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**Biomaterials toolkit (working title)**

## Accompanying booklet

(8 sections, 2 rows)

|  |  |
| --- | --- |
| Header:  Name toolkit  p. 1 | Biomaterials Teaching Toolkit  *Critical making with bio-based materials* |
| Header: Select and execute)  p.2-3 | [Image]   * Front of the card and back of the card   [text]  Introduction   * The short description allows you to quickly assess whether the activity or method on the cards suits your needs.   Category   * Depending on what learners already know and depending on what topic you want to center your activities, the toolkit is divided in four categories. Cards can be about materials science, bio fabrication, diy-microbiology, or critical making.   Estimated Duration   * This is an estimate of how long it will take to execute   the activity.  Explain | Explore | Expand   * Foundational cards contain key activities and methods for learning, understanding, and critically engage with biomaterials. Deep Dive cards build on knowledge of the foundational cards and dive a bit deeper into the subject mentioned on the card.   Recommendations   * Depending on what learners already know and depending on what topic you want to center activities, the toolkit is divided in four categories. Cards can be about materials science, bio fabrication, diy-microbiology, or critical making.   Tasks   * The steps that need to be taken in order to execute the activity |
| Header:  Critical creative research on new material futures  LOGOs  p.4 | Body [max 50 words: frame in what kind of situations this toolkit can support people, e.g. the design method kit supports a design process, what does this toolkit support?] Understanding biomaterials, fostering critical creative research, *what is the scope of this toolkit? Who is this for?*  *How to use this toolkit*   * ...short detailed task-based descriptions help learners quickly undersantd the premises of DIY material fabrication. This makes [name toolkit] perfect for schools, institutions, etc, ?? To dive further into new materials and build new eco-systems to ??. Use [name toolkit] in combination with the materials archive [link] to collaboratively build an open-source archive.”   www. samplemanagementtool.org  Funded by NWO/ Comenius teaching fellowship, awarded to Loes Bogers  In collaboration with:  Textilelab Amsterdam  Loes Bogers  Sam Edens  Ista Boszhard  Micky van Zeijl  Cecilia Raspanti  Beatriz Sandini  Students HBO-ICT  Students Makers Lab  Students minor Textiles  Maria Viftrup? |
| Header title:  Materials (Science + Experience)  p.5 | body:  [±40words explanation about materials science + experience] |
| Header title:DIY Microbiology  p.6 | body:  [±40words explanation about DIY microbiology and lab protocols] |
| Header title:  Critical Making  p.7 | body:  [±40words explanation about critical making] |
| Header title:  Biofabrication  p.8 | body:  [ ±40words explanation about biofabrication] |
| **Achterkantje** | **Supplier list**   * Bla * bla   **Tools & materials**  **Consumables**  **Safety** |

***Richtlijn woordentallen***

|  |  |
| --- | --- |
| Title | 3-5 woorden |
| Subtitle | Max 10 woorden |
| Short description | Max 30 woorden |
| tasks | Max 10 woorden per bullet (bold) Max 20 woorden uitleg (light) |
| recommendations | Max 10 woorden per item |
| Ideas for image |  |

## DIY Microbiology (and lab protocols)

***Explain*** *cards****:***

* Microbes/Fungi/Yeasts/Microalgae & Symbioses
* Biolab rules
* Growth media
* Desinfecting vs. pasteurizing vs. sterilizing

***Explore*** cards:

* (safety) levels of clean and dirty (read Douglas’ *Dirt*)
* Lab protocols
* Kitchen Lab (filmpje/rondleiding)

***Extend*** cards:

* Morphology of tools
* DIY biofilms
* DIY myco

|  |  |
| --- | --- |
| title | Microbes, fungi, yeast and other organisms |
| Short description |  |
| Tasks |  |
| when/why/note/output/next |  |
| Reference |  |
| Ideas for image |  |

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| --- | --- |
| title | Biolab rules & handwash experiment |
| Short description | Biolab rules are aimed at containing uncontrolled spread of microbes, to protect your experiments from becoming contaminated with external microbes. They also protect you from the small possibility of infection. |
| tasks | **Handwashing experiment**  Study the Basic Practical Microbiology Manual in preparation for class, followed by the handwashing experiment. Students practice pouring plates using aseptic technique, and learn to use the autoclave to sterilize media and materials.  Prepare a nutrient agar (500 ml water, 1.5 g yeast extract, 2.5 g peptone, 2.5 g non-iodized salt, 7.5 g agar agar)  Autoclave for 45 mins, allow to cool to 35C  Pour agar into sterilized petri dishes using aseptic technique  Take a bathroom and coffee/tea break until agar sets  Group 1 washes hands w soap and warm water for 20 sec  Group 2 washes hands with only water  Group 3 desinfects hands with hand sanitizer  Group 4 does not wash or desinfect their hands at all  Ask each student to press a finger onto the agar, close the dish, seal with parafilm and label it  Incubate for 2-7 days at room temperature  Study the results without opening the plates  Autoclave the plates for 20 mins afterwards  **Design poster with biolab rules**  Design a poster visualizing the biolab rules:  1. Report spills and damages immediately to a lab technician  2. No food, drink or mouth to face contact in the lab  3. Wash and disinfect your hands before and after lab work. Wear a lab coat and PPE where necessary.  4. Keep personal objects outside the lab (jackets, phones, etc)  5. Don’t leave heat sources or gas flames out of sight  6. Avoid aerosol formation by using proper flaming technique  7. Label all bottles and plates  8. Disinfect surfaces with 70% alcohol or a freshly prepared 10% bleach solution before and after.  9. Autoclave all biological waste and contaminated surfaces |
| when/why/note/output/next | **Why**  Learn why lab rules exist, and what Good Microbiological Laboratory Practice entails, practice with a hands-on experiment. Design a poster to commit to the rules when working in the lab.  **When**  This is a good introductory activity to familiarize students with key concepts, tools and rules in a biolab, before starting any investigations. |
| Reference | Basic Practical Microbiology: A Manual (2016) Microbiology Society: <https://microbiologysociety.org/publication/education-outreach-resources/basic-practical-microbiology-a-manual.html> |
| Ideas for image | Labrules.jpg |

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| --- | --- |
| **title** | **(Safety) levels of clean and dirty** |
| Short description | To make sure that microbiology experiments stay safe and that the work environment is healthy, by familiarizing yourself with biosafety levels. |
| tasks | Find out what biosafety level your lab has clearance for. Depending on where in the world you live, regulations can differ wildly regarding DNA, bacteria, or fungi.  Discussion prompt 1: Read the biosafety levels manuals and discuss the importance of biosafety levels.  Make a list of bacteria and fungi and find out together under which safety level each strain is classified and why. (*or we provide a list with some names*)  Discussion prompt 2: why is working in the lab with a grey Oyster strain different from growing grey oysters out in your garden and different from eating grey oyster?  Change the example of Grey Oyster to a strain or subject that applies to your lab.  Sources: Biosafety Levels Manuals; Good Microbiological Laboratory Practice (GMLP) |
| Recommendations | Recommendations: Consult your local biolab veiligheidsexpert when starting a biolab. |
| Ideas for image | Logo BSL1 |

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| title | Set up a basic biolab |
| Short description | Microbiology requires a designated space to work safely. Set up a basic biolab to prevent contamination and health hazards. |
| Tasks | Find suppliers of lab materials (e.g. Eurofysica)  Learn aseptic technique and Good Microbiological Laboratory Practice (GMLP)  (nog niet af) |
| Recommendations |  |
| Ideas for image |  |

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| --- | --- |
| title | Levels of clean and dirty |
| Short description | ‘Dirt is matter out of place’ -Mary Douglas (1966:44). |
| Tasks | Reappropriating waste materials for bioremediation asks us to reconsider our own and others’ ideas about dirt and cleanliness, and about waste and newness.  Collaboratively discuss and untangle what kind of ideas, beliefs, and value systems are in place regarding the materials you (want to) work with.  With your group, work out strategies to incorporate these beliefs and values in a positive way.  Sources: Mary Douglas, Purity and Danger, 1966 |
| Recommendations | The idea of ‘waste’ is not tied to the functionality or materiality of an object. Regarding the social, cultural, political, and economic dynamics allows for a more holistic perspective on waste, bioremediation, and sustainability. |
| Ideas for image | Melissa’s grey oyster on cigarette bud |

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| **title** | **Lab protocol** |
| Short description | [±30 words, may be extended with an example] |
| tasks |  |
| when/why/note/output/next | Source: where did we base our lab protocol on Good Microbiological Laboratory Practice (GMLP) |
| Ideas for image | Lab coat and bunsen burner |

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| title | Morphology of tools |
| Short description | [±30 words, may be extended with an example] |
| tasks |  |
| when/why/note/output/next |  |
| Ideas for image |  |

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| **title** | **DIY Biofilms** |
| Short description | Biofilms are ? layers formed by microorganisms. They can help with water purification or nutrient cycling but can also be grown into a material that can be considered vegan leather. |
| tasks | **Choose a well-documented bacteria or yeast**  -Kombucha or kaasschimmels (of een aparte kaart over kombucha?) |
| when/why/note/output/next |  |
| Ideas for image | Tiago’s experiments or scoby |

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| --- | --- |
| title | DIY Applied mycology |
| Short description | Mycology is the study of fungi and their applications in several industries (food, materials, pigments, medicine, bioremediation). The availability of tools and DIY processes make this field accessible to enthusiasts. |
| tasks | **Set up a basic biolab (refer to card)**  Find suppliers of lab materials (e.g. Eurofysica)  Learn aseptic technique and Good Microbiological Laboratory Practice (GMLP)  **Choose a well-documented strain**  Pleurotus Ostreatus (Gray Oyster) or Ganoderma Lucidum (Reishi) foodsafe strains that are suitable for beginners  Find a supplier who can sell you *sporeless* strains to avoid unwanted sporulation (e.g. Homegreen in NL)  **Learn how to grow mycelium in a petri dish**  Learn how to make a malt-yeast-agar  Learn how to make a potato dextrose agar  **Learn how to create a grain jar/grain spawn**  Learn how to *sterilize* a grain jar  Learn how to *inoculate* a grain jar  **Learn how to colonize a bulk substrate (for materials)**  Find out which substrates your strain thrives on  Learn how to *pasteurize* bulk substrates Learn how to *inoculate* a bulk substrate Learn how to *incubate* and maintain a bulk substrate Learn how to dry a bulk substrate  **Learn how to train a strain (for mycoremediation)** |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  light malt extract, yeast extract, potatoes, dextrose, water, vial of liquid culture (sporeless), coffee, hemp, wood dust, wood chips, agar, 70% alcohol, bleach  **Tools**  pressure cooker, glass bottles/jars, petridishes, parafilm, scalpel, sterile syringes, autoclaveable polypropylene (PP5) bags or boxes, autoclave tape, hammer, nails, non-absorbent synthetic wool (e.g. fiberfill)  **References**   * Peter McCoy (2016) *Radical Mycology* * Freshcap Mushrooms Blog and video channel <https://learn.freshcap.com/growing/> and <https://www.youtube.com/c/freshcapmushrooms>   **See also**  Mycelium-hemp composite |
| Ideas for image | Mycelium\_agar.JPG |

## Biofabrication

***Explain*** *cards****:***

* ***🡪 mss toch recepten hier?***

***Explore*** cards:

* Glossary “bio-everything”
* Glossary Fabrication vs manufacturing vs production
* Fabrication techniques (pressing, felting, extruding, composites etc)
* @HOME Materials kitchen

***Extend*** cards: :

* Be a 3Dprinter/ print paste
* (Un)making the mold
* Mono-material connections
* Morphology of ingredients
* “Semi” fabrication (zelf kijken naar manieren van verwerking, dus manieren om vouwen/persen/rollen etc na de bootsen)

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| --- | --- |
| title | Glossary “bio-everything” |
| Short description | [±30 words, may be extended with an example]  Wij cureren± 30 woorden, opdracht is om voor alle woorden definities te zoeken om samen tot een glossary te komen  Biodesign  Bioart  Biology  Biofabrication  Biodegredable  Biorenewable  Biocompostable  Biomimicry  Biobased  Biomass  Biosynthesis  Bioremediation  Biohacking  Bioethics  Biotechnology  Bionics  Biomechanics  Biodesctructible |
| tasks |  |
| Recommendations |  |
| Ideas for image |  |

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| title | @HOME Materials kitchen |
| Short description | Exploring your kitchen is a good starting point for a lot of biomaterials. DIY Bioplastics are often made with ingredients and equipment found in your kitchen cupboard, and natural dyes can come from food waste such as pits or peels. |
| tasks | Give a small video tour in your kitchen: show us how you have converted your kitchen into a Biomaterials-fabrication site.   * Shopping & collecting list week 1 minor: * Silicone baking mat (heatproof) * Precision scale 0.01 g (e.g. bol.com for 5e) * Old pot you can dedicate to non-food experiments * Kitchen scale * Strainer * Glycerine, 1L (e.g. drogisterij.net) * Denatured alcohol 96%, 1L (e.g. drogisterij.net) * Gelatine powder (not sheets, look at online shops) * Agar agar powder * Sodium carbonate or cleaning soda (NL: kristalsoda) (supermarket) * White vinegar (supermarket) * Hand soap and dishwashing soap * Cutting mat (hobby stores) * Scalpel/hobby knife (hobby stores) * Clamps or clips to hang things * Ruler (min 30 mm) * Roll of painting tape * Roll of strong tape e.g. duct tape * Scissors and if possible: small scissors for precision work * Textile swatches 20x30 cm minimum (e.g. cotton, denim, can be cut-up old clothing/sheet/towel) * Loose leaf green tea * Rubber bands (supermarket) * Cane sugar * Whole cloves (NL: hele kruidnagels) * Corn starch * Coconut oil OR vaseline OR purol * Fresh Kombucha Scoby (ekoplaza or https://yayakombucha.com/products/organic-kombucha-starter) > keep in the fridge until use * Acrylyc sheet PMMA 3 or 4 mm, minimum 50cm x 100cm e.g. https://kunststofplatenshop.nl/ * Roll of white paper (light gray/beige fine too), or a sheet of min 45 cm wide and 100cm long * Glass jars several sizes (e.g bean jar 250ml, big mayonaise jar 500ml, big yoghurt jar 1000ml) * Wide glass jar or plastic container (min 15 cm diameter or width) * Handful of old rusty metal scraps |
| recommendations | Collect old pans, pots and utensils for bioplastics and natural dye. Do not use them for cooking and store them separately. |
| Ideas for image | Collected Kitchen materials |

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| title | Fabrication vs manufacturing vs production |
| Short description | Fabrication, manufacturing and production are terms that are often used as though they are synonyms. Although the processes show similarities, there are some differences to keep in mind.  Source: <https://www.pacific-research.com/manufacturing-vs-fabrication-what-is-the-difference-prl/#:~:text=Fabrication%20is%20about%20the%20creation,process%20of%20assembling%20those%20parts>. |
| “Tasks" | Fabrication is about processing raw materials and making parts from these raw materials that are suitable for assembly. Common fabrication methods are welding, cutting, folding, machining, and extruding.  Manufacturing is when those parts are assembled into products intented for consumers. Semi-manufacturing is the making of components for products (think of companies specialised in making pcb’s for computers). A typical manufacturing process uses machines, assembly lines and skilled labor to assemble products.  Production is a term that simply denotes utility. As such, it can cover both fabrication and manufacturing and it is also applicable to the creation of intangible goods. |
| When/why/note/  output/  next | When making biomaterials, we talk about biofabrication. We fabricate materials that can be made into parts, or we directly make parts by casting biomaterials into molds.  Working with biomaterials may ask for |
| Ideas for image |  |

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| --- | --- |
| title | **Morphology of ingredients in biofabrication** |
| Short description | Studying the structure of biomaterials, and understanding the functions of ingredients in recipes will help you find new alternatives to experiment with. What are possible alternatives for each ingredient? |
| tasks | **Make a hypothesis**  Select a biomaterial recipe  Research what kind of compound each ingredient is  Use the functions graph as reference  Make a hypothesis of the function(s) of each ingredient  **Morphology**  Determine what could be alternatives for each ingredient  Locate alternatives that can be found in waste streams  Locate alternatives that are more locally abundant  **Experiments**  Recreate the biomaterial recipe by replacing one ingredient  Analyse the results, reassess your hypotheses  Do this with at least 3 times, changing one variable at a time |
| when/why/note/output/next | **Why**  Many biomaterials recipes include purified store-bought virgin materials and foodstuffs. In order not to compete with food, it’s worth finding alternatives that can be sourced from waste streams, or alternatives that are more abundant in your environment. In many cases very pure food-grade ingredients can be avoided.  **When**  You’ve experimented with bioplastics and want to dig a little deeper so you can start developing new materials that are embedded and tuned to a specific local context.  **Next**  Locate an abundant waste stream that might be utilized. Contact a material scientist to further explore the chemistry of your materials. Share your experiments openly. |
| Reference | Functions graph (2021) Loes Bogers, Cecilia Raspanti & Sam Edens |
| See also | Kater Franklin and Caroline Till (2018) Radical Matter: Rethinking Materials for a Sustainable Future. |
| Ideas for image | morphology-ingredients.jpg |

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| **title** | **Being a 3D printer** |
| Short description | Being the Machine is an alternative 3D printing process that operates in terms of negotiation rather than delegation. It takes Gcode (the instructions typically provided to 3D printers) and presents them to human makers to follow. |
| tasks | Prepare by reading Devendorf & Ryokai’s article  Follow a laser with a pencil to draw paths on paper (15 mins)  **Build**  Select a 3D model to build (e.g. on thingiverse)  Express any desires you have to modify the design  Select an everyday, abundant material to work with  Put the model in a slicer, and find the path viewer  Person 1 traces the gcode paths with the laser  Person 2 follows the laser by “printing” the paths with the chosen material  There’s no right or wrong, only negotiation  **Reflect**  How did you decide on the material selection?  Can you describe the experience of working with the system?  When did you deviate? Why?  What did you learn about working with this material?  Describe the features of your object |
| when/why/note/output/next | **why**  Subverting an expected relationship between humans and machines in making 1) helps explore the *semiotic effects* that are produced when different materials, contexts, and processes are brought into juxtaposition with one another and 2) helps create understanding of a medium on both *symbolic* and *technical* levels.  **output**  Users negotiate control between themselves, the system, and their materials in order to enter into meditative, reflective, and collaborative modes of making.  **next**  Develop your own 3D printing paste by modifying one of the bioplastics recipes, and repeat the exercise with your pastes. |
| Reference | Laura Devendorf and Kimiko Ryokai. 2015. Being the Machine: Reconfiguring Agency and Control in Hybrid Fabrication: <https://dl.acm.org/doi/abs/10.1145/2702123.2702547> |
| See also | Recipe cards |
| Ideas for image | 3Dprinter.png |

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| --- | --- |
| **title** | **(Un)making the mold** |
| Short description | Consumer electronics are often encased by injection-molded thermoset plastics that long outlast their actual time of use. Challenge these archetypes by using materials and processes that allow for organic distortions and unexpected results. |
| tasks | **Dissect a product**  Select a (broken) consumer electronics product  Take it apart and study the electronics and its functions  Make a visualization of your dissection  **Develop your own mold**  Choose a biomaterial to work with (see recipe cards) Make a mold – to create new casing for the electronics  Test it out by casting the material and allow it to dry (1 week)  **Testing and refining**  Set new goals and iterate on your mold and method  Document the process and results, share with class |
| when/why/note/output/next | **Tips**  Consider these parameters: compatibility between materials of mold and material being molded | accommodate need to apply pressure | accommodate need for ventilation | accommodate absorption of excess material onto a “bleeder” or sacrificial layer | release angles and release agents | warping and shrinkage  **Next**  Draw your mold design in a CAD program (e.g. Rhino)  Fabricate your design and cast models in different materials |
| Reference | Jeongwon Ji (2013) BioElectric <https://www.dezeen.com/2013/07/01/bioelectric-plastic-made-of-crab-shells-by-jeongwon-ji/> |
| See also | Basics Mold Making (n.d.) Smooth-on <https://www.smooth-on.com/howto/basics-mold-making/> and How to Make Molds (n.d) Instructables: <https://www.instructables.com/How-to-make-molds> |
| Ideas for image | umaking-mold2.png caption: BioElectric by Jeongwon Ji (2013) |

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| **title** | **Mono-material connections** |
| Short description | Designing interlocking connections – or how you can construct by connecting a material to itself - is a useful design strategy to create objects made from *mono-materials*. |
| tasks | **Select a material**  Select the material you want to design a connection for. Not all connections are transferable to other materials, so choose first, design after.  **Paper prototyping**  Prototype your material connections by drawing and making paper prototypes using scissors.  **Testing**  Test your paper prototypes with more accuracy. Design them in a vector drawing software and cut them with a laser cutter.  **Play & iterate**  Play with your modules, experiment with the kinds of shapes and structures you can make with them. Iterate on their design as new ideas come up. |
| when/why/note/output/next | **Why**  Many waste materials (e.g. leather offcuts) often come in small pieces, and making your own materials will initially happen on smaller scale before scaling up in size. Moreover, materials are easier to recycle when they are made of one single materials or *mono-materials.*  **When**  When you want to design products that don’t need to be deconstructed to be recycled. When you decide to work with a material feedstock that typically comes in small pieces.  **Next**  Translate your interlocking connection mechanism into a generative design. Using parametric design tools, you can make your modules *adaptive*, expanding their potential for creating complex 3D shapes, rather than only flat materials. |
| References | Zoe Romano (2019) *Circular Open-Source Fashion*, for Fabricademy. <https://class.textile-academy.org/classes/2019-20/week03/>and <https://oscircularfashion.com/> |
| See also | Tutorial interlocking tesselation design with Rhino & Grasshopper by Lorenzo Massini (2020) <https://youtu.be/Nb_lfpgM9WU> |
| Ideas for image | monomaterial.png |

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| --- | --- |
| title | “Semi” fabrication (zelf kijken naar manieren van verwerking, dus manieren om vouwen/persen/rollen etc na de bootsen) |
| Short description | [±30 words, may be extended with an example] |
| tasks |  |
| when/why/note/output/next |  |
| Ideas for image |  |

## Materials science and experience

***Explain*** *cards****:***

* Agar plastic (gum)
* Alginate plastic (gum)
* Carrageenan plastic (gum)
* Starch plastic (starch)
* Milk plastic (casein)
* Gelatine plastic (collagen)
* Mycelium composite (chitin e.a.)
* Fruit leather (pectin)
* Microbial leather (cellulose)
* Fish leather (collagen)
* Flower paper (cellulose)
* Onion skin pigment extraction
* Madder pigment extraction
* Oak gall tannin & pigment extraction
* Fungal dye (sulphur tuft)
* DIY pH paper
* DIY iron acetate
* Scouring and mordanting wool fibres
* Scouring and mordanting silk fibres
* Scouring and mordanting cellulose fibres

***Explore*** cards:

* What is a raw material? (Shit/Dust/Poo articles, materials and resources, waste streams)
* What is a material property? (develop a shared vocabulary)
* What is a material experience> (MDD)
* How do you test a material property? (DIY protocol material testing)
* Biopolymers and bioplastics – morphology/functions of ingredients
* Additives and biocomposites
* Microbial dyes (bacteria & microalgae)
* Dyes, inks and pigments

***Extend*** cards:

* Material Objects (Zoe Laughlin)
* Better Together (combining polymers)
* Lightfastness test, temporality of dyes

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| --- | --- |
| Title | **Agar bioplastic** |
| Subtitle | Agar is a gum polysaccharide found in red algae |
| Short description | Agar, carrageenan, and alginate are *gum polysaccharides*. As food-safe biopolymers they are used widely in the food industry as thickeners and stabilizers but they also have good film-forming qualities. |
| tasks | **Weigh the ingredients**  Bring water up to 80 degrees C  Add glycerine and agar, stir gently to avoid bubbles  **Allow mixture to thicken**  Keep the temperature around 80C  Stir gently throughout for 30 mins  Allow water to evaporate until liquid is like light syrup  **Cast the bioplastic**  Cast the bioplastic slowly in the center of the mold  Allow to dry for a week without touching  **Release the bioplastic**  Check that the plastic no longer feels cold to the touch  Gently peel it off the surface |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  5 g Agar, 15 g Glycerine, 250 g Water  **Tools**  Scale, pot, stove, spoon, wide mold or casting surface  **Reference**  Biofabricating Materials lecture notes, by Cecilia Raspanti, Fabricademy 2019: https://class.textile-academy.org/classes/2019-20/week05A/  **See also**  Alginate bioplastic  Carrageenan bioplastic |
| Ideas for image | Agar.jpg |

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| --- | --- |
| Title | **Alginate bioplastic** |
| Subtitle | Alginate is a gum polysaccharide found in brown algae. |
| Short description | Agar, carrageenan, and alginate are *gum polysaccharides*. As food-safe biopolymers they are used widely in the food industry as thickeners and stabilizers but they also have good film-forming qualities. |
| tasks | **Prepare the bioplastic mixture**  Weigh the ingredients  Put the glycerine and half of the water in a blender  Turn on the blender, sprinkle in the sodium alginate  When the paste is homogenous, add the remaining water  Leave the mixture overnight in a closed jar  **Prepare the cross-linker**  Put the calcium chloride in a glass jar  Add 100 g hot water and stir to dissolve  Allow to cool and transfer to spray bottle  **Cast the bioplastic**  Cast the bioplastic slowly in the center of the mold  Spray generously with calcium chloride solution  Allow to dry until no longer cold to the touch  **Releasing the bioplastic**  Gently peel off the casting surface |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  For the bioplastic: 10 g Sodium Alginate, 20 g Glycerine, 200 g Water.  For the cross-linker: 10 g Calcium Chloride, an additional 100g water.  **Tools**  Scale, blender, spray bottle, glass jar, casting surface  **Reference**  Biofabricating Materials lecture notes, by Cecilia Raspanti, Fabricademy 2019: https://class.textile-academy.org/classes/2019-20/week05A/  **See also**  Agar bioplastic  Carrageenan bioplastic |
| Ideas for image | Alginate\_film.jpg |

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| --- | --- |
| Title | **Carrageenan bioplastic** |
| Subtitle | Carrageenan is a gum polysaccharide found in red seaweed. |
| Short description | Agar, carrageenan, and alginate are *gum polysaccharides*. As food-safe biopolymers they are used widely in the food industry as thickeners and stabilizers but they also have good film-forming qualities. |
| tasks | **Weigh the ingredients**  Bring water up to 80 degrees C  Add glycerine and carrageenan, stir gently to avoid bubbles  **Allow mixture to thicken**  Keep the temperature around 80C  Stir gently throughout for 30 mins  Allow water to evaporate until liquid is like light syrup  **Cast the bioplastic**  Cast the bioplastic slowly in the center of the mold  Allow to dry for a week without touching  **Release the bioplastic**  Check that the plastic no longer feels cold to the touch  Gently peel it off the surface |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  16 g carrageenan kappa, 3 g glycerine, 350 g water  **Tools**  Scale, pot, cooker, spoon, casting surface  **Reference**  Lugae Valenti, Making Carrageenan 2021: https://vimeo.com/386012184  **See also**  Agar bioplastic  Carrageenan bioplastic |
| Ideas for image | Not yet |

|  |  |
| --- | --- |
| Title | **Gelatin bioplastic** |
| Subtitle | Gelatin is hydrolized *collagen*: a protein found in cartilage, bone and skin of animals, which is a biopolymer. |
| Short description | Gelatin or hydrolized collagen and is found in cartilage, bone and skin of animals. It is used as a gelling agent in food, medicine and microbiology, and is used in photography and paper sizing. |
| tasks | **Weigh the ingredients**  Bring water up to 80 degrees C  Add glycerine and gelatine, stir gently to avoid bubbles  **Allow mixture to thicken**  Keep the temperature around 80C  Stir gently throughout for 10-20 mins  Allow water to evaporate until liquid is like a thick syrup  **Cast the bioplastic**  Cast the bioplastic slowly in the center of the mold  When solidified: release from the mold  Allow to dry fully for a week |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  50 g gelatine, 15 g glycerine, 250 g water  **Tools**  Scale, pot, cooker, spoon, casting surface  **Reference**  Biofabricating Materials lecture notes, by Cecilia Raspanti, Fabricademy 2019: https://class.textile-academy.org/classes/2019-20/week05A/  **See also**  Agar bioplastic  Carrageenan bioplastic |
| Ideas for image | Gelatine.jpg |

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| Title | **Mycelium-hemp composite** |
| Subtitle | Composite of hemp fibres, *chitin* and other polymers |
| Short description | Mycelium is the vegetative part of the mushroom, and consists of several biopolymers such as chitin, cellulose and proteins. |
| tasks | **Clean all tools and surfaces with 70% alcohol**  **Prepare the composite mix**  Wear gloves and open the bag with clean scissors  Add the GIY mix to the bowl and mix in the flour  Crumble up all the lumps with your hands until even  **Prepare the mold**  Desinfect the mold with alcohol  Distribute the mycelium-hemp mix  Cover the mold with cling film  Punch small holes every 3 cm with a clean scalpel  **Let it grow**  Put the mix in a dark place at 20-25 degrees C  Allow the mycelium to colonize the substrate for 3-5 days  When it is completely white, carefully take it out  **Dry the composite**  Dry the composite for 2-3 hours at 40 degrees C  Keep the door of the oven open to allow moisture to escape  Bake for another 2 hours at 80 degrees until light and firm |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  GIY kit from grown.bio, plain flour (30g per kg grow kit)  **Tools**  Scale, 70% alcohol, scissors, large bowl, scalpel, cling film, latex or nitrile gloves, molds  **Reference**  Grow-It-Yourself kit via Grown.bio https://www.grown.bio ​  **See also**  Kick-start your Mycoculture by Fabtextiles https://issuu.com/nat\_arc/docs/myceliumfabtextiles |
| Ideas for image | Mycelium\_composite.jpg |

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| Title | **Onion skin pigment extraction** |
| Subtitle | Plant-based pigment extracted from onion skins |
| Short description | The outer skins of onions contain a pigment called pelargonidin that can be used to create a medium light fast textile dye. |
| tasks | **Separate yellow and red onion skins**  Yellow onion skins create a yellow/gold/orange hue  Red onion skins create a greens and greenish yellow  Pre-wet the mordanted fibre by putting them in water  **Cover the onion skins with water and bring to the boil**  Extract the pigment by letting it simmer for 30-60 minutes  Allow to cool to 30 degrees C  **Dyeing**  Add the pre-wetted mordanted fibres  Slowly reheat, keep temperature below 80 degrees C  Dye for 1 hour, turn off the heat and leave overnight  **Rinsing and modifying**  Rinse the fibres until the water runs clear, squeeze out excess  Cut the fibre into 4 parts. Dip one in a jar of vinegar, dip one in a soda solution (PH9-10), and dip the last one in an iron sulphate solution to shift the colors.  **Re-use or store the dye**  add new fibres to the exhaust bath, evaporate more water and add a binder such as Arabic gum to create an ink, or create a lake pigment e.g. <https://rebeccadesnos.com/blogs/journal/making-lake-pigments> |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  10-20 g Onion skins (red and yellow onions separated), 20g mordanted natural fibres, water, PH modifiers (soda solution, vinegar), iron modifier, cloves or clove oil.  **Tools**  Cooker, pot, spoon, scale, strainer, glass jar  **Reference**  ​https://class.textile-academy.org/classes/2019-20/week04/  **See also**  Joy Boutrup & Catherine Ellis (2019) The Art & Science of Natural Dyes: Principles, Experiments.  Jason Logan (2018) Make Ink: A Forager’s Guide to Natural Inkmaking. |
| Ideas for image | Onion.jpg |

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| Title | **Starch bioplastic** |
| Subtitle | Starch or amylum is a *polysaccharide* (or polymeric carbohydrate) produced by plants for energy storage. |
| Short description | In industry, (modified) starches are used to manufacture bioplastics, alcohol and biofuel, as thickener for e.g. sauces. Non-food applications include stiffening textiles, adhesives and papermaking. Because native starch has poor processing and mechanical properties, gelatin is added here. |
| tasks | **Prepare the gelatine mix**  Weigh the ingredients  Bring water to the boil, add the glycerine and gelatine  Keep temperature below 80 degrees C  Stir slowly until gelatine is fully dissolved  **Prepare the starch mix**  Put starch in a bowl and dissolve with 2 tbsp hot water  Add the mixture to the gelatine mix and stir slowly  **Casting and drying**  When it thickens but is still liquid, cast on surface  Quickly spread out with spatula if needed  Allow to dry at room temperature near an open window |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  50 g potato starch, 50 g gelatin powder, 100 g glycerine, 100 g water, 15 g vinegar  **Tools**  Cooker, pot, scale, spoon, casting surface  **Reference**  ​Starch-based rubber by Loes Bogers (2020) <https://class.textile-academy.org/2020/loes.bogers/files/recipes/biorubber/>  **See also**  The Bioplastics Cookbook: A Catalogue of Bioplastics Recipes by Margaret Dunne for Fabtextiles (2018) <https://issuu.com/nat_arc/docs/bioplastic_cook_book_3> |
| Ideas for image | starch\_rubber.jpg |

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| Title | **Milk composite** |
| Subtitle | Mammal milk contains a protein called *casein*, which is a biopolymer |
| Short description | Casein was first patented in 1899 and was used to copy horn. It was commonly used for small items such as buttons, cutlery handles and knitting needles. |
| tasks | **Preparing the casein**  Heat up the milk and add the vinegar, stir  After 1 minute: strain the casein curd from the liquid  Put in the blender and blend with glycerine  Press into mould and dehydrate fully  **Making the composite**  Wear a mask to protect airways from small particles  Grate the dried casein plastic into a fine powder  Dissolve the calcium hydroxide in hot water  Dissolve the calcium carbonate in the vinegar  Mix both with the calcium carbonate  **Casting and drying**  Cast into a mould and press for 1 hour  Dehydrate at 50 degrees C in the oven for at least 4 hrs  Allow to air dry until fully dehydrated. |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  65 g calcium carbonate or finely ground egg shells, 25 g calcium hydroxide, 8 g glycerine, 800 g low fat milk, 30 g white vinegar  **Tools**  Face mask, scale, bowls, grater, oven, cooker, pots, blender  **Reference**  ​William Christmas (1924) Casein Plastic Composite patent <https://bit.ly/3C7rdYF>  **See also**  Tessa Silva (2016) Chalk & Cheese, and Protein project: https://www.tessasilva.com/chalk-cheese |
| Ideas for image | milk\_composite.jpg |

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| Title | **Fruit leather** |
| Subtitle | Most fruits contain the biopolymer *pectin*, a polysaccharide |
| Short description | Fruit leather was originally conceived of as a way to preserve fruit to be eaten as a snack. To make fruit leather, overripe fruit is best, used with skin and all. Unsold market fruits are a big waste stream in the Netherlands. |
| tasks | **Prepare the mixture**  Cut the mango in smaller pieces and puree with blender  Put the puree in a pot with some water  Keep at low heat for 30 minutes while stirring to kill bacteria  **Cook the mixture**  Dissolve the starch in a dash of cold water  Add to the hot mango mixture and stir  Cast the paste into the mould  **Drying**  Heat the oven to 40-50 degrees C  Dry the sheet for 16 hours in the oven  Peel off the sheet and flip to dry the other side  Allow to airdry for another 5-7 days |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  1 overripe mango with skin, 10 g potato starch, 8 g vinegar  **Tools**  Blender, walled mould, cooker, pan, spoon, scale, oven  **Reference**  ​Beatriz Sandini (2018) Ephemeral Fashion Lab: <https://class.textile-academy.org/2020/beatriz.sandini/projects/final-project/>  **See also**  Fruit Leather, Rotterdam: https://fruitleather.nl/ |
| Ideas for image | fruitleather.jpg |

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| Title | **Microbial leather** |
| Subtitle | Kombucha culture contains *Acetobacter Xylinum*, a bacteria that produces pure *nanocellulose* as it ferments sugars. |
| Short description | Kombucha is a fermented tea drink that can be made with living culture called a SCOBY: symbiotic culture of bacteria and yeast. By building up this culture, you can create a small cellulose factory. |
| tasks | **Prepare your work area**  Clean and disinfect your work area and wash all tools with very hot water and soap. Rinse off the soap well  **Brew the sugary tea**  Brew 400 ml of tea, add the sugar and stir to dissolve  Allow to cool to 30 degrees C  Strain the tea and catch the liquid in the clean glass jar  **Add the living culture**  Add the kombucha culture form the starter pack (both the liquid SCOBY and the pellicle).  Add white vinegar until pH of the liquid reaches pH6  Cover the jar with a coffee filter or piece of clean t-shirt, and wrap a rubber band around it. The filter allows for oxygen to come through but keeps bugs out.  Allow the culture to go in a warm spot away from sunlight  **Wait 3-4 weeks**  Check for every few days for contamination, without moving the pot or the filter.  If the culture is contaminated (see link below), discard!  You should see a white or translucent pellicle growing on the top of the surface after a few weeks.  Wait until the pellicle is 10 mm thick  **Harvesting**  Wash your hands and tools well, take out the pellicle  Prepare a citric acid solution with pH2-3 and soak the pellicle in it overnight, this will make it more supple  Allow it to until fully dehydrated (e.g. oven at 50 degrees C)  **Continuous culturing**  Repeat the process by adding more cold sugary tea to the liquid SCOBY in the jar and wait another few weeks.  Your culture will get stronger and grow faster over time. |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  1x Yaya Kombucha starter pack (contains SCOBY), 4 g green or black tea, 40 g sugar, vinegar, 400 ml water, citric acid  **Tools**  Clean glass 1000 ml jar, dishwashing soap, PH strips, large round coffee filter or old t-shirt, rubber band  **Reference**  ​ Suzanne Lee (2011) Grow Your Own Clothes TedTalk: https://www.ted.com/talks/suzanne\_lee\_grow\_your\_own\_clothes  **See also**  Kombucha Mold! How to Identify Mold vs. No Mold and What to Do Next (n.d.) Kombucha Kamp: https://www.kombuchakamp.com/kombucha-mold-information-and-pictures |
| Ideas for image | kombucha.jpg |

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| Title | **Fish leather** |
| Subtitle | Fish skin is rich in the protein *collagen*, a biopolymer |
| Short description | This treatment with alcohol *denatures* or damages the living cells of the fish skin, to prevent decomposition. Glycerine re-hydrates and plasticizes the skin, making it pliable and stable. |
| tasks | **Clean the skins**  Scrape off fat, meat and membrane with a blunt scraping tool  Wash the skins with cold soapy water and rinse  **Prepare the tanning liquid**  Put the glycerine and alcohol in the jar  Submerge the skins in it and shake vigourously for 1 min  Put a little weight (like a marble) on the skin to keep it down  **Tanning process**  Keep the skins in the jar for 3 days, shake daily for 1 min  Take out the skins, massage and stretch them for 1 hr  Nail them to the wooden board and leave outside to dry |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  Fresh uncooked fish skins, 250 ml denatured 96% alcohol, 250 ml glycerine  **Tools**  Blunt scraping tool, 1000 ml glass jar, dishwashing soap, wooden board, nails, hammer  **Reference**  Fish Skin Tanning from the 6-8th grade Heritage Kit Curriculum, by Chugachmiut Heritage Preservation, Anchorage USA:​<https://chugachheritageak.org/pdf/CLO_6-12%20_FISH_SKIN_TANNING_Final.pdf>  Cecilia Raspanti (2019) Fish skin leather: <https://class.textile-academy.org/classes/2019-20/week05A/>  **See also**  Nienke Hoogvliet (n.d.) Re-Sea Me <https://www.nienkehoogvliet.nl/portfolio/re-seame/> |
| Ideas for image | fish\_leather.jpg |

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| Title | **Flower paper** |
| Subtitle | Plant cells in flower petals – and other parts of green plants - contain *cellulose,* a biopolymer |
| Short description | With this simple technique you can make your own paper. Stems can also be used, but need longer cooking time and result in rougher and thicker paper. |
| tasks | **Prepare the paper slurry**  Pick the flower petals from the bouquet  Cover them with water, add a tsp of soda ash  Bring to the boil and cook for 30 mins or until soft  Strain the flower leaves and pound them in the mortar  Optional: blend them with a blender, but this cuts the fibres and results in a more brittle paper.  **Distribute the slurry**  Scoop the slurry onto the mesh or mould & deckle  Spread out evenly, about 2 mm thick  Carefully submerge in water to help distribute the slurry  **Allow to dry**  Leave to dry for about 2 days  Carefully peel the paper off the mesh  Press under a stack of books or heavy object to keep flat |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  Bouquet of withered flowers, sodium carbonate (soda ash), water  **Tools**  Mortar and pestle, cooker, pot, mould & deckle or a picture frame lined with a fine mesh, strainer  **Reference**  ​ May Babcock for Paper Slurry (2014) Hand-papermaking With Plants: <https://www.paperslurry.com/2014/08/20/hand-papermaking-with-plants-illustrated-infographic/>  **See also**  https://class.textile-academy.org/2020/loes.bogers/files/recipes/flowerpaper |
| Ideas for image | flower\_paper.jpg |

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| Title | **Madder pigment extraction** |
| Subtitle | Like indigo (blue) and weld (yellow), madder is a *Grand Teint*: a classic dyeplant that is color fast and lightfast*.* Madder produces reds, oranges and browns. |
| Short description | Madder came from the roots of *Rubia Tinctorum* plants found in Southern Europe and West-Asia. Madder was brought to the south of the Netherlands and Flanders around 1300 where the clay soil was optimal for madder cultivation. Compared to red pigments coming from the synthetic garancine, madder is less ecologically taxing. |
| tasks | **Soak the roots**  Soak the dried madder roots in water overnight  Blend them with a blender  **Extract the pigment**  Put the roots in the pantyhose and make a knot to close  Put the madder in a pot and cover with water  Optional: adding a tbsp of soda ash and/or calcium carbonate brings out the red tones  Bring up to 60 degrees C, and keep there for 2 hours  Overheating causes pigment to shift to brown  Allow to cool, keep the madder roots for a 2nd extraction  **Use or store the pigment**  Use the pigment solution as a textile dye, or evaporate water on low heat to create a water-based ink, or create a lake pigment for DIY crayons and paints. |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  50 g dried madder roots, water  **Tools**  Pot, thermometer, cooker, spoon, old pantyhose, blender  **Reference**  ​ Joy Boutrup & Catherine Ellis (2019) The Art & Science of Natural Dyes: Principles, Experiments.  **See also**  Onion pigment extraction |
| Ideas for image | madder.jpg |

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| Title | **Oak gall tannin extraction** |
| Subtitle | Oak gall extractions can be used as tannin mordant to prepare textiles for dyeing, and when combined with ferrous acetate creates dark iron gall ink. |
| Short description | Oak galls form when gall wasps inject their larvae into developing buds of the oak tree. An oak gall forms as the larvae undergo metamorphosis into adults. |
| tasks | **Extracting the tannins**  Put the galls in a plastic bag and smash with a hammer  Cover with water and bring to the boil  Simmer for at least an hour to extract the tannins, strain  **Modifying the color**  When tannins are exposed to iron ions (such as DIY iron acetate) the pale yellow/beige color will turn dark gray/purple.  **Uses**  Use the extraction to dye textiles, or use a diluted extraction as tannin mordant to prepare textiles for dyeing. Or evaporate more water to turn it into a water-based ink. |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  100 g oak galls, water, DIY iron acetate  **Tools**  Plastic bag, hammer, cooker, pot,  **Reference**  ​​Joy Boutrup & Catherine Ellis (2019) The Art & Science of Natural Dyes: Principles, Experiments.  Catherine Ellis (2018) Are All Oak Galls Equal? <https://blog.ellistextiles.com/2018/08/06/are-all-oak-galls-equal/>  **See also**  DIY iron acetate (“iron vinegar”) |
| Ideas for image | oak\_gall.jpg |

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| Title | **Fungal dye** |
| Subtitle | Pigment from the toxic Sulphur tuft mushroom or *Hypholoma fasciculare* can be used as wool dye (and glows under a blacklight!) |
| Short description | This mushroom (NL: zwavelkop) is highly abundant in the Netherlands and can be found in groups at the foot of deciduous and conifer trees in parks and forests. |
| tasks | **Find a mycologist to help you identify the right mushrooms**  **Preparing the dye bath**  Clean the mushrooms and break them into smaller pieces  Put the pieces in a wash bag  Put the wash bag in the pot and cover with water  Bring to 80 degrees C and extract the pigment for 1 hr  Allow to cool, then add the wet mordanted wool  Dye the wool at 80 degrees C for 30-60 minutes  **Rinsing and modifying**  Take half the wool out, rinse with warm water  Add a splash of DIY iron acetate to the dye bath and modify the color of the remaining wool.  Take out the wool, rinse with warm water |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  250 g fresh sulphur tuft mushrooms, 25 g mordanted wool, DIY iron acetate  **Tools**  Large pot (non-food only), cooker, wash bag, spoon  **Reference**  ​Miriam Rice (1974) Mushrooms for Color  **See also**  DIY Iron Acetate  That Which Sustains Us: Lessons from the Forest Natural Dyeing with Mushrooms (2020) Museum of Vancouver: <https://youtu.be/o-IXeTI7AwY> |
| Ideas for image | fungaldye.jpg |

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| Title | **DIY pH paper** |
| Subtitle | Extract of red cabbage juice changes color when exposed to solutions of varying acidity (or pH): it is purple when neutral (pH 7-8), turns pink below pH 6, and blue/green from pH9 and up. |
| Short description | The purple color in red cabbage comes from a class of pigment molecules called anthocyanins. The level of acid or alkali (i.e., lower or higher than pH 7) around the molecule changes the color of the anthocyanin. |
| tasks | **Prepare the ink**  Grate the red cabbage  Put in the pot and cover with water  Bring to the boil and simmer for 30 mins  Strain the liquid and put in a spray bottle  Spray the purple liquid to cover the entire filter paper  Allow to dry  **Make a legend**  Boil some water and put in the bowls  Add a pinch of citric acid to one bowl, stir to dissolve  Add a pinch of soda ash to another bowl, stir to dissolve  Dip a piece of paper in each and tweak until you get the following colors: fuchsia pink (pH3-4), pink/purple (pH5-6), blue/purple (pH7-8), blue/green (pH9-10), green (pH 13-14)  Write up a legend and glue the papers to it |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  Half a red cabbage, water, citric acid, soda ash  **Tools**  Food grater, pot, cooker, a clean spray bottle, filter paper or white coffee filters, 4 bowls  **Reference**  Anne Marie Helmenstine (2020) Make Red Cabbage pH paper: <https://www.thoughtco.com/make-red-cabbage-ph-paper-605993>  **See also**  <https://class.textile-academy.org/2020/loes.bogers/files/recipes/phmodifiers> |
| Ideas for image | phpaper.jpg |

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| Title | **DIY iron acetate** |
| Subtitle | DIY iron acetate is also called iron vinegar or iron liquor and can by made by letting white vinegar corrode iron scraps. |
| Short description | It is high in iron ions, which react with tannins found in several natural dyes and foodstuffs. DIY iron acetate shifts colors of tannin rich dyes to greens and grays and increases color fastness of dyes when used as a mordant. |
| tasks | Put the rusty iron nails or the steel wool in the jar  Cover with vinegar  Leave for 1-3 weeks  Wear household gloves before using  Can be used as mordant, dye modifier or wood stain.  Use only small – diluted - amounts, the iron is corrosive to fibres and irritant to eyes and skin. |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  White vinegar, rusty iron nails or a fine steel wool sponge  **Tools**  Large glass jar, house hold gloves  **Reference**  Make Wood Stain (n.d.) <https://www.apieceofrainbow.com/make-wood-stain/>  **See also**  Oak gall tannin extraction  Fungal dye |
| Ideas for image | iron\_nails.png |

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| Title | **Scouring and mordanting wool fibres** |
| Subtitle | Scouring and mordanting wool (protein fibre) to prepare it for textile dyeing with natural dyes. |
| Short description | Scouring is a method of cleaning the fibres. Mordants are typically mineral salts that are applied to natural fibres before dyeing, to improve dye uptake and light and wash fastness. |
| Tasks | **Scouring**  Soak the fibres in water overnight  Dissolve the Eucalan detergent in hot water  Put the wool in a large pot, add the solution and cover with water until the wool can float freely  Bring up to 80 degrees C and keep there for 30 mins  Allow to cool a little and rinse with warm water  **Mordanting**  Measure the alum and cream of tartar, and put in the jar  Add some boiling water and stir to dissolve  Put the fibres in a large pot, add the solution  Cover the fibres with additional water so they float freely  Bring the fibres to 80 degrees C, slowly  Turn off the heat and leave overnight  Squeeze out excess water, rinse lightly  Replenish the mordant bath by adding 50% to re-use |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  100 g wool (dry weight), 1 g eucalan detergent, 15 g alum, 5 g cream of tartar, water  **Tools**  Large pot, cooker, glass jar, scale, spoon, bucket, thermometer  **References**  How to Scour (n.d.) Botanical Colors: <https://botanicalcolors.com/how-to-scour/>  Joy Boutrup Catherine Ellis (2018) The Art & Science of Natrual Dyes: p. 120-121.  **See also**  Scouring and mordanting silk fibres  Scouring and mordanting cellulose |
| Ideas for image | mordanting\_wool.jpg |

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| Title | **Scouring and mordanting silk fibres** |
| Subtitle | Scouring and mordanting silk (protein fibre) to prepare for textile dyeing with natural dyes. |
| Short description | Scouring is a method of cleaning the fibres. Mordants are typically mineral salts that are applied to natural fibres before dyeing, to improve dye uptake and light and wash fastness. |
| Tasks | **Scouring**  Soak the silk in water overnight  Dissolve the detergent in hot water  Put the silk in a large pot, add the solution and soda  Cover with water until the wool can float freely  Bring up to 80 degrees C and keep there for 30 mins  Allow to cool a little and rinse with warm water  Add vinegar to the rinse water and leave for 20 mins  Rinse again, squeeze out excess water  **Mordanting**  Measure the alum, and put in the jar  Add some boiling water and stir to dissolve  Put the fibres in a large pot, add the solution  Cover the fibres with additional water so they float freely  Bring the fibres to 80 degrees C slowly  Turn off the heat and leave overnight  Squeeze out excess water, rinse in hot water  Replenish the mordant bath by adding 50% for re-use |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  100 g silk (dry weight), 1 g sodium carbonate (soda ash), 1 g neutral detergent, 15 g alum, water, 5 g vinegar.  **Tools**  Large pot, cooker, glass jar, scale, spoon, bucket, thermometer  **References**  How to Scour (n.d.) Botanical Colors: <https://botanicalcolors.com/how-to-scour/>  Joy Boutrup Catherine Ellis (2018) The Art & Science of Natrual Dyes: p. 124.  **See also**  Scouring and mordanting wool fibres  Scouring and mordanting cellulose fibres |
| Ideas for image | mordanting\_silks.jpg |

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| Title | **Dyeing cellulose fibres** |
| Subtitle | Scouring, mordanting and dyeing cellulose fibres (linen, cotton, hemp, ramie) |
| Short description | Scouring is a method of cleaning the fibres. Cellulose mordants typically start with application of tannins followed by mordanting with mineral salts before dyeing, to improve dye uptake and light and wash fastness. |
| tasks | **Scouring**  Fill a large pot with warm water  Add and dissolve 1 g detergent and 1 g soda ash  Measure pH, add soda until it reaches pH8-9  Add fibres and cover with water, fibres should move freely  Heat to 100 degrees C (boil), keep there for 1-2 hours  Move the textiles regularly  Allow to cool in the mordant bath, then rinse well  **Application of tannins**  Fill a large (30L) pot with hot water (50 degrees C)  Add the tannin powder and stir until dissolved.  Add the fibres and soak for 2 hrs. Do not heat the bath.  Remove fibre, squeeze out wearing gloves  While still damp: proceed to alum mordant  **Alum mordanting**  Dissolve the alum in boiling water, allow to cool  Dissolve the soda in boiling water, allow to cool  Combine the alum and soda solution, while stirring  Add enough warm water (50 degrees C) to immerse fibres  Place moist tannin-treated fibres in mordant, soak for 2 hours  Stir occasionally, then take out wearing gloves  Squeeze our excess mordant and rinse well. |
| \*ingredients  \*tools \*reference \*see also | **Ingredients**  100 g cellulose fibres, 1 g soda ash and 1 g detergent for scouring, 10 g oak gall extract OR: 30 g ground oak galls, 12 g alum and 1.5 g soda ash for mordanting.  **Tools**  Large pot, cooker, glass jar, scale, spoon, bucket, pH paper, rubber gloves  **References**  How to Scour (n.d.) Botanical Colors: <https://botanicalcolors.com/how-to-scour/>  Joy Boutrup Catherine Ellis (2018) The Art & Science of Natrual Dyes: p. 117, 127, 132.  **See also**  Scouring and mordanting silk fibres  Scouring and mordanting wool fibres |
| Ideas for image | mordanting\_cellulose.jpg |

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| title | **Matter | Material | Materiality** |
| Short description | [±30 words, may be extended with an example] |
| tasks | Matter, material and materiality  How are these terms defined in different contexts?  Which terms are used to signify their opposites?  Looking at these oppositions, is one typically considered to be better or more highly valued than the other?  A dictionary  An etymological dictionary  Fine arts  Sciences (physics and chemistry)  Material science  Theology ()  Philosophy (Manuel Kant, Hegel, Martin Heidegger, Vilem Flusser,)  Engineering ()  Design (Michael Ashby & Kara Johnson, Marc Esslinger, Chris Lefteri)  Marxism (Karl Marx, Raymond Williams)  Media theory (Roland Barthes, Friedrich Kittler, Marshall McLuhan)  🡪 moet nog even over denken. Mss een goede tekst vinden om het aan op te hangen |
| when/why/note/output/next |  |
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| **title** | **What is a material property?** |
| Short description | Material sciences have developed shared vocabularies to describe material properties but are often underpinned by technical material tests and mathematical formulas. Develop a shared vocabulary underpinned by example materials and tactile experiences. |
| tasks | Make duos and assign all property keywords  Research and formulate a one-sentence definition per property in your own words  Find an object that represents a material that would score very low on the scale, and one that represents a high score or even maximum of the scale for that property and one in the middle  Determine words that can express the minimum and maximum of the scale for each property (e.g. for strength: weak to strong)  List interactions with the material that help determine its score on the scale of that property  **Property keywords**  *Strength, hardness, transparency, glossiness, weight, structure, texture, temperature, shape memory, odor, stickiness, weather resistance, acoustic properties, scratch resistance, surface friction, weight, elasticity, ductility, wear resistance, water resistance, heat conductivity, creep, density*  **Class discussion**  Bring your objects to class and reflect on each other’s definitions and “testing” methods.  Assess how well the presented samples represent the range (min/max) of the scale for that property  Suggest better examples of the min/max/middle  **Visualize your shared vocabulary**  Together, make a visual overview of your shared vocabulary of material properties, words used to describe the range, and images of the sample materials that represent different points on the scale for each property. |
| when/why/note/output/next | **Why**  When we document material experiments, it is useful to have words to describe their properties and be specific about the differences between those words (e.g. hardness vs. elasticity vs. stiffness). Calculating a modulus however is demystifying for those without a background in material science. Finding a shared vocabulary based on tactile experience and discussion offers a contextual and embodied approach to defining and comparing materials and their properties within a community of practice.  **Next**  Formalize your vocabulary further by developing DIY testing methods using simple tools that allow for numerical comparison, e.g. <https://www.education.com/science-fair/article/tensile-stregth-fishing-line/> |
| Reference | Properties of Materials Introduction (2018) Science Learning Hub <https://www.sciencelearn.org.nz/resources/2659-properties-of-materials-introduction> |
| See also | List of materials properties, Wikipedia: <https://en.wikipedia.org/wiki/List_of_materials_properties>  Open-Source Universal Test Machine (2019) CNC Kitchen Youtube: <https://youtu.be/uvn-J8CbtzM> |
| Ideas for image | material\_property.jpg |

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| **title** | **What is a material experience?** |
| Short description | The notion of *materials experience* emphasizes the role of materials as being simultaneously technical and experiential. People experience materials in products at four experiential levels, namely sensorial, interpretive, affective and performative. |
| tasks | **Understand the material: technical**  tinker with the material (e.g. make variations on the recipe)| test material’s properties, compare to similar materials | describe opportunities and constraints | explore and describe possible manufacturing processes  **Understand the material: experiential**  Explore how the material is experienced by people using the MA2E4 toolkit. Inquire about their experiences on the *performative*, *sensorial, affective* and *interpretive* level.  **Create a materials experience vision & patterns**  Express how you envision the material’s role in creating functional applications and unique user experiences, in relation to other products, people and wider contexts. See also reference below.  **Designing material/product concepts**  Integrate all findings into 3 product concepts that mobilize the material’s unique properties in a meaningful way. |
| when/why/note/output/next | **Why**  Developing an *experiential characterization* of a material entails investigating of how a material is received, what it makes people think, feel and do. It helps designers mobilize unique material qualities in design processes.  **When**  When you’ve developed one or more interesting materials and want to systematically explore their possible application in real products/objects. |
| Reference | Elvin Karana, Bahareh Barati, Valentina Rognoli & Anouk Zeeuw van der Laan (2015) Material Driven Design (MDD): A Method to Design for Material Experiences. International Journal of Design. |
| See also | Serena Camere & Elvin Karana (2018) MA2E4 Toolkit: Experiential Characterization of Materials: <https://materialsexperiencelab.com/ma2e4-toolkit-experiential-characterization-of-materials> |
| Ideas for image | materials\_experience.jpg  OF  materials\_experience2.png |

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| **title** | **Material-objects** |
| Short description | Making, displaying and using series of *material-objects* can reveal specific aspects of material science in an experiential way. They communicate aspects of the relationship between form, functionality and materiality. |
| tasks | **Select**  Choose a form or object you are interested in exploring (e.g. a spoon, a sheet material)  Choose one or more material recipes you are interested in exploring further  **Make**  Create a series of objects that have the same form, but are made with a different material recipe.  Variations between the recipes can be very small and incremental (e.g. from no glycerine to a lot of glycerine), or substantial (e.g. using to entirely different recipes with different biopolymers).  Document each recipe in detail: weigh the ingredients, record cooking and drying times, measure temperatures etcetera.  **Share**  Allow others to explore the material series and documentation and explore what they’re able to understand about the materials by interacting with the series and comparing the samples.  Contribute the set to your material archive. |
| when/why/note/output/next | **Why**  The strategy of creating *material-objects* has been proposed by Zoe Laughlin (2010) as a way to express the relationship between form, function and materiality by letting the material itself represents the science behind materials in the context of a material library [24]. Laughlin demonstrated this by creating a series of cubes, spoons, bells, and tuning forks identical in form but made of different materials, whose properties can then be experienced and compared.  **When**  Designing a set of material-objects is a method to systematically understand and expand upon a material recipe by making variations on a theme.  **Output**  A set of material samples that are identical in form (the thing), but different in terms of the material (the stuff). Can be contributed to a shared material archive when documented together with recipes. |
| Reference | Zoe Laughlin (2010) How can the Science of Materials be Represented by the Materials Themselves in a Materials Library? <https://doi.org/10.13140/RG.2.2.16034.94405> |
| See also | <http://zoelaughlin.com/research-papers> |
| Ideas for image | material-objects.png |

## Critical Making

***Explain*** *cards****:***

* What is critical making?
* Reframing expectations > good enough/good for whom/good for what
* Open source /open design

***Explore*** cards:

* Reframing perfect/imperfection > (kintsugi etc)
* Waste walk
* More than human collaboration
* Collaborative open-source archiving

***Extend*** cards:

* Define your eco-compatibility principles
* Simultaan readings: 1 topic, 2-4 papers, 2-4 disciplines
* Bioremediation
* Sample management tool

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| title | **What is critical making?** |
| Short description | note the differences between 'critical' understood as merely reflexive and hermeneutic, and  'critical' as defined here and linked to the overt goal 'to liberate human beings from the circumstances  that enslave them'  criticality tends to first delete – or at least put aside – current value propositions associated with technology.  Who benefits?  Pay attention to the variety of naturalized values typically associated with technology and technological development |
| Tasks | Read Ratto & Hertz  Find examples of critical making   * Critical design (question profit and commercialization) * Critical-technical practice (question the value attached to different ways of knowing in technical disciplines) * Reflective design (critical objects that spark reflection in users) * Speculative design (inquiry, experimentation and expression over usability, usefulness or desirability * Ludic design] * Slow design * Design noir |
| why/when/note/output/next |  |
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| title | **A history of design & nature** |
| Short description | Ideas and knowledge are constructed, and come about under the pressures of culture, (geo)politics, economics, and historical legacies of what qualifies as “knowing”. Explore the history of ideas around design & nature. |
| Tasks | 1. Select a biodesign or bioart project that inspires you 2. Read Louise St. Clair’s text 3. Assess whether the project you selected is more aligned with the *mechanistic* or the *organicist* view of ecology (see below). 4. Present your argument in the form of an essay, a diagram, image, poem or other. 5. Take the same topic as your chosen project, and develop an activity taking the opposite approach.   **Mechanistic view of ecology**:  Ecological design as mastery  *Keywords: human-centric (solving human problems), mastery, rationality, economic growth, emotional and intellectual distance, perfection, nature as passive/controlled/mute, colonialism*  **Organicist views of ecology**  Design and nature as experiential exploration  *Keywords: spiritual, philosophical, embodied/physical explorations, ritualistic, humility, interdependence, intimacy, vulnerability, slow design, practices of care, capacity of nature to organize itself, decolonizing* |
| why/when/note/output/next | **Note**  St. Pierre’s text describes how designers throughout history have been searching for ways to design with nature. She organizes them by looking at the way ecology is understood in the different design frameworks since the 1500s.  **Why**  Understanding this old search provides designers, artists, academics with a number of frameworks and spaces to *rehearse, critique* and *learn* to work with nature and position their work. |
| Reference | Louise St. Pierre (2019) “Design and Nature: a History” in: Kate Fletcher, Louise St. Pierre & Mathilda Tham (eds.) Design and Nature: A Partnership: p. 92-108. |
| See also |  |
| Ideas for image | westernideas.JPG |

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| title | **Design to disappear** |
| Short description |  |
| Tasks |  |
| why/when/note/output/next |  |
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| title | **Shit, hair, d(isg)ust** |
| Short description |  |
| Tasks |  |
| why/when/note/output/next |  |
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| title | **Reframing: who benefits?** |
| Short description |  |
| Tasks |  |
| why/when/note/output/next |  |
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| title | **Open design** |
| Short description |  |
| Tasks |  |
| why/when/note/output/next |  |
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| title | **Imperfection/kintsugi** |
| Short description |  |
| Tasks |  |
| why/when/note/output/next |  |
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| title | **Waste walk** |
| Short description | Going on a waste walk helps you explore untapped local waste streams and helps to unlearn our habit of working with virgin materials |
| Tasks | Split up into groups and decide on a location where you will do the waste walk  Walk around the area for 2 hours, and identify any waste streams of biological origin (e.g. natural materials) you encounter. Take a picture of each of them.  Start in your home and expand outwards:   * Start in your kitchen (the fridge, your waste bin, maybe your garden or balcony) * Expand to your neighbourhood, include streets, parks, even shopping streets. * Look at plants and trees and identify which parts they shed and when (e.g. leaves, branches), both naturally and through maintenance (e.g. mowing, pruning) * Go into food shops like fish mongers and cafes to ask about the type of waste they produce a lot of (e.g. coffee waste, stale bread, fish skins, overripe fruit, fruit skins, and so on)   Make a catalogue of all the potentially useful waste streams you identified, and research historical crafts techniques that make use of them. Think of: basket weaving branches, paper-making, fish leather tanning or combining materials into composites. Use the references below for inspiration.  Optional: try out some of the techniques you found if you can |
| why/when/note/output/next | **Why**  Learn to identify unused sources of biomaterials that can be turned into materials of value for artmaking and design.  **When**  Autumn is typically a good season to do waste walks  **Output**  A catalogue of potential local waste streams and their uses |
| Reference | Kate Franklin & Caroline Till (2018) Radical Matter: Rethinking Materials for a Sustainable Future  Seetal Solanki, ed. (2018) Why Materials Matter: Responsible Design for a Better World. |
| Ideas for image | wastewalk.png |

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| title | **Beyond biomimicry: more-than-human-collaborations** |
| Short description | Human-centred design methods led us into the Anthropocene. We need to develop approaches that are more in tune with biological systems. |
| Tasks | Design practice have proven to be destructive to our ecologies. As an antidote, come up with a design process where you collaborate with a living organism. Find an angle that doesn’t merely imitate nature, but aims to enhance ecological performance in the long term.  Refer to the references and examples for background information and inspiration.  Sketch out or realize the system of collaboration and build an argument for why it contributes to the health of our ecosystems. |
| why/when/note/output/next | **Why**  Colloborating with living systems forces you to try to understand the interrelations at work in our ecologies. How can you act within those dynamic processes without playing god?  **Note**  Reflect on the amount of control you exert on the biological processes at work. Could you exert less control in order to give the organism more agency and live its best life? If the organisms could advocate for its needs, what would they be? |
| Reference | Bill Myers (2012) “Beyond Biomimicry” in: Biodesign: Nature, Science, Creativity: p. 10-17. |
| See also | Edhv(2010) *Debug*. Poster designs and chair created in collaboration with ants. <https://www.edhv.nl/design-lab/projects/debug/>  Diana Scherer (ongoing) *Interwoven*: <http://dianascherer.nl/>  TCBL labs & Waag (2016-ongoing) *Bioshades*. Textile-dyeing with bacteria. <https://bioshades.bio/> |
| Ideas for image | morethanhuman.png |

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| title | **Collaborative open-source archiving** |
| Short description | Documenting, archiving and presenting your material explorations together opens up access to a wealth of options you could never explore alone. |
| Tasks | **Discuss the idea of *open-source***  What does it mean? Where does it come from? Could it be applied to making materials? What could be pitfalls? What are the benefits? Do you have any hesitations?  **Decide what system you will use**  Design, or choose a template all materials will be archived with  Make sure there’s a template for small, medium and large samples  Find a place where you can display everyone’s samples safely  Decide on the paper stock (something that fits an office printer)  **Do material experiments**  Keep notes on all material experiments you do: write down details on ingredients, cooking and drying time, references, etc.  **Document and archive**  Collect all your notes and fill out the labels for your samples.  Make sure to list a main reference and state which changes you made to create a new variation (your “contribution to the field”).  **Display**  Trim your materials if needed, and mount them onto the labels  Attach a hang tab or other system to hang them up  Put them in your material archive. |
| why/when/note/output/next | **Why**  Having a large collection of small variations gives you a good feeling for how material recipes can be tweaked to achieve very different results. By having a sample available with a recipe attached, you get a better idea than from a picture or piece of text alone.  **When**  When you find yourself in a group of people who are interested in experimenting with natural design materials, and believe you could learn more from each other than alone.  **Next**  If you want to formalize the process, consider installing software to build your own online/offline archive and sample management tool: <https://samplemanagementtool.org/> |
| Reference | OS Material Archive developed at Textile Lab Amsterdam (2016-ongoing): <https://tcbl.eu/project/os-material-archive> |
| See also | Labels designed by Maria Viftrup for Textile Lab Amsterdam can be downloaded here: <https://bit.ly/3wdJkdb> |
| Ideas for image | collabarchiving.jpg |

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| title | **Define your eco-compatibility principles** |
| Short description | Sustainability is not something absolute that can be measured: it depends on the context a material is applied in, and the life cycle of the object. Shared guidelines help to systematically classify and compare different options. |
| Tasks | **1. Research & define**  Research these terms and define them in 1 or 2 sentences. Try to come to an agreement with your peers on what definition you agree on, so you have a yardstick to assess when these terms apply to a particular material.  **2.** **Suggest ways to research the parameters**  Describe methods to look into each of these for a given material or feedstock.  **Low environmental impact in use:**   * Eco-efficiency (relates to embodied energy & emissions) * Short distribution chain (relates to sourcing of feedstock) * Non-toxicity (relates to toxicity of material when in use) * Renewable resources (relates to time required for resource to replenish itself, e.g. regrow in nature)   **Extension of the useful life of materials:**   * Durability (is the lifespan of material in proportion to lifetime of use of the product it is used for?) * Recyclability (homogeneity of material, and quality of recycled output) * Biodegradability (time and conditions required)   **Ethical production:**   * Is the feedstock or semi-finished product or ingredient manufactured in a responsible way? |
| why/when/note/output/next | **Why**  If a product is to be truly eco-compatible during its life cycle it must minimise, if not eliminate, resource consumption (energy and materials) and emissions (air, water, and solid waste). Lerma, diGiorgi & Allione developed a multi-criteria interpretation system top help designers interpret the environmental performance of design materials in a context-aware way.  **Output**  Shared definitions that work as a yardstick to help you assess when you can make certain claims about a material (e.g. say it is biodegradable).  **Next**  Select and - if necessary - simplify some of the parameters to use them as guidelines in your projects. |
| Reference | Beatrice Lerma, Claudia diGiorgi & Cristina Allione (2013) Design & Materials: Sensory perception sustainability project: p. 103: <https://bit.ly/3BHM9nZ> |
| See also | Here’s an adaptation used for a material archive: <https://samplemanagementtool.org/#/about> |
| Ideas for image | eco-compatibility.png |

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| title | **Cross-disciplinary reading** |
| Short description | To understand any topic holistically, it can be enlightening to read texts expressing very different perspectives on an area. What can different disciplinary lenses show you? |
| Tasks | In this example you study the topic of fungal reproduction through three disciplinary lenses: DIY biology, anthropology and material science. All texts talk about the potential of mycelium, but they do so in very different ways. Describe the framing implicit in these texts, and discuss the extent to which they differ and overlap.  Reading questions to try answer together:   * Who are they writing for? * What prior knowledge is implied? * What is the scope of their respective studies of these fungal systems? * Finish this sentence: *“Author …[insert name]… studies the fungal systems by…..[activity]…. In doing so, the author wants to understand the ….. and ….. of …… fungi and what this means/what are the possibilities for …..* |
| why/when/note/output/next | **When**  When you are about to embark on a journey at the intersection of disciplines.  **Why**  Get an understanding of the different lenses different disciplines take, and what each of them allows us to see. |
| Reference | McCoy, Peter. “Chapter 8: Working With Fungi” in: Radical Mycology: A Treatise on Seeing and Working with Fungi. Portland: Chthaeus Press, 2016 (1985): pp. 201-223 or beyond.  Anna Lowenhaupt Tsing (2015) “Interlude: Tracking” in: The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins: p. 136-144.  Haneef, Muhammad et.al. “Advanced Materials From Fungal Mycelium: Fabrication and Tuning of Physical Properties” Scientific Reports, (7), 2017: pp. 1-11. |
| Ideas for image | crossdisciplinaryreading.jpg (Wikimedia,Tobi Kellner 2012) |

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| title | **Bioremediation** |
| Short description |  |
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| title | **Install a sample management tool** |
| Short description | When you want to maintain a material archive for longer, it can help to invest energy in setting up sample management software that helps you organise your samples and generate printable labels. |
| Tasks | Contact your systems administrator (or find one)  Ask them if they are able to install the software below on your server  Decide who you want to make admins  Update the logo to your organisation’s logo  Add users and explore together how the tool works  Negotiate things that are unclear or unusful to you  Read the about page for more info: <https://samplemanagementtool.org/#/about>  Start archiving your material samples! |
| why/when/note/output/next | **Why**  The Sample Management Tool is a label generator and database to support creative communities in documenting and sharing material experiments. It was designed around the idea of collaboratively building an archive of alternative design materials with an emphasis on materials that are easily renewable, reusable, (home) compostable within 90 days, locally abundant and make use of local waste streams.  **When**  After you have done some experimenting and want to commit to material experimentation for a bit longer. Is designed for use in university and art school courses to help teachers and students showcase material experiments in shared studios, to learn from and get inspiration. |
| Reference | Software: <https://github.com/Koziad/visualm-5>  Example of tool in use: <https://samplemanagementtool.org> |
| See also | This tool was developed based on the OS Material Archive, a project developed at Textile Lab Amsterdam by Cecilia Raspanti: <https://tcbl.eu/project/os-material-archive> |
| Ideas for image | install\_sample\_tool.png |

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