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| **Subject:** Science | **Grade:** 8 | **Unit ID:**  |
| **Unit 4:** Life Science - Heredity & Biological Evolution4A: Reproduction / DNA4B: Biological Evolution: Unity and Diversity | **Length:** 30 Days |
| ***Stage 1: Desired Results*** |
| **Standards:****Content Standards:****8.MS-LS1-5.** Construct an argument based on evidence for how environmental and genetic factors influence the growth of organisms. (REVISIT AT END OF UNIT)Clarification Statements: • Examples of environmental conditions could include availability of food, light, space, and water. • Examples of genetic factors could include the genes responsible for size differences in different breeds of dogs, such as Great Danes and Chihuahuas. • Examples of environmental factors could include drought decreasing plant growth, fertilizer increasing plant growth, and fish growing larger in large ponds than they do in small ponds. • Examples of both genetic and environmental factors could include different varieties of plants growing at different rates in different conditions. State Assessment Boundary: • Methods of reproduction, genetic mechanisms, gene regulation, biochemical processes, or natural selection are not expected in state assessment. 4A Reproduction and DNA**8.MS-LS3-2.** Construct an argument based on evidence for how asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. Compare and contrast advantages and disadvantages of asexual and sexual reproduction. Clarification Statements: • Examples of an advantage of sexual reproduction can include genetic variation when the environment changes or a disease is introduced, while examples of an advantage of asexual reproduction can include not using energy to find a mate and fast reproduction rates. • Examples of a disadvantage of sexual reproduction can include using resources to find a mate, while a disadvantage in asexual reproduction can be the lack of genetic variation when the environment changes or a disease is introduced. **8.MS-LS3-4(MA).** Develop and use a model to show that sexually reproducing organisms have two of each chromosome in their cell nuclei, and hence two variants (alleles) of each gene that can be the same or different from each other, with one random assortment of each chromosome passed down to offspring from both parents. Clarification Statement: • Examples of models can include Punnett squares, diagrams (e.g., simple pedigrees), and simulations. State Assessment Boundary: • State assessment will limit inheritance patterns to dominant-recessive alleles only. **8.MS-LS3-3(MA).** Communicate through writing and in diagrams that chromosomes contain many distinct genes and that each gene holds the instructions for the production of specific proteins, which in turn affects the traits of an individual. State Assessment Boundary: • Specific changes at the molecular level or mechanisms for protein synthesis are not expected in state assessment. **8.MS-LS3-1.** Develop and use a model to describe that structural changes to genes (mutations) may or may not result in changes to proteins, and if there are changes to proteins there may be harmful, beneficial, or neutral changes to traits. Clarification Statements: • An example of a beneficial change to the organism may be a strain of bacteria becoming resistant to an antibiotic.• A harmful change could be the development of cancer; a neutral change may change the hair color of an organism with no direct consequence. State Assessment Boundary: • Specific changes at the molecular level (e.g., amino acid sequence change), mechanisms for protein synthesis, or specific types of mutations are not expected in state assessment. 4B Natural Selection**8.MS-LS4-4.** Use a model to describe the process of natural selection, in which genetic variations of some traits in a population increase some individuals’ likelihood of surviving and reproducing in a changing environment. Provide evidence that natural selection occurs over many generations. Clarification Statements: • The model should include simple probability statements and proportional reasoning. • Examples of evidence can include Darwin’s finches, necks of giraffes, and peppered moths. State Assessment Boundary: • Specific conditions that lead to natural selection are not expected in state assessment. **8.MS-LS4-5.** Synthesize and communicate information about artificial selection, or the ways in which humans have changed the inheritance of desired traits in organisms. Clarification Statement: • Emphasis is on the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, and gene therapy). **Practice Standards/Concepts & Skills:**1. Asking questions (for science) and defining problems (for engineering). 2. Developing and using models. 3. Planning and carrying out investigations. 4. Analyzing and interpreting data. 5. Using mathematics and computational thinking. 6. Constructing explanations (for science) and designing solutions (for engineering). 7. Engaging in argument from evidence. 8. Obtaining, evaluating, and communicating information |
| **Overview:**This life science unit primarily focuses on heredity and genetics. It is broken into two sub-units. First, students will learn about DNA and reproduction, and then they will learn about natural selection. **FOCUS LANGUAGE GOALS:** |
| **Understandings**4A Reproduction and DNA* Chromosomes contain many distinct genes which determine production of proteins and thus the traits.
* As a result of asexual reproduction, the offspring have identical genetic information to the parent.
* Sexual reproduction results in offspring that differ from their parents with a unique combination of the parents’ genetic traits.
* Structural changes to genes may or may not result in a change to proteins.
* Mutations produce either harmful, beneficial, or neutral changes to traits.

4B Natural Selection* The genetic variation of traits in a population increases some individuals probability of surviving and reproducing in a specific environment, which tends to increase the probability of these traits in the population.
* Natural selection over many generations results in changes to populations.
* Humans influence genetic outcomes by artificially selecting desired traits in different species.
 | **Essential Questions**How do organisms live, grow, respond to their environment and reproduce? 4A Reproduction and DNA* What does DNA do?
* Why(How) do individuals of the same species vary in how they look, function, and behave?
* Why don’t offspring always look like their parents?
* How are the characteristics of one generation passed to the next?
* How are the characteristics of one generation related to the previous generation?

4B Natural Selection* How can we explain the genetic diversity found on planet earth?
* How do life forms change over time?
* How does genetic variation among organisms affect survival and reproduction?
* How does the environment influence populations of organisms over multiple generations?
* Are the organisms of the planet becoming more similar or more different over time?
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| **Knowledge:** *Students will know...***Content:**4A Reproduction and DNA* sexual and asexual reproduction have advantages and disadvantages for both the offspring and the species
* during reproduction, genes are passed down from parents to offspring
* that genes are sections of DNA found on chromosomes in the nucleus.
* proteins that cells produce are determined by the cell’s genes.
* that genes come in different forms called alleles.
* the combination of alleles determines the expression of a trait.
* members of the same species can have different traits due to genetic variation
* mutations may or may not be beneficial

4B Natural Selection* the availability of resources (i.e. food, light, space, water) in the environment influence the growth of organisms
* different environments can favor different variations of a given trait. These differences can, over time, lead to adaptations within a particular population.
* evolution is the process by which a species changes due to the accumulation of adaptations as determined by natural selection.
* natural selection can lead to the development of new species
* how human activities can influence genetic variation in a species, as well as alter the environment in which a species lives.

**Language:**Students will become familiar with a variety of different text types in the four skills (reading, writing, listening and speaking) for such purposes as:* Explaining the differences between phenotype and genotype
* Explaining the differences between asexual and sexual reproduction
* Explain how genetic information is passed from one generation to another

**Vocabulary:** [**(see definition of CCSS tiered vocabulary)**](https://drive.google.com/open?id=0B1oO5U3iU008Q1ZGaEpFeFpLVnc)

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| **Tier 1** | **Tier 2** | **Tier 3** |
| genescharacteristicTraitOffspringspecies | adaptationvariationmutationheredityInheritedhybridProbabilityproteinDominantRecessiveSpeciesNatural selection | allelechromosomenucleotidesex-linkednitrogen basessexual reproductionAsexual reproductionMitosisPhenotypeGenotypeHeterozygousHomozygousHomologous structures |

 | **Skills**: *Students can ...***Content:**4A Reproduction and DNA* develop a model to show details in DNA and chromosomes (8.MS-LS3-3(MA))
* construct a Punnett square to predict the appearance of a trait. (8.MS-LS3-4(MA))
* model mutations in genes (8.MS-LS3-1).

4B Natural Selection* using data to gain information about the relationship between environment and evolution. (MS-LS4-4)
* conducting an investigation through models/simulations to support explanations about natural selection. (MS-LS4-4)
* obtaining and evaluating evidence of the human role in artificial selection (MS-LS4-5)

**Language:**4A Reproduction and DNA* construct an argument on the advantages and disadvantages of asexual reproduction vs sexual reproduction (8.MS-LS3-2)

4B Natural Selection* Construct an explanation on how populations can shift over time due to environmental and/or artificial factors.
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| ***Stage 2: Assessments*** |
| Assessments administered in this unit:* Traditional computer based or paper and pencil teacher generated assessment
* Common district assessment questions (pending)
* Pearson Quick Lab: [Coin Crosses](https://drive.google.com/file/d/1FiUTufRo3Mx_QmjlwGdxyphUMOOGIJQ7/view?usp=sharing)
* Optional:
	+ Students will create a model of their choice to represent structure of DNA molecule
	+ Students will write CER papers for different part of this unit.
		- CER 1: [Environmental vs. genetic factors CER prompt](https://bpsscience.weebly.com/uploads/2/2/1/3/2213712/environmental_vs_genetic_factors_cer_prompts.pdf)
		- CER 2: [Evaluate the effect of mutation on phenotype of an organism](https://betterlesson.com/lesson/resource/3184671/cer-template)
		- CER 3: Identify which of your traits is phenotype or genotype. Support your claim with evidence and explain with scientific reasoning. [Traits activity](https://learn.genetics.utah.edu/content/basics/activities/pdfs/InventoryOfTraits.pdf)
		- CER 4: What determines whether a species will survive or go extinct over long duration of time? [Born to Run](http://www.indiana.edu/~ensiweb/lessons/Born_to_Run_2_pdf24.pdf)
		- CER 5: Case Study: What are genetic disorders and how do they influence growth or development? [Our Genes, Our Choices](http://www.pbs.org/inthebalance/archives/ourgenes/lesson_probabilities.html)
	+ Research a genetic disorder and create a presentation
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| ***Stage 3: Learning Plan*** |
| **Summary of Key Learning Events and Instructions:**This unit will be started with a brief review of students’ prior knowledge about cells, environmental factors and their general knowledge about heredity and traits. It is important for students to understand that aside from red blood cells and cornified cells, all other cells in the human body contain nuclear DNA. * Students will explore the structure of DNA; understand that there are several genes on a chromosome, and that different organisms have different numbers of chromosomes.
* Students will differentiate between the terms DNA, chromosomes and genes.
* Students will understand that reproduction involves splitting of cells and reproduction is either sexual (mitosis and meiosis) or asexual (only mitosis but no meiosis).
* Students will understand that during this process mutations may occur due to environmental and genetic interactions and these mutations may affect the signals that determine proteins production which may cause neutral, beneficial or harmful phenotypes/genotypes.
* Students will explore the term adaptations as characteristics that are more beneficial than others as they help organisms adapt to their environment. These suitable characteristics are passed onto offspring and this leads to natural **selection** causing organisms with favorable traits to survive.
* Students will then understand the term artificial selection as an intentional breeding of species by humans in order to promote desired characteristics and differentiate it from natural selection.
* Students will explore genetic disorders and how advancements in genetic engineering can lead to cure or treatment of these diseases.

Sample lessons are listed below and many of the lessons provide accessibility, modifications, and extensions for all students including English Learners, Students with Disabilities, and SAGE students.“Reproductive” unit)**Additional sample lessons:**[Sample lesson Exploring Genetics](http://www.greenomes.org/pdf/NCState_Exploring_Genetics.pdf)[Better Lesson Genetics](https://betterlesson.com/lesson/633821/tour-the-basics) (Ignore the simple machine related topics)[CK-12 resource](https://www.ck12.org/ngss/middle-school-life-sciences/heredity%3A-inheritance-and-variation-of-traits)[NSTA resources for Life Science topics](http://ngss.nsta.org/classroom-resources-results.aspx?CoreIdea=8) [Teaching activities for Genetics](https://gsoutreach.gs.washington.edu/files/toothpick_fish.pdf)["Model" organism lesson](http://www.ccitonline.org/ceo/home/content_images/bcm-reebops_s.pdf) |
| **Instructional Notes:****Sociocultural implications*** Heredity can be a highly sensitive topic because of references to family traits. Consider students who may not know both of their biological parents.
* The theory of natural selection may contradict with students’ religious beliefs.
* Mention contributions of scientists from around the globe towards genetics and research
* Connections can be made between genetics and global population diversity and phenotypes and genotypes.

**Connections to Prior Knowledge*** 6.MS-LS4-1. Analyze and interpret evidence from the fossil record to describe organisms and their environment, extinctions, and changes to life forms throughout the history of Earth.
* 6.MS-LS4-2. Construct an argument using anatomical structures to support evolutionary relationships
* 7.MS-LS1-4. Construct an explanation based on evidence for how characteristic animal behaviors and specialized plant structures increase the probability of successful reproduction of animals and plants. among and between fossil organisms and modern organisms.

**Connections to Future Knowledge*** HS-LS1-1. Construct a model of transcription and translation to explain the roles of DNA and RNA that code for proteins that regulate and carry out essential functions of life.
* HS-LS1-4. Construct an explanation using evidence for why the cell cycle is necessary for the growth, maintenance, and repair of multicellular organisms. Model the major events of the cell cycle, including (a) cell growth and DNA replication, (b) separation of chromosomes (mitosis), and (c) separation of cell contents.
* HS-LS3-1. Develop and use a model to show how DNA in the form of chromosomes is passed from parents to offspring through the processes of meiosis and fertilization in sexual reproduction.
* HS-LS3-2. Make and defend a claim based on evidence that genetic variations (alleles) may result from (a) new genetic combinations via the processes of crossing over and random segregation of chromosomes during meiosis, (b) mutations that occur during replication, and/or (c) mutations caused by environmental factors. Recognize that mutations that occur in gametes can be passed to offspring.
* HS-LS3-3. Apply concepts of probability to represent possible genotype and phenotype combinations in offspring caused by different types of Mendelian inheritance patterns.
* HS-LS3-4(MA). Use scientific information to illustrate that many traits of individuals, and the presence of specific alleles in a population, are due to interactions of genetic factors and environmental factors.
* HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence, including molecular, anatomical, and developmental similarities inherited from a common ancestor
* HS-LS4-2. Construct an explanation based on evidence that Darwin’s theory of evolution by natural selection occurs in a population when the following conditions are met: (a) more offspring are produced than can be supported by the environment, (b) there is heritable variation among individuals, and (c) some of these variations lead to differential fitness among individuals as some individuals are better able to compete for limited resources than others.
* HS-LS4-4. Research and communicate information about key features of viruses and bacteria to explain their ability to adapt and reproduce in a wide variety of environments.
* HS-LS4-5. Evaluate models that demonstrate how changes in an environment may result in the evolution of a population of a given species, the emergence of new species over generations, or the extinction of other species due to the processes of genetic drift, gene flow, mutation, and natural selection.

**Common Misconceptions*** Offspring will inherit “all” of their parents’ traits
* Students assume “I get ½ of traits from mom & dad” but that the contributions are not the same, e.g., mom gives hair color, while dad gives eye color
* Gene expression is guaranteed if the gene is present, one gene = one trait
* Parents each pass down two copies of each of their genes to their offspring
* Mutations are “always” harmful
* Recessive traits are “weaker” than dominant traits, “stronger” traits are dominant (example: darker colors being dominant)
* Offspring inherit acquired traits from parents (musculature from body builder)
* Evolutionary changes occur within a single member of a species and not over time amongst the population
* Changes are immediate
* Organisms can “try” to change
* The biggest and strongest individuals always survive and reproduce
* Evolution and natural selection are the same.
* Species die out only due to a catastrophic environmental change.

**Instructional Strategies*** [Teaching students with special needs](https://static.discoveryeducation.com/techbook/pdf/StrategiesTeachingSpecialNeeds.pdf)
* [Teaching ELLs](https://static.discoveryeducation.com/techbook/pdf/TeachingEnglishLanguageLearners.pdf)
* [Note taking strategies](https://static.discoveryeducation.com/techbook/pdf/NotetakingStrategies.pdf)
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| **Resources:****Texts:*** Pearson Interactive Science Grade 7 2017 Massachusetts Textbook Reading Chapters 9, 10, and 11
* <https://www.readworks.org/>

**Websites:*** [Mendel’s Peas Video](https://ed.ted.com/lessons/how-mendel-s-pea-plants-helped-us-understand-genetics-hortensia-jimenez-diaz)
* [PBS Journey into DNA](https://mass.pbslearningmedia.org/resource/tdc02.sci.life.gen.journeydna/journey-into-dna/#.WL773G_yvIU)
* [Paper Pets Worksheet](http://beasleyac.org/ourpages/auto/2013/1/15/49258242/Paper%20Pets.pdf)
* [Bee Mutation](https://docs.google.com/document/d/1X9zW8zYr2zaVbOdyXF0Nvb3HEka66xQViEajbm13gtw/edit)
* [Teaching Genetics w/ Dragons Concord Consortium](https://concord.org/teaching-genetics/dragons/)
* [Reproductive Strategies](https://teach.genetics.utah.edu/content/evolution/files/ReproductiveStrategies.pdf)
* [2 Methods of Reproduction](http://www.biotopics.co.uk/genes1/asexual_and_sexual_reproduction.html)
* [Build DNA](https://teach.genetics.utah.edu/content/dna/HaveYourDNAandEatItToo.pdf)
* [A Recipe for Traits](https://learn.genetics.utah.edu/content/basics/activities/pdfs/A%20Recipe%20for%20Traits_Public.pdf)
* [SpongeBob Punnett Square Practice](https://drive.google.com/file/d/0B9KBVJcTt0OlOW9qN2NTd3o2YTQ/view) / [More Practice](https://drive.google.com/file/d/0B9KBVJcTt0OlbTJfR3IweW9Bd3M/view)
* [Artificially Selecting Dogs](https://ucmp.berkeley.edu/education/lessons/breeding_dogs/)
* [Myths & misconceptions about evolution](https://www.youtube.com/watch?v=mZt1Gn0R22Q&list=PL5w1V0pKqy1SmIga9I0uD0wZh4fds3scx&index=9) (video)
* [Vocabulary Checklist](https://docs.google.com/document/d/15-Mg2z1aiJ8wRO5c4XYgJbvGu6Bihx7-Rg8P9HSATYQ/copy) (worksheet)
* [Clip bird lesson plan](http://www.ucmp.berkeley.edu/education/lessons/clipbirds/) (lesson plan)
* [Blending Butterflies Link](http://camillasenior.homestead.com/camouflaged_-_butterflies.pdf) (worksheet)
* [TED Talk’s 5 Fingers of Evolution Link](http://ed.ted.com/lessons/five-fingers-of-evolution) (video)
* [Introduction to Genetics](http://teach.genetics.utah.edu/content/heredity/)
* [PBS Genetics](http://www.pbs.org/wgbh/nova/body/cracking-your-genetic-code.html)
* [NOVA Genetics](https://mass.pbslearningmedia.org/collection/cygc12/#.W2i0o9IzpPY)
* [Phenomena](https://thewonderofscience.com/msls32#phenomena)
* CDSM Units [8](https://docs.google.com/document/d/1vHoznc5pyIpC04ptlXfj9p9NvkQcUjFhPwBfqmcVvbI/edit?usp=sharing) and [9](https://docs.google.com/document/d/1vD2xQvBy42ne2ZPhK2cNsoRZetwR5RIbRTznm0dZyWs/edit)

**Arts, Music, Media:*** [pasta genetics](https://gsoutreach.gs.washington.edu/files/pastagenetics_12-10-10.pdf)
* [creative ideas to teach genetics](https://www.theguardian.com/teacher-network/2015/sep/07/six-creative-ways-teach-genetics-genes)
* [Art of genetics](http://www.boiseartmuseum.org/wp-content/uploads/2017/02/Art-of-Genetics-PreVisit-Art-Pack.pdf)
* [role play lesson Genetic Disorders](http://racheliufer.com/wp-content/uploads/2014/02/Genetic-Diseases-Case-Studies-Middle-School.pdf)
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