**Chapter 5: Mitosis Notes**

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| Objectives | Vocabulary | |
| **Identify** four examples of cell division in eukaryotes and one example in prokaryotes.  **Differentiate** between a gene, a DNA molecule, a chromosome, and a chromatid.  **Differentiate** between homologous chromosomes, autosomes, and sex chromosomes.  **Compare** haploid and diploid cells.  **Predict** how changes in chromosome number or structure can affect development. | * Gamete * Binary fission * Gene * Chromosome * Chromatid * Centromere * homologous chromosome | * Diploid * Haploid * Zygote * Autosome * Sex chromosome * karyotype |

**Formation of New Cells by Division**

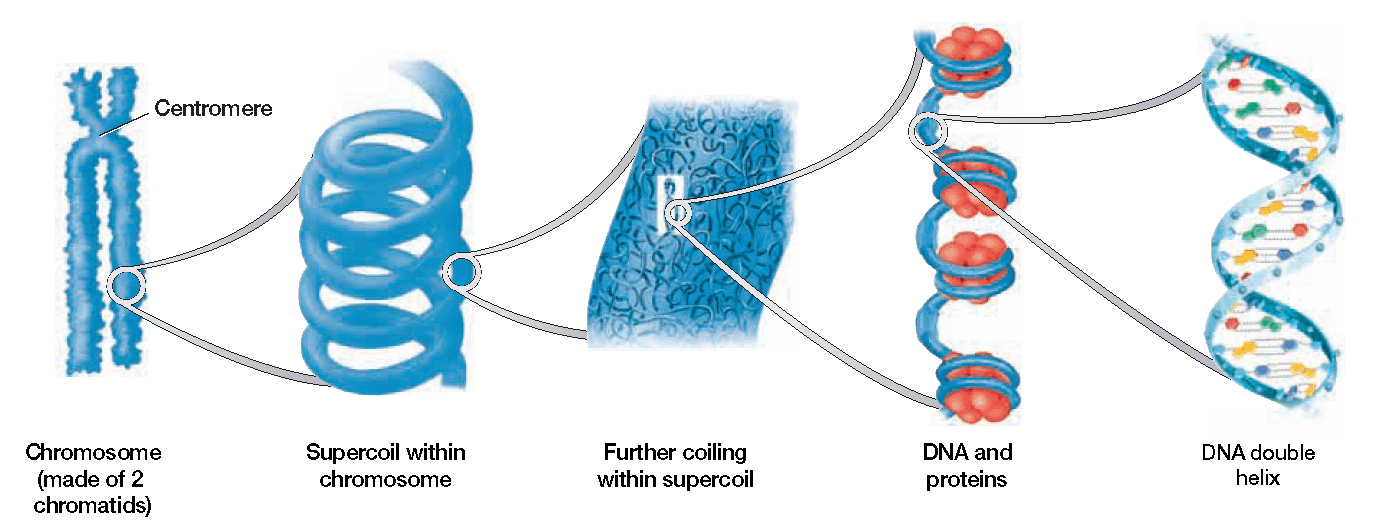
* Cell division, also called cell \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, occurs in humans and other organisms at different times in their life. Before a cell can divide, the DNA must first be \_\_\_\_\_\_\_\_\_\_ and then \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to new cells
* Why does each new cell need an identical copy of DNA?

**Prokaryotic Cells**

* Prokaryotes carryout a very simple type of cell division called \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_
* Occurs in two stages:
  + 1st DNA is \_\_\_\_\_\_\_\_\_\_\_\_\_
  + 2nd the original cell divides into \_\_\_\_\_\_\_ new cells
* The original cell divides by adding a new cell \_\_\_\_\_\_\_\_\_\_\_\_\_ between the copied DNA. As new material is added, the membrane \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in. Next, a new cell \_\_\_\_\_\_\_\_\_\_\_\_ forms around the membrane. Last, the original cell pinches off into two \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cells
* Binary fission is a form of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reproduction because….It only involves a \_\_\_\_\_\_\_\_\_\_\_\_\_ parent that passes \_\_\_\_\_\_\_\_\_\_\_ copies of its DNA to its offspring. So the offspring are \_\_\_\_\_\_\_\_\_\_ copies of the parent prokaryotic cell.

**Eukaryotic Cells**

* Before eukaryotic cells divide, their DNA is \_\_\_\_\_\_\_\_\_\_\_\_ and referred to as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Recall that DNA is a \_\_\_\_\_\_\_\_\_\_\_\_\_ helix made up of subunits called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Your DNA is normally uncoiled because the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ it contains is being used to make \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Recall that specific segments of your DNA, called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, code for the production of \_\_\_\_\_\_\_\_\_\_\_\_\_ proteins
* Before a eukaryotic cell divides, the DNA is \_\_\_\_\_\_\_\_\_\_\_\_, and it \_\_\_\_\_\_\_\_\_\_ up to form a chromosome. First, DNA coils around proteins called \_\_\_\_\_\_\_\_\_ to form small structures called \_\_\_\_\_\_\_\_\_\_\_\_\_\_. Next, the nucleosomes actually end up coiling \_\_\_\_\_\_\_\_\_\_ on themselves to form a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. This supercoil is tightly packed in a structure called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



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| * Chromosomes have two \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ sides because they contain DNA that has already been \_\_\_\_\_\_\_\_\_\_\_\_. Each side is called a sister \_\_\_\_\_\_\_\_\_\_\_\_\_ and they are attached at a point called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. These sister chromatids \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ at the centromere during cell division to ensure that each new cell has the \_\_\_\_\_\_\_\_\_ genetic information as the original cell * Different species contain different numbers of chromosomes🡪 Ex: Humans have \_\_\_\_\_\_ chromosomes while a dog has \_\_\_\_\_\_\_ chromosomes | **Untitled-1 copy** |

**Asexual Reproduction—Eukaryotic Cells**

* Eukaryotic cells will make \_\_\_\_\_\_\_\_\_ copies of themselves during asexual reproduction for four different types of cell division
  + One type is simply for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Eukaryotes may also make new cells for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Asexual reproduction only occurs in body cells which are also called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cells. Examples of somatic cells are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cells. You want these new cells to do the same job as their parent cell, so it is good that they make exact \_\_\_\_\_\_\_\_\_\_of each other. Overtime…the ends of your DNA strands start to deteriorate so your cells \_\_\_\_\_\_ and change slightly even though they are “copies”. All of your somatic cells contain \_\_\_\_ chromosomes, which means they are \_\_\_\_\_\_\_\_\_ cells. A **diploid** cell is mathematically written as \_\_\_\_\_\_, which means they have two \_\_\_\_\_\_\_ of chromosomes…you inherit one set from your \_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_

**Sexual Reproduction—Eukaryotic Cells**

* \_\_\_\_\_\_ pair of your chromosomes are called your \_\_\_\_\_\_\_ chromosomes, because they are involved with determining your \_\_\_\_\_\_\_\_\_\_\_\_. Your other 22 pairs of chromosomes are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Your two sex chromosomes are referred to as \_\_\_\_\_ and \_\_\_\_\_
* You inherit one from each parent \_\_\_\_\_\_ = male \_\_\_\_\_\_ = female
* Females can donate only X’s while males can donate an X or a Y…
* Your \_\_\_\_\_\_\_\_\_ cells reproduce sexually because \_\_\_\_\_\_ cells are needed to make another cell. Your sex cells, also called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, consist of \_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_ cells. Gametes are \_\_\_\_\_\_\_\_\_\_\_\_\_ cells, which are written mathematically as \_\_\_\_\_\_, meaning they have a \_\_\_\_\_\_\_\_\_\_\_\_\_ set of chromosomes. If human somatic cells (2n) have 46 chromosomes…how many chromosomes do gametes (n) have?
* When two gametes \_\_\_\_\_\_\_\_\_\_\_\_\_, they make a diploid body cell in the process of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* This fertilized cell is called a \_\_\_\_\_\_\_\_\_\_\_\_. The zygote will then continue to grow and develop through \_\_\_\_\_\_\_\_\_\_\_\_ into an \_\_\_\_\_\_\_\_\_\_\_ organism
* Interesting Question…If a zygote divides and grows through mitosis, how does our body contain so many different types of cells?
* Developing \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ consist of \_\_\_\_\_\_\_\_\_\_\_\_ cells that have the ability to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ into different cells. Adults have \_\_\_\_\_\_\_ cells too, but scientists currently think that their ability to differentiate is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. In order for sexual reproduction to occur, organisms must inherit \_\_\_\_\_\_\_\_\_\_\_\_ chromosomes, which are similar in \_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_, and genetic \_\_\_\_\_\_\_\_\_\_
* Your 46 chromosomes are actually \_\_\_\_ sets or pairs of homologous chromosomes
* Having too many or too few chromosomes can result in \_\_\_\_\_\_\_\_\_\_\_\_\_Abnormalities in chromosome # can be detected in a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, which is a \_\_\_\_\_\_\_\_ of the chromosomes in a dividing cell that shows the chromosomes arranged by \_\_\_\_\_\_\_\_\_\_\_
* Sometimes an individual may inherit an incorrect number of chromosomes if the chromosomes fail to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ properly. This type of error is called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. One well known disorder that results from nondisjunction is \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_

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|  | 🡨Example: Down syndromThis condition is also called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because it results from having \_\_\_\_\_\_\_\_\_\_\_\_sets of chromosome 21  You can also identify sex in a karyotype. Does this karyotype show a male or female?  Untitled-3 copy |

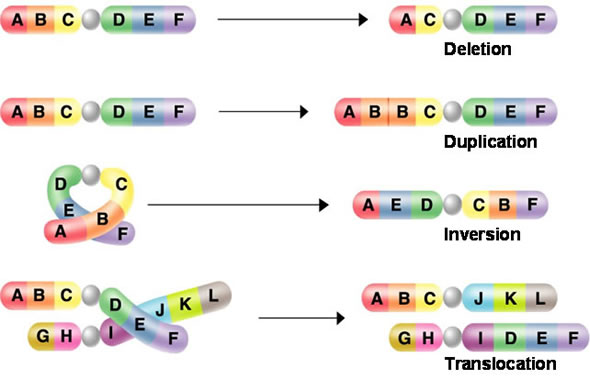
* Your sex chromosomes are the only chromosomes that are not \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_because they are different in \_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Chromosome Mutations**

* Breakage of a chromosome can lead to four types of mutations that are usually \_\_\_\_\_\_\_\_\_\_\_ in animals
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Occurs when a gene from a chromosome breaks off or is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ during division. A new cell will\_\_\_\_\_\_\_\_\_\_ a certain gene and the \_\_\_\_\_\_\_\_\_\_it coded for

\* How is a gene deletion different from a deletion in a frameshift mutation?

* + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Occurs when a chromosome fragment \_\_\_\_\_\_\_\_\_\_\_ to its homologous chromosome . A new cell will have \_\_\_\_\_\_\_\_ of certain genes and the \_\_\_\_\_\_\_\_\_\_ it coded for
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Occurs when a chromosome fragment breaks off and reattaches in the wrong \_\_\_\_\_\_\_\_\_\_\_\_. Genes will be\_\_\_\_\_\_ of order and certain proteins may \_\_\_\_\_be made
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Occurs when a chromosome fragment breaks off and attaches to a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ chromosome. The gene may not be \_\_\_\_\_\_\_\_\_ because it is on the wrong chromosome

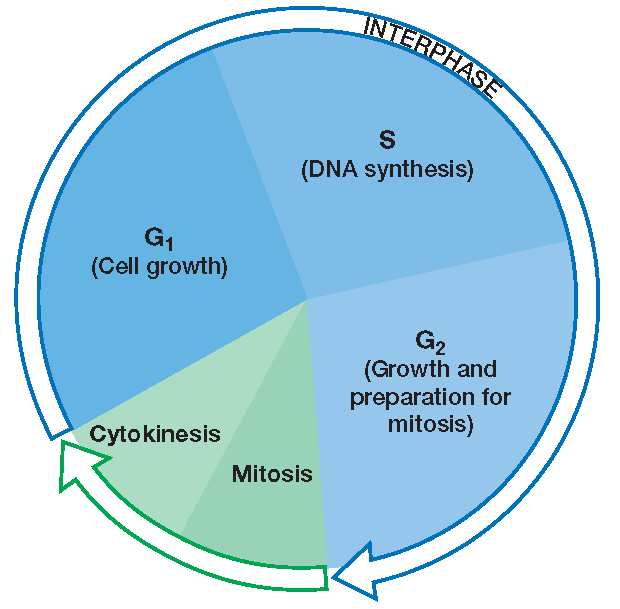


1. **Identify** four examples of cell division in eukaryotes and one example in prokaryotes.
2. **Differentiate** between a gene, a DNA molecule, a chromosome, and a chromatid.
3. **Differentiate** between homologous chromosomes, autosomes, and sex chromosomes.
4. **Compare** haploid and diploid cells.
5. Predict how changes in chromosome number or structure can affect development.

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| Objectives | Vocabulary | |
| * **Identify** the major events that characterize each of the five phases of the cell cycle. * **Describe** how the cell cycle is controlled in eukaryotic cells. * **Relate** the role of the cell cycle to the onset of cancer. | * Cell Cycle * Interphase * Mitosis * Cytokinesis * Cancer | P53  Cyclin  Mutagen  Checkpoint  Oncogene  Mitotic spindle |

**Eukaryotic Cell Division**

* Cell division in eukaryotic cells is more complex than division in bacteria because…
  + DNA is located in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Many other membrane-bound \_\_\_\_\_\_\_\_\_\_\_\_\_ must also be constructed and distributed to each new cell



* **The life of a eukaryotic cell is often depicted as a \_\_\_\_\_\_\_\_\_**
* The **cell cycle** is a repeating sequence of cellular \_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ during the life of an organism
* A cell spends \_\_\_\_\_ percent of its time in the first three phases of the cycle, which are collectively called **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
  + **\_\_\_\_\_\_**
  + **\_\_\_\_\_\_**
  + **\_\_\_\_\_**

**G1 Phase (Gap 1)**

* A period of \_\_\_\_\_\_\_\_\_\_\_ growth
* The cell carries out all of its \_\_\_\_\_\_\_\_\_\_\_\_ functions
* Cells that are not dividing \_\_\_\_\_\_\_\_\_\_\_ in the G1 phase
  + Example:
    - After you are developed ***some*** of your \_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cells stop dividing and replicating…so it is important to take care of them
* If a cell no longer divides, sometimes scientist say that it is in the \_\_\_\_\_\_ stage, because it has left the cell cycle

**S Phase**

* Period during which DNA is \_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_
* To be copied, the DNA must be \_\_\_\_\_\_\_\_\_\_\_ out, so it is called \_\_\_\_\_\_\_\_\_\_\_\_\_\_
* The two identical copies will form the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in a chromosome

**G2 Phase (Gap 2)**

* Other organelles necessary for reproduction, such as \_\_\_\_\_\_\_\_\_\_\_ fibers, are made
  + They consist of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that pull apart the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of chromosomes so that they can be divided between new cells
* After interphase, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ occurs, which is sometimes called the \_\_\_\_\_ phase
* During mitosis, the copied DNA coils up into \_\_\_\_\_\_\_\_\_\_\_\_\_\_
* These chromosomes, are passed onto each new cell when the cell divides…but the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ must first disintegrate.
  + A new nucleus \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in each new cell
  + Due to this occurrence, mitosis is often referred to as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ division
* After mitosis, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ occurs. Cytokinesis involves the splitting of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Once cytokinesis is complete, the original cell has divided into \_\_\_\_\_\_\_ new, \_\_\_\_\_\_\_\_\_\_\_\_\_ cells

**Control of the Cell Cycle**

* How exactly does a cell know when to divide… or not divide?
  + The cell has three inspection points, called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that provide feedback which will \_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_ the occurrence of the next phase

**G1 Checkpoint**

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_checkpoint
* As long as the cell is \_\_\_\_\_\_\_\_\_ enough and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, cell proteins will trigger the synthesis of DNA

**G2 Checkpoint**

* DNA \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ checkpoint
* DNA polymerases check and \_\_\_\_\_\_\_\_\_\_\_\_ any errors made while copying the DNA
* If the DNA has been copied correctly, cyclins will trigger the start of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* If too much damage has accumulated in the copied DNA, another protein called \_\_\_\_\_\_\_ can halt division and signal for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, which is cell death…
* Half of all human cancers result from a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ p53 protein

**M Checkpoint**

* \_\_\_\_\_\_\_\_\_\_\_\_\_ checkpoint
* Triggers the \_\_\_\_\_\_\_\_\_ from mitosis
* Once cell division is complete, a cell will reenter the \_\_\_\_\_\_\_\_\_\_\_\_\_ stage

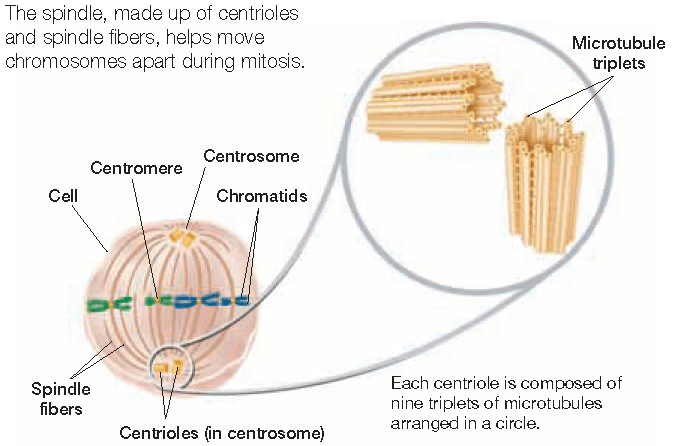
**When Control is Lost 🡪 Cancer**

* Certain genes, called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, contain the information necessary to make the proteins that regulate cell growth and division.
* If one of these genes is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, cell reproduction may occur at an uncontrolled rate
* The uncontrolled replication of cells results in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* What are some factors that can damage or mutate your cells?
  + Any factor that can cause your cells to mutate is called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Once damaged…
  + The cell loses \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the cell cycle
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ division occurs
  + A \_\_\_\_\_\_\_\_\_\_\_ forms, blocking \_\_\_\_\_\_\_\_\_\_\_\_\_\_ from reaching nearby healthy cells
  + If you develop cancer in somatic cells, like your lung cells, will your offspring inherit lung cancer?

1. Identify the major events that characterize each of the five phases of the cell cycle
2. Describe how the cell cycle is controlled in eukaryotic cells
3. Relate the role of the cell cycle to the onset of cancer

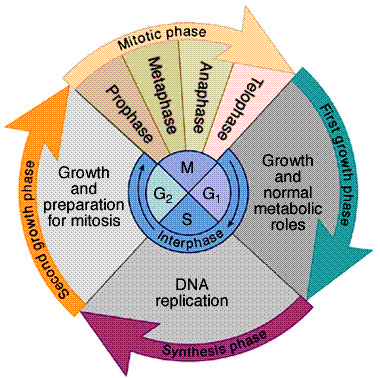
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| Objectives | Vocabulary |
| * **Describe** the structure and function of the spindle during mitosis. * **Summarize** the events of the four stages of mitosis. * **Differentiate** cytokinesis in animal and plant cells. | * Spindle * Prophase * Metaphase * Anaphase * Telophase * Cell plate * Cleavage furrow * Kinetechore |

* Once cells pass the G1, DNA is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Each copy of the DNA is then separated into \_\_\_\_\_ new cells through the process of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Chromosomes are actually pulled apart with the help of a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* A spindle consist of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and individual \_\_\_\_\_\_\_\_\_\_\_\_ which are made up of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



At the beginning of mitosis, the centrioles move to areas on the opposite poles of the cell called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The centrosome organizes the formation of the \_\_\_\_\_\_\_\_\_\_\_\_

As the centrioles move, the spindle fibers begin to form and \_\_\_\_\_\_\_\_\_\_\_\_\_ towards the chromosomes



* Scientists are unclear about the role of centrioles in cell division, because they are not necessary for spindle \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Plant cells, which do not have centrioles, form a spindle that is almost \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to those in animal cells

**Separation of Chromatids**

* The two \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that make up a chromosome are moved to each pole of the cell in a manner similar to bringing in a fish with a fishing rod and \_\_\_\_\_\_\_\_\_\_\_
* When the microtubule “fishing line” is “reeled in,” the chromatids are \_\_\_\_\_\_\_\_\_\_\_\_\_\_ to opposite poles.
* When the chromatids separate, you may call each one a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mitosis actually occurs in \_\_\_\_\_\_ continuous phases…

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|  | Description | Picture |
| **Prophase** |  |  |
| **Metaphase** |  |  |
| **Anaphase** |  |  |
| **Telophase** |  |  |
| **Cytokinesis** | In animal cells, cytokinesis actually begins during \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. A belt of protein \_\_\_\_\_\_\_\_\_\_ pinches the cell in half. This indentation is called a \_\_\_\_\_\_\_\_\_\_\_  In plant cells, vesicles containing \_\_\_\_\_\_\_\_\_\_\_\_ begin to congregate between the two nuclei. These vesicles begin to fuse, forming a cell \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, while the cellulose is used to form a cell \_\_\_\_\_\_\_\_\_\_. As the new cell wall forms in between the cell membranes, this structure is called a cell \_\_\_\_\_\_\_\_\_ |  |

End result of mitosis🡪 A diploid parent cell has been divided into two, identical \_\_\_\_\_\_\_\_\_\_\_\_ daughter cells. These new cells are small and will begin to grow during the \_\_\_\_\_ phase of interphase

1. **Describe** the structure and function of the spindle during mitosis.
2. **Summarize** the events of the four stages of mitosis.
   1. Prophase
   2. Metaphase
   3. Anaphase
   4. Telophase
3. **Differentiate** cytokinesis in animal and plant cells