Memo No. _____

Date 08 / 07 / 2025

Nora Carlson Nora.V.Carlson@gmail.com

Any questions please email me

Science Fair project idea:

Analyzing the impact of nanoplastics on the root microbiome of crops

- Ideas by Natania:
  - you need to be original. Isaac and Dalyssa didn't win awards due to the idea already existing
  - make it more niche
  - make it impactful.
  - if not solution-based, at least make it have a good conclusion.

Solution-Based: The problem is given a solution (you find or make a solution to the problem)

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Potential Research question:

What cellular and molecular mechanisms are impacted by nanoplastics in crop rhizosphere microbes?

↳ how are crop root microbes impacted by microbes

Literature Review

1. Micro- and nanoplastics in agricultural soils: Assessing impacts and navigating mitigation.
   - The impact of nanoplastics is hard to determine. It can be positive or negative. It's hard to determine due to the nature of soil
   - Nanoplastics usually enter soil through irrigation or a plastic mulch film.

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Date 07 / 06 / 2025

The plastic mulch film is actually essentiall in ~~pro~~ crop growth. They provide water, weed, and temperature control in horticulture (growing plants). However, the plastic can breakdown and create many problems ~~fo~~ for plant production. However alternatives aren't being implicated.

- An affordable replacement to the plastic mulch film

More studies of the adsorption of nanoplastics by plants, esspecially potatoes and carrots should be done as they have more contact with nanoplastics.

- Study of nanoplastic mechanism of impact on potatoes.
- A device to detect traces of nanoplastics in crops.

Memo No.

Date 27/06/2025

Louise Berger LBerger@mhc.ab.ca

- paper: safe planetary boundaries
- atmospheric pollution

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2. multi-omics analyses reveal the responses of wheat + rhizosphere bacterial community to nanoplastics
    - Although this paper was highly comprehensive they suggested some improvements
        - The role of different MNP sizes on the plant toxicology
        - development of crop resistent strategies
        - Impact of MNP's on other crops instead of wheat.

Date 07/06/2022

To take the existing research further, an idea is to do the following question:

- What is the impact of different micro-nano plastics on ~~the~~ the potato rhizosphere microbiome?
  - ↳ what makes it better?
  - o studies a different type of planet
  - o ~~was~~ explores different forms of micro-nano plastics

---

I want to see the impact of ~~nano~~ nanoplastics on the health of plants and the rhizosphere microbiome. However, this was already tested before.

Name: Mia
Date: 09/06/2024

After further research, the gaps in knowledge seem to be in assessing the impacts of nanoplastics in the natural environment. This includes looking into irregular nanoplastic sizes, simulating natural conditions (instead of lab), and more long-term testing.

- testing irregular nanoplastic sizes means looking into creating (or finding) these irregular sizes
- testing in simulated natural conditions means looking into gathering samples from farms, and predicting where there are the most nanoplastics
- for long term, would I test? This might not be possible due to the time

This can be easily combined

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3 ways to simulate natural conditions:

- varies plastic sizes + natural conditions
  - gathering data from real farms
- varies plastic sizes
  - collect microplastics from washing machines or use bottled water
- will this be reliable? how will it work?
  - The extremophile testing pressure chamber thing and simulate Earth conditions.

Questions for Mr. Stranzinger:

(1) What are some ways to evaluate the impacts of nanoplastics on cells

(2) can plant cells' mechanisms? of impacts apply to human cells?

(3) How to simulate natural conditions?

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looking at endosytosis and exosytosis

ways to test
- Talk to Ms. Mac (for farm)
- looking at agricultural people
- prevelance in oceans
- cyaloge
- ammino tagging
- enzyme-linking ammino assay
- ammino fourest

~~09~~ 17/09/25

Researching about nanoplastics, gaps in research were found.

1. Plat resistance strategies to np's hasn't been thouroughly researched
2. np detection in plants
3. Impact on plant metabolism?
   ↳ metabolic pathways, hormone regulation, nutrient uptake.

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3. Effects of Polystyrene nanoplastics (PSNPs) on the Physiology and molecular metabolism of corn (Zea mays L.) seedlings
   - after 15 days of exposure, the photosynthetic characteristic remained stable.
   - maximum photochemical quantum yield + non-photochemical quenching coefficient was stable
   - root microstructure was damaged
   - antioxidant enzyme activated.
   - malondialdehyde increased by 2.25-4.50 fold
     ↳ MDA is formed after lipid peroxidation; marker of oxidative stress

21/06/2025

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Date 06/27/2025

Current/potential research question:

How can a cost-effective colorimetric test strip be developed to detect and quantify concentrations of nanoplastics in plant puree?

07/20/2025

To run A.I., you need a lot of energy. For example, asking chatGPT 1 question is equivalent to asking 10 questions to google. This is a limiting factor in the growth of A.I.

A.I. data ceters will require a lot of Electricity but only half of it will be from renewables.

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The most limiting factor in the growth of A.I. is energy. How is it possible to supply energy to so many data centers?

What are data centers?

Places where computers and storage systems are kept to run tech.

The Growing Environmental Impact of AI data centers' energy demands (PBS NewsHour).

Renewable energy can't catch up for the demand for A.I. data centers.

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before, data centers used Air cooling. Now, liquid cooling is used. Closed-loop liquid cooling systems are energy efficient. But the are expensive upfront.

I can explore the idea of thermo electricity in closed-loop liquid AJ. GPU coolers.
↳ thermoelectricity is complicated

*heat Exchangers

Rephrased: Using thermo-electic generators (TEGs) to harvest electricity from the hot water in a closed-loop GPU cooler.

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Using heat from GPU cooling in green house farming.

Human's will just need more data, esspecially with A.I. data centers need a lot of water.
According to Al Jazeera English, there is only limited information on how much water is taken up exactly. The problem is that some data centers are being built in drought-prone areas such as Mexico. These data centers are estimated to take up the same amount of water as thousands of households. Closed-loop systems are getting increasingly common.

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Date 08/06/2025

plastic pollution is ~~is~~ is a huge issue globally, following second to only climate change. plastics enter farms through mulch, fertilizer, and wastewater. Organisms and human activities can move nanoplastics around even more. Nano-plastics are so small, they can enter plants, but not fully understood why. There is a lot unknown:

- Nanoplastic impact on human health,
- Nanoplastic detection
- How nanoplastics harm people and nature.

↳ micro(nano) plastics uptake, toxicity and detoxification in plants. Challenges + prospects

Ecology et al.

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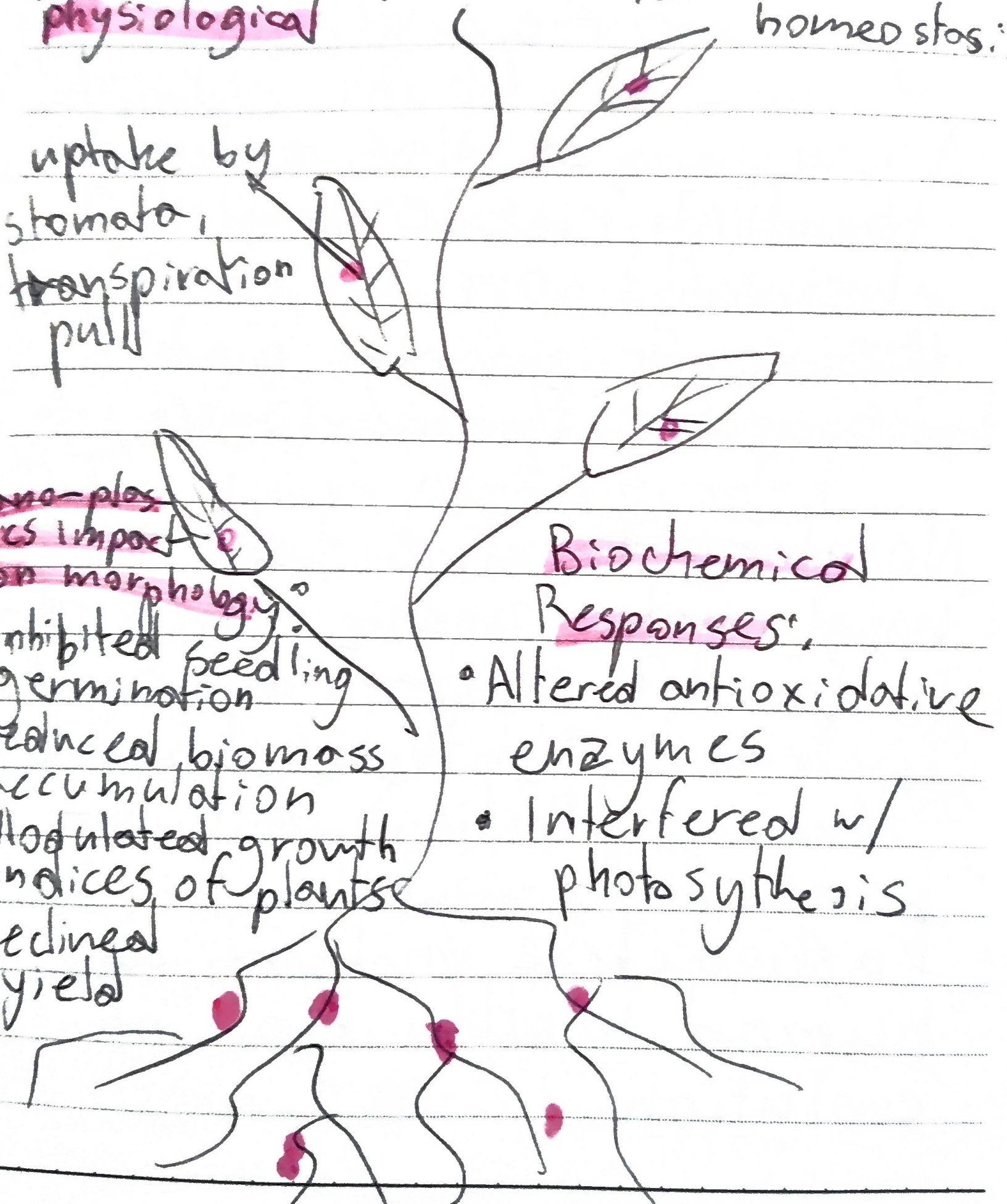
Date / /

(Cr) → uptake via apoplastic and symplastic pathways

Biochemical responses:
- oxidative stress
- disturbed homeostasis

physiological

uptake by stomata, transpiration pull



Nanoplastics impact on morphology:
- Inhibited seedling germination
- reduced biomass accumulation
- Modulated growth indices of plants
- declined yield

Biochemical Responses:
- Altered antioxidative enzymes
- Interfered w/ photosythesis

Earth beyond 6 of 9 boundaries
by: Richardson, et all
Memo No.
Date 08/06/2025

Nine planetary boundaries framework identifies 9 processes for the Earth system to stay stable.

Novel entities has entered the high risk zone. New chemicals are entering ~~the~~ earth yearly and disrupting Earth

Novel Entities are truly novel anthropogenic introductions to Earth's system. This includes: Synthetic chemicals (microplastics), anthropogenically mobilize radioactive material, and human modification of evolution.

2025

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Novel entities are quickly introduced without understanding their consequences on Earth. However, they can have terrible impacts on Earth as seen with insecticide, DDT and chlorofluorocarbons (CFCs). This means the only way to implement a novel entity is by evaluating all aspects and harm it can do to Earth. Even assessing risks has limitations because it doesn't look at the "cocktail" effect.

Regional climate in Northwest China: Implications for climate-resilient agriculture - Ruan, et.al

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Considerable field measurements show that plastic mulch is beneficial for many things: modulating soil moisture/H_2O, temp and (N) budget, raising crop water use efficiency by 49-85%.

Plastic mulch reduced the use of water by 30-45% while maintaining high soil moisture. This shows water conservation in areas w/ scarce water. Plastic mulch supress soil evaporation by 42-47% in a maize field.

The plastic mulch film can prevent extreme percipitation by slowing evapotranspiration (evaporation from soil and plants). This type of percipitation accounts for 42% of extreme percipitation.

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Negative aspects → plastic mulch can decelerate the internal watercycle by suppressing soil evaporation.

→ plastic mulch can cause soil pollution

→ plastic mulch can enhance heat stress

* Using ~~biodegradable~~ biodegradable mulch can be the solution.

Higher Potential leaching of inorganic and organic additives from biodegradable compared to conventional agricultural plastic mulch film. By: Reay, et.al

~~Bio~~ biodegradable film has much more leaching of "unknown" compounds.

Although there are numerous benefits to using plastic mulch, there is also a potential for it to turn into microplastics. Its also very difficult to remove and recycle soil-contaminated films. Because of this, there is a growing interest in biodegradable mulch films to minimise microplastic accumulation but the additives/co-contaminents can easily leach into the environment as they aren't chemically bound. An evaluation of all additives used in all kinds of plastic showed: 3% of known compound met no hazard criteria, 24% were of concern/potential concern, 39% had insufficient information. This show potential risks entering our environment.
There is a concern that unknown substances can enter the food chain or freshwater sources. This includes the increasing discovery of endocrine disrupters like phthalates.

Using biodegradable films raises concerns for pollution swapping due to the relatively higher leaching of organic additives, polymer degradation products and metal/metalloid additives from biodegradable films compared to LDPE films. Some of the additives from biodegradable films are a higher concern than microplastics.

Implications and future outlook

the additives of high concern should be replaced with more benign alternatives in biodegradable mulches. Also chemicals should be assesse

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A Guide to the Manufacture, Performance, and potential of plastics in Agriculture.

Horticulture → art and science of growing trees, shrubs, fruits, vegetables and other ornamental vegetation like flowers.

the use of plastic mulch film (pmf) is growing over the years for its known advantages (including what was previously mentioned) such as modulating soil temperature by 4-5°C → isn't that a little low? How likely is that number to cause heat stress? Clear mulch raises temp much more ~~than~~ than black mulch.

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Important Factor: phytochrome is a light-sensing protein. It exists in two forms: Pr (absorbing red light, signaling to grow flowers) and Pfr (absorbing far-red light to lean towards light).
phytochrome is being used to have greater yield. For example, red plastic mulches generated around 20% more tomatos in some trials.
Negatives → heat buildup, attract pests, cost, red pigments can degrade.

How are plants watered with plastic mulching?

Experiments in china had 15-50% more yield where cotton was mulched. Source - Energy and conservation in buildings by Sun Xiaoren

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Date 28/06/2025

A guide to the Manufacture, Performance, and potential of plastics in Agriculture

PMF disadvantages: One of the biggest disadvantage to using PMF is the removal and disposal as this causes the formation of micro(nano)-plastics. Also many places are unable to recycle them.

In early 1960's photodegradable plastic mulch was identified as a potential replacement. There is also work on biode-gradable starch-based film.

Even biodegradable options use conventional tech. ~~made from plastics so it may be treated with others~~

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Date 08/12/25

~~polymers for plasticizers~~ Today, Many biodegradable mulches are made of plant starch which is brittle. So, it has to be blended with other polymers or/and **plasticizers.**

Another disadvantage is the high initial cost due to investments in specialized equipment. But, these costs can be offset by a greater yield of crops.

Soil and Tillage Research by Kader et. al

Sometimes natural mulches aren't good for weed control as they can introduce seeds from straw, hay, etc. Organic mulch like wood chips can also cause too much moisture creating problems.

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Date 06/10/2025

Carbon-rich mulches like straws and sticks can cause nitrogen immobilization in soil due to ~~nitrogen~~ micro-organisms using nitrogen to decompose carbon-rich mulches. Paper mulches decompose too fast.

A guide to the Manufacture, performance, and potential of plastics in agriculture.

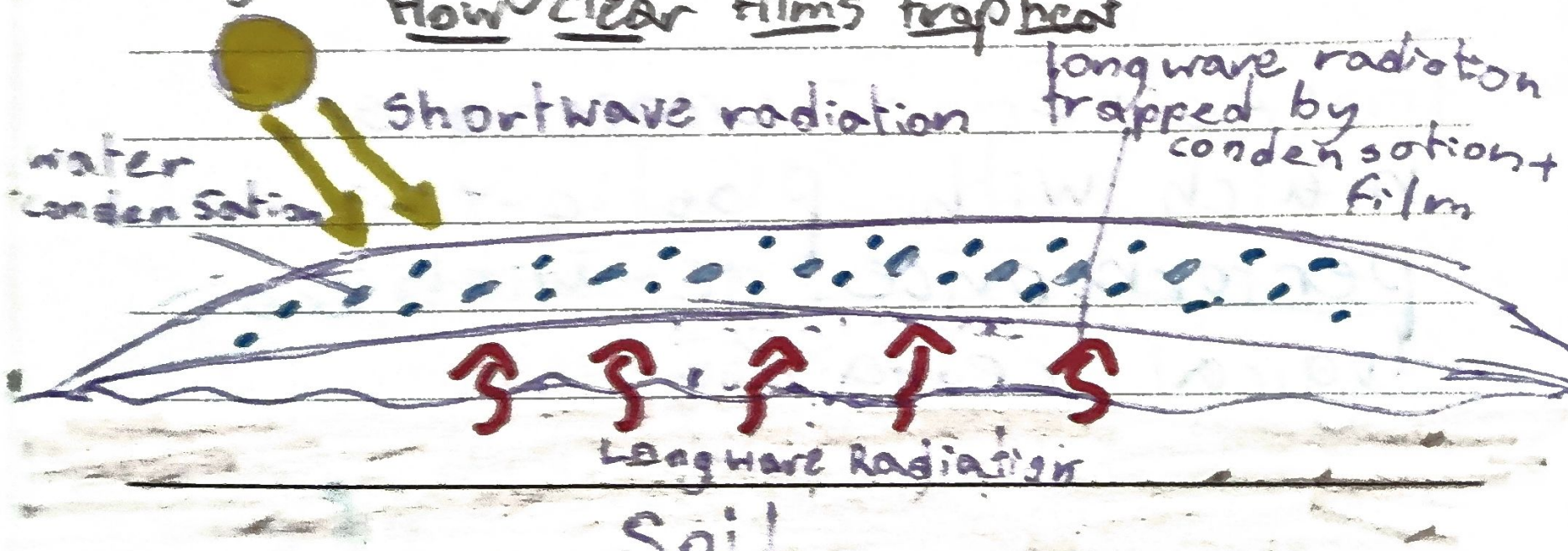
Importance of Colour

mulch colour of mulch determine its energy-radiating behavior and its influence on ~~plants~~ the **microclimate** of the plant. Color determines surface T° of mulch + soil. Most researchers focused on clear, white, and black films which are still the most common today.

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Black mulch is an opaque black body so a lot of solar UV/infrared is absorbed by the film. Though a lot of the solar energy is lost to the atmosphere through forced convection/radiation, much of that energy ends up in the soil as it's a better thermal conducter than air. This results in the heating of the soil by 2.8°C at 5cm depth and 1.7°c at 10cm depth, compared to bare soil. clear plastic can trap more heat because it lets more light through, raising the soil T° by +4-7.8°C higher at 2cm depth and 3.3-5.0°C ~~highest~~ higher at 10°C.

How clear films trap heat



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EN 17033 is a European standard used for biodegradable plastic mulches. It is the most rigorous evaluation standard but even this doesn't take into account the ~~unknown~~ substances/additive leaching with unknown risk. This means even the "best" mulches cannot be completely safe. For plastic-like performance EN-17033 certified mulches are the safest modern option today but for complete ecological certainty, performance has to be sacrificed.

Project Idea: creating a mulch with plastic-like performance, yet with ecological certainty

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What exactly should the mulch do and under what conditions?

testing parameters:

1. Decomposition → must decompose in a given amount of time for my testing.
2. "Non-leachingness" → it MUST NOT leach harmful chemicals into the soil, even chemicals/compounds w/ unknown impacts on human health and/or crop yield
3. Moisture retention
4. T° regulation
5. Weed prevention and pest prevention
6. Strength → tensile Strength, flex test
7. higher yield + quality food

the main requirements are ability to decompose without leaching harmful chemicals while permeforming similarly to PMFs.

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physical characteristics of plastic mulch film:

- thickness: 0.01 - 0.05mm
  - thicker films are more expensive but last longer
- texture and finish: smooth, some are textured to increase grip
- colour: there are many different options with different benefits to each due to phytochrome and other factors. But there are common colours.
  - Black: weed suppression
  - Clear: warms soil most but weed can grow
  - White/silver: keeps soil cool
  - Bi-colour: black under reflective top (dual benefits)
  - "fun" colours: red according 2 phyto

Name Nu
Date [illegible]

- Strength: strong tensile strength, and resistant to tears
- Impermeability: common plastic ones are impermeable
- Weight: very light weigh <50g/m²
- ✱ Colour CONTROLS
  HEAT

In summary, my version needs to be smooth, thin, strong tensile strength and chosing specific colours for performance desired performance. Trap water vapour.

flexible
biopolymers.

a polymer is a macromolecule made of repeatin units called monomers. Biopolymers are natural polymers derived from living organisms. Bio-polymers are DNA, RNA, proteins, Cellulose, chitin, starch etc. It is

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a renewable resource so it prevents the negative impacts to the environment than fossil fuels.

In my project I am planning to test my engineered film on a grow shelf.

I also want to ~~create~~ explore the potential of utilising hydro- gels with biopolymers to create a composite film. Hydrogels have a low tensile strength ~~compared~~ when wet so the biopolymers can make it ~~so~~ stronger, Plus drip irrigation systems won't have to be implemented, reducing upfront cost of the mulch film.

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* current BMF (biogeradable mulch films) are low mechanical strength and poor H_2O vapour barrier quality (the ability to trap water vapours).

pectin is found in fruit pomace and can form films. It also is biodegradable and exhibits gelling capacity.

Gelling capacity → how much water it can take up or release (like polymers and hydrocolloids)

~~hydrocolloids~~ polysachhrides can be extracted from fruit waste such as pomace from fruit. It can also be found in other food waste such as crab shells.

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There needs to be certain research done to optimize the extraction of polysacchrides from by-products like fruit pomace

↑ by: Song Wei, Et-Al

Source - From waste to functional materials: preperation, modification, and applications of polysaccharide-based films.

08/14/2025

Biopolymers has limitations in food packaging:

1) Brittle: they crack + break understress
2) sealability problems → doesn't apply to mulching
3) instable in heat
4) high permeability 2 water vapour and oxygen → water vapour should be trapped but not oxygen

*Mulch film needs to be able to exchange gases

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5) low melt strength

hydrocolloid properties:
- protein provide barriers for oil+grease
- polysaccharides offer better mechanical strength (no plasticizers)
- lipids = moisture affinity but reactive to oxygen
- polysaccharides dissolve quickly. Protein sollubility can be changed. lipid is almost insoluble.
- Some proteins and poly-saccharides can be antimicrobial or antioxidant → (PLA)

• Polyactides are the most commonly used biopolymer. It is readily available. It is biodegradable. Polyactides have high mechanical strength, low toxicity, resistant

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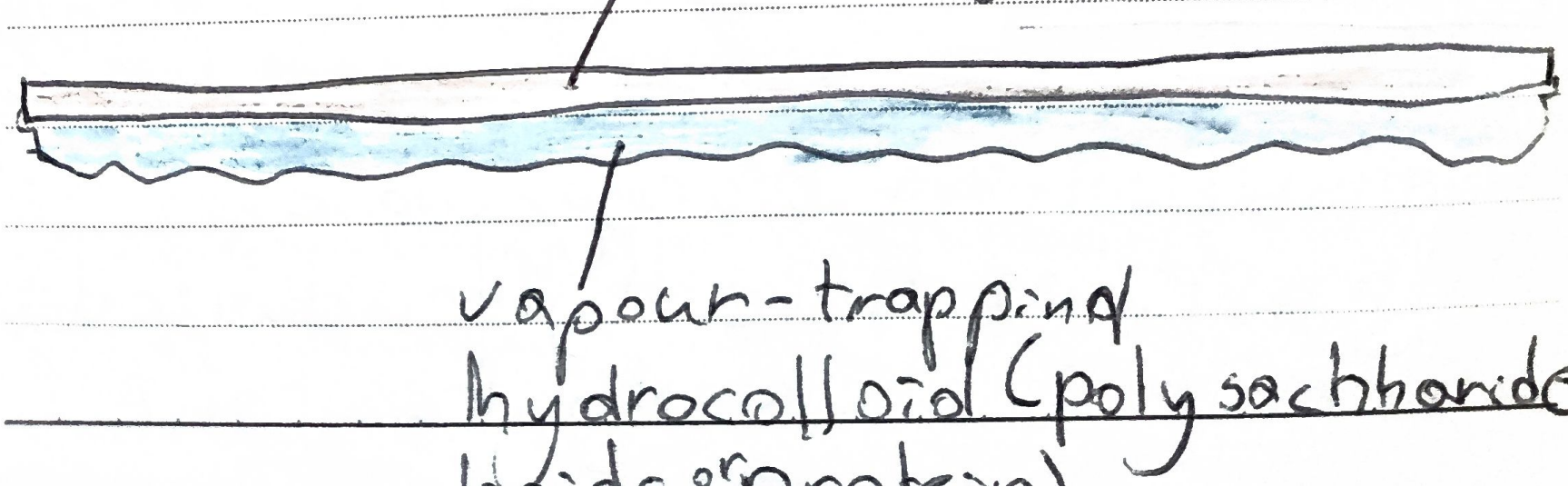
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to wear and tear, and stability under UV. It's also gas and vapour permeable.

- Polyhydroxyalkanoates (PHA's) produced by microorganisms they are suitable for food packaging but have high cost
- Polybutylene Adipate terephthalate (PBATY) are flexible and permeable but they need to be composted.
- Polycaprolactone (PCL) is hydrophobic and has a low melting point. Its properties can be enhanced with coating s.

proposed design.



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many biopolymers are permeable to vapour and gas. Vapour can be trapped using a hydrocolloid, while gas exchange is important for the soil microbiome.

08/16/2025

Bilayer: top is permeable 2 gas and vapour.
Bottom is permeable 2 only gas (hydrocolloid)

top layer options	Bottom layer options
• Electrospun pullulan with PVA ↓ PVA will need to be replaced: • Starch derivatives • Chitosan • Pectin • Cellulose • Zein	• Sodium Alginate • Alginate + TiO_2 • konjac glucomanan Sodium Alginate blend • Alginate + Quince seed • Alginate + apricot skin pectin

Source: from wastes 2 functional materials: preparation, modification, application of

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Steps to produce Pullulan

Pullulan

pullulan is a polysachride which consists of maltotriose units. (trisachride).
Pullulan is produced from starch by fungus: Aureobasidium pullulans.
Pullulan is mostly tasteless and edible
Currently used in - breath Freshner and hygeine, and vegetarian alternative to gelatin in capsules.
Potential use in - injectible scaffolds for bone tissue engineering cartilage tissue engineering and intervertebrate regenerations

Source - Wikipedia

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Pollulan is different from other polysachhrides (easily water Soluable).

Source - The use of Pollulan in Cosmetic products.

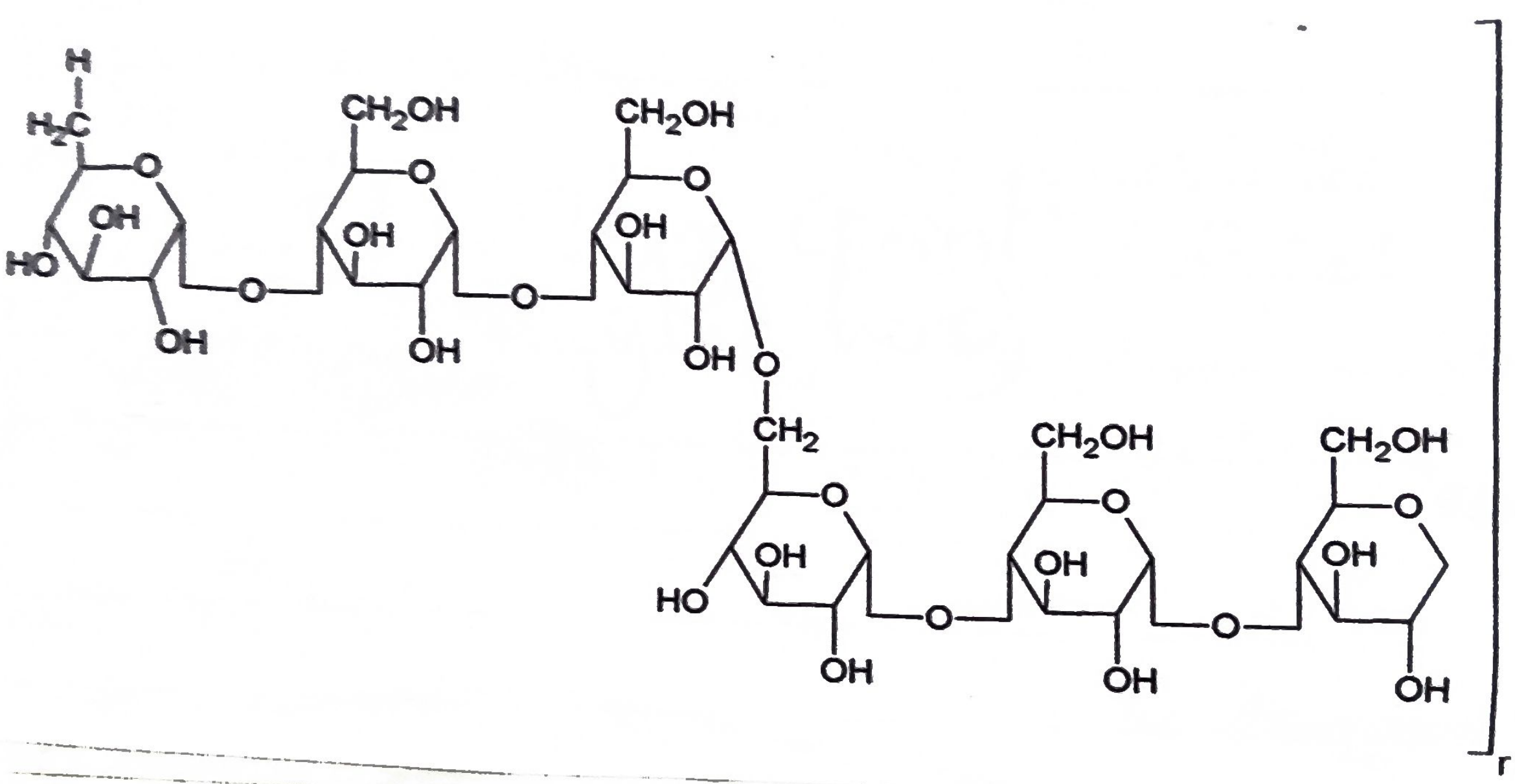
Pullulan is made with simple fermentation with certain feedstocks made w/ sugars Pullulan can also be made to be partialy or fully soluble in water or even insoluble. This can easily be altered chemically. It can be used as a flocculent. Pollulan exhibits oxygen barrier. It acts similarly to polystyrene (Styrofoam).

Source - biopolymers for biocomposites and chemical Sensor applications

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Pullulan structure:



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how to Read Research Papers?

Figure out your "Why" -> determines how you will read the paper.

the first step is to take a "birds eye view" -> look at the words and ask yourself if this is st you want to do.
then you will "swoop". Find the main conclusions, methods, and research questions (3-5 minutes).
It's unnessecary to read the whole paper start to finish to get the answer & all your why's "street view" -> to go into full depth, (mostly unrequired), print the paper and make highlights + notes.
But most of the time, this not

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necessary and most of your "whys" can be solved by the first 2 steps.

Some papers may not be written well but its important to pay attention to papers that written well and then try to emulate it.
If still unable to do anything -> ask the mentor. or other students.

"Rubber Duck" method ->
talk to a rubber duck about your project as simply as possible to remove unnessecary jargon. This increases audience and impact.

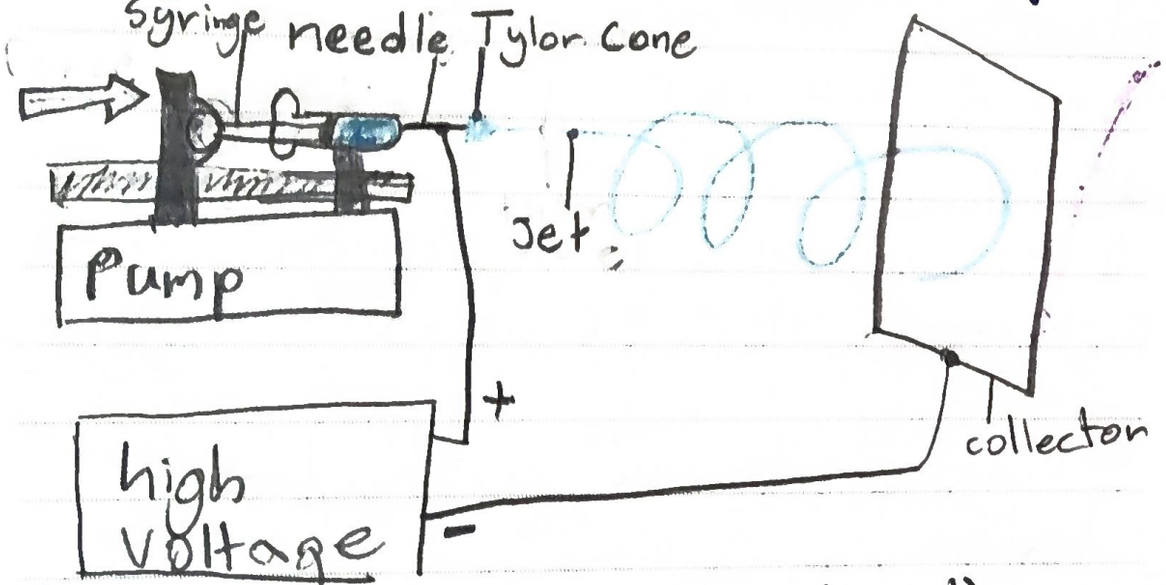
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Electrospinning

Electrospinning is a voltage-driven fabrication process. It is an electrohydrodynamic phenomenon where nano sized fibres are created from a polymer solution. The basic setup:



(Image source → researchgate.net)

The spinning process begins when an electrical field is established between the needle tip and collector. If the solution viscosity is under a certain threshold, the technique generates solid fibres. The result is a non woven fibre mat on the collecto

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Electrospinning is being applied in many fields from medicine, biotextiles, life sciences, and battery research.

Effects of Solution Parameter

Viscosity	Viscosity is one of the key properties. ↑ viscosity ecourages polymer chain entanglements. ↓ viscosity causes electrospraying
Conductivity	Solutions with high conductivity create more bead free formulas. It is import to asess the impacts of additives on conductivity.
Solvent Selection	the solvent should completely evaporate during the electrospinning process. solvent with too low of a boiling point can clog the needle

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Solvent Selection Con't	A solvent w/ low vapour pressure can be selected. fiber diameter can also by boiling point conductivity. ~~low cap~~ Lower boiling point solvents with low conductivity mean high diameter. The opposite relation applies 4 vapour pressure/dielectric constant

Processing Parameters

- Voltage
  - Needle Voltage: positive, ↑ voltage = ↓ diameter.
  - Collector Voltage: Usually grounded, negative. Improves fibre density, deposition, and focus.
- Needle 2 collector
  - closer, the less time solvent has to evaporate.
  - if kept closer, it can help w/

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- Flow rate & syringe
  - Stable flow rate maintains taylors cone
  - Flowrate influences fibre size; syringe materials and size matter
  - speed affects deposition density (slow = thicker, fast
- Needl
  - B
  - I
  - f
- Colle
  - o
  - o
  - others
- Sample collection
  - conductive materials r common but hard removal
  - hybrid materials are also us

- Will I need random fibre Placement? or specific placements

applica
ate
fibres
om on

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Environment

temperature, and humidity impact viscosity, solvent evaporation, and fiber quality. Air flow improves solvent evaporation and prevents defects. Gas-assisted hot-air spinning can reduce clogging + stabalize clogging.

Alternative Process: no voltage, just pressurized air; blow spinning

Source: Nanoscience Instruments (electrospinning)

Solution Blow Spinning (SBS)
SBS is a portable and conformational device. It allows for fibre formation/deposition on any substrate. Electrospinning needs a voltage + conductive target, while industrial processes

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require expensive and bulky machinery
There are fewer essential guidelines for polymer-solvent system:

- Polymer-Solvent compatibility
  - for fibre formation the solvent must dissolve to or greater than c
- Polymer molecular weight
  - polymers should have a sufficiently high molecular weight to form fibres
- Surface Tension
  - high or low surface tension solvents lead to capillary action. Manage it w/ temp, humidity + distance
- The rate of evaporation
- Impact of fillers such as nanoplarticles

~~SBS fibres are more porous than electrospinning~~

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SBS fibres are more porous but electrospinning offers more tensile strength due to lower diameter. Also, SBS fibres have fiber bundles which isn't typically seen in SBS. → SBS is more porous
→ electrospinning is more strong

Source: A Review of the Fundamental Principles and Applications of Solution Blow Spinning → John. L. Daristotle, et al.

09/20/2025

Alginate; Properties and Biomedical Applications

Alginate is a biomaterial that is being applied in a variety of fields such as wound healing drug delivery and tissue engi-

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challenge Source: Alginate: properties and biomedical properties applications By: Kuen Yong Lee, et. al.

Biopolymers as Adhesives (sodium alginate)

- Sodium alginate can be a strong adhesive for metals but it must cover the whole surface area.
- Adhesion is stronger after drying. (in this study it was stronger at 48 hrs than 6-24hrs.)
- though bonds stayed strong in high temps tair, it weakened upon exposure to water.
- light sanding is esential
- Sodium Alginate performed better than others biopolymers and performed similarly to standard

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metal adhesives
- Mostly adhesive failure, not cohesive.

Most biopolymers aren't water resistant as they are water soluble/hydrophilic.
Source: Biopolymers as sustainable metal bio adhesives
By: Binoy Maiti, et al.
08/21/2025

Microplastics are plastics smaller than 5 milimeters. Although current tech doesn't allow to accurately quantify population-level microplastics or how much they accumulate in bodies or the impacts on health, studies done on human cells and animals are alarming many.

Microplastics are being encountered every where from trash, dust

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cosmetics, cleaning products to even human breast milk and meconium, an infants first poop.

Though impacts of Microplastics are not fully understood, here's what has been found.

- Nanoplastics, plastics smaller than 1 micrometer, warry scientists as they can infiltrate cells
  - in cell cultures, marine wildlife, and animals show that microplastics can lead to cell damage, oxidative stress, and damage, DNA damage, changes in DNA activity, and risks of cancer development
  - studies in mice show problems to reproductive health

Source: Microplastics Everywhere by: Stephanie Dutche

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Classification of polysacchrides

Type	Description
pectic polysaccharides	pectin forms the primary structural component of plant cells. It can form gels. It can formfilms. Its biocompatible. It has tunable barrier capabilities.
Cellulose derivaties	the most abundant renewable resource is cellulose. Natural cellulose is difficult to dissolve and process. Nanocellulose can increase tensile strength to oxygen barrier properties. It is hydrophillic
Chitin derivatives	Chitin is extracted from shrimp crab shells and insect exo-skeleton. Seconnd most abundant polysaccharide. Barrier is that it take lots of energy.

Mo Tu We Th Fr Sa Su

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Fruit Pomace Polysachhride extraction:

- Physical Methods
  - Ultrasonic-assisted extraction (UAE) disrupts plant cell walls through microjets and shear force.
  - high pressure homogenized-assisted aqueous extraction disrupts cells' walls w/ intense mechanical shear forces and turbulent effects
  - Microwave-assisted extraction (MAE) uses dipole rotation and ionic conduction of polar molecules, & generating rapid volumetric heating.

Phyical methods are enviornmentally friendly and efficent.

- Biological methods

Mo | Tu | We | Th | Fr | Sa | Su

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- Using enzymes provides an extremely reliable technical support for ~~extraction~~ efficient pomace extraction.
- the barrier of enzyme utilization is:
  - Δ cost
  - Δ Optimization in efficiency of these parameters:
    - Enzyme hydrolysis process
    - Fermentation process
    - Tech integration
- Novel solvent systems
  - they open a path-way for greeen extraction.
  - Novel solvents include deep eutectic solvents

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o future research can look into:
(1) Precise design of DES structures for tailors solvents for specific polysachhrides
(2) Intelligent optimization of subcritical water extraction paramcters, establishing temp-PH-time synergy.
(3) creating hybrid techniques w/ physical processes.

Film Forming methods
1. Solution casting: produces films with uniform surfaces and dense structures through solution casting and volitilization drying
2. Extrusion Blowing: where molten biopolymers are shaped through ~~using~~ ~~air~~ blowing air.

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Date 08/24/2025

- 3D printing technology
- Electrospinning
- layer-by-layer assembly
  - Layer by Layer (LBL) assembly. This technique involves alternating deposition of oppositely charged polysaccharide molecules.

To ~~enhance~~ enhance films, blending technology has become a ~~crucial~~ crucial method for preparing polysaccharide-based films. multi-crosslinking helps to improve mechanical properties, biocompatibility, and degradability. Incorporating nanomaterials such as cellulose nanofibres and metal-oxide nanoparticles can improve mechanical properties, barrien charateristics and functional characteristic

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crosslinking modification involves adding chemicals, heat, or light to make long chains of sugar bond together. This process also creates strong films.

Source: From waste to functional material: preperation, modifications and applications of polysaccharides-based biodegradable films

08/25/2025

to measure the leaching potential, the film will be inserted in chemicals to simulate soil conditions the leachate solutions will then be analysed ~~according~~ (hazard classification) according to the EU REACH hazard critirea.. This is inspired by a previous study done in 2025.

Source: Higher potential leaching of inorganic and organic additives from BDM's compared to conventional plastic.

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Date 08 / 26 / 2025

08/26/2025

there are some risks involved in taking pullulan: Allergic reactions, Digestive issues, low quality and impacts on the absorption of nutrients, and drug interactions. However, pullulan is still generally recognized as safe from various food safeties authorities. Futhermore, most concerns arise when taken in high dosages or if low quality. Therefore, it is important to take in small amounts from reputable manufacturers

Source: Top 5 Dangers of Pullulan: A detailed examination

→ By: Mimei Biology

Negative impacts of pullulan is typically seen at ≥10g per day

Mo Tu We Th Fr Sa Su

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Date 08/27/2025

Rough Method

1. Researching different biopolymers

2. form
   prin
   use
   for

3. Te

Other things to test:
- hole sizes variation for aeration
- colour
- specific vs random electrospinning fibre

b. Functionality testing
   ↳ tensile strength
   ↳ gas exchange
   ↳ vapour trapping
   ↳ bioassay (film + photo impact on seed germination)
   ↳ growing plants: comparing yield, yield value, etc.

SRS

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Date 08/22/2025

4. Adjust film to make it better.
5. Analyse results of final mulch.

08/28/2025

3D printing technologies innovative paths. Despite the fact that polysaccharides are difficult to print, many innovative NSQ strategies have emerged. This technique successfully achieves high precision 3D printing of 5 polysaccharides including glucomannan. Printed structures maintained shape stability for over 3 months.

PVA has excellent compatibility with various polysaccharides and serves as an ideal printing material. When PVA is combined with SA, and carboxymethyl cellulose (CMC) at a 7% ratio, it forms a strong cross-linked network which enhances SA's printing by 20.63 times.

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Memo No.

Date 09/04/2025

An electrospinning setup has 3 main [illegible] with a sp[illegible] voltage pow[illegible] collector The [illegible] at [illegible] solution [illegible] a stra[illegible] elec[illegible] nano- fib[illegible] fibres are dep[illegible] collector ma[illegible] reaching [illegible] enter He[illegible]

025

In a lab too?

Q's 4 Yohan Mom

- electrospinning
- pullulan? cellulose? Pectin? Alginate?
- to make a complete toxic leachate-free film, do I need to use natural substances

Pomace is collected from a juicer then wash with water then boil is acified water then, when cool, put it in a centrifuge to seperate the pectin pulp then clean with dilute baking soda and dry it. Glycerin that's food grade can easily be obtained.

Question List — Jack Walker

- Any replacements for electrospinning
- Is it "novel" enough
- Should I test different colours?
- Is using chemicals like PVA ok if I find a way for them to not leach → is that even possible?
- I will put the film in distilled water and let the film leach any substances. Then I want to test the leachates with solvents to mimic pesticides.
- How would I choose these solvents?

RE/MAX
BUYING or SELLING!
One of Calgary's Top Producers with over 20 years of experience.
Talking House
A Talking House Connection More Leads
Not intended to solicit already listed properties

- [illegible] fibers into powder

- [illegible] Extraction -

- [illegible] powder in acidic water (2-3.5 pH)

- [illegible] fibrous waste

- [illegible] pectin

- [illegible] powder

- [illegible] into powder

09/24/2025

Today I was considering a shift in my approach/method. Instead of focusing on leachate toxicity, I think I should focus on water management through drought through built-in

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Mo Tu We Th Fr Sa Su

hydrogel/hydrocolloids. However, previous leachate idea may also be used in a combination.

↳ If two ideas are combined, will it make me lose the main focus?

↳ How can I effectively combine leachate toxicity and water retention in drought?

09/28/2025

I will focus on leachate testing still but incorporate the aspect of hydrocolloid for drought and water retention, as I was already going to.

leachate toxicity

water retention

Toward Sustainable Agriculture: A Non-Toxic Biodegradable Mulch Film for Drought Resistance and Weed Control

Mo Tu We Th Fr Sa Su

Memo No.

Date 09 / 29 / 2025

Objective

1. Toxic-Leachate free
   - ↳ analytical chemistry
   - ↳ bioassay testing

2. Similar Physical/other properties to commercially available plastic fims
   - 2.1. Cost
     - ↳ using food waste-derived biopolymers
   - 2.2 Tensile Strength
   - 2.3 moisture retention
   - 2.4 weed suppression
   - 2.5 plant yield
   - 2.6 gas exchange

Memo No.

Date 11 / 15 / 2025

I will begin collecting materials for the project today. I need:

- pectin powder
- cellulose (CMC)
- glycerin
- Mulch film

The plan is to evaluate the physical/chemical properties of the preliminary pectin/cellulose film. Obviously it will not be perfect. In fact, I'm expecting it to be not as good as the plastic film but I will need to physically see the film ~~behavior~~ so I can make necessary adjustments.

I chose pectin as it's super readily available and it's one of the most commonly wasted ~~bio~~ biopolymer but

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it can form excellent films.

Cellulose is for stability as its water soluble.

glycerin is a natural plasticizer. And vegetable glycerin is natural

Right now, I'm still confused on how to analyse the leachates. I might just do bioassay tests by analysing germination but liquid chromatography/spectrometry will be the best.

Predictions for Preliminary Prototype

1. I expect it to have a jelly-like texture
2. It wont be as strong as the plastic film

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3. it will be clear in colour
4. it will be slightly thicker
5. it will be uniform with no or minimal holes.

12/13/2025

hour	Observations
hour 0	I changed the amount of glycerol in each film and added ½ more glycerin • The solution smells "woody" • Pectin forms clumps • heating helps to dissolve clumps • the amount of glycerin film seemed less thick • The solution was very slippery to the touch
hour ½	¾ tsp - visible pectin clumps - uniformly dry but well-like - pectin present - more jelly on right side

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Date 12 / 10 / 2023

hour	observations
7½	$\frac{2}{4}$ tsp - uniformly dry -less gellMike than $\frac{1}{4}$ - more jelly-like on bottom section -cold to touch
	$\frac{1}{4}$ tsp - very hard in center - dryness not uniform, (middle is less dry) -many air bubbles - the most clear of all -Right edge is most jelly-like
24	$\frac{3}{4}$ - still very wet - needs more time, at least 24 more hours
	$\frac{2}{4}$ - slightly wetter than $\frac{3}{4}$ -became thinner
	$\frac{3}{4}$ - almost completely dry

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Date 2 / 11 / 2025

hour	Observations
32	$\frac{1}{4}$ - so dry that it come off the plate - removed from yogurt lid $\frac{2}{4}$ - sides starting to come off plate but not fully dry $\frac{3}{4}$ - still completely wet.
50	$\frac{4}{4}$ - peeled off → strong + flexible → plastic-like $\frac{2}{4} + \frac{3}{4}$ - films not dry yet.

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Date 12/11/2025

hours	Observations
60	- everything is dry and peeled - Some of the solution in 3/4 leaked making it hard to peel the 1/4 - the 2/4 one seems the most flexible despite having less than 3/4.

12/20/2025

Testing - Film #1

Thickness

1/4 tsp glycerin - 1/2 mm

observations - sides are very dry and brittle. I noticed as I was trying to flatten the sides a bit.

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1/4 tsp glycerin - 1/2 mm
observations. also very brittle, easily able to tear it. This is a problem because once a tear is started, it's easy to break.

3/4 tsp glycerin - 1mm
observations - the sides that were folded in kinda "attached" since I likely took it out w/o complete drying so it must've fused. It was less brittle on actual

Lux

1/4 tsp glycerin - 1092
observations - kinda confused tho but this measurement as lux changes from place to place but ok.

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2/4 tsp glycerin - 1129

3/4 tsp glycerin - 1267

Mass

I dont have acess to a lab so I have to estimate. I believe 1/2 + 2/4 must be 2 grams. 3/4 must be 2.5 grams.

Area

All area is same.

$$A = \pi r^2$$
$$= \pi \left(\frac{11}{2}\right)^2$$
$$= 95.03 cm^2$$

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Permeability (60 seconds, 10mL)

This test will be done before mechanical tests as it will showcase if the film will genuinely perform even w/ wet spills/irrigation.

1/4 tsp glycerin - became a bit jelly-like where the water touched
- 0.1 mL passed.

2/4 tsp glycerin - still jelly-like (I think its less jelly-like)
- 0 mL passed.

3/4 tsp glycerin - even less jelly-like,
- 0 mL passed.

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Stiffness Coverhang length

3/4 tsp - 5cm

2/4 tsp - 4cm

1/4 tsp - 3cm

Flexibility

1/4 tsp before - 11
after - broke of 1 lbs.

2/4 tsp before - 11
after - broke at 3 lbs

3/4 tsp before - 11
after - broke at 5 lbs

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Tear resistance/puncture resistance

3/4 - 10.11g / 182.08g

2/4 - 25.27g / 108.05g

1/4 - 26.59g / 94.90g

Qualitative Observations:
- Solution casting leaves the sides brittle
- The film becomes weak after getting wet
- air bubbles/tiny undissolved particles

12/21/2025

Mini Analysis

1. Brittle sides
- To address this, the film will be casted onto a flat surface.

Materials
Date 2/12/2026

2. Waterproofing
   - Address this using beeswax and coconut husk.
3. Tear resistance
   - calcium? coconut coir
4. Flexibility
   - needs to be 0.2mm (33.3% less material)
   ↳ pour on parchment paper

Original Recipe:
- 1/2 cup water
- 3/4 tsp glycerin
- 1/2 tsp cellulose
- 1 tsp pectin

→ use 1/2 of this

New Recipe:
- 1/4 cup water
- 1/4 tsp glycerin
- 1/8 tsp cellulose
- 1/4 tsp pectin

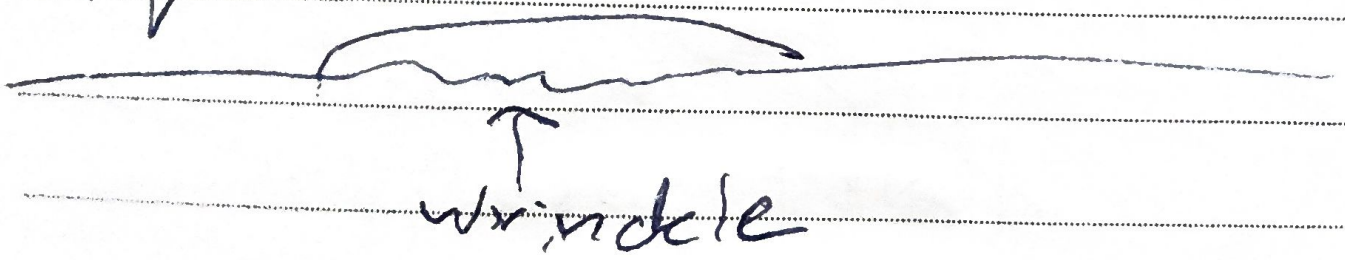
Memo No.
Date 12/21/2025

Film: Take 2

- Added coconut coir to warm water.

$\frac{1}{4} = \frac{6}{24}$ $\frac{1}{6} = \frac{4}{24}$ = $\boxed{\frac{1}{8} = \frac{3}{24}}$

- Calcium added but immediately clumped up?
- At first the films seemed to be more liquidy but this wasn't the case as it soon became more viscous
- The parchment paper began to wrinkle up when touched w/ the liquid



- sides are very uneven
- the film didn't spread as much as expected as it becomes viscous quickly.

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Date 12/21/2025

- I don't think the coconut coir will be enough to reduce lux transmission and tear resistance → either more coir is needed OR another fibre. → maybe try cellulose next? 12/23/2025

Testing — Film #2

Observations / notes

- The film is BRITTLE
- trying to make the film more flexible caused me to make it thinner but that made the film brittle.
- ~~I will keep~~
- The coconut didn't seem to do much.
- Crosslinking through calcium + citric acid can help.

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- Also, too much pectin (might) is keeping the film stiff
source: National Center for Home Food Preservation
- Or, I can add more glycerin
  → must be glycerin, needs to be up to 45%.
  source: Linyong PVC
- Crosslinking
  → can make the film stiff - so should I overcompensate with more plasticizer?
  → ionic: less rigid, more flexible, reversable
  → covalent: permanent

Data

Thickness: Film #1: 0.1 mm
Film #2: 0.1 mm
Film #3: 0.1 mm

Lux: Film #1 –
Film #2 –
Film #3 –

Mass: All are likely 1 gram

Area: Film #1 –
Film #2 –
Film #3 – } 22.5 cm²

Permeability: Film #1 – 0 cm
Film #2 – 5 cm
Film #3 – 0 cm

Stiffness: Film #1: 4 cm
Film #2: 5 cm
Film #3: 1 cm

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Date 4/22/2025

Flexibility: Film #1 - 0lbs
Film #2 - 0lbs
Film #3 - 0lbs

Tear Resistance: Film #1 - 8.8g
Film #2 - 4.4g
Film #3 - 22g

Puncture Resistance: Film #1 - 4.4g
Film #2 - 4.4g
Film #3 - 4.4g

Qualitative Observations:
- hard to peel from surface
- very rough
- not uniform
- coconut coir makes holes
- not flexible at all - like wood paper

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Date 12/23/2025

Film: Take 3

New recipe:

- 1/4 tsp pectin
- 1/8 tsp MC
- 3/8 tsp glycerin
  - → tripled amount of glycerin
- 1/16 tsp citric acid
- 1/2 cup water

Observations:

- The film was soo liquidy this time. The middle one is thickening but the rest don't seem to.
- I left the cellulose to hydrate a bit may have added too much water
- I casted the film on yogurt lids again

- Overnight
- The Film

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Date 12/26/2025

12/26/2025

- Peeled film off but won't come off smoothly - likely didn't oil properly
- bought plastic mulch (LDPE)
  - ↳ its similar in strength and flexibility but it does not stretch nearly as much.
- I need to make the film more flexible, leading me to go for more plasticizer but it already feels tacky
  - ↳ another thing: film is not completely clear so weed suppression testing might be difficult
- If I increase plasticizer film may get too tacky or weak

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- Also, the egg shell → vinegar reaction has seemingly stopped forming calcium acetate.
  ↳ ionic crosslinking will be attempted

The problems with Film #3

1. It does not stretch
2. It's still not waterproof
3. glycerin is expensive

Potential Solutions

1. Sorbitol
2. Lignin? Chitsan derivatives?
3. Sobitol derived from waste

What is the best waste-derived plasticizer? (or natural)

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Date 12/27 12:03

- Beeswax is expensive so I want to create a composite material with banna wax (naturally found in peels).
  ↳ must be a small amount as the Film still must degrade in 5-6 months. So, we'll make beeswax: bannana wax ratio 1:3.

Testing - Film #3

observations/notes:

- films are thin and flexible, but just a bit tacky
- they were put in the oven at 150°F (for crosslinking and it worked. (seemingly) it seems stronger
- the films are broken due to strong adhesion, I will put more oil on the new coasters

- [illegible]
- [illegible]
- [illegible]

Quantitative:

	Film #1	Film #2	Film #3
Thickness	0.1mm	0.1 mm	0.1 mm
Lux			
Mass	[illegible]	[illegible]	[illegible]
Area	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Flexibility	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

Memo No.
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Testing - LDPE film

Observations:

- The film is clear but has a bit of a 'white' finish to it
- It is soo stretchy but not very elastic
- its very light and smooth, not to dry at all
- It was also very cheap, $8 for a whole role.
- As not very elastic
-

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Testing Notes:

- lower than expected flexibility

	Trial #1	Trial #2	Trial #3
Thickness	0.1mm	0.1mm	0.1mm
Area	~99cm²	~99cm²	~99cm²
Mass	<1g	<1g	<1g
Lux			
Permeability	0mL	0mL	0mL
Stiffness	2.5cm	3cm	4cm
Flexibility	1lbs	0.5lbs	0.5lbs
Tear resistance	120g	130g	140g
Puncture resistance	19g	16g	13g

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Memo No.

Date 12/21/[illegible]

Film: Take 4

New Recipe:

- 1/2 tsp pectin
- 1/8 tsp MC
- 1.5 tsp Glycerin
- 1/8 tsp citric acid
- 1/2 cup water.
- calcium acetate (10mL?)

Although the ratio of all ingredients increased by a factor of 2, the amount of glycerin was doubled to get more stretchy. Also, I spilled some calcium acetate I cleaned most of it but some of the residue I used to see if it made any changes to the film... It made an immense difference, making it much stronger only after a few minutes

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Date 12 / 27 / 2025

of testing
Observations: ↗ has 15 mL of solution.
also each plate
- put double amount of glycerin, I can doesn't feel as "slippery". feels more like water
- poured on the Mickey Mouse posters (MMC)
- it has really strong surface tension allowing it to stay on the MMC.
- had some extra so poured it on aluminum foil
  → has a bit of a grayish tint so I don't like the aluminum foil caused the original colour
- 2 coasters have extra oil
- some of the edges of the films are a bit rough (not a clean circle)
- although I didn't notice much of a difference w/ citric acid, I still added it.

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Date 12/24/24

Mo Tu We Th Fr Sa Su

- The films are drying → seems like they thinned a bit
- Also put peels in Acetone to extract wax (beeswax) from the peels
- After the banna peels sat for a long time, some peels seemed more smooth (maybe placebo effect)
- filtered the acetone after soaking the bannana peels 4 60 minutes.
  - → solution was orange
  - → some solids still passed through after the coffee filter
  - → some consistency (liquidy)
  - → has acetone smell

Aluminum Foil Trial Film:
- Wanted to just observe the properties as a quick trial
- It was hard to remove, also very thin and sticky (from plasticizers?)
  - → before crossline no

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Date 12/28/2025

- after crosslinking for 15 minutes, film was not sticky
- some are still soaking in calcium acetate
  ↳ also, had to remake calcium acetate as it fell
- most films still feel tacky → not ready to remove yet.

12/29/2025

- some films peeled but they broke
- I found that I had to razor its edges all around to peel properly
- the 'extra' oil' films are still wet

12/30/2025

mode apple pomace

- All films peeled, thicker the film, easier to peel
- You can join broken ends w/ H_2O

Memo No.
Date 12/31/20

Testing - Film #4

Observations:
- Last step was adding banana wax. Yes, there was low yield but it a little went a long way
- The wax was a bit hard to apply
- All films are perfectly circle
- think they could've crosslinked more. Put the film together. Will test permeability later.

	Film 1	Film 2	Film 3
Thickness	0.4mm	0.3mm	0.4mm
Inx			
Mass	2g	2g	2g
Area	d=9.5cm	d=10cm	d=9.5cm
Permeability	1 lbs	2 lbs	0.5 lbs
Stiffness	4cm	6cm	4.5cm
Flexibility	1 lbs	2 lbs	0.5 lbs
Tear Resistance	35g	33g	29g
Puncture Resistance	93g	50g	85g

2 = amended 1

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Memo No.

Date / /

Film: Take 5

Previous films were expensive. Getting Pomona's pectin is $8 when I can make my own with food waste. So, the table below summarises information on biopolymer/other useful material extraction:

	Material	Source
plasticizer	NADESs solution	Glycerin + pineapple peel syrup
Film former	Pectin/starch	Apple/potato peel
reinforcer	Cellulose	Paper
crosslinking	Calcium Acetate	eggshell + Acetic acid
coating	wax	banana wax

The crossling and coating is already made. I need to make: Pineapple peel syrup and apple pectin and paper-derived cellulose.

Mo Tu We Th Fr Sa Su

Memo No.

Date 2/3

To buy
pectin
Buy: Isopropyl alcohol
NADES
Buy: pineapple.

Recipe for Cellulose

1. Cellulose ✓

1. Shred paper
2. Boil paper w/ enough water to cover paper.
Add 1tsp baking soda
3. Pour all contents into a strainer
4. Rinse pulp till clear
5. Blend pulp w/ 1.5 cups fresh water

Observations:

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- I put the apple pomace to dry in the oven at 150°F for 1 hr
- I noticed the film on the side of the cup after filtering the paper
  ↳ the water is kinda yellow

Observations
- I filtered all the pomace/acid water
- I put 400mL of 91% isopropyl alcohol to precipitate pectin
- I made the cellulose powder today and its a decay substance
- currently the isopropyl alcohol/pomace effluent is in the fridge for one hour.

Mo Tu We Th Fr Sa Su

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Date 01 / 01 / 2026

Way to structure project

Phases: 1. A toxic-leachate free mulch

2. Reducing Cost through using waste materials

3. Evaluating its use against traditional mulches.

Phase 1 is complete, I have a good film. Just need to do bioassay - analysis

Today, I need to cast my waste-derived film

TO-DO:

- Start bioassay
- Cast waste film

Mo Tu We Th Fr Sa Su

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Date 01/01/2026

- Put films in water @ 5 p.m
- put 200 mL of water or 2 banana peels
- put chopped orange in 500mL of acidic water w/ 1/4 tsp citric acid
- put filtered banana syrup to wet

= banana syrup didn't work but some why accumulated on the bottom (higher yield than without honey).

- Put 300 mL Isopropanol in the boiled peels and A LOT percipitated
- Made Sodium Acetate by putting a lot of baking soda in 750 mL vinegar. Boiled it until I saw crystals. Now waiting for it to turn to solid

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- ~~Weighed out~~ - 780 grams of pineapple peels
- Sodium Acetate has significant crystalized.
- control #2 no growth, still moist, will water tomorrow.
- Leachate #3 has a seed with half of it w/ no skin?
- nothing in leachate trial one either.
- Leachate #2 has a seed with skin peeled off.
- nothing in control #3 or #2
- Overall, no growth so far.

→ boiling for 90 minutes.

- Made the plasticizer, similar consistency to glycerin but a bit less viscous (waiting to cool), colour is amber (scored that its a bit caramelized)

- noted seeds/shoot longer

# of germinated seeds/shoot length

Days	1	2	3	4	5	6	7
Control #1	0	0	0	0	0	0	0
Control #2	0	0	0	0	0	0	0
Control #3	0	0	0	0	0	1	1
Leachate #1	0	0	0	0	0	0	0
Leachate #2	0	0	0	0	1	2	2
Leachate #3	0	0	0	0	0	1	0

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- after cooling, got much more viscous.

Making Waste-derived Film Phase 2: Take 1

1. add 1/8 tsp cellulose in 1/3 cup water
2. dissolve 1/4 tsp pectin
3. 3/4 tsp plasticizer + 1/16 tsp citric acid
4. 1/16 tsp banana wax

- Adding the citric acid caused a reaction, is it basic?
- The pectin took so long to dissolve
- The consistency is like water, not slippery with speckles.
- Only made enough for one film.

Mo Tu We Th Fr Sa Su

Memo No:

Date 01/03/20

Potential Problems

1 - Not enough water while casting the film
- Lormalised sugar
  ↳ NADES not made properly
- Cellulose is also NOT incorporated properly

Revised Plan

- precipitated pectin directly in blended cellulose
- Remake NADES
- Calcium Acetate instead of Sodium Acetate

Mo Tu We Th Fr Sa Su

Memo No.
Date 01/04/2026

- This time using 450g pineapple waste.
  L> 616 mL of water
- Reduced pineapple syrup to make it more concentrated
- also put orange peel extract to cool Chas Uxeon 5 hours)
- Blended 10g cellulose pulp in 100mL water
- Still no germination, maybe ~~doesn't~~
- some film samples here
- blended 5g of cellulose pulp in 500mL of water, using 250 mL of that water to make film.
- 1g dry weight pectin

Memo No. _____

Date 01/04/202

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Recipe:

- 100 mL 1% cellulose (1g) suspension
- 150 mL water
- 3 tsp wet pectin (1g dry?)
- 1/4 tsp wax
-

Plasticizer calc's

40% of polymer weight

(0.4(2)) = 0.8g round up

2g of plasticizer

2:1 ratio

2:1 glycerin:

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Memo No.

Date 01/04/2026

- Potencial criteria for classification of fuctional groups: bioaccumulation in soil/organisms or synthetic v/s natural
- I got the pectin ready, tried to wash it instantly but alcohol did'nt come out fully
- The pectin yield is too low, I think the pH while extraction is too high.

01/05/2026

- Took plant measurements
  ↳ no growth yet

01/06/2026

same

Memo No.

Date 01/07/2024

- Today, we got 1 germination from a leo drote sample
- Also I casted the next films but they seem a bit too liquidy 😐... This happened before too, so it should be okay.
- Also! Got FTIR ACESS!!!

Recipe:
- 75 mL distilled water
- 120g peel pectin.
- 25 mL 0.4% cellulose mixture
- NADES: 0.5 mL Glycerin: sugar syrup 2:1

- The film has a bit of a orange smell and tle

> will add once dry:
- banana wax
- calcium crosslinking.

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Memo No.

Date 01/07/2026

Leachate #2:

2 germinated:

- 4mm

- 0.3mm.

Leachate #3:

1 germinated:

- 3mm

01/09/2026

Leachate #3:

1 germinated

- 5mm (curled up)

Control #3:

1 germinated

- 4mm.

Leachate #2

2 germinated:

- 1cm

- 0.5cm

Plants:

- It grew faster + more in leachates than control

- Didn't germinate as fast as the

Memo No. _____

Date 01 / 09 / 2026

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- The og film (Phase 2 - Prototype 1) failed completely the layer of cellulose I was planning absorbed like 90% of the solution I only had enough for one
- Phase 2 - prototype 2 went better. for some reason there was a layer of brown surrounding it
- Pectin yield too low - too high pH?

01/10/2026

- Remaking pectin now using litmus paper.
  - pH is at 2.
  - heating for 60 minutes. (70-80°C)

Name No.
Date 01 / 11 / 2026

- Got pectin extracted,
  ↳ soaking for 24 hours instead of 30 minutes.
- Made sure the pH was low as well.

01/11/2026

- Removed pectin clumps, seemingly a lot more was extracted.
  ↳ Now waiting for it to dry so I can smash it into a powder
  (I have to be quick, and get it done before the H2O)
  ↳ If this batch of pectin don't work I have to use store-bought pectin.

Memo No. _____

Date 01/14/2026

- Pectin yield ended up being higher but not by all much (15-20%. more).
- Making another batch as percent amount & be enough
- Pectin made in even more acidic waters (let it percipiate 4 24 hrs in fridge
- The NADES smells yummy
- The "micro" cellulose dried. Due to time constraints, might have to use it wet.

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Memo No.

Date 01/18/2026

Film creation (waste derived):

Take 3

- pectin: 2g
- NADES: 1/16 tsp
- 5% cellulose: 1/2 tsp
- water: 50 mL

- While mixing the film I had to submerge water per 1 cup of total solution 50 mL
- Solution feels slimey + a lot of pecting sticking on sides.
- Weird apple-sponge consistency?
  - From sponge particles

01/21/2026

Mo Tu We Th Fr Sa Su

Memo No. _____

Date / /

	Film 1	Film 2	Film 3
Thickness	0.1mm	0.1mm	0.1mm
Area	~ 7 1 cm2	~ 7 1 cm2	~ 7 1 cm2
Mass	< 1 g	< 1 g	< 1 g
lux			
permeable	9	9	9
stiffness	5	4.5	5
Tear resis..	T3 g	84 g	91 g
Punct.. resist.	59 g	78 g	72 g

01/20/2026

Film creation (waste derived)

Table 4

- pectin: 12g (wet mass)
- NADES: 1/8 tsp
- 5% cellulose: 1/2 tsp
- water: 50 mL

- I dont have enough time to dry the pectin fully, only waited for isopropanol to evaporate.

Memo No.
Date 01/21/2025

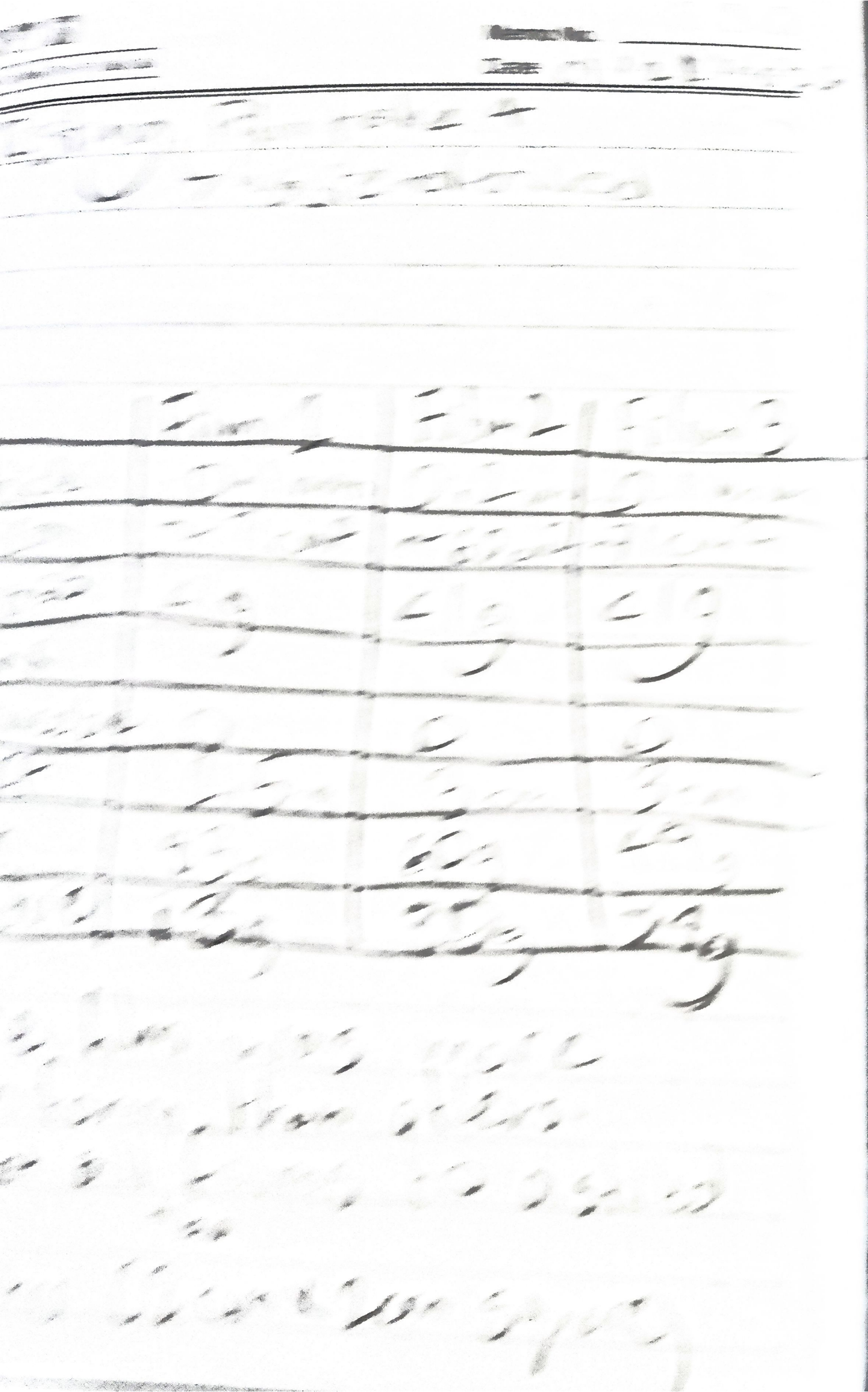
- coated the films
- solution felt more slimey (good sign)
- the films are coated on the MMCs

Later on...

- a similar orange border showing up → why?
- the film does look thicker but I hope its not too thin.

01/22/2025

- peeled the films but ripped a bit
- they have some leftover peel particles
- soaked in calcium acetate 2t. solution.



- went to the lab (early)
- started bioassay.
- Vial 2: biodegraddable:
  - putting it on the ATR crystal
    - diamond
  - Mixing it all evenly to make sure the sample is even
- The instrument can't measure past 450
  - Vial 2 had a dip at 1699
- Vial 2: Pectin
  - Doing the same mixing
  - Unfortunately seems the concentration is too low
- Vial 2: biodegradable conventional
  - Some dips on all.

- Vial 3: Conventional Biodegradable
  - Some dips
- Vial 1: Pectin
  - Some dips
- Vial 2 and 3: plastic
  - Some dips.

01/29/26

- Control #2 has one seed that split open (no germ)
- Leachate #3 has split open (one seed) -> no germ yet
- Plastic #2 has one split
- Con bio #2 has split open (one)
- Everything else is the same

Memo No.

Date 01/29/26

-01/03/26

	7	6	5	4	3	2	1	
	—	—	—	—	1	1	0	Pectin
	e	0	e	1	0	0	0	con Bio
	—	—	—	—	0	0	0	Ref.
	e	e	0	0	0	0	0	H_2O

Memo No.

Date 01/29/26

-01/03/26

	A	9	8	7	6	5	4	Triol	3	2	1	
	—	—	—	0	0	1	e		0	e	0	Pectin
	0	0	—	0	0	—	e		0	e	0	Con Bio
	—	—	—	0	0	—	e		0	0	0	Peptic
	e	e	e	e	e	e	e		0	0	0	H_2O

Memo No.
Date

- Leachate #3 length day 7:
0.6cm
- Control #1: 0.3cm
- Leachate #1: 0.5cm
- plastic #2: 0.3cm
- Control #3: 0.3cm 0.1c
- Plastic #1: 0.5cm
- pectin #2: 0.8cm

pec (1) (2) (3)
plastic 2 (2) (3)
Control (1) (2) (3)
H2O (1) (2) (3)

Problems with this film

1. high stiffness
2. banana wax was hard to use even w/ new method

calcium acetate
- ½ tsp calcium acetate
- 10 mL H_2O

ecipe for cellulose wat
oating. Source: Dev of water-
bis fast paper using chitosan
-ha plant-based wax extracted
rom banana leaves.
1. hydrate ~~on~~ 2/3 tsp MC
powder in 100 mL water

Plastic
its the
before
its the

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Memo No.

Date 02/15/26

02/15/26

- Working on compiling info on platform and online.

Phase 3: Film 2

~~Lots of ff~~ have access to

Could not have enough plasticizer)

- 1/2 tsp pectin
- 1/4 tsp cellulose
- 25 tsp NADES
- 1/2 cup H_2O
- calcium acetate
- beeswax

X

- 1/4 tsp pectin
- 1/4 tsp MC
- 1/2 tsp NADES
- 1/2 cup H_2O
- calcium acetate (10%)
- beeswax

Mo Tu We Th Fr Sa Su

Memo No. _____

Date 02/15/26

I increased methylcellulose concentration to 1:1 ratio. I did this as the lost pectin film was crosslinked too much, the pectin film needed to be strong w/o compromising flexibility. So, MC concentration was ~~increased~~ increased

the other film was stiff after crosslinking and since the banana wax was hard to use, switched to beeswax.

With this film it originally is feeling less slimy but this might be because MC is not as slimy in texture.

The film is clear when casted

Also the beeswax arrived.

Mo | Tu | We | Th | Fr | Sa | Su

Memo No.

Date 02/17/26

- Crosslinked the films

- Trying to understand my project more.
  - Insolvent ~~extraction~~ casting, the polymer chains interpenetrate
    - ↳ meaning the "weave" into each other without chemically bonding
  - How is methyl cellulose created?

Etherification → alcohol + water → H_2O Ester

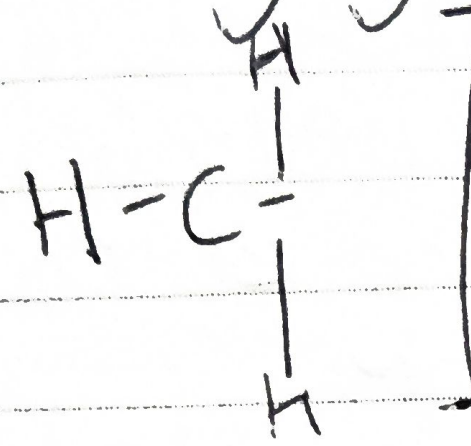
Ester crosslinking:
when an ester bonds two polymers together.

Degree of substitution - how many hydroxide (-OH) groups replaced with methyl groups.

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Date 02/17/26

methyl group: $-CH_3$



- make it more flexible
- makes it more water soluble.

Reasons for making methylcellulose

02/18/26

Method for wax coating.

1. ~~Measure~~ Melt 1.5 tsp beeswax
2. Gather 100 mL H_2O
3. Hydrate + dissolve methyl-cellulose in water
4. Add 1/2 tsp beeswax and heat solution before
5. Dip film
6. Instantly take out film
7. Dry film on a flats



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Memo No.

Date 02/18/26

- 1/2 tsp was far too much
  ↳ reduce to 1/4 tsp

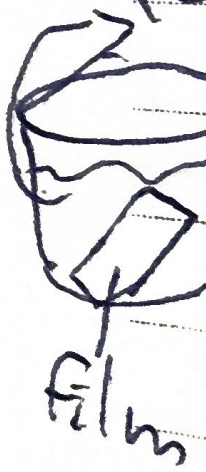
02/19/26

- working on checking extra film drying (trial 2)
- Re-put radish seeds to germinate because others grew too large
- Preparing project presentation
- Sending spectra to Mr. Hoffman
- preparing material for tmrw.

↓ School science fair

SCHOOL SF - 02/20/26

↳ received 2 gold medals
- top grade 9
- top Innovation



Memo No. _____

Date 02/20/2026

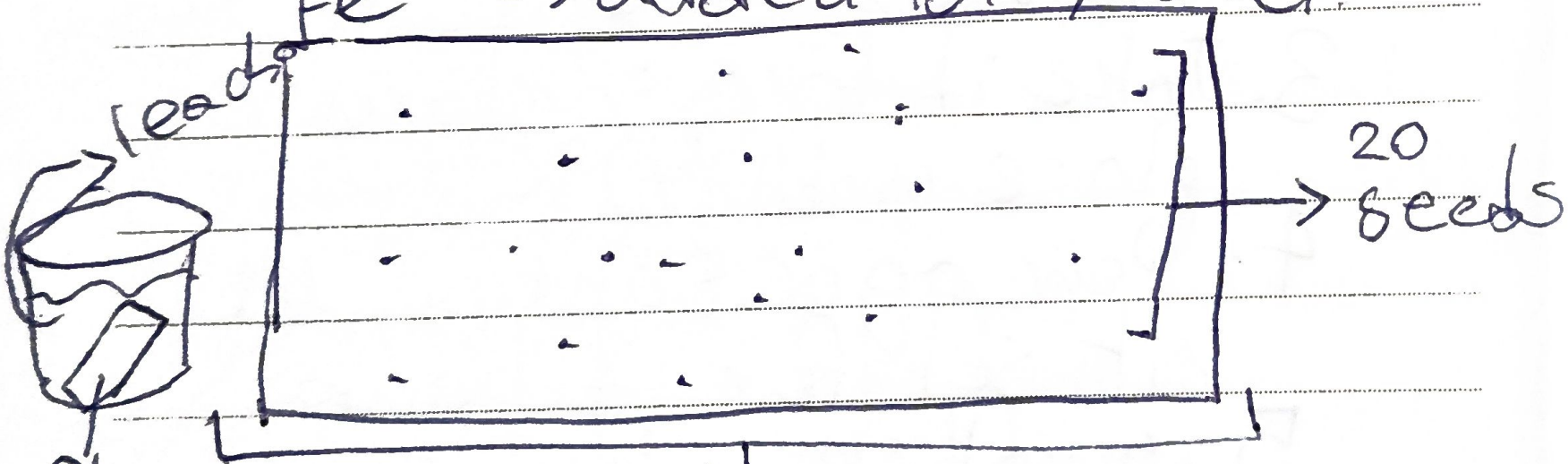
$\bar{\nu} = 1638\ cm^{-1}$



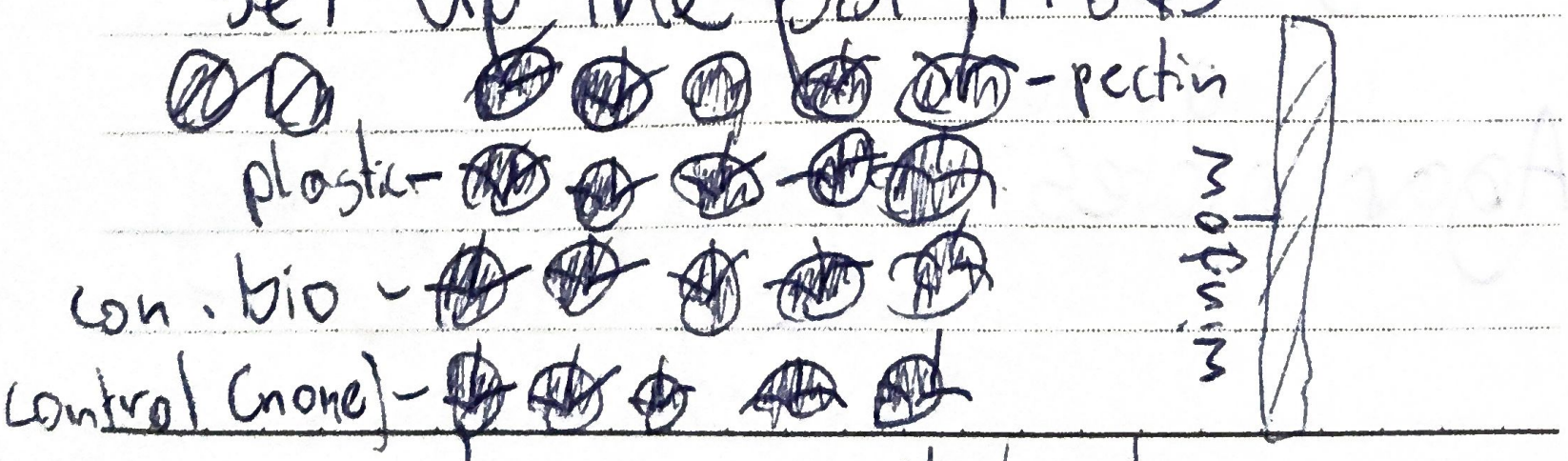
- crosslinked film
- attended school sciene fair → progressing to CYSF.

02/21/26

- Set up the germinating seeds → added 10ml/towel



- set up the pot trials



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Memo No.

Date 02-12 12c

To-do: Agar plates, film coating adding seeds into the pots

Agar plates

1. dissolve agar, sugar, potato ~~peel~~ water, and water.
2. Cook it in instapot under pressure setting for 15-20 minutes.
3. Take it to a sanitary place until 50°C
4. Pour agar soution, let it set for 1 hour
5. swab microbes and put it on the plate
6. See how much microbes grow in 5 days.

Agar plates: 10g agar plates, 10g sugar, 140mL ~~Potato extract~~ 360 mL water.

Mo Tu We Th Fr Sa Su

Memo No. _____

Date 02/21/26

- Tried making wax coating with pectin.
  - 1/4 tsp pectin
  - 1/16 tsp calcium acetate
  - 1/4 tsp ~~glycerin~~ wax
  - 100mL water

much better than before, but the crosslinking mode it worse, try again without crosslinking (crosslink afterwards).



film had a visible wax layer after crosslinking.

Then extra wax was removed with a tissue and left a nice wax layer below.

Memo No. _____

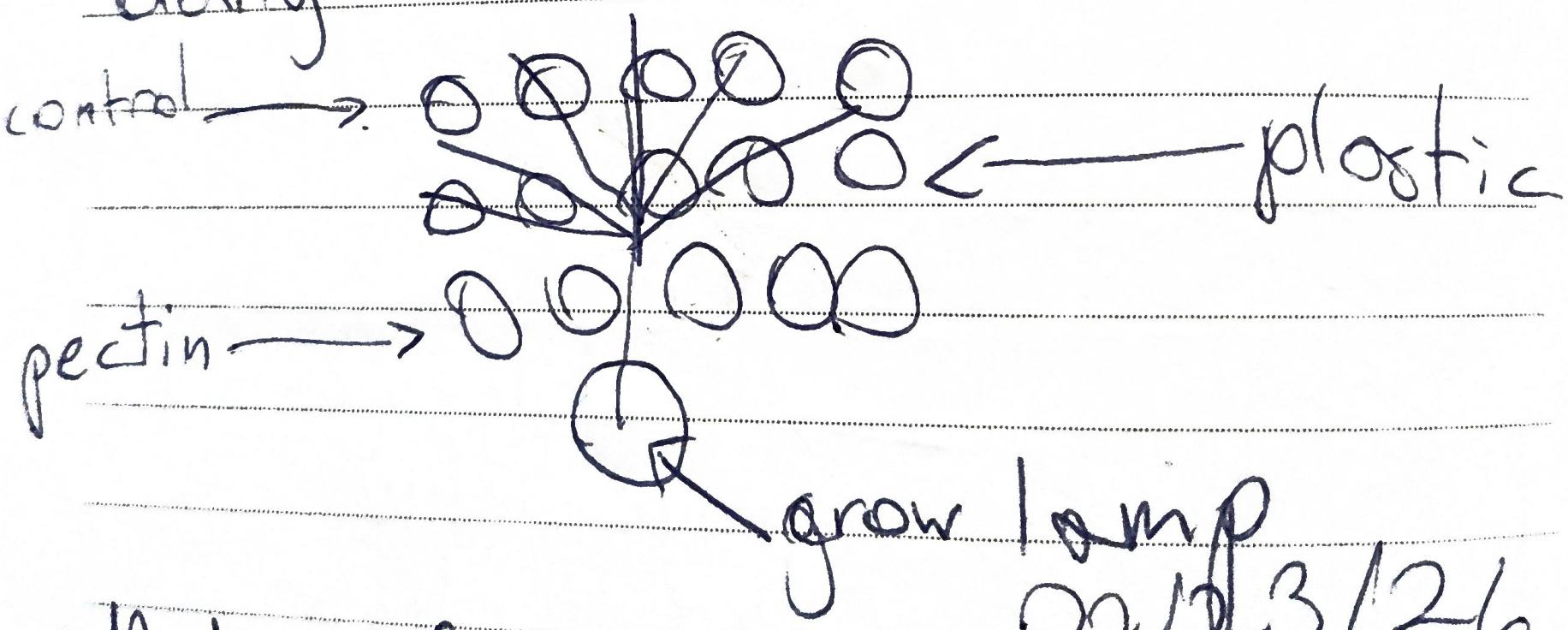
Date 02/21/26

Mo Tu We Th Fr Sa Su

New formula:
- 1/4 tsp pectin
- 1/4 tsp wax
→ inside 100mL water.

02/22/26

- Potted all the plants → need to measure starting height to subtract later.
- Also got grow lamp
- I will rotate each group daily



02/23/26

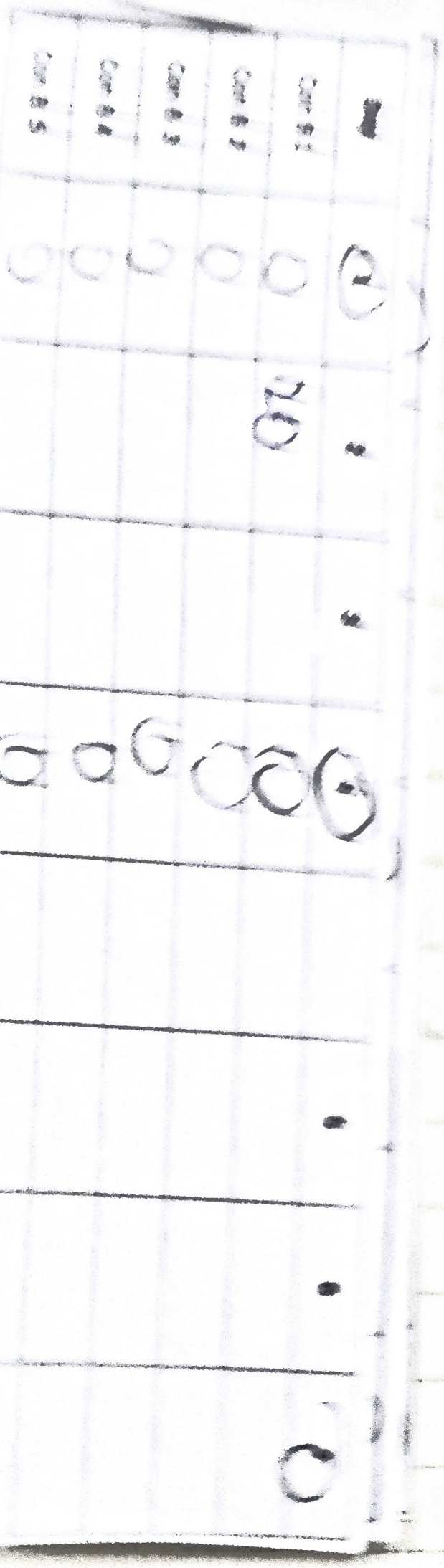
- Making film once again

Mo | Tu | We | Th | Fr | Sa | Su

Memo No.
Date 02/23/26

ermination

Rodd, ob growth





Memo No.

Date 02/23/26

Mo Tu We Th Fr Sa Su

- Raddish seeds all germinated, which is too fast, have to use mustard seeds again
- Raddish seedlings too weak so started growth from seed this time

To-do: Analytical chem samples, mustard seeds.

02/27/26

- Soaking film in isopropanol (50% and 91%)

50% → 50mL isopropanol
→ 40mL water.