Lesson A4–1

PRINCIPLES OF HEREDITY: ALBINISM IN CORN

Unit A. Plant Science

Problem Area 4. Managing Inputs for Plant Growth

Advanced Life Science Area: Plants and Soils

Standard PS.4.1 Plant Genetics—Chemistry and Expression: Describe how the interaction between the genotype and the environment produces a phenotype. Explain the flow of information from gene to protein. Discuss the production and roles of messenger RNA, transfer RNA and ribosomes during protein synthesis. Explain how alterations in a plant’s chemical or physical environment can change whether or not a gene is turned on, and thus whether a phenotype is expressed.

Standard PS.4.6 Plant Genetics—Chemistry and Expression: Describe the relationship between DNA replication, mitosis and meiosis.

Standard PS.4.7 Plant Genetics—Chemistry and Expression: Explain that DNA replication and gene expression are independent phenomena.

Standard PS.5.5 Evolutionary Trends and Ecology: Define hybridization, and describe how it can lead to the development of unique species and varieties.
**Student Learning Objectives.** Instruction in this lesson should result in students achieving the following objectives:

1. Define genetics and explain why it is important.
2. Explain what factors govern genetics.
3. Explain how organisms reproduce.
4. Explain what Gregor Mendel learned about genetics.
5. Explain the outcome of a monohybrid cross for complete dominance.

**List of Resources.** The following resources may be useful in teaching this lesson:


**List of Equipment, Tools, Supplies, and Facilities**

- ✓ Writing surface
- ✓ Overhead projector
- ✓ Transparencies from attached masters
- ✓ Copies of student lab sheets

**Terms.** The following terms are presented in this lesson (shown in bold italics):

- allele
- cell
- chromosome
- complete dominance
Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Obtain product literature from several seed companies (i.e. corn, wheat, vegetables, flowers) which describe the superior qualities of seed. As a class, compile a list of superior traits for any crop from the available literature. Pose the questions, how do seed companies develop varieties of plants which possess the qualities described in the literature? What is the ideal plant and why hasn’t one superior variety been developed that is better than all others? Use these questions to begin the discussion on principles of heredity.
Objective 1: Define genetics and explain why it is important.

Anticipated Problem: What is genetics and why is it important to understand genetics?

I. Plants are an important part of our life. They not only supply us with food for nutrition, but they also provide us with medicine, latex, oils, latex, and resins. Because plants are so valuable, humans have tried to manipulate plants for our benefit for thousands of years. Early man realized that some plants tasted better than others and that seeds could be harvested and planted to increase the availability of certain plants. Modern methods of plant breeding have dramatically improved crop yield and nutritional quality in modern cultivars, (i.e. the development of hybrid corn in the 1930’s is one of the most important developments in agriculture in the 20th Century). The planting of hybrid cultivars and good farming practices have resulted in corn yields of 400 bushels per acre.

The founding of the International Rice Research Institute (IRRI) in 1962 is another example of how man has manipulated plant genetic information for our benefit. This was one of the cornerstones of the green revolution of the 1960’s. The IRRI developed cultivars which dramatically increased yields. By 1974, modern dwarf rice accounted for more than 99% of irrigated rice averaging 45–80 bushels per acre.

During the 19th century we learned that genetics governs the traits that are expressed in plants. Today scientists are experimenting with genetic engineering to change the genetic make-up of plants.

A. **Genetics** is the study of how traits are passed from parents to offspring. The passing of traits from one generation to another is **heredity.** It is important to understand that traits are governed by genetics as well as the environment. The amount of environmental influence can vary greatly depending on the trait.

B. Each living thing produces offspring like itself.

C. Each kind of organism has certain common traits that distinguish itself from other kinds of organisms called defining traits (i.e. cats, dogs, humans, and corn plants each have their own set of defining traits).

D. Each kind of organism has traits that vary among member of their own kind and distinguishes them as different from each other (i.e. white leaves vs. green leaves or purple seeds vs. white seeds on a corn plant).

E. Plant breeding is a systemic process of improving plants using scientific methods. There are a variety of methods used to make certain plants pollinated, as well as methods to prevent unwanted pollination of plants. The goals of plant breeding vary according to
the type of improvement in the plant that is desired by the plant breeder. Plant breeding may be used to accomplish a variety of goals. Some of them are:

1. Gain disease resistance.
2. Gain insect resistance.
3. Improve environmental adaptation.
4. Improve productivity.
5. Make a species more suited to cultural practices.
6. Obtain a more desirable product from plants.

Use TM–A. Assign students to conduct the Current Events assignment found on LS–D. Use newspapers or the Internet to conduct the research. Students can find their own articles to evaluate or printed copies can be supplied to them to ensure good quality articles. Each student should use a different article and then present their findings so that the class can learn about a wide variety of genetic topics in the news. Students should begin the experiment found on LS–A since it will take about one week for the seedlings to grow. TS–B provides sample answers to the lab’s questions.

**Objective 2:** Explain what factors govern genetics.

**Anticipated Problem:** What governs genetics and how are genes passed from offspring to parents?

II. A cell is the basic unit of life. The cell is made up of the cell membrane, cytoplasm, and the nucleus. The cell membrane protects the cell and regulates what can go in and out of the cell. The cytoplasm contains the organelles which are like small organs that perform a variety of functions that are vital to the cell. Examples of organelles include the mitochondria, microtubules, ribosomes, endoplasmic reticulum, golgi complex, vacuoles, plastids, and many more. The nucleus is the “brain” of the cell and contains the genetic information that directs the activities of the cell.

A. **Chromosomes** are found in the nucleus; they carry the genes which govern specific traits. Chromosomes are found in pairs in all cells except in the reproductive cells. They exist in pairs; corn has 20 chromosomes or 10 pairs.

B. Chromosomes contain genetic units known as genes.

C. Both members of the chromosome pair contain the same genes in the exact same location on the chromosome, therefore, for any one trait there exists a pair of genes responsible for its expression. The following lists the number of chromosomes that each plant contains: corn—20, barley—14, alfalfa—32, potato—48, cotton—52, carrot—18, garden pea—20, lettuce—18, and wheat—42.
Objective 3: Explain how organisms reproduce.

Anticipated Problem: How do organisms reproduce?

III. Cells can reproduce by two main methods in multicellular organisms—mitosis and meiosis.

A. **Mitosis** is a type of asexual reproduction where two new cells are created from the original cell.
   1. Each new cell is genetically identical to the parent cell.
   2. This process continues throughout an organism’s life.
   3. The steps of mitosis include: prophase, metaphase, anaphase, and telophase. The cell cycle includes Interphase, Mitosis, and cytokinesis. Interphase is a stage where the cell grows in size and replication of the chromosomes occurs. Cytokinesis is a resting phase which lasts for a short period of time.
   4. Mitosis is important to the growth of all organisms.
   5. For example, human cells contain 46 chromosomes. During the cell cycle, the number of chromosomes is doubled so that the cell contains 92 chromosomes. Then, the cell divides into two new cells each containing 46 identical chromosomes.

B. **Meiosis** is cell division that creates four new cells from the original parent cell resulting in four sex cells. This occurs in the flower (in angiosperms) to form the cells from which the pollen grains and the embryo sac (which contains the egg) develop.
   1. The four new cells or daughter cells are not genetically identical nor are they identical to the parent cell.
   2. The chromosomes in the daughter cells do not contain chromosomes in pairs.
   4. Meiosis allows for the random assortment of parental genes.
   5. For example, human cells contain 46 chromosomes. The chromosomes replicate to 92—divide once forming two cells containing 46 chromosomes—and then divide again forming four daughter cells of 23 chromosomes. The egg and sperm cells are examples of cells created through meiosis.

C. When the gametes which are created by meiosis unite or fertilize sexual reproduction has occurred. Offspring produced by sexual reproduction receive half of their genetic information from their female parent and the other half from their male parent.

D. A **zygote** is a protoplast resulting from the fusion of gametes; the beginning of a new plant in sexual reproduction.
E. A **species** is a group of related organisms that produce fertile offspring. A **cultivar** or variety is an international term denoting certain cultivated plants that are clearly distinguishable from others by any characteristic and that when reproduced retain their distinguishing characters. However, different cultivars can be crossed to obtain plants with unique characteristics.

Use TM–B, TM–C, TM–D, and TM–E, and TM–F to help reinforce the main content of this objective.

**Objective 4:** Explain what Gregor Mendel learned about genetics.

**Anticipated Problem:** Who discovered genetics and what did they learn about how traits are passed from parents to offspring?

IV. **Gregor Mendel** was an Austrian monk that conducted experiments on pea plants. As a result, the father of genetics learned many things about how traits are passed from parents to offspring.

A. Mendel conducted experiments on pea plants. He made observations on the color of the flowers, whether the flowers were axial or terminal, pod color, seed color, and others. (See the transparency for more specific information on the experiments that he performed. Make a copy of the transparency showing his observations for the students.)

1. **Inheritance** is the acquisition of traits by offspring.
2. The passing of traits from parents to offspring is heredity.
3. The passing of pure traits always results in offspring with the same trait.

B. Plants pass their traits to their offspring through the process of pollination. **Pollination** is the transfer of pollen from one flower to another flower of the same species. The pollen is transferred from one anther (male) to a stigma (female).

1. **Self-pollination** is the transfer of pollen from the anther of one flower to the anther of another flower on the same plant.
2. **Cross-pollination** is the transfer of pollen from an anther on one flower to the stigma on another plant.

C. Mendel drew several conclusions based upon his results.

1. The **Principle of Independent Assortment** says that there are two factors which govern a particular trait and they are distributed independently.
   a. A **dominant** factor is one that hides the other factor for a particular characteristic. Green pea pods and purple flowers are two examples of dominant factors. In humans, tongue rolling and free ear lobes are examples of dominant alleles.
   b. A **recessive** factor is one that is hidden by the dominant factor. Yellow pea pods and white flowers are two examples of recessive factors. In humans, dwarfism, straight hairline, short eyelashes, and straight thumbs are examples of recessive alleles.
2. Mendel’s second principle was the **Principle of Segregation.** This principle states that each pair of factors is separated during the formation of the gametes (egg and sperm). This happens through the process of meiosis.

D. Mendel called these factors alleles. An **allele** is a contrasting form of a gene. For example, green pea pods versus yellow pea pods. A **gene** is a short segment of DNA (deoxyribonucleic acid).

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**Use Mendel’s role in genetics to illustrate and reinforce TM–G. Hand out LS–E.**

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**Objective 5:** Explain the outcome of a monohybrid cross for complete dominance.

**Anticipated Problem:** How is the outcome of a monohybrid cross for complete dominance determined?

V. One of the keys to understanding genetics is to understand how to determine the outcome of various genetic crosses. A **monohybrid cross** is a cross between two individuals involving one pair of alleles or traits. **Complete dominance** is a condition where one allele completely masks or hides the other allele; it is completely dominant over the other.

A. A **punnett square** is used to determine the genotype, phenotype, and probability of a genetic cross.

B. **Phenotype** is the physical makeup or outward appearance of an organism. For example, green pea pods or yellow pea pods.

C. **Genotype** is the genetic makeup of an organism. The factors or alleles for a particular trait are represented by letters. For example, “G” may represent green pea pods while “g” represents yellow pea pods. Because green pea pods are dominant to yellow pea pods, the green allele is dominant and the yellow allele is recessive. Thus, a pea plant with the genotype “GG” or “Gg” is green while one with the genotype “gg” is yellow.

D. **Homozygous** means the same alleles are present. “GG” and “gg” are examples of a homozygous genotype.

E. **Heterozygous** means that different alleles are present. “Gg” is an example of a heterozygous genotype.

F. **Probability** is the chance that a specific event will occur. It is calculated by dividing the number of one kind of event by the total number of events. For example, if there are four pea pods present and one of them is yellow, then the probability is ¼ or 25%.

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**Use TM–H to summarize observations made by Mendel. Use LS–B as an assignment to reinforce the concepts introduced here. Quiz the student’s knowledge using LS–C. Upon completion of this lesson and the experiment on Albinism, test the students’ understanding using LS–D. Contact your local seed dealer. Have them visit with the class to talk about the seed research industry and how it works. Make sure to ask about education and employment experience necessary for the different types of jobs. Tie the different aspects of seed production to science and emphasize how
genetic understanding is making increased yields and disease resistance possible. Visit Monsanto’s Research Center in Chesterfield, Missouri for a first hand look at research; this must be arranged locally (i.e.—fertilizer company).

**Review/Summary.** Focus the review and summary of the lesson around the student learning objectives. Call on students to explain the content of each objective.

**Application.** Application can involve one of the following student activities using the attached transparency masters and lab sheets:

- TM–A: Plants—Important for Life
- TM–B: Cell—Factors Governing Genetics
- TM–C: Cellular Reproduction
- TM–D: The Cell Cycle
- TM–E: Mitosis
- TM–F: Meiosis
- TM–G: Gregor Mendel—The Father of Genetics
- TM–H: Observations Made by Gregor Mendel
- LS–B: Albinism Review #1
- LS–C: Albinism Quiz #1
- LS–D: Current Science Report
- LS–E: Observations Made by Gregor Mendel
- TS–A: Genetic Outcomes
- TS–B: Principles of Heredity

Students should conduct the Albinism experiment and perform Review #1. In addition, a Current Science Events Report assignment/rubric is included for your use. Assign students to either look for current articles on genetics related topics or provide them with articles that you have selected. Internet sites of major news agencies (TV, newspaper, etc.) provide very good and current sources of information.

**Evaluation.** Evaluation should concentrate on student achievement of the lesson’s objectives. A sample test is included.

**Answers to Sample Test:**

**Part One: Matching**

1. c
2. g
3. d
Part Two: Fill-in-the-Blank
1. Gregor Mendel
2. sperm, egg
3. nucleus

Part Three: Multiple Choice
1. b
2. c
3. a
4. b

Part Four: Short Answer
1. Answers will vary.
2. Gregor Mendel was the father of genetics. By experimenting with pea plants he learned came up with the Principle of Segregation (each pair of factors is separated during gamete formation) and the Principle of Independent Assortment (two factors govern each trait and they are sorted independently of each other). He also discovered dependent and recessive alleles.
3. The different between self-pollination and cross-pollination is that self-pollination is the pollination or fertilization between flowers on the same plant and cross-pollination occurs between flowers on different plants.
4. Mitosis and meiosis are both types of cellular reproduction; both processes create new cells. Mitosis is the production of 2 new cells from the original cell producing an exact replica of the parent cell. Meiosis results in four daughter cells that are not genetically identical and only contain one copy of each chromosome instead of two.
5. |   | Y | y |
  |---|---|---|
  y |   | Yy| yy|
  y |   | Yy| yy|
  y |   | Yy| yy|
Genotypes—2/4 $Yy$, 2/4 $yy$
Phenotypes—2/4 yellow, 2/4 green

Genotypes—2/4 $SS$, 2/4 $Ss$
Phenotypes—4/4 smooth
PRINCIPLES OF HEREDITY: ALBINISM IN CORN

Part One: Matching

Instructions: Match the word with the correct definition.

a. allele  d. complete dominance  g. Heredity
b. Cell      e. cultivar        h. species
c. chromosomes f. genes         i. zygote

1. structures that carry the genes
2. the passing of traits from one generation to the next
3. a condition where one allele completely masks another allele
4. a group of related organisms that produce fertile offspring
5. genetic units of DNA that code for specific traits
6. the contrasting form of a gene
7. results from the union of the gametes
8. an international term denoting certain cultivated plants that are clearly distinguishable from others by any characteristic
9. the basic unit of life

Part Two: Fill-in-the-Blank

Instructions: Complete the following statements.

1. ______________________ was the father of genetics.
2. _______________ and _______________ are examples of gametes.
3. Chromosomes are found in the ______________________ in the cell.
Part Three: Multiple Choice

Instructions: Circle the letter of the correct answer.

1. The factor which masks or hides the other corresponding factor or allele is called
   a. allele
   b. dominant
   c. recessive
   d. gene

2. The factor which is hidden by another allele is called
   a. allele
   b. dominant
   c. recessive
   d. gene

3. Which is an example of a homozygous dominant genotype?
   a. AA
   b. Aa
   c. aa

4. Which of the following is an example of a heterozygous genotype?
   a. AA
   b. Aa
   c. aa

Part Four: Short Answer

Instructions: Answer the following questions.

1. What is genetics and why is it important to study genetics?

2. Briefly describe the findings of Mendel.

3. Distinguish between self-pollination and cross-pollination.
4. Compare and contrast mitosis and meiosis.

5. Complete the Punnett Square (3 points), list each different genotype (1 point), list each different phenotype (1 point), and list the ratios of each genotype (1 point) and phenotype (1 point). YY and Yy = yellow pea seeds and yy = green pea seeds. Cross Yy × yy.

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Genotypes—

Phenotypes—

6. Complete the Punnett Square (3 points), list each different genotype (1 point), list each different phenotype (1 point), and list the ratios of each genotype (1 point) and phenotype (1 point). SS and Ss = smooth pea pod and ss = wrinkled pea pod—Cross heterozygous with homozygous dominant.

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Genotypes—

Phenotypes—
Technician Sarah Wyatt performs DNA fingerprinting on several rootstock genotypes to discover molecular markers linked to dwarfing genes.
Cell is the basic unit of life

Organelles include the mitochondria, microtubules, ribosomes, endoplasmic reticulum, golgi complex, vacuoles, plastids, and many more

The nucleus is the “brain” of the cell and contains the genetic information that directs the activities of the cell.

Chromosomes:
- are found in the nucleus
- carry the genes which govern specific traits
- exist in pairs in all cells except in the reproductive cells
- contain genetic units known as genes.
CELLULAR REPRODUCTION

- Mitosis is a type of asexual reproduction where two new cells are created from the original cell.
- Meiosis is cell division that creates four new cells from the original parent cell resulting in four sex cells.
- Sexual reproduction—one chromosome from each parent.
- Zygote—results from the fusion of gametes.
- Species—a group of related organisms that produce fertile offspring.
- Cultivar—denoting certain cultivated plants that are clearly distinguishable from others by any characteristic and that when reproduced retain their distinguishing characters.
THE CELL CYCLE

♦ Interphase—a stage where the cell grows in size and replication of the chromosomes occurs

♦ Mitosis—a type of asexual reproduction where two new cells are created from the original cell

♦ Cytokinesis—a resting phase which lasts for a short period of time
Mitosis

**Prophase**
- Chromosomes visible.
- Nuclear membrane fragments.

**Metaphase**
- Duplicated chromosomes are aligned at equator.
- One half of each pair of sister chromatids attach to spindle fibers.

**Anaphase**
- Daughter chromatids separate and move toward each pole.

**Telophase**
- Nuclear membranes reform.
- Two new cells are separated.
MEIOTIS

MEIOTIS I

PROPHASE I

Chromosomes still duplicated. Nuclear membrane fragments.

METAPHASE I

Chromosomes aligned at equator.

ANAPHASE I

Chromatids divide. Chromosomes move toward poles.

TELOPHASE I

Nuclear membrane reforms. Meiosis completed.

MEIOTIS II

PROPHASE II


METAPHASE II


ANAPHASE II


TELOPHASE II (gametes)


Chromosomes move toward poles.
GREGOR MENDEL—
THE FATHER OF GENETICS

Mendel’s Conclusions

♦ Principle of Independent Assortment—two factors govern a particular trait and they are distributed independently

■ Dominant—factor that hides the other factor for a particular characteristic

■ Recessive—factor that is hidden by the dominant factor

♦ Principle of Segregation—each pair of factors is separated during the formation of the gametes (egg and sperm)

Allele—a contrasting form of a gene
OBSERVATIONS MADE BY GREGOR MENDEL

♦ Pea Plants

<table>
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<tr>
<th>Characteristic</th>
<th>Dominant</th>
<th>Recessive</th>
<th>Probability</th>
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<tr>
<td>Height of Plant</td>
<td>Tall</td>
<td>Short</td>
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<tr>
<td>Flower Color</td>
<td>Purple</td>
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<td>Seed Color</td>
<td>Yellow</td>
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<td>Seed Texture</td>
<td>Smooth</td>
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<td>Pod Color</td>
<td>Green</td>
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<td>Pod Appearance</td>
<td>Inflated</td>
<td>Constricted</td>
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<td>Position of Flowers on the stem</td>
<td>Axial</td>
<td>Terminal</td>
<td>3:1</td>
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PRINCIPLES OF HEREDITY: ALBINISM IN CORN

Research Problem

How are traits inherited from parents to offspring in corn plants?

Agricultural Applications and Practices

The abundant food supply in our nation is partially a result of public and private plant breeding programs which have produced superior cultivars for almost all cereal, vegetable, forage, fruit and ornamental crops. Public plant breeding programs have been in existence for over a century at state agricultural experiment stations in the nation’s land-grant colleges and universities. Private plant breeding programs are conducted by seed companies with the goal of developing better agronomic, vegetable, and flower cultivars.

Innovations by plant breeders include the development of F₁ hybrids through hybridization for many agronomic crops with increased vigor and insect and disease resistance. By developing plants with strong resistance to insects and disease, the need for insecticides and fungicide is being reduced. Increasingly biotechnology is making these goals even more possible.

Science Connections—Questions for Investigation

1. How has the mechanism of evolution affected the food supply available in the world today?
2. How have plant improvement programs affected the food supply available in the world today?
3. What genetic processes and structures control inheritance in plants?
4. How do plants reproduce?
5. Explain the genetic basis for the outcome of this experiment? Be sure to use several terms that were discussed in class.
Purpose of Laboratory and Student Performance Objectives

The purpose of this experiment is to observe the results of genetic crosses in order to determine how genes are distributed into gametes and recombined into zygotes. Through this experiment and related discussions students will be able to:

1. Explain the relationship between reproduction, genetics, and plant improvement.
2. Describe the reproductive cycle in seed plants.
3. Explain how traits are inherited from parents to offspring.

Materials and/or Equipment

- 30 F₂ corn seeds
- potting medium
- planting flat
- marking pencil
- plastic bag with a twist-tie
- water

Procedure

Give each student or group of students a copy of the worksheet to perform the activity. Each student or group of students will also need multiple copies of the Plant Flat Sketch worksheet to record observations of the plant flats every day.

Helpful Hints

- Don’t tell the students about albinism before they conduct the experiment. Let them inquire and determine why they have white plants and why they will suddenly die.
- If limited space is available, have the students plant their seeds in soil in a 2 liter pop bottle. The bottle can be cut in half, filled with soil, the seeds planted, watered, and resealed. This acts as a terrarium and if the seeds are exposed to warmth and sunlight, they can germinate in less than one week.

Anticipated Findings

Results will vary as to the total number of seeds which sprout in each planting flat. The white seedlings have albinism. Albino plants lack chlorophyll which is necessary for photosynthesis to occur. Photosynthesis is the process of taking the sun’s energy and turning
it into food such as glucose. The glucose is then broken down through the process of respiration to turn it into usable energy for the plant such as ATP (Adenosine Triphosphate). Albinism is usually lethal in higher plants. Of those seeds that sprout, approximately one-fourth will be white and fail to thrive while three-fourths will be green and remain healthy. They were able to sprout and grow for a short period of time because the seed provided the energy to this point. When the seed’s energy was depleted, the seedling died.

**Ideas for Other Experiments**

Consult science supply catalogs for other seeds which possess recessive traits that can be grown easily in the laboratory. Some examples that can usually be found include dwarf, color, presence of hair on the stem, and similar albino seeds. Dihybrid crosses can also usually be found.
PRINCIPLES OF HEREDITY:
ALBINISM IN CORN

1. Partly fill a planting flat with potting medium.

2. Scatter the 30 F₂ corn seeds with a layer of potting medium. Water the seeds thoroughly. Label the flat with your class, grade, room number, and teacher’s name.

3. Place the flat inside a plastic bag. Close the plastic bag with a twist tie. Place the flat in a warm place in the classroom.

4. Check on the flat on a daily basis for any germinating seeds. (It should take approximately one week. Therefore, the earlier in the week this is started insures more of the following school week to work with this activity.) Once sprouting begins, remove the plastic bag and place the flat in a sunny place in the classroom. Add water when needed to prevent the soil from drying out. Note: Make sure the plastic bag is opened or removed once germination takes place. If contents stay too moist, plants may “damp off” and develop a harmful fungus.

5. Make a sketch of the position of the seeds in the flat. Note the color of the seedlings. Record the number of the seedlings of each color. Do a new sketch each day with a clean worksheet.

6. Observe the growth of the seedlings for several weeks. Note which of the seedlings thrive and which die. Sketch the position of the seeds in the flat and note the color of the seedlings. Record the number of seedlings of each color and indicate if they live or die.
## ALBINISM REVIEW #1: GENETICS—21 POINTS

### Answers

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Genotypes—4/4 Tt  
Phenotypes—4/4 tall

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Genotypes—¼ TT, 2/4 Tt, ¼ tt  
Phenotypes—¾ tall, ¼ short
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Genotypes—2/4 Tt, 2/4 tt
Phenotypes—2/4 tall, 2/4 short
ALBINISM REVIEW #1: GENETICS—21 POINTS

Directions

For each of the problems listed below complete the Punnett Square (3 pts), list each different genotype (1 pt), list each different phenotype (1 pt), and list the ratios of each genotype (1 pt) and phenotype (1 pt). TT and Tt = Tall tt = short

1. TT × tt

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2. Tt × Tt

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3. Heterozygous Father × Homozygous Recessive Mother
ALBINISM QUIZ #1: GENETICS—21 POINTS

Answers

1.

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<thead>
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<td>a</td>
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Genotypes—4/4 Aa
Phenotypes—4/4 axial

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Genotypes—¼ AA, 2/4 Aa, ¼ aa
Phenotypes—¾ axial, ¼ terminal
3.

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</table>

Genotypes—2/4 AA, 2/4 Aa

Phenotypes—4/4 axial
ALBINISM QUIZ #1: GENETICS—21 POINTS

Directions

For each of the problems listed below complete the Punnett Square (3 points), list each different genotype (1 point), list each different phenotype (1 point), and list the ratios of each genotype (1 point) and phenotype (1 point). AA and Aa = axial flower attachment, aa = terminal flower attachment

1. AA × aa

   2. Aa × Aa
3. Homozygous Dominant Father × Heterozygous Mother

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## CURRENT SCIENCE REPORT

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<th>Requirement</th>
<th>Points Possible</th>
<th>Points Awarded</th>
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<tr>
<td>1</td>
<td>Student’s Name (5 points)</td>
<td>5—first and last name listed</td>
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<td>0—no name listed</td>
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<td>2</td>
<td>Today’s Date (3 points)</td>
<td>3—date listed correctly</td>
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<td>0—no date listed</td>
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<td>3</td>
<td>Magazine or Journal Name (3 points)</td>
<td>3—title listed</td>
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<td>0—title not listed</td>
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<td>4</td>
<td>Date of magazine or journal issue (3 points)</td>
<td>3—date listed correctly</td>
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<td>0—date not listed</td>
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<td>Article Name (3 points)</td>
<td>3—Article name listed completely</td>
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<td>0—Article name not listed</td>
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<td>6</td>
<td>Page Number (3 points)</td>
<td>3—Page numbers listed</td>
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<td>0—No page numbers listed</td>
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<tr>
<td>7</td>
<td>One sentence statement about why you chose this article (Maximum of 5 points)</td>
<td>5—Complete well written sentence explaining why you chose this article</td>
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<tr>
<td>8</td>
<td>At least three paragraphs explaining the main points of the article</td>
<td>6—Focus—Establishes and maintains a clear focus throughout. The first paragraph states the overall message of the article</td>
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<td>6—Organization—Has logical progression of ideas; maintains fluency by using transitions throughout the writing; has multiple paragraphs. All paragraphs help develop the main idea</td>
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<td>6—Support—Details are effective, vivid, explicit, and/or pertinent—Data/Facts are used to support the main idea</td>
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<td>3—The last paragraph summarizes the article</td>
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<td>3—The paragraphs thoroughly summarize the article</td>
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<td>3—The article is written in the students own words/paraphrased—direct quotes are properly identified</td>
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<td>Requirement</td>
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| 9  | At least one paragraph explaining your view and what you learned from the article (15 points) | 15—excellent explanation of what was learned by the student and their opinion on the topic  
12—good explanation given  
9—fair explanation given  
5—poor explanation given |
| 10 | Conventions—Grammar and Spelling (5 points)                                   | 5—has few, if any, errors—proper grammar and spelling are used throughout the report |
| 11 | Oral Presentation (28 points)                                                | 4—Organization  
• establishes and maintains a clear focus throughout  
• details are effective, vivid, explicit, and pertinent  
• the introduction got the attention of the audience, introduced the topic, and briefly identified the main points  
4—Organization  
• has a logical progression of ideas; maintains fluency by using transition throughout the presentation  
• the body of the presentation was clearly and effectively organized providing the audience with a clear understanding of the topic  
4—the conclusion of the presentation summarized what the audience heard, stated the importance of the topic, and clearly stated how this impacts them  
3—good; 2—fair; 1—poor  
0—no conclusion was given  
2—the presenter spoke in a clear voice  
2—the presenter was easy to understand  
2—the presenter made eye contact with the audience  
3—the presenter was able to answer questions by the teacher, if asked  
7—The presentation is over 2 minutes in length with little stuttering and stalling  
4—the presentation was 1.5–1.9 minutes in length  
1—the presentation was under 1.5 minutes  
0—no presentation was given |
# OBSERVATIONS MADE BY GREGOR MENDEL

## Pea Plants

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Dominant</th>
<th>Recessive</th>
<th>Probability</th>
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</thead>
<tbody>
<tr>
<td>Height of Plant</td>
<td>Tall</td>
<td>Short</td>
<td>3:1</td>
</tr>
<tr>
<td>Flower Color</td>
<td>Purple</td>
<td>White</td>
<td>3:1</td>
</tr>
<tr>
<td>Seed Color</td>
<td>Yellow</td>
<td>Green</td>
<td>3:1</td>
</tr>
<tr>
<td>Seed Texture</td>
<td>Smooth</td>
<td>Wrinkled</td>
<td>3:1</td>
</tr>
<tr>
<td>Pod Color</td>
<td>Green</td>
<td>Yellow</td>
<td>3:1</td>
</tr>
<tr>
<td>Pod Appearance</td>
<td>Inflated</td>
<td>Constricted</td>
<td>3:1</td>
</tr>
<tr>
<td>Position of Flowers on the stem</td>
<td>Axial</td>
<td>Terminal</td>
<td>3:1</td>
</tr>
</tbody>
</table>
GENETIC OUTCOMES

♦ Monohybrid cross—a cross between two individuals involving one pair of alleles or traits
♦ Complete dominance—a condition where one allele completely masks or hides the other allele
♦ Punnett square—used to determine the genotype, phenotype, and probability of a genetic cross
  ■ Phenotype—the physical makeup or outward appearance of an organism
  ■ Genotype—the genetic makeup of an organism
  ■ Homozygous—the same alleles are present
  ■ Heterozygous—different alleles are present
  ■ Probability—the chance that a specific event will occur
♦ Solving a monohybrid cross
  ■ Determine the genotype of the father and record one letter over each column on the punnett square. Fill in the columns with the appropriate letter.

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Determine the genotype of the mother and record one letter to the left of each row. Fill in the rows with the appropriate letter.

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Next, record all of the different genotypes that are present in the punnett square. Each square represents one offspring. Record the probability of each different genotype.

- Genotype—4/4 Gg

Then, record all of the different possible phenotypes and the probability of each.

- Phenotype—4/4 green pea pods

This is an example of a homozygous dominant father crossed with a homozygous recessive mother.

Cross a pea plant that is homozygous dominant for yellow seeds with one that is heterozygous. Y = yellow seeds and y = green seeds

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<td>y</td>
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</table>

- Genotypes—2/4 YY, 2/4 Yy
- Phenotypes—4/4 yellow pea seeds
Cross a pea plant that is heterozygous for pod color with another plant that is heterozygous for pod color. Green pods (G) are dominant to yellow (g) pea pods.

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- **Genotypes**—¼ GG, 2/4 Gg, ¼ gg
- **Phenotypes**—¼ green pea pods, ¼ yellow pea pods
1. **How has the mechanism of evolution affected the food supply available in the world today?**

Evolution involves two factors: random genetic variation in a population through mutation, and selective pressure on that population that preferentially results in the successful survival of a part of that population with “advantageous” genetic properties.

Agriculture as we know it began with the selection of “good” food plants by ancient people. Most of these early food plants are still cultivated in much improved forms. These improved forms have been developed through careful selection for optimal crop plants in terms of yield, size of fruit, pest resistance, etc.

2. **How have plant improvement programs affected the food supply available in the world today?**

Modern methods of plant breeding have dramatically improved crop yield and nutritional quality in modern cultivars, (i.e. the development of hybrid corn in the 1930’s is one of the most important developments in agriculture in the 20th Century). The planting of hybrid cultivars and good farming practices have resulted in corn yields of 400 bushels per acre.
3. **What genetic processes and structures control inheritance in plants?**

Some genetic processes and structures that control inheritance in plants include:

a. Chromosomes are found in the nucleus; they carry the genes which govern specific traits. Chromosomes are found in pairs in all cells except in the reproductive cells. They exist in pairs; corn has 20 chromosomes or 10 pairs.

b. Chromosomes contain genetic units known as genes.

c. Pollination is the transfer of pollen from one flower to another flower of the same species. The pollen is transferred from one anther (male) to a stigma (female).

(d) Self-pollination is the transfer of pollen from the anther of one flower to the anther of another flower on the same plant.

e. Cross-pollination is the transfer of pollen from an anther on one flower to the stigma on another plant.

f. Meiosis is cell division that creates four new cells from the original parent cell resulting in four sex cells. This occurs in the flower (in angiosperms) to form the cells from which the pollen grains and the embryo sac (which contains the egg) develop.

(g) The Principle of Independent Assortment says that there are two factors which govern a particular trait and they are distributed independently.

h. A dominant factor is one that hides the other factor for a particular characteristic. Green pea pods and purple flowers are two examples of dominant factors. In humans, tongue rolling and free ear lobes are examples of dominant alleles.

i. A recessive factor is one that is hidden by the dominant factor. Yellow pea pods and white flowers are two examples of recessive factors. In humans, dwarfism, straight hairline, short eyelashes, and straight thumbs are examples of recessive alleles.

j. Mendel’s second principle was the Principle of Segregation. This principle states that each pair of factors is separated during the formation of the gametes (egg and sperm). This happens through the process of meiosis.

k. An allele is a contrasting form of a gene.

l. **Mutations** are the result of miscommunication during the reproductive process resulting in a mutant.
4. How do plants reproduce?

Plants reproduce through the process of meiosis; cell division that creates four new cells from the original parent cell resulting in four sex cells. This occurs in the flower (in angiosperms) to form the cells from which the pollen grains and the embryo sac (which contains the egg) develop. Meiosis allows for the random assortment of parental genes. When the gametes which are created by meiosis unite or fertilize through the process of fertilization, sexual reproduction has occurred. Plants pass their traits to their offspring through the process of pollination. Pollination is the transfer of pollen from one flower to another flower of the same species. The pollen is transferred from one anther (male) to a stigma (female). Self-pollination is the transfer of pollen from the anther of one flower to the anther of another flower on the same plant. Cross-pollination is the transfer of pollen from an anther on one flower to the stigma on another plant. Offspring produced by sexual reproduction receive half of their genetic information from one parent and the other half from the other parent. A zygote is a protoplast resulting from the fusion of gametes.

5. Explain the genetic basis for the outcome of this experiment? Be sure to use several terms that were discussed in class.

(Results will vary.) The white seedlings have albinism. Albino plants lack chlorophyll which is necessary for photosynthesis to occur. Photosynthesis is the process of taking the sun’s energy and turning it into food such as glucose. The glucose is then broken down through the process of cellular respiration to turn it into usable energy for the plant such as ATP (Adenosine Triphosphate). Albinism is usually lethal in higher plants. Of those seeds that sprout, approximately one-fourth will be white and fail to thrive while three-fourths will be green and remain healthy. They were able to sprout and grow for a short period of time because the seed provided the energy to this point. When the seed’s energy was depleted, the seedling died. Since one-fourth of the offspring showed the homozygous recessive (aa) phenotype, then both parents must have had a heterozygous genotype (Aa).