

**MIDDLE GRADE INITIATIVE**

**College and Career**

**C O N N E C T I O N S**

**E Q U I N E G E N E T I C S**

There are a variety of choices of careers working with animals. This **C O N N E C T I O N** uses genetics tolink the Eighth Grade Science Standards with the University of Arizona, Department of Animal Science.

**AZCCRS addressed in this C O N N E C T I O N:**

**Science Strand 4: Life Science, Eighth Grade**

**University of Arizona** [**Animal Sciences**](http://animal.cals.arizona.edu/)

**From their website:**

<http://www.ua-rtip.org/>

*“The Race Track Industry Program (RTIP) at the University of Arizona is the only program of its kind. We offer two paths based on student interest. The Business Path prepares students for employment in the areas of race track management, regulation and pari-mutuel racing organizations. The Equine Management Path prepares students for employment in areas dealing with racing and breeding animals.*

*The mission of the RTIP is to offer students a broad-based university education with emphasis on the pari-mutuel racing industry and provide support for the industry through a variety of outreach programs.”*

**Degree Program:**

**Bachelor of Science, Race Track Industry Program** (Courses include:)

**ACBS 316; Equine Reproductive Physiology and Management -**   
The course will provide a review of basic equine reproductive physiology, and introduce students to the common reproductive management practices found in the industry today.

**ACBS 213; Animal Genetics -** Principles of genetics including classical, molecular and population genetics

**Lesson:**

**In order to design and implement successful breeding programs for bloodstock, it is important to track genetic traits in bloodlines and reliably predict the occurrence of those traits in offspring.**

The color of a horse is controlled by a very small number of genes, which combine in sometimes confusing ways. Consider the graying gene, **G**. Foals can exhibit any color variation at birth, but presence of the graying gene, **G**, causes the animal to lose pigmentation in its hair throughout its life, until it is totally gray or silver (not unlike humans).

Each gene is composed of two *alleles*: the *dominant* **G**, which causes graying or the *recessive* **g**, which does not affect the foal’s color as it matures. An animal’s *genotype* may contain two dominants, **GG**, two recessives, **gg** or one of each, **Gg**. Because the graying gene is dominant, even one **G** allele will cause the horse to become gray over time.

|  |  |  |  |
| --- | --- | --- | --- |
| Genotype | **GG** | **Gg** | **gg** |
| Appearance | Graying | Graying | Not-Graying |

***Assume that an equestrian farm wants to cross two animals:***

***Dam - a chestnut mare***

***Sire – a graying buckskin***

***How can they determine the possibilities for the offspring?***

For the dam, the genotype is easy. Because she is not graying, she must have two recessive genes, **gg**. The sire however may be either **GG** or **Gg**. From previous experience, the trainer knows that the buckskin has a genotype of **Gg**. How can she predict the results of breeding these two horses with respect to the graying gene? She can use a *Punnett Square*.

In a Punnett Square, the genotype of each parent is built into a matrix, which shows all of the possibilities for that gene. Since each possibility is equally likely, probabilities can be calculated easily.

|  |  |  |  |
| --- | --- | --- | --- |
| **SIRE** | **DAM** | | |
| genotype | **g** | **g** |
| **G** | **Gg** | **Gg** |
| **g** | **gg** | **gg** |

The chart shows the possible genotypes of foals for these two parents. Two of the possibilities show the genotype **Gg**, which means that the offspring will have the graying characteristic. Two have **gg**. Two recessive alleles means that the horse will not be affected.

The phenotype is the physical result of the genotype.

|  |  |  |  |
| --- | --- | --- | --- |
| SIRE | DAM | | |
| genotype | **g** | **g** |
| **G** | **Gg, graying** | **Gg, graying** |
| **g** | **gg, not graying** | **gg, not graying** |

In this case, the probability that a foal born to these two parents will gray as it ages is two out of four possibilities, 50%.

Although managing the genetics of horses for the color of their coats is common, there are often more important reasons to consider potential variations in offspring. For example, some horses carry the dominant Overo gene, **O**, causing the horse to have large unpigmented (white) markings. The recessive allele is referred to as **n**. While other genotypes also have white markings, the Overo horses are distinctive, and very desirable.

Unfortunately, there is a problem when a horse inherits the *homozygous* dominant genotype, **OO**. These horses are born completely white, with a deadly intestinal disorder which invariably kills them within days. Because the condition is cruel and painful, foals must be euthanized as soon as they are identified. The genotype **OO** is called **lethal white**, and is to be avoided. (Not all white horses have this genotype.) As a result, all adult Overo horses have the genotype **On**.

***A training facility specializes in Overo horses and wants to begin raising their own stock based on their beautiful Overo mare, who carries one dominant* O *allele and one recessive non-Overo allele,* n*. They would like to ensure that they produce as many Overo horses as possible, but want to avoid lethal white results. They have a male horse with the Overo genotype* On *as well as a non-Overo male horse with the genotype* nn*. How can they decide which horse would be best choice of sire?***

|  |  |  |  |
| --- | --- | --- | --- |
| non-Overo **SIRE** | Overo **DAM** | | |
| genotype | **O** | **n** |
| **n** | **nO** | **nn** |
| **n** | **nO** | **nn** |

***Describe each phenotype described in this table and determine the probability of it occurring.***

***What concerns would that raise for the facility?***

**Answers:** This cross shows two cells of **On**, which will produce an Overo horse and two with **nn**, which will produce a non-Overo horse. The probability that a foal will be Overo is 2/4, 50%.

Crossing the Overo mare with the non-Overo sire will only produce Overo foals half of the time.

Now, make a Punnett Square that shows the cross of the Overo dam, **On,** and an Overo sire, **On**.

|  |  |  |  |
| --- | --- | --- | --- |
| Overo **SIRE** | Overo **DAM** | | |
| genotype | **O** | **n** |
| **O** |  |  |
| **n** |  |  |

**Answer:**

|  |  |  |  |
| --- | --- | --- | --- |
| Overo **SIRE** | Overo **DAM** | | |
| genotype | **O** | **n** |
| **O** | **OO** | **On** |
| **n** | **nO** | **nn** |

***Describe each phenotype described in this table and determine the probability of it occurring.***

***What concerns would that raise for the facility?***

**Answers:** This cross shows two cells of **On**, which will produce an Overo horse and one with **nn**, which will produce a non-Overo horse. It also shows one cell with **OO** which will produce a foal with lethal white. The probability that a foal will be Overo is 2/4, 50%.

The probability of an Overo foal is not any higher than when the sire is non-Overo. The big difference is that this cross introduces the potential of having foals with lethal white. The probability of lethal white will be 1/4, 25%. Another 25% will be non-Overo.

<http://www.aces.edu/pubs/docs/A/ANR-1420/ANR-1420.pdf>

Alabama Cooperative Extension System

<http://www.jenniferhoffman.net/horse/appaloosa.html#gamewindow_anchor>

**Application to Humans – the Widows Peak**

The genetics concepts at work in animals are also true for humans. An easy example is the widows peak, a V-shaped point in the hairline of the forehead. The allele for a widows peak, **W**, is dominant. People who are homozygous for the recessive allele, have the genotype **ww** and have a straight hairline.

Straight Hairline Widows Peak

***Consider parents who are both heterozygous (*Ww*) for widow’s peak.***

***What is the phenotype of each parent?***

**Answer**: The widow’s peak trait is dominant and even one allele will cause it to show. Since each parent’s genotype is heterozygous, they each have the allele, and the trait will show in each. Both parents have widow’s peaks.

***Use what you have learned earlier to complete the Punnett Square for the characteristic of widow’s peak.***

|  |  |  |  |
| --- | --- | --- | --- |
| **Father** | **Mother** | | |
| genotype | **W** | **w** |
| **W** |  |  |
| **w** |  |  |

***What is the probability that their offspring will also have the trait?***

***Explain your prediction.***

**Answers:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Father** | **Mother** | | |
| genotype | **W** | **w** |
| **W** | **WW** | **Ww** |
| **w** | **wW** | **ww** |

Three of the four cells contain the dominant **W** allele, so the probability that a child of these parents has the trait of widow’s peak is 3/4, 75%.

**Group Activities**

The class will be broken into groups of 4, each considering human examples of genetic traits (either blood type or eye color). Researching either the curricular materials or the Internet, they will look at the dominance properties of the assigned trait and the probabilities of various genotypes. They will produce Punnett Squares and write explanations of their findings.

When all groups have completed their work, they will meet with other groups (Pair, Square) who have examined the same characteristic and compare finings. The mixed groups will come to a consensus and prepare a final, combined project and ensure that each group member is prepared to teach a classmate what they have learned.

Individual students will then pair off with someone in class who explored the other trait, and the two will share what they have learned. How are the two traits similar? What is different? What can be used to explore other genetic traits?

Each student will then write a reflective paragraph, describing what he learned about pairing alleles and genetic dominance.

**Deliverables and Assessment**

Standards by assignment

**Group Assignment**

PO 2. Principals of heredity

PO 3. Distinguish between the nature of dominant and recessive traits in humans.

**Discussion**

PO 2. Principals of heredity

PO 3. Distinguish between the nature of dominant and recessive traits in humans.

**Reflection**

PO 2. Principals of heredity

PO 3. Distinguish between the nature of dominant and recessive traits in humans.

**From the Arizona Department of Education Website:**

**AZCCRS for Eighth Grade Science**

**Strand 4: Life Science**

Life Science expands students’ biological understanding of life by focusing on the characteristics of living things, the diversity of life, and how organisms and populations change over time in terms of biological adaptation and genetics. This understanding includes the relationship of structures to their functions and life cycles, interrelationships of matter and energy in living organisms, and the interactions of living organisms with their environment.

Concept 2: Reproduction and Heredity; Understand the basic principles of heredity.

PO 2. Explain the basic principles of heredity using the human examples of:

• eye color • widow’s peak • blood type

PO 3. Distinguish between the nature of dominant and recessive traits in humans.

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**C O N N E C T I O N S**

**Feedback**

**E Q U I N E G E N E T I C S**

Thank you for taking a moment to share your feedback regarding the **College and Career** **CONNECTION, Equine Genetics**. We appreciate your time! Please send the completed form to Dawne.Spangler@nau.edu

Participant: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Title: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

District: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ School: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What grade(s) and subject(s) do you teach? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Please share your thoughts: Was this **CONNECTION**

**Relevant**? Yes Somewhat No

Comments

**Interesting to students**? Yes Somewhat No

Comments

**Practical**? Yes Somewhat No

Comments

What suggestions do you have to improve this **CONNECTION**?

What requests or suggestions do you have for new **CONNECTIONS**?