Biology

UNIT 2 Heredity: Inheritance and Variation of traits

Big Ideas:

- How does cellular information pass from one generation to another?
- What is the structure of DNA, and how does it function in genetic inheritance?
- How does information flow from the cell nucleus to direct the synthesis of proteins in the cytoplasm?
- How can we use genetics to study human inheritance?
- How and why do scientists manipulate DNA in living cells?

Essential Questions:

Where does an organism get its unique characteristics?

How are different forms of a gene distributed to offspring?

How can we use probability to predict traits?

How do alleles segregate when more than one gene is involved?

What did Mendel contribute to our understanding of genetics?

What are some exceptions to Mendel's principles?

Does the environment have a role in how genes determine traits?

How many sets of genes are found in most adult organisms?

What events occur during each phase of meiosis?

How is meiosis different from mitosis?

How can two alleles from different genes be inherited together?

What clues did bacterial transformation yield about the gene?

What role did bacterial viruses play in identifying genetic material?

What is the role of DNA in heredity?

What are the chemical components of DNA?

What clues helped scientists solve the structure of DNA?

What does the double-helix model tell us about DNA?

How does RNA differ from DNA?

How does the cell make RNA?

What is the genetic code, and how is it read?

What role does the ribosome play in assembling proteins?

What is the "central dogma" of molecular biology?

What are mutations?

How do mutations affect genes?

What is a karyotype?

What patterns of inheritance do human traits follow?

How can pedigrees be used to analyze human inheritance?

How do small changes in DNA molecules affect human traits?

What are the effects of errors in meiosis?

What techniques are used to study human DNA?

What are the goals of the Human Genome Project, and what have we learned so far?

What is selective breeding used for?

How do people increase genetic variation?

How do scientists copy the DNA of living things?

How is recombinant DNA used?

How can genes from one organism be inserted into another organism?

How can genetic engineering benefit agriculture and industry?

How can recombinant-DNA technology improve human health?

How is DNA used to identify individuals?

What privacy issues does biotechnology raise?

Are GM foods safe?

Should genetic modifications to humans and other organisms be closely regulated?

Vocabulary:

LS3-3, LS3-2 Genetics, fertilization, trait, hybrid, gene, allele, principle of dominance, segregation, gamete, probability, homozygous, heterozygous, phenotype, genotype, Punnett square, independent assortment, incomplete dominance, codominance, multiple allele, polygenic inheritance, homologous, diploid, haploid, meiosis, tetrad, crossing-over, zygote

LS1-1 Transformation, bacteriophage, base pairing, replication, DNA polymerase, telomere

LS1-1, LS3-1, LS3-2 RNA, messenger RNA, ribosomal RNA, transfer RNA, transcription, RNA polymerase, promoter, intron, exon, polypeptide, genetic code, codon, translation, anticodon, gene expression, mutation, point mutation, frameshift mutation, mutagen, polyploidy, operon, operator, RNA interference, differentiation, homeotic gene, homeobox gene, Hox gene

LS3-2 Genome, karyotype, sex chromosome, autosome, sex-linked gene, pedigree, no disjunction, restriction enzyme, gel electrophoresis, bioformatics, genomics, *Selective breeding, hybridization, inbreeding, biotechnology, polymerase chain reaction, recombinant DNA, plasmid, genetic marker, transgenic, clone,*

gene therapy, DNA microarray, DNA fingerprinting, forensics

Students who demonstrate understanding can:

HS-LS3-1. **Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.**[*Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.*]

HS-LS3-2. **Make and defend a claim based on evidence that inheritable genetic variations may result from:(1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.** [Clarification Statement: Emphasis is on using data to support arguments for the way variation occurs.] [Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.]

HS-LS3-3. **Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.**[Clarification Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.] [*Assessment Boundary: Assessment does not include Hardy-Weinberg calculations.*]

HS-LS1-1.

Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.[*Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis*.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 9-12 builds on K-8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. • Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1) **Analyzing and Interpreting Data** Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS3-3) **Engaging in Argument from Evidence** Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	**LS1.A: Structure and Function** • All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. *(secondary to HS-LS3-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.)* **LS3.A: Inheritance of Traits** • Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1) **LS3.B: Variation of Traits** • In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1),(HS-LS3-2) **Scale, Proportion, and Quantity** • Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3) - *Connections to Nature of Science* **Science is a Human Endeavor** • Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3-3) • Science and engineering are influenced by society and society is influenced by science and engineering. (HS-

• Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)	a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2) • Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2),(HS-LS3-3)	LS3-3)

Connections to other DCIs in this grade-band:
HS.LS2.A (HS-LS3-3); **HS.LS2.C** (HS-LS3-3); **HS.LS4.B** (HS-LS3-3); **HS.LS4.C** (HS-LS3-3) **HS.LS3.A** (HS-LS1-1);

Articulation of DCIs across grade-bands:
MS.LS2.A (HS-LS3-3); **MS.LS3.A** (HS-LS3-1),(HS-LS3-2); **MS.LS3.B** (HS-LS3-1),(HS-LS3-2),(HS-LS3-3); **MS.LS4.C** (HS-LS3-3) **MS.LS1.A** (HS-LS1-1) **MS.LS3.A** (HS-LS1-1) **MS.LS3.B** (HS-LS1-1)

Common Core State Standards Connections:

ELA/Literacy -

RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. *(HS-LS3-1),(HS-LS3-2)*
RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. *(HS-LS3-1)*
WHST.9-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-1)
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1)

Mathematics -

MP.2	Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-1)