Curriculum Sample Template
Max. 8 Pages

Grade Level	High School	**Content Area**	Science
Course Title (grades 9-12 Only)	Biology		
Expected Prior Knowledge *The knowledge/skills mastered earlier in the year foundational to the mastery of the required Standard in the current sample.*	Students will have a thorough understanding of fundamental energy concepts and the way in which energy transference causes change. Additionally, students will have had a basic introduction to evolution through reading selections of Darwin's Origin of Species. Finally, students will understand how genotypic and phenotypic variation can result in adaptations that influence an organism's success in an environment and concepts related to gene flow and mutation.		
Alignment to Program of Instruction *Briefly outline methods of instruction found in this sequence of lessons that align to the Program of Instruction described in A.3.*	The science program will employ the Socratic Method and discovery learning techniques as described and developed in the ASU Modelling Method program. Where appropriate, science teachers will also use Socratic techniques from Michael Strong's *The Habit of Thought*. *(Portions of this lesson were adapted from curriculum materials developed Anne Brokaw and published by the Howard Hughes Medical Institute.)*		
Standard Number and Description *List the Number* and the full description for the Required Standard or Science Performance Objective listed in section A.6.*	HS.4.4.3 Grade: HS Strand: 4 – Life Science Concept: 4 – Biological Evolution (Understand the scientific principles and processes PO: involved in biological evolution) #3 - Describe how the continuing operation of natural selection underlies a population's ability to adapt to changes in the environment and leads to biodiversity and the origin of new species.		
Materials/Resources Needed	Copies of Chapter 4 from Charles Darwin's *The Origin of Species*, HHMI video "The Making of the Fittest: Natural Selection and Adaptation" (available online), copies of a Smithsonian magazine article by Dr. Sean Carroll, genetic code chart.		

**** Standard Number**: For English Language Arts (Reading and Writing), use Grade, Strand, Standard (e.g., 3.RI.2). For K-8 Math, use Grade, Domain, Standard (e.g., 6.EE.7). For HS Math, use Conceptual Category-Domain, Standard (e.g., A-REI.6). For Science, use Grade, Strand, Concept, PO (e.g., 4.1.3.1).*

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Lesson (add as needed)	**Instructional Strategies**	**Student Activities**
1	This is a 3 day lesson. Day 1 The teacher will begin by reviewing information from previously read chapters of *The Origin of Species*, paying particular attention to specialized vocabulary. The teacher will hand out copies of Chapter 4 from *The Origin of Species* and ask students to begin reading portions aloud.	Students will engage in a brief discussion to review what they have learned from reading *The Origin of Species* in previous lessons. After reading aloud briefly, students will continue reading Chapter 4 silently to themselves. Once they have completed the reading they should journal their thoughts and questions. They will finish any reading and journaling for homework. In particular, students should prepare questions for seminar the following day.
2	Day 2 The teacher will pass out a brief reading quiz. Once the quiz is finished, the teacher will invite all students to write one seminar question on the white board. Once all questions have been written, the teacher will guide students toward choosing one question to begin the discussion that has the best potential for Socratically leading the class to a deeper understanding of the text.	**Summative Assessment #1**: Independent Reading Quiz **Summative Assessment #2**: Once a question has been selected, students will engage in a 30 minute seminar.
3	Day 3	

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	The teacher will allow time to finish discussion of any ideas from the previous day's seminar. The teacher will then present the 10 minute video from the Howard Hughes Medical Institute called "The Making of the Fittest: Natural Selection and Adaptation." This video provides an opportunity for students to analyze amino acid data and draw conclusions about the evolution of coat-color phenotypes in the rock pocket mouse. The rock pocket mouse, Chaetodipus intermedius, is a small, nocturnal animal found in the deserts of the southwestern United States. Most rock pocket mice have a sandy, light-colored coat that enables them to blend in with the light color of the desert rocks and sand on which they live. However, populations of primarily dark-colored rock pocket mice have been found living in areas where the ground is covered in a dark rock called basalt. The basalt formed from cooling lava flows thousands of years ago. Scientists have collected data from a population of primarily dark-colored mice living in an area of basalt called the Pinacate lava flow in Arizona, as well as from a nearby light-colored population. Researchers analyzed the data from these two populations in search of the genetic mutation responsible for the dark color. Their analysis led to the discovery of a mutation in the Mc1r gene, which is involved in coat-color determination.	Students will engage in a brief final discussion of Chapter 4. Students will take notes on the video and review key concepts and mechanisms of evolution that they have learned so far including mutation, gene flow (or migration), genetic drift, and natural selection. After viewing the video students will read an excerpt from an article entitled "Evolution in Black and White" published in *Smithsonian* magazine by Dr. Sean Carroll, a leading evolutionary biologist and Howard Hughes Medical Institute investigator. Once students have discussed the findings of Dr. Carroll and the natural selection issues raised in the video, they will complete a genetic adaptation table using a genetic code chart (see **Summative Assessment #3**). **Summative Assessment #3**: Students will complete the table and the associated questions.

Summative Assessment Items: *Attach here.* For each summative assessment item, include an answer key or scoring rubric describing how points are to be awarded.

Summative Assessment #1: Reading Quiz over Chapter 4 of *The Origin of Species*. (Each question is worth 2 points.)

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1. Darwin claims that "nature's productions should be far 'truer' in character than" what? (Ans: "man's productions")
2. In social animals, natural selection will adapt the structure of each individual for the benefit of what? (Ans. "community")
3. Name one of Darwin's two imaginary "Illustrations of Natural Selection." (Ans: Wolf; plants excreting "sweet juice")
4. Darwin comments on hermaphrodites in nature to illustrate what idea? (Ans: self-fertilization)
5. According to Darwin, is isolation a favorable or unfavorable condition for natural selection? (Ans: favorable)
6. What does Darwin assert about the pace of natural selection? (Ans: It will happen extremely slowly.)
7. "The advantage of _____ in the inhabitants of the same region is, in fact, the same as that of the physiological division of labour in the organs of the same individual body." (Ans: diversification)

Total Points Possible: 14
Mastery: 12 points (85%)

Summative Assessments #2 represents an activity that is approved and used by the top liberal arts academies in the Phoenix area. It is designed to be aligned with the philosophy of the school and fulfill the mission of the Socratic Method which requires the active engagement of students with each other even though they may be evaluated independently. Furthermore, this style of evaluation is cross-aligned with the evaluation system used in other classes at the school, particularly Humane Letters and Math, in order to create a consistency across the entire curriculum.

Summative Assessment #2: Seminars/discussions over Darwin's *Origin of Species* will be tracked and graded according to the following rubric:

	1	2	3	4
Relevant Participation	Student rarely speaks and does not contribute meaningfully to the conversation.	Students speaks infrequently, but the quality of comments is good.	Students speaks moderately frequently and offers analysis that keeps the conversation moving positively.	Student speaks frequently without dominating the conversation and offers crucial insight that engenders further analysis from others.
Effective Use of Text	Student rarely uses the text as a basis for seminar contributions.	Student uses the text occasionally, but should anchor comments and	Student often uses the text to support analysis.	Student consistently use the text as a basis for analysis and supports all

		analysis more directly in textual evidence.		claims exceptionally well.
Peer Interaction	Student does not engage in discussion with peers.	Student seems more comfortable speaking directly to the teacher and not with peers.	Student generally speaks to peers, but occasionally looks to the teacher for affirmation.	Student speaks directly to peers and rarely to the teacher, except when necessary.
Civil Discourse	Student is generally disrespectful of peers.	Student is respectful but can be prone to showing momentary irritation, hostility, or condescension.	Student is generally polite and respectful.	Student is exceptionally courteous and respectful even during debates and disagreements.

Total Points Possible: 16
Mastery: 14 points (≈85%)

Summative Assessment #3: Genetic Code/Amino Acid Table (answers for blanks in bold – 1 point each) and associated questions.

Mc1r Gene Missense Mutation Amino Acid Positions		Pinacate Light Mouse Population	Pinacate Dark Mouse Population	Kenzin Dark Mouse Population	Armendaris Dark Mouse Population	Carrizozo Dark Mouse Population
018	mRNA	CGC	UGC	CGC	CGC	CGC
	Amino Acid	Arg	Cys	**Arg**	**Arg**	**Arg**
109	mRNA	CGG	UGG	CGG	CGG	CGG
	Amino Acid	Arg	Trp	**Arg**	**Arg**	**Arg**
160	mRNA	CGG	UGG	CGG	CGG	CGG
	Amino Acid	Arg	Trp	**Arg**	**Arg**	**Arg**
233	mRNA	CAA	CAC	CAA	CAA	CAA
	Amino Acid	Gln	His	**Gln**	**Gln**	**Gln**

QUESTIONS (answers in bold)

1. Most rock pocket mouse populations have sandy-colored fur, which is consistent with the light color of the desert rocks and sand on which they live. On the other hand, dark coat-colored rock pocket mouse populations have been found living on black, basaltic rock formations caused by geologic lava flows. What is the best explanation for these facts? Discuss both. (5 points)

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The dark-colored mouse has a selective advantage if living in a dark-colored habitat such as the Pinacate lava flow. Since rock pocket mice reproduce quickly and often, the frequency of this favored trait would quickly accumulate in the population. Any light-colored mice in the dark-colored habitat would have a selective disadvantage as it would most likely be preyed upon by visual predators. This would decrease the frequency of their genes. Likewise, the light-colored mouse has a selective advantage if living in a light-colored habitat, and the dark-colored mice in that same light-colored habitat would have a selective disadvantage, therefore decreasing the frequency of their genes.

2. The Mc1r gene encodes a protein called the melanocortin 1 receptor (MC1R). This receptor plays a role in the coat color of the rock pocket mouse. When the normal Mc1r gene is present, melanocytes, which are melanin-producing skin cells, decrease the production of the dark-colored pigment called eumelanin and increase the production of the light-colored pigment, pheomelanin. The mutated version of the Mc1r gene results in an increase in the production of eumelanin by melanocytes, resulting in the dark coat-color phenotype.

a. In the data provided, the MC1R protein in the dark rock pocket mouse population from the Pinacate lava flow contains how many mutations? (1 point)

The MC1R protein contains four mutations.

b. Compare the amino acid data of dark-colored mice from the other three populations to that of the wild-type (light-colored) mice in the Pinacate region. What do you notice? (3 points)

The three additional dark coat-colored rock pocket mouse populations from lava flows other than the Pinacate flow do not have the mutated *Mc1r* gene. Instead, they have the normal MC1R receptor protein, but have the dark coat color phenotype.

c. Use the information in the passage on page 1 to explain the evolutionary significance of MC1R protein variations in the different mouse populations. (4 points)

This indicates that dark coat color in rock pocket mice from Arizona and New Mexico has evolved independently through changes in different genes. These discoveries reveal that the evolution of melanism (or the development of dark-colored pigment in skin or hair) is not some rare accident but a common, repeatable process. Evolution can and does repeat itself, and it has in the different dark coat-colored rock pocket mice studied in the southwestern United States.

3. Charles Darwin proposed the mechanism of evolution called natural selection. Explain the theory of natural selection. (5 points)

Natural selection is the process by which individuals in a population who are best-adapted to their environment survive and pass on their genes to the next generation more frequently than those individuals who are less well-adapted. In this way, favorable traits will increase in frequency in a population, whereas unfavorable traits will decrease.

4. Natural selection is just one mechanism of evolution. What are the others? Use your textbook or other Internet resources if necessary. (6 points)

Gene Flow: Gene flow is commonly called migration. It is the movement of alleles into and out of a population's gene pool. This is a common source of genetic variation within a population.

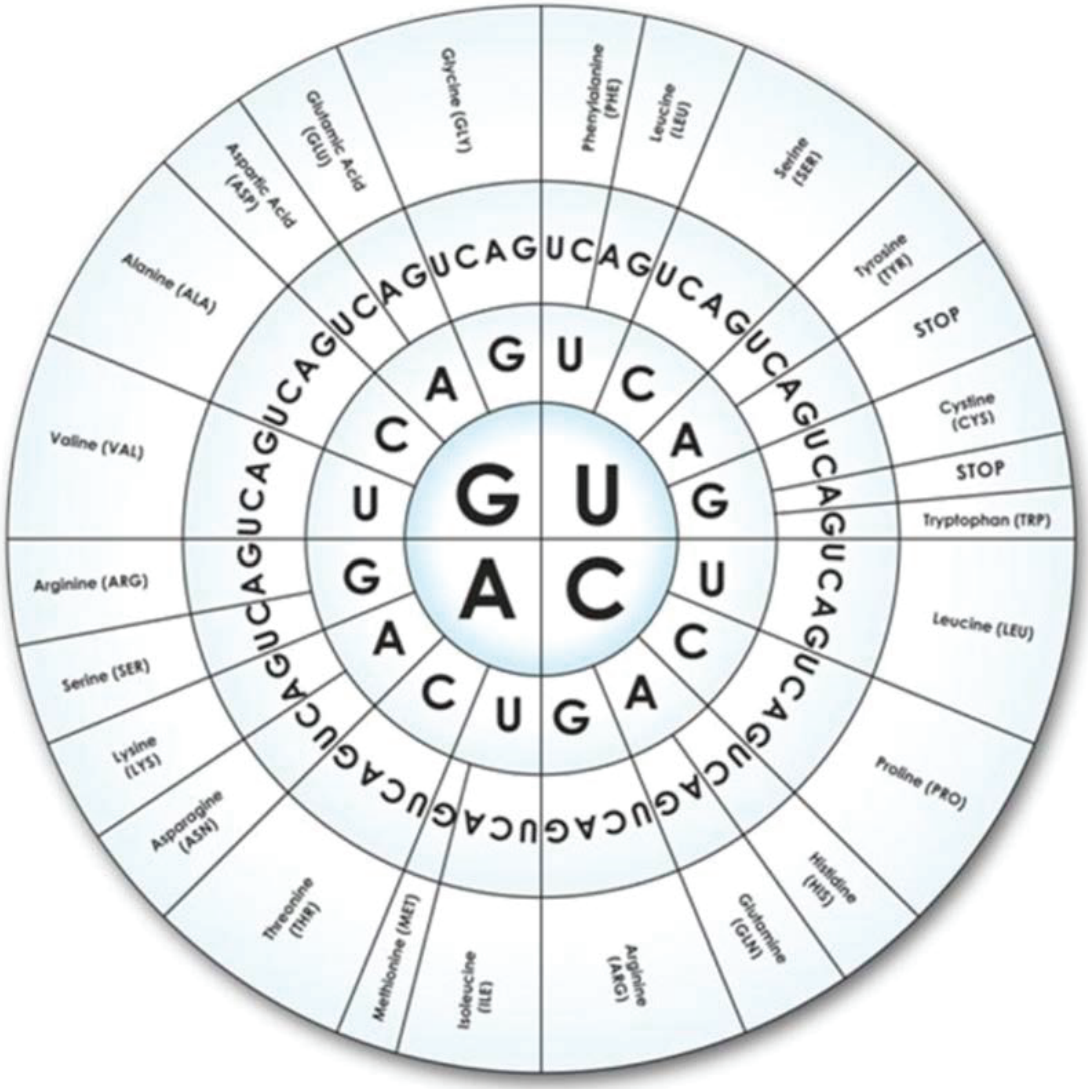
Genetic Drift: This mechanism causes a change in the gene pool of a small population and occurs strictly by chance. Genetic traits can be lost or become widespread in a population without regard to the survival or reproductive value of the alleles involved.

Mutation: Mutation is a random change in the DNA sequence of an organism and the main source of new alleles in a population. In some cases, as in the rock pocket mice, a mutant allele can actually make its bearer better suited for its environment, thus enhancing reproductive success.

5. If two of the lava flows in New Mexico were in close proximity to each other and included spans of rocky outcrops between them, what would be a possible mechanism, other than new mutations, to drive the decrease in the light coat-colored gene frequency and the increase in the dark coat-colored gene frequency in these rock pocket mouse populations? Explain your answer. (5 points)

Gene flow (migration) could be the mechanism in the described scenario. If the lava flows were indeed close to one another, rock pocket mice may be able to migrate from one population to another. Also, if there are spans of rocky outcrops between the lava flows, these habitats would provide suitable locations for migrating dark mice to "hide" in during the migration in order to avoid predators. Gene flow may introduce beneficial alleles into different populations experiencing similar selective pressures.

Total Points Possible: 41
Mastery: 35 points (≈85%)


Glycine (GLY)
Phenylalanine (PHE)
Leucine (LEU)
Serine (SER)
Tyrosine (TYR)
STOP
Cysteine (CYS)
STOP
Tryptophan (TRP)
Leucine (LEU)
Proline (PRO)
Histidine (HIS)
Glutamine (GLN)
Arginine (ARG)
Isoleucine (ILE)
Methionine (MET)
Threonine (THR)
Asparagine (ASN)
Lysine (LYS)
Serine (SER)
Arginine (ARG)
Valine (VAL)
Alanine (ALA)
Aspartic Acid (ASP)
Glutamic Acid (GLU)
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