Monte L. Bean

Life Science Museum

Brigham Young University

Protect the Wildlife

see complete details on pg. 75

Explore the Galapagos

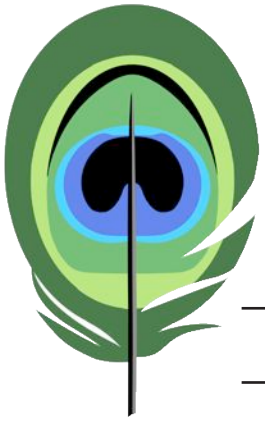
find materials and directions, plus curriculum tie-ins on pgs. 40-44

Animal Dentistry

learn about motivating factors behind teeth evolution on pg. 52

adaptations

Designed and Produced by the Brigham Young Univerisity
Monte L. Bean Life Science Museum



Monte L. Bean

Life Science Museum

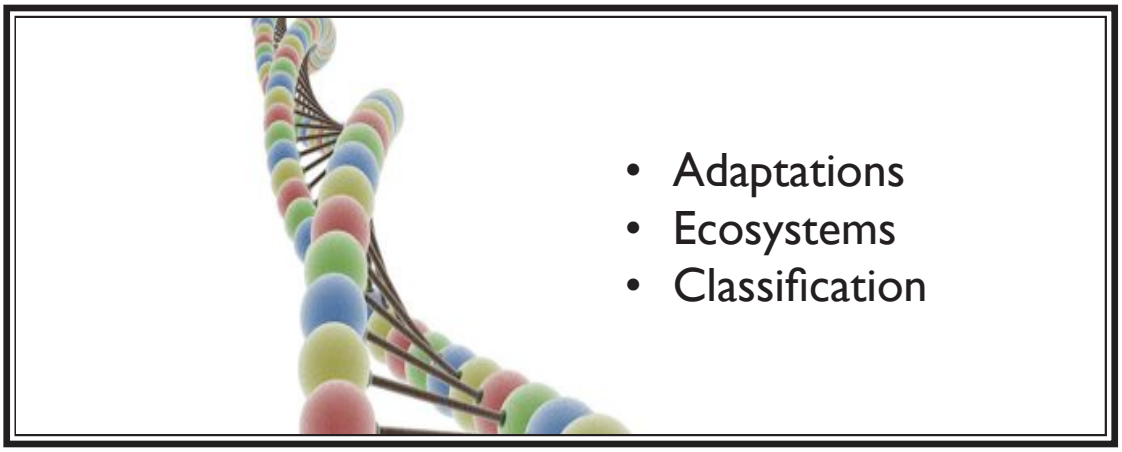
Brigham Young University

Table of Contents

A Note From The Director

Greetings!

The M.L. Bean Life Science Museum at Brigham Young University is committed to using its vast biological collections to support the museum's mission to promote world class teaching and research. Furthermore, we are fully dedicated to working closely with our public and private school colleagues to help secondary level students more fully appreciate the patterns and processes of living systems. As part of our commitment, the museum, through its education programs, offers resources to support educators in their efforts to more effectively teach our children. This "Bio-Box" is one element of that program. It has been designed with both educators and students in mind.



We are convinced that you will find that the "Bio-Box" program will provide invaluable support for your teaching efforts. We invite you to take advantage of the other education-related services offered by The Bean Life Science Museum, including exhibit tours, live animal shows (in house and outreach), and Nature Experienceships. Please visit our website (mlbean.byu.edu) for more information on these and other programs.

Best wishes,

Larry L. St. Clair
Director

User Registry

Date	Name	Group [Age]

Using the Guidebook:

Using the Guidebook: This diagram will help familiarize you with the layout and information codes in the "Bio Box" series guidebooks. The books are intended as idea sources, not lesson plans--and we need your notes and feedback to keep improving them.

Preparation Level

- Very Little Prep.
- Gathering/Re-arranging
- Background Work

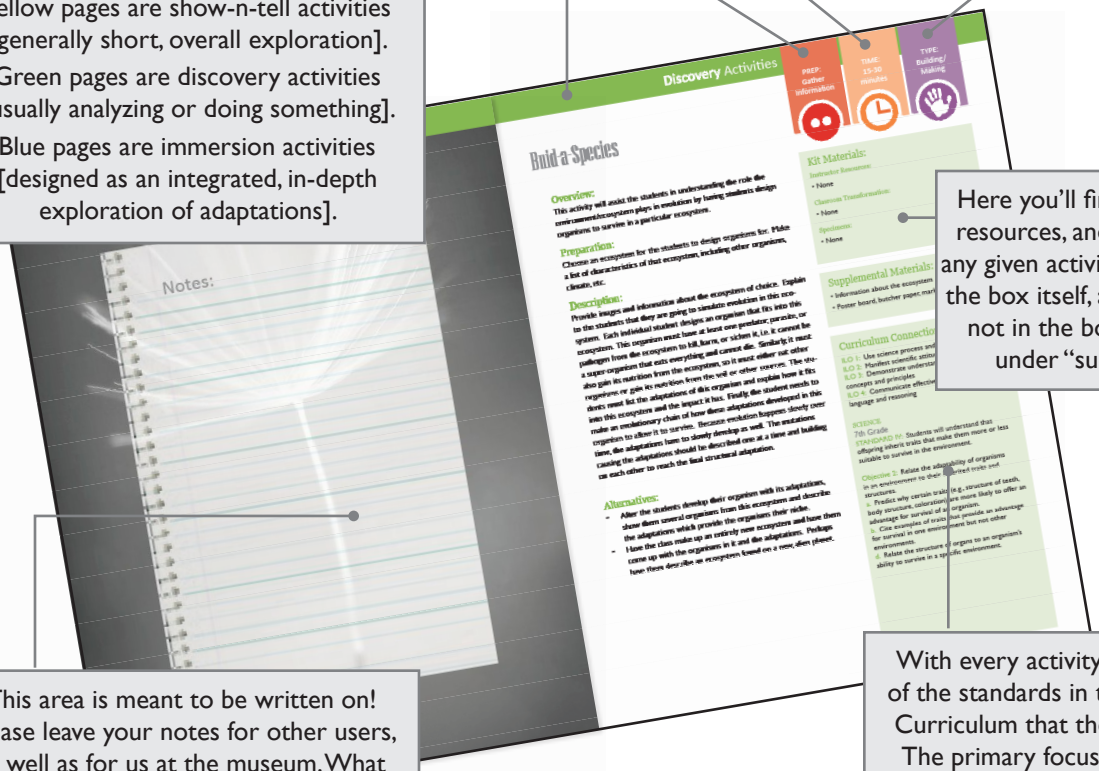
Time Requirement

- About 15 Minutes.
- About Half an Hour.
- About 45 Minutes.
- About an Hour.
- Multiple Class Periods

Activity Type

- Building/Making
- Exploring/Analyzing
- Integrated

The stripe across the top of each activity page is a color code:
Yellow pages are show-n-tell activities [generally short, overall exploration].
Green pages are discovery activities [usually analyzing or doing something].
Blue pages are immersion activities [designed as an integrated, in-depth exploration of adaptations].



Here you'll find a list of all the materials, resources, and specimens you'll need for any given activity. The area is broken up like the box itself, and anything you need that's not in the box will be clearly indicated under "supplementary materials."

This area is meant to be written on! Please leave your notes for other users, as well as for us at the museum. What worked? What didn't work? How did you adapt the activity? What other great ideas do you have? We want to know!

With every activity is a brief overview of the standards in the Utah State Core Curriculum that the activity addresses. The primary focus in development of Science, but cross curriculum standards are represented here as well.

Did you remember your field notebook?

The Scientific Method involves the process of making observations, formulating hypotheses, making predictions and designing experiments based on the hypotheses. All of these steps need to be carefully recorded. This process aids the scientist and others in further research.

As students use this bio box, it is important for them to use a field notebook to keep track of everything they do. Following each activity, students should take some time to record their observations and everything they have learned. The next step is for each student to create a hypothesis based on the observations. Each hypothesis must be testable and students will then come up with experiments to test the hypothesis. These should be recorded in the proper place in the field journal. This process will help students to think more like a scientist.

Sketches and description out of Darwin's Field Notebook. Here he describes the Galapogas Tortoise.

Sketches and description out of Darwin's Field Notebook. This is Darwin's first diagram of an evolutionary tree.

Activity Index...

Preparation Level



- 20 Questions
- Becoming Biologists
- Matchy-Matchy
- Observing Biology in Action
- If the Foot fits, ...
- Pelt Probe
- Pass the Seeds
- Build-a-Species
- Adapt. Strategies
- Darwin's Islands
- Fossils
- Survivor
- Dental Appointment
- Asexual vs. Sexual
- Feet
- Species Protection
- Farmer For a Day

Time Requirement





- 20 Questions
- If the Foot Fits, ...
- Pelt Probe
- Pass the Seeds
- Build-a-Species
- Adapt. Strategies
- Becoming Biologists
- Matchy Matchy
- Observing Biology
- Darwin's Islands
- Fossils
- Dental Appointment
- Feet
- Survivor
- Asexual vs. Sexual
- Farmer for a Day
- Species Protection

Activity Type



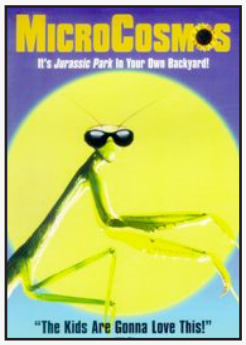
- Build-a-Species
- 20 Questions
- Becoming Biologists
- Matchy-Matchy
- Observing Biology
- If the Foot fits, ...
- Pelt Probe
- Pass the Seeds
- Adapt. Strategies
- Darwin's Islands
- Fossils
- Survivor
- Dental Appointment
- Asexual vs. Sexual
- Feet
- Farmer For a Day
- Species Protection

Resource Index...

The Blue Planet: Open Ocean/ The Deep

The open ocean is a watery wasteland between the burning sun and the dark abyss, home to some of the ocean's most spectacular predators. Far below lurk some of the Earth's strangest inhabitants– the denizens of the deep.

Microcosmos

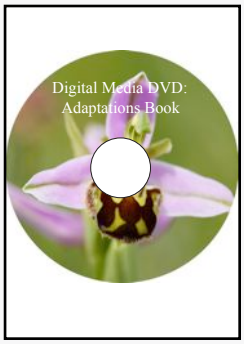


This documentary shows nature on a small scale. Insects are the protagonists, and it gives valuable insight into life for insects and other small creatures in nature.

Eye Wonder: Plant

by Fleur Star
This book describes life for plants with their many adaptations allowing survival in different habitats.

Digital Media DVD



This DVD has a PDF version of this guide and digital copies of all images and files used to allow teachers to display and use the images and files in digital format.

Bird Songs CD

This CD has bird songs to allow students to hear bird calls and learn about how birds communicate. This is used in the Darwin's Islands activity.

Specimen Index...

Turkey Display

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Asexual vs. Sexual
- Species Protection

Sea Star

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Asexual vs. Sexual
- Species Protection

Daffodil

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Asexual vs. Sexual
- Species Protection

Sego Lily

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Asexual vs. Sexual
- Species Protection

Stick Insect and Katydid

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Adapt. Strategies
- Species Protection

Mule Deer Skull

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Dental Appt.
- Species Protection

Beaver Skull

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Dental Appt.
- Species Protection

Red Fox Skull

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Dental Appt.
- Species Protection

Warthog Tusk

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Dental Appt.
- Species Protection

Whale Baleen

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Dental Appt.
- Species Protection

Opossum Skull

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Dental Appt.
- Species Protection

Elephant Tusk

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Dental Appt.
- Species Protection

Hippopotamus Tusk

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Dental Appt.
- Species Protection

Murex Shells

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Survivor
- Asexual vs. Sexual
- Species Protection

Sea Shells

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Survivor
- Species Protection

Scarlet King-snake

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Survivor
- Adapt. Strategies
- Species Protection

Bird Head Displays

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Darwin's Islands
- Adapt. Strategies
- Species Protection

Animal Pelts/ Hides

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Pelt Probe
- Species Protection

Bird Feet

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- If the Foot Fits...
- Feet
- Species Protection

Mammal Feet

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- If the Foot Fits...
- Feet
- Species Protection

Bird, Bat, Moth Wing Displays

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Adapt. Strategies
- Species Protection

Seed Dispersal Kit

- 20 Questions
- Matchy-Matchy
- Becoming Biologists
- Pass the Seeds
- Adapt. Strategies
- Species Protection

Resource Usage:

	Print Resources																Multimedia Resources				Other	
	Specimen Cards	Fossil Images	Era Charts	Bird Images	Environment Images	Poison Dart Frog Image	Coral Snake Image	Aquatic Spider Images	Skunk Image	Adapt. Strat. Quetion Cards	Adapt. Strat. Image Set	Bacteria Card (*E. Coli*)	Fossils Worksheet	Plant Book	Footsie Cards	Pelt Probe Cards	Pass Seeds Cards	Blue Planet Clips	Bird Sounds CD	Microcosmos Clips	Digital Media DVD	Potato Game Kit	4 Sided Dice
20 Questions	●																						
Matchy-Matchy	●																						
Becoming Biologists	●																						
Observing Biology in Action								●										●		●	●		
If the Foot Fits, Wear It															●								
Pelt Probe																●							
Pass the Seeds, Please																	●						
Build-a-Species																							
Adaptation Strategies										●	●												
Feet					●																		
Darwin's Islands Recreated				●															●		●		
Fossils		●	●										●								●		
Survivor						●	●		●				●					●			●		
Dental Appointment																							
Asexual vs. Sexual Reproduction	●								●			●		●							●		
Farmer for a Day																						●	●
Species Protection	●											●											

Specimen usage:

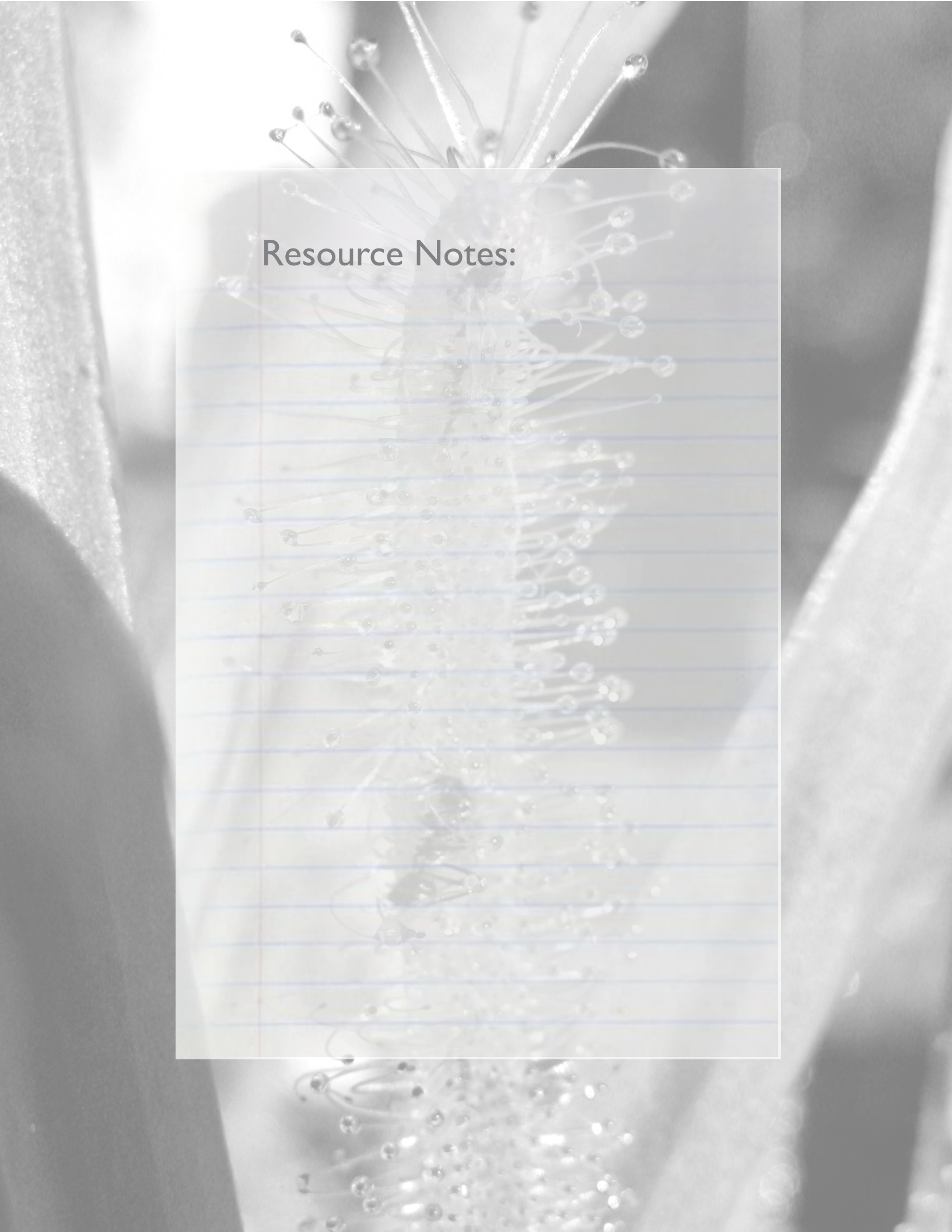
	Turkey Display	Starfish	Daffodil	Sego Lily	Mule Deer Skull	Beaver Skull	Fox Skull	Warthog Tusk	Whale Baleen	Opossum Skull	Elephant Tusk	Hippopotamus Tusk	Murex Snail Shells	Sea Shells	King snake	Bird Head Displays	Animal Pelts/hides	Bird Feet	Mammal Feet	Bird, Bat, Moth Wing Displays	Seed Dispersal Kit	Stick Insect and Katydid
20 Questions	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Matchy-Matchy	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Becoming Biologists	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Observing Biology in Action																						
If the Foot Fits, Wear It																		●	●			
Pelt Probe																	●					
Pass the Seeds, Please																					●	
Build-a-Species																						
Adaptation Strategies															●	●				●	●	●
Feet																		●	●			
Darwin's Islands Recreated																●						
Fossils																						
Survivor													●	●	●							
Dental Appointment					●	●	●	●	●	●	●	●										
Asexual vs. Sexual Reproduction	●	●	●	●									●									
Farmer for a Day																						
Species Protection	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	

Curriculum Connections...

You can use Bio Box activities to teach the Utah State Core Curriculum! This kit contains activities that address standards from the science curriculum (observing and predicting). These charts will help you find activities that relate to the content you need to teach for your grade level.

	ILO				7th Lang. Arts		SEVENTH SCIENCE								H.S. BIOLOGY													
					Std.		STANDARD IV								STANDARD IV							STANDARD V							
	1	2	3	4			OBJ. 1				OBJ. 2				OBJ. 1			OBJ. 2				OBJ. 1				OBJ. 2			
					2	3	a.	b.	c.	d.	a.	b.	c.	d.	a.	b.	c.	a.	b.	c.	d.	a.	b.	c.	d.	a.	b.	c.	d.
20 Questions	●	●	●	●					●		●	●	●	●														
Becoming Biologists	●	●	●	●					●		●	●	●	●														
Matchy-Matchy	●	●	●	●					●		●	●	●	●								●	●				●		
Observing Biology in Action	●	●	●	●							●	●	●	●								●	●	●		●	●	●	
If the Foot Fits, Wear It	●	●	●	●							●	●		●								●	●						
Pelt Probe	●	●	●	●							●	●		●								●	●						
Pass the Seeds, Please	●	●	●	●							●	●		●								●							
Build-a-Species	●	●	●	●							●	●		●															
Adaptation Strategies	●	●	●	●							●											●				●			
Darwin's Islands Recreated	●	●	●	●							●	●	●	●								●	●	●	●	●	●	●	●
Fossils	●	●	●	●																		●				●			
Survivor	●	●	●	●							●	●	●	●								●	●			●			
Dental Appointment	●	●	●	●							●			●															
Asexual vs. Sexual Reproduction	●	●	●	●				●	●	●					●	●	●	●	●	●	●	●	●						
Feet	●	●	●	●							●	●	●	●								●							
Farmer for a Day	●	●	●	●				●	●				●		●	●	●	●	●	●	●				●				
Species Protection	●	●	●	●	●	●					●	●		●							●	●	●						

	20 Questions	Becoming Biologists	Matchy-Matchy	Observing Biology in Action	If the Foot Fits, Wear It	Pelt Probe	Pass the Seeds, Please	Build-a-Species	Adaptation Strategies	Darwin's Islands Recreated	Fossils	Survivor	Dental Appointment	Asexual vs. Sexual Repro.	Feet	Farmer for a Day	Species Protection
ILO 1	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
ILO 2	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
ILO 3	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
ILO 4	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
7th Lang. Arts Std. 2																	●
7th Lang. Arts Std. 3																	●
SEVENTH GRADE STANDARD IV																	
Objective 1	●	●	●											●		●	
a.																	
b.														●		●	
c.	●	●	●											●		●	
d.														●			
Objective 2.	●	●	●	●	●	●	●	●	●	●		●	●		●	●	●
a	●	●	●	●	●	●	●	●	●	●		●	●		●		●
b.	●	●	●	●	●	●	●	●		●		●			●		●
c.	●	●	●	●						●		●			●	●	
d.	●	●	●	●	●	●	●	●		●		●	●		●		●
H.S. BIOLOGY STANDARD IV																	
Objective 1														●		●	
a.														●		●	
b.														●		●	
c.														●		●	
Objective 2														●		●	●
a.														●		●	
b.														●		●	
c.														●		●	
d.														●		●	●
STANDARD V																	
Objective 1			●	●	●	●	●		●	●	●	●		●	●	●	●
a.			●	●	●	●	●		●	●	●	●		●	●		●
b.			●	●	●	●				●		●		●			●
c.				●						●							
d.										●						●	
Objective 2			●	●					●	●	●	●					
a.				●					●	●	●	●					
b.			●	●						●							
c.				●						●							
d.										●							



Resource Notes:

PREP: Minimal Prep.

TIME: 15-30 minutes

TYPE: Explore/ Analyze

20 questions

Overview:

These ideas offer a variety of ways for students and teachers to familiarize themselves with the specimens and explore the adaptations illustrated by the specimens in this kit.

Suggested Activities:

- Have the students either sit in a circle or at their desks with paper and writing utensils. Hold up an artifact without any explanation. Choose a question, or several based on the information on the artifact card: "What ecosystem does this come from?" "What interesting adaptations does this specimen have?" etc. and have the students write their answers. Call on several to share their predictions and reasoning, if desired. Then explain the answer and move on to the next specimen.
- With the students sitting in a close circle, hold up a specimen, again with no explanation. Call on students to ask yes or no questions to come up with a description of the specimen, it's ecosystem, diet, habitat, and adaptations. You might assign someone to record on paper or the board what is learned through each question, then compare the summary they come up with to the information provided on the card.
- Pass a specimen out to each student, along with the Specimen Card that accompanies it. Allow them a few minutes to familiarize themselves with their specimen. Then collect the cards, shuffle them, and choose one secretly. Have all the students stand with their specimens and play an elimination game [played like the board game "Guess Who?"] Choose one student to be "it" and have them ask questions ["Does this specimen have fur?"] If the answer is yes, those students whose specimen doesn't have fur sit down, and so on until the student guesses the specimen on the chosen card correctly.

Kit Materials:

Instructor Resources:

• Specimen Cards

Classroom Transformation:

• none

Specimens:

• All

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE
7th Grade
STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

Objective 1: Compare how sexual and asexual reproduction passes genetic information from parent to offspring.
c: Cite examples of organisms that reproduce sexually and those that reproduce asexually.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a: Predict why certain traits are more likely to offer an advantage for survival of an organism.
b: Cite examples of traits that provide an advantage for survival in one environment but not other environments.
c: Cite examples of changes in genetic traits due to natural and manmade influences.
d: Relate the structure of organs to an organism's ability to survive in a specific environment.

PREP: Minimal Prep.

TIME: 20-40 minutes

TYPE: Explore/ Analyze

Becoming Biologists

Kit Materials:

Instructor Resources:

• Specimen Cards

Classroom Transformation:

• none

Specimens:

• All Specimens

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

7th Grade

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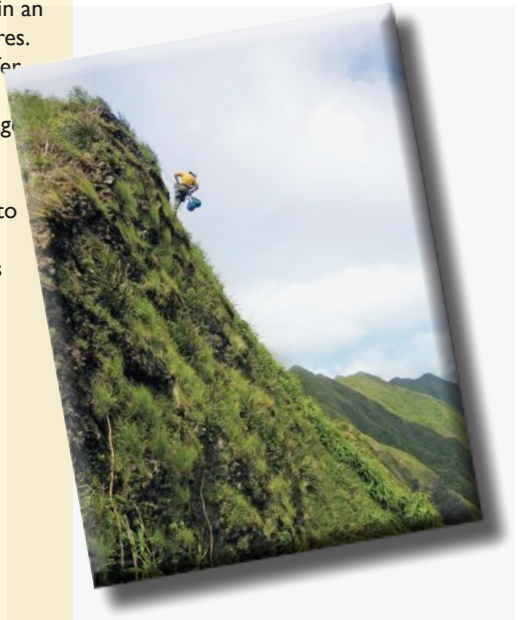
d: Relate the structure of organs to an organism's ability to survive in a specific environment.

Overview:

This activity helps students explore adaptations by providing specimens to the students and asking them to research the organism.

Suggested Activities:

- Each student or group of studentsreceives a specimen with the associated Specimen Card. The student is then instructed to research the organism. The research should include information about the habitat, the diet, the predators, the challenges faced by the organism, and adaptations that the organism has to survive in its environment. After the students have done this research, going above and beyond what is written on the specimen card, each student/group prepares a short presentation to share the adaptations of the organism to the class.
- Small groups of students are given a specimen without the specimen card. These students are then instructed to study the organism, hypothesize about the habitat of the organism, and make a list of interesting attributes of the organism which allow it to survive in its hypothesized ecosystem. The students are then given the card to determine if their hypotheses are correct. Finally, the students choose one interesting adaptation of the specimen, do independent research about this adaptation, and write a short paper describing the benefits.



PREP: Minimal Prep.

TIME: 20-40 minutes

TYPE: Explore/ Analyze

Matchy-Matchy

Overview:

These ideas offer a variety of ways for students and teachers to familiarize themselves with the specimens and explore the adaptations among the specimens in the kit.

Suggested Activities:

- Distribute the Specimen Cards to students, or pairs of students, instructing them to study only the front side [without the photo.] *You could also tape the cards face up to students' desks.* Bring out specimens from the kit one by one and let any students who think that specimen is the one on their card present their arguments. If more than one student think they have a match, the class votes. Hand the specimen to the student to study and handle. Once all the specimens have been distributed, the students turn over their cards and see if they were right. and redistribute specimens if necessary. Each student then presents his or her specimen to the class.
- Distribute the specimens to students or pairs of students. Give them several minutes to study their specimens and write down their observations and/or hypotheses. Have the students choose their Specimen Card from the stack and compare their observations with the information there. As a class, make a list of several adaptations you think might be common or unique among the specimens. Go through the list of adaptations and ask the students to stand if their specimen meets the criterion.
- Have the students sit in a circle or at their desks with several sheets of blank paper and drawing utensils. Place a specimen in a box, under a cloth, behind a screen [or concealed in some other way] and give the students clues from the Specimen Card as to the specimen's make-up, adaptations, significance etc. and ask them to draw what they think it would look like. Have the students post their drawings, uncover the specimen, and talk about the similarities and differences between the specimen and the drawings.

Kit Materials:

Instructor Resources:

- Specimen Cards

Specimens:

- All

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

7th Grade

STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.
Objective 1: Compare how sexual and asexual reproduction passes genetic information from parent to offspring.
c: Cite examples of organisms that reproduce sexually and those that reproduce asexually.
Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a: Predict why certain traits are more likely to offer an advantage for survival of an organism.
b: Cite examples of traits that provide an advantage for survival in one environment but not other environments.
c: Cite examples of changes in genetic traits due to natural and manmade influences.
d: Relate the structure of organs to an organism's ability to survive in a specific environment.

Biology Core

STANDARD V: Students will understand that biological diversity is a result of evolutionary processes.
Objective 1: Relate principles of evolution to biological diversity.
a: Describe the effects of environmental factors on natural selection.
b: Relate genetic variability to a species' potential for adaptation to a changing environment.
Objective 2: Cite evidence for changes in populations over time and use concepts of evolution to explain these changes.
b: Identify the role of mutation and recombination in evolution.

Notes:

PREP: Minimal

TIME: 20-40 minutes

TYPE: Exploring/ Analyzing

Observing Biology in Action

Overview:

By watching video clips of fascinating biological spectacles and answering related questions, students will develop an understanding for science while developing their scientific thinking skills.

Description:

Nutrition in Sundews ("MicroCosmos" 53:26-54:51)

Play the movie clip of the Sundew plant. After the clip, direct an in-class discussion of what was seen. The discussion should include but not be limited to the following questions:

1. What adaptations does this plant exhibit?
2. In what environment would you expect to find this plant?
3. Why?
4. List as many characteristics as possible which this plant would have required to evolve from a non-carnivorous plant to the plant we see in this clip.

Insect Mimicry ("MicroCosmos" 57:26-57:56 and 1:03:35-1:03:51)

Play the clips of the leaf mimic and the stick bug. Again, lead an in class discussion including the following elements.

1. These are insects. What adaptations do these insects have to increase their survival in their given environments?
2. How do these adaptations provide greater fitness (ability to survive) to the insects?

Sexual Selection and Stag Beetles ("MicroCosmos" 58:41-1:01:46)

Play the clip of the stag beetles. Use the following questions in the class discussion.

1. Many beetles such as these have evolved large mandibles, which look like horns or antlers. From this video clip, what role do the mandibles play?
2. Are the mandibles used to provide the species a greater chance to survive in its environment, or are the mandibles used for other purposes?
3. How do more effective mandibles provide an evolutionary advantage for an individual beetle?

Kit Materials:

Instructor Resources:

- MicroCosmos DVD
- The Blue Planet "The Deep" DVD
- Digital Media DVD (to display aquatic spider images)

Supplemental Materials:

- DVD player and projector

Curriculum Connections:

ILO 1- ILO 4

SCIENCE

7th Grade

STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a: Predict why certain traits are more likely to offer an advantage for survival of an organism.
b: Cite examples of traits that provide an advantage for survival in one environment but not other environments.
c: Cite examples of changes in genetic traits due to natural and manmade influences.
d: Relate the structure of organs to an organism's ability to survive in a specific environment.

Biology Core

STANDARD V: Students will understand that biological diversity is a result of evolutionary processes.

Objective 1: Relate principles of evolution to biological diversity.
a. Describe the effects of environmental factors on natural selection.
b. Relate genetic variability to a species' potential for adaptation to a changing environment.
c. Relate reproductive isolation to speciation.
Objective 2: Cite evidence for changes in populations over time and use concepts of evolution to explain these changes.
a. Cite evidence that supports biological evolution over time.
b. Identify the role of mutation and recombination in evolution.

Arms Race with Hatchetfish and its Predator ("Blue Planet: The Deep" 5:50-8:28)

Play the movie clip of the hatchetfish. After the clip, direct an in-class discussion of what was seen. The discussion should include but not be limited to the following questions:

1. What adaptations does the hatchetfish have?
2. How has the hatchetfish's predator adapted?
3. Describe the process of natural selection on these adaptations. How have these two species affected the adaptations of the other species?
4. If half of the hatchetfish didn't have working photophores, what would you expect to happen to the hatchetfish population over time?
5. If half of the predators didn't have yellow lenses, what would you expect to happen to the predator population over time?

Behavioral Adaptation in Ocean Sunfish ("Blue Planet: Open Ocean" 21:56-24:34)

Play the movie clip of the Ocean Sunfish. After the clip, direct an in-class discussion of what was seen. The discussion should include but not be limited to the following questions:

1. According to this video clip, what adaptations of the sunfish can you list that help increase its fitness?
2. Do these adaptations cause structural differences in the body of the sunfish? If so, how?
3. If some adaptations do not affect the structure of the sunfish, in what ways can they provide an advantage?
4. Can you list some other examples of adaptations that do not affect structure but provide an evolutionary advantage?

Aquatic Spider and Behavioral/Structural Adaptations ("MicroCosmos" 40:11-42:09)

Play the movie clip of the aquatic spider, also known as *Argyroneta aquatica*. After the clip, direct an in-class discussion of what was seen. Be sure to show the picture of the spider as it appears above ground and underwater (if preferred, the digital copy is located on the Digital Media DVD). The discussion should include but not be limited to the following questions:

1. What do you observe that allows the spider to live underwater?
2. How do these structural adaptations provide a niche for the spider compared to water surface and land spiders?
3. From the pictures associated with this species, what structural adaptations were necessary for the evolution of this species? (How does this spider differ structurally from other spiders?)
4. What behavioral adaptations did this spider need to develop in order to live underwater?

Alternatives:

- As opposed to an in-class discussion, the class could be split into small groups and given the list of questions to answer.
- Students could be assigned to view one of the clips and asked to do research on this topic to understand more about the specific type of adaptation, nutritional supplementation, mimicry, sexual selection, evolutionary arms race, behavioral adaptation, or ecological niches.

Notes:

PREP: Room Setup

TIME: 15-30 minutes

TYPE: Exploring/ Analyzing

If the Foot Fits. . . Wear It!

Kit Materials:

Instructor Resources:

• None

Classroom Transformation:

• Organize Stations

Specimens:

• Animal Feet: All bird feet, rhinoceros foot, sheep hoof, and wolf foot

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

7th Grade

STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a. Predict why certain traits (e.g., structure of teeth, body structure, coloration) are more likely to offer an advantage for survival of an organism.
b. Cite examples of traits that provide an advantage for survival in one environment but not other environments.
d. Relate the structure of organs to an organism's ability to survive in a specific environment.

Biology Core

STANDARD V: Students will understand that biological diversity is a result of evolutionary processes.

Objective 1: Relate principles of evolution to biological diversity.
a. Describe the effects of environmental factors on natural selection.
b. Relate genetic variability to a species' potential for adaptation to a changing environment.

Overview:

This activity will help students recognize that animal feet are adapted to specific habitats. This specificity increases the likelihood of survival in their environments.

Preparation:

Provide a station for each foot. Number each station and place a foot and a "Footsie" card.

Description:

Assemble students in to groups. Each person in a group needs paper and a writing utensil. Distribute students evenly at each station. Have students number their papers beginning with the station they are at. Allow students to study the feet, discuss, and answer the questions. Bring the class together and have students compare their answers and share their reasoning.

Footsie

1. Observe as many characteristics or traits as you can for each foot. Record them.

2. Predict the type of habitat each organism may have lived in. Defend your answers.

3. Compare and contrast the feet. Support how a trait which is advantageous in one habitat may be disadvantageous in another.

Notes:

PREP: Room Set-up

TIME: 15-30 minutes

TYPE: Exploring/ Analyzing

Pelt Probe

Kit Materials:

Instructor Resources:

- None

Classroom Transformation:

- Organize Stations

Specimens:

- Pelt sets

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

7th Grade

STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

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a. Predict why certain traits (e.g., structure of teeth, body structure, coloration) are more likely to offer an advantage for survival of an organism.
b. Cite examples of traits that provide an advantage for survival in one environment but not other environments.
d. Relate the structure of organs to an organism's ability to survive in a specific environment.

Biology Core

STANDARD V: Students will understand that biological diversity is a result of evolutionary processes.

Objective 1: Relate principles of evolution to biological diversity.
a. Describe the effects of environmental factors on natural selection.
b. Relate genetic variability to a species' potential for adaptation to a changing environment.

Overview:

This activity will help students recognize that organisms may have multiple survival strategies (coloration, coat/fur type, etc) which enable them to survive in specific habitats.

Preparation:

Place a set of pelts and a "Pelt Probe" card at each station.

Description:

Assemble students into evenly divided groups. Each student needs paper and a writing utensil. Allow students to study the pelts. Have each group discuss and answer the questions. Bring the class together and have students compare their answers and share their reasoning.

Pelt Probe

1. Observe as many characteristics or traits as you can for each pelt. Record them.

2. Predict the type of habitat the organism may have lived in. Defend your answer.

3. Compare and contrast the pelts. Support how a trait which is advantageous in one habitat may be disadvantageous in another. Give some examples.

Notes:

PREP: Room Set-up

TIME: 15-30 minutes

TYPE: Exploring/ Analyzing

Pass the Seeds, Please

Kit Materials:

Instructor Resources:

- None

Classroom Transformation:

- Organize Stations

Specimens:

- Seed Dispersal Kit

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE
7th Grade
STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

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a. Predict why certain traits (e.g., structure of teeth, body structure, coloration) are more likely to offer an advantage for survival of an organism.
b. Cite examples of traits that provide an advantage for survival in one environment but not other environments.
d. Relate the structure of organs to an organism's ability to survive in a specific environment.

Biology Core
STANDARD V: Students will understand that biological diversity is a result of evolutionary processes.

Objective 1: Relate principles of evolution to biological diversity.
a. Describe the effects of environmental factors on natural selection.

Overview:

This activity will assist the students in understanding that plants have evolved strategies which help them to survive. In this case we are addressing strategies which make a plant more reproductively successful and thus able to pass on its genes.

Preparation:

Place a seed set and a "Pass the Seeds, Please" card at each station.

Description:

Assemble students in to groups. Each person in a group needs paper and a writing utensil. Distribute students evenly at each station. Have students number their papers beginning with the station they are at. Allow students to study the seeds, discuss, and answer the questions. Bring the class together and have students compare their answers and share their reasoning.

Pass the Seeds, Please

Plants have developed ways to move their seeds to areas which may be far away from the parent plant. This is called seed dispersal. These different adaptations have helped them to be reproductively successful. In front of you are a few seeds that represent some of the dispersal methods. Using the clue, match each seed to its dispersal method and write a description of why it's effective. List at least two more plants that use the same dispersal mechanism.

"Sticky Situation"

"Think Outside the Bun"

"Blowing in the Wind'

"Propeller Power"

"Go with the Flow"

"Stop, Drop, and Roll"

Notes:

PREP: Gather Information

TIME: 15-30 minutes

TYPE: Building/ Making

Build-a-Species

Kit Materials:

Instructor Resources:

- None

Classroom Transformation:

- None

Specimens:

- None

Supplemental Materials:

- Information about the ecosystem
- Poster board, butcher paper, markers, pencils, pens

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE
7th Grade
STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

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a. Predict why certain traits (e.g., structure of teeth, body structure, coloration) are more likely to offer an advantage for survival of an organism.
b. Cite examples of traits that provide an advantage for survival in one environment but not other environments.
d. Relate the structure of organs to an organism's ability to survive in a specific environment.

Overview:

This activity will assist the students in understanding the role the environment/ecosystem plays in evolution by having students design organisms to survive in a particular ecosystem.

Preparation:

Choose an ecosystem for the students to design organisms for. Make a list of characteristics of that ecosystem, including other organisms, climate, etc.

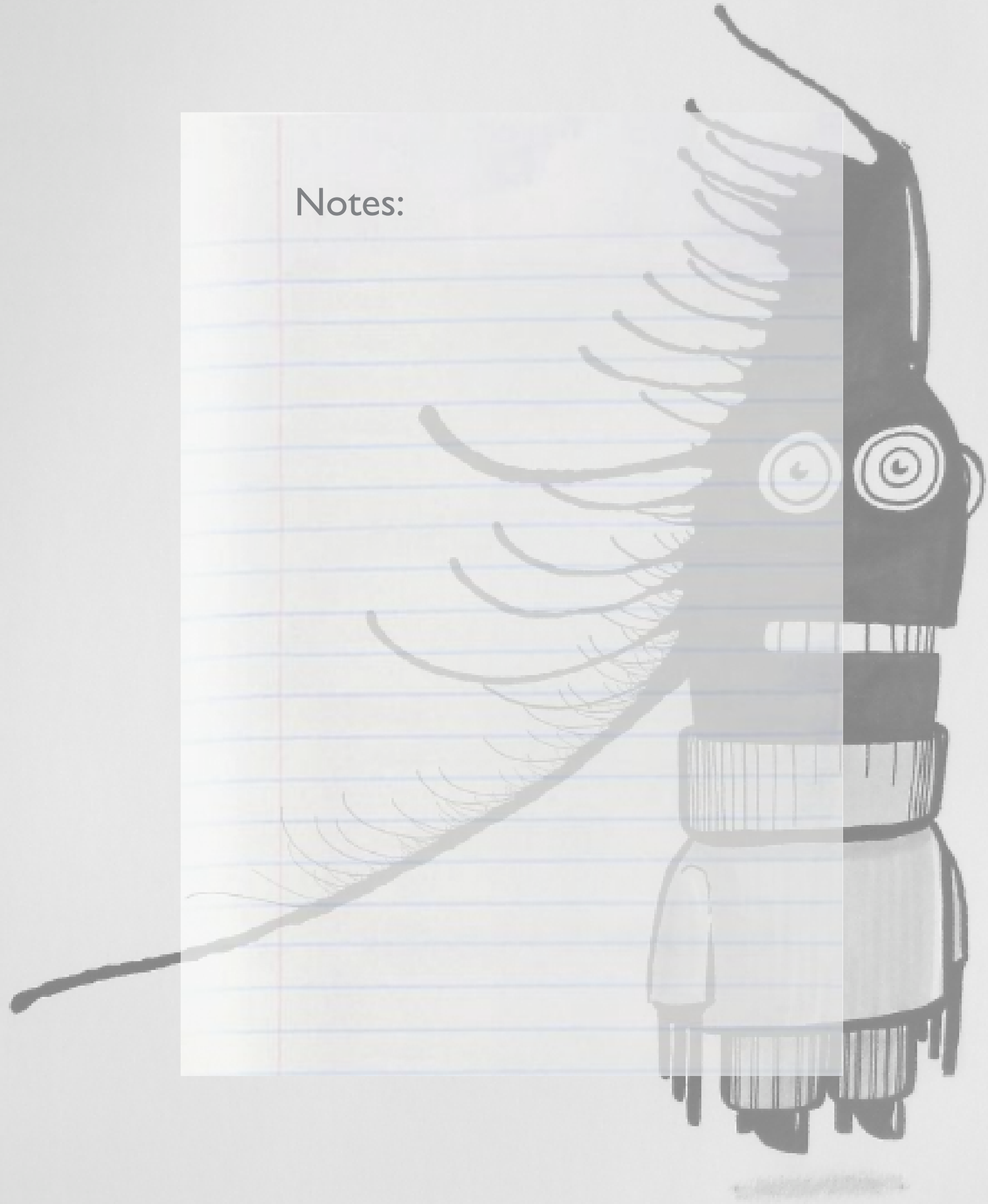
Description:

Provide images and information about the ecosystem of choice. Explain to the students that they are going to simulate evolution in this ecosystem. Each individual student designs an organism that fits into this ecosystem. This organism must have at least one predator, parasite, or pathogen from the ecosystem to kill, harm, or sicken it, i.e. it cannot be a super-organism that eats everything and cannot die. Similarly, it must also gain its nutrition from the ecosystem, so it must either eat other organisms or gain its nutrition from the soil or other sources. The students must list the adaptations of this organism and explain how it fits into this ecosystem and the impact it has. Finally, the student needs to make an evolutionary chain of how these adaptations developed in this organism to allow it to survive. Because evolution happens slowly over time, the adaptations have to slowly develop as well. The mutations causing the adaptations should be described one at a time and build on each other to reach the final structural adaptations.

Alternatives:

- After the students develop their organism with its adaptations, show them several organisms from this ecosystem and describe the adaptations which provide the organisms their niche.
- Have the class make up an entirely new ecosystem and have them come up with the organisms in it and the adaptations. Perhaps have them describe an ecosystem found on a new, alien planet.

Notes:



PREP: Room Set-up

TIME: 15-30 minutes

TYPE: Exploring/ Analyzing

Adaptation Strategies

Kit Materials:

Instructor Resources:

- Adaptation Strategies Question Cards and Images

Classroom Transformation:

- Organize Stations

Specimens:

- Bird, Bat, Moth Wing Displays (Station 1)
- Bird Head Displays (Station 2)
- Stick Insect and Katydid (Station 3)
- Kingsnake (Station 4)
- Seed Dispersal Set (Station 6)

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

7th Grade

STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a. Predict why certain traits (e.g., structure of teeth, body structure, coloration) are more likely to offer an advantage for survival of an organism.

Biology Core

STANDARD V: Students will understand that biological diversity is a result of evolutionary processes.

Objective 1: Relate principles of evolution to biological diversity.
a. Describe the effects of environmental factors on natural selection.
Objective 2: Cite evidence for changes in populations over time and use concepts of evolution to explain these changes.
a: Cite evidence that supports biological evolution over time.

Overview:

This activity uses an inquiry based method to teach students about common ancestry, homologous and analogous structures, convergent and adaptive radiation, mimicry, and evolution.

Preparation:

Place the set of specimens and/or photos as described in each category with its associated question card at each station. The appropriate photos are packaged with the corresponding question card.

Description:

Assemble students in to groups. Each person in a group needs paper and a writing utensil. Distribute students evenly at each station. Have students number their papers beginning with the station they are at. Allow the students to discuss what they observe and to generate their own definitions and answers to the questions.
Bring the class together and have students compare their answers and share their reasoning.
Teacher goes to front of room and asks each group to report their definition/description of the adaptation strategy for each station. Using students' responses, the teacher combines the most accurate details from student responses to refine and/or define each term.

Question Cards:

Station 1 Concept: Analogous Structures

These structures are all used for flight and are examples of **analogous structures**.

Based on your observations:

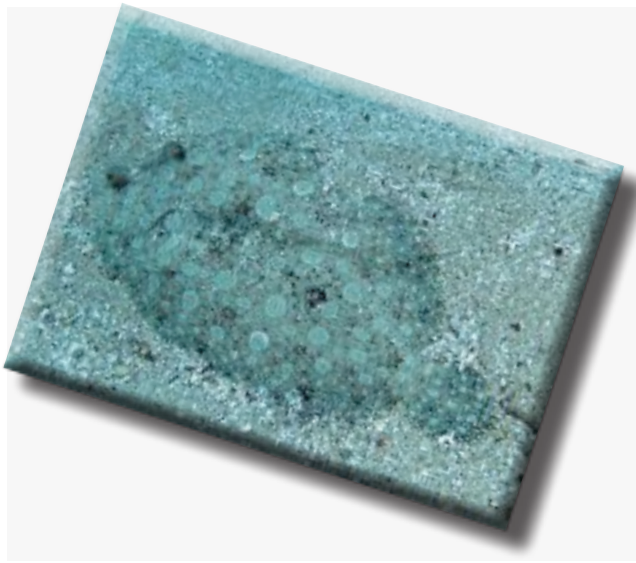
1. Determine and list which animals have internal skeletons in their wings.
2. Which animals are most closely related? What are the criteria you used to make this determination?
3. List a feature unique to each of the wing specimens.
4. Select a wing. Explain the advantages the wing you chose wing has over the others.
5. Write a definition of analogous structure.

Station 2 Concept: Adaptive Radiation

The structures here are all bird beaks and exhibit **adaptive radiation**.

Based on your observations:

1. For each bird, describe the structure of its beak.
2. Based on size and shape of each beak, what type of food that would be eaten by each bird?
3. What are the advantages or disadvantages of having different beaks? How do different beaks affect competition for food?
4. Write your own definition of adaptive radiation.



Station 3 Concept: Cryptic Coloration

These specimens display cryptic coloration.

Based on your observations

1. What environment would you expect to find each animal in?
2. How does the coloration help the animal to survive?
3. Define cryptic coloration.
4. Identify 4 or 5 other animals that exhibit cryptic coloration.

Station 4 Concept: Mimicry

Each organism here displays an example of mimicry.

Based on your observations

1. What is the model for each mimic?
2. List each organism and identify how many different strategies are used to mimic the model.
3. Besides insects, identify other mimics.
4. Define mimicry.

Station 5 Concept: Aposematic Coloration

Each of these animals exhibits aposematic coloration.
Based on your observations
1. What inferences can you make about these animals from their colors?
2. Why do you make those inferences?
3. Cite some examples that man has used to communicate similar messages with color.
4. What does aposematic coloration mean?

Station 6 Concept: Seed Dispersal

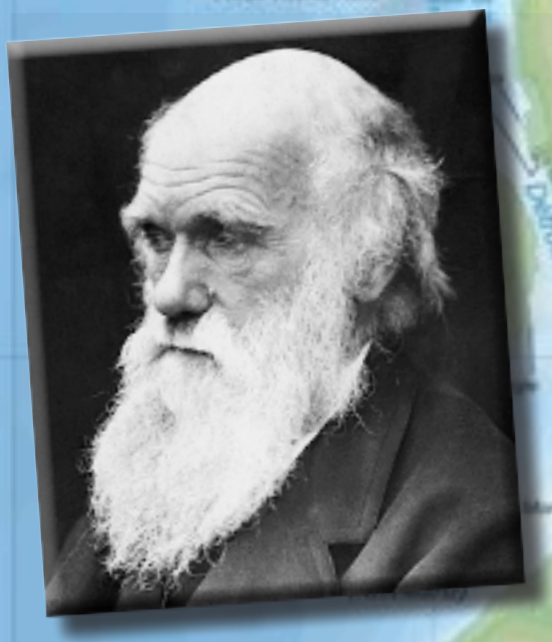
Each of these seeds gets transferred from one place to another by a different dispersal method.
1. Defend your answer as you predict which seeds are dispersed by
    - Water
    - Wind
    - Animals
    - Mechanical (explosive) means
2. What is the evolutionary advantage to having multiple dispersal methods?

Notes:

Darwin and His Islands

Darwin originally wanted to be a doctor but couldn't stand the sight of blood. He then began to study for the clergy before becoming a geologist. Talk about changing your major.

Darwin was seasick for the entire five year voyage to the Galapagos Islands.



Darwin took his time; it took 20 years after returning from the Galapagos before he finally published his findings on natural selction and evolution!

Îles Galápagos (Archipel de Colón)

The book, "The Origin of Species" was originally called, "On the Origin of Species by means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life". The title was later changed for the 6th edition.

Even though Darwin published his findings in 1859, the Royal Society in London reported that there had been no major scientific discoveries that year!

When Darwin was young his teachers thought he was a disgrace. They said he only cared about shooting, riding, and beetle collecting. His father thought he would amount to nothing too. Shows you Dad!

Darwin was a member of the Cambridge Gourmet Club that ate unusual animals. While in Galapagos he tasted tortoises, owls, pumas, and iguanas.

PREP: Room Set-up

TIME: 30-45 minutes

TYPE: Exploring/ Analyzing

Darwin's Islands Recreated

Kit Materials:

Instructor Resources/Specimens:

- Digital Media DVD: Bird Image
- Bird Songs CD
- Bird head displays

Classroom Transformation:

- Desks divided into 6(+) islands
- Photo of the original bird ready to display on projector or on the blackboard
- Have the Bird Songs CD loaded onto the computer or CD player and ready to play

Supplemental Materials:

- CD player and projector

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

7th Grade

STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.
Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.

Biology Core

STANDARD V: Students will understand that biological diversity is a result of evolutionary processes.
Objective 1: Relate principles of evolution to biological diversity.
Objective 2: Cite evidence for changes in populations over time and use concepts of evolution to explain these changes.

Overview:

Students will make observations and inferences as Darwin did about adaptations of birds. Students will identify and apply genetic drift and natural selection to the birds in this jigsaw activity.

Description:

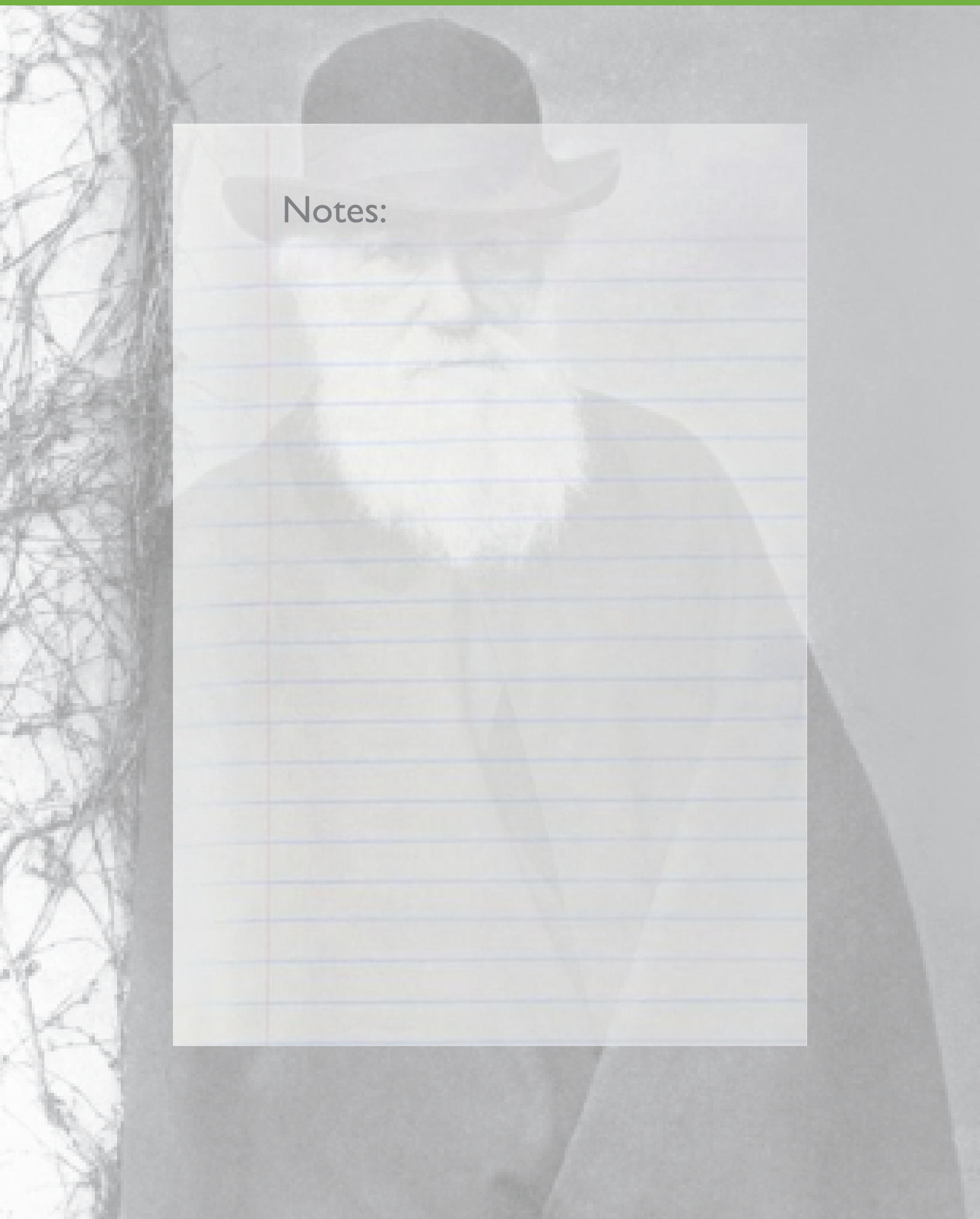
- Tell the students to close their eyes. Begin to tell the "Shipwrecked on Darwin's Islands" story on the page to the right.
- Place the display boxes on each table while the students have their eyes closed and while telling the story. When the students should awake, begin to play the music. (The Bird Songs CD should be in the CD player and the CD player should be set to repeat the track. From this point simply hit play.)
- When the story is over, explain to the students that the new bird they caught is in front of them. Have them answer two questions:
  What observations can you make about this bird?
  How would these characteristics help the bird survive and reproduce in its environment?
- Have the islands (groups of students) compare observations by combining together new groups, each containing one member of an island. Each person in these new groups will explain and teach the others in their group about their bird (jigsaw). This allows every student to teach and learn.
- Show the father bird and explain that it was the original ancestor of all the other birds. Have the students answer the following question:
  How has your bird adapted from the original ancestor?
- Have the students use these adaptations to explain natural selection, speciation, and inherited and acquired traits.

Alternatives:

- For high school, more emphasis can be placed on Darwin's voyage and study of finches.
- For 7th grade, the importance of offspring and sexual reproduction can be emphasized.

Shipwrecked on Darwin's Islands

The year is 1828. You are standing on the wooden deck of a ship. The timbers are creaking and groaning as the boat rocks with the waves of the tropical sea. You look up at the blue sky and see the white canvas sails flapping in the wind. The air is warm and storm clouds are forming on the horizon. After weeks of sailing in the Pacific Ocean one sailor shouts, "Land ho!" You peer over the railing and see the faint outline of a green tropical island. Abruptly the wind picks up, and waves wash over the boat and you fall to the deck with a crash! The boat has stopped moving, you have run into a coral reef! Everyone abandons ship and when you jump over the side of the boat, you begin to swim to the life raft. Once there you pass out from exhaustion.
(Play music and begin to set out birds)
You wake up the next morning with a dry throat. You hear birds chirping, and sounds coming from the tropical jungle just off the beach near where you life boat has landed. You and the other survivors begin to explore your new island. you manage to capture a new species of bird that no one has ever seen before. Open your eyes.



Notes:

PREP: Room Set-up

TIME: 20-40 Minutes

TYPE: Exploring/ Analyzing

Fossils

Overview:

Students will be given pictures of fossils from different periods. They will draw their own conclusions as to how and why extinctions occur and why they affect specific groups of animals.

Description:

Divide the students into small groups. Each group will be given the exact same pictures, but in their small group they will examine the pictures more closely and discuss them in a way that each student can participate.

Each group needs an Era Chart and the pictures of fossils. Using these resources, the students answer the following questions on their own pieces of paper or their own worksheet if worksheets have been printed for each student.

Alternatives:

- After the students complete the activity, have the students research to see which animals and plants have become extinct during the last few hundred years.

Kit Materials:

Instructor Resources:

- Era Charts
- Fossil Cards

Classroom Transformation:

- Arrangement into groups

Specimens:

- None

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

Biology Core

STANDARD V: Students will understand that biological diversity is a result of evolutionary processes.

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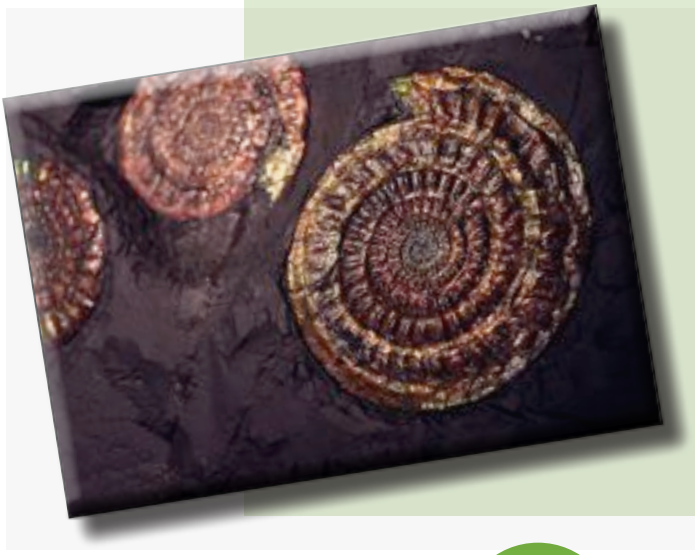
a. Describe the effects of environmental factors on natural selection.
Objective 2: Cite evidence for changes in populations over time and use concepts of evolution to explain these changes.
a: Cite evidence that supports biological evolution over time.



...Worksheet

FOSSILS

Questions 1-4 refer to the Era Chart and fossil images.

1. Put the fossil cards in order from oldest to most recent using the information on the cards and the Era Charts.
2. What observations do you make about the age of the organism and its environment?
3. Based on the sample fossils you observe, what changes occurred over time? What could have been the cause of these adaptations?
4. Which of these species are alive today? If so, approximately how long have they survived?

FIVE MAJOR MASS EXTINCTIONS:

- End Ordovician – All known life at the time was in the ocean and seas. This was the 2nd largest extinction killing many of the marine specimens.
- Late Devonian – By this time there were plants, insects and amphibians, but the extinction seems to have only affected marine life.
- End Permian – This was the most severe extinction in which 96% of marine life as well as 70% of terrestrial vertebrates became extinct.
- End Triassic – This event brought about extinction of 20% of marine life and many amphibians and non-dinosaurs. Dinosaurs flourished and became the dominant animal life for the Jurassic time period.
- End Cretaceous – Almost all dinosaurs became extinct.

Questions 5-6 refer to the information about mass extinctions presented above.

5. Mass Extinction doesn't imply that all the organisms alive are harmed; you'll notice that in the five major mass extinctions above, not every species is affected. What factors could be responsible for the extinction of some species but not all?
6. Develop predictions as to what conditions may have affected:
   - Marine life but not land life (Late Devonian)
   - Marine life and amphibians but not dinosaurs (End Triassic)
   - Dinosaurs but not mammals and birds (End Cretaceous)

Questions 7-8 refer to the Holocene (present-day) extinction event, which is possibly the fastest extinction according to some scientists.

7. What are some plants or animals that have become extinct in the past few hundred years? What factors led to their extinction?
8. Identify several organisms that are threatened or endangered. Make some suggestions about what we can do to increase the population sizes so that these organisms are no longer threatened.

Notes:

PREP: Room Set-up

TIME: About 45 Minutes

TYPE: Exploring/ Analyzing

Survivor

Kit Materials:

Instructor Resources:

- Blue Planet: Deep Sea DVD
- 2 Murex Snails
- 3 shells (bivalve, cone shell, thick shell)
- Skunk Image
- Kingsnake specimen
- Poison dart frog picture
- Coral snake picture

Classroom Transformation:

- Set up the 6 stations for this activity

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

7th Grade

STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a: Predict why certain traits are more likely to offer an advantage for survival of an organism.
b: Cite examples of traits that provide an advantage for survival in one environment but not other environments.
c: Cite examples of changes in genetic traits due to natural and manmade influences.
d: Relate the structure of organs to an organism's ability to survive in a specific environment.

Biology Core

STANDARD V: Students will understand that biological diversity is a result of evolutionary processes

Objective 1: Relate principles of evolution to biological diversity.
a: Describe the effects of environmental factors on natural selection.
Objective 2: Cite evidence for changes in populations over time and use concepts of evolution to explain these changes.
a: Cite evidence that supports biological evolution over time.

Overview:

Students will understand more about adaptations by learning about different survival techniques.

Description:

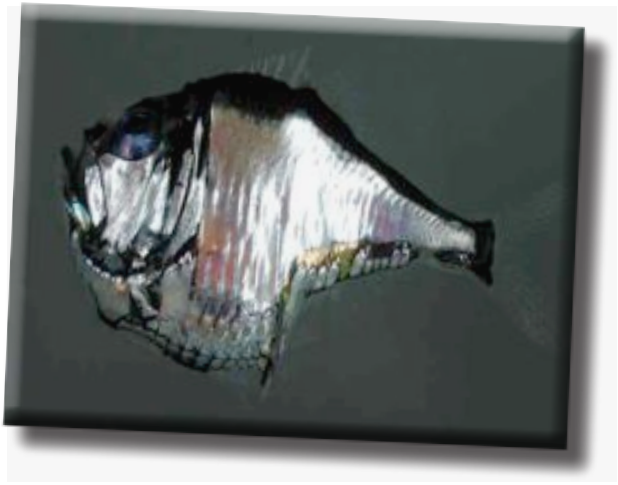
Divide the students into six groups each with a pencil and two pieces of paper. At each station, they will be given a specimen and possible questions for them to think about and discuss. They will write down their conclusions based on their observations and then switch to the next station. After the students have been to each of the six stations, you may wish to have some students share their ideas with the class. You may also wish to explain each station (briefly), so the students can compare their observations with yours.

The following explains each station and questions that you may wish to use:

Station 1 - Film on Hatchet Fish:

This clip is found on the "Blue Planet: Deep Sea" DVD between the times 5:50 and 8:28. Gather the students around a TV where they can watch a short clip on Hatchet Fish and then answer the following question:

1. What adaptations do hatchet fish have?
2. How has the hatchet fish's predator adapted?
3. Describe the process of natural selection on these adaptations. How have these two species affected the adaptations of the other species?
4. If half of the hatchet fish didn't have working photophores, what would you expect to happen to the hatchet fish population over time?
5. If half of the predators didn't have yellow lenses, what would you expect to happen to the predator population over time?



Station 2 - 2 Murex snails (camouflage):

CAREFUL! They're fragile.

Place these two snail shells on the table at the designated station and consider the following questions:

These are marine snails and live in the intertidal zone of the ocean.

1. Each specimen has something growing on its shell, what is it?
2. How does it help the snail survive?
3. Based on your observations, determine where each snail will live.
4. If both snails were taken from their natural habitats and moved to the habitat of the opposite snail, what would be the consequences and why?
5. Do you think that one snail has an advantage over the other? Explain.
6. Besides the lack of water, decide how each snail would survive (based on its current camouflage) in one of the following environments. Describe what adaptations would have to occur to camouflage itself in its new environment.
    - Desert
    - Jungle floor
    - Arctic or Antarctic pole
    - Grasslands
    - Tropics

Station 3 - 3 defense mechanisms (shell structure):

Place the three shells (bivalve, cone shell, and thick shell) at the station for students to handle carefully and observe while considering:

Each of these marine critters has a unique way of protecting itself from predators (based on their shells).

1. Based on what you see describe each defense mechanism due to its physical structure.
2. How does each trait help these animals survive?
3. If these marine animals are good at defending themselves, how do they get eaten?

Station 4 - Aposematic Coloration:

This table should have the following specimens: skunk image, kingsnake specimen, poison dart frog picture, and coral snake picture.

Each of these animals displays aposematic coloration:

1. Based on their coloration, what can you infer about these animals? Why?
2. Define Aposematic Coloration
3. Notice the picture of the coral snake. The snake specimen given is actually not poisonous, but is mimicking the aposematic coloration of the coral snake in the picture. How is this mimicry beneficial for the docile kingsnake?
    - Remember: "When red touches black, it's ok Jack," but when "red touches yellow, you're a dead fellow."
4. Cite some examples that man has used to convey similar messages with color.

Survivor

...Continued

Station 5 - Reflective Writing:

At this station, there is no specimen; the students will be given questions about which to write.

Write as much as you can think of during your time at this station.
Choose one or two of the following questions to write about:

1. Explain what you know about camouflage. Identify some animals which use it. Give some examples.
2. Explain how you understand if an animal is dangerous (list everything you possibly can).
3. Explain your understanding of how animals stay alive (either as an individual, a colony, or a species). Feel free to describe a single species in depth.
4. What are some ways plants stay alive by avoiding herbivory (being eaten)?
5. If a plant produces offspring that grow too closely to the parent plant, then they both compete for nutrients and space. What are some ways plants make sure their offspring aren't too close to them so that they both live?

Alternatives:

- Choose a survival technique for the students to research. Each student/group could have a different one if you so choose. Send them to the library to research that subject so that they can teach you!
- Choose one activity to use for the whole class.

Notes:

PREP: Room Set-up

TIME: 20-40 Minutes

TYPE: Exploring/ Analyzing

Dental Appointment

Kit Materials:

Instructor Resources:

- None

Classroom Transformation:

- Arrange into groups

Specimen :

- Mule deer skull
- Beaver skull
- Fox skull
- Warthog Tusk
- Whale Baleen
- Opossum skull
- Hippopotamus Tusk

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

7th Grade
STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a: Predict why certain traits are more likely to offer an advantage for survival of an organism.
d: Relate the structure of organs to an organism's ability to survive in a specific environment.

Overview:

Help the students understand how teeth/modified teeth help animals survive.

Description:

This is a jig-saw activity. Divide the class into seven groups. Each group will be given one specimen to study. The group will observe its specimen and discuss the answers to the questions regarding it. Have the students write down their answers. This group is the "expert" group on a given specimen. When finished, regroup the students so that there is a representative from each of the seven stations in every group. Each student "expert" teaches the rest of the new group the information acquired.

These are the seven specimens:

- Mule Deer skull (herbivore)
- Beaver skull (herbivore)
- Fox skull (carnivore)
- Warthog Tusk (carnivore)
- Whale Baleen (carnivore)
- Opossum skull (omnivore)
- Hippopotamus Tusk (omnivore)

Have the students answer the following questions in their group. Then do the jigsaw.

1. Is this a carnivore, herbivore, or omnivore? Defend your answer.
2. Is it predator or prey? On what do you base your answer?
3. What is its diet? Why do you think so?
4. How do its teeth function?
5. What else can you infer from this animal based on its teeth?

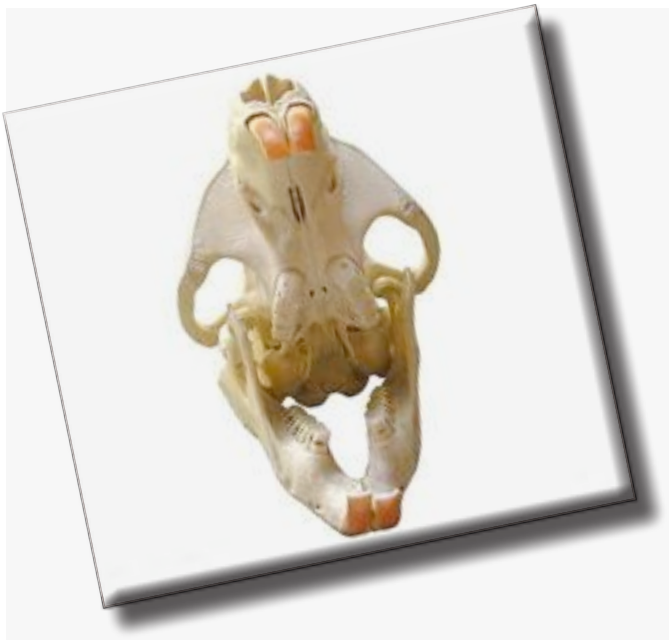
Extra questions for specific specimens:

- Beaver skull - Its front teeth never stop growing. Why do you suppose that is?
- Warthog Tusk - What are tusks used for? Why do you suppose it's so worn down on one side?
- Whale Baleen – How does this whale eat?

Alternatives:

- Have a picture of human teeth to compare with given specimen. Use the following questions:
  1. Humans have three main types of teeth. Describe them.
  2. What type(s) of teeth do both humans and your specimen have in common?
  3. What relationships do you see between this specimen's teeth and human teeth?

- Don't tell students which animal each skull/tooth belongs to. Use the following questions:
  1. What kind of animal is this?
  2. What environment might it live in?
  3. What does it eat? How do you know?



Notes:

PREP: Room Set-up

TIME: About 45 Minutes

TYPE: Exploring/ Analyzing

Asexual vs. Sexual Reproduction

Overview:

This activity is set up as 7 stations, where each station covers one particular mode of reproduction. Students discuss in groups the associated questions which lead them to understand more about the differences between sexual and asexual reproduction and variations within both.

Activity Ideas:

- Have groups of 4 to 6 rotate from station to station. Each group answers the questions at the station. Compare and contrast the answers between the different groups. Feel free to pick and choose which stations to use.
- Place Specimen at the front of the classroom. Show the worksheet on a projector so all the students can see. Have small groups work on the questions and then when everyone is finished, discuss the answers as a class. Then move on to the next section. Repeat until all the methods of reproduction have been covered.

Stations and associated questions:

(following pages)

Kit Materials:

Classroom Transformation:

- Set up 7 stations with one specimen each from list below
- Place worksheet with appropriate specimen

Specimens:

- Skunk Image
- Sea snails
- Bacteria card
- Sego lily and Eyewitness Plants book
- Daffodil
- Starfish
- Turkey egg display

Curriculum Connections:

SCIENCE

7th Grade

STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.
Objective 1: Compare how sexual and asexual reproduction passes genetic information from parent to offspring.
b: Contrast the exchange of genetic information in sexual and asexual reproduction
c: Cite examples of organisms that reproduce sexually and those that reproduce asexually

Biology Core

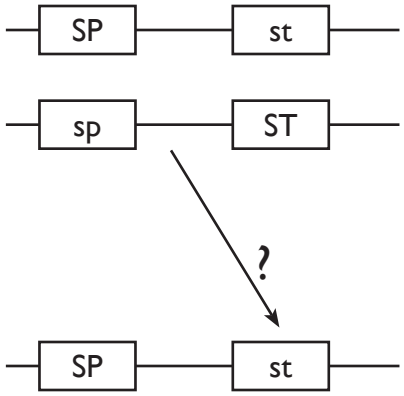
STANDARD IV: Students will understand that genetic information coded in DNA is passed from parents to offspring by sexual and asexual reproduction. Changes in DNA may alter genetic expression.
Objective 1: Compare Sexual and asexual reproduction
a: Explain the significance of meiosis and fertilization in genetic variation
b: Compare the advantages/disadvantages of sexual and asexual reproduction to survival of species
Objective 2: Predict and interpret patterns of inheritance in sexually reproducing organisms
a: Explain Mendel's laws of segregation and independent assortment and their role in genetic inheritance.
b: Demonstrate possible results of recombination in sexually reproducing organisms using one or two pairs of contrasting traits.
STANDARD V Objective 1b: Relate genetic variability to a species' potential for adaptation to a changing environment.

Asexual vs. Sexual Reproduction ... Continued

Sexual Reproduction Only (Skunk Image):

1. Most multicellular organisms utilize sexual reproduction in one form or another. What conclusions can you draw from this fact?
2. How does meiosis relate to variability and sexual reproduction?
3. Examine the skunk. Both the warning stripes and the skunk's spray are advantageous for the skunk's survival, particularly when paired together. Look at the diagram below. This skunk is heterozygous for both genes, which happen to be on the same chromosome. One chromosome has the functional spray allele (SP) and the other chromosome has the functional stripe allele (ST). Can this skunk pass on a chromosome with both SP and ST to one of its offspring? Discuss why it can or cannot.

Spray Stripe



Homologous Chromosomes within the skunk before meiosis

SP is a dominant, working spray allele, sp is a recessive, nonfunctional allele

ST is a dominant, working stripe allele, st is a recessive, nonfunctional allele

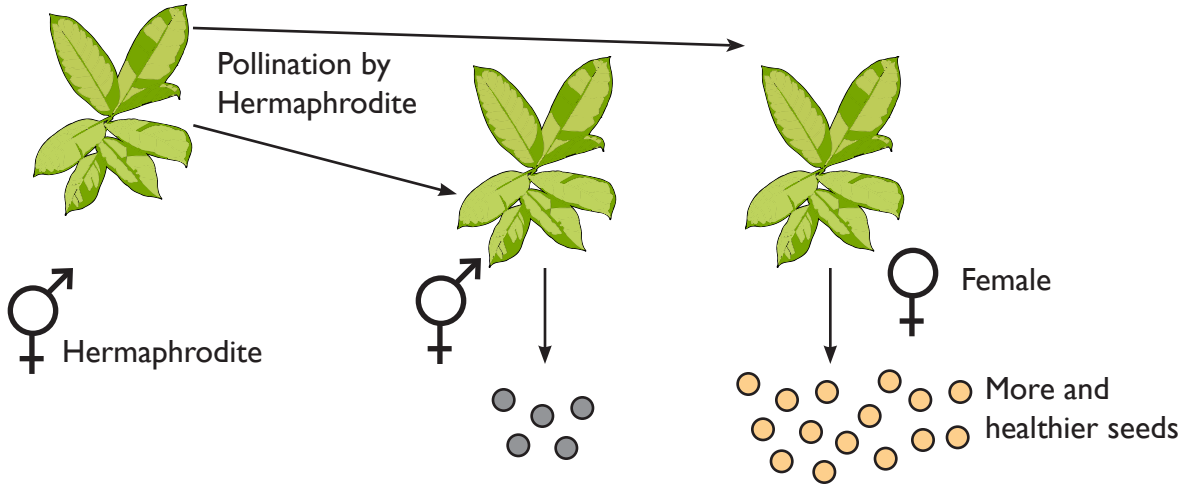
4. Can a sperm or egg cell from this skunk have this genotype? In what ways does sexual reproduction introduce greater variability than asexual reproduction?

Hermaphroditic Organisms (Sea Snail Specimen):

- Hermaphroditic species are species in which individuals contain both male and female sexual reproductive organs and are capable of using both. A hermaphroditic snail can provide both the sperm for its mate and be simultaneously impregnated.

1. Two species of sea snails exist in the same area. One species is hermaphroditic and one species has males and females, but these species are identical in every other way. If both species start with the same number of individuals, which species will spread faster? Why? What advantages/disadvantages does this give to hermaphroditic species?

2. Scientific articles have been published which describe gynodioecious (guy-no-di-ee-shous) plant species. These are species with hermaphrodite individuals and male-sterile (a.k.a. female) individuals. These articles have shown that male-sterile plants fertilized by the pollen of the hermaphrodite individuals produce more and healthier seeds than the hermaphrodites. Does specializing in one sex allow that role to be better performed? How?

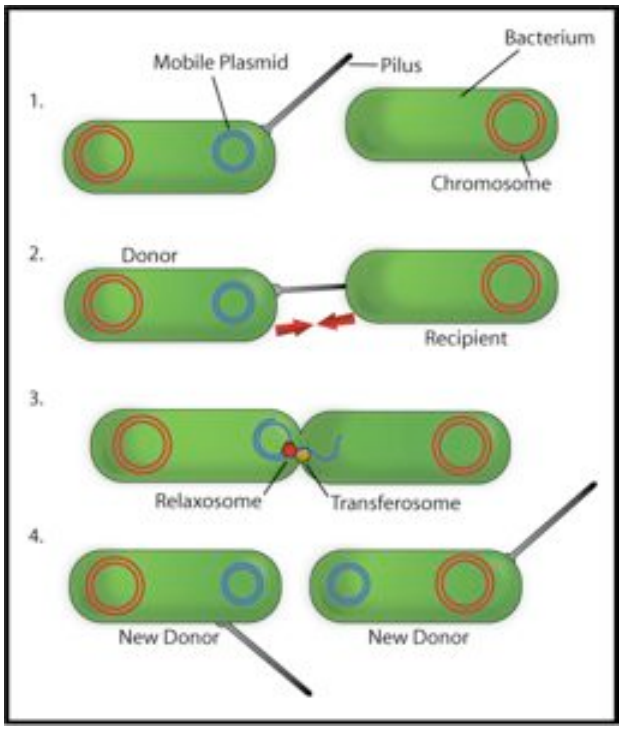


3. Similarly, it has been suggested that organisms allocate a fixed amount of energy to reproduction. Using this extra information, what can you deduce about the differences between dioecious plants (each individual is specialized to be either male or female) and hermaphroditic species?
4. Using this information, what can you deduce about the pros and cons to hermaphroditic organisms?

Asexual vs. Sexual Reproduction ... Continued

Asexual Reproduction Only (Bacteria Card):

1. What do you notice about these organisms compared to the organisms which reproduce sexually? Based on these observations, what apparent limitations does asexual reproduction have?
2. How can asexual reproduction be advantageous?
3. Although these organisms don't reproduce sexually, they have developed methods to transfer small portions of genetic material called plasmids back and forth. How does this method, called horizontal gene transfer, compare and contrast to sexual reproduction?



Horizontal Gene Transfer

4. Most microorganisms reproduce asexually but there is still a lot of variety within species. What is the driving force for creating variation? Based on the driving force, describe the relationship between the time it takes to reproduce and genetic variation.

Vegetative and sexual reproduction (Sego lily specimen and PLANT book):

- Look at pages 32 and 33 of the Eyewitness PLANT book

- Vegetative reproduction is the method some plants use to produce new genetically identical offspring without spores or seeds.

1. If these species are capable of reproducing sexually, why do they also reproduce asexually? What are the advantages of having both asexual and sexual modes of reproduction?
2. What possible negative effects could this have on an organism? a species?
3. On a recently formed remote volcanic island, would you expect to find more plants capable or incapable of vegetative reproduction? Why?

Asexual vs. Sexual Reproduction ... Continued

Self-fertilization (Daffodil specimen):

- Self-fertilization describes the process of one organism using its own pollen (or sperm) to fertilize its ova (or egg cell).

1. How can this adaptation benefit the species?
2. What problems can be associated with self-fertilization? What happens genetically over generations to an organism and its offspring if they rely solely on self-fertilization? How can this be a problem?
3. In what situations could self-fertilization be advantageous? In what situations could it be disadvantageous?
4. In many plants, the flower structure is similar to the flower in the picture below. Notice the pollen is produced very close to the stigma, which collect pollen and take it to the ovaries. Some plants like this manage *not* to self-pollinate. What methods could plants use to avoid self-pollination? What are the advantages and disadvantages?

Pollen is produced in the anthers (1)

The stigmas (2) receive pollen and deliver the sperm to the ovaries

Fragmentation (Sea star specimen):

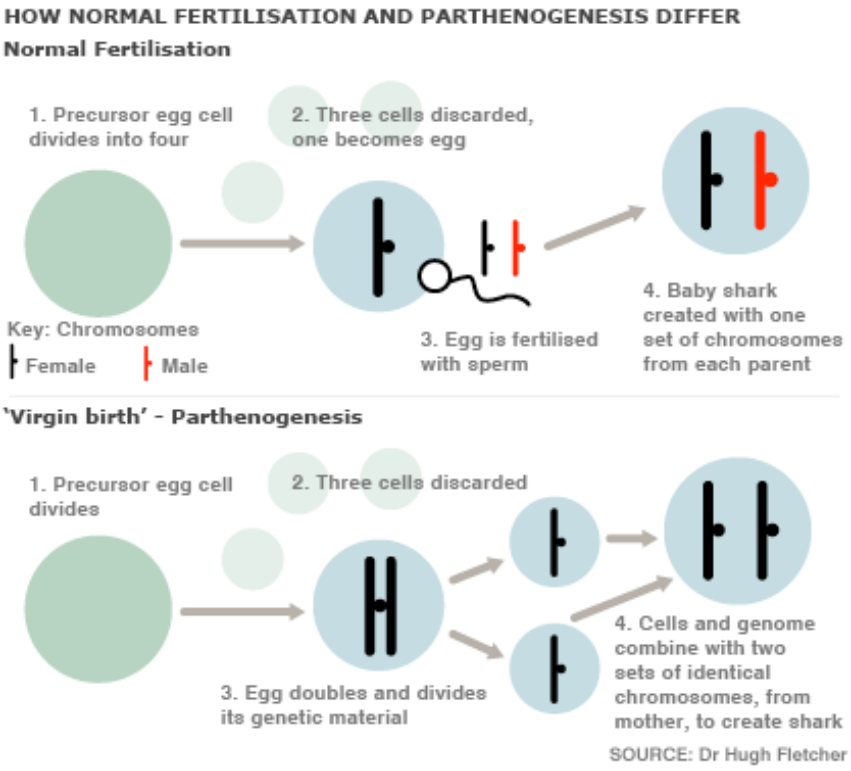
- Fragmentation is the process whereby a portion of an organism breaks or buds off and generates a new organism. In some sea stars, when an arm is broken off, the arm forms a new sea star and the original sea star regenerates the lost arm.

1. How is fragmentation and regeneration beneficial for an organism? How is it beneficial for a species?
2. Can fragmentation be disadvantageous for an organism? How so?
3. What are the costs to an organism of regenerating a limb? What are the benefits?
4. Abalone, a mussel, is harvested by humans. Sea stars compete with the humans for the abalone. In the past, abalone (an edible sea snail) farmers caught sea stars and chopped them up trying to kill them and threw them back into the ocean. Is this a good idea? Why or why not? If you were an abalone farmer and caught this sea star praying on your abalone, how would you dispose of it?

This is a picture of a sea star which is in the process of regrowing an entire body from a detached arm.

Asexual vs. Sexual Reproduction ... Continued

Parthenogenesis (Turkey Egg Display):



Parthenogenesis occurs when a haploid egg exactly duplicates its chromosomes to become diploid.

This illustration demonstrates how parthenogenesis occurs in hammerhead sharks.

1. How is this different from self-fertilization (sperm fertilizing an egg of the same organism)?
2. Look at the table below. If an organism is heterozygous for 2 genes, A and B, and undergoes parthenogenesis, what are the possible genotypes of the offspring? What about if the organism self-fertilizes? What are the differences? What are the genotypic ratios?

Genotype of parent: Aa Bb	Parthenogenesis	Self-fertilization
Remember gametes (egg and sperm) are haploid and receive either a or A and either b or B.	Haploid egg duplicates chromosomes, becomes diploid	An organism fertilizes its egg(s) with its own sperm
	What are the possible genotypes in the offspring of the organism heterozygous for A and B?	What are the possible genotypes in the offspring of the organism heterozygous for A and B?

3. In birds, the sex chromosomes are ZW instead of the XY system in mammals and some other animals. A bird with the ZZ genotype is male and ZW is female. WW will not survive. If the mother turkey produced the egg you see in the jar through parthenogenesis and the chick survives, what is the gender of the chick?

Notes:

PREP: Room Set-up

TIME: 15-30 minutes

TYPE: Exploring/ Analyzing

Feet

Kit Materials:

Instructor Resources:

- Bird Feet: Heron, Eagle, Finch, Seagull, and Duck
- Bird Environments Pictures: Marsh, Grasslands, Forest, Shoreline, Pond
- Mammal Feet: Horse, Weasel, Black Bear, Leopard, Rhinoceros, Giraffe, Lion, Wolf, Bighorn Sheep

Classroom Transformation:

- Divide into 12 groups

Supplemental Materials:

- Library and internet resources
- Paper and pencils.

Curriculum Connections:

ILO 1: Use science process and thinking skills
ILO 2: Manifest scientific attitudes and interests
ILO 3: Demonstrate understanding of science concepts and principles
ILO 4: Communicate effectively using science language and reasoning

SCIENCE

7th Grade

STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a: Predict why certain traits are more likely to offer an advantage for survival of an organism.
b: Cite examples of traits that provide an advantage for survival in one environment but not other environments.
c: Cite examples of changes in genetic traits due to natural and manmade influences.
d: Relate the structure of organs to an organism's ability to survive in a specific environment.

Biology Core

STANDARD V: Students will understand that biological diversity is a result of evolutionary processes.

Objective 1: Relate principles of evolution to biological diversity.
a. Describe the effects of environmental factors on natural selection.

Overview:

Students learn about the effects of the environment on adaptations and how species evolve to survive in a particular habitat. Through a study of the evolution of feet, students are helped to understand more about how adaptations help an organism to survive.

Description:

This activity begins with a class discussion. The teacher leads the class to match the five bird feet with their respective five environments.

- Heron: marsh
- Hawk: grasslands
- Finch: forest
- Seagull: shoreline/ocean
- Duck: pond

Suggested Questions for the Group Discussion

1. What characteristics of the foot help this organism survive in its environment?
2. Does the foot structure give any insight into diet of this bird?
3. What is this foot designed to do?
4. Where in this habitat would you expect this bird to be found?

After the class discussion, the students break up into 9 groups and each group is assigned one of the different mammal feet. Each group needs to answer the following questions about their assigned foot.

1. What environment would this foot be best suited for?
2. What characteristics of the foot help the animal survive? What is this foot designed for? Defense? Structure? Insulation? Weight bearing? Climbing? Swimming?

After their ideas are noted, the teacher then gives the students the name of the animal of which the foot belonged. The students then go to the library or use the internet to research their ideas and predictions and see if they were correct. Drawing diagrams and cross-sections of the structures is also recommended.

When the group reports are completed, the students get together in jigsaw groups and share their foot's adaptations with others in their new groups.

Alternatives:

- Instead of the teacher leading the class discussion, have the students break into small groups to match the feet to the environments and answer the same questions as above.
- Show the environments and ask students to hypothesize about what adaptations bird feet would have to survive. Then show the feet pictures, have them match the feet to the environment, and then compare the predictions to the actual feet.

Notes:

PREP: Familiarity with Game

TIME: 50-90 Minutes

TYPE: Integration Activity

Farmer for a Day

Overview:

Students play a game in which they get to be potato farmers, teaching them important principles as the difference between asexual and sexual reproduction, genetic engineering, and the importance genetics has in all areas of our lives, even agriculture. As potato farmers, they need to make decisions about how to produce the most potatoes in a set amount of time. These decisions include when to cross plants and which plants to cross in order to produce beneficial hybrids, when to plant acres of land using potatoes' asexual mode of reproduction, and whether or not to utilize genetic engineering.

Game Rules:

Congratulations! You and some of your friends have each inherited 15 acres of beautiful potato farmland. Now it is up to each of you to produce as many potatoes as possible to try to help fight starvation (and of course to earn a healthy little profit for yourselves). Potato farming is not super-easy, so this is a little guide to assist you through your experience.

How to Win: Be the farmer with the most bushels of potatoes at the end of the game.

Setup

- 4 players per game.
- Place the laminated Punnett Square card in the middle and have a dry-erase marker handy.
- Each player gets one "Harvested Potatoes" card and one card of each starting plant variety (1-3) for a total of 3 plant varieties. Add one acre of each of these varieties to the available farmland box on the "Harvested Potatoes" card.
- Shuffle all action cards and place them face down in the middle. All empty potato cards are placed aside until needed.
- Each player rolls the 4-sided die to determine who goes first. The highest roll goes first.

Game play

On each turn:

- Draw an action card and follow the instructions on the card. The Harvest, Disease, Famine, and Protest cards affect all players. Insect Infestation, Weather Damage, Mutation, and Genetic Engineering cards affect only the player who drew it.
    - For every additional bushel of potatoes harvested, add one tally mark to the harvested potatoes box.

Kit Materials:

Game Materials

9 boxes each containing a set of rules and:

- 1 Punnett square sheet
- 4 harvest potatoes cards
- 41 action cards
- 40 potato cards

Classroom Transformation:

- Set up playing areas for groups of 4 students

Prerequisite Concepts:

- Simple Punnett squares
- Dominance and codominance

Curriculum Connections:

SCIENCE

7th Grade

STANDARD IV

Objective 1: Compare how sexual and asexual reproduction passes genetic information from parent to offspring.

b: Contrast the exchange of genetic information in sexual and asexual reproduction.

c: Cite examples of organisms that reproduce sexually and those that reproduce asexually.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.

c: Cite examples of changes in genetic traits due to natural and manmade influences.

Biology Core

STANDARD IV

Objective 1: Compare sexual and asexual reproduction.

a: Explain the significance of meiosis and fertilization in genetic variation

b: Compare the advantages/disadvantages of sexual and asexual reproduction to survival of species.

Objective 2: Predict and interpret patterns of inheritance in sexually reproducing organisms.

a: Explain Mendel's laws of segregation and independent assortment and their role in genetic inheritance.

c: Relate Mendelian principles to modern-day practice of plant and animal breeding.

STANDARD V

Objective 1: Relate principles of evolution to biological diversity.

d: Compare selective breeding to natural selection and relate the differences to agricultural practices.

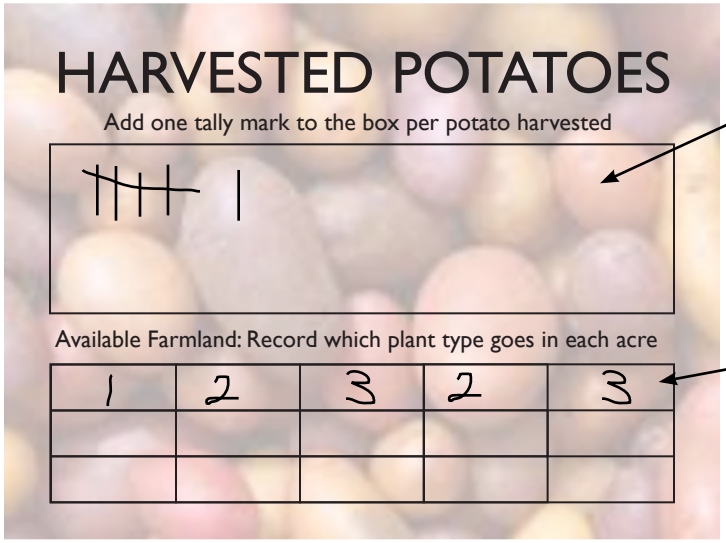
Farmer for a Day

... Continued

- Any potato varieties destroyed by disease or insects are flipped over and out of the game until replanted. (See replanting)

- After the directions on the card have been followed, the player then has the opportunity to plant more potato plants in one of the following 4 ways:
  - Sexual Reproduction
  - Asexual Reproduction
  - Genetic Engineering
  - Replanting destroyed varieties
- For each additional plant grown, record the plant type on the Available Farmland box in the next open acre slot.
- Each farmer only has 15 acres to work with. If all 15 acres are already planted, one acre needs to be cleared of its previous variety before for it can be replanted with a different variety.

- At the end of this turn, the player hands the die to the player to the left.



Keep a tally of the harvested potatoes in this box with the dry-erase marker.

Every time an acre is planted, record the plant type that fills that acre. Each box represents one acre. Everyone should start with the first 3 boxes filled with 1, 2, and 3 respectively.

Card Types

- **Harvest:** Each plant has a gene, P, which determines the potato production number. The alleles are P^1, P^2, and P^3. This gene exhibits incomplete dominance, so the production number is the average (rounded-down) of the number on the two alleles. If the alleles are P^2P^1, the average is 1.5, so rounded down, the production number is 1. When a harvest card is drawn, the die is rolled to determine which plants produce potatoes. All plants with a production number greater than or equal to the number rolled produce one bushel of potatoes. Any plants with a production number less than the roll produce nothing.
  - **Example:** If a 2 is rolled, potatoes with a production number (average of the alleles) 2 or higher produce one bushel. Potatoes with a production number of 1 produce no bushels.
- **Disease:** Each plant has three disease resistance genes, a-res, b-res, and c-res. There are two alleles per gene, one (A, B, or C) which is dominant and causes resistance to that particular disease. The other alleles (a, b, or c) are recessive and when homozygous, cause the plant to be sensitive to that disease. When a disease card is drawn, the die is rolled to determine which disease type is introduced. If 1 is rolled, that indicates disease type A, 2 indicates type B, 3 indicates type C, and 4 is no disease. All plants without resistance to this particular type of disease are killed. Erase the plant tally from the card and flip it over. Empty the acres containing this variety from the available

farmland boxes. This variety is out of the game until replanted (see replanting).

- **Insect Infestations:** A new swarm of insects invade your crops and feed specifically on one variety of your potato crops. Shuffle your potato cards and have the player to your left pick one at random. This variety is destroyed by insects. Flip this card over. Be sure to empty the acres containing this variety from the "Available Farmland" box. This variety is out of the game until replanted (see replanting).
- **Famine:** Other food crops fail. In order to prevent mass starvation, the government requires all potato farmers to share half of their reserves. All players lose half of all harvested potatoes, rounded down.
- **Weather Damage:** Your crops get hit by severe weather. Roll the die twice and take the sum. This is the number of acres that are affected. The player chooses the affected acres. These plants are unable to produce any potatoes for the next 3 harvests. Weather Damage affects only the player who drew the card.
- **Mutation:** One of your plant types receives a mutation, either in the disease C resistance Gene (c-res) or the production number gene (tater). Shuffle cards and have the player to your left pick a plant at random. Roll the die. If the roll is a 3 or 4, this is a gain of function mutation and that gene becomes homozygous dominant, or if it is the tater gene, both production numbers increase by one (P2P2 goes to P3P3, P3P3 goes to P4P4, etc.). If the roll is a 1 or 2, this indicates a loss of function mutation and this gene becomes homozygous recessive, or if it is the tater gene, both production numbers decrease by 1 (P2P2 goes to P1P1). If this was in the c-res gene, it now becomes cc and non-resistant to Disease C. Cross out the original genotype with the marker and write in the new genotype.
- **Genetic Engineering:** If you draw this card, you have the opportunity to genetically engineer one gene of your choice for a reduced cost of 8 bushels of potatoes. If you choose to do this, choose one gene of one plant variety to be modified. If this is a disease resistance gene, this gene becomes homozygous dominant and the plant becomes resistant the corresponding disease. If this is the tater gene, the production number of both alleles increases by 1 (P1P3 becomes P2P4).
- **Protest:** If this card is drawn, the harvesting of any genetically engineered plants stops for 3 harvests. All other plants are unaffected.

Reproduction

On their turn, the player has the option of planting more plants. Because potatoes reproduce both sexually and asexually, there are multiple options. On each turn you can (but don't have to) select one of the following methods.

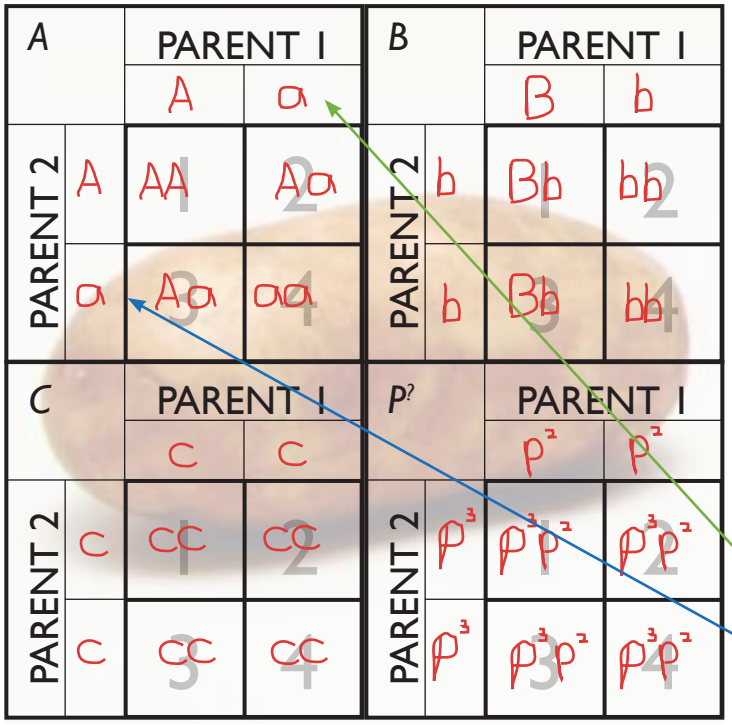
- **Asexual reproduction:** Potatoes reproduce asexually when an eye forms a bud. To plant more potatoes through asexual reproduction, subtract one from the total potatoes harvested and plant two plants of the variety of your choice. Record the newly planted acres in the "Available Farmland" box. (See Harvested Potatoes card on previous page)
- **Replanting:** If any variety of potato gets flipped over because of disease or insect infestation, no plants are left. In order to replant these varieties, a 5 potato fee must be paid, the card is flipped over, and one acre of this variety is added to the "Available Farmland" box.
- **Genetic Engineering:** With modern technology, a gene can be manipulated for a cost. If a player wants to create a plant with a specific genetic change without the time and effort of crossing plants, genetic engineering is the way to go. On a player's turn, a new plant type can be created from a previous strain with one gene of choice genetically engineered. This costs 15 bushels of potatoes. If the gene of choice is a disease resistance gene, this causes the plant to be homozygous dominant (AA, BB, or CC) and thus disease resistant. If the gene is the tater gene, this causes the production number of both alleles to increase by one (P1P3 becomes P2P4) which in turn

Farmer for a Day

... Continued

increases the overall production number of this variety. Mark the box on the card indicating this plant type has been genetically engineered. Remember, if the protest card is drawn, these plants will be out of commission for 3 turns.

- **Sexual reproduction:** Potatoes are angiosperms and thus also reproduce through pollination. This allows for greater genetic variation, unlike asexual reproduction. To cross two plants through sexual reproduction, pay 2 bushels of potatoes from the "Harvested Potatoes" box as the time and energy cost. Then list the genotypes in the Punnett Squares provided for you and determine the possible offspring. Because genetics is random, roll the die for each gene and write down on a blank potato card the genotype of the offspring correlating to the numbered squares determined by the rolls. (see diagram below for an example)



To make a cross, take the genotype of one parent and put the alleles of each gene in the appropriate box along the top. Place the alleles of the other parent in the boxes along the side. Fill in the Punnett Square. Roll the 4-sided die once for each gene. The number on the die determines which box of the Punnett Square is the genotype of the new plant.

This is the example if you were to cross plant type 2 (genotype AaBbccP^{2}P^2) and 3 (genotype AabbccP^{3}P^3). If the rolls were 2, 3, 1, 2, then the genotype of the new plant would be AaBbccP^{3}P^2 corresponding to the respective boxes.

Variety 2 genotype (top of Punnett Square)

Variety 3 genotype (side of Punnett Square)

End of Game

- The game is over after the previously specified time is up. The length of time is variable and the teacher can decide. 45 minutes is the suggested length of time. At this point, all players count the number of harvested potatoes. The player with the most is the winner.

Follow Up Options:

- Focus on Asexual vs. Sexual Reproduction: Give each group a question from 1 through 6. Have each group discuss their question. Then have the groups rearrange into new groups so each new group has at least one student with each of the questions. Each original group might need to have more than one question to make this work. Have each new group discuss their original questions and explain them to each other. Finally, have each student write a one page paper about the best method of potato farming. Use this as a lead-in to the Asexual vs. Sexual Reproduction activity.

- Focus on Genetic Engineering: Give each group one of the following questions: 3, 4, 7, 8, 9, 10. Have each group discuss their question. Then have the groups rearrange into new groups so each new group has at least one student with each of the questions. Each original group might need to have more than one question to make this work. Have each new group discuss their original questions and explain them to each other. Finally, have each group discuss and work on question 11, developing a policy to balance the positive and negative effects of genetic engineering.
- Have each group or individual do some research on a particular topic

  GMOs
  - Write a paper about the benefits and controversies of genetically modified food crops
  - Be sure to use trustworthy sources and not sources with an agenda
  - http://www.ornl.gov/sci/techresources/Human_Genome/elsi/gmfood.shtml is a good place to start

  Plant Breeding
  - http://en.wikipedia.org/wiki/Plant_breeding
  - Triticale is an interesting example of breeding

Questions: (See Answer Sheet)

1. Which method of reproduction would allow for the largest potato crops?
2. If the goal was to produce a strain with a combination of positive traits from multiple plant types, how would you go about doing this?
3. What are the advantages of sexual reproduction compared to asexual reproduction?
4. What are the disadvantages of sexual reproduction?
5. What are the advantages of asexual reproduction?
6. What are the disadvantages of Asexual Reproduction?
7. What are some weaknesses in food crops that can be overcome/compensated for by genetic engineering?
8. How could overcoming weaknesses through genetic engineering have negative effects on the environment?
9. What are the differences and similarities between genetic modification of crops and artificial selection through breeding?
10. What differences are there between artificial manipulation (breeding or genetic engineering) and natural selection?
11. Discuss a policy balancing the positive and negative effects of genetic engineering.

Notes:

PREP: Room Set-up

TIME: 1-2 class periods

TYPE: Research/ Presentation

Species Protection

Overview:

Students (individually or in small groups) make a poster of information about their specimen. The classroom can then be made into a Scientific Poster Showcase room where the groups explain reasons why we should preserve these organisms.

Description:

Because of the concern about diminishing biodiversity and global catastrophes, the Fish and Wildlife Services (FWS) of the U.S. Government has asked that students (individually or in small groups) research and present to them one species each. They want to know which species should have priority if the global situation becomes worse and what we can to save the biodiversity of the world. Each student or group is to make a poster presentation about the details of the specimen, its adaptations, and why we should preserve this species. Use drawings, photographs, and persuasive writing to convince FWS that your specimen should be at the top of the list of preserved species. Teachers may want to allow students to spend time researching their specimen online or at home if they want the students to learn more about the organism than is described on the specimen card. Features of the poster presentation could include:

- Habitat, diet and other lifestyle information
- Adaptations of the organism contributing to biodiversity
- Effect of the specimen on its environment
- Plan of action for preserving this species

The desks or tables need to be arranged so that the classroom has a station for each specimen group. For the first 30 minutes, half of the class (leaving at least one person from each group to man their stations) visits the other posters and asks the researchers about the species which they are trying to protect. Students who are visiting fill out the provided handout as they learn about each species. Researchers answer the questions to the best of their ability and try to persuade their peers support their species. Students vote on the posters based on the following categories:

- Most creative
- Most humorous
- Most informative
- Most Scientific
- Most interactive

Switch roles for the last 30 minutes of class and repeat the process. Feel free to use the presentation rubric to grade the presentations.

Alternatives:

• Students produce a television commercial promoting their species.

Kit Materials:

Instructor Resources:

• Specimen Cards
• Class access to all other resources

Classroom Transformation:

• Arrange room for presentation of displays.

Specimens:

• All

Supplemental Materials:

• Poster creation materials: large post-it paper/butcher paper, markers, glue, ribbon, etc.

Curriculum Connections:

LANGUAGE ARTS

7th-8th Grade

Standard 2 (Writing): Persuasive Writing
Standard 3 (Inquiry/Research/Oral Presentation): Reports and Presentations

SCIENCE

7th Grade

STANDARD IV: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.
a: Predict why certain traits are more likely to offer an advantage for survival of an organism.
b: Cite examples of traits that provide an advantage for survival in one environment but not other environments.
d: Relate the structure of organs to an organism's ability to survive in a specific environment.

Biology Core

STANDARD IV Objective 2d: Analyze bioethical issues and consider the role of science in determining public policy.

STANDARD V: Students will understand that biological diversity is a result of evolutionary processes

Objective 1: Relate principles of evolution to biological diversity.
a: Describe the effects of environmental factors on natural selection.
b: Relate genetic variability to a species' potential for adaptation to a changing environment.

Species Protection

... Scientific Poster Guidelines

The following information is courtesy of Penn State University found at: http://www.writing.engr.psu.edu/posters.html

Posters are a special type of presentation. When well designed, they are not simply journal papers pasted onto boards. Nor are they mounted sets of presentation visuals. Rather, posters, when effectively designed, are something in between.

The purpose of scientific posters is to present work to an audience who is walking through a hallway or exhibit. In poster presentations at conferences, the presenter usually stands next to the poster, thus allowing for passers-by to engage in one-on-one discussions with the presenter.

So what then makes for an effective poster?

- First, the title of an effective poster should quickly orient the audience. Here are some guidelines for poster titles:
  1. Make the title the most prominent block of text on the poster (either center or left justify at the top).
  2. Do not typeset the title in all capital letters (such text is difficult to read).
  3. Use small words such as of, from, with, to, the, a, an, and and to separate details in the title.

  While phrase titles are most common, some scientists and engineers effectively use sentence titles for posters that present one main result. In such titles, state the result in the title and capitalize the words as you would in a sentence. Because the sentence title is a stand-alone, as opposed to being part of a paragraph, the period is generally dropped.

- Second, the poster should quickly orient the audience to the subject and purpose. One good test is whether the audience recognizes the subject and purpose within 20 seconds of seeing the poster. Usually, a poster accomplishes this goal with a well-crafted title and with supporting images. Also, make sure that the type is large enough to be read and that enough contrast exist between the color of the type and poster's background.

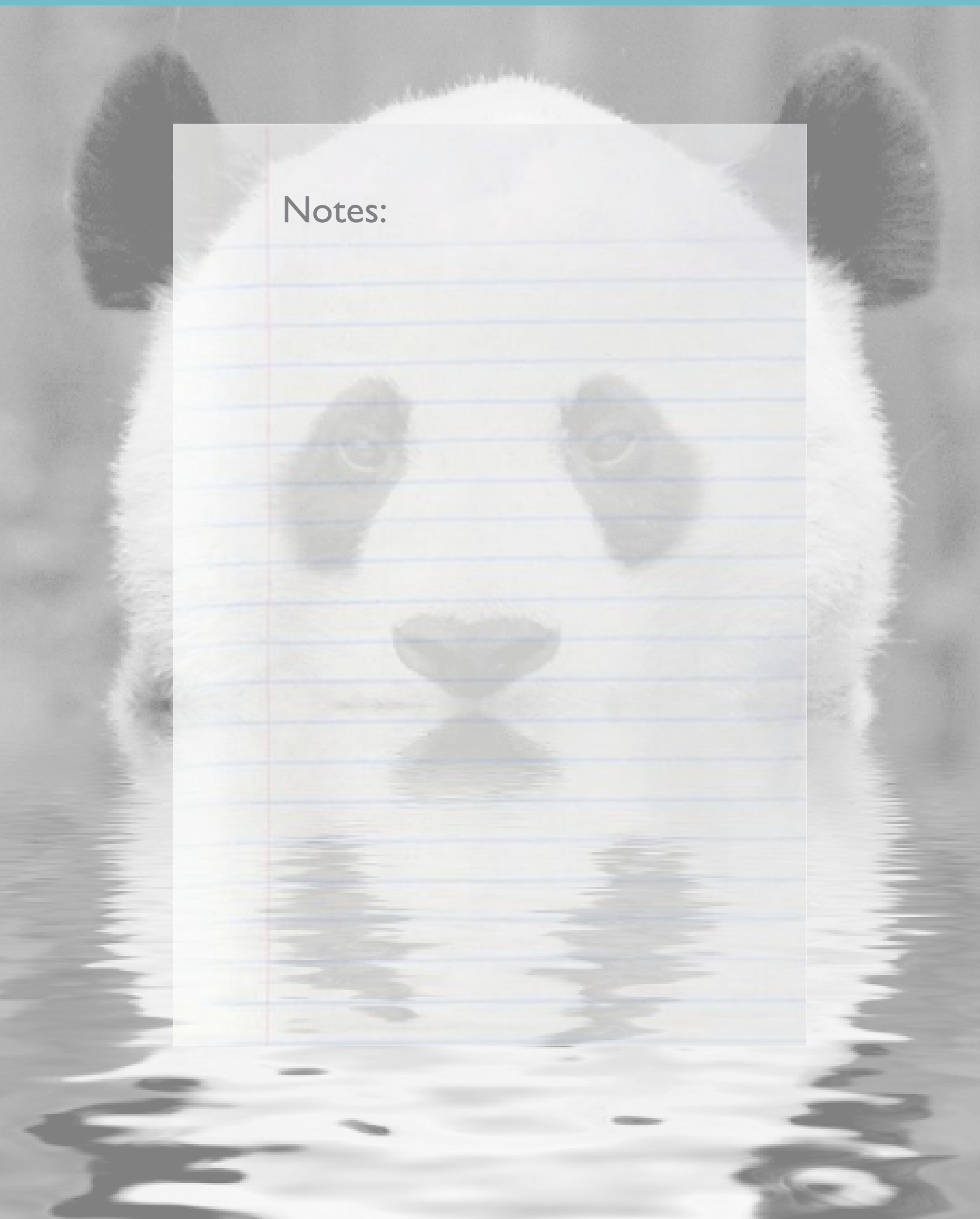
- Third, the specific sections such as the results should be easy to locate on the poster. Once readers recognize what the work is, they decide how much energy to invest into the poster. For instance, many will read only the motivation for the work, the objectives (or goals) of the work, and then the final results. Others, who have a deep interest in the topic, will try to read the poster from beginning to end. Given these different approaches to reading posters, another characteristic of an effective poster is that specific sections are easy to locate.

- Fourth, you should design the individual sections of a poster so that they can be quickly read. Given the distractions that occur while reading posters in a symposium, the poster should not contain large blocks of text. Neither should the poster contain long sentences. If possible, the sections should rely on images: photographs, drawings, and graphs.

Advertising Presentation Rubric

Group Members

	Beginning	Developing	Accomplished	Exemplary	Score
Participation	1 point One main speaker; little participation from other group members	2 points Most group members participate; unequal contributions	3 points All group members have significant participation	4 points Well balanced participation by all group members	
Information Presented	Minimal Information presented	Some information given; not complete or accurate	Complete, accurate information given	Complete, accurate well-organized presentation of information. All the information in the instructions was included.	
Visuals	There are no visuals	There is a picture of the specimen	There is a picture of the specimen and other visuals	The picture of the specimen is interesting, original, colorful. It is accompanied by other visuals that are also interesting, original, and colorful	
Delivery	Poorly organized, hesitant, shows lack of rehearsal	Some organization and rehearsal	Good organization. Smooth. Obviously rehearsed.	Very Professional, polished. Confident. Excellent flow.	
Categories for delivery	No audience eye contact, distracting mannerisms.	Very little eye contact, relies heavily on notes.	Good eye contact, only somewhat dependent on notes.	Excellent eye contact, minimal reliance on notes.	
Most creative Most humorous Most informative Most Scientific Most interactive	Very poor vocal inflection: mumbling, monotone, too soft.	Somewhat lacking vocal inflection. Some stumbling and mumbling.	Projects voice clearly and loudly with good inflection.	Excellent use of voice enhances this presentation: loud, clear, animated, varied pitch.	
Comments:					Total:



Notes: