Ernest E. Just Youth Marine Science Program

Increasing Interest, Confidence and Mastery of Science, Technology, Engineering and Math Disciplines for YOUTH OF COLOR

Sponsored by the American Honda Foundation/Zeta Rho Foundation
Presented by in-kind volunteers from Omega Psi Phi Fraternity, Inc.
Ernest Everett Just was a true scholar. He sought to find “truth” using scientific methods and inquiry. Although Dr. Just was bold enough to challenge the theories of leading biologists of the 19th and 20th centuries, he was humble and unassuming. Dr. Just was passionately driven to understand the world of the cell. His tenacity and motivation led him to add to our understanding of the process of artificial parthenogenesis and the physiology of cell development.

Dr. Just was born August 14, 1883 in Charleston, South Carolina. At an early age, he demonstrated a gift for academic research. For example, in 1907, he was the only person to graduate magna cum laude from Dartmouth College with a degree in zoology, special honors in botany, and history, and honors in sociology.

Immediately after graduation, Dr. Just taught at Howard University where he was appointed head of the Department of Zoology in 1912. At Howard, he also served as a professor in the medical school and head of the Department of Physiology. Dr. Just as a faculty advisor, assisted three Howard University students in the forming of Omega Psi Phi Fraternity, Inc.

The first Spingarn Medal was awarded to the reluctant and modest Just by the NAACP in 1915 for his accomplishments as a pure scientist. In 1916, Dr. Just graduated magna cum laude from the University of Chicago receiving his doctorate in experimental embryology.

Dr. Just experienced many racial injustices which caused him to move outside of the United States. Dr. Just died October 27, 1941 in Washington, D.C. In books chronicling his life, he has been referred to as the Black Appollo of Science. It is only befitting that a program targeting minority youth in the science disciplines would be named in Dr. Just’s honor.

**PROGRAM OBJECTIVES**

1. Increase Understanding of SCIENCE
2. Develop Scientific Reasoning Skills
3. Develop Practical Skills and Confidence
4. Demonstrate value of Science and Math in school and the workplace.
5. Strengthen Teamwork Skills
6. Increase Interest in STEM Disciplines
7. Increase Positive Attitudes about Science and Math

**PROGRAM RULES**

1. RESPECT for self, staff and others is required at all times.
2. Disruptive Behavior will not be tolerated.
3. No-Gum, candy or other snacks
4. No radios, iPods, electronic games or devices.
5. No Talking During Instruction.

**THIS BOOK BELONGS TO:**
Marine Mammal Background:
Whales, dolphins, seals and sea lions are marine mammals. Whales and dolphins spend their entire life in the ocean while seals and sea lions spend a lot of time out of the water on land or on buoys catching some sun to warm up. These animals are mammals, which means they breathe air with lungs, have hair or fur, and give live birth to their young that they nurse with milk produced by the mother. They are also warm blooded which means they can maintain their body temperature no matter what the temperature is of the environment. This is unlike a cold blooded animal like a snake, lizard or fish that's body temperature is the same as the environment they live in and need to seek a warmer area to warm their body up or a colder area to cool down.

Adaptations for Survival
Whales are specially adapted for their environment. To adapt means to change to be more comfortable in your environment. If you moved from California to Germany you would probably need to adapt to that environment by maybe eating different foods, wearing different clothes or speaking another language. Whales and dolphins have many physical characteristics that help them adapt to living their lives in the ocean.

Fins- Whales and dolphins have strong fins that help them swim. They have flippers at their sides that help them balance in the water when they are swimming forward and an extremely strong tail to push them forward. A whale’s tail moves up and down in the water not side to side like a fish. The fins are also shaped in a way to diminish drag and allow water to flow easily so they can get the most speed they can while swimming.

Blowhole/breathing- The blowhole is how whales and dolphins breathe. It is basically their nostrils but they have moved to the top of the head over evolutionary time to allow them to breathe at the surface without sticking their face out of the water. Because whales and dolphins are mammals and breathe air they must come to the surface to breathe but have to do it consciously (think about doing it) unlike us that do it naturally without thinking about it.

*FUN FACT: In order to sleep whales and dolphins must keep half their brain awake to remember to breathe so they “shut off” half their brain at a time to sleep and literally sleep with one eye open!

Blubber- This is a layer of fat under the skin of most marine mammals that helps to keep them warm without having a heavy fur coat like most other mammals. Whales and dolphins do have hairs but very few so as to decrease drag. Blubber also smoothes out their skin so there are not huge bumps and grooves making them more streamlined. This is similar to how surfers or swimmers wear a wetsuit to stay warm and decrease drag when swimming.

Teeth/Baleen-
Toothed Whales- These are whales like orcas (killer whales), dolphins, porpoises, and sperm whales. Toothed whales tend to be smaller and hunt other animals and eat meat. They have sharp pointed teeth for grabbing fish, octopus, squid, or even other marine mammals. Toothed whales and dolphins will usually live in a group called a pod so they can hunt together similar to wolves on land. Dolphins will work together to herd fish into big groups and then take turns swimming into the ball of fish catching as many fish as they can eat each time. Orcas will hunt for large fish like tuna or salmon but also eat seals and sea lions. They will stalk their prey like a lion and attack them quickly using their sharp teeth to grab them and kill them. You can relate dolphins and orcas to other predatory packs like lions or wolves.

Baleen Whales- These whales have very special teeth called baleen. Whales that have baleen are gray whales, blue whales, humpback whales, and fin whales amongst others. Baleen is made out of the same material as our fingernails called keratin and looks like a brush or comb growing in the front of their mouth. Instead of using their teeth to grab fish or to chew, they use their baleen to sift through the water and capture tiny shrimp like...
Whales are large, intelligent, aquatic mammals. They breathe air through blowhole(s) into lungs (unlike fish who breathe using gills). Whales have sleek, streamlined bodies that move easily through the water. They are the only mammals, other than manatees (seacows), that live their entire lives in the water, and the only mammals that have adapted to life in the open oceans.

Like all mammals:
Whales breathe air into lungs,
Whales have hair (although they have a lot less than land mammals, and have almost none as adults),
Whales are warm-blooded (they maintain a high body temperature),
Whales have mammary glands with which they nourish their young,
Whales have a four-chambered heart.

Whales range in size from the blue whale, the largest animal known to have ever existed[3] at 30 m (98 ft) and 180 tonnes (180 long tons; 200 short tons), to various pygmy species, such as the pygmy sperm whale at 3.5 m (11 ft).

NOTES:

TRANSITION FROM LAND TO SEA?

Whales are known to be descendants of land mammals via several physical characteristics: bones in their flippers which resemble the forelimbs of land mammals, vertical (up-and-down) movement of their spines which resembles a running terrestrial animal, and the fact that they must breathe air.

Cetacea is an order of mammals that includes whales, dolphins, and porpoises. Cetaceans are the descendants of terrestrial (land) animals that returned to the sea. Present classifications put cetaceans as close relatives to hippopotamus, and also somewhat closely related to ruminants such as cattle and deer.
GENERAL BACKGROUND:
All fishes are vertebrates (Subphylum Vertebrata), which means that they have a backbone. fishes are a very diverse group, but the major characteristics of fishes are that they 1) live and grow in water, 2) swim with fins, and 3) use grills for gas exchange (breathing). There are three classes of fishes; the jawless fishes, the cartilaginous fishes, and the bony fishes. As their name suggests, jawless fishes do not have lower jaws, and typically suck onto their prey using hooklike teeth. The cartilaginous fishes are the sharks and rays. They do not have a calcified bony skeleton like ours, but rather a more flexible skeleton made of cartilage, like what our ears and noses are made of. Sharks have a very large oil-filled liver that helps them to remain buoyant in the water column. The bony fishes are the most diverse and abundant class of fishes. They have a calcified bony skeleton like ours and use a special gas-filled organ, the swim bladder, for buoyancy. The more gas the fish pumps into the bladder, the more buoyant it is.

The external anatomy of a fish is very different from our own, because fishes are adapted to move and live in water, and we are adapted to live on land. Therefore, locomotion and sensory structures may look very different, although their general functions are very similar. For example, fishes have “noses” (called nares) that don’t look anything like our own, yet their purpose is to smell chemicals in the water. Likewise, the internal anatomy will look very different from our own, however, most of the major organs are the same (e.g., heart, stomach, liver, spleen) and have the same basic function. A few internal structures, like the swim bladder, are of course unique to fishes.
Salinity is the saltiness or dissolved salt content of a body of water. It is a general term used to describe the levels of different salts such as sodium chloride, magnesium and calcium sulfates, and bicarbonates.

The technical term for saltiness in the ocean is salinity. In oceanography, it has been traditional to express salinity not as percent, but as parts per thousand (‰), which is approximately grams of salt per kilogram of solution.

Marine waters are those of the ocean, another term for which is euhaline seas. The salinity of euhaline seas is 30 to 35. Brackish seas or waters have salinity in the range of 0.5 to 29 and metahaline seas from 36 to 40. These waters are all regarded as thalassic because their salinity is derived from the ocean and defined as homoiohaline if salinity does not vary much over time (essentially constant).

The Scientific Method

**Problem**
- Identify the problem (question)
- Collect information
- Form a hypothesis

**Procedure**
- Test the hypothesis
- Experimental Design

**Observations & Data**
- Make observations
- Assemble tables and graphs

**Conclusions**
- Support or reject hypothesis based on data
- Report and publish results

The Scientific Method is a way scientists answer questions and solve problems. When scientists look for answers, they mostly use the same steps. Scientific methods provide a framework for conducting careful investigations and understanding the natural world.

**Ask a Question:** The scientific method starts when you ask a question about something that you observe: How, What, When, Who, Which, Why, or Where?

**Construct a Hypothesis:** A hypothesis is an educated guess about how things work: “If _____ [I do this] _____, then _____ [this] _____ will happen.”

**Test Your Hypothesis** by Doing an Experiment: Your experiment tests whether your hypothesis is true or false.

**Analyze Your Data and Draw a Conclusion:** Once your experiment is complete, you collect your measurements and analyze them to see if your hypothesis is true or false.

**Communicate Your Results:** To complete your science fair project you will communicate your results to others in a final report and/or a display board.
Food Chain and Food Webs

Food webs illustrate the relationship between animals and what they feed on in the biotic community. Food webs also show how material and energy is transferred and lost within the ecosystem.

Each organism is a source of energy and material for another organism. The path in which biomass is moved can be illustrated in a food chain or food web. Grouping organisms into trophic levels is helpful when attempting to understand how much energy has been lost from the capture of the energy from the sun or from chemicals by primary producers. Primary producers, or autotrophs, can be any species that produce organic material from energy and/or from inorganic sources to be used by other organisms. In the deep sea, primary producers do not have access to sunlight; therefore, they utilize energy from chemicals and are called chemoautotrophs.

Microscopes are one of the vital tools that have allowed science to leap forward in many fields, biology, medicine, and anatomy, just to name a few. The microscope gives humans the ability to study the very small. This view of a realm that is beyond our vision with the naked eye enables understanding of how new drugs work, the way genes are constructed, even how atoms bind together to form larger molecules.

A light microscope works very much like a refracting telescope, but with some minor differences. A telescope must gather large amounts of light from a dim, distant object; therefore, it needs a large objective lens to gather as much light as possible and bring it to a bright focus. Because the objective lens is large, it brings the image of the object to a focus at some distance away, which is why teleopes are much longer than microscopes. The eyepiece of the telescope then magnifies that image as it brings it to your eye.

In contrast to a telescope, a microscope must gather light from a tiny area of a thin, well-illuminated specimen that is close-by. So the microscope does not need a large objective lens. Instead, the objective lens of a microscope is small and spherical, which means that it has a much shorter focal length on either side. It brings the image of the object into focus at a short distance within the microscope’s tube. The image is then magnified by a second lens, called an ocular lens or eyepiece, as it is brought to your eye.
PLANKTON - “The Wanderers”

**PLANKTON** are primarily divided into broad functional (or trophic level) groups:

**Phytoplankton (from Greek phyton, or plant)**, autotrophic, prokaryotic or eukaryotic algae that live near the water surface where there is sufficient light to support photosynthesis. Among the more important groups are the diatoms, cyanobacteria, dinoflagellates and coccolithophores.

**Zooplankton (from Greek zoon, or animal)**, small protozoans or metazoans (e.g. crustaceans and other animals) that feed on other plankton and telonemia. Some of the eggs and larvae of larger animals, such as fish, crustaceans, and annelids, are included here.

**Bacterioplankton, bacteria and archaea**, which play an important role in remineralising organic material down the water column (note that the prokaryotic phytoplankton are also bacterioplankton).

**PhytoPlankton** - *Phyto = “Light” Plankton = “Floating/Suspended”*  
Phytoplankton are microscopic plant-like organisms that live in the ocean. There are many species of phytoplankton, each of which has a characteristic shape. Phytoplankton grow abundantly in oceans around the world, and they are the foundation of the marine food chain. Small fish, and some species of whales, eat them as food. Larger fish then eat the smaller fish. Humans catch and eat many of these larger fish. Since phytoplankton depend upon certain conditions for growth, they are a good indicator of change in their environment. For these reasons, and because they also exert a global-scale influence on climate, phytoplankton are of primary interest to oceanographers and Earth scientists around the world.

The larger the world’s phytoplankton population, the more carbon dioxide gets pulled from the atmosphere, hence, the lower the average temperature due to lower volumes of this greenhouse gas. Scientists have found that a given population of phytoplankton can double its numbers on the order of once per day. In other words, phytoplankton respond very rapidly to changes in their environment. Large populations of this organism, sustained over long periods of time, could significantly lower atmospheric carbon dioxide levels and, in turn, lower average temperatures. Populations of this marine plant will grow or diminish rapidly in response to changes in its environment. Changes in the trends for a given phytoplankton population—such as its density, areal distribution, and rate of population growth or diminishment—will alert Earth scientists that environmental conditions are changing there.
What is an ecosystem? An ecosystem is a unit of the environment in which living and nonliving components interact. Bolsa Chica may be called an ecosystem where saltwater from the ocean and freshwater from land meet and mix. A clear understanding of the nature of the interactions between living things and nonliving things at Bolsa Chica would be very helpful in determining how best to protect it and maintain it in the future.

The prominent nonliving parts of the Bolsa Chica are the sun, saltwater, freshwater, air and mud. The mud is composed of detritus, or decomposed organic matter, and soil carried into the marsh by rainfall draining off the upland slopes.

The living parts of the marsh include birds, fish, invertebrates, and plants (including plankton). Of these components, the plants are the most important to the ecosystem. They are called the primary producers because they can make their own food from carbon dioxide and water, using the sun’s energy. This process is called photosynthesis, and it is essential to the continued existence of the marsh. One important by-product of photosynthesis is oxygen.
**Bolsa Chica : A Tidal Salt Marsh**

What is a tidal salt marsh? It is a community of plants and animals that are tolerant of wet, saline conditions. This community is a transition between land and ocean systems, and thus contains aspects of both. The soil is saturated with water or covered by shallow water, and this water has a salinity level generally between that of freshwater and saltwater. The level of the water in a tidal salt marsh fluctuates daily due to tidal action.

The tidal salt marsh has a complex zonation of plants and animals. The lower and upper limits of the marsh are set by the tide range: the high marsh is flooded irregularly and the low marsh (including mudflats) is flooded at least daily. Narrow subtidal channels serve as conduits between the salt marsh and the adjacent ocean. Each of these zones is a distinct habitat favored by different groups of plants and animals.

Bolsa Chica is dominated by the high marsh, but it also has extensive mudflats, with some channels and open water. Another habitat found at the Bolsa Chica is the salt flat. The salt flats have no vegetation, and contain water only after rains. These interim ponds are quite salty and support many insect larvae. Shorebirds can feed on these larvae without competition from fish.

**Zonation** depends on several factors: two important ones are salinity and nutrient availability. Salinity changes depending on these conditions:

a. frequency of tidal inundation  
b. rainfall  
c. tidal creeks and drainage  
d. soil texture  
e. vegetation  
f. depth of water table  
g. freshwater inflow

**Pickleweed** species belong to the Goosefoot family (Chenopodiaceae) which includes sugar beets and spinach. Salicornia virginica is a California native species of pickleweed. It has many common names including turtleweed, glasswort, saltwort, Virginia pickleweed, sampfire, and sea asparagus. The name ‘pickleweed’ comes from the pickle-like appearance of its stem segments and its salty taste. It is a halophyte commonly found in estuaries and bays where there is protection from wave action. It is often said that pickleweed can survive under conditions that no other salt tolerant plant is able to.
California Least Terns are in the gull family, Laridae. The smallest of the North American terns, they are migratory seabirds that breed primarily along the California coast. Their swallow-like flight gave them their earlier common name, Sea Sparrows. Their flight is very light, graceful, and buoyant. When it increases in speed, their wing beats are so rapid they cannot be counted, in contrast to the slower ones of larger terns that can be.

The Great Blue Heron is the best known and most widely distributed of all North American herons. These large gray-blue birds with their long legs, necks, and bills are familiar sights throughout many parts of the United States as they stand silently and majestically in shallow water poised to launch at unsuspecting prey, or fly overhead with neck curled over their shoulders, long legs extended, and widespread wings slowly and gracefully beating.

California Brown Pelican Of the seven or eight species of Pelicans found worldwide, two are native to North America—the marine Brown Pelican, Pelecanus occidentalis, and the fresh water White Pelican, (Pelecanus erythrorhynchos). The California Brown Pelican, a subspecies of P. occidentalis, is the smallest member of the pelican family. It is easily recognizable because of its famous pouched bill that inspired the limerick: that begins: “A wonderful bird is the pelican. His bill will hold more than his belican”. The limerick is true. A pelican’s pouch will hold 11 l (3 gal) of water and his stomach only 3.8 l (1 gal). Highly social and gregarious, pelicans rest, roost, and nest in colonies.
WHAT IS SCIENCE?
Science is the systematic study of all of nature, from particles too small to see to the human body to the entire universe. Since no individual can study all of nature, science is divided into different fields. All the different science fields can be grouped in three broad categories: Life science, physical science and earth science.

• **LIFE SCIENCE** - focuses on the study of living things. (Biology, Botany, Ecology, Zoology and Human Biology)
• **PHYSICAL SCIENCE** - focuses on the study of what things are made of and how they change. (Chemistry and Physics)
• **EARTH SCIENCE** - focuses on the study of our planet and its place in the universe. (Geology, Oceanography, Meteorology, Astronomy)

Introduction to the Invertebrates

An invertebrate is any animal without a backbone. Invertebrates make up 95% of all species of animals on the earth, and the variety of invertebrates is enormous. Scientists group or “classify” all of these different types of animals into broad categories called phyla, on the basis of their patterns of symmetry and on the basis of their overall body plan. There are 6 particularly important invertebrate phyla (and another 23 or so less important phyla). The major invertebrate groups are classified as:

- Phylum Porifera: sponges
- Phylum Cnidaria: sea anemones, corals, and jellyfish
- Phylum Annelida: segmented worms
- Phylum Mollusca: clams, snails, and squids
- Phylum Arthropoda: lobsters, beetles, crabs, and flies and scorpions
- Phylum Echinodermata: sea urchins, sea cucumbers, and starfish

LIFE SCIENCE BASICS:

Cells - The basic unit of life is the cell. All living things have cells. It is the smallest unit of life that is classified as a living thing, and is often called the building block of life.

Organism - All living things, whether they have one or many cells are described as an organism. All organisms are classified by:

- Organization - the way the organism’s body is arranged.
- Growth - the way the organism grows and develops over its lifetime.
- Reproduction - the way an organism produces offspring.
- Response - the way an organism interacts with its surroundings.

ALL LIVING THINGS HAVE THE FOLLOWING CHARACTERISTICS:
1. Organization
2. Ability to grow and develop
3. Ability to respond to environment
4. Ability to reproduce
Kayaking

Snorkeling

**Extinction**
Extinction is the end of an organism or group of taxa. The moment of extinction is generally considered to be the death of the last individual of that species (although the capacity to breed and recover may have been lost before this point). Because a species’ potential range may be very large, determining this moment is difficult, and is usually done retrospectively. This difficulty leads to phenomena such as Lazarus taxa, where a species presumed extinct abruptly “re-appears” (typically in the fossil record) after a period of apparent absence. Through evolution, new species arise through the process of speciation—where new varieties of organisms arise and thrive when they are able to find and exploit an ecological niche—and species become extinct when they are no longer able to survive in changing conditions or against superior competition. A typical species becomes extinct within 10 million years of its first appearance,[2] although some species, called living fossils, survive virtually unchanged for hundreds of millions of years. Extinction, though, is usually a natural phenomenon; it is estimated that 99.9% of all species that have ever lived are now extinct.

**A Brief Introduction to Sampling**
Researchers usually cannot make direct observations of every individual in the population they are studying. Instead, they collect data from a subset of individuals – a sample – and use those observations to make inferences about the entire population. Ideally, the sample corresponds to the larger population on the characteristic(s) of interest. In that case, the researcher’s conclusions from the sample are probably applicable to the entire population.

**The USC Catalina Hyperbaric Chamber**
Located on the campus of the USC Wrigley Marine Science Center at Big Fisherman Cove at the West End of Catalina Island, is an emergency medical facility for the treatment of scuba diving accidents. Without proper treatment, major problems from diving accidents, most commonly Decompression Sickness (the “Bends”) and Air Embolism, can lead to permanent disabling injuries and in some instances be fatal. In the Southern California area around Catalina Island, the combination of effective on-site management of a diving accident along with the rapid response by Los Angeles County Baywatch Lifeguards, or the U.S. Coast Guard, and swift, effective treatment at the Chamber can save a diver’s life.

**Snorkeling**
Snorkeling is the practice of swimming on or through a body of water while equipped with a diving mask, a shaped tube called a snorkel, and usually swimfins. In cooler waters, a wetsuit may also be worn. Use of this equipment allows the snorkeler to observe underwater attractions for extended periods of time with relatively little effort.
Engineering is the discipline, art, skill and profession of acquiring and applying scientific, mathematical, economic, social, and practical knowledge, in order to design and build structures, machines, devices, systems, materials and processes. http://en.wikipedia.org/wiki/File:All_Gizah_Pyramids-3.jpg

The Pharos of Alexandria, the pyramids in Egypt, the Hanging Gardens of Babylon, the Acropolis and the Parthenon in Greece, the Roman aqueducts, Via Appia and the Colosseum, Teotihuacán and the cities and pyramids of the Mayan, Inca and Aztec Empires, the Great Wall of China, the Brihadeshwara temple of Tanjavur and tombs of India, among many others, stand as a testament to the ingenuity and skill of the ancient civil and military engineers.

The earliest civil engineer known by name is Imhotep. As one of the officials of the Pharaoh, Djosèr, he probably designed and supervised the construction of the Pyramid of Djoser (the Step Pyramid) at Saqqara in Egypt around 2630-2611 BC. He may also have been responsible for the first known use of columns in architecture.

Ancient Greece developed machines in both the civilian and military domains. The Antikythera mechanism, the first known mechanical computer, and the mechanical inventions of Archimedes are examples of early mechanical engineering. Some of Archimedes’ inventions as well as the Antikythera mechanism required sophisticated knowledge of differential gearing or epicyclic gearing, two key principles in machine theory that helped design the gear trains of the Industrial revolution, and are still widely used today in diverse fields such as robotics and automotive engineering.

Architecture is both the process and product of planning, designing and construction. Architectural works, in the material form of buildings, are often perceived as cultural symbols and as works of art. Historical civilizations are often identified with their surviving architectural achievements.

Building first evolved out of the dynamics between needs (shelter, security, worship, etc.) and means (available building materials and attendant skills). As human cultures developed and knowledge began to be formalized through oral traditions and practices, building became a craft, and “architecture” is the name given to the most highly formalized and respected versions of that craft.

In many ancient civilizations, such as that of Egypt and Mesopotamia, architecture and urbanism reflected the constant engagement with the divine and the supernatural, and many ancient cultures resorted to monumentality in architecture to represent symbolically the political power of the ruler, the ruling elite, or the state itself.

With the emerging knowledge in scientific fields and the rise of new materials and technology, architecture and engineering began to separate, and the architect began to concentrate on aesthetics and the humanist aspects, often at the expense of technical aspects of building design.

What are similarities between Architecture & Engineering? ____________________________________________________
_____________________________________________________________________________________________________
_____________________________________________________________________________________________________

What are differences between Architecture and Engineering? ____________________________________________________
_____________________________________________________________________________________________________
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PROGRAM SPONSORS

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