MICROBES, FUNGI, YEAST

AND OTHER ORGANISMS

XXX

SEE ALSO: xx

EST. TIME:

MICROBES, FUNGI, YEAST

INGREDIENTS
XX

TOOLS
XX

TASKS

XX

- XX

REFERENCE: XX

BIOLAB RULES

PRACTICING MICROBIOLOGY SAFELY

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.

SEE ALSO: Handwash experiment

EST. TIME:

BIOLAB RULES

WHY

Learn why lab rules exist, and what Good Microbiological Laboratory Practice entails. 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.

TASKS

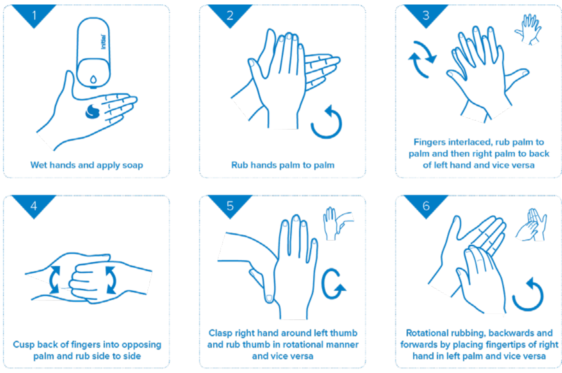
Study *Basic Practical Microbiology: A Manual* in preparation for class and design a poster visualizing the biolab rules:

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

REFERENCE: Basic Practical Microbiology: A Manual (2016) Microbiology Society: https://microbiologysociety.org/publication/education-outreach-resources/basic-practical-microbiology-a-manual.html

HANDWASH EXPERIMENT

CCC



XXX

SEE ALSO: Biolab rules

EST. TIME:

HANDWASH EXPERIMENT

WHY
Learn why lab rules exist, and what Good Microbiological Laboratory Practice entails, practice with a hands-on experiment.

WHEN
This is a good introductory activity to familiarize students with key concepts, tools and rules in a biolab, before starting any investigations.

TASKS

Study ***Basic Practical Microbiology: A 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

REFERENCE: Basic Practical Microbiology: A Manual (2016) Microbiology Society: https://microbiologysociety.org/publication/education-outreach-resources/basic-practical-microbiology-a-manual.html

BIOSAFETY LEVELS

OR: CONTAINMENT LEVELS

Kelsey Chisamore, The Noun Project.

TO MAKE SURE THAT MICROBIOLOGY EXPERIMENTS STAY SAFE AND THAT THE WORK ENVI-RONMENT IS HEALTHY, BY FAMILIA-RIZING YOURSELF WITH BIOSAFETY LEVELS.

SEE ALSO:Starting a community lab

EST. TIME:

BIOSAFETY LEVELS

WHY
Starting to understand how required levels of cleanliness and containment depend on a num-ber of interrelated factors (skill level, protocol and use, volume of culture) enables you to critically assess risks and possibilities.

WHEN
After you have done some text-book experiments, and are star-ting to wonder and ideate what else might be possible.

TASKS

Discussion prompt 1:
Read ***Basic Practical Microbiology: A Manual*** and discuss the importan-ce of ***biosafety levels*** or ***levels of containment***. What is the difference with the school levels discussed in the manual? Why do you think they address those specifically?

Discussion prompt 2:
Find out under which biosafetylevel each of these organisms is typically classified (may differ per strain!). Discuss whether you would consider using these
organisms in a school biology setting: why/why not?

Pleurotus ostreatus | Serratia Marcescens | Janthinobacterium lividum | Komagataeibacter Xylinus

Discussion prompt 3:
Why is working in the lab with ***Pleurotus ostreatus*** to make materials different from growing grey oysters in your kitchen and different from eating store-bought grey oysters to use for dinner? Why can you eat the mushrooms that you grow in your kitchen (see also Rotterzwam grow-kits), but you cannot eat mushrooms you grow in a lab where you are also experimenting with other organisms?

REFERENCE: Microbiology Society (2016) Basic Practical Microbio-logy: a Manual: https://microbiologysociety.org/publication/educati-on-outreach-resources/basic-practical-microbiology-a-manual.html

SET UP A COMMUNITY LAB

CREATE AN OPEN-ACCESS LABORATORY FACILITY

SAFE PRACTICE IN MICROBIOLOGY REQUIRES A DESIGNATED, LIMITED ACCESS SPACE AND TRAINING. A PROPER ENVIRONMENT PREVENTS CONTAMINATION AND HEALTH HAZARDS. THIS CARDS CONTAINS POINTERS TO GET INFORMED BEFORE DOING PRACTICAL WORK.

SEE ALSO: Biolab rules, Biosafety

EST. TIME:

SET UP A COMMUNITY LAB

WHY

Establishing a shared foundation for biosafety and security practices is key when you are considering to set up a community lab in your institution or community. Familiarizing yourself with resources to do so enables you to conduct safe lab practices with non-biologists.

WHEN

When you want to create an open-access laboratory facility that supports non-biologists such as artists and designers to explore microbiology in a hands-on way.

TASKS

- Study *Basic Practical Microbiology: A Manual* thoroughly with your team (see reference)
- Consult someone with experience as lab technician over seeing practical microbiology work in high schools.
- Find a biosafety advisor who can help with risk assessments
- Find suppliers of high school lab materials (e.g. Eurofysica, Carolina)
- Learn aseptic technique and Good Microbiological Laboratory Practice (GMLP) by getting training from an expert
- Write step-by-step protocols defining the acceptable experi ments in your lab, review protocols and changes in the future with an expert

REFERENCE: Microbiology Society (2016) Basic Practical Microbiology: a Manual: https://microbiologysociety.org/publication/education-outreach-resources/basic-practical-microbiology-a-manual.html

LEVELS OF CLEAN AND DIRTY

WHAT IS WASTE?

HUMAN AND BIOLOGICAL WASTE ARE ABUNDANT, SUSTAINABLE FEEDSTOCKS FOR MATERIAL-MAKING. NEGATIVE CONNOTATIONS AROUND SHIT, HAIR AND DUST HOWEVER AND OUR PERCEPTIONS OF BEAUTY NEED TO SHIFT FOR THESE MATERIALS TO BECOME ACCEPTABLE (AGAIN).

SEE ALSO: XX

EST. TIME:

LEVELS OF CLEAN AND DIRTY

WHY

Reappropriating waste materials to create art and design objects asks us to reconsider our own and others' ideas about dirt and cleanliness, and about waste and newness.

WHEN

After you have tried out some biomaterial recipes and realize that making materials out of food grade ingredients might be unnecessary and unsustainable, and want to start looking elsewhere.

TASKS

Study the projects listed below:

- Merdacotta & the Shit Museum (2015-ongoing) by Gianantonio Locatelli & Luca Cipelletti: http://www.theshitmuseum.org/prodotti/ and https://materialdistrict.com/material/merdacotta/
- The New Age of Trichology (2016-ongoing) by Sanne Visser: https://sannevisser.com/The-New-Age-of-Trichology
- How Dust This Feel? (2015) by Matilda Beckman: https://www.dezeen.com/2015/02/06/matilda-beckman-furniture-made-from-dust-stockholm-2015/

Discuss the following questions:

- Which ideas, beliefs, and value systems are in place regarding the materials these artists and designers work with?
- Which strategies do the makers use to shift our perspective towards these materials?
- Are they successful in shifting your perspective on waste? And/or why not?

Find a material in your environment that is typically considered dirty or disgusting but could have interesting qualities to work with. Develop a strategy that helps shift peoples' perspective on and connotations with that material.

REFERENCE: Kate Franklin & Caroline Till (2018) "Shit, Hair, Dust" in: Radical Matter: Rethinking Materials for a Sustainable Future: p. 75-107.

BIOLAB ETIQUETTE

VVV

LEARN THESE RULES BY HEART AND REMIND EACH OTHER TO STICK BY THEM ENSURES SAFES PRACTICE IN YOUR BIOLAB.

SEE ALSO: VV

EST. TIME:

BIOLAB ETIQUETTE

WHY
Good Microbiological Laboratory Practice (GMLP) is one of the main ways to ensure safe practice when working with microorganisms.

WHEN
Before starting any practical microbiological work.

TASKS

Study ***Basic Practical Microbiology: A Manual*** (see reference) to understand the importance for Good Microbiological Laboratory Practice (GMLP). Design a poster together, listing all the rules, to make them visible in your shared lab space:

- You are responsible for reporting spills or damage immediately to a lab technician.
- Only do work you are trained and instructed to do. When in doubt: ask!
- No eating, drinking or hand-to-face contact: may cause accidental ingestion of hazardous materials or culture.
- Label everything, always: so other people are aware of their contents (date, name, organism, growth medium)
- Handwashing: before microbiological work to avoid contami nating your experiments with unknown organisms, and after to ensure no living cultures accidentally leave the lab on your hands. Wear a lab coat when in the lab.
- Never leave open flames or running pressure cookers: they are potential fire hazards and need to be monitored, always
- Dispose of waste properly: all living cultures and materials that have been in contact with living cultures need to be steam autoclaved before disposal.
- Keep personal items (notebooks, phones, laptops, coats) outside the lab and at all times away from the lab bench.
- You are not allowed to take any living cultures from the or bring in living cultures without permission from a technician.

REFERENCE: Basic Practical Microbiology: A Manual (2016) Microbiology Society: https://microbiologysociety.org/publication/education-outreach-resources/basic-practical-microbiology-a-manual.html

LAB DESIGN

RECOMMENDATIONS FOR DESIGNING A BIOLAB

WHETHER SETTING UP A SPACE FOR THE FIRST TIME, OR MOVING TO A NEW SPACE, CONSIDER THE FOLLOWING LIST OF RECOMMENDATIONS FOR MATERIALS TO USE, AND THE INFRASTRUCTURE REQUIRED TO HANDLE THEM WHEN DESIGNING A BIOLAB.

SEE ALSO: cc

EST. TIME:

LAB DESIGN

INGREDIENTS
Vcv

TOOLS
ssdd

CONSIDERATIONS

- Walls and floors should be smooth, impermeable to liquids and easy to clean. No carpets or flammable materials.
- Benchtops should be impermeable to liquids including disinfects, and chemicals. Benchtops should be scratch-resistant and have no open seams.
- Sink for handwashing, dishwashing and disposal of non-toxic and non-hazardous liquids should be provided.
- Lab furniture such as chairs and stools should be non-porous and easily cleaned (e.g. vinyl, hard plastic, rubber)
- PPE storage such as lab coats should be available upon entry. Lab coats need to be separated, not stacked.
- Personal storage space non-lab items need to be stored outside the lab (e.g. coat racks, closets, lockers).
- Office space is separate from labspace. Demarcate space for eating, drinking and office work
- Fire safety equipment and smoke detectors are often legally required. Fire extinguishers should use carbon dioxide or dry chemical type A-B-C extinguishers.
- Ventilation ideally provides inward airflow without circulation. If mechanical ventilation is not possible, install screens to prevent insects from entering through windows.

REFERENCE: Angela Armendariz, Patrik D'haeseleer and others (ongoing) "Lab Infrastructure & Design" in: Community Biology Biosafety Handbook: https://bit.ly/3k9Tkz9

MORPHOLOGY OF TOOLS

SUBSTITUTING EQUIPMENT WITH EVERYDAY ITEMS

MANY PEOPLE IN THE DIY BIOLOGY REALM HAVE CONSIDERED WAYS TO MAKE MICROBIOLOGICAL WORK MORE ACCESSIBLE BY FINDING ALTERNATIVES TO EXPENSIVE SPECIALIST EQUIPMENT. SOME TOOLS AND MATERIALS CAN BE SUBSTITUTED.

SEE ALSO:VVV

EST. TIME:

MORPHOLOGY OF TOOLS

GLASSWARE

You might find that lab grade glassware such as glass bottles can get expensive. Sterilizing media can also be done in glass jam and yogurt jars with a lid. Glass is used because it can withstand the heat of an autoclave (121 degrees C), polypropylene (PP5) plastic, often used in the production of food containers, is also autoclavable.

GAS EXCHANGE

Many microorganisms are aerobic, which means they require fresh air to grow. Others release gases, which can build up in a plate or jar. Parafilm is commonly used to ensure gas exchange while providing a barrier for contaminants. Syringe filters, synthetic filter disks (Tyvek) or synthetic wool (e.g. Polyfill, or non-absorbent cotton wool) can be used to plug a little air vent drilled into the lid of your jar or bottle.

STEAM AUTOCLAVE

Pressure cooker pans are used in many schools as an alternative. Use of autoclave tape is recommended. For steam sterilization to occur, the entire item must completely reach and maintain 121°C for 15–20 minutes with steam exposure at 15 PSI (longer for higher volumes).

INCUBATOR

Make your own using instructions from the Biohack Academy program, or look for incubators used to hatch reptile eggs.

AUTOCLAVEABLE WASTE BAGS

Invest in different sizes as they can also function as a container for incubated cultures, when closed with rubber band and plugged with a material that serves as gas exchange material (see above).

SEE ALSO:

- https://learn.freshcap.com/growing/using-pressure-cookers-for-growing-mushrooms/#
- https://archersmushrooms.co.uk/how-to-make-grain-spawn-jars/
- https://github.com/BioHackAcademy/BHA_Incubator

DIY BIOFILMS

BVV

VV

SEE ALSO:vv

EST. TIME:

DIY BIOFILMS

INGREDIENTS
vv

TOOLS
vv

TASKS

vv

REFERENCE: bbb

DIY APPLIED MYCOLOGY

VVV

MYCOLOGY IS THE STUDY OF FUNGI AND THEIR APPLICATIONS IN SEVERAL INDUSTRIES (FOOD, MATERIALS, PIGMENTS, MEDI-CINE, BIOREMEDIATION). THE AVAILABILITY OF TOOLS AND DIY PROCESSES MAKE THIS FIELD ACCESSIBLE TO ENTHUSIASTS.

SEE ALSO: VV

EST. TIME:

DIY APPLIED MYCOLOGY

INGREDIENTS

light malt extract, yeast extract, pota-toes, dextrose, water, vial of liquid cultu-re (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)

TASKS

Set up a basic biolab (see card: ***Setting up a community lab***)
- 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)

REFERENCE: Peter McCoy (2016) Radical Mycology; Freshcap Mushrooms Blog and video channel https://learn.freshcap.com/growing/ and https://www.youtu-be.com/c/freshcapmushrooms

GLOSSARY BIO-’EVERYTHING’

//

/

SEE ALSO: ///

EST. TIME:

GLOSSARY BIO-’EVERYTHING’

INGREDIENTS
bb

TOOLS
ff

TASKS

BB

REFERENCE: NN

@HOME MATERIALS KITCHEN

DIY BIOMATERIALS FROM YOUR KITCHEN CUPBOARD

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.

SEE ALSO: bbb

EST. TIME:

@HOME MATERIALS KITCHEN

INGREDIENTS & TOOLS
See ingredients and tools list on the back of the folder/booklet.

RECOMMENDATIONS
Collect old pans, pots and utensils for bioplastics and natural dye. Do not use them for cooking and store them separately.

TASKS

Collect the ingredients and tools on the list found at the back of the folder/booklet of the toolkit.

Give a small video tour in your kitchen: show us how you have converted your kitchen into a Biomaterials-fabrication site.

REFERENCE: vvv

RECYCLING

INDUSTRIAL PROCESSING AND CONVERSION TECHNIQUES

FABRICATION IS ABOUT PROCESSING RAW MATERIALS AND MAKING PARTS THAT ARE SUITABLE FOR ASSEMBLY OR MANUFACTURING OF GOODS FOR CONSUMERS.
KNOWING THE MAJOR TECHNIQUES FOR PROCESSING OR CONVERSION OF MATERIALS HELPS YOU EXPLORE POSSIBILITIES OF BIOMATERIALS IN DEPTH.

SEE ALSO: ALLE SOORTEN INDUSTRIAL PROCESSING CARDS

EST. TIME:

RECYCLING

WHY

When making biomaterials, we talk about biofabrication. To imagine possible applications, we need to understand how they can be made into semi-manufactured materials and functional parts.

TASKS

[what is recycling]

Explore your material recipes by subjecting them to different processing techniques. Curate a series of samples showing possible processing techniques for one of your material recipes. Research the method listed below:

Recycling
- *Chemical recycling* (treatment to separate constituents for reuse)
- *Mechanical recycling* (shredding, beating, grinding, crushing)
- *Organic recycling* (composting to produce fuel or fertilizers)

REFERENCE:Daniel Kula & Élodie Ternaux (2008) Materiology: The Creative Industry's Guide to Materials and Technologies.

EXTRACTIVE MANUFACTURING

INDUSTRIAL PROCESSING AND CONVERSION TECHNIQUES

FABRICATION IS ABOUT PROCESSING RAW MATERIALS AND MAKING PARTS THAT ARE SUITABLE FOR ASSEMBLY OR MANUFACTURING OF GOODS FOR CONSUMERS.
KNOWING THE MAJOR TECHNIQUES FOR PROCESSING OR CONVERSION OF MATERIALS HELPS YOU EXPLORE POSSIBILITIES OF BIOMATERIALS IN DEPTH.

SEE ALSO: ALLE SOORTEN INDUSTRIAL PROCESSING CARDS

EST. TIME:

EXTRACTIVE MANUFACTURING

WHY
When making biomaterials, we talk about biofabrication. To imagine possible applications, we need to understand how they can be made into semi-manufactured materials and functional parts.

TASKS

[what is extractive manufacturing]

Explore your material recipes by subjecting them to different processing techniques. Curate a series of samples showing possible processing techniques for one of your material recipes. Research the method listed below:

Extractive manufacturing
• ***Cutting*** (e.g. saws, scissors, knives, lasercutting, hotwire, piercing)
• ***Machining*** (drilling, milling, turning, abrasion)
• ***Engraving*** (laser engraving, etching, carving)

REFERENCE:Daniel Kula & Élodie Ternaux (2008) Materiology: The Creative Industry's Guide to Materials and Technologies.

ADDITIVE MANUFACTURING

INDUSTRIAL PROCESSING AND CONVERSION TECHNIQUES

FABRICATION IS ABOUT PROCESSING RAW MATERIALS AND MAKING PARTS THAT ARE SUITABLE FOR ASSEMBLY OR MANUFACTURING OF GOODS FOR CONSUMERS.
KNOWING THE MAJOR TECHNIQUES FOR PROCESSING OR CONVERSION OF MATERIALS HELPS YOU EXPLORE POSSIBILITIES OF BIOMATERIALS IN DEPTH.

SEE ALSO: ALLE SOORTEN INDUSTRIAL PROCESSING CARDS

EST. TIME:

ADDITIVE MANUFACTURING

WHY
When making biomaterials, we talk about biofabrication. To imagine possible applications, we need to understand how they can be made into semi-manufactured materials and functional parts.

TASKS

[what is additive manufacturing]

Explore your material recipes by subjecting them to different processing techniques. Curate a series of samples showing possible processing techniques for one of your material recipes. Research the method listed below:

Additive manufacturing
- *3D printing* (manual or digital/automated)
- *Contact moulding* (alternating plastics with various substrates e.g. fibres, using a lay-up method. Also called composites)

REFERENCE:Daniel Kula & Élodie Ternaux (2008) Materiology: The Creative Industry's Guide to Materials and Technologies.

FABRICATING

INDUSTRIAL PROCESSING AND CONVERSION TECHNIQUES

FABRICATION IS ABOUT PROCESSING RAW MATERIALS AND MAKING PARTS THAT ARE SUITABLE FOR ASSEMBLY OR MANUFACTURING OF GOODS FOR CONSUMERS. KNOWING THE MAJOR TECHNIQUES FOR PROCESSING OR CONVERSION OF MATERIALS HELPS YOU EXPLORE POSSIBILITIES OF BIOMATERIALS IN DEPTH.

SEE ALSO: ALLE SOORTEN INDUSTRIAL PROCESSING CARDS

EST. TIME:

FABRICATING

WHY

When making biomaterials, we talk about biofabrication. To imagine possible applications, we need to understand how they can be made into semi-manufactured materials and functional parts.

TASKS

[what is fabricating]

Explore your material recipes by subjecting them to different processing techniques. Curate a series of samples showing possible processing techniques for one of your material recipes. Research the method listed below:

Fabricating

- ***Folding*** (cold vs hot, optional: scoring, applying stiffeners)
- ***Thermoforming*** (vacuum forming, dome blowing)
- ***Stamping*** (cold pressing sheets using molds)
- ***Sintering*** (heating powders with or without binder, laser sintering)
- ***Cast-moulding*** (using liquids, open/closed mould)
- ***Rotational moulding*** (multi-layered, open-closed)
- ***Extruding*** (extruding and co-extruding, blow-moulding)

REFERENCE:Daniel Kula & Élodie Ternaux (2008) Materiology: The Creative Industry's Guide to Materials and Technologies.

ASSEMBLING

INDUSTRIAL PROCESSING AND CONVERSION TECHNIQUES

FABRICATION IS ABOUT PROCESSING RAW MATERIALS AND MAKING PARTS THAT ARE SUITABLE FOR ASSEMBLY OR MANUFACTURING OF GOODS FOR CONSUMERS. KNOWING THE MAJOR TECHNIQUES FOR PROCESSING OR CONVERSION OF MATERIALS HELPS YOU EXPLORE POSSIBILITIES OF BIOMATERIALS IN DEPTH.

SEE ALSO: ALLE SOORTEN INDUSTRIAL PROCESSING CARDS

EST. TIME:

ASSEMBLING

WHY

When making biomaterials, we talk about biofabrication. To imagine possible applications, we need to understand how they can be made into semi-manufactured materials and functional parts.

TASKS

[what is assembling]

Explore your material recipes by subjecting them to different processing techniques. Curate a series of samples showing possible processing techniques for one of your material recipes. Research the method listed below:

Assembling

- ***Joinery*** (wood joinery, snap fit, interlocking, screws, nails)
- ***Sewing*** (stitches: running-, basting-, slip-, back-, zigzag-, overlock-)
- ***Bonding*** (using adhesives, heat or solvents)
- ***Folding*** (riveting, rolled edges)
- ***Heat sealing*** (heat welding, soldering, laser welding, friction welding)

REFERENCE:Daniel Kula & Élodie Ternaux (2008) Materiology: The Creative Industry's Guide to Materials and Technologies.

FINISHING

INDUSTRIAL PROCESSING AND CONVERSION TECHNIQUES

FABRICATION IS ABOUT PROCESSING RAW MATERIALS AND MAKING PARTS THAT ARE SUITABLE FOR ASSEMBLY OR MANUFACTURING OF GOODS FOR CONSUMERS.
KNOWING THE MAJOR TECHNIQUES FOR PROCESSING OR CONVERSION OF MATERIALS HELPS YOU EXPLORE POSSIBILITIES OF BIOMATERIALS IN DEPTH.

SEE ALSO: ALLE SOORTEN INDUSTRIAL PROCESSING CARDS

EST. TIME:

FINISHING

WHY
When making biomaterials, we talk about biofabrication. To imagine possible applications, we need to understand how they can be made into semi-manufactured materials and functional parts.

TASKS

[what is finishing]

Explore your material recipes by subjecting them to different processing techniques. Curate a series of samples showing possible processing techniques for one of your material recipes. Research the method listed below:

Finishing
- ***Painting*** (mix of binder, pigment, additives and solvents)
- ***Coating*** (finishing processes for textiles and paper)
- ***Varnishing*** (transparent paints, with or without color)
- ***Sanding & polishing*** (sanding, chemical polishing, rubbing)
- ***Printing*** (gravure, silkscreen, offset, UV-printing, stenciling, RISO)

REFERENCE:Daniel Kula & Élodie Ternaux (2008) Materiology: The Creative Industry's Guide to Materials and Technologies.

MORPHOLOGY OF INGREDIENTS

IN BIOFABRICATION

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?

SEE ALSO: cc

EST. TIME:

MORPHOLOGY OF INGREDIENTS

WHY

Many biomaterials recgipes 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.

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

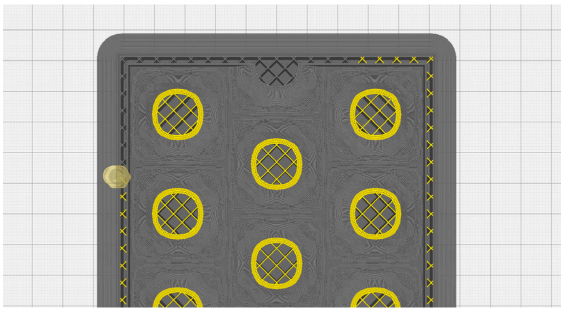
Morphology
- Determine what could be alternatives for each ingredient
- Locate alternatives that can be found in waste streams
- Locate alternatives that are more locally abundant

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

REFERENCE:Functions graph (2021) Loes Bogers, Cecilia Raspanti & Sam Edens

BEING A 3D PRINTER

BEING THE MACHINE



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.

SEE ALSO:RECIPE CARDS

EST. TIME:

BEING A 3D PRINTER

OUTPUT

NEXT

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

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

(UN)MAKING THE MOLD

UNDERSTANDING AND RECREATING CASINGS

BioElectric by Jeongwon Ji (2013)

CONSUMER ELECTRONICS ARE OFTEN ENCASED BY INJECTI-ON-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

SEE ALSO: VV

EST. TIME:

(UN)MAKING THE MOLD

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.

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

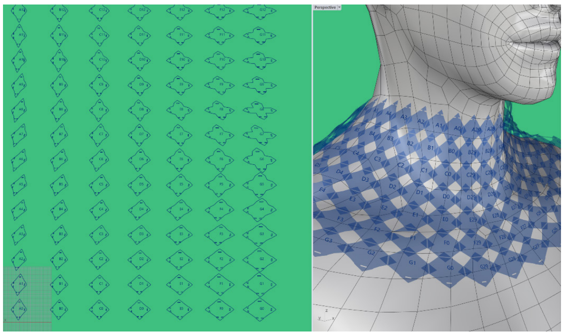
Develop your own mold
- Choose a biomaterial to work with (see recipe cards)
- Make a mold – to create new casing for the electronics
- Test it out by casting the material and allow it to dry (1 week)

Testing and refining
- Set new goals and iterate on your mold and method
- Document the process and results, share with class

REFERENCE: Jeongwon Ji (2013) BioElectric https://www.dezeen.com/2013/07/01/bioelectric-plastic-made-of-crab-shells-by-jeongwon-ji/

MONO- MATERIAL CONNECTIONS

DESIGNING INTERLOCKING CONNECTIONS


Interlocking necklace design, Lorenzo Massini (2020)

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***.

SEE ALSO:RECIPE CARDS

EST. TIME:

MONO-MATERIAL CONNECTIONS

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.

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.

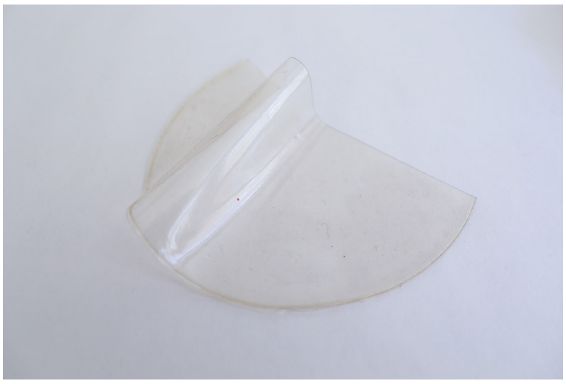
Play & iterate

- 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.

REFERENCE: Zoe Romano (2019) Circular Open-Source Fashion, for Fabricademy. https://class.textile-academy.org/classes/2019-20/week03/ and https://oscircularfashion.com/

AGAR BIOPLASTIC

AGAR IS A GUM POLYSACCHARIDE FOUND IN RED ALGAE



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.

SEE ALSO: Alginate bioplastic, Carrageenan bioplastic

EST. TIME:

AGAR BIOPLASTIC

INGREDIENTS
5 g Agar, 15 g Glycerine, 250 g Water

TOOLS
Scale, pot, stove, spoon, wide mold or casting surface

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

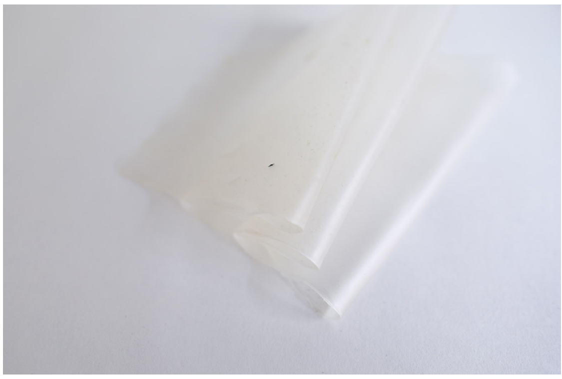
Cast the bioplastic
- Cast the bioplastic slowly in the center of the mold
- Allow to dry for a week without touching

Release the bioplastic
- Check that the plastic no longer feels cold to the touch
- Gently peel it off the surface

REFERENCE: Biofabricating Materials lecture notes, by Cecilia Raspanti, Fabricademy 2019: https://class.textile-academy.org/classes/2019-20/week05A/

ALGINATE BIOPLASTIC

ALGINATE IS A GUM POLYSACCHARIDE FOUND IN BROWN ALGAE



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.

SEE ALSO: Agar bioplastic, Carrageenan bioplastic

EST. TIME:

ALGINATE BIOPLASTIC

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

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

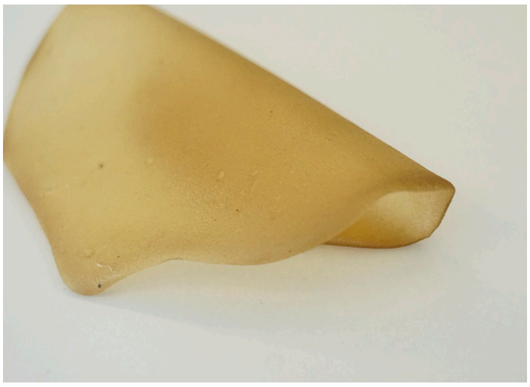
Cast the bioplastic
• Cast the bioplastic slowly in the center of the mold
• Spray generously with calcium chloride solution
• Allow to dry until no longer cold to the touch

Releasing the bioplastic
• Gently peel off the casting surface

REFERENCE: Biofabricating Materials lecture notes, by Cecilia Raspanti, Fabricademy 2019: https://class.textile-academy.org/classes/2019-20/week05A/

CARRAGEENAN BIOPLASTIC

CARRAGEENAN IS A GUM POLYSACCHARIDE FOUND IN RED SEAWEED



AGAR, CARRAGEENAN, AND ALGINATE ARE GUM POLY-SACCHARIDES. AS FOOD-SAFE BIOPOLYMERS THEY ARE USED WIDELY IN THE FOOD INDUSTRY AS THICKENERS AND STABILIZERS BUT THEY ALSO HAVE GOOD FILM-FORMING QUALITIES.

SEE ALSO: Agar bioplastic, Alginate bioplastic

EST. TIME:

CARRAGEENAN BIOPLASTIC

INGREDIENTS
16 g carrageenan kappa, 3 g glycerine, 350 g water

TOOLS
Scale, pot, cooker, spoon, casting surface

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

REFERENCE: Lugae Valenti, Making Carrageenan 2021: https://vimeo.com/386012184

GELATINE BIOPLASTIC

GELATIN IS HYDROLIZED COLLAGEN: A POLYMER FOUND IN CARTILAGE, BONE AND SKIN OF ANIMALS

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.

SEE ALSO: Agar bioplastic, Carrageenan bioplastic

EST. TIME:

GELATINE BIOPLASTIC

INGREDIENTS	TOOLS
50 g gelatine, 15 g glycerine, 250 g water	Scale, pot, cooker, spoon, casting surface

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

REFERENCE: Biofabricating Materials lecture notes, by Cecilia Raspanti, Fabricademy 2019: https://class.textile-academy.org/classes/2019-20/week05A/

MYCELIUM-HEMP COMPOSITE

COMPOSITE OF HEMP FIBRES, CHITIN, AND OTHER POLYMERS

MYCELIUM IS THE VEGETATIVE PART OF THE MUSHROOM, AND CONSISTS OF SEVERAL BIOPOLYMERS SUCH AS CHITIN, CELLULOSE AND PROTEINS.

SEE ALSO:vv

EST. TIME:

MYCELIUM-HEMP COMPOSITE

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

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

REFERENCE: Grow-It-Yourself kit via Grown.bio https://www.grown.bio

LEVELS OF CLEAN AND DIRTY

'DIRT IS MATTER OUT OF PLACE' - MARY DOUGLAS (1966)

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.

SEE ALSO: Safety levels of clean and dirty, Define your eco-compatibility principles.

EST. TIME:

LEVELS OF CLEAN AND DIRTY

INGREDIENTS

TOOLS
paper, pens, disussion space

COLLECTIVE ACTIVITY

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.

REFERENCE: Sources: Mary Douglas, Purity and Danger, 1966

SAFETY LEVELS OF CLEAN AND DIRTY

UNDERSTANDING BIOSAFETY LEVELS

MAKE SURE THAT MICROBIOLOGY EXPERIMENTS ARE SAFELY CONDUCTED IN A SAFE AND HEALTHY WORK ENVIRONMENT BY FAMILIARIZING YOURSELF WITH BIOSAFETY LEVELS.

SEE ALSO: Alginate bioplastic, Carrageenan bioplastic

EST. TIME:

SAFETY LEVELS OF CLEAN AND DIRTY

RECOMMENDATIONS:
Consult your local bio safety expert when starting a biolab.

TASKS

Find out what biosafety level(s) is/are allowed for your lab and/or experiments.Depending on where in the world you live, regulations can differ wildly regarding DNA, bacteria, or fungi. Read manuals about biosafety levels and familiarise yourself with Good Microbiological Laboratory Practice (GMLP).

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.

Discussion prompt 2:
•Why is working in the lab with a ***Pleurotus Ostreatus*** (Gray Oyster) strain different from growing ***Pleurotus Ostreatus*** in your garden and different from eating ***Pleurotus Ostreatus*** mushrooms?
•Change the example of ***Pleurotus Ostreatus*** to a strain or subject that applies to your lab.

REFERENCE: Biosafety Levels Manuals; Good Microbiological Laboratory Practi-ce (GMLP)