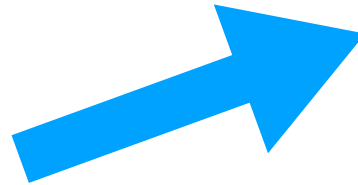
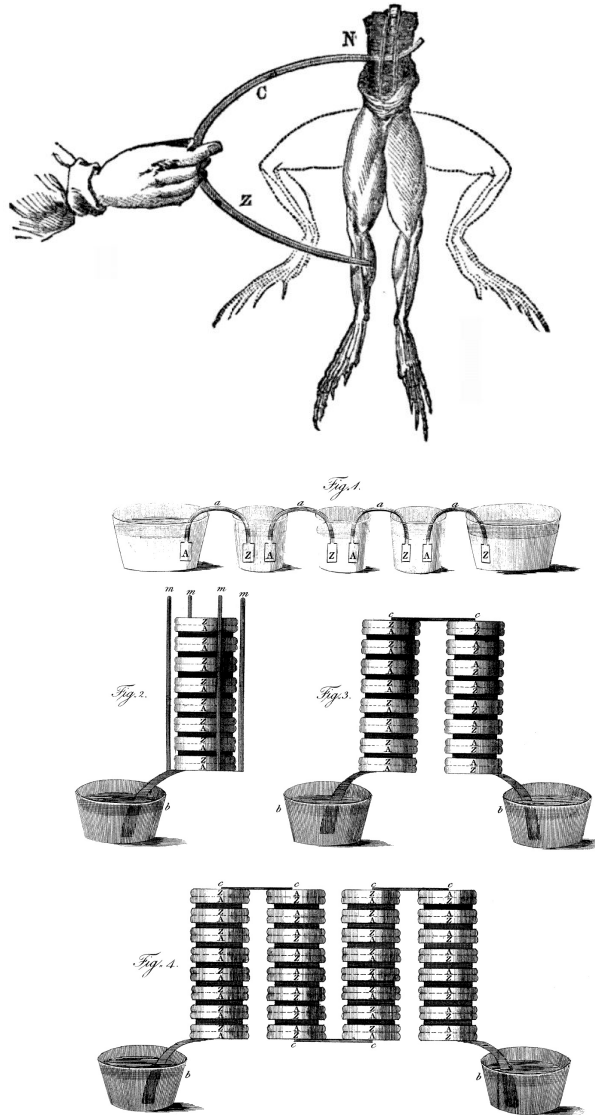


**WELCOME!**

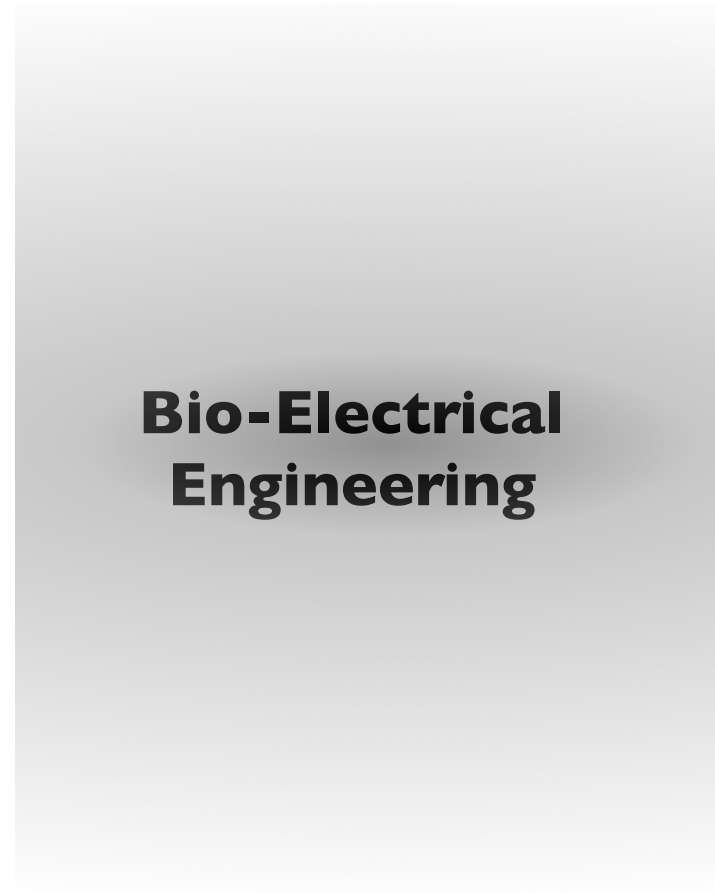


**A structured approach to innovation**

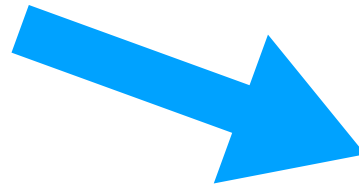
# BIO-ELECTRICAL ENGINEERING



**Neuroscience**



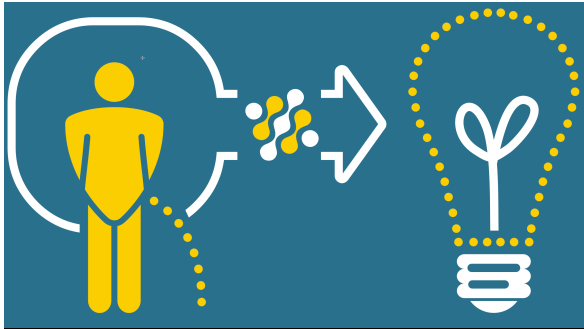
**Bio-Electrical  
Engineering**



**Electrochemistry**

# BIO-ELECTRICAL ENGINEERING

## Metabolic conversions via electrical control/interface of metabolism



Urine to electricity via microbes

## Energy harvesting with electrobiochemistry

nature energy

Enhancing power density of biophotovoltaics by decoupling storage and power delivery

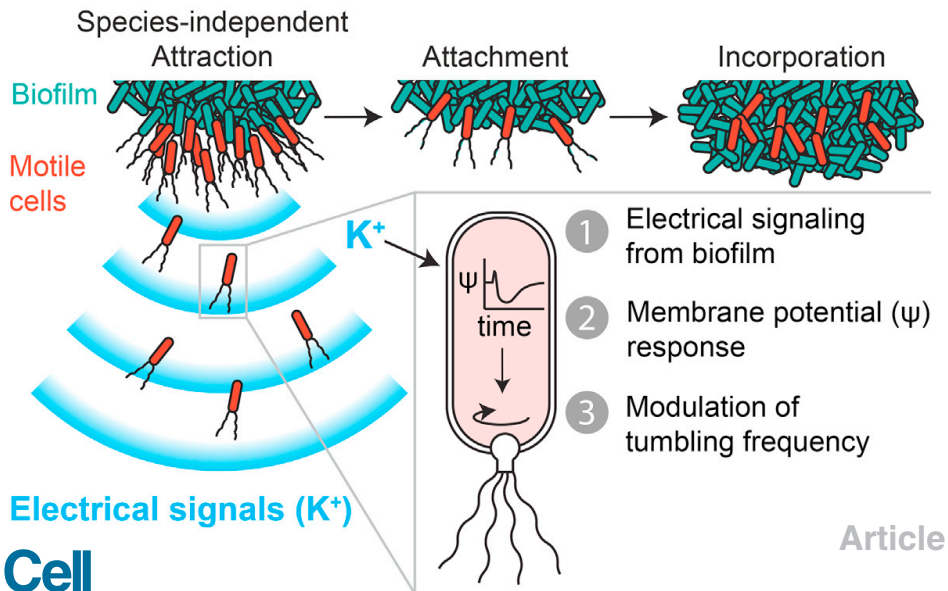
ARTICLES

<https://doi.org/10.1038/s41560-017-0073-0>



Electricity to biogas via microbes

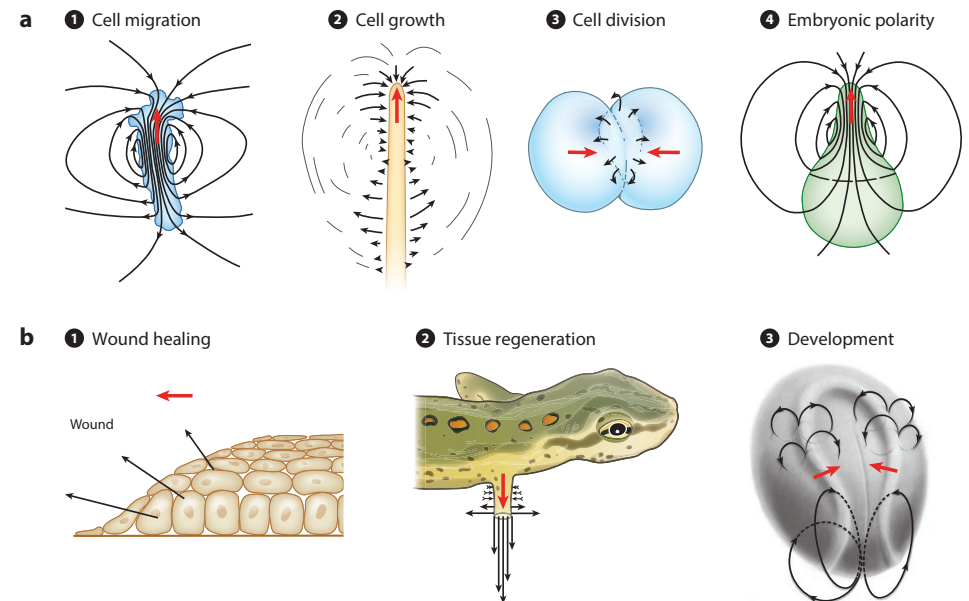
## Biological organisations through electrical fields



Article

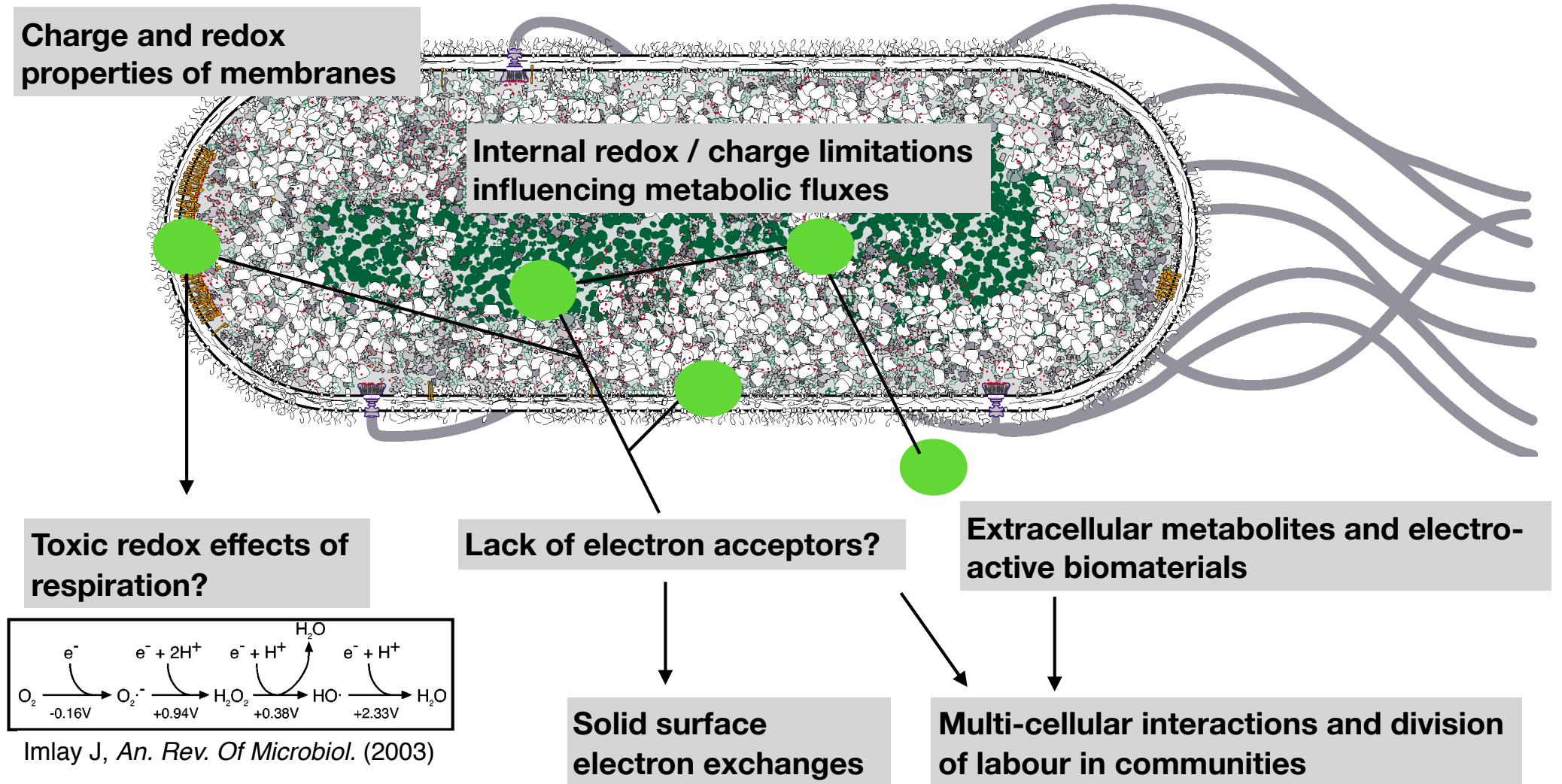
Species-Independent Attraction to Biofilms through Electrical Signaling

## Electrochemical Control of Cell and Tissue Polarity



# Cells as masters of electrochemistry

## Cell Physiology Arising From Electron Flow



Interrogating metabolism as an electron flow system.

Christian Zerfass, Munehiro Asally, Orkun S Soyer  
*Current Opinion in Systems Biology* 13: 59-67 (2019).

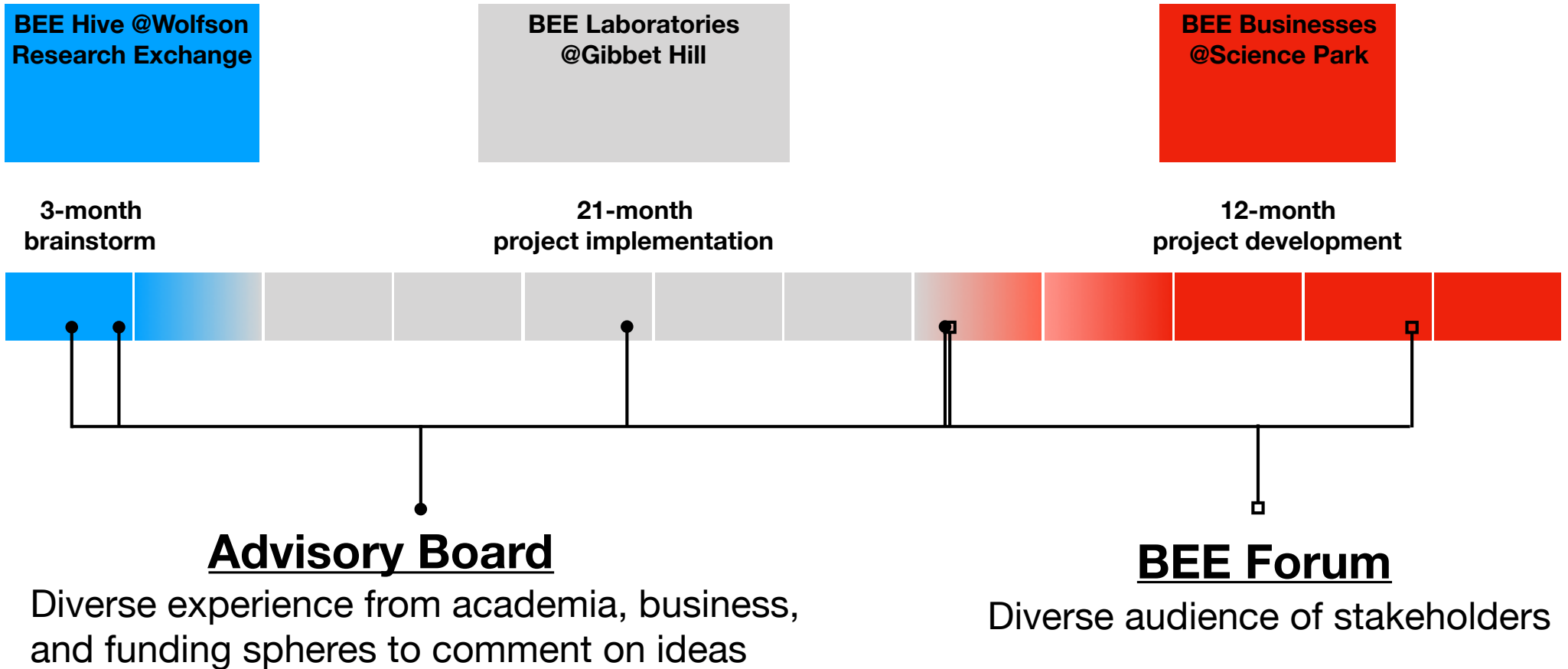
Engineering microbial communities using thermodynamic principles and electrical interfaces.

Christian Zerfass, Jing Chen, Orkun S Soyer,  
*Current Opinion in Biotechnology* 50:121-127 (2017).

An exciting project funded and supported by:



Bio Electrical Engineering  
Innovation Hub at Warwick



## Initial Innovator Club

Patrick R. Unwin



**Electrochemistry  
Electrical imaging**

Gabriel Meloni



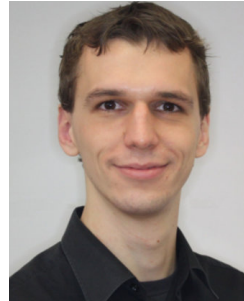
**Colloids chemistry  
Chemical engineering**

Stefan Bon



**Synthetic biology  
Systems biology**

Christian Zerfaß



Munehiro Asally



Orkun S. Soyer



**Plant biology  
Molecular biology**

Murray Grant



## Advisory Board

Jeremy Shears (Shell)  
Colin Miles (BBSRC)  
Emre Ozer (ARM)  
Mark Scaife (Mara corp)  
Jim Goodchild (Syngenta)  
Holly Smith (Green Biologics)  
Teuta Pilizota (U of Edinburgh)

## BEE Forum

**Industrialists, funders, investors,  
policy makers, entrepreneurs.**



THE UNIVERSITY  
of EDINBURGH



# **BUILDING A BEE COMMUNITY**



**AIM:** to form a truly interdisciplinary community covering expertise in;  
Applied Mathematics, Microbiology, Plant biology, Synthetic biology, Physics,  
Environmental Engineering, Chemical Engineering, Biochemistry, Chemistry,  
Electrochemistry, Robotics, Electrical Engineering, Biophysics

# Growing the BEE Hub...

with new collaborations, PhD/MSc studentships, UG projects, and grants

Patrick R. Unwin



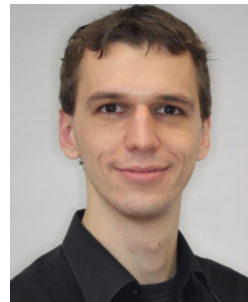
Gabriel Meloni



Stefan Bon



Christian Zerfaß



Munehiro Asally



Orkun S. Soyer



Murray Grant



Marco Polin



Jerome Charmet



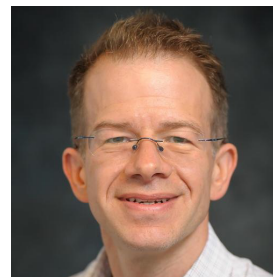
Zoe Schofield



Kelsey Cremin



Andrew Marsh



Oluwasegun Wahab



.....

...

Biophysics, Engineering, Organic & Analytical Chemistry ...





# 1st BEE WORKSHOP

## 30/31 May 2018

### TO EXPLORE BEE REMIT

Targeted UK only, with broad representation from all related fields; Cell biology, microbiology, environmental biotechnology, plant biology, neuroscience, and electrochemistry.

For presentations, see;

[https://warwick.ac.uk/fac/sci/lifesci/research/beehive/beeworkshop\\_program](https://warwick.ac.uk/fac/sci/lifesci/research/beehive/beeworkshop_program)



# BEE REMIT

	<b>Fundamental Underpinnings</b>	<b>Electrical control</b>	<b>Bioelectrical conversions</b>	<b>Bioelectrical components</b>
<b>Bioenergy</b>	Measurement tools for bioelectrical phenomena  Modelling approaches to bioelectrical phenomena	Ultra-low power energy harvesting	Electrical fermentation	Electroactive biomaterials
<b>Chemicals</b>		Control of expression	Conversion of organics	Electrically active enzymes
<b>Water</b>		Control of metabolism	Microbial fuel cells	
<b>Petrochem.</b>		Biofilms	Self-sustainable bio-electronic devices	Forms of information storage
<b>Coatings</b>		Gut-microbiota control	Biophotovoltaics	
<b>Electronics</b>		Form growth manipulation	Microbial batteries	
<b>IoT</b>		Root growth control	Bioenergy	
<b>Agri-Tech</b>		Wound healing	Plant immunity	
<b>Waste</b>				

# 2nd BEE WORKSHOP

## 28/29 March 2019

**TO EXPLORE BEE REMIT**

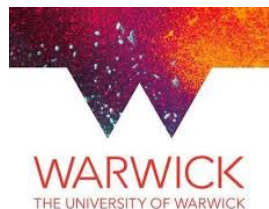
International, small workshop focusing on 'electrical cell biology' with support from  
Physics Of Life Network (EPSRC)

**EPSRC**

Engineering and Physical Sciences  
Research Council

For program, see;

[https://warwick.ac.uk/fac/sci/lifesci/research/beehive/bee\\_hub/2nd\\_bee\\_workshop/](https://warwick.ac.uk/fac/sci/lifesci/research/beehive/bee_hub/2nd_bee_workshop/)



Imperial College  
London



EMORY  
UNIVERSITY



university of  
 groningen



Northwestern  
University



UNIVERSITY OF  
BIRMINGHAM



THE UNIVERSITY  
of EDINBURGH

# Have a Great Meeting

Enjoy the Science

Form Collaborations

Think Opinion / Perspective Piece

.....



**Bio Electrical Engineering  
Innovation Hub at Warwick**

# BEE OUTLOOK

3-month  
brainstorm

21-month  
project implementation

12-month  
project development



## BEEs in Public



**wellcome  
collection**

**International Workshops**

**Industrial Exchanges**

**Entrepreneurial Training**

**Projects**

**Grant applications**

**BEE makers UG group!**

**BEE opinion paper(s)**

**BEE measurement platform(s)**

**BEE spin outs**

...