää aineistoasi?

As much data as possible will be handled with Microsoft Excel and README. Raw sequence data (too large for the aforementioned formats) will be documented using standard open data formats e.g FastQ, Fasta, SAM and BAM.

Tallentaminen ja varmuuskopiointi tutkimushankkeen aikana

4.1 Minne aineistosi tallennetaan ja miten se varmuuskopioidaan?

Data is primarily stored on the UEF university server, and at IonTorrent PGM server with back up service. The genomic data will be stored and analysed at CSC Finland.

4.2 Kuka valvoo pääsyä aineistoon ja miten suojattua pääsyä aineistoon valvotaan?

Right to access the data is controlled by Professor Oksanen, Dr. Tervahauta and Dr. Bhatnagar, and technical access control is provided by IT-services of UEF.

As the data in the project is non-sensitive, it will be available to all researchers of the project via shared, secure network drives.

Aineiston avaaminen, julkaiseminen ja arkistointi tutkimushankkeen päätyttyä

5.1 Mikä osa aineistosta voidaan asettaa avoimesti saataville tai julkaista? Missä ja milloin aineisto tai siihen liittyvät metatiedot asetetaan saataville?

Following any scientific publications; chemical, structural (pertaining to bioreactor design), and sequence data will be available to the general public. The full dissertation may be published by UEF's online library.

5.2 Mihin pitkällä aikavälillä arvokkaat tiedot arkistoidaan ja kuinka pitkäksi ajaksi?

Sequence data in particular can be published in online nucleotide archives.

5.3 Arvioi, kuinka paljon aikaa ja työtä tarvitaan aineiston valmistelemiseen julkaisua tai arkistointia varten.

Data publication is largely automated. Preparation time allotted for publishable manuscripts is 2-6 months, depending on work conducted during the study.