BioHack Academy 2: BioFactory

Construct the machines for a Biolab

The age of personal biotechnology is upon us! Engineers have turned biology in a design discipline and it's now up to us to shape it's applications. After completing the BioHack Academy (BHA) you can grow your own fuel, food, filaments, farmaceuticals, fragrances, fungi and much more funky bio stuff at home. We'll teach you how to join the bio revolution and build your own BioFactory using a Fablab, Maker/Hackspace or other shared machine shop.

Learn how to design, grow and extract your own biomaterials using only Open Source hardware you fabricate yourself. Whether it's a new type of bio ink, bio polymer or bio fuel, we'll show you can grow it yourself and share the results with others.

For starters, you may choose a product from our collection, such as violacein (purple dye), cellulose (biopolymer), ethanol fuel (yeast fermentation), spirulina algae (super food), lactic acid (yoghurt), penicillin (antibiotic), kombucha (drink), acidic acid (vinegar), citric acid (aspergillis), mycelium (filaments) and/or tell us about your own living material of choice.

The BHA 2: BioFactory consists of 10 classes. Step by step we construct all the necessary machines you need to run a biolab. Along the way you will learn how to operate them.

Duration:
10 classes in 2,5 months

Number of participants:
Max 15

Subjects:
Incubator
Microscope
3D & 2D design
Sterile hood
Centrifuge
Magnetic stirrer
Spectroscope
Syringe & peristaltic pump
Bioreactor controller
Graduation

Sign up now to become a master in digital fabrication applied to biotechnology!

More information can be obtained by contacting wetlab@waag.org

How we get it done

In just 2,5 months we will build up our own biofactories together. Every week a lecture will be given and recorded. You will also have access to the Amsterdam Open Wetlab and Fablab during two days a week to build equipment, conduct experiments and get the support you need.

The lectures will give you insight in what kind of tool we are building and it's usefulness in the lab. You may choose to either replicate the design of the tutor, improve it or build your own device from scratch. It's up to you how sophisticated things may get.

All students are required to keep track of their progress on the BHA Github page, allowing to learn from each other. Two weeks in advance of each lecture students will receive a recommended materials list and access to the tutor's design, allowing for enough time to purchase items or to seek alternatives.

The program is a hands-on bootcamp. By the end of the course you and your fellow class mates will be turned into fully equipped biohackers, capable of growing a broad range of biomaterials. Ready to continue production independently at home.

What's next
After the Academy has been completed, you will receive a BHA BioFactory certificate. The project Github page and Vimeo channel are open to the public to share the results with the Open Source biotech community at large.

In possession of your own BioFactory, you may continue to advance your production skills, engage in directed evolution experiments, produce bio gas, purify water, bioremidate polluted soil, just to give a few. Bio has no limits!

Your tutors:

Pieter van Boheemen
Pieter is an all-rounder in digital fabrication and biotechnology, founder of the Dutch Do It Yourself Biology community and supervisor of the Open Wetlab laboratory for creative biotechnology. He has taught numerous Do It Together Bio workshops to designers, artists, scientists, engineers and hackers of all age groups on the subject of biohacking, biodesign and bio informatics. In the Open Wetlab he turns the experience from his masters degree in Life Science & Technology of the Delft University of Technology into hands-on activities that are easy to understand by anyone. Pieter is a frequent user of Open Source hardware and creator of the open source RWXBioFuge.

Alex Schaub
Alex is co-founder of the Amsterdam FabLab and our expert in digital fabrication. Apart of a mastering materials and construction he also successfully finished his study Master of Music at the Koninklijk Conservatorium in The Hague.

Lucas Evers
Lucas is head of the Waag Society's Open Wetlab and has profound knowledge of the intersection of biology, design and art. He has an education as an artist and teacher in the creative arts and studied politics at the University of Amsterdam. He is co-initiator of the Do It Together Bio series and the Bio Art & Design Award.

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BHA2: BioFactory schedule
Fall 2015

The BHA2: BioFactory series consists of 10 classes. Step by step we construct all the necessary machines you need to run a biolab. Along the way you will learn how to operate them.

Class	Description	Date
1. Incubator	Build your own incubator and start growing microbes under controlled conditions. During the class you will also get to know the fundamentals of microbiology. We'll use our purple pigment bacteria as a default, but can also choose your own favourite biological agent. A crash course Arduino programming and soldering is included.	15-09-15
2. Microscope	We will make our own microscope to take a closer look at how last week's cultures have grown. The subject of this class is microbio physiology and open source publishing.	22-09-15
3. 3D & 2D design	This class is essential. You will learn how to design objects in 2D and 3D and transform them into real objects with a lasercutter or 3D printer. As a demo we will make basic lab utilities, such as tube racks.	29-09-15
4. Sterile hood	In order to make it easier to work sterile with microbes, we will construct our own sterile hood. During class you will learn more about biological safety and how to purify strains.	06-10-15
5.Centrifuge	We'll try to isolate our first biomaterial. For that we need centrifugal force to take your samples for a spin. In class you will learn more about analog electronics and physical separation techniques.	13-10-15
6. Magnetic stirrer	In order to scale up our BioFactory, we need to stir things up. Production is often limited by mass transport, so the stirrer will fix that. We'll explore the basics of bioreactor design too.	20-10-15
7. Spectroscope	Spectroscopy is an essential tool for monitoring the growth and production in your bioreactor. We will make our own light source and detector setup. The class is about other analytical techniques too.	27-10-15
8. Syringe & peristaltic pump	The microbes in your bioreactor need fresh food. Let's get rid of the manual labour and connect syringe & peristaltic pumps. You will also learn more about feed stocks and other substrates. We'll go a bit deeper into metabolic networks too.	03-11-15
9. Bioreactor controller	Now that we have constructed pumps, stirrers and a spectroscope we can start connecting all the dots into one big bioreactor. The controller will be able to set the environmental parameters, input and analyse the effluent of your reactor.	10-11-15
10. Graduation	Demo your bioreactor and share your designs with the world. Done, you've competed your own BioFactory!	17-11-15

Equipment & skills

What will we build? What will you learn?

During each lecture you will learn what the basic requirements are for each machine you will need in your BioFactory. During the Academy it's up to you to go MacGyver DIY style or be a bit more sophisticated, depending on your needs, budget and confidence. Here are a few examples of what you could end up with:
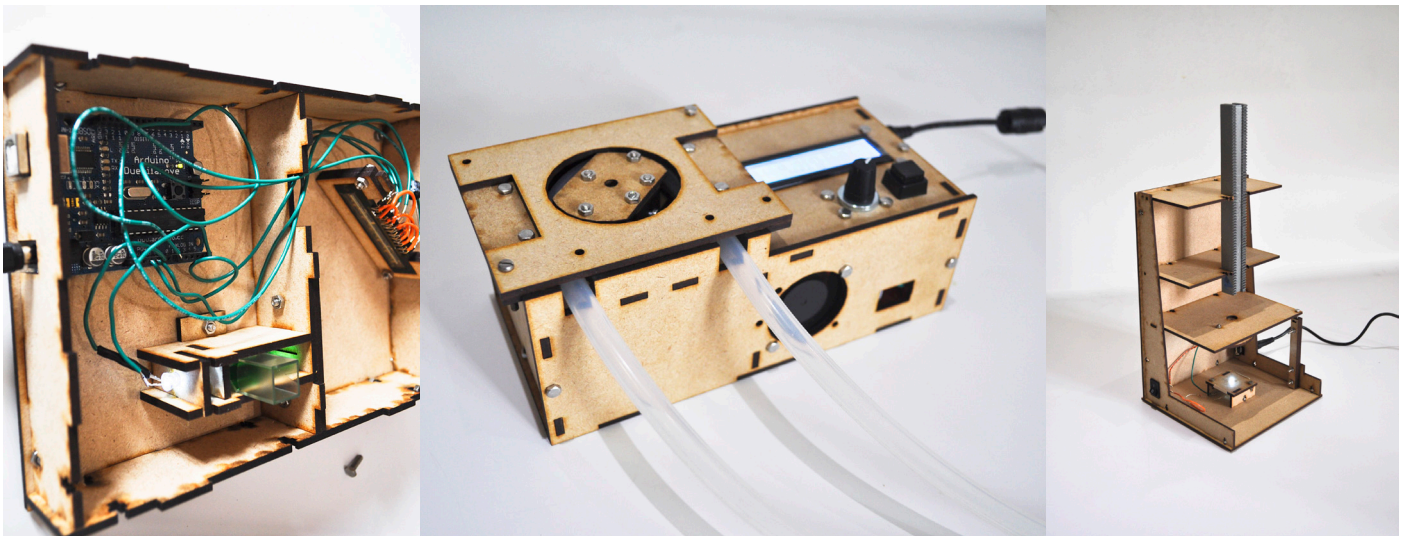
Required prior knowledge
There is no specific knowledge required, just an inventive and creative attitude. We're not going to build the lab for you, you will have to do that yourself with the help of the instructors and the other participants.

Skills you will learn:
• Microbiology
• Molecular biology
• Biotechnological reactor design
• Biorefinery
• Spectral analytics
• Bio informatics
• Analog electronics
• AVR microprocessor programming
• 3D drawing and parametric design
• 2D computer aided design
• 3D printing

• Image processing
• (Micro)fluid dynamics
• Thermodynamics
• Mechanics
• Open design licensing
• Chemical and biological safety

Tools you will learn to use:
• All the tools you will build yourself
• Lasercutter
• 3D printer
• Arduino processing language
• OpenSCAD 3D modeling
• Sketchup 3D modeling
• Fritzing electronic circuit design
• Inkscape 2D design
• Markdown language
• Wikimedia and Github

Practical information
Fees, payment & location

The fee consists of a tuition fee and costs for materials. The tuition fee is a fixed fee for the entire course, but the material costs are up to you. Three weeks in advance of the course you will receive a list with suggested materials at minimal cost.

In order to spend the least amount of money, you will sometimes need to scavenge parts through second hand market places like Ebay. It is up to you to upgrade and spend a bit more money on your BioFactory to the extend you prefer.

The fees include two days a week of access to the Amsterdam Open Wetlab and Fablab facilities, access to the BHA Github page to keep track of your projects and Vimeo channel with recorded lectures.

Tuition fee
BioHack Academy 2 BioFactory tuition fee: 1,000 Euro. Expected material costs: 500 Euro.

On top of these costs you are expected to have access to the following:
• Laptop computer
• Arduino compatible microprocessor (multiple units are recommended if want to keep the machines working independently), you may use cheaper clones like Rxduino, Seeeduino, Funduino, etc too.
• General kitchen equipment: pressure cooker, microwave, oven, fridge and freezer, plastic (tupperware) containers of various sizes, and access to a supermarket and aquarium store
• A limited set of these tools are available in the Open Wetlab. However it is highly recommended to get your own in order to build a full lab at home.
• Keep in mind that you need about 100 up to 200 euros of budget for consumables, such as chemicals and tubes too.

Payment
Payments can be made by bank transfer to Waag Society. You will receive an invoice with the appropriate bank number (IBAN).

The tuition fee is non-refundable.

Scholarships
There are two scholarships available for students that are enrolled in a higher education program (Bachelor or Master). The scholarship reduces the tuition fee to 200 euro. Please indicate in your application form whether you would like to apply for the scholarship as part of your motivation.

Location
You can take part in the academy at the Open Wetlab or at a remote location. The lectures will take place on Tuesday evening between 19.00 and 21.00 hrs.

Open Wetlab biohacker space
All classes will take place in the Open Wetlab, an unique biohacker space on the bleeding edge between art, science and technology. The lab is co-located with the Amsterdam Fablab in the Waag building in the centre of Amsterdam. This location is best reached by public transport.

Remote location
In order to take part in the academy remotely, you need to have access to a BioHack Academy partner lab. Via a video stream you can follow the lectures remotely, the lab will provide biological samples of the strains and you get access to the BHA Github page.

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How to apply

Congrats on deciding to build your own BioFactory. Here's how you sign up for our course:

1. Fill in the application form;
2. Your tutor, Pieter van Boheemen, would like to get to know you in a short interview;
3. You will receive the assessment outcome, and payment instructions (invoice).

Application schedule Fall 2015

	From	To
Application period	20 April	12 June
Assessment interview	22 June	3 July
Notification	6 July	
BioFactory 2 classes	15 September	17 November

Contact information
If you have any further questions, please contact the Open Wetlab at wetlab@waag.org

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1012 CR Amsterdam

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Application form

To be sent to the office address (see contact information).
Also available online as e-mail form online at the project page (waag.org/biohackacademy).

First Name ....

Last Name ....

Email ....

Date of Birth ....

Nationality ....

Personal website ....

Address ....

Phone number ....

Short Bio ....

....

Motivation ....

....

What is your proficiency in the following (mark with x):

Skill	Low	Medium	High	Expert
Biotechnology				
Electronics				
Digital fabrication				
Programming				
2D and 3D modelling				

Which classes do you intend to attend (please mark)?

1. Incubator ☐
2. Microscope ☐
3. 3D & 2D design ☐
4. Sterile hood ☐
5. Centrifuge ☐
6. Magnetic stirrer ☐
7. Spectroscope ☐
8. Syringe pump ☐
9. Bioreactor controller ☐
10. Graduation ☐