SynBioStandards Network

** MARCH 2010 NEWS*FLASH* **

Spring at last! Herewith some news that might be of interest to Network members:

NETWORK NEWS

Welcome to new Network members Rainer Breitling (Glasgow), Jamie Davies (Edinburgh), Tom Ellis (Imperial), Pablo Schyfter (Edinburgh/Stanford) and Bristol iGEM team supervisors Nigel Savery, Claire Grierson and Mario di Bernardo. Welcome also to speculative designers James King and Alexandra Daisy Ginsberg.

Fancy hosting an artist or designer in the lab, and seeing what working life is like on the other side? The Synthetic Aesthetics project team (led by Jane Calvert) is setting up a number of exchanges over the next year. To take part in a residency, visit www.syntheticaesthetics.org and complete an application. Deadline: 31 March 2010.

The SynBioStandards website has recently been streamlined and updated — check out the new 'Activities' section and read some of the 'notable quotes' on the homepage. If you would like to update your member profile or have suggestions for new content, please contact Emma (emma.frow@ed.ac.uk).

The BBSRC/EPSRC Public Dialogue in synthetic biology is drawing to a close. Several Network members have participated in workshops held around the country: Jane Calvert trekked to Llandudno in North Wales for workshops in February and March, Jen Hallinan and Claire Marris participated in the February workshop in Newcastle, Emma Frow took part in the February workshop in London, and Alistair Elfick and Steve Yearley were invited experts at the Edinburgh workshops. Findings from this project will be communicated later in the year.

Networkers have been travelling the globe this month — Jane Calvert and Daisy Ginsberg attended the SynBERC retreat in early March, and Geoff Baldwin participated at the Institute of Biological Engineering conference in Boston. Geoff has kindly shared some of his meeting highlights with us — read below or access his report from the Network website.

FOR YOUR READING PLEASURE…

- A recent *Nature* paper from Jason Chin's lab: Encoding multiple unnatural amino acids via evolution of a quadruplet-decoding ribosome.
- A new book by Rob Carlson, hot off the Harvard University printing press: *Biology Is Technology: The Promise, Peril, and New Business of Engineering Life*.
- 'Do-it-yourself genetic engineering' in the 10 February weekend edition of the *New York Times*
- Notes, thoughts, and news about synthetic biology on Oscillator, a blog by Christina Agapakis, a PhD student based in Pam Silver's lab at Harvard.

COMING UP…

31 March 2010: Deadline for applying to take part in the Synthetic Aesthetics project
5 April 2010: Deadline for abstract submission to the Second International Workshop on Bio-Design Automation (14-15 June, Anaheim, CA)

Network events for the rest of the year are currently being mapped out — stay tuned for details! If you have ideas for specific events or activities that you would like to see the Network run, just get in touch with Alistair, Emma or Jim H. And don't forget to take advantage of Network travel bursaries for seminars or collaborative writing!

If you would like to publicise an event, article, funding opportunity, etc. in the next Network newsletter, just email details to emma.frow@ed.ac.uk.

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IBE Conference (Boston, 4–6 March 2010)

Conference report by **Geoff Baldwin (Imperial)**

Bruce Logan gave the stand-out presentation of the conference and kicked off the grand challenges session. Water is a grand challenge identified by the National Academy, and it is also intimately linked to energy, another grand challenge. Currently 1 billion people lack adequate drinking water, and 2 billion lack good sanitation. Globally 4-5% of total electricity supply is utilised in water infrastructure and distribution, some of this is accounted for by desalination. Increasing supplies of drinking water and sanitation is therefore also linked to energy supply as well as the water resource itself.

Wastewater has 9.3X more energy content than what treatment consumes. There is therefore the potential to use this energy to supply the treatment plant and generate further electricity, if this energy content can be harnessed. Microbial fuel cells (MFCs) provide a potential method to make the water infrastructure not only energy sustainable, but a net energy supplier.

The basic principle of an MFC is to have bacteria growing anaerobically as a biofilm on an electrode. The electrons produced by the electron transport chain go onto the anode and flow down a circuit to a cathode. At the cathode the electrons must combine with O_2 and H^+ to give water at the anode. Initially the anode was a separate chamber with a salt bridge for the passage of H^+ and a Pt catalyst to split O_2. This design was improved by having an air cathode with the Pt on an air surface so that it was in direct contact with anode chamber, thus eliminating the salt bridge from the design. Further designs have demonstrated that activated carbon is a good and much cheaper alternative to Pt. Devices are typically cathode limited, the surface area of the biofilm anode can be effectively increased by having a bottle brush arrangement with stainless steel bristles. They have gone from power levels of mW to 3.7 W/m^2 (cathode area).

These designs use natural biofilm-forming bacteria. They have characterised different bacteria and found that they have different efficiencies of electricity production. The real-life

fuel cells have mixed populations, but those present in the greatest amount are not necessarily the best power producers.
It is interesting that all of this has been achieved without any engineering of the bacterial being used. It is interesting to speculate whether the efficiency of these processes could be enhanced through engineering. There is clearly a lot to be explored, and it is not currently understood why different microbes work with different efficiency.

For those interested in this area, he has recently published a book; *Microbial Fuel Cells*, published by Wiley. There is also a 2009 review in *Nat. Rev. Microbiology*.

Grand Challenges
Following on from Bruce Logan, 4 other speakers summarised key areas relating to grand challenges. In general this session was more depressing than inspiring, it provided some context to the scale of challenges around technologies for CO_2 reduction such as carbon sequestration but in so doing revealed the enormity of the task. The atmosphere at the subsequent panel date was consequently rather subdued and the session less than enlightening.

However, **Ben Stuart** of Ohio state gave a very nice talk on the possibilities of using photosynthetic algae as a biomass source for bioenergy, thus recycling CO_2 . Algae require water, sunlight (but not necessarily high intensity), CO_2, and N_2 which thus requires management of the Nitrogen cycle. Issues with algae growth were discussed as below:

Sunlight

- Fossil fuels are chemically stored, biologically derived solar energy
- Sunlight is ubiquitous, but of varying intensity
- Photosynthetic efficiency is low – in the 1-6% range for conversion of solar energy to chemical energy (can this be improved?)
- Potential for UV damage

Water

- Different algae can survive in all types of water, fresh, brackish, saline, acidic and thermal extremes
- Can use reclaimed wastewater
- Potential for evaporative loss, especially in the desert, which can then change salinity
- Water management requires intensive pumping and hence electricity

CO_2

- Ubiquitous and FREE
- 1.5 – 2.0 kg of CO_2 consumed per kg of biomass, thus is good sequestration ratio
- Biological systems are effective at ambient temp
- Could use elevated CO_2 levels to stimulate growth (e.g. flu gas)
- Using the biomass leads to re-release of CO_2 so a life cycle analysis of C is required to ascertain the benefit
- Mass transfer of CO_2 to liquid phase is dependent on a number of factors including Temp, pH, salts and interface area.

Nutrients

- Significant nutrients are present in waste streams
- Nutrient recycling and capture is a must, especially given the need to control N_2 cycle
- Integration of energy generation schemes with waste water schemes is essential (this mirrored the message from Bruce Logan)
- Provides possibilities for synergistic biomass to energy campuses

To have an impact on global CO_2 levels, 24 million acres of algae farms need to be cultivated. This would deliver the equivalent energy of 1.4 billion barrels of oil per year. This requires 7000 acres to be cultivated per day to reach the required level to contribute meaningfully to global CO_2 stabilisation.

Menachem Elimelech also gave an interesting talk on desalination. This again emphasised the link between energy and water. Bruce Logan had also given an interesting method by which microbes could be used in desalination cells.

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