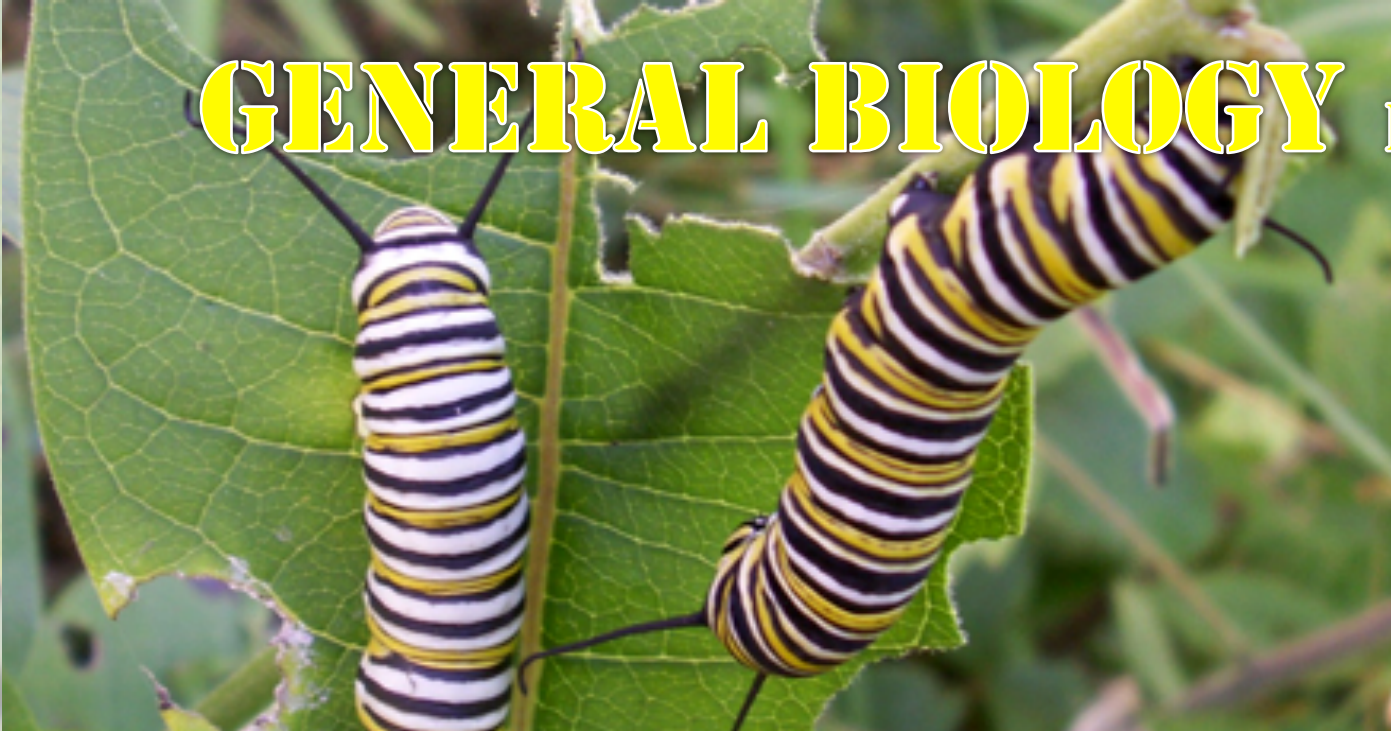


GENERAL BIOLOGY

BIOL 202/2



CHAPTER 6: CHROMOSOMES AND CELL DIVISION



Continuity and variety

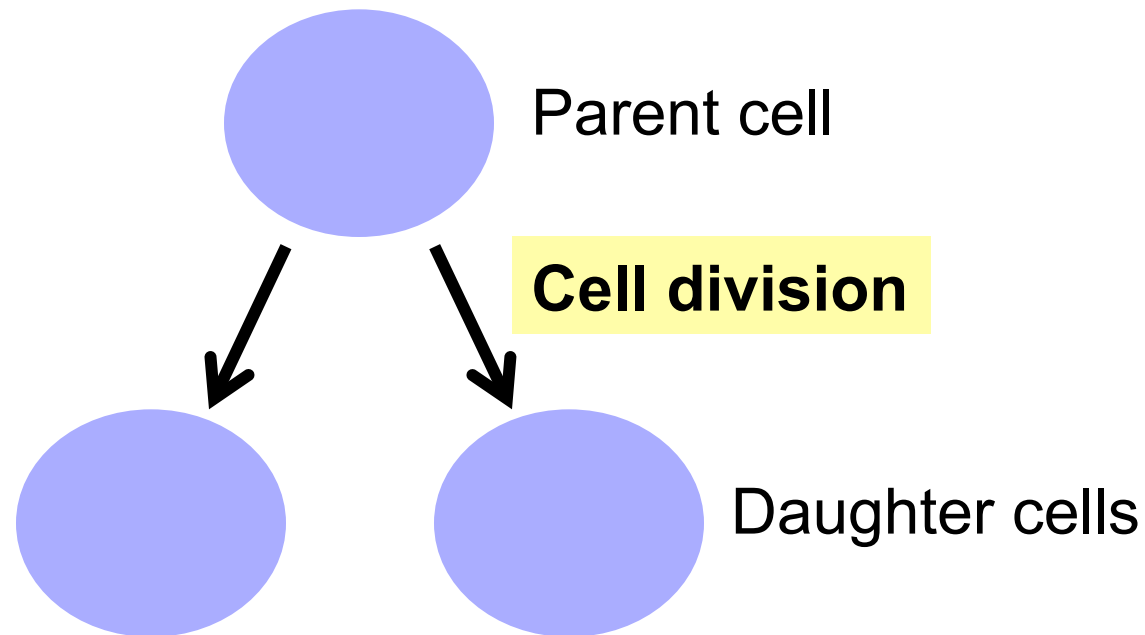
Learning Objectives

- Understand and be able to describe the different types of cell division
 - ▣ Understand and be able to explain how through mitosis worn out old cells are replaced with fresh new duplicates
 - ▣ Understand and be able to explain how gametes are generated through meiosis
- Describe the sex differences in the chromosomes
- Discuss the consequences of deviations from the normal chromosome number

Cell Division

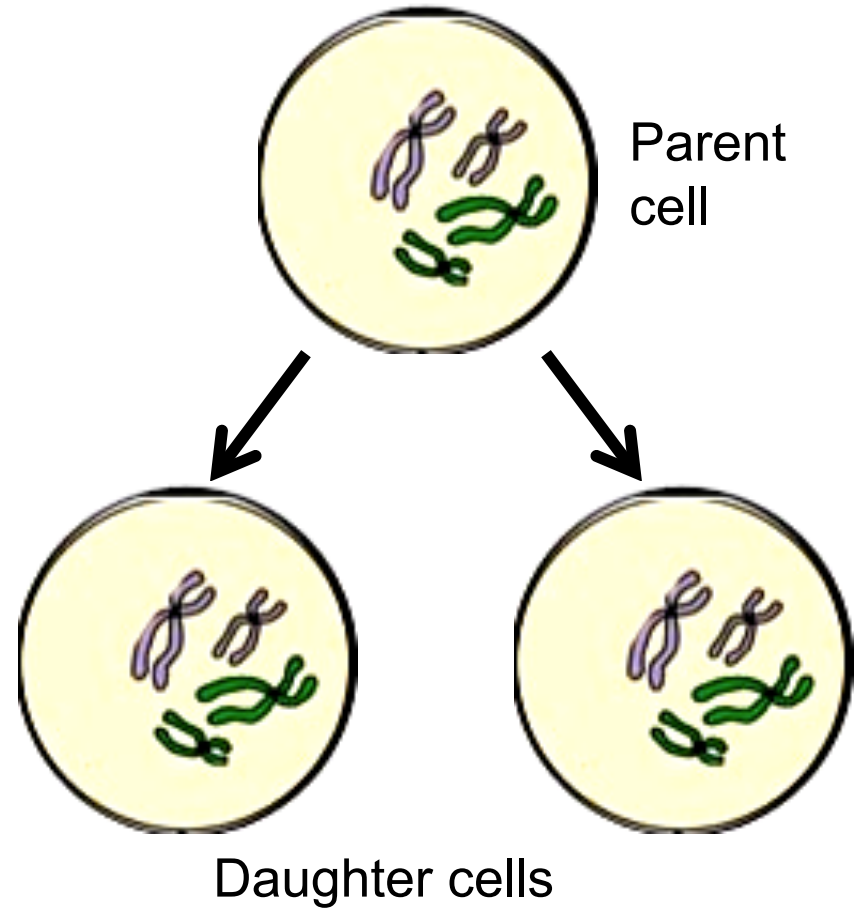
Cell Theory “All organisms are composed of cells and all cells come from preexisting cells.”

New cells are generated by cell division.



Cell division

- Cells must accurately distribute genetic materials (chromosomes) into daughter cells.

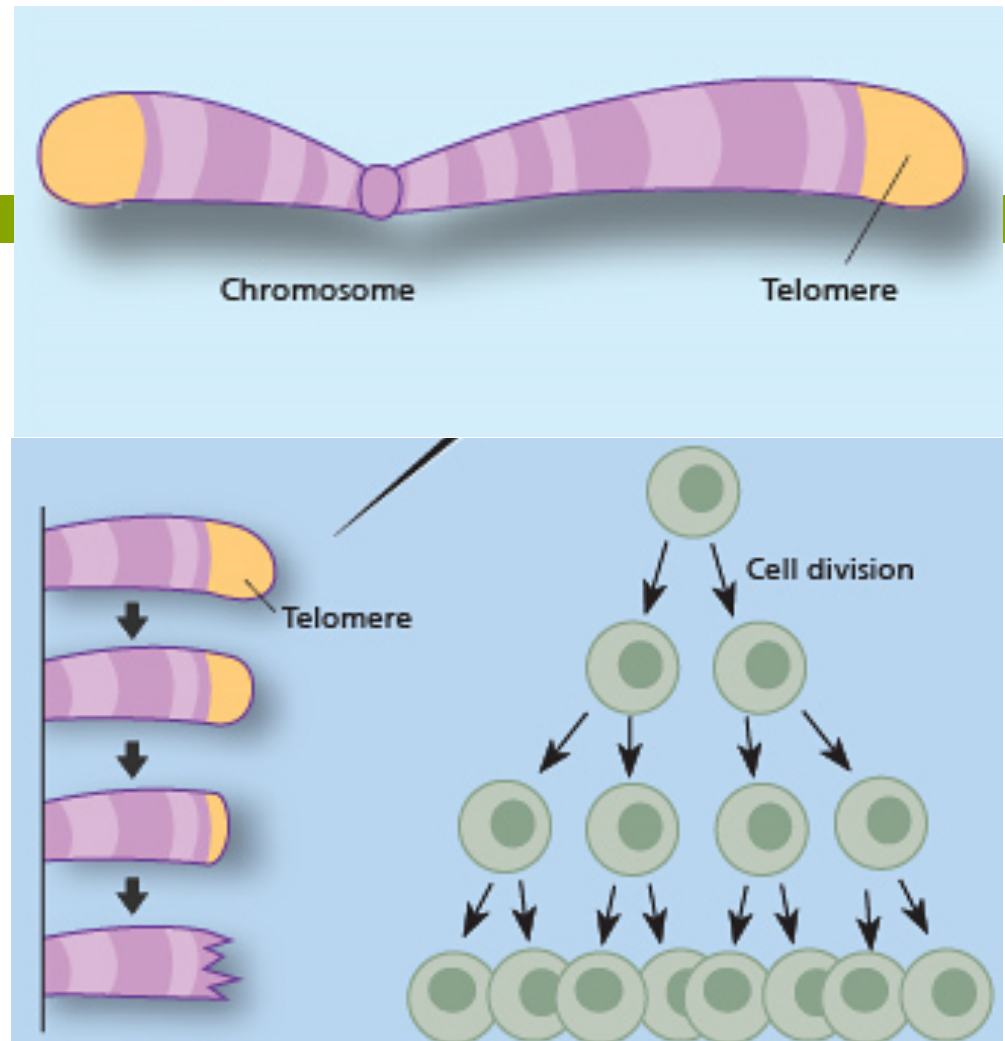


Cell Division

- Cell division is an ongoing process in most organisms and their tissues; disruptions to normal cell division can have serious consequences.
- In eukaryotic cells, a protective section of DNA called the telomere, at each end of every chromosome, plays a role in keeping track of cell division, getting shorter every time the cell divides.
- If telomeres become too short, additional cell divisions cause the loss of essential DNA and cell death.
- Cells that rebuild their telomeres with each division can become cancerous.

Telomeres

- A protective cap at the end of the DNA.
- Every time a cell divides, the telomere gets shorter.
- Cells stop dividing when telomere is gone completely

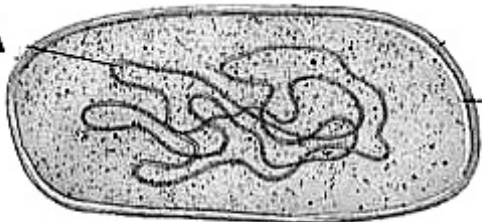


Cell division

Prokaryote

- Binary fission

DNA

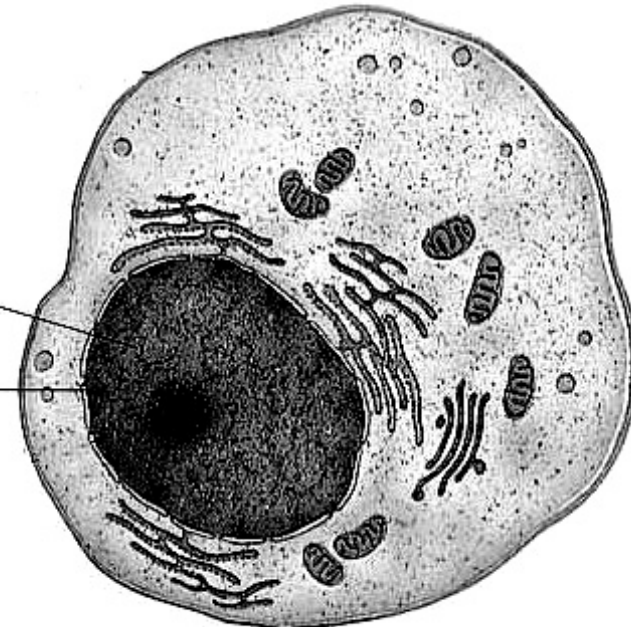


Prokaryotic Cell

Eukaryote

1. Mitosis
2. Meiosis

DNA
Nucleus

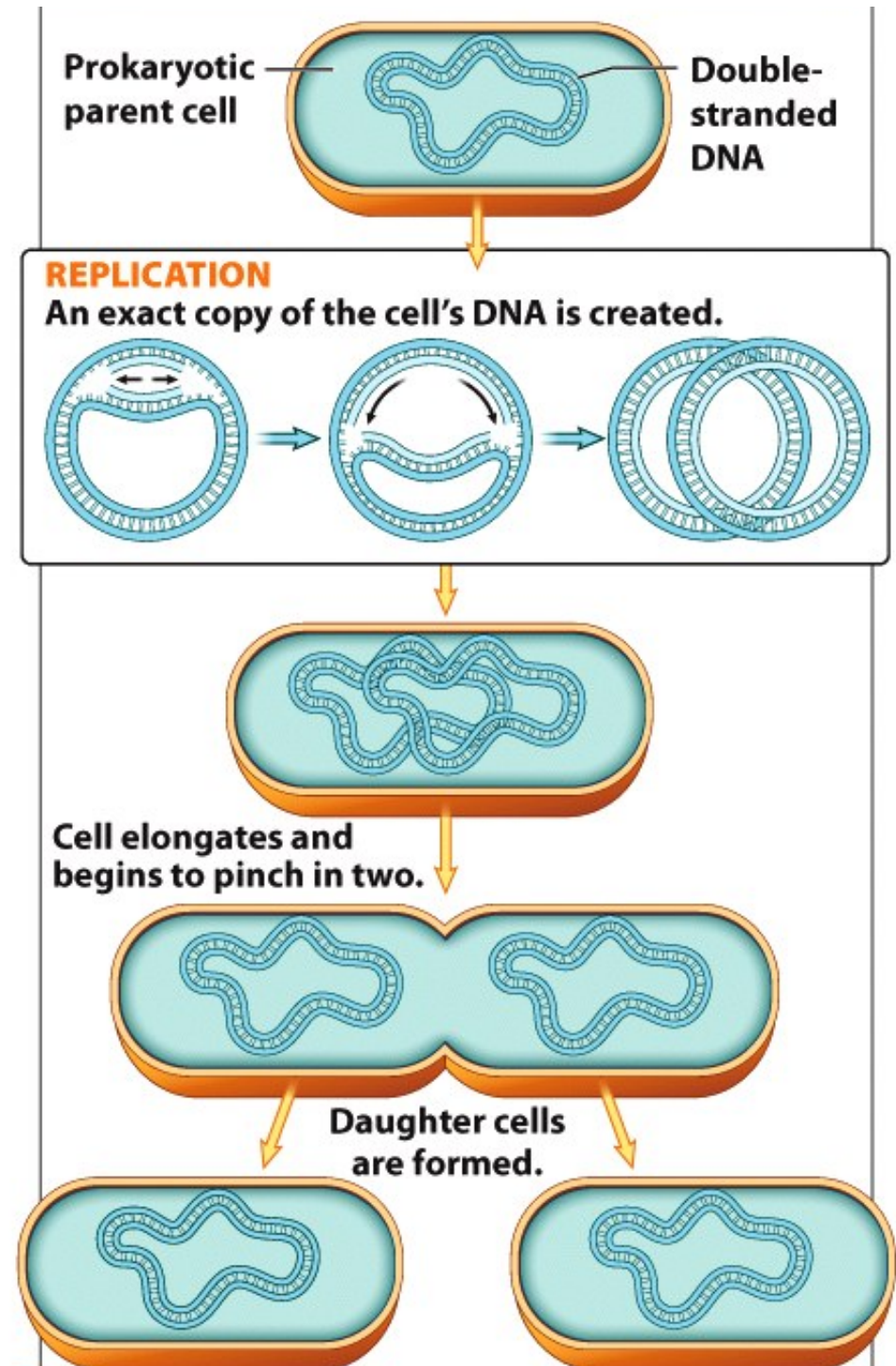


Eukaryotic Cell

Prokaryotic cell divide by binary fission

Bacteria divide by a type of asexual reproduction called binary fission:

- 1. DNA replication:** Before division, cell makes a second copy of chromosomal DNA.
- 2.** Cell elongates and is pinched into two new cells.
- 3.** Each daughter cell contains one copy of DNA.



Two types of cells in higher organisms

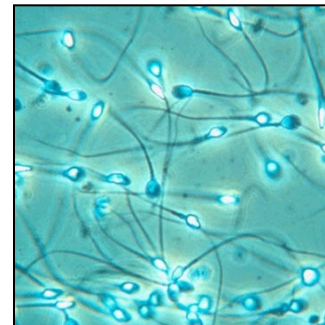


- **Somatic cells**

- ▣ Cells that make up body.
- ▣ New somatic cells are produced by **mitosis**

- **Gametes**

- ▣ Sperm and eggs (reproductive cells)
- ▣ Produced after **meiosis**.

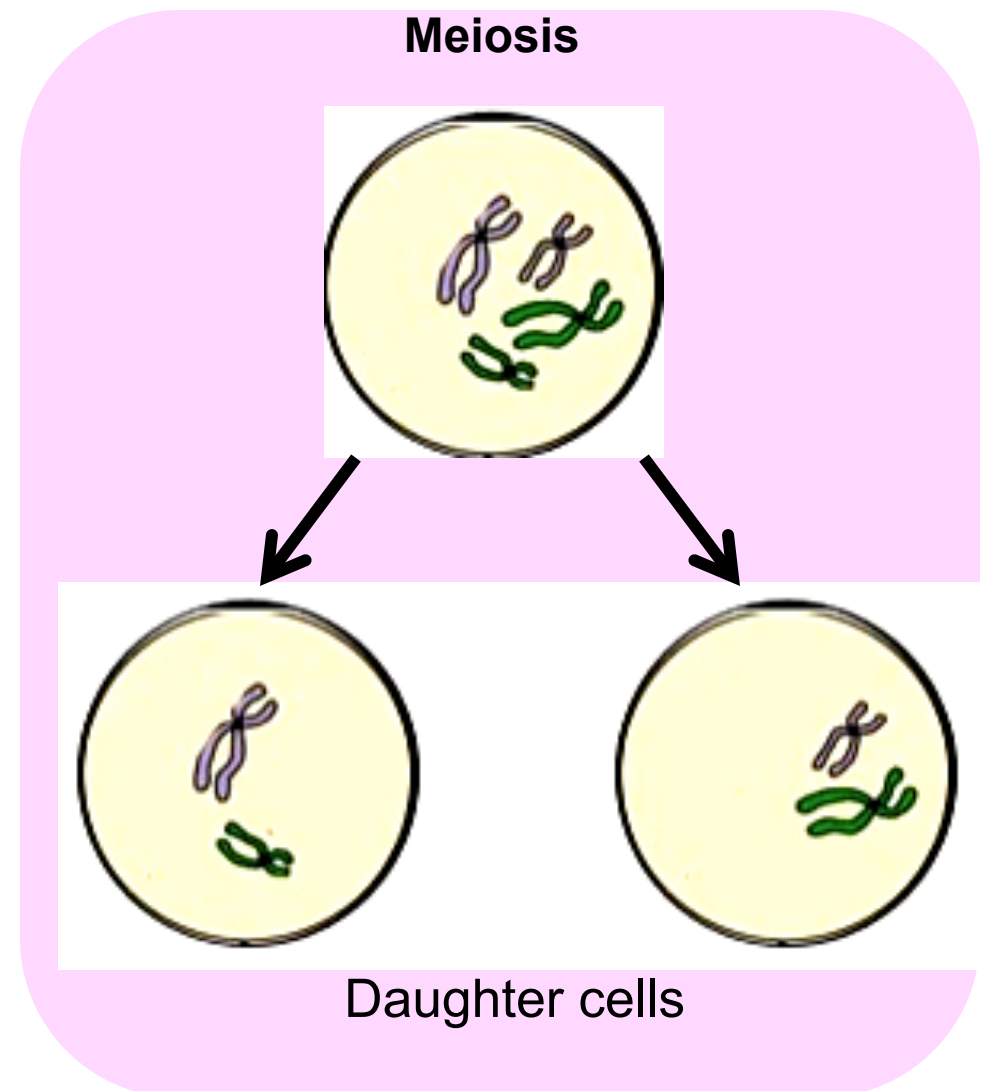
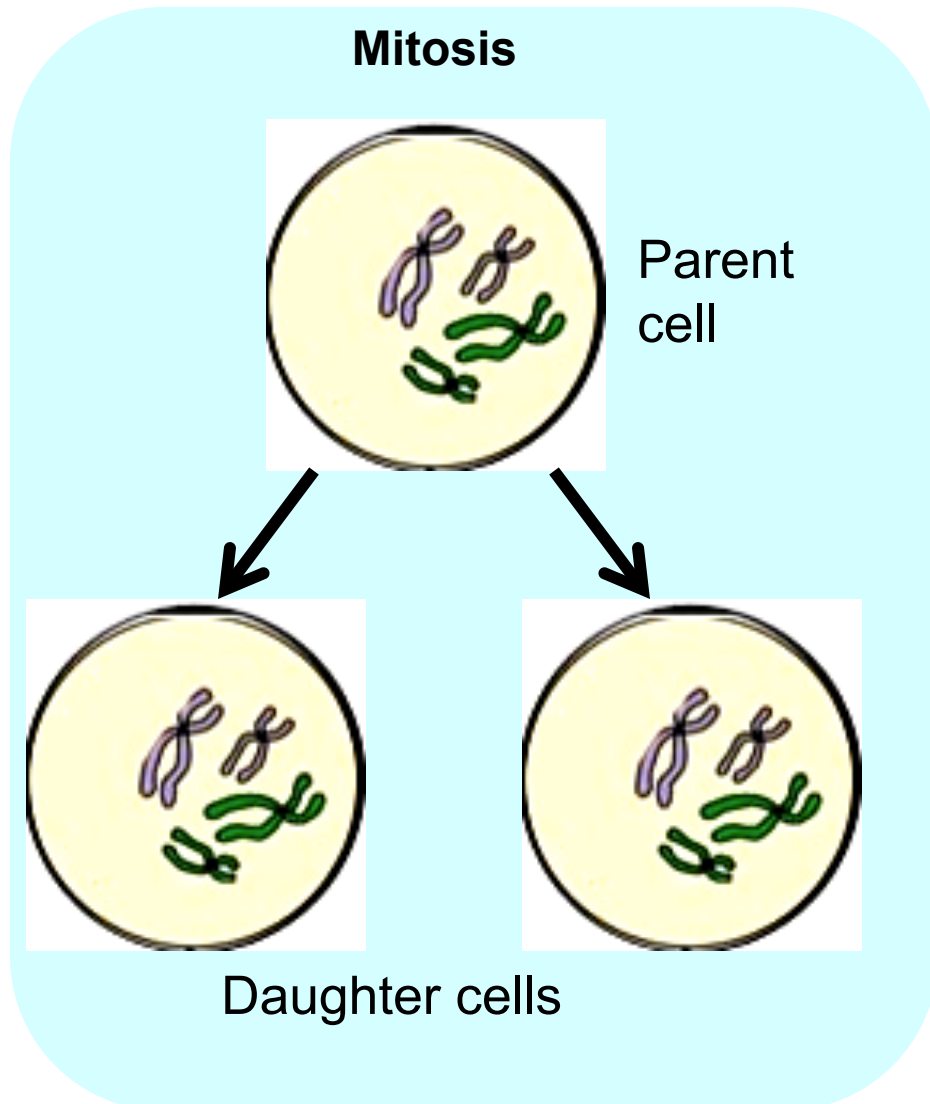


Human Chromosomes

- Somatic cell contains 46 chromosomes (two sets of 23 chromosomes)
 - ▣ 44 non-sex chromosomes
 - ▣ 2 sex chromosomes
- Gamete contains 23 chromosomes.
 - ▣ 22 non-sex chromosomes
 - ▣ 1 sex chromosome



Two types of cell division: Mitosis vs Meiosis



Two types of cell divisions in eukaryotes

- **Mitosis**

- ▣ Cell division of somatic cells
- ▣ Creates genetically identical daughter cells

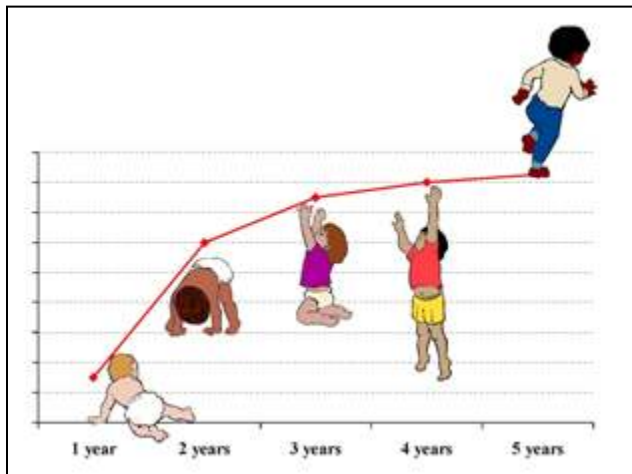
- **Meiosis**

- ▣ Cell division to produce gametes
- ▣ Daughter cells contain only half of genetic materials
- ▣ Results in daughter cells different in genetic compositions

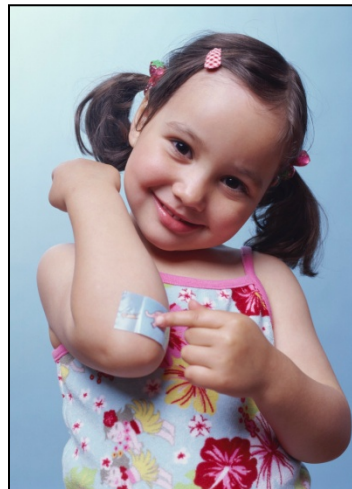
MITOSIS

Cell division to produce somatic cells

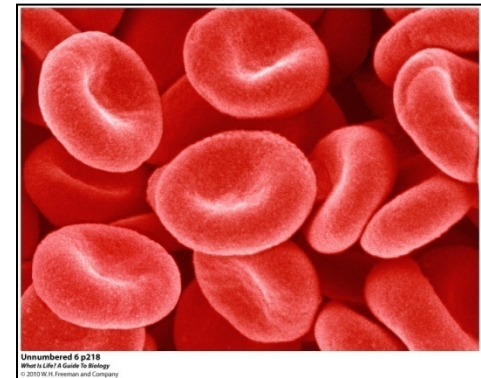
Involved in:



Growth

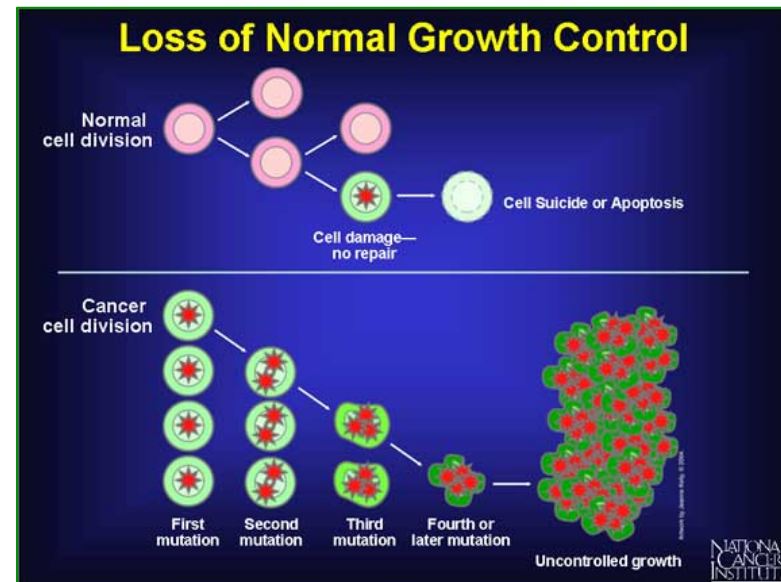


Cell replacement



To divide or not to divide

- Timing and number of cell divisions is strictly controlled.
- Too few cell divisions → no or little growth, aging
- Too many cell divisions → cancer



Cell Cycle

- Eukaryotic somatic cells alternate in a cycle between cell division and other cell activities.
- The cell division portion of the cycle is called the **mitotic phase**.
- The remainder of the cell cycle, called **interphase**, consists of two gap phases (during which cell growth and other metabolic activities occur) separated by a DNA synthesis phase during which the genetic material is replicated.

Cell Cycle

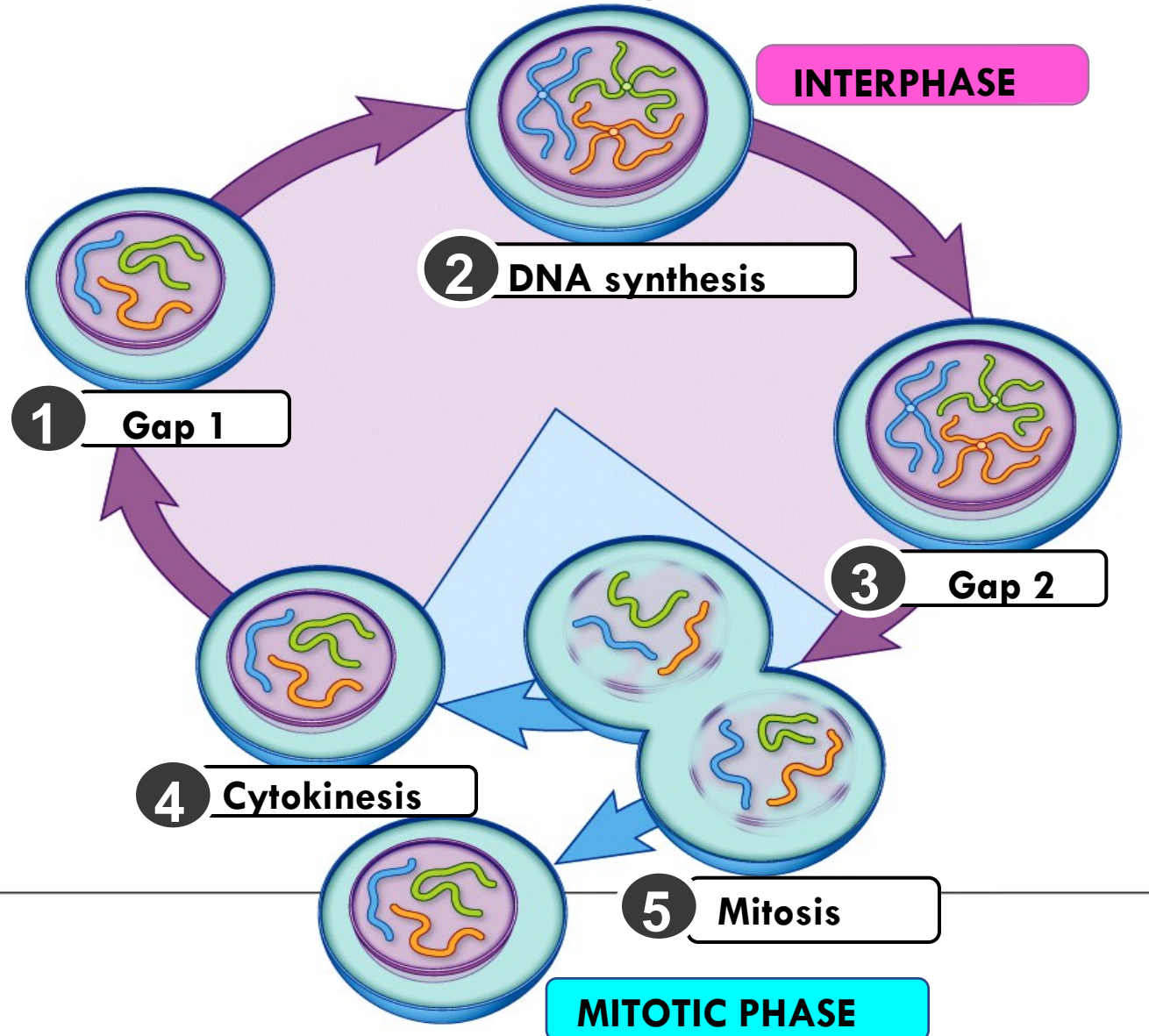
Cell cycle is a series of events leading to cell division

Interphase

- Gap 1
- DNA synthesis
- Gap 2

Mitotic phase

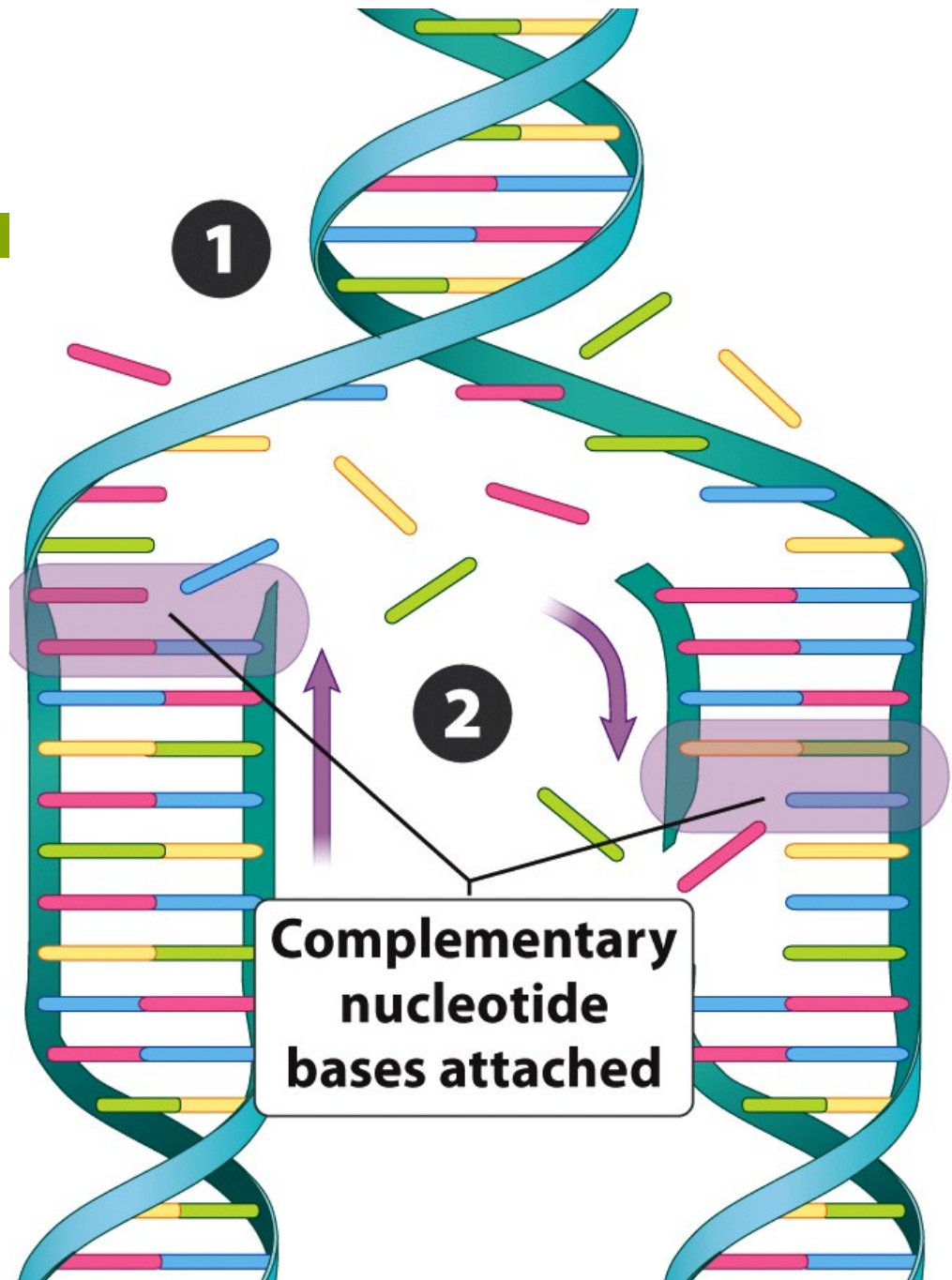
- Mitosis
- Cytokinesis



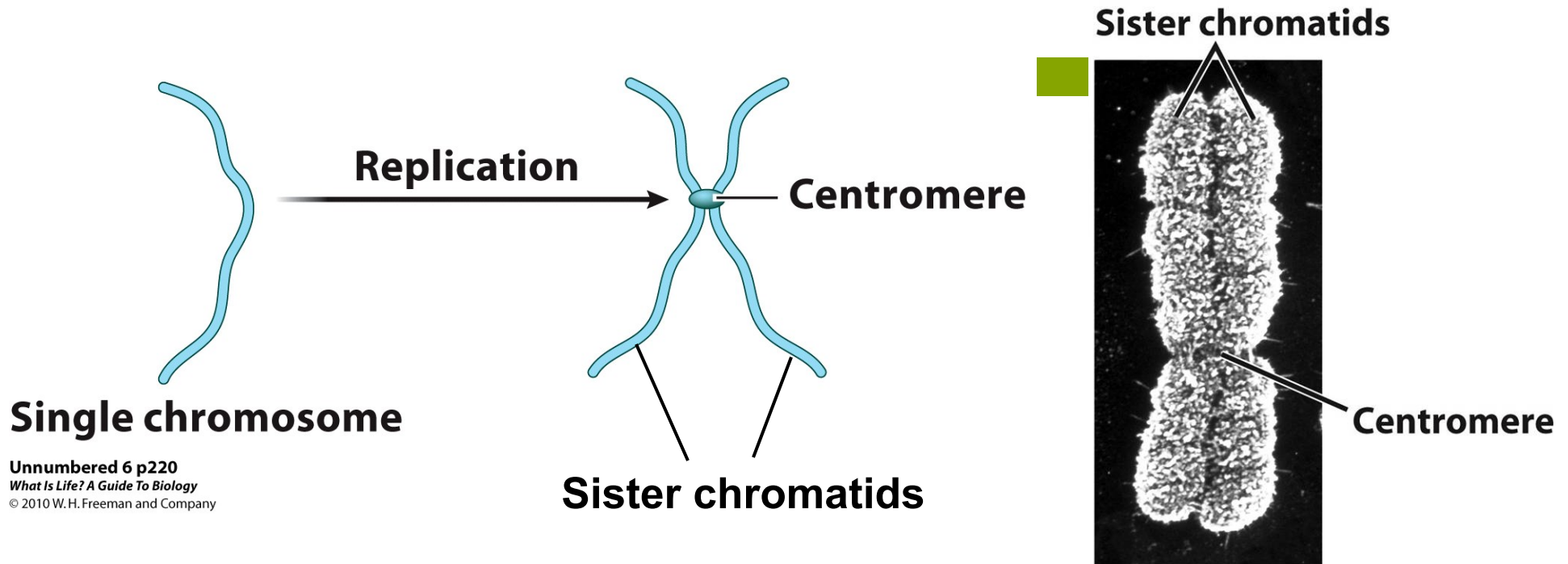
DNA Replication

- Every time a cell divides, the cell's DNA must duplicate itself so that both new cells have all the DNA of the parent cell.
- Two strands of DNA unzip, exposing bases on each strand.
- New strand of DNA is created using the original DNA as a template.

	Adenine
	Cytosine
	Guanine
	Thymine



DNA Replication



- Chromosomes replicate during the DNA synthesis phase of interphase.
- The replicated DNA molecules are called **sister chromatids**.
- Sister chromatids are joined together at the **centromere**.

Chromosomes
replicate during
interphase

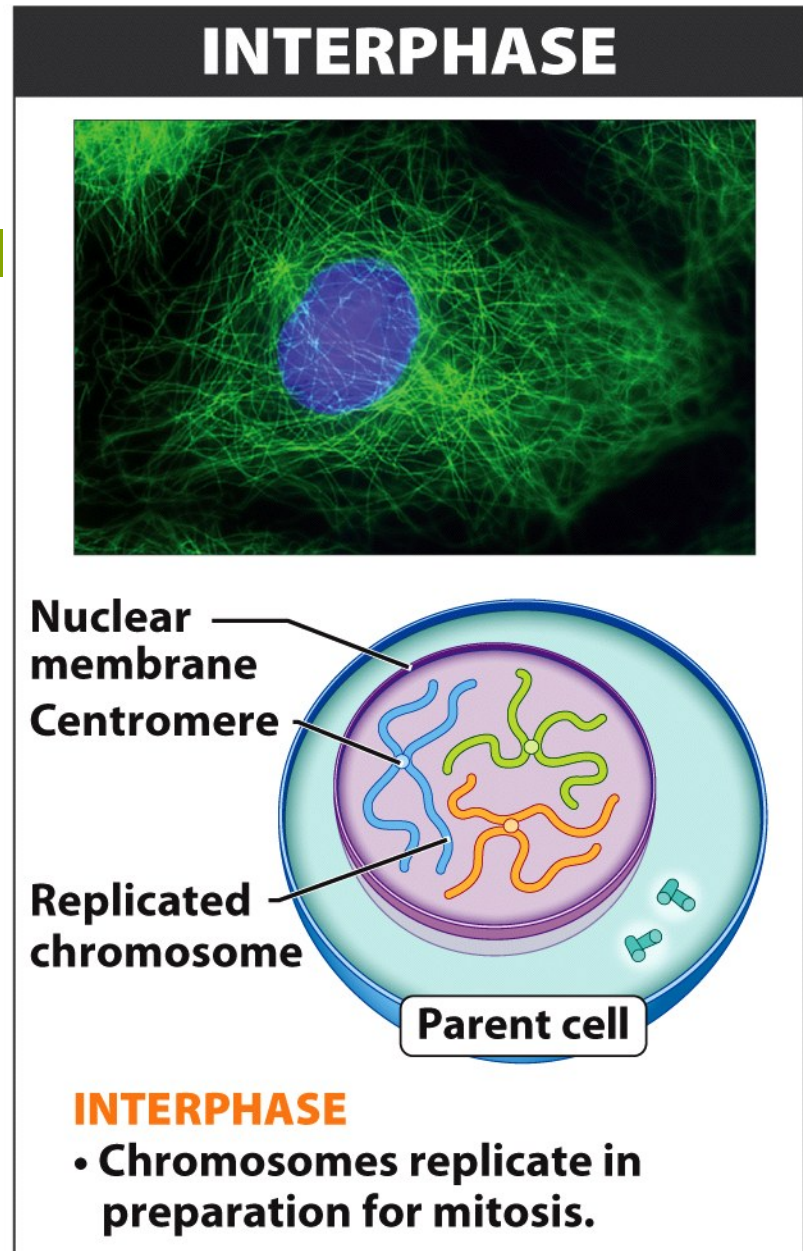
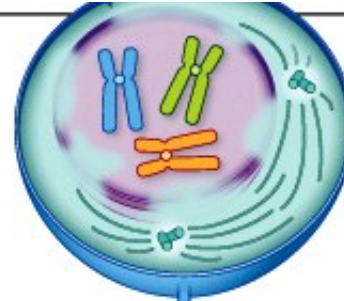


Figure 6-9 part 1
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Four phases of mitosis

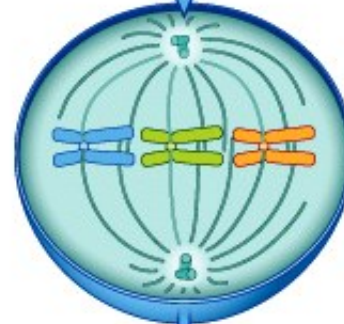
MITOSIS

1 Chromosomes condense.



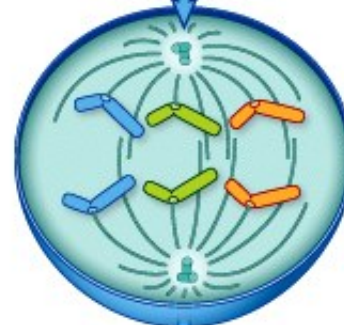
Prophase

2 Chromosomes line up in the middle of the cell.



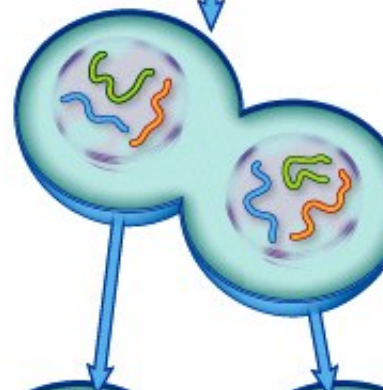
Metaphase

3 Each chromosome is pulled apart from its duplicate.



Anaphase

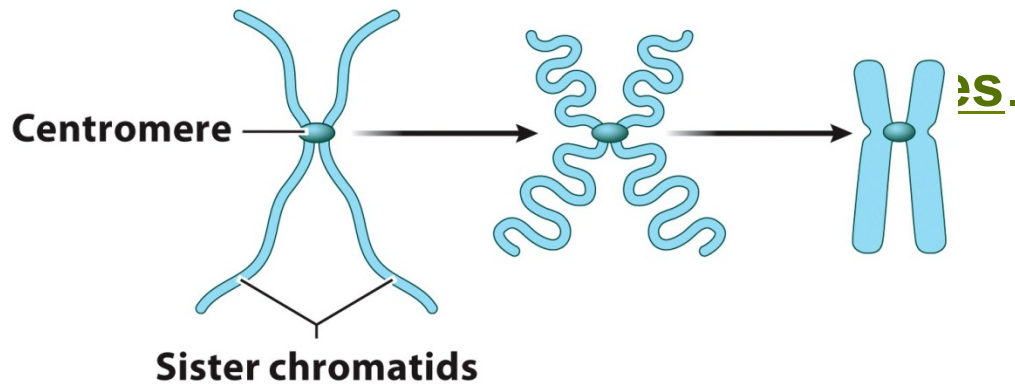
4 New membranes form around each complete set of chromosomes and the cell divides.



Telophase

Prophase

1. Nuclear envelope disappears.
2. Sister chromatids become condensed

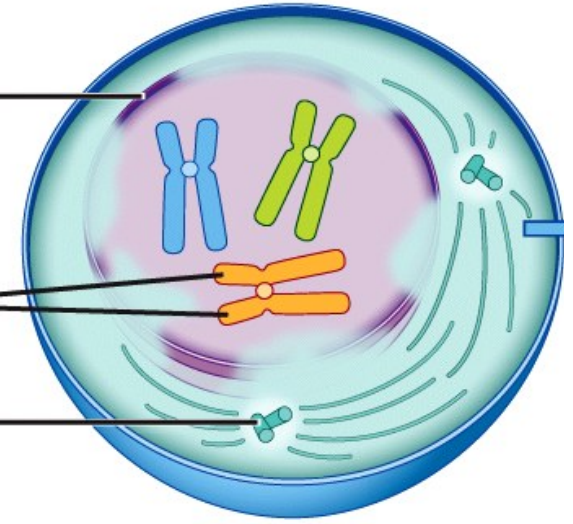


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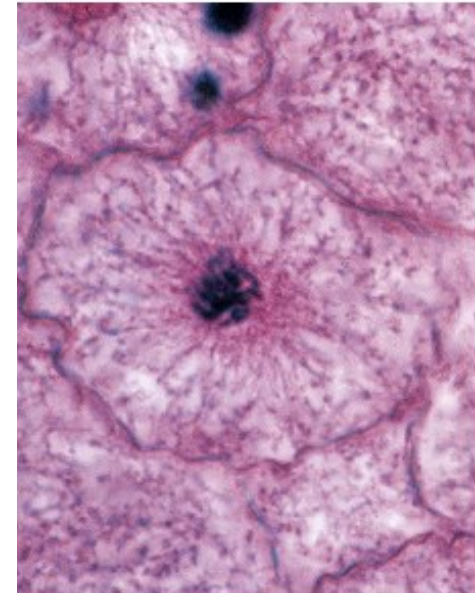
Nuclear membrane

Sister chromatids

Spindle



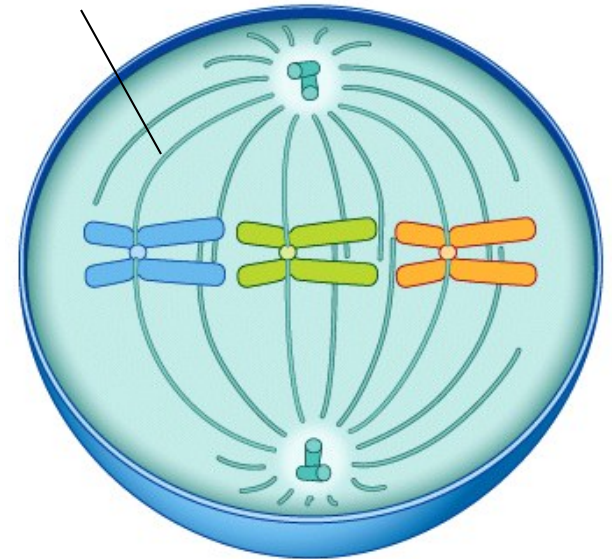
1 PROPHASE



Metaphase

- Chromosomes **align at the center** of the cells.
- One of sister chromatids is attached to the spindle fiber that comes from one pole and the other sister chromatid is attached to the spindle fiber from the other pole.

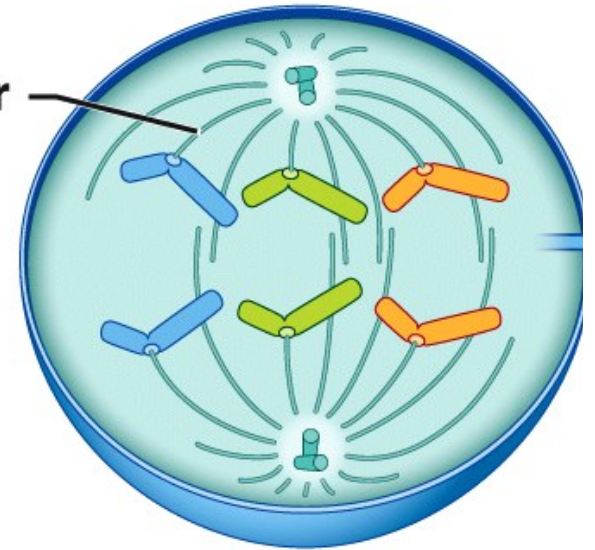
Spindle fiber



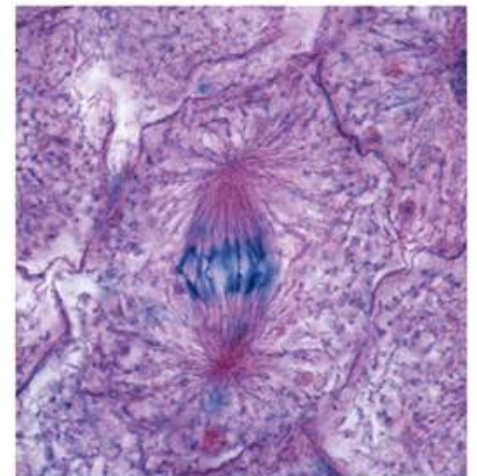
Anaphase

- Sister chromatids separate.
- The spindle microtubules pull chromosomes towards the two poles.

Spindle fiber

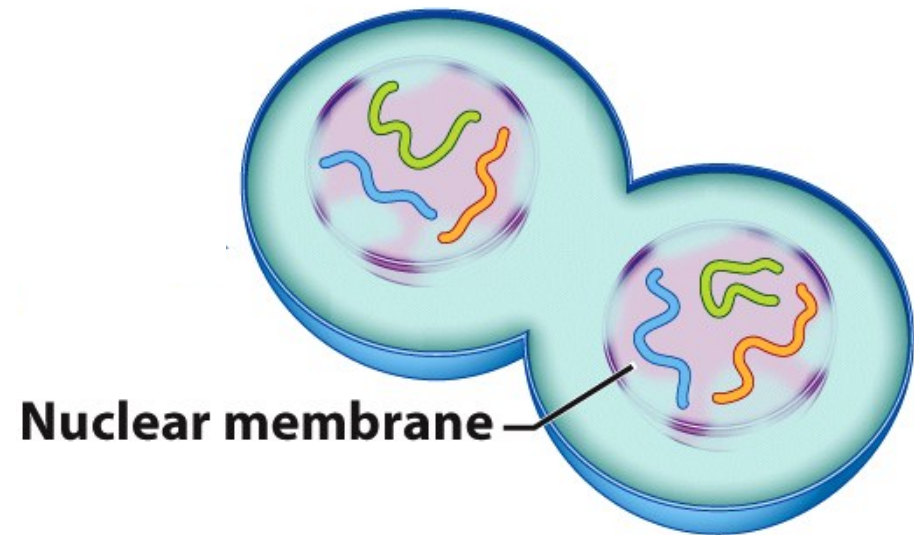


3 ANAPHASE



Telophase

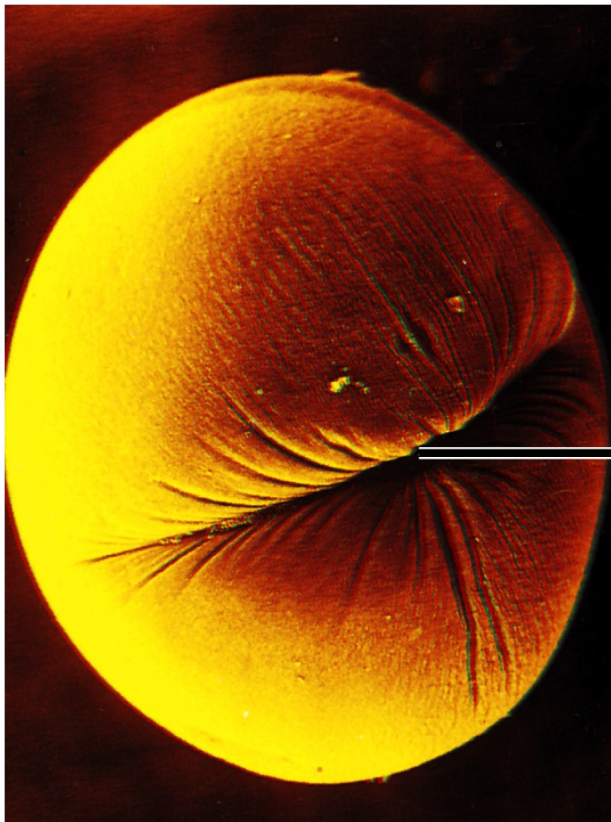
- Chromosomes uncoil.
- Nuclear envelopes form around the chromosomes.
- The spindle fibers disappear.



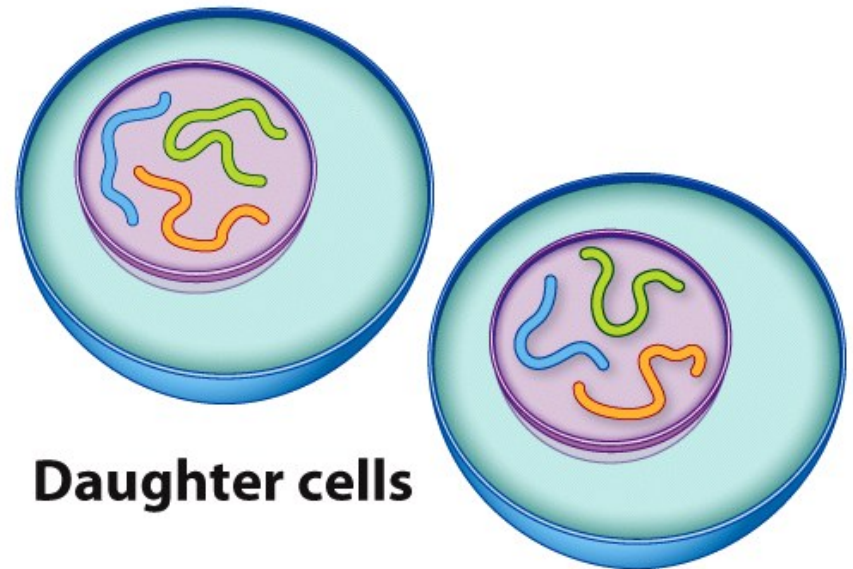
4 **TELOPHASE**

Cytokinesis (animal cell)

- Division of the cytoplasm after mitosis.
- Organelles are equally distributed.



**Cleavage
furrow**

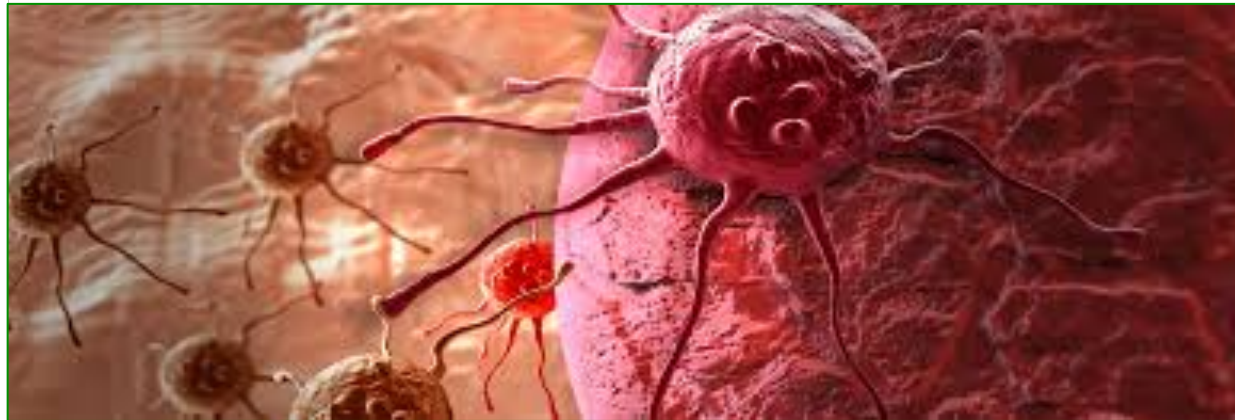


Daughter cells

Cancer

Unrestrained cell growth and cell division

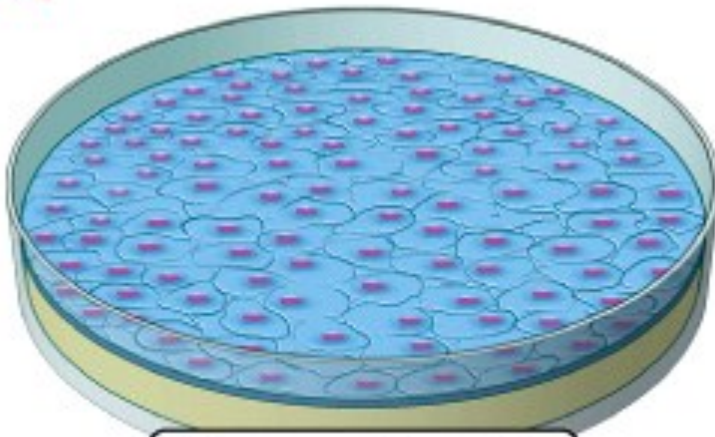
1. No contact inhibition
2. Divide indefinitely (immortal)



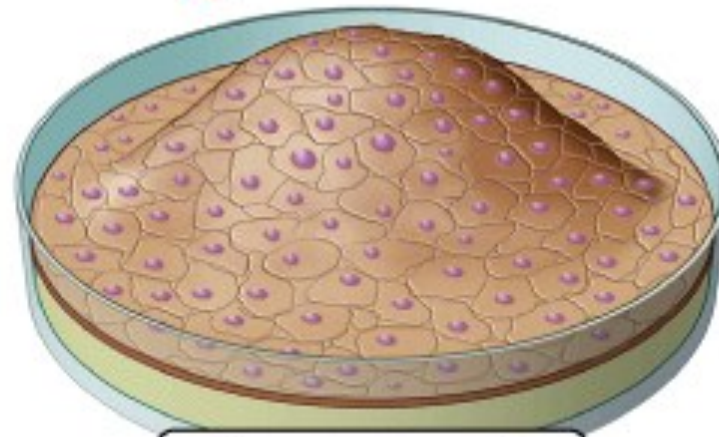
Cancer cells do not display contact inhibition

Normal cells divide until they bump up against other cells or tissues, at which point they stop dividing.

Cancer cells, however, ignore the signal and continue to divide, piling on top of one another.



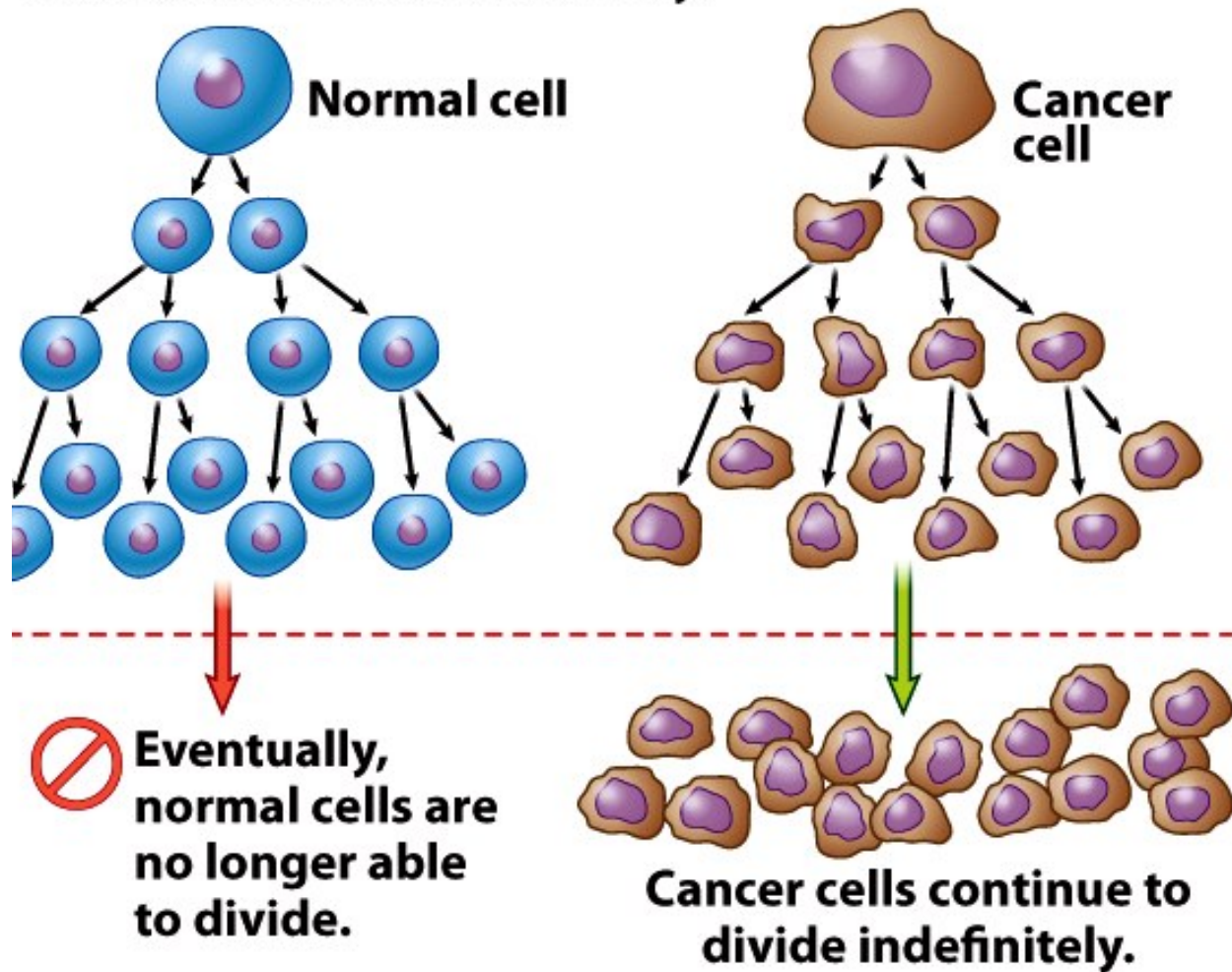
Normal cells



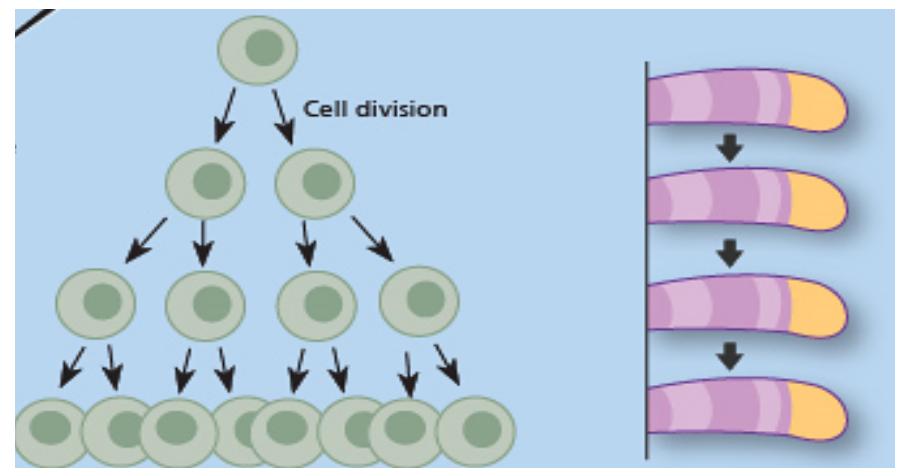
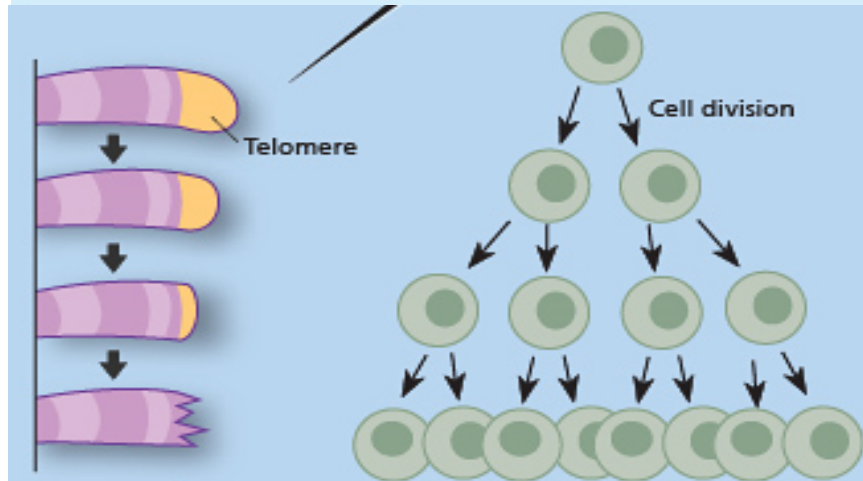
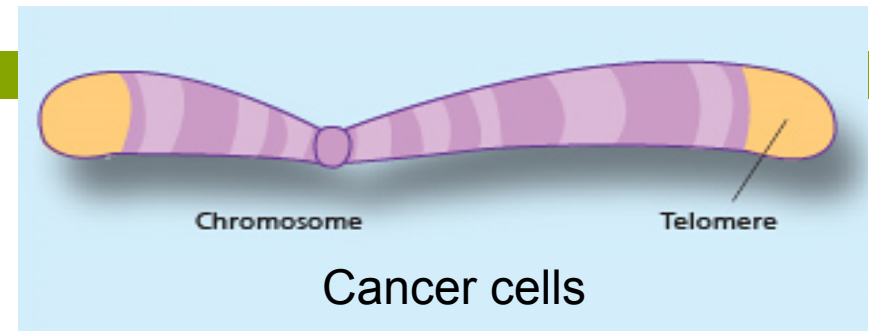
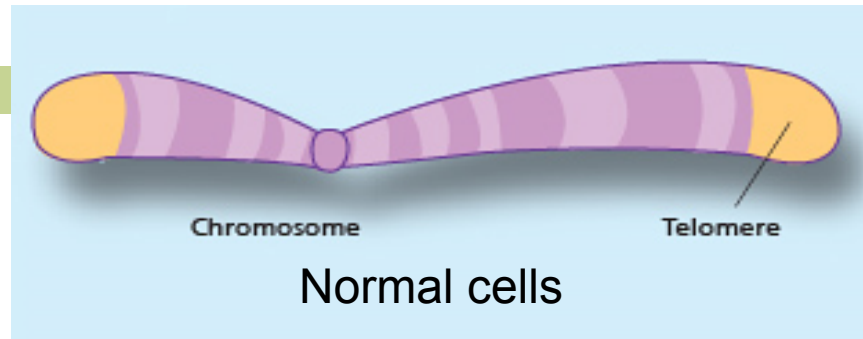
Cancer cells

Cancer cells divide indefinitely

Normal cells can divide a finite number of times. Cancer cells never lose their ability to divide, and continue to do so indefinitely.

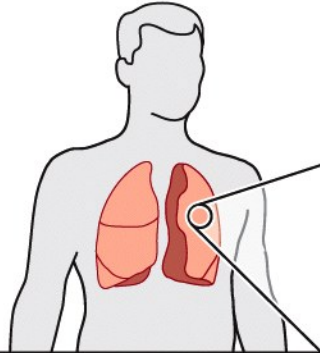


Cancer cells are immortal

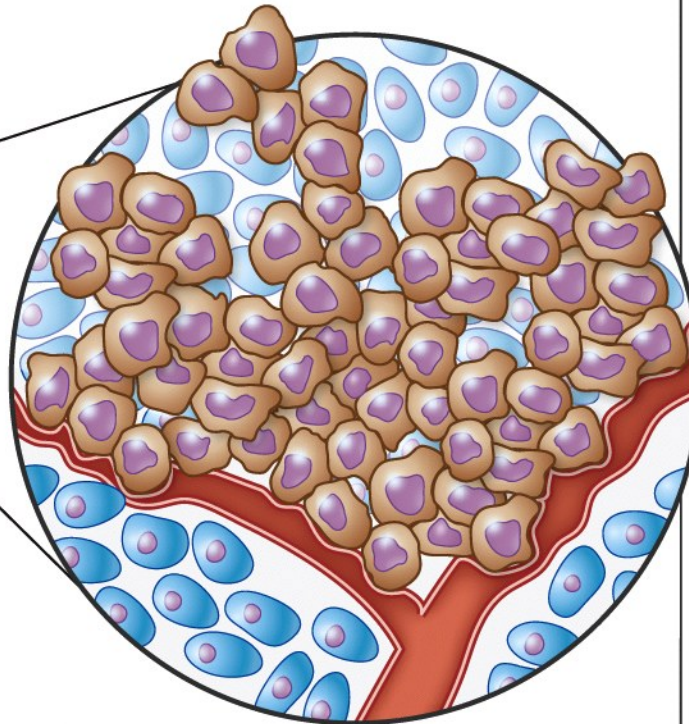


- Cancer cells can add telomere to chromosome ends.
- This allows cancer cells to divide infinitely.

THE DANGER OF CANCER CELLS



A malignant tumor develops in a patient's lung tissue. As the tumor gets larger, it takes up more and more space, pressing against neighboring cells and tissue.



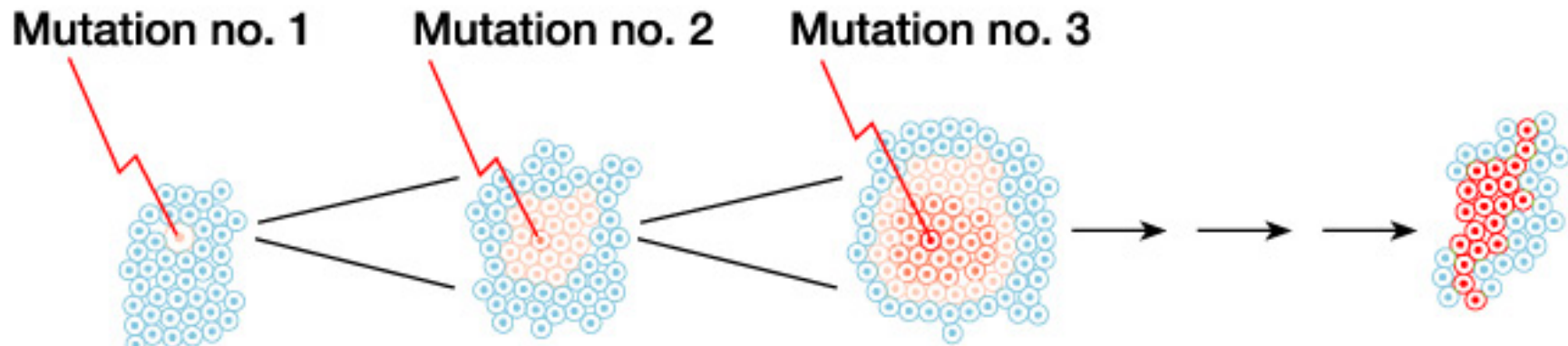
As a tumor grows, it can impinge on other tissue, interfering with normal functioning and even causing death.

Figure 6-12

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Cancer is caused by mutations



Benign tumor: At this stage, cells may divide excessively but they are not invasive

Malignant tumor (cancer): Cells grow uncontrollably.

Immune system attacks tumor cells.

May or may not need surgical removal.

Cancer cells may be **metastasized**, spreading to other organs.



Carcinogens

- Agents that initiate & promote cancer. Many of them are also mutagens.
- **Viruses**
 - ▣ Human papillomaviruses (HPV) is the major cause of cervical cancer
 - ▣ Chronic hepatitis virus infection can cause liver cancer.
- **Chemicals**
 - ▣ Tobacco is the major cause of lung cancer.
 - ▣ Heavy alcohol drinkers can get liver cancer.
- **Radiation**
 - ▣ Excessive exposure to UV light can cause skin cancer.

Cancer therapy

- **Surgical removal**
- **Chemotherapy**
 - ▣ Kills rapidly dividing cells
 - ▣ Severe side effects, as the drugs also kill normal cells.
- **Radiation therapy**
 - ▣ Kills rapidly dividing cells
 - ▣ Localized treatment.



Figure 6-13
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True or false?

If you are a smoker for very long time, quitting now does not make any difference.

- False!
- The cancer risks are cumulative.
- If you quit, your risk will level off. If you continue smoking, your risk will continue to rise.

-
- More slides to follow for Lecture 6



INCOMPLETE