Mitosis under the Microscope

A lesson plan arranged by:

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Submitted in partial fulfillment of the requirements of EDI 432 – Secondary Science Practicum

Grand Valley State University

05 February 2013

INTRODUCTORY INFORMATION

- Grade: 9th (32 Students/Class)
- Class: Stem Biology (Innovation Central High School)
- Time Allotted: 3 days (55 minutes/day)

OUTLINE OF LESSON

- Day 1: Engage & Explore
- Day 2: Explain
- Day 3: Elaborate/Extend
- Continuations evaluation and assessment of student learning will occur in each day.

STANDARDS

High-School Content Expectations

- **B1.1C** Conduct scientific investigations using appropriate tools and techniques
- **B4.3A** Compare and contrast the processes of cell division (mitosis and meiosis), particularly as those processes relate to production of new cells and to passing on genetic information between generations.

Next Generation Science Standards

Performance Expectations

- **HS-LS1-4.** Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

Science and Engineering Practices

- **Developing and Using Models:** Use a model based on evidence to illustrate the relationships between systems or between components of a system.

Disciplinary Core Ideas

- **LS1.B Growth and Development of Organism:** In multicellular organisms, individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism.

Crosscutting Concepts

- **Systems and System Models:** Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Standard Connections to Lesson

These standards (HSCES and NGSS) will be addressed in this lesson.

- HSCES B1.1C will be addressed during the explore portion of the lesson, where students will use microscopes and prepared slides (appropriate tools) to examine mitosis in onion root tip and whitefish blastula. They will also have to use the appropriate techniques of using a microscope to be successful in this lab activity.
- HSCES B4.3A standard asks students to compare and contrast cellular division (mitosis and meiosis). In this lesson, students will be learning about mitosis so their ability to compare and contrast mitosis and meiosis will not be fully addressed in this lesson. However, students will

Standard Connections to Lesson

need to learn about each of these concepts (mitosis and meiosis) before they can compare. Therefore, students will be building their knowledge about the cell division process of mitosis. Students will begin to learn the process of mitosis by examining mitosis microscope slides (Explore). Then as a class this process will be further discussed using a FRAME with reading (Explain) and then students will create a model of mitosis (Elaborate) illustrating the process of mitosis.

- Performance Expectations NGSS will be achieved by using prepared mitosis microscope slides to model the process of mitosis (Explore). Students will analyze the various stages of mitosis on the slides. Students will also their own model to illustrate the process of mitosis (Elaborate)
- Science and Engineering Processes for developing and using models will be achieved because students will have examined the stages of mitosis by examining onion root tip and whitefish blastula slides (evidence) that will help them to create a model illustrating mitosis during the elaborate section of the 5E.
- Disciplinary Core Idea of Growth and Development of an Organism will be addressed in the explain section of the 5E. In discussing the process of mitosis, students will read about the various phases and complete a FRAME routine that has them outline the process of mitosis, as well as explain why this process is important.
- Cross cutting concept of Systems and System Models will be addressed when students will create a model of mitosis out of various materials to simulate cellular division.

NATURE OF SCIENCE (NOS)

Science is a creative endeavor

Many of my students have a negative attitude towards science in terms of it being boring and hard. In this lesson, students will be using microscopes to examine a cell division process called mitosis. Instead of learning about this process through the textbook students will be able to see the process through a hands-on activity. Therefore, I hope that the explore and elaborate activity will challenge their beliefs about science in terms of its creativity. Before beginning this lesson, I will have students answer a short response question asking them about their opinions on science as a creative endeavor. Then I after the lesson, I will ask them to answer the NOS question again and then compare the before and after results.

OBJECTIVIES

1. Students will be able to explain the importance of why cells reproduce.
2. Students will be able to draw/illustrate various phases of mitosis (prophase, metaphase, interphase, telophase).
3. Students will be able to identify the phases of mitosis (prophase, metaphase, interphase, telophase).
4. Students will be able to explain/summarize/outline events that occur in the phases of mitosis.
5. Students will be able to list the phase of mitosis in order.
6. Students will be able to assemble a model for mitosis.

REQUISITE KNOWLEDGE

Students will have learned about chromosomes in a previous lesson. They will also have learned about the S, G1, G2 phases of the cell cycle. They will know and be able to explain the following terms: autosomes, sex chromosomes, centromere, chromatid, haploid, and diploid. They will have been introduced to the following stages interphase, prophase, metaphase, anaphase, and telophase in relation to the cell cycle, but will not have an understanding of these stages in regards to what occurs.

SAFETY CONSIDERATIONS AND PRECAUTIONS

Students will need to be careful when working with premade slides. The slides are glass and if they are dropped, there is a possibility of the slides breaking. Discuss with the students proper handling of slides, as well as proper lab behavior. In addition, students will use scissors in one of the activities in this lesson. Be aware that some students may not appropriately use scissors.

SCIENTIFIC BACKGROUND

Cell division is a process in which cells produce offspring cells. This process is different in prokaryotic and eukaryotic cells. In prokaryotes, cells undergo cell division through a process known as binary fission (Figure 1). In eukaryotes, there are two types of cell division, which are known as mitosis and meiosis. Meiosis cell division (Figure 2) reduces the number of chromosomes in the new cells to half the original number of the cell. Mitosis is cell division that creates new cells that are identical to the original cell. Somatic cells (all cells that are not associated with sexual reproduction) undergo mitosis as their form of cell division. Mitosis is also part of a concept known as the cell cycle. The cell cycle is a set of events that occurs in the life of a cell (Figure 3). The cell cycle is broken down into two main parts: interphase and cell division. The interphase portion of the cell cycle consists of three phases: G1, S, and G2. The first stage of interphase is the G1 phase and in this phase, cell growth occurs. Then in the S phase of interphase the DNA of the cell is copied. After the DNA is copied, the cell undergoes the G2 phase of

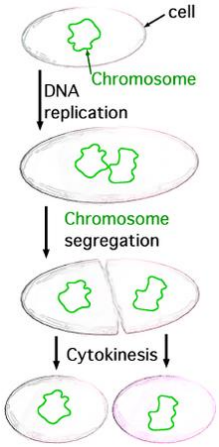

Figure 1. The process of binary fission in prokaryotes.

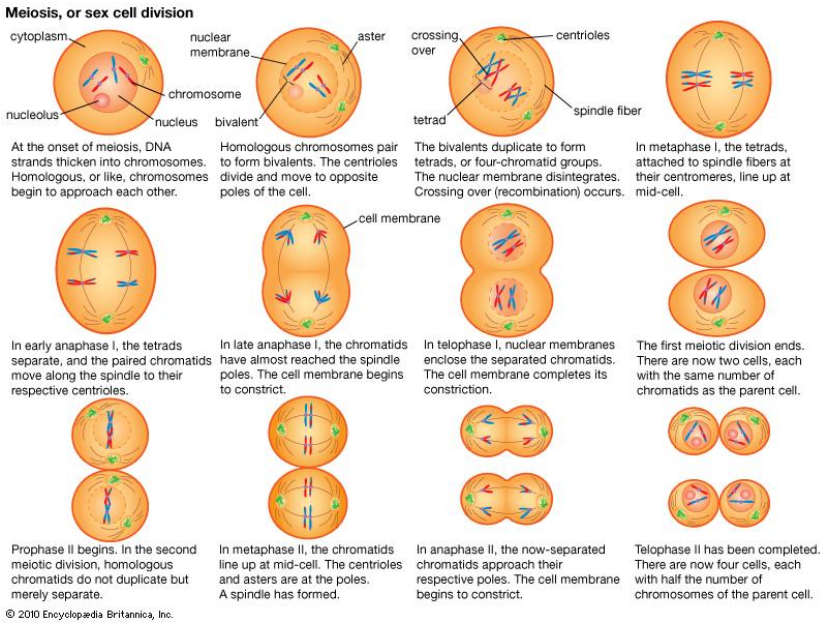

Figure 2. The process of Meiosis.

SCIENTIFIC BACKGROUNG CONTINUED:

interphase. In the G2 phase, the cell prepares for cell division. After the G2 phase is completed, the cell enters cell division. Cell division is divided into the M phase (mitosis) and cytokinesis. In mitosis, the cell goes through four phases: prophase, metaphase, anaphase, telophase (Figure 4). In prophase, the DNA begins to condense and form chromosomes. These chromosomes are composed of two chromatids that are attached at the centromere. In addition, spindle fibers begin to form and move towards opposite ends of the cell. Then before the cell enters metaphase, the nuclear membrane disintegrates and the spindle fibers attach to the chromatids at the kinetochore. In metaphase, the chromosomes line up in the middle of the cell along the metaphase plane. The next phase is anaphase. In anaphase, the sister chromatids separate at the centromere and move to opposite poles. The fourth phase in mitosis is telophase. In telophase, the chromosomes reach the opposite ends of the cell and the spindle fibers disassemble. Two nuclei form in the cell and the nuclear membrane begins to reform. The chromosomes also become less condensed. After this final phase (telophase) the cell under goes cytokinesis. In cytokinesis, the cytoplasm is divided. In animals, the dividing cell is separated into two new cells at the site known as a cleavage furrow (Figure 5). In plant cells, a cell wall forms dividing the cell into two new cells (Figure 65). Overall, the process of mitosis in one cell produces two offspring cells each with an identical copy of the original cell's chromosomes.

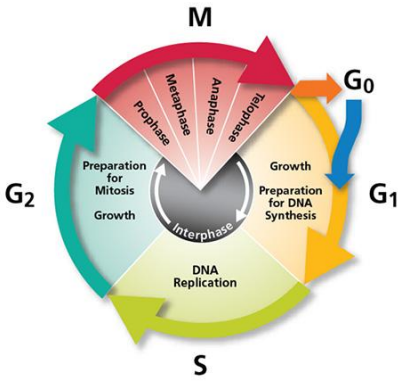

Figure 3. The life cycle of a cell.

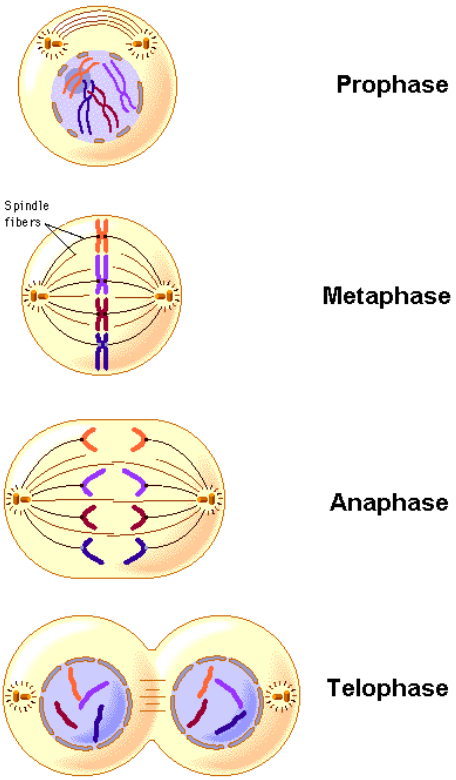

Figure 4. Stages of Mitosis

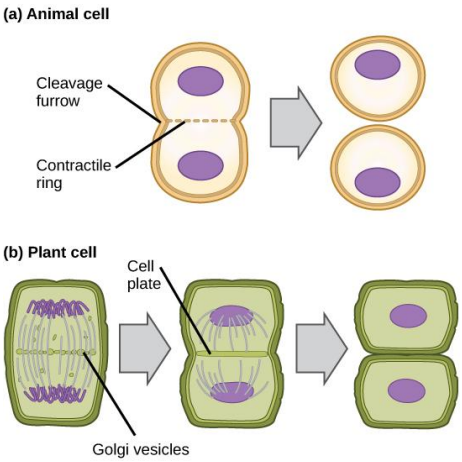

Figure 5. Cytokinesis in an animal cell versus a plant cell.

MISCONCEPTIONS

Cell division can be a complex and confusing concept to understand. Much research has been conducted analyzing common misconceptions students have about cell division. Some common misconceptions are listed below. These misconceptions will be addressed in Explain segment of this 5E lesson through classroom dialogue about what occurs during each of the stages. Furthermore, students will then apply their understanding by creating a booklet that explains each stage of mitosis. In addition, in a lesson prior to this lesson, emphasis has been given to the terminology associated with cell division in regards to misconception #4.

1. DNA replication occurs in the prophase during the cell division (Dikmenli, 2010).
2. Interphase is the resting phase of mitosis (Dikmenli, 2010).
3. The chromosome number is doubled in prophase of mitosis and halved in anaphase of mitosis (Dikmenli, 2010).
4. Students confuse chromatids with chromosomes, or replicated chromosomes with unreplicated chromosomes (Chinnici et al., 2004).

DIFFERENTIANTION

This lesson provides accommodations for a wide range of diverse learning needs. My lesson contains a FRAME routine, which is a universal design technique that can be beneficial to all learning levels of students. The FRAME is an organizational tool that helps students will special needs, those with poor organization skills or struggle with taking notes for reading. Yet, the FRAME is also great for students who are successful academically. My lesson also incorporates multiple intelligences via a variety of instruction. For instance, verbal linguistic students are students who love to read. I have incorporated a reading activity into the lesson during the explain portion. This reading activity can be done alone or in pairs and therefore I am accommodating for intrapersonal individuals who like working alone and interpersonal individuals who like to work together. I also have students work in groups during a lab activity and in creating a model of mitosis. Incorporating group work is beneficial to interpersonal individuals, as well as students who are struggling because they can receive help from other people. In some of the activities I have planned in my lesson, such as the lab activity and the mitosis model benefits kinesthetic individuals because these activities give them the ability to move around. My lab activity also accommodates for logical and mathematic students because I have students work with microscopes. Additionally, in the model mitosis activity these logical and mathematic people will appreciate that they can use technology (i.e. camera/cell phone) to photograph the phases of mitosis. Furthermore, I accommodate for visual and spatial individuals by showing diagrams to illustrate mitosis and showing a video clip in the engage and explain portion of my lesson. I also have incorporated drawing into my lesson, which benefits visual/spatial students as well. Overall, I believe my lesson accommodates for a wide range of learners.

5E LESSON

BELL RINGER ACTIVITY/PRE-ENGAGE (5 minutes)
Each day when students enter the classroom prepared to learn. The teacher will greet the students as they enter. The students will retrieve their organized binders from the designated locations. Once the classroom bell rings, the teacher will begin the day by welcoming the students to class, stating the daily objectives, and discussing the agenda. After this is complete, the teacher will instruct the students to complete warm-up activity.

ENGAGE (5 minutes)		
I. Overview and Objectives	The lesson will begin by having students watch a 1 ½ minute video clip from YouTube. This video will aim to generate student interest in the lesson and will address the following objective. ✓ Objective: Students will be able to explain the importance of why cells reproduce.	
II. Materials and Set-Up	**Materials** ▪ Computer ▪ Projector w/Whiteboard or Smart Board ▪ Internet Access ▪ Video Link: http://www.youtube.com/watch?v=L0k-enzoeOM	**Set-Up** Make sure that the computer, projector and internet are working properly prior to the beginning of class.
III. Procedure	Once the warm-up activity is completed, follow this procedure. 1. Explain to the student that they are going to watch a short video clip. 2. Go to http://www.youtube.com/watch?v=L0k-enzoeOM 3. Allow the video to load and press the play button. 4. Allow the video to play and then stop the video when the time reaches 1:30 5. Ask the students to reflect on the video clip and pose the following question: "Why is cell reproduction important?" 6. Call on 2-3 students to share their answers. 7. Base on their answers asses their understanding of why cell reproduction is important. 8. Transition to Explore Activity.	
IV. Assessment	Before, continuing to the explore section of the lesson. The teacher will assess the objective of the "Engage" portion of the 5E lesson. Assessment will be completed by the teacher checking for understanding though asking the following question to the class. ▪ Why is cell reproduction important? Why do your cells need to undergo cell division and produce more cells? The teacher will assess student understanding based on the responses from the students. Student Responses will vary. Below is a list of some examples student responses. ▪ Cells reproduce for growth and repair. Cells reproduce because cells are constantly dying and have to be replaced for our survival.	

<table>
<tr><th colspan="4">EXPLORE (40 minutes)</th></tr>
<tr><td>V.</td><td>Overview and Objectives</td><td colspan="2">Students will work in groups of 2-3 students to observe mitosis. The students will use compound microscopes and Onion Root Tip and Whitefish Blastula premade slides to observe the stages of mitosis. Each student will complete a worksheet with this activity called “Observing Mitosis Lab.” Student will first examine the onion root tip slide and draw five different cells, and then they will examine the whitefish blastula slide. While observing the whitefish blastula slide they will have to draw five different cells, observe, and then label each of the five different cells they drew with the appropriate phases of mitosis. The lab will conclude with post-lab questions that address each of the phases of mitosis specifically.
✓ <u>Objective:</u> Students will be able to draw various phases of mitosis (prophase, metaphase, interphase, telophase).
✓ <u>Objective:</u> Students will be able to identify the phases of mitosis (prophase, metaphase, interphase, telophase).</td></tr>
<tr><td>VI.</td><td>Materials and Set-Up</td><td>Materials
▪ “Observing Mitosis Lab” Worksheet Handout
▪ 15 compound microscopes
▪ 15 Whitefish Blastula Mitosis Slides
▪ 15 Onion Root Tip Mitosis Slides
▪ Mitosis Exit Ticket

Note: Slides can be purchased from <u>www.carolina.com</u>
Item # 308816 $21.00

CAROLINA®</td><td>Set-Up
The day before the lesson, be sure to complete the following tasks.
1. Copy the lab handout for each student.
2. Set –up microscopes at each lab station/desk. One microscope per table.
3. Check slides to make sure they are useable (i.e. no cracks or damages).</td></tr>
<tr><td>VII.</td><td>Procedure</td><td colspan="2">1. Explain to the students that they will be examining mitosis in onion root tip cells and a whitefish blastula.
2. Pass out the “Observing Mitosis Lab” worksheet handout to each student.
3. Review how to properly focus a compound microscope.
4. Allow students to begin the mitosis lab.
5. While the students are working, the teacher will observe the students at work, assist, and answer questions when needed.
6. Once, students have completed the lab, the teacher will collect the “Observing Mitosis Lab” handout.
7. Once the hangouts are collected and students have cleaned up their work area, the teacher will pass out an exit ticket.
8. Explain the tasks students will need to complete via the exit ticket. *If there is no time to complete the exit ticket, use the exit ticket as an admittance ticket for the beginning of class the next day.</td></tr>
<tr><td>VIII.</td><td>Assessment</td><td colspan="2">This portion of the lesson will be assessed via an exit ticket. Students will be asked to identify the phases of mitosis by matching the correct phase name with its illustration. The teacher will collect the exit tickets before class is dismissed. The teacher will examine the student responses and go over the exit ticket the following day. In addition, this “Explore” portion of the lesson will be assessed by</td></tr>
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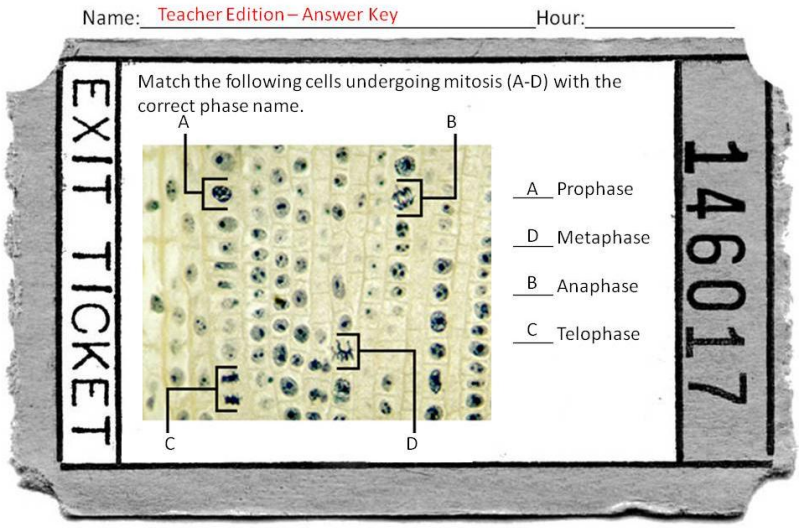
	examining the student "Observing Mitosis Lab" worksheet handouts. 

EXPLAIN (50 minutes)		
I. Overview and Objectives	The "Explain" portion of the lesson will begin by going over the "Observing Mitosis Lab". The teacher will lead the class in a discussion. After the discussion, the class will participate in a critical reading activity regarding the process of mitosis. In this reading activity, students will create a FRAME outlining mitosis. After completing the FRAME, a mitosis video will be shown to tie everything together. ✓ Objective: Students will be able to summarize/outline events that occur in of mitosis. ✓ Objective: Students will be able to illustrate the phases of mitosis. ✓ Objective: Students will be able to list the phase of mitosis in order.	
II. Materials and Set-Up	Materials ▪ Computer ▪ Projector w/Whiteboard or SmartBoard ▪ PowerPoint Program ▪ PowerPoint Presentation (Explain) ▪ Internet access ▪ Video Link: http://www.youtube.com/watch?v=C6hn3sA0ip0 ▪ "Mitosis Frame" handout ▪ "Mitosis Reading Packet"	Set-Up ▪ Make sure that the computer, projector and internet are working properly prior to the beginning of class.
III. Procedure	1. Go over "Observing Mitosis Lab" worksheet Handout and discuss the activity. The teacher can address the following questions. ▪ What did we observe in each phase of mitosis?	

	▪ What are the black dark spots inside the cell? ▪ Was there any difference in the phases that occurred in the onion root tip vs. the whitefish blastula? 2. After going over the lab, the students will participate in a critical reading with FRAME activity. Pass out to the students a "FRAME" handout and the "Mitosis Reading Packet." 3. To complete the reading activity with Frame, complete the following steps. 4. First, the teacher will explain what the FRAME is. ▪ "This frame is a strategy designed to assist you in organizing your thoughts about the reading. I will help you will the first part of the FRAME and then you will work on it." 5. The teacher reads the information in the packet underneath the title "Mitosis". 6. After reading, the teacher will ask, "What is mitosis?" 7. The teacher will call on a student to respond. ▪ Student Response: Mitosis is the creation of two cells. 8. After student responses are made students will write what Mitosis is about in the designated box on their FRAME. 9. Next, the teacher will ask a student to read the next section in the reading (e.g. Prophase). 10. Once the student has finished reading, the class will work together to summarize Prophase and write the key events that our in Prophase in the "Essentials Details – Prophase" section on the frame and draw a picture of the phase in the illustration box. The teacher will lead the students through this. 11. Once the Prophase box is completed students will continue to finish the FRAME by reading, collecting key details to put in the FRAME for the Metaphase, Anaphase, and Telophase sections. This will be done by reading silently or quietly in groups of two. 12. Once the students have completed those boxes, the teacher will gather the class and ask the class to discuss each of the essential details for the phases of mitosis listed in the FRAME and answer any questions the students may have. 13. The teacher will then ask, "So why is the process of Mitosis important?" 14. Students will respond to the teacher's question ▪ Student Response: It is important because it is the process in which cells grow and repair. For example, when your skin is cut, you want more skin cells to come in and repair the cut. 15. Once the class has discussed why Mitosis is important students will write it down in the designated box on the FRAME. 16. Once the FRAME is completed, the teacher will collect the FRAME to analyze the student's work. The teacher will return the frame to the students the next day. 17. Conclude this section of the lesson by showing a video of the whole process of mitosis (http://www.youtube.com/watch?v=C6hn3sA0ip0).
IV. Assessment	The teacher will assess student understanding through observation and completion of the FRAME.

<table>
<tr><th colspan="4">ELABORATE/EXTEND (55 minutes)</th></tr>
<tr><td>I.</td><td>Overview and Objectives</td><td colspan="2">In this portion of the lesson, students will model mitosis using pipe cleaners and string. Students will work in groups of 2-4 and create each stage of mitosis using the pipe cleaners and strings. The pipe cleaners will represent chromosomes and the string will represent the cell membrane. A bead will represent the centromere. The penne noodles will represent the centrioles. The spindle fibers will be represented fishing line. Students will document the creation of each stage by photographing the stage using a camera. Then they will print out their photos, create a poster displaying each stage, and identify each phase. Students will be encouraged to be creative.
✓ <u>Objective:</u> Students will be able to assemble a model for mitosis.
✓ <u>Objective:</u> Students will be able to explain the phases of mitosis.</td></tr>
<tr><td>II.</td><td>Materials and Set-Up</td><td>Materials
▪ 6 -8” long pieces of pipe cleaner (per group)
▪ 6-4” long pieces of pipe cleaner (per group)
▪ 6 beads (per group)
▪ 15 Scissors (1 per group)
▪ 60 ft of String (per group)
▪ 1 box of Penne Noodles
▪ 1 Package of Fishing Line
▪ Camera (1 per group, students can bring in their own or use their cell phones)
▪ Large Blank Poster (1 per group)
▪ “Modeling Mitosis Assignment/Rubric” handout
<u>Note:</u> These materials can be purchases at Meijer/Walmart/Hobby Lobby</td><td>Set-Up
▪ The day before the elaborate activity, create bins that have the materials need for this activity.
▪ On the day of the elaborate activity divide, the class into groups of 2-4 students (depends on size of class).</td></tr>
<tr><td>III.</td><td>Procedure</td><td colspan="2">1. Explain to the students that they will be building a model for mitosis using pipe cleaners, string, beads, and fishing line.
2. Divide the students into groups of 2-4 students depending upon the class size.
3. Hand out the “Modeling Mitosis Assignment/Rubric.”
4. Have students retrieve materials from their lab bins.
5. Allow students to begin working on their model.
6. While the students are working, the teacher will supervise, observe, and assist when needed.
7. Students will turn in their poster models of mitosis once complete.
8. The teacher will score each poster using the rubric that is in the “Modeling Mitosis Assignment/Rubric” handout.</td></tr>
<tr><td>IV.</td><td>Assessment</td><td colspan="2">Students will be assessed via analysis of their mitosis models using the “Modeling Mitosis Assignment/Rubric”</td></tr>
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EVALUATE

Assessments

Location of Assessment	Description of Assessment
Engage (Page 6)	In this section of the 5E lesson, the teacher will evaluate the students based on observation. The teacher will pose questions and evaluate understanding based on student responses. The teacher will be evaluating student understanding of the purpose of mitosis.
Explore (Page 8-7)	Students will be evaluated in this section of the 5E lesson plan via exit ticket. In this section, students observed mitosis under the microscope. The exit ticket will evaluate their ability to identify each stage of mitosis. Students will also be evaluated on their ability to make observations. The teacher will analyze the observations they wrote down in the lab handout.
Explain (Page 9)	Students are evaluated in this section of the 5E lesson plan via completion of their FRAME. They will be evaluated based on their ability to describe/summarize what occurs in each phase of mitosis after having read about each phase.
Elaborate/Extend (Page 10)	Students are evaluated in this section of the 5E lesson through the creation of their model for mitosis. Students are evaluated on their abilities to correctly model each phase of mitosis, as well as their ability to correctly explain the key events in each phase of their model. In addition, they will be assessed on their ability to label each phase of their model.
NOS Assessment	Science as a Creative Endeavor Questionnaire will be completed before this lesson begins and then filled out after this lesson is completed. I will then compare results (before vs. after).

SUPPORTING MATERIALS

The following support materials are included.

- Video Links:
  - http://www.youtube.com/watch?v=L0k-enzoeOM
  - http://www.youtube.com/watch?v=C6hn3sA0ip0
- Worksheets/Handouts/Assessments:
  - Observing Mitosis Lab
  - Mitosis Exit Ticket
  - Modeling Mitosis Assignment/Rubric
  - Mitosis Frame
  - Mitosis Reading Packet
  - NOS Question Handout
  - PowerPoint Presentation (Mitosis Explain)

DATA-SUPPORTED REFLECTION

To be completed at a later date (within 7 days after instruction).

REFERENCES

1. Chinnici, J. P., Yue, J. W., & Torres, K. M. (2004). Students as "human chromosomes" in role-playing mitosis & meiosis. *The American Biology Teacher, 66*(1), 35-39.

2. CK-12 Foundation. (2014). *Mitosis and Cytokinesis*. Retrieved from http://www.ck12.org/biology/Mitosis-and-Cytokinesis/lesson/Mitosis-and-Cytokinesis/.

3. Clark, N. (n.d.). *Observing Mitosis Lab*. Retrieved from http://www.nclark.net/MitosisLab.pdf.

4. Dikmenli, M. (2010). Misconceptions of cell division held by student teachers in biology: A drawing analysis. *Scientific Research and Essay, 5*(2), 235-247.

5. Lederman, N. G., Abd-El-Khalick, F., Bell, R. L., & Schwartz, R. (2002). Views of nature of science questionnaire: Toward valid and meaningful assessment of learner's conceptions of nature of science. *Journal of Research in Science Teaching*, 39(6), 497-521.

6. Zoubina, E. (n.d.). *Mitosis*. Retried from http://www.ck12.org/user:ZXpvdWJpbmFAaG90bWFpbC5jb20./section/Mitosis-%253A%253Aof%253A%253A-Cell-Division%253A-Mitosis/.

SELF-ASSESSMENT

Using the rubric for EDI 432 to evaluate lessons, I have evaluated this lesson. My self-evaluation is attached.