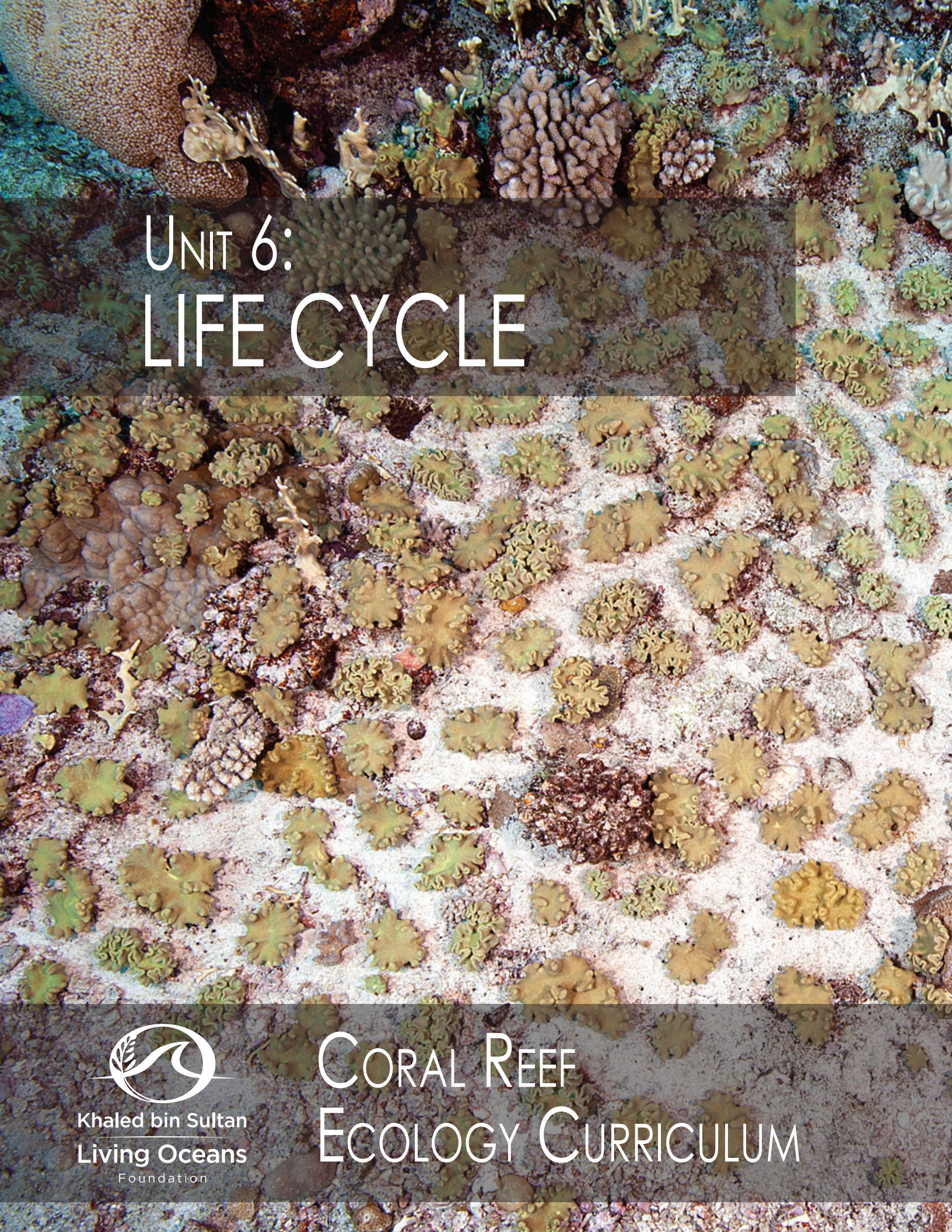

Unit 6:
Life Cycle

Khaled bin Sultan Living Oceans Foundation

Coral Reef Ecology Curriculum

Khaled bin Sultan
Living Oceans
Foundation

This unit is part of the *Coral Reef Ecology Curriculum* that was developed by the Education Department of the Khaled bin Sultan Living Oceans Foundation. It has been designed for secondary school students, but can be adapted for other uses. The entire curriculum can be found online at *lof.org/CoralReefCurriculum.*

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Cover Photo: ©Michele Westmorland/iLCP

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SCIENCE WITHOUT BORDERS®

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KEYWORDS

- Asexual Reproduction
- Broadcast Spawners (plural)
- Brooder
- Cell Cycle
- Cell Division
- Cell Theory
- Centriole
- Centromere
- Centrosome
- Chiasma
- Chromatid
- Chromosomes (plural)
- Cilia (plural)
- Cleavage Furrow
- Corallite
- Crossover
- Cytokinesis
- Daughter Cell
- Diploid
- Embryo
- Eukarya
- Fertilization
- Gamete
- Gap 1 (G_1)
- Gap 2 (G_2)
- Haploid
- Homologous Chromosome
- Interphase
- Kinetochore
- Larva
- Life Cycle
- Meiosis
- Metamorphosis
- Metaphase Plate
- Microtubule
- Mitosis (M)
- Negatively Buoyant
- Nuclear Envelope
- Parent Cell
- Planula
- Polyp
- Positively Buoyant
- Sexual Reproduction
- Sister Chromatids (plural)
- Spindle

LIFE CYCLE

This unit explains the cell cycle and the life cycle of corals.

STANDARDS

- **CCSS**: RST.9-10.1, 2, 4, 5, 6, 8, 10; RST.11-12.1, 2, 4, 6
- **NGSS**: HS-LS1-1, HS-LS1-4, HS-LS3-2
- **OLP**: 5.C.44, 5.C.47, 5.C.48, 5.C.53, 5.C.55, 5.C.56

LEARNING OBJECTIVES

- Define life cycle.
- Define cell division and explain why it is necessary for life.
- Explain cell theory.
- List the two different eukaryotic cell cycles.
- Label and define the parts of a chromosome and a cell during division.
- Describe each phase of mitosis and what occurs during each phase, including how many cells and chromosomes are produced by each division.
- Describe each phase of meiosis and what occurs during each phase, including how many cells and chromosomes are produced by each division.
- Define planula.
- List the steps in broadcast spawners' life cycle.
- List the steps in brooders' life cycle.
- Differentiate between the life cycle of broadcast spawners and brooders.
- Describe how meiosis and mitosis are a part of a coral's life cycle.
- Differentiate between a gamete, zygote, and embryo.

UNIT PROCEDURE

1. Teach *Background Information* section *A) Coral Life Cycle.*
   a. Complete **Lesson 1: Coming Full Circle** student worksheet.
2. Teach *Background Information* section *B) Cell Cycle*.
   a. Complete **Lesson 2A: Dividing the Parts** and **Lesson 2B: Label It!** student worksheets.
3. Teach students how to read and critique blogs.
   a. Complete **Read It! Coral Recruitment** student worksheet.
4. Evaluate students using **Unit 6: Life Cycle Quiz** (found online at *www.lof.org/education/portal/quiz/lifecycle-assessment-1/*). NOTE: User must be logged in.

KEYWORDS CONTINUED

- Spindle Fiber
- Substrate
- Synthesis (S)
- Tetrad
- Zooplankton
- Zygote

BACKGROUND INFORMATION

A) CORAL LIFE CYCLE

A **life cycle** is a series of events in an organism's life, as it changes from one form to the next, and eventually returns to the starting state, by means of reproduction. In this lesson, we will learn about the cell cycle and the life cycle of corals.

In *Unit 5: Coral Reproduction*, we learned that there are two ways that corals undergo **sexual reproduction**. There are **broadcast spawners** and **brooders**. The broadcast spawner's life cycle is shown in figure 6-1. The numbers referenced below correlate with the numbers on the diagram.

Broadcast Spawners:

1. Mature corals use energy to produce gametes. Gametes are produced through meiosis (see section 2*) Meiosis*).
2. When the environmental conditions are right, corals release their gametes (egg and sperm) into the water column. The gametes float to the surface because they are **positively buoyant**. External **fertilization** takes place between male and female gametes (see *Unit 5: Coral Reproduction*).
3. The egg is now fertilized and begins to develop. The fertilized egg is called a **zygote**. During this phase, the zygote drifts in the current.
4. The zygote continues to drift and begins to go through cell division. This type of cell division is known as mitosis (see section *1) Mitosis*). After the first division, there are now two cells.
5. Each of these two cells undergo mitosis, creating 4 new cells. These cells continue to go through mitosis, dividing over and over again, creating an **embryo**.
6. A **larva** forms called a **planula**. The planula is a type of **zooplankton**. In this case, it's a coral plankton. The planula is able to maneuver by the **cilia** that covers its body. These planulae are microscopic and although they have the ability to move, they are not strong enough to swim against the current. During this phase, the planula is looking for a suitable solid substrate to settle on.
7. The planula settles on a hard substrate and begins undergoing metamorphosis. **Metamorphosis** occurs when an organism develops from a juvenile to an adult.
8. The juvenile **polyp** begins to lay down a calcium carbonate ($CaCO_3$) **corallite**. If the coral is colonial, then the polyp will go through **asexual reproduction** to form more polyps, expanding the size of the coral colony and increasing the number of coral polyps. When the adult polyps become sexually mature, the life cycle will begin all over again (steps 1-8).

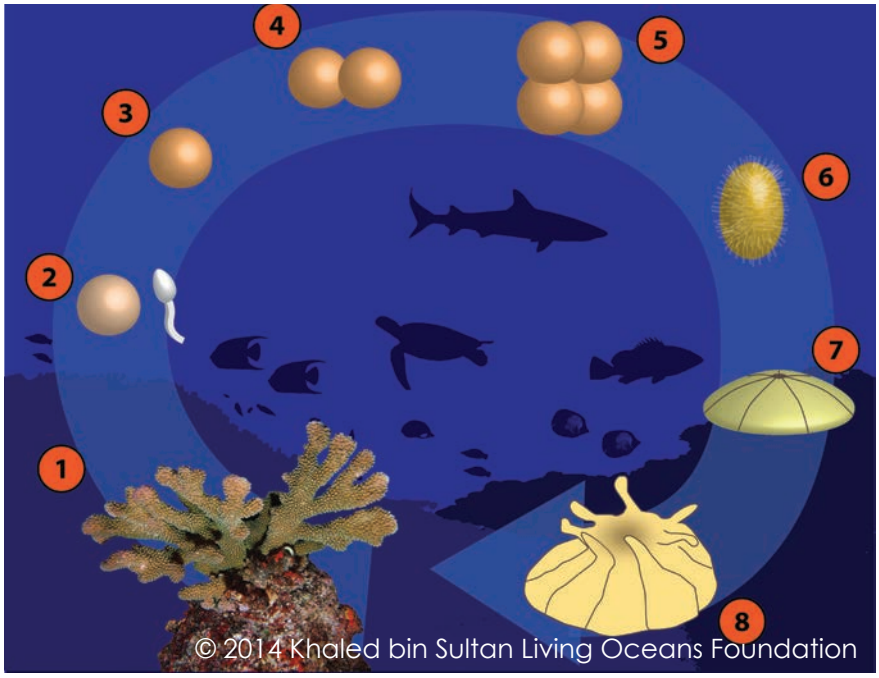


FIGURE 6-1. Broadcast spawner's life cycle

Brooders:

1. Corals expend more energy to create a fully developed planula.
   a. Brooding corals release only **negatively buoyant** (when an object does not float in a liquid) sperm into the water column.
   b. The sperm finds unfertilized eggs in an egg-carrying coral. Fertilization takes place within the coral.
   c. The fertilized egg (zygote) undergoes mitotic cell division (see section *1) Mitosis*) forming an embryo.
   d. The embryo grows into the planula within the brooding coral.
2. The planula is released from the coral polyp. Steps 6-8 are the same as broadcast brooders. See the steps above.

B) CELL CYCLE

All life begins with a single cell. Just like living organisms go through a life cycle (which we just saw with corals in Section A), all cells go through a cell cycle.

How do we go from a single cell to a complex, multicellular organism? The answer is cell division. **Cell division** is when a **parent cell** divides into two **daughter cells**. From one cell, the cell divides, creating two cells. Then the two new cells divide creating four cells, and so on and so on. Our bodies are made of trillions of cells and they are constantly dividing!

Cell division is necessary for life. Not only do cells divide as organisms grow and develop, but more cells are created to repair damaged or old and worn out cells. For instance, if you scrape your knee, you bleed, a scab forms, and eventually new skin replaces the scab. This all occurs because new cells are being created. Your skin cells divide to create more skin cells to replace the ones that were damaged.

Cell theory states that cells can only arise from other living cells. The theory also states that all organisms are composed of one or more cells and cells are the most basic unit of life.

Organisms from the Domain **Eukarya** have complex cells that divide and replicate in a **cell cycle**. Eukaryotes have two different cell cycles: meiosis and mitosis. Each of these cell cycles plays a vital role in the larger life cycle of an organism.

As we dive into cell cycles, refer to the Appendix if you need to review the parts of a chromosome or cell.

1) MITOSIS

The first cell cycle we will look at includes a type of division called **mitosis**. During this cycle, one parent cell divides to create two identical daughter cells that have their own nucleus and identical chromosomes. During mitosis, organisms have **diploid** cells (2N), which are cell cycles that have two copies of each chromosome (figure 6-2).

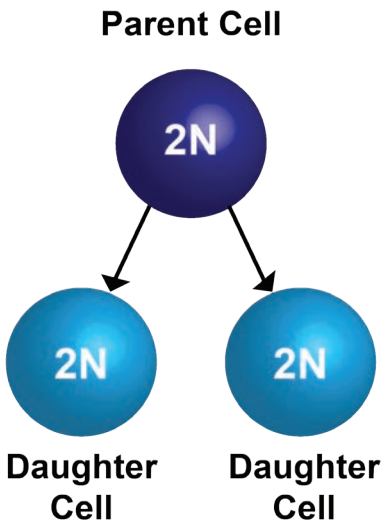


FIGURE 6-2. Mitosis: cells produced by each division and number of chromosomes

There are two parts that make up this cell cycle – interphase and mitosis. Before cell division begins, the cell is in interphase. **Interphase** makes up the majority of the cell cycle (figure 6-3). This phase prepares the cell for division during mitosis and can be broken into three phases: the growth one phase or **Gap 1 (G_1)**, followed by **Synthesis (S)**, and then growth two phase or **Gap 2 (G_2)**.

Phase	What happens?
G_1	The cell grows, doubling in mass and organelles in preparation for cell division.
S	DNA is replicated. Each chromosome gains an identical copy.
G_2	Microtubules are replicated. They help the cell separate chromosomes during mitosis. The cell is ready to enter mitosis.

The mitotic phase, sometimes referred to as the *M* phase, only lasts for a short period of time. During this phase, the chromosomes separate and undergo cytokinesis. **Cytokinesis** is the division of the parent cell into two daughter cells (figure 6-2). There are several different mitotic phases (figure 6-3).

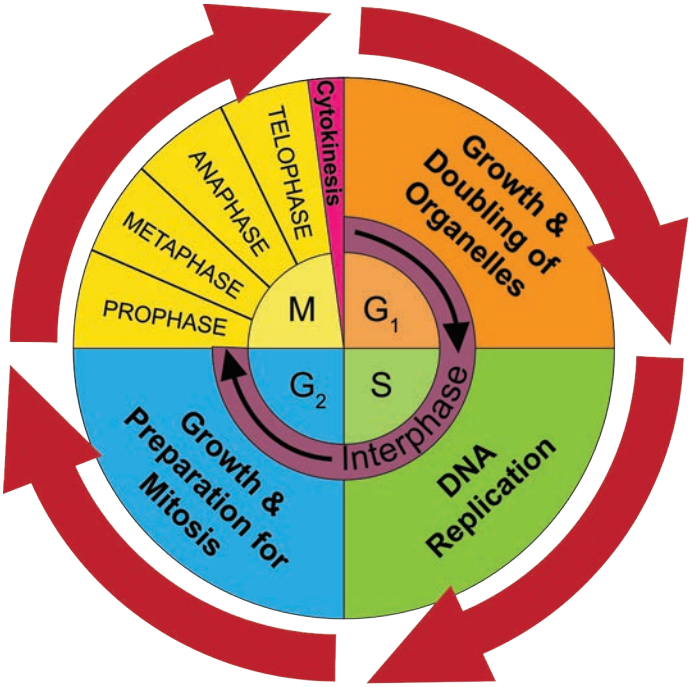
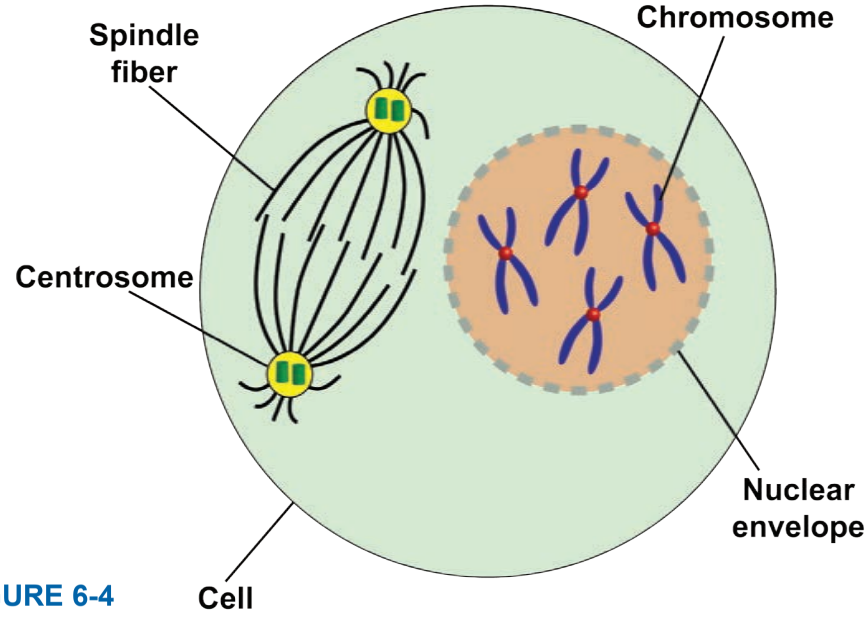
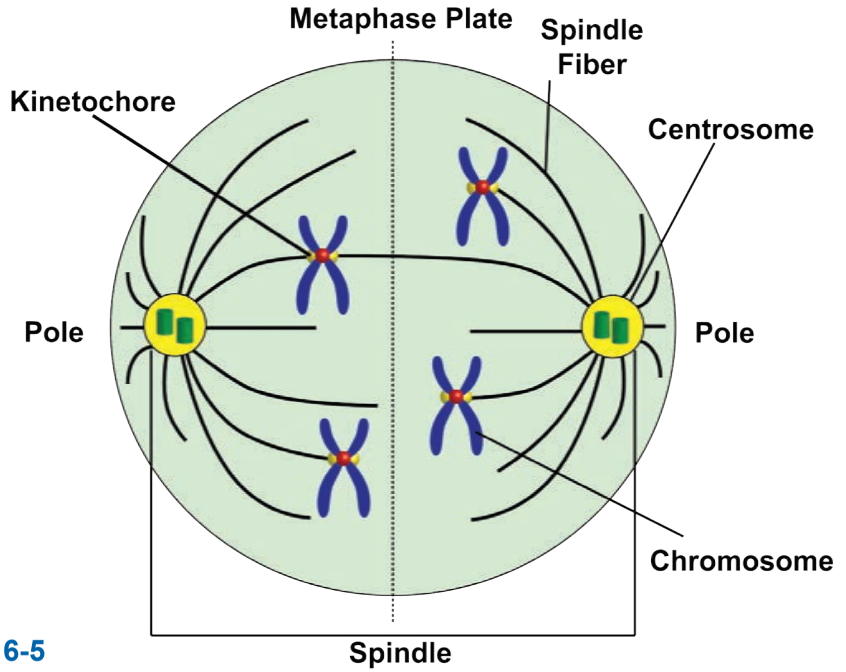


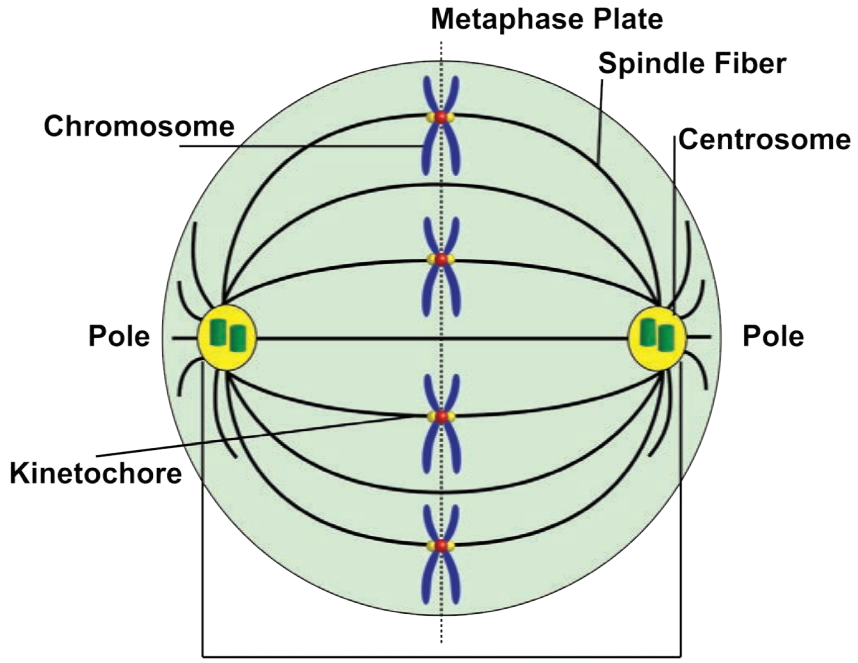
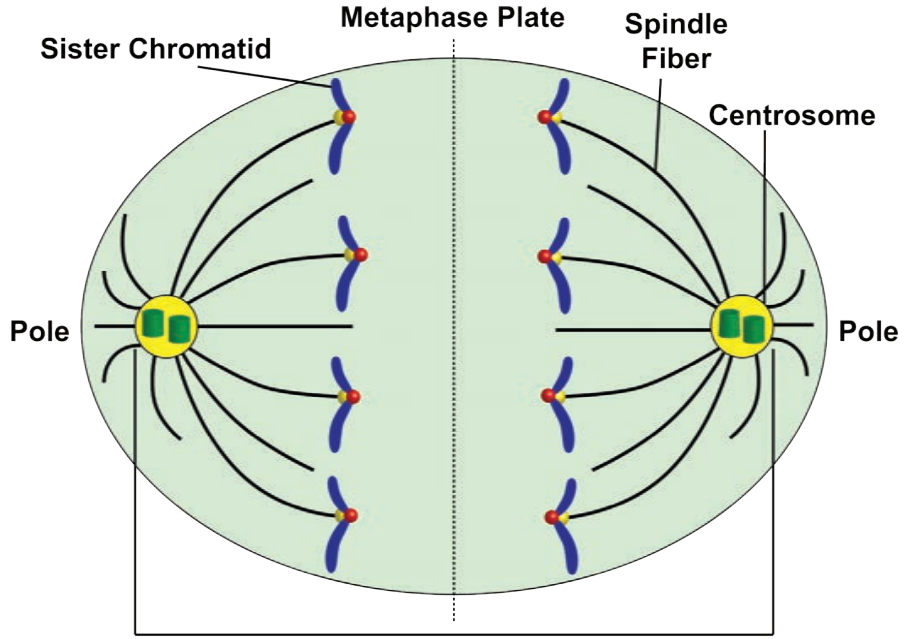
FIGURE 6-3. Mitosis is only the M part. The cell cycle is continuous, which is illustrated by the red arrows.

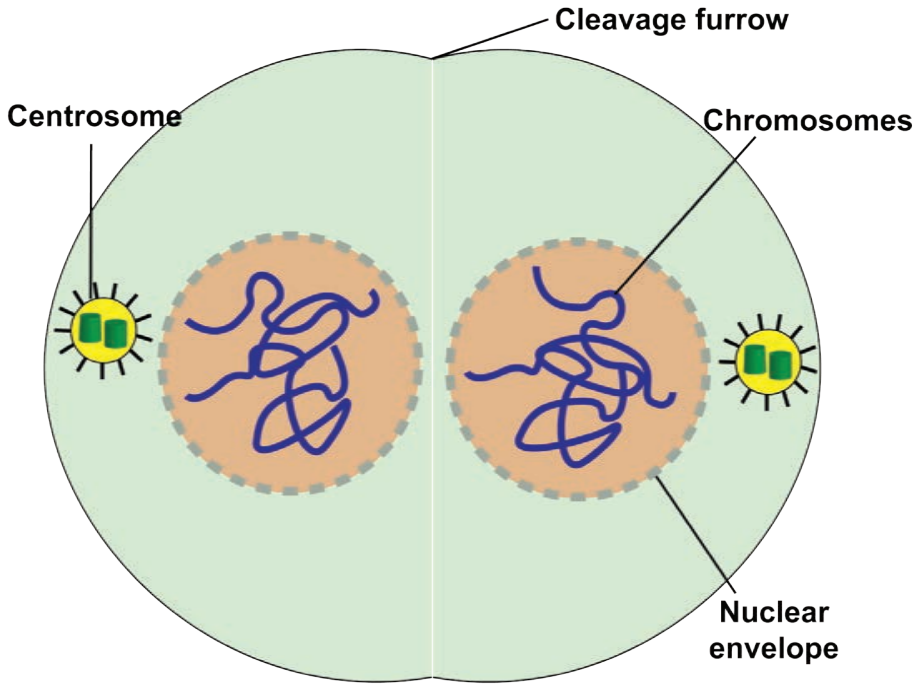
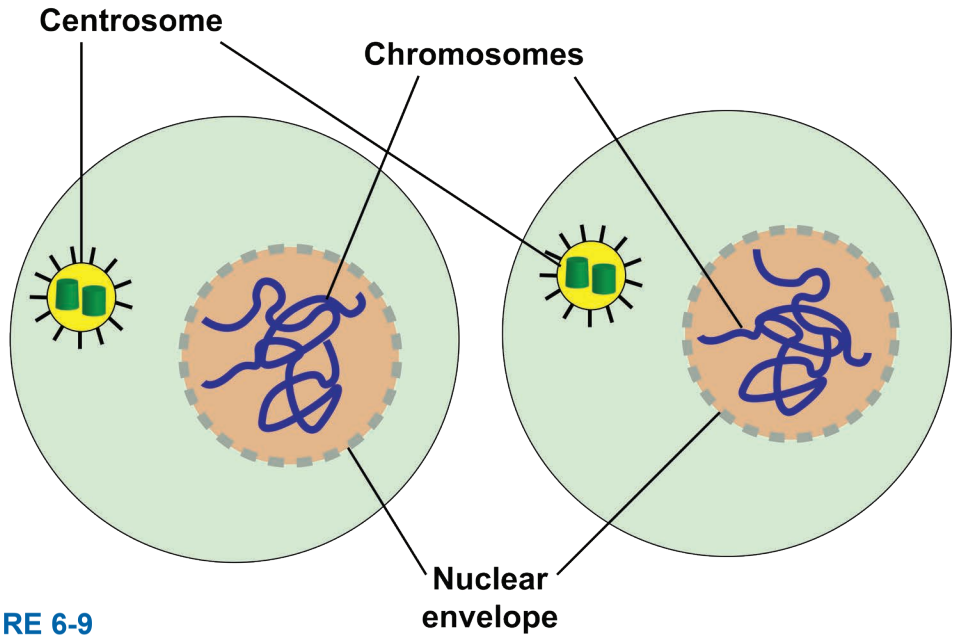
We can remember the acronym **PMAT** to help us remember the order of the phases during cell division.

- **P**rophase
- **M**etaphase
- **A**naphase
- **T**elophase

The four phases of mitotic division are: Prophase, Metaphase, Anaphase, and Telophase, which is then followed by cytokinesis.

Phase	What happens?	Diagrams
Prophase	• The chromosomes condense (shorten). • Centrosomes begin moving toward opposite poles.	 FIGURE 6-4
Prometaphase NOTE: There are many steps that take place during prophase and metaphase that scientists often add this additional phase.	• The nuclear envelope disappears. The **nuclear envelope** is a double-layered membrane that surrounds the nucleus, separating the nucleus from the cytoplasm. • Two kinetochores form at each centromere. • Spindle fibers attach to the kinetochores. • Chromosomes begin migrating toward the center of metaphase plate.	 FIGURE 6-5

Metaphase	• Chromosomes align at the metaphase plate.	 FIGURE 6-6
Anaphase	• Chromosomes split apart into **sister chromatids** (identical copies of chromatids). • The spindle fibers move the chromatids toward opposite poles. • The cell starts to elongate in preparation for division.	 FIGURE 6-7

Telophase	• In preparation for division, the cell continues to elongate, forming a **cleavage furrow** (an indentation of the cell's surface). • The chromosomes uncoil. • A new nuclear envelope forms. The spindle fibers disappear.	 **FIGURE 6-8**
Cytokinesis	• The parent cell divides into two daughter cells. After cytokinesis takes place, the cell cycle continues again with the new cells going into interphase.	 **FIGURE 6-9**

2) MEIOSIS

All sexually reproductive organisms create mature reproductive sex cells (egg and sperm) called **gametes**. They create these cells through a process known as **meiosis**.

Meiosis consists of two different stages – Meiosis I and Meiosis II (figure 6-10). Before meiosis can begin, the parent cell must undergo interphase. In mitosis and meiosis, interphase goes through the same steps. See section *1) Mitosis* for more information about interphase. Note that interphase does not occur between Meiosis I and Meiosis II.

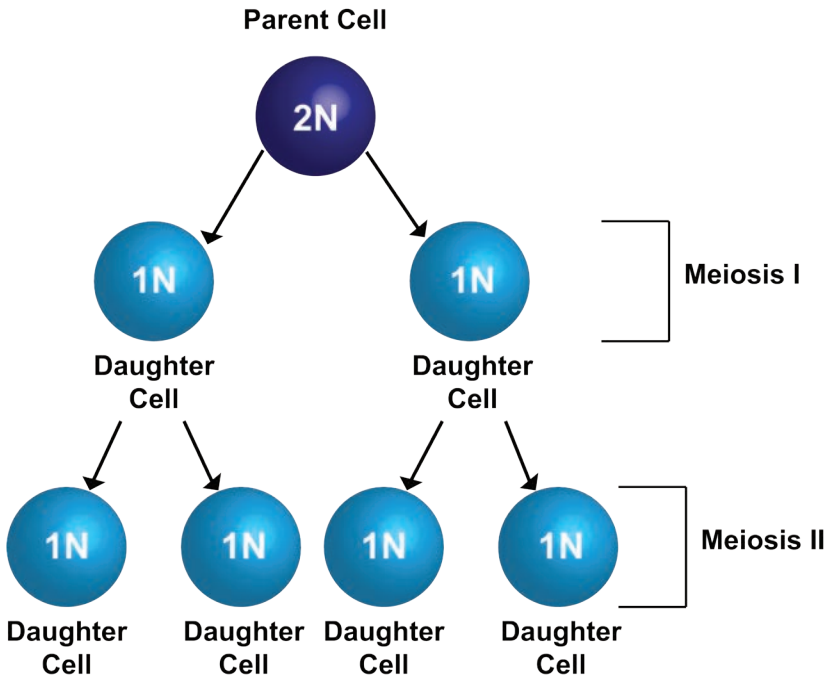
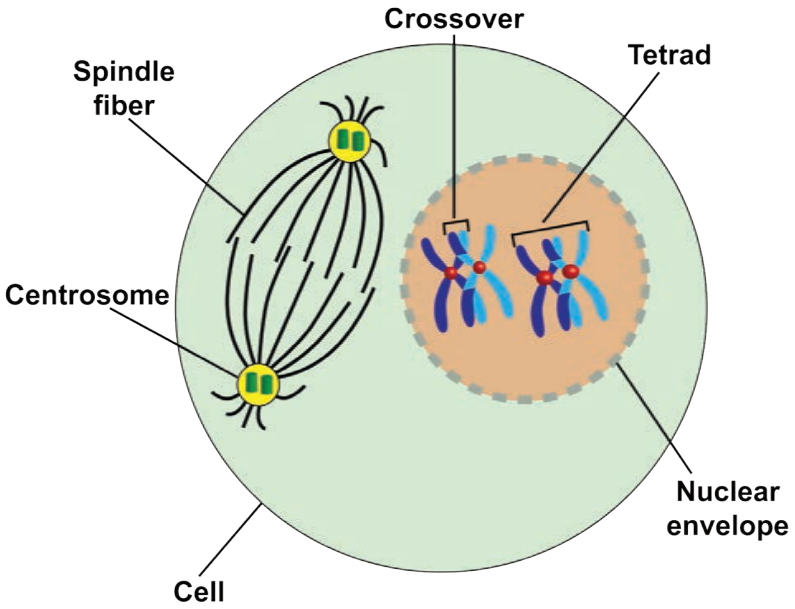
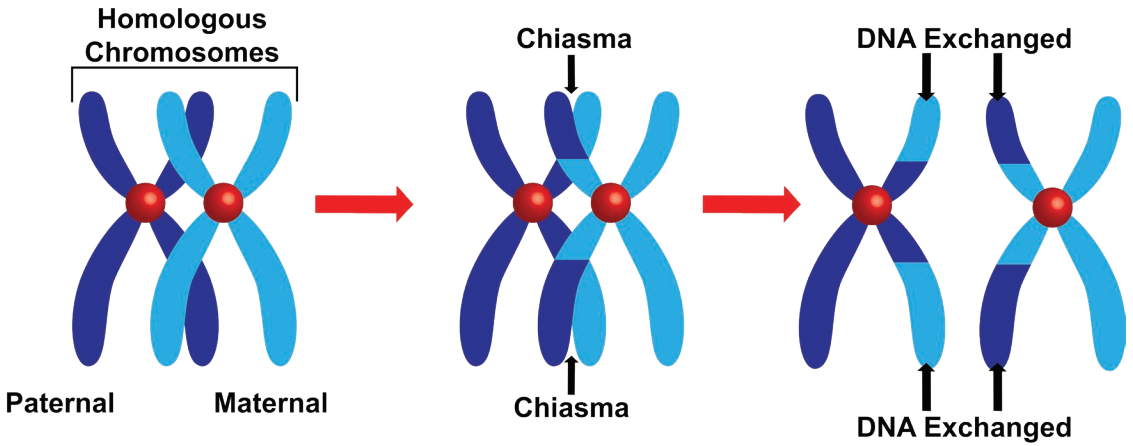
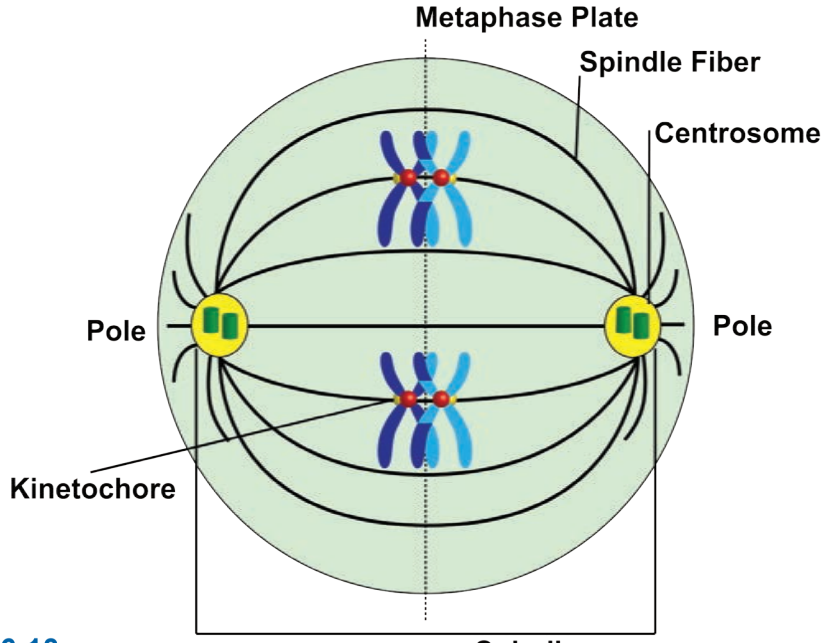
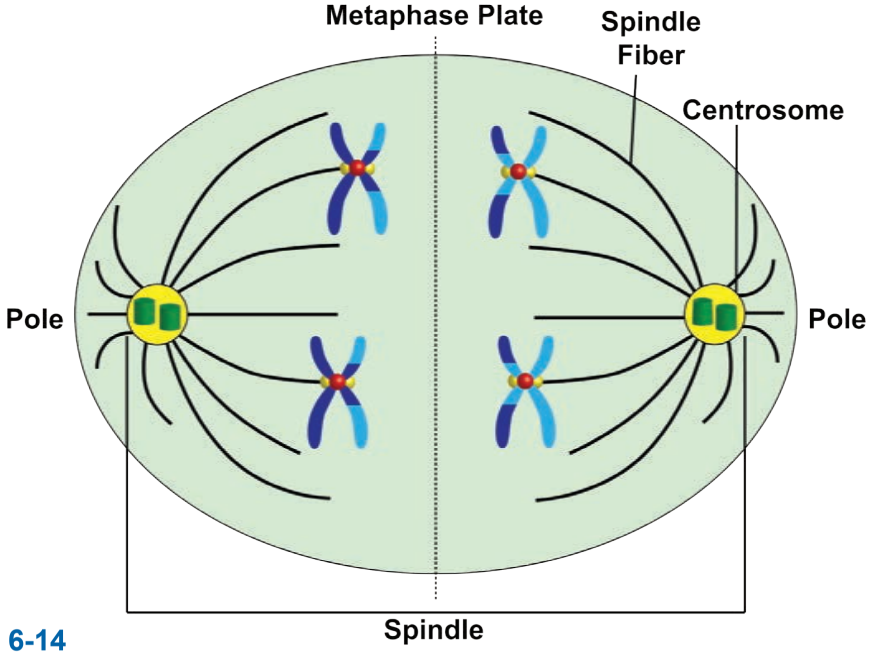


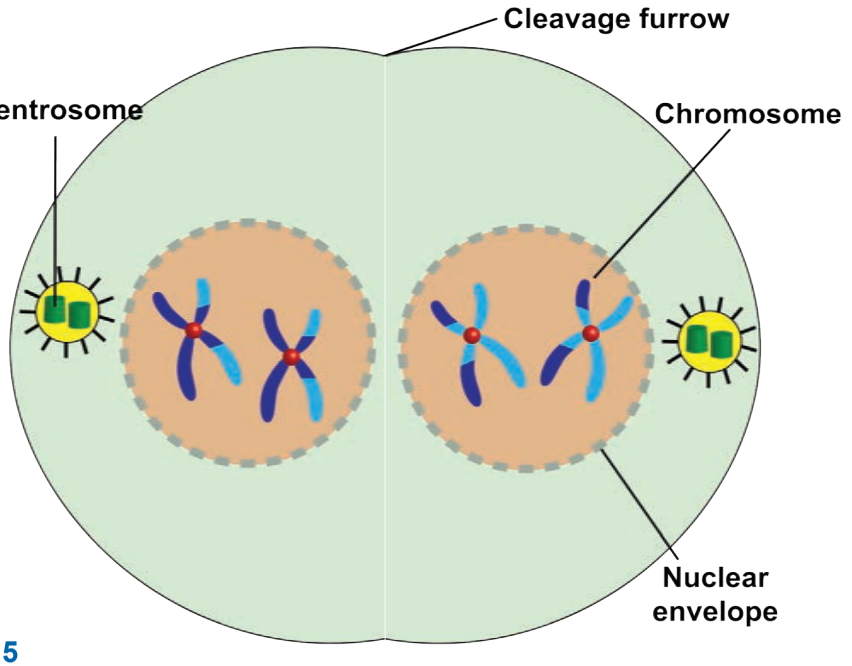
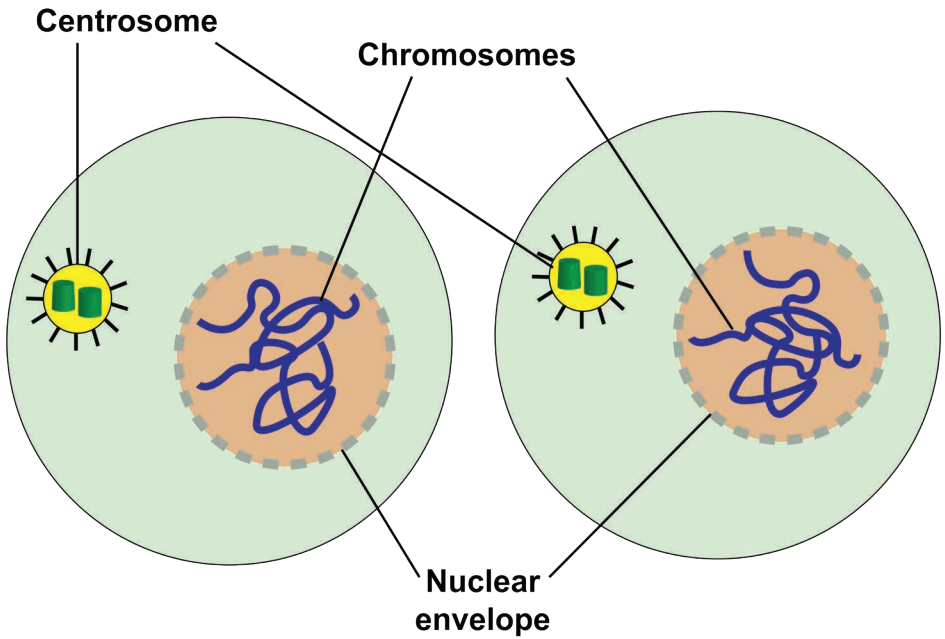
FIGURE 6-10. Meiosis: cells produced by each division and number of chromosomes

The process of meiosis begins with one parent cell, which is diploid (2N) meaning it has two copies of the chromosomes (figure 6-10). During Meiosis I, cell division takes place creating two daughter cells, which are **haploid** (1N) meaning that there are half the number of chromosomes of the parent cell (figure 6-10). These two haploid cells then enter Meiosis II and the cells undergo division again, without replication of the DNA. The result of this division is four daughter cells that are each haploid (1N) (figure 6-10).

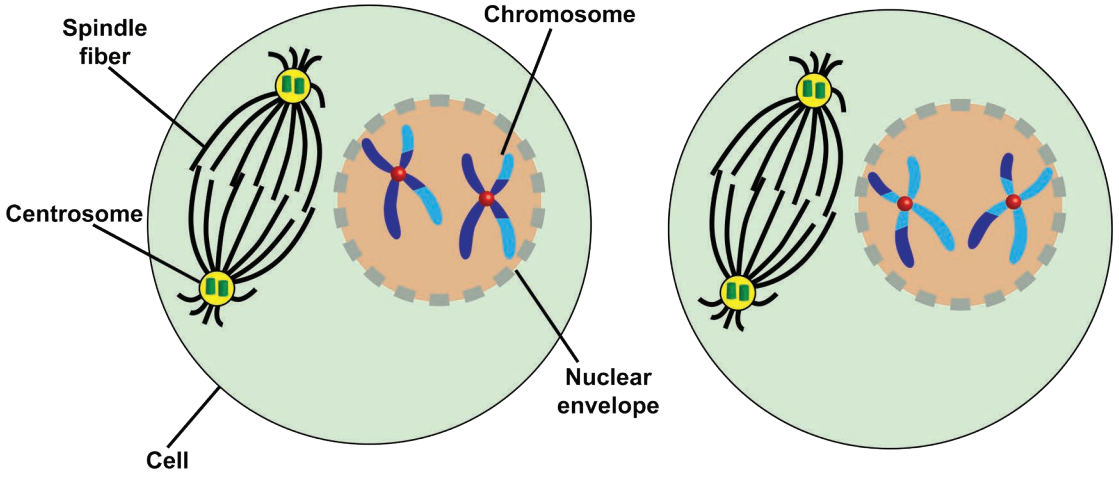
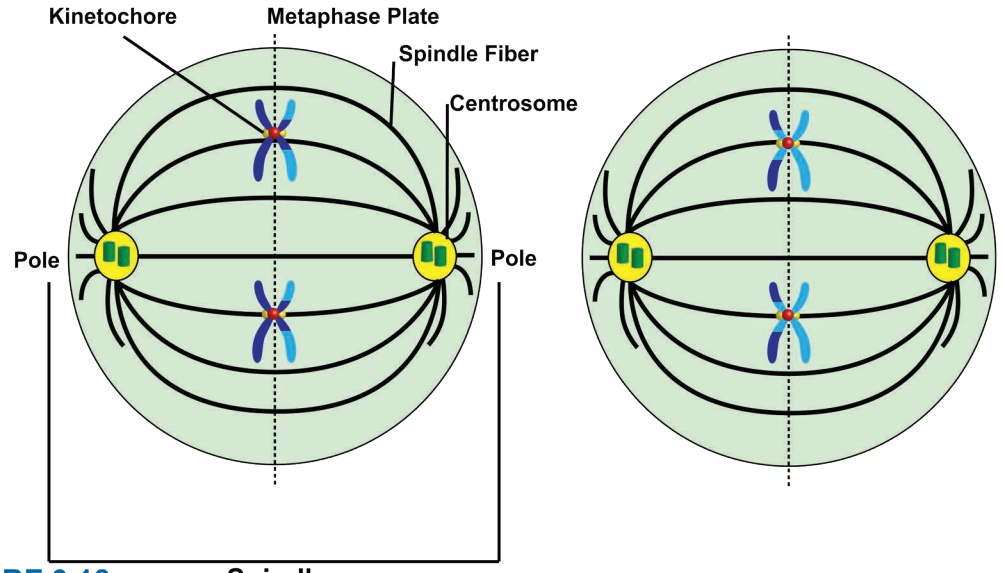
MEIOSIS I:

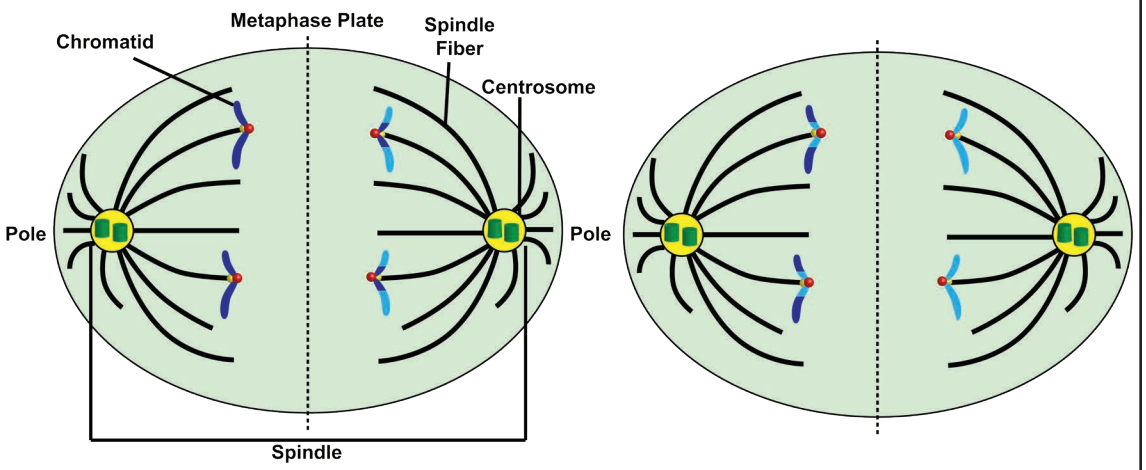
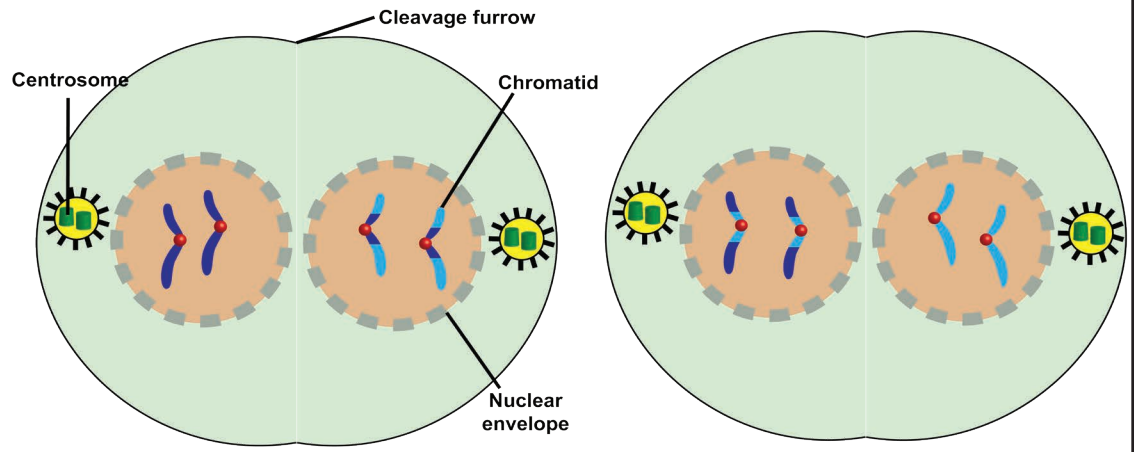
Phase	What happens?	Diagrams
Prophase I	• The chromosomes condense- (shorten). • The nuclear envelope disappears. • Centrosomes move towards opposite poles. • **Homologous chromosomes** (one paternal and one maternal copy of a chromosome) become paired. From this point on they are known as a **tetrad**. Each tetrad is composed of four chromatids. • Crossover can take place (figure 6-12). **Crossover** is the process of exchanging chromosome segments (DNA) between chromosomes. In other words, segments of chromosomes from mom switch spots with the same part of the chromosomes from dad. The area where crossover takes place is called the **chiasma**. • This is the longest phase of meiosis.	 FIGURE 6-11  FIGURE 6-12

Metaphase I	• Spindle fibers attach to the kinetochore. • Tetrads become aligned at the metaphase plate.	 FIGURE 6-13
Anaphase I	• The spindle fibers split the tetrad and move homologous chromosomes toward opposite poles. • The cell starts to elongate in preparation for division.	 FIGURE 6-14

Telophase I	• In preparation for division, the cell continues to elongate, forming a cleavage furrow. • The nuclear envelope reforms around the chromatids. The spindle fibers disappear.	 FIGURE 6-15
Cytokinesis I	• The parent cell divides into two daughter cells. After cytokinesis takes place, the cycle continues. Each cell is now haploid. Figure 6-16 shows the chromosomes uncoiled, which does not always happen during telophase I.	 FIGURE 6-16

MEIOSIS II:

Phase	What happens?	Diagrams
Prophase II	• If the chromosomes have decondensed, then they will begin to condense. • The nuclear envelopes disappear and centrosomes move toward opposite poles.	 FIGURE 6-17
Metaphase II	• Spindle fibers attach to the kinetochores. • Chromosomes line up at the metaphase plate.	 FIGURE 6-18

Anaphase II	• The chromosomes split and each chromatid heads towards opposite poles. • In preparation for division, the cell continues to elongate, forming a cleavage furrow.	 FIGURE 6-19
Telophase II	• Chromosomes consist of one chromatid. • The nuclear envelopes develop around each set of chromatids. • The spindle fibers disappear.	 FIGURE 6-20

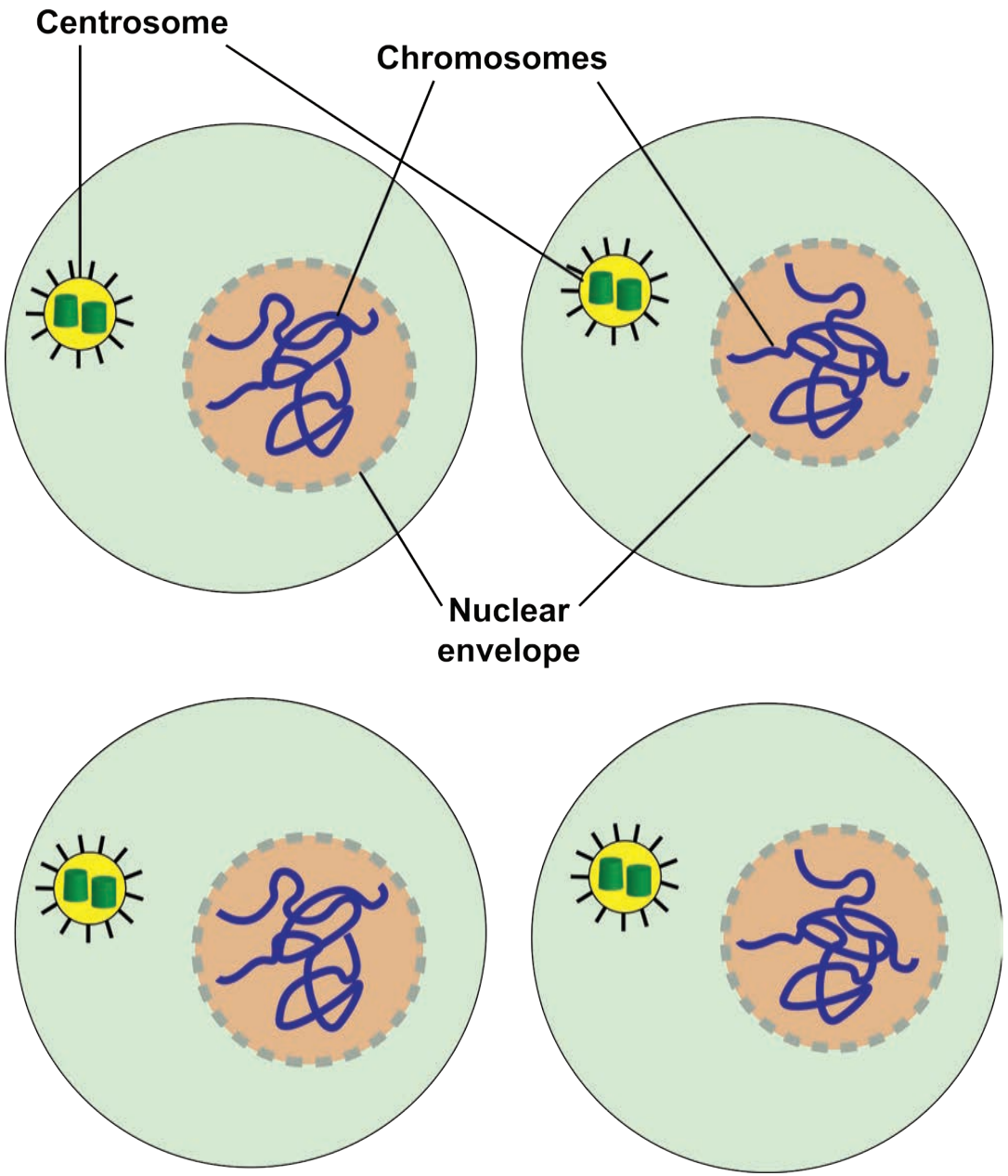
Cytokinesis II	• The two daughter cells divide into four daughter cells.	

FIGURE 6-21

Let's recap the life and cell cycles of corals. Coral polyps become sexually mature and their cells undergo meiosis, producing gametes (egg and/or sperm). The gametes are fertilized, producing a zygote. The zygote continuously creates new cells by the process of mitosis, eventually forming a planula that settles and forms a coral polyp. As the coral grows, its cells continue to go through mitosis. When the coral polyp is sexually mature, it performs meiosis, starting the cycle all over again (figure 6-22).

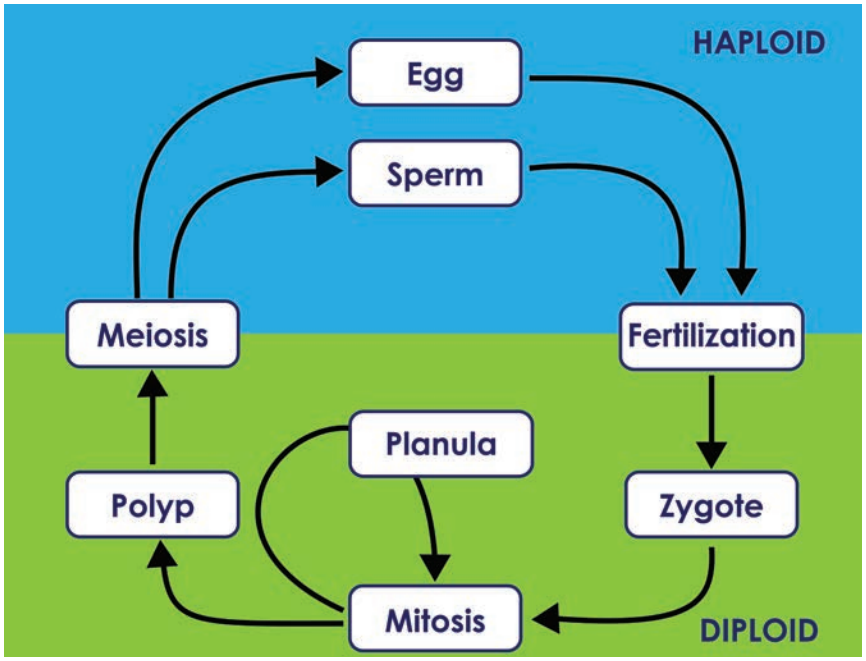
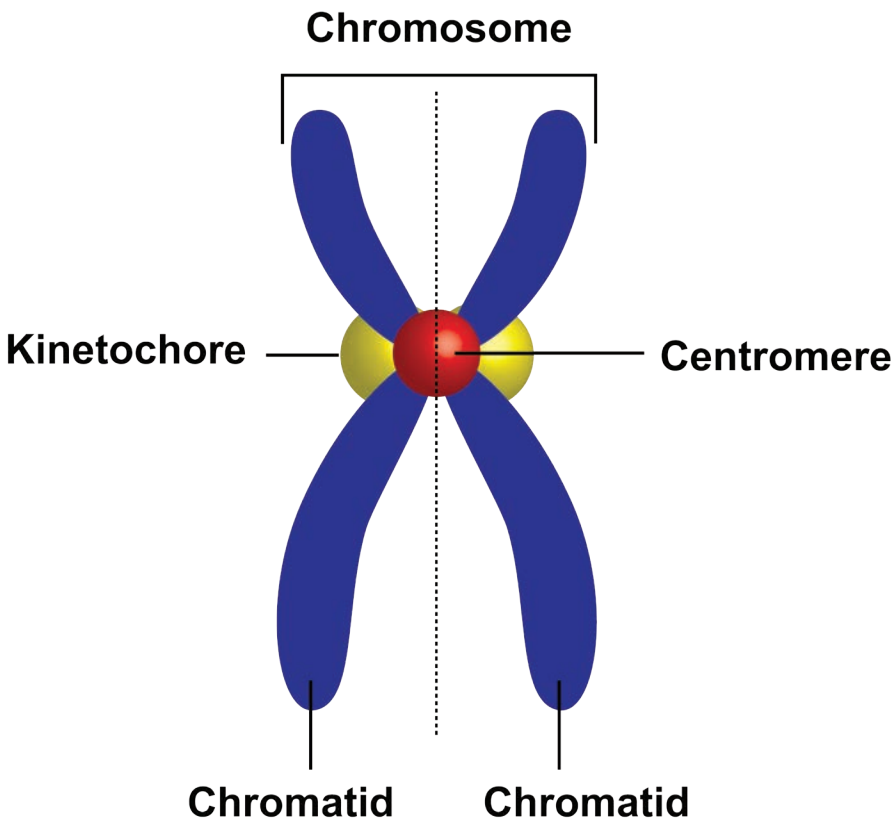


FIGURE 6-22. Coral polyp's life cycle and cell cycles

APPENDIX: CHROMOSOME AND CELL TERMINOLOGY

Below is a review of some of the parts of a chromosome (figure 6-23) and a cell (figure 6-24).



Centromere: The area on the chromosome where the kinetochores attach during cell division and that connects the chromatids together.

Chromosomes: Long strands of molecules called DNA.

Chromatid: When dividing the chromosome longitudinally, each half is considered a chromatid. They contain a double helix of DNA.

Kinetochore: A structure that forms on the centromere and is the point of attachment for microtubules during cell division.

FIGURE 6-23. The parts of a chromosome

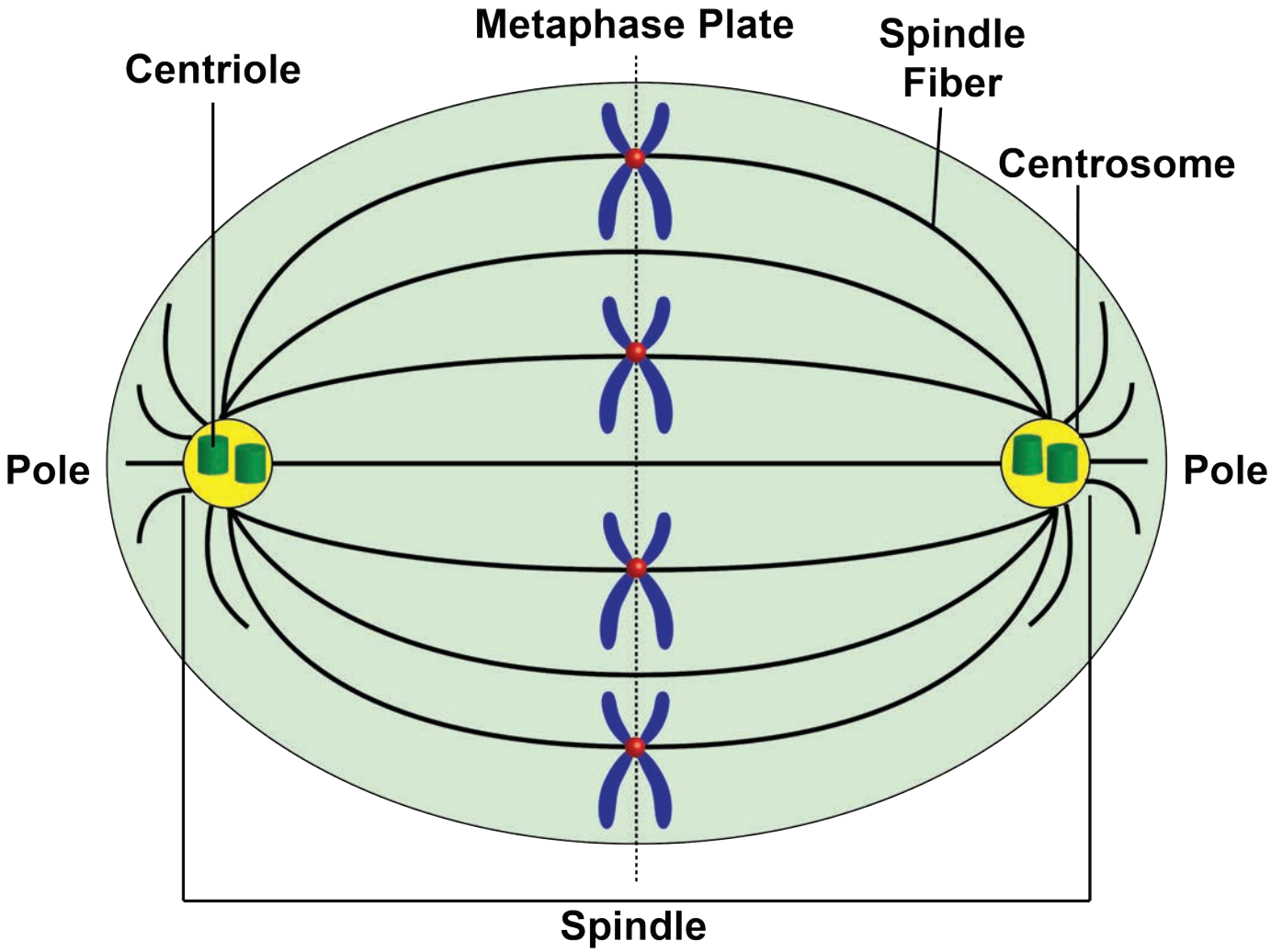


FIGURE 6-24. The parts of a cell during cell division

Centriole: A cylindrical organelle that consists of microtubules. They help to anchor the spindle fibers during cell division.

Centrosome: Replicates during interphase. It is part of the spindle and contains two centrioles. During cell division, they migrate to opposite poles and aid in pulling apart the chromosomes.

Metaphase plate: An imaginary vertical plane that divides the cell into two halves.

Microtubule: Miniature tubes that help to support the structure of the cell. It is like our skeleton and how it functions to support our body. They form spindle fibers during cell division.

Spindle fiber: Clusters of microtubules that help to move chromosomes during cell division.

Spindle: The structure that separates chromosomes during cell division. It contains the spindle fibers and centrosomes.

ATTRIBUTION

Figure 6-22. Adapted from Alternation of generations.svg: By Peter coxhead derivative work: Peter coxhead [Public domain], 20 February 2012 via Wikimedia Commons. *http://commons.wikimedia.org/wiki/File%3AAlternation_of_generations_simpler.svg*.

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LESSON 1 TEACHER'S NOTES

AUTHORS

- Ashley Miller & Amy Heemsoth, Khaled bin Sultan Living Oceans Foundation

LEARNING OBJECTIVES

- Describe each stage of a coral's life cycle.
- Organize the stages of a coral's life cycle in sequential order.
- Construct a model of a coral's life cycle using a story wheel.

KEYWORDS

- Asexual Reproduction
- Broadcast Spawners
- Cilia
- Corallite
- Embryo
- Fertilization
- Gamete
- Meiosis
- Metamorphosis
- Mitosis
- Planula
- Polyp
- Positively Buoyant
- Sexual Reproduction
- Substrate
- Zooplankton
- Zygote

MATERIALS

- Scissors
- Colored pencils and/or markers
- 2 pieces of cardstock or regular printer paper (per student)
- 1 paper fastener (per student)
- Protractors (optional)
- **Watch It! Birds and the Bees** student worksheet (optional)
- **Lesson 1: Coming Full Circle** student worksheet
- **Appendix A: Story Wheel Templates 1 or 2**
- **Appendix B: Instructions for Completing Story Wheel**

INTEGRATING SUBJECTS

- Geometry

EXTENSION

- Students can create a story wheel for coral broadcast spawning and compare the two cycles.

STANDARDS

- CCSS: RST.9-10.4, 5, 7; RST.11-12.4
- NGSS: HS-LS1-4, HS-LS3-2
- OLP: 5.C.47, 5.C.48, 5.C.53, 5.C.55, 5.C.56

PROCEDURE

1. Watch *Birds and the Bees* YouTube video (*https://youtu.be/rpKSQM2cDk0*). Answer questions on **Watch It! Birds and the Bees** student worksheet. This information can be found in *Unit 5: Coral Reproduction*.
2. Teach *Unit 6 Background Information* section *A) Coral Life Cycle.*
3. Hand out **Lesson 1: Coming Full Circle** student worksheet.
4. Go over the instructions on the student worksheet. Before the students begin the activity, show them an example of a story wheel that they will be constructing. An example can be found in the teacher answer key.
5. Using a protractor, students can create their own story wheel using Story Wheel Template 2 or they can use the pre-made Story Wheel Template 1. Both are provided in **Appendix A**. There are additional instructions provided in the teacher key for creating a story wheel template using a protractor.
6. Once students have completed their story wheel, instruct them to finish the questions on their student worksheet.

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LESSON 1 COMING FULL CIRCLE

INTRODUCTION: You will be constructing a story wheel that represents each of the different stages of a broadcast spawner's life cycle. Below, there are directions for building your model. After you complete your story wheel, answer the questions.

MATERIALS:

- Scissors
- Colored pencils and/or markers
- 2 story wheel templates
- 1 paper fastener
- Protractors (optional)

INSTRUCTIONS:

1. Use two pieces of paper or cardstock to create your story wheel.

Circle 1:

2. Cut out the circle from the Story Wheel Template 1 - Circle 1.
3. For each of the 8 sections, draw and describe the stages of a coral's life cycle. Refer to the *Unit 6: Reproduction - Background Information* for more details. It doesn't matter which section you begin with on the circle, as long as you place each stage of the coral's life cycle in chronological order.

Circle 2:

4. Cut out the circle from the Story Wheel Template 1 - Circle 2.
5. Cut out one wedge the same size as each section on Circle 1 (dotted lines).
6. Place Circle 2 on top of Circle 1. Make sure that they line up perfectly.
7. Use the fastener to puncture the center of each circle. Bend back the tails of the paper fastener to keep your circles in place.
8. Create a title and write it on your story wheel.
9. Answer questions on your worksheet.

INSTRUCTIONS: Answer the following questions.

1. At what stage in the coral's life cycle does DNA from two different individuals mix?

2. What does it mean when a coral is going through metamorphosis?

3. Why is it important that corals can reproduce sexually and asexually? Explain.

4. Can a coral survive without undergoing meiosis?

5. Can a coral survive without undergoing mitosis?

6. What factors could affect a coral's life cycle? List at least three examples.

7. If you are in charge of sexually breeding corals for a fish store, what factors would you have to take into consideration when designing the breeding tanks?

INSTRUCTIONS: Answer the following questions.

1. At what stage in the coral's life cycle does DNA from two different individuals mix?
   DNA mixes during fertilization.

2. What does it mean when a coral is going through metamorphosis?
   Metamorphosis occurs when a coral planula settles on a substrate and develops the structures of a juvenile polyp. The juvenile polyp will then metamorphose into an adult.

3. Why is it important that corals can reproduce sexually and asexually? Explain.
   Both of these reproductive methods are important. Sexual reproduction allows the coral to pass on their genes to future generations and increase the genetic diversity of corals. Asexual reproduction allows for corals to expand their colonies by creating new polyps even though they will have the same genes as their parent polyp.

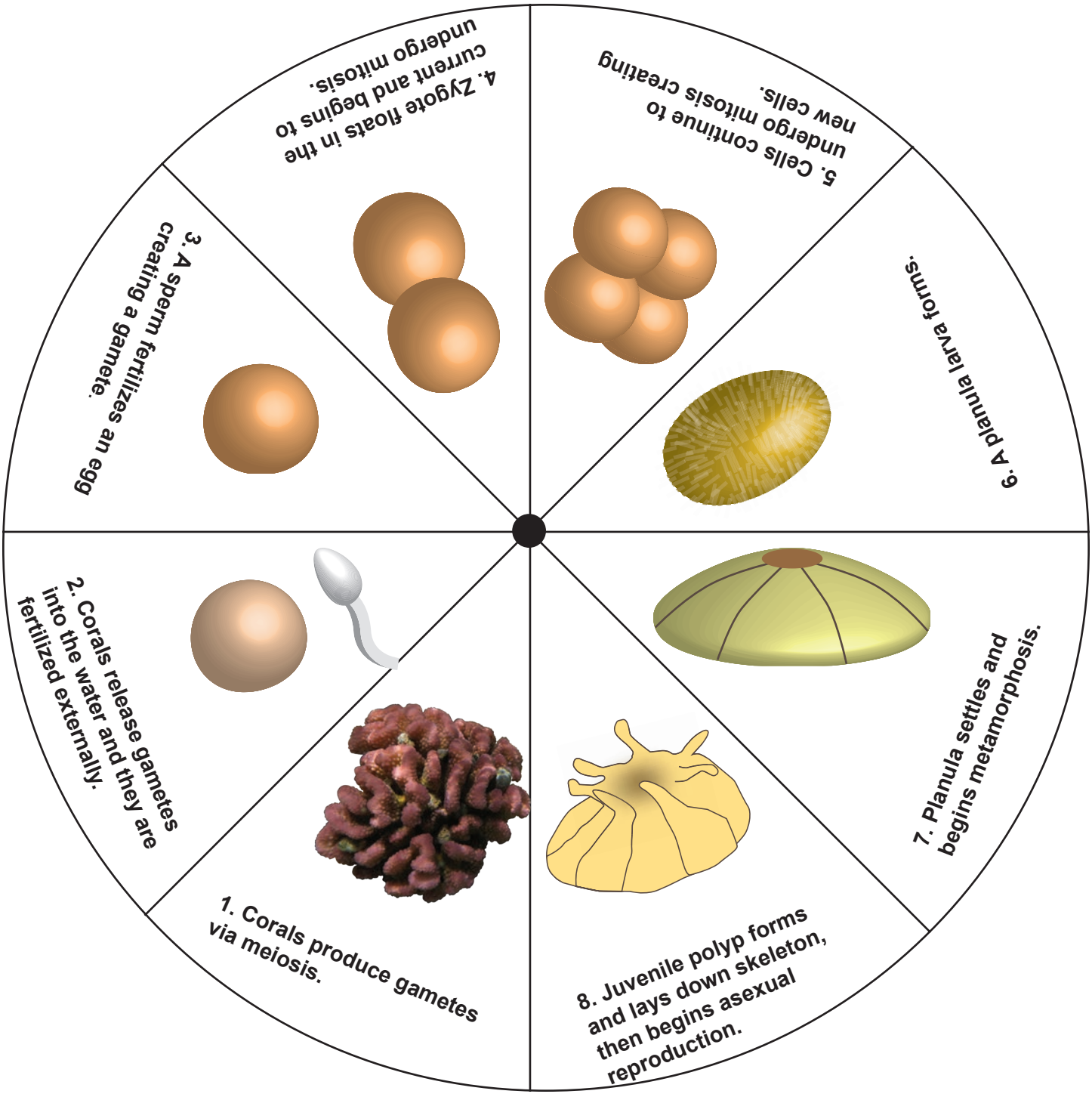
4. Can a coral survive without undergoing meiosis?
   Corals can survive without undergoing meiosis; however, they will not be able to create offspring via sexual reproduction. Gametes are created via meiosis. Although the coral can survive without sexual reproduction, it will not create genetically diverse offspring. Corals will only be able to create identical clones via asexual reproduction. If corals could only reproduce asexually, then there would not be any genetic diversity at all. If the entire coral dies, then there would be no way to create new polyps.

5. Can a coral survive without undergoing mitosis?
   Corals cannot survive without the mitotic cell cycle. Our cells are dying and being replaced all the time. Cells die when they are old, damaged, or worn out and new cells replace them. Our bodies also grow because more cells are being created. If we cannot create new cells via mitosis, then we would never exist.

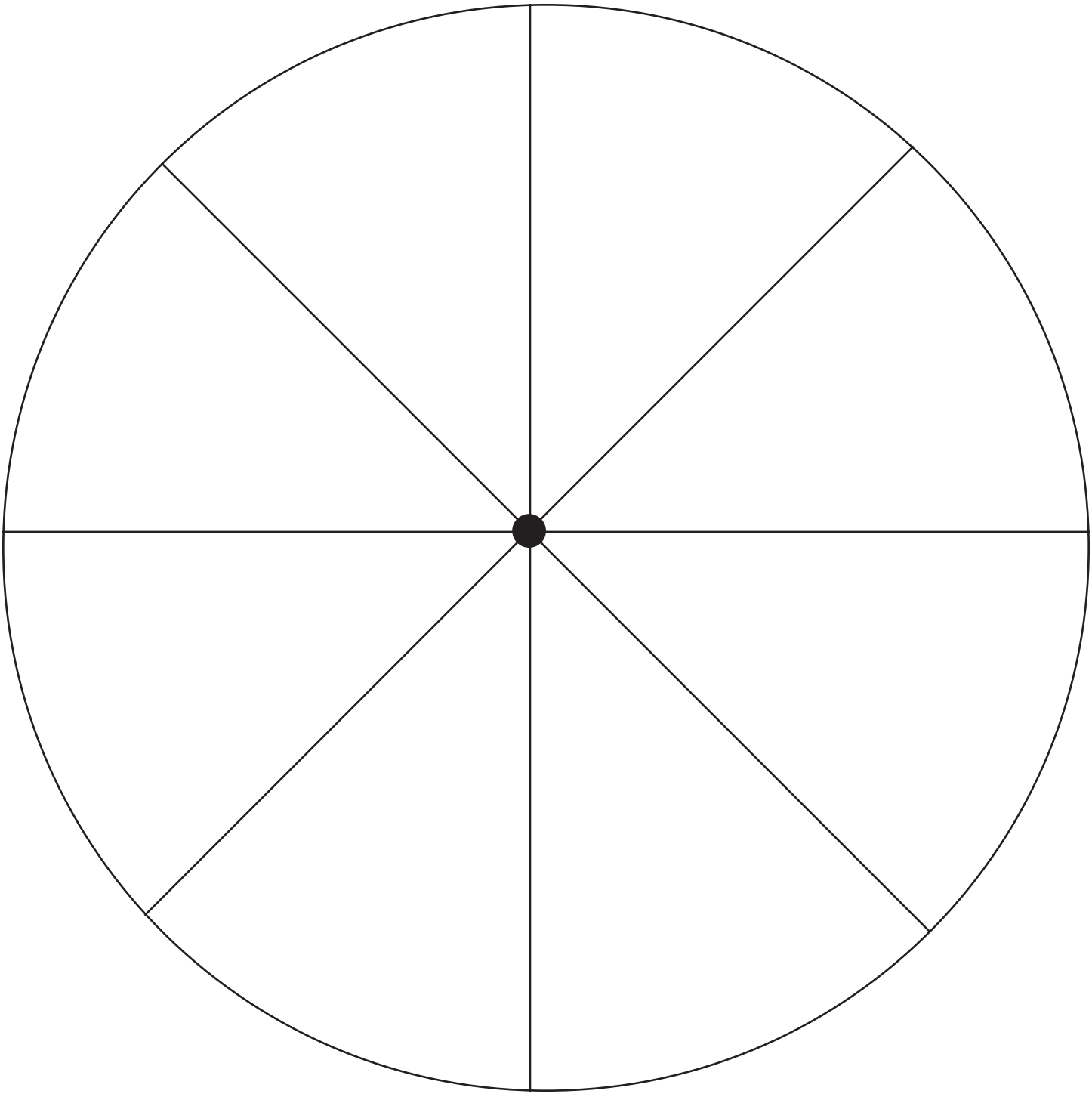
6. What factors could affect a coral's life cycle? List at least three examples.
   Answers may vary. There are many different factors that could affect a coral's life cycle. Here are a few: ocean temperature, pH, wind and ocean currents, substrate type, salinity, ocean depth, turbidity, light availability, nutrient concentration, pollution, sedimentation, presence of storms, food availability, number of predators present.

7. If you are in charge of sexually breeding corals for a fish store, what factors would you have to take into consideration when designing the breeding tanks?
   Answers may vary.
   - **Corals will need to have a substrate to settle on.**
   - **The filters used must not filter out the gametes or planulae.**
   - **There must be male and female corals or hermaphroditic corals in order for them to reproduce.**
   - **The corals must be sexually mature in order to create gametes.**
   - **There must be food available for the planulae to eat.**
   - **There must not be other animals in the tank that could eat the gametes, planulae, or juvenile polyps.**
   - **Corals typically sexually reproduce due to environmental cues. These cues would have to mimic the same ones that they respond to in a natural environment.**

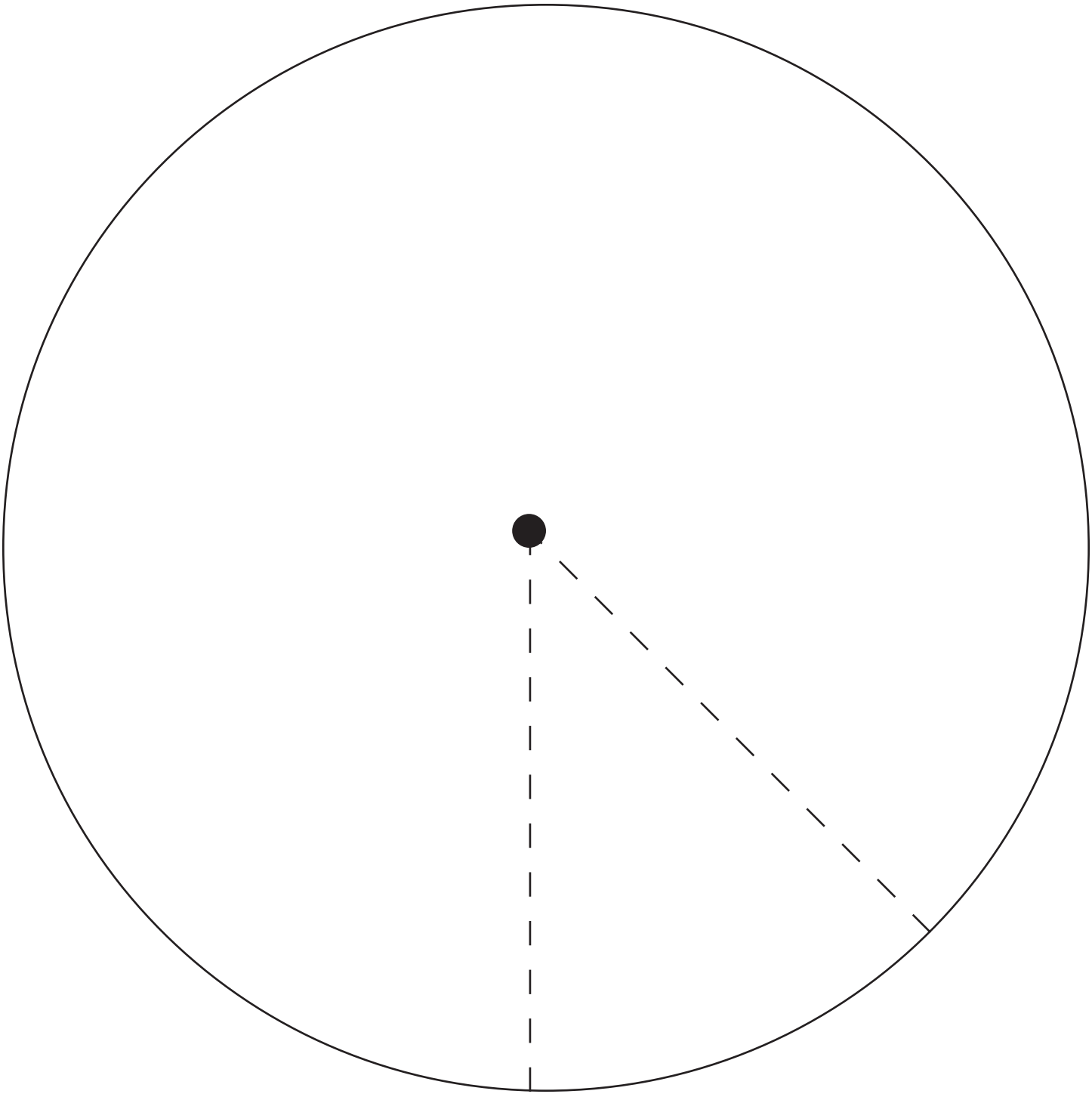
EXAMPLE STORY WHEEL



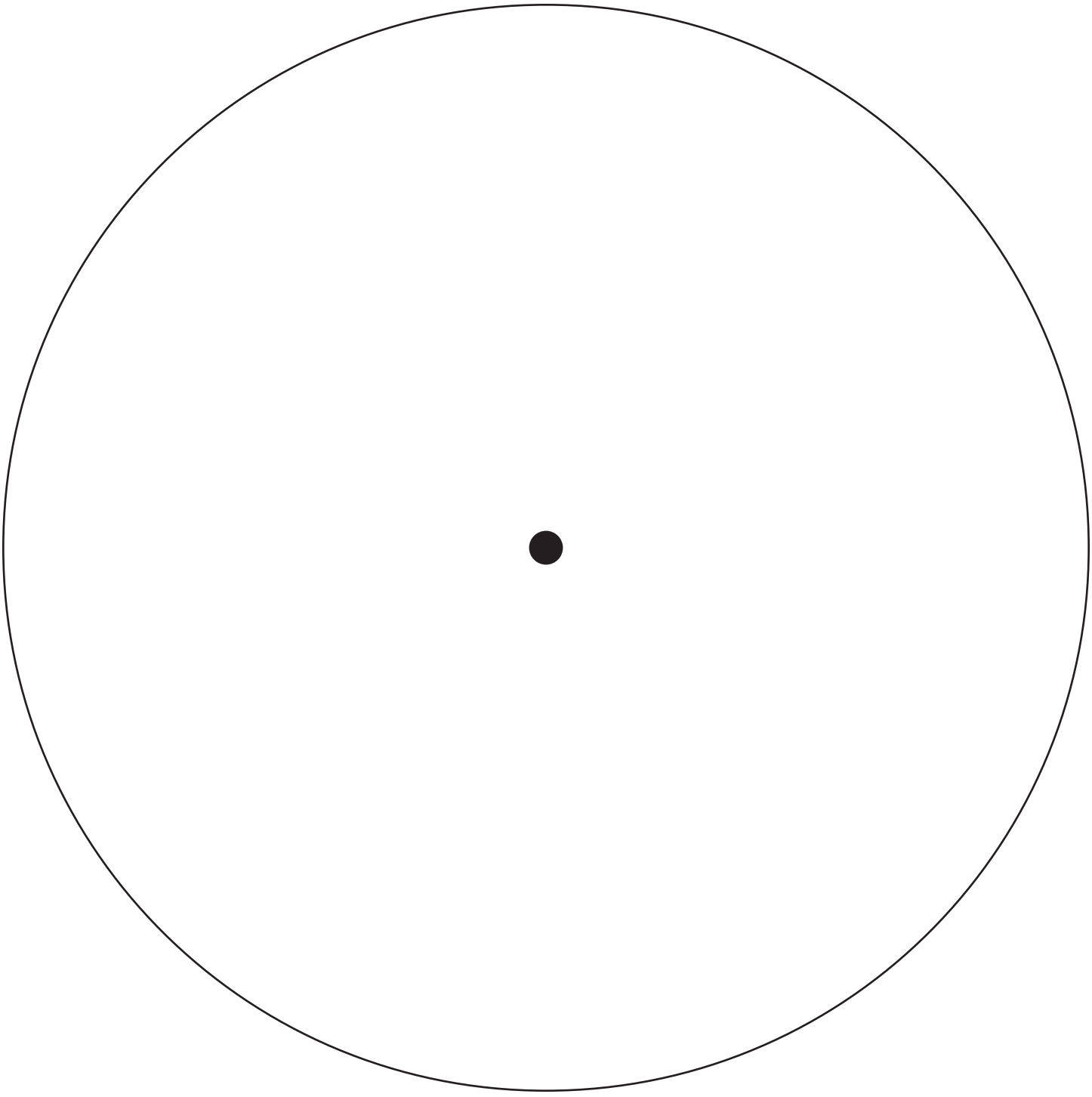
STORY WHEEL TEMPLATE 1 - CIRCLE 1



STORY WHEEL TEMPLATE 1 - CIRCLE 2

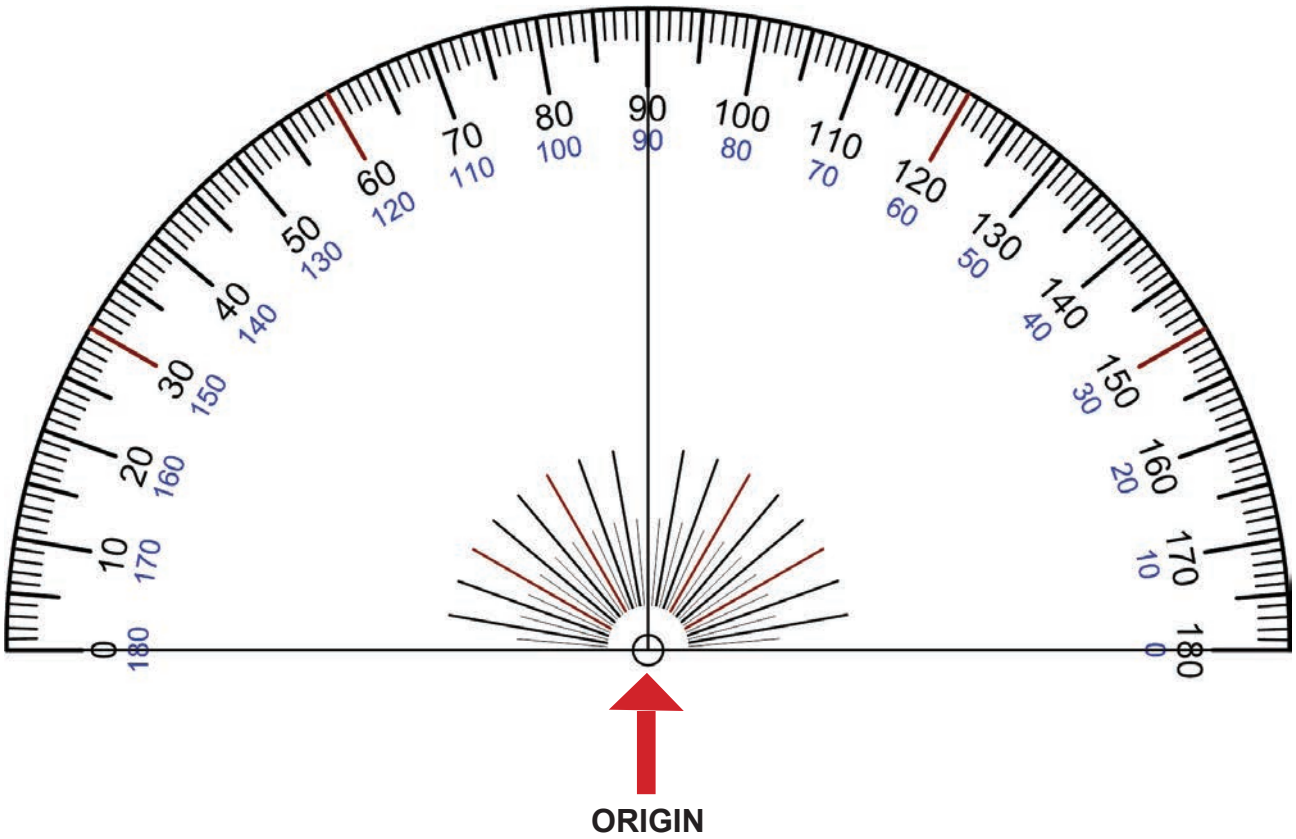


STORY WHEEL TEMPLATE 2



INSTRUCTIONS FOR CREATING A STORY WHEEL USING A PROTRACTOR

1. Using the Story Wheel Template 2, line up your protractor with the small dot in the middle of the template. You can do this by lining up the origin (the area that contains either a small circle or a line that is located near the bottom and center of the protractor) with the black dot on the template.
2. Create eight different sections in the circle. A circle has 360°. If you want to create 8 equal sections, then divide 360° by 8. When you do, each section must be 45°.
3. Use the protractor to place a mark on the circle every 45°. It's easiest to begin at 0°. Here are the degree increments that you should come up with: 0, 45, 90, 135, 180, 225, 270, 315, and 360.
4. Draw a line from each mark to the center of the circle. When finished, there will be 8 different sections.
5. For the second circle, mark one 45° sized section and cut it out.



ATTRIBUTION

Protractor By Scientif38 (Own work) [Public domain], 23 June 2010 via Wikimedia Commons. *http://commons.wikimedia.org/wiki/File%3AProtractor_Rapporteur_Degree_V1.jpg*.

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LESSON 2 TEACHER'S NOTES

AUTHOR

- Amy Heemsoth, Khaled bin Sultan Living Oceans Foundation

LEARNING OBJECTIVES

- Identify the words that match the definition for the parts of a chromosome.
- Identify the words that match the definition for the parts of a cell during cell division.
- Label the parts of a chromosome.
- Label the parts of a cell during cell division.

KEYWORDS

- Centriole
- Centromere
- Centrosome
- Chiasma
- Chromatid
- Chromosomes
- Crossover
- Kinetochore
- Meiosis
- Metaphase Plate
- Microtubule
- Mitosis
- Nuclear Envelope
- Spindle
- Spindle Fiber
- Tetrad

MATERIALS

- **Lesson 2A: Dividing the Parts** student worksheet
- **Lesson 2B: Label It!** student worksheet

STANDARDS

- CCSS: RST.9-10.4, 5, 7; RST.11-12.4
- NGSS: HS-LS1-4, HS-LS3-2
- OLP: 5.C.44

PROCEDURE

1. Teach *Background Information* section *B) Cell Cycle*.
2. Ask students to complete **Lesson 2A: Dividing the Parts** crossword puzzle. Students will determine the word that best describes each clue that is provided on the worksheet. This crossword reviews the of the parts of a chromosome and the parts of a cell during cell division.
3. Hand out **Lesson 2B: Label It!** student worksheet. Instruct students to fill in the correct labels on the lines provided. The diagrams include a chromosome and a cell during cell division.

Name: _____ Date: _____

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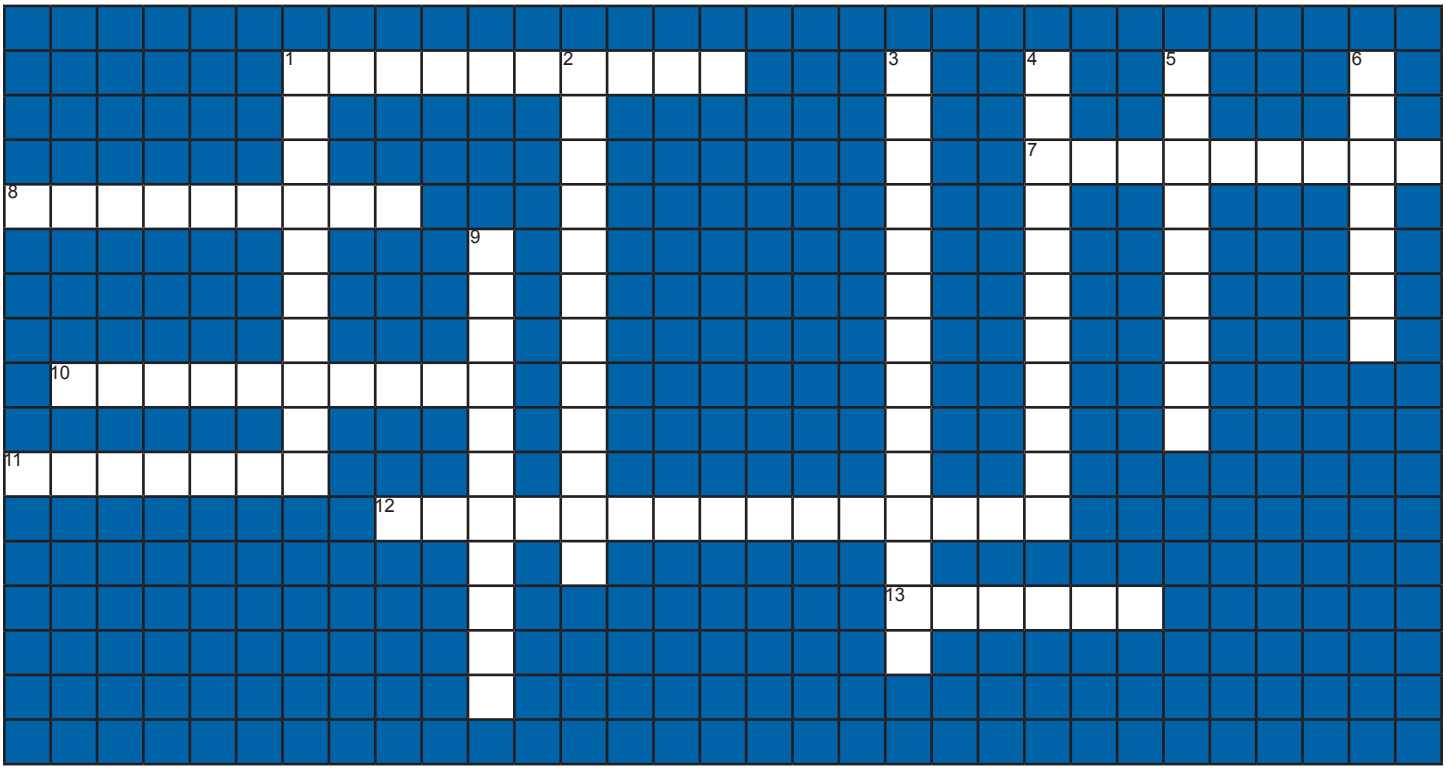
LESSON 2A

Dividing The Parts

INSTRUCTIONS: Fill in the crossword puzzle using the clues below.



ACROSS

1. During cell division, it migrates to opposite poles and aids in pulling apart the chromosomes.
7. When dividing a chromosome longitudinally, each half is called a _____.
8. A cylindrical organelle that consists of microtubules.
10. The area on the chromosome where the kinetochores attach during cell division.
11. A structure that separates chromosomes during cell division. It contains the spindle fibers and centrosomes.
12. A double layered membrane that surrounds the nucleus, separating the nucleus from the cytoplasm.
13. A group of four chromatids that form during meiosis.

DOWN

1. A long strand of molecules called DNA.
2. Clusters of microtubules that help to move chromosomes during cell division.
3. An imaginary vertical plane that divides the cell into two halves.
4. Miniature tubes that help to support the structure of the cell.
5. A process of exchanging chromosome segments (genetic material) during meiosis.
6. The area where crossover takes place and genetic material is exchanged during meiosis.
9. A structure that forms on the centromere of a chromosome that is the point of attachment for microtubules during cell division.

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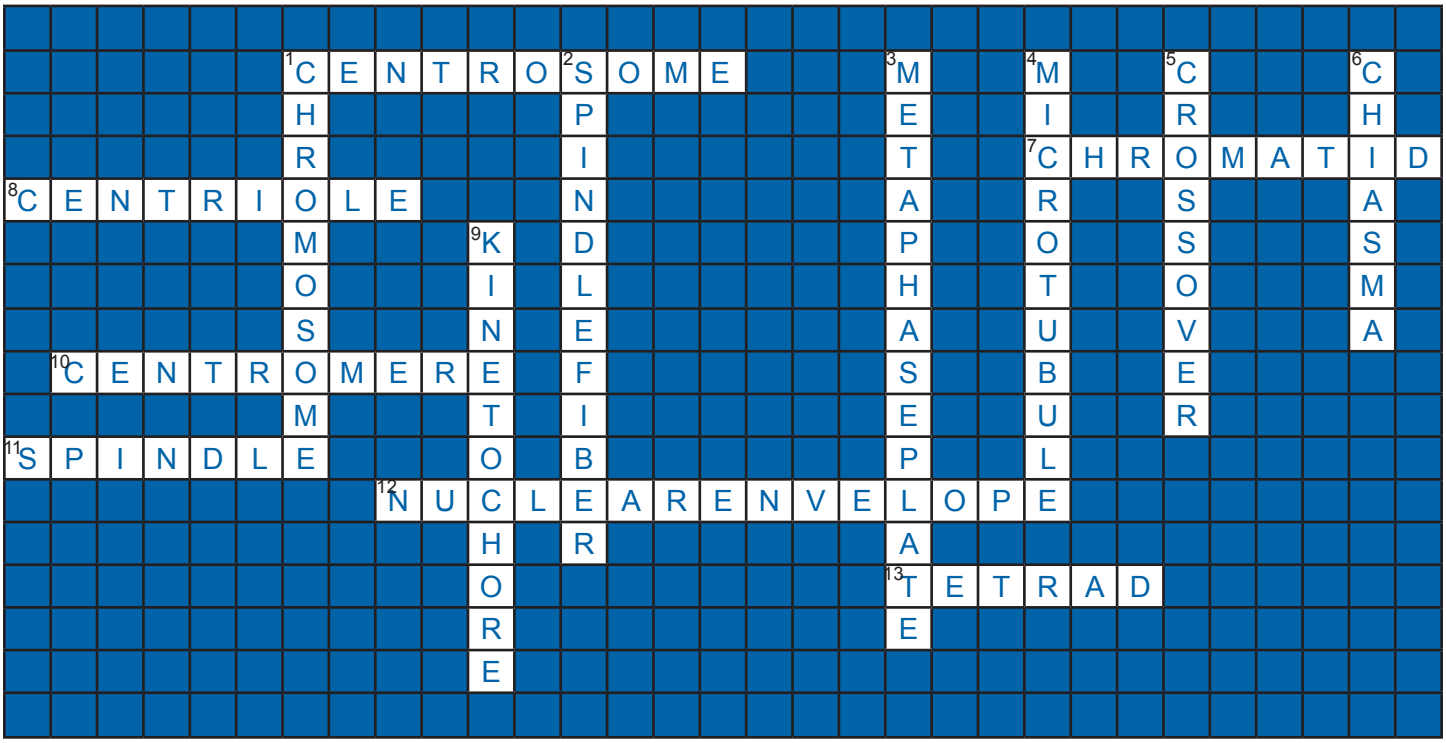
LESSON 2A

DIVIDING THE PARTS

INSTRUCTIONS: Fill in the crossword puzzle using the clues below.



ACROSS

1. During cell division, it migrates to opposite poles and aids in pulling apart the chromosomes.
7. When dividing a chromosome longitudinally, each half is called a _____.
8. A cylindrical organelle that consists of microtubules.
10. The area on the chromosome where the kinetochores attach during cell division.
11. A structure that separates chromosomes during cell division. It contains the spindle fibers and centrosomes.
12. A double layered membrane that surrounds the nucleus, separating the nucleus from the cytoplasm.
13. A group of four chromatids that form during meiosis.

DOWN

1. A long strand of molecules called DNA.
2. Clusters of microtubules that help to move chromosomes during cell division.
3. An imaginary vertical plane that divides the cell into two halves.
4. Miniature tubes that help to support the structure of the cell.
5. A process of exchanging chromosome segments (genetic material) during meiosis.
6. The area where crossover takes place and genetic material is exchanged during meiosis.
9. A structure that forms on the centromere of a chromosome that is the point of attachment for microtubules during cell division.

Name: _____ Date: _____

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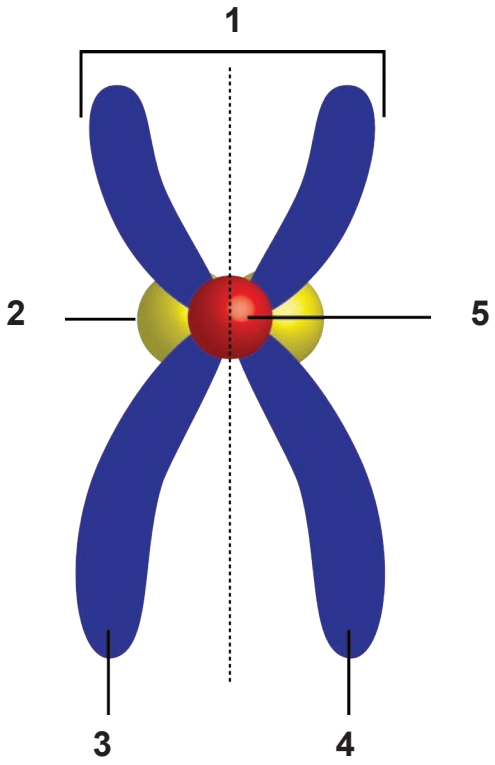
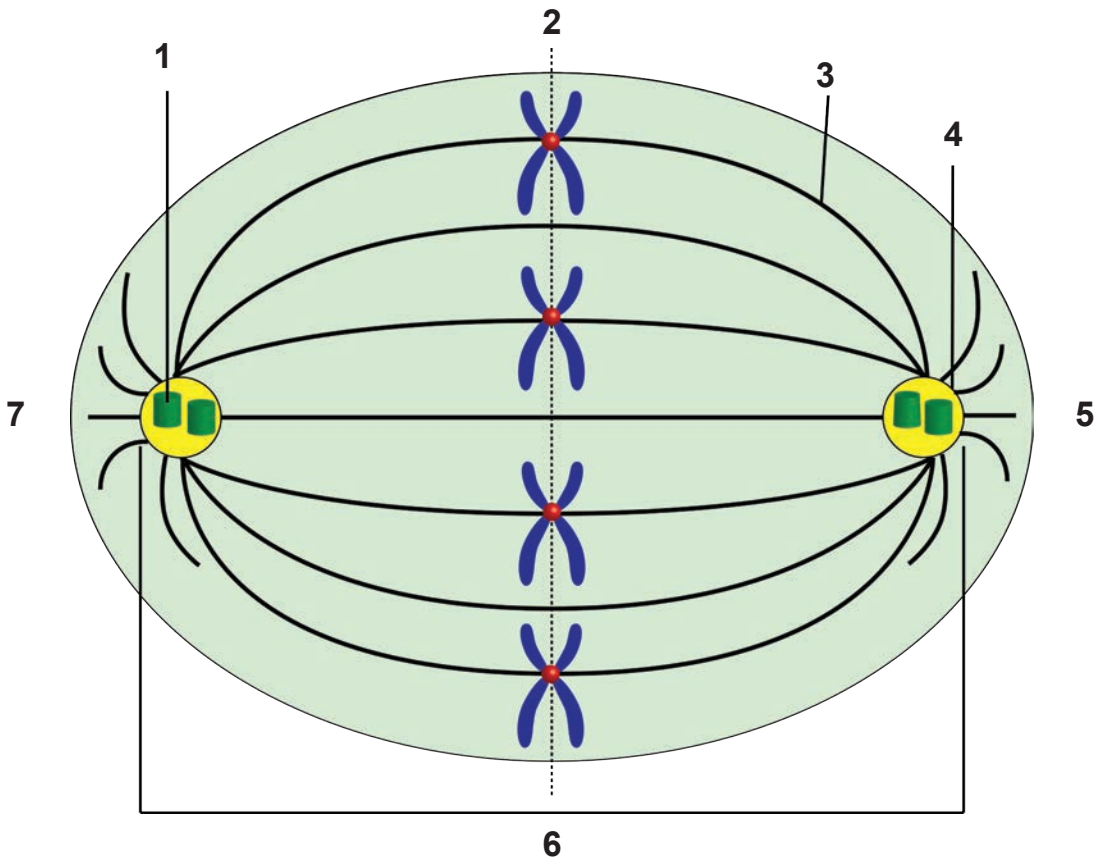
LESSON 2B LABEL IT!

INSTRUCTIONS: Label the parts of a chromosome and cell.





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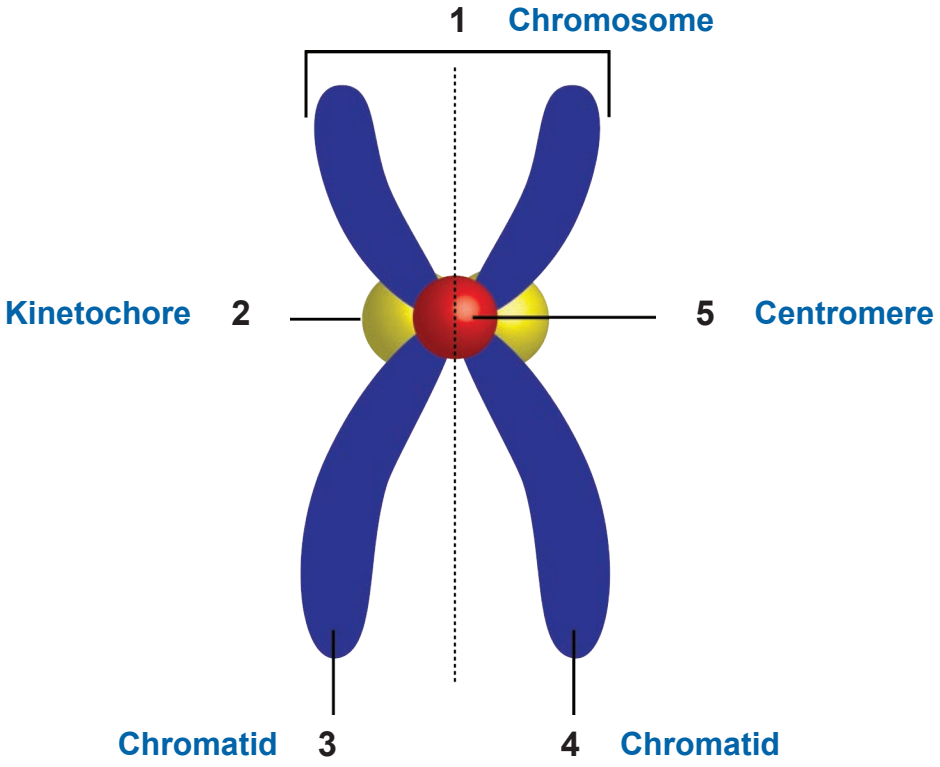
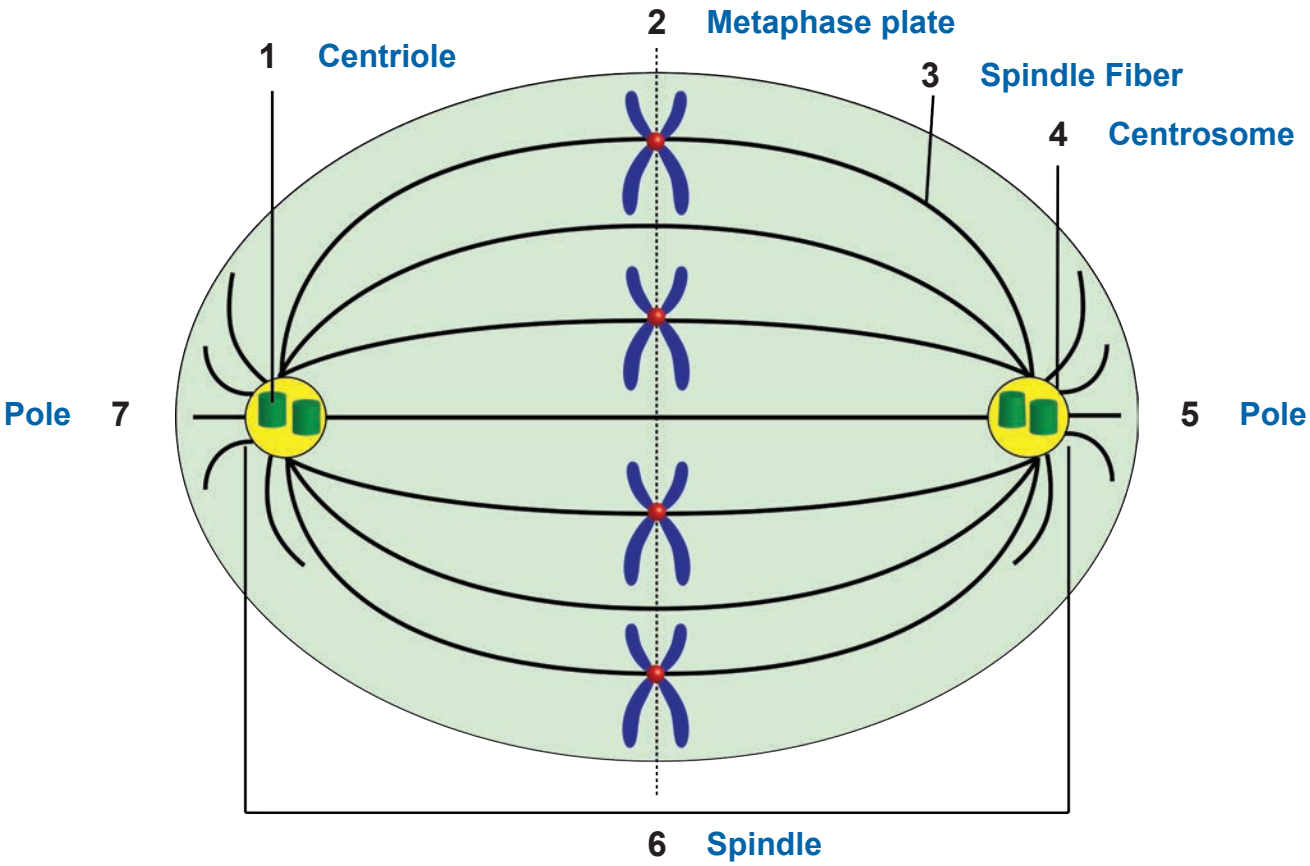
LESSON 2B LABEL IT!

INSTRUCTIONS: Label the parts of a chromosome and cell.





READ IT! Teacher's Notes

AUTHOR

- Melinda Campbell, Khaled bin Sultan Living Oceans Foundation

LEARNING OBJECTIVES

- Read, interpret, and comprehend a blog.
- Determine how to responsibly use the internet for collecting and responding to information.

MATERIALS

- Internet access
- *Coral Recruitment* blog (*http://www.lof.org/coral-recruitment-in-the-garden-of-good-and-evil-how-baby-corals-get-started-on-coral-reefs/*)
- **Read It! Coral Recruitment** student worksheet

INTEGRATING SUBJECTS

- English Language Arts

PRIOR KNOWLEDGE

- Students will have prior knowledge about bias and how to critique the validity of websites.

STANDARDS

- **CCSS**: RST.9-10.1, 2, 4, 5, 6, 8, 10; RST.11-12.1, 2, 4, 6
- **NGSS Practices**: 1, 6, 7, 8

PROCEDURE

1. Have students read *Coral Recruitment* blog (*http://www.lof.org/coral-recruitment-in-the-garden-of-good-and-evil-how-baby-corals-get-started-on-coral-reefs/*).
2. While reading, instruct students to take notes, connecting the information to their prior knowledge. They can note things that they agree and disagree with. A space, called *Notes*, is provided for this on the **Read It! Coral Recruitment** student worksheet.
3. Ask students to analyze the blog to determine the elements (like tone or visual design) and content that they like and dislike. Remind students to explain why they like or dislike each element they mention. There is also a space provided for these answers on the student worksheet.
4. Have students answer the questions on their worksheet. When they are looking for definitions, they should use the context from the blog, our glossary, or other online resources. You may want to set rules distinguishing other websites or resources that they are allowed to access.
5. If you set up an online community for your class, have the students post their comment(s) from the last question and allow them to respond to each other. If you do not have an online community, have the students share their comment(s) with each other, either orally or by passing their written responses around the classroom.

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READ IT! CORAL RECRUITMENT

INSTRUCTIONS:

1. Read *Coral Recruitment in the Garden of Good and Evil*, a blog from our Tuamotu, French Polynesia mission (*http://www.lof.org/coral-recruitment-in-the-garden-of-good-and-evil-how-baby-corals-get-started-on-coral-reefs/*).
2. While reading the blog, take notes and connect it to your prior learning. Note things that you agree or disagree with. There is a space, below, for this.
3. Next, document what you like and dislike about this blog in the space below. Be sure to pay attention to things like style and tone, along with the content and visual design. Be sure to *explain* what it is that you do or do not like about each element.
4. Answer the questions.

NOTES

LIKES

DISLIKES

1. What is the central idea of this blog?

2. What major question has been answered since Dr. Steneck, the author, has started researching coral?

3. How do baby corals figure out where to settle? Cite specific textual evidence to support this.

4. Did the author fully support his claim? Explain why you think this.

5. *Larva*, *buoyancy*, and *coralline algae* are specific vocabulary for the topic of this blog. Define them below.

6. Write a sentence of your own creation that connects the three words from #5, above.

7. Is this blog a reliable source for scientific information? Why or why not?

8. Do you notice any bias in this writing? If so, what?

9. Describe three things that you learned while reading this blog entry (they do not have to relate to the central idea).

10. Construct a comment to post in response to this blog. Remember that a good comment makes connections, asks a question, or gives an opinion in a respectful manner. You might want to quote the part of the blog that you are specifically referring to. Don't be afraid to disagree with another writer, but be sure to explain yourself and remain polite.

1. What is the central idea of this blog?

   Coral larvae need to find a good place to settle in order to survive.

2. What major question has been answered since Dr. Steneck, the author, has started researching coral?

   How and when does coral reproduction occur?

3. How do baby corals figure out where to settle? Cite specific textual evidence to support this.

   Larvae can taste and evaluate potential spots where they can settle to make sure they are not near a coral that will eat them or a seaweed that will harm them. Students should have specific quotes to back up this claim, which may vary but might include the following:

   - **"…corals are terrible places for larvae to settle since they'd get eaten…"**
   - **"…the coral reef… can be tasted and evaluated by the tiny coral larvae…"**
   - **"…seaweed can beat them up and some seaweeds can poison the newly settled corals…"**

4. Did the author fully support his claim? Explain why you think this.

   Answers may vary. Be sure they explain their reasoning.

5. *Larva*, *buoyancy*, and *coralline algae* are specific vocabulary for the topic of this blog. Define them below.

   - **Larva: a juvenile form of an organism that usually looks very different from the adult form.**
   - **Buoyancy: the ability to float.**
   - **Coralline algae: a type of algae that uses calcium carbonate to build their cell walls.**

6. Write a sentence of your own creation that connects the three words from #5, above.

   Coral *larvae* adjust their *buoyancy* while they find a place to settle, preferably on certain species of *coralline algae*.

7. Is this blog a reliable source for scientific information? Why or why not?

   Yes. This is a first-hand account of what the author has seen. It is from a reputable organization that is based on scientific research. It also links you to the author's credentials.

8. Do you notice any bias in this writing? If so, what?

   Answers may vary, but should include that the author is investigating coral larvae.

9. Describe three things that you learned while reading this blog entry (they do not have to relate to the central idea).

   Answers may vary.

10. Construct a comment to post in response to this blog. Remember that a good comment makes connections, asks a question, or gives an opinion in a respectful manner. You might want to quote the part of the blog that you are specifically referring to. Don't be afraid to disagree with another writer, but be sure to explain yourself and remain polite.

    Answers may vary.

Coral Reef Ecology Curriculum

The Coral Reef Ecology Curriculum is a comprehensive educational resource designed to educate people about life on coral reefs. Developed by educators and scientists at the Khaled bin Sultan Living Oceans Foundation, this curriculum strives to increase ocean literacy by creating awareness about coral reefs, the threats they face, and how people can help to preserve these diverse ecosystems.

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The Khaled bin Sultan Living Oceans Foundation is a US-based nonprofit environmental science organization. The Foundation was established to protect and restore the world's oceans through scientific research, outreach, and education.