Symbols Key:

☄ = Inquiry
✳ = Real World Competency
★ = Differentiation
↔ = NGSS (Next Generation Science Standards) Cross-Cutting Themes
△ = NGSS Practices

Unit: Evolution			**(Length: 51 min)**
Standard	BIO.B.3.1.1: Explain how natural selection can impact allele frequencies of a population.		
	BIO.B.3.1.2: Describe the factors that can contribute to the development of new species (e.g., isolating mechanisms, genetic drift, founder effect, migration).		
Objective		**Essential Question**	
To understand the conditions necessary for a population to be at equilibrium. To understand that the Hardy-Weinberg equation cannot be used for a population undergoing natural selection. To be able to calculate genotypic frequencies using the Hardy-Weinberg equation of a population at equilibrium.		How does structure affect function? How can math be used to quantify the natural world?	
Lesson Agenda			
Agenda/Time	**5 E's**	**Learning Activities**	
		Teacher will…	**Students will …**
8 min	**Engage (Quick Start/ Review)**	1. Project a map of the prevalence in the world of lactose intolerance. 2. Give students the phenotypes of a family with lactose intolerance and ask them to label the homozygous dominant trait, the heterozygous dominant trait, and the	1. Review terms from the genetic units that will be necessary to understanding and calculating Hardy Weinberg frequencies. 2. Be engaged through the use of a human genetic example they most likely have heard of.

Brianna Malone 4/13/16 10:11 PM
Comment: Students are fascinated that most of the worlds population is lactose intolerant and that lactose tolerance developed in Europe due to the increased use of cattle.

		homozygous recessive trait. 3. (3min) Review with students what the following terms are: genotype, phenotype, homozygous, heterozygous, dominant, recessive. (✳ Real World Competency) △ - 4. Analysing and Interpreting Data	
30 min This activity requires more time. In the future this should be split into a two day activity since only 10 min was left to begin the activity.	**Explore**	Ask the class to complete the goldfish activity, which models the Hardy-Weinberg equation in a population at equilibrium and how natural selection does not fit the conditions necessary for Hardy Weinberg. ↔ 4. - Systems and System Models ↔ 7. Stability and Change △ - 4. Using mathematics, information, computer technology, and computational thinking	Practice calculating p, q, p^2, 2pq, q^2 for a population at equilibrium using the Hardy Weinberg equation. Students will then try calculate the Hardy Weinberg frequencies in a population affected by natural selection (a factor that does not meet the Hardy Weinberg conditions).
13 min Deriving the formula with students, working on a practice Hardy Weinberg Problem	**Explain**	1. Explain to students the conditions necessary for Hardy Weinberg. 2. Show how the formula ($p^2 + 2pq + q^2 = 1$) is derived from p	Begin to understand how the condition necessary for Hardy Weinberg, where the equation comes from, and how they can use it calculate genotypic frequencies in a population at equilibrium.

Brianna Malone 4/13/16 9:59 PM

Comment: Reviewing the terms allele, homozygous, heterozygous, dominant, and recessive from students background knowledge helped students grasp the concept of p and q in the Hardy Weinberg Equation.

Brianna Malone 4/13/16 10:09 PM

Comment: Great activity. We created a class fishbowl population where students would come and select 10 fish at random to simulate random mating, one of the conditions necessary for Hardy Weinberq equilibrium.

Brianna Malone 4/13/16 10:01 PM

Comment: I first taught students the Hardy Weinberg equation as a means to measure allelic frequencies and then explained the conditions that must be met. I found that students struggled to grasp why the equation is necessary since the conditions are hardly ever met.

together, and then having students complete one with a partner took around 30 min rather then 13min.	**Explain**	+ q = 1 using the quadratic formula. 3. Using lactose intolerance as an example, show students how to calculate Hardy Weinberg frequencies using the equation. △ - 4. Using mathematics, information, computer technology, and computational thinking	Begin to understand how the condition necessary for Hardy Weinberg, where the equation comes from, and how they can use it calculate genotypic frequencies in a population at equilibrium.
	Extend		
	Evaluate (Assessment/ Closure)		
Homework	Students will complete for homework three Hardy-Weinberg problems online at http://www.phschool.com/science/biology_place/labbench/lab8/hardwein.html		
Core Vocabulary			
Notes/Lesson Differentiation	Students should have used the quadratic formula in math, however if not, students may struggle to understand the mathematical derivation of the equation. (★) Depending on the student population, not all students may have access to computers at home. For those who don't, provide a hand out of the questions for homework so they can complete the assignment by hand. (★)		

Brianna Malone 4/13/16 10:05 PM

Comment: Since students understand quadratic equations, I derived the quadratic equation with them to help them understand the difference between p and p^2. This helped them understand that p refers to one dominant allele while p^2 refers to two dominant alleles or being homozygous dominant.

Brianna Malone 4/13/16 10:06 PM

Comment: Rather then use lactose intolerance, I used an example with pea plants color to tie back to students understanding of Mendelian Genetics.

Brianna Malone 4/13/16 10:15 PM

Comment: While students worked in pairs, this provided me time to come walk around the classroom and assist students who were struggling. Half the class is participating in a before school SAT 2 Biology prep class. These students have already covered the Hardy Weinberg equation, so there was varying levels of understanding. Working in pairs provided students who were attending the prep class to help their classmates.