

Topic: Dinosaur Evolution Project

Summary: Students pretend to evolve two dinosaurs using genetics and watch how the dinosaurs adapt to an environmental change. This is a very comprehensive project including genetics, fossils, natural selection, speciation and ecology.

Goals & Objectives: Students will be able to explain natural selection. Students will be able to map out how mutations generate new traits in a gene pool. Students will be able to innovate and to use their problem-solving skills to discover how a new species is formed.

Standards: CA Biology *5c Students know* how mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein. *5e Students know* proteins can differ from one another in the number and sequence of amino acids. *7a Students know* why natural selection acts on the phenotype rather than the genotype of an organism. *7c Students know* new mutations are constantly being generated in a gene pool. *7d Students know* variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions. *8a Students know* how natural selection determines the differential survival of groups of organisms. *8b Students know* a great diversity of species increases the chance that at least some organisms survive major changes in the environment. *8e Students know* how to analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction.

Time Length: 6 days of class time for students to work on the project.

Materials:

- Photocopy large pictures of fossil drawings
- Book: Dinosaur Encyclopedia by American Museum of Natural History
- 2 blank pieces of paper
- Color pencils and white paper for drawing
- Dinosaur handout per person.

Teacher Setup:

1. Photocopy packet and staple together in correct order.
2. Photocopy page size pictures of complete dinosaur fossils / bones drawings.

Procedures:

1. Students should start the project by drawing the original dinosaur fossil.
2. Students then describe the *dinosaur background*.
3. Students then describe the *dinosaur mutation*.
4. Students then describe the *dinosaur genetics*.
5. Students then should draw the mutated dinosaur fossil.
6. Students then fill in the answer sheet *dinosaur habitat*.
7. Students then fill in the answer sheet *dinosaur speciation*.
8. Students then answer six short answer questions.

Accommodations:

Students with an IEP can join another student to form a group of two students. Students who are dyslexic can write a smaller portion of the short answer and longer fill-in the blank questions and concentrate on the drawings. Students with an IEP can take their section home if they need extra time.

Evaluation:

The project is worth a total of 100 points:

20 points for their two drawings, each drawing is worth 10 points

30 points for short answer, each answer is worth 5 points

50 points for the answer sheets correctly filled in, each section is worth 10 points

Mutant Dinosaur

Intro

A dinosaur is born with a new genetic mutation. Your job is to map out the genes that influenced by the mutation and to discover how the new dinosaurs interact with the environment using the principles of evolution.

Order of Progression

1. Draw original dinosaur fossil
2. Dinosaur background
3. Dinosaur mutation
4. Dinosaur genetics
5. Draw evolved dinosaur fossil
6. Dinosaur habitat answer sheet
7. Dinosaur speciation answer sheet
8. Short answer questions

Drawings

You are going to draw how a dinosaur evolves to form a new species. You will draw one fossil picture of an original dinosaur and draw the fossil of the new dinosaur species. This project includes two, page-size, complete dinosaur fossil drawings. Please title and label the mutated parts. Make the drawings very detailed and precise.

Individual Grading

Drawings 20 points. Short answers 30 points. Answer sheets 50 points.

mRNA Codon Table

1 s t B a s e	U	Phenylalanine	Serine	Tyrosine	Cysteine	U C A G	3 r d B a s e
		Phenylalanine	Serine	Tyrosine	Cysteine		
		Leucine	Serine	Stop	Stop		
		Leucine	Serine	Stop	Tryptophan		
C	Leucine	Proline	Histidine	Arginine	U		
	Leucine	Proline	Histidine	Arginine	C		
	Leucine	Proline	Glutamine	Arginine	A		
	Leucine	Proline	Glutamine	Arginine	G		
A	Isoleucine	Threonine	Asparagine	Serine	U		
	Isoleucine	Threonine	Asparagine	Serine	C		
	Isoleucine	Threonine	Lysine	Arginine	A		
	Methionine	Threonine	Lysine	Arginine	G		
G	Valine	Alanine	Aspartic acid	Glycine	U		
	Valine	Alanine	Aspartic acid	Glycine	C		
	Valine	Alanine	Glutamic acid	Glycine	A		
	Valine	Alanine	Glutamic acid	Glycine	G		
		U	C	A	G		
		2nd Base					

Dinosaur Background

What is the scientific name of the original dinosaur? _____

What body part of the dinosaur is going to change? _____

What are you going to change about this body part? _____

What is the new name for your mutant dinosaur? _____

Explain the new trait's phenotype in detail (uses, benefits for survival, how does it work).

Dinosaur Mutation

Pretend a single gene controls the body part above. This protein will cause a physical appearance change in the dinosaur. The physical change must be able to leave some skeletal or fossil evidence. *You are now going to create two mutations for this single gene.* The first type of mutation is called chromosome mutation. You will cause a mutation by manipulating the dinosaur's chromosomes. The second type of mutation on the following page is called a point mutation.

There are five types of chromosome mutations (insertion, deletion, duplication, inversion, and translocation). Pretend the number of dinosaur chromosomes is the same as human 2N (46 chromosomes).

What type of chromosome mutation will happen to the chromosome? _____

Which dinosaur chromosome number will the mutation happen on? _____

Draw using colors for *two* original and mutated chromosomes below.

Original Chromosomes

Mutated Chromosomes



Dinosaur Genetics

Original Gene – make up original DNA sequence for the single-gene trait. Make sure there is no start or stop codons in the middle of your original DNA code (TAC, ATC, ATT, ACT).

Original Dinosaur DNA:

TAC / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / ATT

mRNA:

_____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / UAA
 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

tRNA:

_____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / AUU

Original Amino Acid Sequence

_____ / _____ / _____ / _____ / _____ /
 1 2 3 4 5
 _____ / _____ / _____ / _____ / _____ /
 6 7 8 9 10
 _____ / _____ / _____ / _____ / _____ /
 11 12 13 14 15

Mutated Gene - Mutated DNA (copy the DNA from above but mutate it by inserting, deleting or substituting one or more bases. Silent mutations are not allowed.) *Circle mutated DNA.*

Mutated DNA:

TAC / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____

mRNA:

_____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____
 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

tRNA:

_____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____ / _____

Mutated Amino Acid Sequence – *circle* what has changed from the original amino acid sequence

_____ / _____ / _____ / _____ / _____ /
 1 2 3 4 5
 _____ / _____ / _____ / _____ / _____ /
 6 7 8 9 10
 _____ / _____ / _____ / _____ / _____ /
 11 12 13 14 15

Circle one: What type of DNA point mutation happened? insertion, deletion, or base substitution

Dinosaur Habitat

Please use the reference page with information about your dinosaur to help answer the following questions. Look at the reference of *Habitat* and *Diet* and compare to information on biomes in your textbook.

Current Habitat

What type of biome would your dinosaur live in? _____

List abiotic factors found in this biome. _____

List biotic factors found in this biome. _____

What does your original dinosaur eat? _____

Does the diet change based upon the mutation? If yes, explain how your mutant dinosaur's diet is different than the original dinosaur's diet? _____

Environmental Change

An environmental change is happening to the habitat your dinosaur lives in. In real life you can not choose your environmental change, but for this project pick one that your mutant dinosaur would be best adapted for. *Circle only one change* (one *).

- * Cooling to an ice age
- * Climate warming causing a lot more rain
- * Rise of the sea level
- * Climate warming causing a long severe drought
- * Earthquakes cause the flow of a large river to go right through your dinosaur's habitat
- * Many volcanoes erupt and release toxic gasses in the middle and upper atmosphere during a 500 year period.
- * Volcanic lava flows isolate your dinosaur's habitat from rest of population on the island.

Dinosaur Habitat

Please use the reference page with info about your dinosaur to help answer the following questions.

How is the dinosaur's water sources affected by the environmental change? _____

How is the dinosaur's shelter/nesting sites necessary to live and reproduce affected by the environmental change? _____

How would the food chain of your dinosaur's ecosystem be affected by the environmental change? _____

Some of the original dinosaurs do not survive the environmental change but your mutated dinosaur survives. Briefly explain why many of the original dinosaurs do not survive the environmental change. Make sure to use concepts of adaptation or competition.

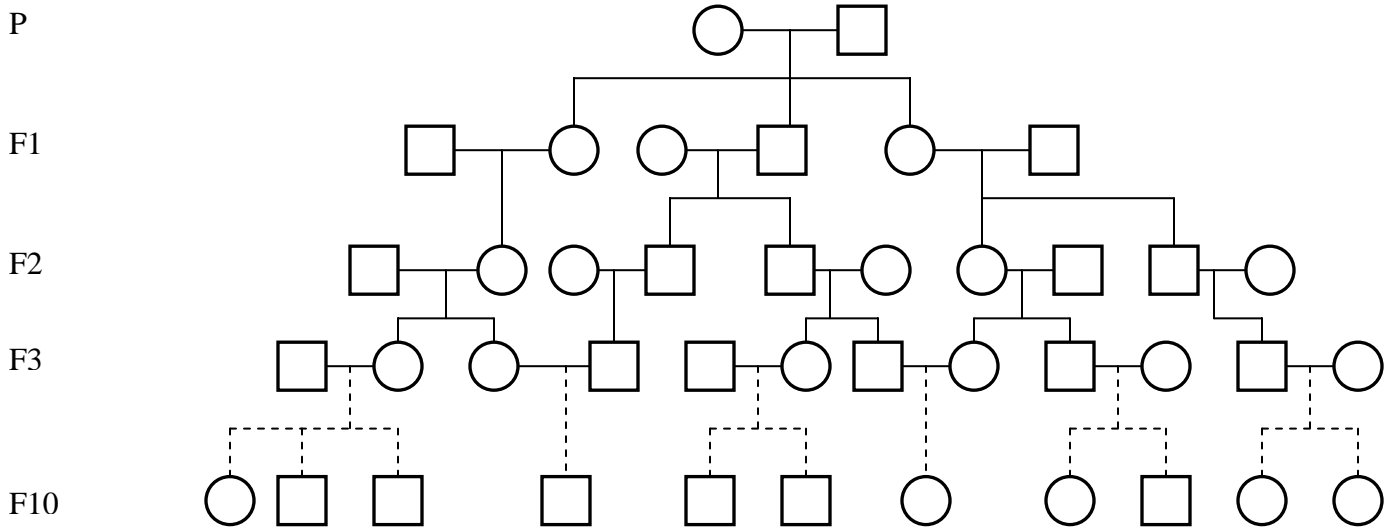
What is the definition of a species? _____

What is the definition of a population? _____

Dinosaur Speciation

Now, based upon the dinosaur's habitat, the surviving dinosaurs will reproduce. Pretend the mutated gene created on Dinosaur Genetics page is **dominant**. Is you mutant dinosaur a male or a female? _____

Below is a pedigree showing how the mutant gene is passed on from generation to generation. Your dinosaur's mutation is beneficial to their survival after the environmental change. Start from the P generation and go down one generation and fill in all the children you want to inherit the dominant gene. After you complete that generation, do the next generation. After the F3 generation, skip down to the F10 generation and pretend that mutants increased in the population in each generation. The mutated gene needs to be passed on.



What is the relative frequency of the mutated gene in the F10 generation? _____

In order for your mutant dinosaur to become its own species, it needs to create its own gene pool. Reproductive isolation plays a key role in speciation. There are three main types of reproductive isolation: behavioral, geographical and temporal. Come up with an idea of how the mutant dinosaur uses one of the types of isolation to become separate from the original dinosaur's gene pool.

Draw mates for the children in the F10 generation. Make all the mates a mutant. In what generation would your mutant be considered a new species? _____

Turn this page upside down; the pedigree now looks like a _____ and would show that the original and mutant dinosaur would share a _____.

Short Answer Questions

Please write legibly, in complete sentences, answering each question using as much detail and evidence as possible.

1. Explain how variation *within a species* increases the species chance that one variation will survive when the environment changes.

2. Your two fossil drawings show evidence on how one species is related to another species. Explain, using concepts like homologous structures and common ancestor, how your dinosaur fossils are evidence for speciation.

3. Explain how natural selection acts on the *phenotype* and not the genotype of your dinosaur.

4. Explain how competition for resources affected your dinosaur's fitness?
5. Explain the process of speciation and isolation in regards to your dinosaur.
6. Pretend all the dinosaurs in this class make up a small community on an island.
Explain why a larger number of different species increases the chance that at least some dinosaurs will survive a major change in the environment on the island.