

Biology

Core Experiment

Standard ## 3520-03 Students will analyze how genetic information is passed from one cell to another.

Objective ## 3520-0302 Explain the significance of DNA replication relative to heredity.

ILOs: Use basic science process skills by making observations, categorizing information, and making estimations based on current knowledge. Use integrated science process skills by formulating questions, developing a strategy for answering the questions and analyzing data to draw warranted inferences. Manifest scientific attitudes and interests by demonstrating curiosity and by remaining open to new ideas and alternative points of view. Learn and use appropriate concepts and terminology. Communicate ideas using appropriate language and reasoning.

Topic:
Heredity

3520-03

Description of Activity

Activity Title: Heredity and the Sense of Taste.

Activity Overview: Students will experiment with chemicals known to taste different to different people and, based on their findings and extrapolations, discuss the relationship of genes to the senses. Students will also learn to construct pedigrees and Punnet squares and have the opportunity to create real pedigrees for themselves.

Duration: This activity should last three to five class periods and perhaps involve some homework depending on student interest level and desire for inquiry. The amount of time spent in review and skills development may add significantly to the duration of the activity depending on students' prior experience and the curriculum goals of the teacher.

Background Information

The substances phenylthiocarbamide (PTC) and thiourea both have an unpleasant taste to those who can taste them. The ability to taste either seems to be inherited according to strict Mendelian laws of dominance and recessiveness with the ability to taste being dominant. This implies that the recessive gene is probably a defective gene for an enzyme that is used in the tasting process. Students who can taste PTC will not necessarily taste thiourea. The reverse is also true.

Sodium benzoate tastes differently to different people. Some may perceive a salty taste while others may claim the sodium benzoate tastes sour, bitter or sweet. Others may not taste the sodium benzoate at all. The inheritance of these various traits is not well documented and may be

a good subject for an extended data collection activity for your students.

Once students see that the sense of taste varies depending on the effects of genes they may be led to wonder if the other senses vary similarly. Variations in the other senses may not be as easily observed as those in the sense of taste but students may speculate as to the relationship between things such as color or perfume preferences and genes. Encourage students to drop the notion that humans all function alike and wonder at the marvelous variety that exists in the human gene pool.

Teaching and Learning Strategies

Punnet Squares and Pedigrees - Many, if not all, students will come to a high school biology class with some understanding of the purpose and function of Punnet squares and pedigrees but you may need to reinforce that understanding. The activities suggested in the Development of Laboratory Skills and Tools section below may be used to reinforce student proficiency with these tools. Use supplementary or entirely different activities if you feel they are more appropriate for your classes or situation.

The Problem - The human senses are generally taken for granted in that we assume they function similarly in all humans who are not considered handicapped. Serious students of physiology and biochemistry soon learn that while much of the chemistry of life must occur in a precise manner and within certain parameters, there are many of the less critical processes that vary greatly depending on the proteins that participate in those processes. Invite the students to learn about these variations by following the suggestions in the Invitation to Learn section below or, better yet, use your own imagination to help spark your students' interest in this potentially fascinating study.

Development of Laboratory Skills and Tools

(NOTE: The information and activities below are merely suggestions as to content and methodology for helping students learn to use the tools of genetics and, more importantly, their mind. Use or modify these materials as you see fit.)

I. Punnet Squares -

A. Background concepts and ideas:

1. Students should be made aware that after his careful studies of garden plants Gregor Mendel correctly stated that heredity is controlled by factors that are passed from generation to generation with fairly predictable results. Mendel's work and conclusions eventually led to the conception of several basic genetic principles.

a. The principle of *dominance* states that, when present, some hereditary factors will be expressed over other more recessive factors.

b. The principle of *segregation* states that, during gamete formation, pairs of alleles are separated so that each gamete contains only one member of the pair.

c. The principle of *independent assortment* states that as gametes form, the genes for various traits are not tied together and separate independently of one another. (Save the discussion of chromosome linkage for later.)

2. Punnet squares can be valuable tools when used to visualize the probabilities associated with the inheritance of traits as described by Mendel.

3. The first step in using a Punnet square is to define the meaning of the symbols to be employed. Once students grasp this first step, much of the confusion associated with Punnet squares abates.

4. Progressing beyond the level of mono and dihybrid crosses is probably not necessary at this level of study. If you choose to have students attempt trihybrid or more complex crosses you may wish to take the time to teach them algebraic methods of dealing with probabilities rather than requiring them to build monstrous, time-consuming Punnet squares.

B. Teaching Activities:

1. Any good biology text will provide basic background reading, vocabulary and practice worksheets for students. Use these materials as you deem appropriate for both teaching and evaluation.

2. A class discussion or lecture should probably include the following:

a. An explanation of the Punnet square itself, encompassing the ideas that the gametes from two parents are represented outside the square and the zygotes resulting from gamete union are represented inside the square.

b. A description of typical symbol usage. (i.e., upper case letters for dominant alleles, lower case letters for recessive alleles, etc.)

c. A demonstration of all of the basic mono and dihybrid crosses.

d. Student practice with crosses of both homozygous and heterozygous parents.

3. Student reading and class discussions should be followed up with a hands-on session involving probability. Most texts come with adequate materials but, if they are lacking, you might simply have students label coins with X and Y on either side, flip them 10, 50 and 100 times tallying the totals of X and Y at the 10, 50, and 100 levels. With these data students can calculate the percentages of X and Y at each level and, if all goes well, will then see that larger samples produce data that more closely fit the probabilities predicted by Punnet squares. Extensions to this type of activity can include the use of three or four color dice or other objects to represent different probabilities. Encourage students to inquire further.

II. Pedigrees -

A. Background concepts and ideas:

1. Students should be made aware that humans make difficult subjects for genetic study for several reasons. Unlike organisms such as fruit flies or bacteria, humans reproduce slowly and produce very few offspring. Pedigree analysis often provides the only means whereby human traits can be studied.

2. A pedigree is a diagram drawn to show the phenotype of a particular trait in several generations of a family.

3. An understanding of the laws of inheritance and probability can make it possible to determine the genotypes for most of the individuals included in a pedigree.

B. Teaching Activities:

1. Any good biology text will provide basic background reading, vocabulary and practice worksheets for students. Use these materials as you deem appropriate for both teaching and evaluation.
2. A class discussion or lecture should probably include the following:
 - a. An explanation of the basic form of a pedigree including symbol usage. (i.e., square vs. circle for gender, filled vs. unfilled symbols for phenotype.)
 - b. A demonstration of the interpretation of a basic pedigree.
 - c. Students should practice interpreting typical pedigrees such as those found in text books (or easily contrived by teachers).
3. Student reading and class discussions should be followed up with a hands-on session involving pedigrees. Most texts come with adequate materials, but you might simply ask students to select a trait from the list that appears below and have them construct a pedigree for their own family based on that trait. Students should be able to state the genotypes for most of the individuals in their pedigrees and offer explanation as to why some individual genotypes remain unknown.

Trait	Dominant	Recessive
Chin cleft	Absent (C)	Present (c)
Dimples	Present (D)	Absent (d)
Earlobe shape	Free (F)	Attached (f)
Eye shape	Almond (A)	Round (a)
Eye position	Straight (S)	Upward slant (s)
Eyebrow position	Connected (Y)	Not connected (y)
Eyebrow shape	Bushy (B)	Fine (b)
Eyelash length	Long (L)	Short (l)
Face shape	Round (R)	Square (r)
Freckles	Present (P)	Absent (p)
Hair	Curly (H)	Straight (h)
Tongue rolling	Can roll (T)	Can't roll (t)
Widow's peak	Present (W)	Absent (w)

Extensions to this type of activity are limited only by the amount of time students are willing to invest and the number of relatives available and willing to participate. Encourage students to inquire further.

Invitation to Learn - Heredity and the Sense of Taste

Materials, Facilities and Resources:

(NOTE: The quantities of the following may vary for each student depending on the depth to which you or the students choose to pursue this line of study. These items are relatively inexpensive so have plenty on hand.)

Phenylthiocarbamide taste strips
Thiourea taste strips
Sodium benzoate taste strips

(Strips containing combinations of these chemicals are also available from biological supply houses and may prove valuable.)

The Problem:

Things taste different to different people!

Distribute and have students use the taste strips mentioned in the materials section above. Guide students with some or all of the following ideas and activities. Supplement student inquiries only where appropriate. Remember to let them do it their way. Every student may learn something different if you let them.

Ask students to record their own descriptions of each taste then tabulate data for the entire class. Help students analyze data in an attempt to determine which taste traits are dominant or recessive and have them report their findings.

Ask students questions such as: What determines whether we like or dislike particular foods? What determines which smells or colors people prefer?

Suggest that students tabulate data regarding favorite foods and compare these with the data for chemical tasting.

Allow students to take materials home and complete pedigrees for themselves. Encourage them to figure out the genotypes of their family members.

Encourage students to invent ways to study traits other than taste.

Summary of Learning

1.State a valid hypothesis regarding genetics and this experience with the sense of taste. Use data you collected to substantiate your reasoning.

2.The principle of *dominance* states that...

a.*when present, some hereditary factors will be expressed over other more recessive factors.

b.during gamete formation, pairs of alleles are separated so that each gamete contains only one member of the pair.

c.as gametes form, the genes for various traits are not tied together and separate independently of one another.

d.None of the above answers are correct.

3. A cross between an individual who is homozygous for the PTC tasting allele (TT) and an individual who is heterozygous (Tt) will result in probabilities for offspring with...

- a. $3TT:1tt$
- b. $1TT:1tt$
- c. $1Tt:1tt$
- d. $*1TT:1Tt$