Collaborative Communities

Presented by

Facilitator Slides
with notes

Session Index

Overarching Theme – How to we live in collaboration with the living organisms that share our spaces.

Session	General Topic	Technology/Science /Application	Experiments
1	Your Natural Neighbors	Urban ecosystems – role of pollinators	Make your own insect hotel
2		Living walls/urban agriculture	Build your own living walls
3		Animals in your ecosystems	Make your own suet feeder
4	Harnessing Nature	Traits and characteristics	Traits classification activity Design your own, bio-inspired, superhero
5		Microbes/composting	Design your own composter and microbial fuel cell demonstration (optional)
6		Biomimicry	Bio-inspired matching game, bio-inspired redesign
7	Sustainable Materials	Biopolymers	Monomer-polymer visualization activity Create your own milk-based polymers
8		Concrete alternatives	Water drainage experiment
9,10	Design/modify your own community space	Sustainable Design	Design challenge

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Session 1

Preparation	Review: • Before You Begin section in the guide • Instructional activities for session 1 • Lesson slides and how to video for pollinators and insect hotel • Pages 2 and 3 in the participant notebook Prepare: • Your ***About Me*** slides • Cut string into ~1 ft pieces

Session 1

Your Natural Neighbors

What you need

- Participant notebook
- Bamboo stakes (~10/participant)
- Small rubber bands (2/participant)
- String (~1 ft/participant)
- Glue, foil square, ½ cotton swab, toothpick (1 each/participant)
- White cardstock (cut into strips, optional)

Additional Supplies Needed

- Scissors
- Pens/pencil
- Tape (optional)
- Coloring supplies (optional)

Session 1 Materials

Participant Notebook

Session Flow	
15 min	Welcome, introductions, hand out initial materials Introduction to urban ecosystems
10 min	Lesson on the benefits of insects
15 min	Construction of insect hotels Discussion on the engineering design process & design criteria
5 min	Entrepreneur spotlight
Final 10 minutes	Reflection and cleanup

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Session 1

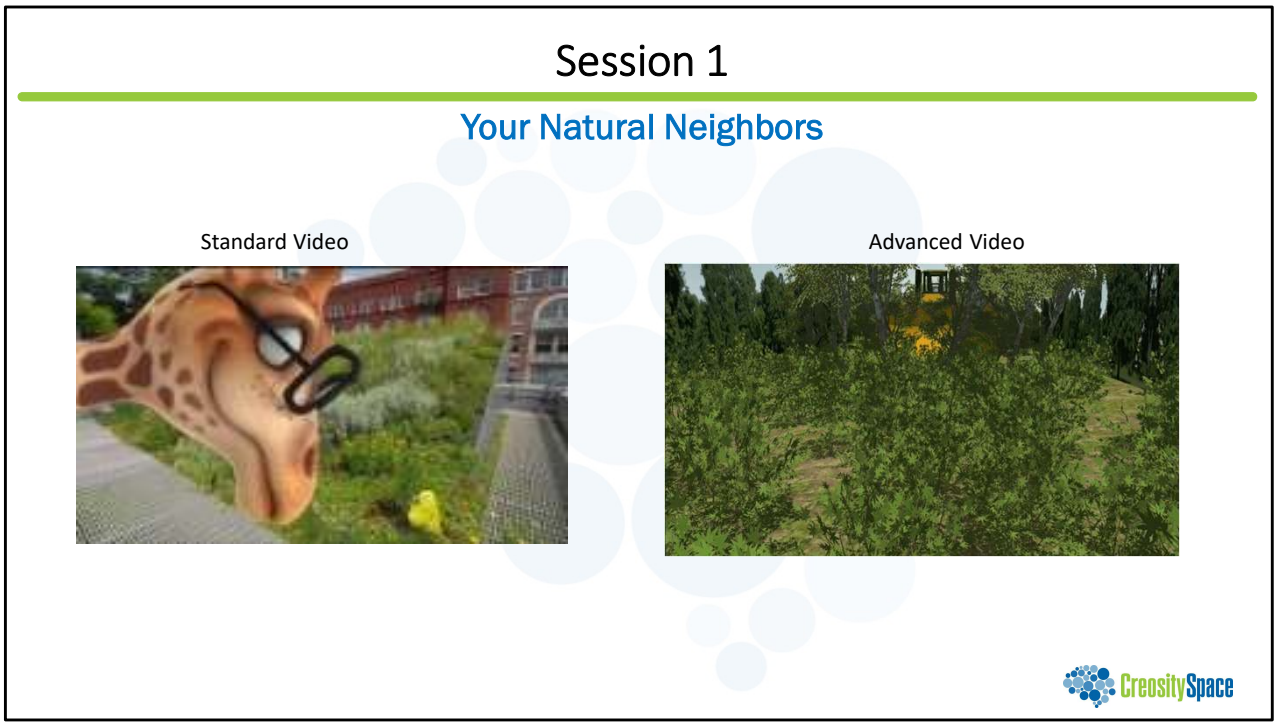
Introduction

About Me

Session 1

Introduction

About Me



Standard Video

https://www.youtube.com/watch?v=RRta4aGJKfc

Advanced Video
https://www.asla.org/sustainablelandscapes/Vid_Wildlife.html (4:41 min)
This is an information-packed video that explains why it is important to consider the local biodiversity when thinking about construction and some ways builders, architects, and homeowners can support their local ecosystem.

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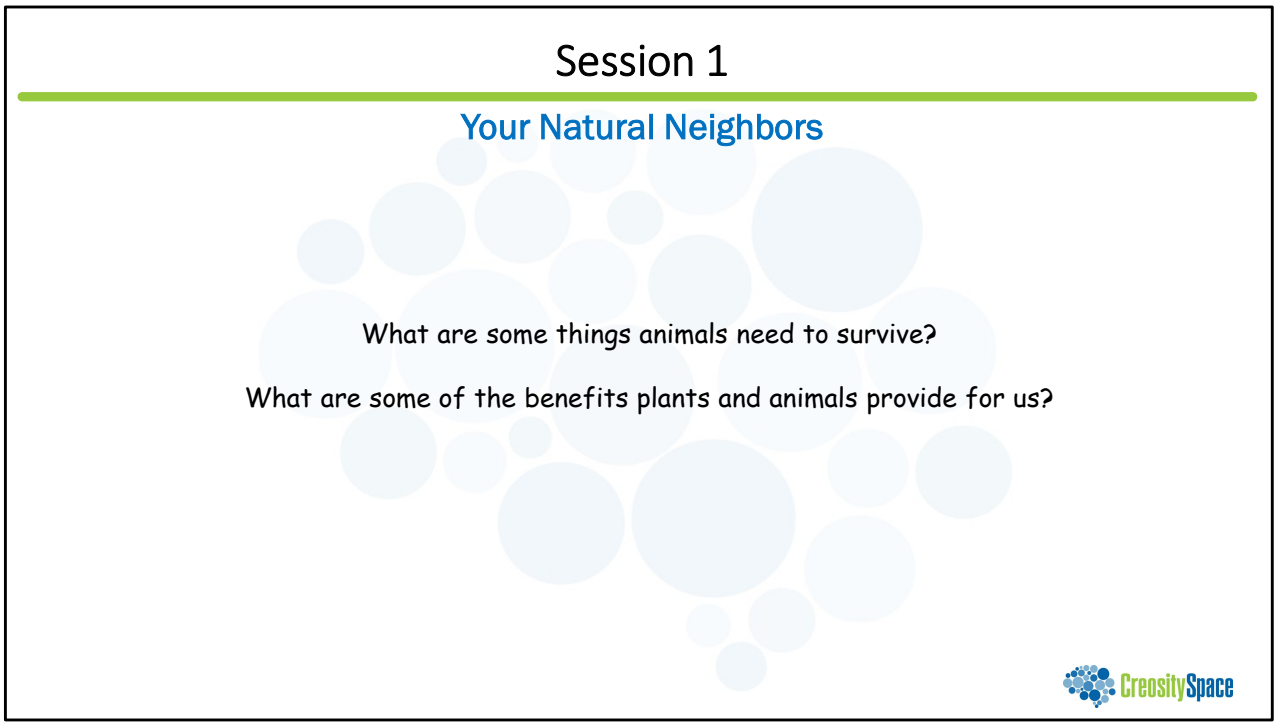

Have a short discussion about the video. You can let participants know that you'll show the video a couple times throughout the session.

Session 1

Your Natural Neighbors

Can anyone share with the group something about insects?

Session 1

Your Natural Neighbors: Bees

What are some cool things about bees?

How do bees help humans?

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What are some cool things about bees?

- Bees have 5 eyes
- Bees are insects, so they have 6 legs
- Bees fly about 20 mph
- Male bees in the hive are called drones
- Female bees in the hive (except the queen) are called worker bees
- Number of eggs laid by queen: 2,000 per day is the high
- Losing its stinger will cause a bee to die
- Bees have been here about 30 million years!
- Bees carry pollen on their hind legs in a pollen basket or corbicula
- An average beehive can hold around 50,000 bees
- Foragers must collect nectar from about 2 million flowers to make 1 pound of honey
- The average forager makes about 1/12 th of a teaspoon of honey in her lifetime
- Average per capita honey consumption in the US is 1.3 pounds
- Bees have 2 pairs of wings
- The principal form of communication among honey bees is through chemicals called pheromones

How do bees help humans?

- Bees are huge pollinators – Bees are important because they pollinate approximately 130 agricultural crops in the US including fruit, fiber, nut, and vegetable crops. Bee pollination adds approximately 14 billion dollars annually to improved crop yield and quality.
- Make honey
- The honeycomb structure has influenced engineering with its efficient, lightweight, strong

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Session 1

Your Natural Neighbors: Ants

What are some cool things about ants?

How do ants help humans?

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What are some cool things about ants?

•Ants have superhuman strength! Yes, you did read that correctly. ...
•Ants don't have lungs. ...
•Ants don't have ears. ...
•Ants are farmers. ...
•Ants have two stomachs. ...
•Ants can swim.
•Some queen ants can live for many years and have millions of babies.
•Ants don’t have ears. Ants "hear" by feeling rumbles in the ground through their feet.
•Ants don’t have lungs. Air enters and leaves through tiny holes all over their body.
•When ants fight, it is usually to the death!
•Ants leave invisible breadcrumbs (called a pheromone trail) everywhere they go, so they know where they’ve been.

How do ants help humans?

- Ants are among the leading predators of other insects, helping to keep pest populations low.
- Ants move approximately the same amount of soil as earthworms, loosening the soil in the process and increasing air and water movement into the ground.
- They keep the ecosystem clean of dead insect carcasses and aid in the destruction and decomposition of plant and animal matter.
- By carrying bits of plants and animal remains into their nests, the soil is fertilized and nutrients recycled through the world's ecosystems.
- Ants are pollinators. They carry seeds and help plants disperse into new areas.

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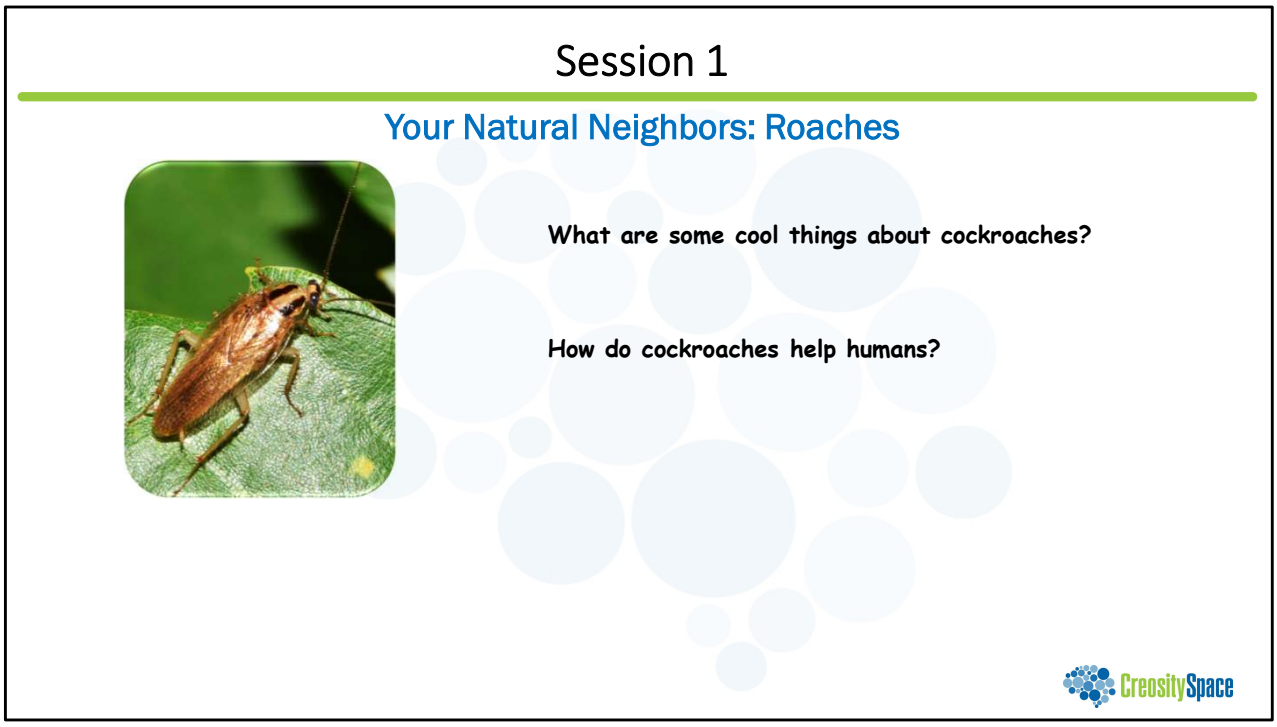

What are some cool things about roaches?

- Cockroaches have been around since the time of dinosaurs!
- A cockroach can live almost a month without food.
- A cockroach can live about two weeks without water.
- Some female cockroaches only mate once and stay pregnant for life!
- A cockroach can live for up to one week without its head!
- Cockroaches can hold their breath for up to 40 minutes!
- Cockroaches can run up to 3 miles an hour.
- Insects, arachnids, reptiles, birds, amphibians, and mammals all eat cockroaches.
- Immune to most pesticides

How do roaches help humans?

- Food for other animals (birds, reptiles, amphibians)
- Nutrient recycling - Cockroaches feed upon decaying organic matter, leaf litter and wood around it. Not only do they help “clean up” degrading plant material, in the process their bodies trap a lot of atmospheric nitrogen. Basically, the purpose of cockroaches in this case is basically for cleaning. Cockroaches then release the trapped nitrogen into the soil (through their feces).

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Session 1

Can you think of something that would help the pollinators in your neighborhood?

If participants are hesitant to contribute, see if they can remember something from the video

Session 1

Insect Hotels

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There are many different types of insect hotels. As habitat is being reduced, insect hotels provide a safe alternative for many pollinators. Different pollinators need a different structure.

Session 1

Let's make some Bee Hotels

Solitary bees – Carpentar, mason, leaf cutter,like tubes that are between 1 – 10 mm in diameter and 8 – 10 cm long.

Session 1

Let's make some Bee Hotels

What you need:

- Bamboo skewers
- Small rubber bands
- String (~1 ft/participant)
- Glue
- Scissors
- White cardstock (optional)
- Tape (optional)
- Coloring supplies (optional)

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Session 1

The Engineering Design Process

Step 1: Start with a question, problem, or goal.

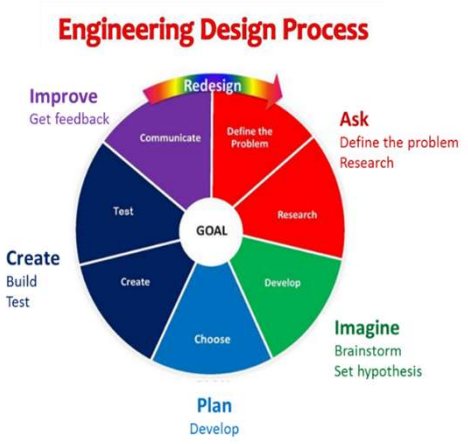
Step 2: Set the DESIGN CRITERIA

Step 3: Think about all the possibilities.

Step 4: Decide which ideas from step 2 you want to use.

Step 5: Create your first draft/prototype/version.

Step 6: Get feedback and improve your design.



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Go over the steps – it's just fancy words for something they do all the time.

Session 1

The Engineering Design Process

Step 1: Start with a question, problem, or goal.

Step 2: **Set the DESIGN CRITERIA**

Step 3: Think about all the possibilities.

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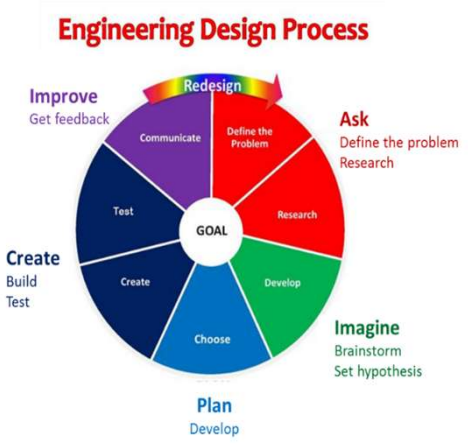

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Take some time talking about the design criteria.

Session 1

Let's make some Bee Hotels

What you need:

- Bamboo skewers
- Small rubber bands
- String (~1 ft/participant)
- Glue
- Scissors
- White cardstock (optional)
- Tape (optional)
- Color supplies (optional)

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Set the design criteria.

Session 1

Let's make some Bee Hotels

Step 1:

a) Make sure all bamboo skewers are hollowed out.

   a) Some will be hollow to start while others will need to be hollowed out with a toothpick.

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Let's make some Bee Hotels

Step 2:

a) Place glue on the skewers

b) Group them up into a bundle and use the rubber bands to keep them in place

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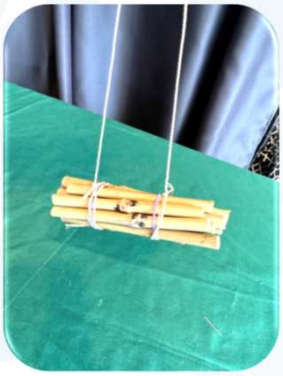
Let's make some Bee Hotels

Step 3:

a) Tie the string around your bundle to hold it together and also to make a hanger



Optional extension – Decorate some cardstock and wrap it around your insect hotel.

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Session 1

Pollinators

MIKAILA ULMER

From: Austin Texas

Age at time of invention: ~ 4 years old

Invention: Specialty lemonade drink that uses her grandmother's special recipe and honey instead of sugar.

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Session 1

Final Reflection

Can you think of something else that would help the pollinators in your neighborhood?

Session 2

Preparation	Review instructional activities below. • Instructional activities for session 2 • Lesson slides and How To video for living walls • Determine if there is a location for a living wall at your site • Review pages 4 and 5 in the participant notebook. Prepare • Find the session 2 bag, picture frames, dirt • Cut apart the felt pockets

Session 2

Your Natural Neighbors

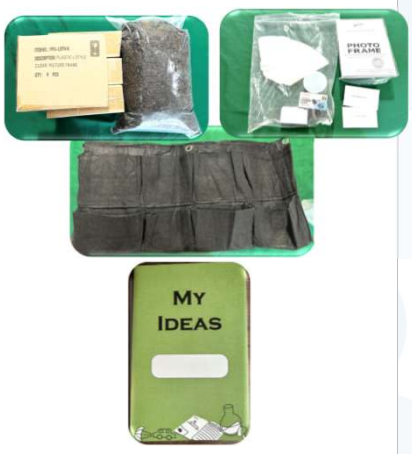
What you need

- Participant notebook
- Per Participant:
  - Acrylic frame (1)
  - Felt pocket (1)
  - Coffee filter (1)
  - Binder clip (1)
  - Soil (1 scoop)
  - Foil (1 sheet)
  - Seeds (4 – 5)
  - Adhesive dots

½ cup scoop

Additional Supplies Needed
- Pens/pencil
- Water (tap)
- Adult Scissors

Session 2 Materials



Participant Notebook

Session Flow

5 min	Welcome. Topic introduction via discussion prompt
5 min	Initial discussion on living walls.
25 min	Initial living wall assembly Reflection on living walls and seed selection Completion of living walls
10 min	Reflection and technology discussion
Final 10 minutes	Cleanup and share out on final reflection

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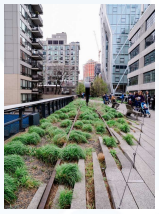
Session 2

Your Natural Neighbors

Where can you find plants in your neighborhood?



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Session 2

Your Natural Neighbors

What about on the walls?

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Session 2

Your Natural Neighbors: Living Walls

Inside:

- The plants provide a source of fresh oxygen.
- The plants naturally absorb sound so people can work, talk, and think.
- Many people find the color green relaxing.

Session 2

Your Natural Neighbors: Living Walls

Outside:

- Living walls provide homes and food for small animals, insects, and pollinators.

Session 2

Your Natural Neighbors: Living Walls

What if we used them to grow food?

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Session 2

Your Natural Neighbors

"Homemade" living walls

Session 2

Your Natural Neighbors: Living Walls

What you need:

- Picture frames
- Felt Pockets
- Coffee filters
- Binder clip
- Soil
- Seeds
- Adhesive dots
- Foil

What are your design criteria?

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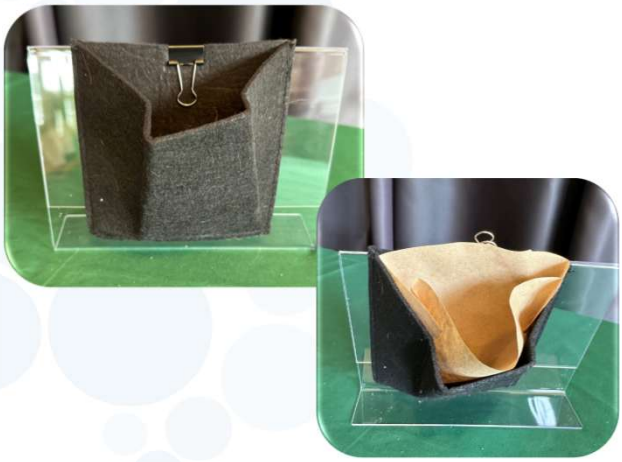
Session 2

Your Natural Neighbors: Living Walls

Step 1:

a) Clip the felt pocket to the picture frame.

b) Put the coffee filter into the felt pocket.



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Session 2

Your Natural Neighbors: Living Walls

Step 2:

a) Fill the pocket half full with soil.

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Session 2

Your Natural Neighbors: Living Walls

Discussion on seed choice

Session 2

Your Natural Neighbors: Living Walls

Step 3:

a) Select the type of seeds you want to add.

b) Add seeds to pocket and then cover with soil.

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Session 2

Your Natural Neighbors: Living Walls

Step 4:

a) Use the foil as a tray to collect water.

b) Lightly water your plant.

Optional extension –
Figure out how to secure the wall to tray.

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Optional extension – Figure out how to secure the wall to tray.

Session 2

Final Reflection

If you could put a living wall somewhere,

where would you put it and what would you plant in it?

Session 3

Preparation	Review instructional activities below • Instructional activities for session 3 • Lesson slides and How To video. Adjust lesson slides to include birds from your region. • Review pages 6 – 7 in the participant notebook. Prepare • Find the session 3 materials • Cut burlap into squares

Session 3

Your Natural Neighbors: Animals in Your Ecosystem

What you need

- Participant notebook

Suet feeder materials:
- Per Participant:
  - ~ 1 ft of string
  - 1 square of burlap
  - One set of plastic gloves
  - Sandwich bag
- Shared Resources:
  - Foil sheet
  - Vegetable shortening
  - Bird Seed
  - ½ cup scoop

Additional Supplies Needed
- Paper towels
- Pens/pencil
- Scissors

Session 3 Materials

Participant Notebook

Session Flow	
10 min	Welcome. Topic introduction via discussion prompt
10 min	Lessons on supporting birds, different types of bird feeders
15-20 min	Suet feeder assembly
10 min	Entrepreneur connection
Final 10 minutes	Cleanup and final reflection

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Session 3

Your Natural Neighbors: Animals in Your Ecosystem

The last previous sessions we've talked about plants and insects that live in urban environments.

Can you think about and described some living organisms you interact with everyday?

Session 3

Your Natural Neighbors

Reshow the video and ask participants to think about how it fits with some of the topics you have already discussed. What is new?

https://www.asla.org/sustainablelandscapes/Vid_Wildlife.html (4:41 min)
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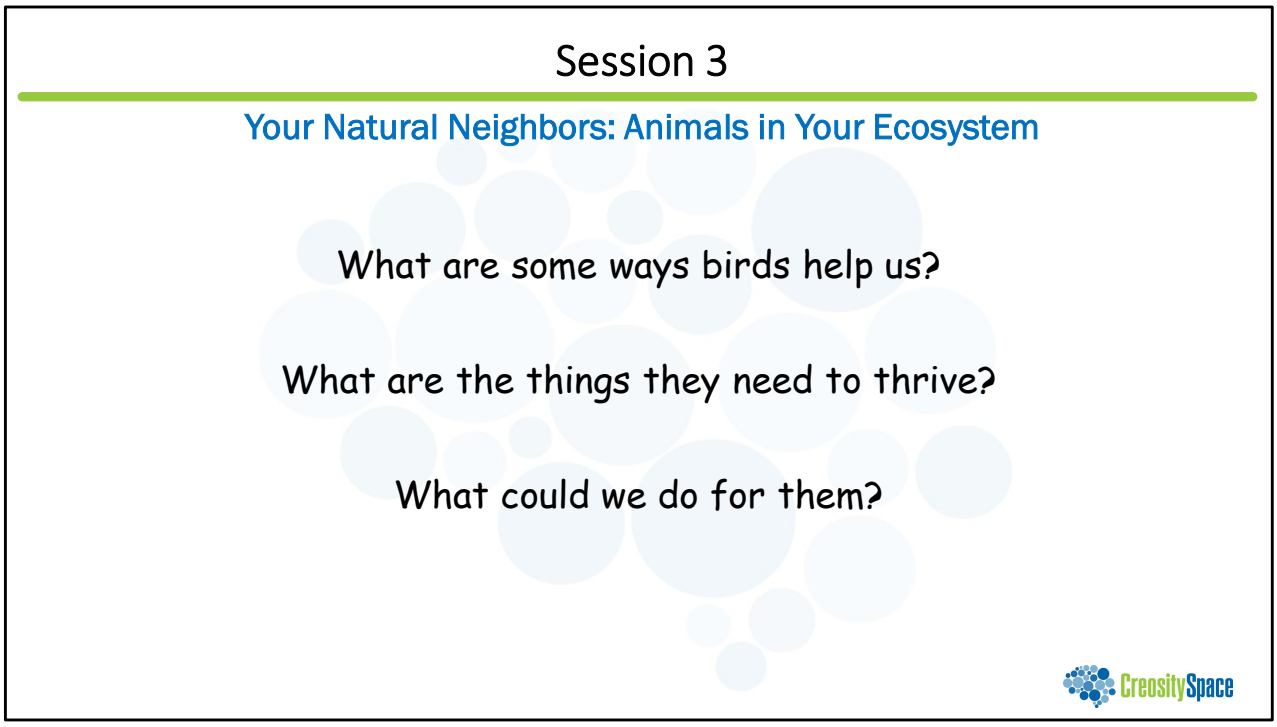
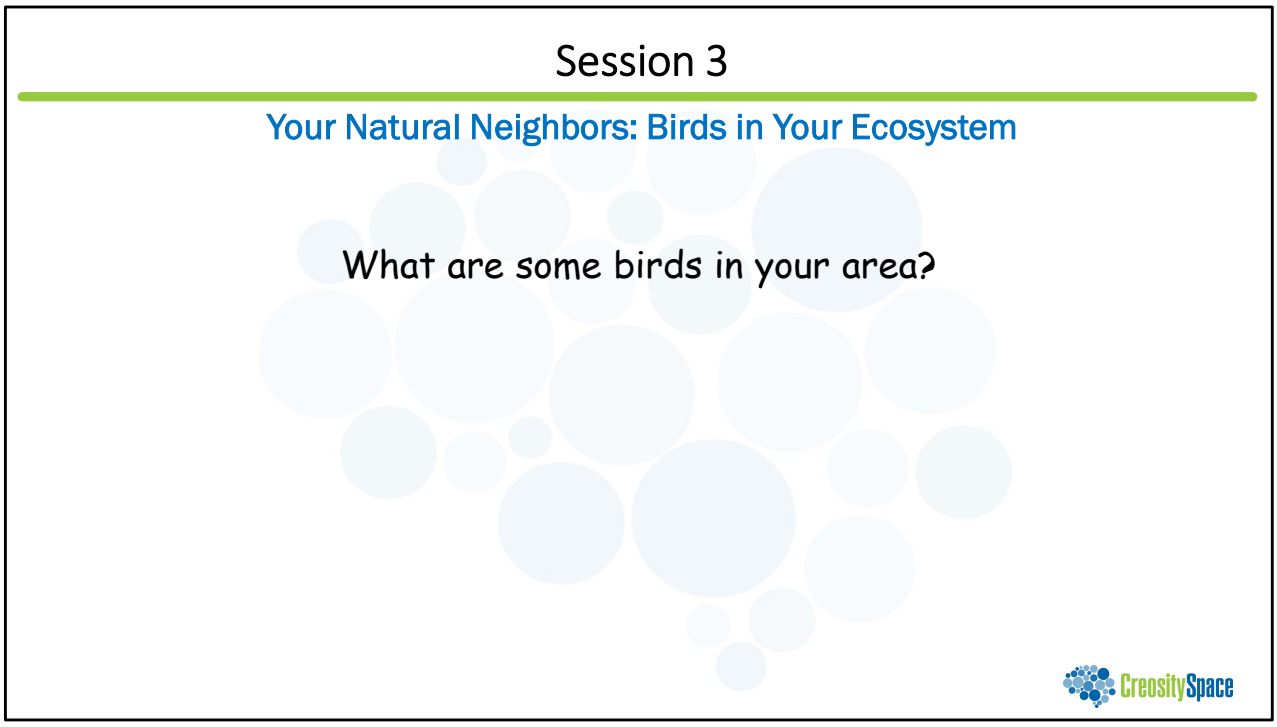


This session we're going to focus on the birds in our neighborhoods.

What are some ways birds help us?
- Pollinators
- Eat insects
- Spread seeds
- Can be fun to watch

What are the things they need to thrive?
- Place to live
- Food and water
- A safe place to raise their young

What could we do for them?
- Plant trees and shrubs for them to live in
- Fountains and water sources
- Native plants
- Bird feeders



This session we're going to focus on the birds in our neighborhoods.

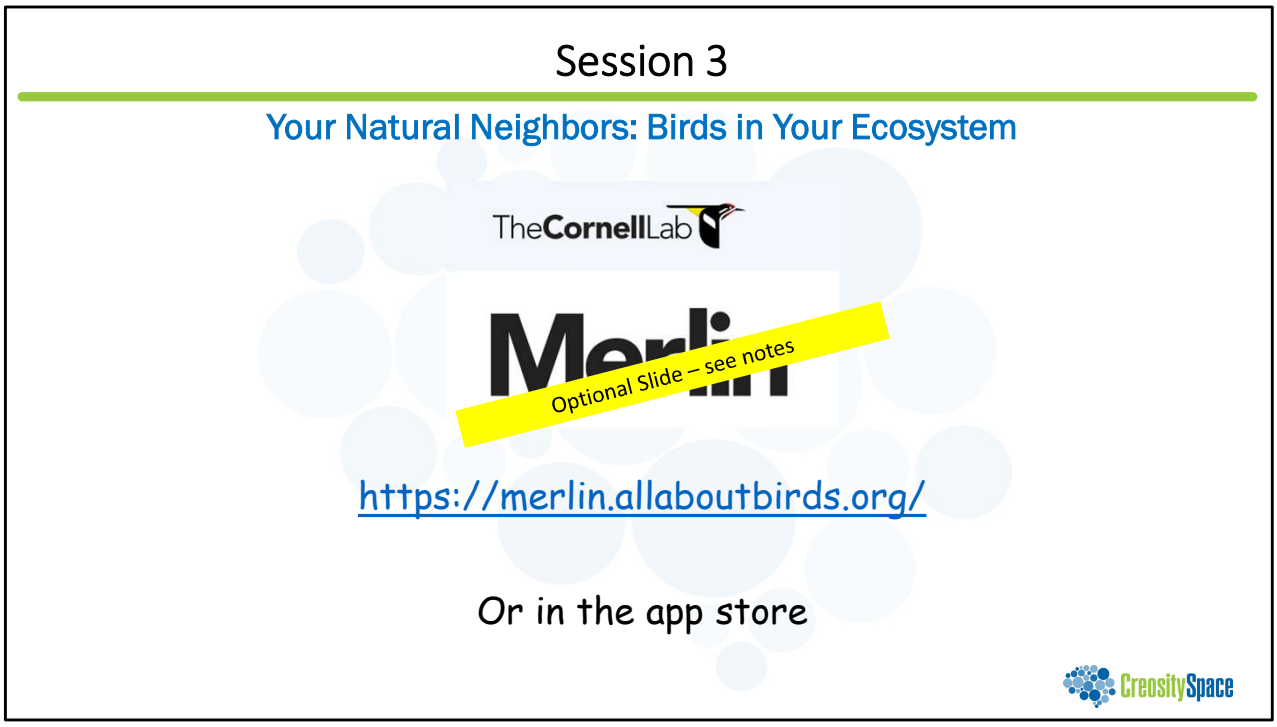
1. House Sparrow
2. American Robin
3. European Starling
4. Pock Pigeon
5. Blue Jay
6. Northern Cardinal
7. White-Throated Sparrow
8. Mourning Dove
9. Common Grackle
10. Red-bellied Woodpecker
11. Gray Catbird
12. Downy Woodpecker
13. Song Sparrow
14. Northen Flicker
15. Tufted Titmouse
16. Red-Winged Blackbird
17. Common Yellowthroat
18. House Finch
19. Ovenbird

20. White-breasted Nuthatch
21. Northern Mockingbird
22. Black-capped Chickadee
23. American Goldfinch
24. Dark-eyed Junco
25. American Crow
26. Mallard
27. Monk Parakeet
28. Peregrine Falcons

Session 3

Your Natural Neighbors: Birds in Your Ecosystem

Facilitator add slides with pictures of some of the birds from your area



If most of the participants in your group have cell phones, consider sharing the CornellLab Merlin BirdID app. It is a free app that makes bird identification fun and easy. It is also in the student notebook, which you can reference if you choose too.

Show pictures of different kinds of feeders and brainstorm pros, cons, and types of birds they support.

1. Hummingbird feeders – sugar water, good only for hummingbirds, need to be careful that it doesn't mold in summer or freeze in winter. Hummingbirds need about half their body weight in bugs and nectar, feeding every 10-15 minutes and visiting 1,000-2,000 flowers throughout the day. When it is cold, they are often awake before other birds and go to sleep later than the other birds.
2. Seed feeders – Good for smaller birds. Can attract a variety of birds as long as they can perch on the feeder
3. Suet Feeder - Suet is particularly attractive to woodpeckers, nuthatches, chickadees, jays, and starlings. Wrens, creepers, kinglets, and even cardinals and some warblers occasionally visit suet feeders. They can be better for bigger birds that have trouble landing on seed feeders.

Session 3

Your Natural Neighbors: Suet Feeders





Looking at our list of NYC birds, which ones might like a suet feeder?

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Session 3

Your Natural Neighbors: Feeders

Step 1:

We are making suet feeders

for birds in your neighborhood.

Before you begin, think about

your design criteria.

What you need:

- Vegetable shortening
- Bird seed
- Burlap
- String
- Plastic gloves

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Design criteria
- Suet cake
- Hang from tree
- Support the cake
- Access for birds

Session 3

Your Natural Neighbors: Suet Feeders

Step 2:

Combine seed and vegetable shortening on the foil. Start with less shortening

Optional extension
The instructional guide contains some suggestions on ratio of seeds to shortening. Depending on the group, let them experiment with different ratios to come up with their optimal consistency.

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Session 3

Your Natural Neighbors: Suet Feeders

Step 3:

Using the string and burlap (optional), form the mixture into your desired shape.

Use the scissors to cut slightly larger holes in the burlap so that birds can get to the suet.

Remember your design criteria

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Session 3

Your Natural Neighbors: Suet Feeders

Step 4:

Test the structural integrity of your suet feeders.

If necessary, make adjustments to your design.

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Session 3

Your Natural Neighbors: Entrepreneur Profile

JUNE GRANT

From: Kingston, Jamaica

Invention: Sustainable Architect

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https://www.pbs.org/newshour/brief/386429/june-grant

https://youtu.be/v-5J6yxle9U
https://www.pbs.org/newshour/brief/386429/june-grant

Session 3

Final Reflection

Where are you going to hang your suet feeder?

If you could invent or design something to help the animals in your neighborhood, what would it be?

Session 4

Preparation	Review instructional activities below. • Instructional activities for session 4 • Lesson slides • Review pages 8 – 9 in the participant notebook Prepare: • Locate bag for session 4 • Cut apart card decks

Session 4

Harnessing Nature: Traits and Characteristics

What you need

- Participant notebook
- Sorting cards
- Prototype supplies: Craft sticks, pipe cleaners, feathers, cardstock

Additional Supplies Needed
- Pens/pencil
- Scissors
- Tape

Session 4 Materials

Participant Notebook

Session Flow

10 min	Welcome. Topic introduction via discussion prompt
10 min	Traits sorting activity (group)
10 min	Reflection, discussion
20 min	Superhero design (group)
Remaining time	Wrap up and share

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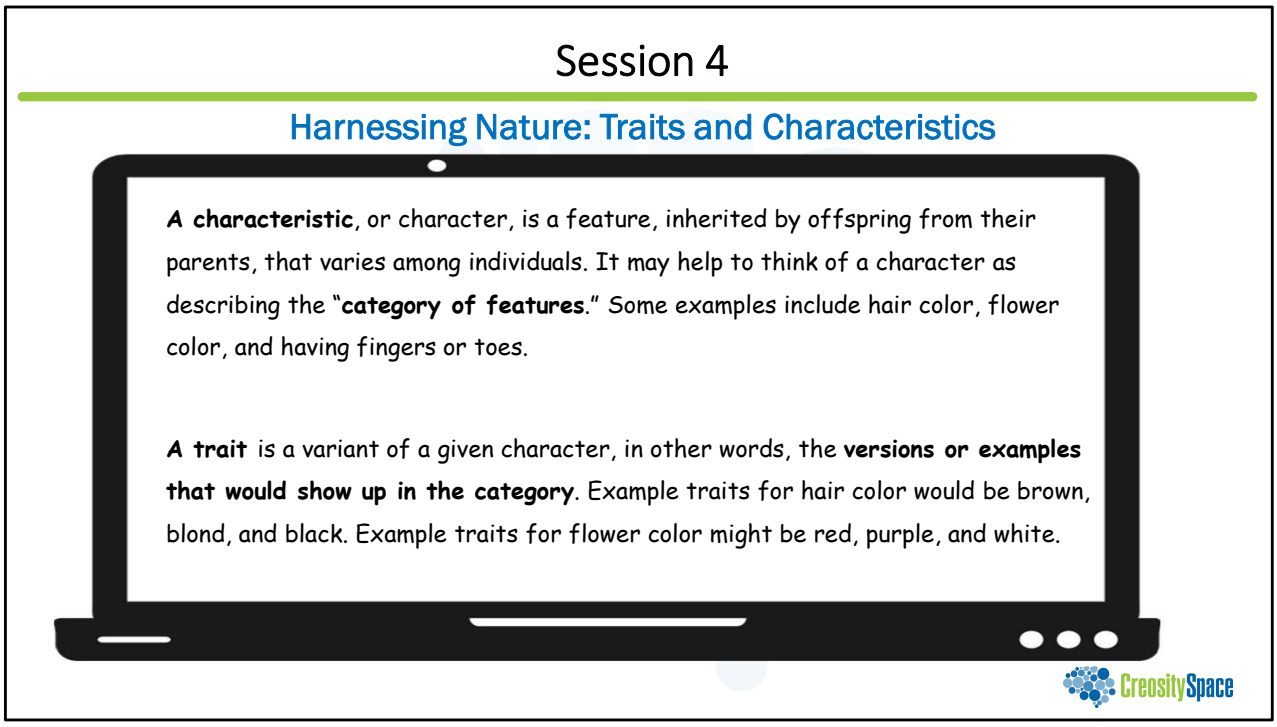
Session 4

Harnessing Nature: Traits and Characteristics

What makes you unique?

What are some things about you that make you unique – or different than everyone else



Begin the session with a general discussion on organization and why we put things in certain places. You can use a relevant example such as the classroom, the library, or the grocery store to help illustrate the point and then ask the participants if they can think of their own examples. After discussing the *what*, move on to chat about the *why*. Why do we organize things and how do we choose to organize them? There are many possible answers, but make sure the discussion also includes the concept of similarities and patterns (both of how things look and how we use them) between different objects as a reason why things are often grouped together. From this discussion you can introduce the concepts of characteristics and traits as a way to organize things.

An example introduction is outlined below.
Look in the cupboards in your kitchen—how are things organized? Probably the plates and bowls are in one place; cups in another; and knives, forks, and spoons in a drawer. People often like to organize their "stuff" based on its shape, size, and function. This helps us remember what we have and where to look when we need something.
A similar thing can be said about how scientists keep track of living creatures. They like to group them together based on their similarities: how they look, what they are made of (their DNA), and how they behave. This activity of classification is called

taxonomy.
Taxonomy helps us keep track of all the organisms in the world and also helps us to understand where they came from, what they need to survive, and how they can be helpful (or harmful) to humans.
For the following investigation you'll be organizing the cards in a number of different ways. Each time we organize them we'll spend some time discussing WHY you decided to organize the cards that way.

Session 4

Harnessing Nature: Traits and Characteristics

Sorting game

- Have participants take the cards and organize based on which ever reason they think is most interesting or relevant.

- Then use just the animals and organize in the following ways:
  - How do they move? (e.g., swim, fly, walk)?
  - How many legs do they have (0,2,3,6,8, more)?
  - What covers their body (hair, fur, feathers, scales, others)
  - How do they breathe (lungs, gills)
  - How are their young produced (live, eggs (hard shell or in water)?
  - Where do they live?

Session 4

Harnessing Nature: Cool Plant and Animal Traits

Do you remember some of the cool traits of the insects that we discussed in the first session?

Ants – can lift 10-50x their weight
Bees – 5 eyes and can fly 20 mph
Cockroaches - A cockroach can live almost a month without food, two weeks without water, and hold their breath for 40 minutes

Session 4

Harnessing Nature: Cool Plant and Animal Traits

Opossums are immune to snake venom

They can be bit by almost 200 rattlesnakes without getting sick.

Session 4

Harnessing Nature: Traits and Characteristics

English ivy can grow almost everywhere – it can trail along the ground or grow vertically up trees, fences, walls and hillsides.

When growing on trees and other plants it often sucks the life out of that tree or plant.

Session 4

Harnessing Nature: Traits and Characteristics

What other cool plant or animal traits can you share?

Session 4

Harnessing Nature: Traits and Characteristics

- Elephants can smell water up to three miles away
- Hummingbirds have wings that beat up to 200 times a second. They are also the only birds able to hover, and they can fly backwards and even upside down!
- Dogs have a sense of smell ranging from 100,000 to 1,000,000 times more sensitive than a human's; 100 million times greater in bloodhounds.
- Cows have almost total 360-degree panoramic vision. They also have an excellent sense of smell and are able to detect odors 5-6 miles away. They can also hear both high and low frequency sounds beyond human capability.
- A butterfly's sense of taste is 200 times stronger than ours!
- Rabbits can see behind themselves without turning their head.
- Chickens have a complex language all of their own, with over 30 different types of alarm calls depending on the type of threat. They also have great memories and can differentiate between over 100 different faces (*of their fellow chickens).*
- Goldfish are the only animals that can see in both infrared and ultraviolet light.
- Electric eels can transmit a shock between 600 and 800 Volts
- Mountain Stone Wetas freeze, but remain alive
- Jaguars have killer jaws
- Owls can twist their heads 270 degrees

- Welwitschia Mirabilis: The stem of this plant, which consists of two leaves, a strong stem and a root, both gets longer and wider and reaches a height of two meters and a width of eight meters. This plant, which draws even the slightest moisture inside it through this stem, can live for five years with no rain.
- The Selaginella lepidophylla also known as "Erica's rose" is also a desert plant. The interesting thing about this plant is that it can live with almost no water. This plant completely dries during times of drought and turns into a ball by tucking in its branches and leaves. However, when rains begin, it revives again by opening its branches and leaves and starts all of its vital functions again.
- Venus fly trap - You might wonder how the trap is triggered. Well, with trigger hairs. When two hairs are touched within 20 seconds of each other or, if a single hair is touched twice, the trap snaps shut. Healthier Venus Flytraps close quicker. Scientists are unsure about the mechanism (it has to do with neighboring cells sending chemical messages to each other).
- The strangler fig is the biggest mooch of the plant kingdom. Not only does it mooch, it kills. There are many different species of strangler fig, but they all are basically the same thing: that roommate who steals all of your food, the guy at a party who steals all of your beer, or that guy in class who copied your homework and got a better grade. They are usually dispersed by hitch-hiking on birds and being dropped on the canopy of trees of a dense forest. They are wacky because they will grow up and down. They grow down so that their roots can rob the living tree of all its nutrients. It grows upwards to absorb sunlight. They often outlive the host tree by years.
- **Bear's-Head Tooth Mushroom** This amazing mushroom fights cancer, stimulates nerve growth, and helps kill roundworms. How do we know? Well, some really brave soul found out it was edible.

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This is a list of plant and animal traits that you can put on the board to help the groups brainstorm.

Session 4

Harnessing Nature: Traits and Characteristics

Working alone or in small groups, design your own superhero (or super villain), with as many cool traits as you want. Be sure to determine the back story of your superhero (or super villain) that describes where and how they got their super-powers.

Session 5

Preparation	Review instructional activities below • Instructional activities for session 5 • Lesson slides • Review pages 10– 11 in the participant notebook. Prepare • Find session 5 materials

Session 5

Harnessing Nature: Microbes

What you need

- Participant notebook

Per Participant:
- 1 container

Shared Prototyping Resources (mentees can pull from them to make their composter)
- Puffballs test compost mixing (4 – 7 each)
- Prototyping supplies (fabric, pipe cleaners, wire, paper straws, craft sticks)
- ½ cup scoop (to hand out soil at the end)

To be handed out at the end:
- ½ scoop soil (save 2 scoops for session 8)

Additional Supplies Needed
- Pens/pencil
- Scissors
- Tape or glue
- Coloring Supplies (optional)

Session 5 Materials

Participant Notebook

Session Flow

10 min	Welcome. Topic introduction via discussion prompt and microbe match
5 - 15 min	*Microbe Battle Royale* (optional)
5 - 10 min	Composting lesson
10 - 15 min	Design your own composter
Remaining time	Wrap up and cleanup

CreositySpace

Session 5

Harnessing Nature: Microbes

What do you know about microorganisms?

What is the smallest living organism you can describe?

Session 5

Harnessing Nature: Microbes

What is a Microbe?

Microorganisms (or microbes) are VERY small creatures that we can only see with special equipment.

The size of the organism—not what it is made of—determines if it is a microbe. Many types of organisms can be microbes including bacteria, fungi, and algae.

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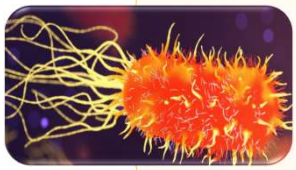
Session 5

Harnessing Nature: Microbes

What is a Microbe?

Some microorganisms are helpful—like antibodies, yeasts, and geobacters—that help our immune systems, make our food taste good, and even produce energy.



Some microorganisms are harmful—like germs and viruses—and these can make us sick.

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Session 5

Harnessing Nature: Microbes

Microbes in our food

Do you like yogurt? How about sauerkraut, kimchi, or bread?

Originally, using microbes for fermentation was used as a method to preserve food. Today scientists, chefs, and entrepreneurs are taking it a step further and turning the practical into a delicious treat.

Bread – fungus (yeast) (Saccharomyces cerevisiae)

Yogurt – bacteria (Lactobacillus bulgaricus and Streptococcus thermophilus)

Kimchi – bacteria (Leuconostoc, Weissella, and Lactobacillus)

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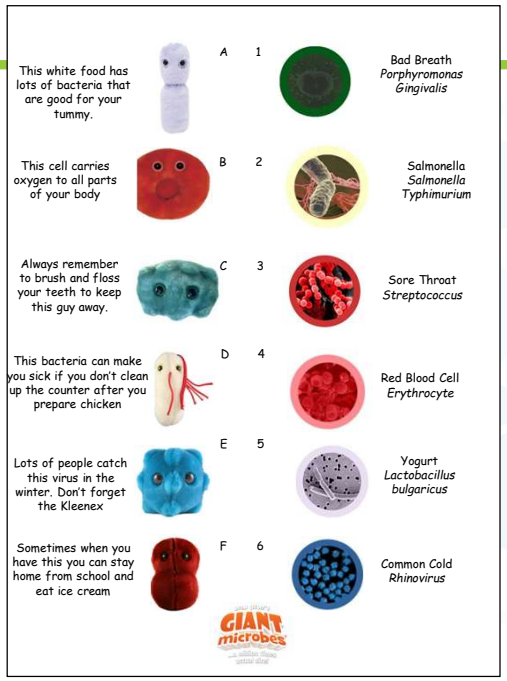
Bread yeast is actually part of the fungus kingdom



Session 5

Harnessing Nature: Microbe Match

Work with a friend to see if you can connect the toy microbes on the left to the actual picture on the right.

Look at the shape and color of the microbe in addition to reading the description.

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Session 5

Harnessing Nature: Microbes

Microbe-based energy generation and storage

Microbial fuel cells use bacteria to digest food waste and sewage to create electrical energy and clean water. This technology is used today in many applications, including cleaning up the water used in wastewater treatment plants and breweries.

This ability comes from a special group of microbes who don't need oxygen to live—they are called **Anaerobic Microbes**.

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Session 5

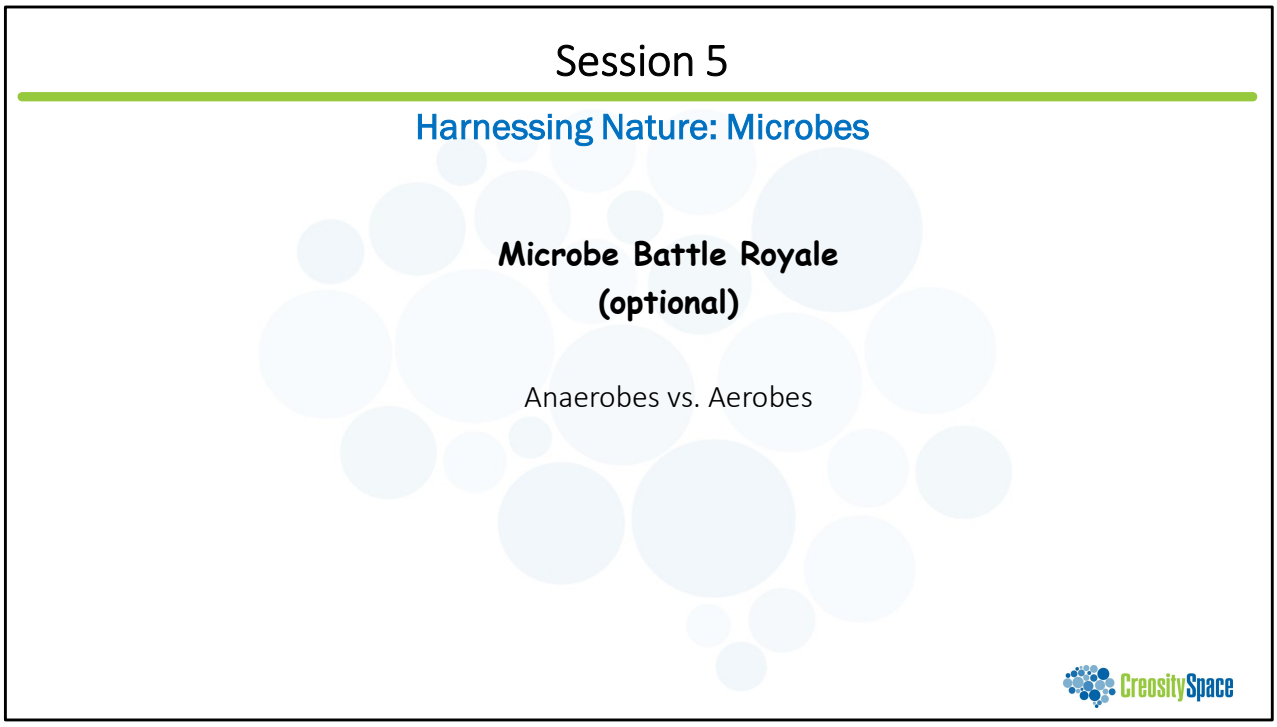
Harnessing Nature: Microbes

Aerobic vs. Anaerobic

Aerobic microbes need oxygen to help breakdown food and pull energy out it.

Anaerobic microbes are able to get energy from food without the help of oxygen.

Where would you explore if you didn't need oxygen to survive?



This is an optional game that you can play with your group if you think they would benefit from a bit of moving around. It is a microbial take on a classic prey/predator population game.

1. Divide the group into three teams. Teams will rotate through being the anaerobes, aerobes and “food” (“food” is both food and oxygen). Every player receives a flag football belt but only the “food” team wears flags. It is suggested that each member of the food team wear four flags. The flags do not need to be all the same color.
2. The anaerobe and aerobe teams line up on either end of the field of play. The “food” team places flags on their belts – blue for oxygen, red for food – and stands spread out in the field of play. Once positioned on the field of play, “food” team members do not move.
3. Participants are reminded that some microbes need food and oxygen (Aerobes) to function while others just need food (Anaerobes).
4. The line leader on either side starts at the go signal by entering the arena and gathering food and/or oxygen. After returning with the food/oxygen, he/she will tag in the next individual and both will go out and get more food/oxygen and

both tag in the next two people, and so on. The game stops when there is no food left.
Anaerobes don't need oxygen to breath, but don't get as much energy per unit food, so they have to gather two units of food each time (but no oxygen) in order to tag the next person in.

Anaerobes don't need oxygen to breathe, but don't get as much energy per unit food, so they must gather two units of food each time (but no oxygen) in order to tag the next person in.

Aerobes need oxygen, but not as much food – so they need one unit of oxygen and one unit of food each time.

Session 5

Harnessing Nature: Microbes

Microbe Battle Royale (optional)

Scenarios

Suggestion – The number of flags in use should be 4x the number of people on a given team. For example, if each team has 5 people, use 20 flags total

Scenario 1	Scenario 2	Scenario 3	Scenario 4
Stagnant Pond	Moving Steam	Compost Bin	Recently Harvested Field
Use 3x as many food flags as oxygen flags	*Use 2x as many oxygen flags as food flags*	*Use 4x as many food flags as oxygen flags*	*Use 4x as many oxygen flags as food flags*

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Session 5

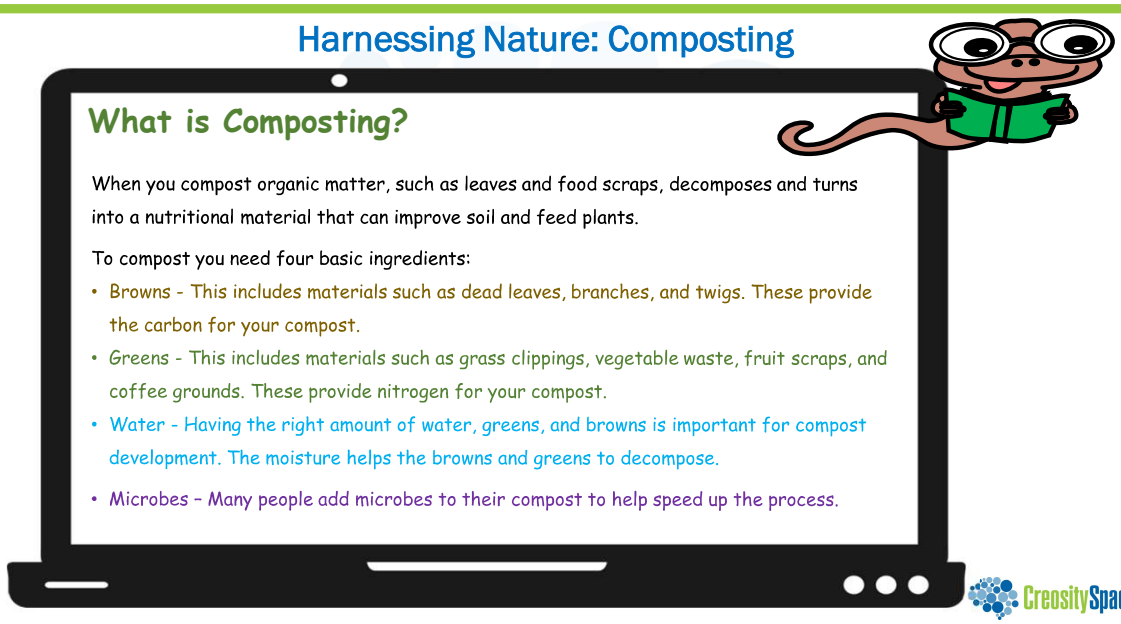
Harnessing Nature: Microbes

Microbes and Waste

Can you think about how microbes might help us manage waste?

Session 5

Harnessing Nature: Composting



Composting not only helps soil but it also reduces the amount of garbage that is sent to the landfill. Composting helps the planet in many ways!

Session 5

Harnessing Nature: Composting

Many composters are big and smelly and outside – what if we had an easy in house composter?

Session 5

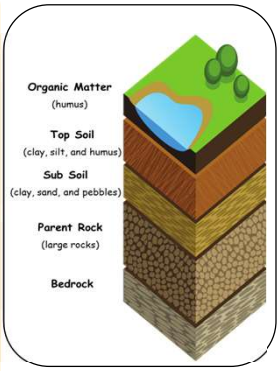
Harnessing Nature: Microbes

Soil is more than just dirt

Soil is a mixture that helps balance food and energy between different living organisms.

The soil performs four jobs that are very important to life on Earth.

1. Soil provides a home and food for plants to grow.
2. Soil provides a home, or habitat, for many different living creatures (animals, insects, good bacteria).
3. Soil cleans and stores a lot of Earth's drinkable water.
4. Soil interacts with the atmosphere and helps to balance the amounts of different gasses.



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The soil includes organic matter, minerals, gases, liquids and living creatures. The soil keeps all these parts together by balancing the interactions with the world around it. For example, when plants are growing, they take nutrients (food) and water from the soil. When plants die, they return the nutrients (organic matter and minerals) and water to the soil through decomposition.

Session 5

Harnessing Nature: Build a Composter

What you need:

- Container
- Fabric
- Scissors
- Wire
- Craft Sticks
- Pipe Cleaners

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Session 5

Harnessing Nature: Build a Composter

Discuss what a composter needs for design criteria

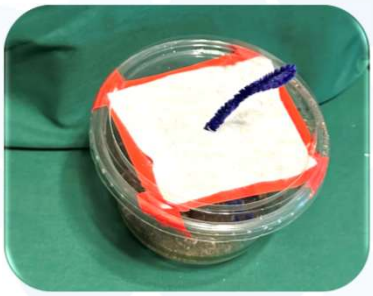
Needs to be sealed, allow for some air, allow for some water, allow for mixing

Session 5

Harnessing Nature: Build a Composter

Design Criteria:

- Must be sealed
- Must allow for some air flow
- Must be able to add water
- Must be able to have some mixing.



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Needs to be sealed, allow for some air, allow for some water, allow for mixing

Session 5

Composters and Innovation

JEREMY LANG

From: Saskatchewan, Canada

Age at time of invention: ~ 30

Invention: Jeremy started the company Pela, with the lofty goal to create a waste free future. One of the ways they are working towards this goal is with their new composting product, Lomi. Jeremy's goal is to make composting fast and easy so more waste stays out of our landfills.

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This is a great 1 minute video on the power of composting innovation.
https://youtu.be/HYv6d6U0E2s

Session 5

Microbial Fuel Cell Inventors

BRENT SOLINA

From: Buffalo, NY

Age at time of invention: ~ 20

Invention: Brent has been working on a new microbial fuel cell system for the past 10 years! He is trying to find the best microbe – electrode combination. His company, MIRCOrganics technology has pilot trials running in Upstate New York.

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Session 5

Microbial Fuel Cell Inventors

ORIANNA BRETSCHGER & SOFIA BABANOVA

From: San Diego, CA

Age at time of invention: ~ 27

Invention: Orianna and Sofia founded Aquacycl in 2016 but started working on the technology almost 15 years earlier when Orianne was in graduate school. Acuacycl focuses on developing systems that can be used in underserved and developing communities around the world.

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Session 6

Preparation	Review instructional activities below • Activity instructions and lesson slides • Review pages 12 – 13 in the participant notebook. Prepare • Retrieve the session 6 bag.

Session 6

Harnessing Nature: Biomimicry

What you need

- Participant notebook
- Biomimicry handouts

Additional Supplies Needed
- Pens/pencil
- Coloring supplies
- Scissor

Session 6 Materials

Participant Notebook

Session Flow	
10 min	Welcome. Topic introduction via discussion prompt
15 min	Biomimicry matching game and discussion
25 min	Biomimicry redesign
Remaining time	Wrap up and cleanup

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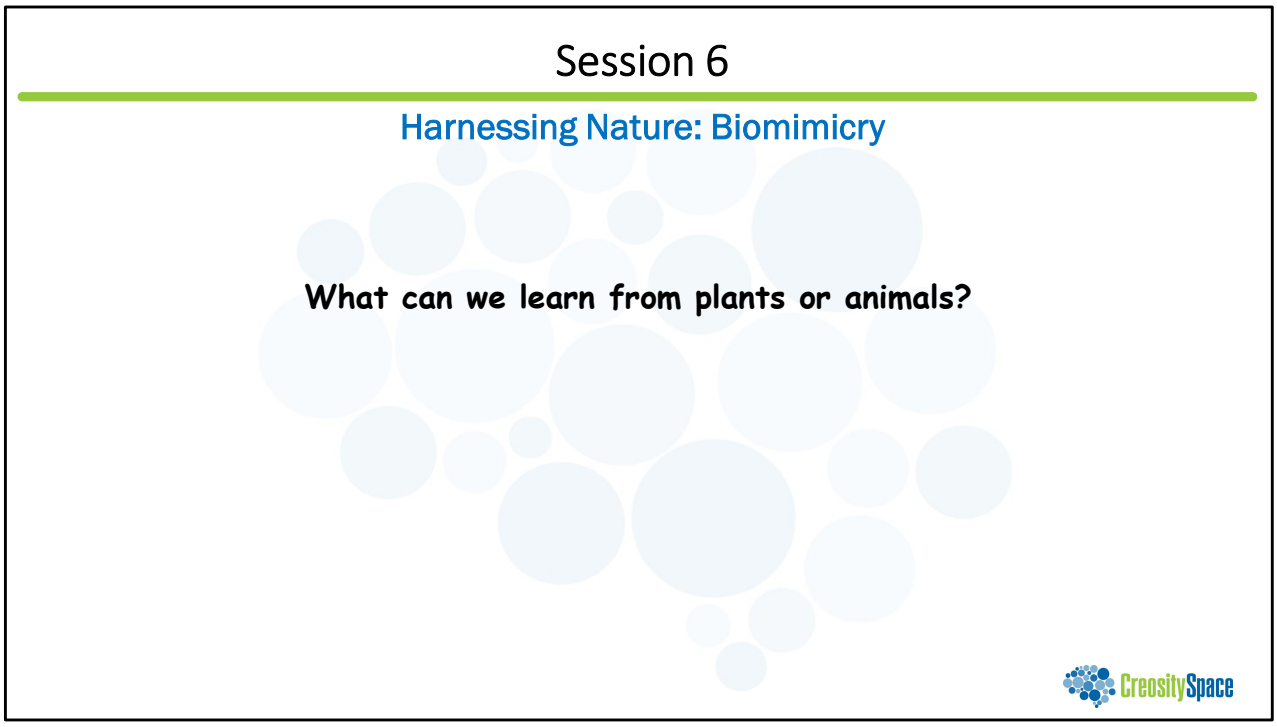
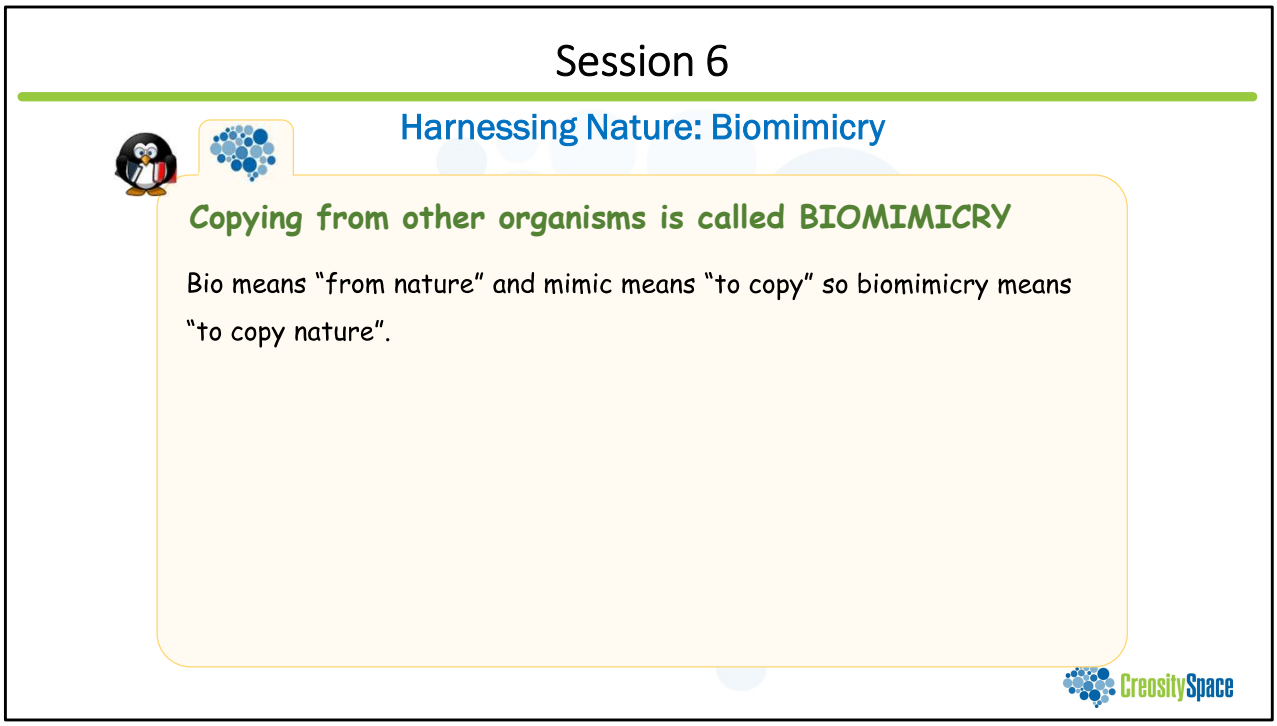


Ask if anyone has any suggestions on things we can learn from plants or animals?



While copying from another student on a test is not a good thing, copying from nature to solve challenges is always welcomed. The Earth is over 3.8 billion years old, so plants and animals have had a long time to learn what works and what doesn't work**. The field of STEM that focuses on learning from nature is called biomimicry. Bio means "from nature" and mimic means "to copy" so biomimicry means "to copy nature".**

Who remembers what the definitions of characteristics and traits are?

A characteristic, or character, is a feature, inherited by offspring from their parents, that varies among individuals. It may help to think of a character as describing the "**category of features**." Some examples include hair color, flower color, and having fingers or toes.

A trait is a variant of a given character, in other words, the **versions or examples that would show up in the category**. Example traits for hair color would be brown, blond, and black. Example traits for flower color might be red, purple, and white.

Session 6

Harnessing Nature: Biomimicry

Can you work in teams to match the innovation to its biological inspiration?

Innovation

Inspiration

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Session 6

Harnessing Nature: Biomimicry

Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match.

Session 6

Harnessing Nature: Biomimicry

The skin of the snake has special properties that allows it to be smooth and lightweight but able to grip the ground so that the snake can slither easily.

Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match.

Session 6

Harnessing Nature: Biomimicry

The skin of the snake has special properties that allows it to be smooth and lightweight but able to grip the ground so that the snake can slither easily.

Researchers in Cambridge, Ma have developed an adaptive shoe grip that mimics the scale in snakeskin. The sole is cut using a Japanese technique (Kirigami) and when it stretches small spikes pop out and grip the ground.

Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match. Describe it, and then ask if someone wants to guess type of biomimicry.

Session 6

Harnessing Nature: Biomimicry

Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match.

Session 6

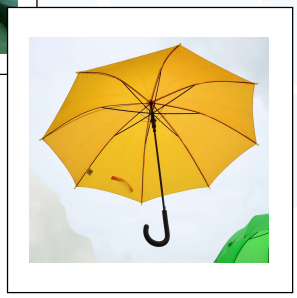
Harnessing Nature: Biomimicry

In some places the leaf of the lotus flower can grow quite large. It is flexible and lightweight.

Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match.

Session 6

Harnessing Nature: Biomimicry



In some places the leaf of the lotus flower can grow quite large. It is flexible and lightweight.

Over 2000 years ago, Lu Ban noticed a group of children shielding themselves from the rain with lotus leaves. He used silk and bamboo to recreate the leaf and developed the first umbrella.

Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match. Describe it, and then ask if someone wants to guess type of biomimicry.

Session 6

Harnessing Nature: Biomimicry

Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match.

Session 6

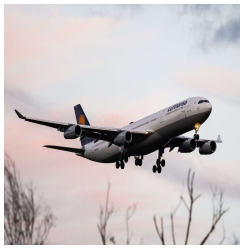
Harnessing Nature: Biomimicry

The bone structure in the wings of bats and many birds enable them to fly across the sky.

Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match.

Session 6

Harnessing Nature: Biomimicry



The bone structure in the wings of bats and many birds enable them to fly across the sky.

This structure inspired both Leonardo da Vinci and the Wright brothers to create the first flying machines, paving the way for air travel as we know it.

Session 6

Harnessing Nature: Biomimicry

The slim hook structure of the burr enables it to attach to passing by animals (and people) to help spread seeds.

Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match.

Session 6

Harnessing Nature: Biomimicry

Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match.

Session 6

Harnessing Nature: Biomimicry

The slim hook structure of the burr enables it to attach to passing by animals (and people) to help spread seeds.

This structure the development of the hook & loop structure of Velcro™.

Session 6

Harnessing Nature: Biomimicry

Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match.

Session 6

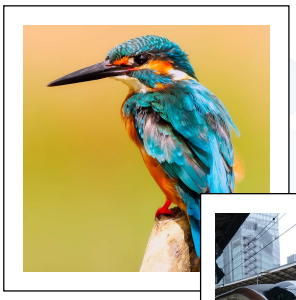
Harnessing Nature: Biomimicry

The shape of the kingfisher's head enables it to dive into the water quickly and silently to catch fish.

Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match.

Session 6

Harnessing Nature: Biomimicry



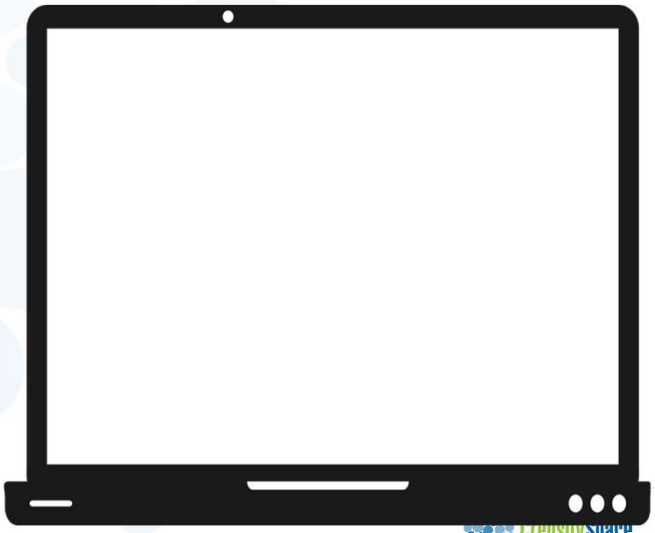
The shape of the kingfisher's head enables it to dive into the water quickly and silently to catch fish.

The bullet train in Japan is super fast. The first design made a loud boom as it exited tunnels sure to the pressure buildup in the tunnel. When the front of the train was redesigned to look like the kingfisher head, this problem stopped!

Session 6

Harnessing Nature: Biomimicry

https://www.mickpearce.com/Eastgate.html



Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match.

Session 6

Harnessing Nature: Biomimicry

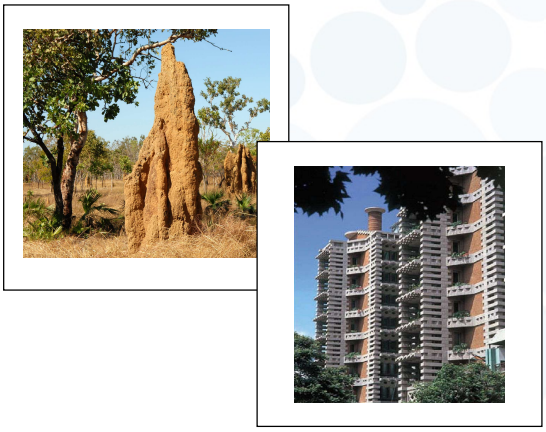
https://www.mickpearce.com/Eastgate.html

Termite mounds are full of "windows" and tunnels that let CO2 out and oxygen in, allowing for fresh airflow.

Describe the key trait, ask if someone wants to suggest the match.
Next slide, show the match.

Session 6

Harnessing Nature: Biomimicry



https://www.mickpearce.com/Eastgate.html

Termite mounds are full of "windows" and tunnels that let CO2 out and oxygen in, allowing for fresh airflow.

Engineers in Zimbabwe have built a shopping mall with a similar structure that also encourages airflow. The building uses 10% less energy for cooling the building mimicking the termite mounds.

Session 6

Harnessing Nature: Biomimicry

Copying from other organisms is called BIOMIMICRY

Bio means "from nature" and mimic means "to copy" so biomimicry means "to copy nature".

People normally group types of biomimicry into three categories:

Form → copying shape

Process → copying how something is done

Ecosystem → Copying how different living things interact

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People normally group types of biomimicry into three categories:

- Form → copying shape
- Process → copying how something is done
- Ecosystem → Copying how different living things interact

Session 6

Harnessing Nature: Biomimicry

Bio-Inspired Redesign

Heat Island Reduction Concrete buildings, reflective windows, and asphalt streets make urban environments hotter. Pick a design element or two you could incorporate in your neighborhood to make it cooler in the summer.	**Smart Water Usage** All the rain in NYC goes down the storm drains and into the water treatment plant. Pick a park or a building in your neighborhood, and design a bio inspired way to use some of that rainwater.
Building Energy Buildings take a lot of energy to heat, cool, and to power things like light and computers. Pick a bio inspired way to make your school, home, or corner grocery store more energy efficient.	**Ground Stabilization** New York City has a lot of coastlines and beaches that can be damaged in storms both from waves and from rain. Upgrade your favorite waterfront park or beach with some bio inspired features to protect the coastline and the people using it.

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Now it is time for participants to choose one place or building for which they can do a mini-bio inspired redesign. They don't need to completely redesign the space, but more suggest and describe an upgrade. They can pick from the list above or else suggest their own location.

Session 6

Harnessing Nature: Biomimicry In Architecture

Construction and Materials

Mushrooms-Mycelium The root structure of mushrooms (called mycelium) is an extensive network that binds soil in the wild. Developers can use just the roots (not the fruit) to bind lightweight insulating material (like straw) and make a biodegradable material that can be used for packaging or insulation.	**Leaves, rivers, flower petals** Curves surfaces are found throughout nature and are both pleasing to the eye and low energy ways for air and water flow. Curved buildings are not only pleasant to look at but also support better airflow inside.
Spider Webs Spiders don't want birds crashing through their webs so they have a special UV reflective materials in their silk to deter birds. Some glass manufactures are trying to replicate this with their window glass.	**Beehive Honeycomb** The honeycomb structure used in beehives is very strong but uses the minimum amount of material for the volume. Lightweight building can use this technique to build a strong structure with the least amount of material.

Session 6

Harnessing Nature: Biomimicry In Architecture

Energy Efficiency

Sunflowers Sunflowers naturally track the sun to maximize exposure. Solar cell manufactures have mimicked this behavior to help design systems that capture the most sunlight.	**Sedona Cactus** These giant cacti have ridges in their truck. These ridges provide built in shade to help keep the cactus cool in the hot sun. Some construction companies have employed similar strategies to help keep buildings cool.
Slime Molds Are a fugus that is very good at mapping the most efficient route to get to its food. City planners are using it to plan the fastest ways to move around, and between, complex and highly populated cities.	**Termite Mound** The small holes and tunnel network force air circulation in termite mounds. Similar

Session 6

Harnessing Nature: Biomimicry In Architecture

Water Usage & Ground Stabilization

Plant Respiration One-way plants help keep neighborhoods cool is because of water evaporation from the surface of their leaves. Building off this concept, some buildings and public spaces have created artificial mini waterfalls that use recirculated collected rain-water to keep the area cooler through evaporation.	**Tall Vetiver Grass** This grass is known for its very long root system that helps stabilized sandy shores against erosion. Using a similar design, engineers often insert 8 ft long steel poles into unstable ground to stabilize it prior to construction.
Forest Ecosystems, Tree Trunks Plants and tree root systems naturally filter water and slow run-off. By plants small greenspaces in sidewalks and parkettes, the amount of rain that enters the sewers and water treatment systems can be decreased. Additionally, the quality of that water improves and puts less strain on the water treatment plants.	**Oyster Reefs** Oysters extract minerals from the water to make their shells. They also filter toxins out of the water naturally. Many costal towns (including around NYC) are creating breakwaters from oyster shells that help protect the coast and clean the water.

Session 6

Harnessing Nature: Biomimicry In Design

Slime molds → efficient routes between locations (city planning)

Humpback whale fins → wind turbine design

Fog Harvester beetle → atmospheric water capture

Mycelium (mushroom roots) → non-toxic (biodegradable) insulation and packaging

Muscles → non-toxic underwater adhesive

Animal Limbs → Earthquake resistant bridges

Plant stems and tree trunks → water filtration

Underwater plants (kelp) and wave motion → energy generation

Maple and sycamore seed pods → ceiling fan design

Octopus limbs → soft, flexible robotics

Forest system → water purification

Spider webs → UV reflective additives to prevent birds from hitting windows.

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Session 7

Preparation	Review instructional activities below ● Activity instructions, lesson slides and How To video. ● Review pages 16 – 17 in the participant notebook. ● Modify lesson slides as desired. Prepare ● Determine strategy for heating milk (including bringing a container that can be used to heat up the milk) Note – This experiment is best done with fresh whole milk, but if that is not an option, powdered whole milk is provided. Additional it is important the milk be hot, so please consider how you will manage this.

Session 7

Sustainable Materials: Biopolymers

What you need

- Participant notebook

Paper clip polymers (mentees should work in teams of 4). Each group receives:
- ~30 regular paper clips
- 5 odd-shaped paper clips
- 2 – 3 colored paper clips

Milk polymers (Participants should work in pairs). Each group receives:
- 2 sets of plastic gloves
- Paper cup
- Craft stick
- 3 packs of vinegar
- Sheet of foil
- ~3/4 cup of warm milk (120 – 150°F)
- 2 snack bags (to take polymer creations home)

Shared Resources
- Mini cookie cutters

Additional Supplies Needed
- Paper towel
- Large mixing and microwavable container for milk
- Water (tap)

Session 6 Materials

Participant Notebook

Session Flow

5 min	Welcome. Topic introduction via discussion prompt
15 min	Paperclip polymers
10 min	Science lesson, technology discussion
20 min	Milk polymers
10 min	Discussion
Remaining time	Wrap up and cleanup

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Session 7

Sustainable Materials: Biopolymers

What can you tell us about plastics or polymers?

Session 7

Sustainable Materials: Biopolymers

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Students will work in groups of 2 or 4 to build paper clip polymers. They'll start with 40 paper clips and the challenge to build as many different polymer chains as they can think of.

Session 7

Sustainable Materials: Biopolymers

Paper clip polymers

Students will work in groups of 2 or 4 to build paper clip polymers. They'll start with 40 paper clips and the challenge to build as many different polymer chains as they can think of.

Session 7

Sustainable Materials: Biopolymers

What is a POLYMER?

POLY means "many" and a MER "is a small particle that likes to attach to similar particles".

POLYMER → Many Mers → a group of Mers attached to each other.

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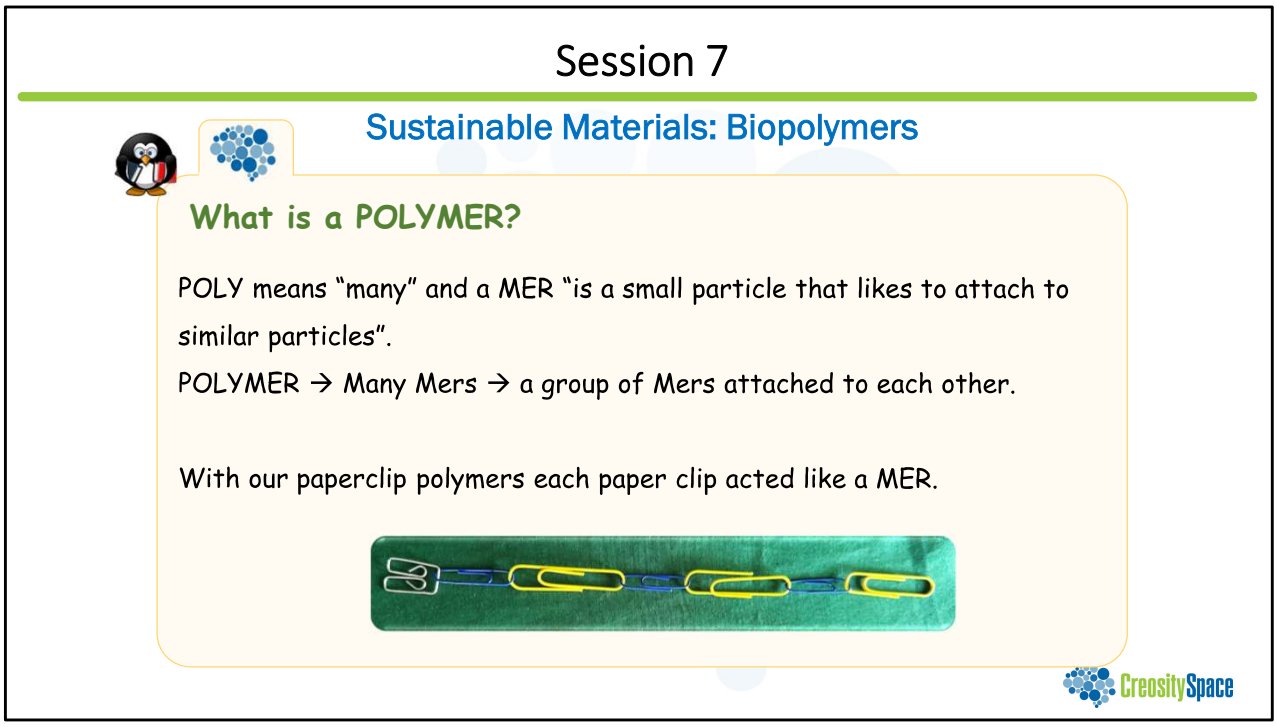
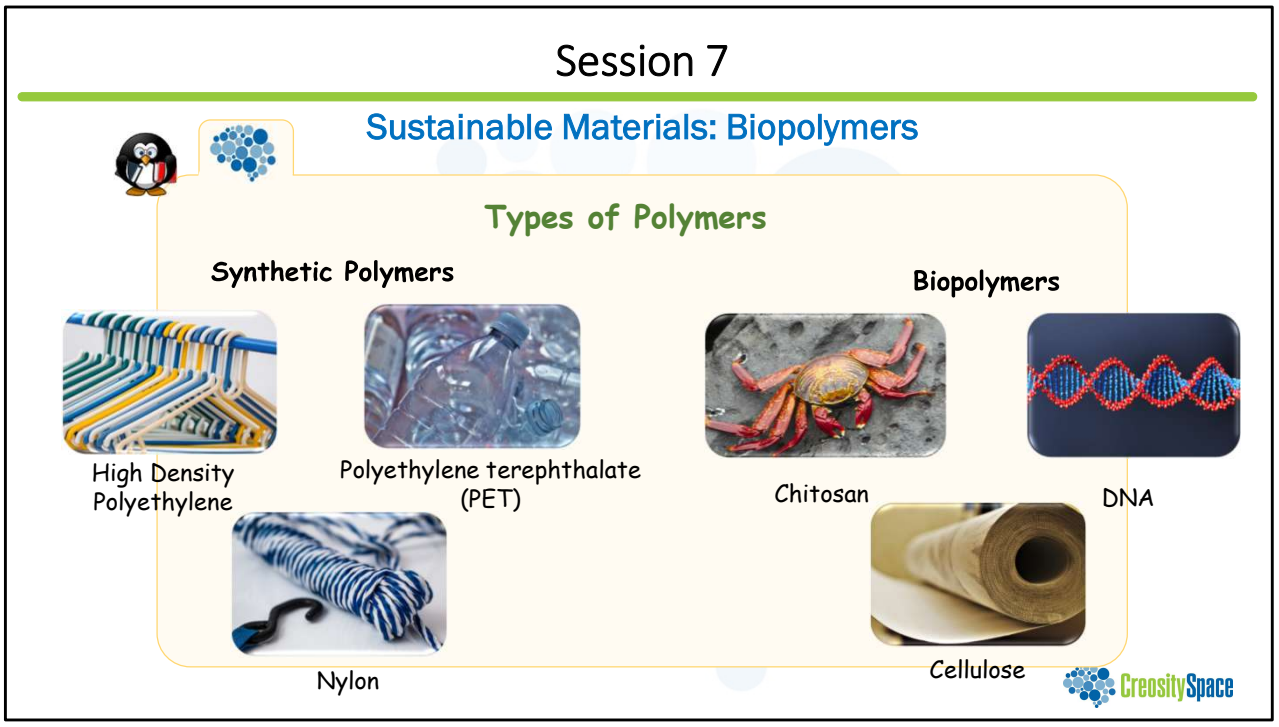


With our paper clip polymers each paperclip acted like a MER.

Polymers are generally flexible materials that are comprised mostly of carbon. Having said that, the possibilities for chemical composition are almost infinite as the polymer molecule is generally created by combining small groups of two to six atoms. Novel polymers can span the range of insulators, semiconductors, and conductors, and researchers and engineers are finding many new materials and applications each day.



There are many types of polymers –

Synthetic polymers are made from oil and fossil fuels.

Biopolymer are made by living organisms or in a similar way (process biomimicry) as a living organism would.

Biopolymers are typically biodegradable whereas synthetic polymers are generally not biodegradable.

Session 7

Sustainable Materials: Biopolymers

Let's make a polymer out of Milk

What you need:

- Milk
- Vinegar
- Craft sticks
- Mixing Containers
- Water
- Nitrile gloves
- Molds
- Snack bags
- Wax paper

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Session 7

Sustainable Materials: Biopolymers

Let's make a polymer out of Milk

Step 1:

a) Mix powdered milk with water to create liquid milk.

b) Heat milk in the microwave until it is warm

   a) You can experiment with temperature if you want but be careful not to make it too hot that it becomes a hazard. Milk should be no warmer than hot coco that would be enjoyable to drink (i.e., not hot coco that would burn your mouth!)

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Session 7

Sustainable Materials: Biopolymers

Let's make a polymer out of Milk

Step 2:

a) Add vinegar to milk while stirring.

   a) Have someone in your group record the observations after each packet of vinegar is added.

   b) Make sure to keep track of the number of packets added

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Session 7

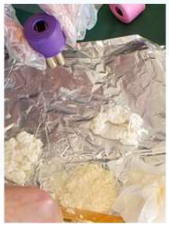
Sustainable Materials: Biopolymers

Let's make a polymer out of Milk

Step 3:

a) Once you have created a semi-solid mass, (one you could form like Play-Doh or Silly Putty) take some of the new polymer and pat is out onto the foil.

b) Use the cookie cutters to create different shapes or mold the polymer into a figurine or into whatever you would like!



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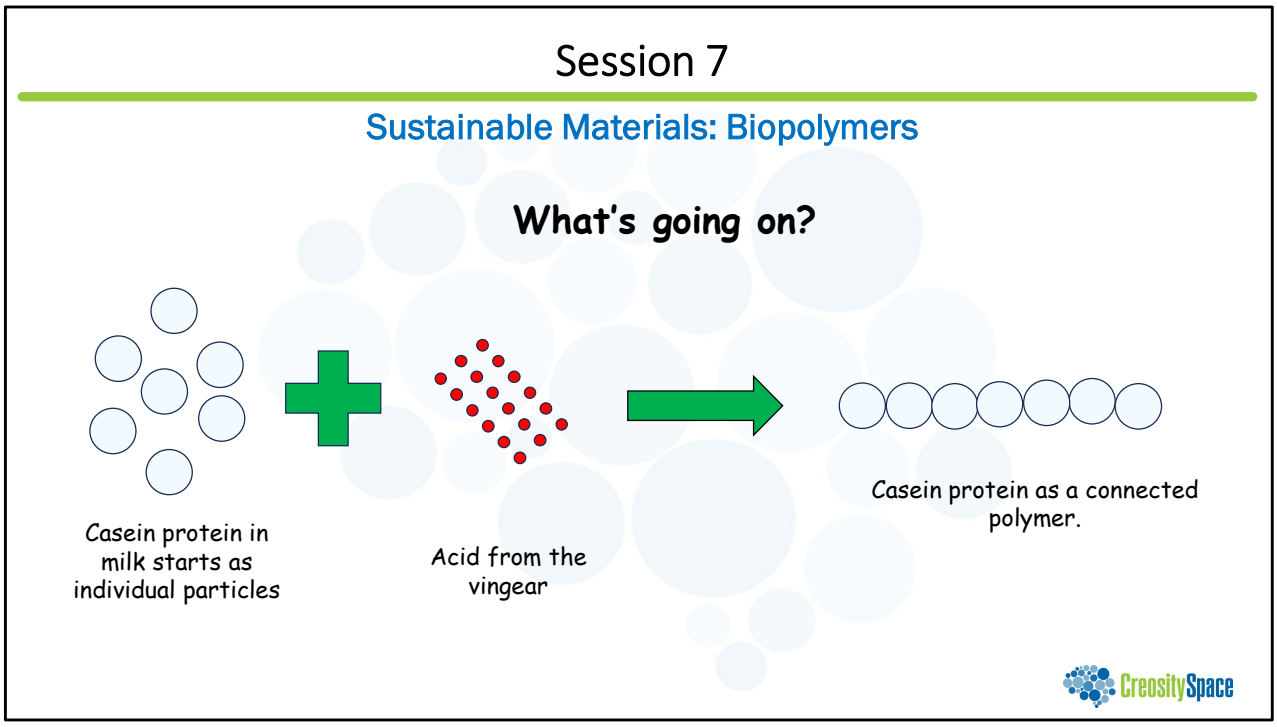

When milk is heated and combined with an acid, such as vinegar, the casein molecules unfold and reorganize into a long chain. Each casein molecule is a monomer and the chain of casein monomers is a polymer. The polymer can be scooped up and molded, which is why plastic made from milk is called casein plastic.

Casein was once used to manufacture buttons, as it was a hard, strong substance and did not dissolve in water. However, polymers from casein can be expensive, and as the demand for plastics increased, a cheaper, oil-based version was discovered. Casein plastic is still used in manufacturing today to aid glue in book binding as well as serving as a glaze for paper

Session 7

Sustainable Materials: Biopolymers

MUSSEL POLYMERS, INC.

JON WILKER

From: Bethlehem, PA

Age at time of invention: ~ 40

Invention: Jon is a professor at Purdue University who studies underwater animals like oysters, mussels, and clams. He noticed how strongly muscles can attach themselves to rocks and figured out a way to make the "mussel glue" in the lab. This glue is environmentally friendly and works 300 times better than products currently in use.

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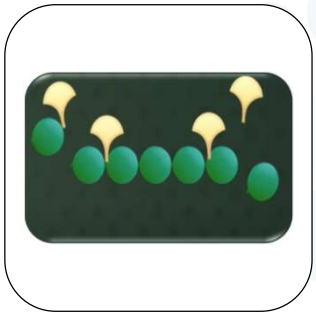
Comment that this is also an example of biomimicry

Session 7

Sustainable Materials: Biopolymers



AARON HALL

From: Oakland, CA

Age at time of invention: ~27

Invention: By adding enzymes (a substance produced by a living organism to make chemistry happen fast in the organism) to synthetic plastics they become self-degrading products that can be composted or perfectly recycled.

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Aaron got the idea for Intropic Materials during graduate school. He realized the work they were doing in the lab could have a massive impact (for the better) on the environment and wanted to see if he could turn it into a product everyone could use.

https://www.youtube.com/watch?v=zzxuiJFXWkY

Session 8

Preparation	Review instructional materials ● Activity instructions, lesson slides and How To video ● Review pages 18 – 19 in the participant notebook ● Modify lesson slides as desired Prepare ● Locate the session 8 materials bag. ● This investigation has a fair amount of material distribution to start with. Consider how you want to distribute the materials to the groups in a timely manner.

Session 8

Sustainable Materials: Concrete Alternatives

What you need

- Participant notebook

Ground water investigation –
Participants will work in groups of 4
Each group receives:

- Filter container
- 4 – 6 filter cups
- Foil sheet
- teaspoon

Shared resources

- Soil
- Clay
- Rocks
- Water
- Push pins

Additional Supplies Needed

- Cup
- Water
- Paper towels
- Pens/pencil

Session 8 Materials

Participant Notebook

Session Flow	
10 min	Welcome. Topic introduction via discussion prompt
10-15 min	Ground water experiment round 1 with discussion
15 min	Science lesson, technology discussion
10 min	Round 2 time permitting
Remaining time	Wrap up and cleanup

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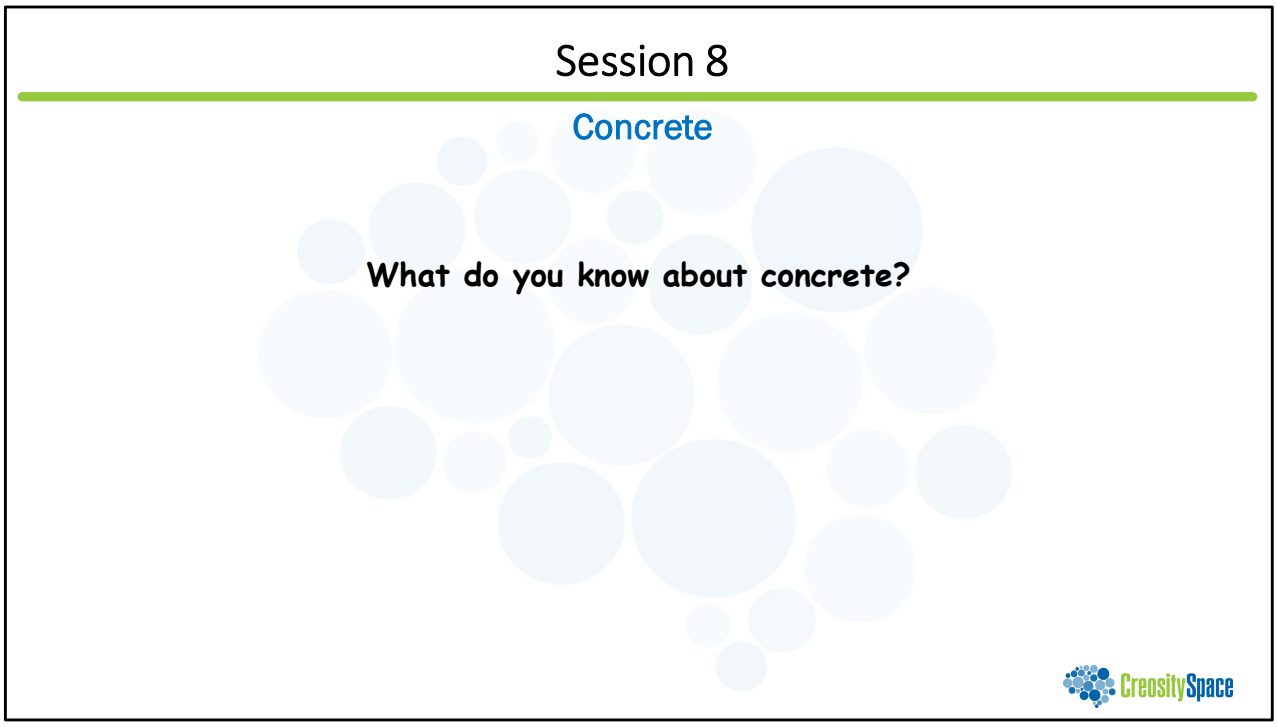


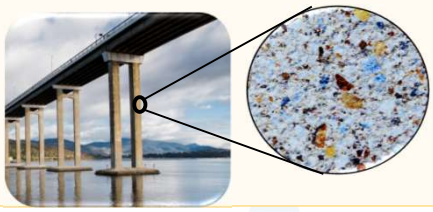
Allow kids to brainstorm a bit

Session 8

Concrete Alternatives

Concrete

Concrete is used in many places throughout construction. It is a mixture of cement, water, sand, and rocks (called aggregate).



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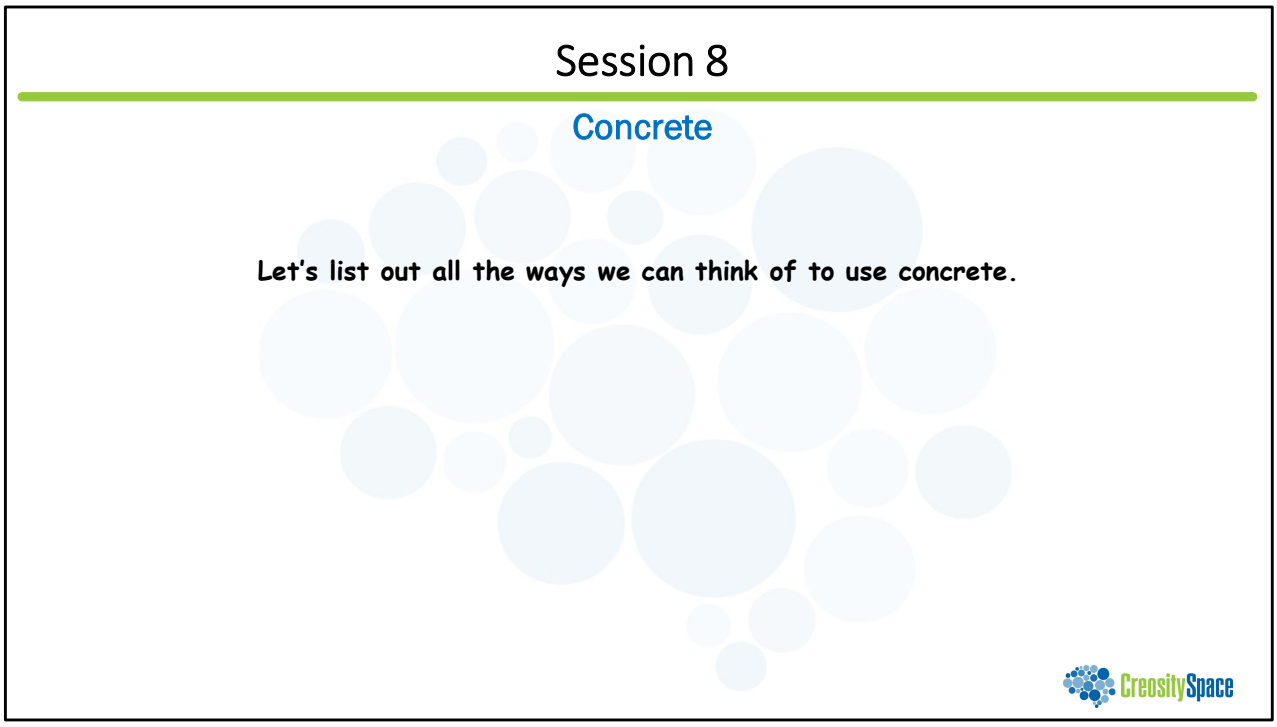
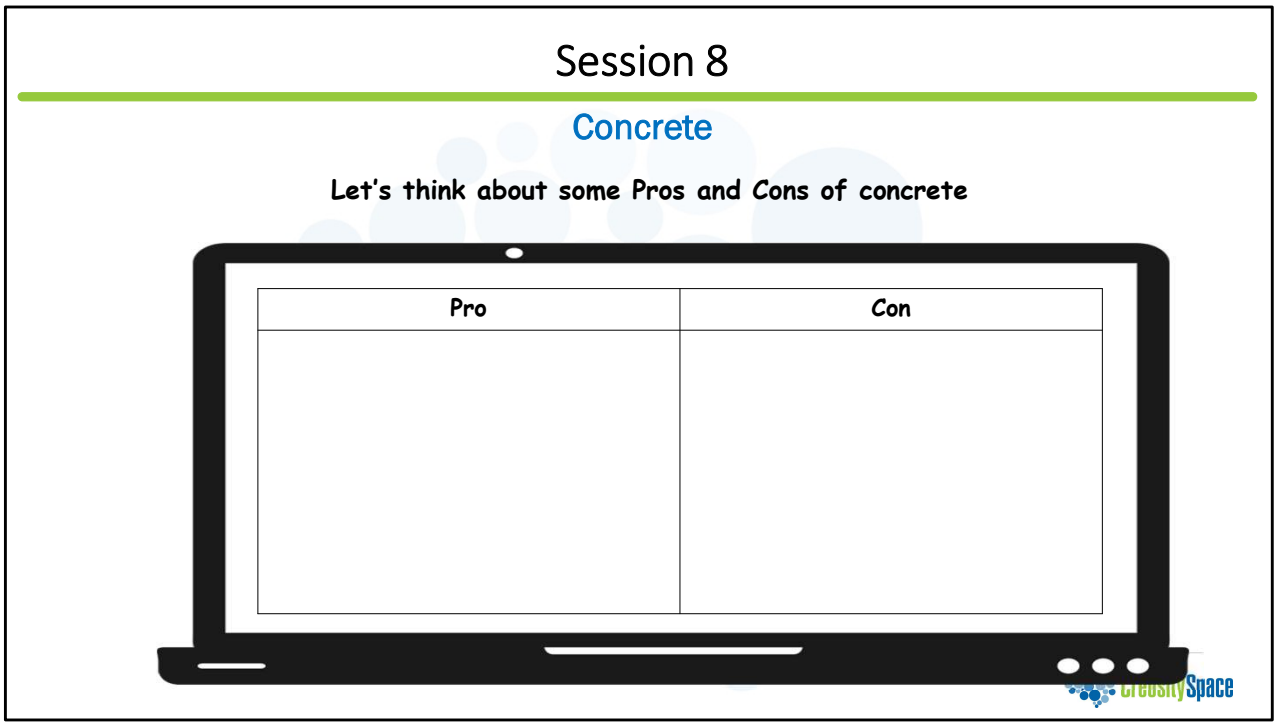


Allow participants a chance to brainstorm a bit about all the ways that we use concrete.



Allow participants to brainstorm a bit about all the ways that we use concrete. After they've had some time to discuss and share, spend a little time filling out the table on this slide.

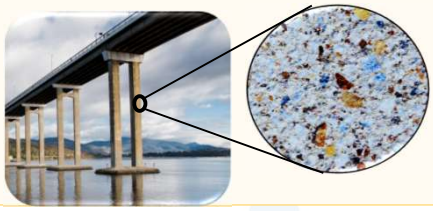
Some examples: Concrete is used in many places throughout construction. Some examples are driveways, walkways, and foundations. It is very strong and durable but requires a lot of energy to make. As well, regular concrete does not provide many benefits for plants and animals.

Session 8

Concrete Alternatives

Concrete

Concrete is used in many places throughout construction. Some examples are driveways, walkways, and foundations. It is very strong and durable but requires a lot of energy to make. As well, regular concrete does not provide many benefits for plants and animals.



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Session 8

Concrete Alternatives: Comparing Ground Materials

Let's examine four different types of ground material and what happens to them in the rain.

- **Soil**
- **Clay**
- **Rocks**
- **Concrete**

What do you think some design criteria are for ground covering?

Session 8

Concrete Alternatives: Comparing Ground Materials

What you need:

- Condiment container
- Paper filter cups
- 1 oz cups
- Foil
- Soil
- Clay
- Tiles
- Rocks
- Teaspoon

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Session 8

Concrete Alternatives: Comparing Ground Materials

Step 1:

a) Set out four paper filter cups and fill one each with tiles, soil, gravel, and clay respectively. All should be about the same height (~ 1 inch or 4 tiles).

b) Gather two 1-ounce cups of water

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Session 8

Concrete Alternatives: Comparing Ground Materials

Step 2:

a) Starting with the tiles, place the paper filter cup into the condiment container. Place or hold a 1-ounce cup under it to catch the water that comes through on the next step.

b) Pour 1-ounce of water on top of the tiles. Wait 1 minute to see how much of the 1-ounce of water makes it through. Describe how fast or the water moved through the system.

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Session 8

Concrete Alternatives: Comparing Ground Materials

Step 2 cont.:

c) Pour a second 1-ounce cup of water over the tiles. Repeat the observations from step 2b. Gently touch the top of the surface of the tiles and describe what you feel.

d) Repeat for the other materials comparing how fast the water comes through, how much water comes through and how the material feels to the touch (e.g., solid, soft, etc.).

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Session 8

Concrete Alternatives: Comparing Ground Materials

What did you notice about the four different materials?

Clay	Soil	Rocks	Concrete

Key observations:

- Clay absorbs a lot of water but has no strength or ability to keep its shape
- Soil is similar – perhaps a bit stronger but absorbs a bit less water
- Rocks – absorb some water (more surface area), but not a lot.
- Concrete doesn't absorb any water and the water runs through it very quickly

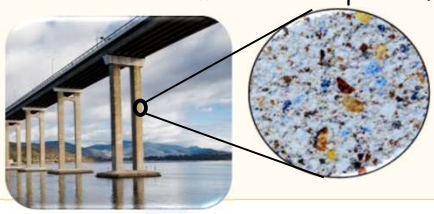
Key observations - Concrete has a lot of advantages in the strength department, but it can't hold any water, which can be an issue when severe rains or coastal storms come. It also doesn't allow for growth of plant or animal habitat.

Session 8

Concrete Alternatives

Timbercrete

Normal concrete is made by mixing rocks into cement. The final product is very strong but very heavy. With timbercrete sawdust or wood chips are added to the cement mixture instead of rocks. This makes a lighter concrete-product. The lighter weight decrease transportation costs and the material uses parts of wood that would otherwise go to waste.



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Session 8

Concrete Alternatives

Grasscrete

Grasscrete does not form blocks for building but reduces the amount of concrete required in a walkway or driveway. A cutout pattern is made so grass or plants can grow between pieces while still maintaining a hard surface. Grasscrete increases the ground's ability to absorb water compared to a space paved over completely. It also allows places for plant life to grow.

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Session 8

Concrete Alternatives

Biocompatible Concrete

A new field of concrete alternatives includes the group of ***biocompatible concretes***. With these materials, a fifth material is added to the concrete blend—in addition to the cement, water, sand, and aggregate—to enable the concrete to actively support living organisms.

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Session 8

Concrete Alternatives

EVELYN TICKLE

From: Charlottesville, VA

Invention: By adding specific chemicals to match the oyster shell composition and producing concrete forms that allow for the integration of living organism, Evelyn was able to develop a product with the strength of concrete but that also supports marine ecosystems.

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Session 8

Concrete Alternatives: Comparing Ground Materials

Round 2:

Repeat your previous experiment but now try combinations of materials. Is there a combination that might work better for different applications?

Session 8

Concrete Alternatives: Wrap up

Think about a place in your neighborhood that uses concrete.

Is there something you could replace that concrete with that would still perform the same task but also work with the plants and animals in the neighborhood?

Sessions 9 & 10

Preparation	Review instructional activities below • Review activity instructions and lesson slides • Review pages 16 - 22 in the mentee notebook Prepare • Gather all remaining kit materials (including the bag labeled prototyping materials) for participants to use to build their prototypes • Review the list of additional prototyping materials (p. 13) and decide if you or your mentees want to bring any of these materials in to use for building prototypes

Session 9 & 10

Innovation Challenge

What you need

- Participant notebook
- Prototyping supplies
- Any remaining from the previous 8 sessions
- Posters

Additional Supplies Needed

- Pens/pencil
- Coloring supplies
- Scissors
- Tape
- Any additional prototyping supplies

Session 9 Flow

5 min	Welcome
10 min	Challenge introduction and group formation
15 - 20 min	Brainstorming
15 - 20 min	Idea selection and initial design
Remaining time	Wrap up and cleanup

Session 10 Flow

5 min	Welcome
30 - 40 min	Design and prototype construction
10 min	Presentation planning (optional)
5 - 10 min	Optional presentation of invention
5 min	Survey
Remaining time	Final reflection

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Session 9

Innovation Challenge

Over the past weeks we've learned about all sorts of things related to living with our natural neighbors.

We've also had a chance to hear about cool inventors and entrepreneurs like Mikaila, Orianna, Aaron, and more.

Session 9

Innovation Challenge

Now it's time for your ideas, and your solutions, to take center stage!

Session 9

Innovation Challenge

Design, or redesign, a community space that is functional and works with the living ecosystem in the area.

Session 9

Innovation Challenge

How it works:

1. Decide if you want to design or redesign a community space.
2. Form a group of 1 – 3 people who want to work on the same prompt as you do.
3. As a group, brainstorm as many ideas as you can think of connected with your challenge
4. As a group, select which ideas you'll use in your invention or innovation.
5. Sketch out your invention. You'll have space and time to make a few revisions.
6. Build a prototype of your invention.

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Session 9

Innovation Challenge: Brainstorming

This is when you write down or draw as many ideas as you can.

The goal of brainstorming is to come up with as many ideas as possible.

Try not to think of ideas as "good" or "bad"—even the wildest ideas can spark new ideas.

Session 9

Innovation Challenge: Idea selection and initial design

Pick out your favorite ideas and make an initial picture (a labeled sketch) of your innovation.

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Session 10

Innovation Challenge: Design and build your prototype

Get building!

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Session 10

Innovation Challenge: Present your idea to the group

Think about answering these questions about your invention:

- Where did you put it?
- Who will use it and how?
- What are some key features that will work with your natural neighbors?

Session 10

Wrap Up

Can you share one thing that you found surprising or exciting about Sustainability, Materials, STEM, or Innovation?