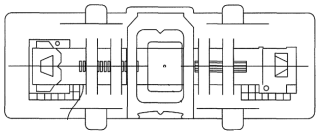
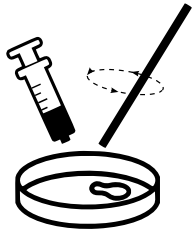
Lab From A Chip

cheapjack.github.io/LabFromAChip





Lab From A Chip:

Lab From A Chip is a DIY intervention in lab-on-a-chip technology inspired by science & technology studies (STS) and the history of microbiological technique. It's part of Ross Dalziel's ***Critical Kits*** project, at the *Division for BioMedical Life Sciences at Lancaster University* (BLS) and makerspace *DoESLiverpool* making add-ons for the *Foldscope*, a folding paper microscope by *Prakash Labs*.

"A lab-on-a-chip is a device that integrates one or several laboratory functions on a single integrated circuit of only millimeters to a few square centimeters" Wikipedia

We've packaged up the existing, friendly & cheap *Foldscope* kit, alongside some materials to follow the innovative practice of scientist & engineer Alexandre Benedetto & colleagues at BLS. They make cheap robust PDMS microfluidic environments to observe model organisms using old vinyl audio records as moulds - it's a DIY shortcut to microfluidic engineering on the cheap that feels like a makerspace strategy. We've tried to make it accessible to microscope *newcomers* & *old-timers* so you can watch ***Euglena gracilis***, a light sensitive, highly motile algae swim amongst some of the amazing hidden structures that make up the everyday surfaces of the human engineered world. It's a way of getting materially engaged with other worlds & scales and perhaps develop feelings for other (micro) organisms.

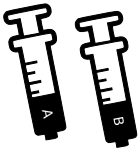
Getting Started

The first step is to assemble & practice the use of your *Foldscope*. All the components and instructions are included in the bag and can be popped out & folded out of the cardboard net - we've also included a glass reference slide to practice. Give yourselves some time to experiment with this before attempting moulding!

Then experiment making your own simple micro-moulds from the PDMS silicon, fragments of vinyl records & surplus electronics included. The *Foldscope* is a deceptively simple ball lens microscope, like the very first microscopes of *Antonie van Leeuwenhoek,* but made with the technology of advanced capitalism. You'll need to get quite intimate with your equipment to be able to 'see' with it - in many ways you have to 'feel' your way - to capture the images on your phone - you see & feel exactly how your every movement *intervenes* in the microbiological world. Historian Ian Hacking thinks this is how we 'see' with microscopes - that *intervening* is crucial to the everyday 'doing' of science and also thinking about it's consequences.

This is a rough guide - experiment! - the first scientists did everything at home, years before having specialist objects like syringes. What other domestic materials can you find that might make tiny spaces we can use? Tell us about it! Tweet **@CriticalKits** or the foldscope team at **linktr.ee/foldscope -** look for help on the website on the cover.

Inventory



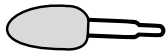
Pouches of PDMS A & B with labelled syringes. PDMS is non-volatile silicon, safe to handle, but not edible. We advise washing hands after use & storing syringes in the plastic sleeves. Unmixed it can store for years. PDMS has amazing 'resolution', getting into the smallest nook & crannies of our worlds...

555 Timer chip. Common integrated circuit - a silicon chip in digital maker projects and many electronic devices.

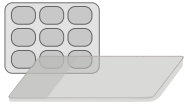
Vinyl fragment. Some of you may not remember, but at the dawn of pop culture music was distributed widely on vinyl discs with micrometre grooves that could vibrate a needle so you could listen to music like Little Richard or Lover's Rock

Petri-dish with lid. Mix PDMS & make impressions with chip surfaces. You can also use plasticine or bluetack to form even smaller moulds. It can take 6-10 hours at room temperatures to set but alot quicker in a warm dry environment. You can heat it but be careful not to melt the petridish and never do so and leave unattended!

1.5ml Eppendorf with click safe-lid containing an algae suspension of *Euglena gracilis*.



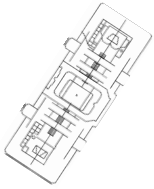
Disposable hand pipette`



Blank glass Microscope slide with set of cover slip stickers for your own PDMS mould/slab. Take care with thickness of slab to help our algal friends swim inside

Pre-prepared reference slide so you know your Foldscope is working

Tweezers for removing set PDMS impressions

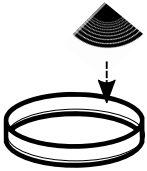


Standard Foldscope classroom kit, instructions, cover slip stickers & paper slide set, lens cleaning Q-tip, lens stage. You can use the paper slides or the glass slide

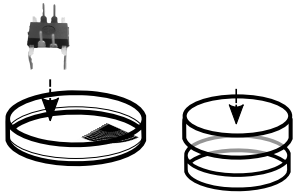
Get Moulding!

Fill your syringes with A & B PDMS from plastic pouches provided & inject equal amounts (approx. 0.4ml) of PDMS A & B into the 'floor' of your mini petri dish (it's the smaller diameter part the lid sits over).

Mix well *first*, then submerge your vinyl fragment in the floor of the petridish. Leave room for your chip or another item. If it's not submerged add PDMS mix.

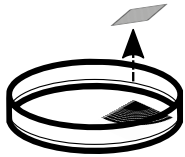


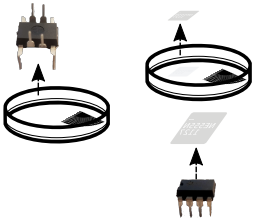
Bend back the mid pins of the 555 chip so they point up. You should be able to submerge the chip & the outer pins will stop it sinking to the very bottom of the dish - adjust so there'll be a super thin 'slab' of PDMS. This is like the reverse of the vinyl technique and useful to learn for taller objects.



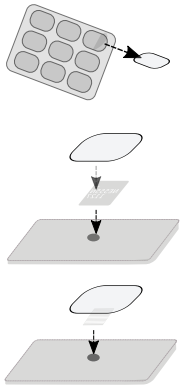
Leave mix to set with lid on. You can speed it up by heating but several hours in a warm room is ok. Think of other ways to make moulds; as long as you contain the edges of the mix, using plasticine perhaps with a bottle top, it will set into a decent slab.

Use a sharp blade (not included) to cut a section out of the now solid set PDMS slab over the vinyl surface. Use tweezers to lift this 'slab' of PDMS and carefully place left of centre of your microscope slide 'groove' side down - you'll move it again shortly. As you lift it you'll see the ridges of the grooves shimmer in the light.





For the chip - cut around it, remove and it should pull a slab from the dish or leave impression. Then cut around the slab & try pull gently up for your slide.



Prepare a glass slide (or paper following *foldscope* instructions) - Pipette a tiny drop of algal suspension onto the centre of the slide, pick up the slab and lower it onto the sample. Use tissue to soak up excess suspension. Peel off a slide cover sticker with tweezers - bending the sheet helps. Now lower the cover slip sticker in one movement to 'seal' in the slab & liquid sample on the slide ready for viewing.

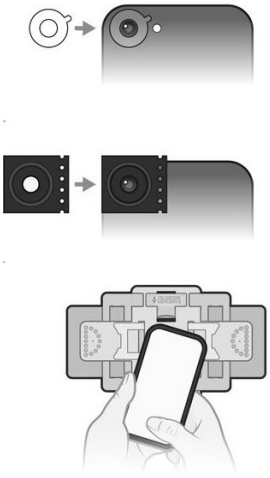
The example glass slide should've stretched the slide-holding slots so you can insert your new slide easily ***(a.)***. Be careful not to push your slab & algae off! It needs placing so the coverslip sticker top is closest to the lens - viewing on the blue side. For fast phone use you can remove the slide holding assembly ***(b.)*** and let the magnetic flap hold the slide.

a.

b.

Tips & tricks

* Look for the key features of chip text so you know what to look for in the image - they can be hard to find and less deep than our vinyl grooves.
* An open laptop screen with daylight helps illuminate while phone viewing. Move the phone and 'scope around to play with the light as it is ***refracted through*** the sample.
* If your silicon 'slab' is too thick the foldscope might not be able to focus. Don't forget to adjust the folded focus ramp for focus issues (see *Foldscope Instructions*)



Setup your phone with the Foldscope and see if our algal friends have found their way into our microfluidic channels. This can be tricky! The vinyl record technique is the most rewarding, you get to see our ***Euglena gracilis*** moving along the grooves; and understand their scale compared to yours. The chip surface is more subtle so harder to find so use the vinyl first.

More guidance at ***https://www.foldscope.com/user-guide/***

These organisms are mixotrophic in that they ingest food but also photosynthesise like plants and seek it out with a tiny light 'eye pit'. Once you put yourself in the algae's position the human engineered world and all it's 'freedoms' becomes vast and almost terrifying or incomprehensible in scale and impact - yet easy to forget and make invisible. Reflect (and refract) on what tiny technical histories might have been necessary to make these tiny spaces and the objects in this kit possible - and on the billions of microorganisms and microevents that make up your own history.

Don't forget to share your images to Twitter ***@CriticalKits*** and ***@teamfoldscope*** on Instagram

Thanks to Alex, Rod & the Worm Breeders Gazette

Lancaster University

Foldscope add-on kit for getting started with DIY microfluidics!