5-E Unit Plan - Evolution

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Unit Title: Evolution

Unit Length: 3 Weeks (6-7 class periods)
90-minute classes

Grade Level: 9th Grade

Unit Overview:

The purpose of this unit is to introduce students to the basic concepts of evolutionary theory. By the end, students will understand that biological evolution, driven by descent with modification, is the scientific explanation for the history of the diversification of organisms from common ancestors. Students will also understand that biological evolution is used to explain the earth's present day biodiversity. Finally, students will understand that organisms vary widely within and between populations and this variation allows for natural selection to occur.

General Learning Goals and Objectives	*State Standard Expectations*
	Standard 1: Science As Inquiry: **Benchmark 1: The student will demonstrate the abilities necessary to do scientific inquiry. The student…**
Create a PowerPoint presentation over this unit's vocabulary that includes the definition, a picture	• Correctly uses the appropriate technological tools and mathematics in their own scientific investigations
Visit one of multiple online simulations that outline the process of evolution by natural selection.	
Create an experiment that outlines how you will determine if a new antibiotic will be successful in fighting bacteria. Make sure you discuss the role on bacterial evolution the pharmaceutical industry has had.	• Actively engages in conducting an inquiry, formulating and revising his or her scientific explanations and models (physical, conceptual, or mathematical) using logic and evidence, and recognizing that potential alternative explanations and models should be considered.
Perform a lab that compares the level of ptyalin in your saliva to that of your classmates. Use the information gained from this lab to better understand the role of variation in evolution	
Perform a lab which models the process of natural selection and report your findings to the class as to which bird design met with the most success.	• Communicates (reports) and defends the design, results, and conclusion of his/her investigation.
Design an experiment to determine if artificial selection could be used to develop brightly colored male fish that already have a few colored spots on	• Actively engages in communicating and defending the design, results, and conclusion of his/her investigation

their sides. After designing the experiment, discuss and defend your methodology. Additionally, predict what results you might expect to achieve and provide evidence for your decision.	
Discuss possible research questions for the example of the English Moth after analyzing data on gene frequency changes over a period of 50 years.	• Actively engages in asking and evaluating research questions
	Standard 3: The student will develop an understanding of the cell, molecular basis of heredity, biological evolution, interdependence of organisms, matter, energy, and organization in living systems, and the behavior of organisms. **Benchmark 3: The student will understand biological evolution**
Analyze how the fossil record supports the theory of evolution	• Understands biological evolution, descent with modification, is a scientific explanation for the history of the diversification of organisms from common ancestors
Explore a museum exhibit on how the process of evolution has led to the current biodiversity found on earth	
Learn the basic vocabulary of the evolution unit	
Explain how a species might diverge into 2 new species	• Understands biological evolution is used to explain the earth's present day biodiversity: the number, variety and variability of organisms.
Design an experiment to determine if artificial selection could be used to develop brightly colored male fish who already have a few colored spots on their sides	
Discuss why variation is essential for evolution to occur	• Understands organisms vary widely within and between populations. Variation allows for natural selection to occur.
Describe Natural Selection, its 4 basic principles and how these principles affect the evolutionary process.	

The contents of this unit are required at the state, district, and school level. In 10th grade, all of USD 497 students are tested over science content. The material for this unit is derived from the 3 tested Kansas curriculum standards (outlined above) and hence it is required to be taught at the 9th grade year, before the students are tested. If this content were not required at the state, district, and local level, I would still require students learn the basic tenets of evolution. Evolution is one of the foundational concepts of the biological sciences and it carries much relevance today as humans are beginning more and more to affect the evolution of organisms all around us.

Unit outcomes:

Major Science Conceptual Themes

- The student will correctly use the appropriate technological tools and mathematics in their own scientific investigations
    - Create a PowerPoint presentation over this units vocabulary that includes the definition, a picture. Be able to pass with 80% accuracy an oral quiz over a random sampling of vocabulary words, administered by the teacher or classroom para.
    - Visit http://www.teachersdomain.org/resources/tdc02/sci/life/evo/anorigin/index.html, explore the simulation, and write a one paragraph reflection for each of these two questions
        - Why did finches evolve different beak sizes on different islands?
        - Could finches on the same island evolve into different species? How?
            - Assessment will based on an a 1-2 minute oral defense of student answers, full credit will be awarded to students who demonstrate understanding of the concepts of speciation, the role of the environment in natural selection, and the overall process of evolution.

- Actively engages in conducting an inquiry, formulating and revising his or her scientific explanations and models (physical, conceptual, or mathematical) using logic and evidence, and recognizing that potential alternative explanations and models should be considered.
    - Students will have 3 options for designing an experiment and must choose one of the following to demonstrate their understanding of all steps in the scientific method.
        - Design an experiment that determines if a new antibiotic will be successful in fighting bacteria. Make sure to illustrate in your conclusions an understanding of future implications on bacterial evolution that this antibiotic may have.
        - Design an experiment based on this situation: "Biologists discovered two populations of frogs that look similar. The populations are separated by the Amazon River. What experiment could be designed to test whether the two populations are one species or two?"
        - Design an experiment based on this situation: "A particular tropical fish has a rather drab body, but the males have a few colored spots on their sides and tails. Design an experiment to determine if artificial selection can be used to develop a more brightly colored variety"
    - Assessment will be based on:
        - Hypothesis – written in the "if, then, because" format.
        - Materials – complete materials list must be provided
        - Procedure – A step by step outline of how you would conduct the experiment
        - Results – Infer what your results might if you conducted your proposed experiment. Data should be organized in tables, graphs, and charts.
        - Discussion – Talk about what your results mean and what factors might have influenced them.
        - Conclusion – Does your data support your hypothesis? Why or why not? Discuss future implications for your work. What could be improved on? What other experiments might need to take place now that you have the results from this one?

- Communicates (reports) and defends the design, results, and conclusion of his/her investigation.
    - After the student has designed one of the experiments outlined above, he will be required to orally defend and discuss the design, expected results, and expected conclusion. Assessment will be based on:
        - A coherent summary of the proposed experiment
        - Solid scientific reasoning behind the expected results and conclusion
        - A discussion of the relevance of this experiment
        - An elaboration of further experiments that could be designed based on the expected results

- Actively engages in asking and evaluating research questions
    - Students will create possible research questions for the example of the English Moth after analyzing data on gene frequency changes over a period of 50 years.
    - Additionally, students will compare research questions with each other and decide which research questions are the most relevant and practical. Assessment will be based on participation in the class discussion.

Evolution Standards

- Understands biological evolution, descent with modification, is a scientific explanation for the history of the diversification of organisms from common ancestors
    - Students will be introduced to the fossil record through video, PowerPoint, and a museum exhibit and shown how fossils provide evidence for evolutionary theory. Additionally, students will be able to see evidence of how descent with modification leads to diversification through examples in the fossil record.
    - Students will discuss the process of speciation and hypothesize as to how the processes that lead to the creation of new species have affected history of the diversification of organisms from common ancestors.

- Understands biological evolution is used to explain the earth's present day biodiversity: the number, variety and variability of organisms.
    - After performing a lab on ptyalin variation within human saliva, students will be able to explain the role variation has played in establishing earth's present day biodiversity.
    - Through video, PowerPoint, and a museum exhibit on the fossil record, students will be able to witness the development of earth's present day biodiversity from a common ancestor.

- Understands organisms vary widely within and between populations. Variation allows for natural selection to occur.
    - Students will perform a lab where the affects of variation in butterfly populations are used to demonstrate the concept of natural selection. Students will create a butterfly to put up somewhere in the school, the goal being to design one that is camouflaged so well, other students will be unable to find it. Upon completion of the lab, students will understand how variability within an environment can affect the process of natural selection.
    - Students will perform a lab in which natural selection is modeled by the creation of origami birds. Students will measure flight distances of birds with different wing dimensions and the birds that fly the furthest will produce new "offspring." After several rounds, students should begin to notice common trends in how selection pressures are influencing the wing size of their birds.

Unit Organizer:

The Unit Organizer

NAME Mike Karlin
DATE 2/18/08

④ BIGGER PICTURE

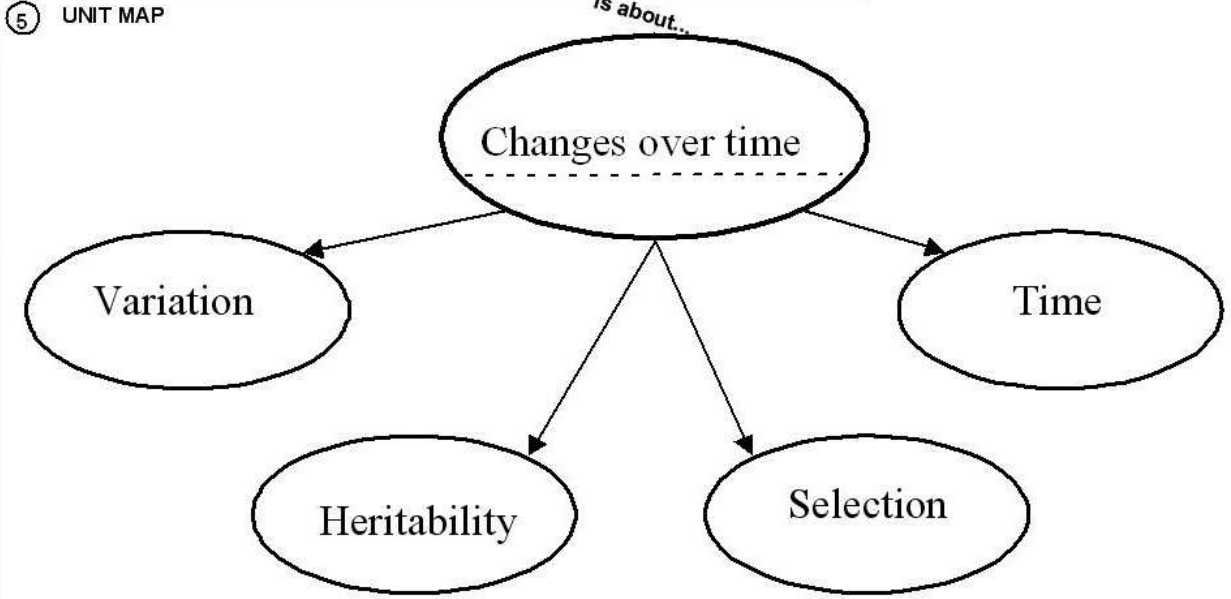
The History of Life

② LAST UNIT/Experience	① CURRENT UNIT	③ NEXT UNIT/Experience
DNA and RNA	Evolution	Viruses and Bacteria

⑧ UNIT SCHEDULE

2/29	Introduction
3/3	Learn vocabulary
3/5	Book Work
3/7	Lab Day
3/11	Museum Day
3/13	Catch-up Day
3/17	Unit Exam

⑤ UNIT MAP



UNIT SELF-TEST QUESTIONS ⑦

1) What role does variation play in natural selection?
2) Can organisms evolve within their lifetime?
3) How does the environment affect the process of evolution?
4) What is the supporting evidence for the theory of evolution?

⑥ UNIT RELATIONSHIPS

Explanation	
Explanation	
Cause / Effect	
Description	

Materials:

-Introductory PowerPoint with handout
-Unit exam
-4-Square vocabulary handout
-Laptop Cart
-Index Cards
-Biology Textbook
-Museum Packet on exploring evolution
-Origami bird lab packet
    -Straws
    -Construction paper
    -Rulers
    -Scissors
    -Tape
-Natural selection in butterflies lab packet
    -Construction paper
    -Scissors
    -Tape
    -Glue
-Variation in saliva lab packet
    -Starch
    -Iodine
    -Test tubes
    -Test tube rack
    -Straws
    -Beakers

Instructional Plan:

Engage

Day 1 - Students will take notes over an introductory PowerPoint which includes multiple video clips from the PBS Evolution series. Students will have a copy of the presentation but the key terms will be left blank for them to fill out. The presentation will last for 30-45 minutes and for the rest of the class period the will be required to do one of the following from the textbook. This will be the only bookwork the students will be required to do for the unit.

- Discuss 2 forms of evidence that are often cited as support for the theory of evolution (pg. 423)
- Discuss how a species might diverge into 2 new species (pg. 438)
- Discuss why variation is essential for evolution to occur (pg. 420)
- Discuss Natural Selection and its 4 basic principles (pg. 420)
- Discuss the 5 components of genetic equilibrium (pg. 432)

Day 2 – Students will spend the second day familiarizing themselves with the unit's vocabulary. They will choose from one of the following:

- Create a PowerPoint slide for each vocabulary word
    - Word
    - Definition
    - Sentence
    - Clip Art/Internet Picture
- Create Flashcards for each vocabulary word
    - Word on one side
    - Picture, definition, and sentence on the other
- Fill in the "4-Sqauare" sheet
    - Word
    - Definition
    - Sentence
    - Illustration.

Explore

Day 3 – Students will perform one of the following labs for the entire 90-minute period:

- Natural Selection with Origami birds
  - Page 391 of DeSalle, also see appendix
- Human Variation in Saliva
  - Page 181 of Miller, also see appendix
- Butterfly Camouflage Kab
  - Handout not yet found by cooperating teacher

Explain

Day 4 – Students will visit the evolution exhibit at the Natural History Museum and use the demonstrations, exhibits, posters, and presentations to explain the role evolution has played in shaping today's environment

- Students will have a packet to guide them through the exhibits; however, it has not yet been completed.

Elaborate

Day 5 – Students will choose from one of the following projects for the fifth day:

-Design an experiment that:

- Critical Thinking Question C – Page 419
- Determines if a new antibiotic will be successful in fighting bacteria
- Think Scientifically – Number 5, page 441

-Create a PowerPoint presentation that:

- Discusses the relevance of evolutionary theory in the modern medical and pharmaceutical fields
- Provides an overview of evolution and includes all relevant unit vocabulary

-Other Project Options:

- Compose a song/rap/ballad about how Variation, Inheritance, Selection, and Time all drive the process of evolution
  - You will have to perform the musical composition

Evaluate

Day 6 – If my pacing is off and students need more time to complete the unit activities, this day can be used as an opportunity to get everyone caught up. Otherwise, students will take a standards-based unit exam (see appendix).

Unit Assessments Organizer

Unit Name: Evolution

Assessed Indicator:

Standard 3: The student will develop an understanding of the cell, molecular basis of heredity, biological evolution, interdependence of organisms, matter, energy, and organization in living systems, and the behavior of organisms.

Benchmark 3: The student will understand biological evolution

Measurable Learning Objective	Name the Level of Blooms Taxonomy	Name the Assessment Format	Is this Assessment Formative or Summative?	Name and Brief Description of Assessment (For example, is this assessment imbedded in a lesson or is it delivered as a stand alone assessment?) If it is part of a lesson, which one?
Students will list and define the 4 factors that drive evolution	Knowledge	Fill in the blank	Formative	This assessment will be completed by the students after an introductory PowerPoint presentation is given on the first day
Students will describe the role variation plays in evolution	Knowledge	Fill in the blank	Formative	This assessment will be completed by the students after an introductory PowerPoint presentation is given on the first day
Students will list and define all major vocabulary words associated with the evolution unit	Knowledge	Oral Quiz	Summative	Students will be orally assessed over their understanding of the basic vocabulary words for the evolution unit.
Students will write 1 paragraph explaining each of the 2 forms of evidence that are often cited as support for the theory of evolution	Comprehension	Writing sample	Formative	This will be one of the choices presented to the students in their bookwork section of the unit. Students will have 5 writing options to choose from
Students will write 1 paragraph discussing how a species might diverge into 2 new species	Comprehension	Writing sample	Formative	This will be one of the choices presented to the students in their bookwork section of the unit. Students will have 5 writing options to choose from

Write one paragraph explaining why variation is essential for evolution to occur	Comprehension	Writing sample	Formative	This will be one of the choices presented to the students in their bookwork section of the unit. Students will have 5 writing options to choose from
Students will define the 5 components of genetic equilibrium and write one paragraph discussing the purpose of genetic equilibrium	Comprehension	Writing sample	Formative	This will be one of the choices presented to the students in their bookwork section of the unit. Students will have 5 writing options to choose from
Students will define Natural Selection and describe its 4 basic principles	Comprehension	Writing sample	Formative	This will be one of the choices presented to the students in their bookwork section of the unit. Students will have 5 writing options to choose from
Students will apply their knowledge of evolutionary concepts to conduct a lab which models natural selection through origami birds	Application	Lab write-up	Summative	Students will have the choice of 2 labs to complete for this unit. Each lab will require students to apply what they have learned at the knowledge and comprehension levels to successfully conduct an inquiry investigation.
Students will apply their knowledge of evolutionary concepts to conduct a lab which models natural selection through enzymes in human saliva	Application	Lab write-up	Summative	Students will have the choice of 2 labs to complete for this unit. Each lab will require students to apply what they have learned at the knowledge and comprehension levels to successfully conduct an inquiry investigation.
Students will visit a museum exhibit on evolution and analyze the				Students will take a 1 day field trip to the KU Natural History Museum.

evidence presented to determine how it could be used to support evolutionary theory.	Analysis	Packet	Formative	While there, they will have a packet which directs them through the different exhibits.
Students will design an experiment, create a PowerPoint, write a song, or complete some other project of their choosing.	Synthesis	Multiple formats possible (PowerPoint, Song, Experimental Design, etc.)	Summative	Students will be able to choose from multiple synthesis activities, all of which require students to demonstrate a complete and correct understanding of evolution.
Students will take a multiple-choice, true/false, and fill in the blank exam to demonstrate their understanding of evolution.	Evaluation	Unit Exam	Summative	Students will have approximately 45 minutes to complete the unit exam over evolution.

References

Biggs et al., Biology, Glencoe Science, McGraw Hill, 2007.

DeSalle & Heithaus, Biology, Holt, Harcourt Education Company, 2008.

Evolution, PBS 2001

ExamView Test Generator using test banks from Prentice Hall and Glencoe

Julie Battaglia, Central Junior High School, Advanced Biology and General Biology, jbattgl@usd497.org

Mandana Hurt, Central Junior High School, General Biology, mandana@sunflower.com

Miller & Levine, Biology Laboratory Manual, Prentice Hall, 2000.

Name _____ Class _____ Date _____

A Human Adaptation

Pre-Lab Discussion

Suppose that for some reason the only food source available to human beings was starch. Obviously, people who could digest starch would have a better chance of surviving than those who could not digest starch.

In human saliva, there is an enzyme called ptyalin that begins the digestion of starch in the mouth. If some people had more ptyalin in their saliva, they would be better suited to the new environment than those people who had very little ptyalin.

In this investigation, you will use a test to show the change of starch into the simple sugar glucose, determine how long it takes for your ptyalin to change starch into glucose, and find out whether other students in your class have the same amount of ptyalin. You will also determine if there is a genetic variation in your class population and whether the variation has a possible adaptive value.

Problem

What test is used to show the change of starch into the simple sugar glucose? Do people have similar amounts of ptyalin? If there is a genetic variation within a population, will this variation have an adaptive value?

Materials *(per group)*

Glass-marking pencil
10 test tubes
Test tube rack
50-mL graduated cylinder
Iodine solution
Water
2 150-mL beakers
Drinking straw
Starch solution
Medicine dropper
Glass stirring rod

Safety

Put on a laboratory apron if one is available. Put on safety goggles. Handle all glassware carefully. Always use special caution when working with laboratory chemicals, as they may irritate the skin or cause staining of the skin or clothing. Never touch or taste any chemical unless instructed to do so. Use care when collecting and working with saliva. Note all safety alert symbols next to the steps in the Procedure and review the meanings of each symbol by referring to the symbol guide on page 10.

Procedure

1. With a glass-marking pencil, number the 10 test tubes from 1 to 10. Place them in a test tube rack.
2. Using the graduated cylinder, add 2 mL of iodine solution to each of the 10 test tubes.
3. To prepare a 6% saliva solution, add 17 mL of water to a beaker. Collect 1 mL of saliva by salivating through a drinking straw into the graduated cylinder. Pour the saliva into the water in the beaker and mix the solution.
4. Place 7 mL of starch solution in another beaker. To this solution, add 1 mL of the 6% saliva solution. Mix the solution by swirling the beaker. Note the exact time that you mixed the starch-and-saliva solution.
5. After 3 minutes, use a medicine dropper to remove a small amount of the starch-and-saliva solution from the beaker.
6. Add 2 drops of the starch-and-saliva solution to the first test tube containing the iodine solution. Be sure to return the rest of the contents of the medicine dropper to the starch-and-saliva solution.
7. Record the color of the iodine solution after adding the starch-and-saliva solution. **Note**: *In the presence of starch, the iodine solution will be blue-black in color. If no starch is present, because it has been broken down by ptyalin, the iodine solution's color will not change.*
8. At 3-minute intervals, add 2 drops of the starch-and-saliva solution to each of the 9 remaining test tubes of iodine solution.

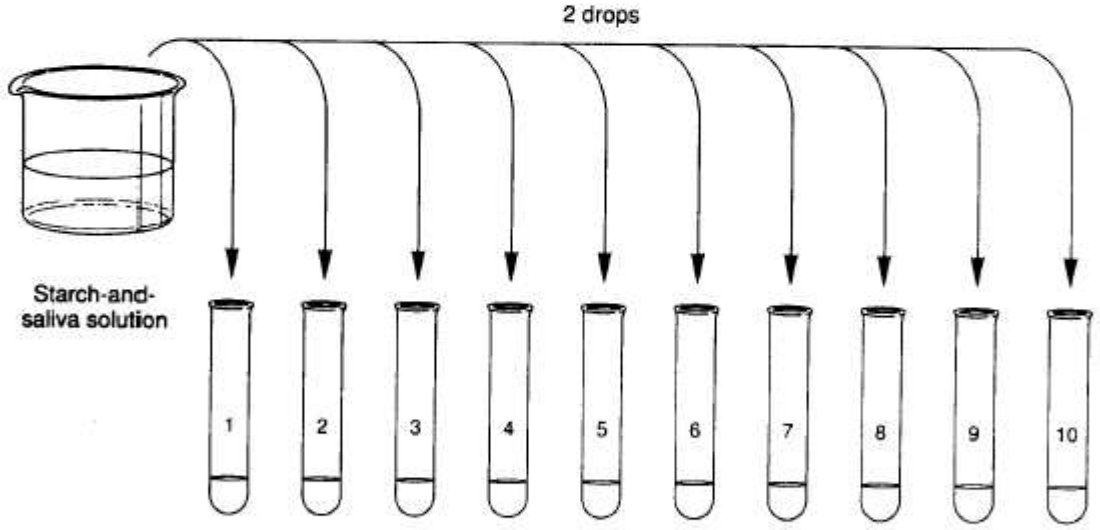


Figure 1

9. Record the color of each test tube in the proper place in Data Table 1. By observing the color of the solution, determine if the test tube contains starch or glucose and record this information as well.
10. In Data Table 2, record the total number of student groups that found a change in the starch solution within each given time interval.
11. Prepare a line graph of the results recorded in Data Table 2 using the graph provided in Observations.

Data Tables:

3-minute intervals	Color of Iodine Solution	Starch or Glucose Present?
0	Blue-Black	Starch
3		
6		
9		
12		
15		
18		
21		
24		
27		
30		

3-minute intervals	Number of Students Observing a Change in Iodine Color
0	0
3	
6	
9	
12	
15	
18	
21	
24	
27	
30	

Saliva Post-Lab Questions

How long did it take for your saliva to digest the starch?

_____

How long did it take the majority of students to digest the starch?

_____

Do the class results show that there can be variation in the amount of ptyalin in saliva? Please explain

_____

_____

_____

_____

If people only lived on starch, what change in ptyalin levels would you expect to see over time and why?

_____

_____

_____

_____

What do you think would happen if you compared your ptyalin levels to your parents and grandparents?

_____

_____

Describe three adaptations that would be useful for a 9th grader

_____

_____

_____

In prehistoric times, people had to struggle every day to survive. Why might a very smart person have an advantage?

_____

_____

_____

The ball-and-socket shoulder joint is an adaptation that is unique to primates (humans, apes, chimps, monkeys, etc.) Why is this adaptation important for the survival of the human population?

_____

_____

_____

Name _____ Class _____

Birdland

In this lab, you will use a paper model of a bird to learn how the natural selection of favorable traits occurs. The imaginary bird you will create lives in the desert and must fly very long distances between water sources in order to live and reproduce

Materials:

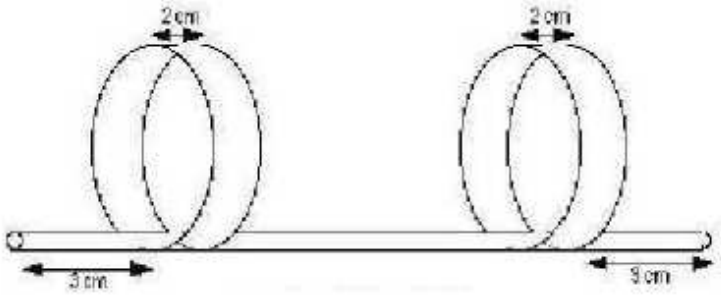
1 Piece of construction paper	Scissors
1 Ruler (with centimeters)	Tape
1 Drinking Straw	Data Table
1 Coin	Calculator
1 Die	Plenty of space to throw things

Procedure:

1) Cut your construction paper into 2 strips that are 2cm x 20cm

2) Make a loop out of each strip, with a 1cm overlap, and tape the ends together

3) Tape one loop 3cm from one end of the straw and the other loop 3cm from the other end. MAKE SURE to mark with a sharpie which end is the front.



4) Test how far your "parent" bird can fly. A gentle overhand toss works best. ALWAYS perform 2 throws for each bird and take the average

5) Each bird lays 3 eggs. The first chick will always be identical to the parent. You will use the coin and the die to create the other 2 chicks. I would suggest recording the distance of the identical chick before creating the new ones.

6) To determine what your new chicks look like, follow steps A-C below

   a. Flip a coin to see which end is affected by a mutation

      Heads = Front wing is affected Tails = Back wing is affected

   b. Throw a die to find out how the mutation affects the wing

      1 = Wing position moves 1cm toward the end of the straw
      2 = Wing position moves 1cm toward the middle
      3 = Wing circumference increases by 2cm
      4 = Wing circumference decreases by 2cm
      5 = Wing width increases by 1cm
      6 = Wing width decrease by 1cm

   c. If a mutation causes a wing to fall off the star or makes a wing's circumference smaller than the straw, the chick cannot "survive." If this happens, just produce another chick instead.

7) For each new chick record the mutation and the new wing dimensions

8) Make sure you throw each bird twice and record the average distance traveled

9) Since these birds must fly long distances to get water, assume that whichever bird flies the furthest is the most successful and will therefore have a better chance of reproducing

10) Therefore, whichever bird flies the furthest will be the parent bird for the next generation

Repeat for 8 generations - this should take about 90 minutes to complete

Bird	Coin Flip (H or T)	Dice (1-6)	Back wing (cm)			Front wing (cm)			Average distance flown (m)
			Width	Circum.	Distance from back	Width	Circum.	Distance from front	
Parent	NA	NA	2	19	3	2	19	3	
Generation 1									
Chick 1									
Chick 2 Chick 3									

Generation 2									
Chick 1									
Chick 2									
Chick 3									

Generation 3									
Chick 1									
Chick 2									
Chick 3									

Generation 4									
Chick 1									
Chick 2									
Chick 3									

Bird	Coin Flip (H or T)	Dice (1-6)	Back wing (cm)			Front wing (cm)			Average distance flown (m)
			Width	Circum.	Distance from back	Width	Circum.	Distance from front	
Generation 5									
Chick 1									
Chick 2									
Chick 3									

Generation 6									
Chick 1									
Chick 2									
Chick 3									

Generation 7									
Chick 1									
Chick 2									
Chick 3									

Generation 8									
Chick 1									
Chick 2									
Chick 3									

Post-Lab Questions:

What patterns in wing size and position did you notice during the experiment?

Why did you use the bird that flew the furthest as the parent for the next generation of birds?

Why is it important that you use a coin and a die, instead of just picking which mutation occurs?

What do you notice about the average flight length of the first generation compared to the last generation?

What does this tell you about the process of natural selection?

What do you think would happen if you moved this species of bird to an area that had plenty of water and they no longer had to fly great distances?

Advanced Biology - Evolution Exam

True/False
Indicate whether the statement is true or false.

____ 1. Natural selection is based on the concepts of variation, inheritance, and the advantages of certain traits in specific environments.

____ 2. Fossils, although interesting, do not actually provide evidence of evolution.

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 3. Within a decade of the introduction of a new insecticide, nearly all of the descendants of the target insects are resistant to the usual-sized dose. What is the most likely explanation for this change in susceptibility to the insecticide?
   a. Eating the insecticide caused the insects to become more resistant to it.
   b. Eating the insecticide caused the insects to become less resistant to it.
   c. The pesticide destroyed organisms that cause disease in the insects, thus allowing them to live longer.
   d. The insects developed physiological adaptations to the insecticide.

____ 4. How do fossils demonstrate evidence of evolution?
   a. They show that ancient species share similarities with species now on Earth.
   b. They show evidence of species that are now extinct.
   c. They are the primary source of evidence of natural selection.
   d. Fossils reveal that many species have remained unchanged for millions of years.

____ 5. A population diverges and becomes reproductively isolated. Which of the following is the best description of that phenomenon?
   a. speciation
   b. bottleneck
   c. postzygotic isolation
   d. sexual selection

____ 6. According to Darwin's theory of natural selection, the individuals that tend to survive are those that have
   a. characteristics their parents acquired by use and disuse.
   b. characteristics that plant and animal breeders value.
   c. the greatest number of offspring.
   d. variations best suited to the environment.

____ 7. Which of the following phrases best describes the results of natural selection?
   a. the natural variation found in all populations
   b. unrelated but similar species living in different locations
   c. the changes in the inherited characteristics of a population
   d. the struggle for existence undergone by all living things

____ 8. The number and location of bones of many fossil vertebrates are similar to those in living vertebrates. Most biologists would probably explain this fact on the basis of
   a. the needs of the organisms.
   b. a common ancestor.
   c. the struggle for existence.
   d. the inheritance of acquired traits.

____ 9. Darwin's theory of evolution is based on the idea(s) of
   a. natural variation and natural selection.
   b. use and disuse.

c. a tendency toward perfect, unchanging species.
d. the transmission of acquired characteristics.

____ 10. One example used to support the common ancestry of modern organisms is
a. The presence of similar heriditary material uch as DNA, replication, transcription, and translation
b. The presence of transitional forms in the fossil record
c. Similarities of embryonic development across species
d. All of the above

____ 11. Over time, inheritated traits
a. Have no effect on the overall process of evolution or natural selection
b. Accumulate changes and diversify
c. Remain the same within a population
d. Are often unique to individual organisms

____ 12. The majority of species that existed in pre-historic times
a. Are still in existance today
b. Have become extinct over time
c. Are easily found within the fossil record
d. Have very few similarities to modern species

____ 13. An inherited trait that helps an individual survive and reproduce in a particular environment is
a. An adaptation
b. A survival trait
c. A genetic trait
d. Natural variation

____ 14. A human arm and a bat wing are eac made up of a similar number and arrangement of bones. This similarity is evidence that humans and bats
a. Evolved at the same time
b. Have the same parents
c. Have an ancestor in common
d. Once shared the same habitat

____ 15. Genetic drift has the greatest impact on
a. Large populations
b. Small populations
c. Growing populations
d. Migrating populations

____ 16. In evolution, extinction describes the end of
a. an allele
b. a single species
c. an individual organism
d. a population of organisms

____ 17. The major source of new alleles in a natural population is
a. Mutations
b. Evolution
c. Genetic drift
d. natural selection

____ 18. Which of the following is an example of non-random mating
a. Genes are removed from the population when individuals migrate
b. A change in a populations' allele frequence is due to chance
c. An individual chooses a mate that has the brightest coloration
d. An individual is eliminated from the gene pool by natural selection

____ 19. Random change in allele frequency due to chance alone is called
a. Gene flow
b. Genetic drift
c. Natural Selection
d. Evolution

____ 20. The theory of evolution
a. Was introduced by Charles Darwin in 1859 when he published *On the Origin of Species*
b. Says that variations in heritable traits are passed on to descendents and accumulate over time.
c. Is supported by geological and biochemical evidence
d. All of the above

____ 21. The concept of Natural Selection can be summarized as
a. Individuals of a species naturally select
c. There is random mating in populations

the habitat and niche to which they are best suited

b. Individuals with more favorable traits are more likely to survive and reproduce these traits, which will become more common in later generations

d. and no selection for or against traits occurs in this process

d. In any population, variation exists and much of it is heritable

___ 22. During his voyage on the *Beagle*, Charles Darwin made many observations
a. in England.
b. in North America.
c. on the Galápagos Islands.
d. in Asia.

___ 23. In each generation, the wings of experimental fruit flies were clipped short for fifty generations. The fifty-first generation emerged with normal-length wings. This observation would tend to disprove the idea that evolution is based on
a. inheritance of natural variations.
b. inheritance of acquired characteristics.
c. natural selection.
d. survival of the fittest.

___ 24. In 1859, Charles Darwin published his revolutionary scientific ideas in a work titled
a. *Principles of Geology.*
b. *Essay on the Principle of Population.*
c. *Evolution in Malaysia.*
d. *On the Origin of Species.*

___ 25. When a farmer breeds only his or her best livestock, the process involved is
a. natural selection.
b. artificial selection.
c. artificial variation.
d. survival of the fittest.

___ 26. According to Darwin's theory of natural selection, individuals who survive are the ones best adapted for their environment. Their survival is due to the
a. possession of adaptations developed through use.
b. possession of inherited adaptations that maximize fitness.
c. lack of competition within the species.
d. choices made by plant and animal breeders.

___ 27. An adaptation is an inherited characteristic that can be
a. physical or behavioral.
b. physical or geographical.
c. acquired during the organism's lifetime.
d. the result of artificial selection.

___ 28. When lions prey on a herd of antelopes, some antelopes are killed and some escape. Which part of Darwin's concept of natural selection might be used to describe this situation?
a. acquired characteristics
b. reproductive isolation
c. survival of the fittest
d. descent with modification

___ 29. Which statement about the members of a population that live long enough to reproduce is consistent with the theory of natural selection?
a. They transmit characteristics acquired by use and disuse to their offspring.
b. They tend to produce fewer offspring than others in the population.

c. They are the ones that are best adapted to survive in their environment.
d. They will perpetuate unfavorable changes in the species.

____ 30. Charles Darwin called the ability of an organism to survive and reproduce in its environment
a. diversity.
b. fitness.
c. adaptation.
d. evolution.

____ 31. Which statement is in agreement with Darwin's theory of evolution?
a. More offspring are produced than can possibly survive.
b. The organisms that are the fittest are always largest and strongest.
c. The number of offspring is not related to fitness.
d. Acquired characteristics that are inherited are the cause of evolution.

Completion
Complete each statement.

32. Not all fossils of _____ organisms have modern counterparts.

33. According to Darwin's theory of evolution, all species on Earth are united by _____.