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| **TEAM Lesson Plan Template** |
| Teacher: Andrew Morency |
| Subject/Grade: High School Biology 1 |
| Lesson Title: Modeling Meiosis |
| **STANDARDS** | **Identify what you intend to teach.** State, Common Core, ACT College Readiness Standards and/or State Competencies; Enduring Understandings and Essential Questions. |
| BIO1.LS3.1 Model chromosome progression through meiosis and fertilization in order to argue how the processes of sexual reproduction lead to both genetic similarities and variation in diploid organisms. Compare and contrast the processes of sexual and asexual reproduction, identifying the advantages and disadvantages of each. This lesson emphasizes:Science practice: Developing and using modelsCCC: Stability and change of systemsLearning performance: Students will enact a model of meiosis and use it to describe how sexual reproduction leads to both genetic similarities and variation in diploid organisms emphasizing stability (similarity) and change (variation) of chromosomes as a system.  |
| **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 name the 8 phases of meiosisI can act out a model of meiosis using playdough chromosomes with my classmatesI can draw a diagram to represent each of the 8 phases of meiosis  |
| **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: Kiddie dough in different colors, 1 color per student, masking tape, marker, four large crumpled paper balls labeled “centrosome”\_x\_ A large amount of clear space for students to move around **Routine for distributing materials** Pair colors of playdough. For example, light purple/dark purple, light red/dark red, and so on. Write “maternal” or “paternal” and the chromosome number each playdough lid to label colors. Label lighter colors “paternal,” and label darker colors “maternal.” We get, for example:Light Purple: “Paternal Chromosome #1” Dark Purple: “Maternal Chromosome #1”Light Red: “Paternal Chromosome #2” Dark Red: “Maternal Chromosome #2”Gray: “Paternal Chromosome #3” Black: “Maternal Chromosome #3” and so on. Make enough chromosome pairs for the entire class. Pass out cans, 1 can per student. If there are an odd number of students, then the teacher gets a can. Prepare the room by placing a 10’ long piece of masking tape on the floor in the center of the room. Use a marker to label the tape “dividing line” or “equatorial plate.” Place one centrosome on each side of this piece of tape, across the room from each other, and as far as practical from the tape. Keep the remaining two centromeres out of sight at the beginning. Place two more 10’ pieces of tape, perpendicular to the first piece, on each side of the first piece of tape. Label these the same way.  |
| **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, it may be appropriate to either 1) let that student call out the phases of meiosis, directing the movement of other students or 2) simply take more time and let the student participate as other students, or 3) assign the mobility impaired student a partner: the pair of students will create and move a single chromosome together. **----- Product** **----- Tiered Assignments** **----- Flexible Grouping****----- Learning Centers \_\_\_\_ Other \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_****Accommodations****\_\_\_ Preferential Seating \_\_\_ Extended Time \_\_\_ Small Group \_\_\_ Peer Tutoring** **\_\_\_ Modified Assignments** **\_\_\_ Other** If any student is colorblind, make a point of introducing that student to his “homologous” partner. “When we reach prophase and homologous pairs need to link up, you go find Henry.” **Early Finishers:** 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. |
| Amoeba Sisters animated video explaining meiosis (7:43) <https://www.youtube.com/watch?v=VzDMG7ke69g> Recall mitosis. Mitosis creates new cells with structure and genetic material identical to the original cell. Today we are going to discuss meiosis, which produces new cells with a different set of genetic material than the original cell. Meiosis is the basis of sexual reproduction.  |
| **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:All living things reproduce, some sexually, some asexually. Either way, living things pass their genetic code sown through generations. Meiosis occurs in gametes cells. In humans these are germ cells of the testes which produce sperm and the ovaries which produce eggs. Meiosis passes chromosomes from one generation to the next, but meiosis produces much more genetic variability than mitosis. In asexual reproduction the offspring are essentially exact genetic copies of the parent. For example, an amoeba splits using binary fission. Populations can grow rapidly, but genetic variety only happens occasionally through mutations. In sexual reproduction, two parents produce offspring that have a unique combination of genes. This produces genetic variety from one generation to the next. Offspring are not exact copies of either parent. This genetic variety is carried through DNA, which is very thin. During cell division, DNA chromatin may continue to coil, thus thickening and becoming visible under a microscope. Meiosis and mitosis are parts of the cell cycle. Recall that Mitosis has four phases. Prophase is Prep, chromosomes condense and nucleus disappearsMetaphase: chromosomes line up in the Middle of the cellAnaphase: Spindle fibers move the sister chromatids ApartTelophase: Two distinct cells with two separate nuclei start to formMeiosis has each of these phases Twice. Meiosis produces cells with half as many chromosomes as the original cell. Let’s model meiosis. Middle: 1. Orient students to the room. Point out the first dividing line and the two centrosomes. Tell students to ignore the second set of dividing lines for now.
2. Pass out playdough to all students tell students to note their chromosome number and the paternal/maternal detail on their lid. Ask several students “What is your chromosome?” to ensure that students understand. A student should reply with “maternal #4” or “paternal #7,” for example.
3. Have each student take half the playdough in his or her can and create a single “worm” of playdough representing an unreplicated chromosome. Remind them that this represents a very densely coiled chromosome, not like the thin playdough we used for the chromatin playdough formation in an earlier lesson.
4. Have the students hold up their unreplicated chromosome and count the entire number of chromosomes in the room **(write this diploid number on the board. This should equal the number of students (or number of students + the teacher) and must be an even number.)**
5. Declare the entire room to be a cell, the class will now go through the S phase of interphase.
6. Have the students take the other half of the playdough from their cans and create another “worm” of playdough and join them together making an “X” shape. Have them pinch it in the middle to really join them together. Ask a student what this joining point is called [centromere]. This is now a chromosome composed of two sister chromatids. Emphasize that the original chromosome and this replicated “X” form still count as one chromosome. Count the centromeres and compare the result to the number written on the board. Announce each phase as you come to it.

Prophase 11. Declare we are now in prophase I. Homologous pairs must find each other. In our model, this means light purple finds dark purple, light red finds dark red, and so on. If anyone has any doubt about color, have him call out “Chromosome #\_” so that he can find his partner by chromosome number.
2. Have the students represent crossing over. Take a bit of dark dough from one dark chromatid and a bit of light dough from about the same spot on a light chromatid. Stick the original chromatids back together using the other color of dough. Do this one to three times. The result will be a bunch of two-toned chromatids.

Metaphase 11. The instructor should tell the students that spindle fibers have grabbed hold of them and are arranging them around the room.
2. Line up all the students with the **homologous pairs across from each other** along the division line. Purples are side by side with the division line between them, Reds are side by side with the division line between them, and so on. (Like dance partners).

Anaphase 11. On the count of 3, have the students on one side of the line go to the centrosome on that side of the line, and have the students on the other side of the line go to “their” centrosome. This will s**plit the homologous pairs,** half the students should move toward one side, the other half the students to the other side.

Telophase 11. Count the chromosomes at each centrosome, remembering to count centromeres, not chromatids. Compare the resulting number for one centromere to the original diploid number.
2. Declare each side of the room to be two separate cells. Note that these new cells are haploid.
3. Each side of the room should have one copy of each chromosome. Emphasize this by instructing “Chromosome #1s, raise your hands; Chromosome #2s, raise your hands; . . . ” Each time there should be a hand raised on each side of the room.

**(set out all 4 centrosomes) Prophase II; we are in two different cells; Note the dividing line for each cell; Note the Four centrosomes now.** 1. Now instruct “Paternal chromosomes, raise your hands; hands down. “ “Maternal chromosomes, raise your hands; hands down.” There should be a random mix on either side (independent assortment). Tell them to keep this in mind for later.

Metaphase II1. Now declare we are going through meiosis II, have the students on each side of the room line up on the second set of perpendicular division lines for metaphase II. Each student should have one foot on one sideof the line and the other foot on the other side.

Anaphase II1. Hold one of your chromatids in your left hand, and the other chromatid in your right hand. On the count of 3, **split the sister chromatids.** Each student should still be straddling the line, but should have arms sticking straight out to the sides with a chromatid in each hand. After a moment have students walk to the centrosome on their left and lay down their left hand chromatid. Then walk to the other centrosome on their side of the room and lay down their right hand chromatid. This should happen in four corners of the room ending with four collections of chromosomes.

Telophase II1. Declare this to be the end of telophase II, now count the chromosomes in each “cell”. If done correctly this should remain haploid. Write this on the board.
2. Point out that each one of these chromosomes is slightly different from each of the others at the other centrosomes. None of the chromosomes matches any other; there are four cells from the original one; each new cell has half as many chromosomes as the original cell.

Ending: We have just modeled meiosis. 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? Have homologous pairs work together to return light playdough and dark playdough to the correct jars as much as possible. That is, undo the “crossing over.” **Motivating Students** \_x\_ Verbal Reinforcement Encourage students as they create their models\_x\_ Game This model turns meiosis into 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:**What does diploid mean?What does haploid mean? **Comprehension:** How many chromosomes are there at this point? **Application:**What are some things in a cell besides the chromosomes? Explain why each of the gametes still has a complete genetic code. [ there is a copy of each chromosome, so there is a code for eye color, hair color, etc. ] **Analysis:** **Synthesis:**Why are we only moving the chromosomes around, when there are other parts of a cell? [ we are viewing chromosomes as a system, a small portion of the cell that is the most significant feature of meiosis. We are purposely simplifying a complex process so that we can more easily understand it (see A Framework for K-12 Science Education pages 91-92).] **Evaluation:** **Thinking*(NOTE: Clearly identify where you will use each of these in your lesson; do not just check the box!)***  \_\_ **Practical** – \_x\_ **Creative**– Students figure out their own crossing over patterns. \_x\_ **Analytical** – Students compare and contrast mitosis and meiosis. \_\_ **Research-based** – Students explore the structure of a DNA model **\*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 determine which actions to take based on the phases of meiosis. They are placing blocks of time into categories. **\_x\_\_ Identifying Relevant/Irrelevant Information** The number and colors of the chromosomes are relevant. The size and shape are not. **\_x\_\_ Creating and Designing** Within the loose guidelines of “make a thin string of playdough,” students are free to create a strand of their own design. It needs to be thick enough not to break while moving around, but thin enough to look like a chromosome rather than a ball.  |

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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 with each student managing a chromosome
 |
| **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!)*****\_\_\_ ThinkLink Probe \_\_\_ Study Island \_\_\_ Teacher Made Test \_\_\_ Unit/Chapter Test \_\_\_ Project \_\_\_ Quiz** **\_\_\_ Group Assignment \_\_\_ Study Guide \_\_\_ Oral Presentation \_\_\_ Graphic Organizer \_\_\_ Exit Ticket** **\_\_\_ Journal \_\_\_ Questions/Answers** **\_\_\_Teacher Observation *(thumbs up/thumbs down, etc.)*\_\_\_ Solution to Real World Problem** **\_\_\_ Other \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**  *\****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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