

## **Getting STEAMED Up About Animal Adaptations**

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### **Unit Description**

After an introduction to organisms, biomes, adaptations and aquatic environments with emphasis on the Inland Bay ecosystem, students will research adaptations in animals and learn about art illustration. They will use their research and creativity to create their own “new and improved” (as in better able to adapt and ultimately survive) animals in colored pencil, watercolors, acrylic paint, pastels, ink/pen, or mixed media. This unit can be used in any class at any grade level where animal adaptations will be studied and creativity is valued. Since there is a natural connection between the arts and science, technology and math, this unit will add the A (for the arts) to STEM, making it STEAM driven. Upon completion, the artwork, along with each student’s written/typed explanation of the behavioral, morphological and physiological adaptations, will be displayed in an art exhibit.

### **Introduction**

This unit is the direct result of active participation in University of Delaware’s Associate Professor of Biology Dr. John Bartley’s seminar *Organisms- Adaptations for Survival in Aquatic Environments*. This course is one of four offered in 2015 by the Delaware Teachers Institute in partnership with the University of Delaware. One of the many strengths of DTI (Delaware Teachers Institute) is the diversity of the public school teacher participants. They are from four different districts, different grade levels and various disciplines. The content and ideas shared between the teacher participants and the University of Delaware leaders/professors create an optimal educational experience and strong, creative in-depth units.

I am one of three art teachers at Newark High School and my plan is to teach my unit in three of my current classes at Newark High School. Of these classes, my Advanced Drawing class is an upper level course consisting of mainly 11<sup>th</sup> and 12<sup>th</sup> graders. My two Art Fundamentals classes are introductory courses and consist mainly of 9<sup>th</sup> graders. These classes range in numbers from 15 to 35 students. Newark High School is a Title 1 school with a population of over 1400 students. Over 60% of the students are considered minority, over 30% are rated as low income and approximately 14% are classified as special education students. Newark has an A/B rotating block schedule and the classes are hour and a half blocks. My students reflect our school’s diverse population.

I have discussed our school’s science curriculum with our science department teachers to find out what and in which specific classes and grade levels our students have been

taught about animal adaptations and the related topics that I wish to cover. I hope to work with those science teachers on our staff who teach classes that include animal adaptations in their curriculum.

Christina School District hosts an annual STEM expo and the organizers have asked for contributions from the visual and performing arts. As an arts advocate, I have joined other art educators who are trying to put the Arts in STEM to change it to STEAM. Not only will the students' illustrations along with their explanations and research be displayed at Newark High School, but they will also be exhibited in a total environment area at the Expo. Newark has a large dedicated art gallery. For both openings, students will be urged to be on hand to offer explanations about their work.

## **Objectives**

Student learning will include knowledge about organisms, biomes, adaptations and aquatic environments with emphasis on the Inland Bay ecosystem. They will research fish adaptations in particular and be able to recognize and differentiate between morphological, physiological and behavioral adaptations. Students should become more aware of environmental issues and hopefully develop more of a sense of responsibility for the environment. As a class, students will successfully research in a school computer lab material that they will need to create their own creatures with adaptations or enhance existing animals. They will make a series of sketches to generate and develop ideas before starting on their final designs.

Types and purposes of illustrations along with famous illustrators will be discussed. Students will become aware of career opportunities in illustration. After teacher demonstrations and student experimentation with various techniques and media on a variety of surfaces, students will then select the medium or media and surface desired for their drawings or paintings. For example, for the Design-a-Fish activity, an appropriate medium might be watercolor with its fluid color and lines. The technique of using salt to create interesting crystal textures in the watercolor can be used.

Also among the unit objectives will be the appropriate presentation of their art. Students will learn how to prepare their work for display and hang it themselves but also as part of a group so that the body of work will form a cohesive whole in the Gallery of Newark High School. Included in their presentations will be signage, name tags and accompanying text explaining their creations. They will also work together to create invitations for the opening of the exhibit. Using the established system in place for critiquing art, they should be able to effectively use the elements of art and principles of design to successfully analyze and critique their own art and that of their peers.

## **Content**

As Dr. Bartley has explained in our seminar, in the last hundred years the human population on earth has exploded in numbers and stressed many of our surrounding environments. These environmental changes have occurred more quickly than the organisms' ability to adjust. Some animals have been greatly reduced in number, endangering some and causing others to go extinct.

The arrangement of topics in our seminar has helped me understand the material so I plan to introduce the material in much the same way to my students. I checked with our science teachers and our students learn about animal adaptations at Newark High School in the 10<sup>th</sup> grade. Since my students range from 9<sup>th</sup> to 12<sup>th</sup> graders, I will explain that for some part of the material will be a review for them and for others it will be new. All should learn information and hopefully become better preservers of the environment. The 10<sup>th</sup> graders in science do not use a textbook for the exploration of adaptations but instead use instructional units from *Nature of Science and Evolution* from a fat science binder provided by the Delaware Department of Education. One of the units is devoted to whales. Included in this illuminating section is the evolution of whales, the role that fossils play in helping to understand how changes occur over time, and traits that make whales mammals and unique characteristics that whales do not share with other mammals. For example, these characteristics include, "A whale's tail has horizontal flukes, which are its sole means of propulsion through water. The dorsal fin is stiffened by connective tissue, but it is fleshy and entirely without supporting tissue..." and "The nasal openings have moved to the top of the skull, creating blowholes." (1)

In seminar, two of the first videos that we were assigned to watch were shorts on the mudskipper. Since it worked so well with us, I plan to start my unit with showing both in my classes. The first one will be to get the students' attention. It starts documentary-style with a narrative of, "A mudskipper is a fish that spends most of its life out of the sea. It can walk on land and breathe air. (2) Then the mudskipper screaming starts. Viewers' jaws drop and then laughter begins as the realization hits that the video has been manipulated. The second video is more informative (though not as humorous) and explains some of the highly unusual and specialized adaptations of these creatures. Mudskippers breathe through their skin and store water in their gills and have eyes on the top of their heads. They can swim, hop, climb trees, burrow, and use their mouths as shovels. The burrows keep their bodies cool. Front fins are used for "walking." Their lives revolve around their burrows in the mud into which they slip when confronted by predators. They pop out for foraging and when rival males approach, they warn them off with a spiny dorsal fin display. (3) After watching, the students will be asked to name some of the adaptations just viewed and discussion will follow.

To determine background knowledge, an ungraded pre-test can be given to determine previous student knowledge about biomes and basic unit terms such as organisms, environment, ecology, and habitat. Then a power point will be shown highlighting the specifics of the tundra, taiga (boreal forest), temperate deciduous hardwood forest,

grasslands, tropical rain forests and desert biomes. Students will learn how temperatures, rainfall, soils, and length of growing season affect species diversity and specialization. For example, the tropical rain forest with its plentiful rainfall and high temperatures has the highest species diversity with highly specialized animals but it is coupled with poor soil. When the vegetation is stripped, the growth cannot be replaced to become rainforest again.

Each biome has animals that have adapted for successful living in their specific environments. As Dr. Bartley pointed out in seminar, multiple factors influence climate and the creation of biomes that range from the directness of the sun's rays (energy to surface) to seasons altered by Earth's tilt on its axis and wind patterns that are affected by the Earth's spin, geology and temperatures. Handouts will be given to the students with general terms and information about climate and biomes.

In his seminar description, Dr. Bartley explains:

“Organisms possess adaptations that have been molded by natural selection over long periods of time. In a sense, natural selection is a negative process since it reduces the reproductive opportunities for organisms that do not possess adaptations that are a proper “fit” for a set of environmental conditions. This process can make it difficult for an organism to find a mate, or it may eliminate it from the population entirely by making it more susceptible to disease or predation.” (4)

As background, the controversial Gaia Hypothesis will be briefly discussed. Developed by James Lovelock in the 1960s, it proposes that the earth functions as a single organism that maintains the conditions necessary for its survival. Lovelock defined Gaia as, “...a complex entity involving Earth's biosphere, atmosphere, oceans, and soil; the totality constituting a feedback or cybernetic system which seeks an optimal physical and chemical environment for life on this planet.” (5)

The effects of global warming on the environment will be discussed. Regardless of one's position on global warming, the melting of ice in certain parts of the world is a harsh reality. In an online article from The New York Times on the melting of ice in Greenland, Coral Davenport and the other three authors report about a small team of scientists camping on the Greenland ice collecting data for the first comprehensive study that actually measures the rate of melting. Referring to team member Brandon Overstreet the authors write, “The scientific data that he and a team of six other researchers collect here could yield groundbreaking information on the rate at which the melting of the Greenland ice sheet, one of the biggest and fastest-melting chunks of ice on Earth, will drive up sea levels in the coming decades. The full melting of Greenland's ice sheet could increase sea levels by about 20 feet.” (6) The authors report that one of the scientists stated that to know what is really happening, data had to be collected first hand so they planned this trip to do exactly that. The online video clip of one of the raging rivers makes quite an impact on the viewer. The authors continue with, “Scientists know that

**the melting of Greenland is accelerating.** As the temperature rises, large lakes form on the surface of the ice, which in turn create a network of rivers... The Rivers then flow down into great holes called **moulins**, which drain through tunnels in the ice sheet and out into the ocean.” (7) In the article scientist Dr. Laurence Smith is quoted as saying, “**The rivers melt down faster than the surrounding ice**, like a knife through butter,...” and “**The ice sheet is porous**, like Swiss cheese,”... “We didn’t know that until this year.” (8) It will be interesting to follow up on their conclusions from this study.

As discussed in seminar, adaptations are genetic and can be morphological, physiological or behavioral. Morphological adaptations, or traits, deal with body form. Adaptations include horns, claws, tails, and shells. Physiological adaptations are chemical or metabolic. Metabolic refers to how fast a body uses energy. For example, a hummingbird has a fast metabolic rate and a snake has a slow one. Adaptions that are behavioral deal with how an organism acts. Examples include flocks, herds and schools. An example discussed in seminar was the rattlesnake. A rattlesnake’s morphological adaptations include rattles to scare off predators, shedding, hollow fangs that are curved and can retract, a jaw that unhinges for swallowing creatures larger than its mouth, and camouflage coloring for stealth with prey and for hiding from predators. Physiological adaptations include slow digestion (needs to be warm enough to digest food), venom and shedding. Behavioral adaptations include strikes and coils (coiling its body gives it striking momentum). There are foreign proteins in venom. The venom in some snakes can have both neurotoxins and blood coagulants. Adaptations can fall into more than one category and often coevolve to make each one more effective, for example, venom injected through hollow fangs.

Dr. Bartley explained that if a human wants to acclimate when it is cold, the human can put on a coat. If no extra clothes are available, shivering can generate some heat from the muscles. Goosebumps are a relic of fluffing fur.

Denny and McFadzean in their book, *Engineering Animals*, write that there are five basic body types for fish (with subdivisions). They explain that, “Predators divide into chasers (e.g., tuna: fast moving and therefore streamlined, often large and usually with a forked tail) and ambushers (e.g., pike: large mouth and with fins concentrated at the back to facilitate rapid acceleration). The surface fish (e.g., Guppies) are small, with upward-pointing mouths. Bottom feeders (e.g., flounder) have flattened bodies and small eyes. Deep-bodied fish (e.g., sunfish) are compressed laterally and usually have big fins and large eyes. Eel-like fish are elongated like a rope or ribbon, with blunt heads that conform to the body cross-section.” (9)

In class we talked about how all the continents, once attached, were called Pangaea. Once the continental masses separated, the organisms were separated also and they started to evolve independently to better fit in their niches. Form and function drive evolution. For example, Australia is loaded with oddball animals like marsupials. South

America has 7 species of marsupials and there are none in Europe. In North America opossums have adapted for survival. They can eat practically anything (within reason) and have developed handy tails. When humans showed up on the map, usually large predators disappeared. Creatures with placentas like humans drummed most of the marsupials into extinction.

Another illuminating example we discussed in seminar involved the close genetic similarity of the jaguar in South America and the leopard in Africa. After the land masses separated into continents, the jaguar became shorter, stockier and more muscular to fit into its environment. As Africa became drier and hotter, its counterpart, the leopard, had to adapt to the Serengeti by becoming taller and leaner so that it could run down prey.

Fish were also affected by the breaking up of the land masses and became much more diverse. Denny and McFadzean write, "The smaller continents created increased coastline length and therefore increased littoral regions and shallow continental shelves. These regions are rich in nutrients and also are bathed in sunlight, and so they are very rich in biomass. The number of fish, and the number of fish species, grew astronomically as a consequence of increased coastlines." (10) They add, "Before Pangaea split up, most of Earth's surface was deep sea, and so predators and their prey had to be swift. Afterward, the shallow seas provided coral reefs, seaweed beds, and other nooks and crannies to hide in, so fish became smaller to exploit these new habitats; they and their predators needed maneuverability rather than raw speed, and so fins were redistributed. Spininess is another method of self-defense when speed is taken away." (11)

The Dorling Kindersley Eyewitness Book on fish has beautiful and colorful illustrations. Author Steve Parker writes about color, "Color can camouflage a fish from both predator and prey: smooth silvery greens, blues, and browns camouflage some species in open water; a riot of reds, yellows and blues conceals others among ... colors of the coral reef. Spots, stripes, and patches "disrupt" or break up a fish's outline, confusing predators." (12) He provides hundreds of examples of specialized adaptations. Parker added about the more muted colored fish from cooler waters, "Many that swim near the surface have "countershading": a darker back and pale belly. Light from above brightens the fish's back and shadows its undersurface- and so the fish "disappears" into the surrounding water." (13) He includes how shapes help fish like the John Dory which, when seen from the front, is narrow and difficult to see and he writes that to hide, shrimpfishes, "...swim vertically among sea urchin spines. The narrow shape and black body strip provide fine camouflage." (14) When viewed from the front, the Dory can barely be seen.

Helfman and Colette in *Fishes: The Animal Answer Guide*, comment on factors that are responsible for the variety of fish colors and patterns. They explain that so many fish are silver because, "Silvery sides make a fish invisible, usually. Silvery, or mirror-sided, fishes disappear into the background under natural lighting... Even the most colorful

fishes by day turn relatively dull or blotchy at night. This day-night difference occurs in just about every habitat.” (15) Usually fish do not want to be seen by predators and prey. However, Helfman and Colette explain that, “...there are times when fish want to be seen, such as during mating or when fighting over territories. These interactions usually occur when fishes are near each other, and again their coloration takes advantage of the peculiarities of underwater light. Many fishes can turn their colors on and off.” (16) They continue with, “Colorful reef fishes often superimpose bright colors over a countershaded body, and then change color patterns depending on whether they are engaged in social interactions or avoiding predators. Hence, butterfly fishes... can be bright or countershaded, and the change can occur in seconds...Most conspicuous colors, especially the longer wavelengths near the red end of the spectrum, are only visible at short distances or in shallow water.” (17)

Who would have thought that I would be unable to put down Helfman and Collette’s *Fishes: The Animal Answer Guide*? I ended up reading the entire book because each section was so interesting. In their section on why fish form schools, they explain that fish usually form schools so that they do not become food and that even predators who are loners group with others when small to avoid being eaten. They write, “Little fish have many more enemies than big fish because so many more predators can catch and eat them. When they are larger, they are too fast or big to swallow.” (18) They explain that “So fish that are vulnerable because of their size, location in the water column, closeness to cover, and kind of activity all group together and coordinate their movements when predators threaten. They also add that two reasons explain why being in a group decreases the chances to be eaten. First is the “many eyes effect.” (19) The phrase is self-explanatory in that many members of the group are on the look-out for predators and the whole group responds when danger is perceived. The authors also write, “Because most predatory fish need to surprise their prey to be successful, many watchful eyes reduce the likelihood that predators can sneak up on potential victims. The second, and ultimate, reason schooling works is because predators, especially other fishes but also squids and birds, get confused when attacking large groups of fish.” (20)

For homework on adaptations in seminar, each of us researched and selected for the next meeting an animal or plant and listed two or more adaptations for the morphological, physiological and behavioral traits for our animal. Since my students are going to be designing their own fish with adaptations to their environment, I want them to engage in a broader exercise in which they can research any organism, not just fish. Dr. Bartley said that plant behavioral adaptations were challenging unless we picked the Venus flytrap. That was enough of a warning for me so I selected and enjoyed researching the fascinating walking stick. This activity is included in Lesson Plan 1 below. However, instead of being a homework assignment, I will take my students to a computer lab and it will be a class activity. That will ensure that all class members participate. If your students are like mine, they do not all turn in every homework assignment.

In seminar we talked a lot about genetics. There is so much amazing material on genetics that it is difficult to decide what to include. Since I am teaching my unit in a more limited time to art students, I thought that I could introduce genetics by trying some of the exercises that we tried in seminar involving so-called “useless” genes. Students love hands-on activities so these exercises should grab their attention. In seminar each of us clasped our own hands together and then were asked if our right or left thumb was on top. Since I am left handed, I presumed that was the reason that my left thumb was on top. Dr. Bartley explained that left-handedness is not the cause. It is all determined by genetics. He had us cross our fingers the opposite way and the unnaturalness of it was startling. Students can also see if they have a “hitchhiker’s thumb” (a thumb that curves in a backward arch) or witches’ fingers (fingers that bend at the end joints while the rest of the fingers remain extended straight) or attached earlobes or unattached earlobes. All of these characteristics are caused by recessive or dominant genes and they do not make us more functional in our environment. While students may consider having additional space for earrings on unattached earlobes as necessary, it is really purely ornamental.

Following these entertaining exercises on ‘useless’ genes, a brief background on genetics can be introduced. It can include a mention of “Lucy” whom we discussed in seminar. She was a partial skeleton discovered in Ethiopia in 1974 that rocked the world for multiple reasons including her age (around three million years old), a skull of small size (akin to those of apes) and skeletal evidence of the ability to walk with a human gait. An explanation can follow of why there are more fossils of certain organisms such as mollusks than mammals such as humans. Mollusks die and are covered in sediment, get compressed and mineralized over time and get fossilized. If people died on the grasslands before burial rituals were developed, then their remains were eaten and the bones scattered and lost. There would be no evidence left, making it more difficult to track the course of adaptations made over the centuries. Lucy “survived” because she was in water and was covered by sediments, protecting her from predators. Her fossilized bones were eventually uncovered again through erosion.

A discussion of genetics can include the founder effect that deals with the mutation of a set of genes that is neutral or does no harm. An example would be the 6-toed cat that supposedly arrived on the Mayflower. That characteristic is dominant so in the small population of cats in New England, there is a larger population of 6-toed cats than in most other places. One of those cats made it down to Assateague Island since there is also a pocket of 6-toed cats down there.

### **Teaching Strategies**

To address different learning styles, increase comprehension and maintain interest, a variety of teaching strategies will be employed throughout this unit. Since I teach art, the majority of my students are visual learners versus audio or kinesthetic learners. I employ a lot of visuals to ensure understanding but I make sure that I incorporate activities that



will stimulate audio and kinesthetic learners also. Not only will written texts be used but also short videos will be shown. A great example of one of the videos is a 5-minute Ted Talk video that shows amazing footage on bioluminescence along with adaptations used for camouflage for some animals like the octopus and cuttlefish. In the video they are shown blending in so well that the observer would never know that they were there hiding from predators or waiting to capture lunch passing by if the videographers had not captured them moving. It is amazing at how quickly some of these animals can change color to match the coral on which they choose to hide (in plain sight) or squeeze into a small hiding place. There is also amusing footage on coloration and mating which is appropriate for even the youngest of students. (21)

Newark High School is the home of the Yellow Jackets. To maximize instructional time, teachers are encouraged every day to have an opening activity called a “stinger” for students to do while attendance is being taken. An example of a stinger would be the display of a photo of an animal with the request to name/guess a morphological, physiological and behavioral adaptation with a reminder not to sneak looks at a cell phone for answers. I would include the definitions of the terms by the photo on the board or slide.

The jigsaw activity is a cooperative learning method for covering more material in a shorter amount of time. The class will be broken down by tables into groups. Each group will be responsible for a different article that they will read and then summarize for the rest of the class. The articles will be on a range of subjects from “*Seeking Mates, Fish Switch Sex*” (22) and *Jersey Shore Oyster Industry Growing Again*” (23) to “*Coydogs and Lynxcats and Pizzlies, Oh My*” (24) and a *Study: Bumblebees Feeling Climate Sting.*” (25). You can tailor your selection of articles to whatever you think will enhance student learning for your unit.

Another strategy is using “Think Pair Share” which can be used with pairs or small groups of students. The students study a problem or read an article and discuss it together. Then they share the highlights with the class.

Since I have class valedictorians in classes sitting next to special education students, I provide resources for different levels of learners. Through the state public library system, books can be obtained from any of the linked libraries. The libraries have delighted books for elementary students such as *Claws, Coats, and Camouflage-The Ways Animals Fit into their World* that has sections with plentiful photos on Adaptation, Fitting In, Staying Safe, Getting Food and Making a New Generation. (26) Other books have the same information but in much greater scientific depth. In *Fishes-The Animal Answer Guide*, the authors write, “Surprisingly, silvery fishes are silver in order to be invisible...The sum of all this reflected light is that mirror-sided fish is the same as a mirror hung in the water, reflecting light that exactly matches the light behind it. As a consequence, the fish looks just like the water background: it disappears.” (27)

One of the students in our DTI seminar wrote a unit on “icky” or useless organisms. Using a roundtable approach, we can go around the room and the students can, “off the top of their heads,” name an animal that they think is abhorrent. When we tried this in seminar, our answers included maggots, head lice, wasps’ eggs laid in caterpillars that eat the caterpillars alive from the inside, mice, spiders and other animals. Following that we can discuss if these animals really are useless. What niche does each fill?

There are three activities included in this unit. In preparation for the art media experimentation activity, students will (hopefully) bring in a book that contains some of their favorite illustrations. I will contribute the children’s book *Just a Dream* by two-time Caldecott Medalist illustrator Chris van Allsburg. Not only does it display van Allsburg’s distinctive shading style but the book’s topic reinforces the content of this unit. It is a story about Walter, a youngster who is a litterbug who does not appreciate the environment until a dream of a trashed future awakens his desire to be more environmentally responsible. (28) Chris van Allsburg illustrates with his trademark smooth shading style. Most of his books are drawn in pencil but his colorful but dark *The Polar Express* is one of the exceptions. I will also bring in his *Jumanji* about a board game that comes to life. (29) Besides appreciating the beautiful illustrations, perhaps the book will impress upon my students the importance of reading directions. The children in the book have to go back and read the directions on the box to stop the destruction caused by the creatures that pop out of the board game.

I anticipate that most of my students will choose some medium for their Design a Fish activity that will let them be expressive with color. If they so choose, however, they can just use pencil or charcoal. I anticipate that only one or two of my advanced Drawing students who are most comfortable with pencil will forgo color. We will discuss the styles and media that illustrators choose in the books that students bring in. I will make sure that I have books illustrated with watercolor, pen and ink, oil and soft pastels, acrylics and oils and those that include prints and also those that represent a range of time periods and styles. I will create and show a power point that will highlight some of these artists and styles through history. My own children and I have childhood favorites plus I searched online for various lists of top children’s illustrators, top illustrators in general, Caldecott winners, popular illustrators of fish, and others. There are so many wonderful selections that choosing ones for class will be difficult.

Besides children’s books, illustrators create images for a variety of purposes for people of all ages. Norman Rockwell was a famous American illustrator who created idyllic and inspirational scenes of America life that were featured on The Saturday Evening Post magazine covers. (30) Charles Schultz is one of many cartoonists with his long-running *Peanuts* strip. (31) Hans Rudolf Geiger has created unsettling Surrealistic illustrations of dark creatures that attracted the attention of film producer Ridley Scott. To see some of his creations realized, watch the film *Alien*. Do not show this R-rated film if

you want to keep your job but you can show sketches or photos from it. (32) Springing from Michael Kutsche's fertile imagination are sophisticated characters for film wizard Tim Burton's *Alice in Wonderland*. (33) There are also artists like Diane Rome Peebles, biological illustrator, who has created quite a name for herself with her realistic fish illustrations for a series of guides for different regions of the country and books. (34) Meilo So creates posters of types of fish. (35) Some artists are not illustrators but feature marine scenes or fish such as Joe Tomelleri (36) and Don Ray. (37) The world famous mural artist Wyland has a mural in downtown Wilmington that features whales. (38)

On his website Vladimir Stankovic writes, "I am Vladimir Stankovic, an illustrator/graphic designer/artist living in Odense, Denmark. In my work I try to combine my love and passion towards illustration and graphic design, with the use of both traditional and digital media. My inspiration comes from science and nature on one hand, and fantasy, fairy tales and all sorts of mysteries on the other." (39) I want students to look at his work because of the clever way that that he combines two organisms together into one. He also captures the antique look of illustrations from the past and adds his own modern slant.

In past centuries hand-drawn or painted illustrations were a staple. Now, with the advent of photography, many illustrations are now photos (made even easier and more accessible with digital photography). However, hand-drawn or painted illustrations are still in demand. Just check on the web and look in current books and at games and look at the number of colleges and art schools that offer illustration majors.)

The third lesson plan included in this unit is Design-a-Fish. After looking online, I determined that Design-a-Fish is not a copyrighted term since it shows up on so many sites and no one claims the name as their own. An activity that could take place before that lesson could involve taking students to a computer lab where they can visually create their own fish by selecting body parts in interactive activities online. The web has multiple sites. The first one I visited was called *Fish Fusion Rocky Reef* and it had five selections for each of its categories of The Body Shop, The Fin Shop, The Tail Shop and The Front End Shop. From their site I chose a spotted eel-type body that was accompanied with this explanation, "This sleek camouflage body can move suddenly for the fish to grab its unsuspecting prey which is usually swimming nearby, unaware of its presence." (40) Then I selected fins that came with this description, "These fins are made for quick changes in direction while grabbing unsuspecting prey. They present a low profile on the body, to decrease drag, so the fish can bolt quickly after prey." (41) The explanation that accompanied my tail selection was, "A deeply forked tail helps this fish swim at high speeds for long distances..." and with my choice of heads was, "Large eyes let this fish see its prey well from a hiding position and a large mouth lets it gulp it down. The large teeth are used to quickly hold and subdue the prey." (42) My final product was not particularly attractive and when I clicked on the button to observe it swimming in the ocean, it lasted less than 5 seconds before being devoured by a shark. The explanation on

the site stated that my tail did not match the body. Students, especially those in the lower grades, would probably enjoy this exercise. I certainly did.

I checked out other sites with Design-a-Fish interactive activities and since the Shedd Aquarium in Chicago is one of my favorite aquariums, I checked out a site involving them next. It was very similar to the one described above except that it had more sophisticated graphics and includes pattern selection. It lets the viewer select the body, mouth and pattern and after the fish I designed was put in the ocean, the screen read, “Too bad! The OTHER FISH ate YOUR FISH in the open water because: The OTHER FISH has the perfect combination of mouth, body, and color to eat YOUR FISH... YOUR FISH’S pancake body can’t swim fast in a straight line.” (43) Even though my students are older, ranging in grade from 9<sup>th</sup> to 12<sup>th</sup> graders, I may check out a computer lab and let my students experiment with one of these interactive sites before embarking on Lesson Plan 3.

### **Classroom Activities**

Lesson Plan 1: Animal Adaption Presentation to Class: Select an Animal and Describe Two or More Morphological, Physiological and Behavioral Adaptations for that Animal

Since this activity that we did in our DTI seminar was such a successful introduction to morphological, physiological and behavioral adaptations, I want to also do this with my students. Like us, my students will research an organism. It will not be limited to fish. We researched our organism as homework for presentation at our next meeting. Since all students are expected to participate and there is no guarantee that all of them will do it as homework, I will sign out a computer lab and the students will do the research during class instead. This activity should span two days.

As an example, I will share with my classes the research that I did on the walking stick. Walking stick morphological adaptations include a twig-like body with long, thin legs and antennae that help it camouflage against bark and twigs of the same brownish-green color. Some larger varieties have spikes on their hind legs with which they can strike enemies. The young can lose a leg instead of their lives if caught. Physiological adaptations include the unpleasant odor that some can give off and bad tasting fluids. Behavioral adaptations include the ability to hold very still. Also, if caught, they pretend to be sticks with the hope of being released. They can swing their bodies back and forth, mimicking small tree parts swaying in the wind. They can also confuse predators by opening up their wings and falling to the ground like debris. Once there, they tuck in their wings and walk away while the predator is still “shaking its head” about where they went.

Each student will select an animal and list at least two morphological, physiological and behavioral adaptations for it. From our previous discussions, they will understand that an adaptation can fit into more than one category. After the students have finished,

each will share their discoveries with the rest of the class. There will be three columns (one each for morphological, physiological and behavioral adaptations) on the board and three volunteers will list them on the board as each student presents his or her findings.

## Lesson Plan 2: Art Media Experimentation

Students will have their choice of medium or media (plural of medium) to use for their Design-a Fish activity. However, before they can make an informed choice, they will need to experiment with different media and be aware of the characteristics inherent with each. They will have already become adept at using graphite pencils because that is the first medium used in my classes so graphite pencils will not need to be explored.

Using very small pieces of paper (approximately 3 x 3"), students will experiment with a list of techniques in different media that I will list on the board. Each piece of paper must be signed on the back in order for the students to receive credit. Since the students will be designing their own fish, the exercises will involve fish and aquatic backgrounds. I will demonstrate techniques in each medium and then student will try the techniques. Newspaper will be used to cover the painting areas to minimize clean-up time.

I will start with watercolor and show ideas for backgrounds. First I will demonstrate the technique of wet-on-wet (painting the paper with clear water and then adding a loaded paintbrush of wet color that will bleed into the water when applied). Then, while the paper is still wet and saturated with color, I will sprinkle table salt on the paper. Each grain or salt crystal will leave a white star or snowflake shape in the color but the students will need to have patience. It takes at least 10 minutes for the salt to dissolve. The effect simulates the look of the ocean. Table salt from the grocery store can be used and it is very inexpensive. If the paper is too dry, nothing will happen with the salt. I will also experiment with wet-on-wet on the paper that is then tilted so that the paint drips in fluid colors. The third exercise will be a flat wash that will be covered with a wrinkled piece of plastic that is held down with a book or heavy object until it dries. Plastic food wrap works but we use plastic grocery bags because it is a form of recycling and they are free. That technique also gives an interesting water effect. For the fourth watercolor exercise, I will demonstrate how to draw a simple fish very lightly (so the pencil can be erased easily and not show) and then I will paint the background only with water, adding color as desired (wet-on-wet). The color will not bleed onto the dry area of the fish. I will be a little sloppy on purpose so that I can demonstrate how the excess paint can be "fixed" by blotted it up with a piece of paper towel, tissue or toilet paper. I will use a hair dryer to dry it quickly so that I can then show how to paint the fish. After my painted fish is dry, I will use dry brush (watercolor that has only a little water added to it) to add details to the fish with a pointed detail brush. When the fish is dry, I will demonstrate how pen and India ink can be used to add contrasting black lines and shading and more detail. Permanent magic marker can also be used.

After I demonstrate watercolor techniques, the students will understand that they can paint layers of color on the paper and also that they must change their water often so that they do not contaminate their next color choices. If they do not get clean water frequently, they inadvertently achieve color mixing and get muddy colors. For example, if they are painting a yellow fish but then switch to blue in the background, then their water suddenly turns green and will affect whatever they paint next. After I demonstrate, then the students will experiment with the techniques. Since the paper is small, the first exercises should not take long at all to execute. The last one has multiple steps with drying times included so it will take longer.

After the class has finished with the watercolor experimentation, I will demonstrate soft pastels on small paper. They will learn how to be safe with them to minimize dust in the air. They must also cover the table with newspaper and pick up any dropped pastels because a pastel that has been stepped on looks like color Armageddon. The mess gets everywhere! Pastels are messy but worth the effort because they offer instant beautiful colors that blend smoothly. To blend the colors, paper towels, tissues, craft sticks that have cotton on the ends or cotton Q-Tips and even fingers can be used. Colors can be layered for rich color and textural effects. Students will experiment with blending backgrounds to look like water using blue and green. On the second piece of paper, they will use a monochromatic color scheme (shades and tints of one color). A shade is a color to which black has been added. A tint is a color to which white has been added. For example, a monochromatic drawing could be shades and tints that are all some variation of teal.

After the students have experimented with soft pastels, I will demonstrate using oil pastels. Oil pastels have a much higher oil content than soft pastels and are blended by directly applying one color on top of another color. Multiple colors are used for richer color effects. They are not dusty like soft pastels but if stepped on, they also make an amazing mess. I will show Vincent van Gogh's *Starry Night* and demonstrate how to overlay the colors to achieve swirls similar to those used in the painting. This technique might be especially good for the portrayal of a luminescent deep sea fish. The students will also create a little mini painting of a fish in water using oil pastels. They have to use at least four colors in the fish (even if it is only gold) and at least four colors in the water (even if it is just blue). The colors can be very bold or they can be blended to be very subtle. For example, if a goldfish is portrayed, reds can be used in the shaded areas and yellow and white can be blended into the highlights. That way the fish will not appear to be just a boring flat gold. The same principles apply to multiple colors in the water.

I will demonstrate the color pencil techniques that involve the layering and overlapping of colors and also the proper use of Prismacolor blenders to blend colors. Then students will follow with their own experimentations on small pieces of drawing paper.

### Lesson Plan 3: Design-a-Fish

A power point will be shown with a variety of fish shapes, fins, tails, mouths, colors, and other adaptations. Questions will be asked throughout such as, “Why do you think that some fish swim in schools?” and “Why do some fish have spots?” The questions will involve the students and hopefully broaden their thinking when it comes to adaptations and environmental concerns. Some of these problems facing fish are the result of human interference (dredging, addition of toxins to the environment, dams, over-fishing, eutrophication) and others include climate change and the melting polar caps (which also may involve human meddling).

The students may work by themselves, in a pair or in a group of three. Together they will create an illustration and write out a sheet with the morphological, physiological and behavioral adaptations with explanations. They must create a name for their creature. The object will be to select a fish or water creature and enhance it with adaptations so that it can better prosper in its environment. Essential questions can include, “Has this fish been introduced to a new environment where it has to adapt to survive?” “How crazy can we get with the creation of this fish?” “How does this fish sense its surroundings?” “How does this fish protect itself?” “How does it acquire food?” Design considerations should include coloration, use and purpose of spots, designs and strips, shape of fish and shape and locations of individual body parts such as fins, tail(s), eyes, and mouth. Is the mouth full of sharp teeth? The students should consider the purpose behind each adaptation.

The students will be given a handout describing the assignment and bullet points of possibilities, requirements and grading considerations. They will also be given handouts on fish body shapes, fins, and mouths. The Journal of Marine Education provides two sheets with clear and concise basics on fish designs with purposes that can be downloaded along with Design-a-Fish lesson plan with National Science Education Standards. (44)

The grading categories will include aesthetics/visual appeal of the finished illustration, creativity/consideration of possibilities/problem solving, thoughtful use of adaptations, use of time in class/effort/teamwork (if applicable), clean-up/safe use of supplies and equipment, effective use of the elements of art and the principles of design, and craftsmanship/proper use of techniques, and signed legibly. A rubric will be provided for grading and the elements of art and the principles of design will be included on it for student reference. They are also on the word wall in the classroom. The elements of art are line, shape, color, value, form, texture and space. The principles of design are balance, contrast, emphasis, movement, pattern, rhythm, and unity.

When completed, each group will present their creations and explain to the class the morphological, physiological and behavioral adaptations of their creature. They should include their reasoning for the adaptations.

Follow-up activities will include the discussion of the proper way to hang an art show. As a class we will go to the art gallery and students will hang their own work. Next to each illustration will be the corresponding typed information that has been collaboratively compiled by the group that created the creature. It will be open for viewing by the school with an opening night reception. Students will critique their own work and that of others in the class and will follow up with a written self-reflection of their work and of the art exhibit.

## Resources

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Mudskipper

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### Reading List for Students

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Barrie, J. M., and Arthur Rackham. *Peter Pan in Kensington Gardens*. New York: Weathervane Books, 1975. Rackham is a classic illustrator from the British Golden Age of illustration (late 1800s-early 1900s). He illustrated a lot of children's fairy tales and there are greeting cards that capitalize on his images. He was known for watercolors and pen and inks.

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[fishwatch.dnr.sc.gov/FishFusion/FishFusionWindow.html](http://fishwatch.dnr.sc.gov/FishFusion/FishFusionWindow.html)[www.pbslearningmedia.org/resource/lsp07.sci...buildafish/build-a-fish/](http://www.pbslearningmedia.org/resource/lsp07.sci...buildafish/build-a-fish/). "In this interactive activity, students can select traits and watch their fish being built in front of them. Then they can test it in the ocean to see if the adaptations they selected ensure its survival."

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2009, [issuu.com/wpcouncil/docs/education\\_design\\_a\\_fish](http://issuu.com/wpcouncil/docs/education_design_a_fish). This contains two helpful student worksheets on fish body shapes, fins and mouths.

Young, Ed., and B. D. Wong. *Lon Po Po a Red-Riding Hood Story from China*. Norwalk, Conn.: Weston Woods, 2006. The artist employs dramatic fuzzy illustrations that use striking lighting.

### Materials for Classroom Use

Resources may include but are not limited to books, articles, magazines, computers, power points, video clips, cell phones for research, notebook paper, and prints and examples to hang in the classroom. Art materials may include but not be limited to sketch paper and paper for the final illustrations, pencils, erasers, Prismacolor colored pencils, acrylic paint, oil or soft pastels, watercolors, plastic bags, salt, frisket, gesso, rulers, triangles, tape, India ink, markers, and templates.

### Implementing District Standards

This unit aligns with all 6 of the Delaware Art Standards which in turn reflect the National Art Standards.

### Delaware Art Standards:

Standard 1: Understanding and applying media, techniques and processes.

Students will choose their own medium such as watercolor or colored pencil or mixed media (such as watercolor and pen and ink). They will also use their selected techniques and processes to design their own fish and animals or organisms.

Standard 2: Using Knowledge of structures and functions.

Students will effectively use the elements of art and principles of design to create their illustrations and to critique and reflect in writing about them.

Standard 3: Choosing and evaluating a range of subject matter, symbols and ideas.

Since students will be creating their own illustrations, they will need to sort through their ideas and sketches to develop their subjects and their adaptations. Symbols will be integrated into their designs.

Standard 4: Understanding the visual arts in relation to history and cultures

Students will develop an understanding of how people from different cultures and areas interact and respond to the environment and its inhabitants and how that will impact the development of the students' illustrations.

Standard 5: Reflecting upon and assessing the characteristics and merits of their work and work of others.

Students will be able to use their observational and critiquing skills to describe, analyze, interpret and judge/evaluate their own art and that of their peers. This will be expressed verbally and through written reflections.

Standard 6: Making connections between the visual arts and other disciplines.

This unit is an integration of science, biology, social studies, writing, and art.

## Notes

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- (22) Avrill, Tom, *Seeking Mates, Fish Switch Sex*, [http://www.philly.com/philly/news/science/20150709\\_Seeking\\_mates\\_fish\\_switch\\_sex.html#OOC6aHaJpJkjQEHa.99](http://www.philly.com/philly/news/science/20150709_Seeking_mates_fish_switch_sex.html#OOC6aHaJpJkjQEHa.99).
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- (25) Ritter, Malcolm, *Study: Bumblebees Feeling Climate Sting*  
*Study: [http://media.philly.com/images/600\\*450/20150711\\_bees\\_1024.jpg](http://media.philly.com/images/600*450/20150711_bees_1024.jpg)*, Accessed September 10, 2015.
- (26) Goodman, Susan E., and Michael J. Doolittle. *Claws, Coats, and Camouflage: The Ways Animals Fit into Their World*.
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**Curriculum Unit Title**

Getting STEAMED Up About Animal Adaptations

**Author**

Karen Yarnall

**KEY LEARNING, ENDURING UNDERSTANDING, ETC.**

After an introduction to organisms, biomes, adaptations and aquatic environments, with emphasis on the Inland Bay ecosystem, students will research adaptations in animals and learn about art illustration. They will use their research and creativity to create their own "new and improved" (as in better able to adapt and ultimately survive) fish in their choice of colored pencil, watercolors, acrylic paints, soft or oil pastels, pen and ink, or mixed media. Not only will the experimentation with and use of these media be part of their enduring understanding, but so will their knowledge of illustration and its place in the world. The students will hopefully be better conservators of the earth and its resources and understand the impact of their choices on the environment and the animals who live in it.

**ESSENTIAL QUESTION(S) for the UNIT**

Why do adaptations exist in animals? How do animals adapt to fit into the environment? How does the survival or removal of one species affect other species? Should endangered animals or animals that have vanished from an area like coyotes and grizzly bears be reintroduced? What is the place of a hybrid animal such as a coydog? What place does illustration have in the world of art? Are there jobs available in art illustration? What media and techniques can you use to make an effective illustration?

**CONCEPT A**

Recognition and understanding of types of animal adaptations

**CONCEPT B**

Experimentation with and understanding of different art media

**CONCEPT C**

Creation of own fish with adaptations

**ESSENTIAL QUESTIONS A**

How do I tell if an adaptation is morphological, physiological, or behavioral? Can an adaptation fit into more than one of these categories?

**ESSENTIAL QUESTIONS B**

How do watercolors, soft pastels, oil pastels, graphite pencils, charcoals, pen and ink, and colored pencils differ? How are they the same? What are the positive qualities of each? What are the negative qualities of each? How do I select the one that is best for me for the creation of my fish illustration?

**ESSENTIAL QUESTIONS C**

How do I go about creating a fish with adaptations for my Design a Fish Project? How do the adaptations I select for my fish affect its chances for survival?

**VOCABULARY A**

adaptation, behavior, morphological adaptation, physiological adaptation, behavioral adaptation, camouflage, counter shading, herbivore, omnivore, carnivore, biome, endangered, extinct, conservation

**VOCABULARY A**

medium, media, pigment, binder, watercolors, wet-on-wet, dry brush, flat wash, graded wash, blotting, mixed media, soft pastels, oil pastels, layering, acrylics, pencils, charcoal, stippling, blending, hatching, crosshatching, feathering, eraser shield, tortillon, fixative

**VOCABULARY A**

Since this is a culminating activity, the reinforcement of vocabulary such as critique will be stressed over the introduction of new vocabulary.

**ADDITIONAL INFORMATION/MATERIAL/TEXT/FILM/RESOURCES**

Computer lab for research, power points, variety of science articles and short videos on a range of subjects from mudskippers, camouflage, and bumblebees to Greenland's melting glaciers, books on adaptations such as Mark Denny and Alan McFadzean's *Engineering Animals- How Life Works* and Steve Parker's *Eyewitness Book Fish*, illustrated books and pamphlets by famous authors and illustrators such as children's book author and illustrator Chris van Allsburg, master of aliens Hans Giger, and fish illustrators Diane Rome Peebles and Joe Tomelleri, interactive on-line sites for designing fish, and artist materials which will include but not be limited to paper, watercolors, acrylics, brushes, soft and oil pastels, pencils, erasers, colored pencils and blending materials.