Lesson Plan

Blue Eyes

Lesson Plan

Grade
9-12

NGSS Standards
HS-LS3-1, HS-LS3-2,
HS-LS4-2

21st Century Skills
Critical thinking, problem
solving

Materials
Access to D&D Virtual
Reality Exhibit, worksheets,
provided links

Estimated time
1-2 hours

Difficulty
Advanced

Vocabulary
Gene flow, mutation, sexual
selection, gene pool, amino
acids, dominant, recessive,
variation, allele

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Objective

Students will learn about mutations and the genetic basis for eye color. This will be used as a jumping off point for students to explore the complexities of inheritance as multiple genes interact to affect phenotypes. Students will also strengthen their understanding of natural selection by distinguishing between selection that increases survivability and selection due to mate choice.

Activity

Students visit the exhibit and/or access the Darwin and Dinosaurs Virtual Reality Exhibit. They explore the exhibit and interact specifically with the touchscreen experience VISTA.

In class, the teacher guides the students throuogh the "Inheritacne: It's Complicated," activity.

Assessment

There are fourteen (14) questions (thirteen worth 2 points one worth 4 points, 30 points total). The answers can be found in the exhibit. The student worksheet can be printed double-sided and handed in by the students for scoring. An anwer key is provided in the teacher section of this lesson plan.

Class Discussion

After the class has visited the exhibit and answered the questions in the assessment, the teacher guides the class through an exercise called "Inheritance: It's Complicated," that illustrates the simplicity of Mendelian inheritance but also the complexity of how genes work, there often being numerous genes involved in determining specific characteristics.

During the discussion, the class works out the inheritance of blue eyes from different parent pairs using Punnett squares.

Lesson plan based on Darwin & Dinosaurs Exhibit
More lesson plans at darwindinosaurs.com

Blue Eyes

Class Discussion

It has often been said that two blue eyed people cannot have a brown eyed baby, although two brown eyed people can have a blue eyed baby. Using simplified genes B = brown (dominant) and b = blue (recessive), it's easy to illustrate these two scenarios using Punnett squares (across the top are the Paternal Genes, down the side the Maternal genes).

	b	**b**
b	bb	bb
b	bb	bb

	B	**b**
B	BB	Bb
b	Bb	bb

In this model, only individuals with two b (recessive) genes will have blue eyes, because even one B (dominant) gene will result in brown e**yes.** This model, however, supposes there is only one gene (in the form of B or b, known as alelles) that determines eye color.

Inheritance: It's Complicated

But it's not that simple. There is more than one way to get blue eyes. One of the mutations that causes blue eyes is a single base change in the HERC2 gene. When this happens, the mutated HERC2 gene (called the HERC2* allele), affects the gene next to it, OAC2, interfering with the production of Protein P and thus the regulation of melanin (too little melanin results in blue eyes). If you have the HERC2* gene from both parents you will have blue eyes.

There is, however, another way to get blue eyes. The OAC2 gene itself can mutate, called OAC2*, which results in less functional Protein P. If you inherited the OAC2* gene from each parent, you would also have blue eyes (regardless of what HERC2 genes you had).

Lesson Plan

Blue Eyes

Using the following four alleles results in a more complex Punnett Square:

O = OCA2
o = OCA2*
H = HERC2
h = HERC2*

	OH	Oh	oH	oh
OH	OO HH	OO Hh	Oo HH	oO hH
Oh	OO Hh	OO hh	Oo Hh	Oo hh
oH	Oo HH	Oo Hh	oo HH	oo Hh
oh	Oo Hh	Oo hh	oo Hh	oo hh

What stands out in this chart is that whenever you have two lower case oo's or hh's, you have blue eyes. This is because you must have at least one non-mutated gene in each case (one non-mutated OCA2 gene and one non-mutated HERC2 gene) to have brown eyes.

NOTE: This chart reflects the odds of having blue eyes given all four alleles are present. If both parents have the unmutated OCA2 and HERC2 genes, no children will have blue eyes.

Lesson Plan

Blue Eyes

How can blue eyed parents can have brown eyed children? Build the Punnett Square given the blue eyed parents had these genes:

Father =   Oo hh (column 4, row 2 on the previous square)
Mother = oo Hh (column 3, row 4 on the previous square)

	Oh	Oh	oh	oh
oH	oO Hh	oO Hh	oo Hh	oo Hh
oh	oO hh	oO hh	oo hh	oo hh
oH	oO Hh	oO Hh	oo Hh	oo Hh
oh	oO hh	oO hh	oo hh	oo hh

The Punnett Square shows that 25% of offspring will have brown eyes and 75% will have blue eyes. This is how two parents with blue eyes can have children with brown eyes—because blue eyes depend on more than one gene and there are combinations where a dominant gene is present such as O or H, but masked by the effect of another gene.

Lesson Plan

Blue Eyes

Teacher Answer Key

No.	Question	Answer	Pts.
1	Complete this sentence: Variation comes from slight...	"...differences in DNA."	2
2	Pollen from a particularly tall stand of trees blows many miles away due to a wind storm. The pollen finds its way onto flowers of a different group of trees that are of the same species and develop into seeds. Which of the following causes of variation does this example represent?	◯ Mutation ☑ Gene flow ◯ Shuffling	2
3	As a bacteria divides and copies its DNA, a slight mistake is made. This results in an enzyme being produced that is slightly better at breaking down penicillin	☑ Mutation ◯ Gene flow ◯ Shuffling	2
4	Two parents have their third daughter, who is almost 2 inches taller than either of her two sisters by the time they all reach adulthood.	◯ Mutation ☑ Gene flow ◯ Shuffling	2
5	When will a mutation disappear from the gene pool?		2

Lesson Plan

Blue Eyes

Teacher Answer Key

No.	Question	Answer	Pts.
6	Glycine, aspartic acid and leucine are three of the twenty _____ that are strung together to make proteins.	◯ Genes ◯ Bases ✓ Amino acids	2
7	The protein that the OCA2 gene makes is called "Protein P". What does this protein do?	Regulates the production of melanin.	2
8	What does the HERC2* form of the HERC2 gene do to the OCA2 gene?	Limits expression of OCA2 and lowers melanin.	2
9	What causes the difference between the HERC2 allele and the HERC2* allele?	A single base pair mutation.	2
10	Do people with blue eyes see better? (Have better acuity?)	No.	2
11	Do people with blue have more or less protection from UV radiation?	Slightly less because they have less melanin.	2
12	Why did the trait of blue eyes increase so fast among certain human populations?	It is a novel trait that mates find attractive.	4
13	How many copies of every gene do we get?	Two.	2
14	What gene (allele) is considered dominant? HERC2 the original, or HERC2*, the mutated form?	HERC2.	2

Student Quiz

Blue Eyes

NAME		CLASS	
URL	my.matterport.com/show/?m=fv3NZ9XP6Zd		

No.	Question	Answer	Pts.
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3	As a bacteria divides and copies its DNA, a slight mistake is made. This results in an enzyme being produced that is slightly better at breaking down penicillin	○ Mutation ○ Gene flow ○ Shuffling	2
4	Two parents have their third daughter, who is almost 2 inches taller than either of her two sisters by the time they all reach adulthood.	○ Mutation ○ Gene flow ○ Shuffling	2
5	When will a mutation disappear from the gene pool?	If and when it has a negative impact on survival.	2

Blue Eyes

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7	The protein that the OCA2 gene makes is called "Protein P". What does this protein do?		2
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12	Why did the trait of blue eyes increase so fast among certain human populations?		4
13	How many copies of every gene do we get?		2
14	What gene (allele) is considered dominant? HERC2 the original, or HERC2*, the mutated form?		2