How Cells Reproduce

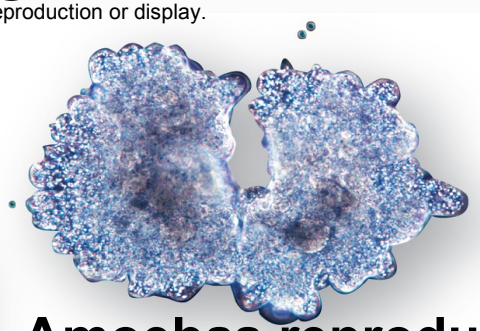
Overview of Cell Division Mechanisms

- At the beginning – we are just one cell!!! All cells come from cells
- Cellular reproduction leads to trillions of cells – and is going on in your body RIGHT NOW!!!

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Growth!!!

Tissue repair



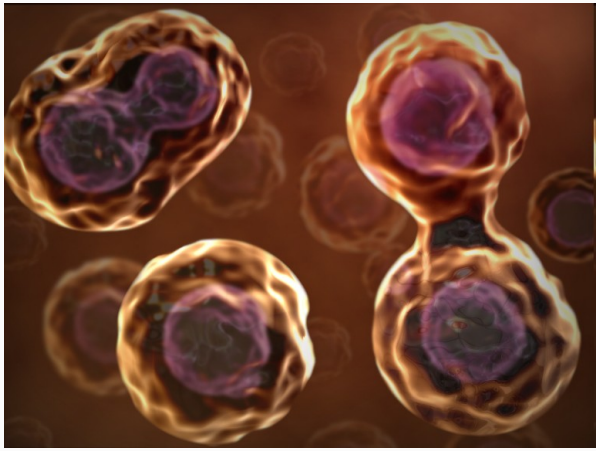
Amoebas reproduce

Zygotes develop

Functions of cell division!!!

Cellular Reproduction is used for various purposes! different processes!!!

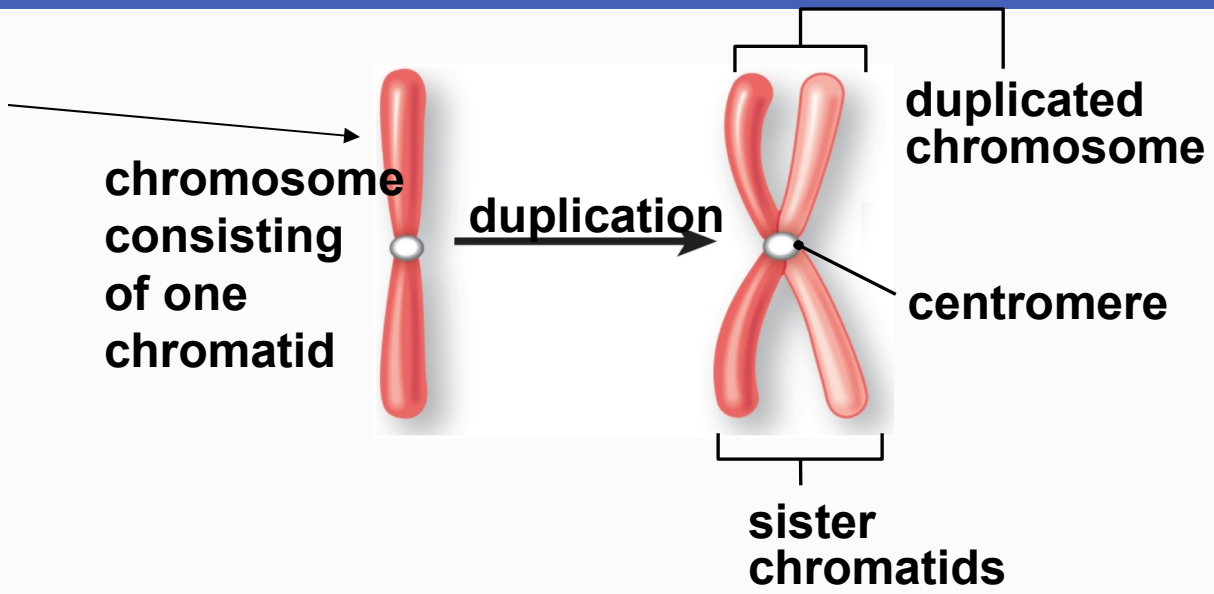
- Asexual reproduction
  - No sperm or egg needed!
    - We'll talk about sexual reproduction next chapter!
- Growth
- Tissue repair



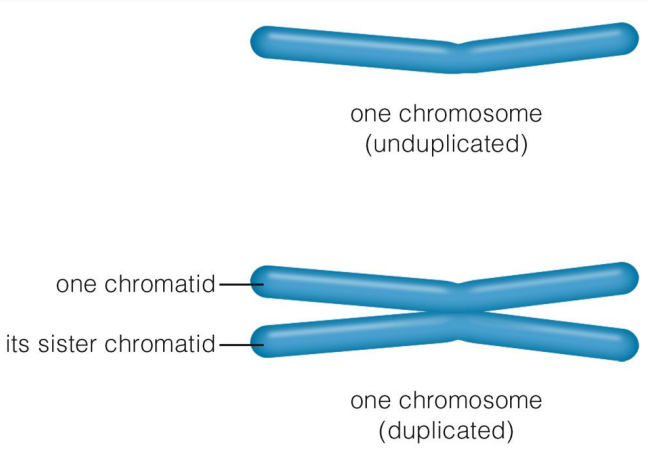
- Cell division includes 2 parts
  - Cell growth – cell duplicates its contents
  - Cell division – parent cell divides into 2 daughter cells

Chromosomes

- In cell division, DNA replicates (copies itself)
  - Later passed to daughter cells
- DNA packaged into chromosomes
  - DNA & proteins
- All DNA & proteins = chromatin



Sister chromatids joined at centromere



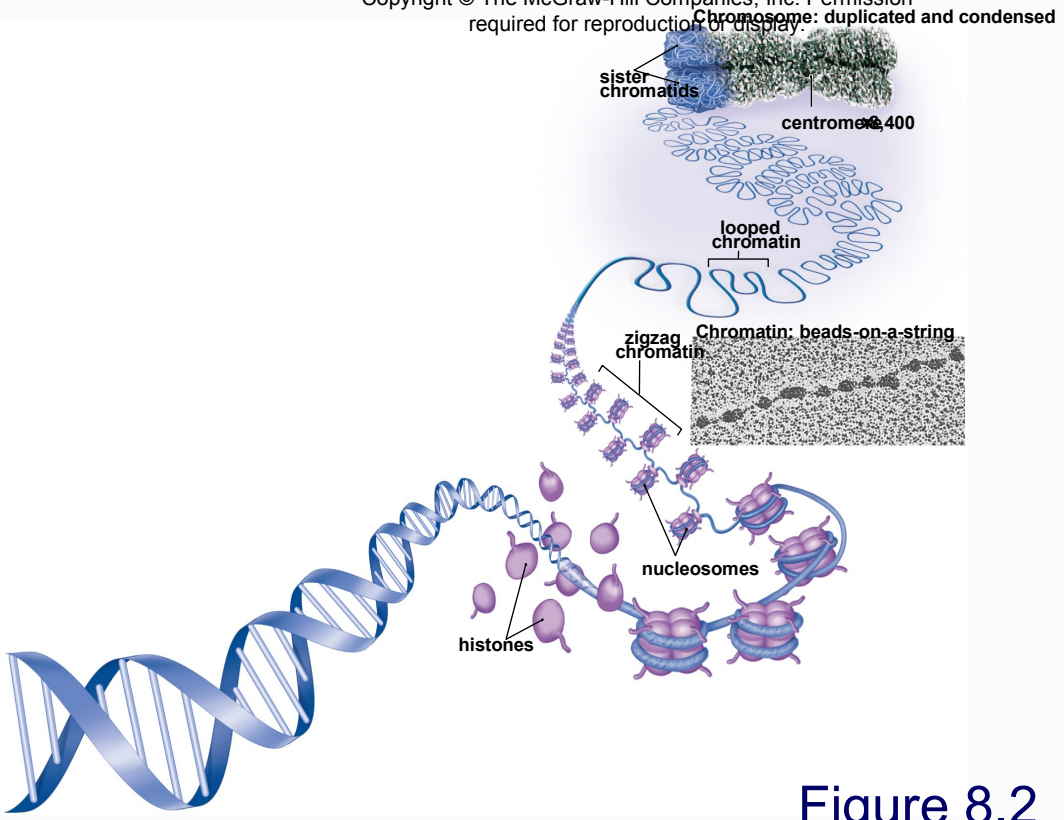
Key Points About Chromosome Structure

- A chromosome consists of DNA that is wrapped around proteins (**histones**) and condensed
- Each histone and the DNA wrapped around it make up a **nucleosome**, the smallest unit of structural organization in chromosomes

Chromosome Structure

- DNA wound around histones to form nucleosomes
- Humans have 46 chromosomes (23 pairs)
- Before cell division chromatin condenses into chromosomes

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



(chromatin): Courtesy O.L. Miller, Jr. and Steve L. McKnight;
(chromosome): © Biophoto Associates/Photo Researchers, Inc.

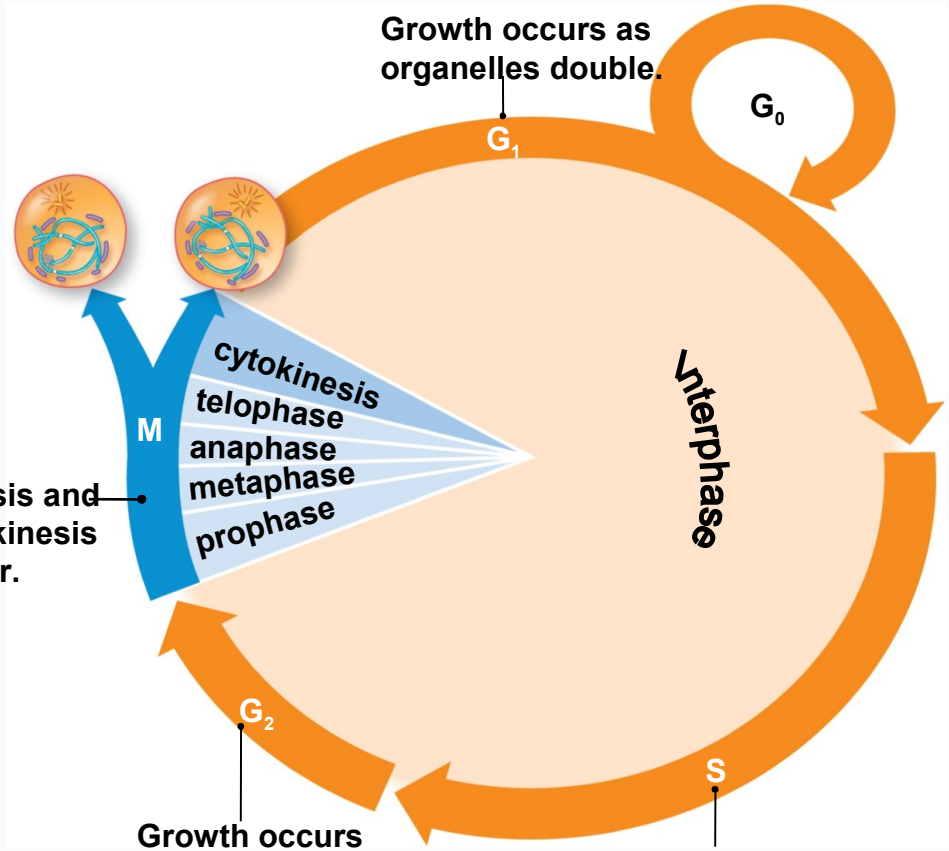
Figure 8.2 Chromosome compaction

http://www.youtube.com/watch?v=gbSIBhFwQ4s

Introducing the Cell Cycle

- A sequence of 2 stages
  - Interphase
  - M (Mitotic) Stage
- Begins when a new cell forms, ends when 2 daughter cells arise

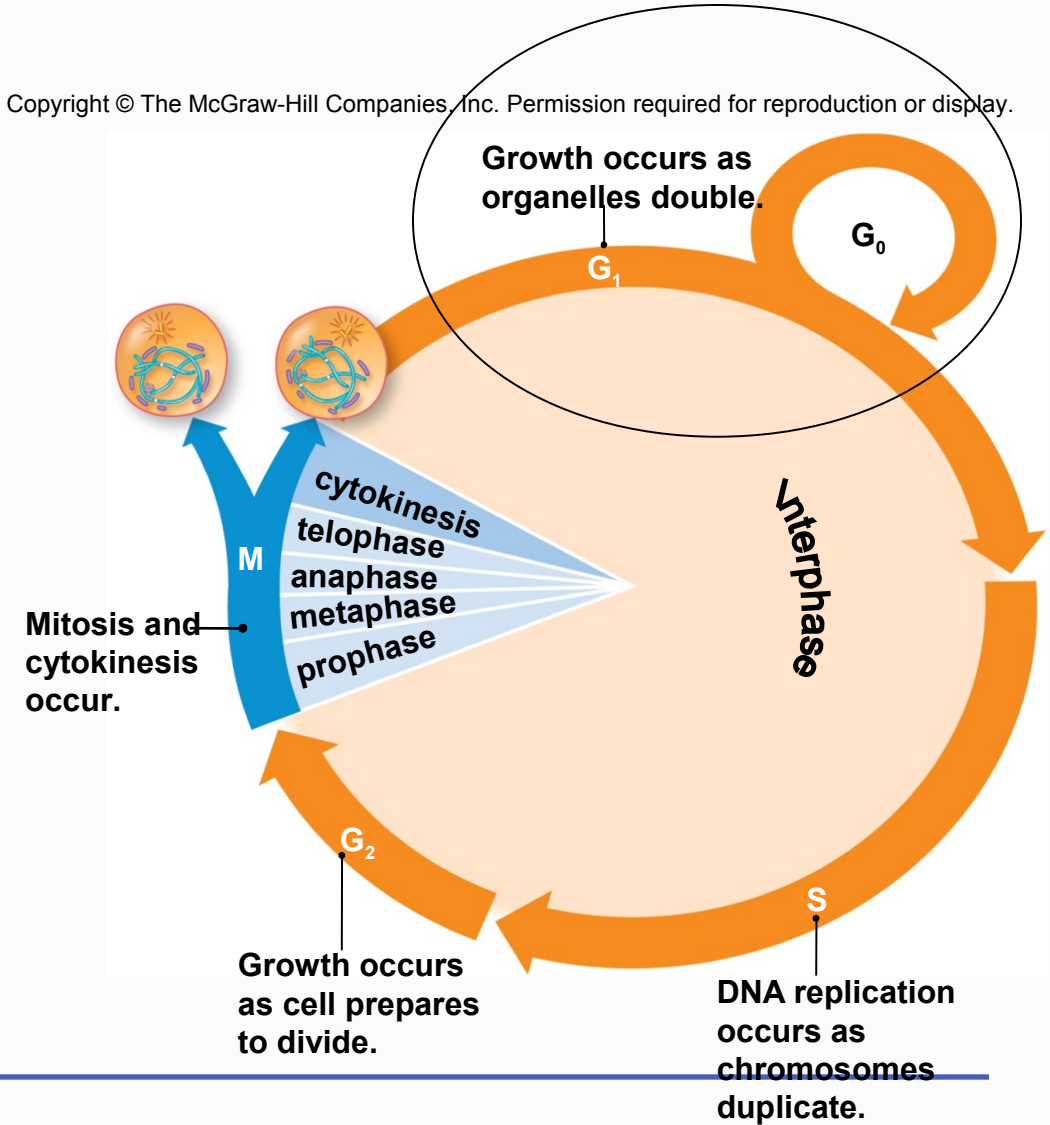
Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



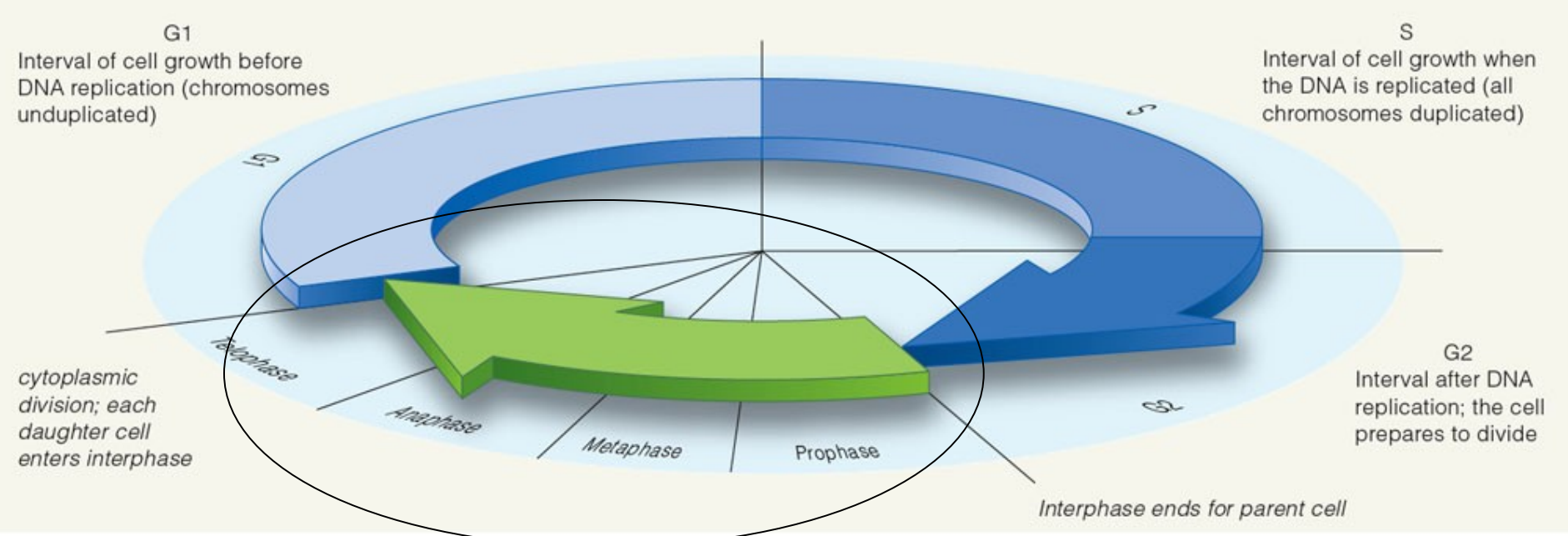
Interphase – Majority of the cell cycle

3 stages of interphase

- G_1: Interval of cell growth and activity
  - Organelles double
  - Divide or not???
    - G_0 – no division
- S: Interval of DNA replication (synthesis)
- G_2: Interval when the cell prepares for division



Eukaryotic Cell Cycle



© Cengage Learning

- **M (mitotic) phase**
  - Cell division occurs
    - Division of nucleus (mitosis)
    - Division of cytoplasm (cytokinesis)

Mitosis & Cytokinesis

- Mitosis produces two diploid nuclei with the same number and kind of chromosomes as the parent
  - Daughter chromsomes = separated sister chromatids

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

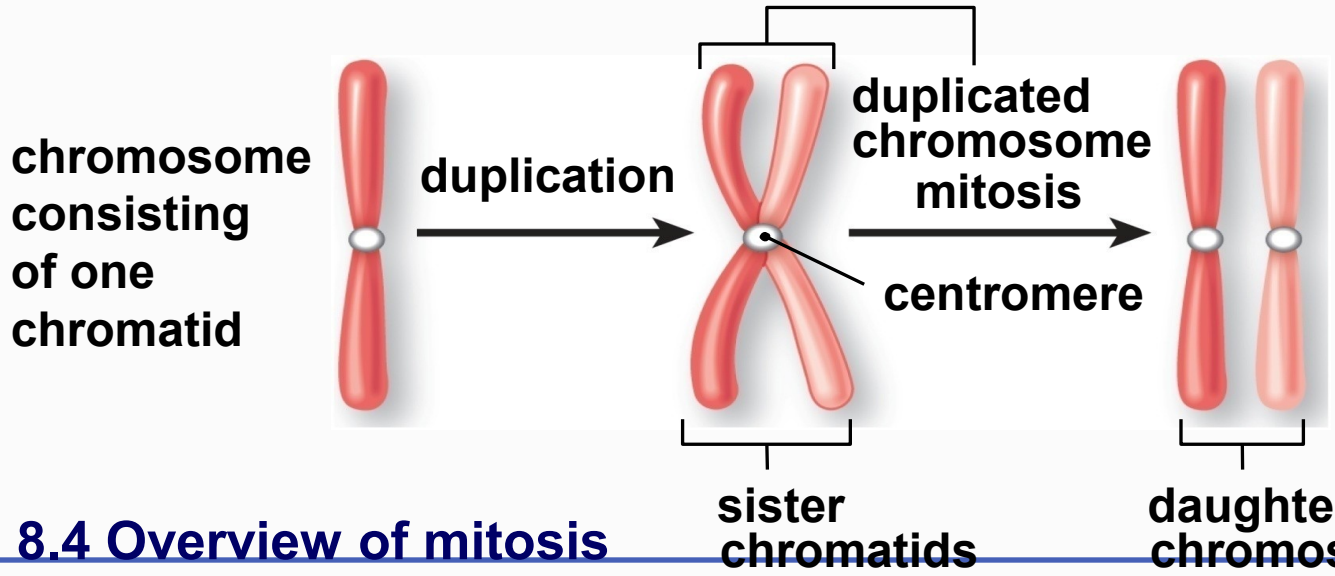
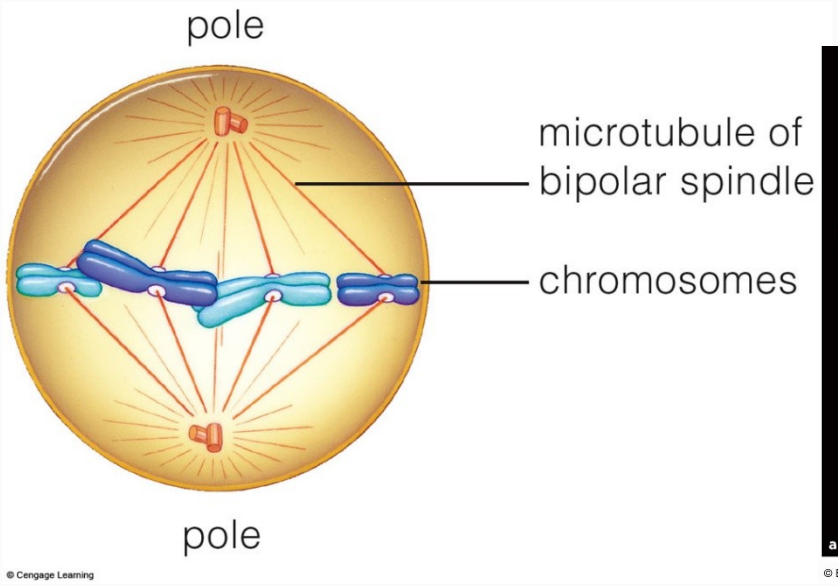
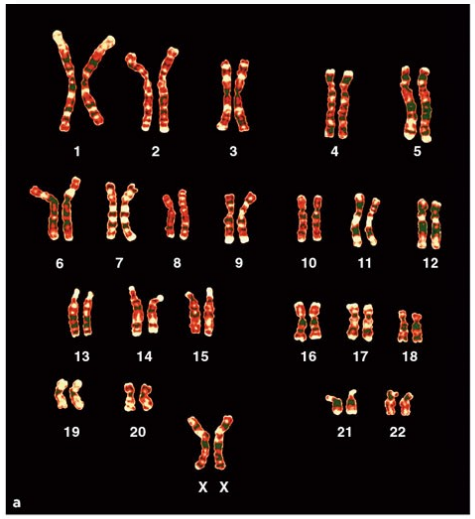


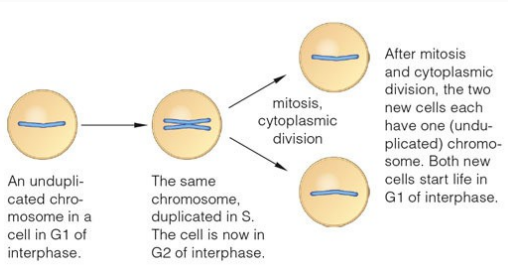
Figure 8.4 Overview of mitosis

Mitosis and Chromosome Number

- Mitosis maintains parental chromosome number from one generation to the next
  - Bipolar spindle (made of microtubules at centrosome) divides sister chromatids
  - Microtubules from opposite poles attach to different sister chromatids and separate them



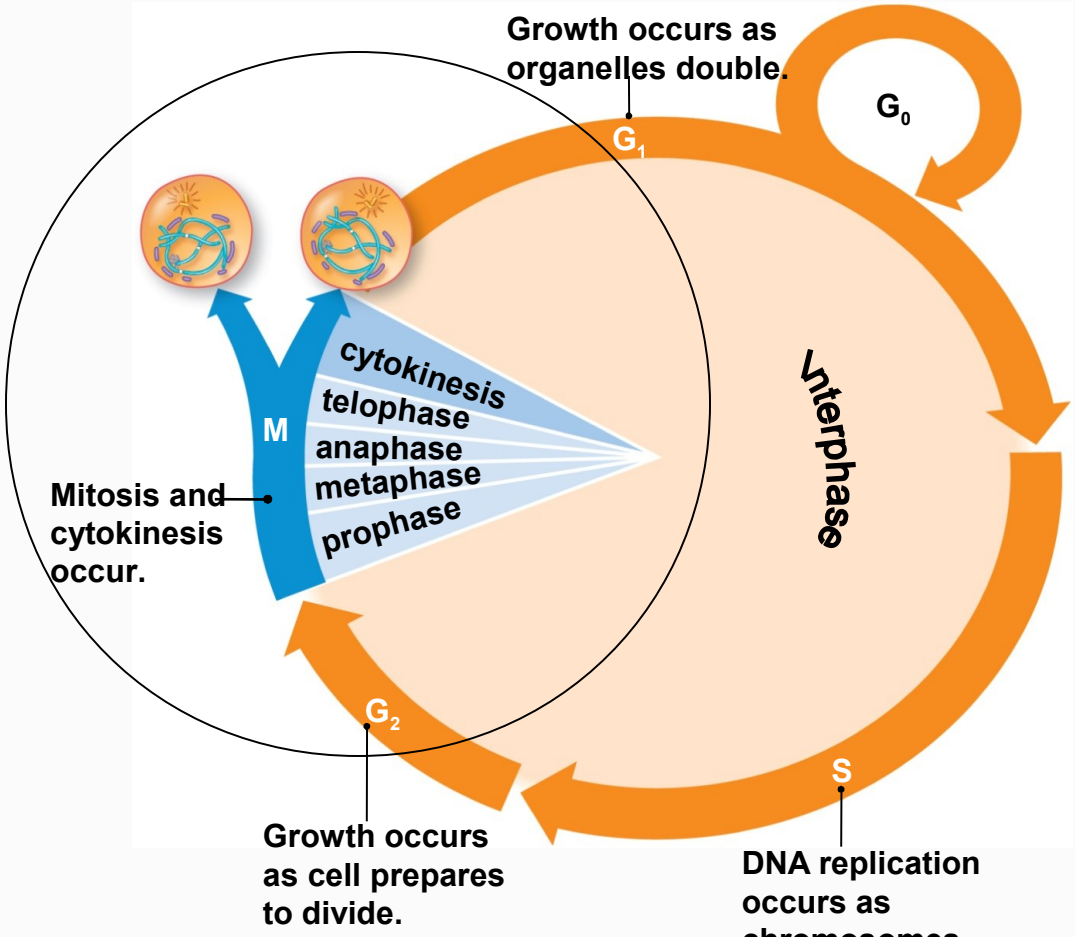




A Closer Look at Mitosis

- Mitosis proceeds in four stages:
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

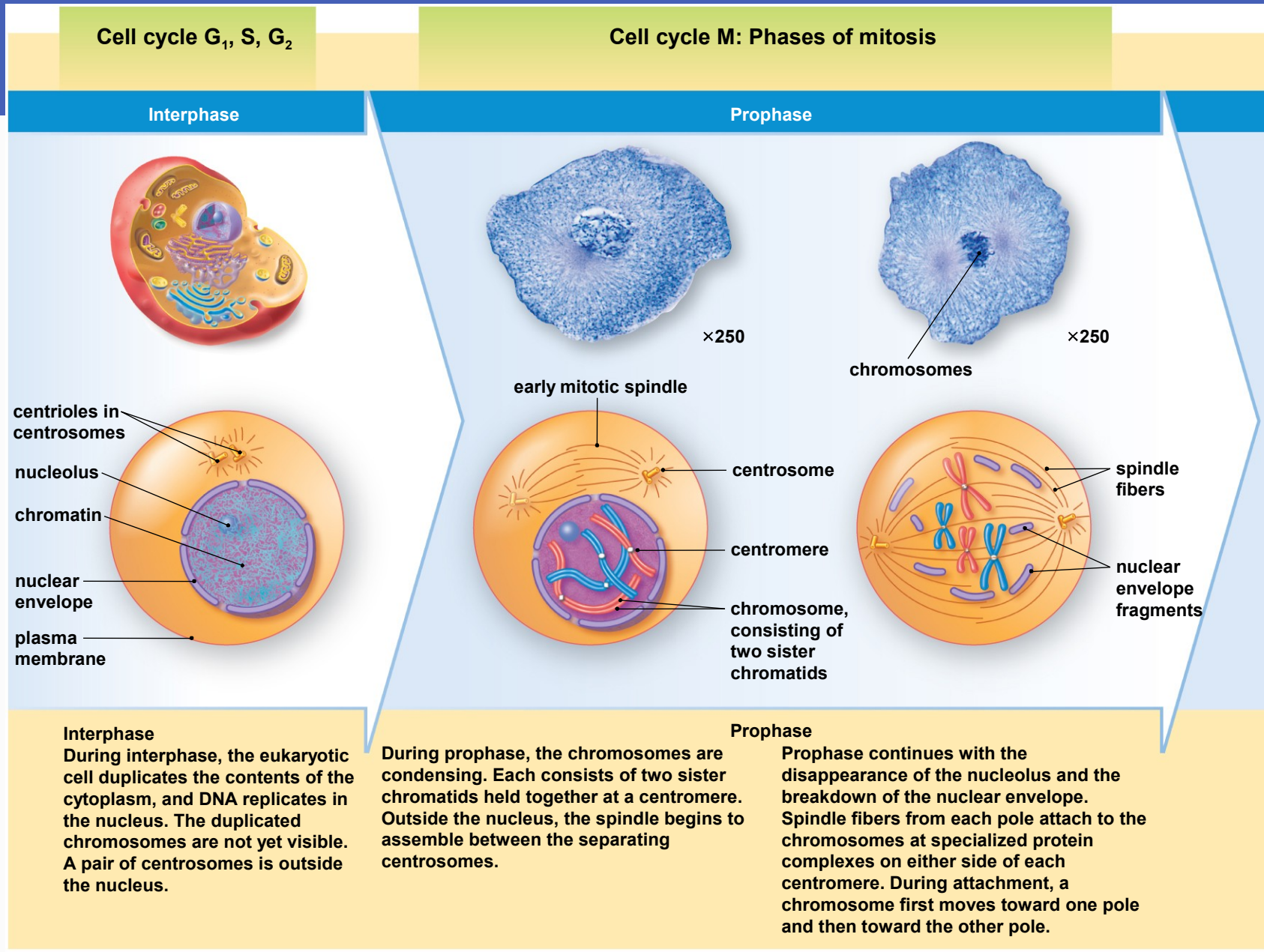


Prophase

- **Prophase**
  - Chromosomes condense
  - Microtubules form a bipolar spindle
  - Nuclear envelope breaks up
  - Microtubules attach to the chromosomes
    - Microtubules from each spindle pole harnesses one chromatid of each chromosome

- **Centrosome**
  - A region near the nucleus that organizes spindle microtubules; usually includes two centrioles (in animal cells)

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



(all): © Ed Reschke

Figure 8.6 Phases of mitosis in animal cells

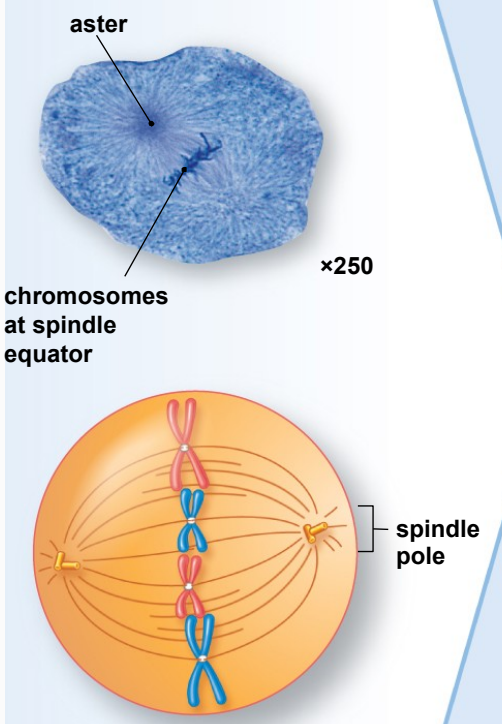
Metaphase, Anaphase, & Telophase

- **Metaphase**
  - All duplicated chromosomes line up midway between the spindle poles
- **Anaphase**
  - Microtubules separate the sister chromatids of each chromosome and pull them to opposite spindle poles
- **Telophase**
  - Two clusters of chromosomes reach the spindle poles
  - A new nuclear envelope forms around each cluster
  - Two new nuclei are formed, each with the same chromosome number as the parent cell

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

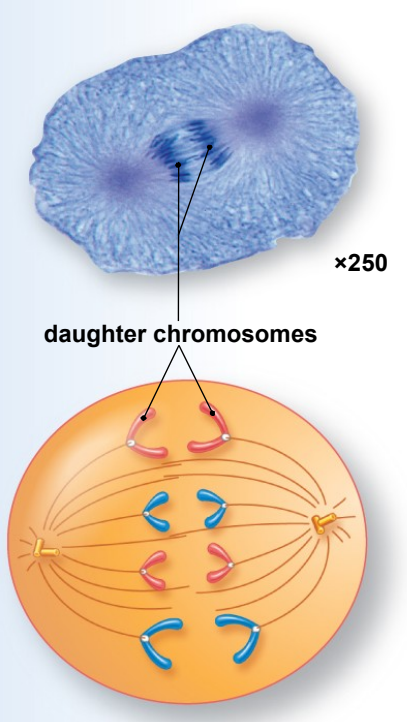
Phases of mitosis

Metaphase



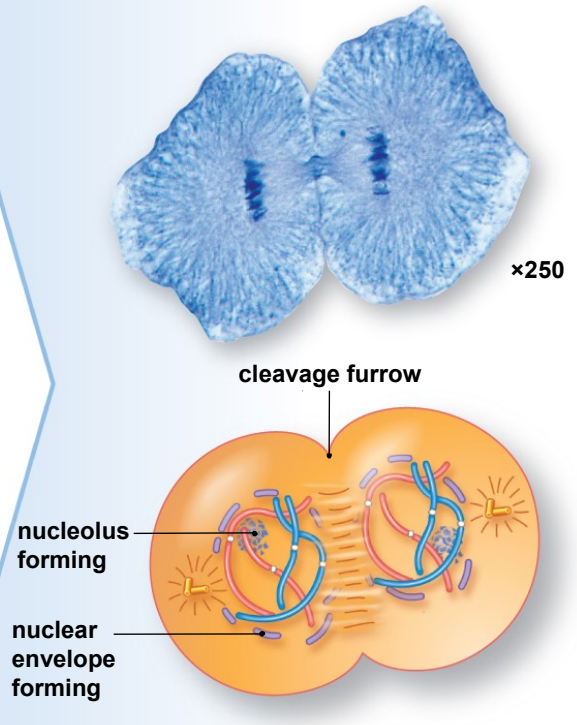
Metaphase
During metaphase, the chromosomes are aligned at the spindle equator midw ay between the spindle poles. The spindle fibers on either side of a chromosome extend to opposite poles of the spindle. Unattached spindle fibers reach beyond the equator and overlap.

Anaphase



Anaphase
During anaphase, the sister chromatids separate and become daughter chromosomes. As the spindle fibers attached to the chromosomes disassemble, each pole receives a set of daughter chromosomes. The spindle poles move apart as the unattached spindle fibers slide past one another. This contributes to chromosome separation.

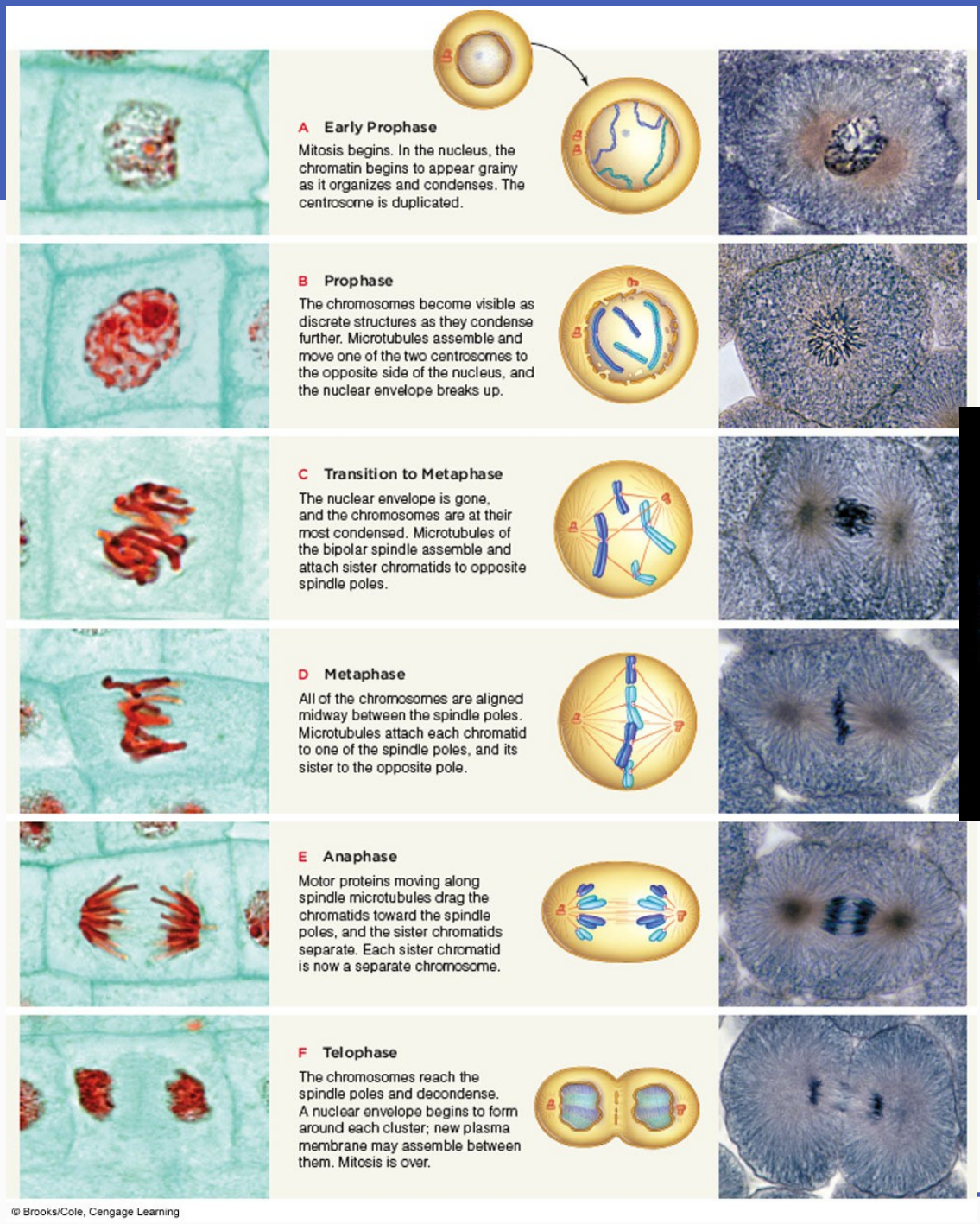
Telophase and Cytokinesis



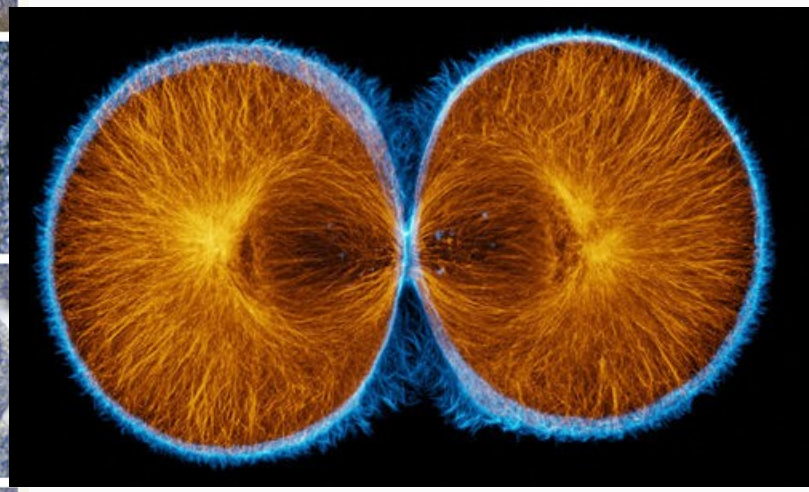
Telophase and Cytokinesis
During telophase, the spindle disappears as new nuclear envelopes form around the daughter chromosomes. Each nucleus contains the same number and kinds of chromosomes as the original parent cell. Remnants of spindle fibers are still visible between the two nuclei. Division of the cytoplasm begins.

(all): © Ed Reschke

Figure 8.6 continued



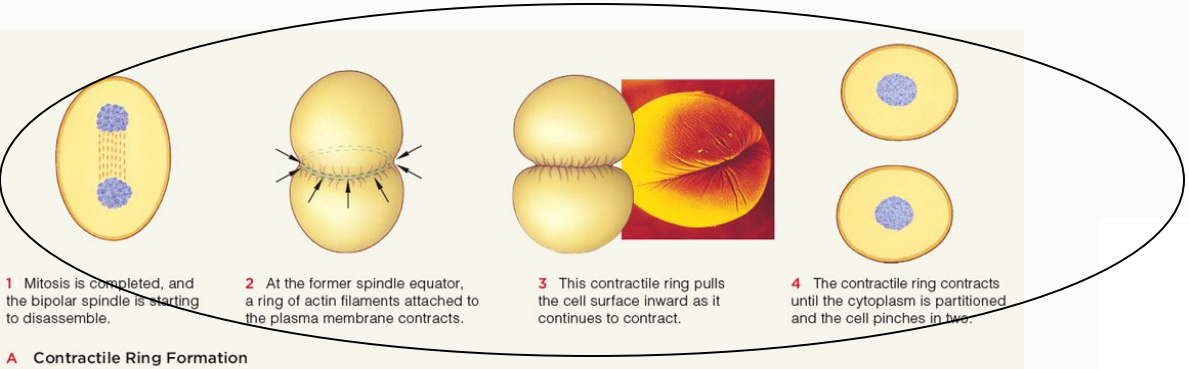
© Brooks/Cole, Cengage Learning

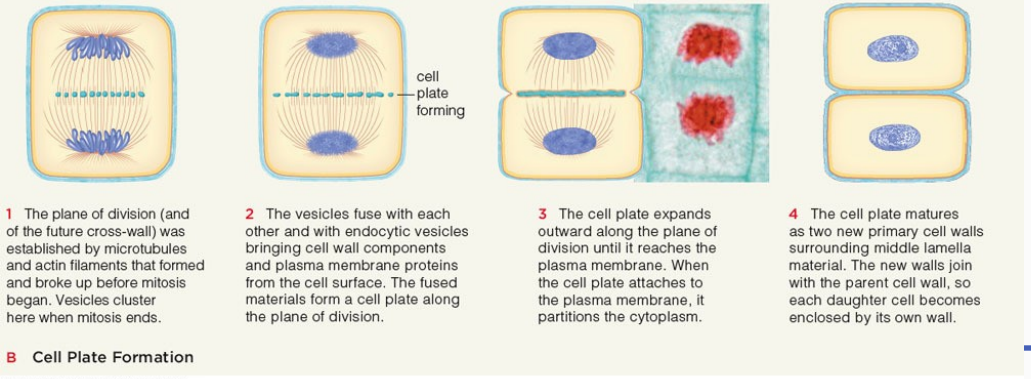


Cytokinesis

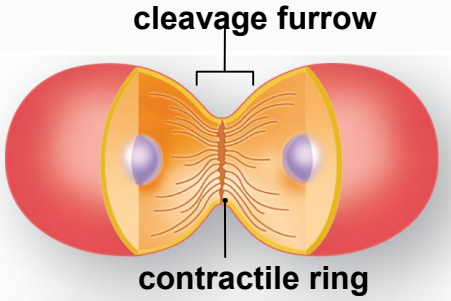
Cytoplasmic Division (cytokinesis) in Animal and Plant Cells

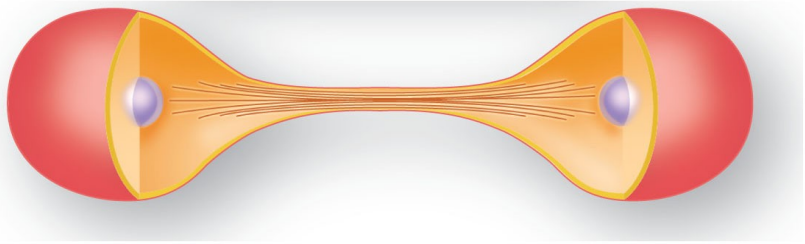
- Animal cells
  - Cleavage furrow & contractile ring form
  - A band of actin filaments rings the cell midsection, contracts, and pinches the cytoplasm in two





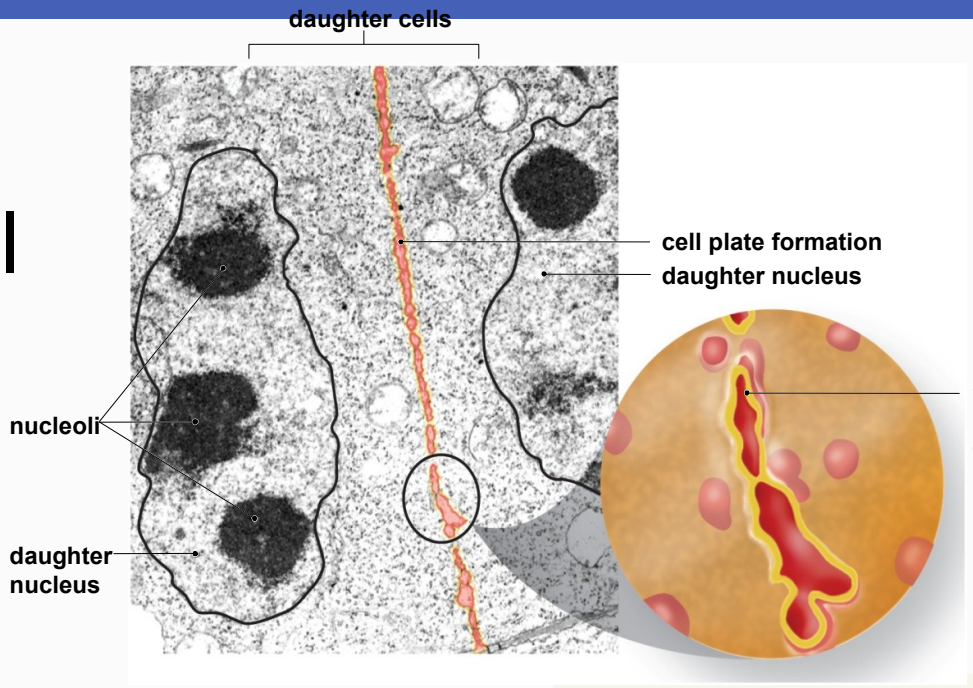
© Brooks/Cole, Cengage Learning

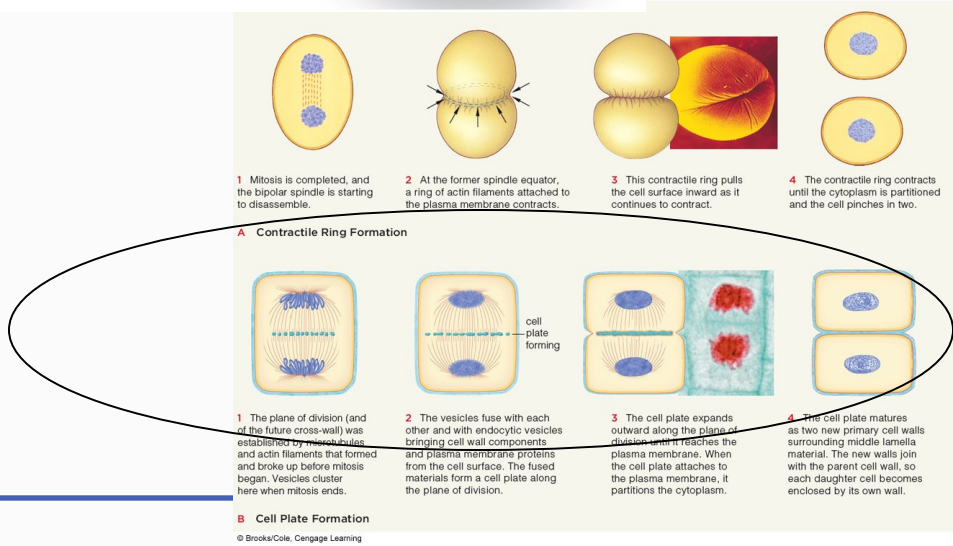




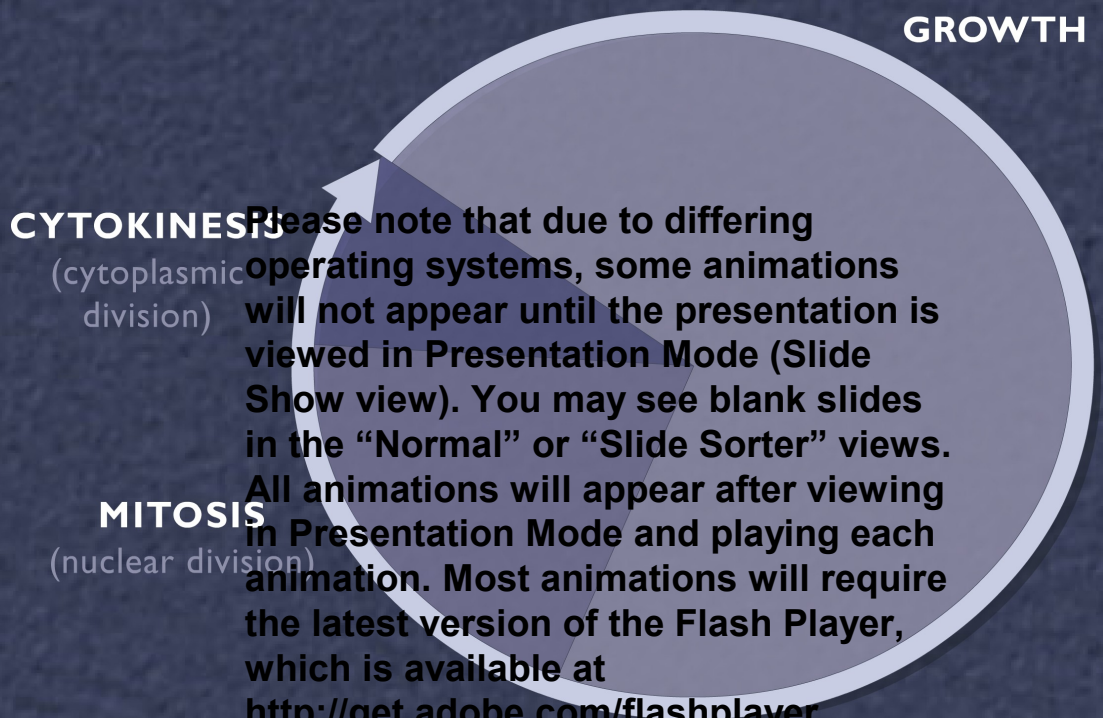
Cytoplasmic Division (cytokinesis) in Animal and Plant Cells

- Plant cells
  - Have cell wall (rigid)
  - No cleavage furrow
  - Cell plate forms between spindle poles
  - Formed from vesicles





How the Cell Cycle Works



Please note that due to differing operating systems, some animations will not appear until the presentation is viewed in Presentation Mode (Slide Show view). You may see blank slides in the "Normal" or "Slide Sorter" views. All animations will appear after viewing in Presentation Mode and playing each animation. Most animations will require the latest version of the Flash Player, which is available at http://get.adobe.com/flashplayer.

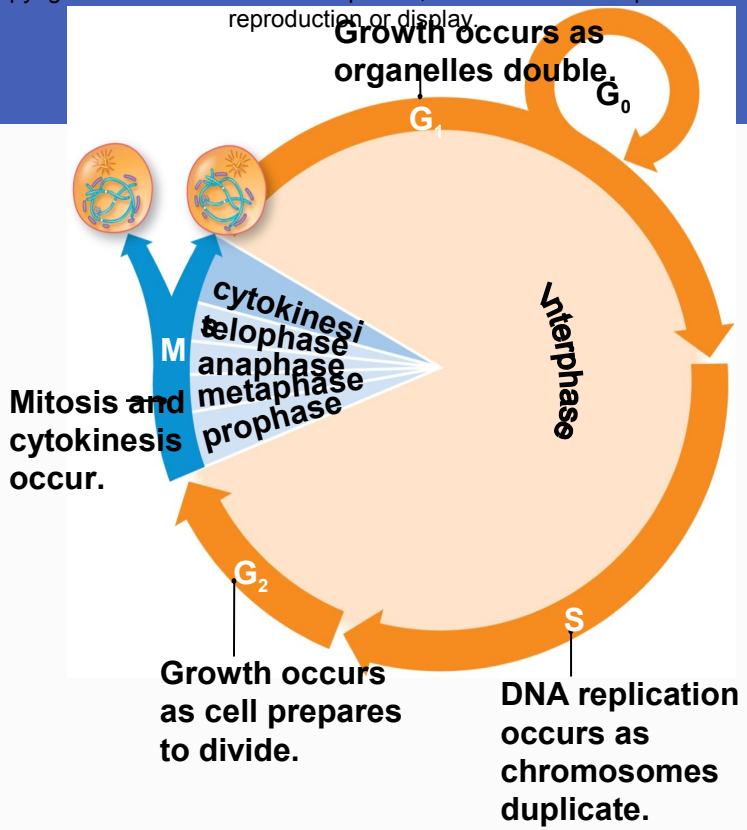
Play | Pause | Audio | Text

Most eukaryotic cells follow a process of growth and division called the cell cycle. These events include a growth stage, mitosis or nuclear division and cytokinesis or division of the cytoplasm.

Copyright © The McGraw-Hill Companies, Inc.

The Cell Cycle Control System

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



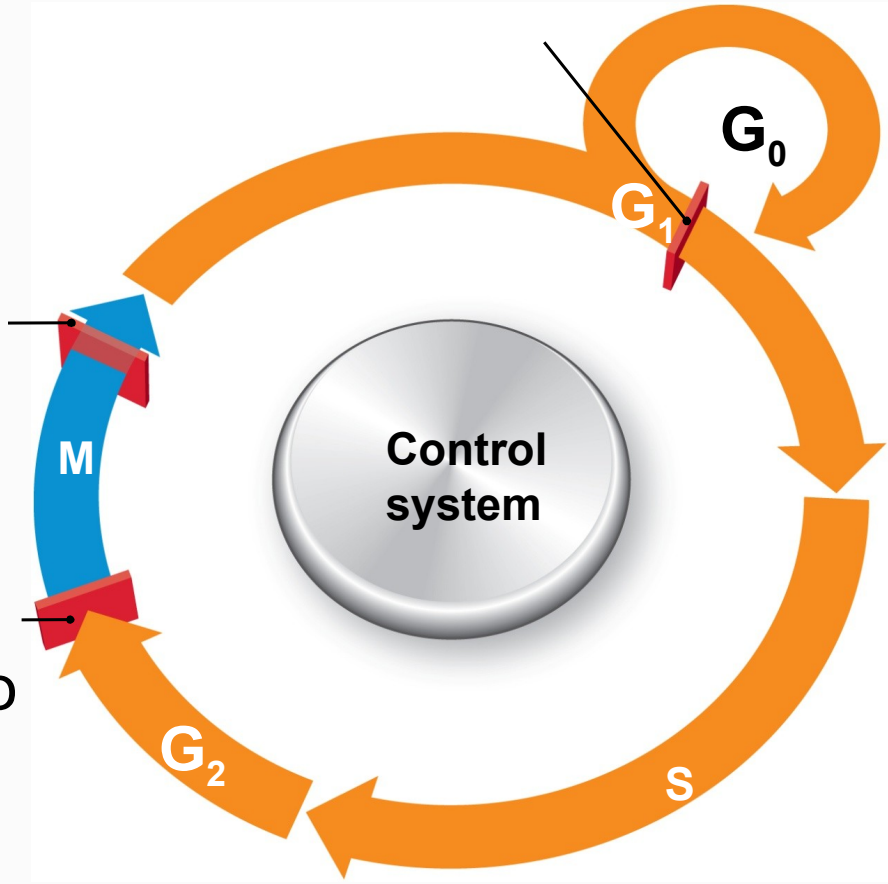
- Is the cell cycle controlled?
  - Yes
- What happens if control is lost?

How is the cell cycle controlled?

- Cell cycle checkpoints
  - Stages go in order and only when previous stage completed successfully

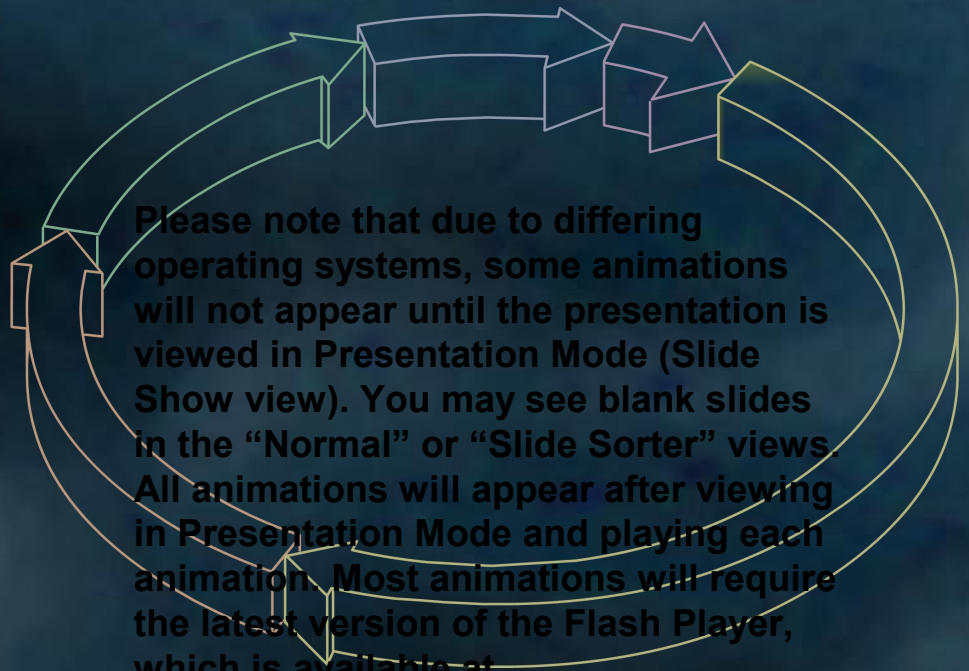
Cell checkpoints

- 3 of the many
  - G_1 checkpoint
  - G_2 checkpoint
  - Mitotic stage checkpoint



- G_1 checkpoint
  - Is DNA damaged?
  - Can enter G_0
- G_2 checkpoint
  - Is DNA damaged?
  - DNA integrity checked
    - DNA repair
    - Cell death (apoptosis)
- Mitotic checkpoint
  - Between metaphase & anaphase
  - After this, committed to divide
  - Chromosomes must be attached to spindle

Control of the Cell Cycle



Please note that due to differing operating systems, some animations will not appear until the presentation is viewed in Presentation Mode (Slide Show view). You may see blank slides in the "Normal" or "Slide Sorter" views. All animations will appear after viewing in Presentation Mode and playing each animation. Most animations will require the latest version of the Flash Player, which is available at http://get.adobe.com/flashplayer.

Play | Pause | Audio | Text

The process of cell growth and division in eukaryotes is called the cell cycle. This cycle is divided into phases based on what is happening in the cell at a given time. A cell grows during the G_1 phase.

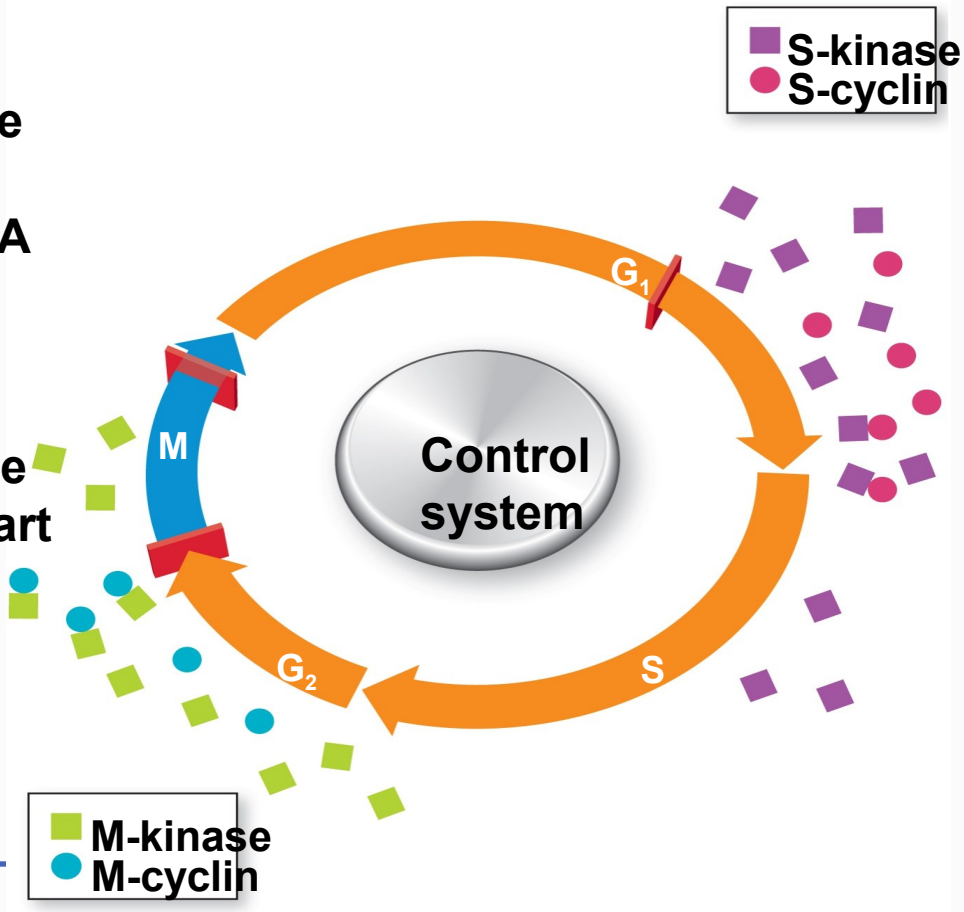
Copyright © The McGraw-Hill Companies, Inc.

How is the cell cycle controlled?

- **Internal** (inside cell) & external (outside cell) signals – a molecule that stimulates or inhibits an event
  - Kinases (an enzyme)
  - Cyclins (a protein)

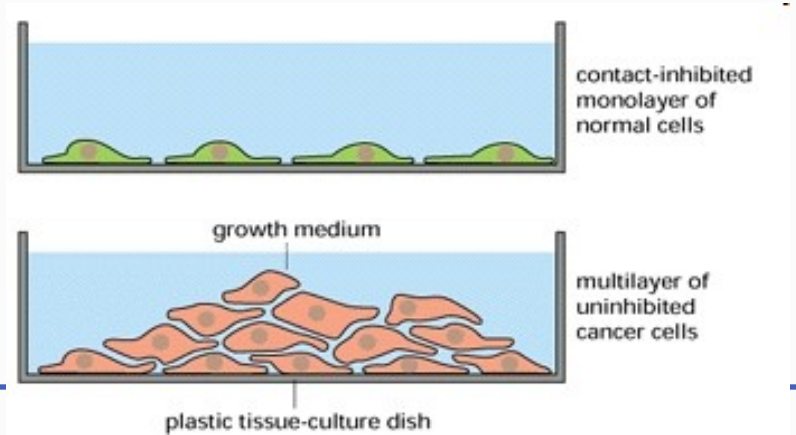
S-cyclin must combine with S-kinase for the cell cycle to begin DNA replication.

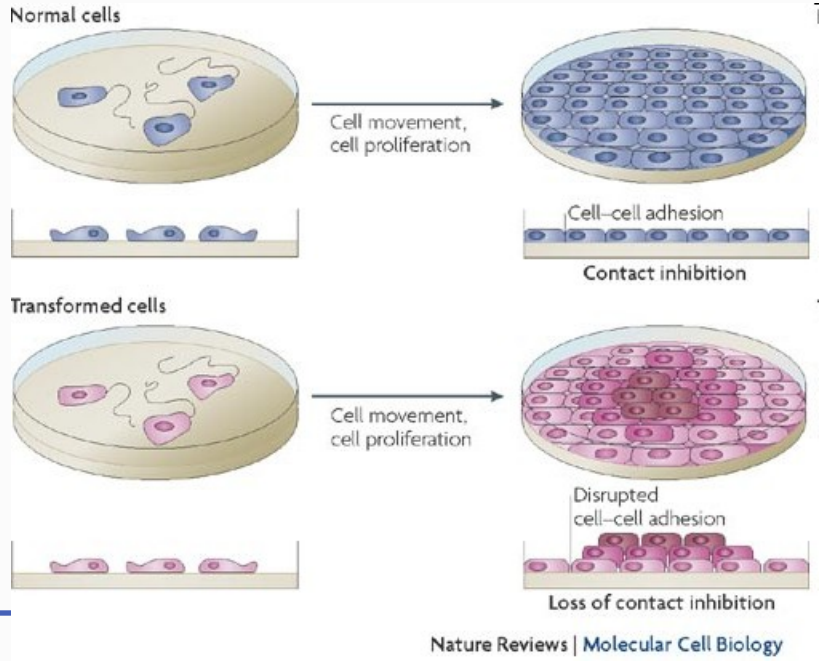
- **M-cyclin must combine with M-kinase for the cell cycle to start mitosis.**



How is the cell cycle controlled?

- Internal (inside cell) & **external** (outside cell) signals – a molecule that stimulates or inhibits an event
  - Growth factors
    - Epidermal growth factor (EPF) stimulates skin cells to finish cell cycle
  - Hormones
    - Estrogen stimulates lining of the uterus to divide in the menstrual cycle
  - Contact inhibition
    - Cells stop dividing when they touch



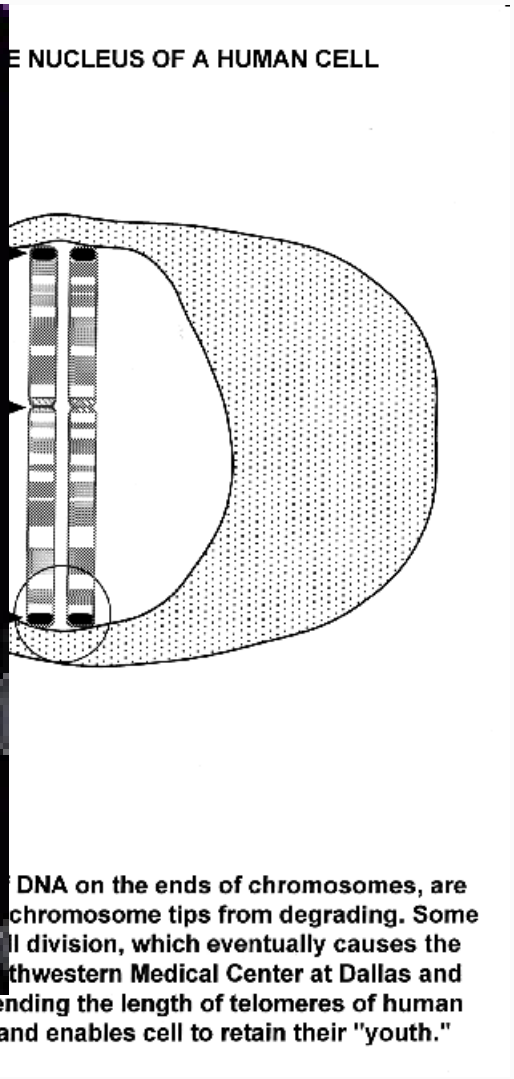


When do cells stop dividing?

- Mammalian cells divid
in culture

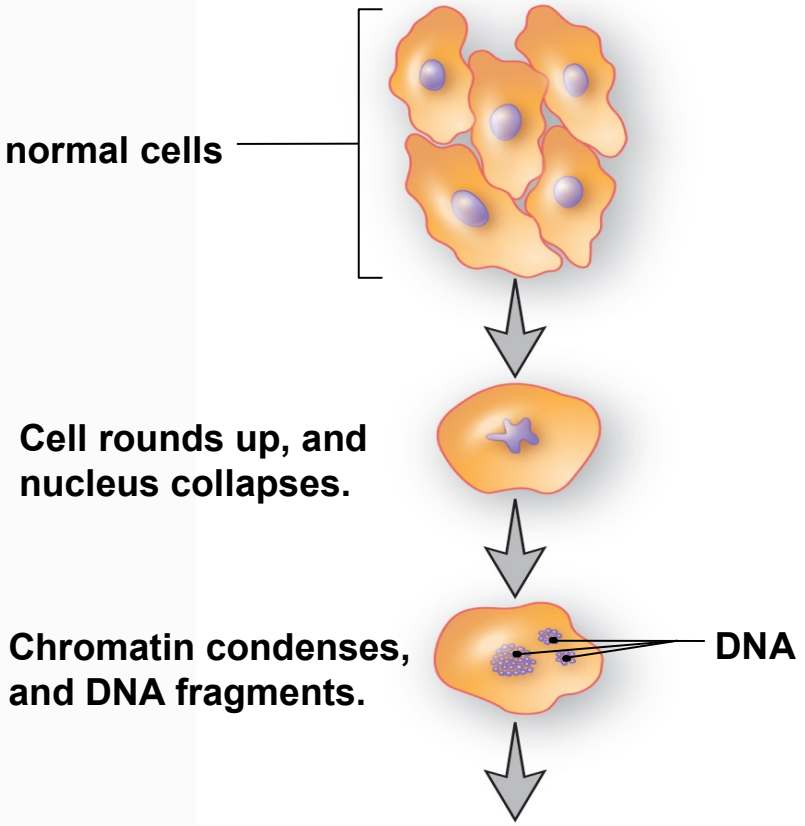
- The shortening of telo
repeating DNA sequen
of the chromosome)
  - Happens w/each c

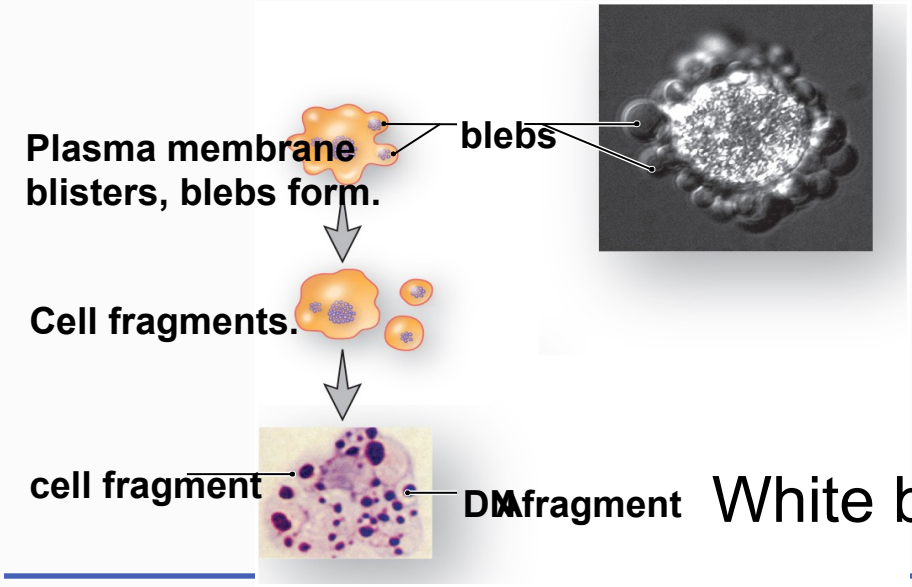
Then what???



Cell death - apoptosis

- Aptoptosis = programmed cell death
  - Tadpole tail
  - Webbing between our digits

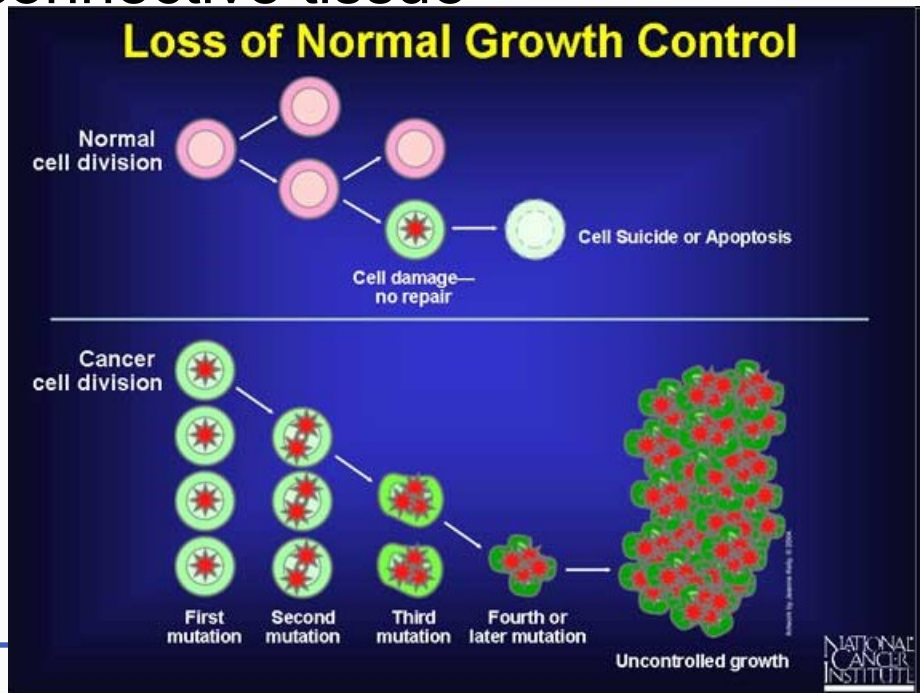




White blood cells engulf the rest

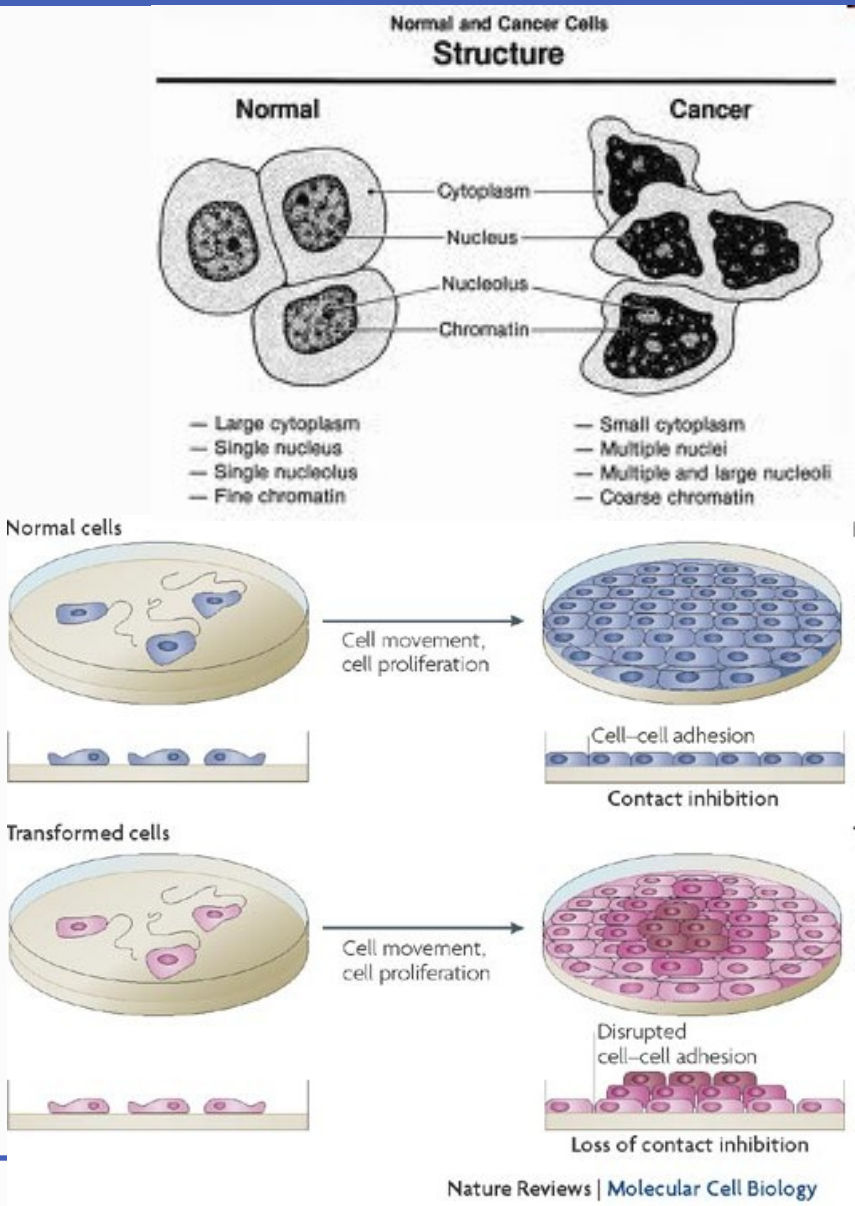
Cell cycle and Cancer

- Cellular reproduction occurs repeatedly – loss of control
  - Classified by location
    - Carcinoma – epithelial tissue that lines organs
    - Sarcoma – muscle or connective tissue
    - Leukemia - blood



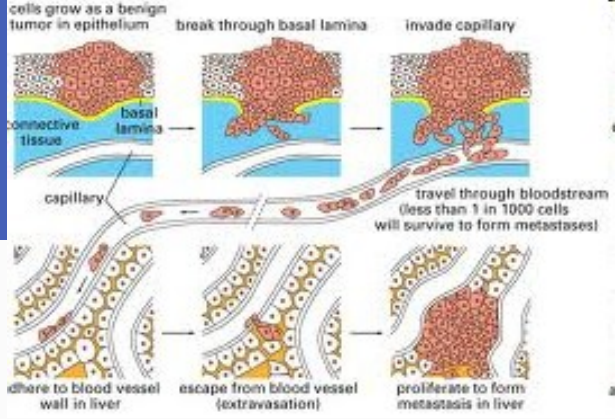
Carcinogenesis – the development of cancer

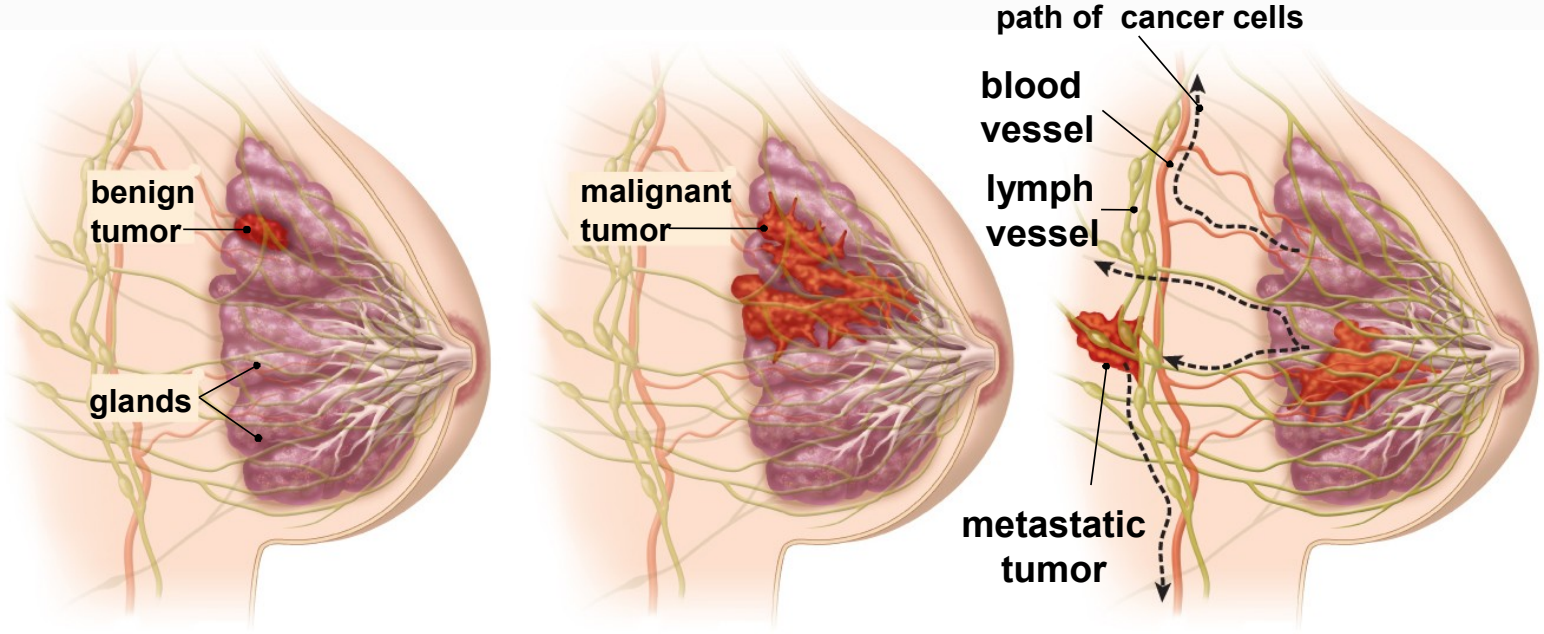
- Cancer cells…
  - May be immortal – divide forever???
  - Don't contribute to body function
  - Have abnormal nuclei with abnormal numbers of chromosomes
  - Don't undergo apoptosis
  - Form tumors – no contact inhibition, no signal inhibition



Cancer cells…

- Undergo metastasis and angiogenesis
  - Benign – contained within a capsule
  - Malignant – invasive and may spread





A single cancer cell grows into a tumor.

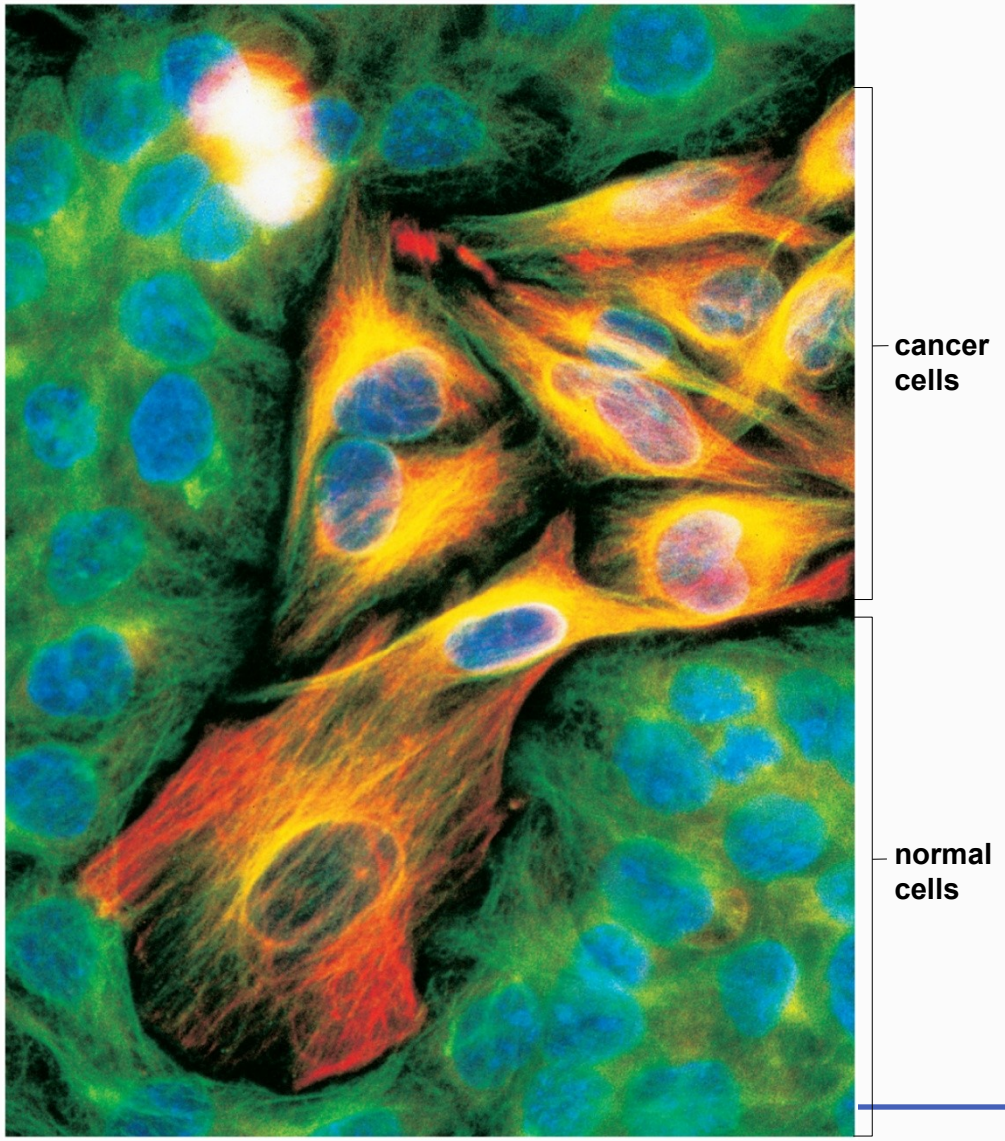
The tumor becomes malignant and invades nearby tissue.

Cancer cells travel (dotted arrows) through lymphatic (green) and blood (red) vessels, and metastatic tumors form.

a. Development of breast cancer and metastatic tumors

Cancer Treatment

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



- Remove tumor
- Stop cancer cells from dividing
  - Chemotherapy
  - Radiation therapy
  - Hormone therapy
    - Will damage other cells and lead to side effects…but wait!!! Watch this video!!!

Prevention of Cancer

- Don't smoke!!! Cigarette smoking = 30% of all cancer death
  - 87% of lung
- Wear sunbloc ead to melanomas
- Don't drink he ophagus, larynx, liver c
- Have a good
  - Obesity = c
  - Vitamin A &
  - Avoid chem

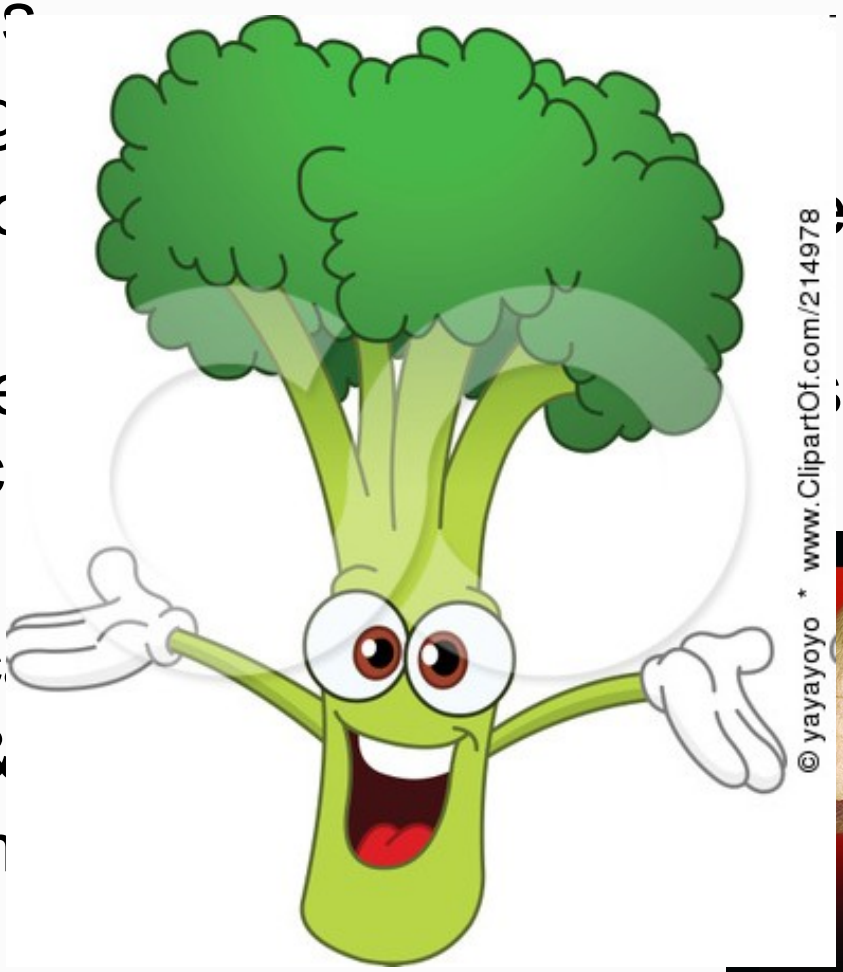
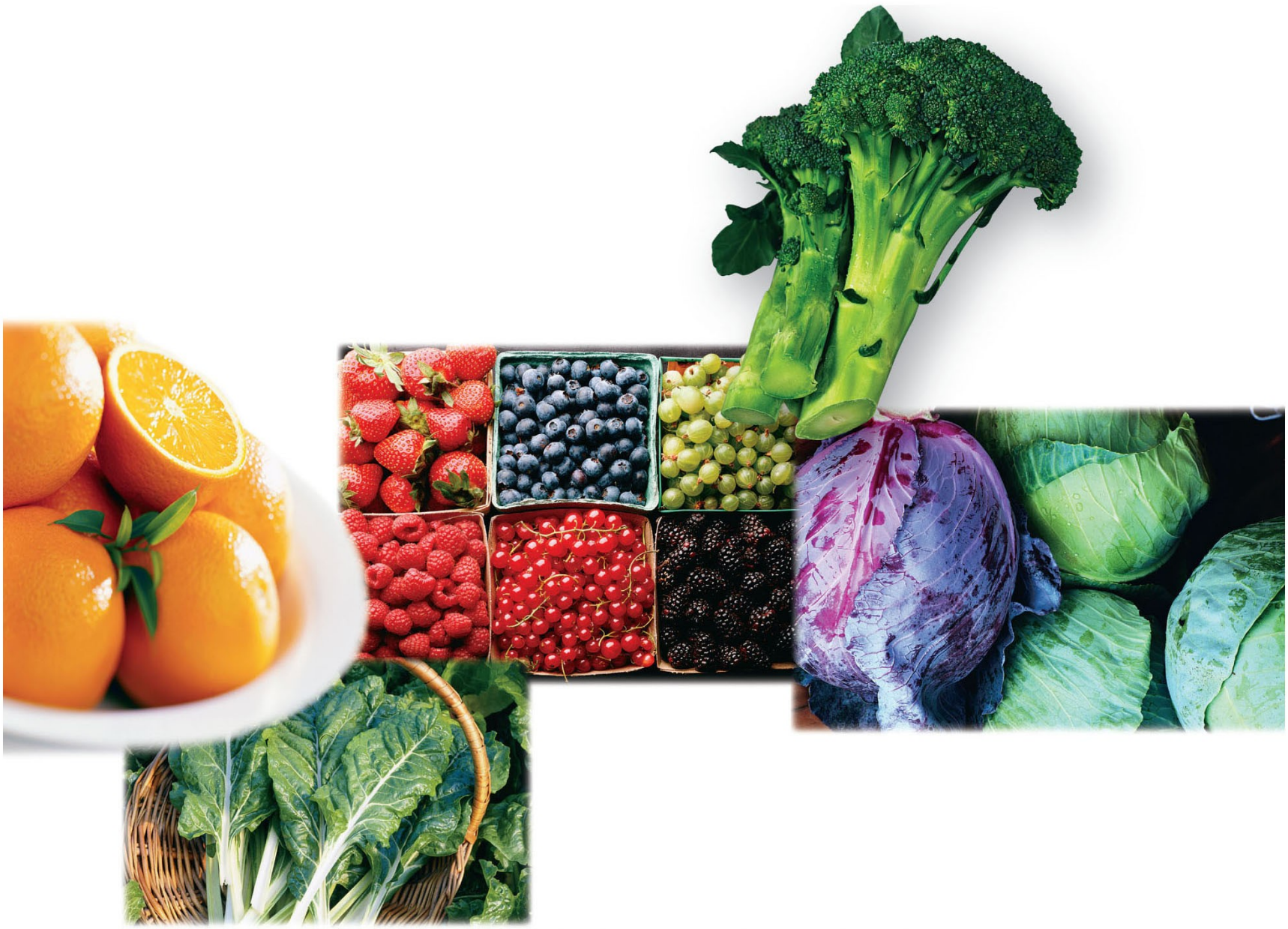


Figure 8.14 The right diet helps prevent cancer

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



(chard): © Roy Morsch/Corbis; (cabbage, berries, broccoli, oranges): © Corbis RF

The immortal cells of Henrietta Lacks

- http://www.radiolab.org/2010/may/17/henriettas-tumo

Put your pens down and listen!!!