

Art on a Cellular Level

Art and Science Educational Resource

Lesson 3



Phoenix Airport Museum

Educators and Parents,

With foundations in art, biology and sustainability, the objective of this lesson is to reference nature for **problem solving** and **design** in human invention.

This educational resource is geared for interaction with students 10 years or older to support the understanding between art and science. Younger children may use this lesson too with the assistance of an adult.

This resource is designed based on our current exhibition, *Art on a Cellular Level*, on display at Phoenix Sky Harbor. This is not your typical science lesson. The questions and activities below were created to promote observation and curiosity. There are no wrong answers.

If you enjoyed these activities and would like to investigate further, check back for future projects as the Phoenix Airport Museum creates new exhibitions. We hope your student will have fun with this and make an art project to share with us. Please send an image of your student's artwork to Airport.museum@phoenix.gov for an opportunity to be featured on Sky Harbor's social media.

You may print this PDF to use as a workbook or have your student refer to the material online. We encourage educators to expand on this art and science course to create a lesson plan.

OBJECTIVES

- **LEARN** about design inspired by nature (biomimicry)
- **IDENTIFY** how different qualities allow organisms to thrive
- **INNOVATE** a new design inspired by nature

OVERVIEW

- Learn about the Phoenix Airport Museum exhibition *Art on a Cellular Level* exhibition at Sky Harbor International Airport.
- Examine artwork inspired by nature's design.
- Learn basics of **biomimicry** – innovation inspired by nature.
- Imagine your own invention using biomimicry principals.

MATERIALS NEEDED

- **Paper**
- **Something to draw with** (pencil, pen, colored pencils, paints, crayons, etc.)

GLOSSARY

Biology: the study of living things.

Organism: a living thing that uses energy, grows and reproduces.

Biomimicry: using nature as a model for human inventions.

Adaptation: a physical or behavioral change which helps an animal survive.

Species: a group of similar living things.

Sustainability: using resources in a way that they can continue to be used in the future.

Engineer: Someone who designs and builds things.

Ecosystem: all of the plants, animals, and other living (and non-living) things that live in and contribute to the health of a common area.

Microbes: an organism (such as bacteria, fungi or viruses) that are too small to see with an unaided human eye.

Art on a Cellular Level exhibition Phoenix Sky Harbor, Terminal 4, level 3 Gallery



Art is a lens through which we view the world. It can be a tool for storytelling, expressing cultural values and teaching fundamentals of math, technology and science in a visual way.

The Terminal 4 gallery exhibition at Phoenix Sky Harbor International Airport, *Art on a Cellular Level*, examines the intersections between **art and science**. Both fields involve exploration and discovery. Scientists and artists attempt to understand and describe the world around us by making observations. They strive to see things in new ways and to communicate that vision.

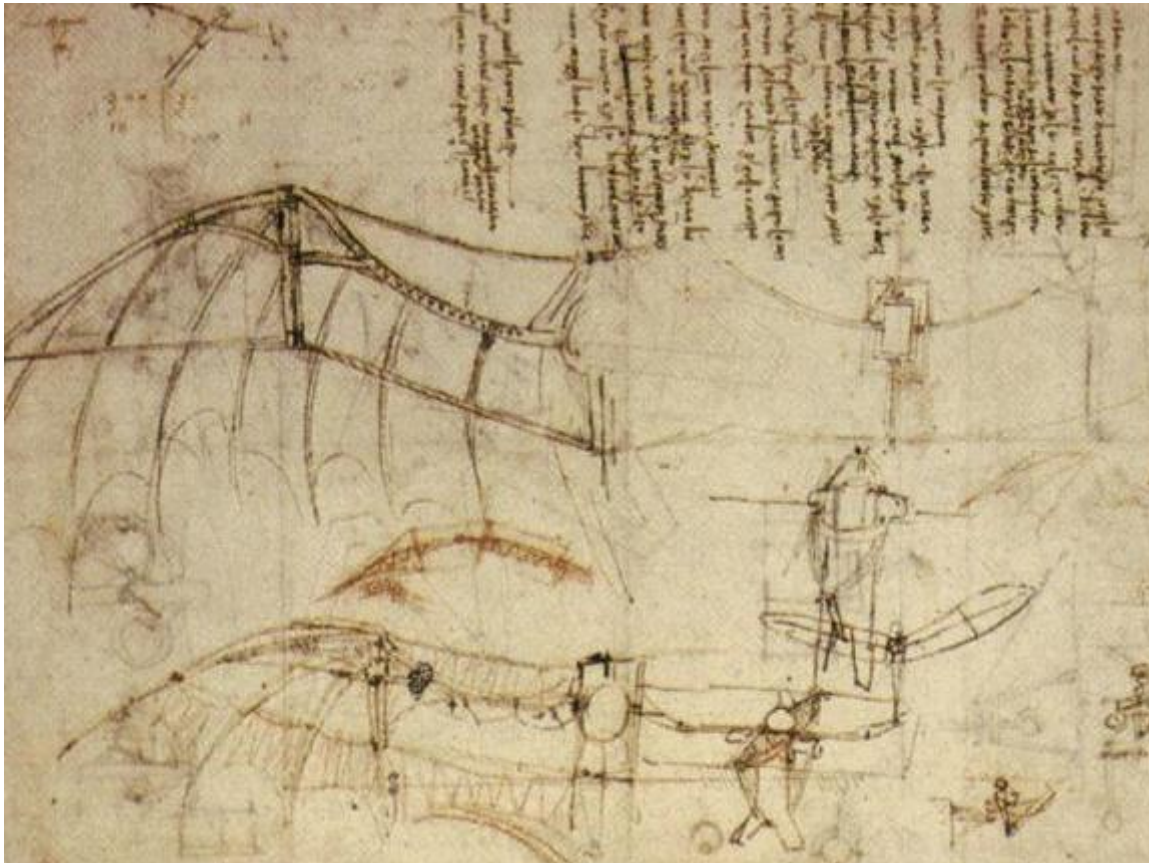
This exhibition features 7 Arizona artists who interpret parts of the natural world that we may otherwise need a microscope, telescope or x-ray to see. From the chemicals of stardust to the intricacies of the human body, these artists draw, paint, sculpt or construct the richness of life on our planet.

Lesson 3: Nature Inspired Design

Nature is the ultimate **engineer**. Our planet has changed a lot throughout time, and so have the lifeforms on it. The plants, animals and **microbes** around us are here because they adapted to earth's ever-changing environment. What couldn't **adapt** no longer exists, and what surrounds us today continues to find ways to survive.

The act of using nature as a model for human invention is called **biomimicry**. *Bio*, meaning life, and *mimicry* (like mimic) means to imitate. So, the word breaks down to "imitating life". Many people who work in science or engineering look at how plants and animals thrive in their environments and use that information to make **sustainable** inventions.

In this lesson, you will see artwork from the *Art on a Cellular Level* exhibition inspired by nature's design. Like artists, many scientists, architects, engineers and inventors have also studied nature for design, problem-solving and innovation.



Leonardo Da Vinci design for a flying machine, 1488

(image credit: <https://library.acropolis.org/biomimicry-human-creation-inspired-by-nature/>)



Alan Bur Johnson
Jerome, Arizona

This artwork is titled, ***Push the Sky 101***. It is comprised of five aluminum metal wing-shapes that are layered and mounted on a wall. The dimensional sculpture has a durable white finish known as a powder coat.

Artist statement: *“Push the Sky 101 incorporates abstracted insect wings and architectural lines of airplanes my father designed.”*

Inspired by flight, Alan Bur Johnson created this sculpture while thinking about the qualities of wings that help something fly.

QUESTIONS:

How many different types of wings do you see in this sculpture?

Do you think they are all from the same insect? Why or why not?

Airplane wings and insect wings both help sustain flight. What similarities do you see between aircraft and bug wings?

BIOMIMICRY IN FLIGHT

Birds fly so effortlessly because of their form or shape. Birds' bodies, slick feathers and wingspan allow air to flow smoothly against their surface during flight. Engineers have used birds as inspiration to model airplanes after, so they do not face air resistance when they are in motion.



(image credit: airbus.com)

When birds want to take off, they raise their wings and their bodies go up through the process of 'lift'. Aircraft use the same notion while taking off and landing. Airplane wings are also wider near the body and thinner on the outer edge, just like bird wings.



(image credit: sciencemag.org)

Birds fly in a V-shape with their flock. This formation creates an air current, allowing the birds to save energy during their flight and travel greater distances. Engineers have shaped aircraft wings inspired by this V formation to save fuel and create better airflow around the figure.



Danielle Wood

Tempe, Arizona

This artwork titled *Elation* is a ceramic sculpture created with porcelain clay. When porcelain is put in a kiln and heated (also known as *fired*) to a high temperature, the material becomes vitrified or glass-like, very hard and impermeable to water.

Artist statement: *“My work contains forms patterned after organisms found in the ocean - an*

environment that still holds much mystery and intrigue. There is a beauty and enigma below the surface that is intriguing and often overlooked.”

Danielle Wood was inspired by coral for this sculpture. Coral is typically very colorful, but the artist chose to put a clear glaze on the porcelain to let the material show through.



In the ocean, coral reefs are not only beautiful, they are crucial to the **ecosystem**. While they make up only 0.1% of the total ocean area, 25% of all marine life lives there. It serves as a home and feeding area to many fish and sea mammals. Coral also offers benefits to humans on land, like minimizing impact on coastal cities from hurricanes.

(source: floridakeys.noaa.gov)



(Image credit: National Geographic)

Although corals look like plants, they are actually animals. The structure that we call “coral” is made up of thousands of tiny animals called *polyps*. Above are some examples of corals at the Great Barrier Reef in Australia.

- How many different colored corals do you see? How many different shapes?
- What kinds of qualities do you notice in the variety of coral? What do you imagine they would feel like (hard, soft, smooth, rough, etc.)?
- There are more than 2,500 different species of coral in the ocean. Using the image above and Danielle Wood’s sculpture, **draw your own species of coral**. Think about size, shape, color and texture as you create your own unique specimen.

BIOMIMICRY IN CITIES

Corals are also a great model for biomimicry — demonstrating how nature sustainably creates *calcium carbonate*, a compound used to make cement. (Source: biomimicry 3.8)



The structures (left) are built by tiny coral polyps, living together inside a calcium-carbonate exoskeleton they grow themselves.

(Image credit: Livescience.com)



With a little imagination, you can see how corals relate to our own need to build shelter. Like corals, we build our own type of “exoskeleton” (buildings). The most popular building material in the world is concrete, a mixture of gravel and cement. Cement comes from limestone, a type of rock formed from ancient sea beds and rich in calcium carbonate.

(image credit: Goldcoast.gov.au)



(Image credit: kidsdiscover.com)

To create cement, limestone is mined from the Earth with heavy equipment and explosives then manufactured through a chemical process. The limestone we mine to make cement is actually the remains of ancient corals and other animals that turn CO₂ into calcium carbonate.



(Image credit: National Geographic)

Corals acquire the same building materials from the sea water around them and create calcium carbonate using a low energy, waste-free process. Instead of mining, biomimicry experts are studying how coral makes calcium carbonate and are attempting to mimic the recipe to create a more **sustainable** cement.

EXPLORE FURTHER

Visit earth.google.com and search “Great Barrier Reef” to experience a 360 degree, underwater view of the most diverse ecosystem on the planet.



Jesse Armstrong

Gilbert, Arizona

This artwork titled *Fuse Series* is a sculpture that hangs on the wall. It is made of wood that has been shaped and painted white. Small round ceramic shapes with dark glass centers are attached to the wood.

While Jesse Armstrong's sculpture is *non-objective* (meaning it does not represent a person, object or organism), it is inspired by organic forms.

The grouping of the circular shapes could be interpreted as **microorganisms**.

Microorganisms, or microbes, live almost everywhere on Earth

but are invisible to the eye. They make up the largest number of living organisms on the planet. There are good microbes that help us break down waste, but there are also harmful microbes that can cause illnesses.

EXPLORE FURTHER:

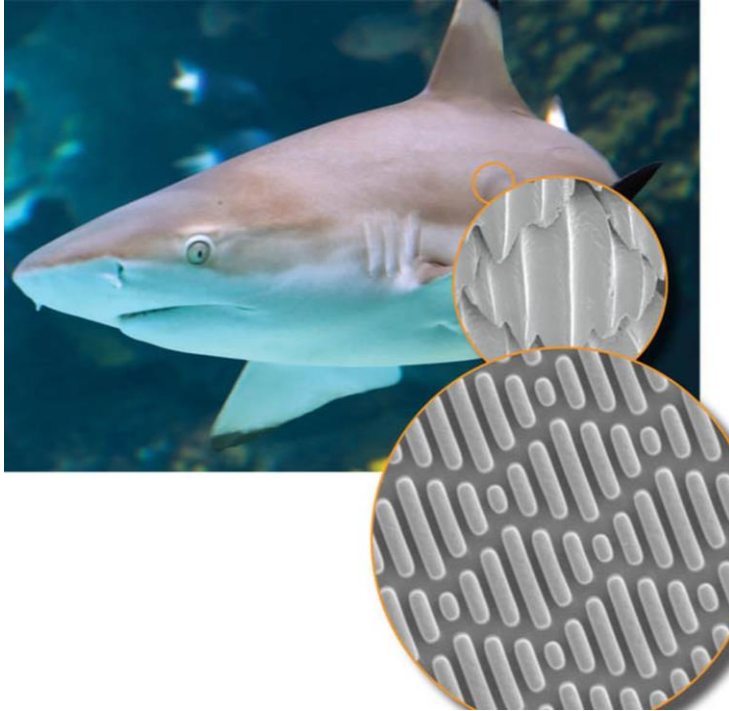


(Image credit: Sciencephoto.com/dennis-kunkel)

To view enlarged microscopic images of bacteria, viruses, single-celled and microorganisms in the human body, visit sciencephoto.com to see the work of Dr. Kunkel. www.sciencephoto.com/dennis-kunkel-microscopy-collection

BIOMIMICRY IN HEALTH

Nature has found a way to make a range of **organisms** - from leaves and flower petals, to insect wings and feathers - resistant to harmful microbes. Biomimicry experts are learning from nature how to design surfaces to resist harmful microbes.



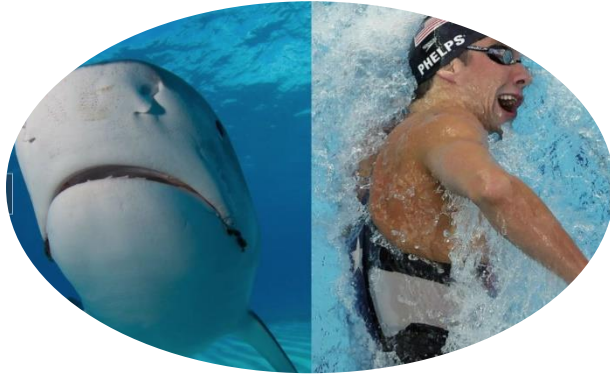
In 2001, scientist Dr. Anthony Brennan noticed that certain sharks are barnacle and algae-free due to the texture of their skin. Their pattern also makes it difficult for bacteria to attach and survive. With that in mind, Brennan's company reproduced the antibacterial texture as a film that could be applied to high-touch surfaces in hospitals to stop the spread of germs.

(Image credit: Popular Science)

- What other highly touched surfaces could you apply this microbe-resistant film to?

Project 3: Art and innovation inspired by nature.

Biomimicry is a design concept that draws **sustainability** ideas from nature's time-tested patterns and solutions. Below are some inventions that came from biomimicry:



Swimsuits that have grooves aligned with water flow, modeled after the texture of sharks' skin.

Hook and loop material (Velcro®) inspired by cockleburs that stick to animal fur and humans when they brush against them.



A material that can collect water from air, like Stenocara beetle who can collect water from the air even in harsh, dry climates. (Massachusetts Institute of Technology)

(All images: mnn.com)

BIOMIMICRY AND YOU

How can we create better designs by looking at the world around us? Look at the super strengths of the organisms below (or reference the previous examples). Draw what you could invent using these concepts on your own sheet of paper. Use your imagination and get creative!



Geckos toe pads have millions of little hairs that act as a strong adhesive, allowing them to climb straight up walls and hang on to ceilings. Their “cling strength” is up to 20 times their body weight.

(image and source: geckskin.umass.edu)

Lotus flower leaves are extremely water-repellent and have self-cleaning properties due to their texture.

(image and source: teacherengineer.org)



Spider silk is (gram for gram) as strong as some of the heaviest metals. It is also extremely flexible and virtually invisible to the human immune system, making it a natural material for medical uses.

(image: smithsonianmag.org; source: science.gov)

Project 3 Examples

