WEEK 4

UNIT 1.6_CELL DIVISION	**Where? How long?**	***Explanations /Questions***
Introduction **Cell division** is the process in which one cell, called the **parent cell**, divides to form two new cells, referred to as **daughter cells**. How this happens depends on whether the cell is prokaryotic or eukaryotic. Most prokaryotic cells divide by the process of **binary fission**. While Eukaryotic cells are more complex with multiple membrane bound organelles and a nucleus that holds multiple chromosomes, cell division in eukaryotes is a multistage process, called **Mitosis** and **Meiosis**.	10 minutes	A cell has a life cycle. It grows, divides, replicates or duplicates. There cell regulation when the series of events happening in the cell cycle is under control. When now the cell cycle regulation is in disorder, diseases such as cancer can occur. As medical students, you are going to be prepared to know that abnormalities of the cell cycle lead to diseases. **Note to students** *You are going to investigate the process by which cells make exact copies of themselves.*
Expectations You will get knowledge on how the Prokaryotic and Eukaryotic cell divide, and how these processes are regulated.		
Course outline Prokaryotic cell division: binary fission Eukaryotic cell division : Mitosis – Meiosis Cell Cycle regulation Cancer		
Learning outcomes		
By the end of this section, you will be able to: • Describe the process of binary fission • Describe the process of mitosis and meiosis • Compare and contrast mitosis and meiosis I • Define and explain the following terms : Cytokinesis , Chiasma and Crossing-over • Distinguish the role of checkpoints in the control of the cell cycle. • Describe cancer in terms of the cell cycle control.		

ACTIVITY AHEAD OF LESSON: PROKARYOTIC CELL DIVISION			
Purpose:	This is have an overview of cell division in prokaryotes	30 minutes	Make sure you take note of all terms you do not understand.
Over to you:	This short video on binary fission explain how bacteria reproduce Watch the video. Then watch it again, making the notes suggested in the activity. ***Be certain to note anything that you don't understand.***		
Activity:	As you watch this animation, make notes of: • Parental and daughter cells • Cross septum • Generation time Bring your notes to class so that you can participate in the conversation about passive transport across the cell membrane.		

PROKARYOTIC CELL DIVISION

Prokaryotes use a type of cell division called binary fission. Cell division is the only method to produce new individuals. The product of cell division is a pair of daughter cells that are genetically identical to the parent cell.

Binary Fission

Binary fission is divided into three main steps:

Step 1: DNA's replication
The starting point of replication, the origin, is close to the binding site of the chromosome to the plasma membrane (Figure 1.2). Replication of the DNA is bidirectional—moving away from the origin on both strands of the DNA loop simultaneously.

Step 2: Chromosome Segregation. The two chromosomes segregate, or separate, and move to opposite ends of the cell.

Step 3: Cell elongation. A new plasma membrane starts growing into the center of the cell, and the cytoplasm splits apart, forming two daughter cells. The two daughter cells that result are genetically identical to each other and to the parent cell.

Step 4: Septation: A septum is formed between the nucleoids from the periphery toward the center of the cell. When the new cell walls are in place, the daughter cells separate. A protein molecule called FtsZ facilitates this process.

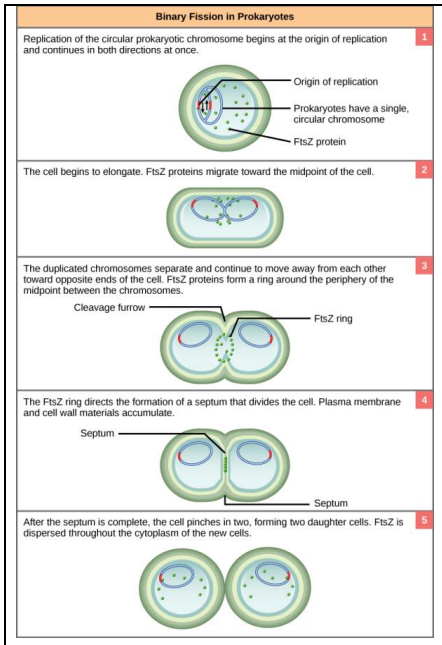


Figure 1.5: The binary fission of a bacterium is outline in five steps. By Mcstrother, nd, [image],accessed on February 14,2019 , https://courses.lumenlearning.com/sunyosbiology2e/chapter/prokaryotic-cell-division-2/

20 minutes

Notes for Tutors

Discuss with students about the new terms they do not understand.

Before starting binary fission , review all parts of the cell that are involved in cell division:

- DNA
- Chromosome
- Origin of replication
- Septation
- FtsZ protein.

IN CLASS ACTIVITY: Prokaryotic cell division			
Purpose:	To explore the function of FtsZ proteins.	15 minutes for search	In this activity the first link is a research paper, while the other is the definition of FtsZ on Wikipedia.
Over to you:	Using your laptop, desktop or tablet, follow this link on associated web pages.		
Activity	Write down in your own words • The characteristics of FtsZ proteins • The functions of FtsZ proteins • The nature of FtsZ proteins • The role of FtsZ proteins in binary fission		Please avoid plagiarism.

ACTIVITY AHEAD OF LESSON: EUKARYOTICCELL DIVISION- MITOSIS			
Purpose:	You will have an overview of cell division in eukaryotes. You already heard about **mitosis and meiosis.** Mitosis is a fundamental process for life. During mitosis, a cell duplicates all of its contents, including its chromosomes, and splits to form two identical daughter cells. Because this process is so critical, the steps of mitosis are carefully controlled by a number of genes. When mitosis is not regulated correctly, health problems such as cancer can result.	20 minutes	If you have downloaded the textbook *Biology* OpenStax resource go to page 279.
Over to you:	Using your laptop, desktop or tablet follow this links and click to open the resource.		
Activity:	***Be certain to note anything that you don't understand.*** Read this section to learn about the cell cycle and mitosis. Be sure to also complete the multiple choice and free response questions. Bring your notes to class so that you can participate in the conversation about cell cycle and mitosis.		

MITOSIS

The cell cycle can be divided into two major components: **interphase** and **cell division.**

Interphase

Interphase is the period of the cell cycle that precedes mitosis. It consists of 3 phases G1, S and G2.

G1 phase (Gap phase) is a period of cellular growth that precedes DNA synthesis. In most cells, G1 lasts approximately 12 hours.

S phase (Synthesis phase) usually lasts for 6-8 hours, and it includes the entire period of DNA synthesis and chromosomal replication.

G2 phase lasts between 3 and 4 hours and resembles the G1 phase in terms of cellular activity, except that the cell is now tetraploid whereas in the G1 phase it was diploid.

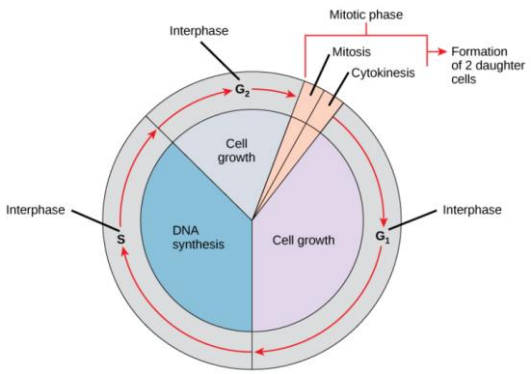


Figure1.6: Phases of cell division.n.d.[image], accessed on February 14,2019 , https://cnx.org/contents/s8Hh0oOc@10.1:Vbi92lHB@10/The-Cell-Cycle

Mitosisis the nuclear division of the cell and is divided into five phases :

- Prophase
- Prometaphase
- Metaphase,
- Anaphase
- Telophase

Prophase: the replicated chromosomes, each consisting of two closely associated sister chromatids, condense. Outside the nucleus, the mitotic spindle assembles between the two centrosomes, which have replicated and moved apart

Prometaphase: starts abruptly with the breakdown of the nuclear envelope.
Chromosomes can now attach to spindle microtubules via their kinetochores and undergo active movement.

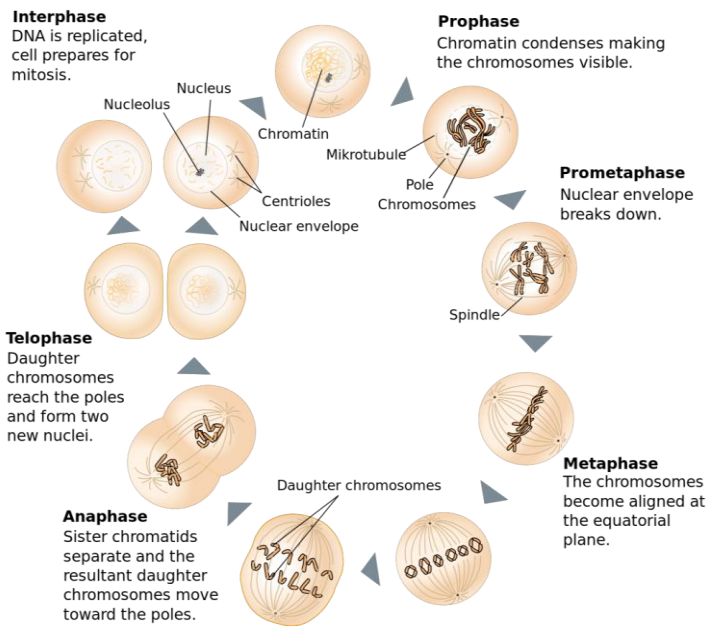
30 minutes

In some cells G1 may be very long. For example, in muscle and nerve cells, G1 is so long that it seems the cells may have completely stopped cycling. Such resting cells are said to be a special G1 state called G0

Introduce the notion of ploidy (diploid and tetraploid)

Explain the following terms:
cytokinesis
Chromatids
Spindle fibers
Centrosomes
Nuclear envelope
Kinetochore

Help students focus

Metaphase: The chromosomes are aligned at the equator of the spindle, midway between the spindle poles. The paired kinetochore microtubules on each chromosome attach to opposite poles of spindles. **Anaphase:** The paired chromatids synchronously separate to form two daughter chromosomes, and each is pulled slowly toward the spindle pole it faces. The kinetochore microtubules get shorter and the spindle poles also move apart, both contributing to chromosomes separation. **Telophase:** The two sets of daughter chromosomes arrive at the poles of the spindle. A new nuclear envelope reassembles around each set, completing the formation of two nuclei and marking the end of mitosis. The division of the cytoplasm begins with the assembly of the contracting ring.	 **Figure 1.7:** Phases of mitosis. By Jpablo cad, October 27,2008.Diagrama_Mitosis.svg: [image], accessed on February 15,2019 ,https://commons.wikimedia.org/wiki/File:Diagrama_Mitosis.svg	10 minutes	on cell division by asking questions such as: Has your body changed in the past six months? How did you recognize this change? Are you taller? Did your hair grow? Did you clip your toenails? Has anyone broken a bone recently? How does your body repair itself? (Answers may vary. Accept all answers and encourage students to explain their answers.) Discuss how the contractile ring is formed in the telophase
During **Cytokinesis** of an animal cell, the cytoplasm is divided in two by a contractile ring of actin and myosin, which pinches in the cell to create two daughters, each with one nucleus.			

ACTIVITY AHEAD OF LESSON: EUKARYOTICCELL DIVISION - MEIOSIS			
Purpose:	Meiosis is the process by which eukaryotic cells make gametes for sexual reproduction. In humans, the primary function of meiosis is the reduction of ploidy in diploid cells to haploid cells, leading to the redaction of the chromosomes number by half. It occurs in before maturation of the gametes. Genetic recombination also occurs in meiosis, and involves the exchange of segments of chromosomes, resulting in a mixing of allelic linkages into new combinations.	20 minutes	If you have downloaded the textbook *Biology* OpenStax resource go to page 303
Over to you:	Using laptop, desktop or tablet follow this link and click to open the resource. ***Be certain to note anything that you don't understand.***		
Activity:	After reading , make notes of what you understand by: - Allelic linkage - Synapse - Crossing over - Tetrad - Bivalent Be sure to also complete the multiple choice and free response questions. Bring your notes to class so that you can participate in the conversation about meiosis		

Commented [TN1]: Which link

MEIOSIS

Meiosis involves ***two complete cell divisions***, each resembling the mitotic division preciously described. There is no DNA replication during either of the two meiotic divisions. DNA replication occurs before the first meiotic division.

Interphase

Consist of 3 phases G_1, S, and G_2 phases

G_1 phase is dedicated on cell growth.

S phase: the DNA of the chromosomes is replicated and each chromosome becomes composed of two identical copies (called sister chromatids) that are held together at the centromere until they are pulled apart during meiosis II. There is also replication of the centromere.

G_2 phase: the cell undergoes the final preparations for meiosis.

Meiosis I

Meiosis I separates the pairs of homologous chromosomes, then cell division reduces the cell from diploid (2n) to haploid (n).

Prophase I: is the longest phase of meiosis and is divided into a series of substages.

Stage A. The chromosomes condense into visible threads, and pairing of homologous chromosomes occurs. The tight pairing of the homologous chromosomes is called **synapsis**. In synapsis, the genes on the chromatids of the homologous chromosomes are precisely aligned with each other. The pairing is precise, except for the X-Y chromosome combination in males.

Stage B. Homologous chromosome pairing is complete and four chromatids appear in each pair; this is tetrad.

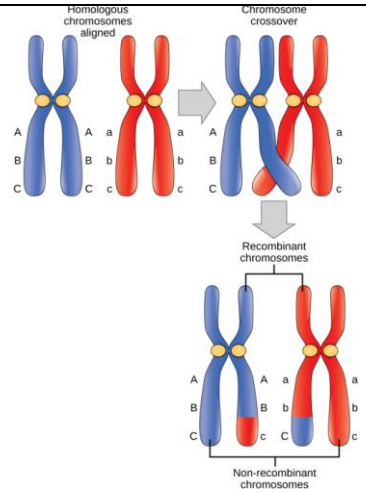


Figure 1.8: Crossing over, the blue chromosome came from the individual's father and the red chromosome came from the individual's mother.n.d. [image],accessed February 16, 2019, https://cnx.org/contents/s8Hh0oOc@14.1:1Q8z96mT@8/7-2-Meiosis

15 minutes

In Humans, Meiosis I reduce the number of 46 chromosomes to 23 chromosomes

Stage C. This is the recombination or **crossing -over** stage where the interchange of chromatid segments between two paired homologous chromosomes can occur. The point of exchange has an X-like appearance and is called **a chiasma**. At the chiasma, the chromosome pairs are held together and at this time large segments of genes are exchanged between homologous chromosomes.

Meiotic metaphase I. Paired chromosomes line up on the mitotic spindle. The two chromosomes of each homologous pair form connections with microtubules leading to opposite ends of the cell.
Meiotic anaphase I. Both chromatids migrate toward the same end of the cell.
Meiotic telophase I. Each daughter cell gets one member of each chromosome pair, for a total of 23 double-stranded chromosomes.

Meiosis II

The steps are similar to those in a mitotic division, except that no DNA synthesis occurs prior to division.

The 23 chromosomes divide at the centromeres and each of the newly formed daughter germ cells receive 23 chromatids. Therefore, each germ cell now has a haploid number of chromosomes and half the amount of DNA of diploid somatic cell.

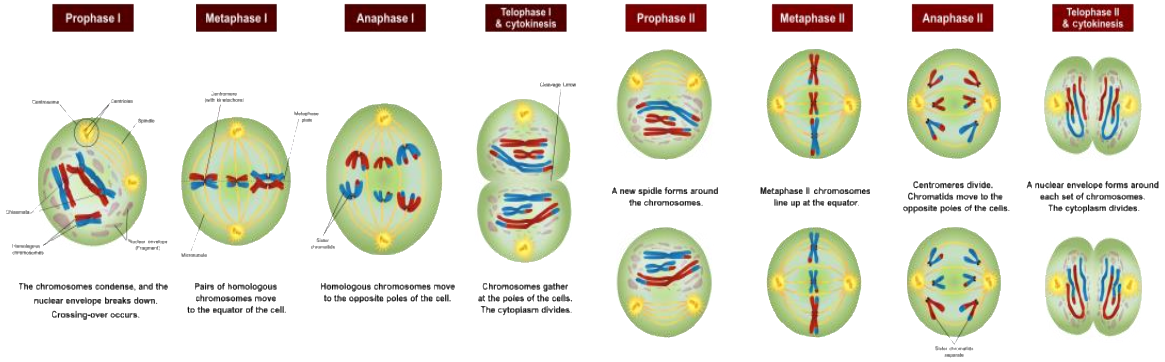


Figure1. 9: The phases of meiosis.
by Ali Zifan**,**June 21,2016,diagram of meiosis,[image], accessed February 15,2019, https://commons.wikimedia.org/wiki/File:Meiosis_Stages.svg

Errors in meiosis produce aneuploid gametes It is critical that the process of meiosis be accurate because any failure produces gametes without the correct number of chromosomes. Failure of chromosomes to move to opposite poles during either meiotic division is called *nondisjunction*, and it produces one gamete that lacks a chromosome and one that has two copies. Gametes with an improper number of chromosomes are called **aneuploid gametes.** In humans, this condition is the most common cause of spontaneous abortion. Example of common chromosomal disorder due to aneuploidy is **Trisomy 21 or Down syndrome.** Reference on this link.	10 minutes	Project this about chromosome Non disjunction

LABORATORY PRACTICALS :MITOSIS IN ONION ROOTS			
Purpose:	To identify stages of mitosis in plant cells	120 minutes	Before this laboratory exercise takes place, make sure the materials specified in the SOPs are available and the laboratory is prepared.
Over to you:	Using microscope images, you will be able to identify the appearance of chromosomes and other cell structures during the phases of mitosis.		
Activity	In this lesson, students will observe onion root tips under a microscope, count the number of cells they find in each stage of the cell cycle, and then use this information to draw a pie graph that will predict the percentage of time spent in each stage.		

Anticipated time required for Unit 1.6 activities :

Theory : 2h all activities + 2h self-learning

Practical : 2h