Name: _____ Date: _____ Block: _____

# Guided Notes
## Unit 4: Cellular Reproduction

## Chapter 5: Cell Growth and Division

### *I. Background*

a. *"Where a cell exists, there must have been a preexisting cell...." - Rudolf Virchow*

b. The division of cells into more cells enables living things:

   i. To repair damage

   ii. To grow

   iii. To produce offspring

c. Cell Division

   i. Two Types

      1. _____

         a. allows for cell reproduction - leading to growth and repair

            i. Example: Cell reproduction through mitosis enables your body to produce new skin cells that replace dead cells at your skin's surface.

      2. _____

         a. allows for sexual reproduction

            i. Example: Cell reproduction through meiosis enables multicellular organisms to produce cells that are necessary for sexual reproduction, such as sperm and egg cells in animals.

### *II. Concept 5.1: The Cell Cycle*

a. Cell Cycle

   i. Cell Cycle: a regular pattern of _____

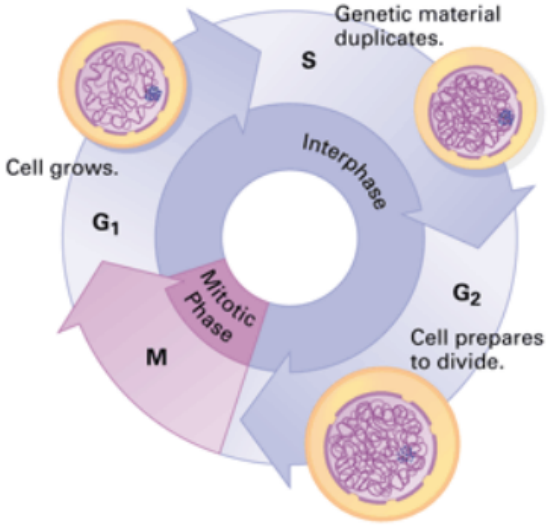
      _____

      _____

      _____

      _____

      _____




   ii. Cell cycle = _____ + _____

b. Interphase

i. 90% of a cell's life is spent in interphase.

ii. Interphase: the stage during which a cell _____

_____

iii. $G_1 \rightarrow S \rightarrow G_2$

1. Gap 1 ($G_1$) phase: _____
2. DNA Synthesis (S) phase: _____

_____

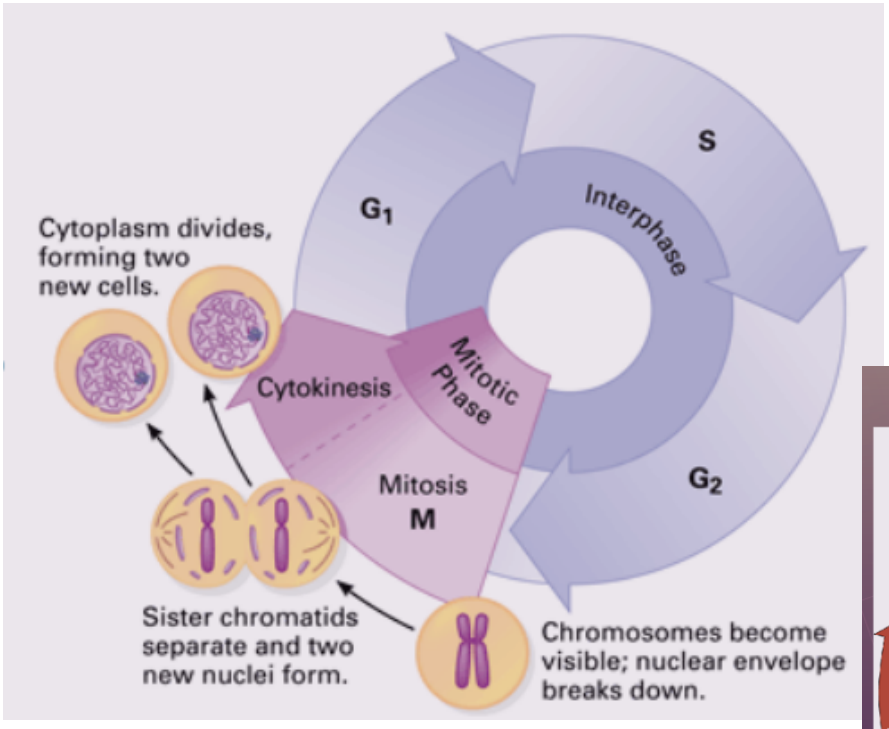
3. Gap 2 ($G_2$) phase: additional growth - each duplicated chromosome remains loosely packed as chromatin fibers

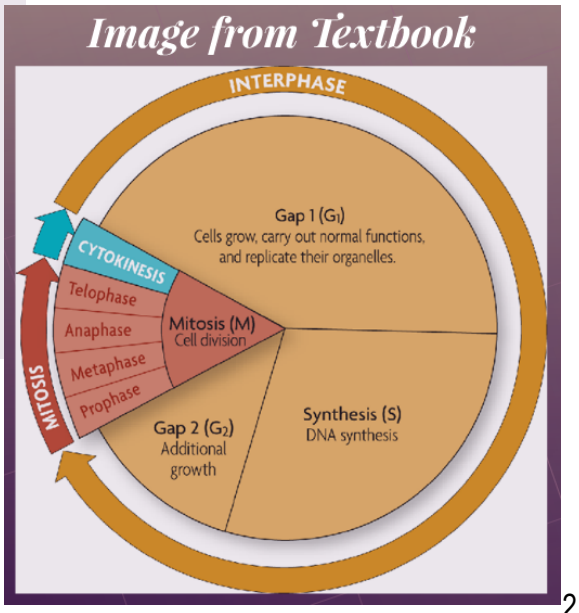
c. Mitotic Phase

i. Mitotic phase (M phase): stage of the cell cycle when the cell is actually dividing; _____

_____

1. Mitosis: process where the nucleus and the duplicated chromosomes divide and are evenly distributed, forming two "daughter" nuclei
2. Cytokinesis: process by which the cytoplasm is divided in two; usually begins before mitosis is completed



ii. The combination of mitosis and cytokinesis produces _____

_____.

iii. Mitosis is unique to eukaryotes.

iv. The rate of cell division varies with the need for those types of cells.

v. Some cells are unlikely to divide or never divide and remain in a stage called _____.

| FIGURE 5.2 CELL DIVISION | |
|---|---|
| CELL TYPE | APPROXIMATE LIFE SPAN |
| Skin cell | 2 weeks |
| Red blood cell | 4 months |
| Liver cell | 300–500 days |
| Intestine—internal lining | 4–5 days |
| Intestine—muscle and other tissues | 16 years |

## *III. Concept 5.2: Mitosis and Cytokinesis*

a. Overview

i. Interphase: chromatin of each chromosome doubles, normal growth and cell functions occur (90% of cell's life)

ii. Mitotic phase: takes place rapidly, distributing the duplicate sets of chromosomes to two daughter nuclei

iii. Cytokinesis: divides the cytoplasm, producing two daughter cells

b. Chromosomes

i. Chromatin: _____

_____

ii. Centromere: _____

iii. Telomere: _____

iv. Chromosomes: _____

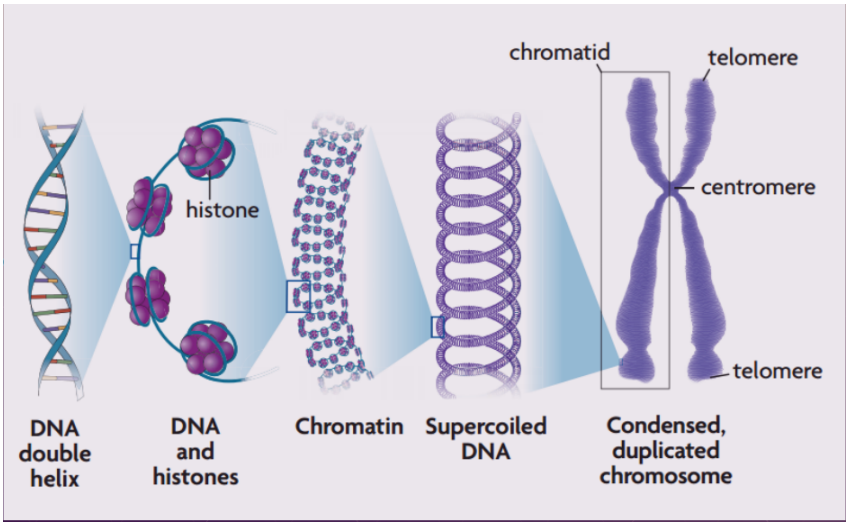
_____

1. (Each chromosome may contain many hundreds of genes.)

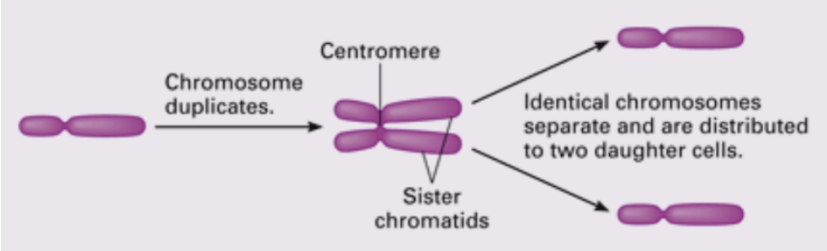
v. Sister chromatids: _____

_____

1. (Before cell division begins, a cell duplicates all of its chromosomes to make these.)




vi. Once separated from its sister, each chromatid is considered a full-fledged chromosome.




c. Human Cells

i. Humans have ____ pairs of chromosomes in their cells. (So you have ____ chromosomes in total.)

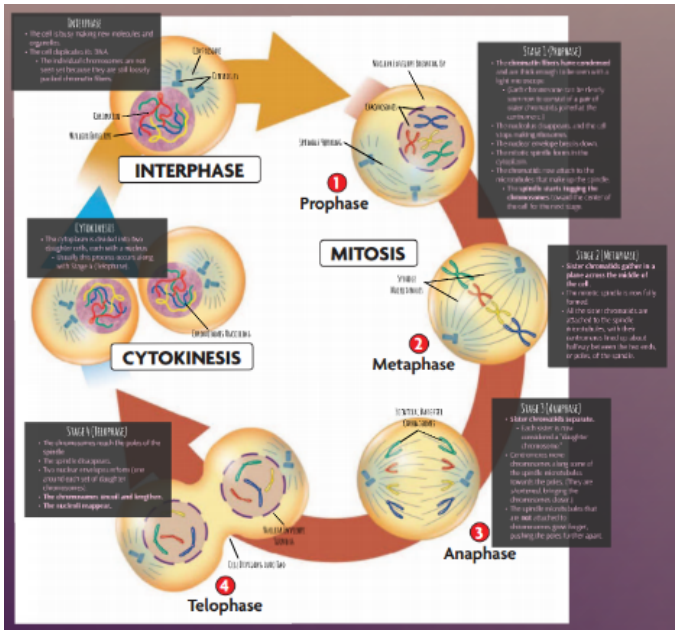
d. The Mitotic Phase

i. Spindle: _____

_____

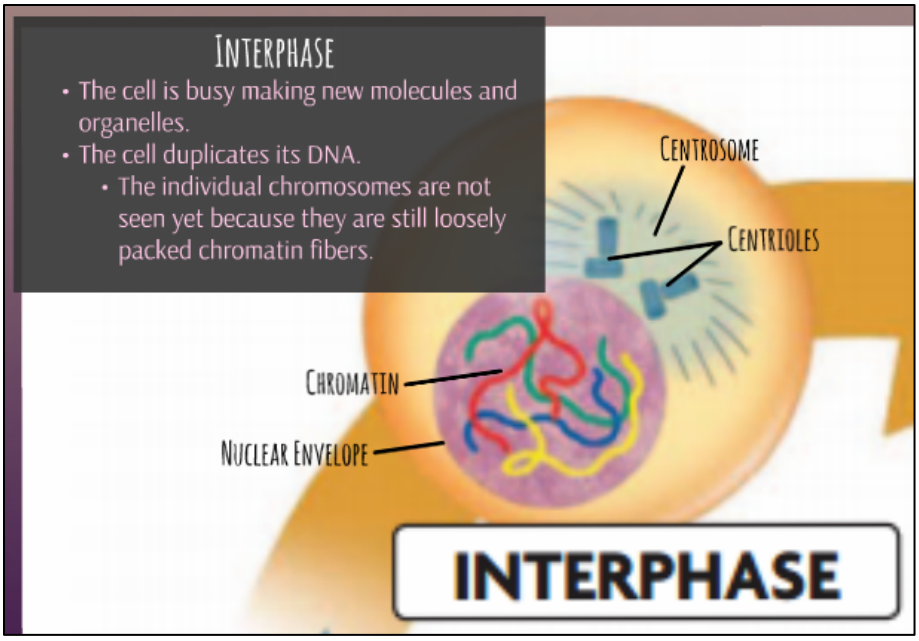
ii. Centrosome: _____

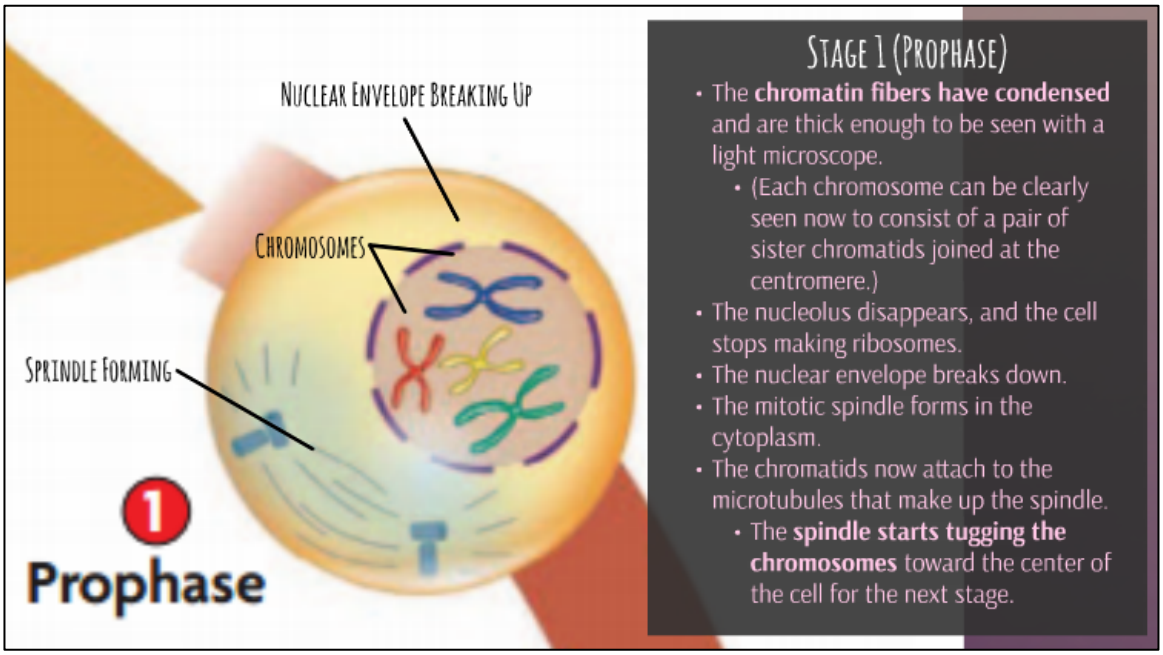
e. *Mitosis occurs in four stages. Your textbook with reference these by name. However, in this class you do not need to memorize stage names, just what is occurring within mitosis as a whole.*



## Interphase

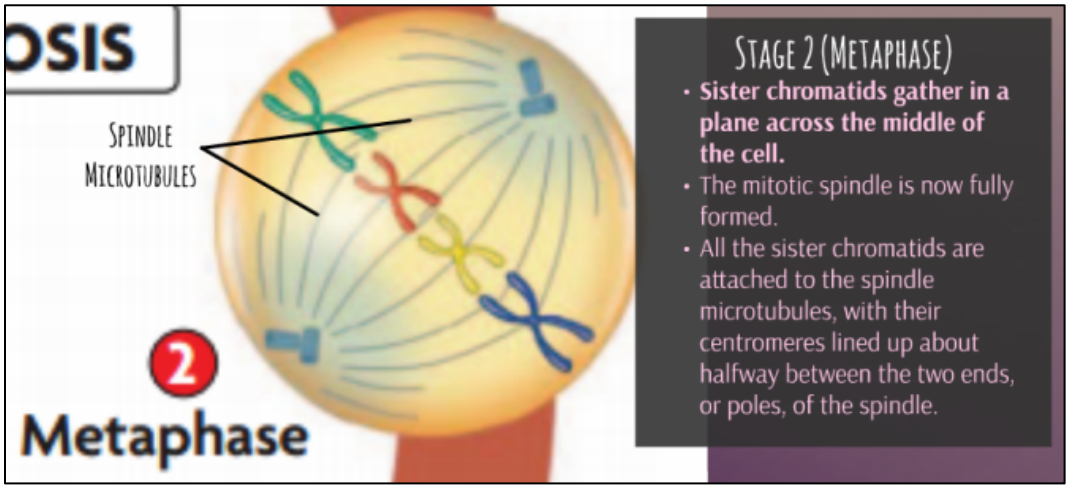
- The cell is busy making new molecules and organelles.
- The cell duplicates its DNA.
  - The individual chromosomes are not seen yet because they are still loosely packed chromatin fibers.



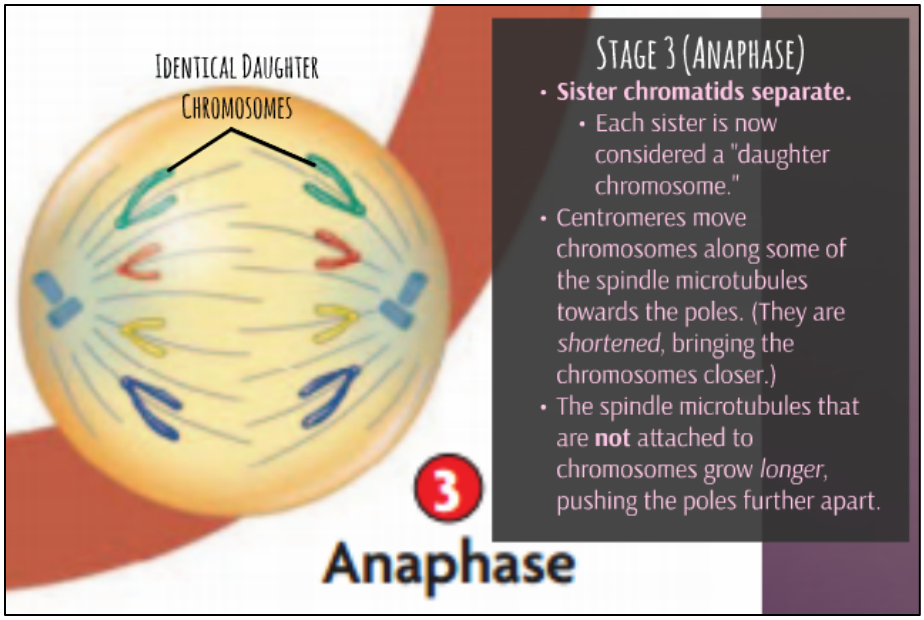

## Stage 1 (Prophase)

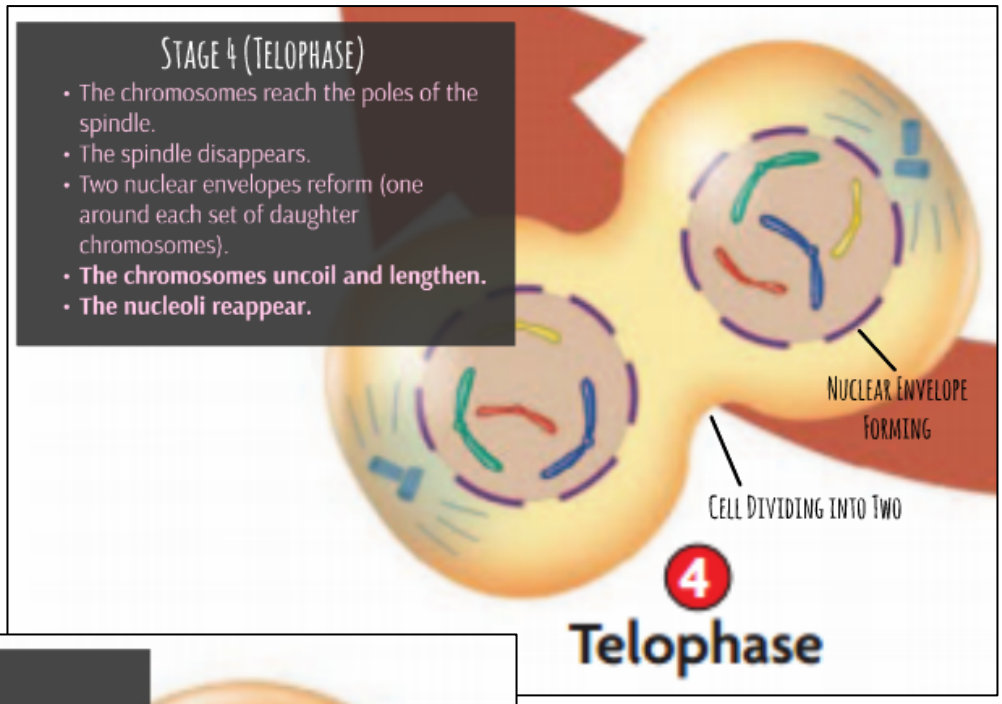
- The **chromatin fibers have condensed** and are thick enough to be seen with a light microscope.
  - (Each chromosome can be clearly seen now to consist of a pair of sister chromatids joined at the centromere.)
- The nucleolus disappears, and the cell stops making ribosomes.
- The nuclear envelope breaks down.
- The mitotic spindle forms in the cytoplasm.
- The chromatids now attach to the microtubules that make up the spindle.
  - The **spindle starts tugging the chromosomes** toward the center of the cell for the next stage.

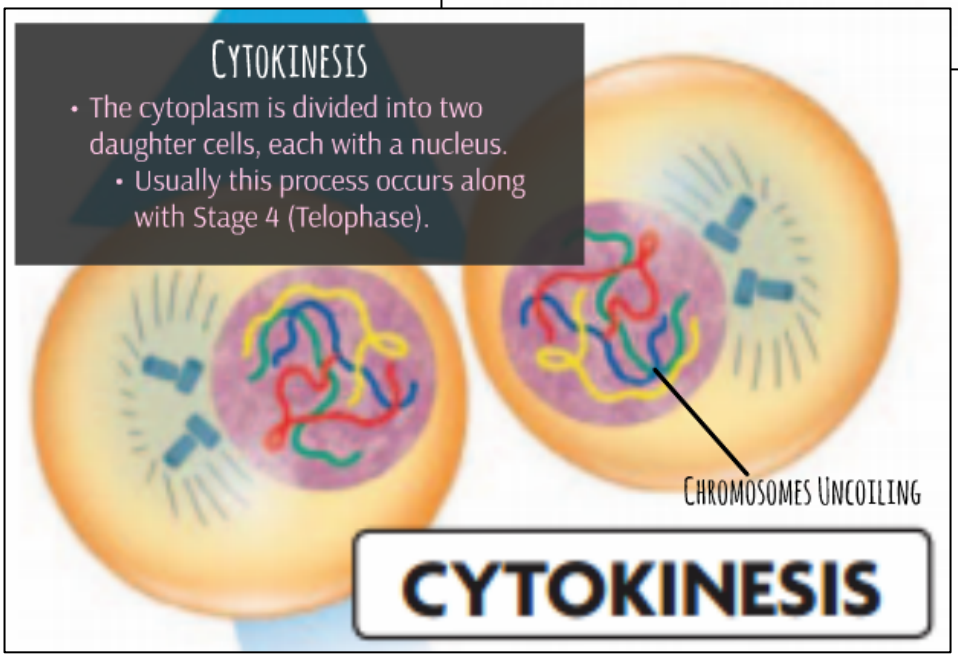


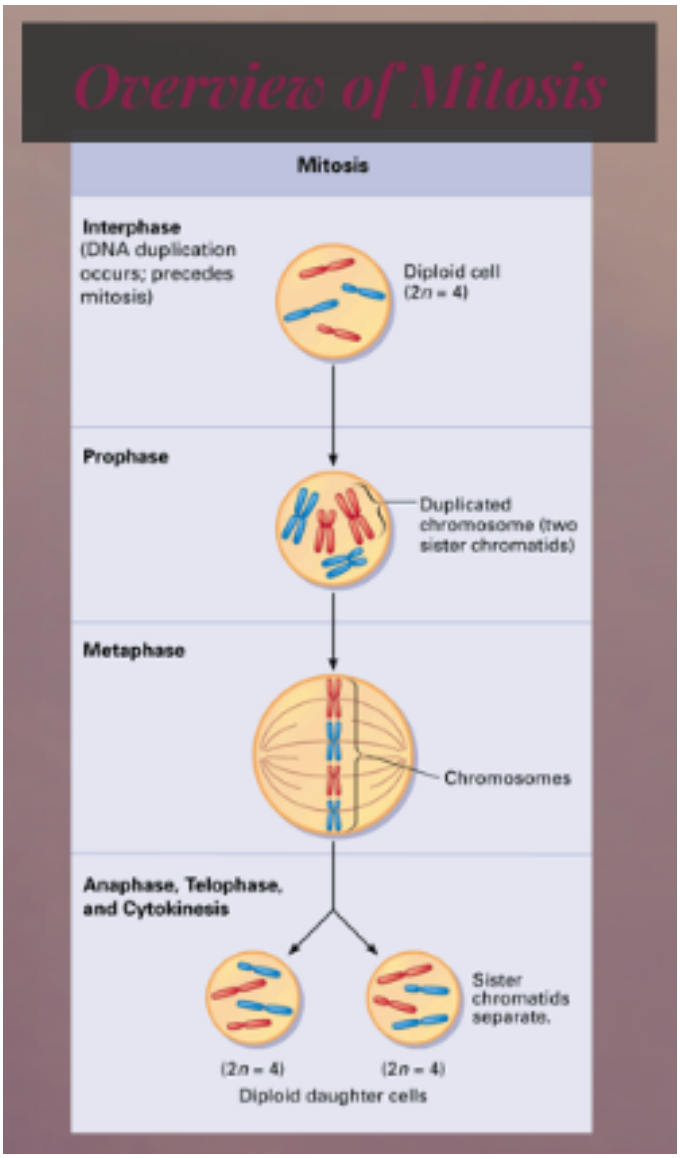

## Stage 2 (Metaphase)

- **Sister chromatids gather in a plane across the middle of the cell.**
- The mitotic spindle is now fully formed.
- All the sister chromatids are attached to the spindle microtubules, with their centromeres lined up about halfway between the two ends, or poles, of the spindle.


Identical Daughter Chromosomes
Stage 3 (Anaphase)
• Sister chromatids separate.
• Each sister is now considered a "daughter chromosome."
• Centromeres move chromosomes along some of the spindle microtubules towards the poles. (They are *shortened*, bringing the chromosomes closer.)
• The spindle microtubules that are **not** attached to chromosomes grow *longer*, pushing the poles further apart.
3
Anaphase


Stage 4 (Telophase)
• The chromosomes reach the poles of the spindle.
• The spindle disappears.
• Two nuclear envelopes reform (one around each set of daughter chromosomes).
• **The chromosomes uncoil and lengthen.**
• **The nucleoli reappear.**
Nuclear Envelope Forming
Cell Dividing into Two
4
Telophase


Cytokinesis
• The cytoplasm is divided into two daughter cells, each with a nucleus.
• Usually this process occurs along with Stage 4 (Telophase).
Chromosomes Uncoiling
CYTOKINESIS

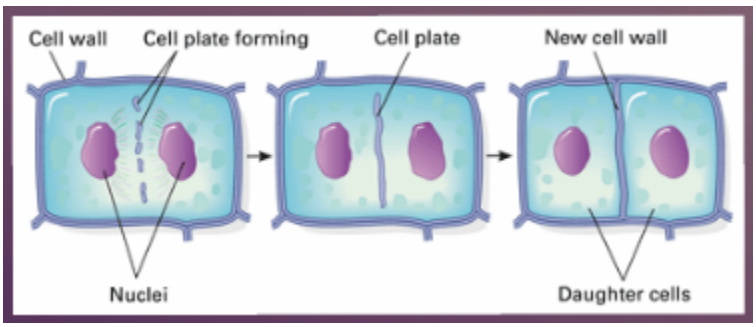



f. Cytokinesis

i. Cytokinesis: _____ _____, typically occurs during the fourth stage of mitosis (telophase)

ii. In animal cells, the first sign of cytokinesis is the appearance of an indentation around the middle of the cell.

iii. In plant cells, a disk containing cell wall material called a _____ forms inside the cell and grows outward.



## *IV. Concept 5.3: Regulation of the Cell Cycle*

a. The timing of cell division is critical to normal growth and development. When the "control system" for cell growth malfunctions, cells may reproduce at the wrong time or in the wrong place.

b. Cell Cycle Regulation

   i. External Factor

      1. Growth factors: _____

   ii. Apoptosis

      1. Apoptosis: _____
      2. The timing of cell division is critical to normal growth and development. When the "control system" for cell growth malfunctions, cells may reproduce at the wrong time or in the wrong place.

c. Tumors

   i. Tumor: _____

   _____

   *(fast reproduction rate and irregular appearance)*

      1. Benign tumors: _____

      _____ *(can sometimes cause health problems, but usually can be completely removed by surgery)*

      2. Malignant tumors: _____

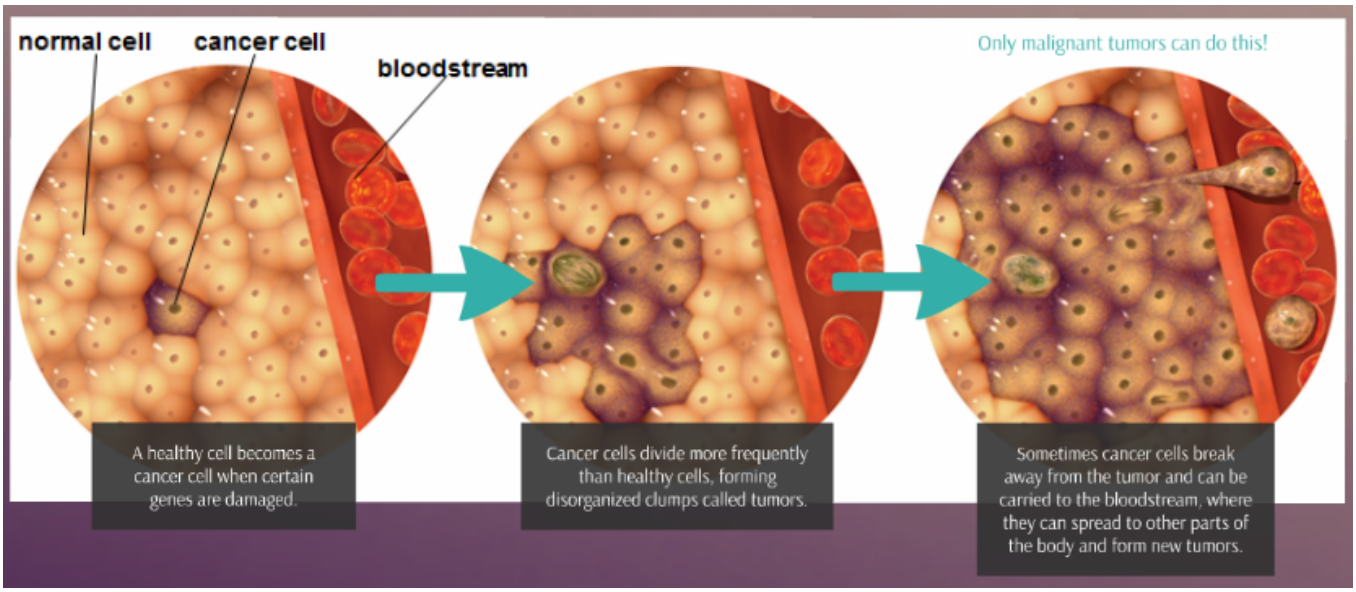
      _____ *(more problematic than benign – they spread to surrounding tissues)*

d. Cancer

   i. Cancer: a disease caused by the severe disruption of the mechanisms that normally control the cell cycle; _____, which if unchecked can result in death

   ii. Metastasis: _____

   _____ - allowing for new tumors to form elsewhere (This is what makes cancer so dangerous.)




iii. How does cancer happen?

1. Gene Mutations caused by: _____
    a. Genetics: some gene mutations are inherited
    b. Carcinogens: _____

    _____

2. *When genes are mutated, the cell cycle may speed up, causing a normal cell to no longer perform its normal functions and to divide and spread quickly – labeling it as a "cancer cell."*

e. Cancer Treatment

i. *There is no single "cure" – just multiple approaches that can help control or halt the progress of the disease.*

ii. Malignant tumors can be:

1. _____
2. _____
3. _____

iii. Radiation Therapy: exposing the parts of the body with cancerous tumors to high-energy radiation, which disrupts cell division

1. Side effects: can damage cells of the ovaries or testes, causing sterility

iv. Chemotherapy: treating the patient with anti-mitotic drugs that disrupt cell division

1. Side effects: nausea or hair loss

## V. *Concept 5.4: Asexual Reproduction*

a. Types of Reproduction

i. Asexual Reproduction

1. Usually unicellular organisms
2. A single cell or group of cells each duplicates its genetic material and then splits into _____ _____ (offspring inherit all their genetic material from just one parent)
3. Example: Paramecium, some sea stars

ii. Sexual Reproduction

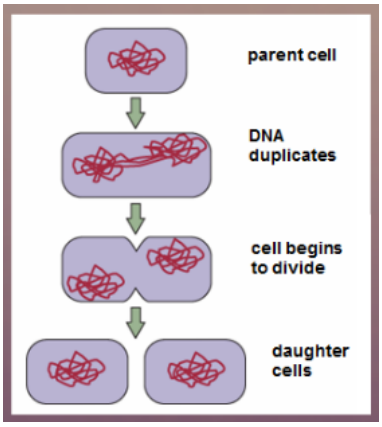
1. Usually multicellular organisms
2. When two parents are involved in the production of offspring - _____ _____ (involves the union of sex cells, such as an egg and a sperm)
3. Example: plants, animals

b. Asexual Reproduction

i. Asexual reproduction: creation of offspring from a single parent

ii. Binary fission: _____ _____ _____- occurs in prokaryotes

1. *Binary fission is very similar to mitosis. However, prokaryotes do not have a nucleus, so the division is distinctly different.*




c. Advantages and Disadvantages of Asexual Reproduction

i. Advantages

1. _____ (often requires less time and energy)
2. _____ (new traits could be harmful in some environments)

ii. Disadvantages

1. _____ (which may be needed if environment changes)

## Chapter 8: From DNA to Proteins

### *I. Concept 8.1: Identifying DNA as the Genetic Material*

a. The Scientists Who Discovered DNA

i. Watson & Crick

1. James Watson and Francis Crick modeled DNA's structure with tin and wire.
2. Using the clues provided by Franklin's work, Watson and Crick created a model in which two strands of nucleotides wound about each other.
3. This formed a twisting shape called a _____.

a. This new model successfully represented DNA's structure.


### *II. Concept 8.2: Structure of DNA*

a. The Building Blocks of DNA

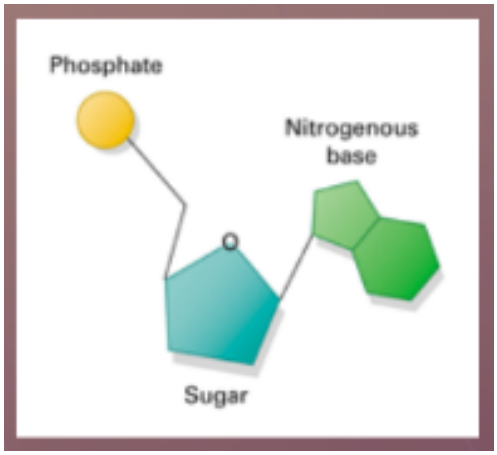
i. Deoxyribonucleic acid (DNA): _____

_____

ii. Nucleotide: _____

_____ (Nucleic acids are a polymer.)

1. DNA uses four different types of nucleotides - but the chemical structure of each type is very similar.
2. Nucleotides have three parts:
   a. A ring-shaped sugar called _____
   b. A _____ group
   c. A _____: a single or double ring of carbon and nitrogen atoms with functional groups (nitrogenous means "nitrogen-containing")



b. Nitrogenous Bases

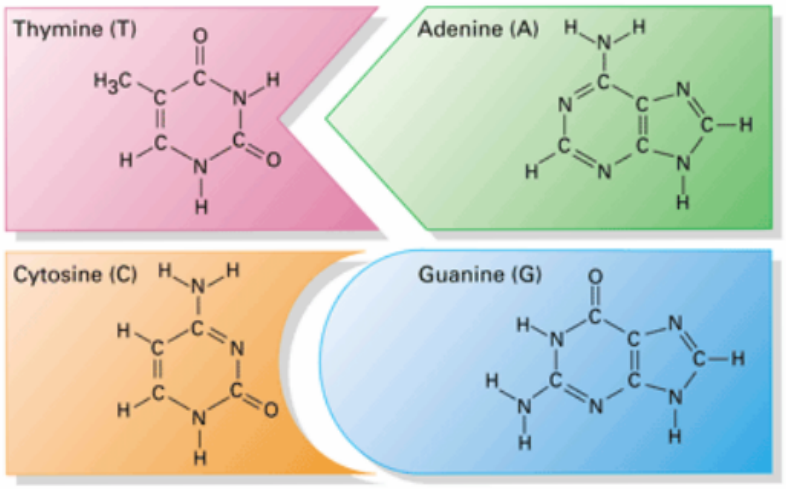
i. The four nucleotides found in DNA differ only in their nitrogenous bases.

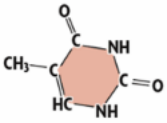
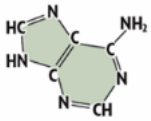
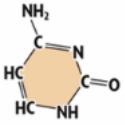
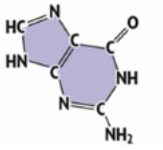
1. single-ring structures:

a. _____ (T) and _____ (C)

2. larger, double-ring structures:

a. _____ (A) and _____ (G)



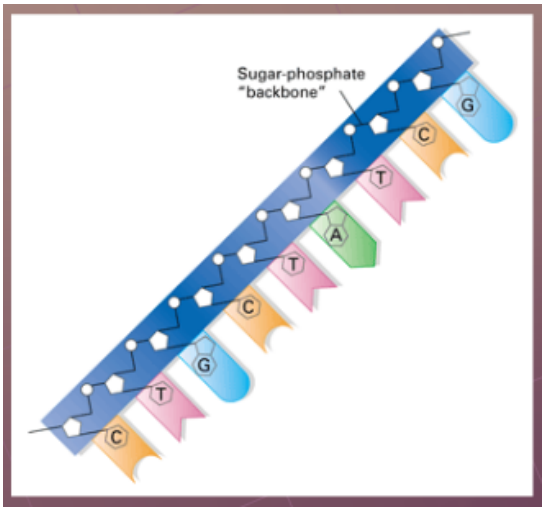

| Name of Base | Structural Formula | Model | Name of Base | Structural Formula | Model |
|---|---|---|---|---|---|
| thymine |  | T | adenine |  | A |
| cytosine |  | C | guanine |  | G |

c. DNA Strands

i. Nucleotide monomers join together by covalent bonds between the sugar of one nucleotide and the phosphate of the next, forming a _____.

1. The nucleotides can combine in many different sequences.

2. The part of DNA shown has 9 nucleotides arranged in the order CTGCTATCG. This arrangement is only one of many possible.



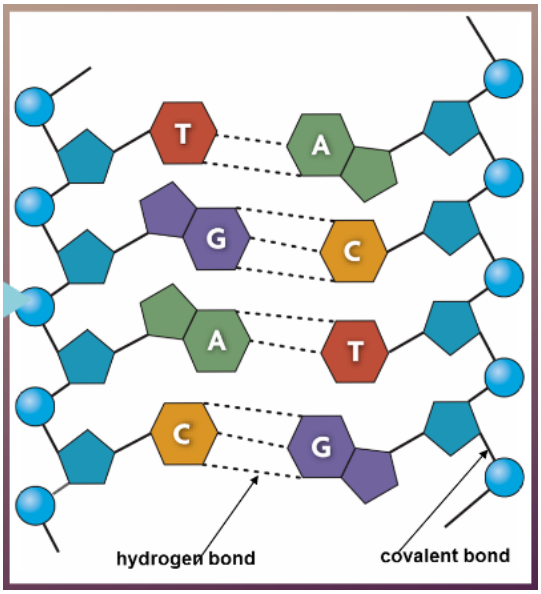
d. DNA's Structure

i. The Double Helix

1. Remember: James Watson and Francis Crick modeled DNA's 3-D structure with tin and wire that formed a twisting shape called a double helix.
2. The _____ _____ _____ _____, forming the double helix.
3. Watson and Crick's discovery built on the work of Rosalind Franklin and Erwin Chargaff.

ii. Complementary Base Pairs

1. *Individual structures of the nitrogenous bases determine very specific pairings between the nucleotides of the two strands of the double helix. These pairings are due to the sizes of the bases and their abilities to form hydrogen bonds with each other.*
   a. The _____ pairs with the _____.
   b. The _____ pairs with the _____.
      i. *(A is said to be "complementary" to T, and G is complementary to C.)*
2. Each base must pair up with its complementary base.




**___ pairs with ___, and**

**___ pairs with ___.**

III. ***Concept 8.3: DNA Replication***

a. Template Mechanism

i. *Remember: Cells duplicate their DNA in Interphase before Mitosis/Meiosis.*

ii. How do cells duplicate DNA?

1. DNA-copying uses a _____.

a. This means it uses one part of the DNA to make the opposite side.

iii. How can cells do this?

1. _____!

2. *(Remember: A pairs with T, and G pairs with C.)*

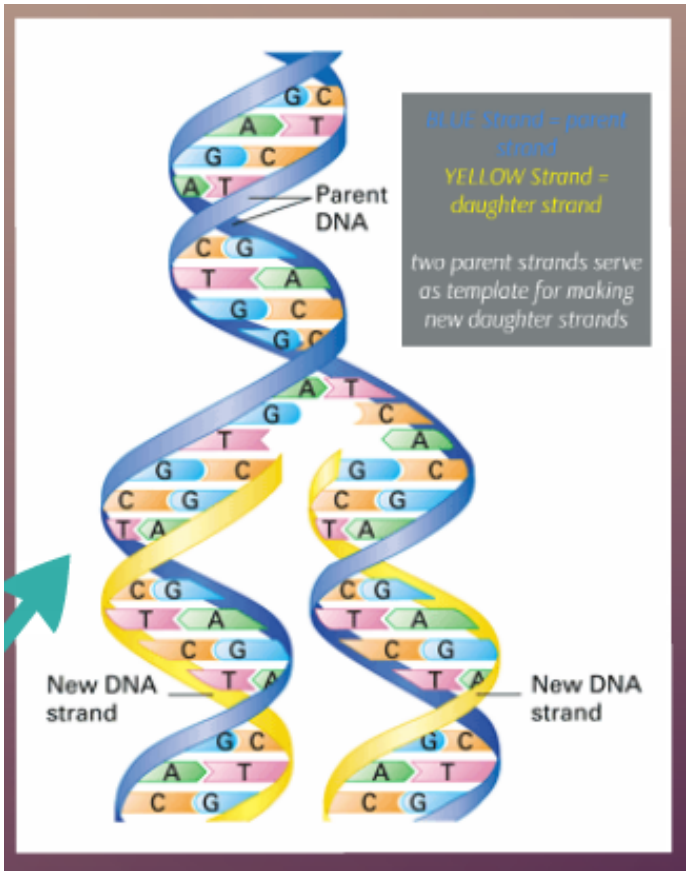
3. Know the sequence of bases on one strand of DNA → Determine the sequence on the other

iv. DNA replication: _____

_____

v. Daughter strands: _____

_____




b. Replication of the Double Helix

i. DNA replication is important when a cell wants to start mitosis.

ii. Without DNA replication, your DNA wouldn't be in every cell!