Mitosis and Cytokinesis

B-2.6 Summarize the characteristics of the cell cycle: interphase (called G1, S, G2); the phases of mitosis (called prophase, metaphase, anaphase, and telophase); and plant and animal cytokinesis.

The cell cycle is a repeated pattern of growth and division that occurs in eukaryotic cells.

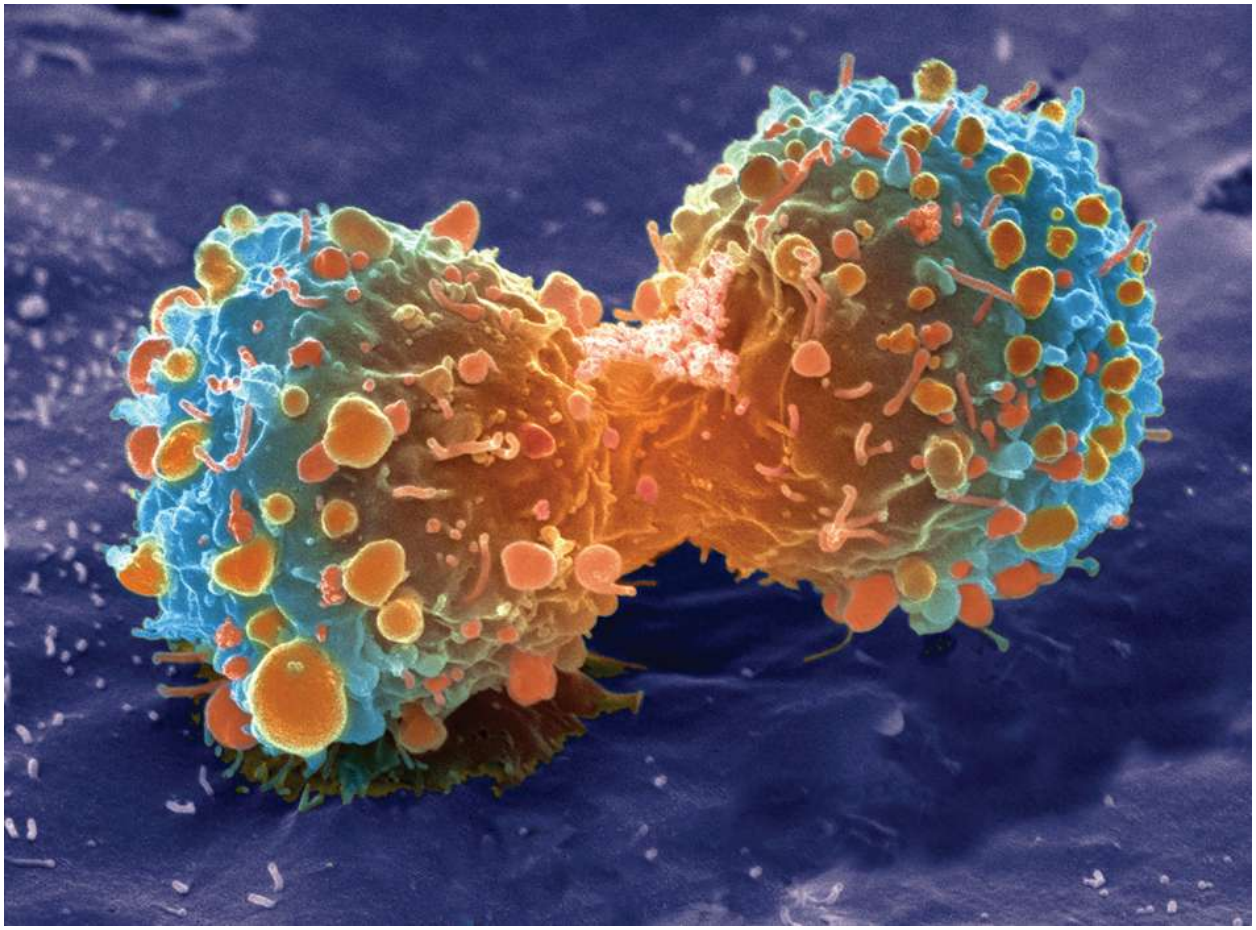
This cycle consists of three phases: G1, S, G2

The first phase represents cell growth while the last two phases represent cell division.

Mitosis and Cytokinesis

KEY CONCEPT

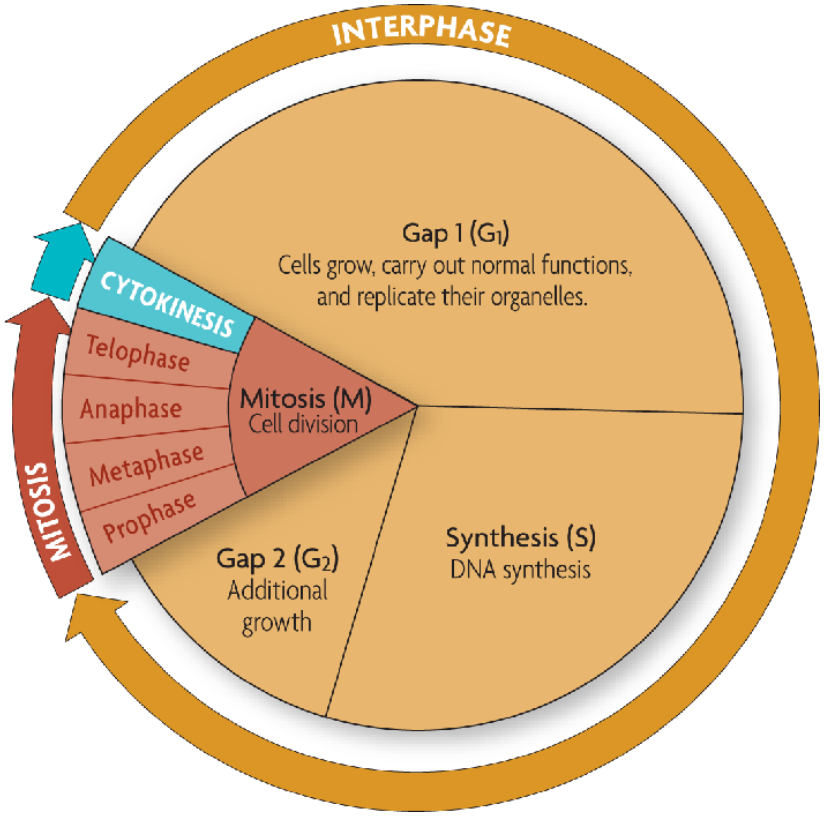
Cells have distinct phases of growth, reproduction, and normal functions.



Mitosis and Cytokinesis

The cell cycle has four main stages.

- The cell cycle is a regular pattern of growth, DNA replication, and cell division.



Mitosis and Cytokinesis

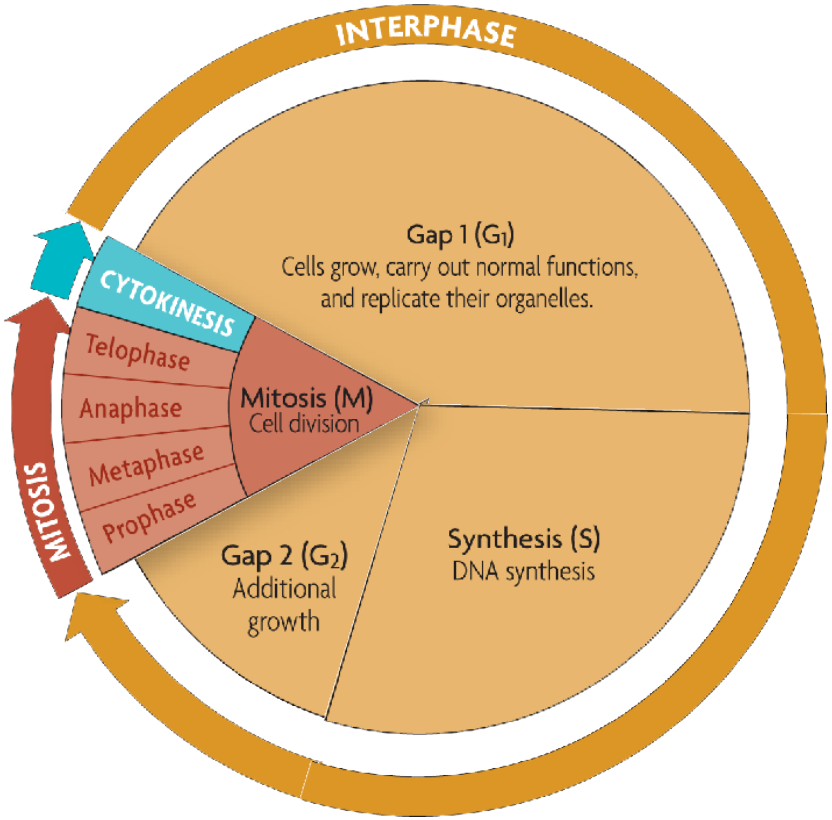
- The main stages of the cell cycle are gap 1, synthesis, gap 2, and mitosis.

Gap 1 (G_1): cell growth and normal functions

DNA synthesis (S): copies DNA

Gap 2 (G_2): additional growth (chromatids become replicated chromosomes)

Mitosis (M): includes division of the cell nucleus (mitosis) and division of the cell cytoplasm (cytokinesis)



Mitosis occurs only if the cell is large enough and the DNA undamaged.

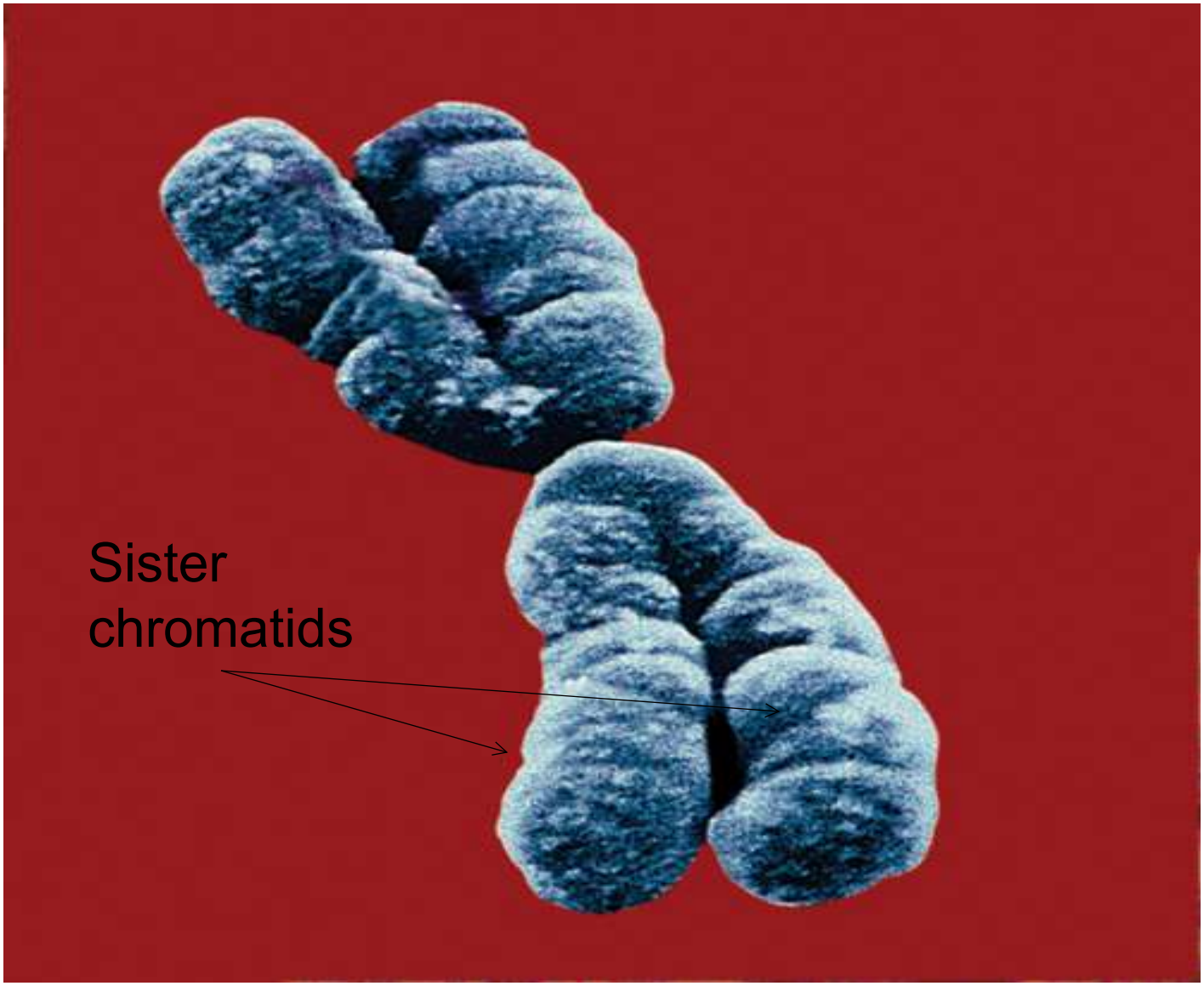
Interphase

Cells spend the majority of their cell cycle in interphase.

The purpose of interphase is for cell growth.

By the end of interphase a cell has two full sets of DNA (chromosomes) and is large enough to begin the division process.

Mitosis and Cytokinesis



How does 6.5 feet of DNA condense into a chromosome?

Mitosis and Cytokinesis

Materials:
Capsule- nucleus
String – DNA

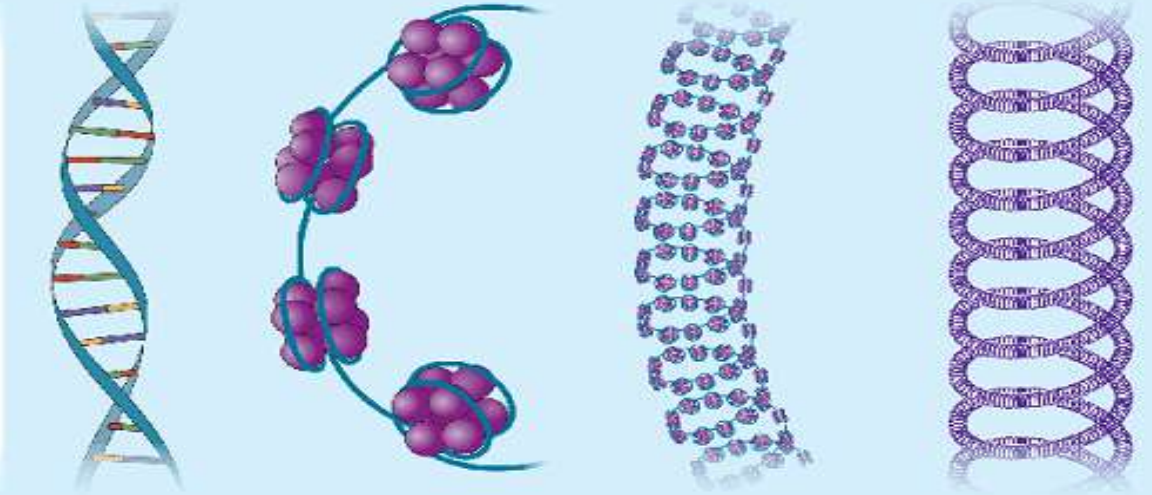
Objective:
With your group, figure out a way to fit all of the DNA into the nucleus. You may use various tools, but ALL DNA needs to fit into the closed nucleus.

Show me when you are done! ☺

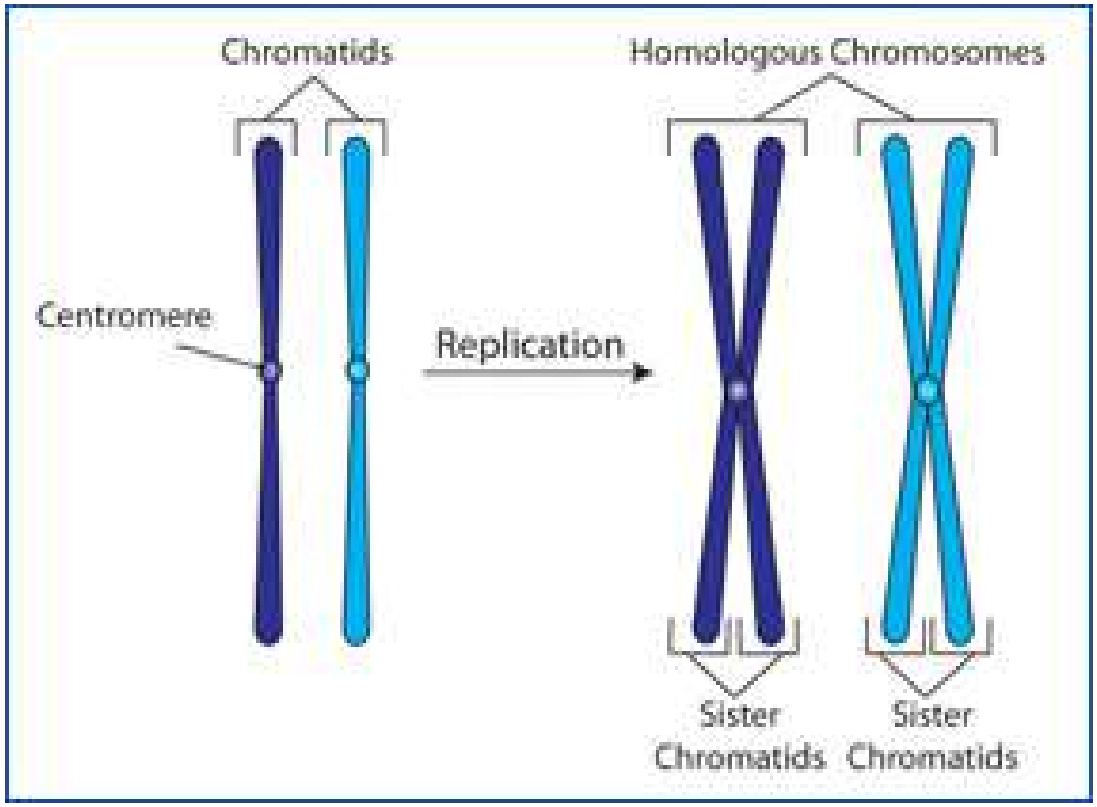
Mitosis and Cytokinesis

Chromosomes condense at the start of mitosis.

- DNA wraps around proteins (histones) that condense it.
- In a typical human cell, there is about 6.5 feet of DNA!



Mitosis and Cytokinesis



Mitosis and Cytokinesis

Mitosis

The purpose of mitosis is cell division: making two cells out of one.

Each cell has to have its own cytoplasm and DNA.

The DNA is replicated in interphase when two chromosome strands became four strands (two strands per chromatid).

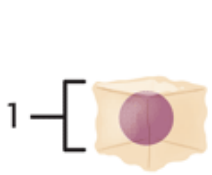
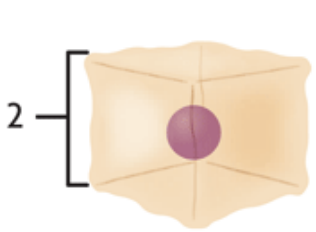
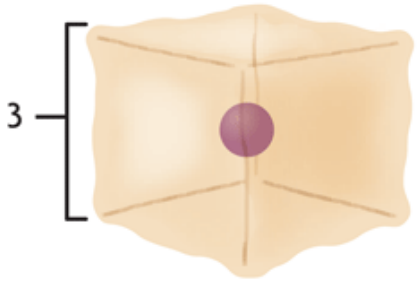
In mitosis the four strands (two sister chromatid) have to break apart so that each new cell only has one double-stranded chromosome.

Two sister chromatids together make a chromosome

Mitosis and Cytokinesis

Cell size is limited.

- Volume increases faster than surface area.

Relative size			
Surface area (length × width × number of sides)	6	24	54
Volume (length × width × height)	1	8	27
Ratio of surface area to volume	$\frac{6}{1} = 6{:}1$	$\frac{24}{8} = 3{:}1$	$\frac{54}{27} = 2{:}1$

Mitosis and Cytokinesis

Prophase is characterized by four events:

Chromosomes condense and are more visible.
The nuclear membrane (envelope) disappears.
Centrioles have separated and taken positions on the opposite poles of the cell.
Spindle fibers form and radiate toward the center of the cell.

Mitosis and Cytokinesis

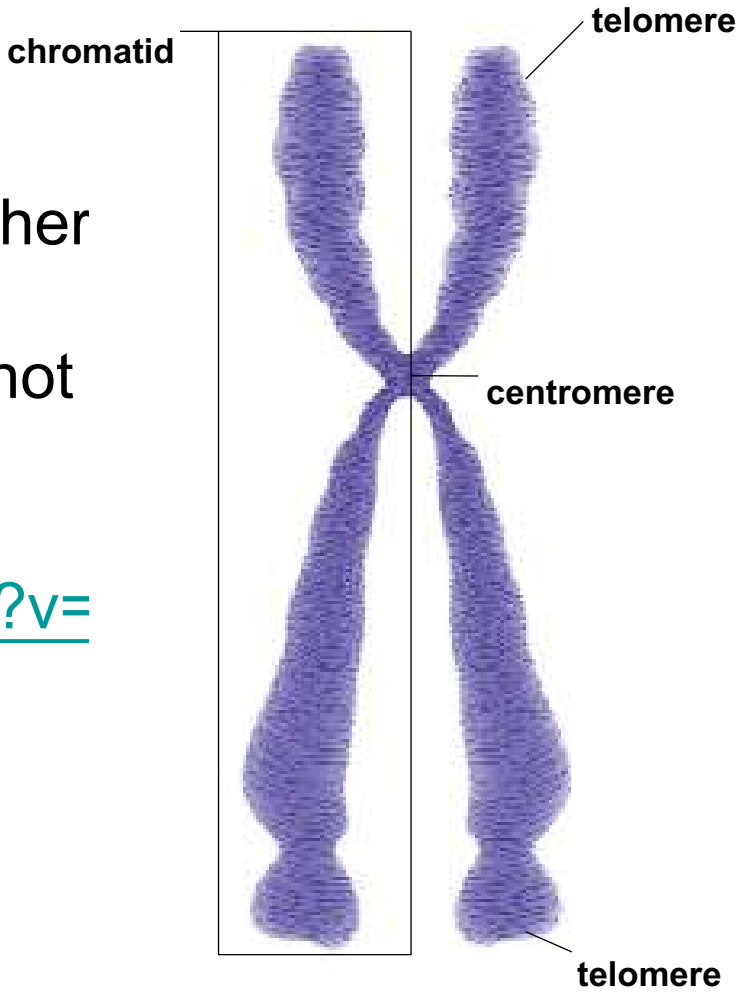
- DNA plus proteins is called chromatin.

One half of a duplicated chromosome is a chromatid.

Sister chromatids are held together at the centromere.

Telomeres protect DNA and do not include genes.

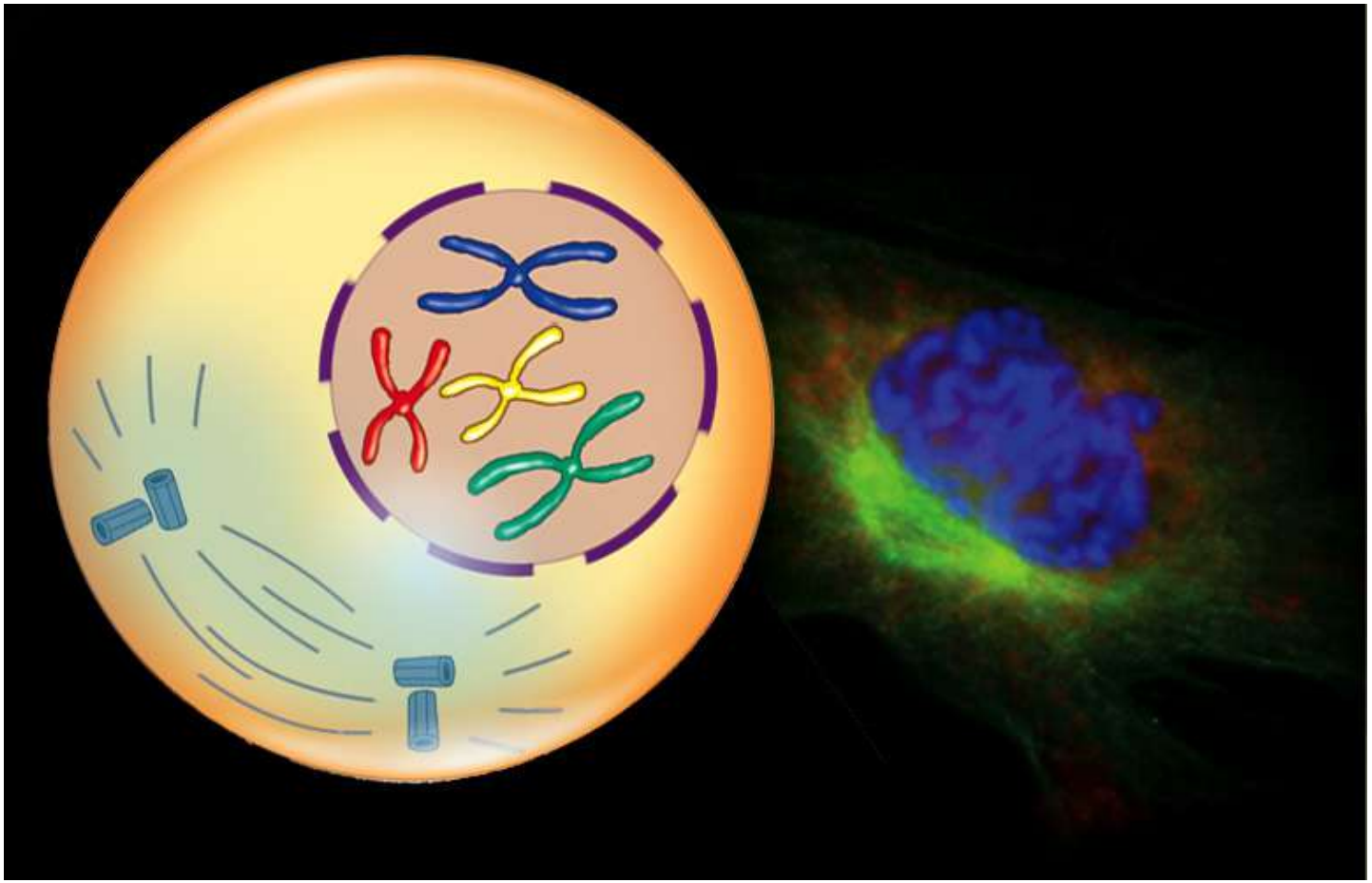
https://www.youtube.com/watch?v=1zw6uRxKYU telomeres and aging



Condensed, duplicated chromosome

Mitosis and Cytokinesis

- Mitosis divides the cell's nucleus in four phases.
  During prophase, chromosomes condense and spindle fibers form.



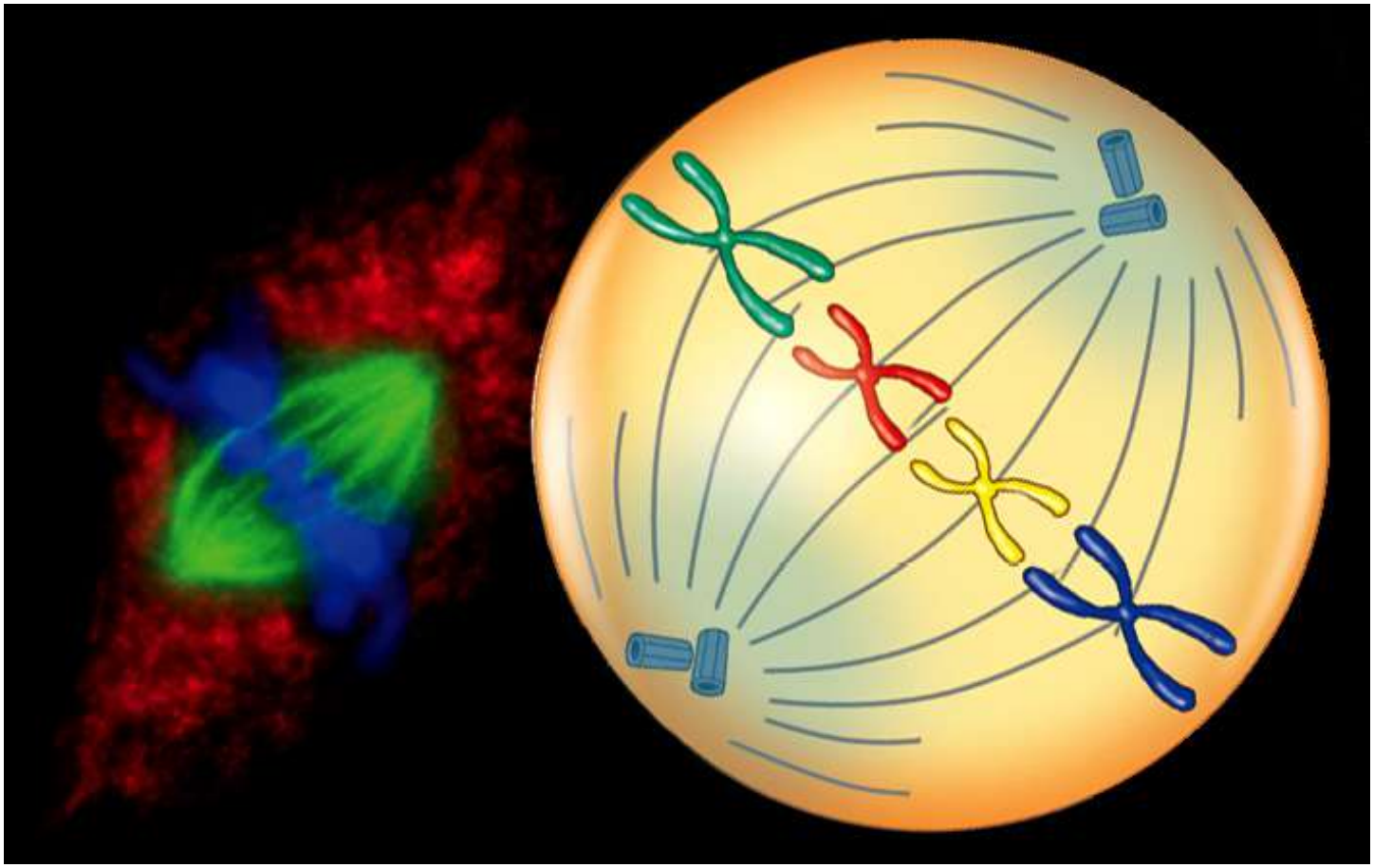
Mitosis and Cytokinesis

Metaphase (the shortest phase of mitosis) is characterized by two events:

Chromosomes line up across the middle of the cell.
Spindle fibers connect the centromere of each sister chromatid to the poles of the cell.

Mitosis and Cytokinesis

- Mitosis divides the cell's nucleus in four phases.
  During metaphase, chromosomes line up in the middle of the cell.

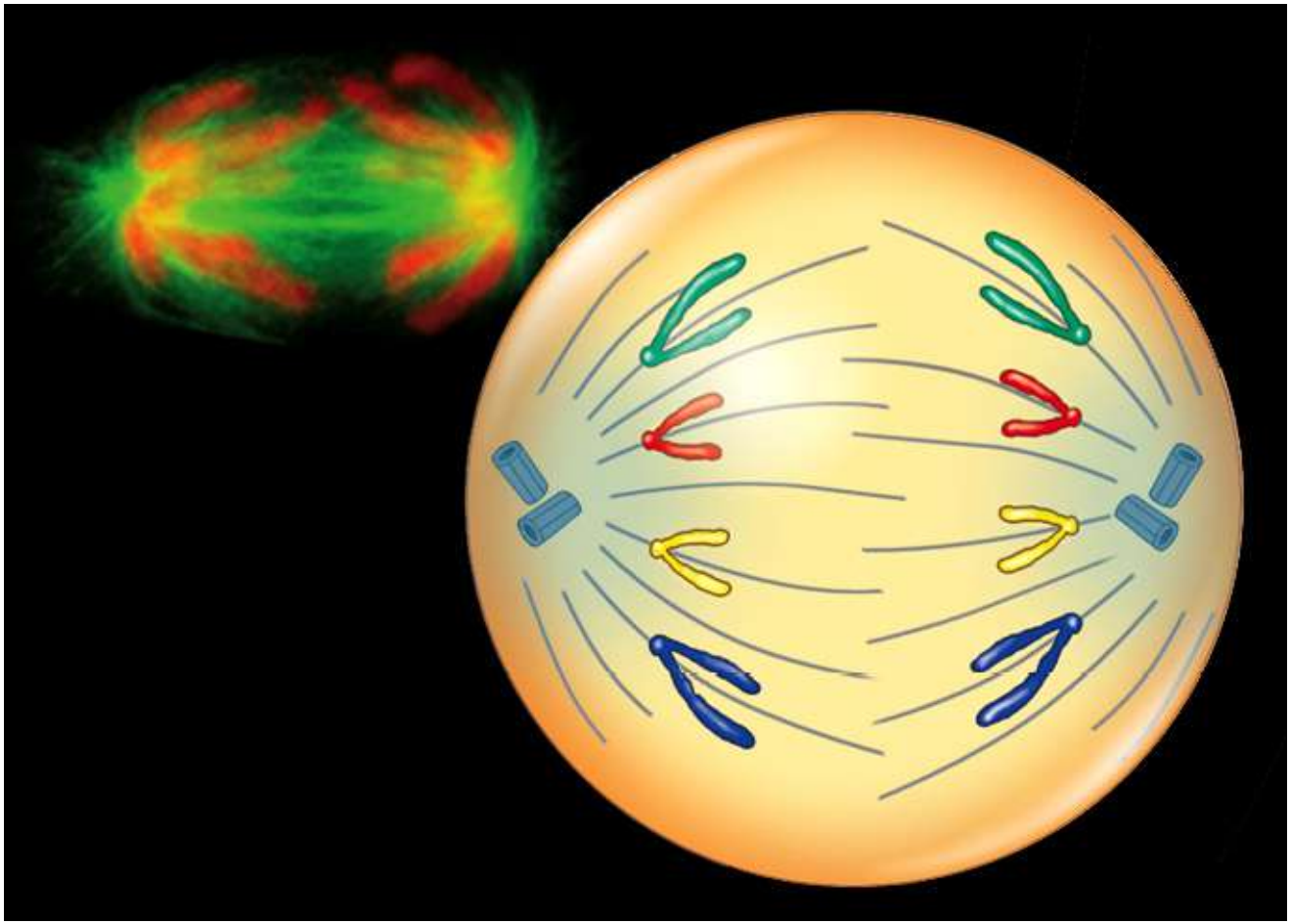


Anaphase is characterized by three events:

Centromeres that join the sister chromatids split.
Sister chromatids separate becoming individual chromosomes.
Separated chromatids move to opposite poles of the cell.

Mitosis and Cytokinesis

- Mitosis divides the cell's nucleus in four phases.
  During anaphase, sister chromatids separate to opposite sides of the cell.



Mitosis and Cytokinesis

Telophase (the last phase of mitosis) consists of four events:

Chromosomes (each consisting of a single chromatid) uncoil.

A nuclear envelope forms around the chromosomes at each pole of the cell.

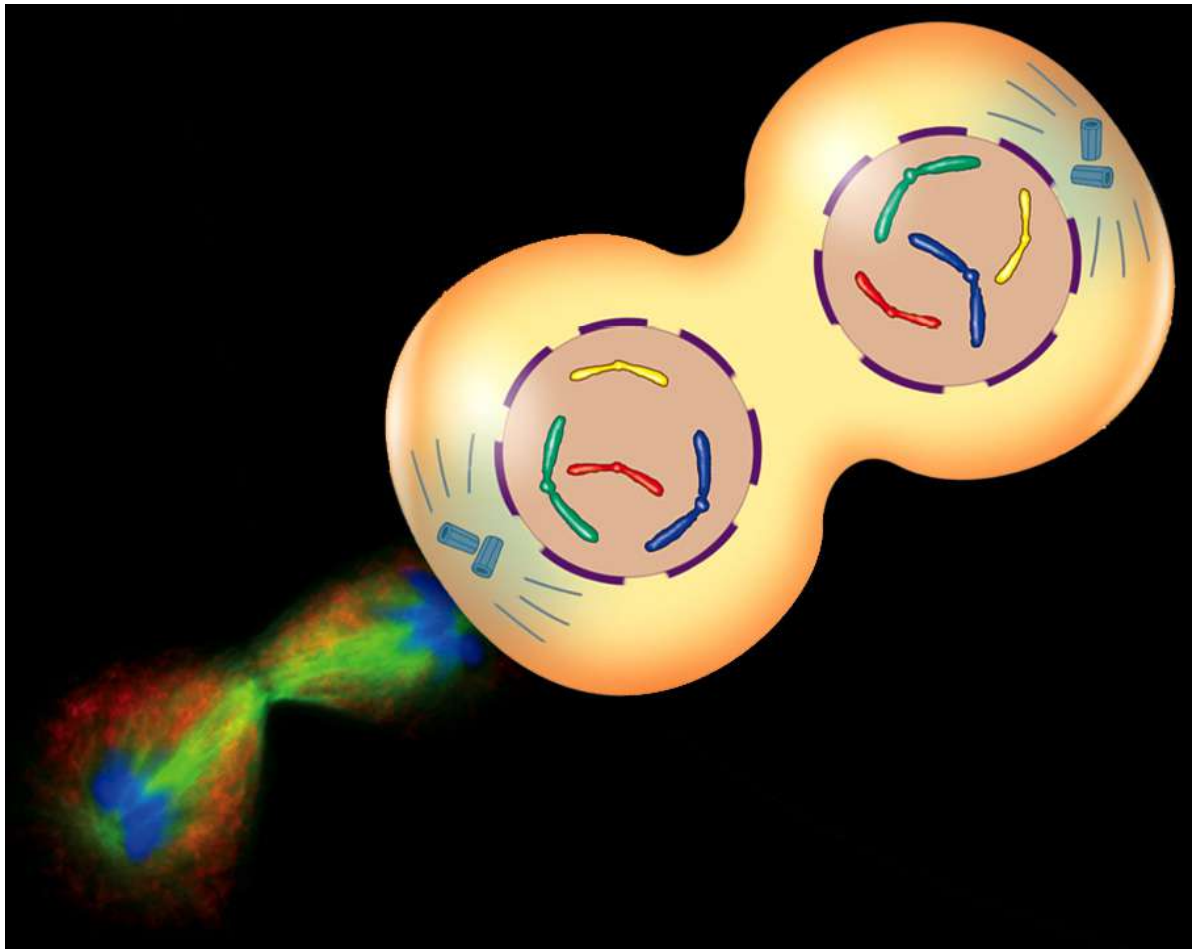
Spindle fibers break down and dissolve.

Cytokinesis begins.

Mitosis and Cytokinesis

Mitosis divides the cell's nucleus in four phases.

During telophase, the new nuclei form and chromosomes begin to uncoil.

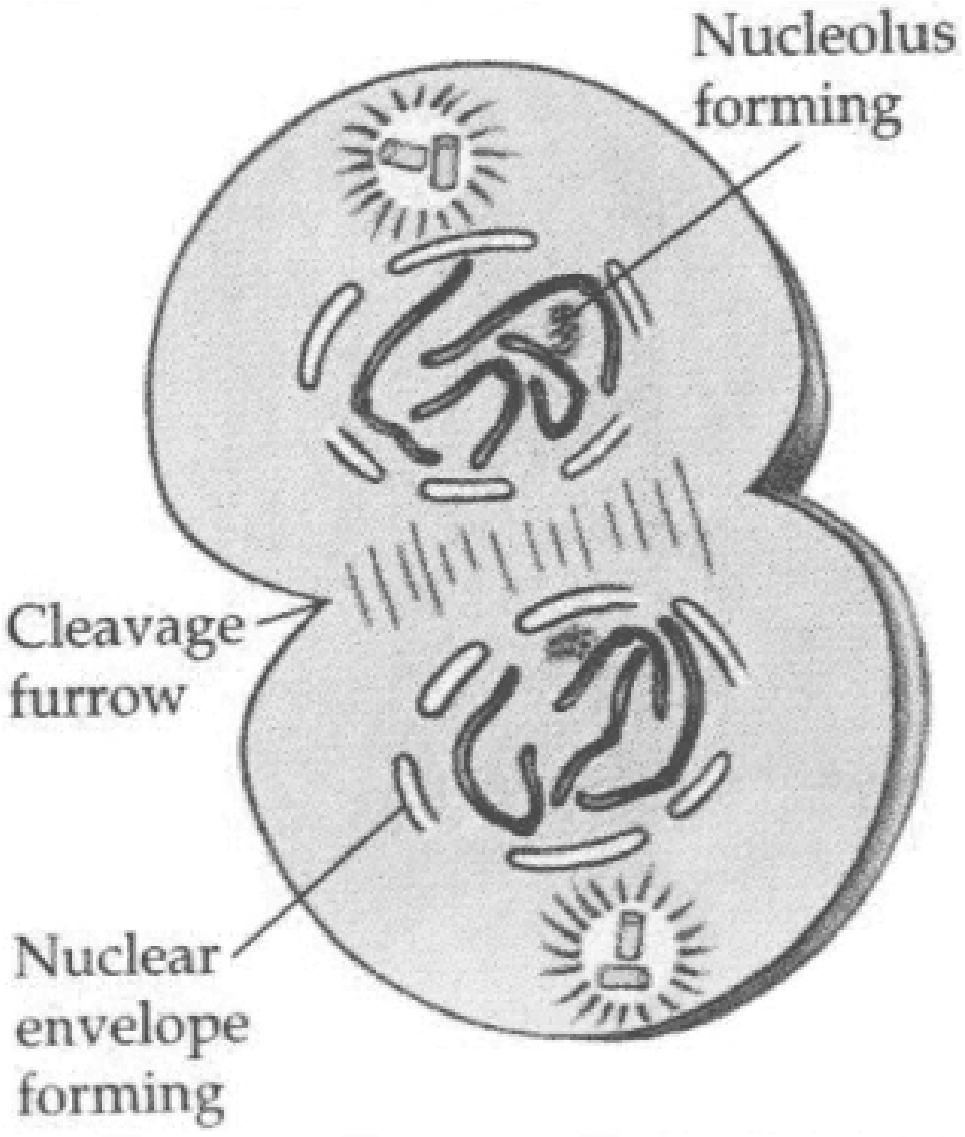


Cytokinesis

Cytokinesis is the division of the cytoplasm into two individual cells.
The process of cytokinesis differs somewhat in plant and animal cells.
In animal cells the cell membrane forms a **cleavage furrow** that eventually pinches the cell into two nearly equal parts, each part containing its own nucleus and cytoplasmic organelles.

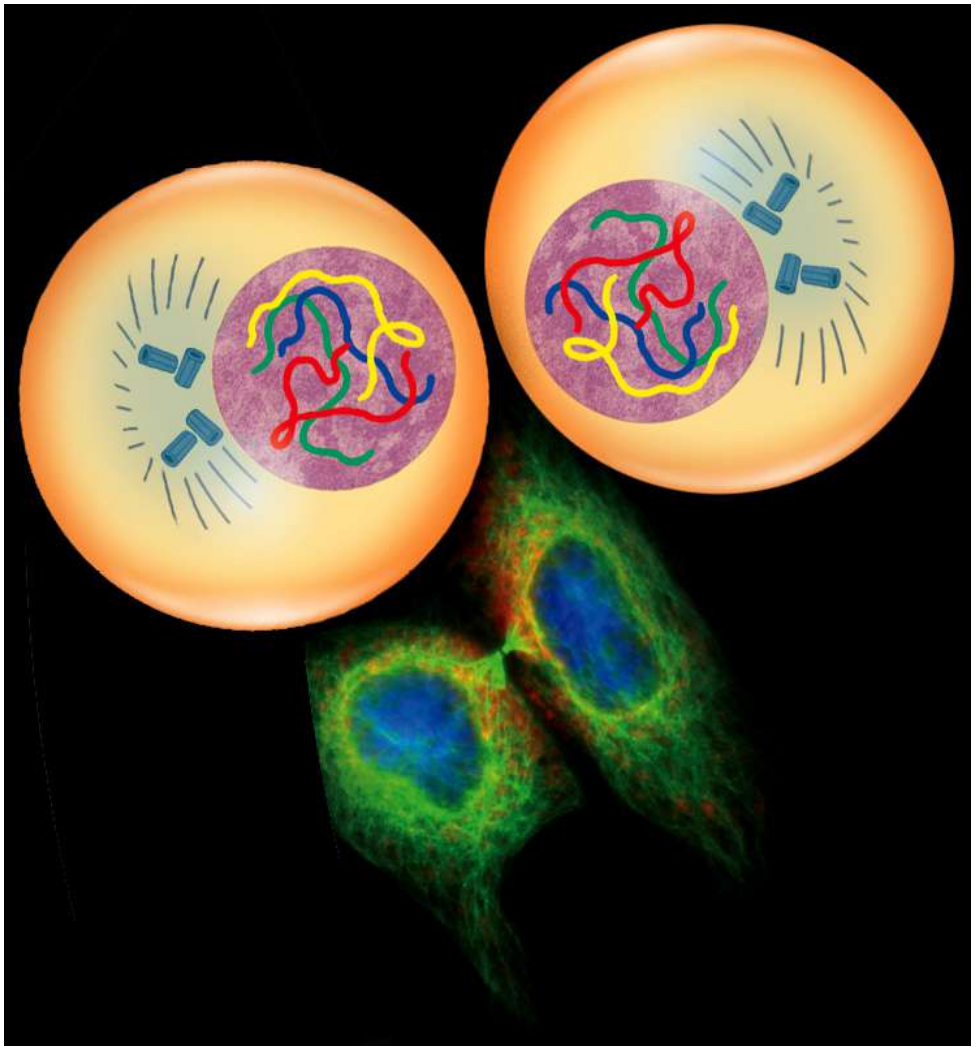
Mitosis and Cytokinesis

Animal Cell Telophase/Cytokinesis



Mitosis and Cytokinesis

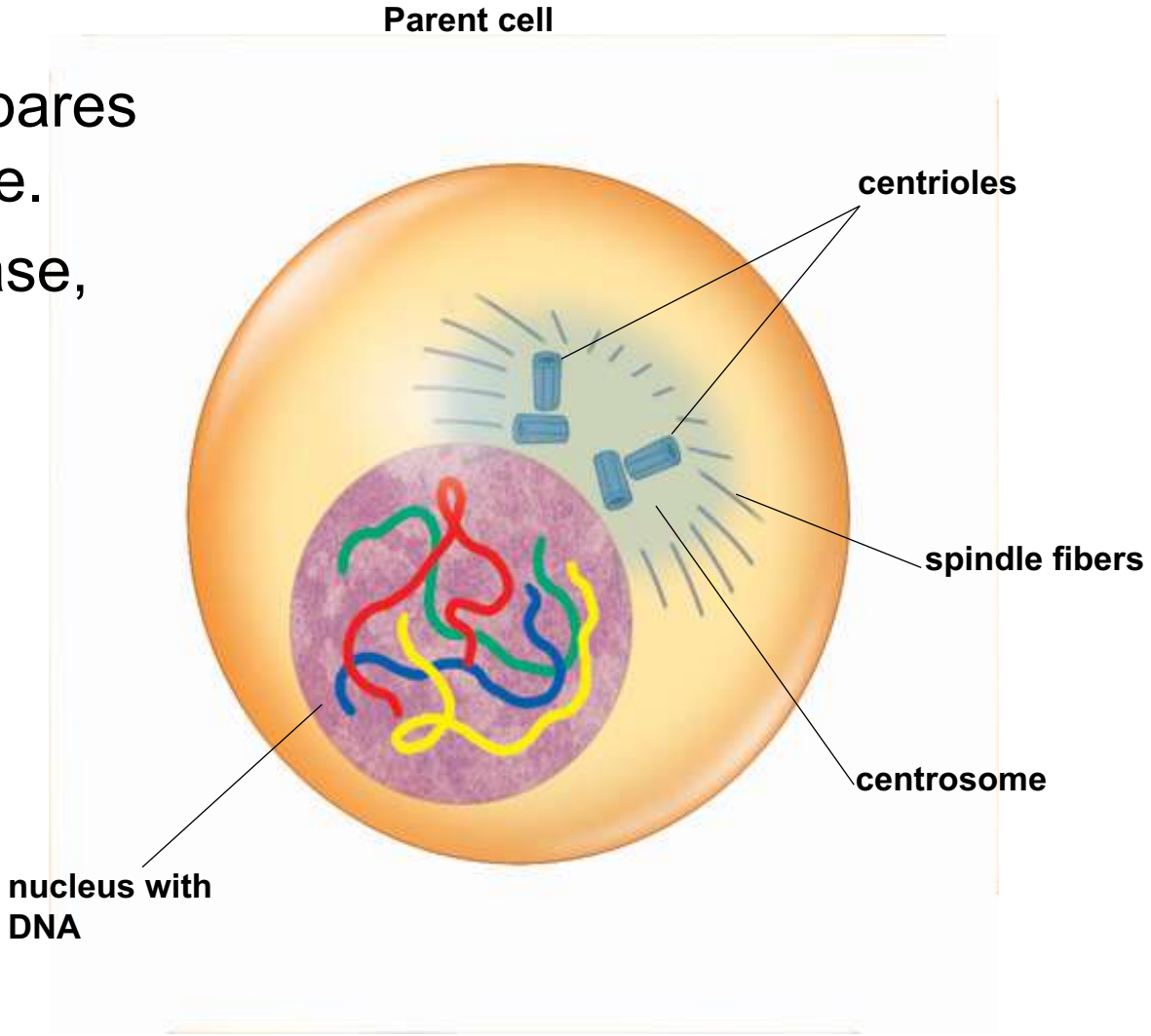
- Cytokinesis differs in animal and plant cells.
  - In animal cells, the membrane pinches closed.
  - In plant cells, a **cell plate** forms.



Mitosis and Cytokinesis

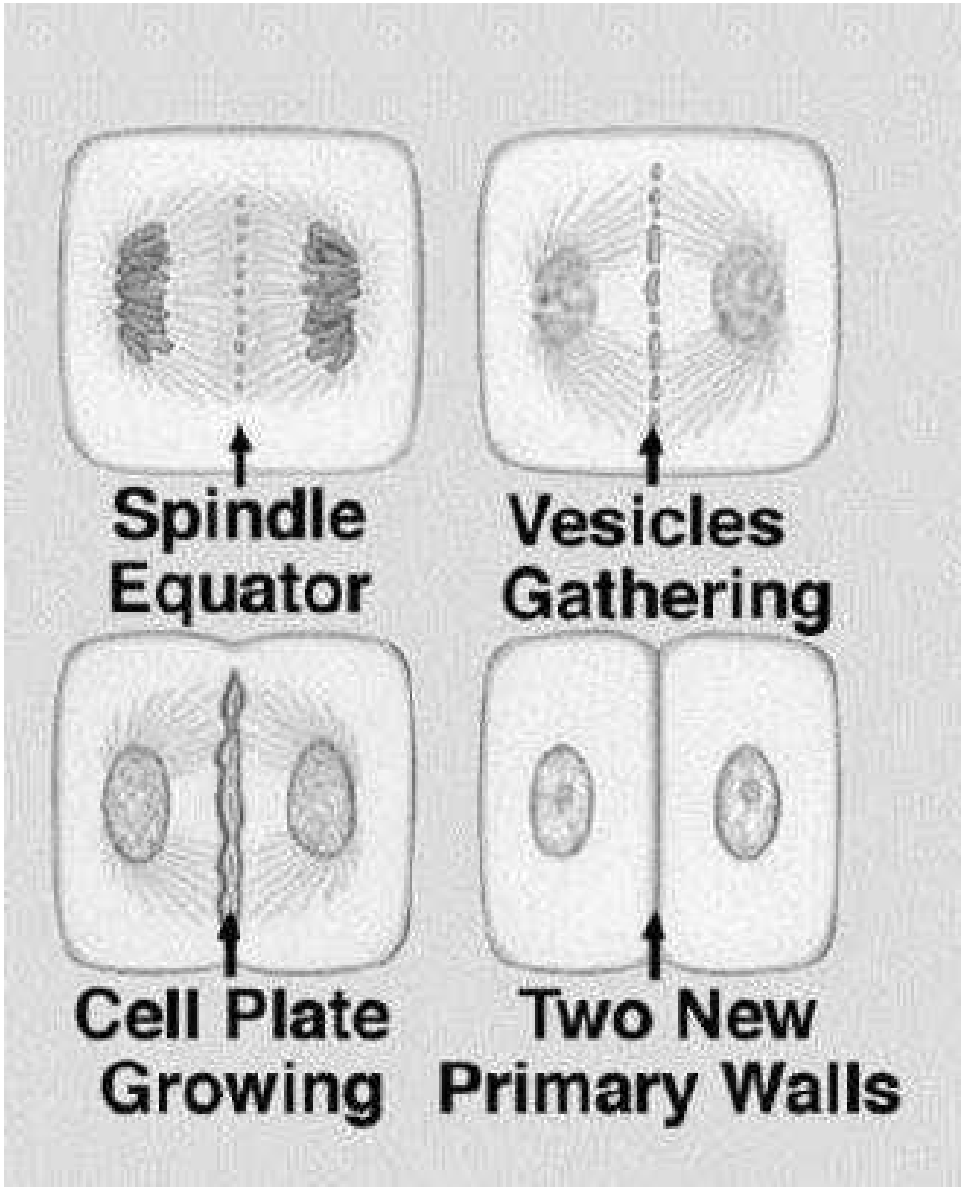
Mitosis and cytokinesis produce two genetically identical daughter cells.

- Interphase prepares the cell to divide.
- During interphase, the DNA is duplicated.



Mitosis and Cytokinesis

Plant Cell Telophase/Cytokinesis



Mitosis and Cytokinesis

Cells divide at different rates.

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

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

Some cells are unlikely to divide (G_0).

Mitosis and Cytokinesis

Diploid

Autosomal cells – body cells or any non- sex cell.

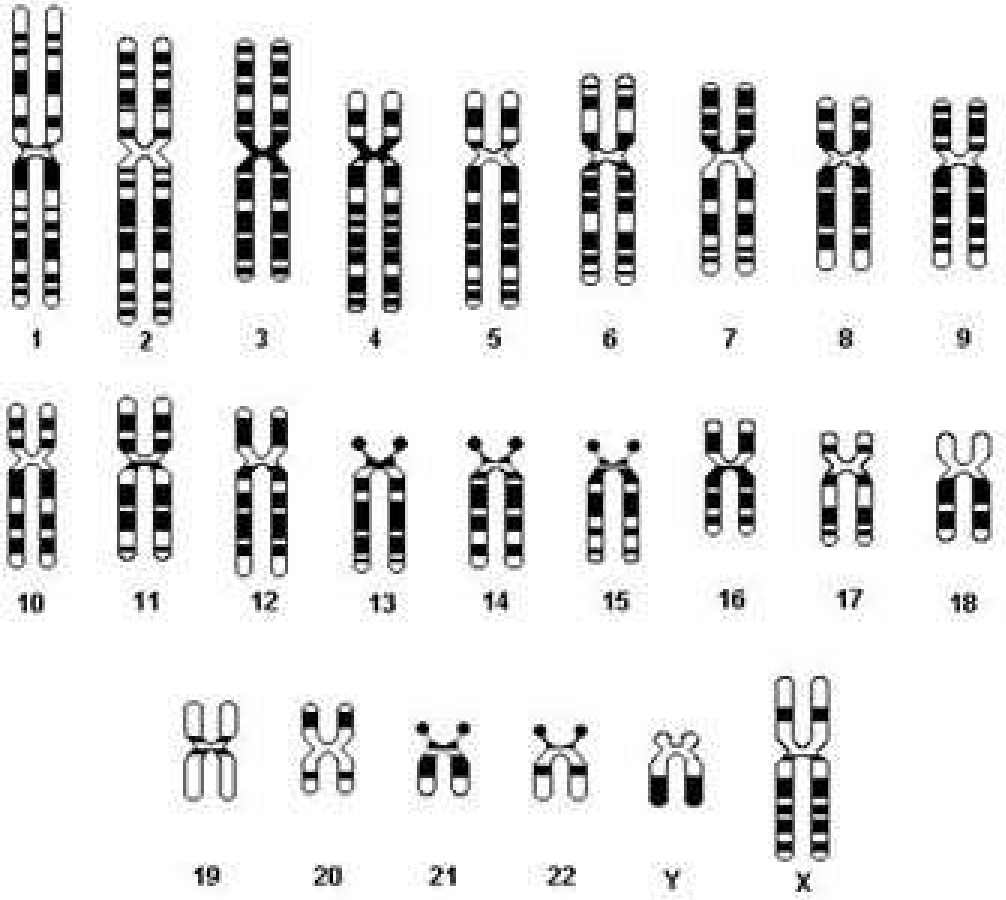
A cell that contains 2 sets of chromosomes.
-The number is represented as 2n (n= number of chromosomes)

Humans have 2 sets of 23 chromosomes for a total of 46 chromosomes. 2n or 2(23)=46

Mitosis and Cytokinesis

- **Somatic Cells**

  In any given somatic cell there are **22 pairs** of regular chromosomes and 1 pair of sex chromosomes.

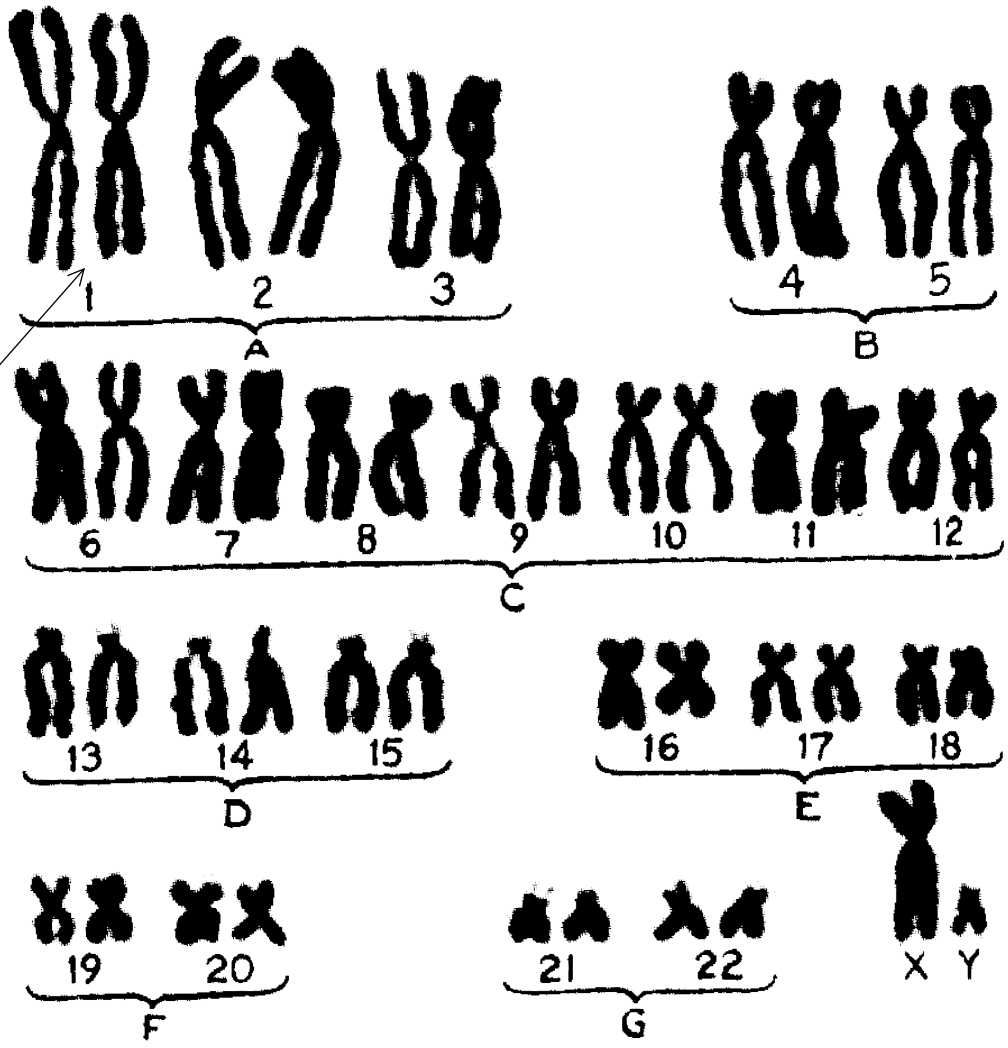


Mitosis and Cytokinesis

Karyotype – the number and appearance of chromosomes

What do you notice about the…
Size
Centromere
Telomere
Sex
Number

Homologous pair:
Why are there 2 of each chromosome?



Mitosis and Cytokinesis

- Homologous chromosomes are two chromosomes that are the same. This happens because diploid organisms have two of each chromosome. Each of the pairs is a homologous pair. One of the homologous chromosomes was inherited from the individual's mother and the other one was inherited from the individual's father. For example, the two chromosomes #1 are homologous. However, a chromosome #1 and a chromosome #2 are not homologous because they are different chromosomes.

Mitosis and Cytokinesis