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| **TEAM Lesson Plan Template** |
| Teacher: Andrew Morency |
| Subject/Grade: High School Biology 1 |
| Lesson Title: Inheritance |
| **STANDARDS** | **Identify what you intend to teach.** State, Common Core, ACT College Readiness Standards and/or State Competencies; Enduring Understandings and Essential Questions. |
| BIO1.LS3.3. Through pedigree analysis, identify patterns of trait inheritance to predict family member genotypes. Use mathematical thinking to predict the likelihood of various types of trait transmission.This lesson emphasizes:Science practice: Constructing explanations and designing solutionsCCC: PatternLearning performance: Students will construct explanations for patterns identified during simulated heredity experiments by noticing patterns.  |
| **OBJECTIVE(s)/Sub-Objectives** | **Connect prior learning to new learning.** Clear, Specific, Observable, Demanding, High Quality, Measurable, Aligned to Standard(s), and Integrated with other subjects, build on prior student knowledgeStudent-Friendly (I Can Statement) |
| I can determine an observed trait from pairings of dominant and recessive genes. I can count results from multiple observations in an experimentI can explain the results of a heredity experiment using a Punnett square and dominant and recessive genes  |
| **MATERIALS AND RESOURCES**  | **Content-related:** Clearly supports lesson objective(s); rigorous & relevant; Incorporates multimedia & resources beyond the textbook.  |
| **Activities & Materials** \_x\_ Whiteboard/markers or Computer/projector/Smartboard\_x\_ Manipulatives: Several pairs of paper sacks; counters or poker chips – half labeled “F” and half labeled “f;” bouncy balls – half yellow and half green. First set: One sack in each pair is labeled “Maternal fur length” and contains “F” poker chips. The other sack is labeled “Paternal fur length” and contains “f” poker chips. Second set: One sack in each pair is labeled “Maternal fur length” and contains an equal number of “F” and “f” poker chips. The other sack is labeled “Paternal fur length” and contains an equal number of “F” and “f” poker chips. Third set: Really several sets of four sacks now. One sack in each pair is labeled “Maternal fur length” and contains an equal number of “F” and “f” poker chips. The second sack is labeled “Paternal fur length” and contains an equal number of “F” and “f” poker chips. The third sack is labeled “Maternal eye color” and contains an equal number of yellow and green bouncy balls. The fourth sack is labeled “Paternal eye color” and contains and equal number of yellow and green bouncy balls. \_x\_ A worksheet and pencil for each student. **Routine for distributing materials** Place the pairs of sacks at several locations where students can form lines. Students will line up and each take a turn at one of the pairs of sacks.  |
| **ACCOMMODATIONS/ADAPTATIONS** | **Learning styles and interests.** Anticipate learning difficulties, regularly incorporate student interests & cultural heritage; differentiate instructional methods. |
| **Modifications/Plans for Diverse Learners *(NOTE: Clearly identify where you will use each of these in your lesson; do not just check the box!)*****Differentiation****----- Content**  **----- Process** For a student with mobility issues, take a pair of sacks to the student. **----- Product** **----- Tiered Assignments** **----- Flexible Grouping****----- Learning Centers \_\_\_\_ Other \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_****Accommodations****\_\_\_ Preferential Seating \_\_\_ Extended Time \_\_\_ Small Group \_\_\_ Peer Tutoring** **\_\_\_ Modified Assignments** **\_\_\_ Other** **Early Finishers:** The activity is not over until the whole group tallies collective results. Everyone will finish this whole-group activity at the same time.  |

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| **MOTIVATING STUDENTS/ANTICIPATORY SET** | **“Hook”: Engage students’ attention and focus on learning.** Personally meaningful and relevant. |
| The web page <https://www.mathsisfun.com/data/probability.html> introduces probability. There are questions near the bottom of the page to check for understanding. Question number 9 involves drawing counters from a bag. Reginald Crundall Punnett <https://en.wikipedia.org/wiki/Reginald_Punnett> is said to have introduced genetics to the general public  |
| **INSTRUCTIONAL PROCEDURES** | **Step-by-Step Procedures-Lesson Sequence: Basic to Complex.** Lesson includes visuals, modeling, logical sequencing and segmenting (beginning, middle, ending); essential information; concise communication; grouping strategies; differentiated instructional strategies to provide intervention & extension; seamless routines; varied instructional strategies; key concepts & ideas highlighted regularly. |
| ***Introductio*n*.***Discuss the following ideas with the class. Write or project major points during the discussion:**Probability** is the likelihood that a particular event will occur. The more samples that we take, the closer our observations will be to the theoretical probability. Bigger samples are better. **Genetic traits**. All living things are built from the same parts, cells and proteins. The order of assembly of these parts determine whether you get a cat, a rat, a bird, a human, or something else. Even though all humans are humans, we have slight differences such as eye color. Even close relatives may be more similar to each other than to people in general, but each person is unique. About 150 years ago scientists imagined the *blending concept of inheritance* for traits: a white flower mated to a red flower would produce offspring with pink flowers. However, sometimes two red flowers would produce a white flower. There is something wrong with the model. **Genotype** is the Genetic makeup of an organism. vs. **Phenotype** is the Physical traits observed in an organism. We cannot necessarily tell the genotype by looking at the phenotype. [Venn diagram opportunity] **Homozygous** (alleles match) **vs. Heterozygous** (alleles are different)A gene is a particular section of DNA that codes for a trait. There are almost always different types of genes that code for the same trait. There are multiple genes that code for eye color, for example. We call these different varieties of traits **alleles**. An offspring with two parents could have gotten the same or different alleles from the mother and father. If the alleles match, then the offspring is homozygous. If the alleles are different, then the offspring is heterozygous. For example, if your eye color genes are BlueBlue, then your genotype is homozygous. If your eye color genes are BlueBrown, or BrownBlue, then your genotype is heterozygous. **Dominant vs. Recessive alleles**The *principal of dominance* states that some alleles are stronger than others. Suppose a cat has received a “long fur” allele (F) from mom and a “short fur” allele (f) from dad. The “long fur” allele is dominant. The cat’s genotype is heterozygous (Ff), but the cat’s phenotype is “long fur.” We see a cat with long fur, even though one of the cat’s alleles codes for short fur. Suppose that the mom cat is homozygous “long fur” (FF), and the dad cat is homozygous “short fur” (ff). What will the offspring look like (what phenotype)? **Punnett squares**A Punnett square is a diagram that helps us visualize the probability of offspring bearing particular traits based on their parents’ genotypes. As an example, take the two homozygous parent cats from above, (FF) and (ff). These cats are called the **parental generation**.

|  |  |  |
| --- | --- | --- |
|  | F | F |
| f | Ff | Ff |
|  f | Ff | Ff |

 The offspring will have genotype Ff with a probability of 1, and the phenotype will be “long fur” since that is the dominant allele. If trait blending happened, the offspring would have medium length fur, but that is not what happens. Each parent passes on only one allele, a concept known as the Law of Segregation. The offspring cats are called the F1 generation. Let’s model this situation. We have several pairs of bags. In each pair, one bag represents a homozygous dominant (FF) parent, and the other bag represents a homozygous recessive (ff) parent. Counters (display one) are labeled either “F” or “f.” Take your worksheets and a pencil and form lines at each pair of bags. Instruct: The first person in line should draw one chip from each bag and record the result on the worksheet. Put the chips **back in the same bag** you took them from. *Watch to make sure that students understand and follow the procedure.* When they have followed instructions, ask them to draw chips three more times. When the first students in line have recorded four results, they should return to their seats. Now, second students in line, follow the same procedure. Get four results and return to your seat. After all students have four results and have returned to their seats, regain the entire group’s attention. Summarize results by writing on the board. Ask students what they observed and write the number of each result on the board. These should be FF– zero, Ff – all, ff- zero. Point out that this is the F1 generation. What do all of these offspring look like? Return to a whole-group discussion. What if cats from the F1 generation produce offspring? Suppose that the mom cat is heterozygous (Ff), and the dad cat is also heterozygous (Ff). Note that both parents have the “long fur” phenotype. What will the offspring look like (what phenotype)?

|  |  |  |
| --- | --- | --- |
|  | F | f |
| F | FF | Ff |
|  f | Ff | ff |

1/4 of the offspring will have short fur, and 3/4 of the offspring will have long fur. Half the offspring will be heterozygous ( Ff ) and half the offspring will be homozygous, either (FF) or (ff). This generation is called the F2 generation. Let’s model this situation. We have several pairs of bags. In each pair, each bag represents a heterozygous (Ff) parent. There are counters labeled “F” for long fur and counters labeled “f” for short fur. Take your worksheets and a pencil and form lines at each pair of bags. Instruct: The first person in line should draw one chip from each bag and record the result on the worksheet. Put the chips **back in the same bag** you took them from. *Watch to make sure that students understand and follow the procedure.* When they have followed instructions, ask them to draw chips three more times. When the first students in line have recorded four results, they should return to their seats. Now, second students in line, follow the same procedure. Get four results and return to your seat. After all students have four results and have returned to their seats, regain the entire group’s attention. Summarize results by writing on the board (or using the FurryEyedCats spreadsheet). Point out that we will count Ff and fF as the same thing. Ask students how many of each genotype they observed. Write the result, and then add all the numbers. It will look something like this (Example for 12 students. Each student must have 4 observations.) Homozygous dominant FF – 0 + 1 + 3 + 1 + 0 + 2 + 1 + 3 + 2 + 0 + 1 + 1 = 15Heterozygous Ff – 2 + 3 + 0 + 2 + 3 + 1 + 2 + 1 + 1 + 3 + 2 + 1 = 21 Homozygous recessive ff – 2 + 0 + 1 + 1 + 1 + 1 + 1 + 0 + 1 + 1 + 1 + 2 = 12Point out that this is the F2 generation. What does each type of offspring look like? Are exactly ¼ of the offspring short furred? Are approximately ¼ of the offspring short furred? **Independent Assortment**Of course, cats have many more traits than just fur length. Let’s look at just one more, eye color. Yellow is the dominant allele (Y) for this gene. Green is the recessive allele for this gene(y). If the genes for eye color and fur length are not connected, then we say that they are independent. This means that a cat with long fur is just as likely to have yellow eyes as green eyes. Suppose that a pair of parental generation cats are both homozygous. The mother cat is homozygous dominant for both “long fur” and “yellow eyes” (FY). The father cat is homozygous recessive with “short fur” and “green eyes” (fy). What happens with their offspring?

|  |  |  |
| --- | --- | --- |
|  | FY | FY |
| fy | Ff Yy | Ff Yy |
|  fy | Ff Yy | Ff Yy |

The offspring will have heterozygous genotype Ff Yy with a probability of 1, and the phenotype will be “long fur” and “yellow eyes” since that is the dominant allele. The offspring cats are called the F1 generation. Now suppose that pair of cats heterozygous for both traits produce offspring. What types of offspring do we expect?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | FY | Fy | fY | fy |
| FY | FF YY | FF Yy | Ff YY | Ff Yy |
|  Fy | FF Yy | FF yy | Ff Yy | Ff yy |
| fY | Ff YY | Ff Yy | ff YY | ff Yy |
| fy | Ff Yy | Ff yy | ff Yy | ff yy |

The offspring cats are called the F2 generation. Remember F is dominant and Y is dominant. [ The highlighted Punnett squares in the FurryEyedCats.xcl document might help students count ]What is The probability that a cat will have long fur? (3/4)The probability that the cat will have short fur? (1/4)The probability that the cat will have green eyes? (1/4)The probability that the cat will be homozygous for long fur? (1/4)The probability that the cat will have heterozygous for long fur? (1/2)The probability that the cat will be homozygous for yellow eyes? (1/4)These are the same probabilities we got when studying a single trait. As you can see, the probability the genes were sorted in were not affected by each other, they were **independent.** This phenomenon is called **independent assortment**Let’s model this situation. We have several sets of four bags. Each bag represents a heterozygous (Ff) parent. Counters labeled “F” and “f” represent the long and short, respectively, fur genotypes. A yellow ball ( display one) represents the “Y” genotype for yellow eyes. A green ball (display one) represents the “y” genotype. [ *Note that for fur, students see a code for genotype on the counters. For the eyes, students see the yellow or green phenotype itself and have to translate it to a code for genotype. This is intentional.* ] Take your worksheets and a pencil and form lines at each set of bags. Instruct: The first person in line should draw a counter from each of the first two bags, record the result on the worksheet, and put the chips **back in the same bag** they were taken from. Then take a ball from each of the third and fourth bags, record the result, and put the balls **back in the same bag** they were taken from. *Watch to make sure that students understand and follow the procedure.* When they have followed instructions, ask them to draw chips three more times. When the first students in line have recorded four results, they should return to their seats. When you are back at your seat, figure out the phenotypes of your offspring. Do they kittens have long or short fur, and do they have yellow or green eyes? Write it on your worksheet. Now, second students in line, follow the same procedure. Get four results and return to your seat. After all students have four results and have returned to their seats, give everyone time to determine the phenotypes for the offspring on their sheets. Summarize results by writing on the board (or use the FurryEyedCats spreadsheet). Point out that we are counting phenotypes, not genotypes. Ask students how many of each phenotype they observed. Write the result, and then add all the numbers, and calculate the fraction of offspring. It will look something like this (Example for 12 students. Each student must have 4 observations.) Long fur, Yellow eyes – 0 + 1 + 3 + 2 + 1 + 2 + 2 + 3 + 2 + 4 + 2 + 2 = 24 24/48 = 8/16Long fur, Green eyes – 2 + 2 + 0 + 1 + 0 + 0 + 2 + 1 + 0 + 0 + 1 + 1 = 10 10/48 $≈$ 3.3/16Short fur, Yellow eyes – 1 + 1 + 1 + 1 + 3 + 1 + 0 + 0 + 2 + 0 + 1 + 1 = 12 12/48 = 4/16Short fur, Green eyes – 1 + 0 + 0 + 0 + 0 + 1 + 0 + 0 + 0 + 0 + 0 + 0 = 2 2/48 $≈$ 0.7/16Point out that this is the F2 generation. We expect 9/16, 3/16, 3/16, 1/16, or a ratio of 9:3:3:1. Did we get this exact ratio? Ending: We have just modeled heredity for one and for two traits. What percentage What kinds of cells are produced this way [gametes]. How does meiosis provide stability and change? What is an advantage of sexual reproduction over asexual reproduction? What is an advantage of asexual reproduction over sexual reproduction? **Motivating Students** \_x\_ Verbal Reinforcement Encourage students as they complete their worksheets. \_x\_ Game This probability experiment is like a game. **Presenting Instructional Content** \_x\_ Lecture/Notes A brief lecture at the beginning introduces meiosis as a contrast to mitosis. ***Instructional strategies:*****Modeling and Guided Practice *–*** Observe students’ movements during the performance of the model. Occasionally, announce a phase, then ask a student what will happen during this phase.  **Check for Understanding (CFU) –** ***What am I doing for students that progress at different rates?*** ***What do I do if they get it?*** ***What do I do if they don’t get it?***  |
| **QUESTIONING/THINKING/PROBLEM SOLVING (embedded throughout)** | **Balanced mix of question types.** Utilizes Blooms Taxonomy/Webb’s Depth of Knowledge; high frequency; purposeful & coherent; require active responses; balance based on volunteers/non-volunteers, ability, & gender; lead to further inquiry & self-directed learning.  **Implement four types of thinking (Analytical, Practical, Creative, & Research-based) & Teach/Reinforce problem-solving types**. Provide opportunities for students to generate ideas & alternatives; analyze, evaluate & explain information from multiple perspectives& viewpoints. |
| **Questioning** **Knowledge:****Comprehension:** **Application:****Analysis:** **Synthesis:****Evaluation:** **Thinking*(NOTE: Clearly identify where you will use each of these in your lesson; do not just check the box!)***  \_\_ **Practical** – \_\_ **Creative**– \_x\_ **Analytical** – Students calculate probabilities and have to determine phenotypes from genotypes.**\*What am I going to do to give Ss opportunity to?** **1. Generate variety of ideas:** **2. Analyze problems from multiple viewpoints:** **Problem Solving** **\_x\_\_ Categorization** Students categorize offspring by genotype and by phenotype **\_\_\_ Identifying Relevant/Irrelevant Information** **\_\_\_ Creating and Designing**  |

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| **GROUPING** | **Maximize student understanding & learning** Varied group composition (race, gender, ability, & age); clearly understood roles, responsibilities & group work expectations; accountability for group & individual work; student opportunities for goal setting, reflection & evaluation of learning. |
| * Whole group activity. Students will submit individual worksheets
 |
| **ASSESSMENT** | **Formative and/or summative assessment.** A variety of assessments, including rubrics, measure achievement of objectives and informs instruction.  |
| ***Assessments: aligned with state stds; measurement criteria; measure student performance in more than 2 ways (project, experiment, presentation, essay, short answer, multiple choice test) (NOTE: Clearly identify where you will use each of these in your lesson; do not just check the box!)*****\_\_\_ Worksheet** Each student will submit a worksheet showing the results of their probability experiment. The teacher will determine if the students correctly identified the phenotype for each of the two-trait results.  *\****Students should achieve \_\_\_\_\_% mastery of this objective: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
| **CLOSURE** | **Reflection/Wrap Up.** Summarizing, reminding, reflecting, restarting, connecting. |
| ***During the conclusion part of creating an effective lesson plan teachers must sum up the ideas learned from the lesson. A teacher should also relate this information to future and past coursework to provide students with a broad understanding of the ideas learned. It is important to allow students enough time to ask questions, assert assumptions, and summarize the lesson during this part of the lesson plan.**** ***Review/Summary: wrap up what has been learned and accomplished in the lesson (even if they are in the middle of an exercise, it is still important to summarize to the point where they are now). Ideally involve students in this synthesis.***
* ***Preview for next lesson: link what they did to day with where they are going next.***
* ***Upcoming assignments: remind them of any upcoming assignments.***

***Here is your exit ticket for today…..*** **Follow-up Activities/Extension *These may be designed to create a longer or more intense lesson. For example, if the class is able to cover the material in a lesson much faster than expected, extensions may prove helpful. Extensions may also be useful in various parts of a lesson where the teacher (and class) decides they should spend more time on a skill or topic.******Reflection: You must reflect on every lesson you teach.*** |

**NOTES:**

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Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_\_

Fur length only: (F, f) \_\_\_ Homozygous parents’ results: \_\_\_\_\_

 Maternal fur Paternal fur

First round: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Second round: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Third round: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Fourth round: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Fur length only: (F, f) \_\_\_ Heterozygous parents’ results: \_\_\_\_\_

 Maternal fur Paternal fur

First round: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Second round: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Third round: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Fourth round: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Two traits: (F, f) and (Y, y) \_\_\_\_\_\_ Heterozygous parents’ results:\_\_\_\_\_\_\_\_\_\_\_

 Maternal fur Paternal fur Maternal eyes Paternal eyes Phenotype

First round: \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_

Second round: \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_

Third round: \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_

Fourth round: \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_