

OpenPlant Fund Application Form:

Open Source Resources for Teaching Synthetic Biology in Low-Resource Settings

Primary contact for the team

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Team

Sabrina Gonzalez-Jorge, Department of Plant sciences, **University of Cambridge**
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Background: Plant Sciences graduate and post-graduate; experience in demonstrating practicals, teaching (both practical and theory) undergraduate courses, as well as supervising PhD students and technicians.

Role: Sabrina will lead the project, and will be specifically responsible for creating, testing, and refining two sets of educational resources, as well as reviewing all materials produced by the project.

Hans Pfalzgraf, **UEA** (BIO) and **JIC** (Metabolic Biology)
E-mail: H.Pfalzgraf@uea.ac.uk

Background: Biochemistry Graduate, MRes Organic Chemistry: Drug Discovery, experience in science communication (FameLab London semi-finals)

Role: Hans will be specifically responsible for creating, testing, and refining two sets of educational resources.

Alexis Moschopoulos, Faculty of Biological Sciences, **University of Leeds**
E-mail: alexis.moschopoulos@gmail.com

Background: Plant geneticist, experience in teaching genetics and plant science to KS3 and KS4 students, as well as teaching and training undergraduate and postgraduate students in research labs at the University of Sheffield and the University of Leeds. Interested in developing low-cost plant genetics teaching resources and Internet of Things devices for plant science research.

Role: Alexis will be specifically responsible for creating, testing, and refining two sets of educational resources.

Aseda Addai-Deseh - Head of Lab 13 Practical Science Education Project, **Kumasi Hive**
E-mail: aseda.oad@gmail.com

Background: Computer Science graduate, experience teaching practical science to high school students in Ghana and running the Lab 13 Practical Science Education Project

Role: Aseda will contribute her knowledge of working with the target audience of the materials, and will review all materials produced for their suitability to be used in the context of Ghana's Junior High School system. She will co-ordinate the lesson trials, and provide information about what items are available locally.

Anna Lowe, Co-founder of **Kumasi Hive**, Makerspace & Innovation Hub in Ghana
E-mail: anna@ioinnovations.com

Background: Business & Management graduate, experience in Manufacturing, Supply Chain, Entrepreneurship, and supporting technology innovation in developing countries.

Role: Anna will support Sabrina in co-ordinating the project, contribute her experience of understandable manufacturing instructions, and will review all materials produced for clarity to a non-scientist.

Summary

This project will create a set of open source resources for teaching synthetic biology in a practical, engaging way in places where there is limited access to funding and scientific equipment. It will test & refine the resources with the Lab 13 practical science education project in Ghana, leaving them with the ability to teach synthetic biology to over 1000 high school students. It will then publish the educational resources online to be used in schools and after-school clubs in developing countries around the world.

Proposal

Despite the wealth of teaching resources available on the internet, there is a lack of good quality resources for teaching synthetic biology concepts in low resource settings. At the same time, the number of makerspaces and fab labs around the world is growing fast, and 3D printers – which can make many items of low cost, open source scientific hardware – are available in ever more places. There is an opportunity here to create easily accessible teaching materials to introduce synthetic biology concepts, and in particular, outcomes of other Open Plant initiatives, to a new audience – so that these can be used to spark the excitement of a new generation of open scientists around the world.

The project will work in partnership with Lab 13, a practical science education program run by Kumasi Hive makerspaces & innovation hub in Ghana. Lab 13 currently works with 6 schools in a peri-urban district, which between them have around 1000 pupils aged 12 – 15. None of the schools has a lab or science equipment other than access to Lab 13.

This project will draw on educational resources already created under previous Open Plant initiatives, and select ideas that can be adapted for use in developing countries where there is little access to costly materials or equipment. In addition, some 'frugal science' methods such as DNA extraction using soap and salt may be included. Some of the lessons may include the creation of items of equipment that can be used in other lessons. Examples of previous Open Plant Fund projects that will be evaluated for development are:

- Waterscope
- Field portable colorimeter
- Desktop plant experiment box
- Open Pi-Image: A low cost-open source plant growth imaging and analysis platform
- **Open Source Autonomous Imaging Station for High Schools, Universities & DIY Science**
- Materials created by Plug and play synthetic biology education resource
- Materials created by Strengthening synthetic biology capacity in Kenya through bioinformatics training

All five listed members of the project will contribute to the selection of topics. Aseda Addai – Deseh of Lab 13 will provide guidance on the creation of the resources regarding what will work in the setting and what equipment & experimental materials are available locally. Once draft resources have been prepared, each researcher will then travel to Ghana to trial them, building Lab 13's capacity to continue teaching synthetic biology in the process. The teaching resources will be refined based on the trial feedback and then published.

Benefits and outcomes

The major benefit of this project is to make outputs of other Open Plant projects accessible to as large a number of people as possible. In so doing it will enrich the education and scientific knowledge of the next generation of scientists in places that today have few opportunities to contribute to synthetic biology. Who knows what the minds taught using these materials and inspired to take up synthetic biology can contribute to our knowledge in the future?

The outcomes of the project will be:

1. **At least six sets of open-source teaching resources to support practical education of synthetic biology topics in low resource settings around the world – fully documented and published. Each set of educational resources will include:**
 - Engaging practical activities for high school students to experience synthetic biology concepts, without assuming specific scientific background. These will be suitable to be delivered in either a traditional classroom setting, or something like an after-school science club.
 - An easy-to-follow teaching guide, which will allow even teachers with little scientific knowledge themselves to feel comfortable guiding the class.
 - A list of equipment and/or materials for the experiments, kept as simple as possible, ideally using only commonly available materials, and with potential substitutes indicated where possible. Some topics may offer follow-on activities which require additional materials or equipment but there should be basic activities that can be undertaken even in rural areas with no access to scientific equipment.
2. **The Lab 13 Practical Science Education Project will be equipped with knowledge and equipment to teach the full curriculum to the 1000 students of the six schools it is currently working with, and will also be able to offer teacher training or demonstration sessions to other schools in Ghana that are interested in taking up the subject.**
3. **Establishment of new interactions between researchers working in Cambridge and Norwich.**

This collaboration between the University of Cambridge and the University of East Anglia will bring together two research areas together i.e. Biology, specifically Plant Sciences and Metabolic Biology, that while they have merits on their own, together the coming together of diverse fields offers a coordinated work strategy to tackle common goals of interest i.e. bring science into the lives of the new generation of African scientists.

Sponsor for the research and cost centre

Dr. Ian Henderson, University of Cambridge, Department of Plant Sciences, irh25@cam.ac.uk

I confirm that I have the full support of the sponsor listed above and that they can be added to the OpenPlant Fund mailing list to receive project updates (to which they can unsubscribe at any time).

Budget

Item	Cost	Qty	Total
Travel			
UK-Ghana return flights	£500	3	£1,500
Local transport	£25	3	£75
Accommodation (12 nights per trip)	£20	36	£720
Other			
Input from Ghana Education Specialist	£800	1	£800
Parts & materials*	£900	1	£900
TOTAL			£3,995

*The resources of Kumasi Hive's makerspace will be used to produce equipment. No charge will be made for this but consumables such as 3D printer filament will be paid for from this budget, along with Arduinos and other components needed.