# Grade 7
# Science
# Unit 6: Reproduction and Heredity

**Time Frame:** Approximately four weeks


## Unit Description

This unit focuses on the basic concepts of genetics. Major topics include sexual and asexual reproduction, mitosis and meiosis, genes and chromosomes, and Mendel's laws. The use of Punnett squares to predict traits will be presented in the unit.

## Student Understandings

Students will compare and contrast the processes or concepts of *sexual* and *asexual reproduction*, and *mitosis* and *meiosis*. Differentiate between the two types of reproduction and forms of cell division. Students will correctly complete Punnett squares to predict phenotypic and genotypic probability ratios in the offspring of genetic crosses involving dominate and recessive traits. Identify and describe uses of fertilization and selective breeding and genetic engineering.

## Guiding Questions

1. Can students describe sexual and asexual reproduction and cite examples of each?
2. Can students articulate the major difference between mitosis and meiosis and describe the phases of each process?
3. Can students describe how genetic information is passed from one generation to the next?
4. Can students explain and identify how and when a change in the DNA molecule can cause a disorder?
5. Can students identify a genetic trait and explain the link via Punnett squares?

## Unit 6 Grade-Level Expectations (GLEs)

| | **GLE Text and Benchmarks** |
|---|---|
| **Science as Inquiry** | |
| *Note: The following Science as Inquiry GLEs are embedded in the suggested activities for this unit. Other activities incorporated by teachers may result in additional SI GLEs being addressed during instruction on the Reproduction and Heredity unit.* | |
| 1. | Generate testable questions about objects, organisms, and events that can be answered through scientific investigation (SI-M-A1) |

| | **GLE Text and Benchmarks** |
|---|---|
| 3. | Use a variety of sources to answer questions (SI-M-A1) |
| 4. | Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2) |
| 5. | Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2) |
| 7. | Record observations using methods that complement investigations (SI-M-A3) |
| 8. | Use consistency and precision in data collection, analysis, and reporting (SI-M-A3) |
| 9. | Use computers and/or calculators to analyze and interpret quantitative data (SI-M-A3) |
| 11. | Construct, use, and interpret appropriate graphical representations to collect, record, and report data (e.g., tables, charts, circle graphs, bar and line graphs, diagrams, scatter plots, symbols) (SI-M-A4) |
| 12. | Use data and information gathered to develop an explanation of experimental results (SI-M-A4) |
| 13. | Identify patterns in data to explain natural events (SI-M-A4) |
| 14. | Develop models to illustrate or explain conclusions reached through investigation (SI-M-A5) |
| 15. | Identify and explain the limitations of models used to represent the natural world (SI-M-A5) |
| 17. | Recognize that there may be more than one way to interpret a given set of data, which can result in alternative scientific explanations and predictions (SI-M-A6) |
| 19. | Communicate ideas in a variety of ways (SI-M-A7) |
| 20. | Write clear, step-by-step instructions that others can follow to carry out procedures or conduct investigations (SI-M-A7) |
| 22. | Use evidence and observations to explain and communicate results of investigations (SI-M-A7) |
| 23. | Use relevant safety procedures and equipment to conduct scientific investigations (SI-M-A8) |
| 26. | Use and describe alternative methods of investigating different types of testable questions (SI-M-B1) |
| 28. | Recognize that investigations generally begin with a review of the work of others (SI-M-B2) |
| 31. | Recognize that there is an acceptable range of variation in collected data (SI-M-B3) |
| 32. | Explain the use of statistical methods to confirm the significance of data (e.g., mean, median, mode, range) (SI-M-B3) |
| 36. | Explain why an experiment must be verified through multiple investigations and yield consistent results before the findings are accepted (SI-M-B5) |
| 37. | Critique and analyze their own inquiries and the inquiries of others (SI-M-B5) |
| 40. | Evaluate the impact of scientific research on scientific thought, society, and the environment (SI-M-B7) |

| | **GLE Text and Benchmarks** |
|---|---|
| **Life Science** | |
| 14. | Differentiate between sexual and asexual reproduction (LS-M-B1) |
| 15. | Contrast the processes of mitosis and meiosis in relation to growth, repair, reproduction, and heredity (LS-M-B1) |
| 16. | Explain why chromosomes in body cells exist in pairs (LS-M-B2) |
| 17. | Explain the relationship of genes to chromosomes and genotypes to phenotypes (LS-M-B2) |
| 18. | Recognize genetic errors caused by changes in chromosomes (LS-M-B2) |
| 19. | Apply the basic laws of Mendelian genetics to solve simple monohybrid crosses, using a Punnett square (LS-M-B3) |
| 20. | Explain the differences among the inheritance of dominant, recessive, and incomplete dominant traits (LS-M-B3) |
| 21. | Use a Punnett square to demonstrate how sex-linked traits are inherited (LS-M-B3) |
| 22. | Give examples of the importance of selective breeding (e.g., domestic animals, livestock, horticulture) (LS-M-B3) |

## Sample Activities

### Activity 1: Reproduction (SI GLEs: 1, 4, 5, 7, 9, 12, 20, 22, 23, 32, 37; LS GLE: 14)

Materials List**:** poster; tape; pictures of living things; Reproduction Vocabulary Self-Awareness Chart BLM (one per student); plants such as ivy, garlic, carrot; pots or small cups (other materials for growing plants); Laboratory Investigation Scoring Rubric BLM (one per student); timer; computer access (optional); cutting utensil (teacher only)

*Safety note*: *Discuss all relevant safety procedures while designing experiments such as proper hand washing and proper handling of living organisms.*

Part A
To utilize the literacy strategy of the *vocabulary self-awareness chart* (view literacy strategy descriptions) group students in pairs and distribute copies of the Reproduction Vocabulary Self-Awareness Chart BLM that contains the following terms: *asexual reproduction, sexual reproduction, budding,* and *regeneration*. Using a timer, allow students 3-5 minutes to complete the chart. Monitor groups to ensure time-on-task. *Vocabulary self-awareness charts* are used to introduce words at the beginning of the reading or activity discussion, and students will complete a self-assessment of their knowledge of these words. Students may add information to the chart as it is presented during the lesson. This chart should also be revisited at the close of the lesson to serve as a quiz and review sheet. At the end of the timed session allow students to share and discuss their charts and provide additional information on asexual and sexual reproduction with examples.

Next provide each group with a poster, tape, and ten pictures of living organisms, including both plants and animals. The pictures should include organisms that reproduce primarily asexually, sexually, and by budding and regeneration (these examples should be different from above). Students should label the poster using the types of reproduction previously listed as headings. Allow students five minutes to place the pictures under the appropriate heading, according to the type of reproduction. Have groups share their posters by completing a classroom carousel around the room to review the work of their classmates. Upon returning to their group poster, allow students five minutes to reevaluate their decisions and make adjustments to their poster, based upon the work of their classmates. Once final decisions have been made, allow each group two minutes to display their poster and provide a rationale explanation about their decisions and adjustments. After student explanations, provide students with the correct groupings and discuss any misconceptions that students may have.

Part B
Provide instruction on various forms of asexual reproduction found in plants. Common plants that reproduce through vegetative propagation are ivy (from stems), garlic (from bulbs), carrot (from root top), and potatoes. Have students work in groups to design an investigation to explore a type of asexual reproduction in plants. Discuss guiding questions that students should consider before beginning the investigation. Possible questions may include the following:

- Can a new plant start from a cutting or stem?
- How long does it take for new roots to appear?

Allow students to add to the list and discuss the testable questions.

Each group will do the following:

- select a plant to investigate its capabilities of asexual reproduction
- write a hypothesis as to whether or not the plant can reproduce asexually
- design an investigation to test the hypothesis
- identify any safety issues to be considered
- identify factors to be controlled—the independent and dependent variables
- make a list of materials needed
- Write step-by-step instructions that another student could follow to conduct a similar investigation and create a data organizer.

Explain to students that they may investigate any part of the plant (except seeds) to see if it will propagate a new plant. Students should select materials easily available for their investigations. After obtaining teacher approval, groups should conduct their experiments and review student designs to ensure they are safe and have a measurable outcome. Students may need ideas and guidance when redesigning investigations. Investigations should test the hypothesis. For example, in order for students to determine if ivy will reproduce through vegetative propagation, they should design an experiment that will allow for the plant to be placed in water until the formation of new roots occurs. Students will observe their experiments over at least a two-week period, and write analyses and conclusions. Students should use consistency and precision when observing, analyzing, collecting, and recording data. Data collection should include statistical interpretation of graphs, charts, or tables and diagrams to help explain experimental results. Where technology is available, students should use a computer program to create and analyze graphs and charts.

Have students present their procedure and findings to the class and compare experimental designs. Using the Laboratory Investigation Scoring Rubric BLM, allow students to critique their inquiries and the inquiries of others. Discuss the importance of communication between scientists and lead students to recognize that investigations generally begin with a review of the work of others. Explain to students that scientists conduct multiple trials before publishing or accepting scientific information as true or theory. Have students collaborate with groups who performed similar experiments to compare results.

Students should be able to differentiate between sexual and asexual reproduction in plants.

As a review of the lesson, students should review the *vocabulary self-awareness* chart to use as a study guide of key terms or quiz.

**Activity 2: Mitosis (SI GLEs: 13, 14, 15, 28; LS GLE: 16)**

Materials List**:** microscope slides of mitosis, microscopes, different colored yarn, uncooked spaghetti, telephone cord, wire toy, pencil, pipe cleaner, glue, tape, poster board, markers or colored pencils, science learning log, access to grade-appropriate research materials

*Safety note*: *Review the proper safety procedures when handling microscopes and glass slides.*

Activate students' prior knowledge about chromosomes and DNA by asking probing questions such as the following:

- What is DNA and where in the body is it found?
- What are chromosomes?
- Where are the chromosomes located within the body?
- How many chromosomes do human cells have?
- Do all human cells have the same number of chromosomes?
- Do all organisms have chromosomes and DNA?

Explain that the word *mitosis* is derived from the Greek word for thread, and *phase* is another word for stage. Have students use reference materials to find the meaning of the prefixes *inter*, *pro*, *meta*, *ana*, and *telo*; then place each phase of mitosis in order by name. Place the acronym I-PMAT on the board to help students remember the order of the phases. Explain that *interphase* is a time when the cell is making preparations to divide. During the *interphase*, the DNA replicates and becomes double stranded in order to prepare for *prophase*, where it coils, thickens, and forms chromosomes. Therefore, the I for *interphase* is set apart from the letters for the other phases. To demonstrate the coiling and thickening of chromosomes, wrap a pipe cleaner around a pencil or use a telephone cord or coiled wire toy to represent the changes that happen to chromosomes during interphase and early prophase. Use illustrations or visuals, to provide students with a brief overview of *prophase, metaphase, anaphase,* and *telophase.*

Have diagrams of cells in various phases of mitosis at microscope stations set up in random order around the room for students to view in a carousel format. As students view each slide, instruct them to indicate the proper arrangement of the phases in their science *learning log* (view literacy

strategy descriptions). Science *learning logs* are created by students to record observations, ideas, comments, and questions about science topics. Upon completion of the viewing activity, allow students to discuss and justify their concluded mitotic arrangement. Identify the proper arrangement for the phases of mitosis and allow students to compare their results.

After forming groups, provide students with a poster board to create a model of each phase of mitosis, using different colored yarn for the chromosomes and uncooked spaghetti for the spindle fibers. Provide students with grade-level reference material, including text or trade books, to use for gathering information for a classroom presentation on the phases of mitosis. Direct each group to divide their poster into four sections and include a short description of prophase, metaphase, anaphase, and telophase based upon information gathered in their research, although they will be assigned at random one phase to discuss orally and share their unique design of that phase. Emphasize that interphase is the time identified when the cell is preparing to enter mitosis by engaging in various metabolic activities. Also emphasize that upon completion of mitosis, a new duplicate cell (daughter cell) has been created containing the same number of chromosomes as the original cell. Thus their poster will only depict the four stages of prophase, metaphase, anaphase, and telophase. Students should discuss why chromosomes in body cells exist in pairs and the relationship of genes to chromosomes. Allow groups to present their findings to the class.

**Activity 3: Meiosis and Me (SI GLE: 13; LS GLEs: 15, 16)**

Materials List: Discussion Guide For Reciprocal Teaching BLM (one per student), grade-appropriate reference materials, video segment on meiosis, chart paper, colored pencils, markers

Although there are similarities between the stages of mitosis and meiosis, they are difficult concepts for many students to understand. Use *Reciprocal teaching* (view literacy strategy descriptions) to introduce the concept of *meiosis*. *Reciprocal teaching* is a strategy in which the teacher models and the students use summarizing, questioning, clarifying, and predicting to better understand content text.

Begin the lesson by stating, "Unlike mitosis, during meiosis the chromosome number is reduced by one half; thus, the nucleus divides twice for certain cells." Ask students why this is necessary. Following direct instruction, modeling, or a video on meiosis, have students complete a compare-and-contrast matrix *graphic organizer* (view literacy strategy descriptions) such as a Venn diagram, of the processes of mitosis and meiosis. A Venn diagram is a way for students to compare two topics by comparing and contrasting information.
Provide students grade-appropriate reference materials that explain the phases of meiosis to use during *reciprocal teaching*. Begin by introducing the technique of summarizing. Share several short reading materials relating to the opening statement read to the class. As a class, develop a summary statement. Group students into four and provide them a copy of the Discussion Guide For Reciprocal Teaching BLM. Instruct student groups to write a prediction about the section of text for which they will read next. After reading, direct students' attention to the prediction and discuss how accurate it was and how it helped guide thinking while reading. After modeling these processes, assign students within the group to take responsibility of fulfilling the role of

summarizer, questioner, clarifier, and predictor. Students should now continue the process to complete the BLM. As a class discuss their findings and clear up any misconceptions that students may still have.

Explain that meiosis is a necessary step in order for sexual reproduction to take place. Once fertilization occurs, i.e., the union of a male and female reproductive cell, the embryonic cells may divide as often as every fifteen minutes. Challenge students to calculate how many cells would be produced at this rate after twenty-four hours from the one fertilized egg cell, which was the result of the union of the two meiotic cells. Discuss, confirm, correct, and/or expand on student calculations in an interactive question-and-answer session.

Assign groups to create a skit, story, or comic strip describing the phases of *Little Me*, the chromosomes involved in meiosis.

In conclusion of the lesson, review the Reciprocal Teaching BLM and Venn diagram to use as a quiz or study sheet.

**Activity 4: DNA Molecule (SI GLEs: 11, 15, 17, 36, 40; LS GLE: 18)**

Materials List: reference booklet (one per group), large chart paper, markers or colored pencils, paper DNA molecule strip (per student), cell model undergoing mitosis (teacher visual), model of DNA molecule (teacher visual)

Place the terms *genes* and *chromosomes* on the board and ask students to explain their relationship. Discuss the students' responses. If students experience difficulty in responding, at this point of the lesson, they will gain a better understanding of this relationship by the close of the lesson. Revisit this information at the end of the lesson.

Provide students with a paper model strip of a single unpaired strand of DNA and explain the pairing of the four nitrogen bases (adenine, thymine, guanine, and cytosine). Tell students that these bases can be thought of as the letters in the genetic alphabet and that each genetic codon has three letters (bases). Have students combine the bases, determining how many different ways the four letters (A, T, G, and C) can be arranged on a single strand in groups of three.

Display models of a cell undergoing mitosis and a model of a DNA molecule. Discuss if the model of DNA being used is a good model. Through probing questions and class responses, guide students to the understanding that genes are the small heredity units on chromosomes and that they are made of a series of four bases in DNA molecules. Point out to students that an individual's complete set of genetic material is referred to as an organism's *genome*. Before a cell divides, the DNA must replicate so that the two new cells will each have the organism's genetic code. Describe how genetic errors caused by changes in chromosomes can lead to genetic disorders such as Down syndrome and Fragile X syndrome. Ask students in what phase of the cell cycle, DNA replicates (interphase) and is thus vulnerable to miscoding. The following websites are an excellent source for information on these two genetic disorders:

http://www.nichd.nih.gov/publications/pubs/downsyndrome.cfm
http://www.fragilex.org/html/molecular.htm.

Provide students with additional practice in pairing DNA bases by writing out series of bases (DNA segments) and asking them to identify complementary bases for each series. Discuss that incorrect base-pairing during DNA replication can produce inoperable genes and causes genetic disorders such as sickle-cell anemia and cystic fibrosis and that pieces of chromosomes can be broken off and deleted to cause severe genetic abnormalities.

Place students in groups and provide them with a teacher-created reference booklet (this booklet can be created by researching relevant information) containing short summaries of the research and work of the DNA pioneers. Suggested DNA pioneers for research include Francis Crick, James Watson, Barbara McClintock, Marice Wilkins, Martha Chase, A.D. Hershey, and Rosalind Franklin. Students should read through the information to determine the contribution of each scientist, the relative amount of time they spent on his/her particular area of research, and how he/she used the work of others to build or in developing his/her own findings. This information can be used to create a group *graphic organizer* (view literacy strategy descriptions) such as a concept map on large chart paper. *Graphic organizers* allow students to arrange information in an organized way. Have students explain why the scientists conducted their investigations multiple times before publishing their findings. The discovery of the shape of the DNA molecule is an excellent example of scientists sharing (and sometimes not) their research. Students should present their findings to the class. After each group has presented, create a timeline to hang on the wall in the classroom. Each group can be assigned a particular scientist to be responsible for, writing the date and contribution of the scientist(s) using different colored markers.

Ask students to speculate why there were several major theories of how the DNA molecule was structured, even though scientists were using similar data. (Scientists were interpreting the data differently, resulting in an alternative explanation.) Discuss with students some of the ways in which the discovery of the structure of the DNA molecule has impacted society and the environment. Ask students to hypothesize how the use of DNA technology in law enforcement aids in the capturing, conviction, and release of falsely-accused criminals.

Invite a guest speaker from the local crime lab or police force to discuss how DNA is used to solve crimes. Students should find articles in the newspaper or magazines concerning the use of DNA in an investigation to share with the class.

**Activity 5: Trendy Traits (SI GLE: 4, 8, 14, 31, 32; LS GLEs: 17, 19, 20, 21)**

Material List: calculators, Trendy Traits Vocabulary Self-Awareness Chart BLM (one per student), Punnett Square BLM (laminated), marker chips, erasable marker, paper towels

Introduce the activity by utilizing the vocabulary *self-awareness chart* (view literacy strategy descriptions) strategy. Distribute a copy of the Trendy Traits Vocabulary Self-Awareness Chart BLM, which contains the following terms associated with *genetics*: *phenotype, genotype, allele,*

*hybrid, monohybrid, dihybrid, dominant,* and *recessive*. A *vocabulary self-awareness chart* allows students to determine their level of understanding (prior to the activity discussion) by placing words in columns that provide definitions and examples. Students may add information to the chart as it is presented during the lesson. This chart should also be revisited at the close of the lesson to serve as a quiz and review sheet. Direct students to an understanding that the word *genotype* refers to the type of genes that an organism has for a particular trait and that the *phenotype* is the trait that is expressed or seen.

Give students a list of human traits such as tongue roller, free ear lobes, almond shaped eyes, brown eye color, widow's peak, and thick lips, all of which are dominant. Recessive traits that may be included are non-tongue roller, attached ear lobes, round eyes, blue eye color, straight hairline, and thin lips. Assign students to cooperative groups of three and ask them to create a data table to display the dominant and recessive traits to be surveyed within the classroom. Allow students to predict which trait will appear most often prior to the start of the activity. The table should include the number and percentage of students displaying the dominant and recessive traits. Discuss results by asking students which trait appeared to be the most common. Using their data, do dominant traits occur more often than recessive? If the survey was extended to another class, would the results follow the same pattern? Were there some students who have traits that were neither clearly dominant nor recessive, but intermediate?

Using the collected data instruct students to calculate the mean, median, mode, and range. Students should recognize that there is an acceptable range of variation in collected data for any investigation.

Provide students with a laminated Punnett square (see Punnett Square BLM), marker chips, an erasable marker, and paper towels. Using their generated list, students will choose the two most frequently appearing traits and decide upon a genotype to represent them. Review the concept of dominance and recessiveness, and assign appropriate alleles. Discuss the Mendelian laws and predict the outcome of a simple monohybrid cross using student-created alleles.
Where technology is available students can practice using a punnett square online at http://www.zerobio.com/drag_gr11/mono.htm. Following a demonstration, have students calculate the genotypic and phenotypic ratios. Complete another monohybrid cross before allowing the groups to create their own. Provide additional practice in the use of Punnett squares to predict outcomes in offspring.

Introduce the terms *incompletely dominant* and *sex-linked traits* (hemophilia and color blindness) and analyze a pedigree showing the pattern of inheritance. Queen Victoria's family tree is a good example to use to observe and analyze a pedigree on hemophilia. Provide instruction and a Punnett square example for incompletely dominant traits such as flower color or hair color in cats. Examples of this information may be obtained from a grade-level text or biology book.

In conclusion, explain the differences among the inheritance of dominant, recessive, and incomplete dominant traits.

**Activity 6: Selective Breeding (SI GLEs: 3, 19, 26, 40; LS GLE: 22)**

Materials List: primary and secondary source readings, Internet access

List the following terms on the board and discuss definitions and explanations: *genetic engineering*, *selective breeding*, *inbreeding*, *hybrids*, and *test cross*. Provide students with grade-level appropriate material of examples and techniques describing successful selective breeding. Discuss the pros and cons of current scientific techniques involving cattle milk producers, plant hybrids, polyploidy in plants, Brangus beef cattle, and disease-resistant plants. Describe the impact of this research on society and the environment.

Provide students with a scenario in which they are either a farmer using selective breeding techniques or a scientist using genetic engineering in developing a disease-resistant crop plant. Instruct them to construct a public announcement explaining their research and how it is beneficial.

## Sample Assessments

### General Guidelines

Assessment will be based on teacher observation/checklist notes of student participation in unit activities, the extent of successful accomplishment of tasks, and the degree of accuracy of oral and written descriptions/responses. Journal entries provide reflective assessment of class discussions and laboratory experiences. Performance-based assessment should be used to evaluate inquiry and laboratory skills. All student-generated work, such as drawings, data collection charts, models, etc., may be incorporated into a portfolio assessment system.

- Students should be monitored throughout the work on all activities.
- All student-developed products should be evaluated as the unit continues.
- When possible, students should assist in developing any rubrics that will be used and should be provided with the rubric during task directions.

### General Assessments

- The student will design and conduct an experiment on asexual reproduction in a plant.
- The student will construct cell models of mitosis and meiosis.
- The student will prepare a four-slide presentation on a phase of mitosis and a phase of meiosis.
- The student will construct a model of a DNA molecule from student-selected materials with written justification about why a particular material was used.
- The student will write a journal entry on the investigation of inherited traits.
- The student will complete a report on selective breeding.

**Activity-Specific Assessments**

- Activity 1: Using the Venn diagram, students are to compare and contrast concepts of asexual and sexual reproduction. Assess the diagrams to determine the accuracy of the location of information.

- Activity 2: Given copies of the phases of mitosis out of sequence, students should place the phases in order and match them to their proper description.

- Activity 4: Provide students with a single DNA strand of unpaired nitrogen bases. Students will draw the complementary base strand. Assess students' strands to determine the proper pairing of the nucleotides.

- Activity 5: Students will solve a Punnett square to predict the genotype and phenotype of an offspring when given the alleles. The Punnett square should show the alleles in the proper locations and both the phenotypes and the genotypes of offspring should be given.

**Resources**

- *Gregor Mendel: And the Roots of Genetics (Oxford Portraits in Science)* by Edward Edelson, Oxford University Press Children's Books.
- *How Cells Divide: Mitosis vs. Meiosis.* Available online at http://www.pbs.org/wgbh/nova/baby/divi_text.html
- *Plants from Test Tubes: An Introduction to Micropropagation* by Lydiane Kyte, Timber Press, Inc.
- *Understanding Mitosis and Meiosis: An Interactive Education Tool* (CD-ROM) by O. Oud and G. Rickards, Springer Verlag.
- *Punnett Square Practice Available online at* http://www.accessexcellence.org/AE/AEPC/WWC/1994/punnett.html
- *Punnett Square Calculator Available online at* http://www.changbioscience.com/genetics/punnett.html (requires JAVA)
- *Genetics Tutorial Available online at* http://library.thinkquest.org/17109/tutorial.htm
- *Phases of mitosis Available online at* http://spacesciencegroup.org/sootw/Default.asp?Theme=cells&pagename=mitosisphases