

<i>PEER One Health Curriculum</i>	
Leader Guide	Genetics – Case Study: Middle East Respiratory Syndrome

Summary:

The genetics module covers the concepts of heredity, reproduction, DNA, patterns of inheritance, and variation in traits. Through the One Health in Action case study, students will have the opportunity to investigate the transmission source and impact of Middle East Respiratory Syndrome (MERS).

Keywords: allele, chromosome, DNA, dominant, gene, genotype, heredity, heterozygous, homozygous, mutation, phenotype, recessive, replication

Subject TEKS:

- 7.14 (A) define heredity as the passage of genetic instructions from one generation to the next generation;
 - (C) recognize that inherited traits of individuals are governed in the genetic material found in the genes within chromosomes in the nucleus.
- Biology 6 (A) identify components of DNA, identify how information for specifying the traits of an organism is carried in the DNA;
 - (E) identify and illustrate changes in DNA and evaluate the significance of these changes;

NGSS Science and Engineering Practices:

- LS3.A: Inheritance of Traits
Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.
- LS3.B: Variation of Traits
In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.

Grade Level: 6th - 9th

Learning Objectives:

1. Define heredity
2. Identify the components of DNA.
3. Explain how allele forms determine an organism's traits.
4. Distinguish between genotype and phenotype.
5. Describe the various ways for variation to occur in organisms.
6. Describe the symptoms of Middle East Respiratory Syndrome (MERS).
7. List the possible transmission paths of MERS.
8. Explain how scientists determined the source of MERS.

Time Required: Three to four, 45-minute class periods

Materials:

- Devices with internet access
- [DNA Testing in the Clinic](#) student handout
- [Patient SNP Results](#) student handout
- toothpicks, ~25
- multicolored gumdrops, ~30
- paper or plastic plate, to work on so the table stays clean from loose sugar
- 1 DNA color key (as found on the [DNA Build Color Key](#); cut apart to create three color keys)
- 1 DNA identity card (as found on the [DNA Build Identity Key](#), cut apart to create 15 unique DNA identity cards)
- blank sheet of paper, for coding notes and sketching
- pencil
- [DNA Build Identity Key](#)

Background and Concepts for Teachers:Heredity

Heredity is the passing of traits from parents to offspring and is accomplished through reproduction. Asexual reproduction occurs when a new organism is produced from a part of another organism via cell division. During cell division genetic material (DNA) in the nucleus is copied and then the nucleus divides into two identical nuclei. This process is called mitosis and results in two nuclei with identical genetic information.

DNA

Deoxyribonucleic acid, DNA, is the genetic material found in the nucleus of every cell. The structure of DNA is similar to a twisted ladder comprised of sides made of sugar-phosphate molecules and rungs made of nitrogen bases. The four nitrogen bases, adenine (A), guanine (G), cytosine (C), and thymine (T), always occur as pairs; A-T and G-C.

Long strands of DNA wrap around proteins forming chromosomes. Sections of DNA found on chromosomes are called genes. These genes contain the instructions for specific proteins a cell will make, which in turn determine an organism's traits.

Body, or somatic, cells contain pairs of chromosomes. Each gene on one chromosome has a similar gene on the other chromosome that code for the same trait. These different forms of a trait that a gene may have are called alleles. If the alleles contain different information about the trait they are heterozygous. If the alleles contain the same information they are homozygous.

How a trait is expressed depends on whether the allele is dominant or recessive. A dominant allele masks another allele of the trait. Recessive alleles are only expressed when the gene is homozygous recessive for the trait.

The types of alleles an organism has is its genotype. The genotype, to a large extent, determines the physical expression, or phenotype, of a trait.

Variation in Traits

Genetic variations are the different expressions of a certain trait. Errors that occur in a cell during meiosis or mitosis may result in mutations, changes in a gene or chromosome. Mutations can have no effect, be beneficial, or harmful to an organism.

Middle East Respiratory Syndrome

Middle East Respiratory Syndrome (MERS) is viral respiratory illness that is new to humans. It was first reported in Saudi Arabia in 2012 and has since spread to several other countries, including the United States. Most people infected with MERS developed severe respiratory illness, including fever, cough, and shortness of breath. Many of them have died.

Scientists do not yet fully understand how the virus spreads. It is likely that a person can get infected with the virus if they have close contact with someone or touch the body fluids of a person sick with MERS. The virus can also spread from camels to people, although it is unclear how that occurs. Touching camels or being around infected camels or their body fluids can increase a person's chances of becoming infected with MERS.

Vocabulary / Definitions:

- **Allele** – an alternate form that a gene may have for a single trait; can be dominant or recessive
- **Chromosome** – structure in a cell's nucleus contains genetic material
- **DNA** – deoxyribonucleic acid; which is the genetic material of all organisms, made up of two twisted strands of sugar-phosphate molecules and nitrogen bases
- **Dominant** – describes a trait that covers over or dominates another form of that trait
- **Gene** – section of DNA on a chromosome that contains instructions for making specific proteins.
- **Genotype** - an organism's genetic makeup
- **Heredity** – the passing of traits from parents to offspring
- **Heterozygous** – describes an organism with two different alleles for a trait
- **Homozygous** – describes an organism with two of the same alleles for a trait
- **Mutation** – any permanent change in a gene or chromosome of a cell; may be beneficial, harmful, or have little effect on an organism

- **Phenotype** – outward physical appearance and behavior of an organism
- **Recessive** – describes a trait that is covered over, or dominated, by another form of that trait and seems to disappear
- **Replication** - the process by which the genome's DNA is copied in cells

Lesson Introduction/Motivation:

Begin the lesson by illustrating the concept of One Health with this simple colored water activity:

<https://drive.google.com/file/d/1GgyzUOp0dros2FL7PMeLrmTkAzG4mJMs/view?usp=sharing>

Leaders could then introduce the concept of a genome to their classes by watching the “How to sequence the human genome” TED-Ed video (<https://youtu.be/MvuYATh7Y74>). After watching, have students discuss what a genome is and the information it contains. How might this information benefit humans? Could this information also benefit or impact animals or the environment?

Alternately, teachers could introduce the module to their classes by having students take an inventory of their own easily observable genetic traits. Working in small groups, they observe how their trait inventories differ from those of others. Students can record their observations in a data table and make a bar graph to show the most and least common traits in the group.

Exploration/Explanation: Day 1

Students should next examine the required concepts (standards) related to genetics through the Essential Knowledge – “DNA & Alleles” and “Variation in Traits” sections of the Genetics module from the One Health online curriculum. This can be done as a whole group, small group, partner, or individual activity. Slides, videos, and stopping points are listed below.

- Slides 1 – 3 “DNA”, “DNA Structure”, “Chromosomes & Genes”
- Genetics Concept Map - (use as whole group activity, or create friendly competition – boys v. girls, etc.)
- Slide – “Mutations” from “Variation in Traits” section
- DNA Build – https://www.teachengineering.org/activities/view/cub_biomed_lesson09_activity2 Students will construct using toothpicks and gumdrops that represent the four biochemicals (adenine, thiamine, guanine, and cytosine) that pair with each other in a specific pattern, making a double helix.

Elaborate: Day 2

- MERS – Students will explore the case study section of Essential Knowledge to discover how scientists traced Middle East Respiratory Syndrome back to camels and how it is impacting humans. This section consists of six short slides, three short videos, and a knowledge check. The videos and knowledge check can be viewed individually or as a whole group with feedback/discussion. Now that

- students have a general understanding of DNA components and structure, ask them to hypothesize how geneticists identified the connection between humans and camels in relation to MERS.
- Prior to beginning the activity have the class watch the video, “Genetics 101: What are SNPs?” by 23andMe/Khan Academy <https://youtu.be/tJjXpiWKMyA>.
 - Personal DNA Testing - Students investigate the genetics behind why people respond differently to the same drug.
https://www.pbs.org/wgbh/nova/teachers/activities/0302_01_nsn.html

Assessment/Evaluation:

- The Genetics Module includes a post-test, which can be used for an overall learning assessment. Other opportunities for assessment include student output on any of the “Elaborate” activities.
- Kahoot - <https://create.kahoot.it/my-library/kahoots/drafts>