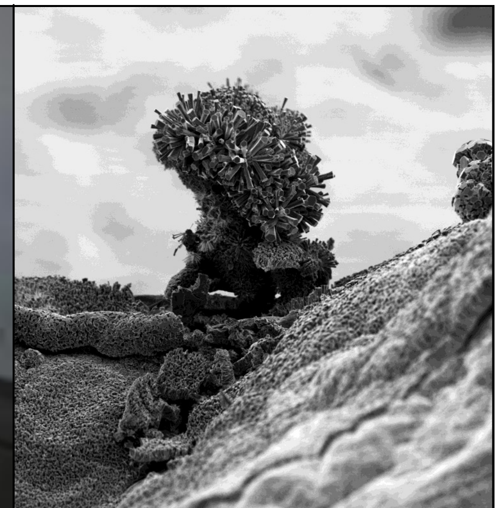
TEMPORARY CONTEMPORARY FALL 2008

A Teacher's Guide to the Tour



MICHAEL OLIVERI:

Innerspace, Permaculture and UFOs

IN THIS GUIDE:

CHEEKWOOD
art & gardens

Through his depiction of hydrocarbons, innerspace, and hydroponics, Michael Oliveri combines ecological sustainability with the realm of fine art. His work playfully explores the inner space of molecular science, nanotechnology and biological engineering; matter that is loaded with scientific possibilities but almost invisible to the human eye. This unique installation of 2D and 3D pieces opens an exchange of ideas when art and science converge in the galleries. Students will experience cutting edge advancements in science and technology through the innovation of contemporary art.

EXHIBITION OVERVIEW

In his new Cheekwood exhibition "Innerspace, Permaculture and UFOs" Michael Oliveri continues his journey into the oddly everyday nature of human experiment. In several sculptures and photographs he dives into the material world that lies at the heart of scientific progress. His work playfully explores the inner spaces of molecular science, nanotechnology, biological engineering, in short, the small- and large-size matter that is loaded with scientific possibilities but almost invisible to the human eye. Take for instance nanotechnology which controls matter on the scale of an atom or molecule. In daily life, nano structures appear in sun lotion, cosmetics, stain resistant clothing, etc. The size of a nanometer to a meter is the same as that of a marble to the planet Earth. Collaborating with his colleagues in physics and engineering at the University of Georgia by utilizing the most advanced scientific imaging technologies, Oliveri turns the scale on its head. In the resulting photographs, Oliveri harnesses nanotechnology for a different end, the aesthetic experience of seeing inner spaces revealed.

Then there are the hydroponic tomato plants growing inside a UFO. A hydroponic tomato farm freshly flown in by extra-terrestrials? Some time ago such a story could only be the product of science fiction. Today strange things are possible outside the realm of fiction. In 1984 NASA did indeed fly tomato seeds into outer space on board the Space Shuttle Challenger. Then elementary-school children around the United States were invited to use the seeds in science projects. During Oliveri's exhibition at Cheekwood, school children will also have the opportunity to conduct hydroponic experiments in a greenhouse lab – except this time the seeds have not gone to outer space.

Jochen Wierich, *Curator of Art*

A pineapple designates topics for discussion and classroom activities.

MEET THE ARTIST

Michael Oliveri received an AA degree in electronics at Orange Coast College, a BFA in Sculpture from San Francisco Art Institute, and an MFA in New Genres from the University of California, Los Angeles. Since 2001, Oliveri has been an associate professor and the Chair of Digital Media at the University of Georgia in Athens, Georgia. His work ranges from video and photography to sculpture, horticulture, and sound. Of his work Oliveri says, “I’m interested in soft science. All the hypotheses that might someday be accepted fact – the ideas that aren’t real yet, but you hope are true.” He believes advancements with the internet have given all ideas a voice. These voices form a discourse that mixes art and philosophy with just enough fact to make it seem real, even if just for a little while. Through his innovations in contemporary art, Michael Oliveri is emerging as an important American digital media artist.

ARTIST STATEMENT

I am conceptually driven, and intrigued by independent scientific discoveries, and theories that reveal coincidental relationships. Once I have absorbed the scope of my research I trust my intuition to weave these observations into a conceptually motivated aesthetic.

My ideas for pseudo scientific objects, installations, videos and photography began in the early 1990s. At first I was using animals and unsuspecting people in interactive sculptural sound installations. These works were experiments with cause and effect relationships. I was hacking and modifying various emerging communications technologies as wireless interfaces to confound the common hierarchy of artist and viewer participant. This allowed for spontaneous and unpredictable relationships to manifest within the installations.

By 2003, my work focused on cross-pollinating the arts and sciences. I was inspired by a daunting theory that the universe is potentially finite and shaped like a Fullerene carbon 60 molecule that is believed to potentially contain the essential amino acids necessary for life. I was provoked by the micro and macro geometric symmetry and more so by the potency of this metaphysical relationship. My creative investigations led to a poetic synthesis including topics on NASA research, hydroponics, sound waves, surfing, ultraviolet light and hydrocarbons, and the exhibitions “Fast Food, Hydrocarbons and Waves in Outer Space”, “UV Hydrocarbons” and “Ultraviolet Acquiescence and Deep Space Drip Culture”. Currently, I am collaborating with a team of nano scientists at the University of Georgia to create imagery from the structures produced in the lab. Although the scientists are observing the nano structures as objects, I am approaching them as subjects and discovering new micro and macro relationships that I have yet to fully understand.

Using current photographic technology and a Scanning Electron Microscope (SEM) I have recently created my own grand scale micrograph interpretation of their research. It is a series of micrographs called “innerspace.” In this series I selected perspectives of unusual microscopic happenings within the actual nano structure samples to blur scale into seemingly familiar human settings.

Michael Oliveri

A CLOSER LOOK

WHAT IS NANOTECHNOLOGY?

Nanotechnology is the art and science of manipulating matter at the nanoscale (down to 1/100,000 the width of a human hair) to create new and unique materials and products. The nanoscale is the scale of atoms and molecules, the fundamental building blocks of the material world. At the nanoscale, scientists can start changing the properties of materials directly, making them lighter, harder or more durable. In some cases, simply making things smaller changes their properties—a chemical might take on a new color, or start to conduct electricity when re-fashioned at the nanoscale. Thus, nanotechnology is a highly multidisciplinary field, drawing from a number of branches of engineering, physics, colloid sciences, chemistry, robotics, and more.

Generally, nanotechnology refers to the development, separation, and consolidation of materials 100 nanometers or smaller. A **Nanometer** is a unit of length in the metric system, equal to one billionth of a meter. To put it into perspective, the size of a nanometer to a meter is the same as that of a marble to the planet Earth.

NANOTECHNOLOGY NOW & IN THE FUTURE

Currently, there are more than six hundred nanotechnology-enabled consumer products on the market. Nanotechnology is used to make bicycle frames and tennis rackets lighter and stronger. Nano-sized particles of titanium dioxide and zinc oxide are used in many sunscreens, to block UV radiation more effectively without making your skin look pasty white. Clothes are treated with nano-engineered coatings that make them stain-proof or static-free. Computer chips using nanoscale components are everywhere in consumer electronics, from computers to mp3 players.

Nanotechnology has enormous potential to change society; however, it remains a science in its infancy. Future applications of the science will become increasingly sophisticated, giving scientists and engineers the ability to tackle challenging problems that affect us all. Nano science could lead to important innovation in treating cancer, generating renewable energy, and providing clean water at any location. Fleets of medical nanorobots smaller than a cell could roam our bodies eliminating bacteria, clearing out clogged arteries, and reversing the ravages of old age. Clean factories could eliminate pollution caused by manufacturing. Low cost solar cells and batteries could replace coal, oil and nuclear fuels with clean, cheap and abundant solar power. Food production could increase ten times per square foot.

Like many new technologies, there are concerns about the development and use of nano science. Scientists face the challenge of upholding safety and ethical standards as they work to advance the science.

EXHIBITION CONNECTION

Artists find inspiration for their work in many different places. Michael Oliveri found his after a simple Google search. His interest in nanotechnology, hydrocarbons, and hydroponics began when he read an internet article which indicated that our universe – the whole cosmos – may be finite. Rather than being infinite in scope, this article suggested that the universe has a set size and number of entities. Oliveri thought it might be fun if the information were true and started to explore the idea through his artwork.

To further investigate this scientific hypothesis, Oliveri began looking through a Scanning Electron Microscope to expose the tiny nanoscale molecules that make up the universe. Through his *Innerspace* series, he gives an up close and personal view of the unseen subatomic world where materials behave dramatically different than they do in the macro one. Somewhat humorously yet, from specific scientific observation, he makes the point that innovation often occurs not as a result of structured research, but of accidental discoveries. Images in the exhibition reflect Oliveri's depiction of the true spirit of the scientific endeavor – successful, failed, unproved or abandoned – as a dynamic conversation based not in reality but in potential.

BUMPY

All of the tools used in nanotechnology share a common challenge of working in a world so tiny that materials behave dramatically different than they do in the macroworld, or big world. Materials at the nanoscale are characteristically bumpy, due to distinct molecular shapes; sticky from strong electrostatic forces; and shaky because they are in constant motion. At the nanoscale, nature follows a different set of rules that can be both awesome and unpredictable. The tools and machines used for nanotechnology are specially equipped to adapt to these qualities. For example, an Atomic Force Microscope uses a highly sensitive laser that produces graphic images of the particles topography.

TRY IT!
Simulate this process by making a pencil rubbing of a coin.
Place a piece of paper over a coin. Rub a pencil slowly across the coin until the image is visible. You are able to detect ridges and bumps without looking at the coin. Imagine getting a similar graphic image of the surface of something so tiny no human eye could ever see it!

STICKY

Gravity is an important part of our lives in the macroworld, but at the nanoscale, particles as small as atoms are influenced more by frictional and electromagnetic forces. These intermolecular forces are tiny but strong, and bind atoms together. Stickiness occurs due to scale. Unlike the macroworld, at the nanoscale the higher the surface area, the stickier the material. Surface area to volume ratio increases as scale size decreases. For example, smaller particles have a higher surface area to volume ratio than larger particles.

TRY IT!
Materials: *Granulated Sugar, Powdered Sugar, Sugar Cubes*
Ask students to discuss which of the sugars would stick the most to their hands if they were to put their hand in each container. Students should take turns placing a hand in each container. (They should clean their hand between containers.) Discuss why they think certain types of sugar stuck to their hands more than others. How does the surface area to volume of each particle play a role in the results? What implications do the observations have for elements in nature's structure and function?

SHAKY

At the nanoscale nothing is ever completely still. Molecules are constantly shaking and bombarding each other because of changes in temperature. When thermal forces (temperatures) are low, molecules move very slowly. As the thermal forces increase, the molecules begin to shake more and more until they are constantly attacking each other.

TRY IT!
Materials: *3 small beakers; 1 filled with cold water, 1 with temperate water, 1 with hot water, food coloring, timer*
Students will explore how thermal forces affect the shakiness of molecules by testing the rate of diffusion of a drop of food coloring in water at different temperatures. Label three small beakers or glasses as cold water, room temperature water, and hot water. Add the cold water to the first glass and then slowly place three drops of food coloring in the water. Time how long it takes for the food-coloring molecules to "shake" and disperse evenly. Record your observations and repeat with the other two beakers. Note: Students should not stir or swirl glasses so they may see the molecules "moving" on their own. Ask the students why the food coloring dispersed differently in the three beakers.

(Explorations adapted from Science Scope, March 2008, volume 31, Number 7)

HANDS-ON FUN

Ask your students to look closely at Michael Oliveri's *Innerspace: Fractal Geometric Valley*. This image of molecules seen through a Scanning Electron Microscope is what Oliveri refers to as a nano photograph. He has been collaborating with Dr. Zhengwei Pan and his research team in the Physics and Engineering Department at the University of Georgia to create imagery from structures produced in their labs. Although the scientists are observing the nano structures as objects, he is approaching them as subjects and discovering new micro and macro relationships that he has yet to fully understand.

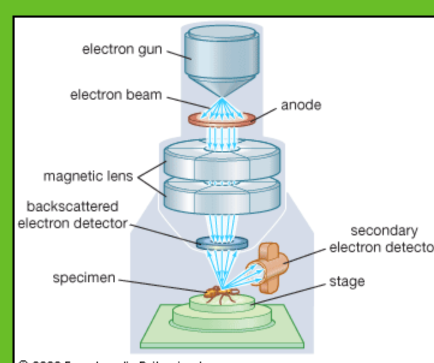
INTERPRET

Oliveri has taken scans from the SEM and pieced them together to create his *Innerspace* images.

- What does this image appear to be?
- What elements are included in the composition to make you think this?
- How is texture used to help create the mood of the composition?
- Is there a feeling of space? Is it flat or deep space?
- Why do you think he gave it the title *Fractal Geometric Valley*?
- How does the black and white color scheme affect the mood of the piece?
- Does this image tell a story? If so, what could it be?

THE SCANNING ELECTRON MICROSCOPE

The scanning electron microscope has a magnification range from15x to 200,000x (reached in 25 steps) and a resolution of 5 nanometers. It creates the magnified images by using electrons instead of light waves and shows detailed 3-dimensional images at much higher magnifications than possible with a light microscope. Without light waves, the images are rendered in black and white. Michael Oliveri has entered a new frontier of art by presenting these unique images of the nano world. It is through innovations in contemporary art like *Innerspace* that place Michael Oliveri among the important American digital media artists.



A CLOSER LOOK

WHAT IS A HYDROCARBON?

Hydrocarbon is the simplest organic compound consisting entirely of hydrogen and carbon. The majority of hydrocarbons found naturally occur in crude oil, natural gas, and coal where decomposed organic matter provides an abundance of carbon and hydrogen. When bonded, the molecules can form limitless combinations of simple chains, branching chains, rings, or other structures. Hydrocarbons can be as simple as methane (CH_4) or highly complex like petroleum and can occur as gases, liquids, solids, or polymers like plastics and proteins.

WHAT IS A FULLERENE?

Fullerenes are a form of carbon consisting of up to 500 carbon atoms arranged in closed shells. This particular hydrocarbon was discovered in 1985 by Robert Curl, Harold Kroto and Richard Smalley at the University of Sussex and Rice University. They received the 1996 Nobel Prize in Chemistry for their discovery of a before unknown allotrope of carbon, in which the atoms are arranged in closed shells. This form was found to have the structure of a truncated icosahedron*(see diagram below) and was named Buckminsterfullerene, after Fuller who designed the geodesic dome in the 1960s.

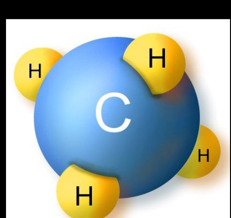
C60s

By far the most common fullerene is C_{60}, also called a buckyball. C_{60} is a molecule that consists of 60 carbon atoms, arranged as 12 pentagons and 20 hexagons. The shape is the same as that of a soccer ball. The black pieces of leather are the pentagons, the hexagons are white. There are 60 different points where three of the leather patches meet. Imagine a carbon atom sitting at each of these points, and you have a model of the C_{60} molecule.

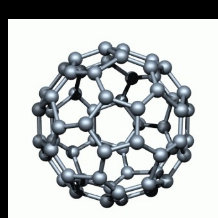
The discovery of C_{60} has stimulated innovative activity in chemistry. It opened up the new branch of Fullerene-Chemistry which studies the families of molecules that are based on fullerenes. Experiments combining fullerenes with other atoms are leading to the development of new superconductor compounds. Below a certain temperature these compounds can conduct electric currents without any resistance. How might this influence our future energy needs?

EXHIBITION CONNECTION

Michael Oliveri's Google search of 'finite universe' led him to an article on carbon 60 molecules (C_{60}) called fullerenes. Resembling the shape of a soccer ball, fullerenes mimic the proposed shape of a finite universe and are thought to potentially contain the essential amino acids necessary for life. As a result, the molecule has become a central component in Oliveri's art through his hydrocarbon sculptures. He is intrigued by the micro and macro geometric symmetry and by the potency of this metaphysical relationship. Whereas his digital images of *Innerspace* reflect Oliveri's study of nanotechnology, his sculptures of hydrocarbons are in response to his interest in fullerenes.

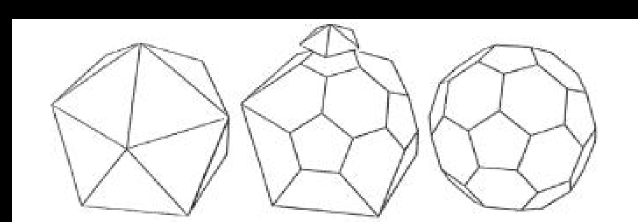


The hydrocarbon methane



Model of a fullerene

Montreal Biosphere,
B. Fuller 1967



Truncating an icoshedron

HYDROCARBONS & FULLERENES

HANDS-ON FUN

Oliveri creates hydrocarbon sculptures to represent the current trends in science technology. His mirrored glass sculptures combine fullerenes held together with carbon tubes. Allow students to explore the scientific world of hydrocarbons and three dimensional art by creating their own hydrocarbon sculpture. A list of materials is provided below, but use your imagination and see what types of hydrocarbons you can create.

TRY IT!

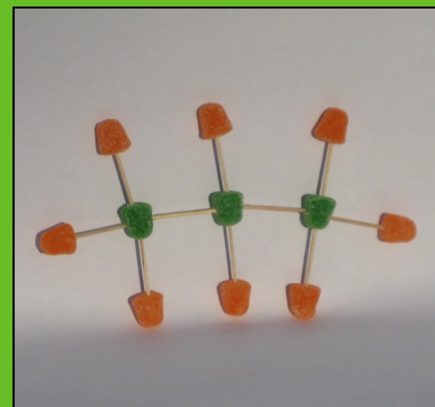
Suggested Materials:
Gumdrops
Toothpicks

Other Potential Materials:
Styrofoam balls
Clay/Model Magic
Straws
Toilet paper/paper towel tubes
Marshmallows and Pretzels
(*for an edible version*)

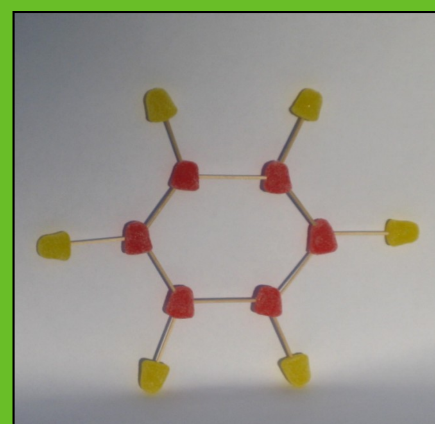
Ask students to create a hydrocarbon with a specific molecular formula. Students may work in groups or make their own. Hand out a chart with molecular formulas for a number of different hydrocarbons. Give students gum drops and toothpicks; make sure you designate carbon with a dark color and hydrogen with a light color.

Set down the guidelines that:

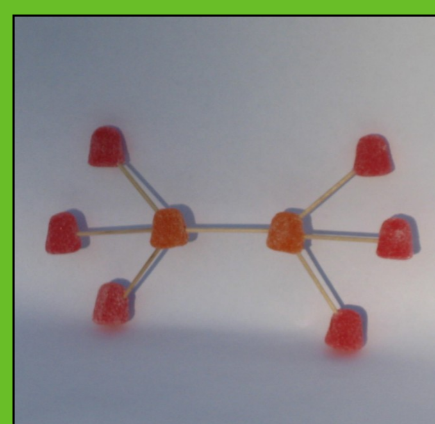
- Carbon has 4 bonds
- Hydrogen has 1 bond
- The hydrogen must be as far apart as possible from the other hydrogen(s).



Propane C_3H_8



Benzene C_6H_6



Ethane C_2H_6

HYDROCARBONS & FULLERENES

A CLOSER LOOK

WHAT IS HYDROPONICS?

Hydro = water   ponos = labor

Derived from the Greek root words *hydro* and *ponos*, hydroponics literally means *working water*. In traditional gardening, plants have to work to get their nutrients from the soil. With hydroponics, a nutrient solution of fertilizer and water feeds the plants directly, without the use of soil.

Many different civilizations have utilized hydroponic growing techniques throughout history. From the hanging gardens of Babylon to the floating gardens of the Aztecs and Incas in Mexico, numerous ancient civilizations practiced hydroponic growing techniques. Egyptian hieroglyphic records dating back several hundred years BCE describe the growing of plants in water. While hydroponics is hardly a new practice, giant strides have been made over recent years in this innovative area of agriculture.

HYDROPONICS NOW & IN THE FUTURE

Throughout the last century, scientists and horticulturists have experimented and refined various hydroponic methods. The many potential applications of hydroponics have driven their research. One such benefit is the ability to set up hydroponic systems indoors. Inside a controlled environment, the plants are not susceptible to changing temperatures and seasons and can be grown year round. This frees up acres of land to be used for livestock or other agricultural needs. Another major advantage of hydroponics over field grown crops is the isolation of the crop from the soil, which often has problems with diseases, pests, weeds, and drainage. With pest problems reduced and nutrients constantly fed to the roots, hydroponic productivity is set at a maximum level. This makes it possible to grow fresh produce in areas of the world without suitable soil.

Hydroponics, however, is not without disadvantages. Relative to conventional open field agriculture, the start-up costs and energy inputs for a hydroponic system are high. Additionally, hydroponic systems require a higher degree of management for successful production.

Despite the disadvantages, hydroponics will continue to play an increasingly important role in shaping the food resources of tomorrow. In addition to refining and expanding current technology, the industry will embrace new advancements in biotechnology and nanotechnology to develop plant varieties that will produce greater yields in smaller areas. The development of these technologies will also result in new methodologies, such as DNA transfer to engineer resistance to disease. In the near future, it is possible that scientists will be able to bio-engineer vegetables with the same protein content as meat, but without the fat!

EXHIBITION CONNECTION

In 1984 NASA sent millions of tomato seeds into space for five years in hopes that anti-gravity would have some phenomenal effect on their growth. Three million elementary school students and their teachers were invited to use the seeds in science projects. It became one of the biggest science experiments ever undertaken. Oliveri purchased some of the seeds on eBay and his high school interest in hydroponics resurfaced.

Oliveri's installations have evolved over time and are dynamic in every sense. Just as he works with engineers and physicists on the *Innerspace* images, Oliveri has worked closely with botanists and horticulturists on his hydroponic installations from their conception. He believes it is important that the original plants stay alive throughout the exhibition. As with growing plants in space, growing plants in a gallery environment requires adjustments to the necessary elements of light, air, water, and food. "By removing the plants from a traditional greenhouse or hydroponic setting and linking them to my artistic vision, I exponentially magnified the importance of their survival." As the plants start to flourish Oliveri believes the art itself becomes part of the soft-science culture that leads to new hypotheses, ideas, and progress.

HANDS-ON FUN

TRY IT!

Growing plants hydroponically can be easy and fun! Follow the guidelines below to grow a plant hydroponically. Coleus and plectranthus plants are both good choices for your first project. For growing tips and insider advice, visit www.growingedge.com.

MATERIALS

Glass Jar
Styrofoam
#2 Pencil
Coleus cuttings

PROCEDURE

- Take cuttings from a mature coleus plant. Clip at a branch's node, or underneath where the leaves join.

- Prepare the glass jar—pickle jars work well. Fill the jar about 3/4 full with water. Cut a piece of Styrofoam in a circle to fit the mouth of the jar. Create small holes in the Styrofoam for each of the cuttings. The holes should be approximately 1cm in diameter—about the width of a standard #2 pencil.

- *Optional*—add nutrients to the water to accelerate growth.

- Insert coleus cuttings through the holes in the Styrofoam lid.

- Place the plant near of source of light. Sit back, relax, and watch your new hydroponically grown plant take root!

CREATE YOUR OWN HYDROPONIC SYSTEM

A CLOSER LOOK : Oliveri'S UFO

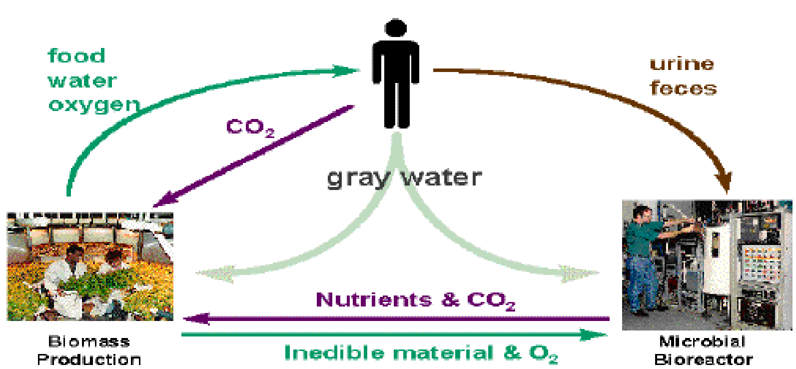
Why do we need plants in space?

All living things need food, water, oxygen, and gravity in order to survive. In outer space, all of these necessary elements are greatly diminished. Therefore, before long term space travel or habitation can become a reality, scientists must discover alternative ways to support life. Growing plants in space proves vital to this endeavor.

In orbit, plants are exposed to an environment in which gravity's effects are significantly decreased. It is called microgravity. Under these conditions, the plant's roots do not know which way to grow. In addition, with microgravity, water will not stay where you put it. It too floats. In space there are also long periods of darkness. Because artificial light requires large amounts of electricity, natural light in space must be collected, stored, and channeled efficiently. In addition, keeping the air moving and circulating in space is another issue scientists must address. There is less natural air circulation in an orbiting outpost, and plants could therefore suffocate on their own "exhaled" oxygen.

For future space travelers, gardening will be a matter of survival. Growing plants in a closed system like space will take care of all of the necessary concerns of food, water, oxygen, and waste removal. Not only will plants provide food when deliveries from Earth are not possible, but plants will also work to make air breathable and water drinkable. Plants and people, two very different kinds of astronauts, could eventually live together in balanced, sustainable habitats where contact with Earth is a luxury and not a necessity.

Scientists are exploring technologies that could unite people, plants, microbes, and machines into a miniature "ecosystem" capable of supporting space travelers indefinitely. This type of life support system called, *bioregenerative*, would be fully self-contained, creating an ecologically sound microcosm where each element supports and is supported by each of the others. Humans consume oxygen and release carbon dioxide. Plants return the favor by consuming carbon dioxide and releasing oxygen. Humans can use edible parts of plants for nourishment, while human waste and inedible plant matter can, after being broken down by microbes in tanks called bioreactors, provide nutrients for plant growth. Plants and microbes can also work to purify water, possibly with help from machines. The only input needed to keep such a system going is energy in the form of light.



EXHIBITION CONNECTION

An integral part of Michael Oliveri's UFO series is the tomato plant. He uses the gallery as a laboratory to grow tomato seeds in his elegantly designed, souped-up hydroponic system, or Ulterior Farming Operation. 'Ulterior' meaning something expected in the future, mysterious, or an underlying meaning other than what is assumed. All of which describes Oliveri's idea behind its design. While not meant to fly into outer space, the UFO is specifically designed to accelerate plant growth. Artificial sunlight inside the structure flickers on and off in 10 minute intervals during the day. Its eight windows glow in a near-dark gallery space. He further optimizes the growing environment using a special nutrient spray and specific sound frequencies within his own original sound track to enhance growth. The recycling nutrient system routinely rains on the plants as gravity assists in their growth.

ULTERIOR FARMING OPERATION

HANDS-ON FUN!

Like humans, plants have several basic needs. In addition to food, water, and light, plants need gravity in order to grow and thrive. As students will see, the roots of the plants grow down into the soil. The stems grow up towards the light.

TRY IT

Students can do an experiment to show how roots grow down toward the gravitational pull, no matter what direction they face when planted.

- Crumple 8 damp paper towels and gently put 2 paper towels in each of 4 cups.
- Put 5 bean seeds in each cup. Make sure each cup's beans point in different directions.
- Label each cup 1,2,3,4. Use a permanent marker to mark the direction the seeds are pointing when planted.
- Place in a lighted area.
- Make sure seeds are kept moist.
- Observe the growth of the roots, and record the results.

FOLLOW-UP DISCUSSION

Discuss how the beans' roots eventually grew toward the pull of gravity.
With no gravitational pull, the roots and stems grow in odd directions. Have students come up with ideas on how plants could be grown in space. What type of apparatus can be used in space to help the roots grow in the right direction? (HINT—NASA is experimenting with nets and special boxes. www.nasaexplores.com)

COMPARE & CONTRAST

Examine the two structures shown below. Use the descriptions and the definitions listed to answer the questions below.

Fuller's prototype Dymaxion House, c. 1940s, The Henry Ford Museum.

The term "Dymaxion" is used to signify a radically strong and light cell structure. Energy-efficient and low-cost, Fuller's Dymaxion House is shaped something like a space ship.

Developed in Wichita, Kansas, the house was designed to be lightweight and adapt to windy climates. It was to be inexpensive to produce and purchase, and easily assembled. The idea was for it to be manufactured using factories, workers and technologies that made World War II aircraft. It was ultramodern-looking at the time, built of metal, and sheathed in polished aluminum. The basic model enclosed 1000 square feet of floor area.
It has several innovative features, including revolving dresser drawers and a fine-mist shower that reduces water consumption. According to Fuller's biographer, Steve Crooks, the house was designed to be delivered in two cylindrical packages, with interior color panels available at local dealers. A circular structure at the top of the house was designed to rotate around a central mast to use natural winds for cooling and air circulation.

Michael Oliveri, *UFO Ulterior Farming Operation*

The primary focus of Michael Oliveri's UFO series is the tomato plant. He uses the gallery as a real time laboratory to grow tomato seeds in his elegantly designed, souped-up hydroponic system. It is specifically designed to accelerate plant growth. Artificial sunlight inside the structure flickers on and off in 10-minute intervals during the day. A special recycling nutrient spray and sound system were both scientifically devised to enhance growth.

Ecological Sustainability: To maintain a sustainable environment, nature's resources must only be used at a rate which they can be replenished naturally. Efforts to reach ecological sustainability include developing renewable resources and controlling excessive waist.

Biogenerative Support System: an ecosystem that is fully self-contained, creating an ecologically sound microcosm where each element supports and is supported by each of the others.

COMPARE & CONTRAST

- How are the two structures alike in appearance? How are they different?
- How does each structure address the issues of ecological sustainability?
- Is each an example of a biogenerative support system? Why or why not?
- How are the two structures similar and different in purpose, philosophy, use and overall design?

VOCABULARY

Atom: tiny basic building block of matter. Atoms are the smallest particles of a chemical element that still exhibit all the chemical properties unique to that element. All the material on Earth is composed of various combinations of atoms.

Biogenerative Support System: an ecosystem that is fully self-contained, creating an ecologically sound microcosm where each element supports and is supported by each of the others

Ecological Sustainability: To maintain a sustainable environment, nature's resources must only be used at a rate which they can be replenished naturally. Efforts to reach ecological sustainability include developing renewable resources and controlling excessive waist.

Fullerenes: a form of carbon consisting of up to 500 carbon atoms arranged in closed shells. The discovered form was found to have the structure of a truncated icosahedron (soccer ball) and was named Buckminsterfullerene, after American architect, author, designer, futurist, inventor, and visionary Buckminster Fuller.

Greywater: non-industrial wastewater generated from domestic processes such as dish washing, laundry and bathing; Greywater comprises 50-80% of residential wastewater.

Hydrocarbon: the simplest organic compound consisting entirely of hydrogen and carbon. The majority of hydrocarbons found naturally occur in crude oil, natural gas, and coal where decomposed organic matter provides an abundance of carbon and hydrogen. When bonded, the molecules can form limitless combinations of simple chains, branching chains, rings, or other structures. Hydrocarbons can be simple such as methane (CH_4) or highly complex like petroleum and can occur as gases, liquids, solids, or polymers like plastics and proteins.

Hydroponics: hydroponics, from the Greek "water working," is simply growing plants without soil. In traditional gardening, plants have to work to get their nutrients from the soil. With hydroponics, a nutrient solution of fertilizer and water feed the plants directly. The physiological requirements of plants can be met without the use of soil or natural sunlight, which can be successfully replaced with proper nutrients and the right artificial light source.

Innerspace: A term used by Oliveri to define his exploration of the inner spaces of atoms and molecules using a Scanning Electron Microscope (SEM).

Nanometer: a unit of length in the metric system, equal to one billionth of a meter; formerly known as millimicron. A nanometer is the most common unit used to describe the manufacturing technology used in the semiconductor industry and also to describe the wavelength of light, with visible light falling in the region of 400–700 nm. To put it into perspective, the size of a nanometer to a meter is the same as that of a marble to the planet Earth. For a real world example, the data on compact discs is stored as indentations that are approximately 100 nm deep by 500 nm wide.

Nanotechnology: a field of applied science that studies the control of matter on an atomic and molecular scale; Generally nanotechnology refers to the development, separation, and consolidation of materials 100 nanometers or smaller. Nanotechnology is a highly multidisciplinary field, drawing from a number of branches of engineering, physics, colloid sciences, chemistry, robotics, and more.

Permaculture: a system of agriculture that uses a combination of trees, bushes, perennial plants, and livestock to create a self-sustaining ecosystem. Permaculture principles stress the thoughtful designs for small-scale growing systems that do not require a great amount of man-power and use biological resources instead of fossil fuels. The term was coined by two Australians during the 1970s and is a combination of permanent agriculture as well as permanent culture.

BIBLIOGRAPHY & ADDITIONAL RESOURCES

WEBSITES & LINKS

Artist Michael Oliveri
www.michaeloliveri.com

National Science Teachers Association
www.nsta.org

Scanning Electronic Microscope
http://www.mos.org/sln/SEM/

NASA
http://science.nasa.gov

Project CENTS
state.tn.us/education/projectcents

Nanotechnology Models
www.indigo.com/models/molecular-models.htm
http://www.nyu.edu/pages/mathmol/library/carbon/
www.crnano.org/whatis.htm
http://hyperphysics.phy-astr.gsu.edu/hbase/organic/hydrocarbon.html

Hydroponics For Kids
www.growingedge.com/basics/

Universe is Finite
www.nationalgeographic.com Sean Markey, October 8, 2003.

BOOKS & PERIODICALS

Nanotechnology: A Gentle Introduction to the Next Big Idea by Mark A. Ratner and Daniel Ratner 2002

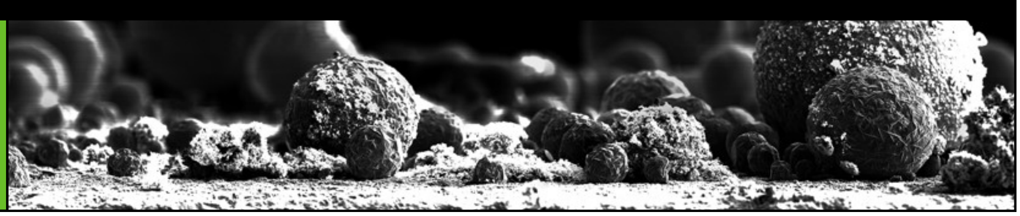
Molecular Origami: Precision Scale Models from Paper by Robert M. Hanson (Paperback - Feb 1995)

Nanotechnology is Coming by Ralph C. Merkle, Principal Fellow, Zyvex
A Hydroponic Lesson Plan by Jessica Hankinson, The Growing Edge, Vol. 11, No. 5

Hydroponics for the Home Gardener: An easy-to-follow, step-by-step guide for growing healthy vegetables, herbs and house plants without soil. (Gardening) by Stewart Kenyon and Howard M. Resh 2005

"The Hypotheses of Hope," Reviewed by Carole J Vansickle. *Practical Hydroponics & Greenhouses.* November/December 2006.

Fast Food Hydrocarbons and Waves in Outer Space, Michael Oliveri Solo Exhibition DVD. Atlanta Contemporary Art Center, June 19 –August 7, 2004.



CURRICULUM CONNECTIONS

ART

2—Structure and Function
Students will use knowledge of structures and functions
2.1 Consistently recognize and identify elements and principles of design
2.2 Use the elements and principles of art to convey ideas
2.3 Discuss the function of art in different environments
3—Evaluation
Students will choose and evaluate a range of subject matter, symbols, and ideas
3.1 Discuss subject matter, symbols, and ideas in works of art by others
4—Historical and Cultural Relationships
Students will understand the visual arts in relation to history and cultures.
4.1 Relate works of art to different times, civilizations, and places
4.2 Demonstrate how art, history, and culture influence each other; identify art created by people from a variety of cultures and historical periods; relate historical events to changes in art styles and methods; discuss connections between art, cultures, and history; Interpret the function and explore the meaning of specific art objects within a culture
4.3 Recognize how artists are influenced by culture, history, and movements in art
Identify ways in which history and culture influence the production of art
5—Reflections and Assessment
Students will reflect upon and assess the characteristics and merits of their own work and the work of others
5.1 Understand that artists create work for a variety of purposes
5.2 Discuss the characteristics and merits of their work and their work of others
5.3 Interpret different responses to artworks; Identify possible purposes intended by an artist; Utilize subject matter, symbols, and ideas to communicate meaning in their artwork; Analyze the purposes intended by the artist for works of art; Evaluate the merit of an art work based on intended criteria; Describe and interpret different ways that human experiences are reflected in contemporary and historic works of art.

SCIENCE

Life Science

Cell Structures and Functions
1. Know that all organisms are made of one or more cells.
Interactions Between Living Things and Their Environment
2. Investigate the relationships among organisms in a specific ecosystem.
Food Production and Energy for Life
3. Realize that plants and animals use food for energy.
Heredity and Reproduction
4. Investigate the life cycles of different organisms.
Earth and Space Science
Earth Features
Earth Resources
10. Recognize that earth materials have a variety of practical uses. Recognize the differences between renewable and non-renewable resources.

Physical Science

Forces and Motion
11. Recognize that gravity is the force that pulls objects toward the earth and as the force that holds the planets and their moons in orbit. Relate tidal conditions with the position of the moon.
12. Recognize that matter has predictable properties and is composed of basic units, some too small to be seen with the naked eye.
13. Describe the types of changes that result from interactions of matter.
7. Explore the role of technology and careers associated with the study of space.

PREPARING FOR YOUR VISIT

This Educator Guide was prepared with the classroom teacher in mind. We hope you will find this packet helpful as you prepare your students for their visit to Cheekwood and also when you return to the classroom.

Garden and Museum Etiquette

- Visitors are asked to stay on the paths for the protection of the plant collections and for their own safety.
- Please do not touch the plants or artwork. Stay at least an arm's length away from works of art in the Museum.
- Speak in a normal 'inside' voice. Please do not disturb other guests in the gardens or Museum by yelling or shouting to others.
- Many varieties of wildlife and insects make their homes at Cheekwood. Please do not disturb these valuable members of our ecosystem.
- Stay with your group. Cheekwood is very large, and it is easy to get distracted. We do not want anyone to get separated from their group.
- Please leave any backpacks or large purses at school or on the bus while visiting Cheekwood. Bulky objects might bump a work of art and damage it.
- Students may only use pencils in the Museum of Art.
  Pens, markers and crayons are not allowed.
- Photography is not permitted in the Museum of Art, but students are welcome to take pictures in the gardens.

CHEEKWOOD
.... art & gardens ....