

4 Examples of Asexual Reproduction



- **Binary fission** of a prokaryotic cell (Bacteria)

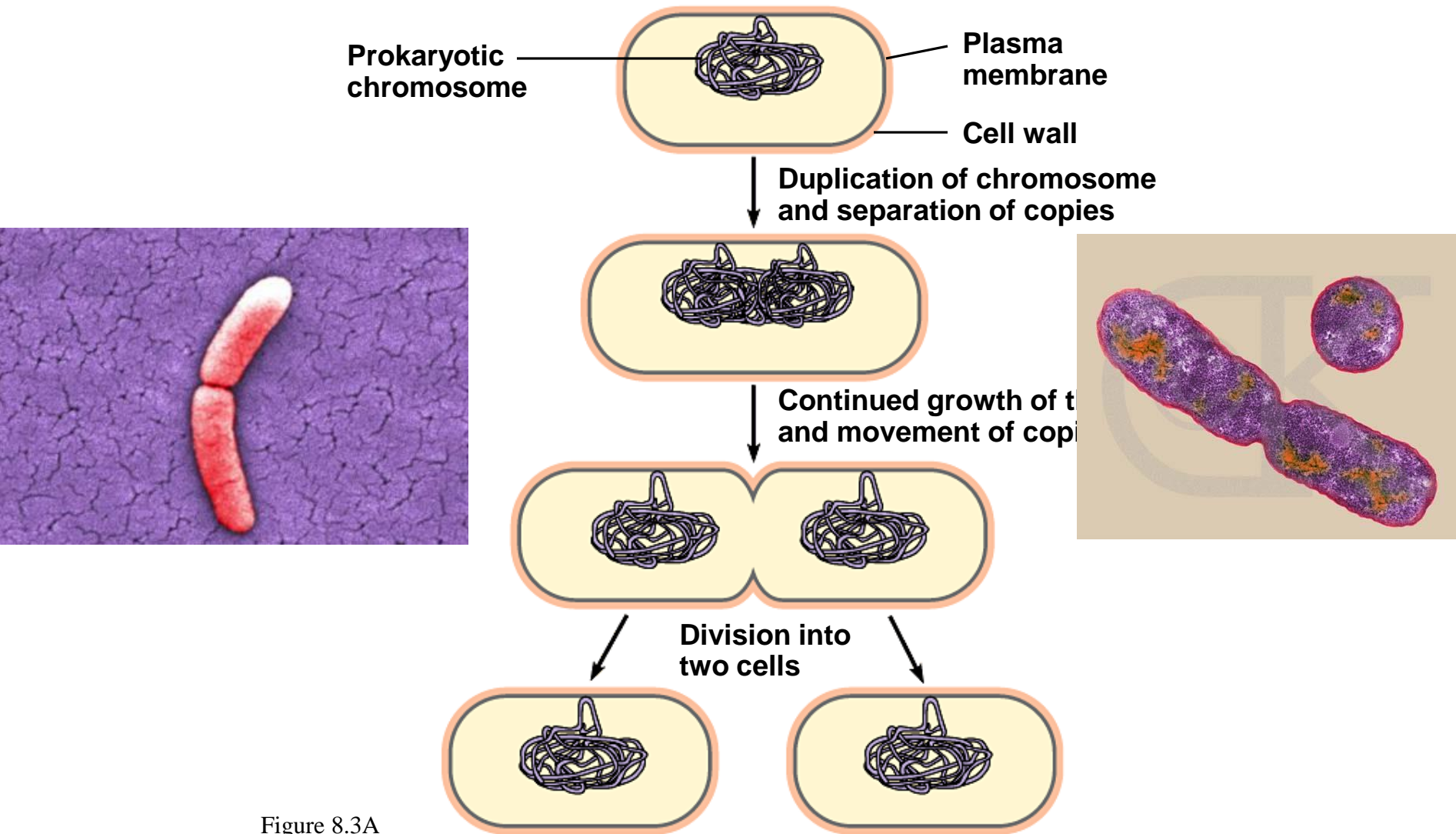
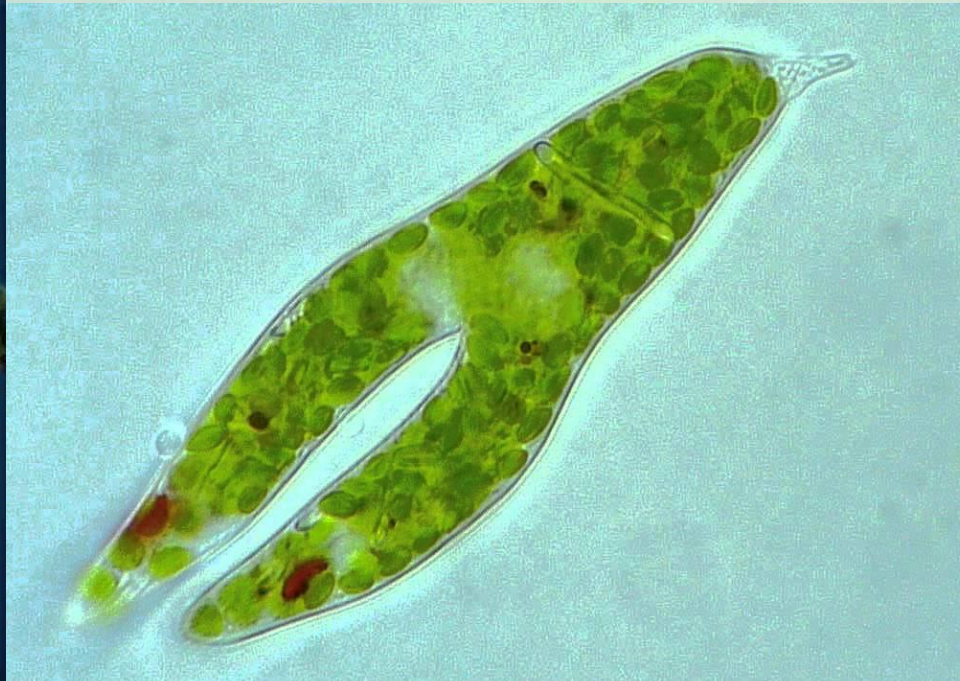
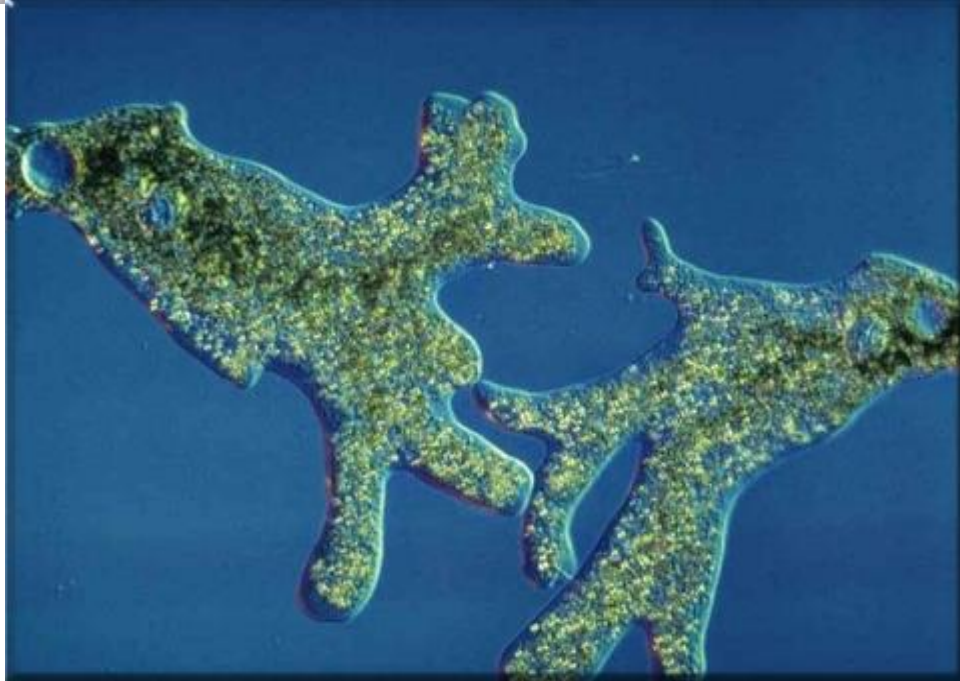


Figure 8.3A

- **Binary fission** of a 1-cell protist

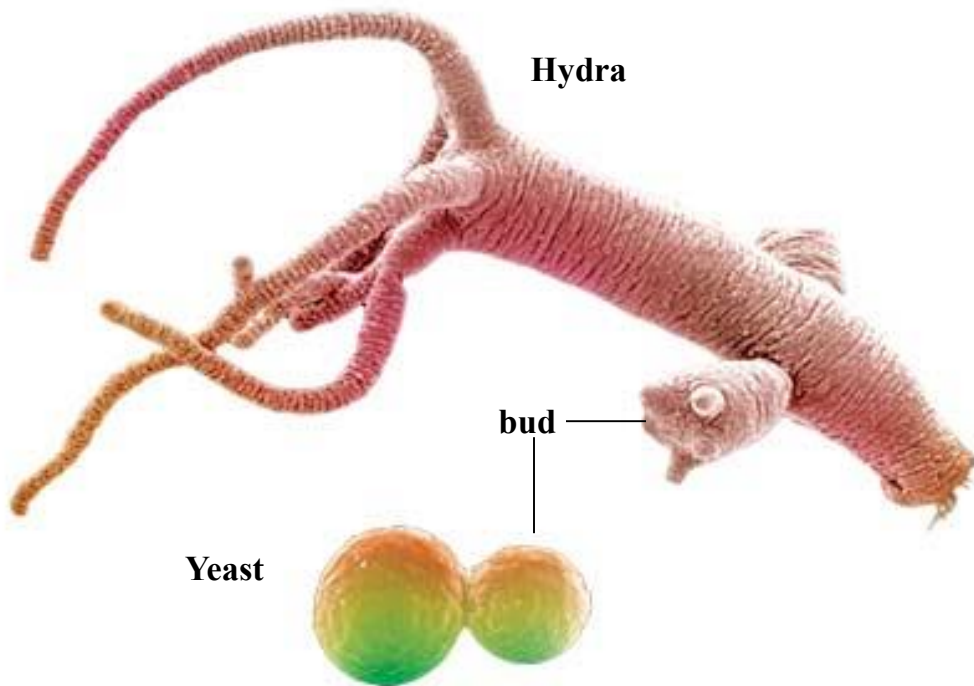


BIODIDAC ♦ J. Houseman



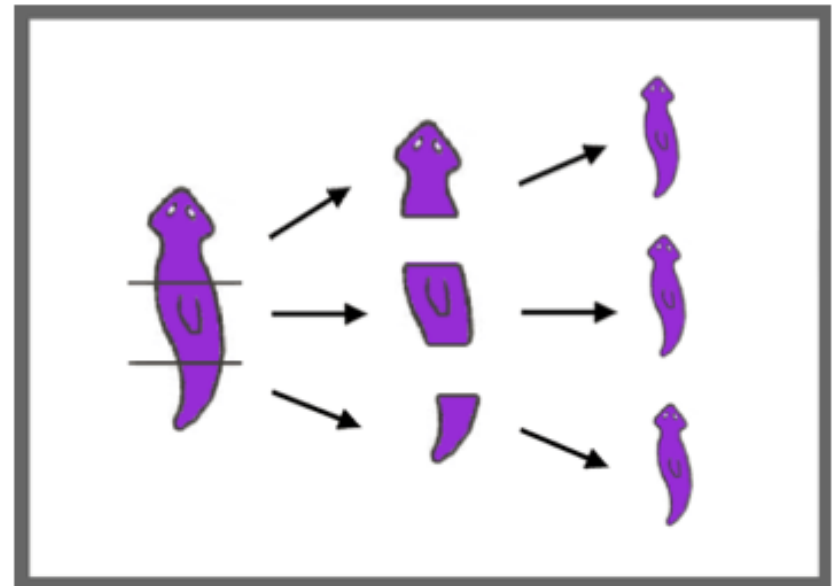
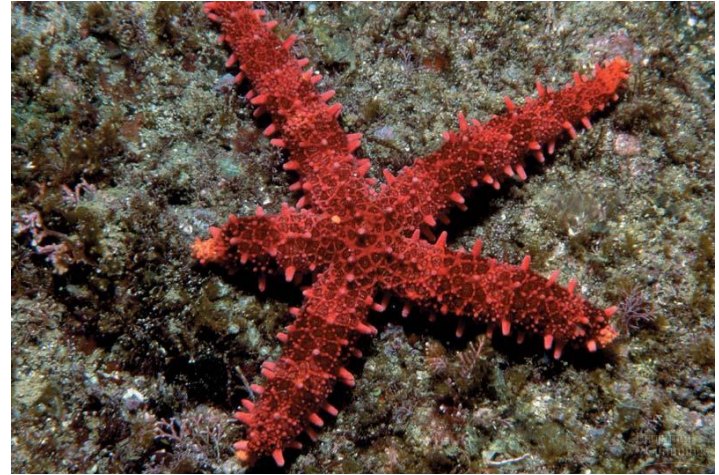
Some eukaryotes reproduce asexually through mitosis.

- **Budding** forms a new organism from a small projection growing on the surface of the parent.



Some eukaryotes reproduce asexually through mitosis.

- **Fragmentation** is the splitting of the parent into pieces that each grow into a new organism.



**Some eukaryotes reproduce
asexually through mitosis.**



Some eukaryotes reproduce asexually through mitosis.

- **Vegetative runners** allow some plants to spread by sending out stem-like runners that surround the original plants with a group of identical “clone” plants.



- A clump of Aspen trees that have spread through asexual reproduction.



- Another way plants spread through **asexual** reproduction.



Asexual Reproduction

Advantages?

Disadvantages?

Sexual Reproduction

Advantages?

Disadvantages?



Mitosis and Meiosis Notes: **The 2 Stories of Cell Division**

- Some organisms make **exact** copies of themselves = asexual reproduction

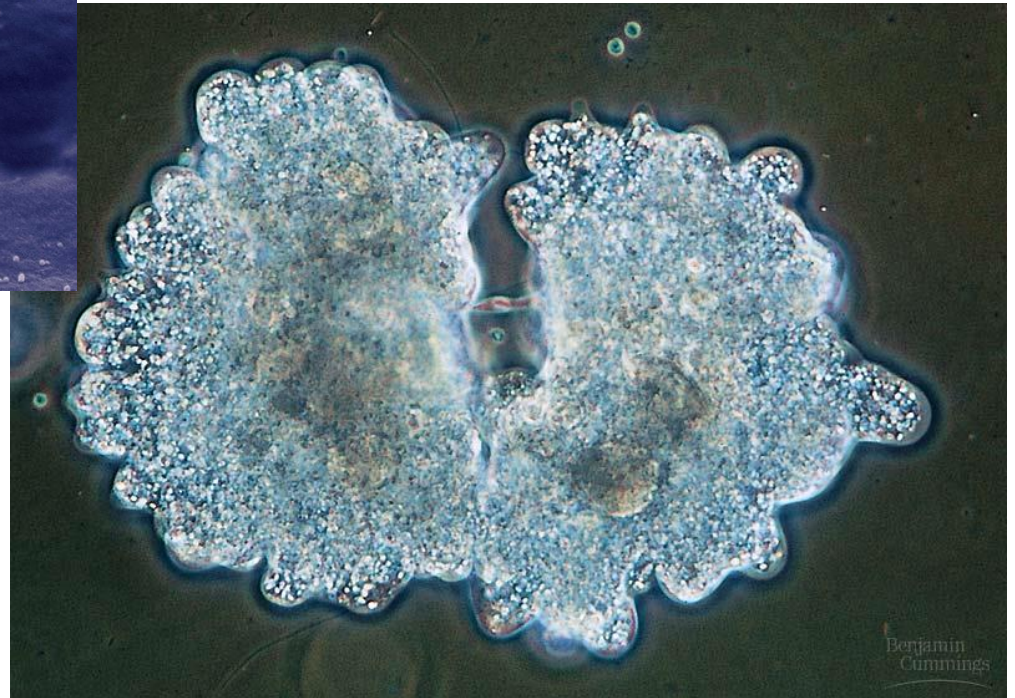
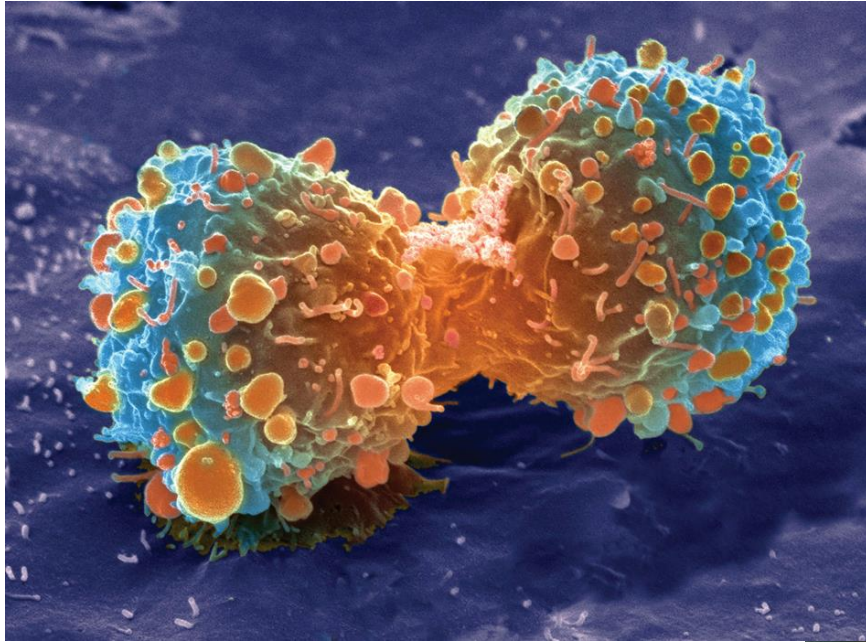


Figure 8.1A

- Other organisms make **similar** copies of themselves with genetic variety in a more complex process = sexual reproduction

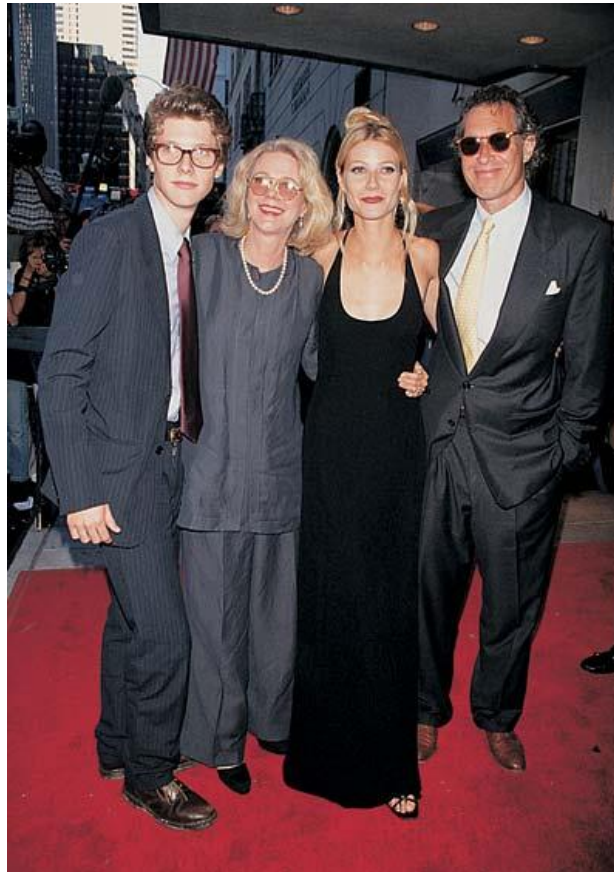
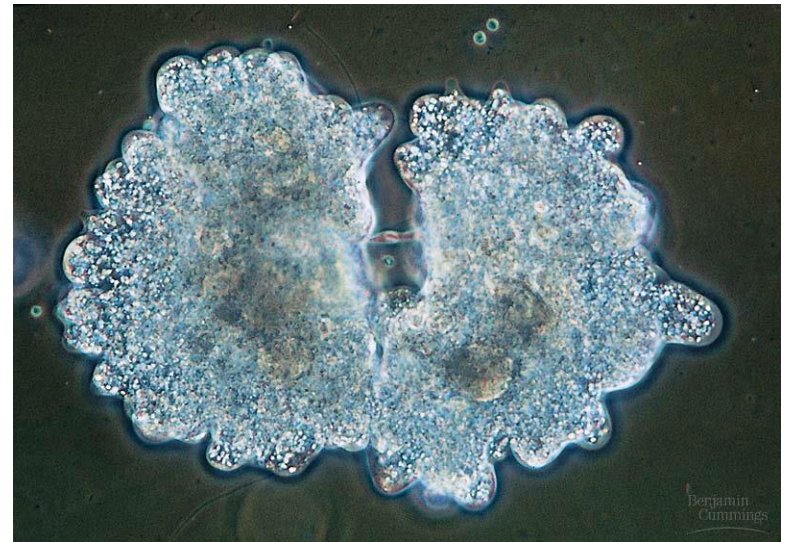


Figure 8.1B

Organisms can reproduce sexually or asexually

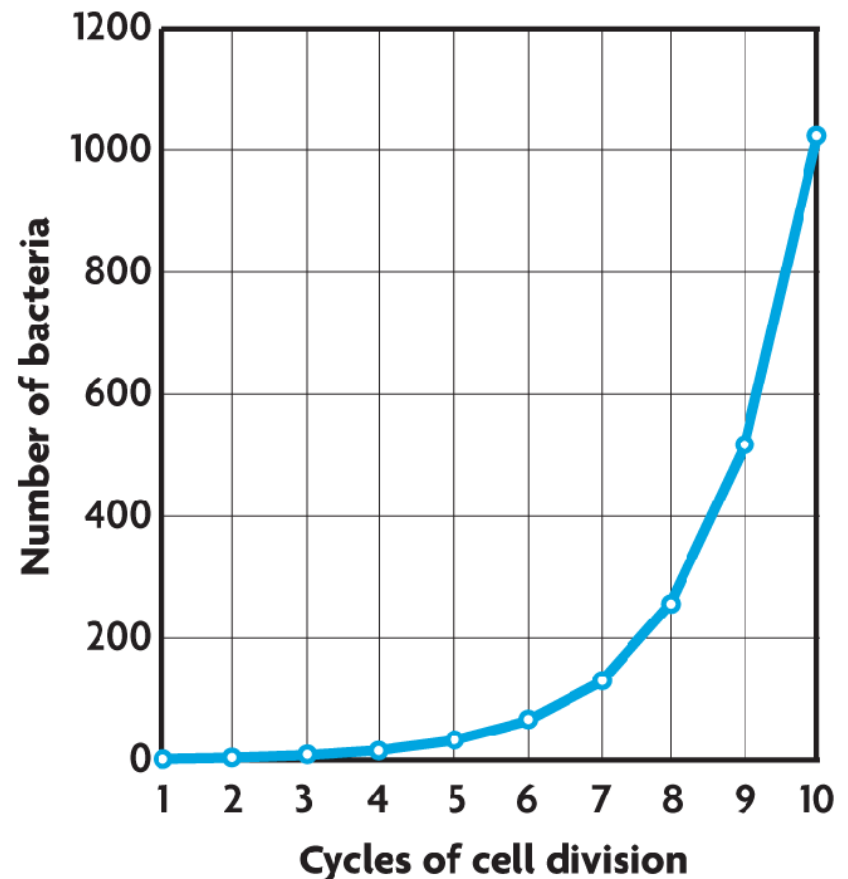
- Asexual Reproduction
 - **ONE parent passes all genes to offspring**
 - **Next generation identical to parent**
 - Entire population of species is **identical**
 - Common in unicellular organisms





- Sexual Reproduction
 - **2** parents each mix up their genes, then give half the DNA to the offspring
 - Offspring are a combination of parental genes and traits
 - **Wide variation in offspring traits**
 - Common in multicellular organisms

- Environment determines what form of reproduction is most advantageous.
 - Asexual reproduction is an advantage in consistently **favorable conditions**.
 - Sexual reproduction is an advantage in **changing conditions**.



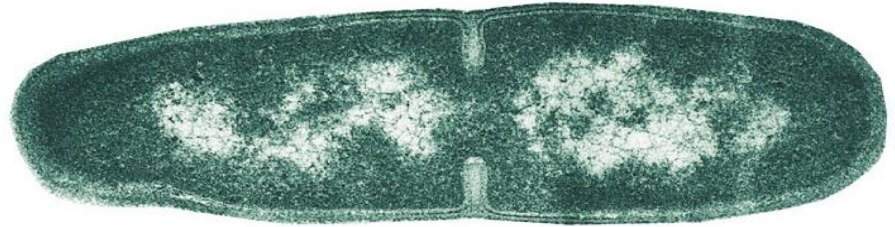
Cells divide at different rates.

- 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).

What are characteristics of **prokaryotic** cells like these?

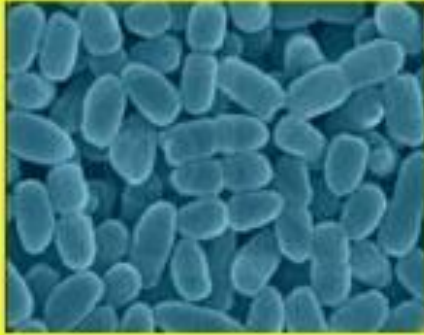


Bacillus

Bordetella

Clostridium

Escherichia

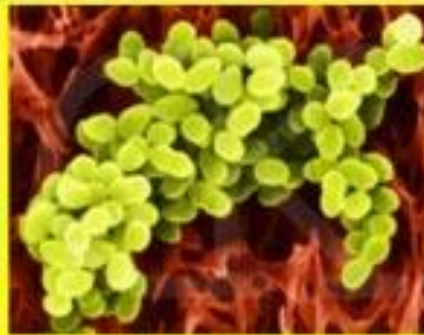


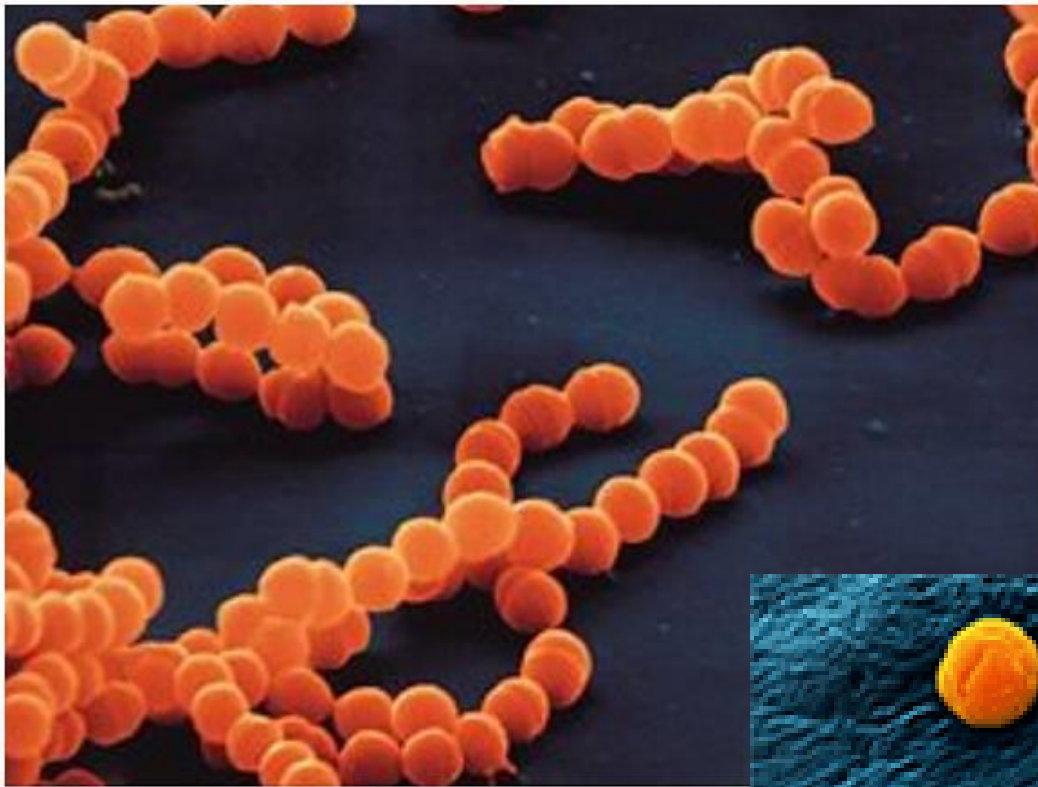
Spirulina

Staphylococcus

Streptococcus

Salmonella





PROKARYOTIC CELLS DIVIDE ASEXUALLY

- These cells possess a **single chromosome, containing genes**
- The chromosome is **replicated**
- The cell then divides into two cells, a process called **binary fission**

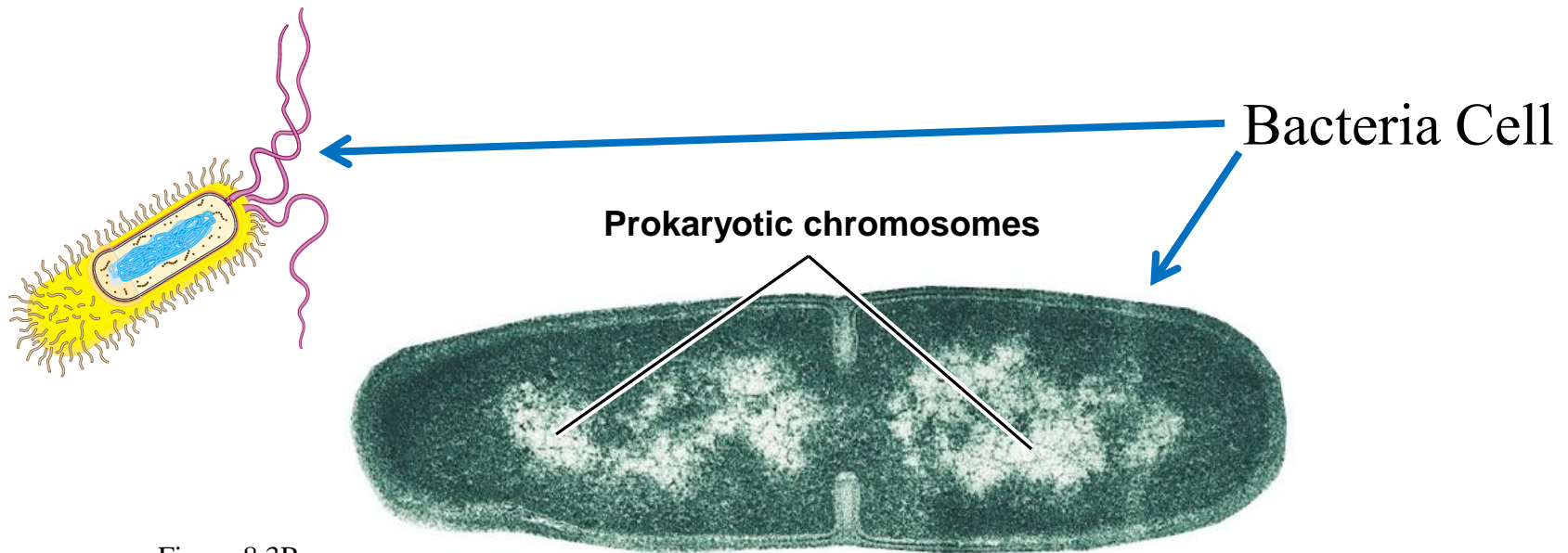


Figure 8.3B

- **Binary fission** of a prokaryotic cell (Bacteria)

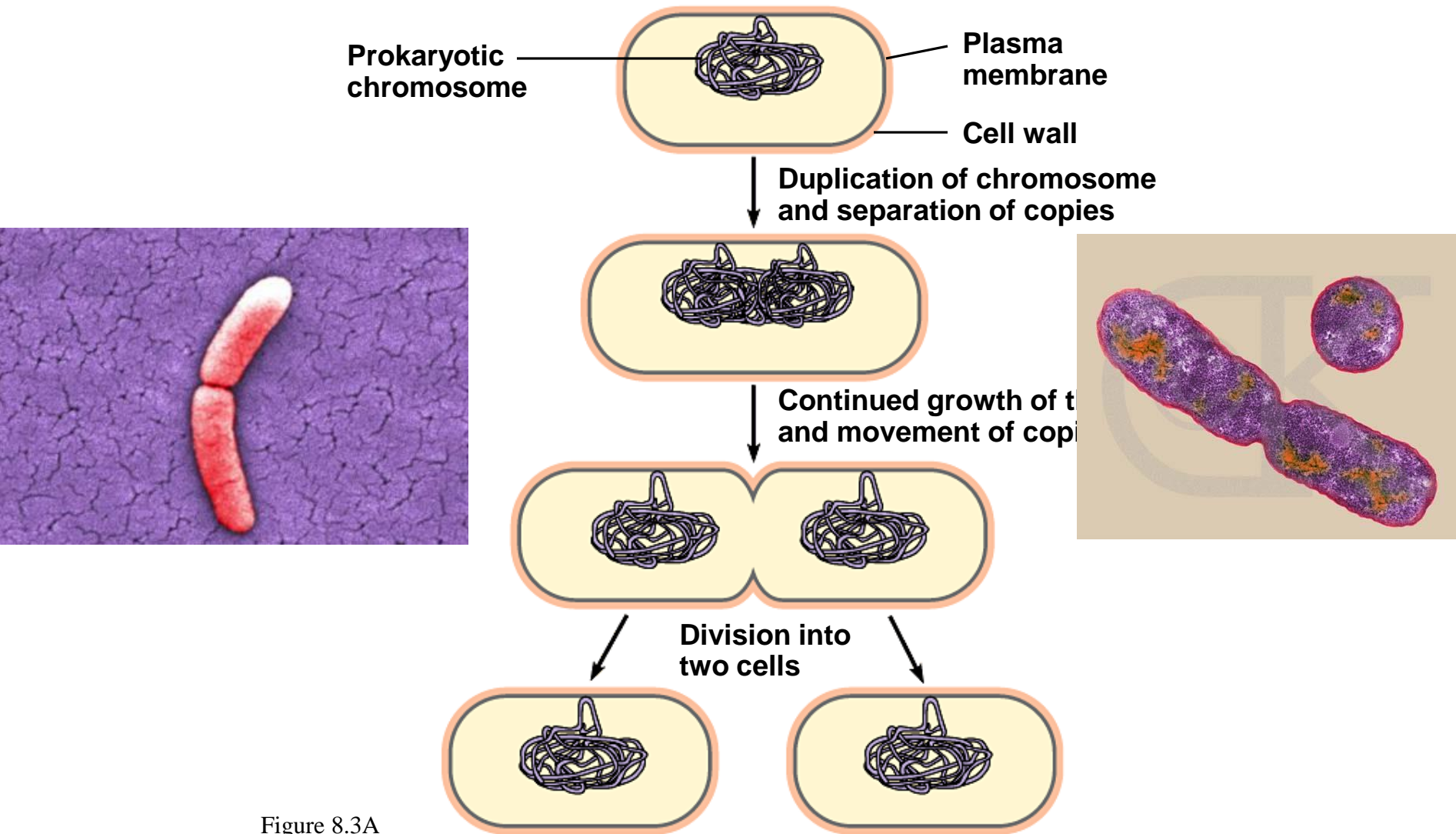
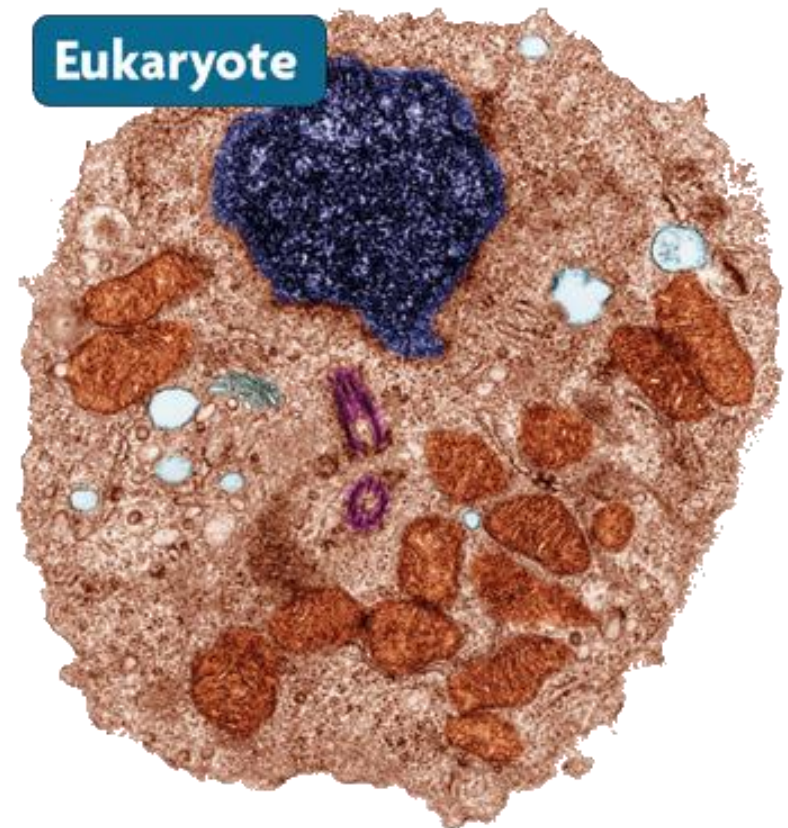
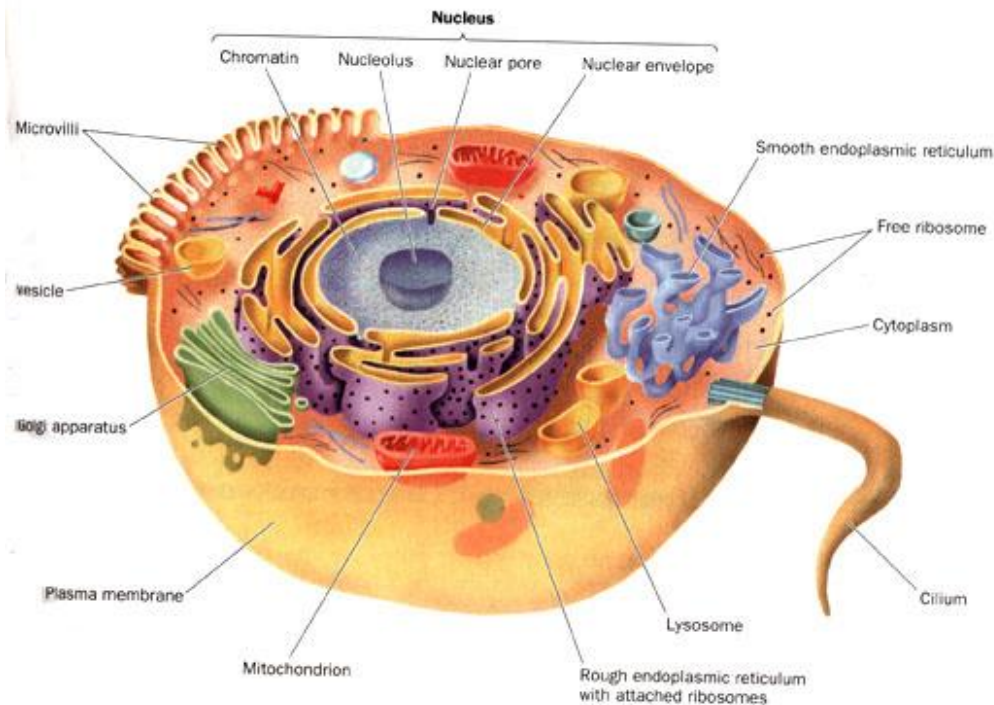


Figure 8.3A

What are characteristics of **eukaryotic** cells like these?



THE EUKARYOTIC CELL CYCLE AND MITOSIS

- A eukaryotic cell has many more genes than a prokaryotic cell
 - The genes are grouped into **many chromosomes, found in the nucleus**
 - The chromosomes of this plant cell are stained dark purple

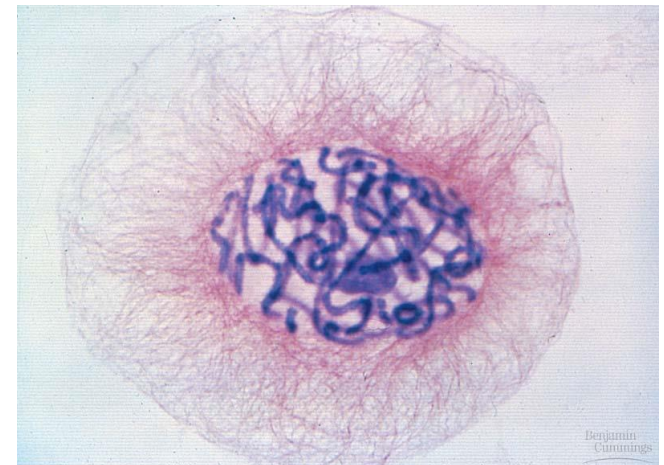


Figure 8.4A

- Healthy human male karyotype

Human male
G-bands

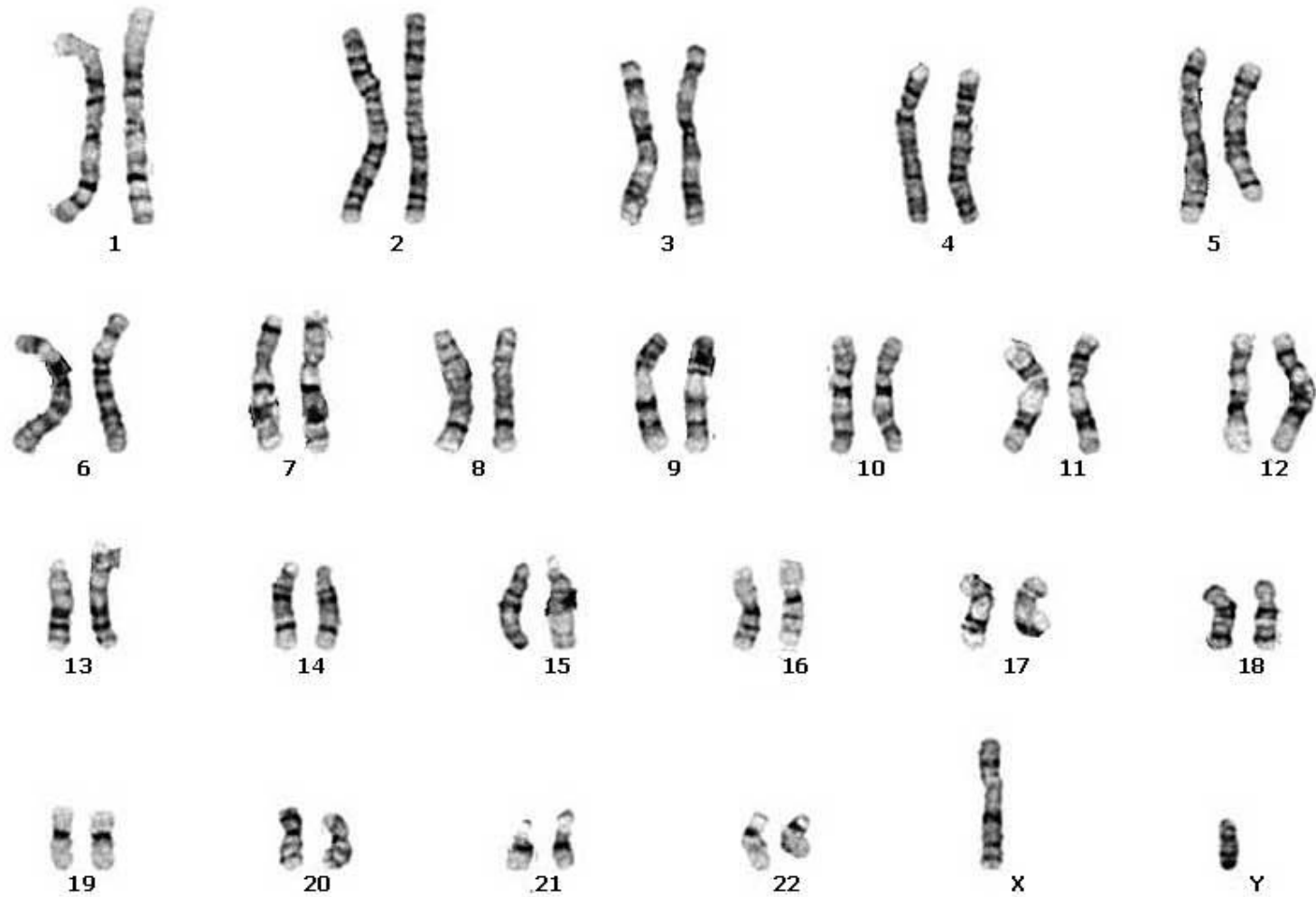
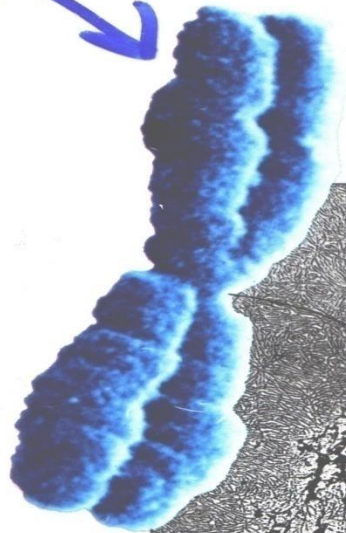
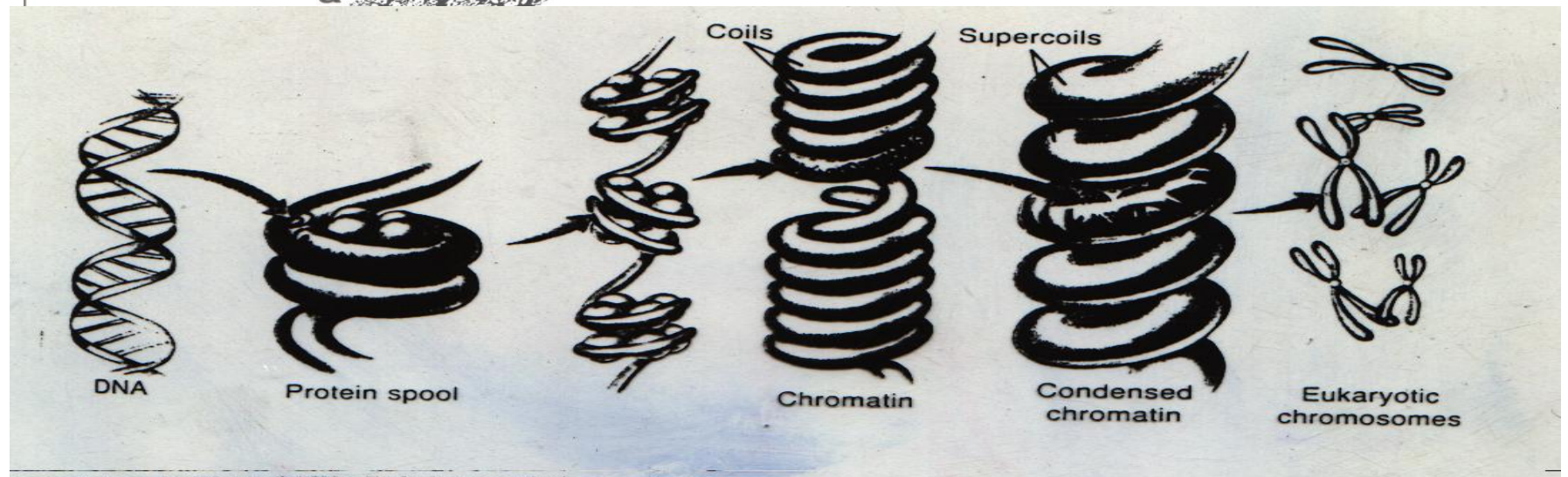
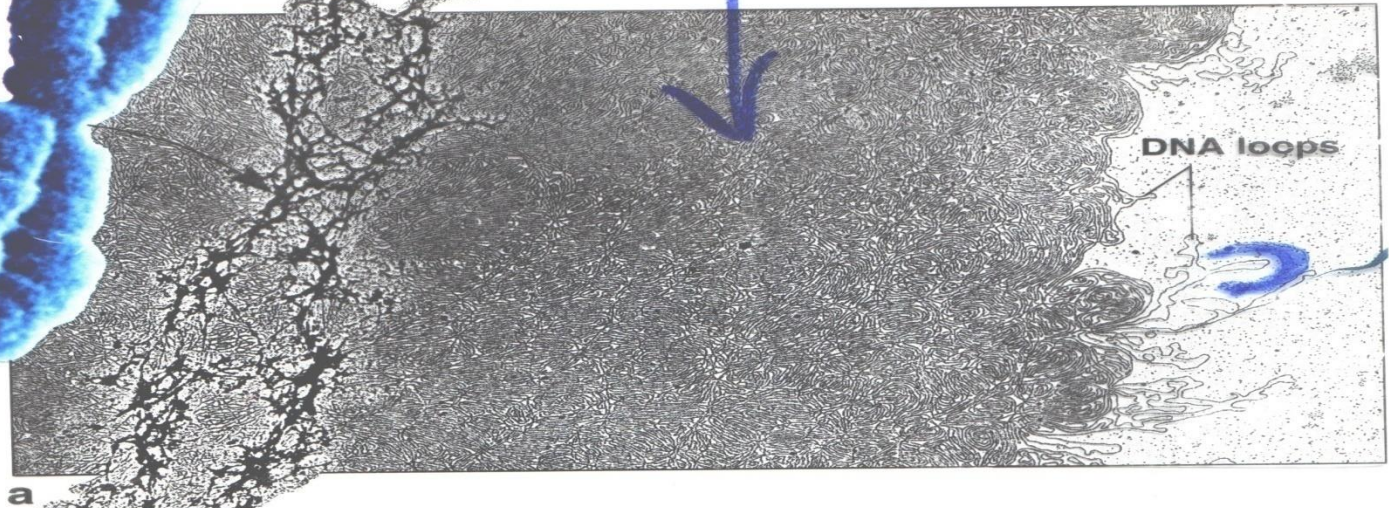


Figure 8.19x4

Chromosome



chromatin



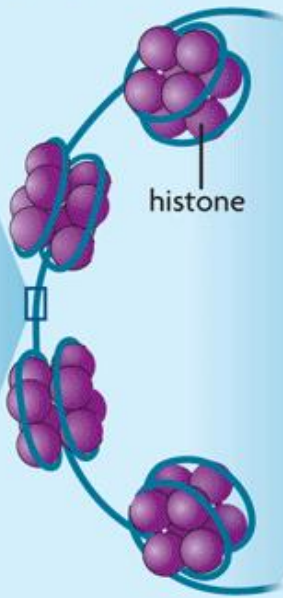
Another look at how chromosomes form during cell division

DNA condenses tightly during the early stages of mitosis.



DNA double helix

Each continuous, double-stranded DNA molecule makes one chromosome.



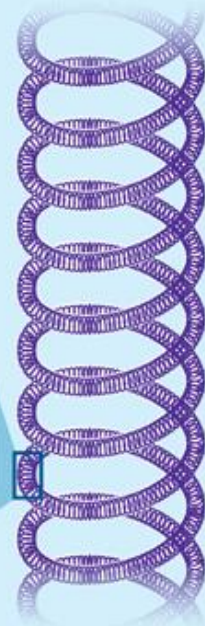
DNA and histones

DNA wraps at regular intervals around proteins called histones, forming chromatin.



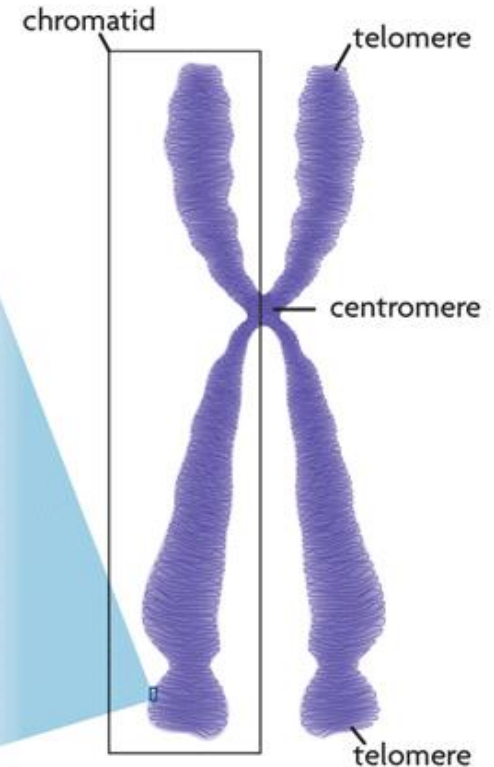
Chromatin

Interactions between parts of the histones further compact the DNA.



Supercoiled DNA

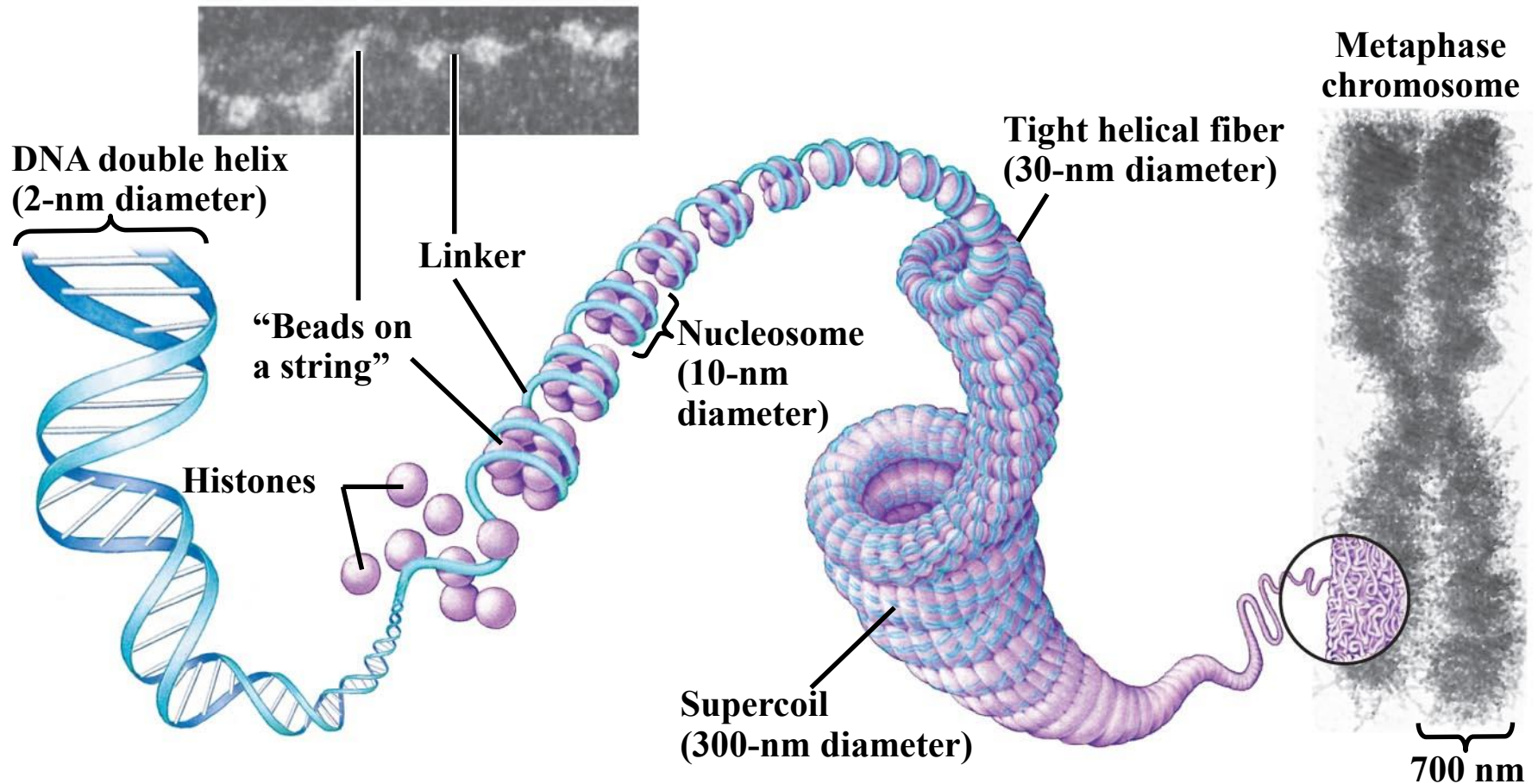
The chromatin coils more and more tightly around organizing proteins.



Condensed, duplicated chromosome

The condensed, duplicated chromosomes can be aligned and separated during mitosis.

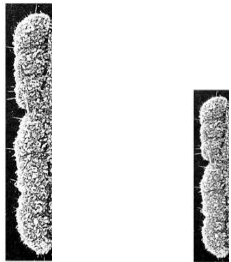
Chromatin folding video



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- Chromosomes contain a very long DNA molecule with thousands of **genes**
 - Individual chromosomes are only visible **during cell division** (Mitosis)
- Before a cell starts dividing, the “single” chromosomes are _____ duplicated
 - This process produces “double” chromosomes containing 2 sister chromatids

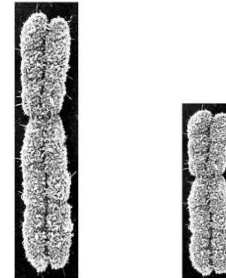
“single” chromosomes
BEFORE DNA Replication



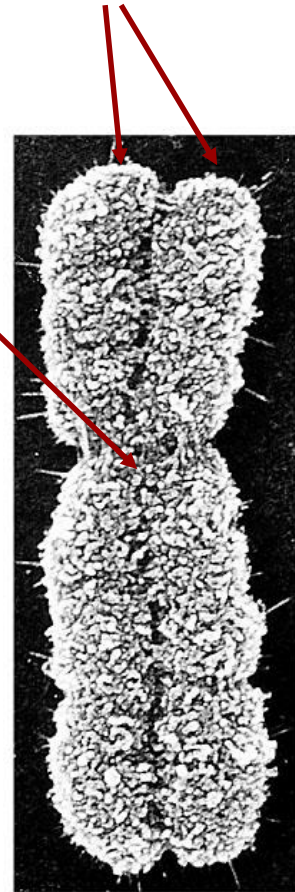
DNA Replication



“double” chromosomes
AFTER DNA Replication



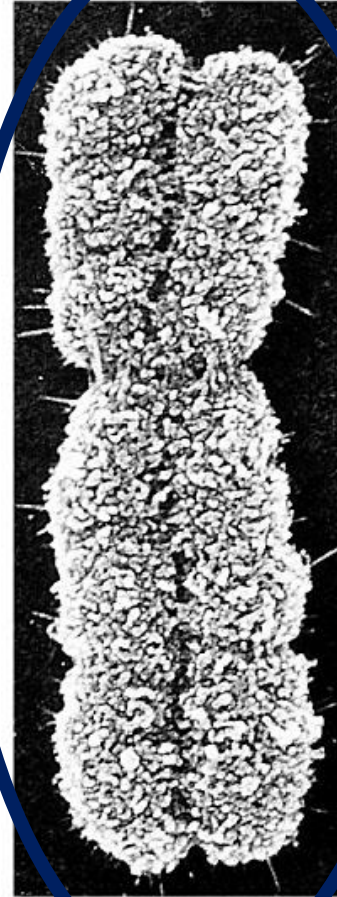
Centromere



Let's review chromosome characteristics:

What is this?

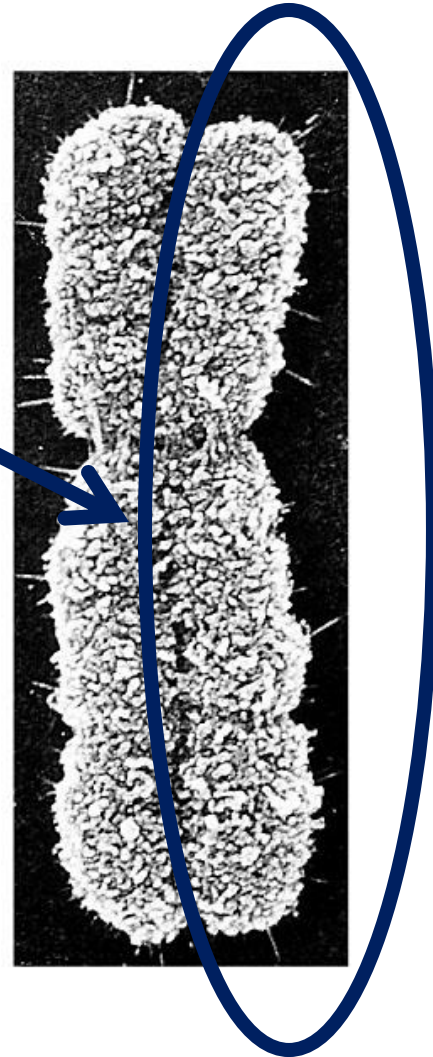
“Double chromosome”



Let's review chromosome characteristics:

What is this?

“sister chromatid”



Let's review chromosome characteristics:

What is this?

centromere



What IS Mitosis?

- A way for a cell to make an **EXACT copy of itself**.
- Each daughter cell has **EXACTLY the same DNA as the original cell**.
- In humans, the original cell starts with 46 chromosomes, and ends with 46 chromosomes.

Why are more cells needed by Mitosis?

- To GROW bigger in size
- To REPLACE old, worn out cells
- To REPAIR injuries
- To REPRODUCE for some unicellular organisms

The Cell Cycle consists of two major phases:

- Interphase where DNA makes a copy of itself and organelles are made.
- Mitosis : when the chromosomes “dance” and separate into 2 groups = nuclear division

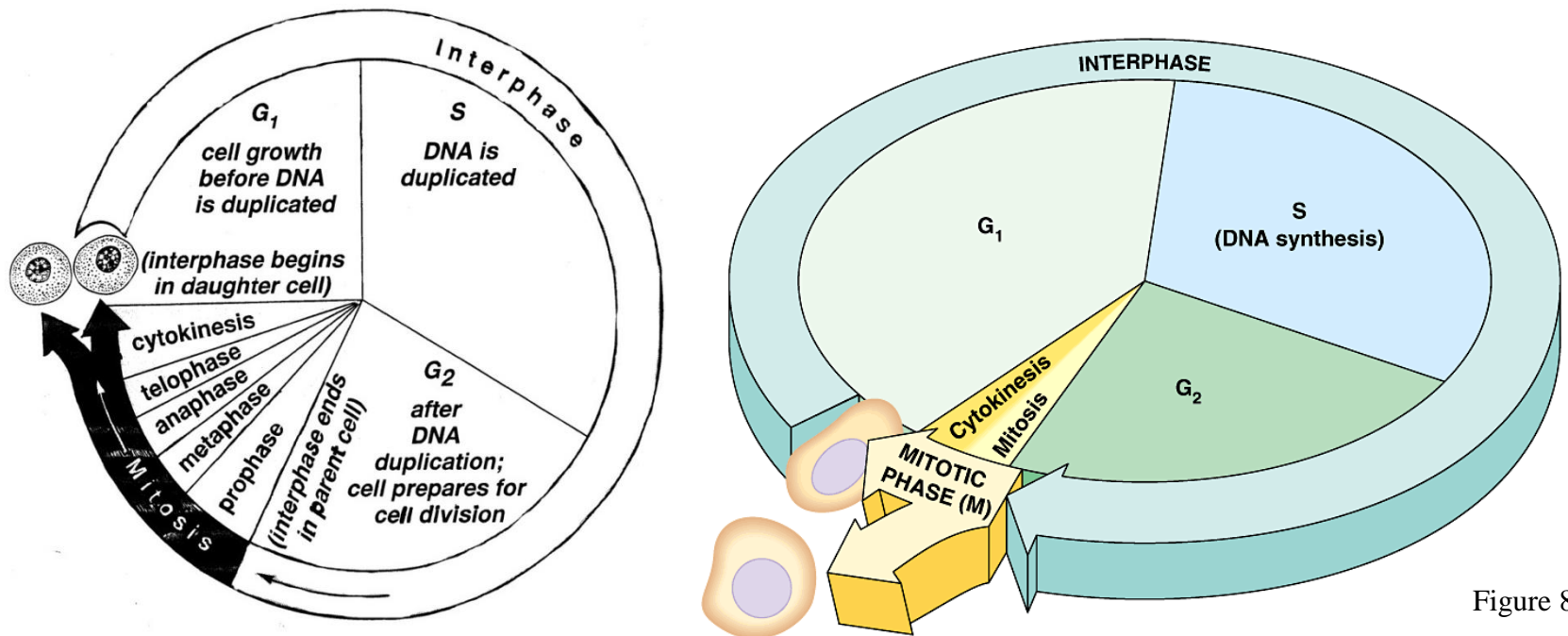
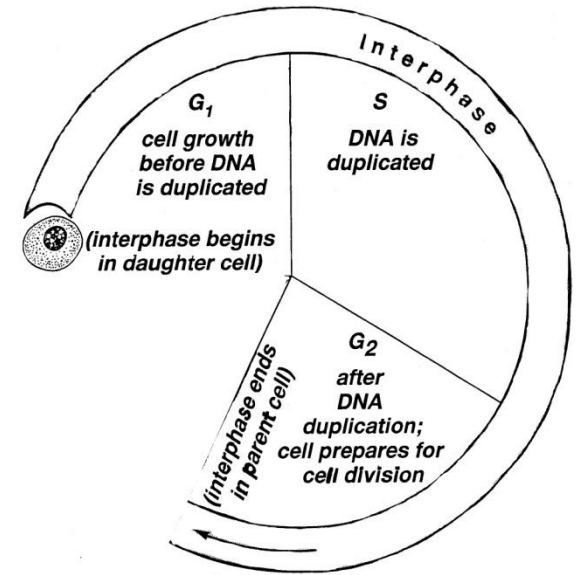
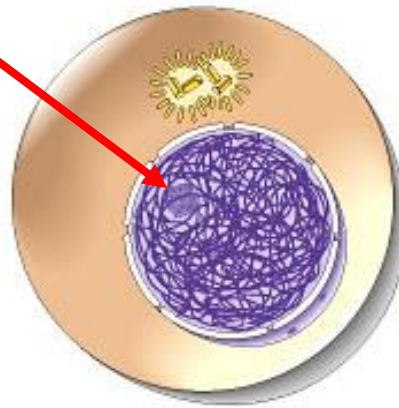


Figure 8.5

Interphase = ~ 90% of the Cell Cycle time

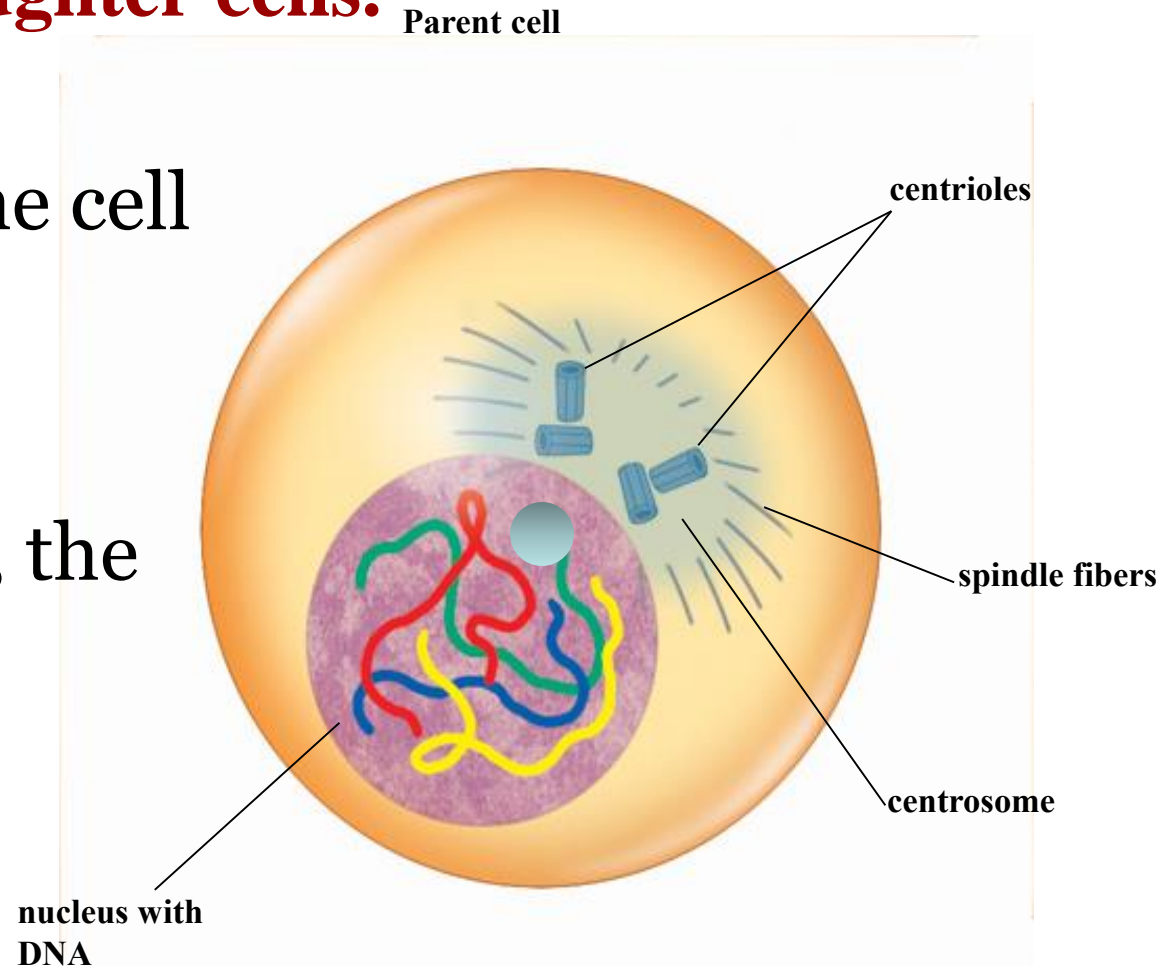
- DNA exists as chromatin “spaghetti” protected by a nuclear membrane
- The nucleolus is visible



- Growth and DNA Replication occur

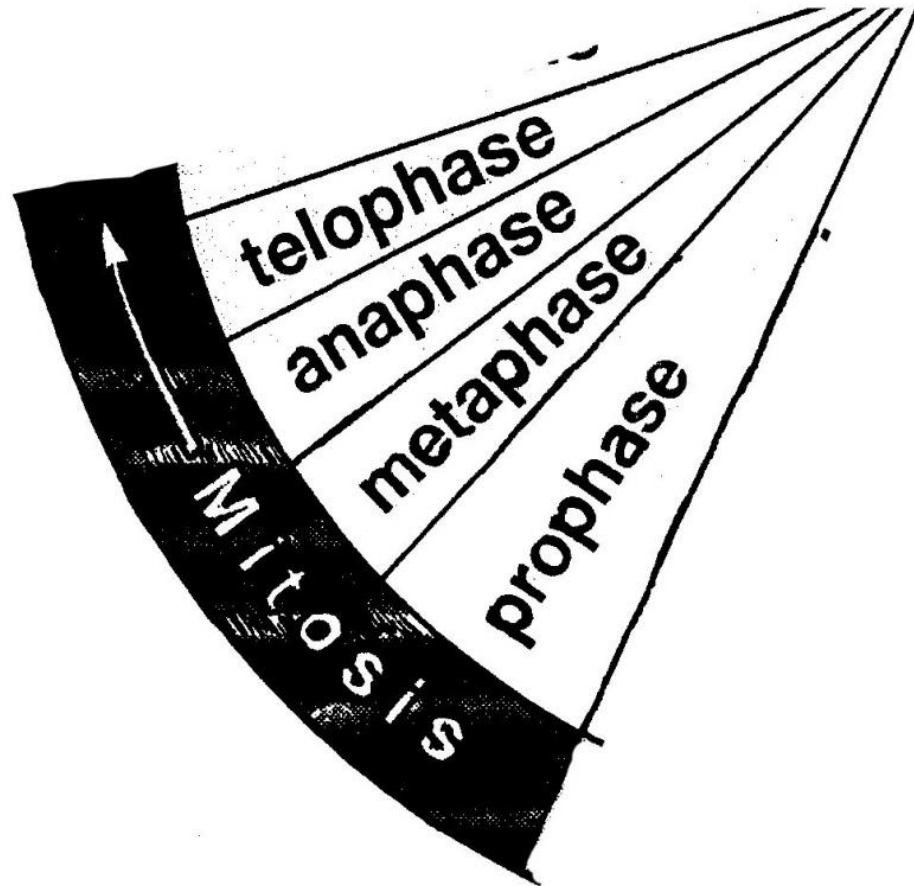
Mitosis and cytokinesis produce two genetically identical daughter cells.

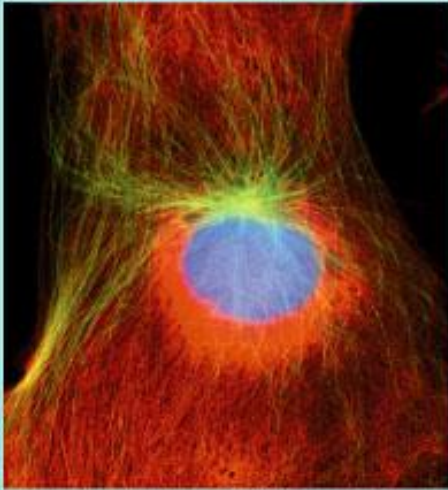
- Interphase prepares the cell to divide.
- During interphase, the DNA is duplicated.



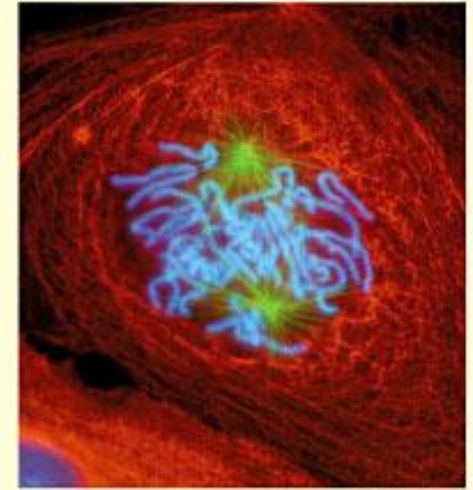
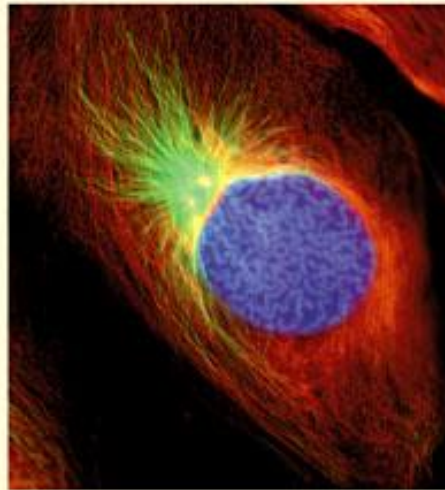
Mitosis = “Dance of the Chromosomes” = PMAT

- ~ 10 % of Cell Cycle time





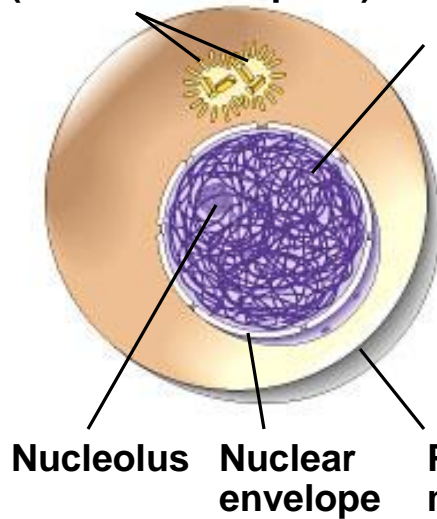
INTERPHASE



PROPHASE

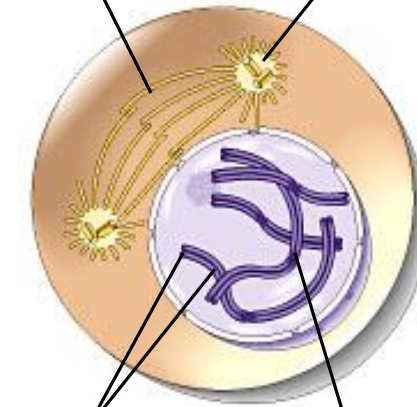
**Centrosomes
(with centriole pairs)**

Chromatin



**Early mitotic
spindle**

Centrosome



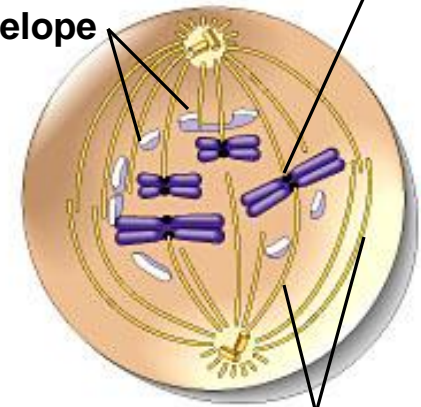
**Chromosome,
consisting of two
sister chromatids**

Centrosome



**Fragments of
nuclear
envelope**

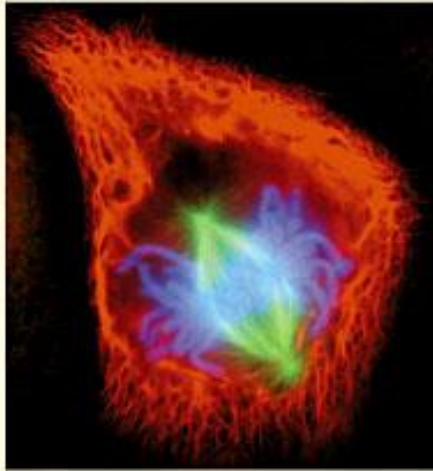
Kinetochores



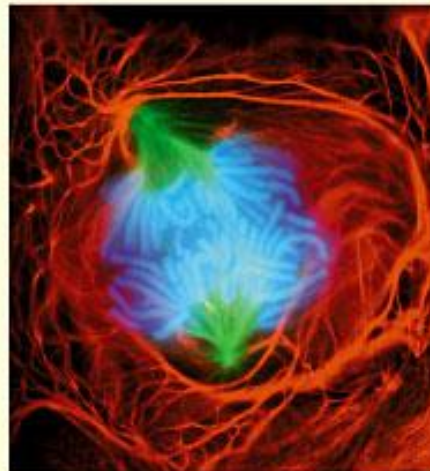
**Spindle
microtubules**



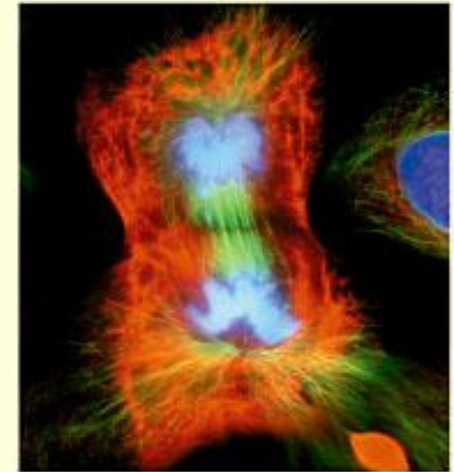
Figure 8.6



METAPHASE



ANAPHASE



TELOPHASE AND CYTOKINESIS

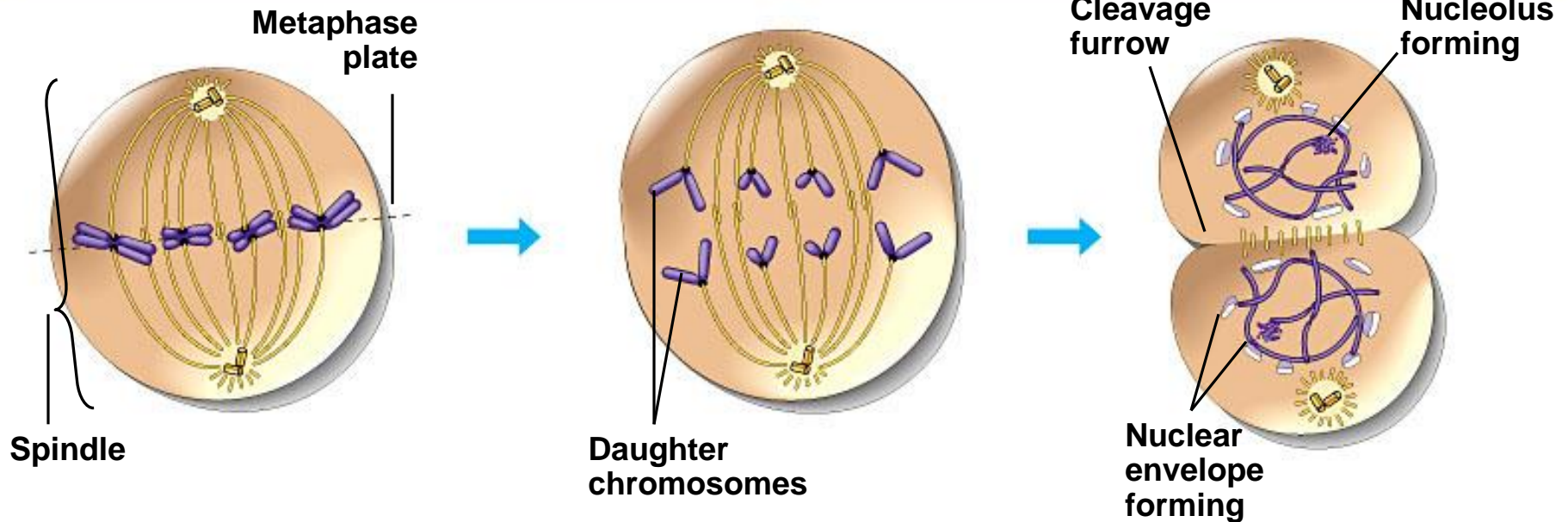
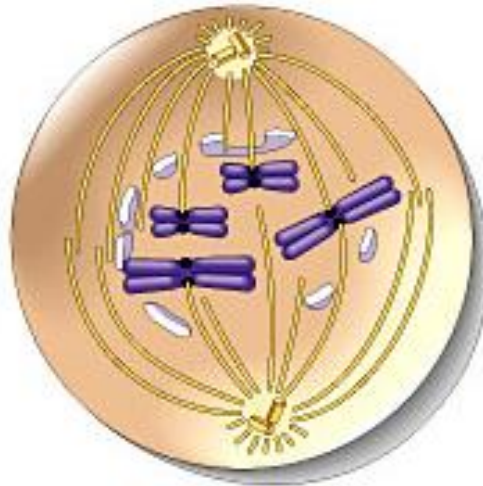


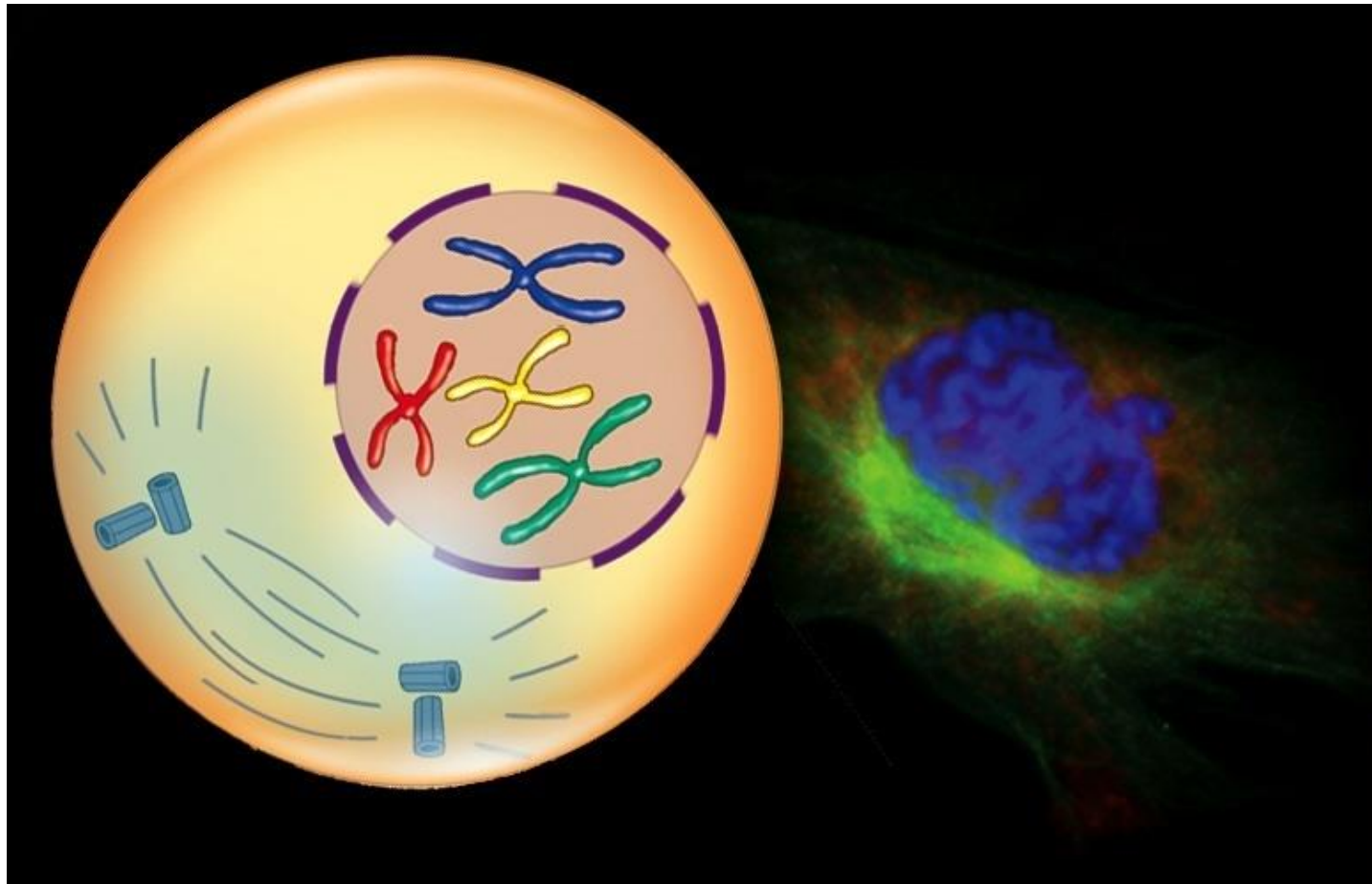
Figure 8.6 (continued)

Prophase

- Chromatin coils tightly into visible “double” chromosomes
- Nucleolus and nuclear membrane disappear
- 2 centrioles separate to opposite poles of the cell and build a football-shaped spindle

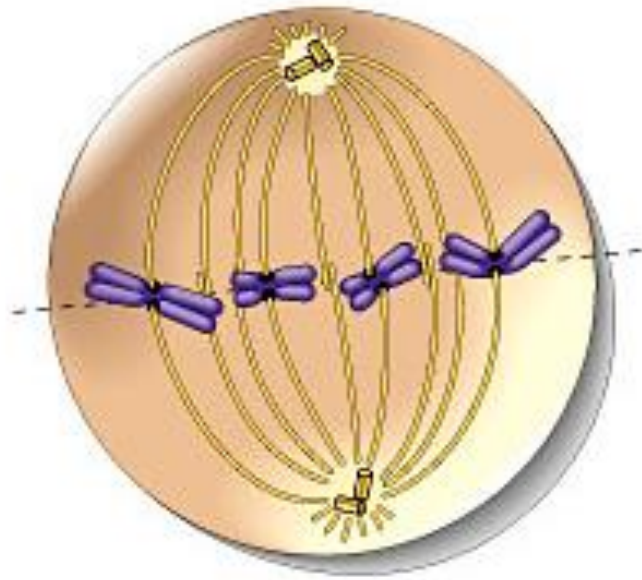


- Mitosis divides the cell's nucleus in four phases. During **prophase**, chromosomes condense and spindle fibers form.

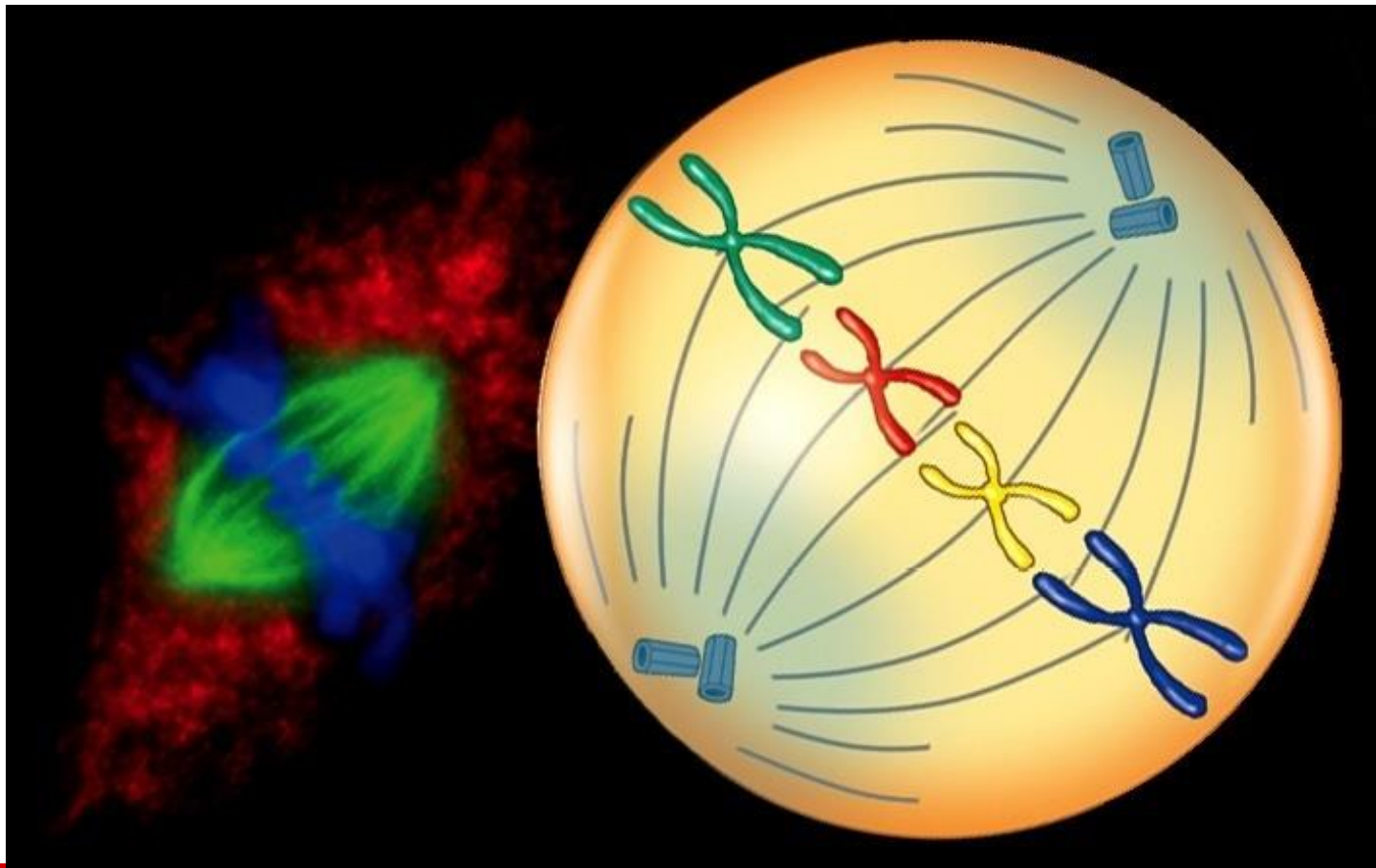


Metaphase

- Chromosomes line up single file in the middle of the cell along the equator
- Chromosomes attach to the spindle fibers at their centromeres

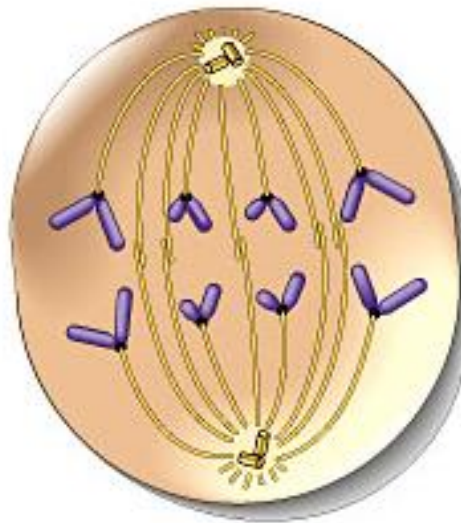


- Mitosis divides the cell's nucleus in four phases.
 - During **metaphase**, chromosomes line up in the middle of the cell.

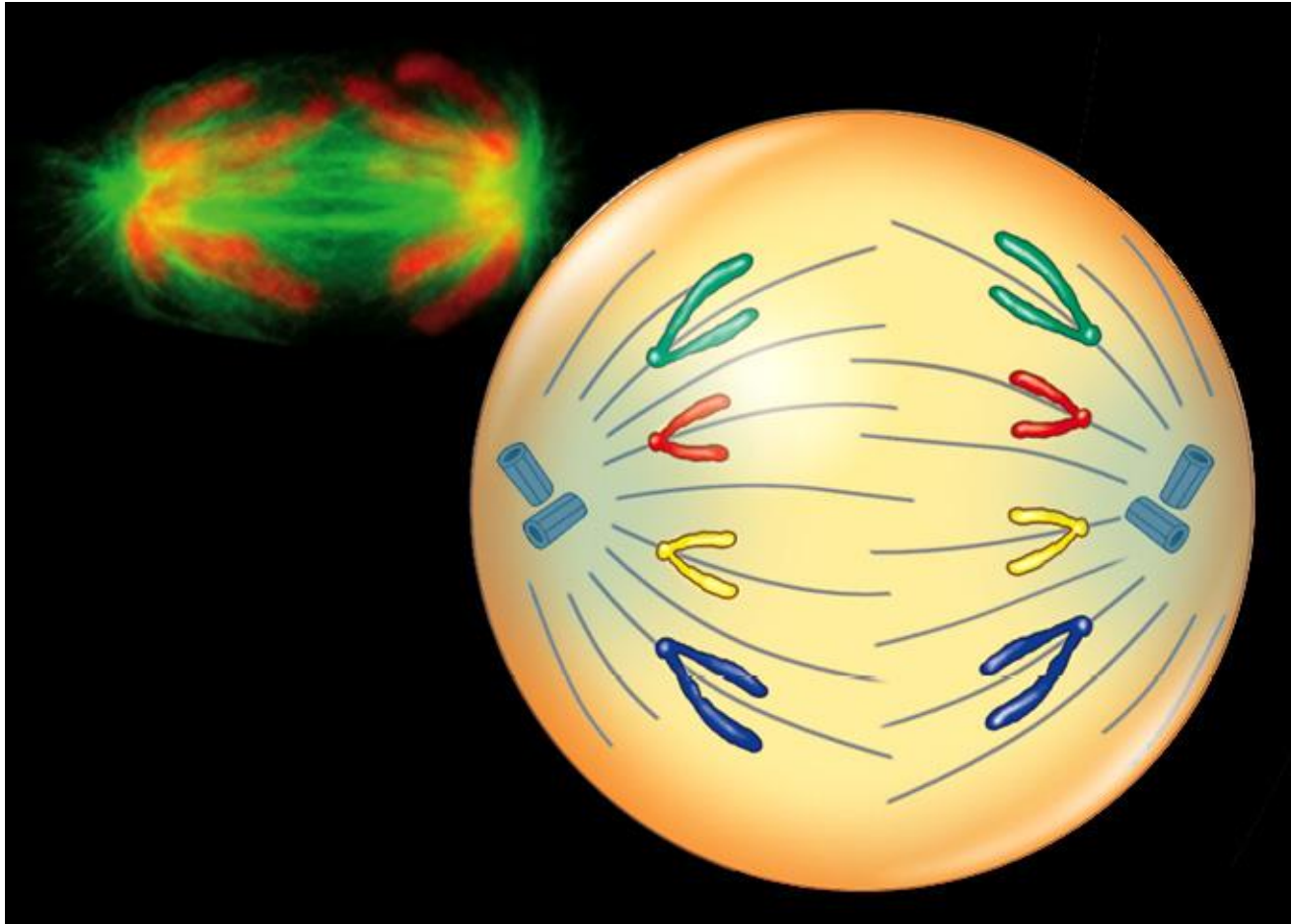


Anaphase

- Spindle fibers retract toward the poles, ripping the “double” chromosomes in half at the centromere
- Sister chromatids split apart forming 2 identical “single” chromosomes that are pulled to the poles at each side of the cell

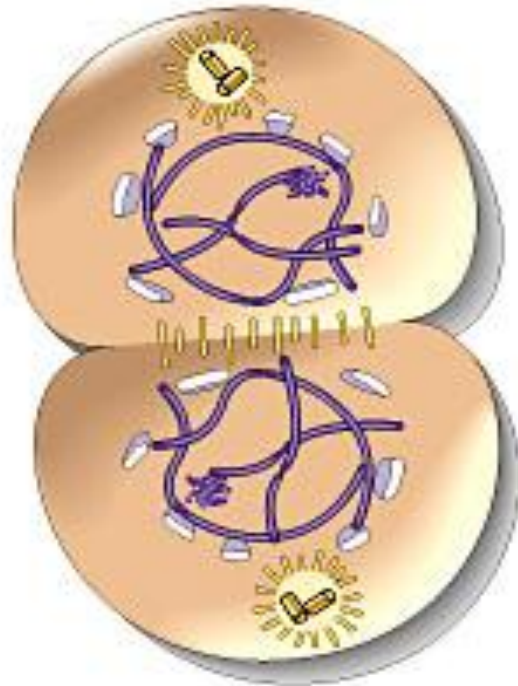


- Mitosis divides the cell's nucleus in four phases.
– During **anaphase**, single chromosomes separate to opposite sides of the cell.

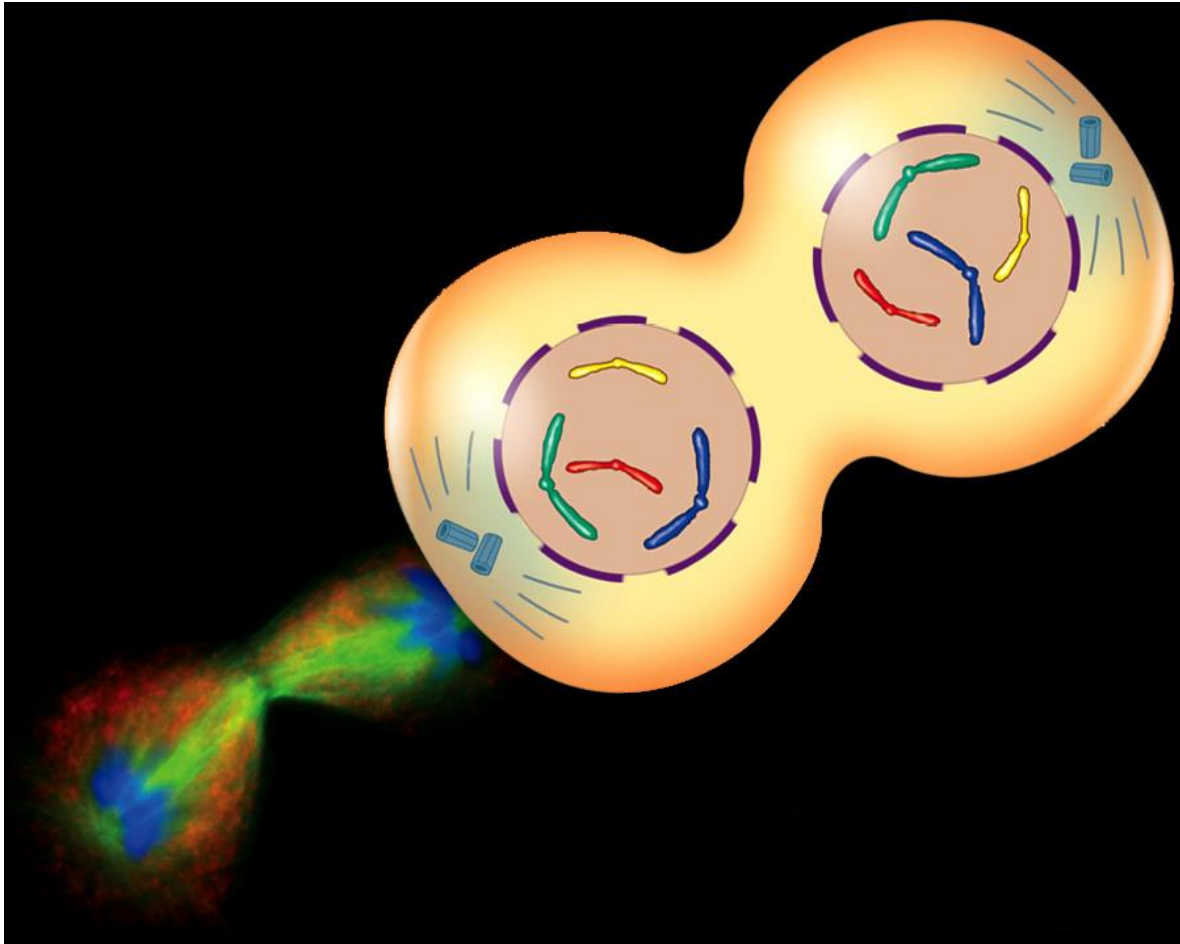


Telophase

- Chromosomes uncoil back into chromatin
- Spindle disappears while the nuclear membrane and nucleolus reappear



- Mitosis divides the cell's nucleus in four phases.
 - During **telophase**, the new nuclei form and chromosomes begin to uncoil.



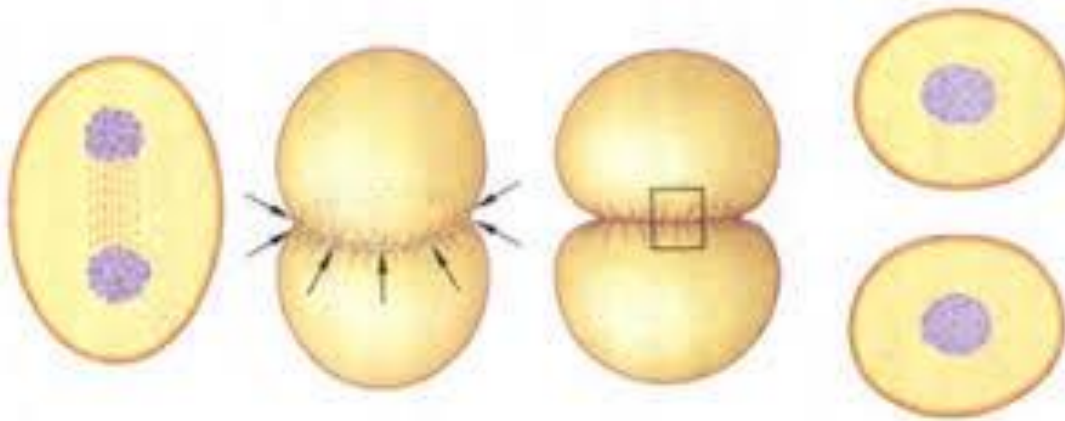
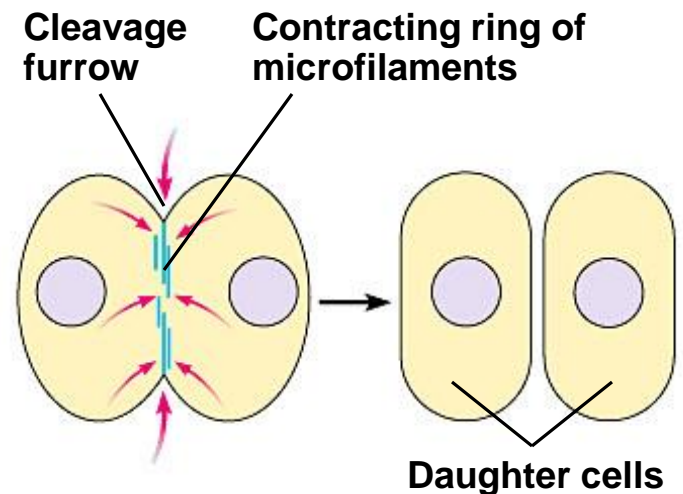
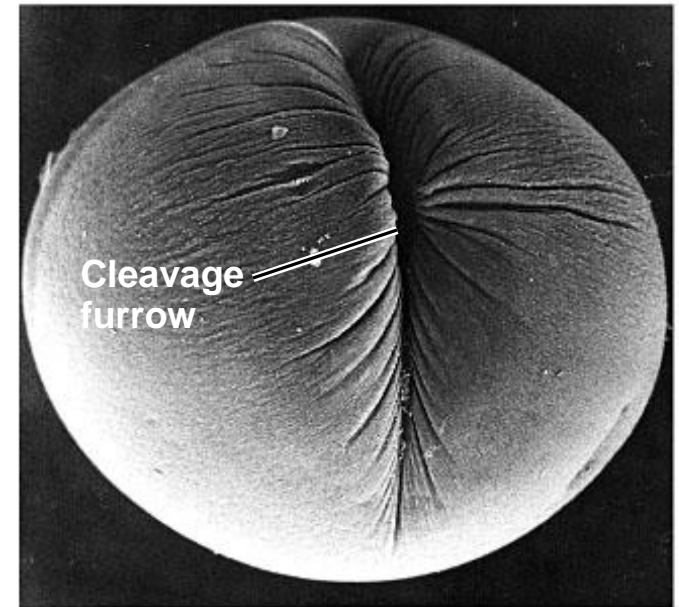
Cytokinesis pinches the cell apart

- In animals, a protein “lasso” pinches the cell in half

Slip knot



Ratchet strap



- In plants, a cell plate forms and splits the cell in two as a new cell wall is built

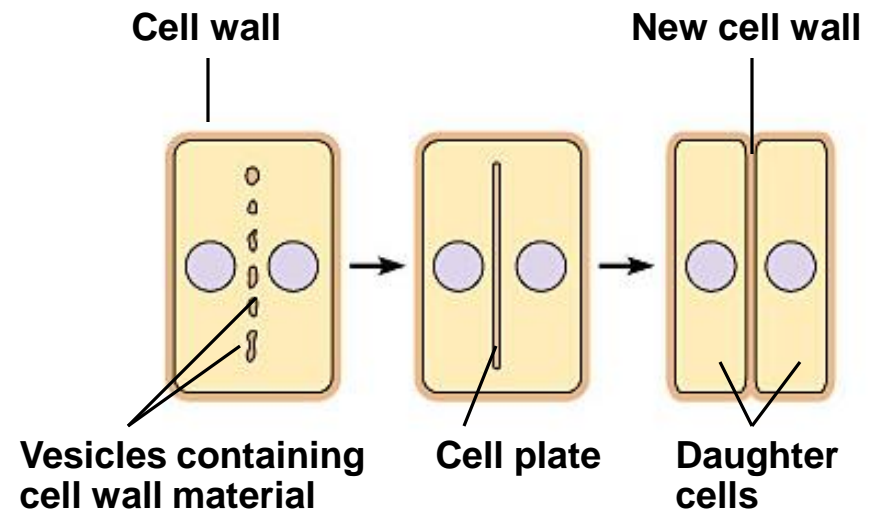
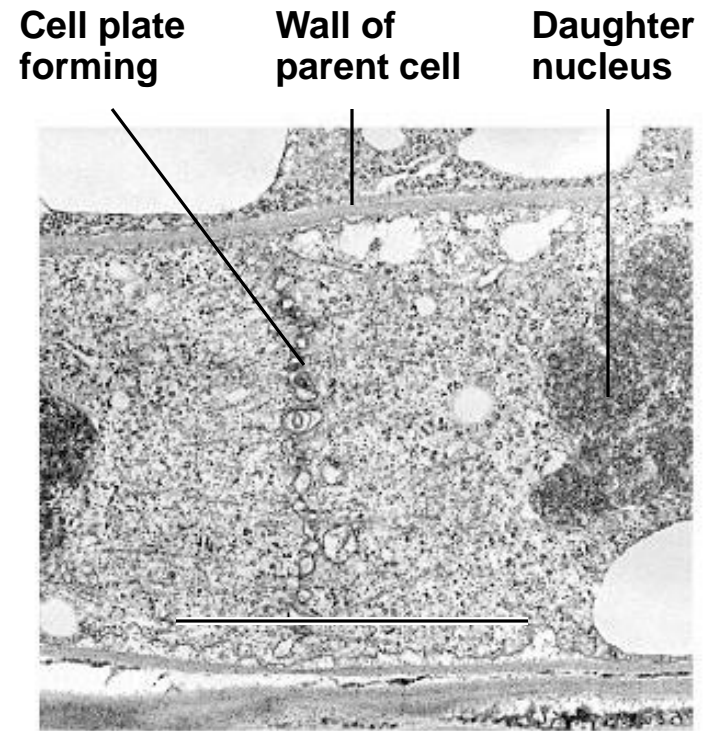
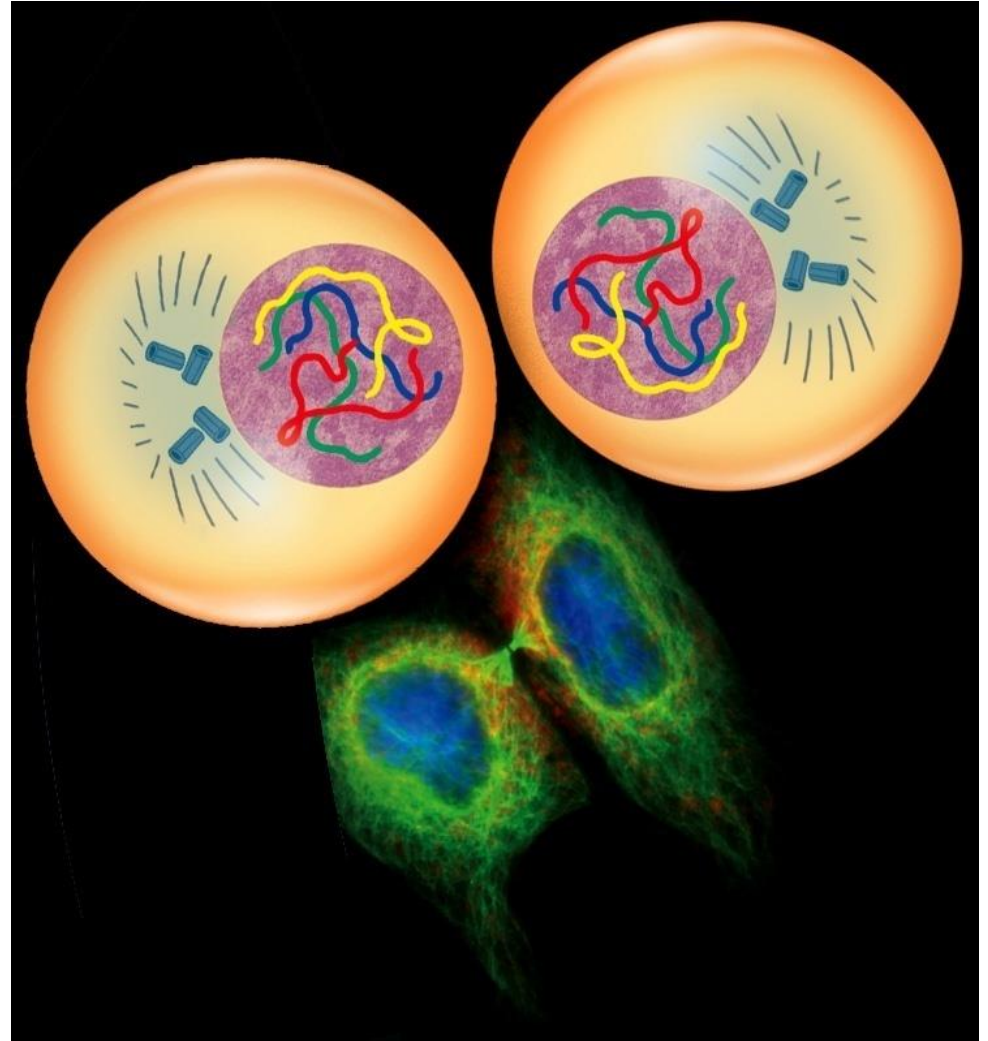


Figure 8.7B

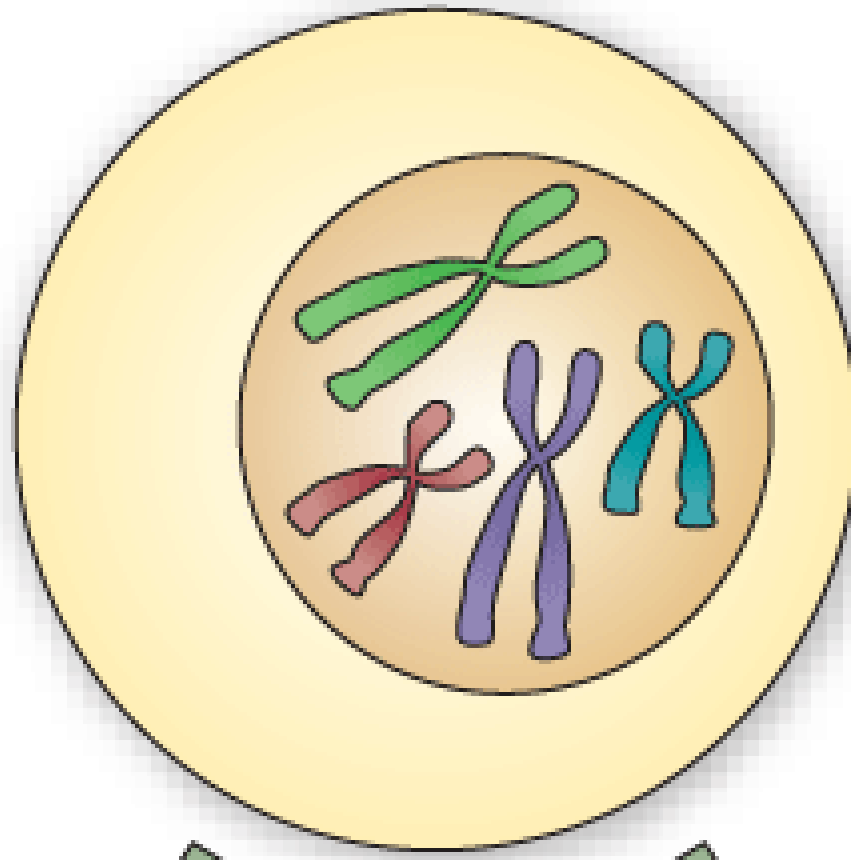
- **Cytokinesis** differs in animal and plant cells.

- In animal cells, the membrane pinches closed.
- In plant cells, a cell plate forms.

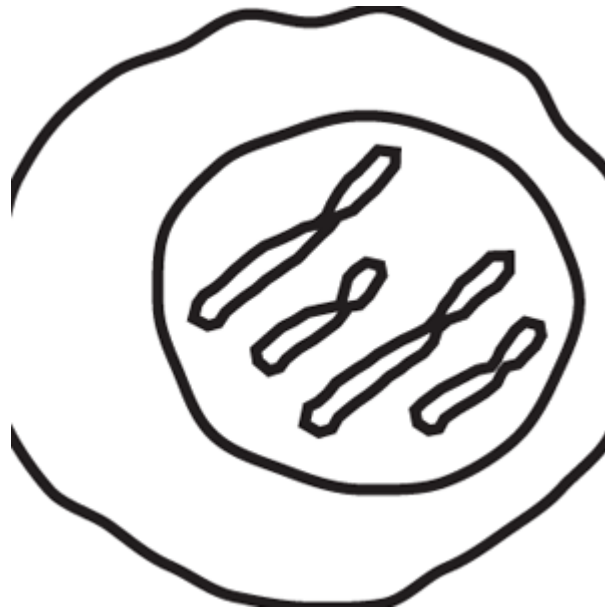
Mitosis Song



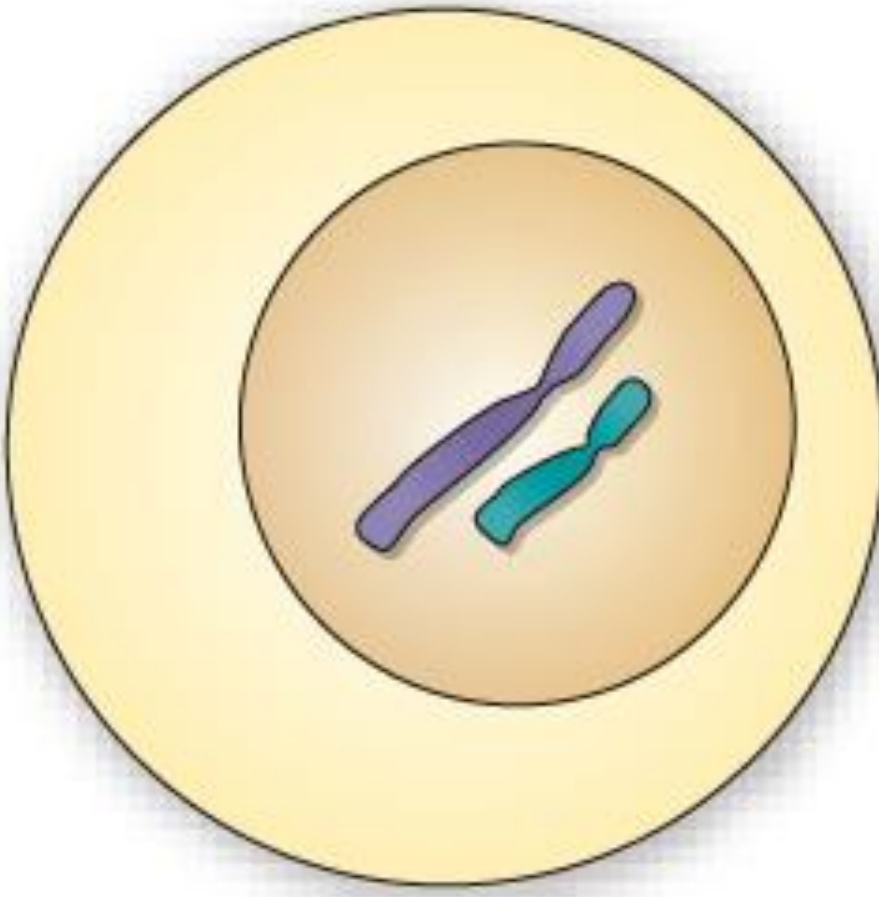
Is this cell Haploid or Diploid?



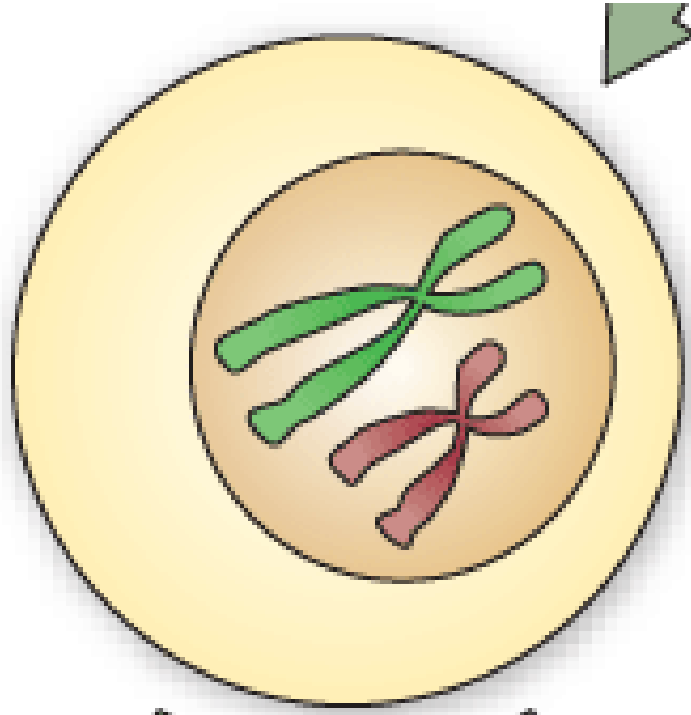
Is this cell Haploid or Diploid?

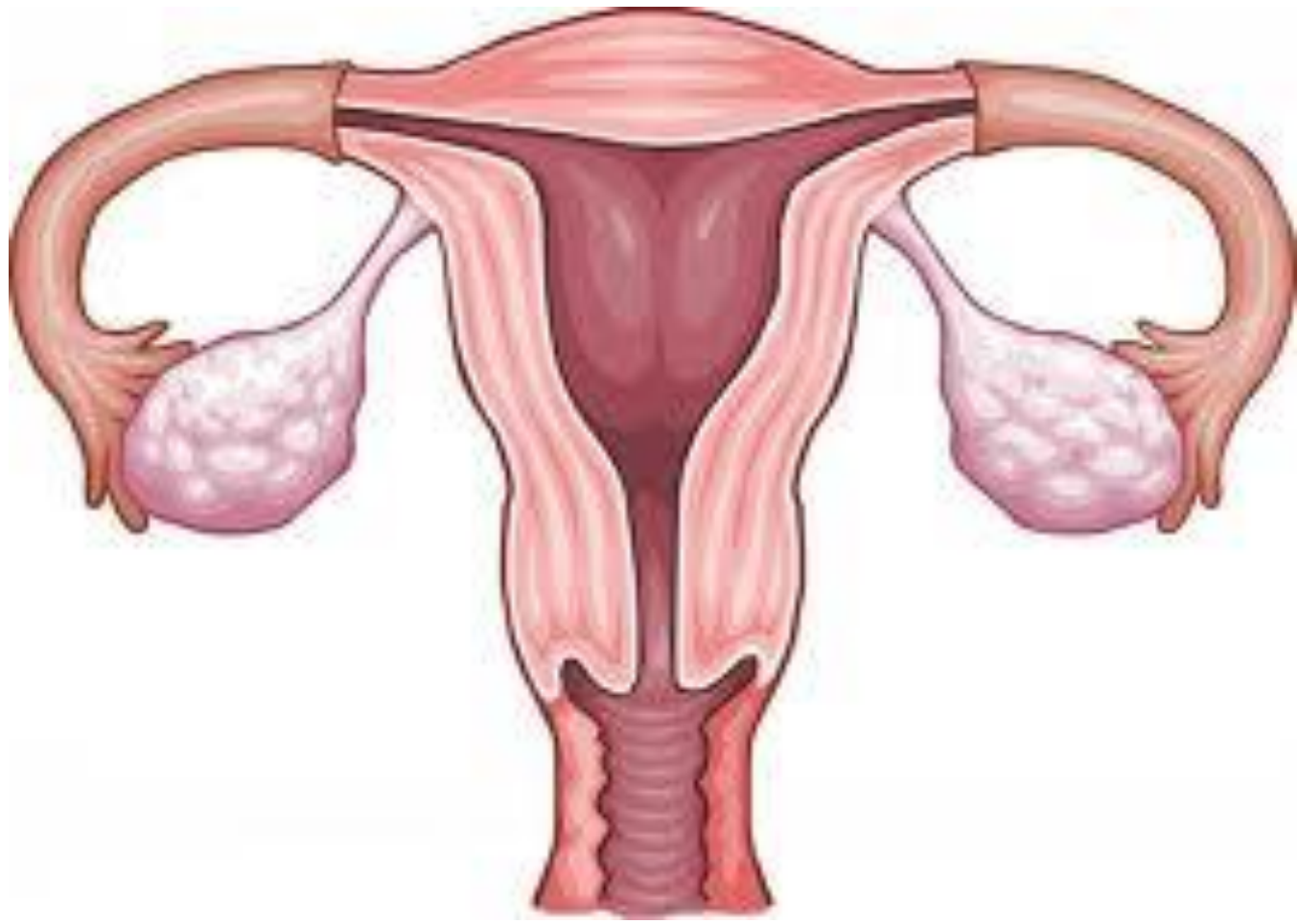


Is this cell Haploid or Diploid?

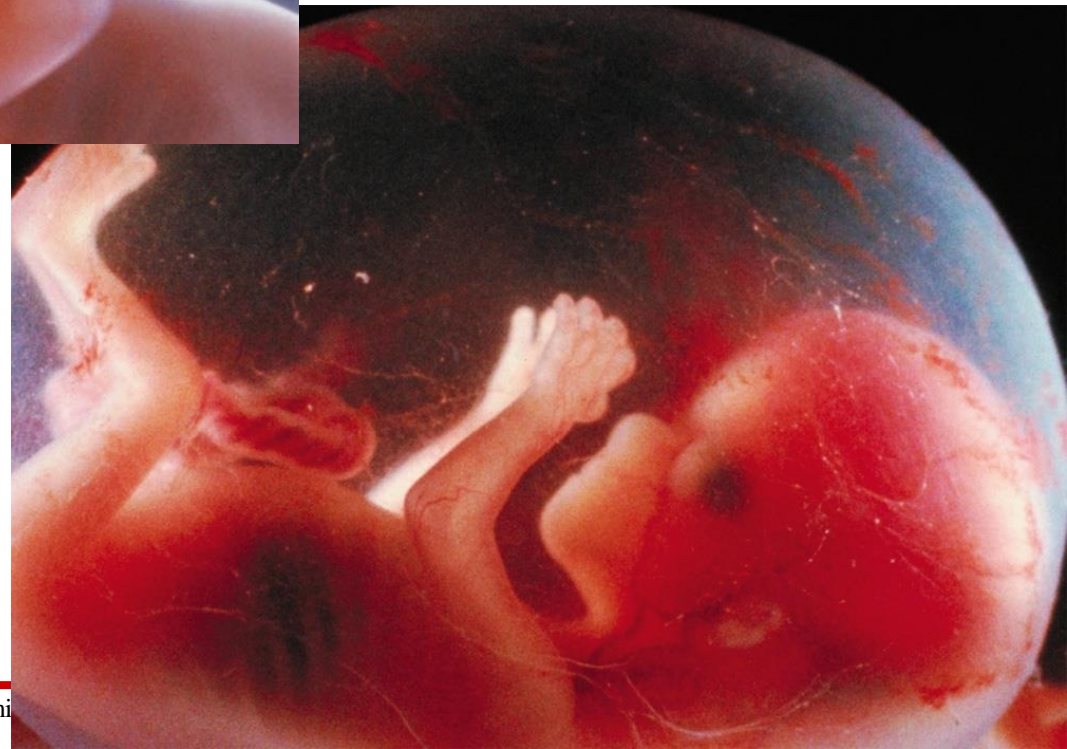


Is this cell Haploid or Diploid?



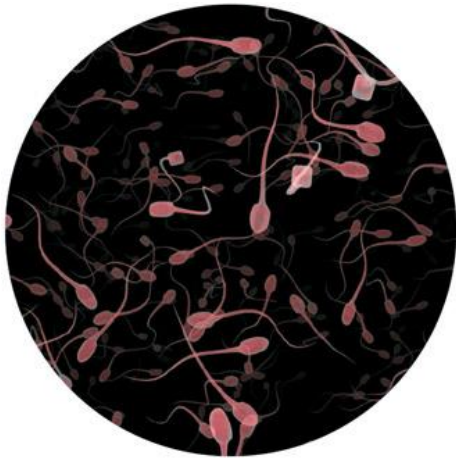






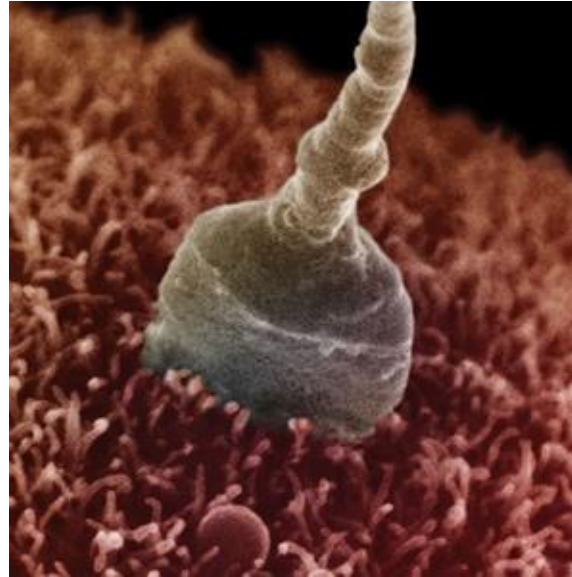
You were created by the combination of two gametes (or sex cells)

- Body cells (somatic) with two sets of chromosomes are said to be Diploid = $2n$
- Gametes are Haploid = n , with only one set of chromosomes



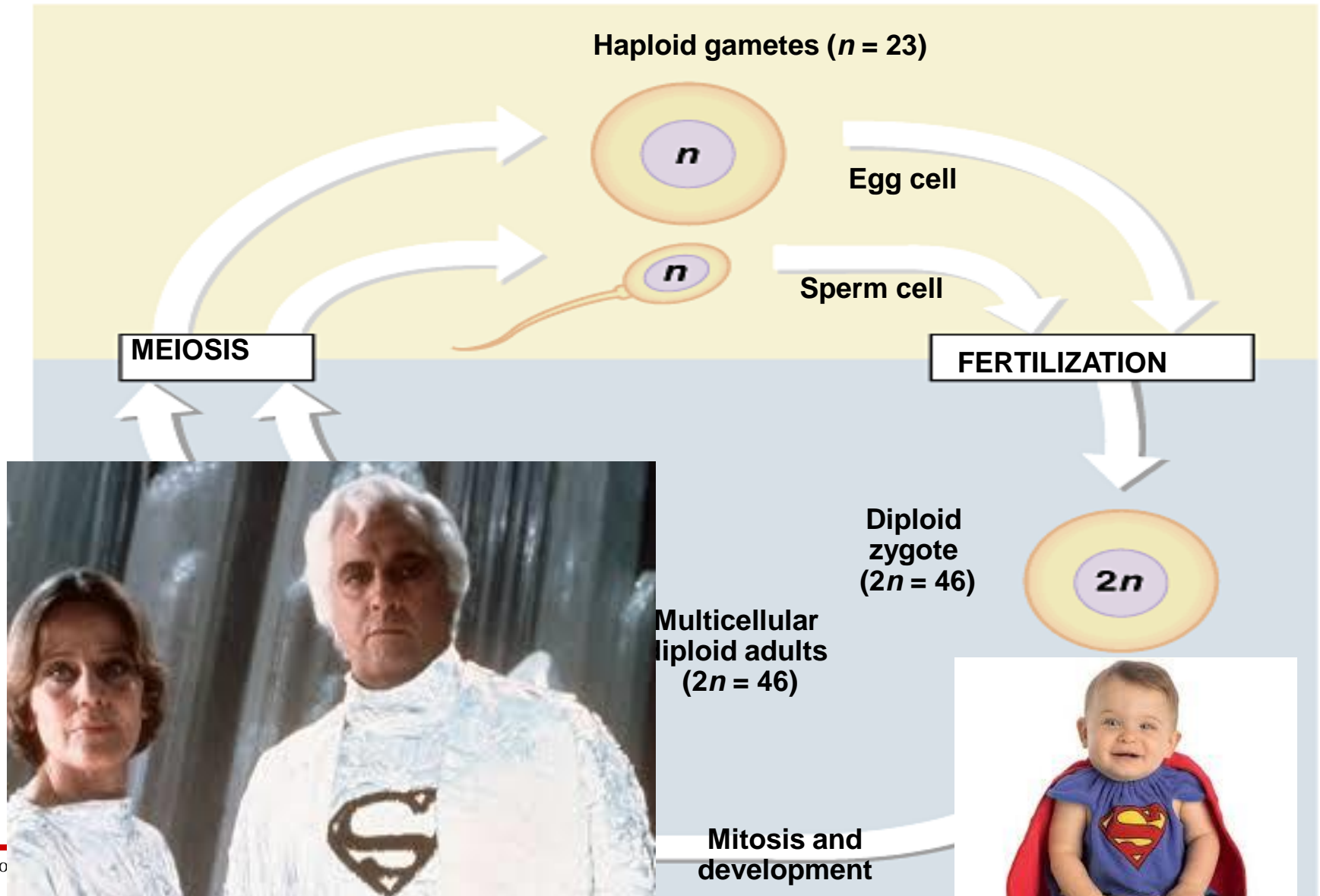
For Humans: 23 + 23 = 46

- At fertilization, a sperm fuses with an egg, forming a **diploid zygote**

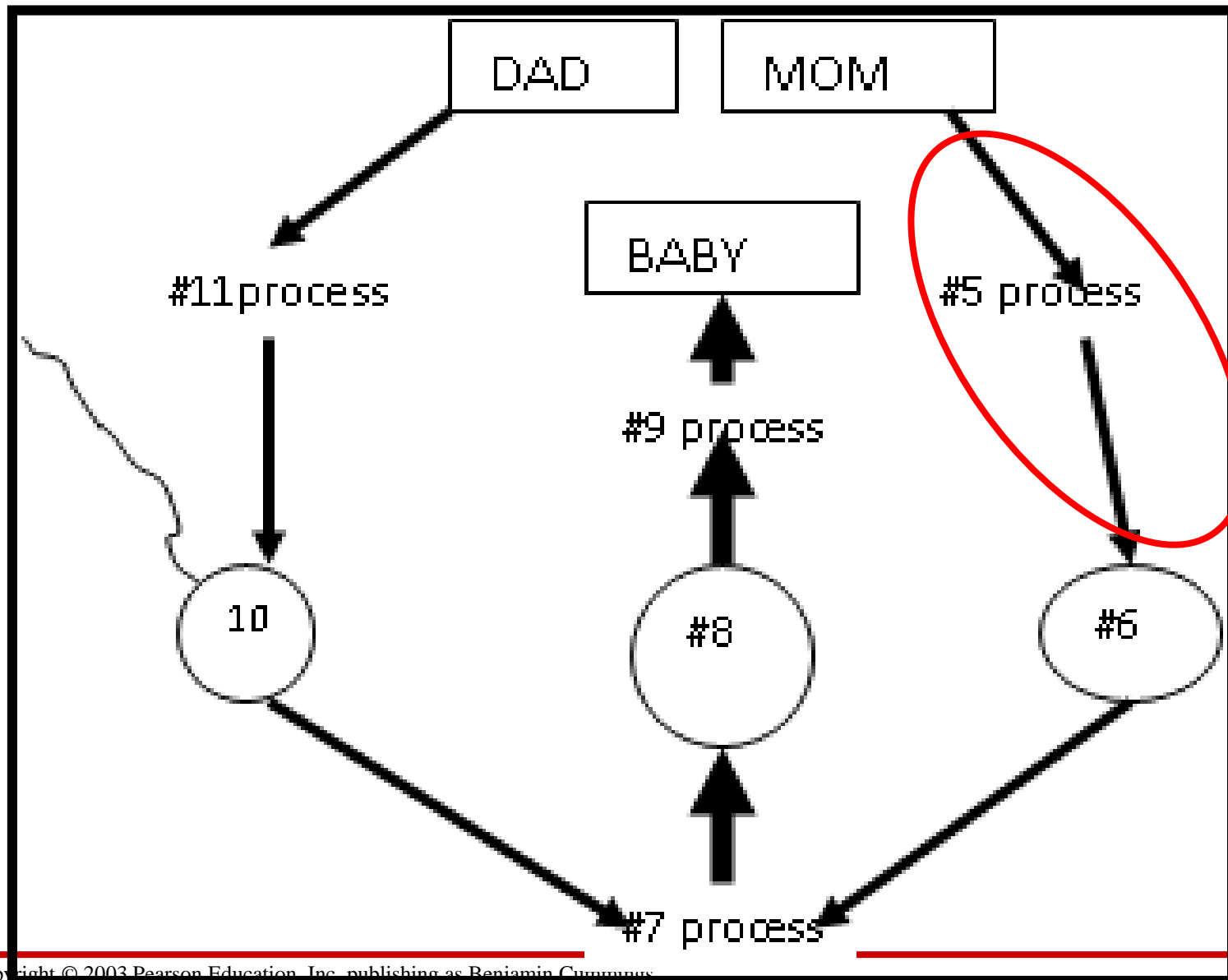


- Repeated mitosis cell division leads to the development of a mature adult
- The adult makes haploid gametes by meiosis cell division

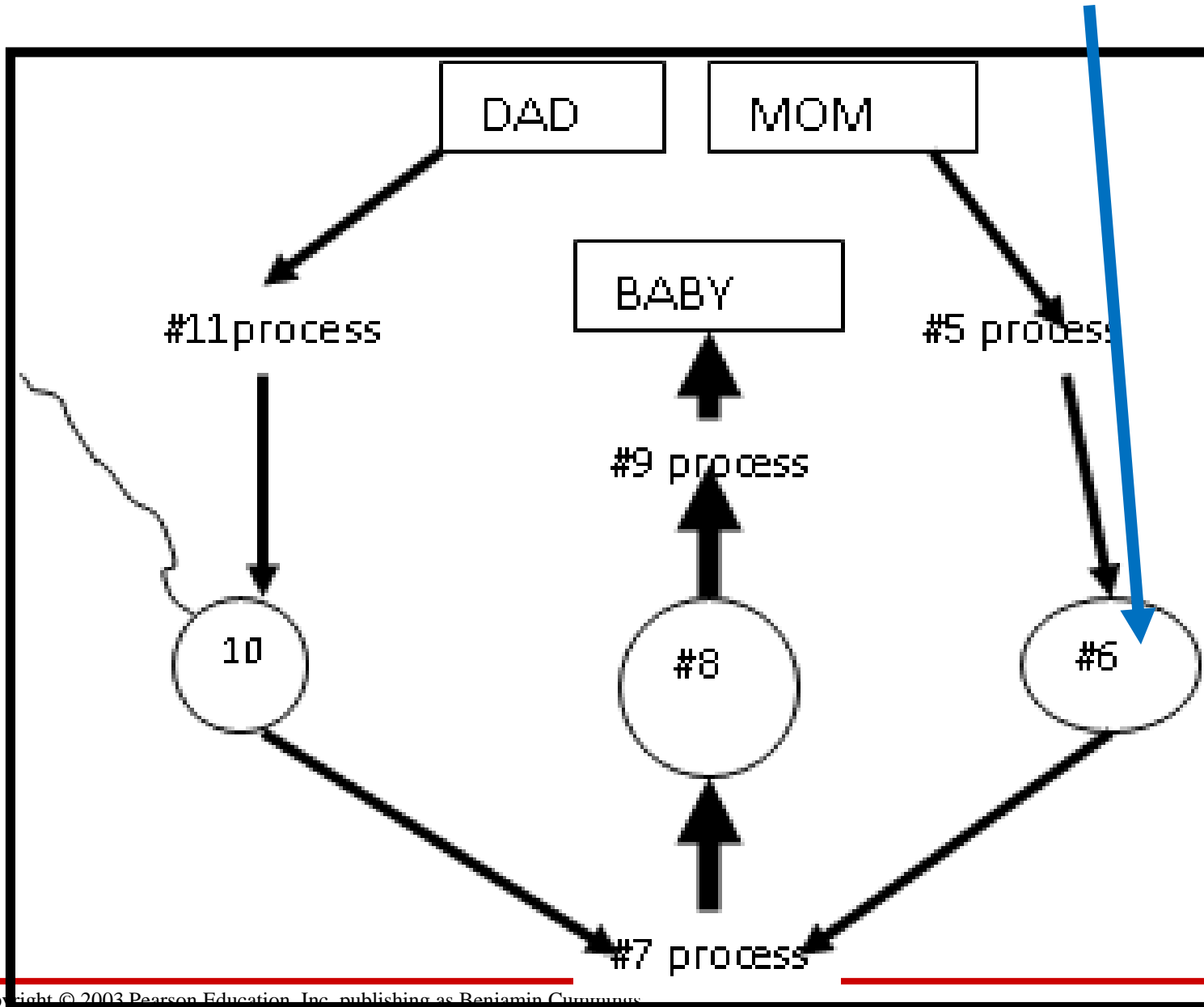
- So, what is MEIOSIS?
 - The creation of genetically different sperm and eggs



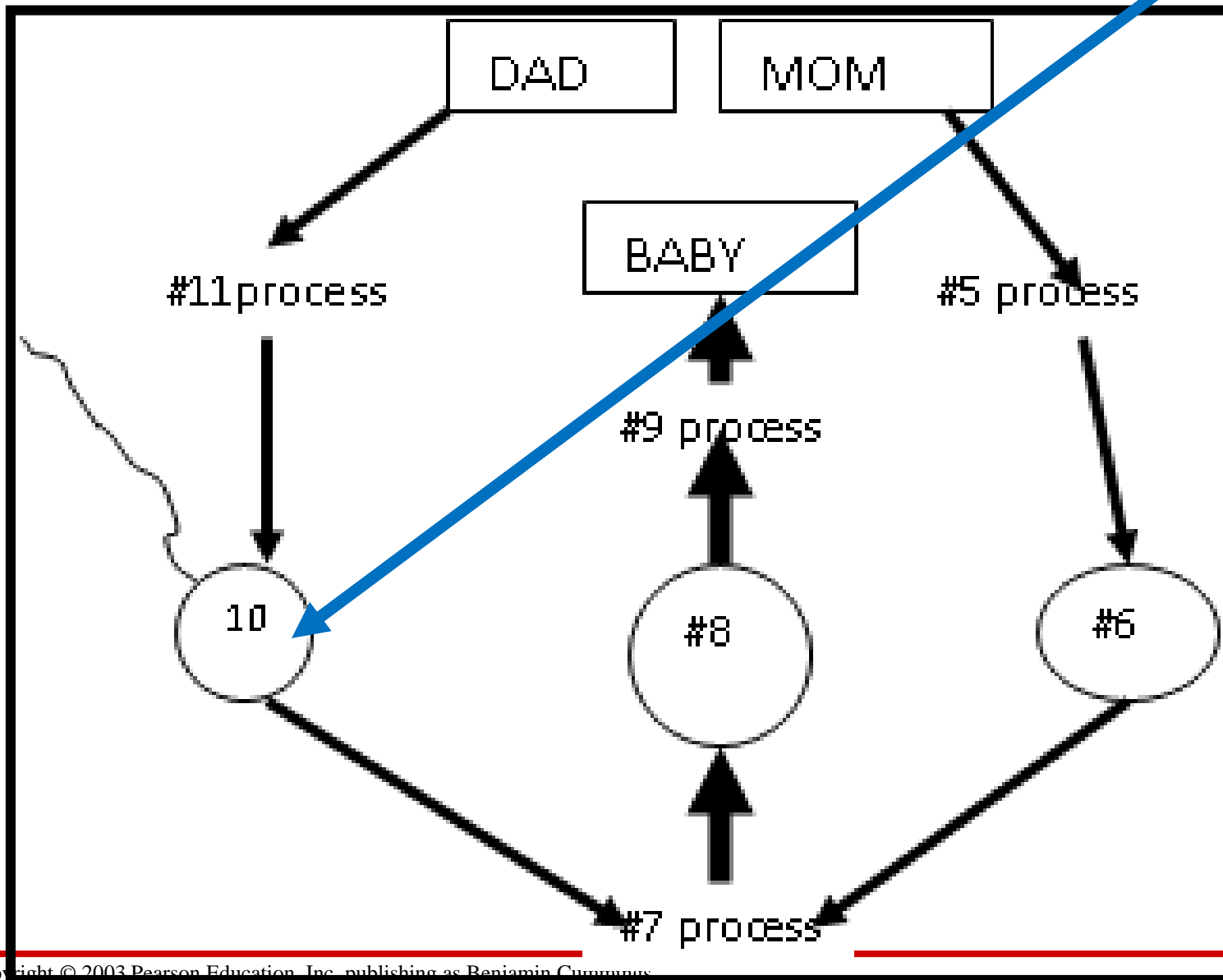
Name the process happening here?



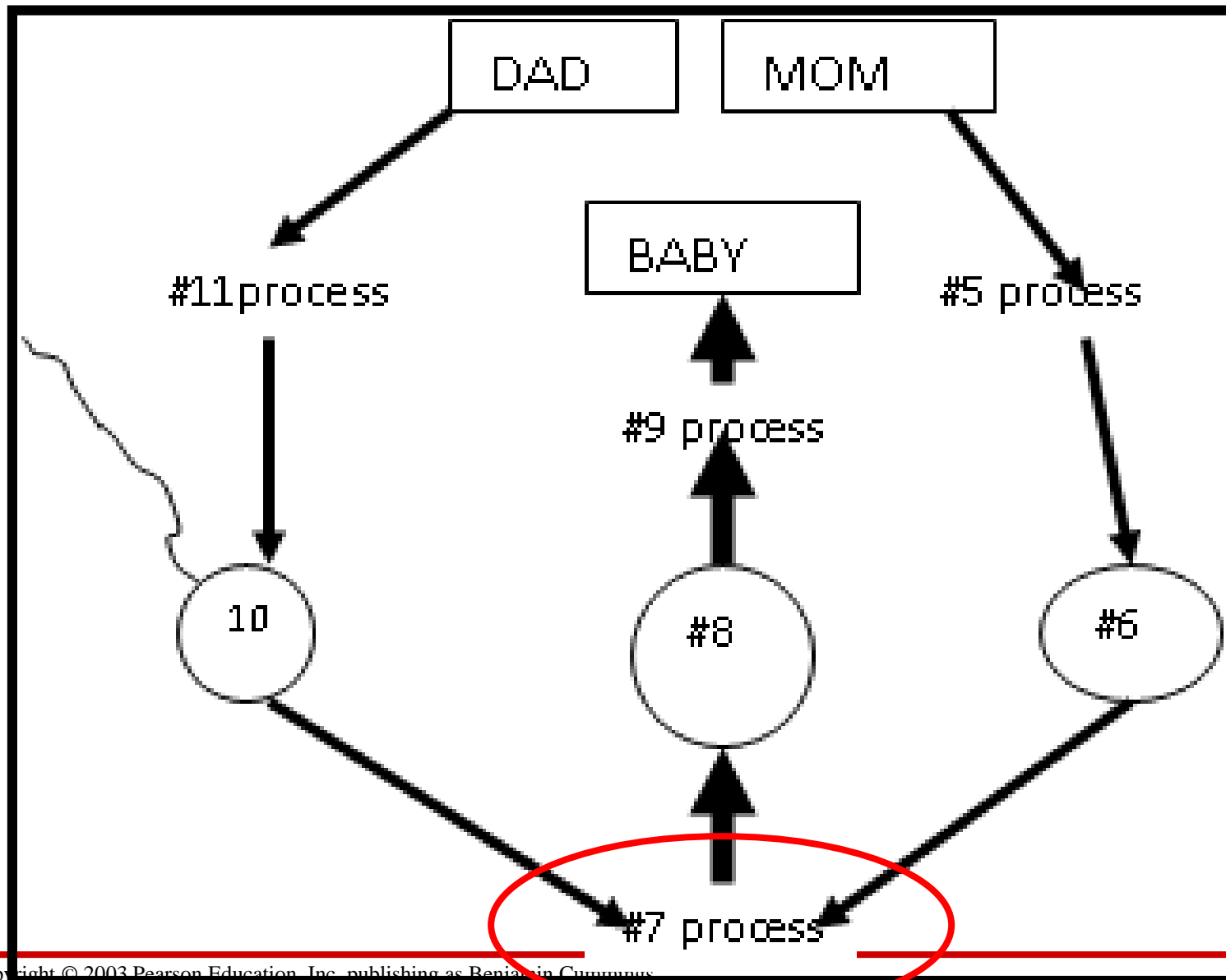
How many chromosomes in a human egg?



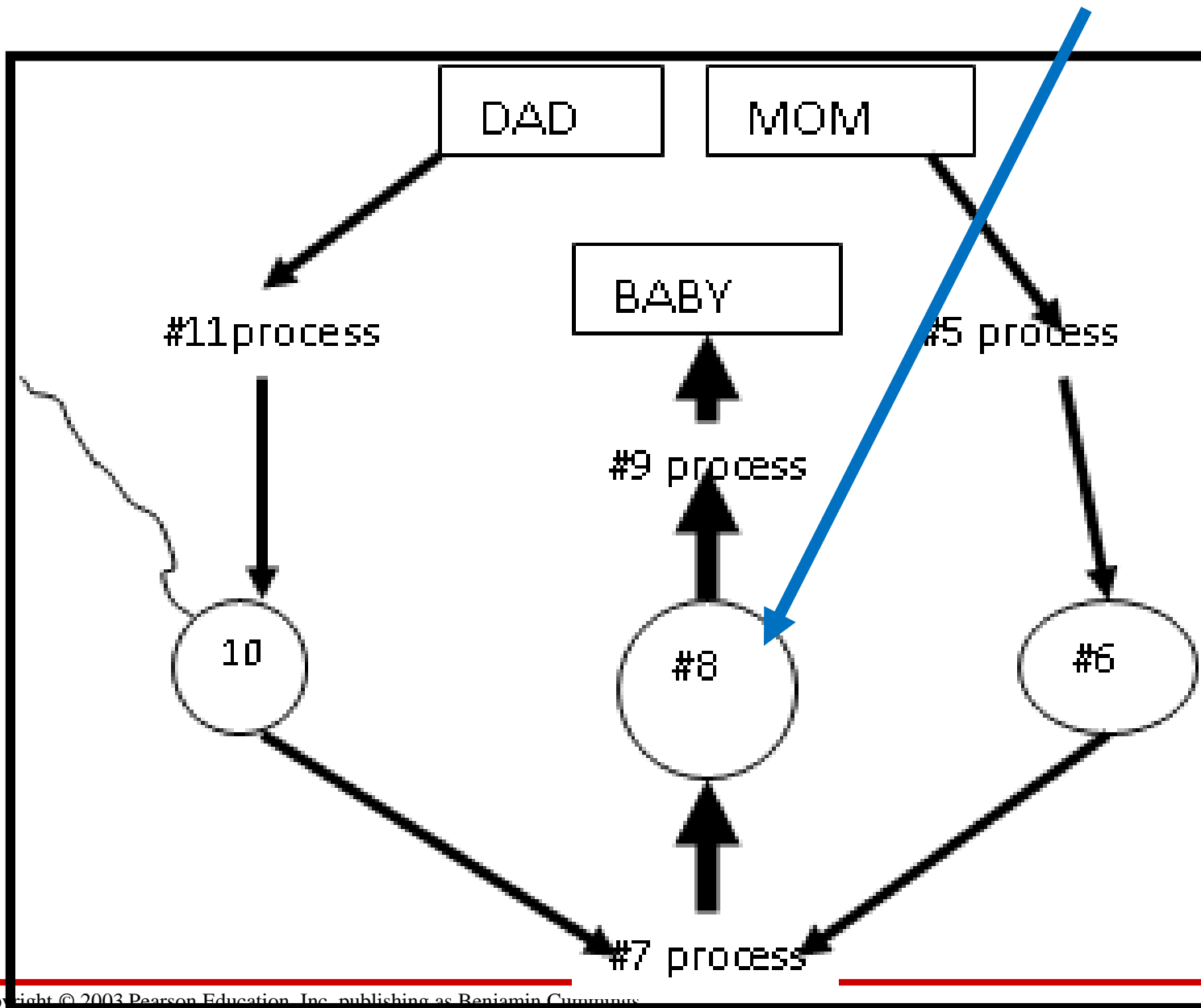
How many chromosomes in a human sperm?



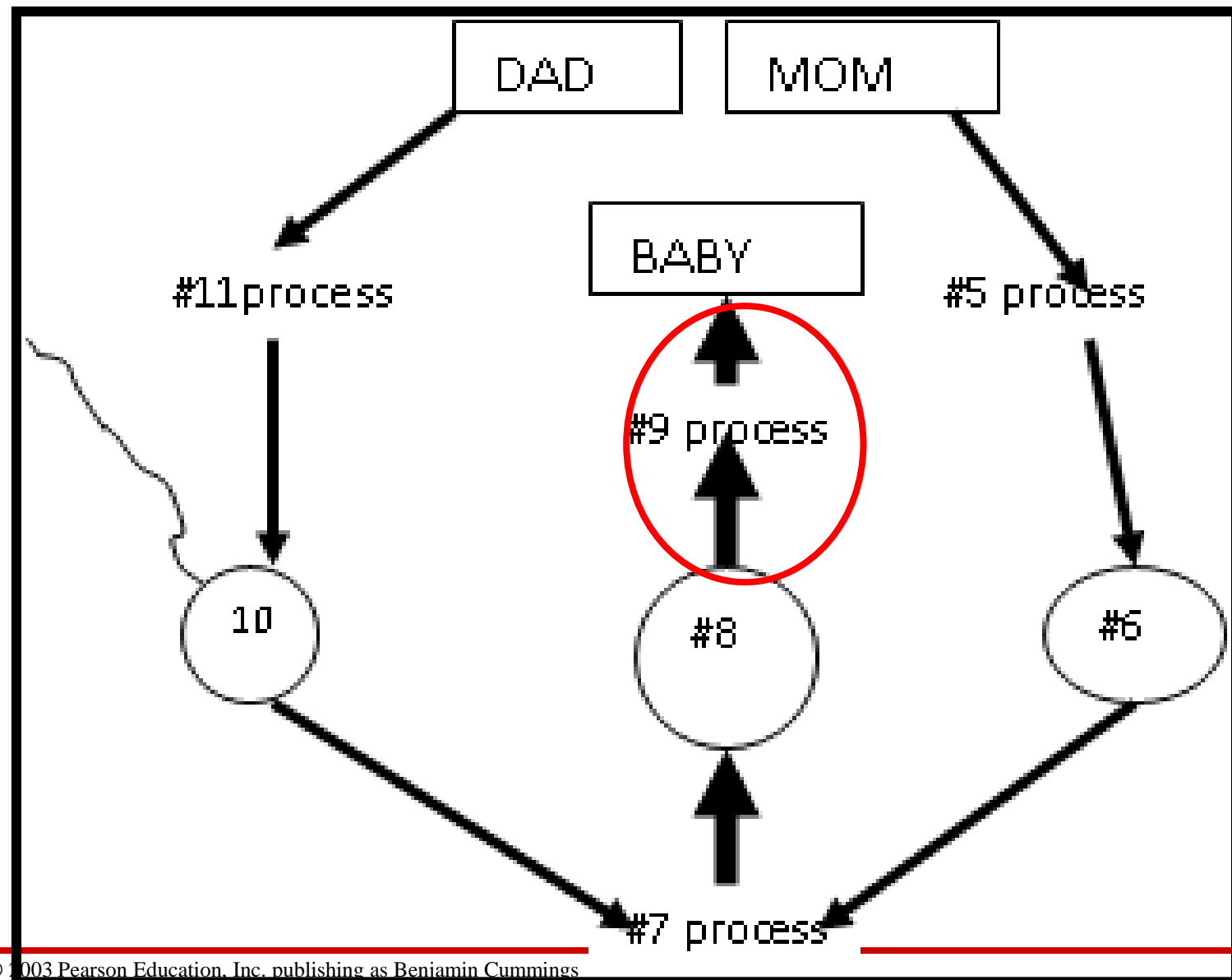
Name the process happening here?



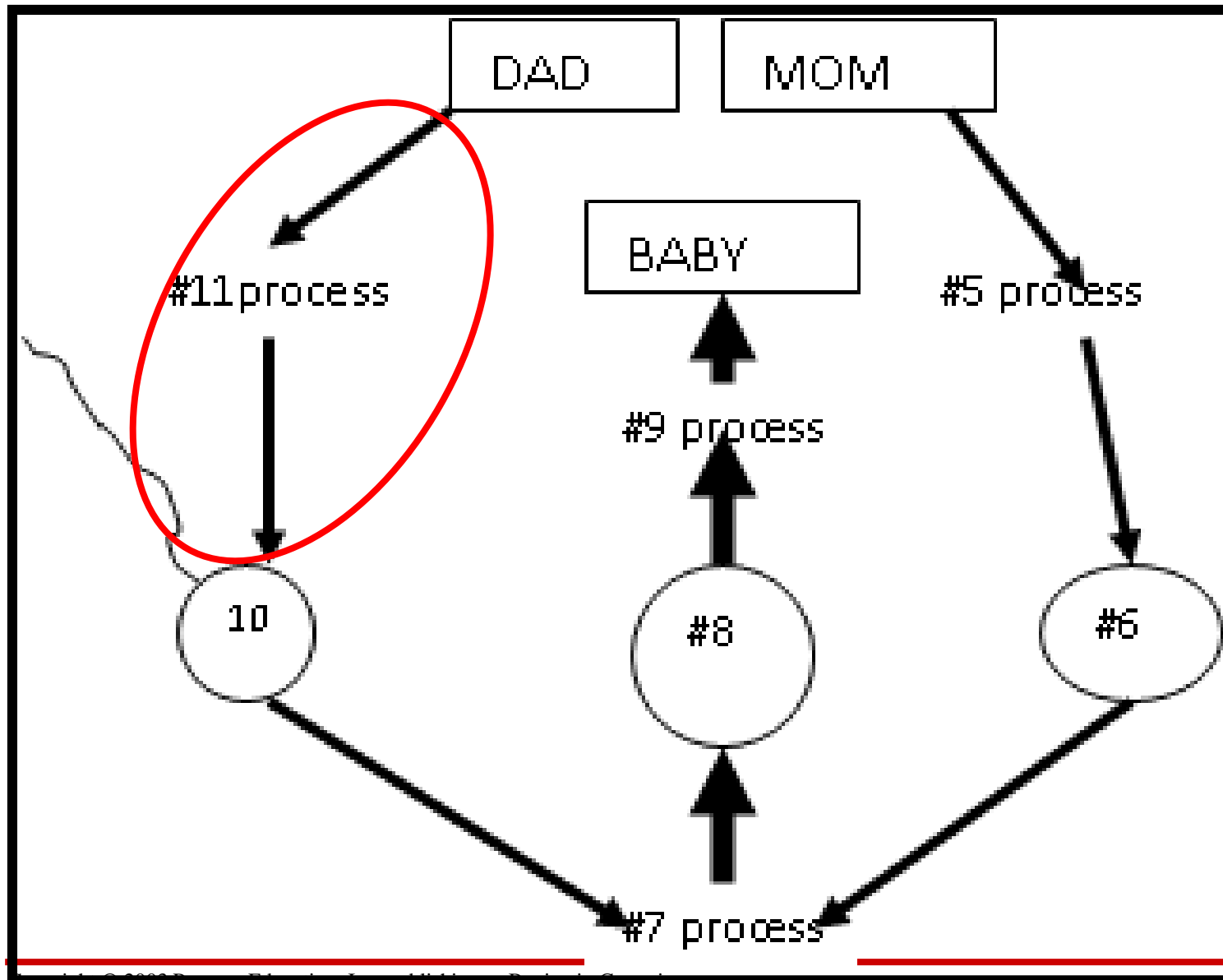
How many chromosomes in a human zygote?



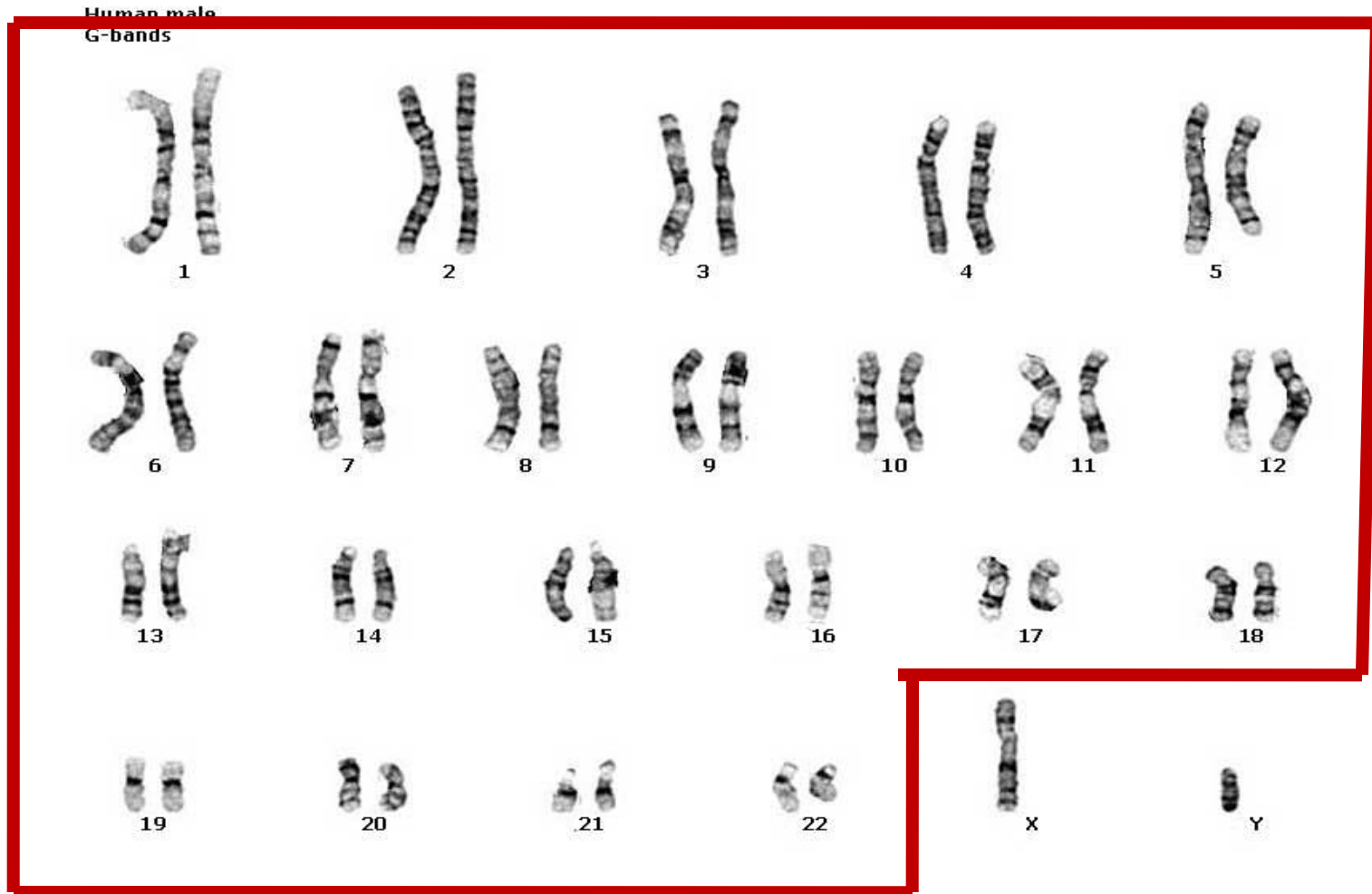
Name the process happening here?



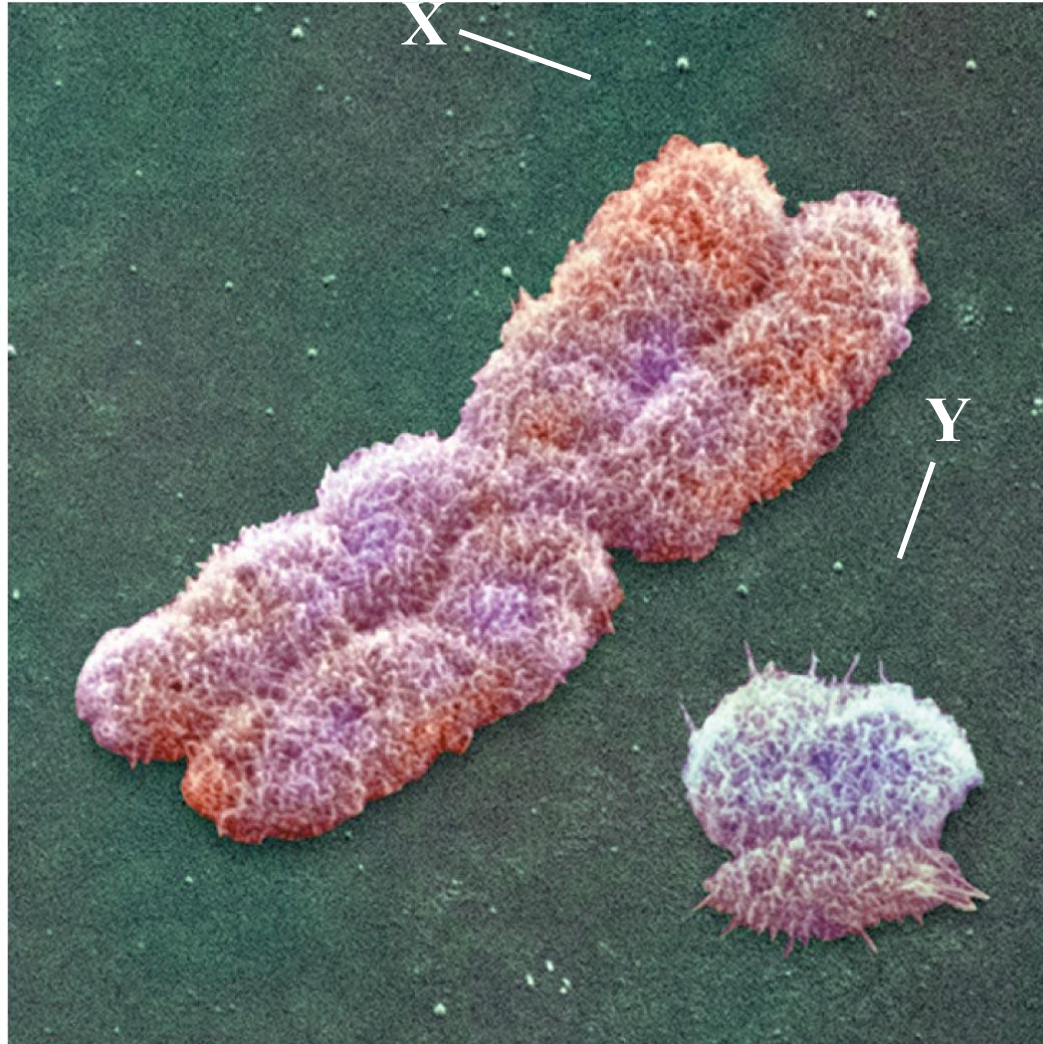
Name the process happening here?



- Most traits are determined by genes that are located on the **autosomes** = (chromosomes 1-22)



Boy or Girl?



- Boy or Girl?

Human male
G-bands

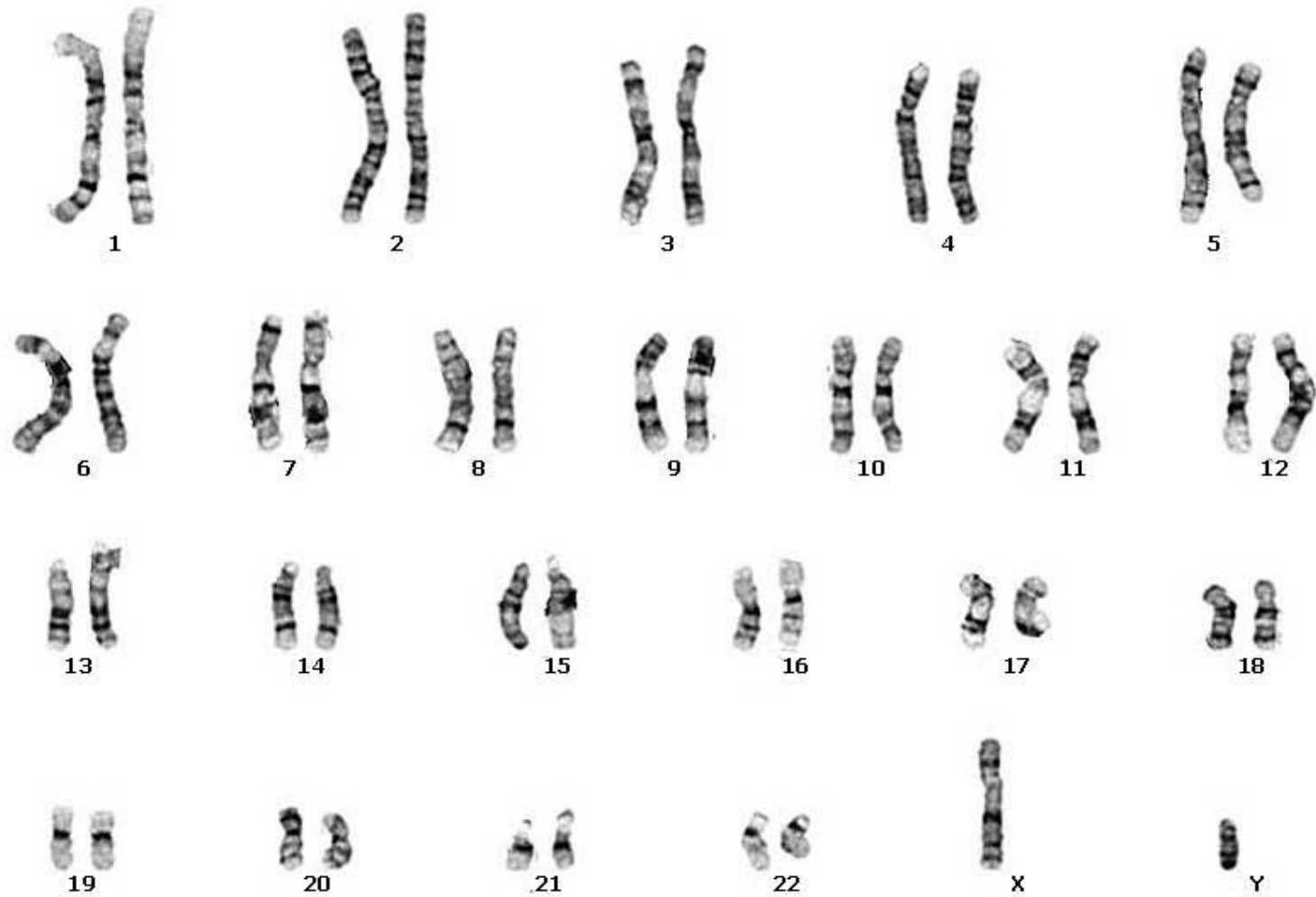


Figure 8.19x4

- Boy or Girl?
- Notice anything wrong with this karyotype?

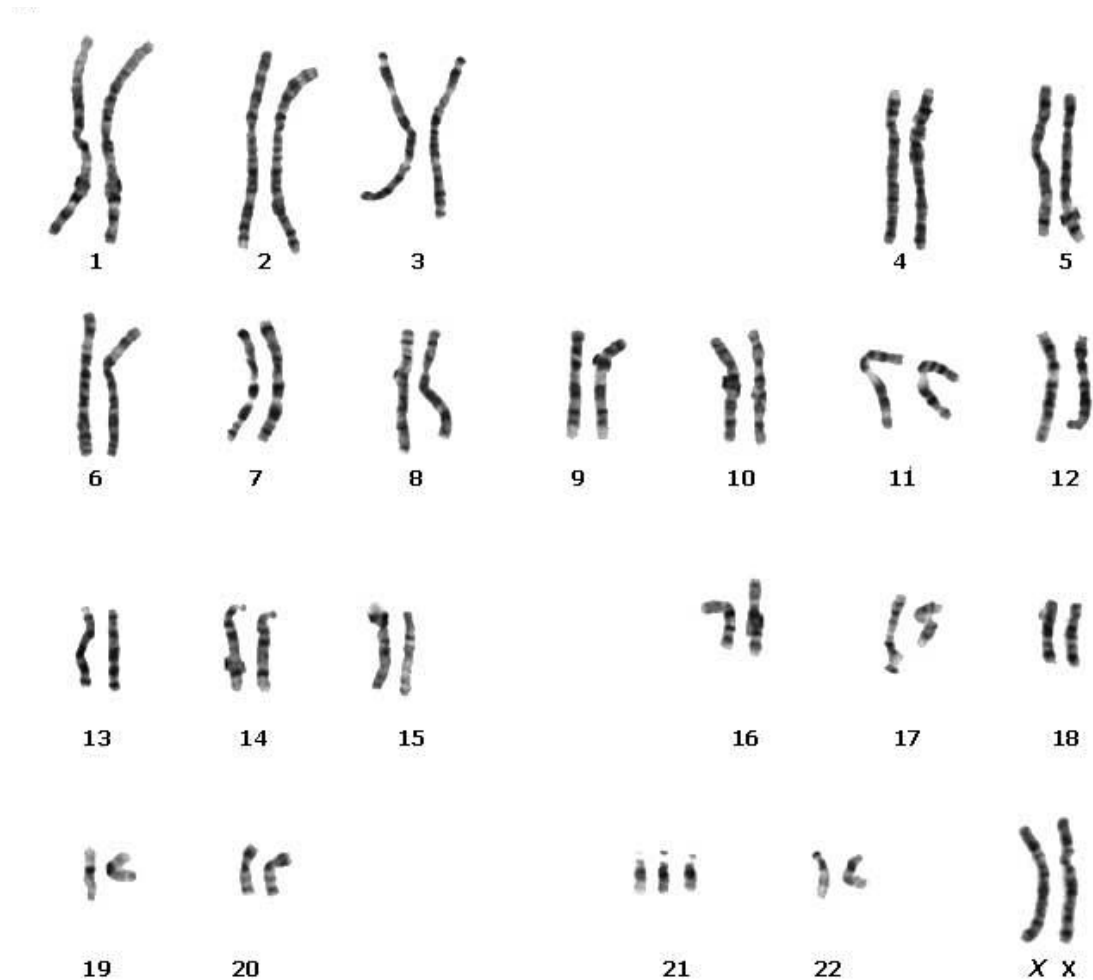


Figure 8.20Ax

An extra copy of chromosome 21 causes Down Syndrome

- This karyotype shows three number 21 chromosomes

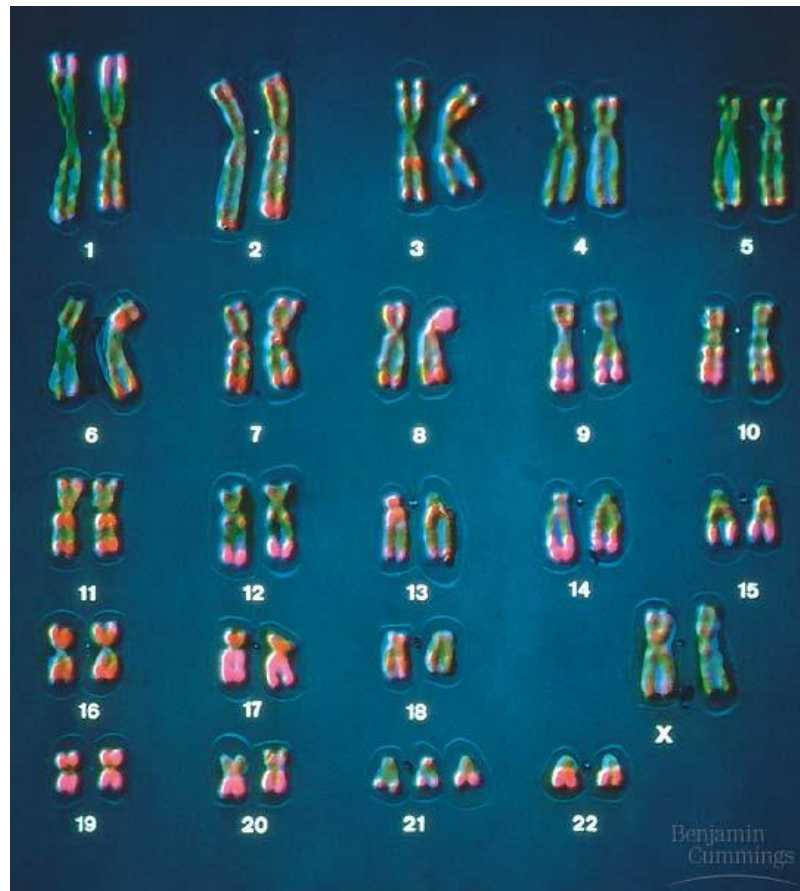


Figure 8.20A, B

After fertilization, the zygote (fertilized egg) has 23 pairs of homologous chromosomes

- Homologous chromosomes have the SAME size, shape, and gene locations, but may have DIFFERENT genetic codes

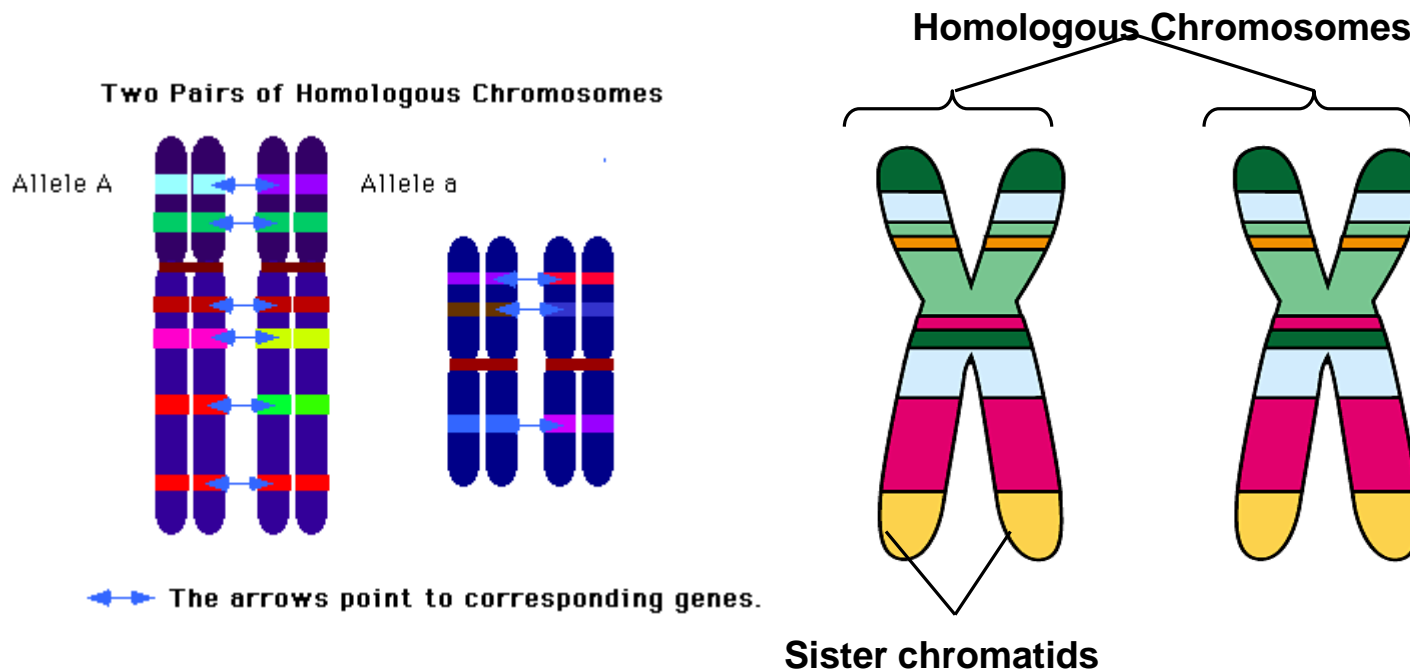
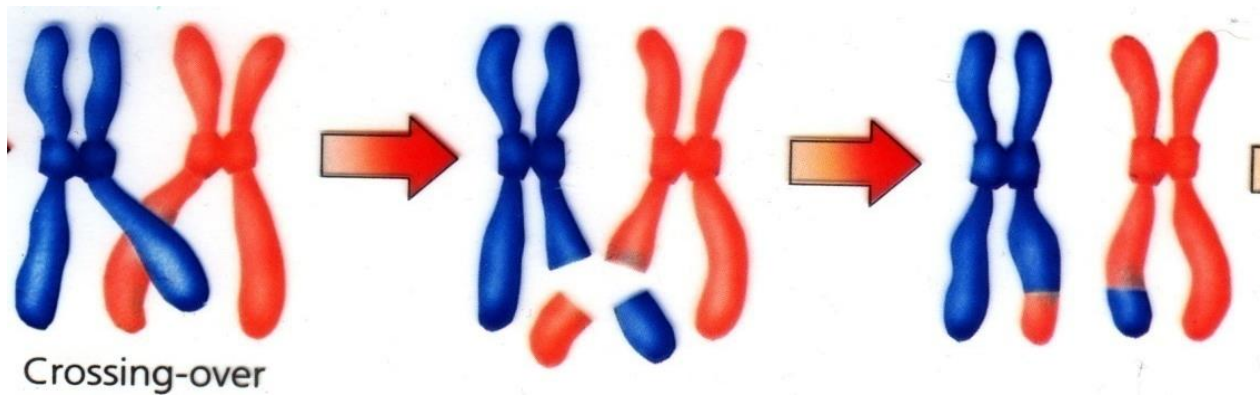


Figure 8.12

- Meiosis acts like a genetic “ blender ” by creating new combinations of genes for each chromosome

Prophase 1 Tango

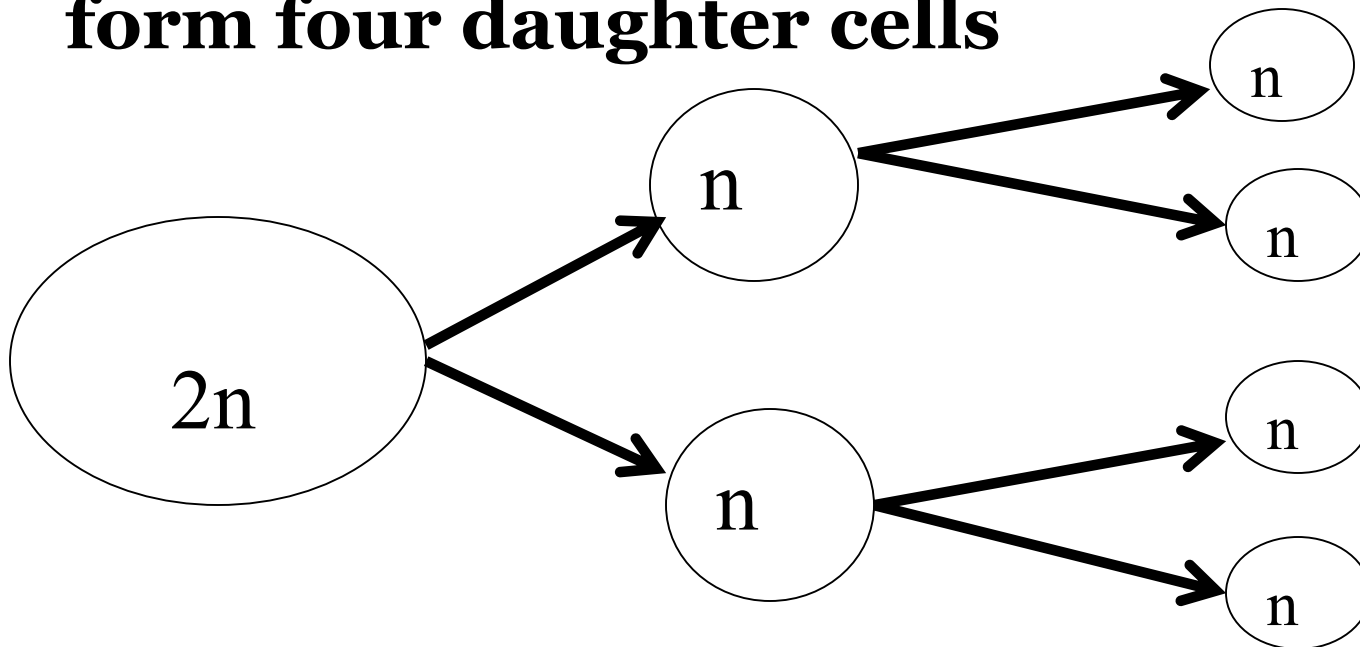
- As the chromosomes “dance” through Meiosis, crossing-over mixes up the DNA in new ways



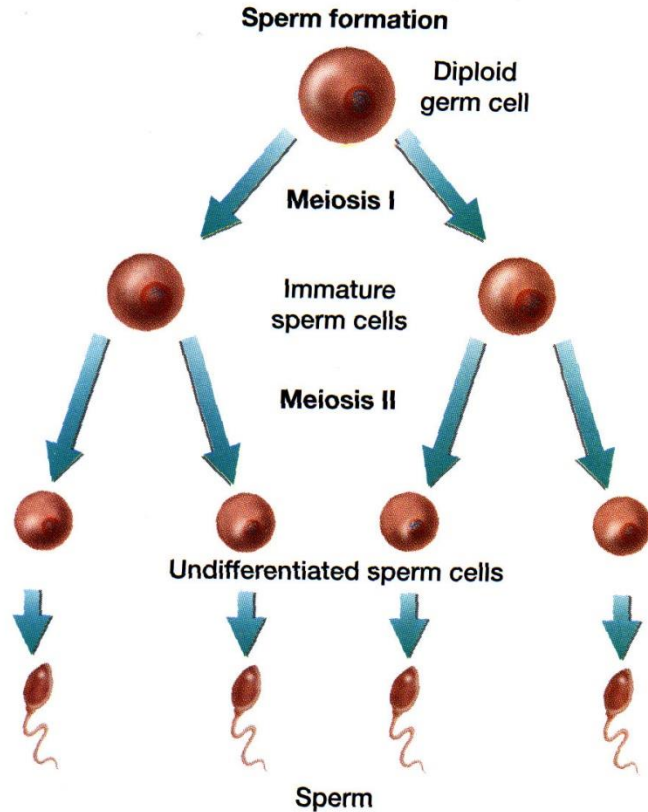
- The chance of any two eggs or sperm receiving the same DNA is extremely remote...thus the offspring for any two parents have a wide variation in traits

Meiosis reduces the chromosome number from diploid to haploid ($2n \rightarrow n$)

- Meiosis, like mitosis, is preceded in Interphase by chromosome replication
 - However, in meiosis the cell divides **twice to form four daughter cells**

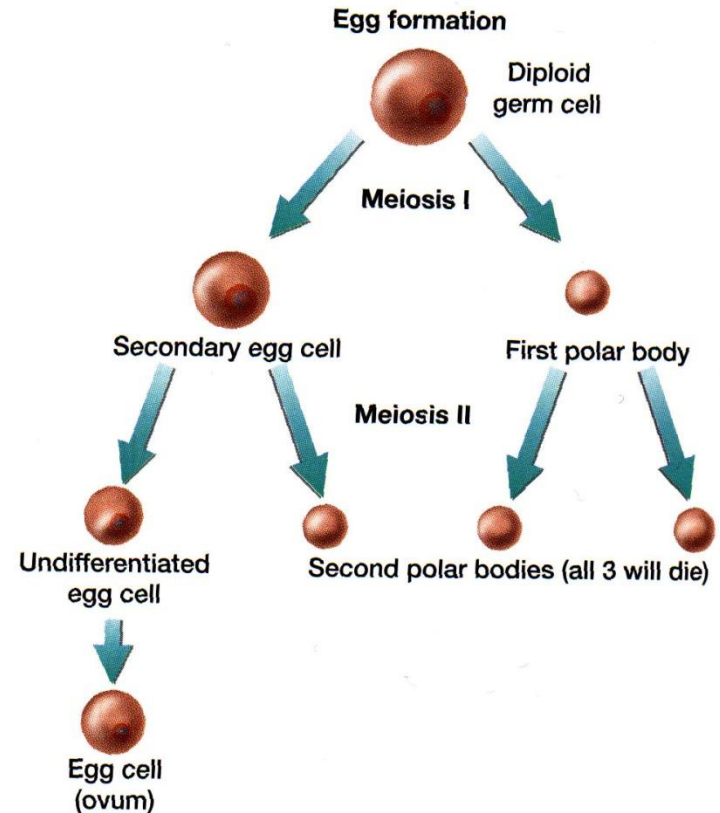


MEIOSIS is different in BOYS and GIRLS



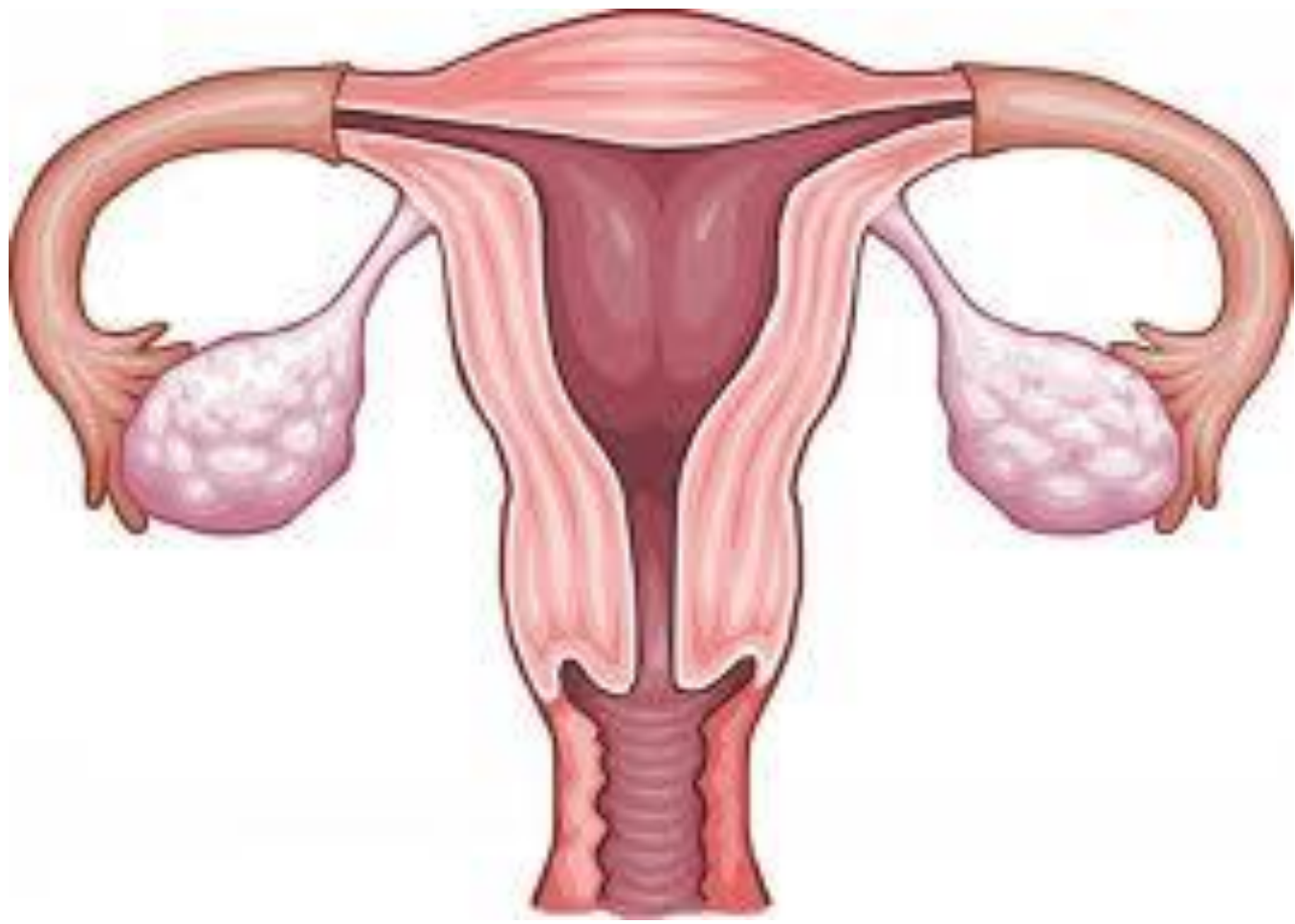
SPERMATOGENESIS

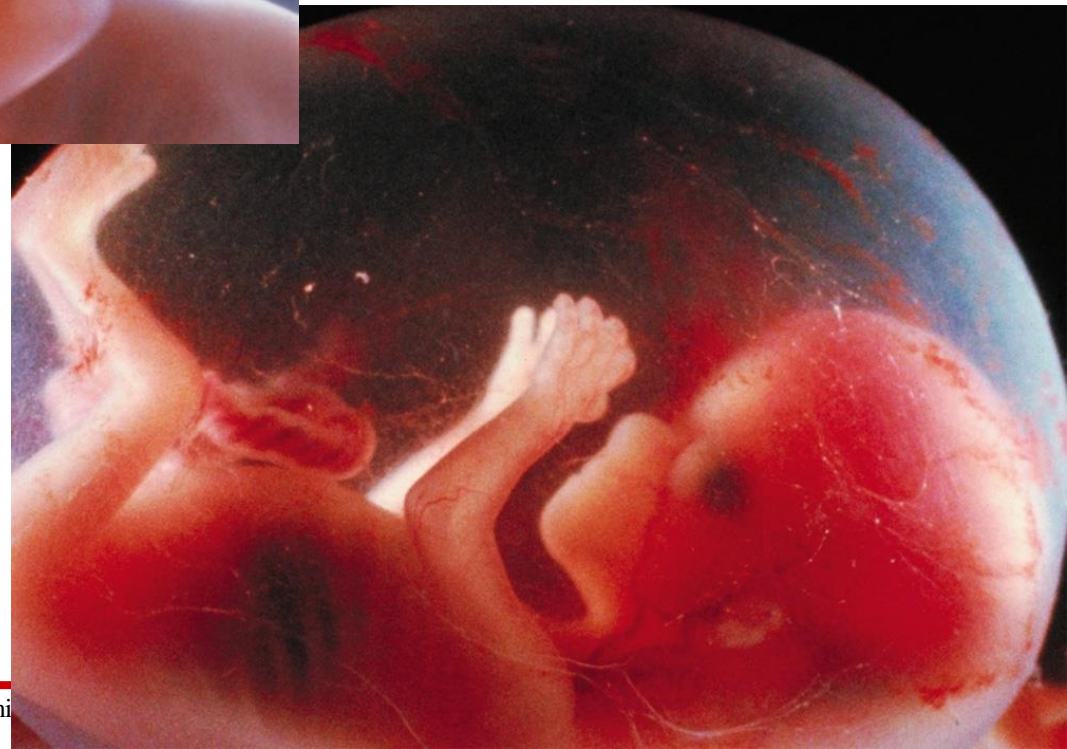
*Made in the testes = 4 sperm



OOGENESIS

*Made in the ovaries = 1 egg







Do you know the phrase that pays?

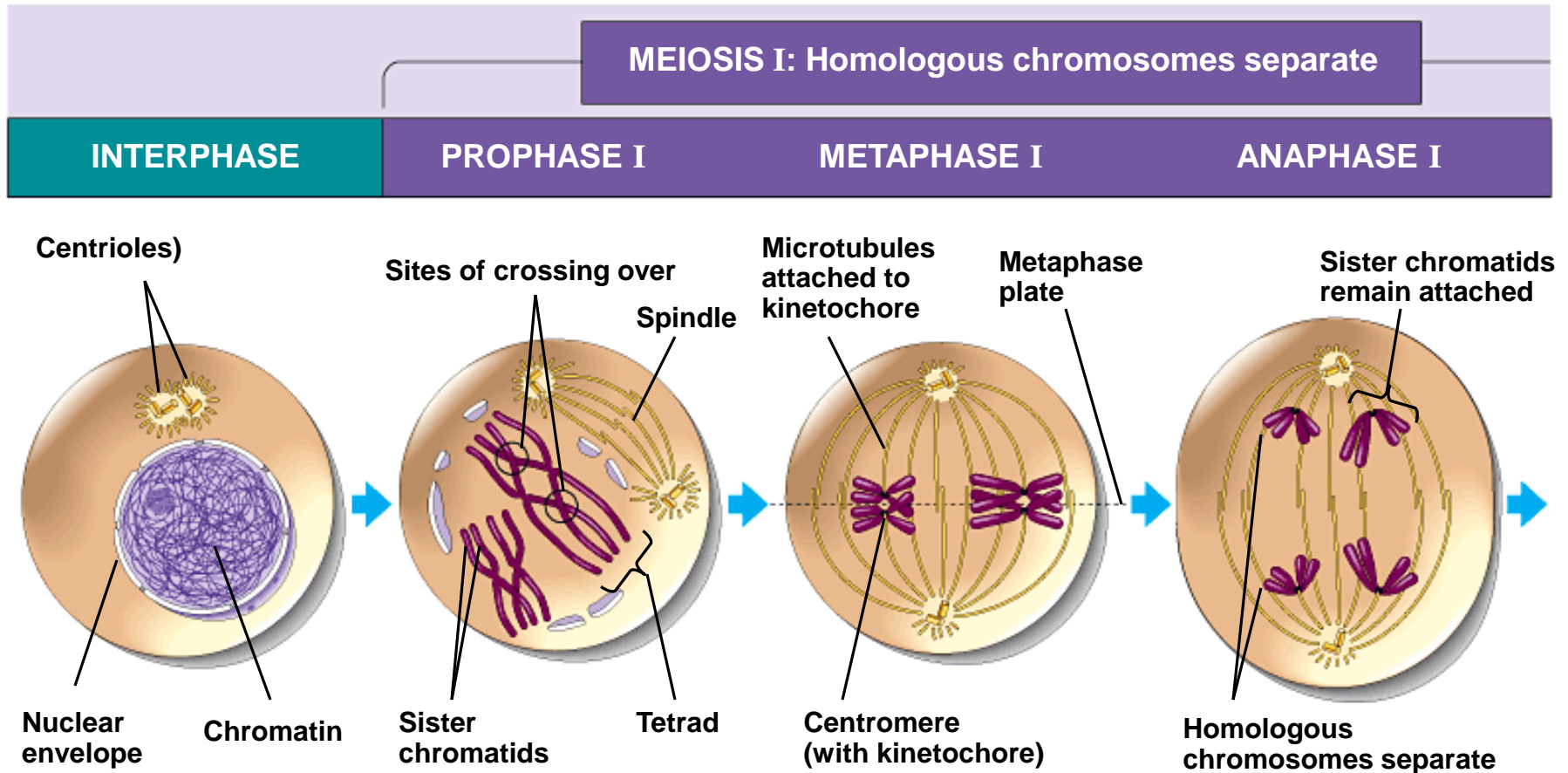
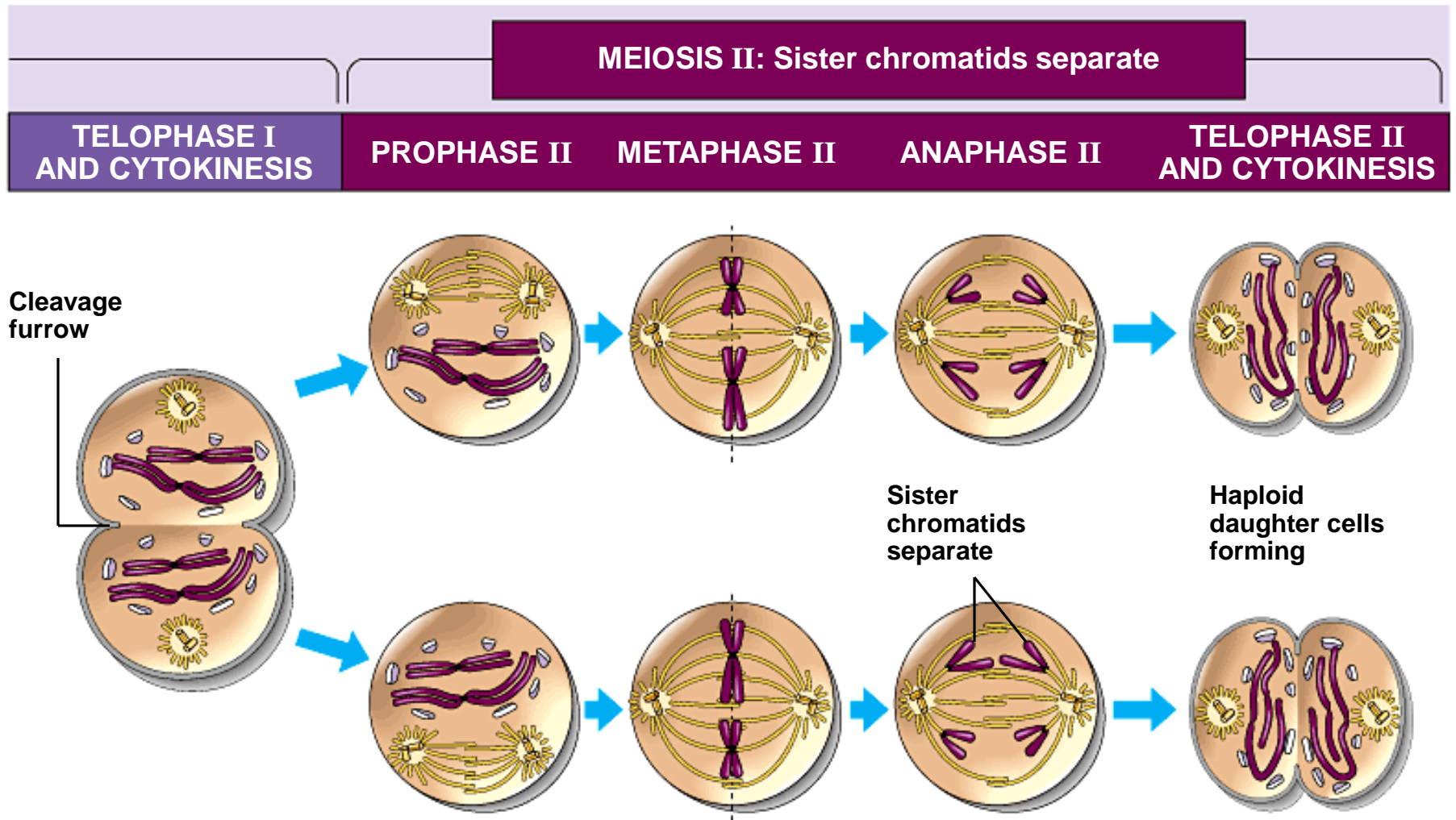


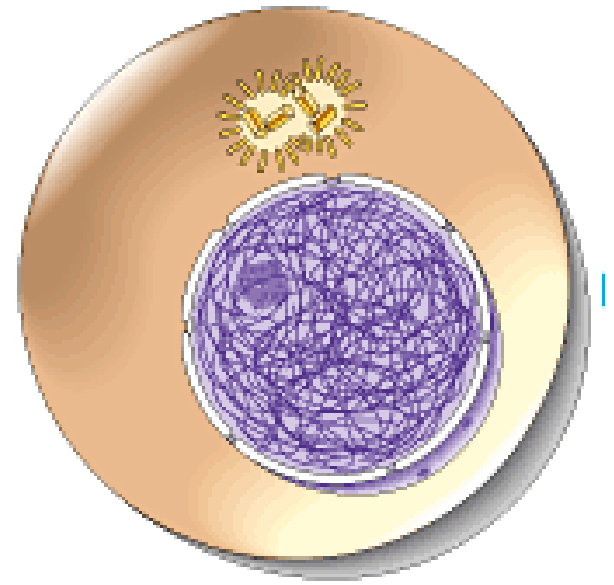
Figure 8.14, part 1



Meiosis song 2

Figure 8.14, part 2

Interphase I

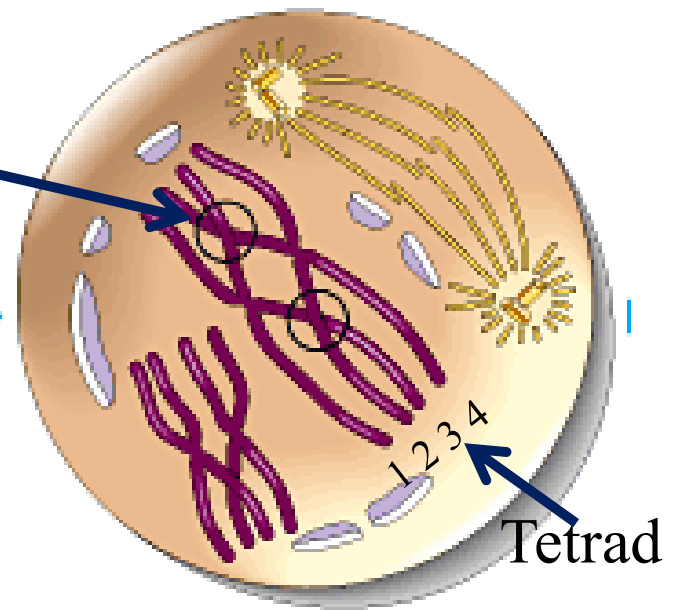


- **Growth** and **DNA replication** occur
- DNA exists as chromatin and the nucleolus is visible
- Most of the cell's life cycle is in this stage

Crossing Over
at a chiasma

Prophase I

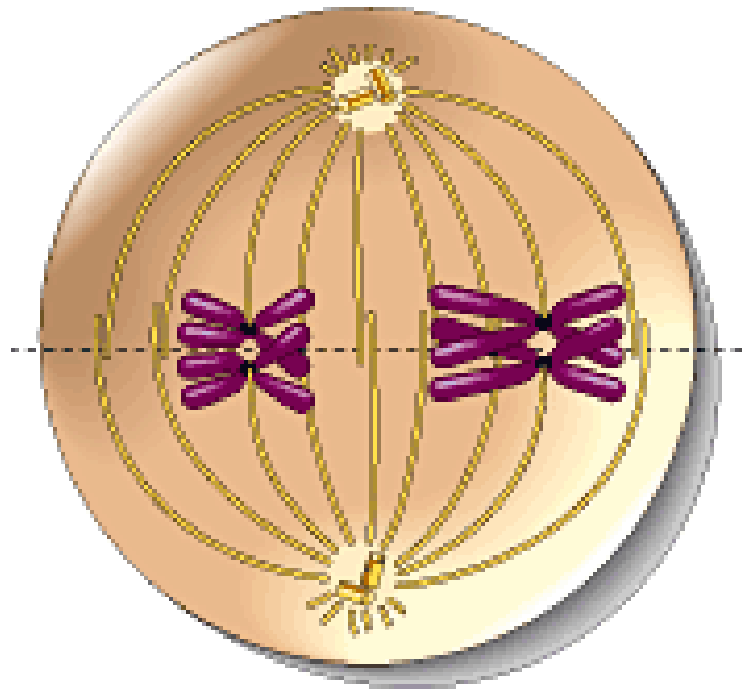
- Spindle fibers begin to form
- Chromatin coils tightly into visible “double” chromosomes
- The nuclear membrane and nucleolus disappear from this diploid cell
- Homologous chromosomes, composed of sister chromatids, come together as pairs forming a **tetrad**
- **Crossing-over** may “blend” the DNA into new gene combinations = **“Mix-E #1”**



Metaphase I

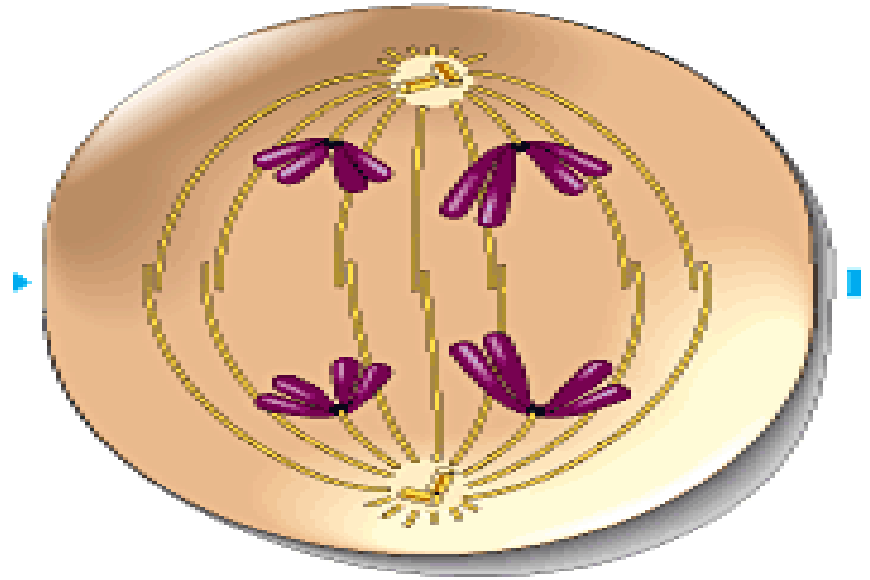
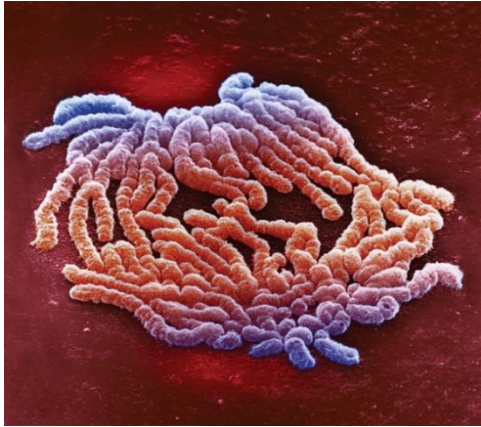
Mix-E #2

[Mix-E 2 video](#)



- The chromosome pairs line up **side-by-side** straddling the cell's equator
- Each chromosome attaches to the spindle fiber at its centromere
- Is **Mom's** or **Dad's** chromosome on the top ???

Anaphase I

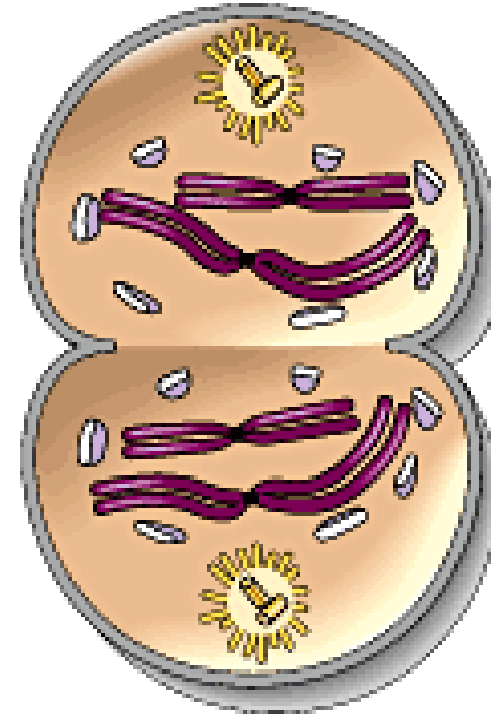


- Chromosome pairs separate and “double” chromosomes move to opposite poles as spindle fibers retract =

“Cut it in Half”

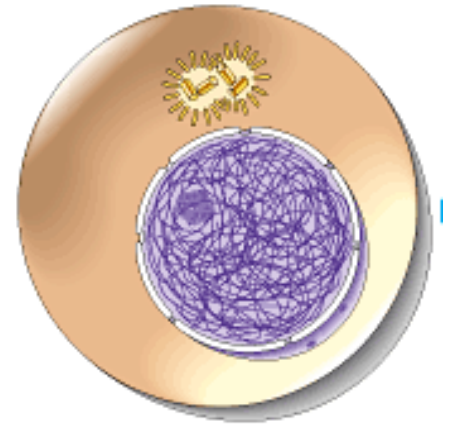
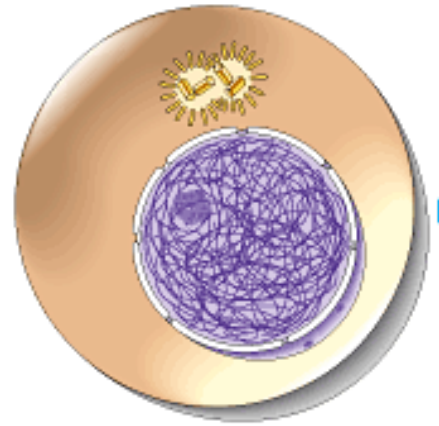
Telophase I

- “Double” chromosomes uncoil back into chromatin
- The spindle disappears as the nucleolus and nuclear membrane reappear
- A cleavage furrow develops (animal cell) and eventually the cell splits into two **haploid** daughter cells



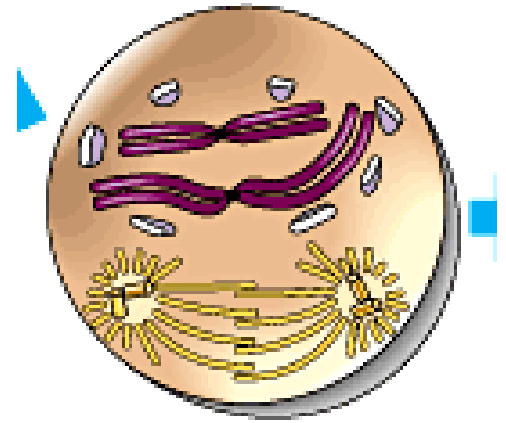
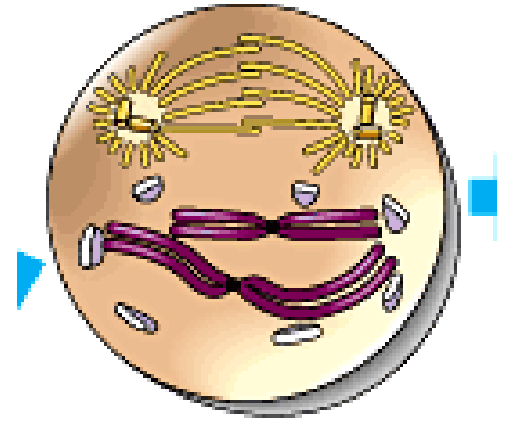
Interphase II

- Some growth occurs but NO **DNA replication**
- DNA exists as chromatin and the nucleolus is visible



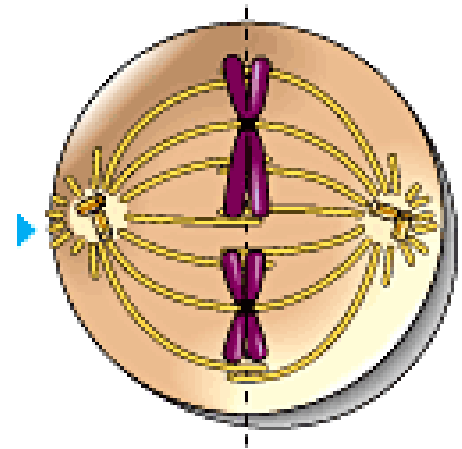
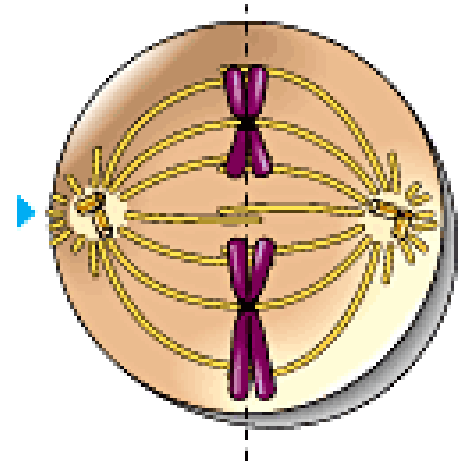
Prophase II

- Chromatin coils tightly into visible “double” chromosomes (composed of sister chromatids)
- Spindle fibers form as the nucleolus and nuclear membrane disappear from this **haploid** cell



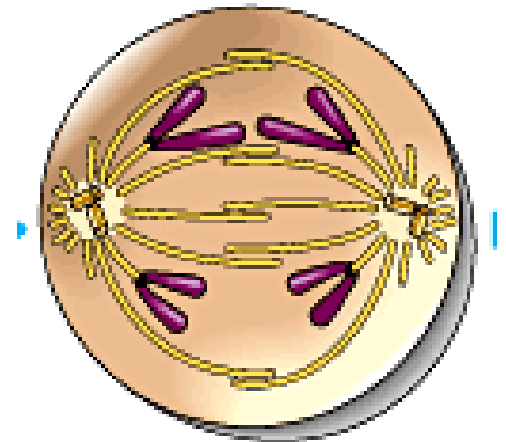
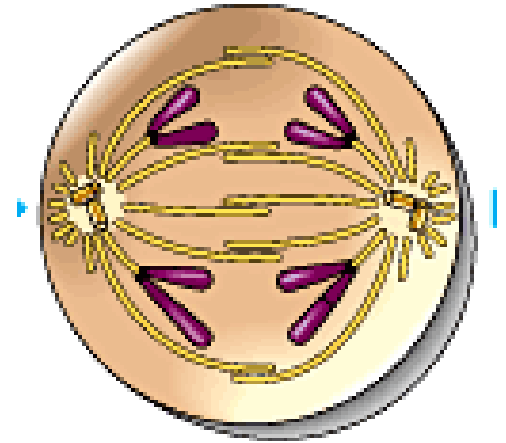
Metaphase II

- “Double chromosomes line up single file along the equator of this haploid cell
- Spindle fibers are attached at the centromere



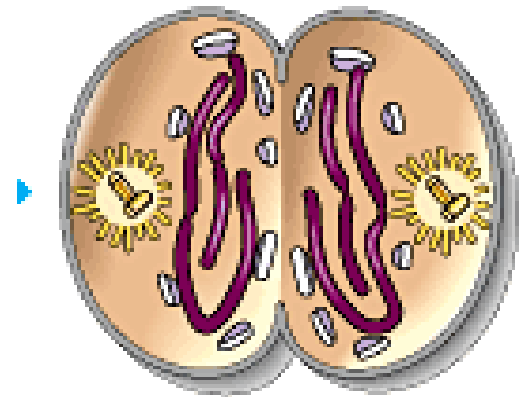
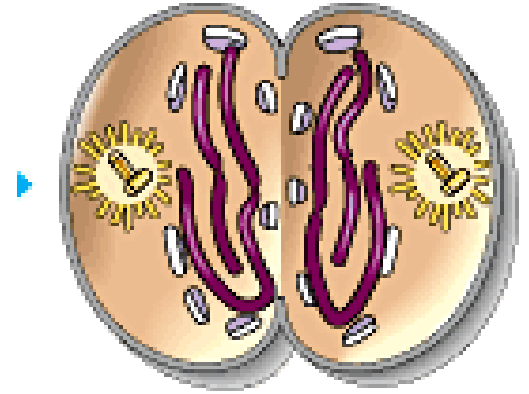
Anaphase II

- Spindle fibers retract, ripping the “**double**” chromosomes in half at the centromere
- “**Single**” chromosomes are pulled to the poles at each side of the cell



Telophase II

- “Single” chromosomes uncoil back into chromatin
- The spindle disappears as the nucleolus and nuclear membrane reappear
- A cleavage furrow develops (animal cell) in both cells and eventually splits forming 4 **haploid** gametes (egg or sperm)

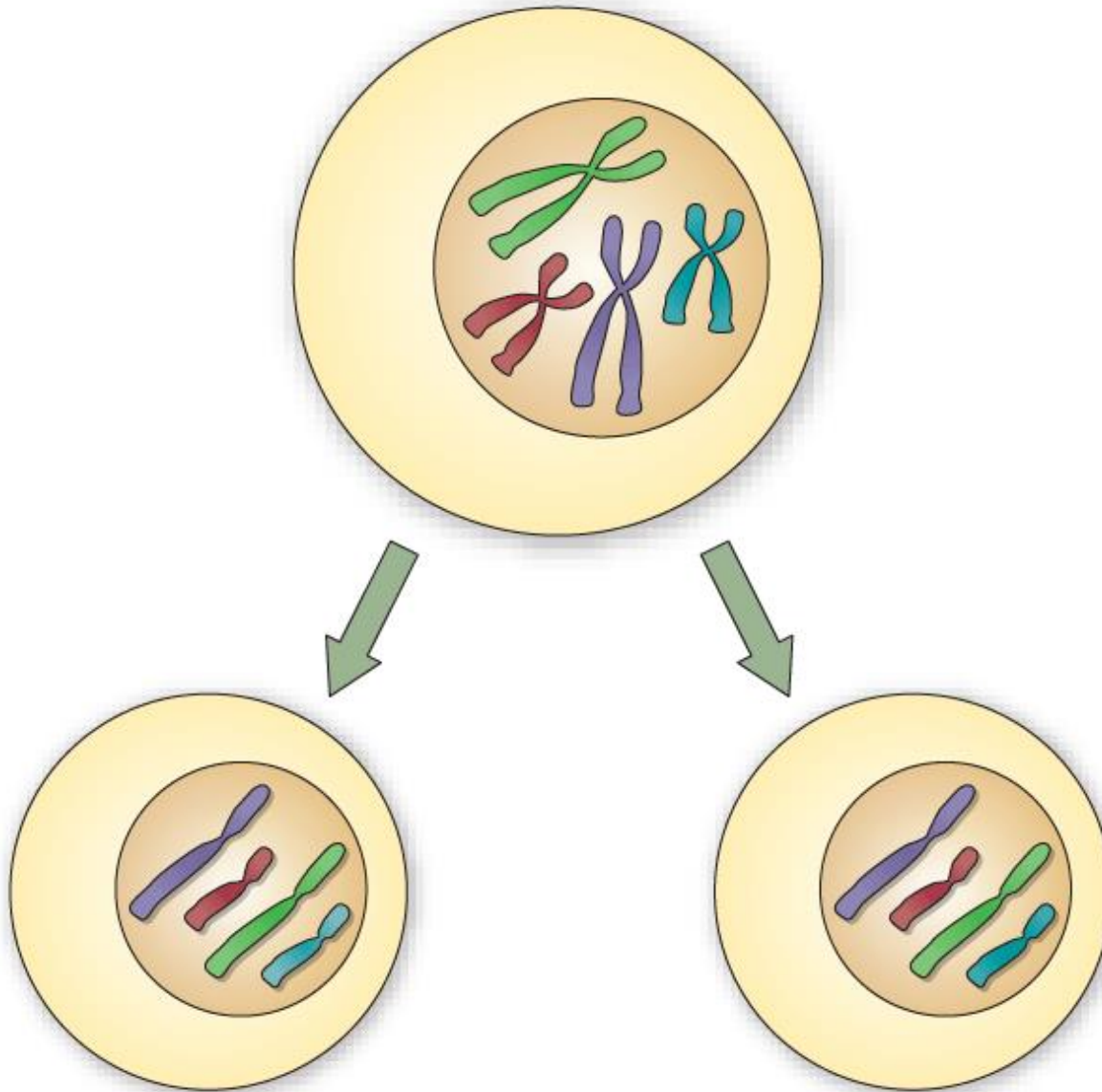


Let's review Meiosis

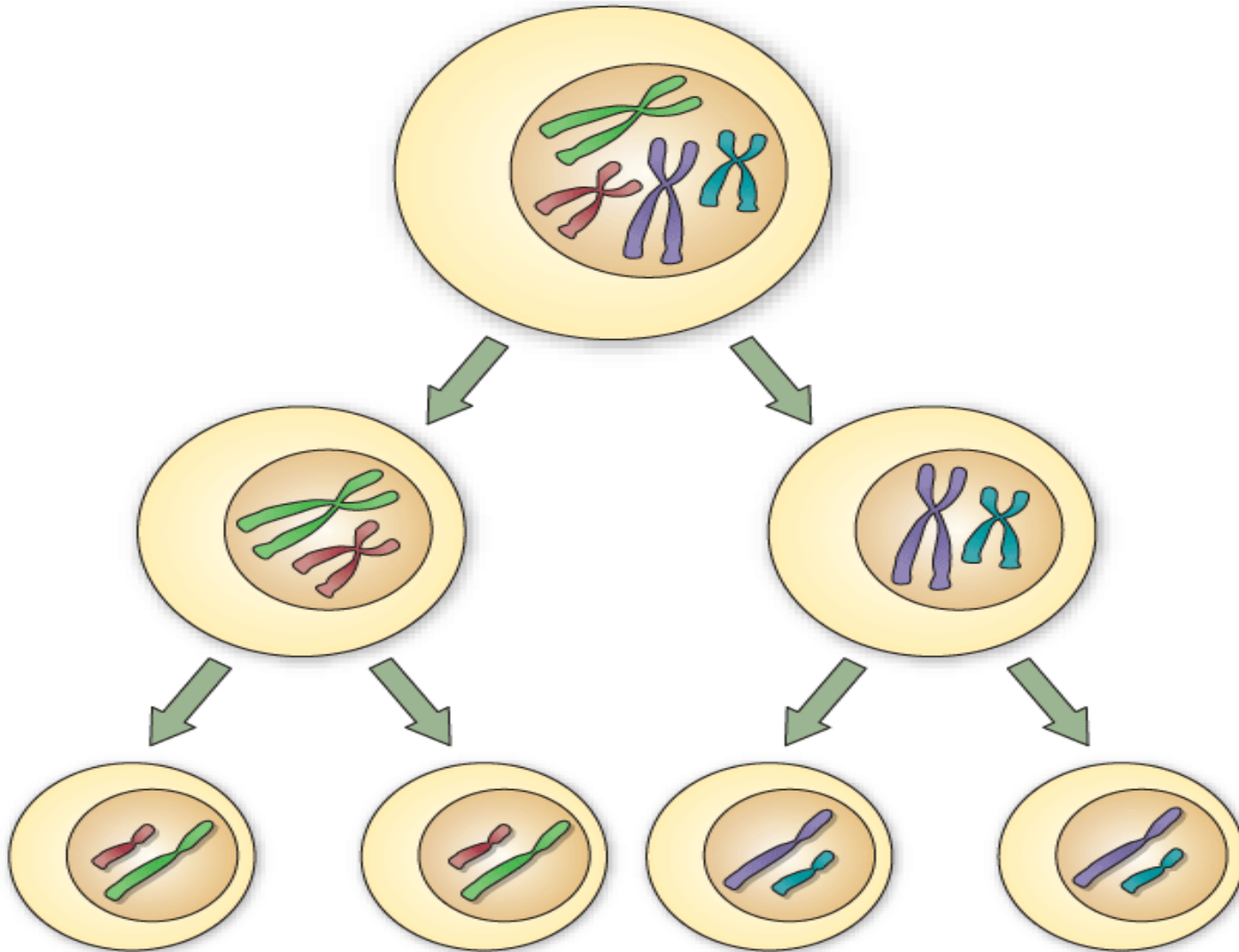
[Meiosis video review 1](#)

[Meiosis song 1](#)

Mitosis or Meiosis?



Mitosis or Meiosis?



Meiosis creates genetic variety

- Twins with variety B n W 1
- Twins with variety B n W 2
- Twins having twins

Twins marry

MEIOSIS is different in BOYS and GIRLS

- The **TIMING** of Meiosis is different:

SPERMATOGENESIS

- 100+ million sperm made fresh each day from puberty to death

OÖGENESIS

- Process begins before birth
- Continues through more stages at puberty
- Concludes at fertilization

[Meiosis song 1](#)

[Meiosis song 2](#)

[Meiosis Animation](#)

[M vs M Rap 1](#)