nature is a better designer than us

artifungus

artifacts in nature

MFA Design for Social Innovation 2022

Ruike Pan

artifungus
artifacts in nature

the most effective approach is already

designed by nature

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contents

encounter

trash diary

A big part of our trash is plastic products, especially plastic containers.

In order to find out what's inside our everyday trash, we did a trash diary to document the categories of things we threw away.

remake the billiard ball

Ivory Billiard Ball, Nationsl Museum of American Hostory

Billiard Balls Today

In1869, the first synthetic polymer was invented by John Wesley, who was inspired by a company that offered ten thousand dollars to anyone who could provide a substitute for ivory. Polymer is a material that is made of long chains of molecules. It was the first human manufactured things that were not constrained by the limits of nature.

Meanwhile, it was also the first time that humans manufactured something that did not engage in the ecology of nature.

It was the first time that human manufacturing was not constrained by the limits of nature.

It was the first time that human created something that does not engage in natural ecology.

It was the first time that human created absolute trash, which is permanent entropy in our ecosystem on Earth.

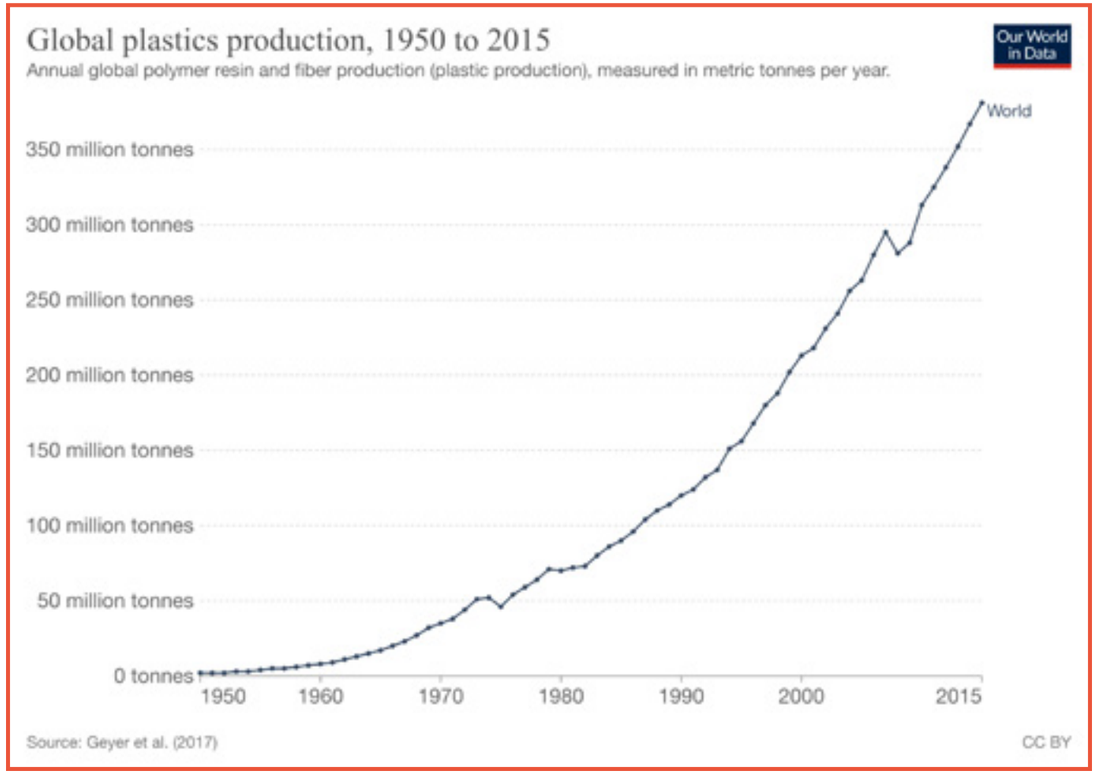
the boom of plastic

The first fully synthetic plastic was Bakelite made by Leo Baekeland in 1907. It was made as an electrical insulator.

During WW2, the scarce natural resources stimulated the expansion of plastic industry, which produced a range of products from parachute to helmet liners, even airplane windows.

The production of plastic has been increased ever since.

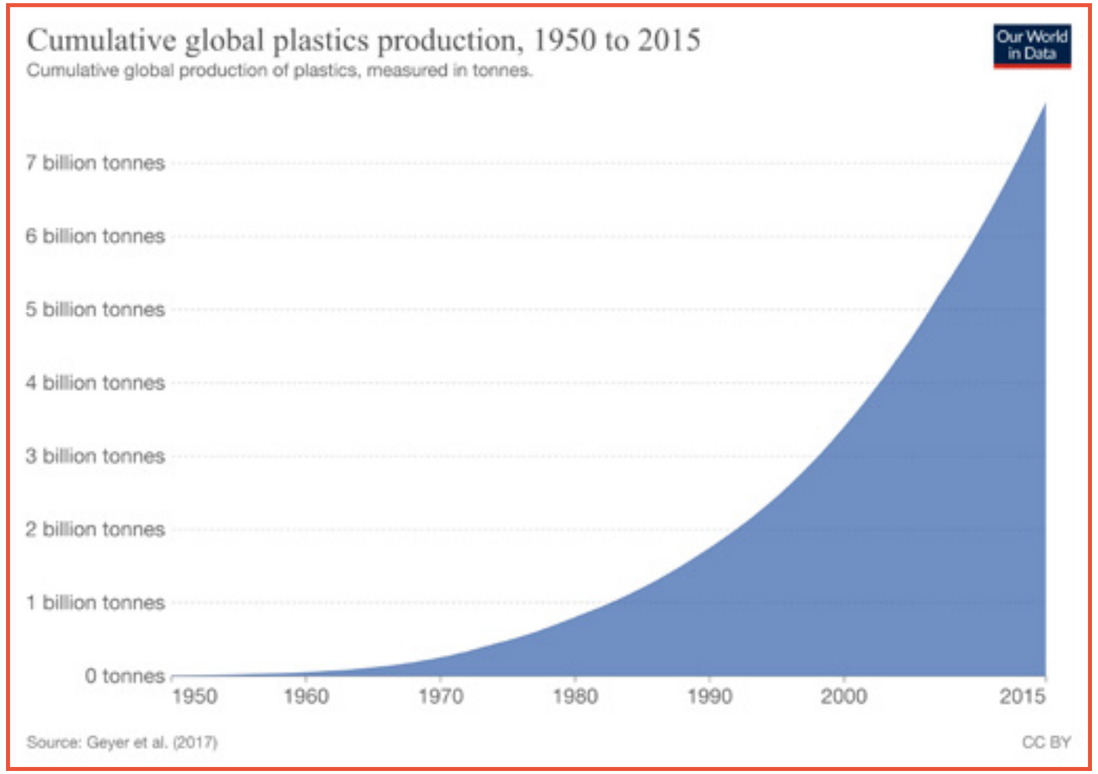
In 2015 alone, the world had produced more than 381 million tons of plastic. In comparison, If the entire human population stepped on a scale, the weight would be 316 million tons.



absolute entropy

Discarded synthetic polymers fit in nowhere in the circulation of matters of the natural ecology. They are unusable entropy occupying the limited mass, resources and room on Earth.

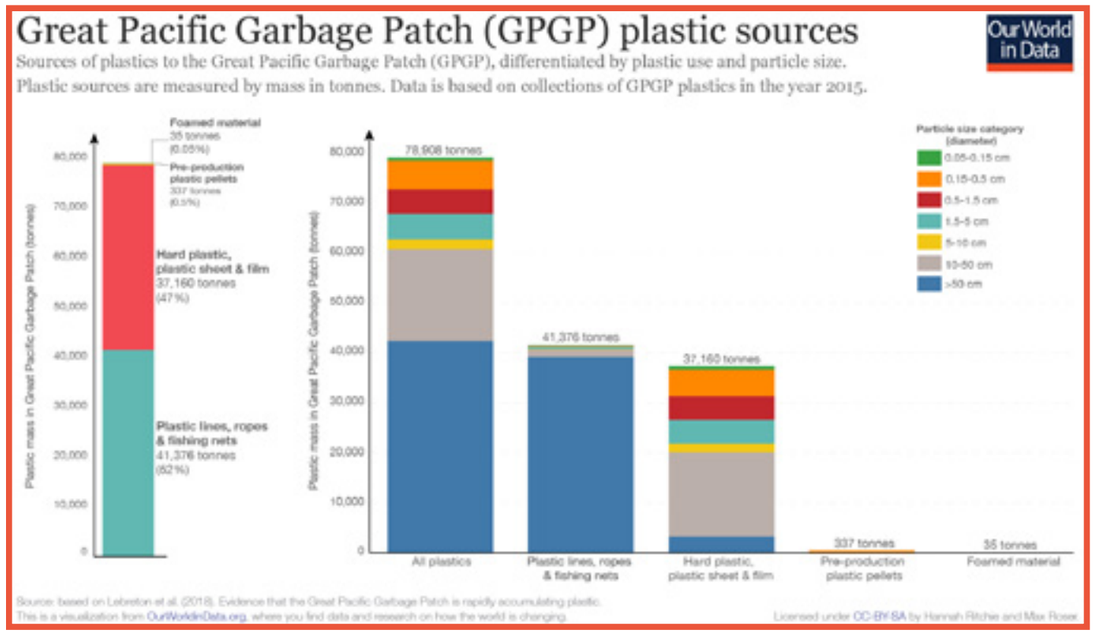
Accumulatively, human has produced more than 7 billion tons of plastic as of 2015, which means there are already more than 7 billion tons of undegradable and unnatural substances on the spaceship Earth.



plastic pollution

The invention of plastic enable people to solve many industrial problems.

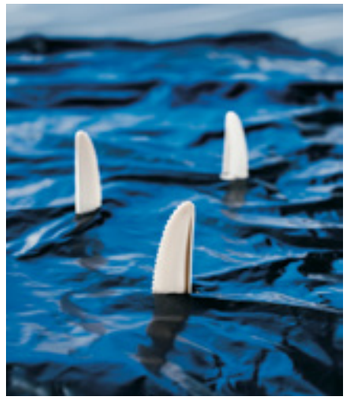
At the same time, it creates more environmental and ecological problems for the whole community on Earth to suffer.



Unwanted plastic is mostly discarded, ending up in landfills or as pollution in the soil or ocean. The Great Pacific Garbage Patch is a collection of marine debris in the North Pacific Ocean. these patches are almost entirely made up of tiny bits of plastic, called microplastics. Marine debris can disturb marine food webs in the North Pacific Subtropical Gyre.

think small

Such plastic pollution could also be broken into countless extremely small pieces of microplastics and goes into the body of animals, threatening the health of the natural ecology on Earth. Microplastics are very small plastic particles generally less than 5 millimeters in length.



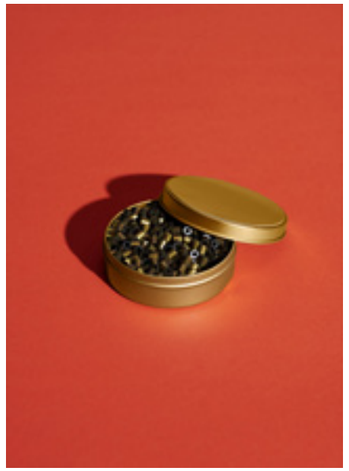
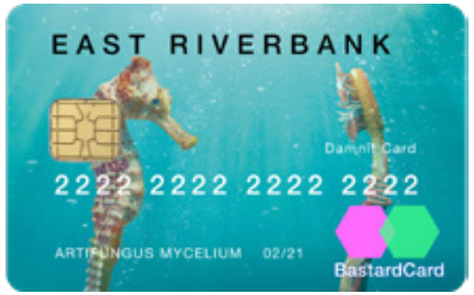


Image: WWF

eating a credit card

A study by WWF from 2019 concluded that people could be ingesting the equivalent of a credit card of plastic on a week, mainly in plastic infused drinking water and seafood, which tend to be eaten microplastic in the ocean.



According to a study by the Marine Biology and Ecology Research Centre (MBERC) in England, the plastic load released from clothes made of synthetic fibers (polyester, polyester-cotton and acrylic) amounts to over 700,000 large MP fibers per machine wash (per 6 kg load) (Napper and Thompson 2016) that end up in waste water. Tons of plastic particles reach their final destination in the sea to enter the food chain through ingestion by marine life (Cho et al. 2019; Van Cauwenberghe and Janssen 2014), through sea salt (Karami et al. 2017; Kosuth et al. 2018; Yang et al. 2015) and/or drinking water (Mason et al. 2018; Schymanski et al. 2018) to further reincarnate on our dining tables. Recent studies have also indicated the presence of MPs in some terrestrial food items, such as edible fruit and vegetables and store-bought rice, but further research is needed to replicate these findings (Dessì et al. 2021; Oliveri Conti et al. 2020). Translated into more imaginable numbers, on average we ingest five grams of MPs per week per person (roughly corresponding to the mass of a credit card) depending on the region in which we live, our lifestyle, and diet (Senathirajah and Palanisami 2021). However, in vitro human cell and in vivo mammalian models suggest that only a limited fraction of the smaller plastics particles will be absorbed by the human body (reviewed by Wright et al. (Wright and Kelly 2017)). A study of human consumption of MPs estimated the ingestion of 90,000 particles through recommended levels of water intake annually from bottled sources of water, compared to 40,000 MPs through tap water only (Cox et al. 2019). The incidental annual human ingestion of plastic particles in the form of airborne MP fibers during an evening meal has been estimated to range between 13,731 and 68,415 fibers per person (Catarino et al. 2018).

Credit: https://link.springer.com/article/10.1007/s12403-022-00470-8

a bloody truth

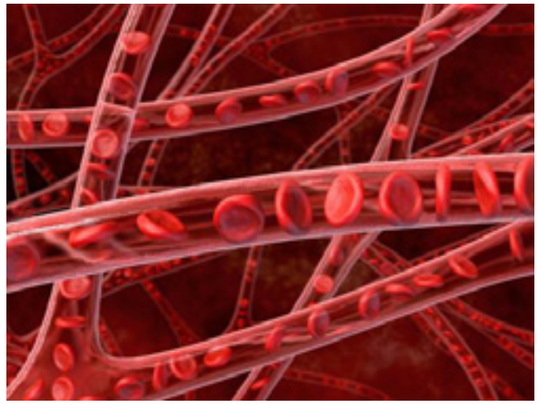


Image: BioSpectrum

A recent study from the team of Professor Dick Vethaak at Vrije Universiteit Amsterdam shows the first indication that we have polymer particles in our blood.

“the sum quantifiable concentration of plastic particles in blood was 1.6 µg/ml”

-- Dick Vethaak

Polyethylene terephthalate (PET), commonly used in disposable water bottles, was the most widely encountered plastic polymer.

The second most common, polystyrene (PS), which is used for food packaging and polystyrene foam.

These plastics are moving from our stomachs to our blood vessels.

Credit:
https://www.theguardian.com/environment/2022/mar/24/microplastics-found-in-human-blood-for-first-time
https://www.smithsonianmag.com/smart-news/microplastics-detected-in-human-blood-180979826/
https://www.sciencedirect.com/science/article/pii/S0160412022001258

we can’t breathe

Microplastics were identified in all regions of the human lungs

Image: science photo library

A team of researchers at Hull York Medical School in the UK analyzed lung tissue taken from 13 patients undergoing surgeries and found microplastics in all levels of the lungs — upper, middle, and lower lung regions.

The types of plastic they found are most commonly used in soft drink bottles, food packaging, and bits of machinery.

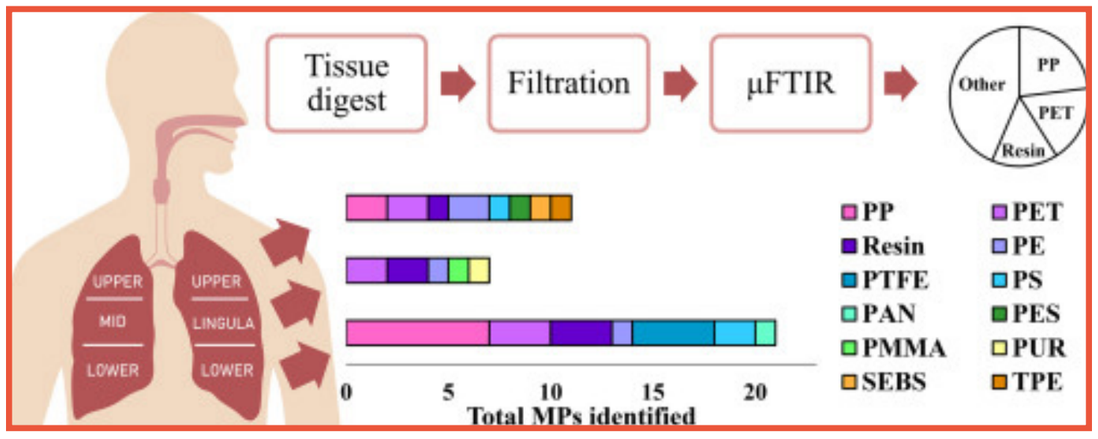


Image: elsevier

Credit:
https://www.sciencedirect.com/science/article/pii/S0048969722020009

“We’re eating them, we’re inhaling them. And we don’t really know how they react with our bodies once they are in.”

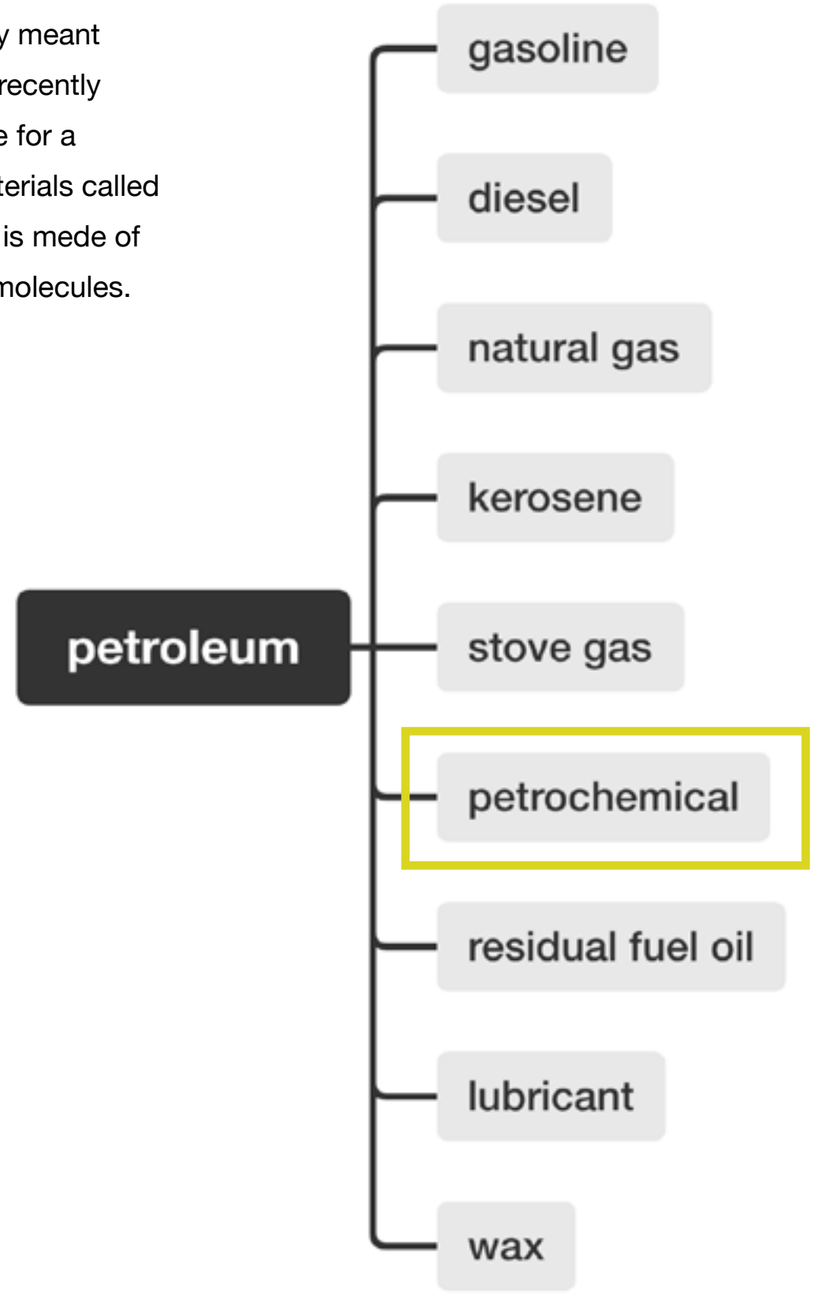
“Once the plastic is in the environment, we can’t really get it out.”

- Evangelos Danopoulos, Hull York Medical School

dive

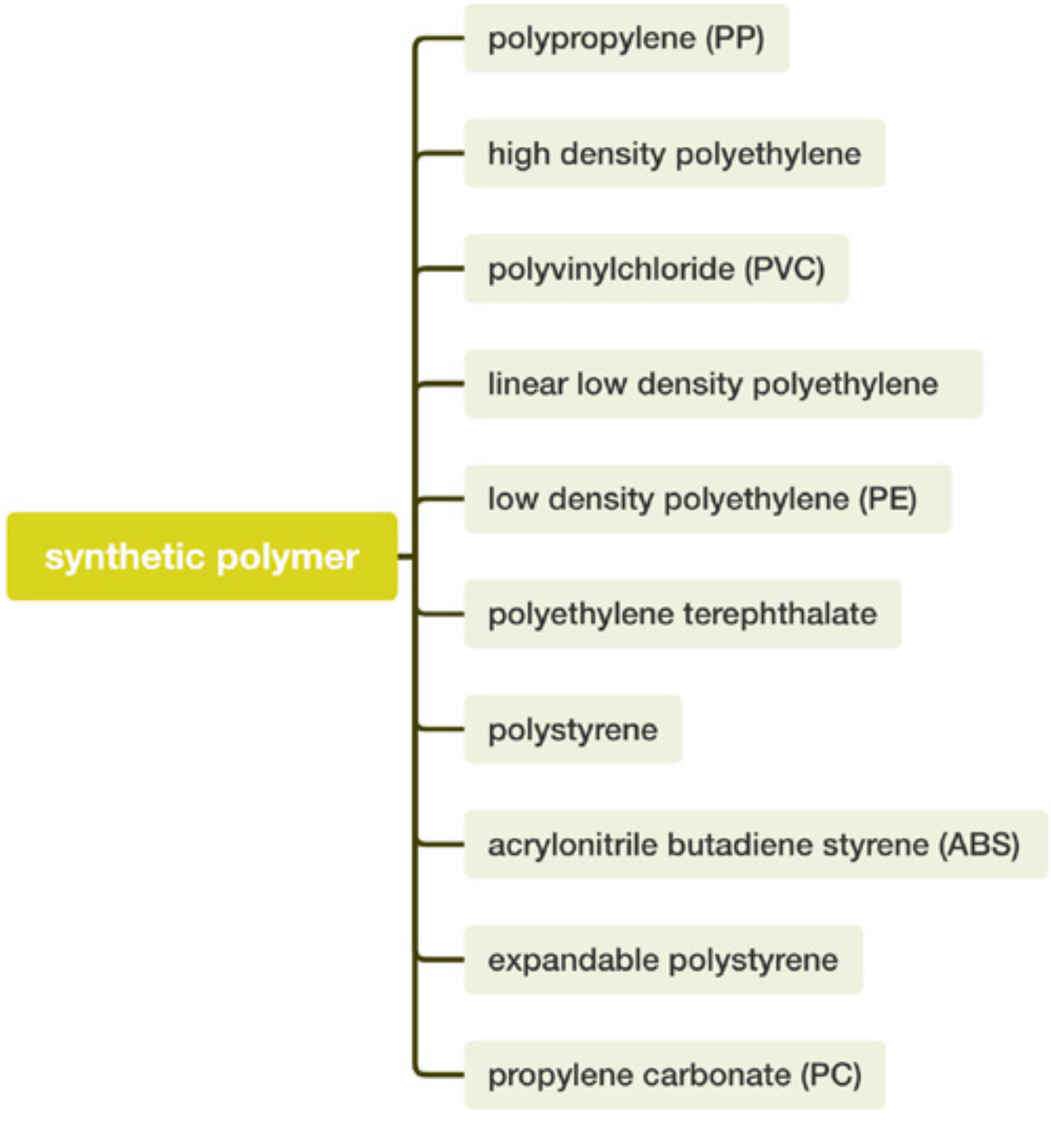
what is it

Plastic originally meant easy to shape, recently became a name for a category of materials called polymer, which is mede of long chains of molecules.



polymer category

These unnatural substances also have unnatural names.
Here are some common types of polymers.



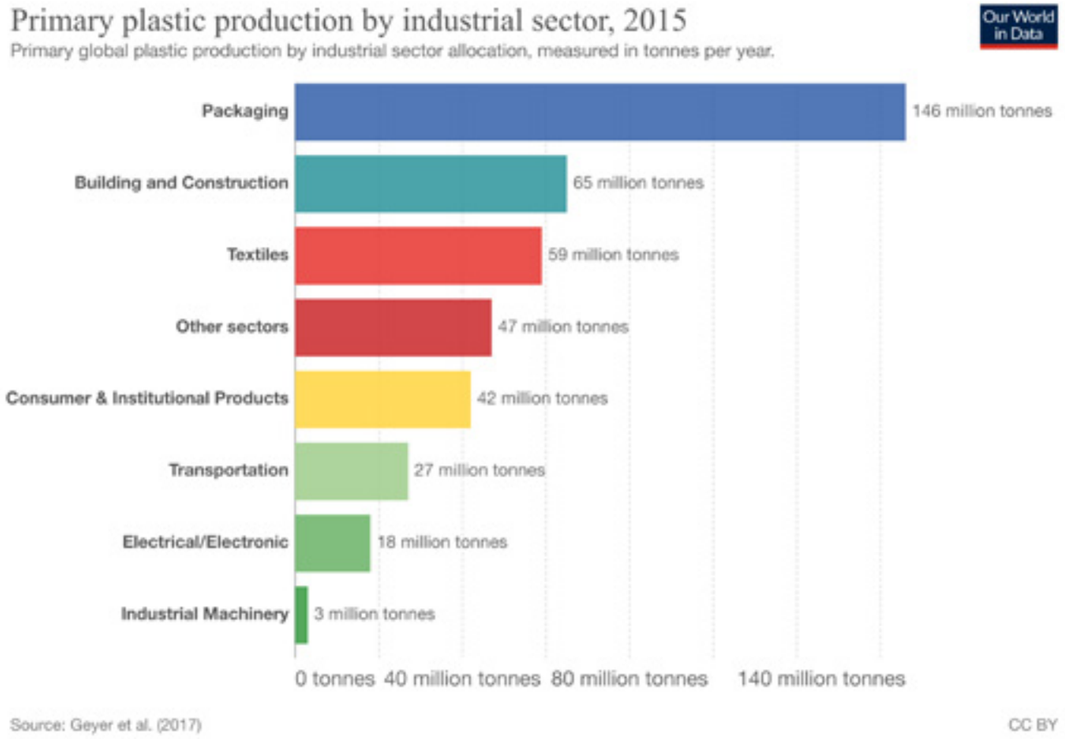
polymer to product

If we look into the final products of these polymers, we will find that they almost conquered the racks in our supermarkets.

Polymer products are everywhere from baby milk bottles to constructions.

plastic in

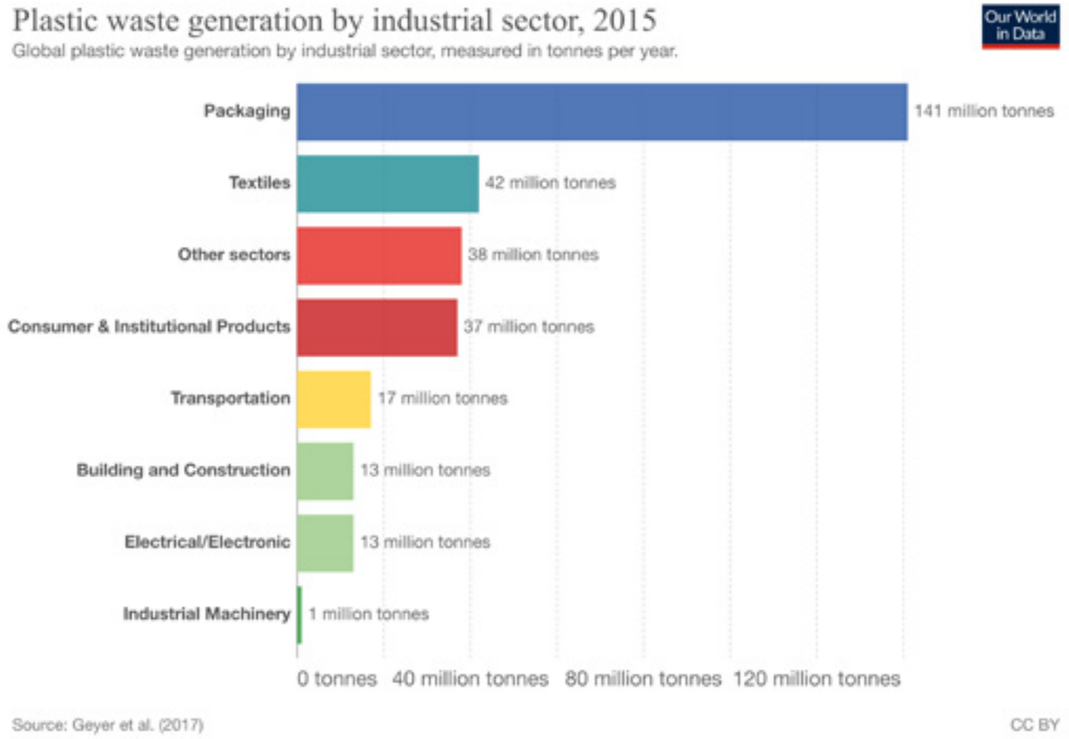
The largest portion of the newly produced plastic goes to packaging, with 146 million tons in 2015.



plastic out

Because of its porpose, packaging has a high rate of disposal. 141 million tons of plastic packaging was discarded in 2015, more than any other categories.

In addition, textile and consumer product also generate a relatively large amount of plastic waste.



saying goodbye

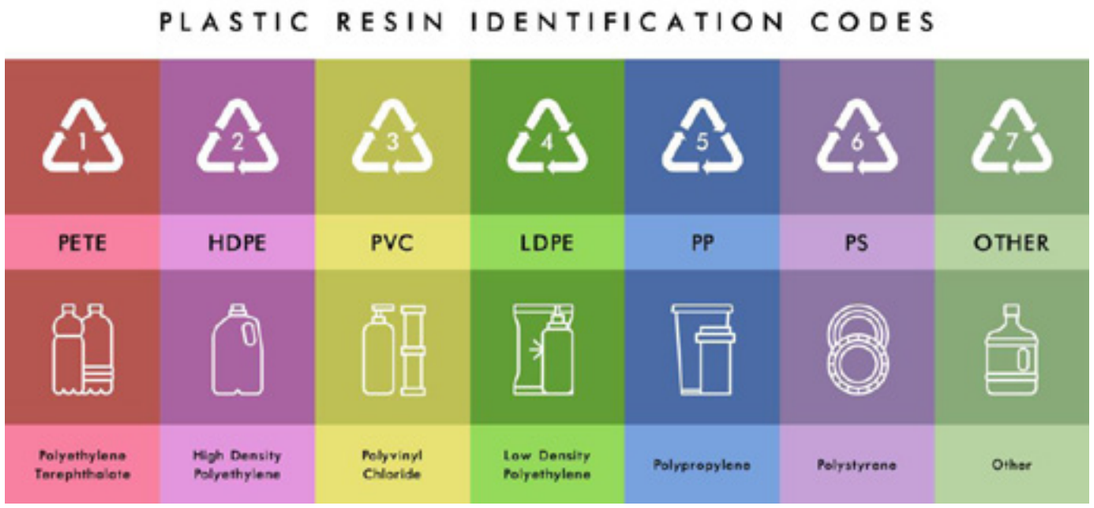
After our consumption, we probably put the polymers into one of those cans.
Where are they going next?

clean the compost

The food waste sent to the compost sites may not be clean, but contaminated with other trash such as plastic forks, nylon bags and foils.

The sites would recruit volunteers to help separate the contaminations in the food waste to make sure that everything in the pile is compostable.

8.7% recycled



These signs with numbers in the middle are identification codes. They have nothing to do with recycling. The real recycle sign does not have a number.

According to EPA, only 8.7% of plastic wastes are recycled in 2021.

Visit Cooper Recycling

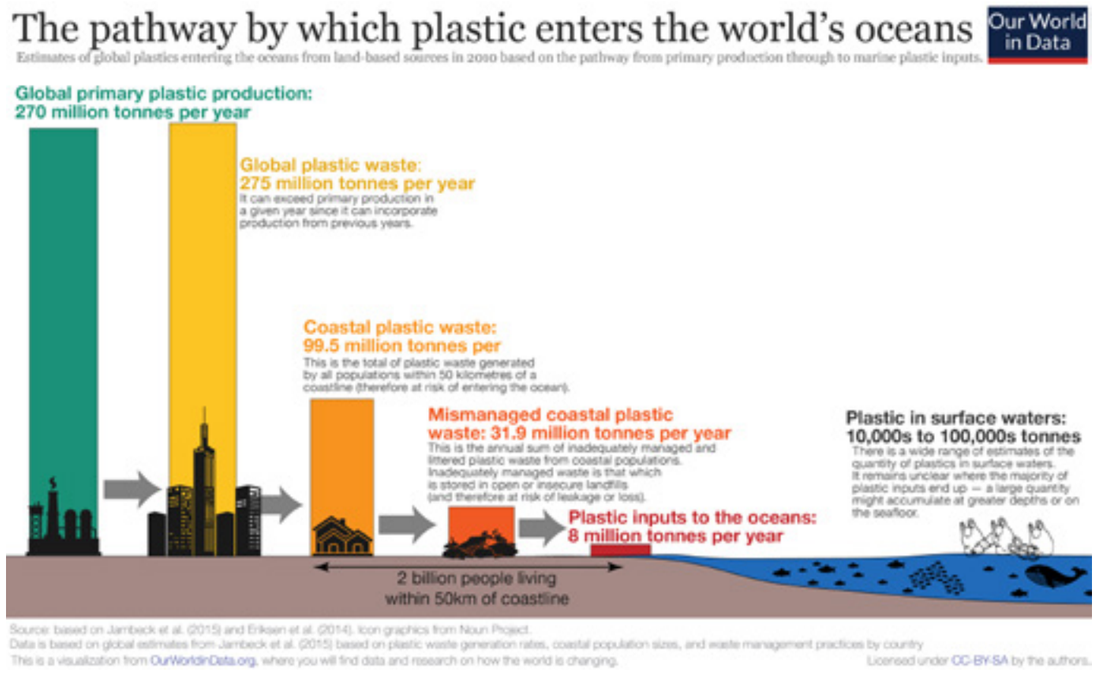
Credit:
https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/plastics-material-specific-data

go with the flow

Each year, 8 million tons of plastic is going to the ocean.

They are mistakenly eaten by fish, wales, seabirds, entering the food chain.

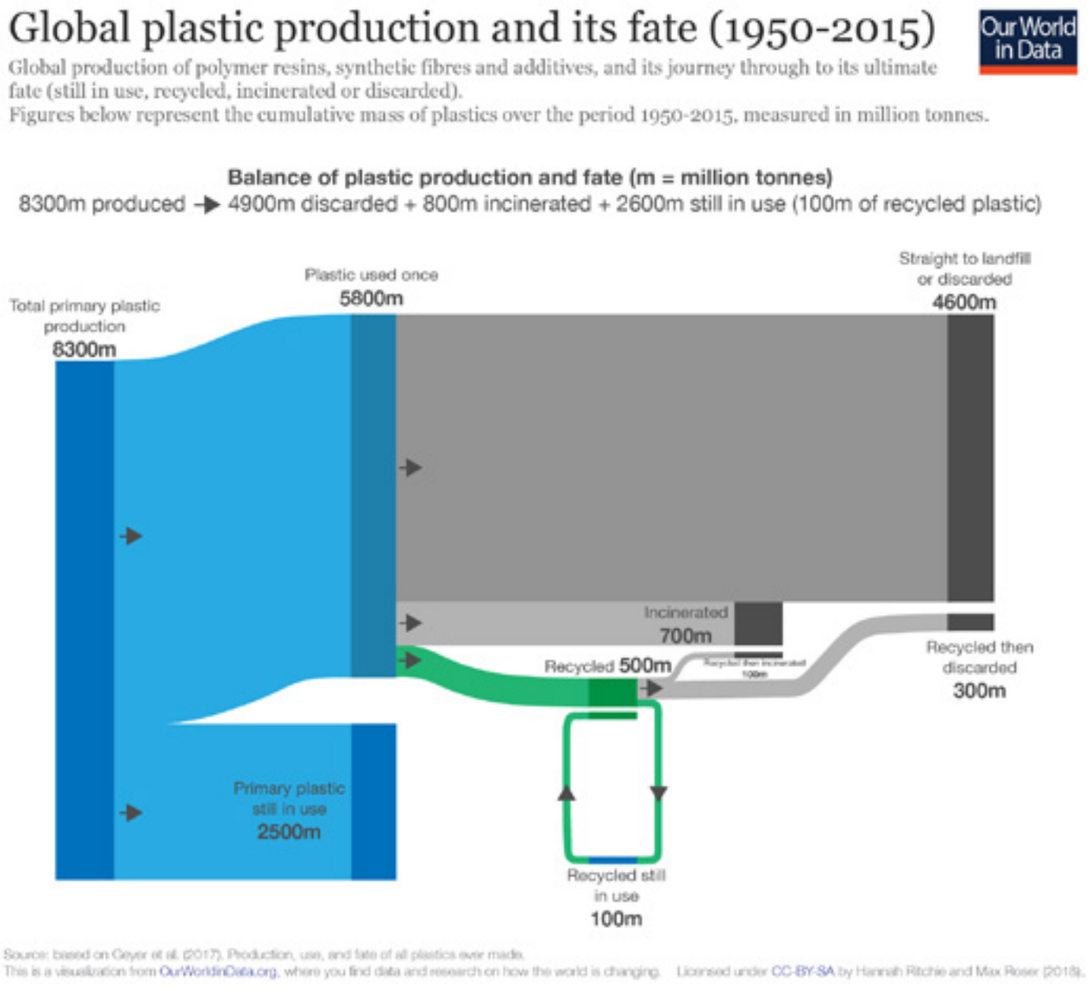
World Ocean Week 2021



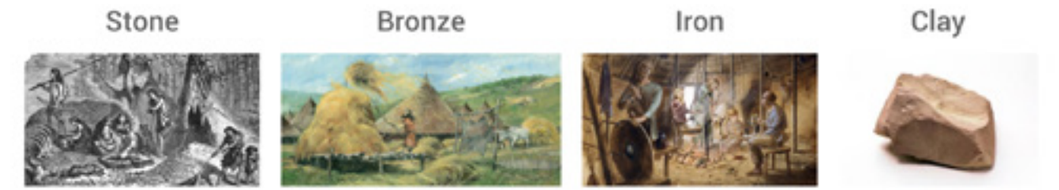
the journey of plastic

500 out of the 5800 million tons of plastic wastes are recycled as of 2015.

The majority is going straight to landfill.



the next thing



The evolution of materials in human history has continued to move on. Synthetic polymer is the first one that does not engage in the natural ecology, but should not be the last one on the timeline. Maybe it is a time for a sustainable alternative to appear and fix the environmental gray rhino which plastic has caused. So what is the next?

answers from nature

starch spoon

image: pasta.life

pasta straw

image: shellwork

shellwork

vegan fabric

image: Mylo-Unleather

mycelium leather

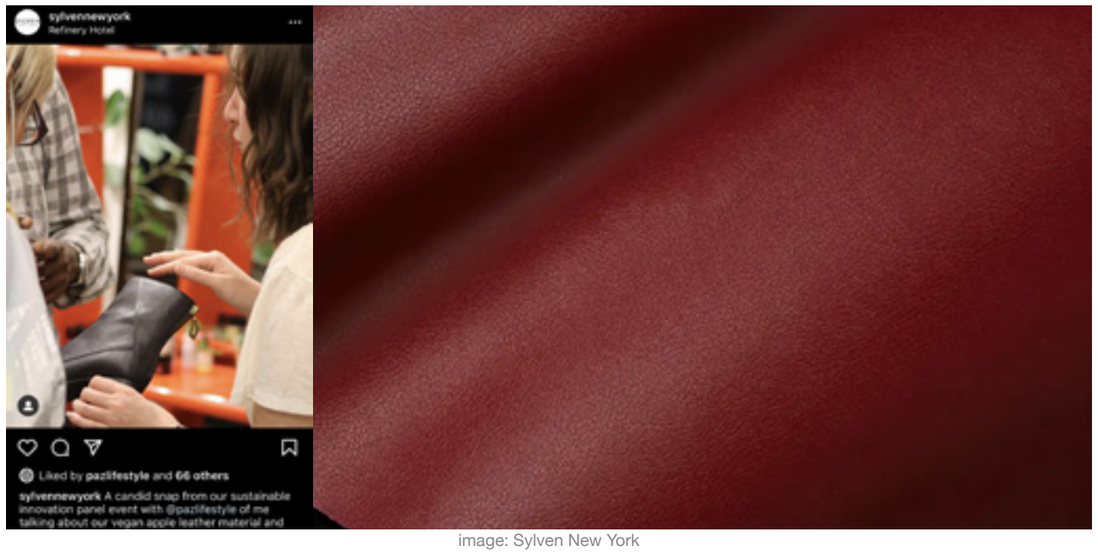


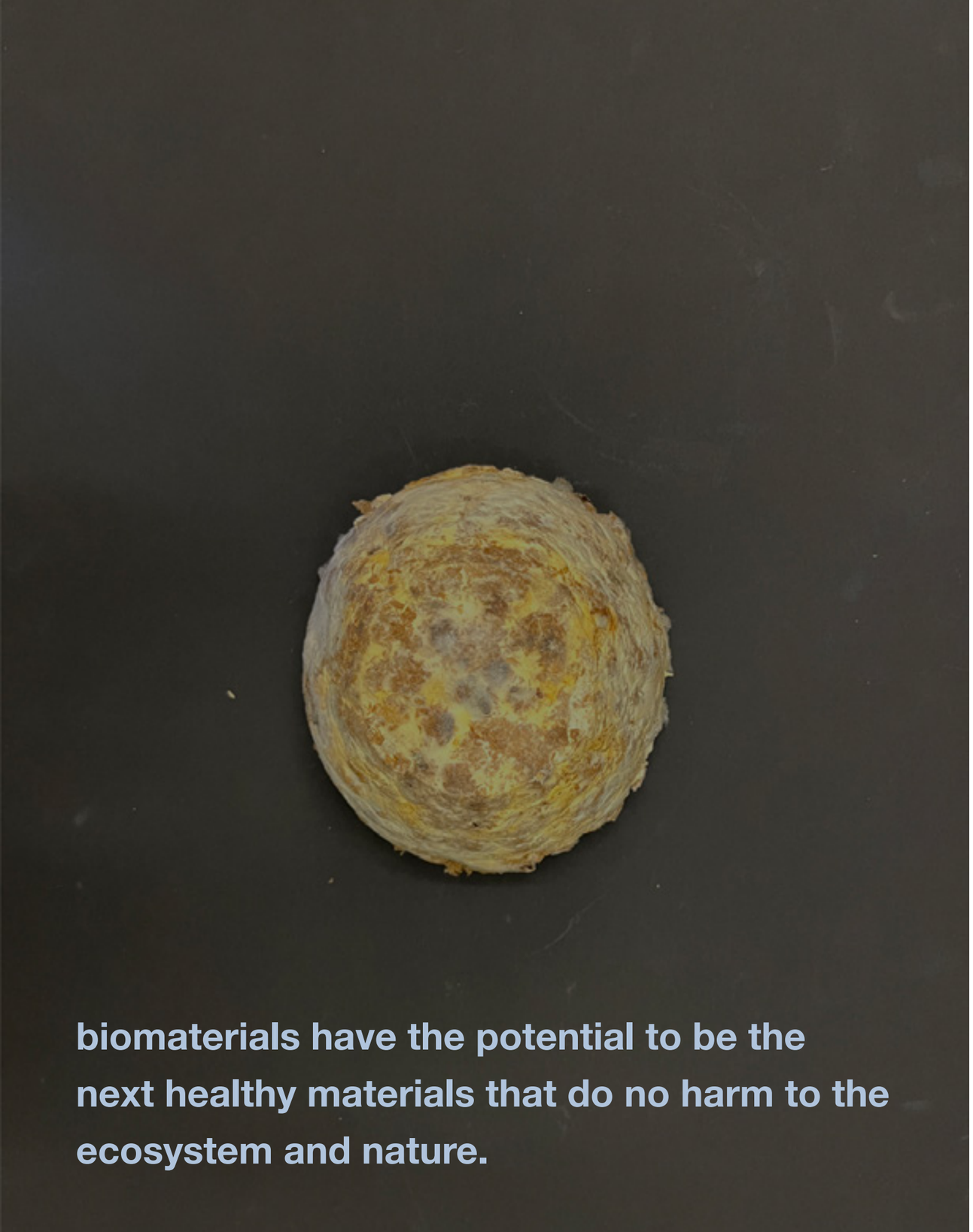
image: Sylven New York

apple leather

While we are continuously creating problems for the environment, the most effective approaches to tackle them are already design by nature.

Biomimicry is how we may learn and utilize nature’s designs.

sprout



biomaterials have the potential to be the next healthy materials that do no harm to the ecosystem and nature.

existing players

Some organizations who are already doing things on biomaterials including mycelium, pasta starch, lobster shells, etc.

mogu
RADICAL BY NATURE

MYLO™

SUSTAINABLE BRAND PLATFORM

GROW 510

ecovative

MYCOWORKS

MycoTEX®

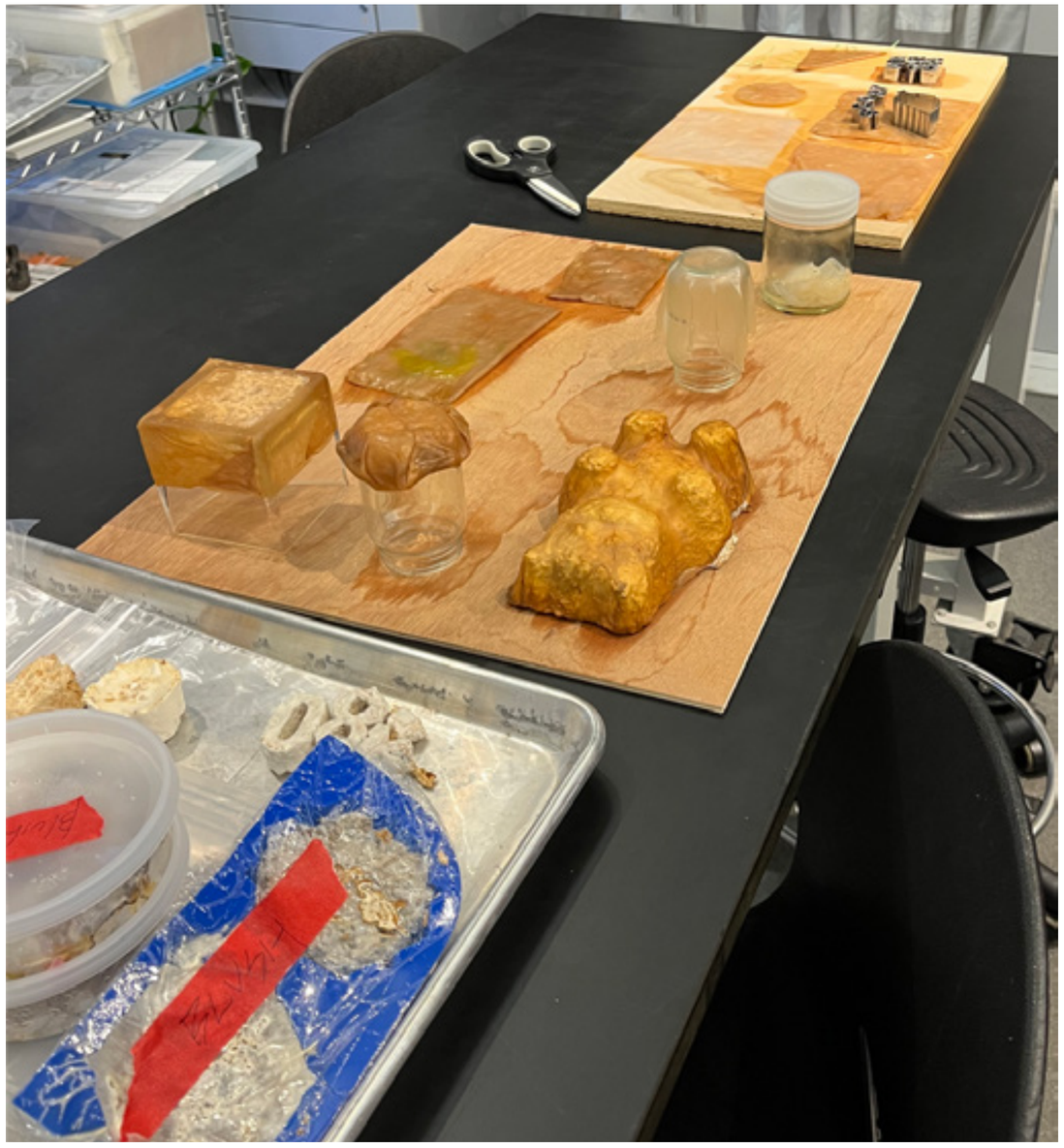
Genspace

VTT

SHELLWORKS

SVA Bio Art Lab

People from SVA Bio Art Lab (https://bioart.sva.edu/) also have biomaterials and professional equipments, intended for fine art purposes.



SVA Visible Futures Lab

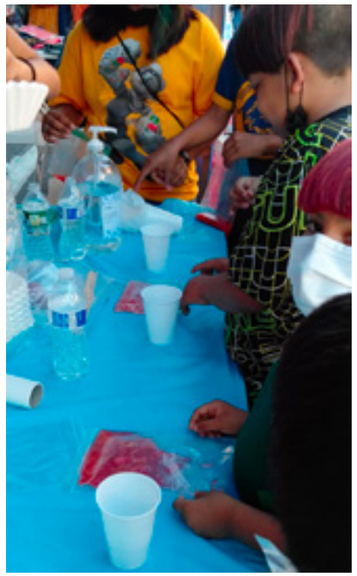
Chester Dols is the director of Visible Futures Lab (https://www.vfl.sva.edu/) at SVA. He has made a mycelium 3D printer in the past. He advised me to grow mycelium on coffee husk, which he had experience with.

Though the printer is not in the lab, there are samples of mycelium objects at VFL.

do you know

In order to increase the general public's awareness for science and acceptance for biomaterials, outreaches may be an effective way to promote the approach and call for action.

At Genspace (https://www.genspace.org/), we do community outreaches by bringing interesting science experiments in public facing events. It seems to be good way to enlight curiosity and urge for learning science in people's hearts.

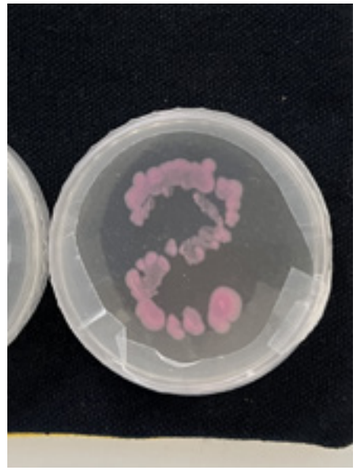


make it fun

Doing bio painting workshop at the SVA holiday bazaar is also a unique experience.

A few students already have abundant knowledges about this kind of microbiology.

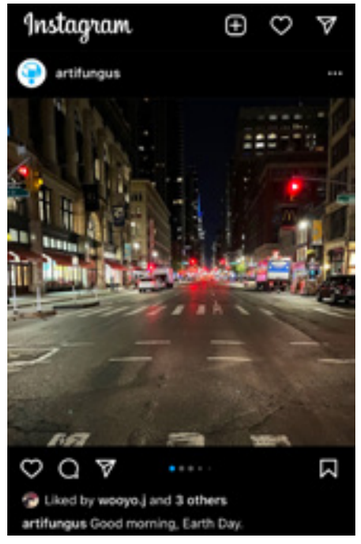
RISO printed poster



Earth Day

artifacts on Earth

People from different corners are doing their approaches for the Earth, while mycelium fabrication is just one of them. It could be inspiring to exchange thoughts with doing clean energy, coffee cup lending, indigenous craft with upcycled materials, pasta straws, ocean protection, and many others.

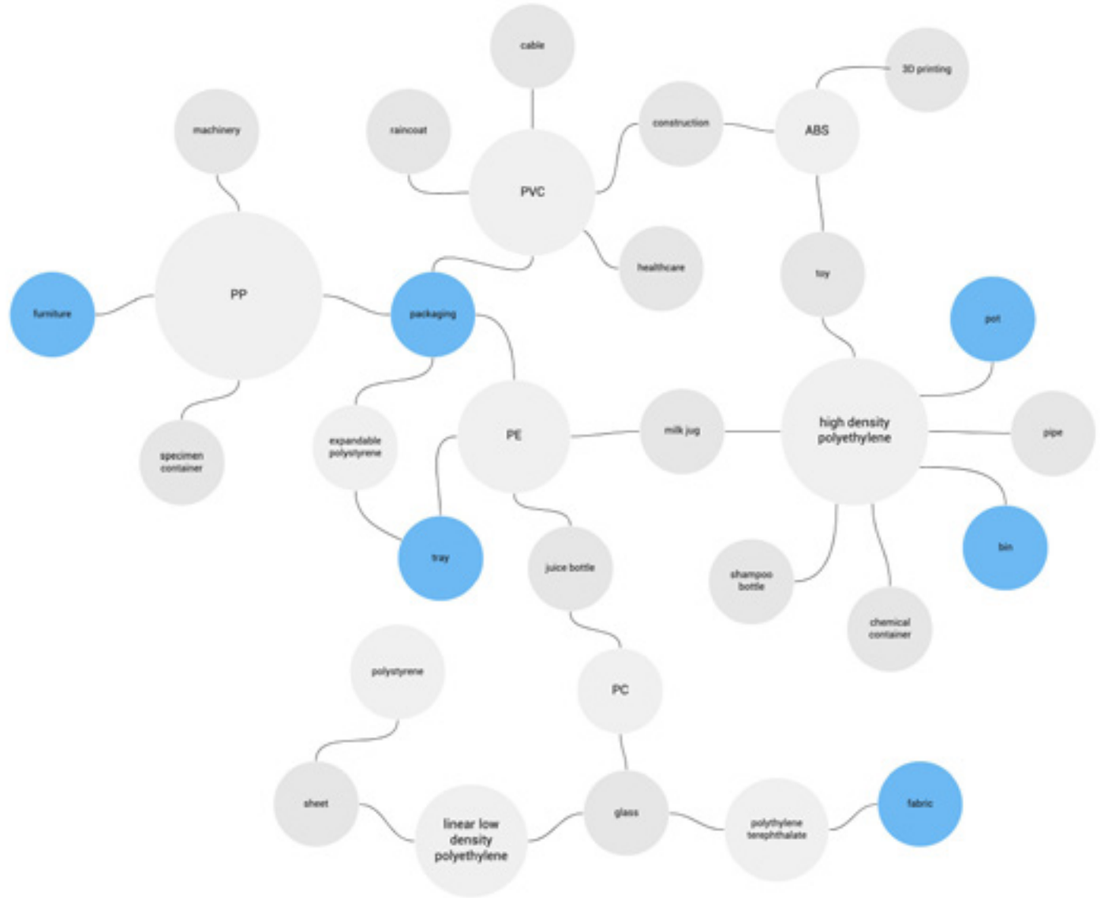


Earth is our shared community

scope

The existing players are already using biomaterials to make some simple products such as mycelium styrofoam, mycelium leather, packaging, wall tiles, shell brick, and more. However, compare with the enormous number of plastic applications, biomaterial is still getting started. There is much to explore.

Here are some categories of plastic product which biomaterials may be practical alternatives. This project aims to explore further on some of these directions.



co design

Knowing the design goals of plastic replacement, it’s time to codesign with mycelium and prototype on what this natural material is capable of.

Given the circumstance today, our interspecies design team start with easy segments such as simple containers, trays, and fabric.

substrate

Substrate is the material which mycelium is growing on. It is usually from agricultural wastes.

For growing mycelium, substrate needs to be sterilized to prevent contamination so nothing else will compete with mycelium for resources.


cacao


straw

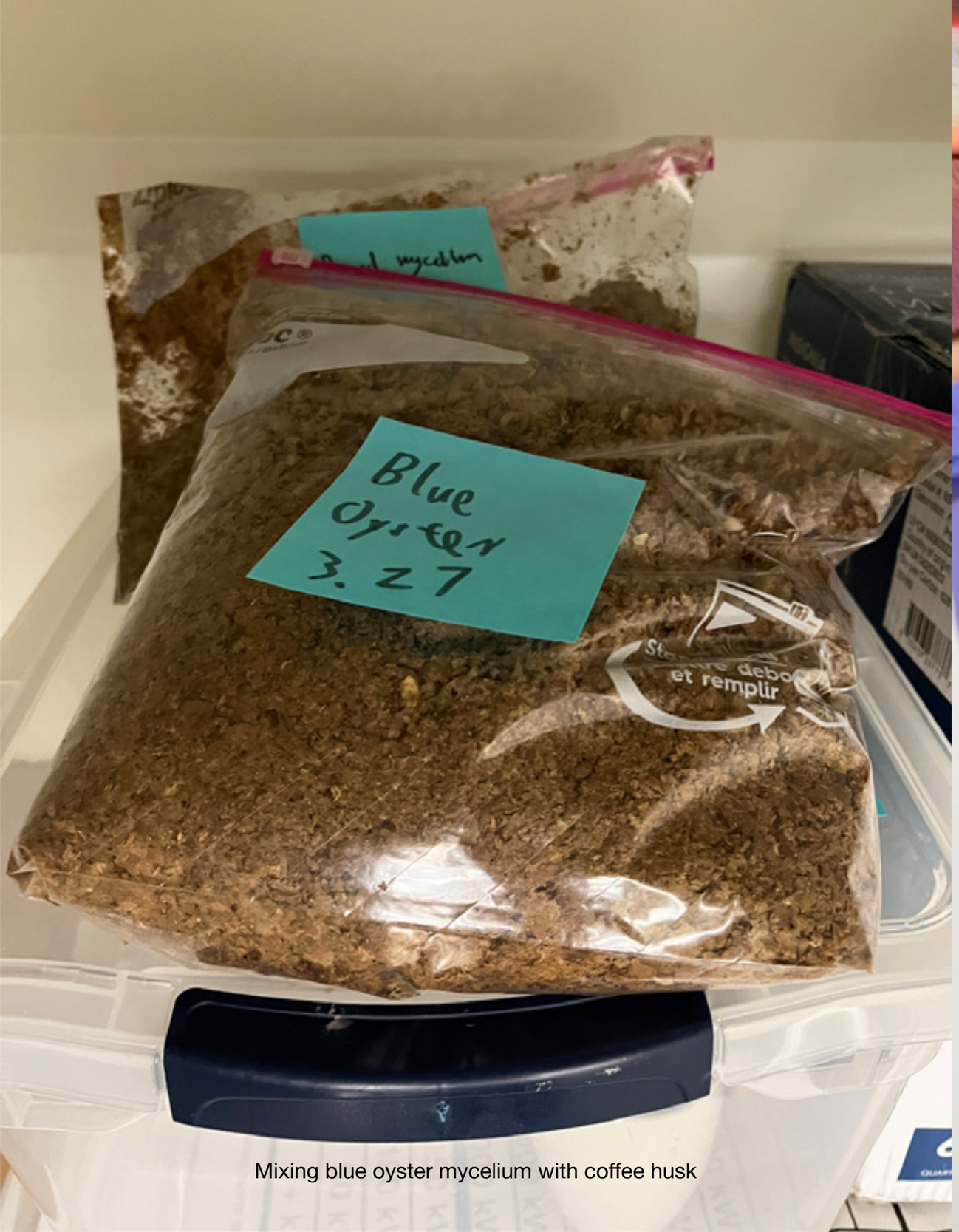

wood chip


hemp


elephant grass


coffee husk

Images: spiceography, istock, pixabay, agro



Mixing blue oyster mycelium with coffee husk

Mycelium fabrication

prototype 1

monitoring & evaluation

ingredients:
ecovative GIT kit, water, flour

substrate:
hemp

growth duration:
2~3 weeks

condition:
contaminated

learnings:
sterilizetion is important

prototype 2

monitoring & evaluation

ingredients:
ecovative GIT kit, water, flour

substrate:
hemp

growth duration:
2 weeks

condition:
contaminated, collapsed

learnings:
don’t stop it too soon when it’s not grown

prototype 3

ingredients:
ecovative GIT kit, water, flour

substrate:
hemp

growth duration:
2~3 weeks

condition:
grown without inside space

learnings:
when it is thicker, it grows more solid

prototype 4

monitoring & evaluation

ingredients:

ecovative GIT kit, water, flour

substrate:

hemp

growth duration:

2~3 weeks

condition:

broken from the middle

learnings:

don’t make it too thin or it won’t grow there

prototype 5

monitoring & evaluation

ingredients:
ecovative GIT kit, water, flour

substrate:
hemp

growth duration:
2~3 weeks

condition:
upper side broken

learnings:
sometimes it needs some holding structure

prototype 6

monitoring & evaluation

ingredients:
ecovative GIT kit, water, flour

substrate:
hemp

growth duration:
2~3 weeks

condition:
inner side broken

learnings:
it stopped growing after certain time

prototype 7

ingredients:
grocery mushroom, water, flour

substrate:
cardboard

growth duration:
3 weeks

condition:
not growing but stinks

learnings:
grocery mushroom won’t work

prototype 8

ingredients:
inoculant, chaff, water, flour

substrate:
coffee chaff

growth duration:
3 weeks

condition:
contaminated

learnings:
sanitation requirement is strick

prototype 9

ingredients:
inoculant, chaff, water, flour

substrate:
coffee chaff

growth duration:
3 weeks

condition:
contaminated, not growing well, stinky

learnings:
too much moisture inside made it bad

prototype 10

ingredients:
inoculant, chaff, water

substrate:
coffee chaff

growth duration:
3 weeks

condition:
not bad

learnings:
it worked. shape can be improved

prototype 11

monitoring & evaluation

ingredients:
inoculant, chaff, water

substrate:
coffee chaff

growth duration:
3 weeks

condition:
contaminated on the top

learnings:
expose to air may let other things grow

prototype 12

ingredients:
inoculant, chaff, water

substrate:
coffee chaff

growth duration:
3 weeks

condition:
also contaminated on the top

learnings:
expose to air may cause contamination

prototype 13

monitoring & evaluation

ingredients:
inoculant, chaff, water

substrate:
coffee chaff

growth duration:
3 weeks

condition:
contaminated on 4 sides

learnings:
maybe contaminated from moisture flow

prototype 14

monitoring & evaluation

ingredients:
inoculant, chaff, water

substrate:
coffee chaff

growth duration:
3 weeks

condition:
fully broken with black mold

learnings:
moisture cause water drops dipped inside

prototype 15

monitoring & evaluation

SCOBY, or
Symbiotic Culture Of Bacteria and Yeast

it is an ingredient used in the fermentation and production of kombucha

ingredients:
kombucha, black tea, boiled water

growth duration:
4 weeks

condition:
very thin layer

learnings:
SCOBY takes a long time to grow

prototype 16

ingredients:

kombucha, black tea, boiled water

growth duration:

5 weeks

condition:

sticky but fragile layer of material

learnings:

it remains sticky for a month after grown


a community

Grown materials are not as same as conventional materials. These microorganisms are living creatures that have their own demand for survival. So make friends in this interspecies community first.

relationship

When we ask the tiny creatures to grow something for us, we need to create a comfortable environment for them to live in. Then they can grow up healthily and create value for other members in the ecosystem. We thrive them first so that they are able to thrive us next.

rhythm

As living things, mycelium and scoby have their own rhythm of growth. It also means that our traditional manufacturing methodologies may bot work. We can't push them to work over the clock to produce extra.

When we break their rhythm, we break their growth.

interrupted growth rhythm

2 weeks

3 weeks

4 weeks

too soon

too long

symbiosis

journey

sustainability

carbon footprint

climate change

trash

pollution

pollution

plastic waste

plastic waste

biomaterial

biomaterial

mycelium fabrication

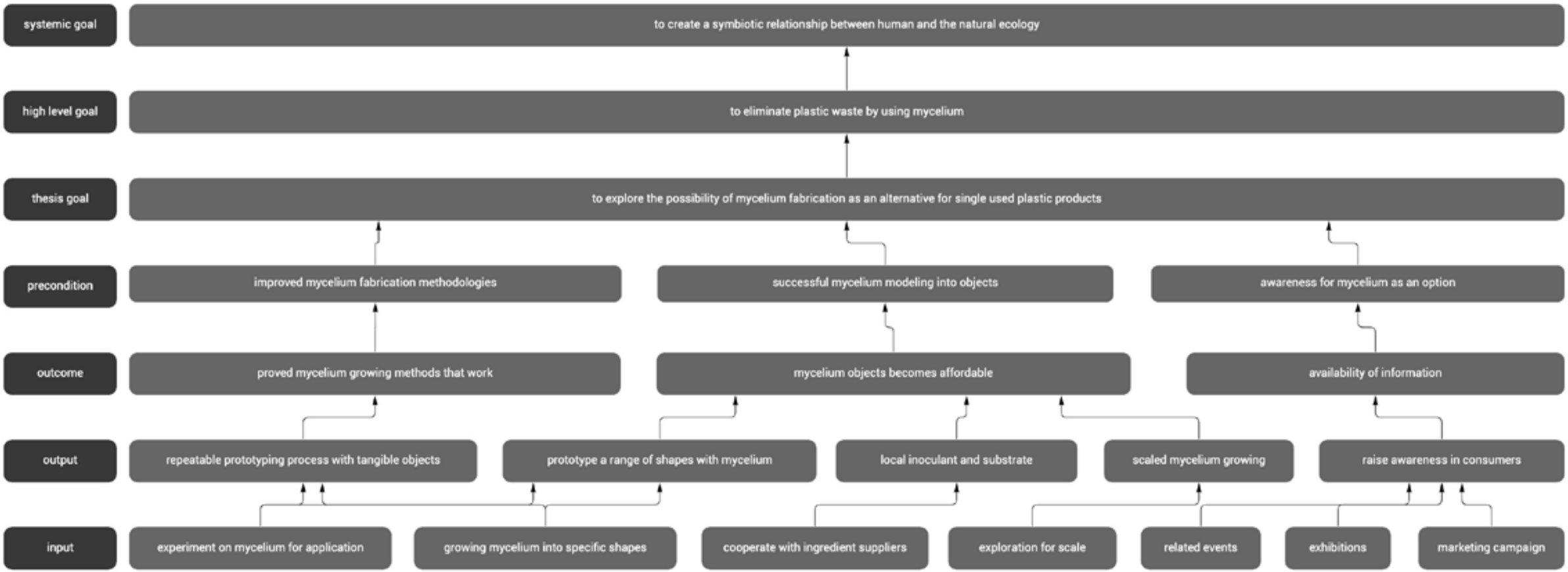
nature engagement

biomimicry

ecological health

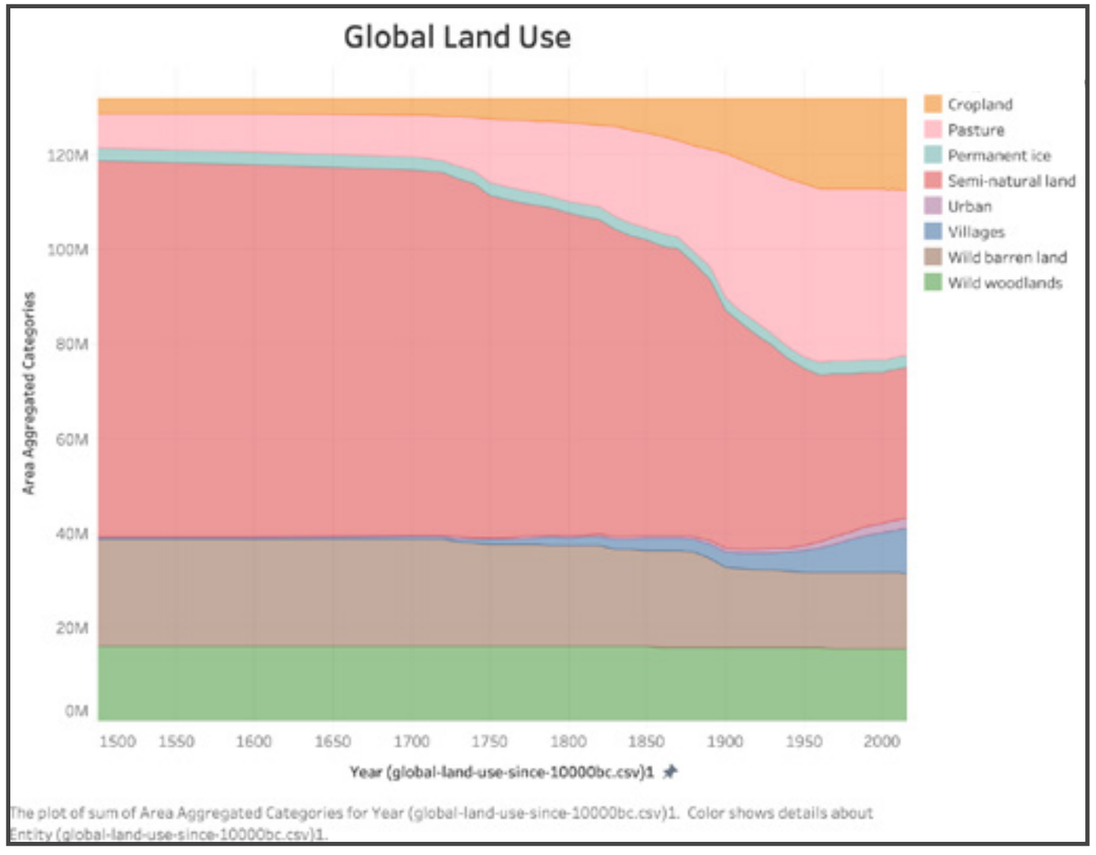
symbiosis

theory of change



conquer the land

In the recent hundreds of years, as the industrialization and growth of population going on, humans have rapidly turned a significant amount of land on Earth from natural landscapes to croplands and pastures. At the same time, the area of nature decreased by a half. In other words, half of the land area on Earth is serving humans.



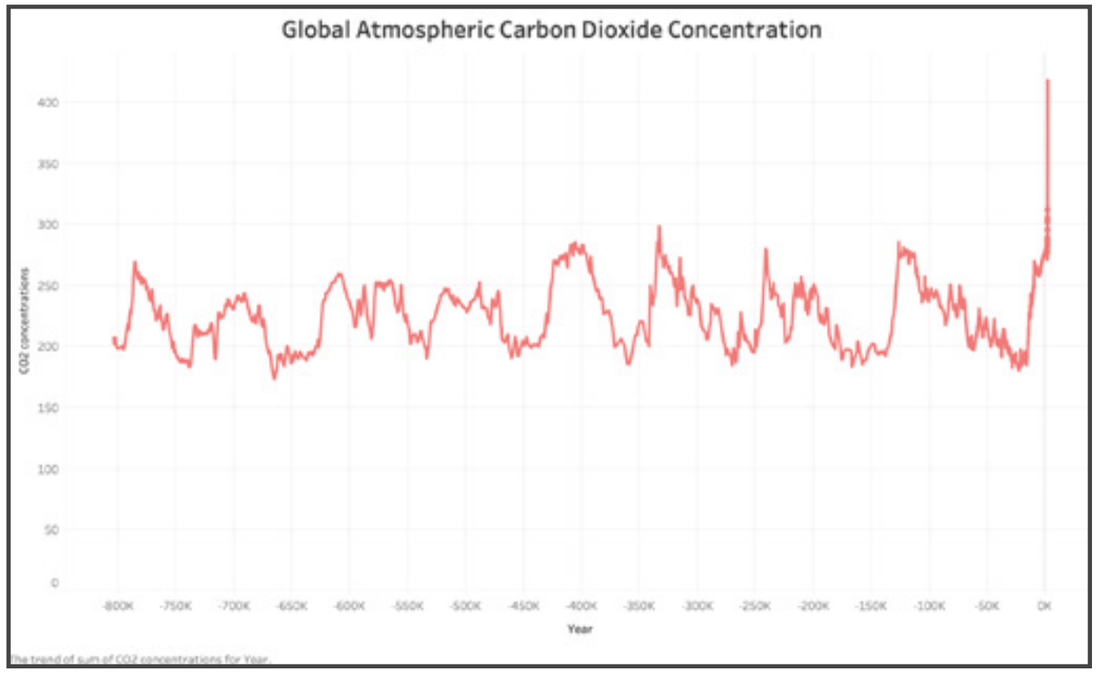
Credit:
Ellis, E.C.; Beusen, A.H.W.; Goldewijk, K.K. Anthropogenic Biomes: 10,000 BCE to 2015 CE. Land 2020, 9, 129. https://doi.org/10.3390/land9050129

in the air

The concentration of carbon dioxide in the atmosphere has been stably fluctuated with a range in the history of Earth.

In the recent five hundred years however, the carbon dioxide concentration suddenly increased sharply. As of 2022, it doubled compare with previous average level.

It is already beyond the regular pattern but there is no sign that it's going back.

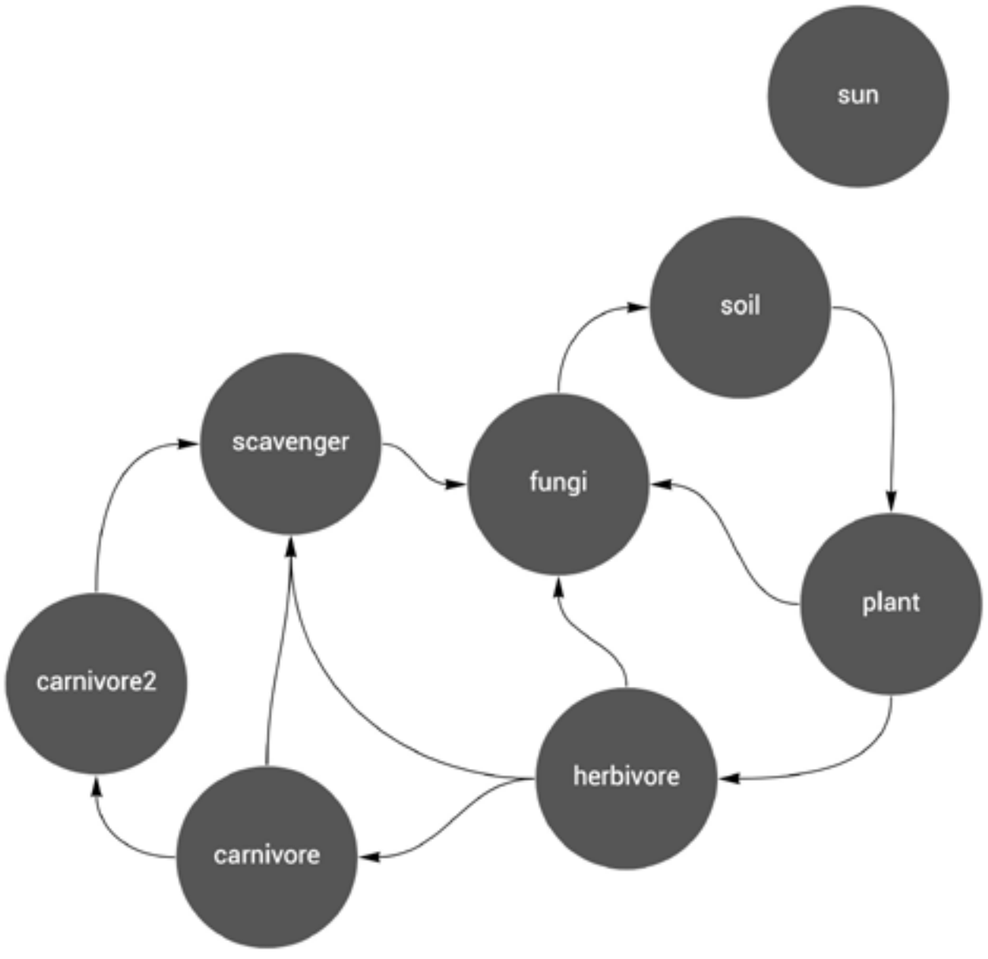


Credit:
https://ourworldindata.org/explorers/climate-change?facet=none&hideControls=true&Metric=CO%E2%82%82+concentrations&Long-run+series%3F=true&country=~OWID_WRL
https://gml.noaa.gov/ccgg/trends/global.html

ecology

In the natural ecology, all the substances move around in circulations. Things are being reused over and over again.

the circulation of substances



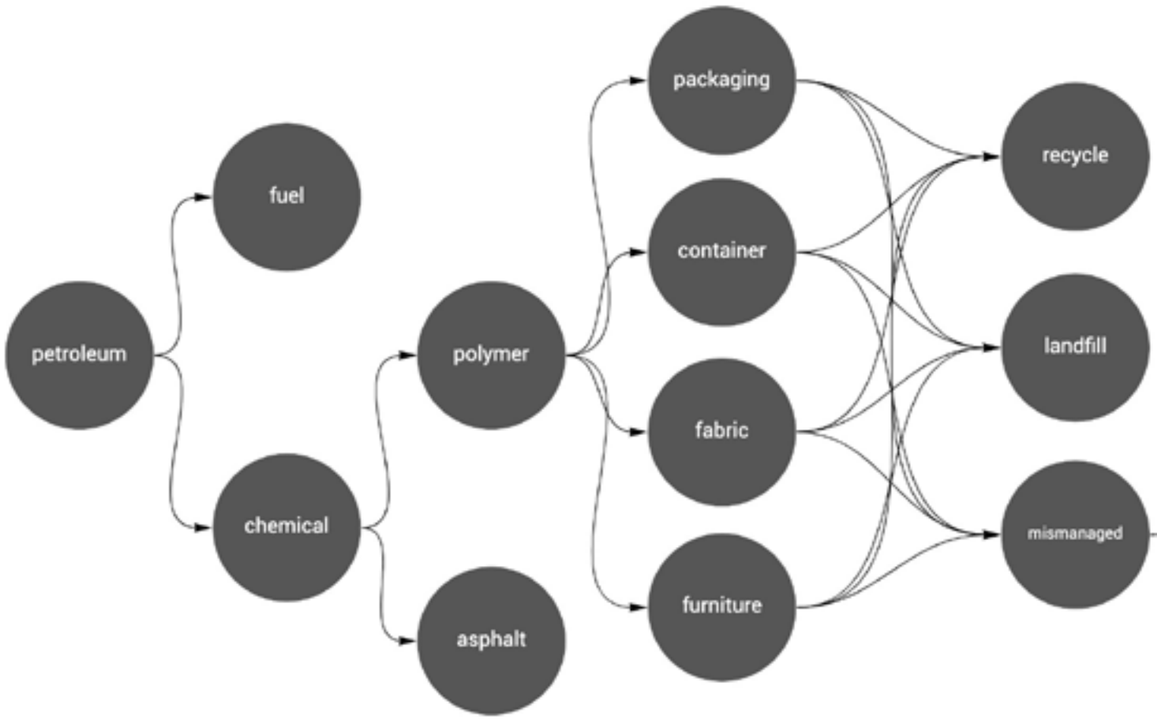
human dominant

After human got engaged in with industries, all things started to serve human and trash was created. It may take thousands of years for landfill to be broken down and rejoin the circulation of substances in ecology.

the circulation of substances with human

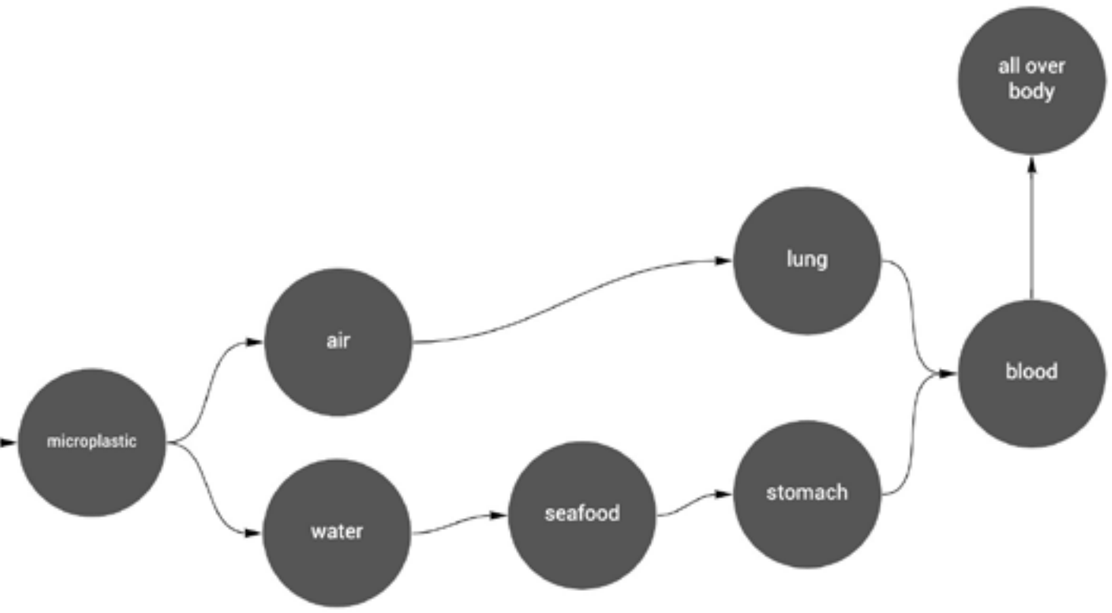
plasticology

Unlike any other substances in the ecosystem, plastic is an artificial chemical made from petroleum and is not degradable in nature. All the discarded plastic will always be somewhere on Earth, taking the mass and room. It is like permanent entropy in our ecology.



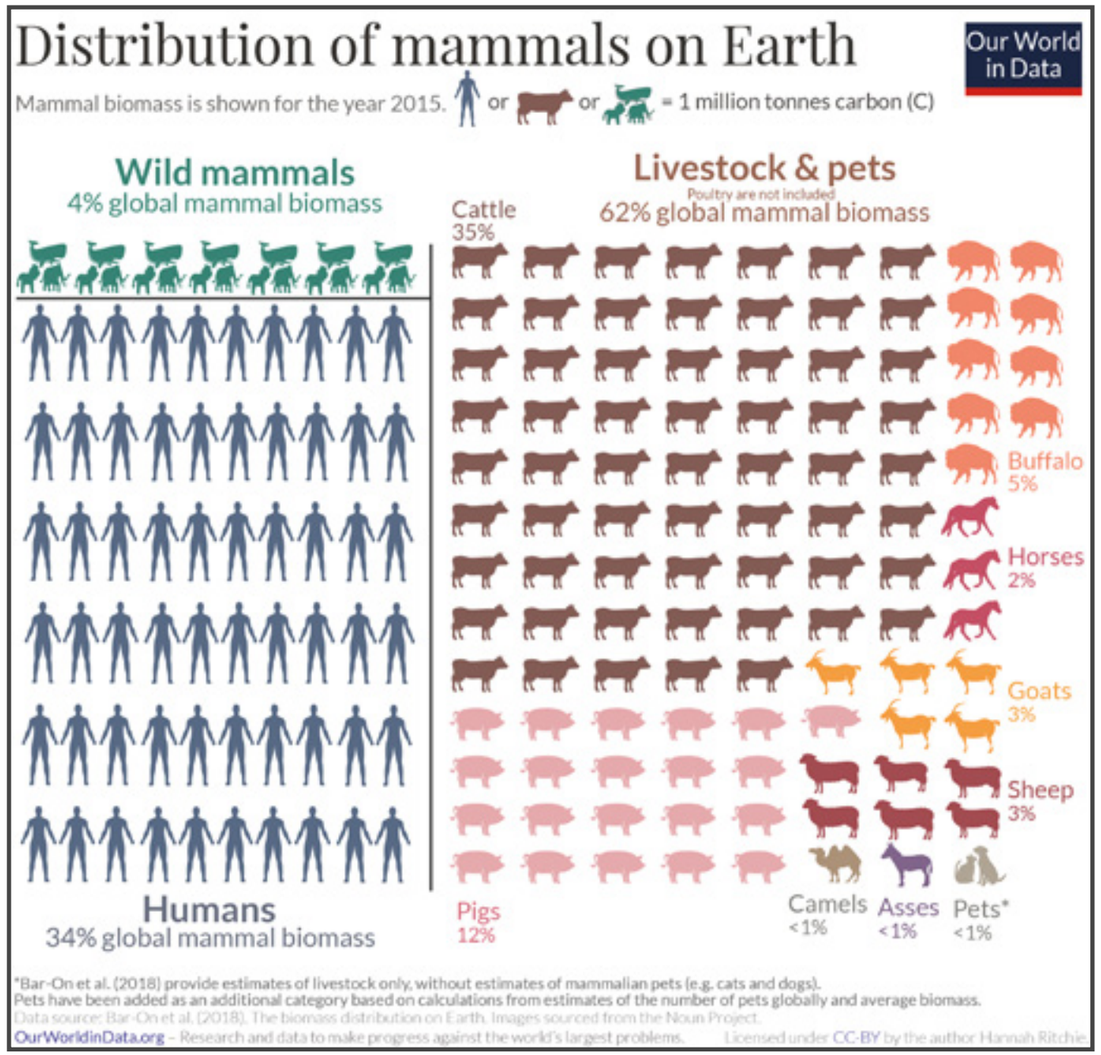
always be here

When the plastic in the environment is broken down into very small pieces of microplastics, they reaches anywhere from our drinking water to lung and blood vessel.



zero sum consumption

Humans make up only 0.01% of life on Earth, but have and continue to take a disproportionate significant amount of resources the nature has to provide. Meanwhile, millions of other wild species are under threat of extinction due to habitat loss and poaching caused by humans.



Credit:
https://www.pnas.org/doi/10.1073/pnas.1711842115

No single egg can stay intact in a fallen nest.

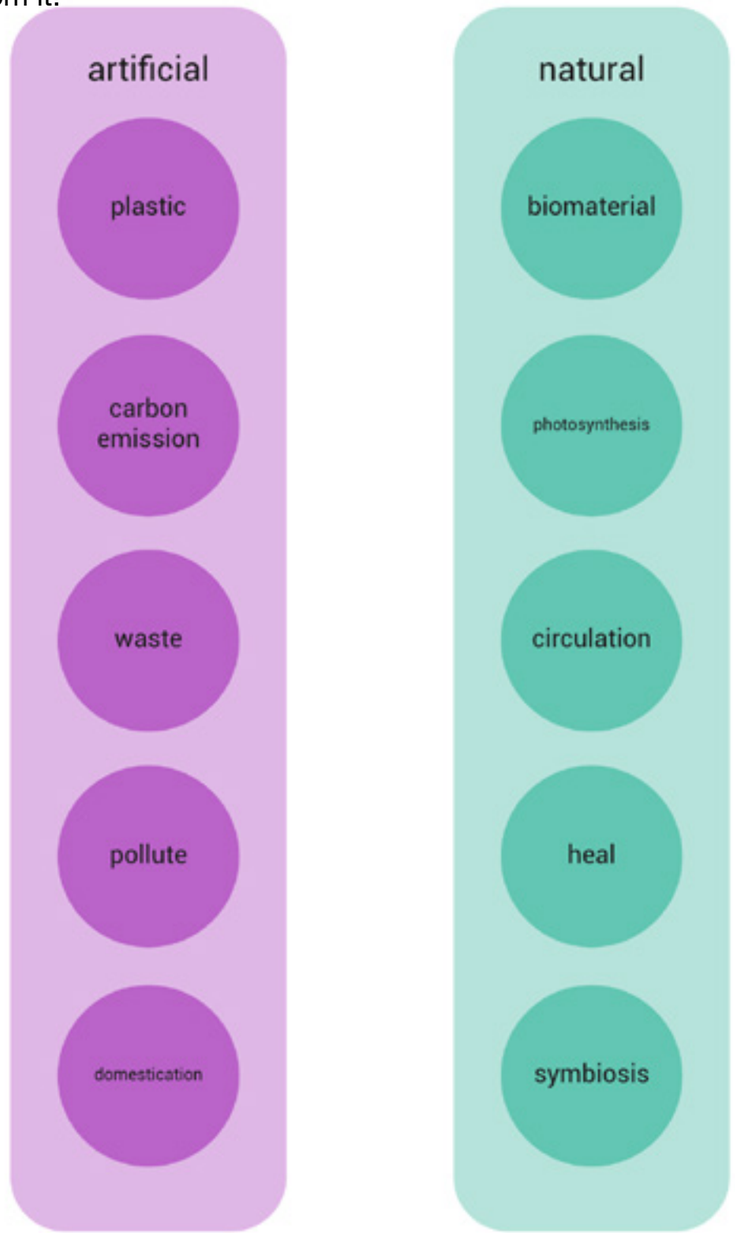
No single species can thrive in a collapsed ecosystem.

In order for humans to survive in long term, we need to keep the ecosystem healthy.

Sustain the nature, not the plastic.

biomimicry

The most effective approaches are already designed by nature.
Lets learn from it.



mycelium design

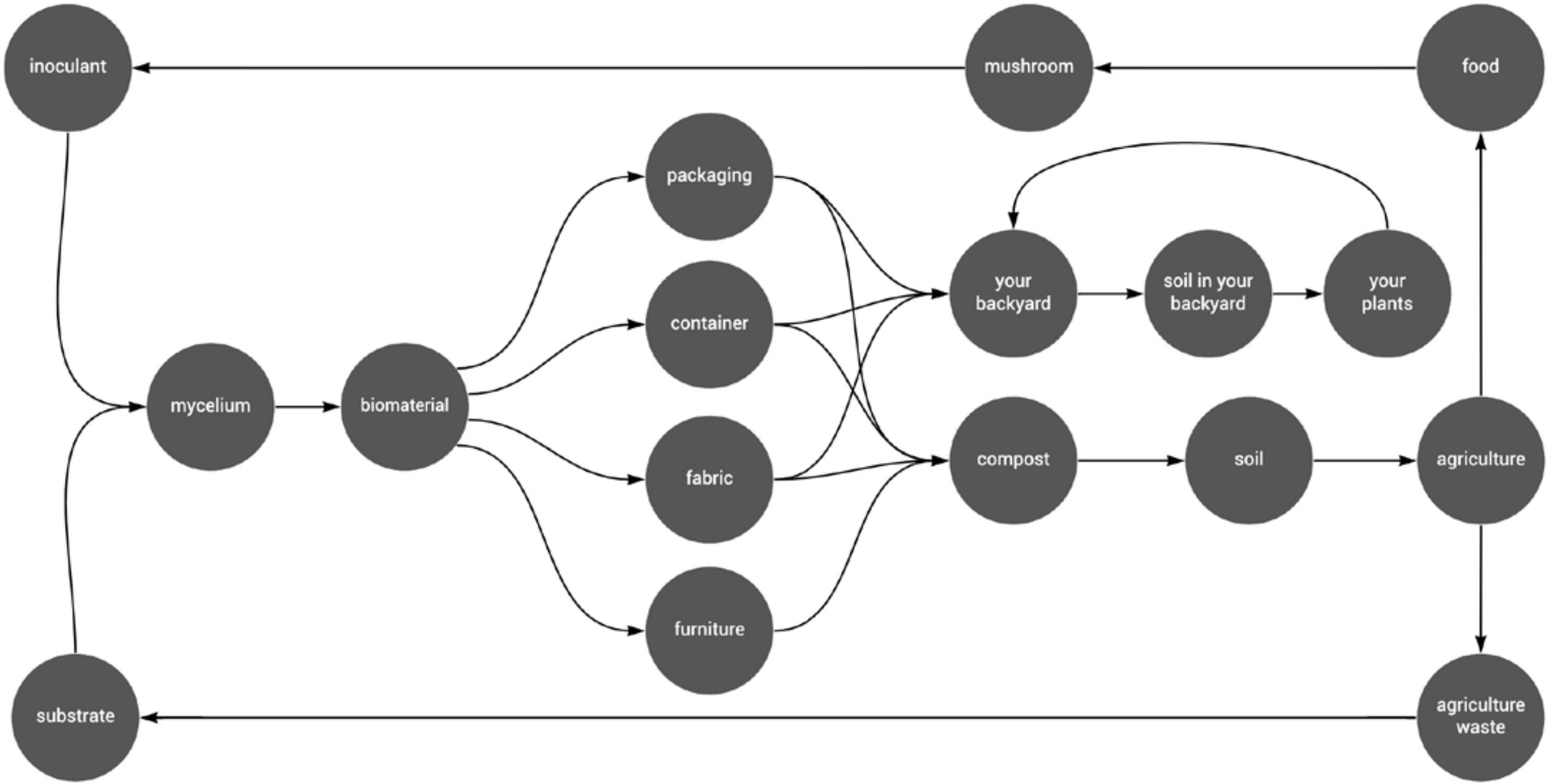
At this time, mycelium may be nature’s design to tackle the mess that humans have created.

While synthetic polymer is the artificial trash, mycelium is the sustainable alternative designed by nature. What we need to do is to mimic its design.

myceliumimicry

In the new proposed model, mycelium as the material goes around the lifecircle over and over, leaving zero entropy to the ecosystem.

This is the way that is sustainable for the ecology on Earth.



No single egg can stay intact in a fallen nest.

When natural resources are scarce, human created artificial products.

When plastic created by human is harming the ecosystem, mycelium has the potential ability to heal the nature after.

If humans can create an environment for mycelium to thrive and do the healing, the symbiotic relationship between humans and fungi is being built: humans rely on fungi for mycelium material, while fungi rely on humans for the growing environment.

What is further, with the engagement of mycelium, we should be able to embed the human society into the natural ecology in a way that does no harm to other species in the ecosystem. So that we can establish a new harmony relationship with nature, which we call

symbiosis.

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symbiotic friends

mycelium

E. Coli

kombucha SCOBY

molds in NYC

squirrels in central park

pigeons in gantry park

plants in MPJ park

trees in Madison Sq park

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thank you

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