Lesson Title: The Mechanisms of Evolution

Lesson Author: Margaret Thayer

Grade Level: 12  Subject Area: Ecology/Evolutionary Biology

Time Allotted for the Lesson:
This lesson will be completed in a single, one-hour class period.

Short Description of Lesson:
This is lesson 1 in a five-lesson unit on biodiversity. In this lesson, students will learn about the four mechanisms of change in evolution that lead to species diversity: mutation, genetic drift, gene flow/gene migration, and natural selection. The students will also discover the truth about some evolution misconceptions and learn why evolutionary biologists use phylogeny instead of Linnaean taxonomy for species identification.

Classroom Layout and Grouping of Students:
All instruction will take place in the classroom. Students will view a YouTube video as a class via a Smartboard projector, participate in class discussions as a group, and review parts of the online Evolution 101 tutorial as well as other online sources via individual computers.

State Curriculum Standards met in this lesson:

State of Wisconsin Science Standard F: Life and Environmental Science
Performance Standards - Grade 12
Content Standard: Students in Wisconsin will demonstrate an understanding of the characteristics and structures of living things, the processes of life, and how living things interact with one another and their environment.

BIOLOGICAL EVOLUTION
F.12.5. Understand the theory of evolution, natural selection, and biological classification
F.12.6. Using concepts of evolution and heredity, account for changes in species and the diversity of species, including the influence of these changes on science, e.g. breeding of plants or animals

National Education Technology Standards for Students (NETS•S) met in this lesson:

ISTE NETS for Students (2007)

3. Research and Information Fluency
Students apply digital tools to gather, evaluate, and use information. Students:
a. plan strategies to guide inquiry.
b. locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
Instructional Objectives:

1. When prompted by a quiz question, students will define the term \textit{genetic variation} with 100% accuracy.
2. When prompted by a quiz question, students will name and describe the four mechanisms of change in evolution with 100% accuracy.
3. When prompted by a quiz question, students will explain why evolutionary biologists identify species by phylogeny rather than Linnaean taxonomy with 100% accuracy.
4. Students will complete the online Evolution Lesson Review quiz with 100% accuracy.

Materials, Resources, and Technology:

\textit{Materials and resources needed for this lesson:}
1. Classroom setting (chairs and desks)
2. Biodiversity Unit syllabus (printed handout)
3. Final project (Google Presentation) instructions and list of topics
4. Signup sheet in Google Spreadsheet for final project groups

\textit{Graphics needed for this lesson:}
1. Advance organizer
2. Evolution Lesson Review quiz

\textit{Technology resources needed for this lesson:}
1. Instructor and student computers with an Internet connection
2. Smartboard projector
3. Access to YouTube.com

\textit{Web addresses needed for this lesson:}
1. Evolution 101: \url{http://evolution.berkeley.edu/evosite/evo101/index.shtml}
2. “Understanding Evolution” Glossary: \url{http://evolution.berkeley.edu/evosite/glossary/}
3. “Understanding Evolution” Misconceptions: \url{http://evolution.berkeley.edu/evosite/misconceps/index.shtml}

Student’s Present level of Performance and Knowledge:

Students must know how to conduct a Web search and have a basic understanding of biology and genetics from their high school biology class. It is expected that many students will already have some previous exposure to basic evolutionary biology concepts, but the lesson is designed so this background is not necessary.

Instructional Procedures:

Lesson Set:

The teacher will introduce the lesson by telling the class that they will be starting a unit on biodiversity to
coincide with the United Nations’ designation of 2010 as the “International Year of Biodiversity.” The teacher will ask the class if they can define biodiversity and suggest reasons why biodiversity is important enough for the United Nations to declare an International Year of Biodiversity. Finally, the teacher will ask the students to describe Wisconsin’s biodiversity and suggest why it might be important to try to protect the state’s species diversity.

Techniques and Activities:

1. Following the lesson set, the teacher will inform the students that they will have one graded assignment for the Biodiversity Unit: to prepare a Google Presentation about biodiversity that will be presented to the class. The teacher will explain that the students will be divided into seven small groups of three or four students each to prepare their presentations. Each group will be given one topic related to biodiversity for their group presentation. Students will sign up for one of the groups at the conclusion of lesson 3.

2. The teacher will distribute a syllabus for the Biodiversity Unit and give a brief overview of the five lessons in the Biodiversity Unit.

3. The teacher will direct the students to the Biodiversity Unit Website and provide a quick orientation to the site’s contents, including the Advance Organizer graphic. The teacher will explain that the Advance Organizer serves as a pictorial outline of the evolutionary process that leads to biodiversity.

4. The teacher will explain that the first lesson in the Biodiversity Unit will focus on the four mechanisms of evolution that lead to biodiversity: mutation, genetic drift, gene flow/gene migration, and natural selection.

5. To introduce the topic of evolutionary change mechanisms, the teacher will show the class the YouTube video “How Evolution Works-Forces” (8:44) via the Smartboard projector. A short class review/discussion will follow.

6. The teacher will distribute the final project/presentation assignment instructions so students will know what information they need to include in their presentations and what presentation topics are available. The teacher will tell the students to be thinking about which topic interests them the most throughout the lesson, because they will need to choose a topic by the end of lesson 3. The following are the presentation topics:

   - How do the mechanisms of change in evolution lead to species diversity?
   - How does phylogeny work?
   - Why should people care about protecting species biodiversity?
   - How do people in Wisconsin benefit from species biodiversity?
   - What is a biodiversity hotspot?
   - Describe one of the world’s biodiversity hotspots (other than Madagascar) and explain why it is designated as a hotspot (2 groups; each must choose a different hotspot)

7. The teacher will direct the students to the Evolution 101 Web tutorial and tell them that they will have 25 minutes to read the following parts of the tutorial: Definitions, Mechanisms (Descent and Mechanisms of Change), and Misconceptions About Evolution and the Mechanisms of Evolution. The teacher will also point out the Understanding Evolution Glossary on the same Website, which they can use as a reference throughout the Biodiversity Unit.

8. The teacher will direct the students to the Evolution Lesson Review quiz posted on the Biodiversity Unit Website and tell them to take the quiz and check their answers. The teacher will ask the students if they have any questions about the quiz or any of the lesson materials.
Lesson Closure:
In the final five minutes, the teacher will ask the students if they have any questions about the Evolution Lesson Review or the Evolution 101 tutorial. The teacher will prompt the students (as a class) to verbally name the four mechanisms of change in evolution, then tell them that they will be studying one of those mechanisms, natural selection, in more detail in lesson 2.

Adaptations for Special Learners:
Screen reader technology will be available for students who have low vision. The YouTube videos are provided with closed captioning for students who have hearing difficulties; for those who do not, the teacher could contact the video sponsors and ask them to provide a transcript and/or closed captioning in their videos. For the small group activity, students with sight or hearing difficulties will be placed in groups with students who do not have these difficulties so the group members can assist them.

Supplemental Activities - Extension and Remediation:


Assessment/Evaluation:
For this lesson, students will self-evaluate their understanding of the lesson's main concepts by taking the online Evolution Lesson Review quiz.

Student Products:
Students will not be completing a product for this lesson. Instead, they will be working on a project for completion at the end of the five-lesson Biodiversity Unit. During this lesson, the teacher should inform the students that they will need to apply knowledge from this lesson to the final project for the Biodiversity Unit that will be in the form of a Google Presentation. Therefore, students are encouraged to begin thinking about the project.
Lesson Title: Natural Selection
Lesson Author: Margaret Thayer

Grade Level: 12          Subject Area: Ecology/Evolutionary Biology

Time Allotted for the Lesson:
This lesson will be completed in two, one-hour class periods.

Short Description of Lesson:
This is lesson 2 in a five-lesson unit on biodiversity. In this lesson, students will learn more about the non-random and cumulative nature of the process of natural selection, which the featured biologist in the lesson’s introductory video refers to as “the single most important force in evolution.”

Classroom Layout and Grouping of Students:
All instruction will take place in the classroom. Students will view a video as a class via a Smartboard projector; participate in class discussions as a group; review parts of the online Evolution 101 tutorial and interact with two online simulations via individual computers; and play a card game that demonstrates the cumulative and non-random nature of natural selection.

State Curriculum Standards met in this lesson:
State of Wisconsin Science Standard F: Life and Environmental Science
Performance Standards - Grade 12
Content Standard: Students in Wisconsin will demonstrate an understanding of the characteristics and structures of living things, the processes of life, and how living things interact with one another and their environment.

BIOLOGICAL EVOLUTION
F.12.5. Understand the theory of evolution, natural selection, and biological classification
F.12.6. Using concepts of evolution and heredity, account for changes in species and the diversity of species, including the influence of these changes on science, e.g. breeding of plants or animals

National Education Technology Standards for Students (NETS•S) met in this lesson:
ISTE NETS for Students (2007)
1. Creativity and Innovation
Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students:
   c. use models and simulations to explore complex systems and issues.
   d. identify trends and forecast possibilities.

3. Research and Information Fluency
Students apply digital tools to gather, evaluate, and use information. Students:
a. plan strategies to guide inquiry.
b. locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.

Instructional Objectives:

1. When prompted by a quiz question, students will identify the two most important traits of natural selection: non-random and cumulative.
2. Students will complete the online Natural Selection Lesson Review quiz with 100% accuracy.
3. Students will answer the questions in the "Natural Selection Among Playing Cards" worksheet via a Google Docs document with 100% accuracy.

Materials, Resources, and Technology:

Materials and resources needed for this lesson:
1. Classroom setting (chairs and desks)
2. Biodiversity Unit syllabus (printed handout)
3. Final project (Google Presentation) instructions and list of topics
4. Signup sheet in Google Spreadsheet for final project groups
5. Four decks of playing cards
6. Sixteen envelopes labeled 1 to 16 for card game

Graphics needed for this lesson:
1. Advance organizer
2. Natural Selection fish graphic

Technology resources needed for this lesson:
1. Instructor and student computers with an Internet connection
2. Smartboard projector
3. Flash players on computers

Web addresses needed for this lesson:
1. Evolution 101 Natural Selection tutorial: http://evolution.berkeley.edu/evolibrary/article/0_0_0/evo_25
**Student's Present level of Performance and Knowledge:**

Students must know how to navigate the Web and have a basic understanding of biology and genetics from their high school biology class. In addition, they should have completed lesson 1 of the unit, which introduces the concept of natural selection.

**Instructional Procedures:**

**Lesson Set:**

The teacher will introduce the lesson by showing the video “How Does Evolution Really Work?” (6:39) to the class via the Smartboard projector. A short class review/discussion will follow. This video serves as a review of lesson 1 content and an introduction to the content of lesson 2.

**Techniques and Activities:**

**First Class Period:**

1. Following the lesson set, the teacher will direct the students to the Biodiversity Unit Website and review the Advance Organizer graphic. The teacher will point out that lesson 2 focuses on the topic of natural selection, which is one of the four mechanisms of change in evolution discussed in lesson 1 and leads to adaptations, which will be discussed in more detail in lesson 3.
2. The teacher will direct the students to the Natural Selection graphic and have the students scroll through it. Then the teacher will ask the students to describe in their own words what the graphic’s important message about natural selection is.
3. The teacher will direct the students to the Evolution 101 Web tutorial on Natural Selection and tell them that they will have 15 minutes to read through it. If the students have time, they can also read through the “sidetrips” that are part of this tutorial. The teacher will remind the students that the Understanding Evolution Glossary is a good reference tool for learning terminology.
4. The teacher will direct the students to two simulation games about natural selection, the Flashy Fish guppy simulation and Darwin Survival Game simulation. The teacher will have the students work with a partner sitting next to them to work through the simulations. The students will have the remaining class period (except the lesson closure in the final two minutes) to explore the simulations. The teacher will tell the students to try one simulation first, and switch to the other simulation halfway through the designated time period. Both students in each group should take turns controlling the mouse in each simulation.
5. The teacher will direct the students to the Natural Selection Lesson Review quiz posted on the Biodiversity Unit Website and tell them to take the quiz and check their answers. The teacher will ask the students if they have any questions about the quiz or any of the lesson materials.

**Second Class Period:**

1. At the beginning of the lesson, the teacher will remind the students that they will have one graded assignment for the Biodiversity Unit: to prepare a Google Presentation about biodiversity that will be presented to the class. The teacher will refer to the final project/presentation assignment instructions and point out the sign-up sheet. The teacher will remind the students to be thinking about which topic interests them the most throughout the lesson, because they will need to choose a topic at the end of
Lesson 3. The following are the presentation topics:

- How do the mechanisms of change in evolution lead to species diversity?
- How does phylogeny work?
- Why should people care about protecting species biodiversity?
- How do people in Wisconsin benefit from species biodiversity?
- What is a biodiversity hotspot?
- Describe one of the world's biodiversity hotspots (other than Madagascar) and explain why it is designated as a hotspot (2 groups; each must choose a different hotspot)

2. Most of the second class period will be devoted to playing the “Natural Selection Among Playing Cards” game and completing the game worksheet. The game instructions and handouts are available at the ENSI site listed in the resources section. The teacher will divide the class into four teams (5 or 6 students each) and distribute the student handouts and game materials to each team.

3. The teacher will explain the game and assign Procedure A to two teams and Procedure B to two teams.

4. The students will have 30 minutes to play the game. The teacher will prompt the students to report their results to the class.

5. The students will have 15 minutes to individually complete the Cumulative Natural Selection worksheet. Students will respond to the questions via a Google docs document and place the document in their class folder.

6. If students complete the worksheet early, they can spend the time reviewing materials from class period 1.

Lesson Closure:
In the final two minutes of the first class period, the teacher will tell the students that they will be playing a card game to learn more about natural selection in the next class period, and they will have more time to review the simulation games, tutorial, and supplementary materials.

In the final two minutes of the second class period, the teacher will explain that lesson 3 will cover adaptations and adaptive radiation.

Adaptations for Special Learners:
Screen reader technology will be available for students who have low vision. The YouTube videos are provided with closed captioning for students who have hearing difficulties; for those who do not, the teacher could contact the video sponsors and ask them to provide a transcript and/or closed captioning in their videos. For the small group activity, students with sight or hearing difficulties will be placed in groups with students who do not have these difficulties so the group members can assist them.

Supplemental Activities - Extension and Remediation:
Supplemental extension activities:

Three-topic tutorial (natural selection, the genetic basis of variation, and microevolution) with interactive
simulations: http://ats.doit.wisc.edu/biology/ev/ns/ns.htm

Remediation activities:


Summary of natural selection from The Biology Web (Clinton Community College): http://faculty.clintoncc.suny.edu/faculty/michael.gregory/files/bio%20101/bio%20101%20lectures/Natural%20Selection/natural.htm

Assessment/Evaluation:

Students will self-evaluate their understanding of ideas from the lesson via the online Natural Selection Lesson Review quiz. Students will be evaluated formally with the “Cumulative Natural Selection” worksheet assignment. The worksheet will be worth 80 points (10 points per question).

Student Products:

Students will complete the “Cumulative Natural Selection” worksheet as a Google Docs document.
Lesson Title: Adaptive Radiation and Speciation

Lesson Author: Margaret Thayer

Grade Level: 12 Subject Area: Ecology/Evolutionary Biology

Time Allotted for the Lesson:
This lesson will be completed in a single one-hour class period.

Short Description of Lesson:
This is lesson 3 in a five-lesson unit on biodiversity. In this lesson, students will learn about species adaptations, adaptive radiation, and speciation.

Classroom Layout and Grouping of Students:
All instruction will take place in the classroom. Students will view videos as a class via a Smartboard projector; participate in class discussions as a group; and review parts of the online Evolution 101 tutorial and interact with two online simulations via individual computers at their desks.

State Curriculum Standards met in this lesson:

State of Wisconsin Science Standard F: Life and Environmental Science
Performance Standards - Grade 12
Content Standard: Students in Wisconsin will demonstrate an understanding of the characteristics and structures of living things, the processes of life, and how living things interact with one another and their environment.

BIOLOGICAL EVOLUTION
F.12.5. Understand the theory of evolution, natural selection, and biological classification
F.12.6. Using concepts of evolution and heredity, account for changes in species and the diversity of species, including the influence of these changes on science, e.g. breeding of plants or animals

National Education Technology Standards for Students (NETS•S) met in this lesson:

ISTE NETS for Students (2007)

3. Research and Information Fluency
Students apply digital tools to gather, evaluate, and use information. Students:
a. plan strategies to guide inquiry.
b. locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.

Instructional Objectives:
1. When prompted by a quiz question, students will define adaptive radiation and describe one example of adaptive radiation.
2. When prompted by a quiz question, students will describe one example of a trait that is not an adaptation.
3. Students will complete the online Adaptive Radiation and Speciation Lesson Review quiz with 100% accuracy.

Materials, Resources, and Technology:

Materials and resources needed for this lesson:
1. Classroom setting (chairs and desks)
2. Biodiversity Unit syllabus (printed handout)
3. Final project (Google Presentation) instructions and list of topics
4. Signup sheet in Google Spreadsheet for final project groups

Graphics needed for this lesson:
1. Advance organizer
2. Adaptive radiation finches graphic

Technology resources needed for this lesson:
1. Instructor and student computers with an Internet connection
2. Smartboard projector
3. Flash players on computers

Web addresses needed for this lesson:
1. Evolution 101 Defining Adaptation tutorial: [http://evolution.berkeley.edu/evolibrary/article/0_0_0/misconcept_06](http://evolution.berkeley.edu/evolibrary/article/0_0_0/misconcept_06)
2. “Understanding Evolution” Misconceptions About Natural Selection and Adaptation tutorial: [http://evolution.berkeley.edu/evolibrary/article/misconcept_01](http://evolution.berkeley.edu/evolibrary/article/misconcept_01)
4. “Understanding Evolution” Speciation tutorial: [http://evolution.berkeley.edu/evolibrary/article/0_0_0/evo_40](http://evolution.berkeley.edu/evolibrary/article/0_0_0/evo_40)
5. “Understanding Evolution” Glossary: [http://evolution.berkeley.edu/evosite/glossary](http://evolution.berkeley.edu/evosite/glossary/)

Student’s Present level of Performance and Knowledge:

Students must know how to navigate the Web and have a basic understanding of biology and genetics from their high school biology class. In addition, they should have completed lessons 1 and 2 of the Biodiversity Unit, which introduced the concept of species adaptations.
Instructional Procedures:

Lesson Set:

The teacher will introduce the lesson by showing the class the short PBS NOVA video, “Evolution in Action: Salamanders” (3:21) via the Smartboard projector. This video describes the adaptations of a salamander species as it spread out to different geographic locations of California. These adaptations represent an adaptive radiation event that is evolving into a speciation event. The video serves as a review of lesson 2 content and an introduction to the content of lesson 3. A short class discussion will follow.

Techniques and Activities:

1. Following the lesson set, the teacher will direct the students to the Biodiversity Unit Website and review the Advance Organizer graphic. The teacher will point out that lesson 3 covers the topics of adaptive radiation and speciation.

2. The teacher will direct the students to the Adaptive Radiation graphic and have the students scroll through it. Then the teacher will explain that the graphic depicts how adaptive radiation can lead to speciation. The teacher will give the students 5 minutes to read the short article by Dolph Schluter that explains how Darwin’s finches represent the adaptive radiation-to-speciation transition.

3. The teacher will direct the students to the Evolution 101 Website and give them 20 minutes to review the following tutorials: Defining Adaptation, Misconceptions About Natural Selection and Adaptation, Triggering Adaptive Radiation, and Speciation. If the students have time, they can also read through the “sidetrips” that are part of this tutorial. The teacher will remind the students that the Understanding Evolution Glossary is a good reference tool for learning terminology.

4. The teacher will show the class the YouTube video “Facts of evolution: Speciation and extinction” (9:18).

5. The teacher will direct the students to the Adaptive Radiation and Speciation Lesson Review quiz posted on the Biodiversity Unit Website and tell them to take the quiz and check their answers. The teacher will ask the students if they have any questions about the quiz or any of the lesson materials.

6. In the final five minutes of the class period, the teacher will remind the students that they will have one graded assignment for the Biodiversity Unit: to prepare a Google Presentation about biodiversity that will be presented to the class. The teacher will refer to the final project/presentation assignment instructions and point out the sign-up sheet. The teacher will remind the students to be thinking about which topic interests them the most throughout the lesson, because they will need to choose a topic at the end of this lesson. The following are the presentation topics:
   - How do the mechanisms of change in evolution lead to species diversity?
   - How does phylogeny work?
   - Why should people care about protecting species biodiversity?
   - How do people in Wisconsin benefit from species biodiversity?
   - What is a biodiversity hotspot?
   - Describe one of the world’s biodiversity hotspots (other than Madagascar) and explain why it is designated as a hotspot (2 groups; each must choose a different hotspot)

Lesson Closure:

In the final two minutes of the second class period, the teacher will explain that lesson 4 will cover
phylogeny, a form of identifying species by their relationships to each other on the “tree of life.”

**Adaptations for Special Learners:**

Screen reader technology will be available for students who have low vision. The YouTube videos are provided with closed captioning for students who have hearing difficulties; for those who do not, the teacher could contact the video sponsors and ask them to provide a transcript and/or closed captioning in their videos. For the small group activity, students with sight or hearing difficulties will be placed in groups with students who do not have these difficulties so the group members can assist them.

**Supplemental Activities - Extension and Remediation:**

Supplemental extension activities:

“Darwin and Natural Selection” tutorial (Palomar College Dept. of Behavioral Sciences):
http://anthro.palomar.edu/evolve/evolve_2.htm

“Species, speciation and the environment” ActionBioscience article:
http://www.actionbioscience.org/evolution/eldredge.html

Remediation activities:

YouTube video “A look at the finches of the Galapagos Islands”:
http://www.youtube.com/watch?v=l25MBq8T77w&feature=related (2:11, closed captioning available)

Three-topic tutorial on speciation, including two interactive case studies:
http://ats.doit.wisc.edu/biology/ev/sp/sp.htm

**Assessment/Evaluation:**

For this lesson, students will self-evaluate their understanding of ideas from the lesson via the online Adaptive Radiation and Speciation Lesson Review quiz.

**Student Products:**

Students will not be completing a product for this lesson. Instead, they will be working on a project for completion at the end of the five-lesson Biodiversity Unit. During this lesson, the teacher should remind the students that they will need to apply knowledge from this lesson to the final project for the Biodiversity Unit that will be in the form of a Google Presentation. Therefore, students are encouraged to continue thinking about the project.
Lesson Title: Phylogeny: The Tree of Life

Lesson Author: Margaret Thayer

Grade Level: 12

Subject Area: Ecology/Evolutionary Biology

Time Allotted for the Lesson:

This lesson will be completed in a single, one-hour class period.

Short Description of Lesson:

This is lesson 4 in a five-lesson unit on biodiversity. In this lesson, students will learn about phylogeny, a form of identifying species by their relationships to each other on the “tree of life.” They will explore portions of the Tree of Life Web Project and answer some questions about it.

Classroom Layout and Grouping of Students:

All instruction will take place in the classroom. Students will participate in class discussions as a group; and review parts of the online Evolution 101 tutorial and the Tree of Life Web Project via individual computers.

State Curriculum Standards met in this lesson:

State of Wisconsin Science Standard F: Life and Environmental Science
Performance Standards - Grade 12
Content Standard: Students in Wisconsin will demonstrate an understanding of the characteristics and structures of living things, the processes of life, and how living things interact with one another and their environment.

BIOLOGICAL EVOLUTION
F.12.5. Understand the theory of evolution, natural selection, and biological classification
F.12.6. Using concepts of evolution and heredity, account for changes in species and the diversity of species, including the influence of these changes on science, e.g. breeding of plants or animals

National Education Technology Standards for Students (NETS•S) met in this lesson:

ISTE NETS for Students (2007)

3. Research and Information Fluency
Students apply digital tools to gather, evaluate, and use information. Students:
  a. plan strategies to guide inquiry.
  b. locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.

Instructional Objectives:
1. When prompted by a quiz question, students will define the term *phylogeny* with 100% accuracy.
2. When prompted by a quiz question, students will explain how phylogeny differs from taxonomy with 100% accuracy.
3. The students will complete the Tree of Life questionnaire via a Google Docs document with 100% accuracy.

**Materials, Resources, and Technology:**

*Materials and resources needed for this lesson:*
1. Classroom setting (chairs and desks)
2. Biodiversity Unit syllabus (printed handout)
3. Final project (Google Presentation) instructions and list of topics
4. Signup sheet in Google Spreadsheet for final project groups

*Graphics needed for this lesson:*
1. Advance organizer
2. Tree of Life Web Project procedures graphic

*Technology resources needed for this lesson:*
1. Instructor and student computers with an Internet connection
2. Tree of Life Web Project questionnaire (Google Docs)

*Web addresses needed for this lesson:*
1. Evolution 101 “Patterns” tutorial: [http://evolution.berkeley.edu/evosite/evo101/I1History.shtml](http://evolution.berkeley.edu/evosite/evo101/I1History.shtml)
5. Wikispecies: [http://species.wikimedia.org/wiki/Main_Page](http://species.wikimedia.org/wiki/Main_Page)
7. Interactive Tree of Life: [http://itol.embl.de/](http://itol.embl.de/)

**Student's Present level of Performance and Knowledge:**

Students must know how to navigate the Web, copy and share a Google Docs document, and have a basic understanding of biology and genetics from their high school biology class. In addition, they should have completed lessons 1 through 3 of the Biodiversity Unit, which introduced the term “phylogeny.”

**Instructional Procedures:**

**Lesson Set:**

The teacher will introduce the lesson by directing the students to the Biodiversity Unit Website to review the Advance Organizer graphic. The teacher will point out that an important aspect of identifying speciation events is being able to accurately identify different species, because what constitutes a “species” is not always obvious. In fact, biologists sometimes disagree on the definitions and classification of organisms. The teacher will encourage students to read the article “What is a species?” (listed as the supplementary activity) to understand the issues surrounding species classification.
Techniques and Activities:

1. Following the lesson set, the teacher will explain that lesson 4 covers the topic of phylogeny, a form of identifying species by their relationships to each other on the “tree of life” that is favored by evolutionary biologists over the traditional Linnaean classification system.

2. The teacher will direct the students to the Evolution 101 Website and give them 10 minutes to review the Patterns tutorial. If the students have time, they can also explore the “sidetrips” that are part of this tutorial. The teacher will remind the students that the Understanding Evolution Glossary is a good reference tool for learning terminology.

3. The teacher will direct the students to the Tree of Life Web Project procedures graphic and explain that they should follow the instructions in the procedures to navigate the Tree of Life (ToL) site. The procedures guide the students to answer a questionnaire posted in Google Docs. The students should make a copy of the questionnaire, answer the questions, and post their answers to their shared assignment folder. The students will have 20 minutes to complete this activity.

4. Using the Smartboard Projector, the teacher will briefly introduce the following online species databases: Encyclopedia of Life, Wikispecies, Catalogue of Life, and Interactive Tree of Life (see Resources list). The teacher will advise the students that all of these species databases may be useful resources for their final project, the Biodiversity Google Presentation.

Lesson Closure:
In the final two minutes of the second class period, the teacher will explain that lesson 5, the final lesson in the Biodiversity Unit, will cover phylogeny, a form of identifying species by their relationships to each other on the “tree of life.”

Adaptations for Special Learners:
Screen reader technology will be available for students who have low vision. The YouTube videos are provided with closed captioning for students who have hearing difficulties; for those who do not, the teacher could contact the video sponsors and ask them to provide a transcript and/or closed captioning in their videos. For the small group activity, students with sight or hearing difficulties will be placed in groups with students who do not have these difficulties so the group members can assist them.

Supplemental Activities - Extension and Remediation:
Supplemental extension activities:

“Island Biogeography and Evolution: Solving a Phylogenetic Puzzle Using Molecular Genetics”: http://www.ucmp.berkeley.edu/fosrec/Filson.html


Assessment/Evaluation:
Students will complete the Tree of Life Web Project questionnaire via Google Docs. The worksheet will be worth 80 points (10 points per question).

**Student Products:**

Students will not be completing a product for this lesson. Instead, they will be working on a project for completion at the end of the five-lesson Biodiversity Unit. During this lesson, the teacher should remind the students that they will need to apply knowledge from this lesson to the final project for the Biodiversity Unit that will be in the form of a Google Presentation. Therefore, students are encouraged to continue thinking about the project.
Lesson Title: Why Does Biodiversity Matter?

Lesson Author: Margaret Thayer

Grade Level: 12 Subject Area: Ecology/Evolutionary Biology

Time Allotted for the Lesson:
This lesson will be completed in five, one-hour class periods.

Short Description of Lesson:
This is lesson 5 of five lessons on Biodiversity. Students will learn about the benefits of and threats to biodiversity. Students will learn about the designation of biodiversity “hotspots” and take a virtual ecotour of Madagascar, one of the world's biodiversity hotspots. Finally, students will complete the final project for the Biodiversity Unit, a Google Presentation on an assigned topic about biodiversity.

Classroom Layout and Grouping of Students:
All learning will take place in the classroom. Students will view videos and participate in class discussions as a group, then students will individually take a virtual ecotour of Madagascar using a computer.

State Curriculum Standards met in this lesson:

State of Wisconsin Science Standard F: Life and Environmental Science
Performance Standards - Grade 12
Content Standard: Students in Wisconsin will demonstrate an understanding of the characteristics and structures of living things, the processes of life, and how living things interact with one another and their environment.

BIOLOGICAL EVOLUTION
F.12.5. Understand the theory of evolution, natural selection, and biological classification
F.12.6. Using concepts of evolution and heredity, account for changes in species and the diversity of species, include the influence of these changes on science, e.g. breeding of plants or animals

National Education Technology Standards for Students (NETS•S) met in this lesson:

ISTE NETS for Students (2007)

2. Communication and Collaboration
Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students:
  2a. interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media: collaborate with peers and field-specific experts to research a critical issue applying effective research strategies, appropriate digital tools for the task(s), field-testing component(s); and publication of results to interested individuals and through appropriate networks.
3. Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students:

b. locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.

Instructional Objectives:

1. Students will answer the Madagascar virtual ecotour questions via a Google Docs document with 95% accuracy.
2. Students will produce (in small groups of 3 or 4 students) a Google Presentation about biodiversity that contains between 16 and 20 slides (8 to 10 picture slides and 8 to 10 text slides).
3. Students will verbally present to the entire class at least 3 text-image slide pairs from their group’s slideshow.

Materials, Resources, and Technology:

Materials and resources needed for this lesson:

1. Classroom setting (chairs and desks)

Graphics needed for this lesson:

1. Advance organizer
2. Map of Madagascar with ecoregions labeled by color

Technology resources needed for this lesson:

1. Computers with an Internet connection
2. Flash players loaded on computers
3. Google Apps, including Google Docs and Google Presentations
4. Access to YouTube.com

Web Addresses needed for this lesson:

1. YouTube video from the United Nations, Official Video of the International Year of Biodiversity 2010: [http://www.youtube.com/watch?v=V1VYmpTikgw](http://www.youtube.com/watch?v=V1VYmpTikgw) (8:27)
2. Conservation International’s series of nine YouTube videos:
   - Part 1: Introduction: [http://www.youtube.com/watch?v=GGAgPrXpibo&feature=related](http://www.youtube.com/watch?v=GGAgPrXpibo&feature=related) (1:39)
   - Part 3: “Setting Global Priorities for Biodiversity Conservation”:
     [http://www.youtube.com/watch?v=ZxrCafQb1us&feature=related](http://www.youtube.com/watch?v=ZxrCafQb1us&feature=related) (4:21)
   - Part 4: “Identifying Priority Species for Biodiversity Conservation”:
   - Part 5: “Identifying Priority Sites for Biodiversity Conservation”:
   - Part 6: “Key Biodiversity Areas (KBA's) Prioritization”:
     [http://www.youtube.com/watch?v=oJTmBJt81OQ&feature=related](http://www.youtube.com/watch?v=oJTmBJt81OQ&feature=related) (2:51)
   - Part 7: “Identifying Priority Landscapes and Seascapes”:
     [http://www.youtube.com/watch?v=lUge1d2Me4&feature=related](http://www.youtube.com/watch?v=lUge1d2Me4&feature=related) (3:14)
Part 8: “Planning and Implementing Conservation Actions”:
http://www.youtube.com/watch?v=kvaXM0qsrPw&feature=related (2:54)
Part 9: “Monitoring Effectiveness of Conservation Actions”:
http://www.youtube.com/watch?v=Bg4bQ7zwTFw&feature=related (2:59)

3. Biodiversity Hotspots Website: http://www.biodiversityhotspots.org/xp/hotspots/Pages/default.aspx
4. Wisconsin Department of Natural Resources (DNR) online report Wisconsin’s Biodiversity as a Management Issue, Chapter 2: Biodiversity: Issues and Implications:
5. YouTube video, “Where did all of Madagascar’s species come from?”,
http://www.youtube.com/watch?v=k6bsH_RwqU8&feature=channel (12:55).
7. YouTube/edu video, “Animals populated Madagascar by rafting there,”
http://www.youtube.com/watch?v=ayjStRD60O (3:41)
8. “Virtual ecotour: Madagascar” Website,

Student’s Present level of Performance and Knowledge:

Students must know how to conduct a Web search, how to create a Google Presentation, and have a basic understanding of biology and genetics from their high school biology class. In addition, they should have completed lessons 1 through 4 of the Biodiversity Unit, which gave them a basic understanding of evolution, natural selection, species adaptation, adaptive radiation, speciation, and phylogeny.

Instructional Procedures:

Lesson Set:

The teacher will introduce the lesson by presenting to the class the United Nations’ video (posted on YouTube) “Official Video of the International Year of Biodiversity 2010” (8:27) to serve as an introduction to the benefits of and threats to global biodiversity. Following the video, the teacher will review the material in the video and spark a discussion about how the livelihoods of people everywhere (including Wisconsin) might be affected by habitat loss and species extinction.

Techniques and Activities:

Classroom Period 1:
1. Following the lesson set, the teacher will direct the students to the Biodiversity Unit Website to review the Advance Organizer graphic. The teacher will explain that lessons 1 through 4 described how the process of evolution leads to biodiversity, as described in the Advance Organizer, and lesson 5 will explore why biodiversity is important to not only plants and animals, but also people.
2. The teacher will present Conservation International (CI)’s series of nine short videos about global biodiversity, biodiversity hotspots, and efforts to protect the world’s biodiversity from extinction. This series of videos will take approximately 40 minutes. Following the series, the teacher will lead a class discussion about the series.
3. The teacher will introduce CI’s biodiversity hotspots Website and the Wisconsin DNR’s biodiversity report as resources for the Biodiversity Unit final project. The remaining time in this class period will be
spent discussing the videos and the resources that have been introduced throughout the Biodiversity Unit that can be used for the final project.

Classroom Period 2:
1. The teacher will explain that this class period will be devoted to exploring one of the world's biodiversity hotspots, the island of Madagascar.
2. The teacher will direct the students to the map of Madagascar's ecoregions posted on the Biodiversity Unit Website. The teacher will ask the students to look at the map a few moments and speculate what the island's ecoregions might suggest about speciation patterns. The class will discuss this topic for about five minutes.
3. The teacher will present to the class three YouTube videos, “Where did all of Madagascar's species come from?” (12:55), “Animals populated Madagascar by rafting there” (3:41), and “Extinction close-up: Madagascar” (6:00).
4. The teacher will introduce students to the virtual tour of Madagascar's ecoregions and allow students time to explore the site on their own. The virtual ecotour contains quiz questions with answer keys.

Classroom Periods 3 and 4:

The next two classroom periods will be student worktime to prepare their final projects for the Biodiversity Unit. Students will work in small groups or on their own, and the teacher will be available to answer questions and help students with their research. The teacher should offer strategies that the students might use for working in their groups. For example, the teacher might suggest that the students start by dividing up the work into tasks and assigning each member of the group to a task. Students may need additional time outside of class to complete the project.

Classroom Period 5: See lesson closure.

Lesson Closure:

In the last class period, students will present their Google Presentations to the class via the Smartboard projector. Each of the seven groups will have seven minutes to present their slideshow. Group members must share the task of describing slides to the class; all members of each group must describe at least three slides to the class. For each text-image slide pair, students should read the text, show the image, and explain why the group chose that image. The groups will present their slideshows in the order on the sign-up sheet.

Adaptations for Special Learners:

Screen reader technology will be available for students who have low vision. Some of the YouTube videos are provided with closed captioning for students who have hearing difficulties; for those that do not, the teacher could contact the video sponsors and ask them to provide a transcript and/or closed captioning in their videos. For the small group activity, students with sight or hearing difficulties will be placed in groups with students who do not have these difficulties so the group members can assist them.

Supplemental Activities - Extension and Remediation:

Supplemental extension activities (all links will be on the Biodiversity Unit Website so students can use
them as potential resources for their final project):

Action BioScience articles, “Speciation and Biodiversity”:
http://www.actionbioscience.org/biodiversity/wilson.html and “The Sixth Extinction”:
http://www.actionbioscience.org/newfrontiers/eldredge2.html

Science Daily articles:


Niche Differences in Biodiversity: Species Differences are Responsible for their Coexistence”: http://www.sciencedaily.com/releases/2009/08/090812163802.htm

“Exceptions Prove Rule of Tropical Importance in Biodiversity”:

Remediation activities:

“What is island biogeography?” article: http://biology.suite101.com/article.cfm/what_is_island_biogeography
Evolution 101 tutorial, “Where did all of Madagascar’s species come from?”:
http://evolution.berkeley.edu/evolibrary/news/091001_madagascar

**Assessment/Evaluation:**

Students will be evaluated formally based on their final project: a Google Presentation on an assigned topic about biodiversity. The final project is worth 200 points (150 points for the slideshow, 30 points for group participation, and 20 points for the class presentation).

**Student Products:**

Students will produce (in small groups of 3 or 4 students) a Google Presentation on an assigned topic about biodiversity that contains between 16 and 20 slides (8 to 10 picture slides and 8 to 10 text slides). Students will present the slideshow to the class. Each of the seven groups will have seven minutes to present their slideshow. Group members must share the task of describing slides to the class; all members of each group must describe at least three slides to the class. For each text-image slide pair, students should read the text, show the image, and explain why the group chose that image.