# An Interdisciplinary Exploration of Genetics and Probability within 7th grade Science and Mathematics

# An Interdisciplinary Exploration of Genetics and Probability within 7th grade Science and Mathematics

## Unit Overview

In this unit, students will be able to increase their understanding of probability and sampling and application of heredity in the natural world through interdisciplinary studies in both math and science. They will explore simple and compound probabilities and make the transfer to construct explanations about the relationship between genes and chromosomes and the transference of genetic information through the process of inheritance. Students will also develop and use Punnett square models in both math and science to show inheritance patterns and use mathematical and computational thinking to predict the probability of phenotypes and genotypes for single genetic traits. Finally, students will provide claims, evidence, and reasoning when constructing a scientific argument concerning both mutations and technology usage.

## Alignment

### Standards/Indicators Addressed

**Standard 7.L.4** The student will demonstrate an understanding of how genetic information is transferred from parent to offspring and how environmental factors and the use of technologies influence the transfer of genetic information.

**7. L.4A**. Conceptual Understanding: Inheritance is the key process causing similarities between parental organisms and their offspring. Organisms that reproduce sexually transfer genetic information (DNA) to their offspring. This transfer of genetic information through inheritance leads to greater similarity among individuals within a population than between populations. Technology allows humans to influence the transfer of genetic information.

Performance Indicators:

**7. L.4A.1** Obtain and communicate information about the relationship between genes and chromosomes to construct explanations of their relationship to inherited characteristics.
**7. L.4A.2** Construct explanations for how genetic information is transferred from parent to offspring in organisms that reproduce sexually.
**7. L.4A.3** Develop and use models (Punnett squares) to describe and predict patterns of the inheritance of single genetic traits from parent to offspring (including dominant and recessive traits, incomplete dominance, and codominance).
**7. L.4A.4** Use mathematical and computational thinking to predict the probability of phenotypes and genotypes based on patterns of inheritance.
**7. L.4A.5** Construct scientific arguments using evidence to support claims for how changes in genes (mutations) may have beneficial, harmful, or neutral effects on organisms.
**7. L.4A.6** Construct scientific arguments using evidence to support claims concerning the advantages and disadvantages of the use of technology (such as selective breeding, genetic engineering, or biomedical research) in influencing the transfer of genetic information.

## Science and Engineering Practices

**Standard 7.S.1:** The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

**7. S.1A. Conceptual Understanding:** The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

**Performance Indicators:** Students who demonstrate this understanding can:

**7. S.1A.2** Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.

**7.S.1A.5** Use mathematical and computational thinking to (1) use and manipulate appropriate metric units, (2) collect and analyze data, (3) express relationships between variables for models and investigations, or (4) use grade-level appropriate statistics to analyze data.

**7. S.1A.6** Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.

**7. S.1A.7** Construct and analyze scientific arguments to support claims, explanations, or designs using evidence from observations, data, or informational texts.

**7.S.1A.8** Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.

## Crosscutting Concepts (from the SDE instructional unit resources document)

1. **Patterns**: The National Research Council states “Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them” (p. 84). Genetic information is passed along from parent to offspring according to a predictable patterns of inheritance as can be determined through the use of Punnett squares.
2. **Cause and effect**: The National Research Council states “events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts” (p. 84). Parental genetic information results in traits and characteristics exhibited and identified in offspring.
4. **Systems and system models**: The National Research Council states that this includes “defining the system under study—specifying its boundaries and making explicit a model of that

system—provides tools for understanding and testing ideas that are applicable throughout science and engineering" (p. 84). Populations of organisms act as systems whose inputs are comprised of new genetic material and outputs are the genetic offspring.

6. **Structure and function**: The National Research Council states that "the way in which an object or living thing is shaped and its substructure determine many of its properties and functions (p. 84). Genes are the substructures that determine the way a living thing is shaped and its properties.

7. **Stability and change**: The National Research Council states "for natural and built systems alike, conditions of stability and determinants of rates of change or evolution of the system are critical elements of study" (p. 84). Genetic mutations, biomedical engineering, selective breeding and genetic engineering affect the stability and changes within genetics systems.

## Math Standards and Standards for Mathematical Practice (as appropriate)

SCCCR Math 7.RP.2 Identify and model proportional relationships given multiple representations, including tables, graphs, equations, diagrams, verbal descriptions, and real-world situations.

a. Determine when two quantities are in a proportional relationship.
d. Use equations to model proportional relationships.

SCCCR Math 7.RP.3 Solve real-world and mathematical problems involving ratios and percentages using proportional reasoning (e.g., multi-step dimensional analysis, percent increase/decrease/ tax).

SCCCR Math 7.DSP.1 Investigate concepts of random sampling.

a. Understand that a sample is a subset of a population and both possess the same characteristics.
b. Differentiate between random and non-random sampling.
c. Understand that generalizations from a sample are valid only if the sample is representative of the population.
d. Understand that random sampling is used to gather a representative sample and supports valid inferences about the population.

SCCCR Math 7.DSP.2 Draw inferences about a population by collecting multiple random samples of the same size to investigate the variability in estimates of the characteristic of interest.

SCCCR Math 7.DSP.5 Investigate the concept of probability of chance events.

a. Determine the probabilities of simple events.
b. Understand that probability measures the likelihood of a chance event occurring.

c. Understand that the probability of a chance event is a number between 0 and 1.
d. Understand that a probability closer to 1 indicates a likely chance event.
e. Understand that a probability close to ½ indicates that a chance event is neither likely nor unlikely.
f. Understand that a probability closer to 0 indicates an unlikely chance event.

SCCCR Math 7DSP.6 Investigate the relationship between theoretical and experimental probabilities for simple events.
a. Determine the approximate outcomes using theoretical probability.
b. Perform experiments that model theoretical probability.
c. Compare theoretical and experimental probabilities.

SCCCR Math 7.DSP.8 Extend the concepts of simple events to investigate compound events.
a. Understand that the probability of a compound event is between 0 and 1.
b. Identify the outcomes in a sample space using organized lists, tables, and tree diagrams.
c. Determine probabilities of compound events using organized lists, tables, and tree diagrams.
d. Design and use simulations to collect data and determine probabilities.
e. Compare theoretical and experimental probabilities for compound events.

## Standards for Mathematical Practice (as appropriate)

**Standard 1:** Make sense of problems and persevere in solving them.
a. Relate a problem to prior knowledge.
b. Recognize there may be multiple entry points to a problem and more than one path to a solution.

**Standard 2:** Reason both contextually and abstractly.
a. Make sense of quantities and their relationships in mathematical and real-world situations.

b. Make sense of quantities and their relationships in mathematical and real-world situations.

**Standard 3:** Use critical thinking skills to justify mathematical reasoning and critique the reasoning of others.

a. Construct and justify a solution to a problem.
b. Compare and discuss the validity of various reasoning strategies.
c. Make conjectures and explore their validity.
d. Reflect on and provide thoughtful responses to the reasoning of others.
e. Construct and justify a solution to a problem.
f. Compare and discuss the validity of various reasoning strategies.
g. Make conjectures and explore their validity.
h. Reflect on and provide thoughtful responses to the reasoning of others.

**Standard 6:** Communicate mathematically and approach mathematical situations with precision.

a. Express numerical answers with the degree of precision appropriate for the context of a situation.
b. Represent numbers in an appropriate form according to the context of the situation.
c. Use appropriate and precise mathematical language.

### ELA Inquiry Standards

**Standard 1:** Formulate relevant, self-generated questions based on interests and/or needs that can be investigated.
**1.1** Develop questions to broaden thinking on a specific idea that frames inquiry for new learning and deeper understanding
**Standard 2:** Transact with texts to formulate questions, propose explanations, and consider alternative views and multiple perspectives.
**2.1** Formulate logical questions based on evidence, generate explanations, propose and present original conclusions, and consider multiple perspectives.
**Standard 3:** Construct knowledge, applying disciplinary concepts and tools, to build deeper understanding of the world through exploration, collaboration, and analysis.
**3.1** Develop a plan of action by using appropriate discipline-specific strategies.
**3.4** Organize and categorize important information, revise ideas, and report relevant findings.
**Standard 4:** Synthesize integrated information to share learning and/or take action.
**4.1** Employ a critical stance to demonstrate that relationships and patterns of evidence lead to logical conclusions, while acknowledging alternative views.
**4.2** Determine appropriate disciplinary tools and develop a plan to communicate findings and/or take informed action.

**4.3** Reflect on findings and pose appropriate questions for further inquiry.
**Standard 5:** Reflect throughout the inquiry process to assess metacognition, broaden understanding, and guide actions, both individually and collaboratively.
**5.1** Acknowledge and value individual and collective thinking; use feedback from peers and adults to guide the inquiry process.
**5.2** Employ past and present learning in order to monitor and guide inquiry.
**5.3** Assess the processes to revise strategies, address misconceptions, anticipate and overcome obstacles, and reflect on completeness of the inquiry.

**ELA Writing**
**Standard 1:** Write arguments to support claims with clear reasons and relevant evidence.
**1.1** Write arguments that:
a. introduce claims, acknowledge alternate or opposing claims, and organize the reasons and evidence logically;
c. support claims with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text;
e. develop the claim providing credible evidence and data for each;
i. provide a concluding statement or section that follows from and supports the argument
**Standard 6:** Write independently, legibly, and routinely for a variety of tasks, purposes, and audiences over short and extended time frames.
**6.1** Write routinely and persevere in writing tasks over short and extended time frames, for a range of domain specific tasks, and for a variety of purposes and audiences.

**ELA Communication**
**Standard 1:** Interact with others to explore ideas and concepts, communicate meaning, and develop logical interpretations through collaborative conversations; build upon the ideas of others to clearly express one's own views while respecting diverse perspectives.
**1.2** Participate in discussions; ask probing questions and share evidence that supports and maintains the focus of the discussion.
**1.5** Consider new ideas and diverse perspectives of others when forming opinions regarding a topic, text, or issue.

## Connections

### Active Learning Strategies (for Purposeful Reading, Meaningful Writing, and Productive Dialogue)

Specific strategies will be utilized with each lesson within the unit.

### Computational Thinking

*Computational thinking (CT) is a problem-solving process that includes (but is not limited to) the following **characteristics**:*

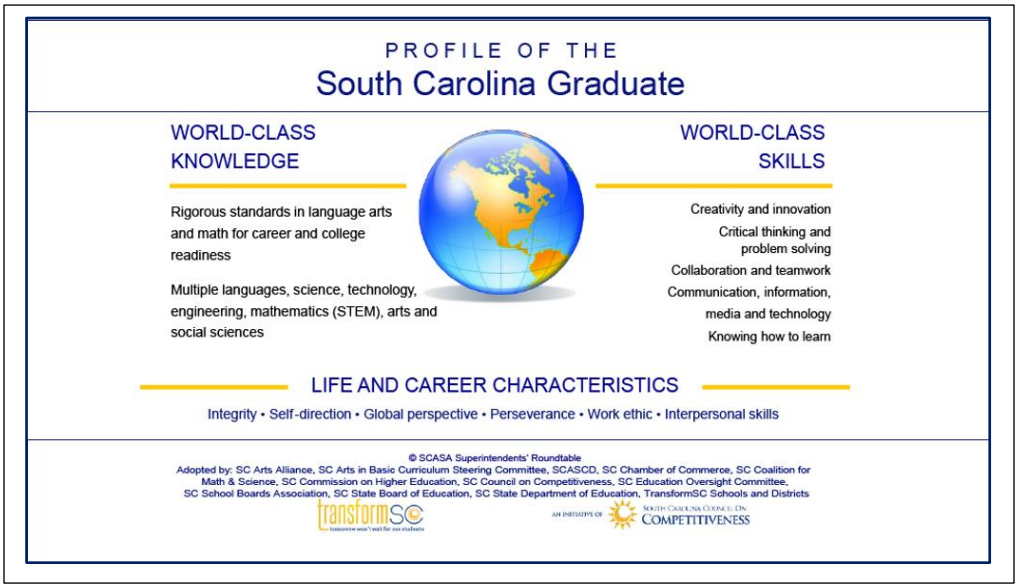
- Formulating problems in a way that enables us to use a computer and other tools to help solve them.
- Logically organizing and analyzing data
- Representing data through abstractions such as models and simulations
- Automating solutions through algorithmic thinking (a series of ordered steps)
- Identifying, analyzing, and implementing possible solutions with the goal of achieving the most efficient and effective combination of steps and resources
- Generalizing and transferring this problem solving process to a wide variety of problems

*These skills are supported and enhanced by a number of dispositions or attitudes that are essential dimensions of CT. These* ***dispositions or attitudes*** *include:*

- Confidence in dealing with complexity
- Persistence in working with difficult problems
- Tolerance for ambiguity
- The ability to deal with open ended problems
- The ability to communicate and work with others to achieve a common goal or solution

### Content Area Connections

- Science
- Math
- English Language Arts
- Computational Thinking




The lessons contained in this unit of study are intentionally designed to support students as they strive to meet the standards described in the Profile of the South Carolina Graduate. Students work collaboratively, communicate information, and actively engage in critical thinking and problem solving as they dive into this exploration of the connections between genetics and probability.

**Other information on the standards and indicators in this unit can be found in the support documents/resources on the SC State Department website.**

> ***www.ed.sc.gov (Instruction → Standards and Learning → Science → Support Documents and Resources)***

**Active Learning strategies and descriptions can be found on the S2TEM Centers SC website in the Disciplinary Literacy Virtual Library:**

> ***s2temsc.org (Resources → Disciplinary Literacy Virtual Library → Strategy Warehouse)***

**Computational Thinking Reference:**

> ***https://csta.acm.org/Curriculum/sub/CurrFiles/CompThinkingFlyer.pdf***
> ***https://csta.acm.org/Curriculum/sub/CompThinking.html***

The lessons contained within this unit are intended to be used for interdisciplinary instruction. The calendar below maps out the order of instruction for both the science and mathematics lessons.

| DAY 1 | DAY 2 | DAY 3 | DAY 4 | DAY 5 |
|---|---|---|---|---|
| **SCIENCE**<br>Genes, Chromosomes, and Inherited Characteristics<br>• Introduction to genetic material terminology | | **SCIENCE**<br>Inherited Traits<br>• Transference of genetic information in sexually reproducing organisms | | **SCIENCE**<br>Variation in Traits<br>• Phenotypes and genotypes of single allele traits and polygenic traits of a human face |
| **MATH**<br>What Are My Chances?<br>• Theoretical and experimental probability of simple events | | | **MATH**<br>What Are My Chances Now?<br>• Theoretical and experimental probability of compound events, both independent and dependent | |

| DAY 6 | DAY 7 | DAY 8 | DAY 9 | DAY 10 |
|---|---|---|---|---|
| **MATH**<br>What Are My Chances Now?<br>• Theoretical and experimental probability of compound events, both independent and dependent | **SCIENCE**<br>Modeling Mendel: Genetic Crosses<br>• Modeling genetic crosses with toothpick chromosomes to predict patterns of inherited traits | **MATH**<br>Just Like Me<br>• Random sampling; drawing inferences about a population based on a random sample | **SCIENCE**<br>Probability and Patterns of Inheritance<br>• Predicting the probability of phenotypes and genotypes through mathematical and computational thinking | **MATH**<br>Exploring the Genetics of Albinism<br>• Punnett squares and probability |

| DAY 11 | DAY 12 | DAY 13 | DAY 14 | DAY 15 |
|---|---|---|---|---|
| **SCIENCE**<br>The Effects of Mutations on Organisms<br>• Beneficial, harmful, or neutral effects | | **SCIENCE**<br>Using Technology to Influence Genes<br>• Advantages and disadvantages of technology | | |