5.1 The Cell Cycle

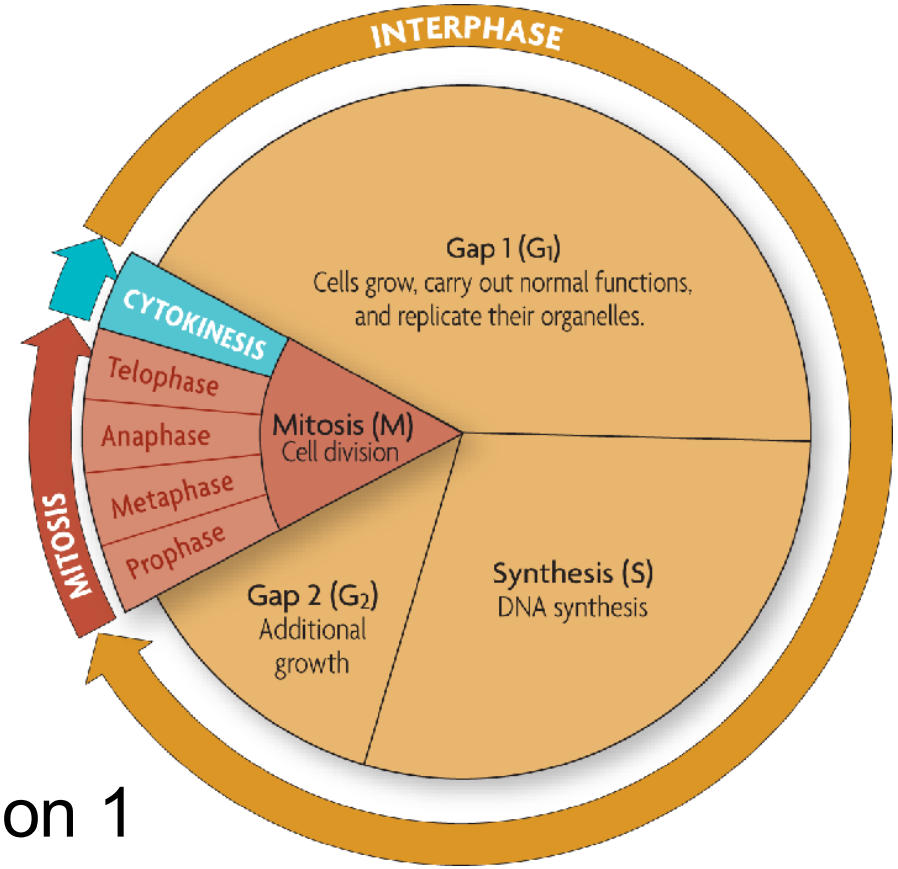
KEY CONCEPT

DNA replication copies the genetic information of a cell.

5.1 The Cell Cycle

The life cycle of a cell is called the cell cycle

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

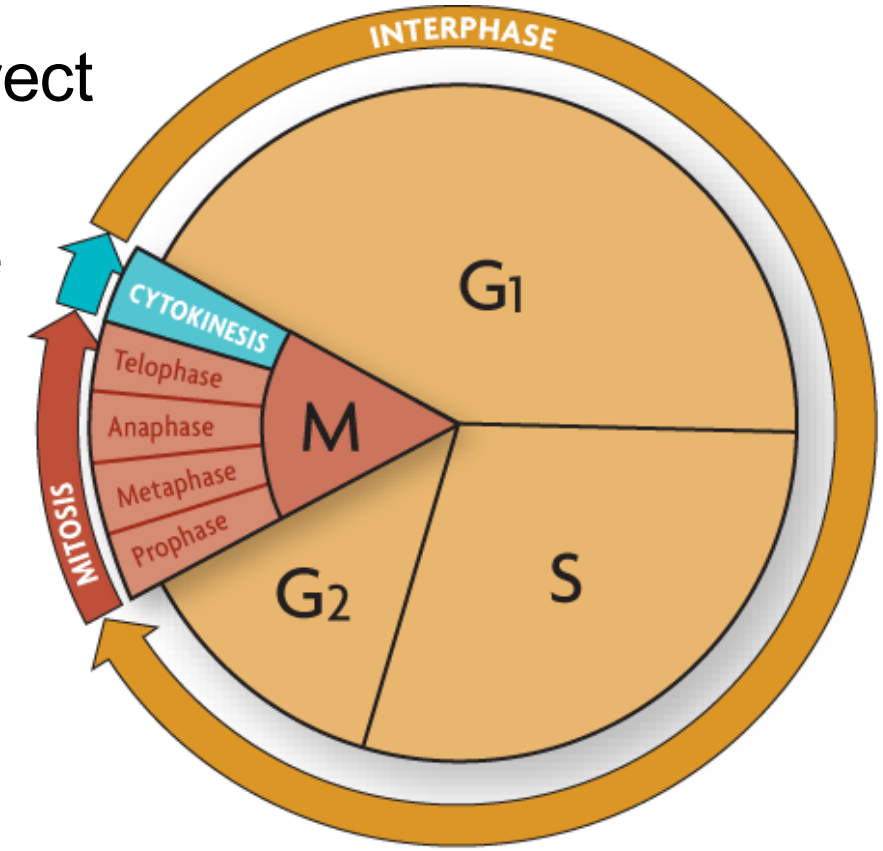


Chapter 5 Section 1

5.1 The Cell Cycle

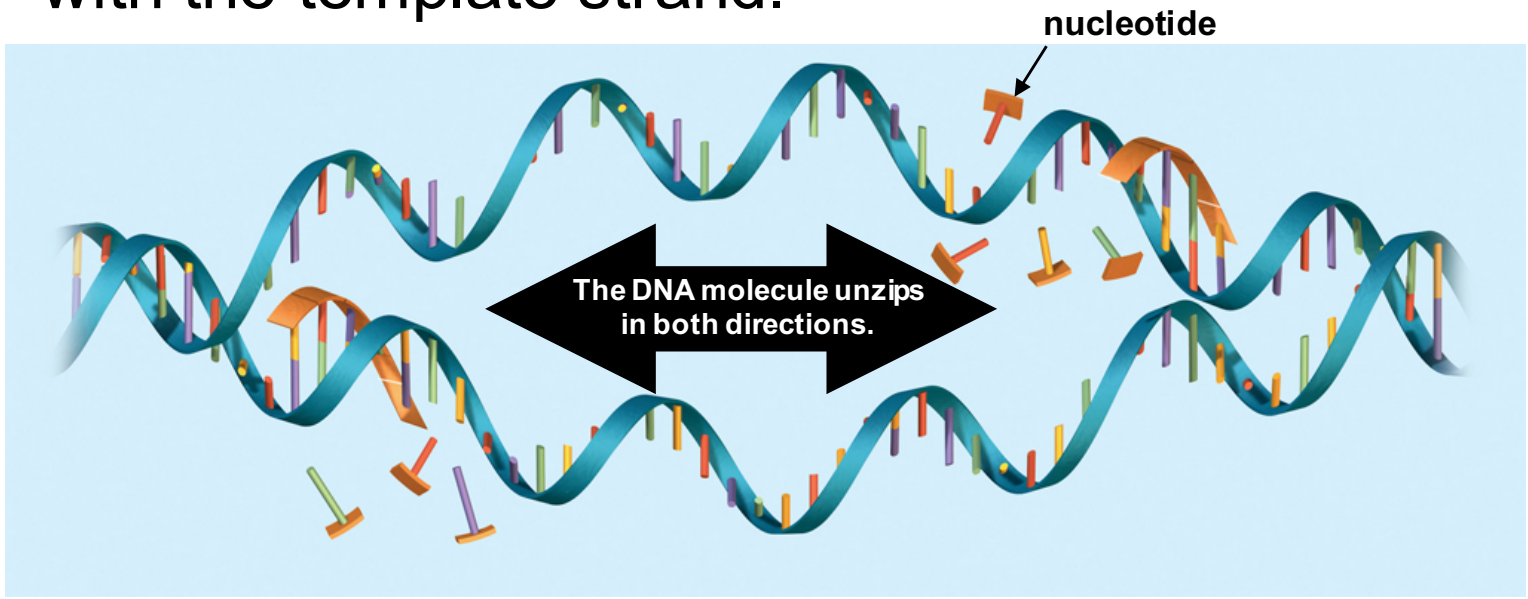
Replication copies the genetic information.

- A single strand of DNA serves as a template for a new strand.
- The rules of base pairing direct replication.
- DNA is replicated during the S (synthesis) stage of the cell cycle.
- Each body cell gets a complete set of identical DNA.



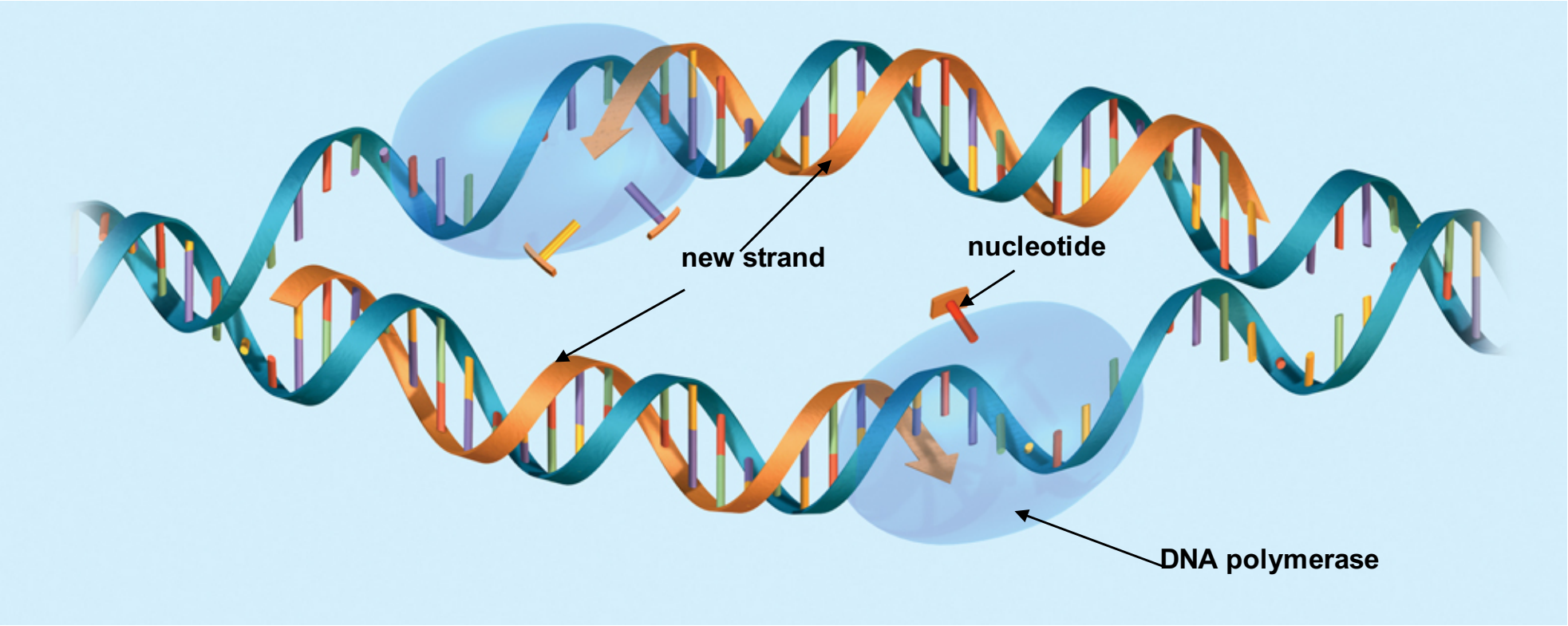
5.1 The Cell Cycle

- **Proteins carry out the process of replication.**
  - DNA serves only as a template.
  - Enzymes and other proteins do the actual work of replication.
    - Enzymes unzip the double helix.
    - Free-floating nucleotides form hydrogen bonds with the template strand.



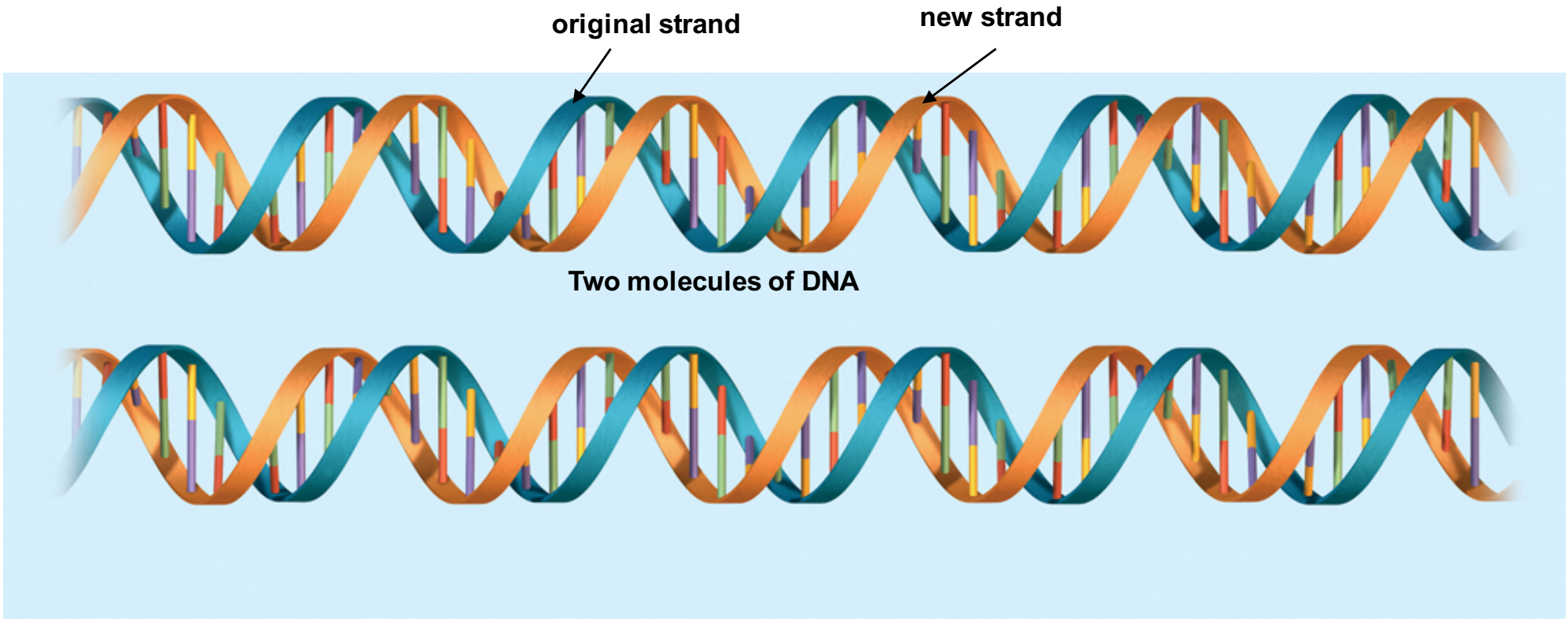
5.1 The Cell Cycle

- DNA polymerase enzymes bond the nucleotides together to form the double helix.
- Polymerase enzymes form covalent bonds between nucleotides in the new strand.



5.1 The Cell Cycle

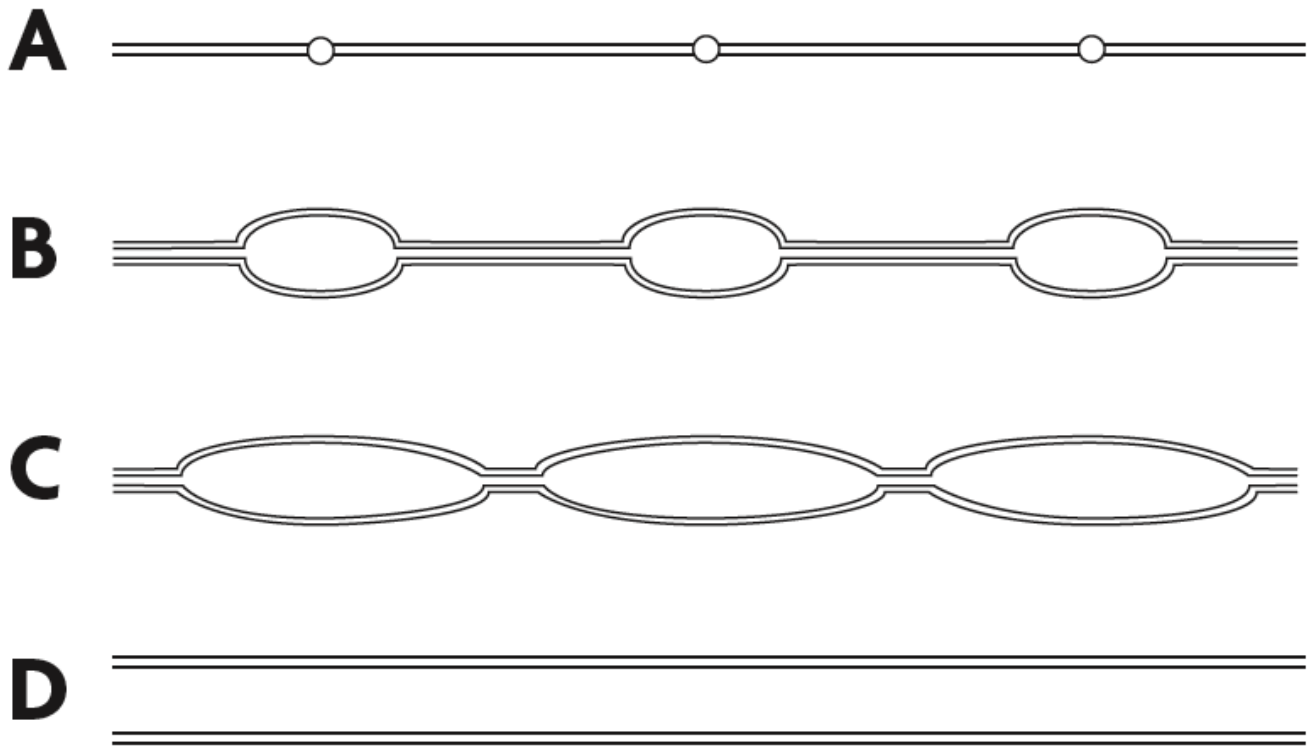
- Two new molecules of DNA are formed, each with an original strand and a newly formed strand.
- DNA replication is semiconservative.



5.1 The Cell Cycle

Replication is fast and accurate.

- DNA replication starts at many points in eukaryotic chromosomes.



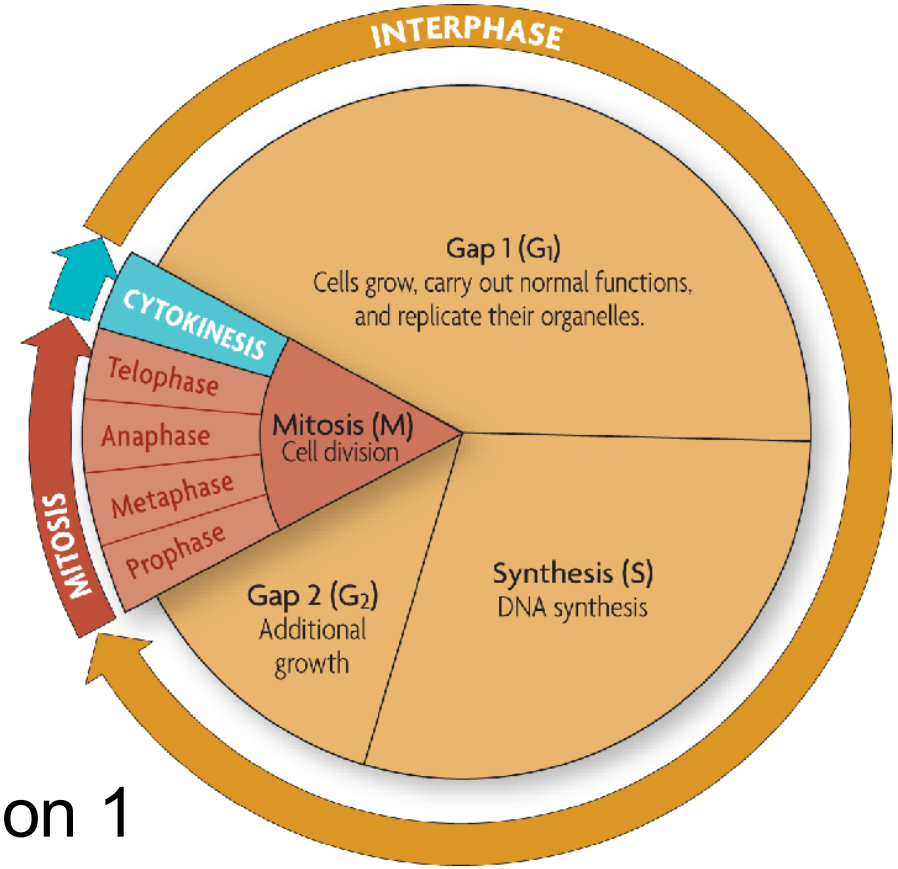
There are many origins of replication in eukaryotic chromosomes.

- DNA polymerases can find and correct errors.

5.1 The Cell Cycle

The life cycle of a cell is called the cell cycle

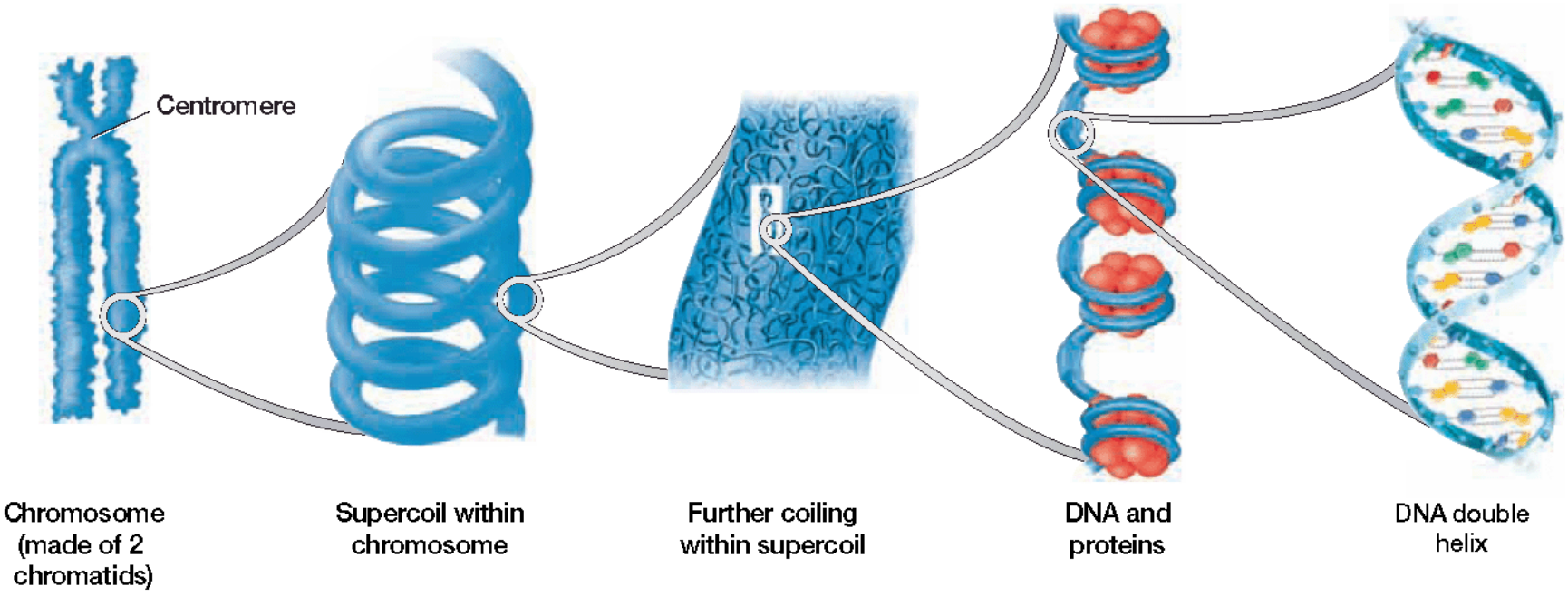
- The cell cycle is a regular pattern of growth, DNA replication, and cell division.



Chapter 5 Section 1

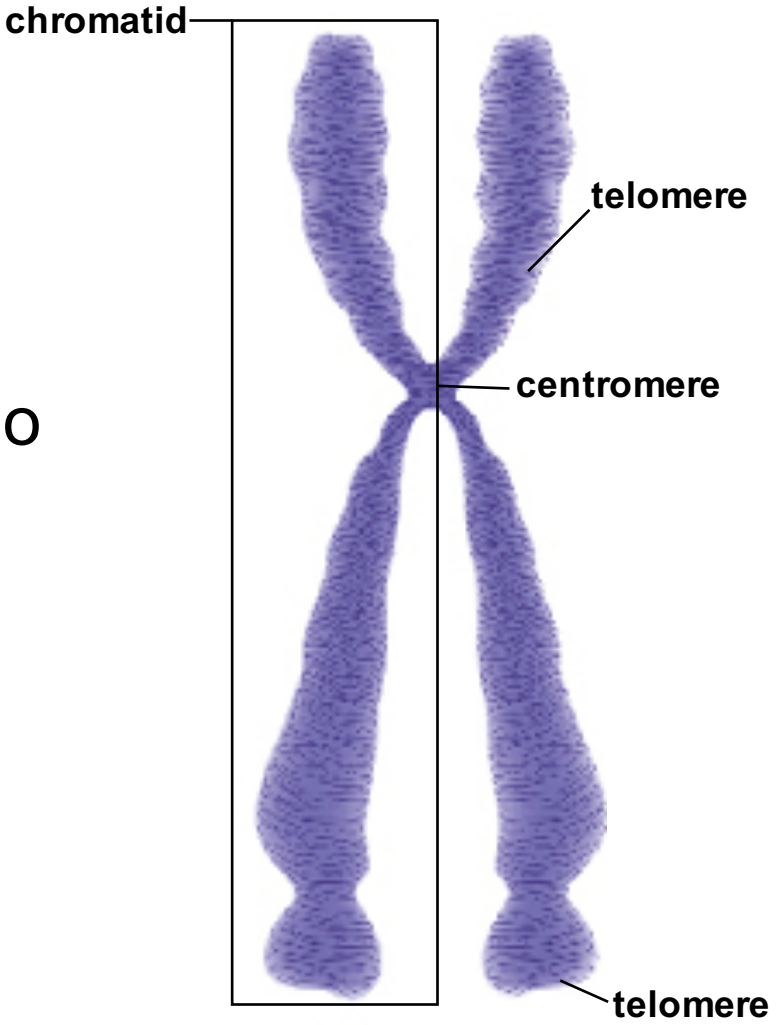
5.1 The Cell Cycle

- Before cell division DNA is replicated and organized into chromosomes



5.1 The Cell Cycle

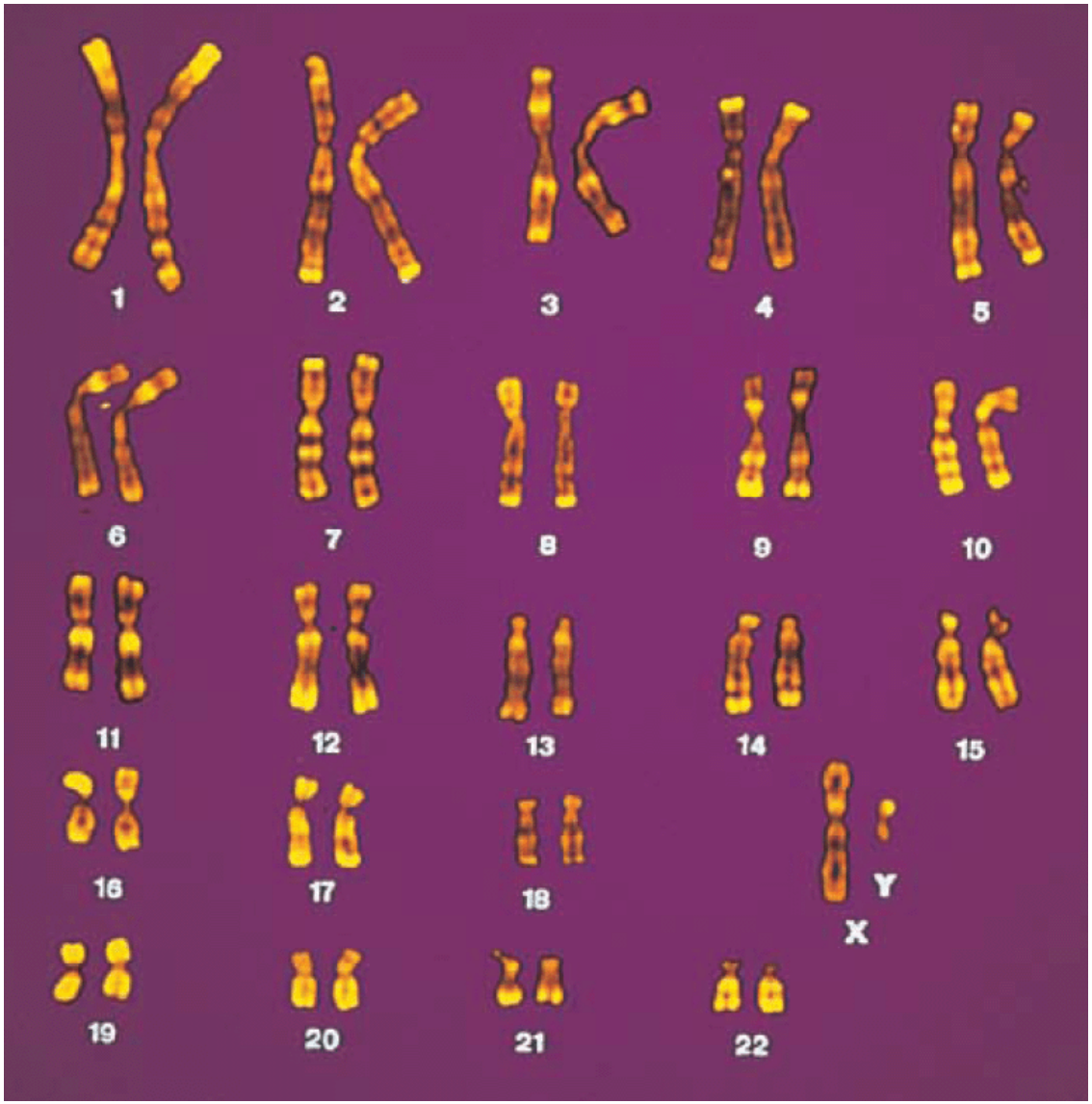
- DNA plus proteins is called chromatin.
- One half of a duplicated chromosome is a chromatid.
- Sister chromatids are held together at the centromere.
- Telomeres protect DNA and do not include genes.



Condensed, duplicated chromosome

5.1 The Cell Cycle

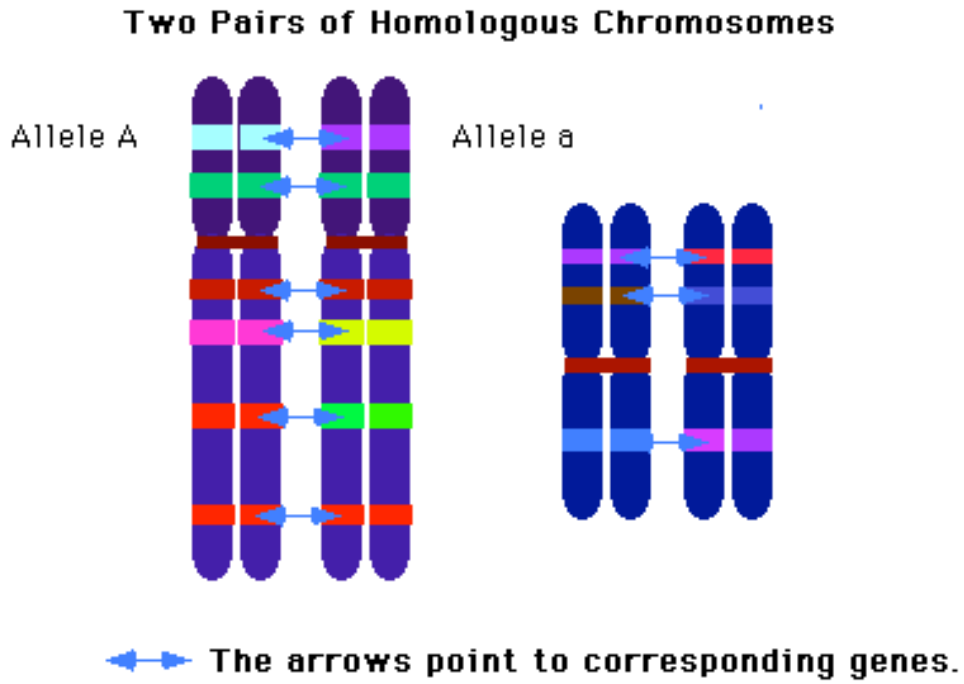
- Karyotype



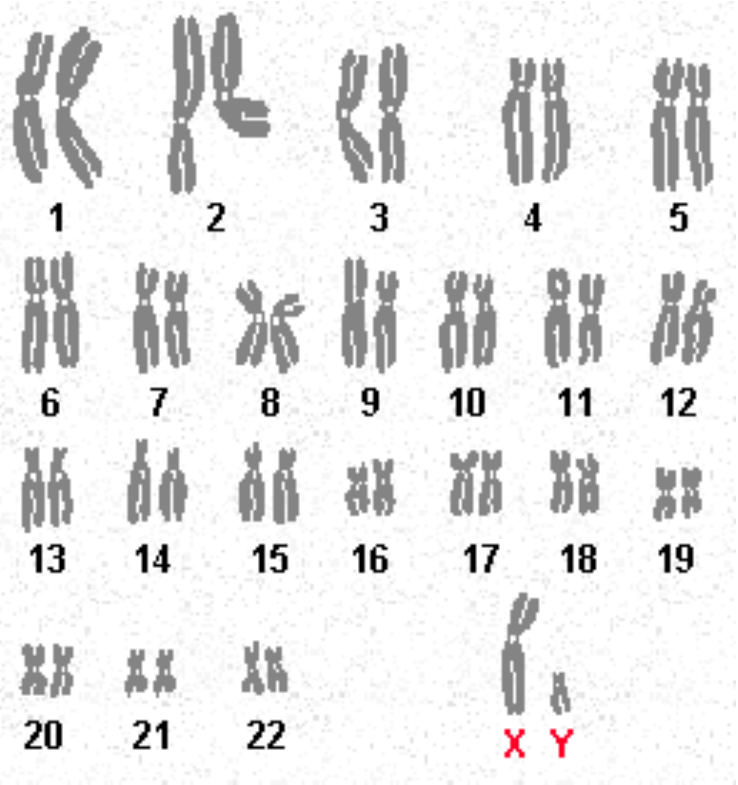
5.1 The Cell Cycle

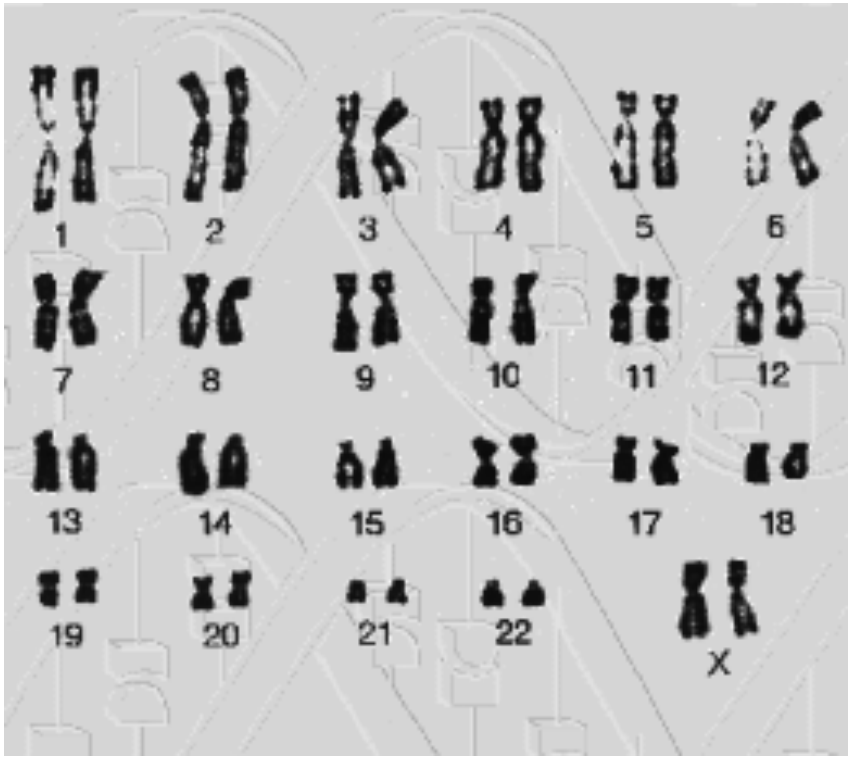
Homologous Chromosomes

- Have the same length, appearance and copies of genes, although alleles may differ
- 23 pair of homologous chromosomes in humans 2n= 46 total chromosomes
- One from each parent

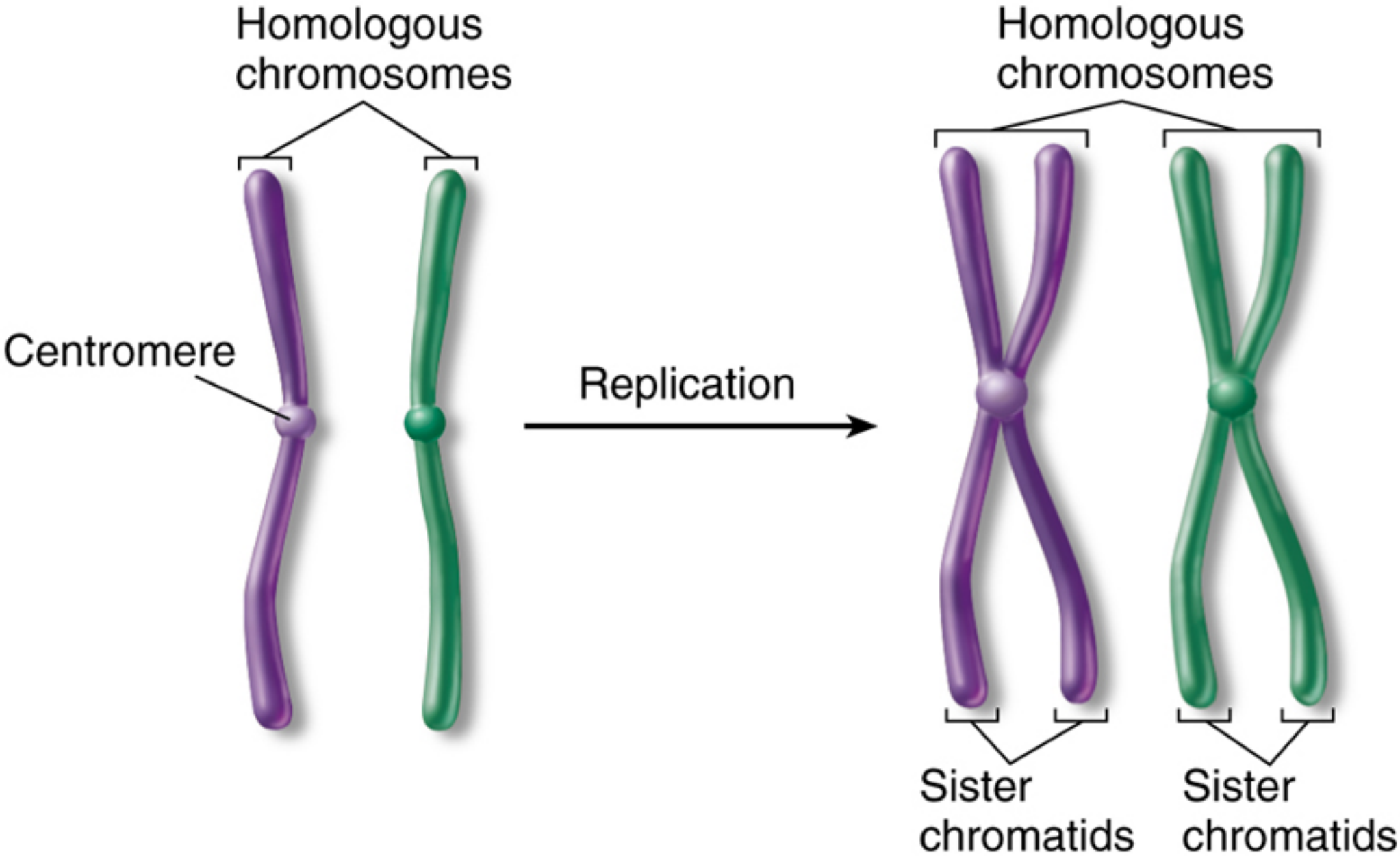


5.1 The Cell Cycle





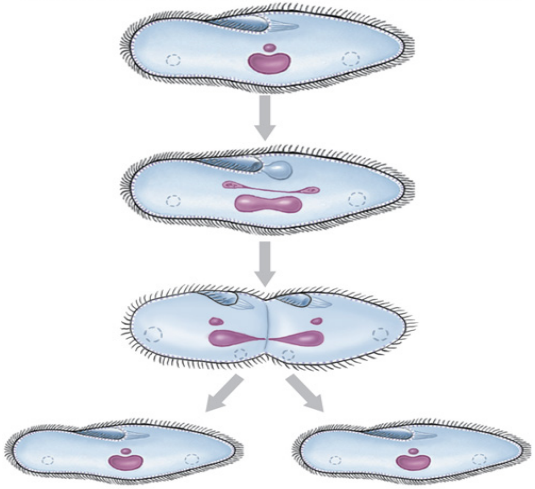
5.1 The Cell Cycle



5.1 The Cell Cycle

- **Reproduction = adding new individuals to a population**

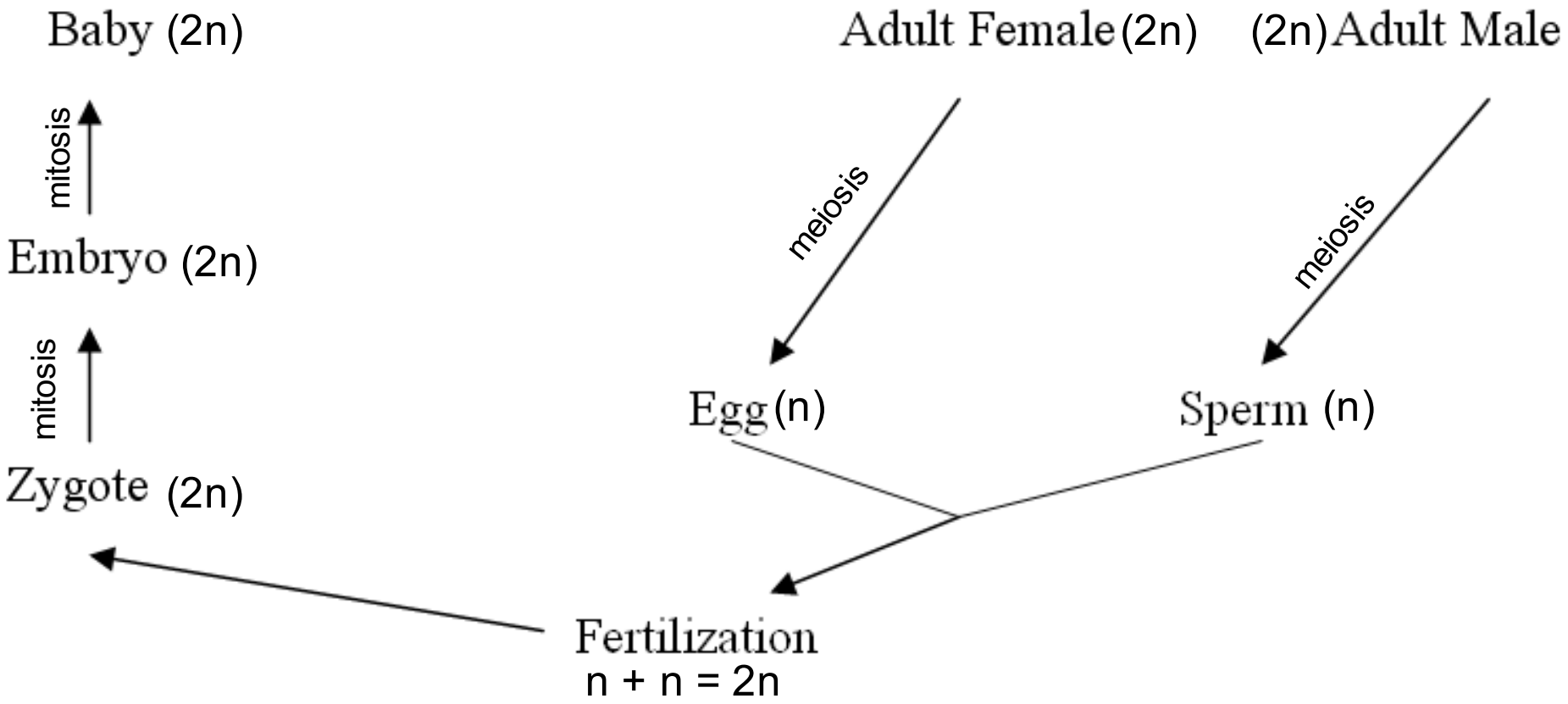
- I. Asexual Reproduction
  - producing more individuals without gametes
  - Results in clones
  - Examples: bacteria & protists
  - 1. Binary Fission
  - 2. Fragmentation/Budding



A Binary fission in *Paramecium*

5.1 The Cell Cycle

- **II. Sexual Reproduction - producing more individuals with the use of gametes (eggs and sperm) from two genetically unique parents**



5.1 The Cell Cycle

Comparison

Asexual Reproduction	Sexual Reproduction
Advantages: Rapid Simple Lots of offspring	**Advantages:** **Genetic Variation!!!!!** Adapt to changing environments
Disadvantage: **Prone to Extinction** No genetic variation	Disadvantages: Complicated Requires more time Wastes energy
Bacteria	Animals & Plants

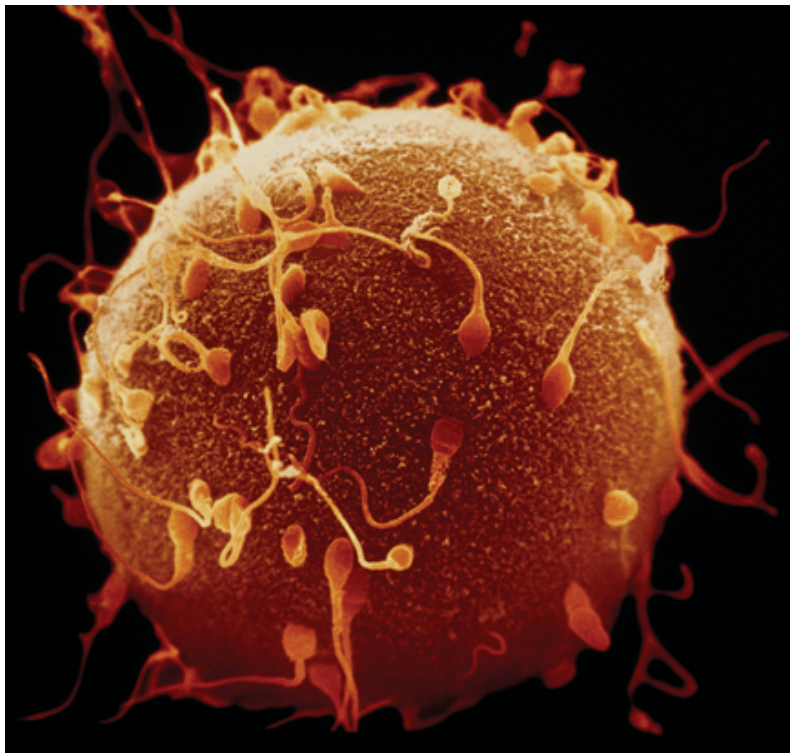
5.1 The Cell Cycle

KEY CONCEPT

You have two types of cells:

-Somatic Cells

-Gametes



Chapter 5 Section 2
Chapter 6 Section 1

5.1 The Cell Cycle

Somatic Cells

- Body cells, like hair, skin, blood, muscle, liver, etc…..
- They are DIPLOID – have both sets of chromosomes
- From both parents

body cells

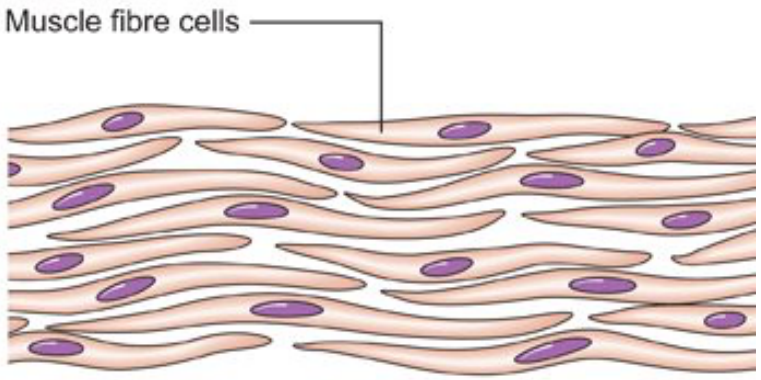
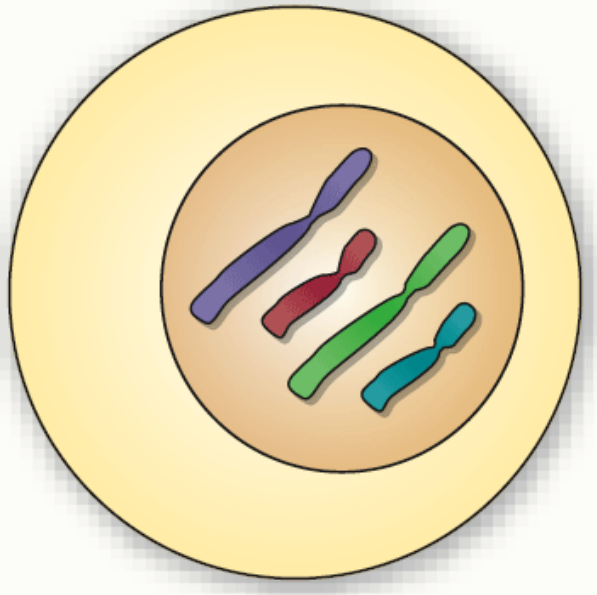


Diagram of muscle cells

5.1 The Cell Cycle

Somatic Cells (Body cells) are diploid

- Diploid (2*n*) cells have two copies of every chromosome.
  - Body cells are diploid.
  - 23 pair of chromosomes (autosomes AND sex chromosomes)
  - Half the chromosomes come from each parent.



Body cells are diploid (2*n*).

5.1 The Cell Cycle

Gametes

- Gametes are sex cells: egg and sperm.
- Gametes are HAPLOID – have just one set of chromosomes (half the DNA)
- Gametes have DNA that can be passed to offspring.

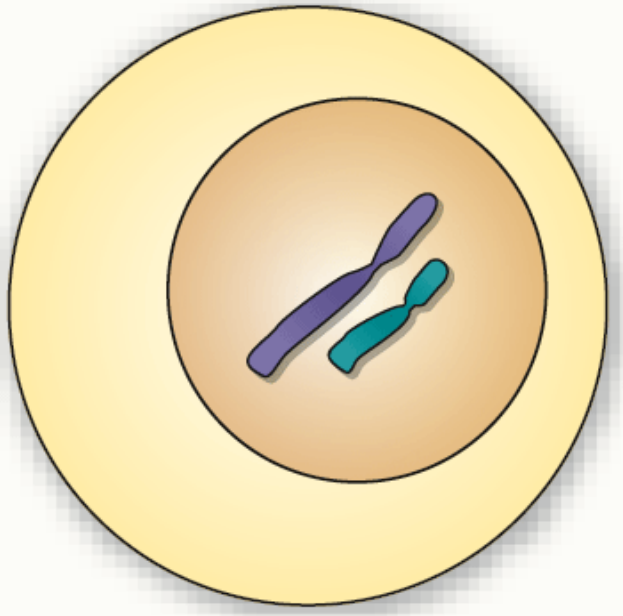
sex cells (sperm)

sex cells (egg)

5.1 The Cell Cycle

Gametes are Haploid

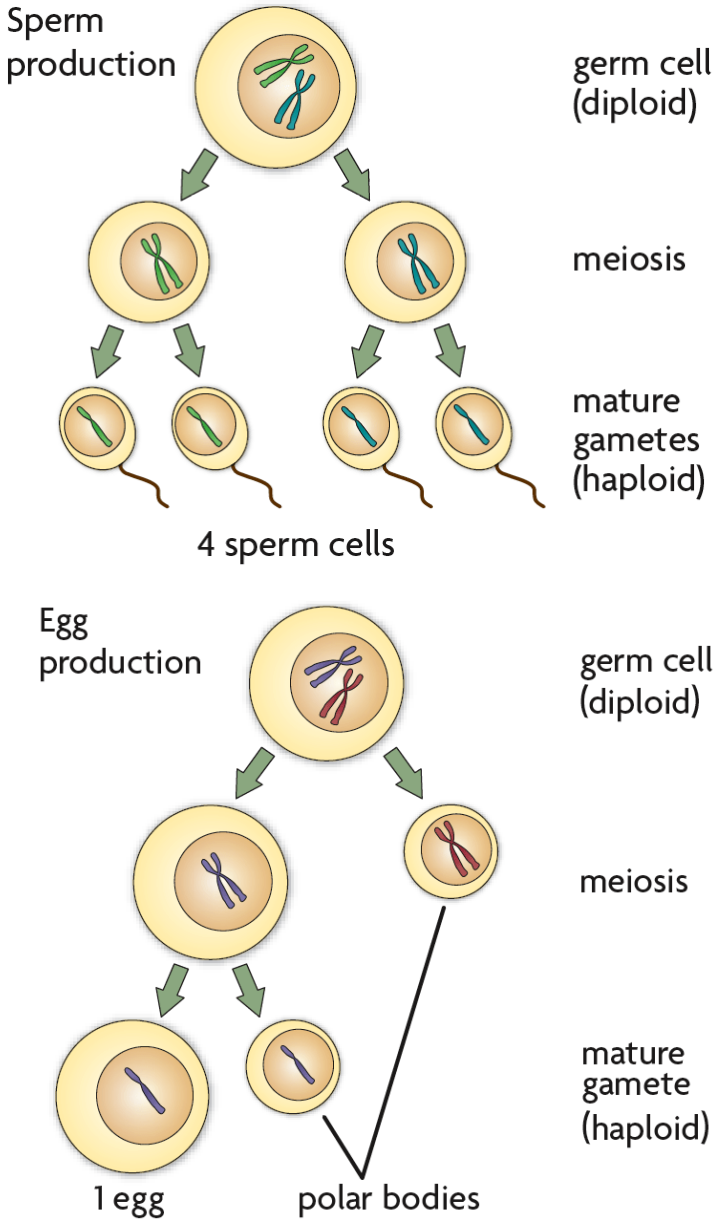
- Haploid (*n*) cells have one copy of every chromosome.
  - Gametes are haploid.
  - Gametes have 22 autosomes and 1 sex chromosome.



Gametes (sex cells) are haploid (*n*).

5.1 The Cell Cycle

- Gametogenesis is the production of haploid gametes.
- Gametogenesis in males is called spermatogenesis
- Gametogenesis in females is called oogenesis

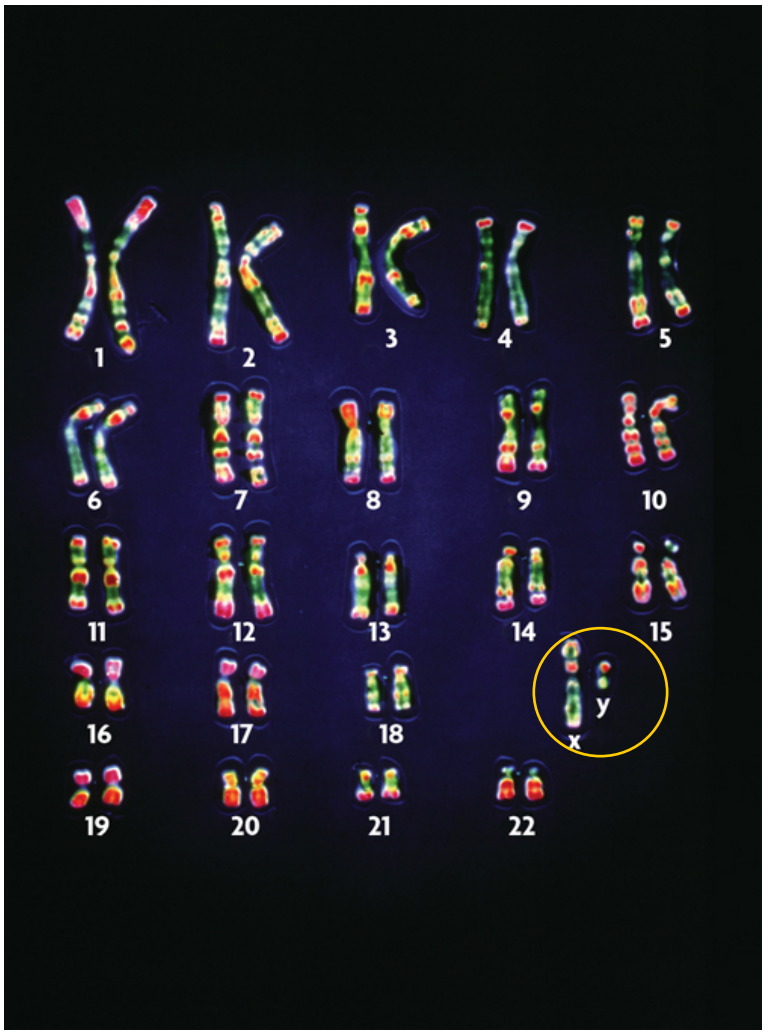


5.1 The Cell Cycle

Autosomes

- 1. Chromosomes pairs 1-22 have genes that code for traits; you inherit one from each parent

- 2. Homologous chromosomes have the same shape, structure and kinds of genes (but are NOT identical; one comes from each parent)

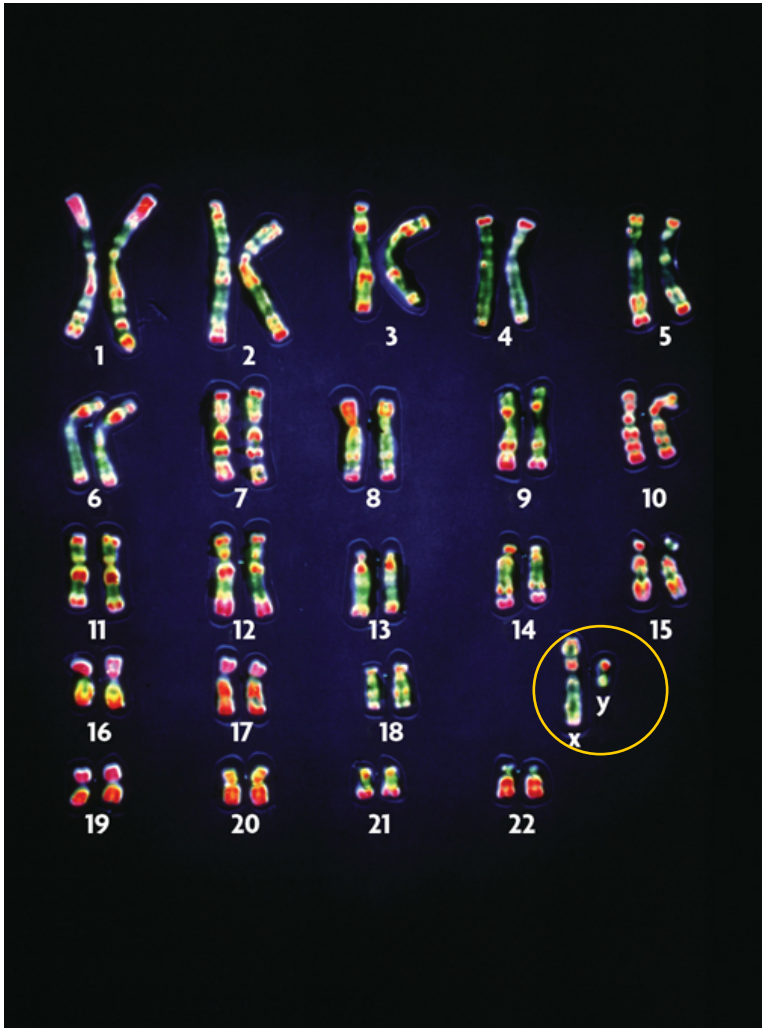


5.1 The Cell Cycle

Sex chromosomes.

- 3. Sex chromosomes:
  - X and Y

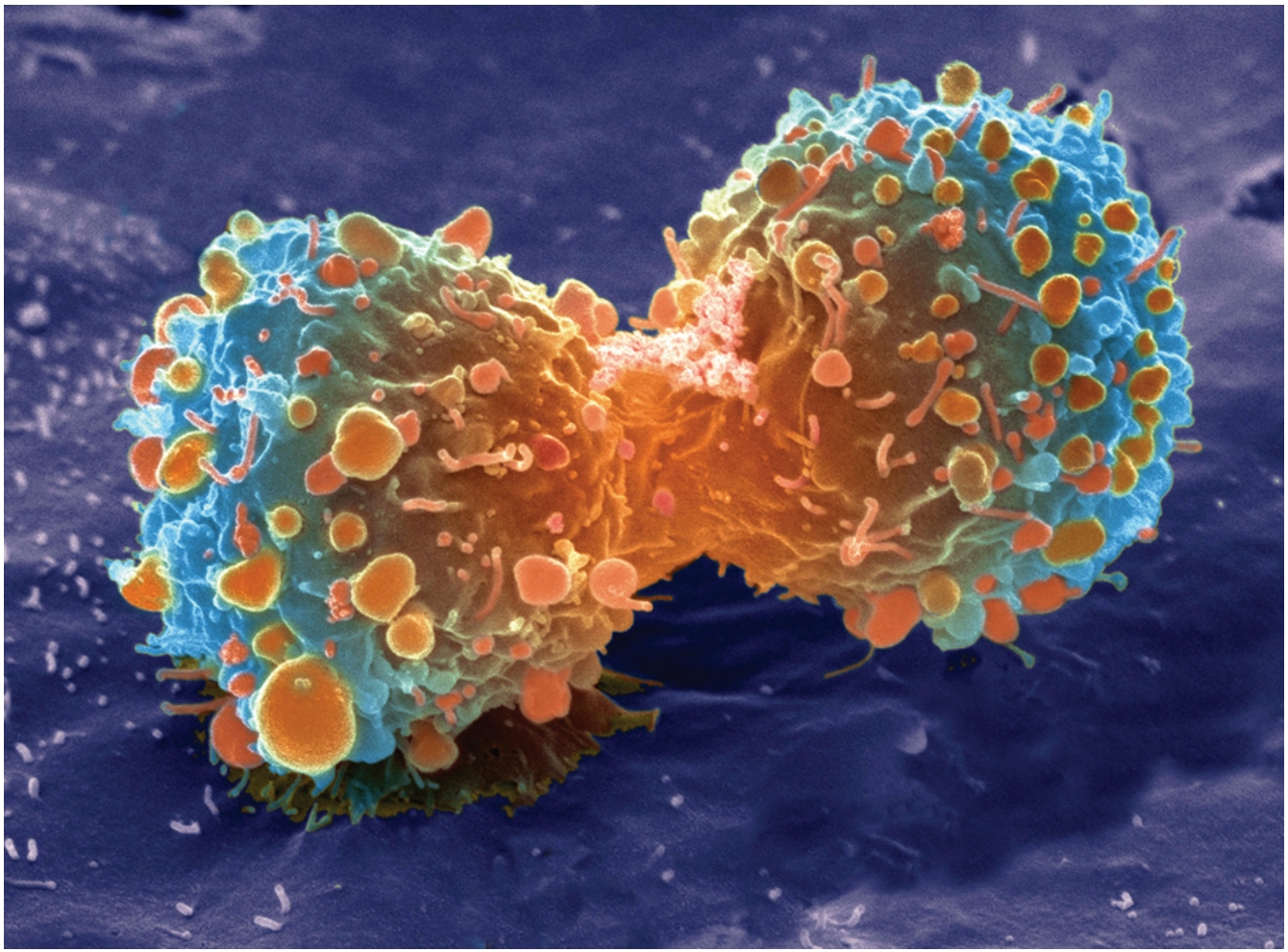
- XX – Female
- XY – Male



5.1 The Cell Cycle

KEY CONCEPT

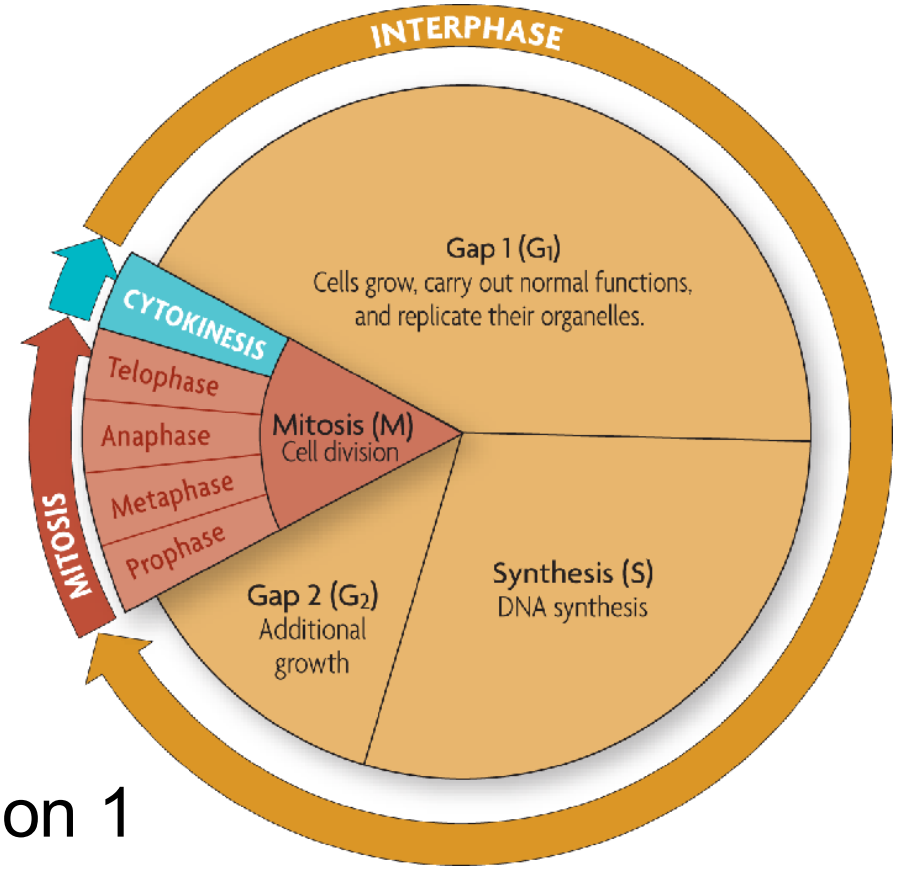
Cells have distinct phases of growth, reproduction, and normal functions.



5.1 The Cell Cycle

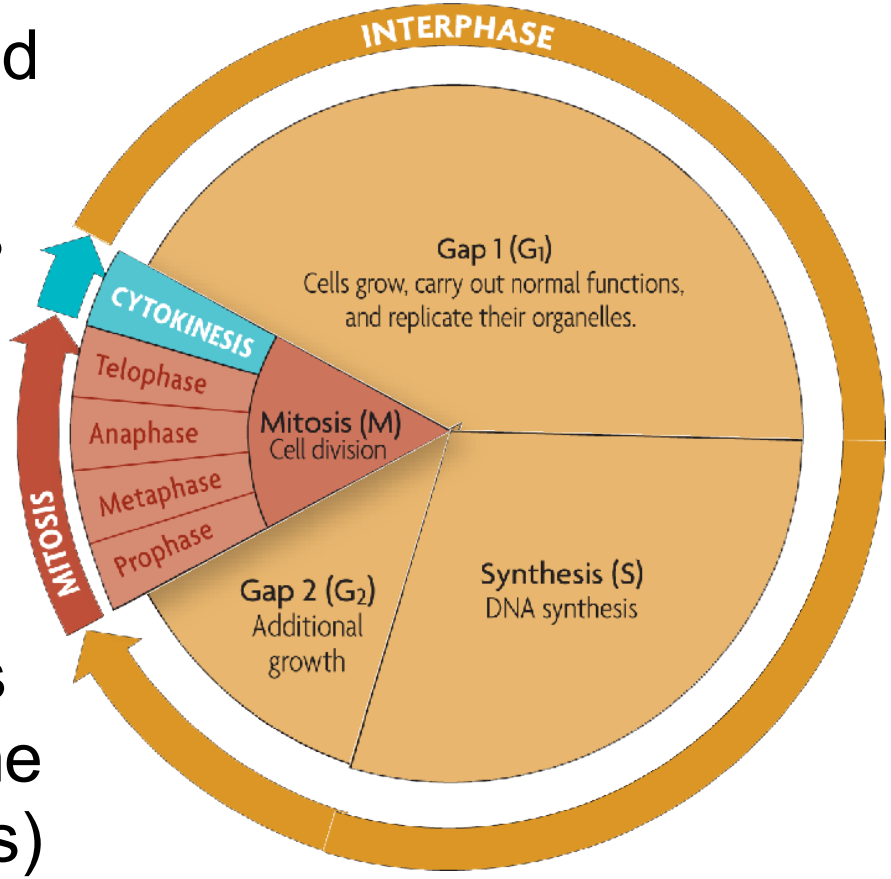
The cell cycle has four main stages.

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



5.1 The Cell Cycle

- 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
  - 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.

5.1 The Cell Cycle

Cells divide at different rates.

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

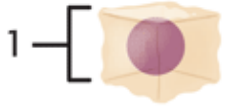
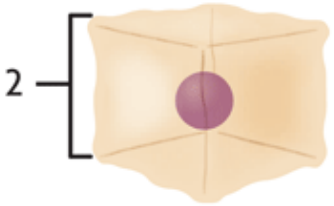
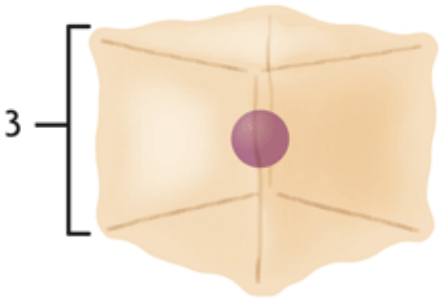
FIGURE 5.2 CELL DIVISION	
CELL TYPE	APPROXIMATE LIFE SPAN
Skin cell	2 weeks
Red blood cell	4 months
Liver cell	300–500 days
Intestine—internal lining	4–5 days
Intestine—muscle and other tissues	16 years

- Some cells are unlikely to divide (G_0).

5.1 The Cell Cycle

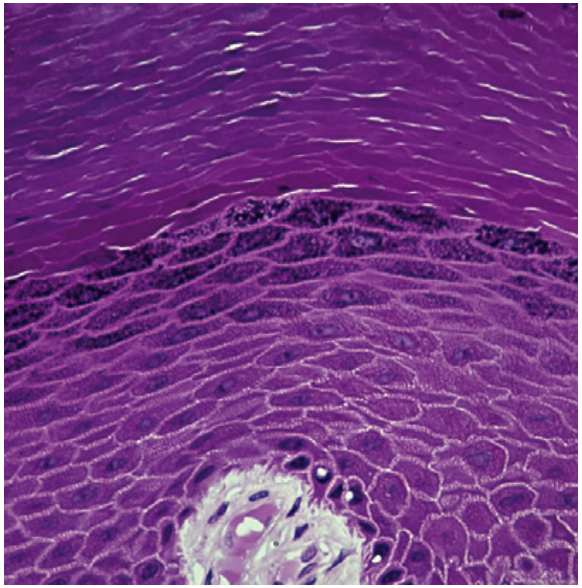
Cell size is limited.

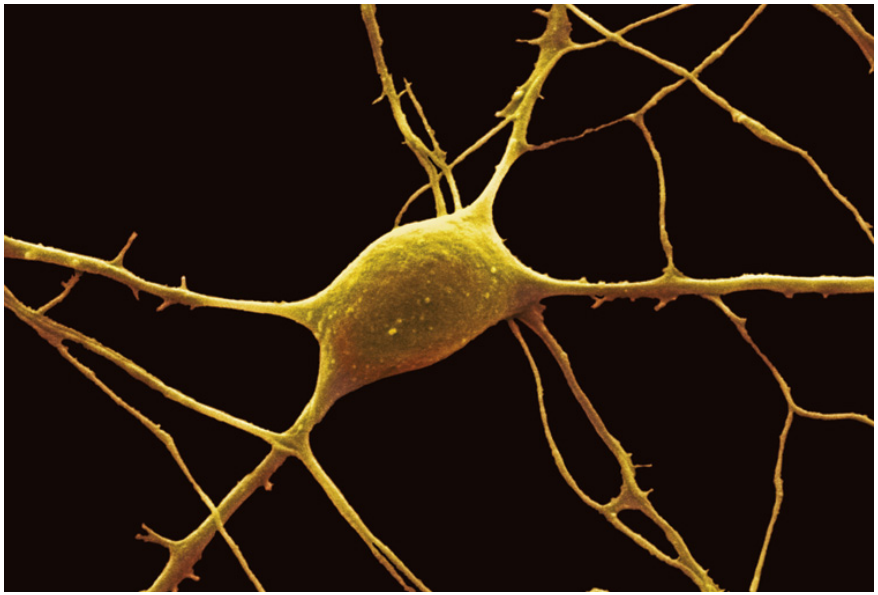
- Volume increases faster than surface area.

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

5.1 The Cell Cycle

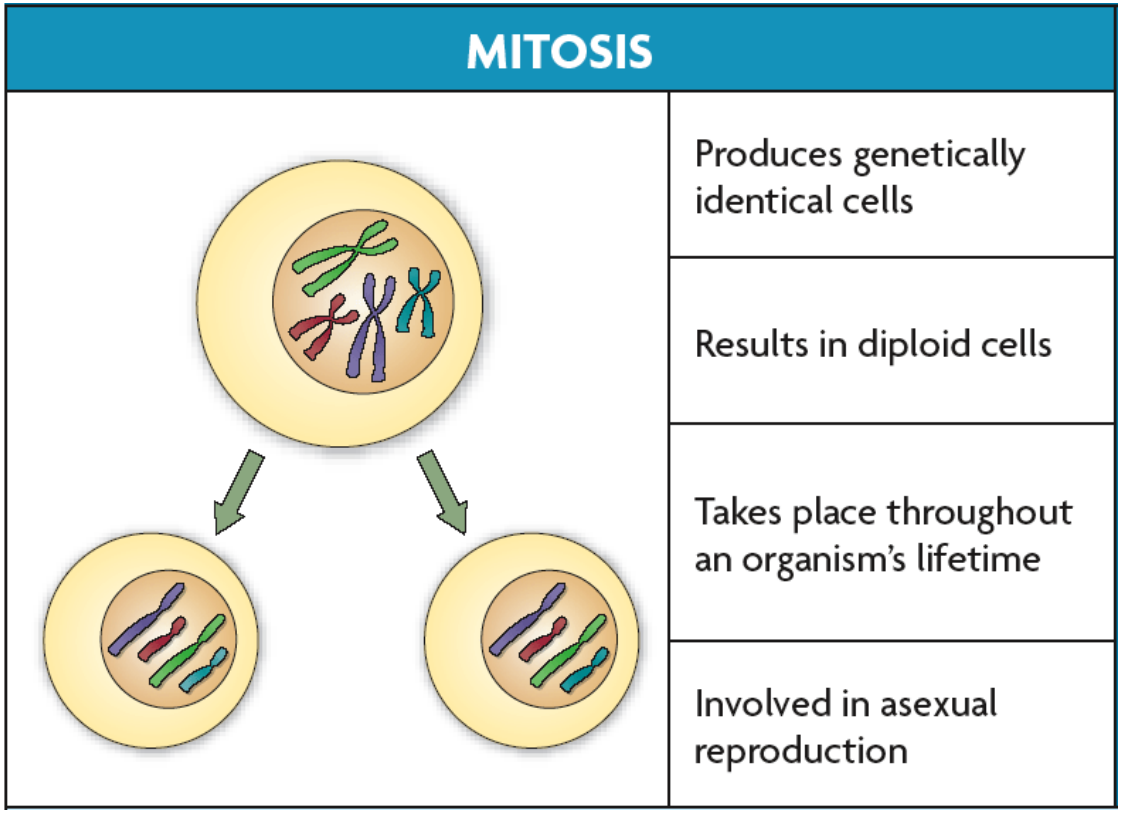
- Surface area must allow for adequate exchange of materials.
  - Cell growth is coordinated with division.
  - Cells that must be large have unique shapes.





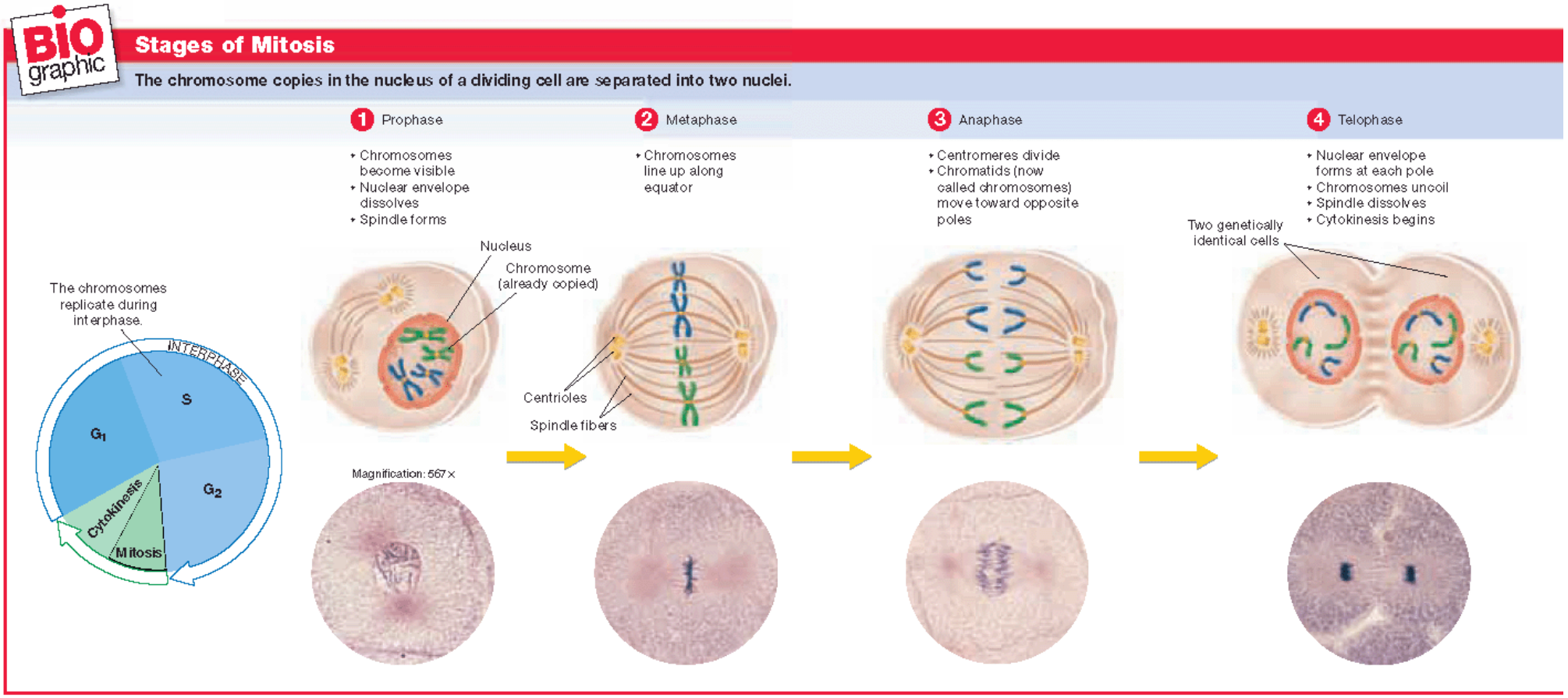
5.1 The Cell Cycle

- Mitosis makes more diploid cells.



5.1 The Cell Cycle

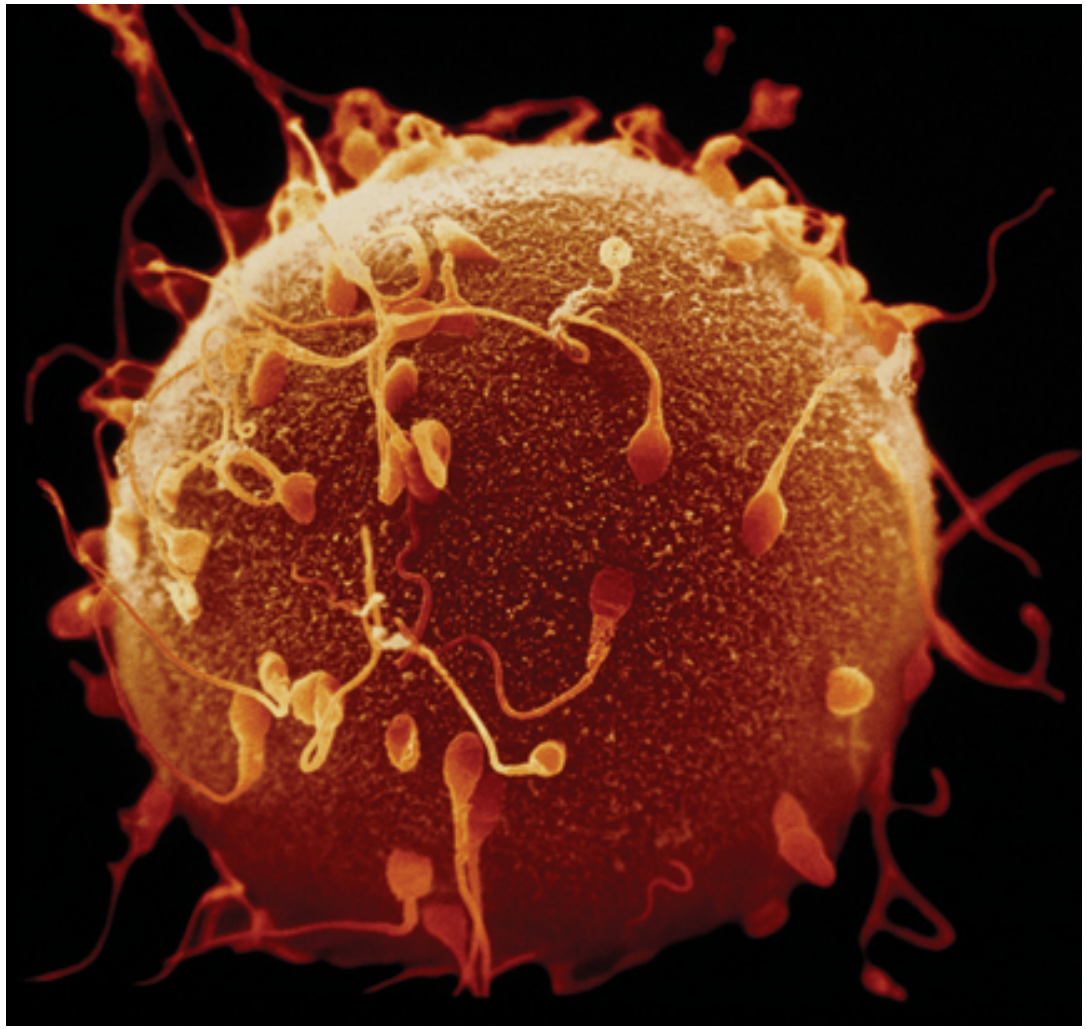
Phases of Mitosis



5.1 The Cell Cycle

KEY CONCEPT

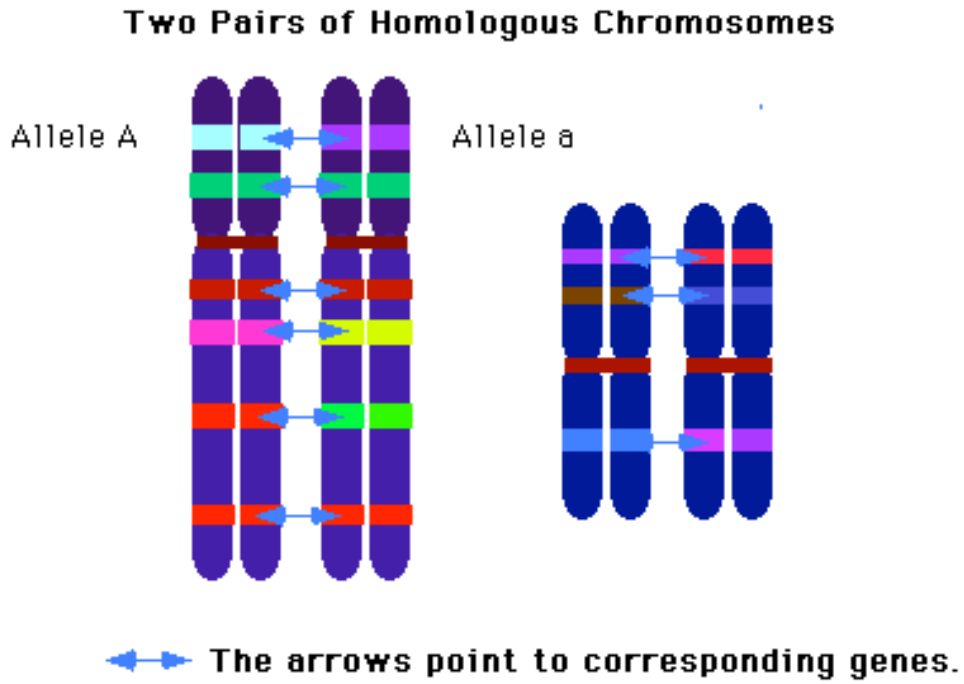
PowerNotes 6.2 Process of Meiosis



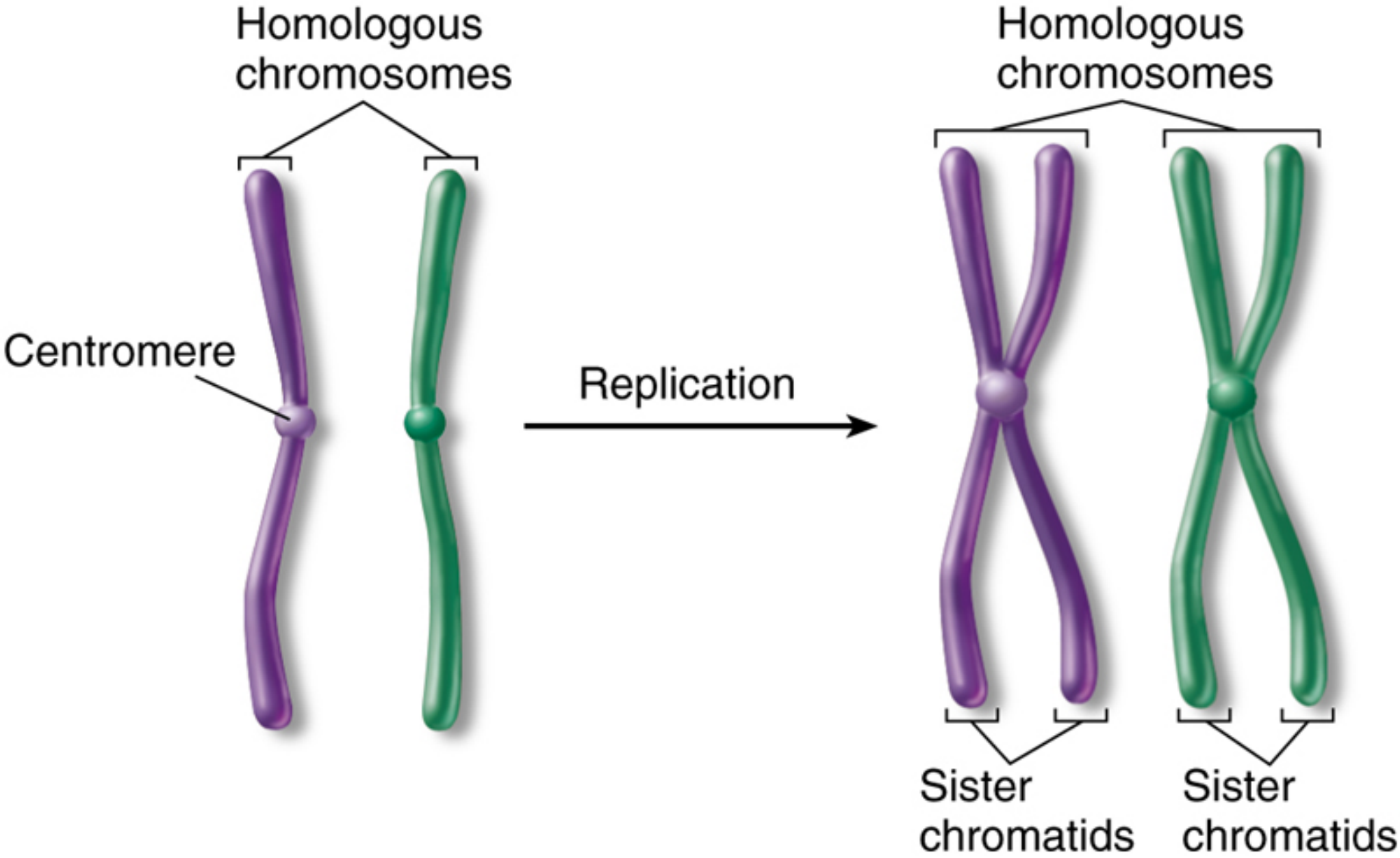
5.1 The Cell Cycle

Homologous Chromosomes

- Have the same length, appearance and copies of genes, although alleles may differ
- 23 pair of homologous chromosomes in humans 2n= 46 total chromosomes
- One from each parent

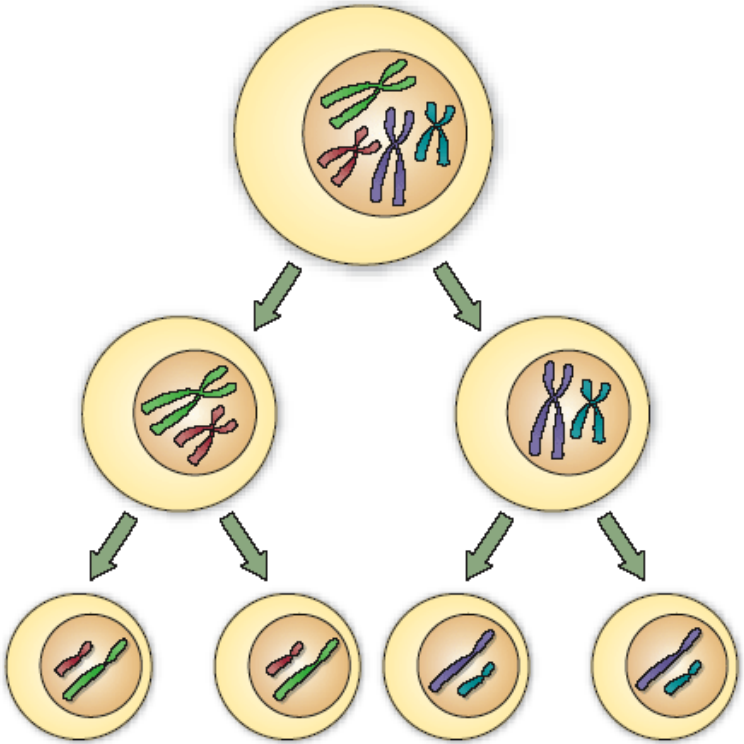


5.1 The Cell Cycle



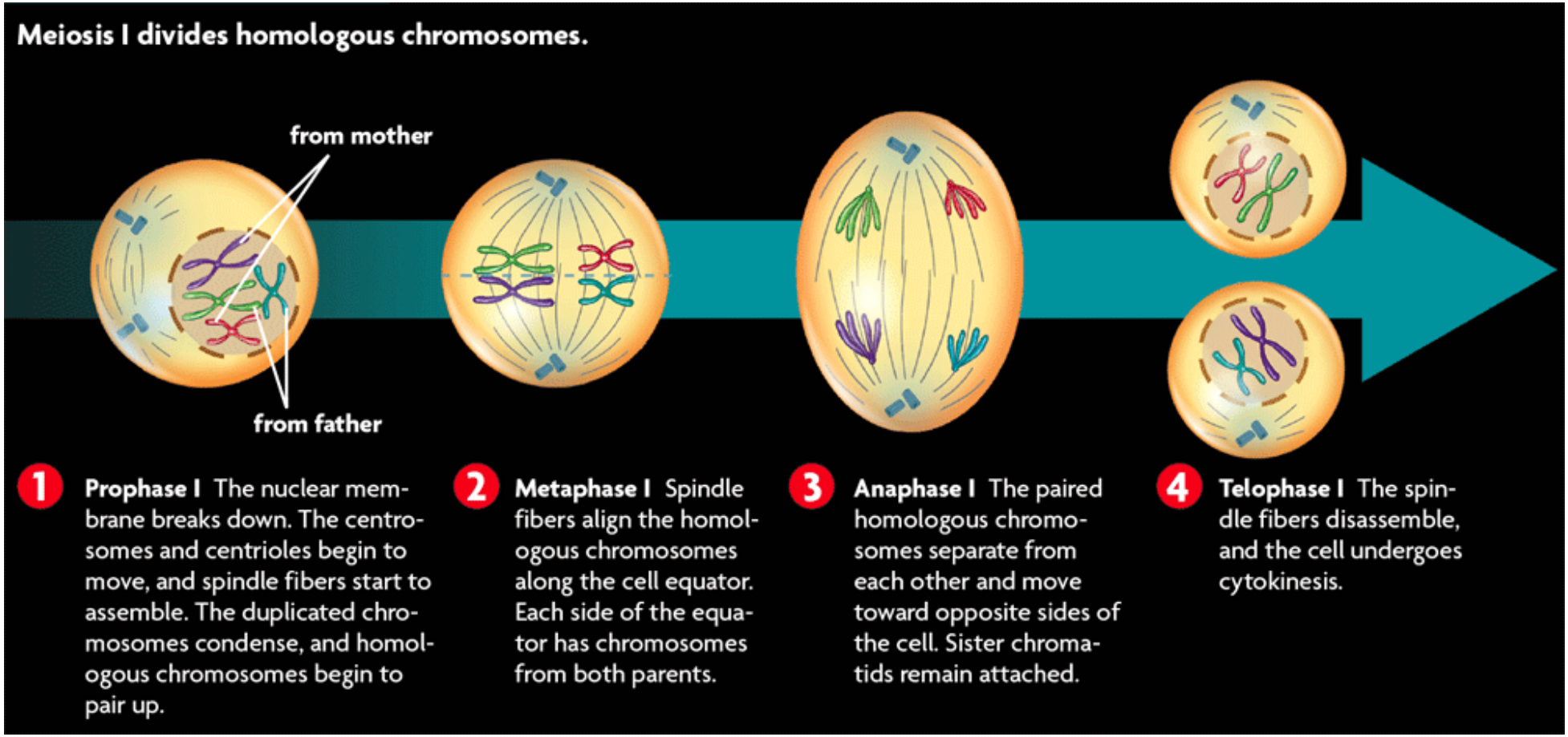
5.1 The Cell Cycle

- **Cells go through two rounds of division in meiosis.**

MEIOSIS	
Produces genetically unique cells	
Results in haploid cells	
Takes place only at certain times in an organism's life cycle	
Involved in sexual reproduction	

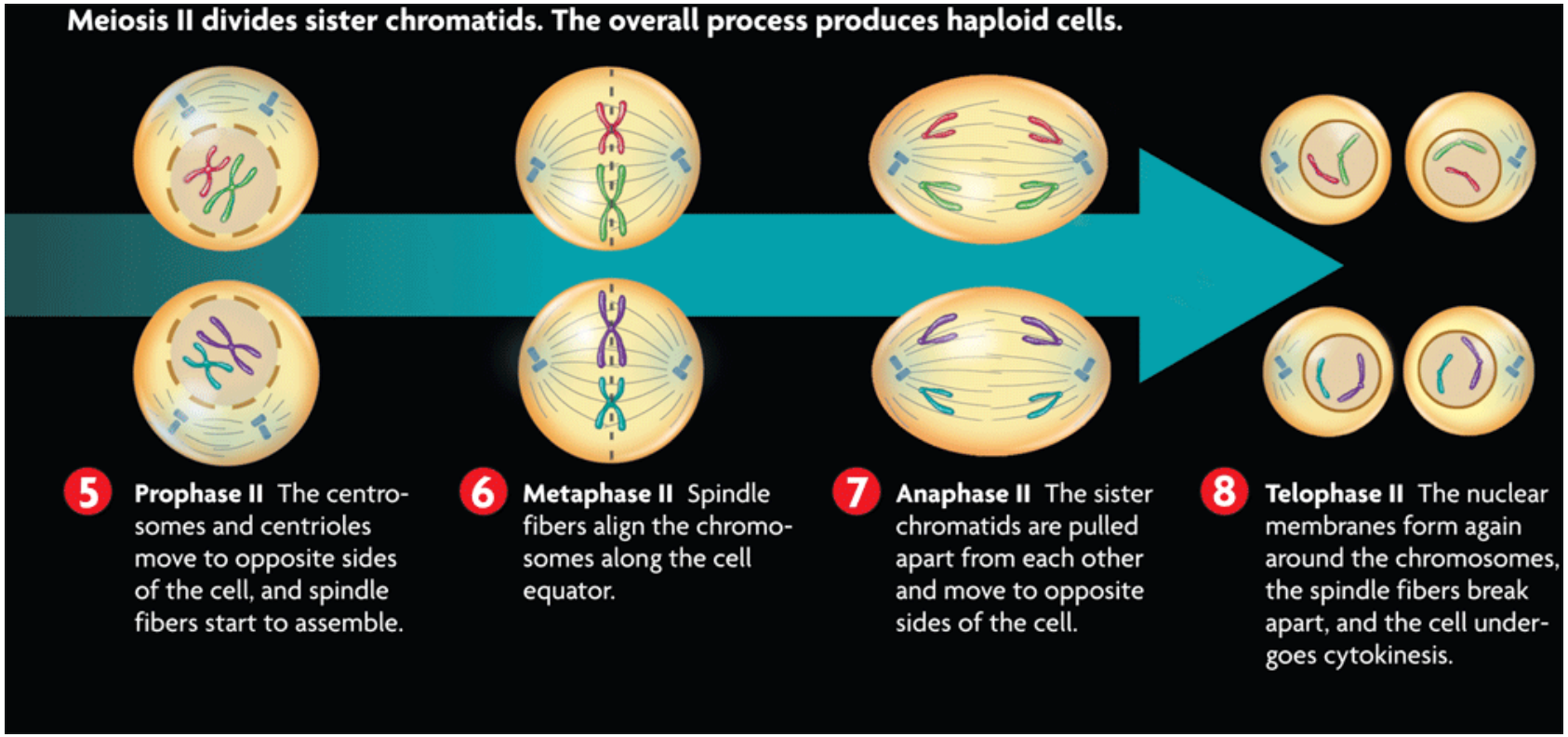
5.1 The Cell Cycle

- Meiosis I occurs after DNA has been replicated.
- Meiosis I divides homologous chromosomes in four phases.
- Daugher cells of Meiosis I are HAPLOID



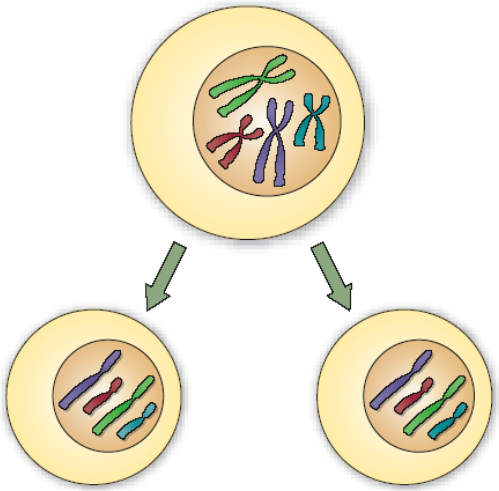
5.1 The Cell Cycle

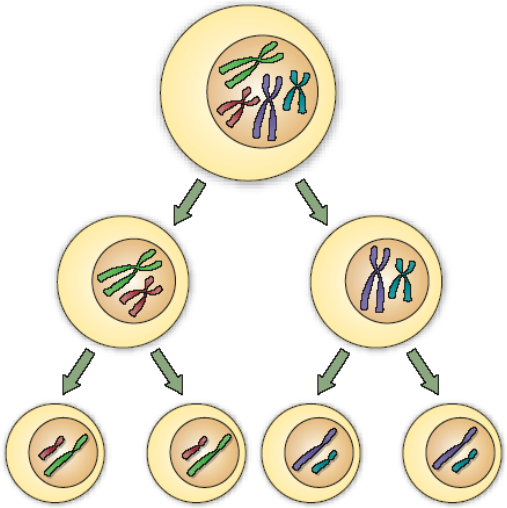
- Meiosis II divides sister chromatids in four phases.
- DNA is not replicated between meiosis I and meiosis II.



5.1 The Cell Cycle

- Meiosis differs from mitosis in significant ways.
  - Meiosis has two cell divisions while mitosis has one.
  - In mitosis, homologous chromosomes never pair up.
  - Meiosis results in haploid cells; mitosis results in diploid cells.

MITOSIS	
	Produces genetically identical cells
	Results in diploid cells
	Takes place throughout an organism's lifetime
	Involved in asexual reproduction

MEIOSIS	
Produces genetically unique cells	
Results in haploid cells	
Takes place only at certain times in an organism's life cycle	
Involved in sexual reproduction	

5.1 The Cell Cycle

Comparison of Mitosis & meiosis

mitosis

- Somatic Cells
- Make copies for growth, repair
- 2 daughter cells
- 2n cells
- In humans = 46
- Liver, blood, spleen…..
- Identical

meiosis

- Gametes
- Sexual reproduction
- 4 daughter cells
- N cells
- In humans = 23
- Egg & sperm
- Genetically DIFFERENT
- **Crossing over**