

The Living Building Teacher Overview

7th Grade: Animals in Action



The Kendeda Building for Innovative Sustainable Design at Georgia Tech, or the Living Building for short is designed to work harmoniously with nature and to be a model of sustainable architecture for the southeast. The building uses the metaphor as flower and when completed, the living building will fulfill seven “petals” of requirements in areas from net positive energy and water to providing social equity. The Living Building Challenge seeks to answer the question, **“What if every single act of design and construction made the world a better place?”**

Buildings are fundamentally integrated with biology. Buildings provide a good parallel to living systems: they breathe, circulate resources, maintain internal temperature, and must cope with and respond to external stimuli. The Living Building represents an opportunity for students to make connections with biology, and between designed and natural environments. The process of BID looks to natural systems to find innovative solutions to existing challenges, for example, connecting the challenge of building insulation with bird feathers, polar bear fur, and whale blubber.

The 7th grade lesson focuses on the Materials Petal and investigate how adaptations of diverse organisms to their environment (adapting to their biome) can be modeled in a building responding to its environment. Students will complete an investigation of organism adaptations in each biome and then design their own building adaptation to meet a requirement of the Living Building Challenge.

Background Knowledge: Students should have basic knowledge of the components of an ecosystem and the interactions between abiotic and biotic factors. Students should understand predator/prey relationships, symbiosis, and how organisms can make adaptations in their environment.

At the end of this lesson:

- Students will be to identify the basic characteristics of the nine major biomes (both marine and terrestrial).
- Students will understand how unique characteristics of organism allow them to adapt to an environment’s abiotic and biotic factors.
- Students will be able to design an element of a building that is derived from an adaptation of an organism to its environment.
- Students will recognize the importance of the Kendeda Building for Sustainable Design in their community.

Time: 10-12 hour class periods (can be adapted depending on how much time you provide students for individual research)

Standards and Essential Questions

Next Generation Science Standards	<p>MS-LS2-2: Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems</p> <p>MS-LS2-3 Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.</p> <p>MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services</p>
Georgia Standards of Excellence	<p>Priority Standard:</p> <p>S7L4d. Ask questions to gather and synthesize information from multiple sources to differentiate between Earth’s major terrestrial biomes (i.e., tropical rain forest, savanna, temperate forest, desert, grassland, taiga, and tundra) and aquatic ecosystems (i.e., freshwater, estuaries, and marine).</p> <p>Supporting Standards:</p> <p>S7L4a. Construct an explanation for the patterns of interactions observed in different ecosystems in terms of the relationships among and between organisms and abiotic components of the ecosystem.</p> <p>S7L4b. Develop a model to describe the cycling of matter and the flow of energy among biotic and abiotic components of an ecosystem.</p> <p>S7L4c. Analyze and interpret data to provide evidence for how resource availability, disease, climate, and human activity affect individual organisms, populations, communities, and ecosystems</p> <p>S7L4d. Ask questions to gather and synthesize information from multiple sources to differentiate between Earth’s major terrestrial biomes (i.e., tropical rain forest, savanna, temperate forest, desert, grassland, taiga, and tundra) and aquatic ecosystems (i.e., freshwater, estuaries, and marine).</p>
Essential Questions	<ul style="list-style-type: none"> • How can living things help us create more environmentally friendly buildings. • What organisms are naturally designed to conserve water energy etc.? • What can nature teach us about sustainable architecture?

Key Vocabulary

Biome: a large naturally occurring community of flora and fauna occupying a major habitat, e.g., forest or tundra.

Adaptation: a change or the process of change by which an organism or species becomes better suited to its environment.

Biotic relating to or resulting from living things

Abiotic: physical rather than biological; not derived from living organisms.

Biodiversity: the variety of life in the world or in a particular habitat or ecosystem.

Full Lesson Plan and Student Sheets Accessed from: <https://tinyurl.com/BIDL2018>

5E Model Lesson Overview

Engage

Students will watch a video introducing the Earth's biomes. Students will participate in a group discussion of the video and focus on challenges associated with survival in each particular biome.

Explore

1. In teams, students will research biomes and learn about their basic characteristics, location, and organisms. The teams will research different organisms and their adaptations to the biomes. These organisms will be applied for learning goals later in the unit. .
2. Students will learn about the Living Building Challenge and, as a class, break down the problems of producing net-positive water, net-positive energy, and sustainable materials. Students will learn what Bio-Inspired design is with a video and activity.
3. Students will engage in a gradual release lesson on bio-inspired design. Students will observe how the teacher researches an organism to discover the mechanism behind the adaptation and how to apply it to a challenge of the Living Building. Then students and teacher will work on an example together, and finally, students will use previous biome research and additional sources and apply their knowledge to the challenges of the Living Building. Groups will choose one challenge to address (such as water filtration, pumping water, cooling the building, etc) and apply their knowledge of organism adaptations to design a Bio-Inspired Design Solution to the challenge.

Explain

Students will share their invention/solutions with the class in a gallery walk format. If they have more than one idea, they will include all their ideas so they can get help narrowing their focus. Each group will need to leave feedback on the pros and cons of the idea. After the gallery walk, groups will get back together and read the feedback, then adjust their design as needed. The class will repeat the gallery walk again after changes have been made or ask another class, parents, or engineers, etc. to come in and learn about the inventions/solutions and offer feedback.

Extend

Students will choose how they want to present their idea that solves a particular challenge of the Living Building. Students can make a physical prototype of their idea, a virtual prototype of their idea, drawings showing the progression of their ideas, or use a different method subject to teacher approval. Students will discuss which ideas did not work and why.

Evaluate

During the research phase, the teacher will conduct ongoing formative assessments to check the progress of student understanding. During the Explore 3 activity, teacher will monitor students work and give feedback on the chart. During the Explain activity, teacher will participate in the gallery walk and leave feedback as needed. During the Extend activity, teacher will evaluate the student's final design.



The Living Building Teacher Instructions

Engage 7th Grade: Animals in Action



This is an introduction to biomes. Teacher will show a short video and students will discuss challenges to living in different biomes. Students will work in groups and share ideas with the class.

Materials Needed:

- Biome Challenges Chart (copies for each student)
- Poster paper/butcher paper/giant sticky note paper (*optional*)

Time Frame:

50-60 minutes

Teacher Prep:

Have video ready to play before students arrive. Have poster paper (if using) placed around the room. If teaching multiple classes, either take down previous classes poster paper, or cover their answers before next class comes in.

Procedure:

1. Show video introducing students to the biomes of Earth:
<https://www.youtube.com/watch?v=hly0ZlyPPDg>
2. Have a class discussion summarizing the biomes in the video and what they were like (cold, hot, dry, wet, etc.) *Optional: You can show the video again if students are having trouble remembering.*
3. This is just an introductory lesson, so you don't have to go into a lot of detail with biome characteristics: just generalize so students can determine what will be challenging in that environment. You will go into more detail later on.
4. List these on the board so students can reference later

Rainforest (humid, wet, warm)

- Mountains (colder as you go up, rainfall varies)
- Deciduous/Temperate Forest (moderate temperature and rainfall)
- Savanna/Grasslands (dry/wet season, hot or cold depending on location)
- Taiga (cold and snowy)
- Tundra (cold and dry)
- Desert
- Marine (salt water, temperatures vary)
- Freshwater (temperature vary, maybe list examples)

5. Have students work in groups to list some challenges associated with living in different biomes. Have students record their ideas on the Biome Challenges Chart (found below), using one chart per group.

6. After brainstorming, have groups share out ideas. You could record these on the board, or record on poster paper placed around the room (one for each biome). If using poster paper, have groups write one idea on one biome poster and then take turns moving from poster to poster. Remind them not to repeat an idea that is already listed. After the class is done sharing, discuss their ideas and add any challenges they may have missed.
7. Ask students to discuss in their groups which biome they think would be most difficult to survive in and why, as well as what biome would be the easiest to survive in and why. If time allows, have groups share some of their answers. *Optional: Have students write their answers in a journal or on the back of their chart.*
8. Finally, ask students to discuss in their groups what questions they still have about biomes. Have groups share their questions and keep a list in the room/on the board.



Name _____

Class _____

The Living Building

Engage 7th Grade: Animals in Action

Biome Challenges

Chart



Biome	What is this biome like?	Challenges to living here <i>(think of both plant and animal survival)</i>
Desert		
Rainforest		
Mountains		
Temperate Forest		
Savanna/ Grasslands		
Taiga		
Tundra		
Marine		
Freshwater		

The Living Building Teacher Instructions

Explore Biomes 7th Grade: Animals in Action



In this explore activity, students will be researching biomes. Students will use links provided by the teacher to learn about the general characteristics of the Earth's biomes as well as organisms that live there. Students will be in groups, with each group having different organisms to research. These organisms will help students with the Bio-Inspired Design and Living Building Challenge lessons. Students will organize their research by biome using the handouts that follow.

Prerequisite:

Students should have completed the engage lessons and have basic background knowledge on biomes.

Materials Needed:

- Computers/tablets/laptops/etc.
- Biome Research Charts (copies for each student)
 - The charts for groups 1 & 5, 2 & 6, 3 & 7 and 4 & 8 are the same.

Time Frame:

3-4 hour long class periods depending on how quickly students are able to gather the needed information.

Teacher Prep:

Students will be researching during this lesson. Computers, laptops, tablets, etc. will be needed, so the teacher may need to secure these in advance of the lesson. Students need to be in groups, these groups will separate to form new groups later on (jigsaw). Materials provided are for 8 four person groups, but can change as needed.

Optionally, you can put research links on your teacher website, Google Classroom, etc.

Procedure:

Explain to students they will be researching the Earth's biomes today. Tell students they will be using links you have provided for them to do their research. Pass out the research charts. Explain that each group has different charts. Some organism sections will be filled in for you and a link is provided for you to learn more about them, while other organism sections are blank for your group to choose their own organism to research.

Research options:

- Each student works independently and researches everything alone.
- Each group divides up the work and then share what they have learned with their group.

If you choose to work independently, have students start with the same biomes and go in the same order so they can share/compare answers at the end of each research day.

If you choose the share what you learned option, stop a couple of times a class period and allow students to share what they've found.

The Living Building

Explore Biomes 7th Grade: Animals in Action



Directions:

Use the following links to complete the research of the Earth's Biomes. Some organism sections are filled in and you will need to reference the links provided. Some organism sections are blank and you can choose the organisms you want to learn more about.

Research Links:

General Information (*use for climate and location as well as some additional organisms*):

http://www.blueplanetbiomes.org/world_biomes.htm
<http://www.ucmp.berkeley.edu/glossary/gloss5/biome/>
<http://www.worldbiomes.com/>

Desert Organisms:

Desert Holly: <https://vimeo.com/channels/asknature nuggets/35722333>
 Thorny Devil: <http://ngm.nationalgeographic.com/2008/04/biomimetics/tom-mueller-text>

Taiga Organisms:

Pine Tree: http://www.bbc.co.uk/schools/gcsebitesize/geography/ecosystems/coniferous_woodland_rev2.shtml
 Bear

Tundra Organisms:

Penguin

Deciduous Forest Organisms:

Honey bees
 Deciduous trees (capillary action)

Rainforest Organisms

Bromeliad: <http://www.rainforest-alliance.org/species/bromeliad>
 Brown lemur

Grassland/Savannah Organisms

Grasses: <http://www.mbgnet.net/bioplants/grass.html>
 African elephant

Marine/Estuary Organisms

Harbor seal
 Sea sponge
 Diatoms

Freshwater/Estuary Organisms

Wetlands: <http://www.esa.org/ecoservices/comm/body.comm.fact.wate.html>
 Lotus leaf

Desert Biome:

Climate: (Seasons? Precipitation? temperature?)		
Location: (name 2-3 places in the world you find this biome)		
Autotrophs: (name 2-3 and how they survive in the biome)	<u>Organisms</u> -Desert holly -	<u>Adaptations</u>
Heterotrophs: (name 2-3 and how they survive in the biome)	<u>Organisms</u> -thorny devil -	

Taiga Biome:

Climate: (Seasons? Precipitation? temperature?)		
Location: (name 2-3 places in the world you find this biome)		
Autotrophs: (name 2-3 and how they survive in the biome)	<u>Organisms</u> -Pine trees -	<u>Adaptations</u>
Heterotrophs: (name 2-3 and how they survive in the biome)	<u>Organisms</u> - Bear -	

Tundra Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - Penguin -</p>	

Deciduous Forest Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Tall trees -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -honey bees -</p>	

Rainforest Biome:



<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -bromeliad -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - brown lemur -</p>	

Grassland/Savannah Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -grasses -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - African Elephant -</p>	

Marine/Estuary Biome:

<p>Characteristics: <i>(What is marine biome like?)</i></p>		
<p>Location: <i>(name the oceans and define estuary)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Diatoms -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -harbor seal -sea sponge</p>	

Freshwater/Estuary Biome:

<p>Characteristics: <i>(what is this biome like?)</i></p>		
<p>Location: <i>(name 3-4 bodies of water in this biome, and explain where an estuary is)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -lotus leaf -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - -</p>	

The Living Building

Explore Biomes 7th Grade: Animals in Action



Directions:

Use the following links to complete the research of the Earth's Biomes. Some organism sections are filled in and you will need to reference the links provided. Some organism sections are blank and you can choose the organisms you want to learn more about.

Research Links:

General Information (*use for climate and location as well as some additional organisms*):

http://www.blueplanetbiomes.org/world_biomes.htm
<http://www.ucmp.berkeley.edu/glossary/gloss5/biome/>
<http://www.worldbiomes.com/>

Desert Organisms:

Gila Monster : <https://www.desertmuseum.org/kids/oz/long-fact-sheets/Gila%20Monster.php>
 Cactus: <https://vimeo.com/59072202>

Taiga Organisms:

Pine Tree (capillary)
 Snowshoe hare (fur/insulation)

Tundra Organisms:

Polar Bear

Deciduous Forest Organisms:

Pine Tree: <https://davidson.weizmann.ac.il/en/online/scienceathome/how-can-we-make-pine-cone-open-and-close>
 Woodpecker: <https://vimeo.com/67171006>

Rainforest Organisms

Brown lemur
 Banyan

Grassland/Savannah Organisms

Prairie dog
 Grasses: <http://www.mbgnet.net/bioplants/grass.html>

Marine/Estuary Organisms

Walrus
 Baleen Whale: <https://asknature.org/strategy/baleen-plates-filter-food/#.WVE8gfnvIU>
 Diatom

Freshwater/Estuary Organisms

Wetlands: <http://www.esa.org/ecoservices/comm/body.comm.fact.wate.html>
 Lotus leaf

Desert Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Cacti -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Gila Monster -</p>	

Taiga Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Pine trees -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - Snowshoe Hare -</p>	

Tundra Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - Polar Bear -</p>	

Deciduous Forest Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Pine tree -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Woodpecker -</p>	

Rainforest Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Banyan tree</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - Brown Lemur</p>	

Grassland/Savannah Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -grasses -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - Prarie Dog -Termites</p>	

Marine/Estuary Biome:

<p>Characteristics: <i>(What is marine biome like?)</i></p>		
<p>Location: <i>(name the oceans and define estuary)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Mangrove -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Walrus -Baleen Whale</p>	

Freshwater/Estuary Biome:

<p>Characteristics: <i>(what is this biome like?)</i></p>		
<p>Location: <i>(name 3-4 bodies of water in this biome, and explain where an estuary is)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -lotus leaf -Wetlands</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - -</p>	

The Living Building

Explore Biomes 7th Grade: Animals in Action



Directions:

Use the following links to complete the research of the Earth's Biomes. Some organism sections are filled in and you will need to reference the links provided. Some organism sections are blank and you can choose the organisms you want to learn more about.

Research Links:

General Information (*use for climate and location as well as some additional organisms*):

http://www.blueplanetbiomes.org/world_biomes.htm
<http://www.ucmp.berkeley.edu/glossary/gloss5/biome/>
<http://www.worldbiomes.com/>

Desert Organisms:

Fogstand beetle: http://news.nationalgeographic.com/news/2001/11/1101_TVdesertbeetle.html
 Tumbleweed

Taiga Organisms:

Bear
 Pine tree: http://www.bbc.co.uk/schools/gcsebitesize/geography/ecosystems/coniferous_woodland_rev2.shtml

Tundra Organisms:

Penguin: <http://tinyurl.com/ydfm5bys>

Deciduous Forest Organisms:

Sunflower
 Salamander

Rainforest Organisms:

Brown lemur
 Bromeliad: <http://www.rainforest-alliance.org/species/bromeliad>

Grassland/Savannah Organisms

Giraffe: <https://vimeo.com/channels/asknatureuggets/39787412>
 Grasses: <http://www.mbgnet.net/bioplants/grass.html>

Marine/Estuary Organisms

Walrus
 Baleen Whale: <https://asknature.org/strategy/baleen-plates-filter-food/#.WVE8gfnvIU>
 Diatom

Freshwater/Estuary Organisms

Wetlands: <http://www.esa.org/ecoservices/comm/body.comm.fact.wate.html>
 Lotus leaf

Desert Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - Tumbleweed</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Fogstand Beetle -</p>	

Taiga Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Pine trees -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - Bear -</p>	



Tundra Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - Penguin -</p>	

Deciduous Forest Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Sunflower -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Salamander -</p>	

Rainforest Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Bromeliad</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - Brown Lemur</p>	

Grassland/Savannah Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -grasses -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - Giraffe -</p>	

Marine/Estuary Biome:

<p>Characteristics: <i>(What is marine biome like?)</i></p>		
<p>Location: <i>(name the oceans and define estuary)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Mangrove -Diatom</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Walrus -Baleen Whale</p>	

Freshwater/Estuary Biome:

<p>Characteristics: <i>(what is this biome like?)</i></p>		
<p>Location: <i>(name 3-4 bodies of water in this biome, and explain where an estuary is)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -lotus leaf -Wetlands</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - -</p>	

The Living Building

Explore Biomes 7th Grade: Animals in Action



Directions:

Use the following links to complete the research of the Earth's Biomes. Some organism sections are filled in and you will need to reference the links provided. Some organism sections are blank and you can choose the organisms you want to learn more about.

Research Links:

General Information (*use for climate and location as well as some additional organisms*):

http://www.blueplanetbiomes.org/world_biomes.htm
<http://www.ucmp.berkeley.edu/glossary/gloss5/biome/>
<http://www.worldbiomes.com/>

Desert Organisms:

Sandgrouse: <http://birdnote.org/show/sandgrouse-desert-water-carriers>
 Cactus: <https://vimeo.com/59072202>

Taiga Organisms:

Snowshoe Hare

Tundra Organisms:

Polar Bear
 Pine Tree (capillary action)

Deciduous Forest Organisms:

Woodpeckers <https://vimeo.com/67171006>

Rainforest Organisms:

Brown lemur
 Orchid <http://www.rainforest-alliance.org/species/orchid>

Grassland/Savannah Organisms

Kangaroo <https://vimeo.com/33376036>
 Grasses: <http://www.mbgnet.net/bioplants/grass.html>

Marine/Estuary Organisms

Sea Star
 Mangrove
 Sea Sponge

Freshwater/Estuary Organisms

Wetlands: <http://www.esa.org/ecoservices/comm/body.comm.fact.wate.html>
 Lotus leaf

Desert Biome:

<p>Climate: (Seasons? Precipitation? temperature?)</p>		
<p>Location: (name 2-3 places in the world you find this biome)</p>		
<p>Autotrophs: (name 2-3 and how they survive in the biome)</p>	<p><u>Organisms</u> -Cacti</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: (name 2-3 and how they survive in the biome)</p>	<p><u>Organisms</u> -Sandgrouse -</p>	

Taiga Biome:

<p>Climate: (Seasons? Precipitation? temperature?)</p>		
<p>Location: (name 2-3 places in the world you find this biome)</p>		
<p>Autotrophs: (name 2-3 and how they survive in the biome)</p>	<p><u>Organisms</u> -Pine trees -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: (name 2-3 and how they survive in the biome)</p>	<p><u>Organisms</u> - Snowshoe hare -</p>	

Tundra Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - Polar bear -</p>	

Deciduous Forest Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Maple tree -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Woodpecker -</p>	

Rainforest Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Orchid</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - Brown Lemur</p>	

Grassland/Savannah Biome:

<p>Climate: <i>(Seasons? Precipitation? temperature?)</i></p>		
<p>Location: <i>(name 2-3 places in the world you find this biome)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -grasses -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - Kangaroo -</p>	

Marine/Estuary Biome:

<p>Characteristics: <i>(What is marine biome like?)</i></p>		
<p>Location: <i>(name the oceans and define estuary)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Mangrove -</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -Sea star -Sea sponge</p>	

Freshwater/Estuary Biome:

<p>Characteristics: <i>(what is this biome like?)</i></p>		
<p>Location: <i>(name 3-4 bodies of water in this biome, and explain where an estuary is)</i></p>		
<p>Autotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> -lotus leaf -Wetlands</p>	<p><u>Adaptations</u></p>
<p>Heterotrophs: <i>(name 2-3 and how they survive in the biome)</i></p>	<p><u>Organisms</u> - -</p>	

The Living Building Teacher Instructions

Explore The Living Building: Animals in Action



In this lesson students will explore the Living Building Challenge. Students will be introduced to the idea of a living building through a video clip. Students will learn about the 7 petals of certification. Together the class will break down the big challenges of the Living Building. Students will learn about bio-inspired design through a slideshow and video. Students will look back to their challenge breakdown to see which areas may be addressed by bio-inspired design.

Materials Needed:

- Slideshow of Living Building Challenge and Bio-Inspired design.
- Butcher paper (one piece per class period)

Time Frame:

1 -2 hour long class periods

Teacher Prep:

Have video and slideshows ready for class. Have butcher paper ready before class.

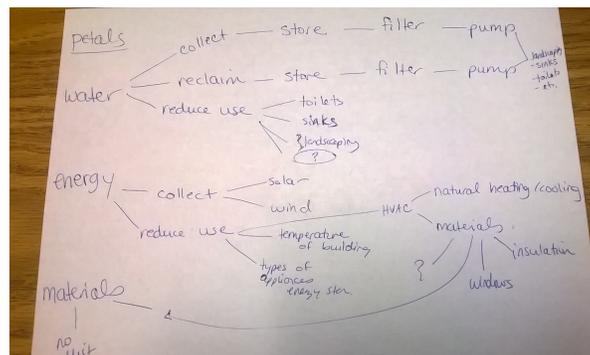
Procedure:

Have a picture of a living building on the board/screen as students walk in. Ask what is different about this building or why they think it is special (example of living buildings can be found at <https://living-future.org/lbc/>). Explain that the building in the picture is a living building. Explain the idea of a Living Building. Could we build smarter, more efficient buildings that make their own energy and collect/treat all their own water (just like an organism)? How could we do this? How could this impact water conservation? Energy conservation? Habitat conservation?

Show students the first four minutes of the following TedEd video (or you could watch the whole thing if you want):

<https://www.youtube.com/watch?v=gSMecC6pcGo>

Together, use the big butcher paper to organize the challenges of the Living Building. See example below:



Tell students they are going to use Bio-Inspired Design and knowledge of organisms to help address the issues with the Living Building Challenge. Ask groups to discuss what they think Bio-Inspired Design is.

Show the following slides and have the students tell which organism they think inspired the designs: https://docs.google.com/presentation/d/1Tva2bzmzi-Vcs4vjnGswUQ4pNb4ht_oSzwXEFIhfZTg/edit?usp=sharing

Show the video on bio-inspired design:

https://www.ted.com/talks/janine_benyus_biomimicry_in_action

Now go back to the butcher paper that breaks down the challenges of the Living Building. Ask the students what areas they think could be solved with bio-inspired design. Circle the items bio-inspired design could address- filtration, collection/reclamation, pumps, energy, insulation, heating/cooling etc.

If you have additional time, have students take out their biome research and start circling or highlighting organisms they think might help solve some of the Living Building Challenges. Have them discuss these organisms and how they could help with their partners.

The Living Building Teacher Instructions

Explain 7th Grade: Animals in Action



Students will use what they already know about biomes to help them create solutions to the challenges represented in The Living Building. Some challenges include filtration of water, collection of energy, and thermal regulation. This lesson is a gradual release modeled lesson (I do, we do, you do). Students will see the teacher modeling how to compile/research information on bio-inspired design, then students and teacher will compile/research information together, then students will compile/research information in their groups then ultimately on their own.

Prerequisite:

Students should have a general idea of the Earth's biomes and have completed research on the organisms specific to each biome with emphasis on adaptations (Explore Activity 1). Students will need to know what the living building is and understand the challenges to engineering/building a living building (Explore Activity 2).

Materials Needed:

- Copies of the handouts: **Bio-Inspired Design: Galapagos Shark, Bio-Inspired Design: Spider Web, and Bio-Inspired Design Research Notes**
- Computers for research

Time Frame:

2-3 hours/class periods depending on how much time you want to allow for additional research and collaboration.

Teacher Prep:

Have access to computers. Create new jigsaw groups from Explore #1 groups: a new group would have a person from the old group 1, 2, 3, and 4. Have copies of the handouts.

Procedure:

Day 1

Briefly go over the problem breakdown from yesterday (Explore Activity #2) and highlight the issues of the Living Building Challenge. Go over what bio-inspired design is and see if students remember the examples from yesterday.

Explain to students that the idea behind bio-inspired design is not to make something look like a specific organism but to figure out how an organism's adaptation works and then mimic the "how." To do this you'll need to figure out not only what an organism does but how it accomplishes that particular function.

Show students how to research bio-inspired design with a gradual release format. First you show them and model your thinking, then do one example as a class, then let students work on their own/in their group.

Pass out the handout **Bio-Inspired Design: Galapagos Shark**. Read through the article and model how you would annotate it. Then model how to fill out the table. These examples do not actually apply to the Living Building Challenge, they are just general examples for practice.

Now the class will do an example together. Pass out the handout **Bio-Inspired Design: Spider Web**. Read the article together and pause after each paragraph; ask the students what they would annotate, or what they thought was important. Continue modeling and checking for understanding. First have students think pair share their answers to the table. Have the pairs share with their group of four, then go over the table with the class.

Arrange students in the new groups you've created. Explain that today and tomorrow your team will be researching organisms to help inspire solutions to the Living Building Challenge. Explain that each member of the team has researched different biome organisms in the previous lessons. Give the groups a chance to choose what Living Building Challenge they want to work on. Let them give their new group a team name.

Tell groups to pull out their biome research and look for ideas that might help solve their challenge from the Living Building. As a group decide on 4-5 organisms you want to further research.

Tell students to follow the same procedure we just went over to find the structure and function of each organism they've chosen. Then brainstorm as a group on how this could inspire a solution to our Living Building Challenge. Distribute the **Bio-Inspired Design: Research Notes** handout.

Students will work in groups to research the organisms and discover the structures and functions that can inspire a solution to the Living Building Challenge.

Day 2

Groups will continue with research as needed. Once groups have looked at 4-5 organisms, they will discuss as a team which 2-3 they think will best meet the needs of the Living Building Challenge they are working on.

Optional - Show this engineer and design process video. It highlights how engineers redesign their ideas over and over again. <https://www.youtube.com/watch?v=fxJWin195kU>

On butcher paper or giant sticky notes, have each team describe and draw their bio-inspired design. See example below, then hang posters around the room or in the hall. Give students sticky notes and do a gallery walk where students give feedback on designs.



After gallery walk, teams go over the feedback they received and adjust their designs. Repeat the process as needed. Once students have chosen their final idea the group will complete the **Bio-Inspired Design: Living Building Challenge** handout. Students will list all organisms considered and circle the one used in the final design.

The Living Building

Explain 7th Grade: Animals in Action

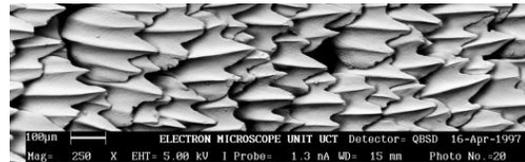


Bio-Inspired Design: The Galapagos Shark

Every year, about 100,000 people die from getting infected by a specific strain of bacteria, *Staphylococcus aureus*. What’s especially troubling about this situation is that we inadvertently bred this strain of dangerous bacteria, by accident, through the use of antibiotics. Antibiotics kill off all the bacteria except those individuals resistant to it, which survive and reproduce. The result is a bacteria now known as MRSA, which stands for Methicillin-resistant *Staphylococcus aureus*. Antibiotic resistant bacteria, sometimes called superbugs, are a growing problem ever since we discovered penicillin and other antibiotics just 70 years ago.

A way out of this dilemma has presented itself, thanks the Galapagos shark. A few years ago a scientist started paying attention to the fact that sharks have very clean skin. This isn’t due to sharks being fast swimmers, because most of the time they’re swimming relatively slowly, cruising through the ocean. And most slow-moving creatures in the ocean have lots of things attached their skin, like barnacles - but not sharks. It turns out this is true at the microscopic level as well. Sharks have virtually no bacteria on their skin. How do they achieve this?

Well, sharks fight bacteria not with chemicals, but with texture. This is what their skin looks like under a scanning electron microscope – it’s not smooth.



The scales of the galapagos shark have lateral ridges and valleys running across them. And this is the key to their success, because it turns out bacteria have great difficulty sticking to this surface. One end of a bacterium is clinging to a thin mountain ridge, while the other end tries to hang on in the valley below, where water is flowing very quickly through the narrowed channel. For a bacterium, this is energetically expensive, and they evidently don’t persist on this kind of surface.

Organism	<i>Galapagos Shark</i>
Structure/ Mechanism	
Function	
Invention/ Application	
Need addressed	
Resources	

The Living Building

Explain 7th Grade: Animals in Action



Bio Inspired Design: Spider Web

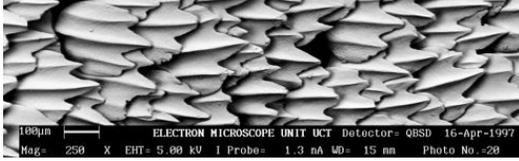
You might be surprised by how much engineers are interested in spider webs. Ounce-for-ounce, spider web material is actually as strong or even stronger than Kevlar, the material used to make bullet proof vests. So engineers have been interested for a while in what makes spider silk so strong. And also how it's made. After all, to make Kevlar, we have to use fossil fuels and acids. Spider silk is merely made out of the digested flies the spider catches!

If you've ever walked into a web, you can see why birds and other organisms may want to avoid them. Spiders would have to expend a lot of time and energy to rebuild every time a bird flies into their web, not to mention they wouldn't be catching any food if their web is ruined. Researchers have noticed that birds will fly into windows because they don't see them but won't fly into spider webs. So why does this happen?

Do spiders somehow communicate with birds to help them see their webs? They do. It turns out that spiders help birds see their webs, by using a light we can't see, but which birds can see very well. When you shine an ultraviolet light on a spider web, it lights up like a Christmas tree, and that's what birds see as they're flying around. Some spiders spin special silk with UV properties. These spiders add the UV reflecting silk to their webs to make sure birds don't overlook them.

Organism	<i>Orb weaver spider</i>
Structure/ Mechanism	
Function	
Invention/ Application	
Need addressed	
Resources	

Teacher Answer Key

Organism	<i>Galapagos Shark</i>
Structure/Mechanism	<p><i>The scales of this shark have lateral ridges and valleys running across them</i></p> 
Function	<i>To keep bacteria from growing on skin. Bacteria have difficulty sticking to this surface. One end of a bacterium is clinging to a thin mountain ridge, while the other end tries to gain purchase in the valley below, where water is flowing, accelerated through the narrowed channel.</i>
Invention/Application	<i>Create a plastic film with the same ridges and valleys. Use the film on counters, door handles, bed rails, and other surfaces in hospitals and doctor offices to keep bacteria from growing.</i>
Need Addressed	<i>Allows bacteria growth to be controlled without the use of antibiotics</i>
Resources	http://www.learningwithnature.org/wp-content/uploads/2015/06/Engineering_Inspired_by_Nature_curriculum_preview.pdf

Organism	<i>Orb weaver spider</i>
Structure/Mechanism	<i>UV spider silk used in webs.</i>
Function	<i>The UV spider silk reflects light so birds see the spider web and don't fly into the web destroying it.</i>
Invention/Application	<i>Make glass with UV reflectors throughout the glass in a spider web pattern to prevent birds from flying into windows.</i>
Need addressed	<i>Allows birds to avoid collisions with glass windows.</i>
Resources	https://www.seeker.com/spider-webs-inspire-bird-safe-windows-1765921411.html

The Living Building
Explain 7th Grade: Animals in Action



**Bio-Inspired Design:
 Research Notes**

Team Name: _____

Challenge to be addressed: _____

Organism	
Structure/ Mechanism	
Function	
Invention/ Application	
Resources	

Organism	
Structure/ Mechanism	
Function	
Invention/ Application	

Resources	
------------------	--

The Living Building
Explain 7th Grade: Animals in Action



**Bio-Inspired Design:
 Research Notes**

Team Name: _____

Challenge to be addressed: _____

Organism	
Structure/ Mechanism	
Function	
Invention/ Application	
Resources	

Organism	
Structure/ Mechanism	
Function	
Invention/ Application	
Resources	

--	--

The Living Building Teacher Instructions

Extend and Evaluate 7th Grade: Animals in Action



Students will create a final design of their Bio-Inspired invention that addresses the Living Building Challenge. Students will choose a format for their design and then present their idea to the class.

Materials Needed:

- Computers
- Glue, tape, scissors, etc. for building models

Time Frame:

2-3 one hour class periods

Teacher Prep:

Have computers or tablets available for groups that choose a virtual model

Prerequisite:

Complete the Engage, Explore, and Explain Activities

Procedure:

Students will take their final design and create a prototype and mini presentation. Give students the option of creating a physical prototype, a virtual prototype or a very detailed illustration of their model with various views and/or close-ups.

Groups will need to be prepared to present what their final idea is, as well as the other ideas they rejected and why. In their presentation students should briefly explain the various organisms they researched. Give the pros and cons of the organisms and why they ultimately chose the organism they did. They should explain the structure/mechanism of the organism and how they applied it to their invention. Groups should also explain how this addresses the Living Building Challenge.

After presentations, have students give each other feedback any way you choose.

Possible rubrics for presentation:

Buck Institute Presentation Rubric:

https://docs.google.com/document/d/1HwDK9iBYrBgG9xzCL7I_VkrOQp9Mj6HBUMNIgxXzWAw/edit?usp=sharing

Buck Institute Creativity and Innovation Rubric: <https://docs.google.com/document/d/1oZl65-yj2W5Aq4GZj6YfMpcmsMTn422d4cCQdH3pWn8/edit?usp=sharing>

Buck Institute Critical Thinking Rubric:

<https://docs.google.com/document/d/1MZ3VJPoRnud3vV72Yaavu1SYWooELMBPIs6UdhKtQd0/edit?usp=sharing>