Grade 11 Biology

CELLS AS A SYSTEM: GROWTH, REPAIR, & DIFFERENTIATION

Limits to Cell Size

- The larger a cell gets, the more demands it places on its DNA.
  - Cell increases in size, DNA does not
  - Library analogy

Limits to Cell Size

- A larger cell is less efficient in moving materials across the cell membrane.
  - Rate of transport materials – surface area
  - Rate of used of materials – volume of cell
  - Increase in cell size = decrease in surface area to volume ratio.
  - Traffic analogy

Cell Division

- Process by which a cell divides into “daughter” cells
- Cells too large – no problem – division decreased cell volume.
- Info overload- no problem – DNA is replicated (copied)

Cell Division & Reproduction

- Reproduction – the formation of new individuals
- Asexual – production of genetically identical offspring from a SINGLE parent
  - Example: bacteria
- Sexual – offspring produced TWO parents, offspring inherits traits from both parents (NOT identical)
  - Example: animals, plants

Chromosomes

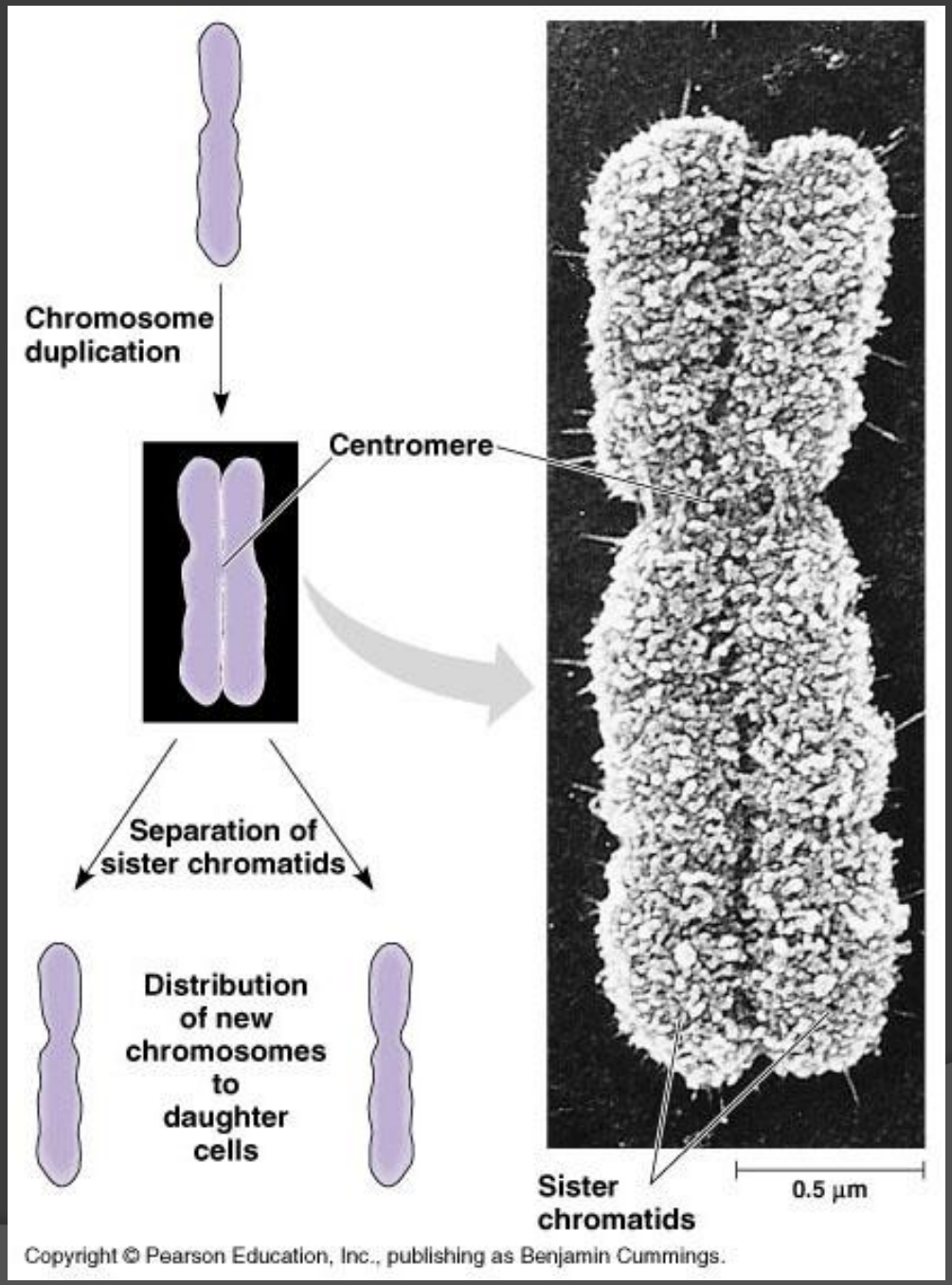
- Packages of bundled DNA (carries our genetic information)
- Number of chromosomes determine the organism
  - Humans = 46
  - Fruit flies =8
  - Carrots = 18
- Chromatin: unwound chromosomes

Chromosomes

- Sister chromatids → identical halves of the duplicated parent chromosome

- Centromere → cell structure that joins two sister chromatids of a chromosome

Figure 12.3 Chromosome duplication and distribution during mitosis



Cell Cycle

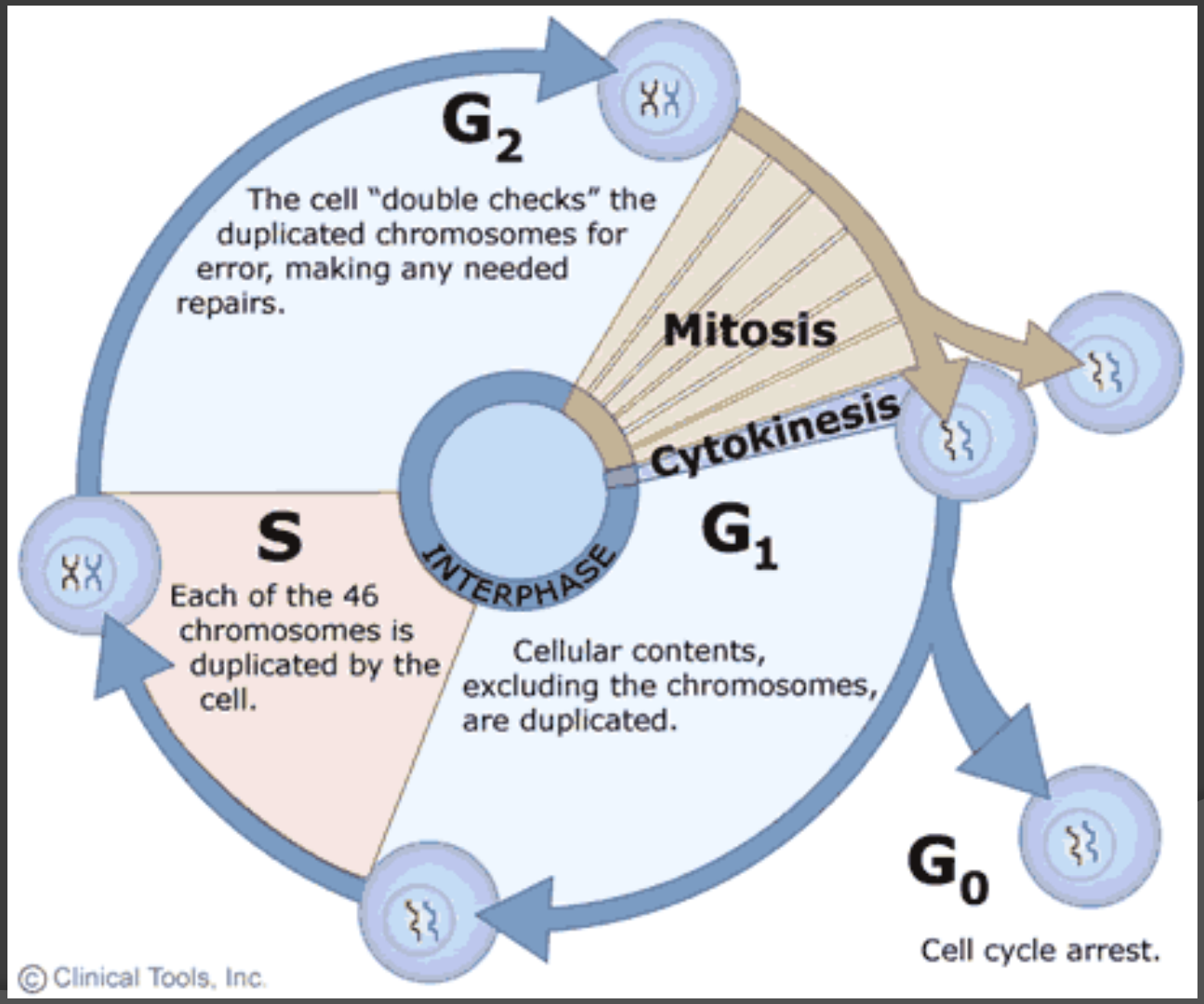

G2
The cell "double checks" the duplicated chromosomes for error, making any needed repairs.
Mitosis
Cytokinesis
INTERPHASE
G1
Cellular contents, excluding the chromosomes, are duplicated.
S
Each of the 46 chromosomes is duplicated by the cell.
G0
Cell cycle arrest.
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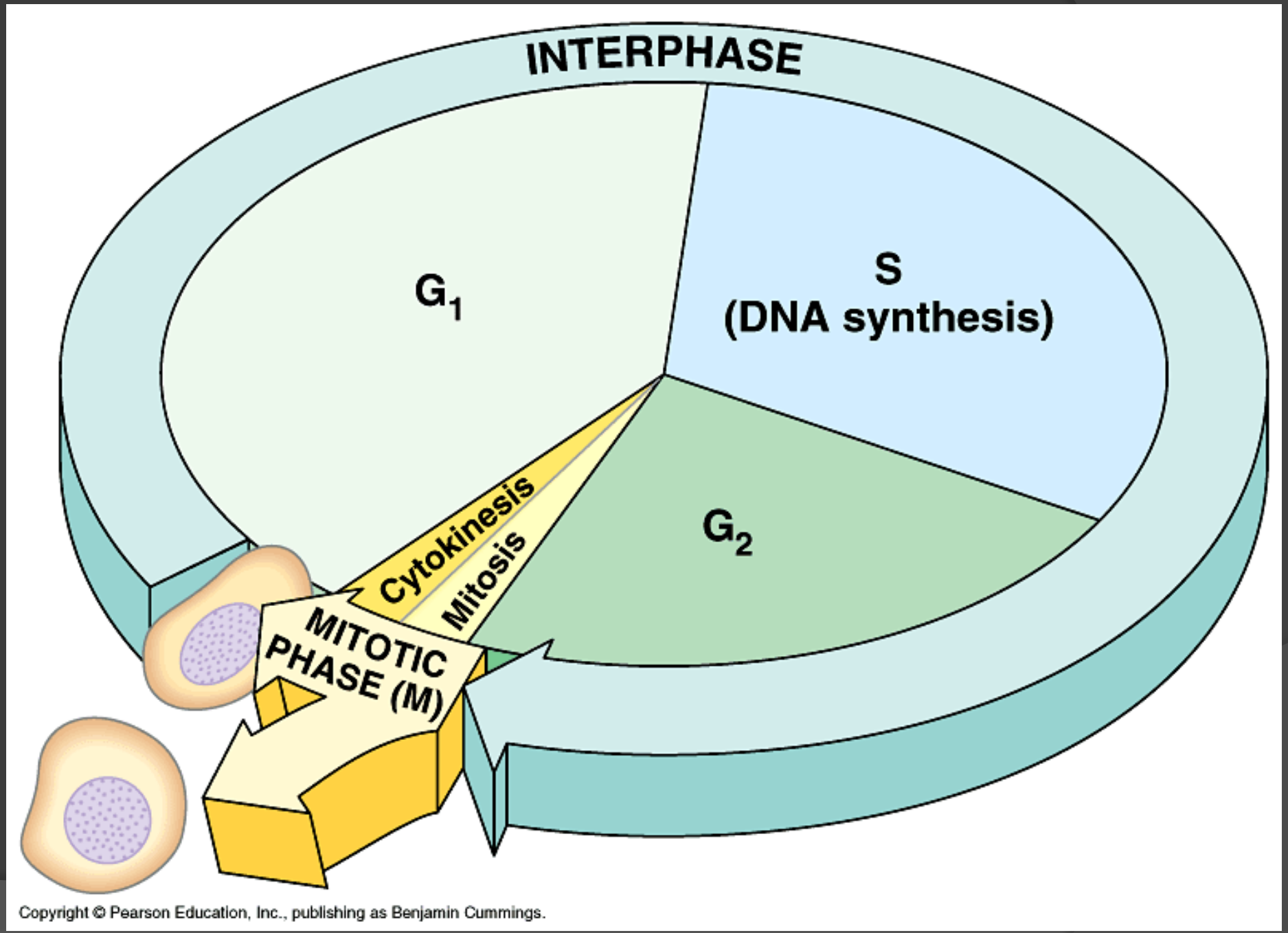
Figure 12.4 The cell cycle



PHASES OF THE CELL CYCLE

G1: GAP 1

- PERIOD OF CELL GROWTH
- CREATES NEW PROTEINS & ORGANELLES.

PHASES OF THE CELL CYCLE

S PHASE

- CHROMOSOMES ARE REPLICATED
- MAKING OF NEW DNA MOLECULES
- ONCE A CELL COPIES ITS CHROMOSOMES, IT USUALLY COMPLETES THE CELL CYCLE.

PHASES OF THE CELL CYCLE

G2: GAP 2

- SHORTEST OF THE PHASES
- PREPERATION FOR CELL DIVISION OCCURS

PHASES OF THE CELL CYCLE

M PHASE

- WHEN CELL DIVISON (MITOSIS) OCCURS
- ALSO WHEN CYTOKINESIS OCCURS

CELL CYCLE

- G1 PHASE, S PHASE, & G2 PHASE ARE COLLECTIVELY KNOWN AS *INTERPHASE* !!!

- INTERPHASE IS NOT A STAGE OF MITOSIS. IT IS WHAT HAPPENS IN BETWEEN CELL DIVISIONS.

MITOSIS

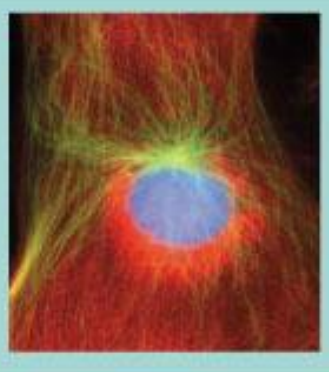
- HAS 4 PHASES IN WHICH THE NUCLEUS OF THE CELL WILL DIVIDE INTO 2 NUCLEI.

- 4 PHASES OF MITOSIS ARE:
  1. PROPHASE
  2. METAPHASE
  3. ANAPHASE
  4. TELOPHASE

Which Cells Go Through Mitosis?

- Somatic Cells:
  - Skin, hair, muscle, tissues, etc.

Figure 12.5 The stages of mitotic cell division in an animal cell: G_2 phase; prophase; prometaphase



PROPHASE

- Long stringy chromatin coils up into visible chromosomes.
- Nuclear membrane and nucleolus disappear.

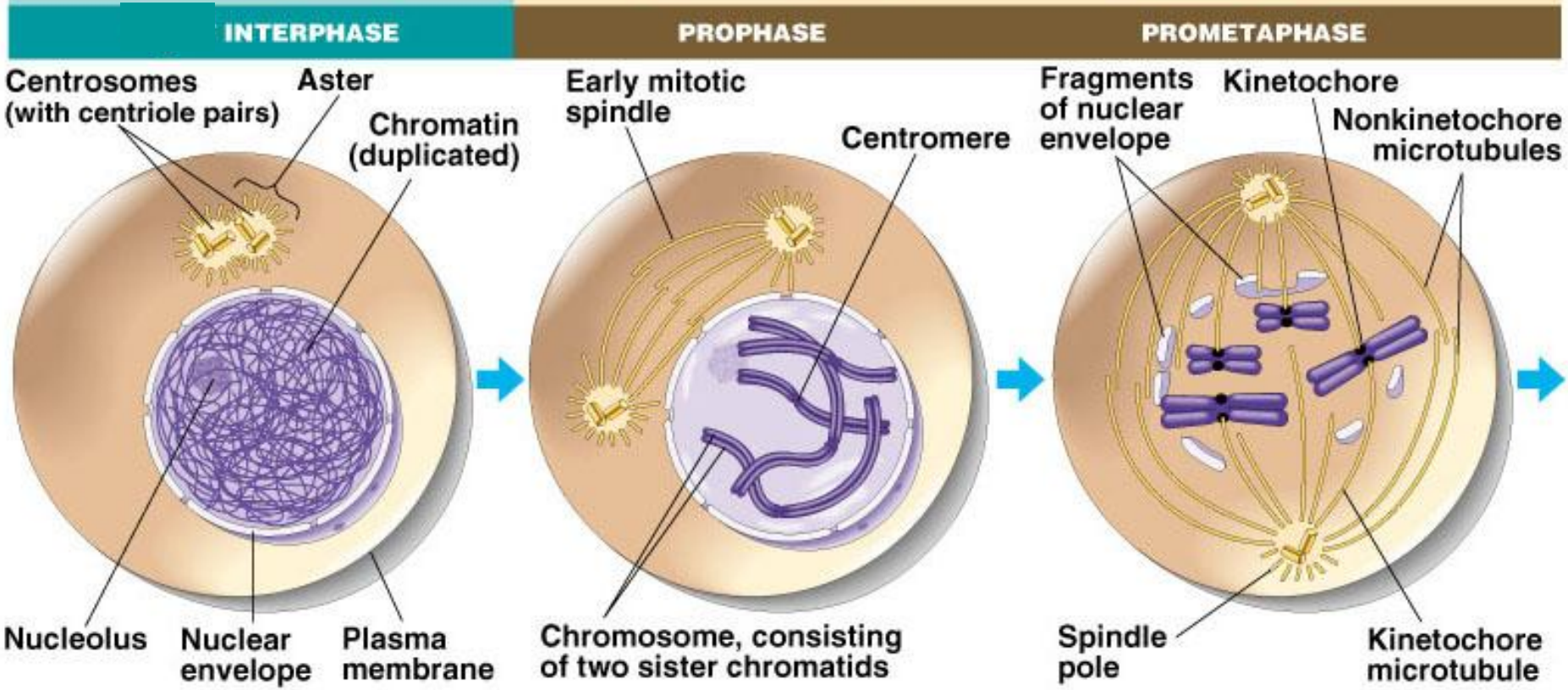


Figure 12.5 The stages of mitotic cell division in an animal cell: metaphase; anaphase; telo

METAPHASE

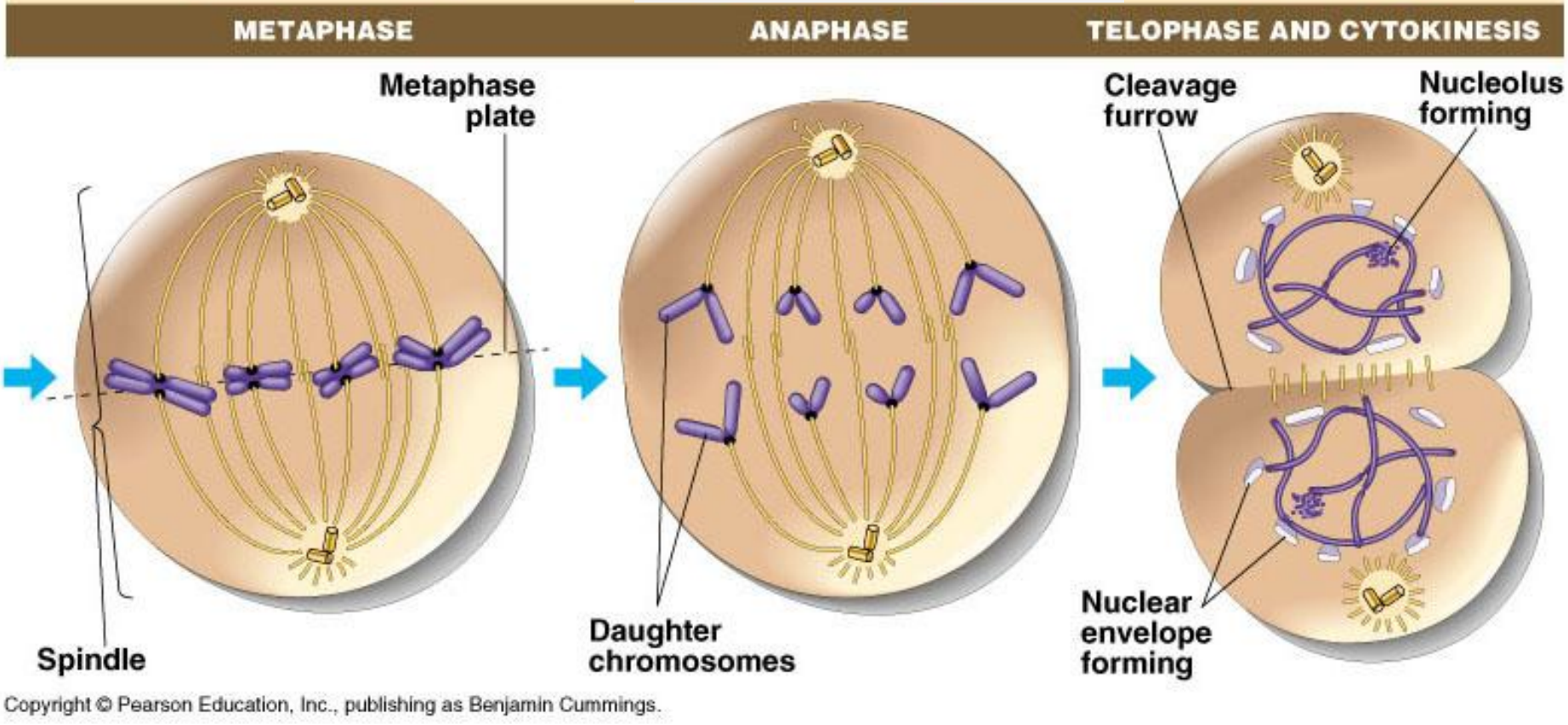
- Chromosomes line up in the middle of the cell.
- Each chromatid is attached to a separate spindle fiber by its centromere.

ANAPHASE

The centromeres split and the sister chromatids are pulled apart to opposite poles of the cell.

TELOPHASE

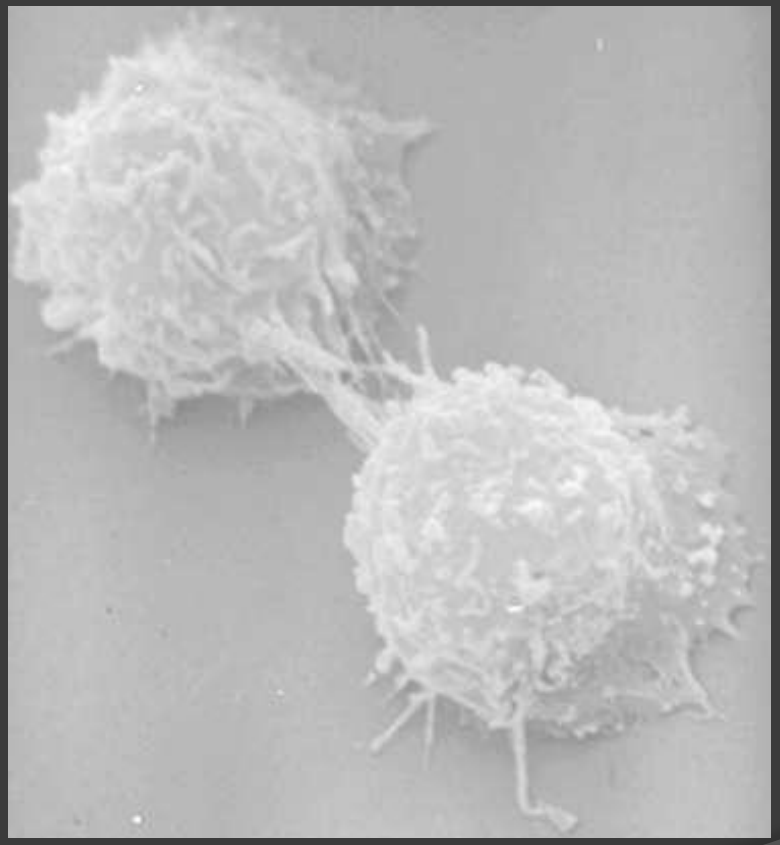
- Final phase—2 daughter cells are formed.
- Nucleolus and nuclear membrane reappear, chromosomes begin to uncoil.



Division of Cytoplasm

- Called cytokinesis.
- Plasma membrane pinches in along the equator.
- 2 new cells are formed, each identical to the other
- Different in plant and animal cells.

Picture of cytokinesis



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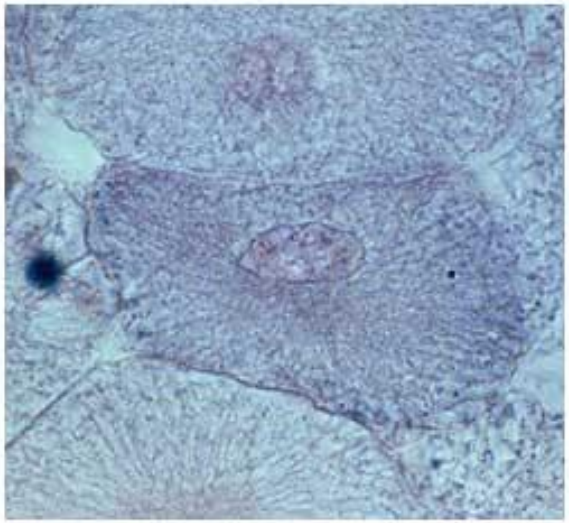
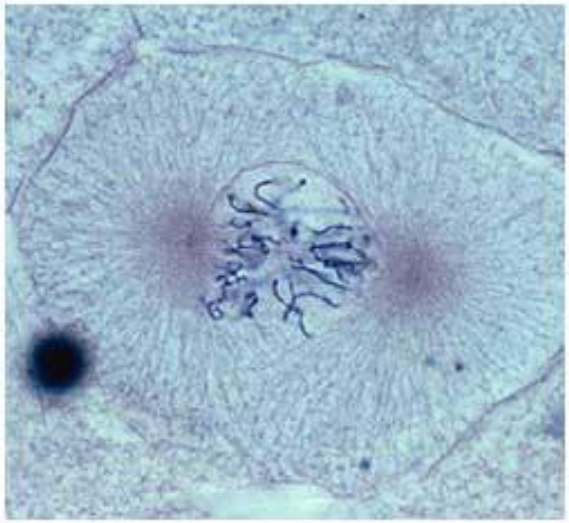
In plants…

- Because plant cells have a cell wall, the plasma membrane does not pinch in.
- Rather a structure known as the cell plate forms across the cell's equator.

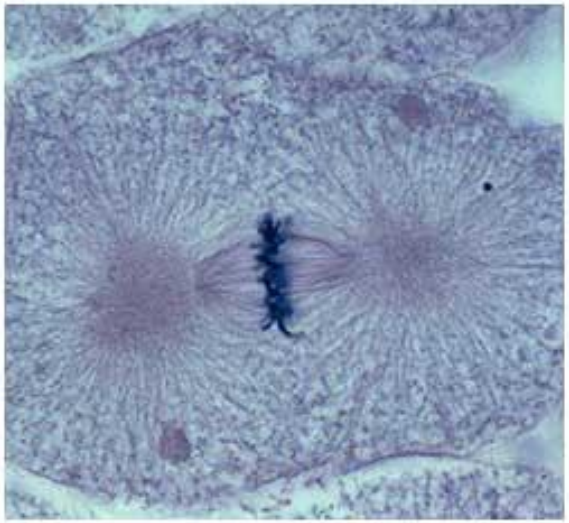
Figure 12.5x Mitosis



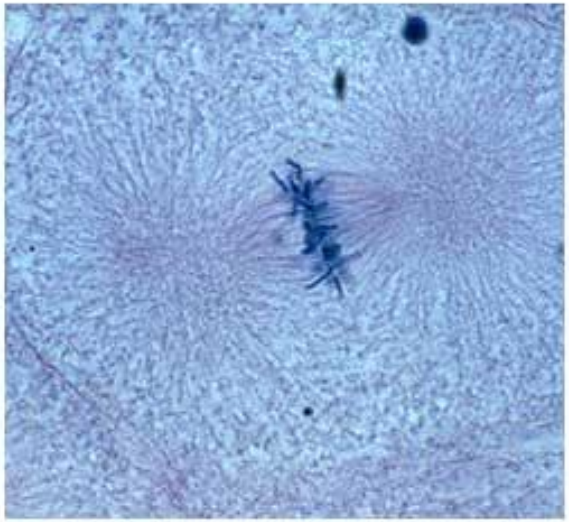
Interphase



Prophase

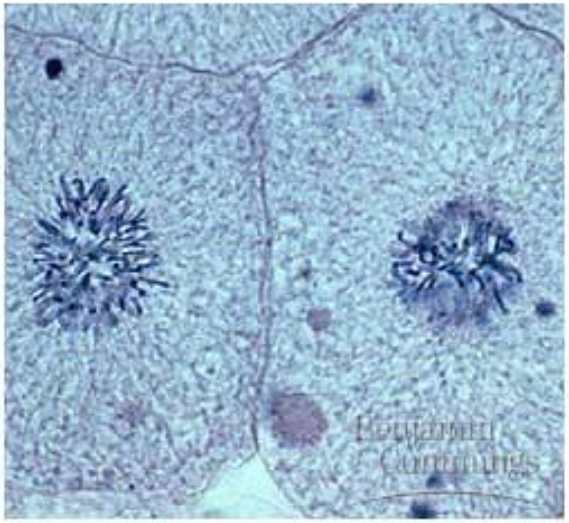


Metaphase



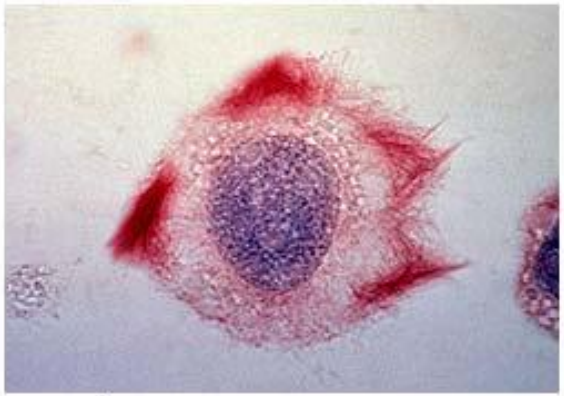
Anaphase

Early Telophase

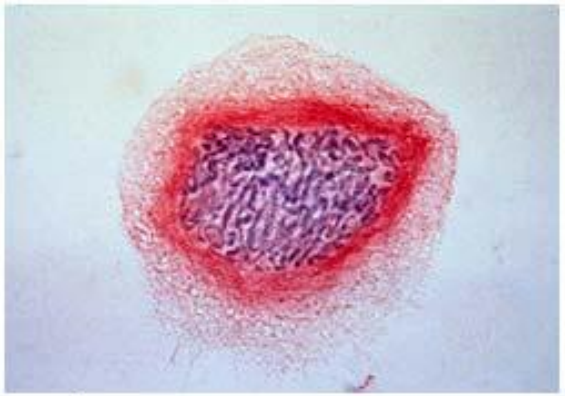


Late Telophase

Figure 12.9 Mitosis in a plant cell



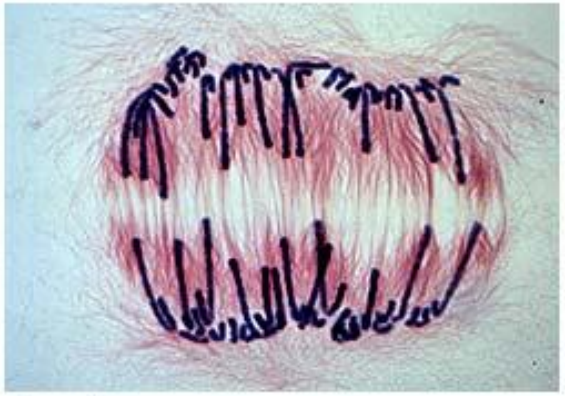
Interphase



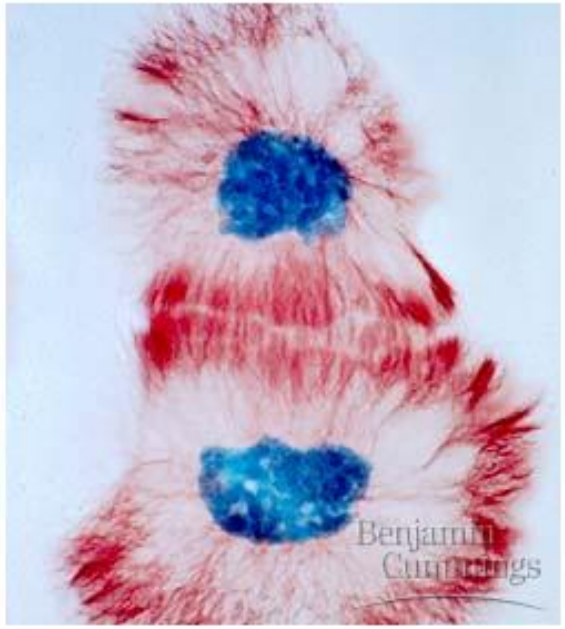
Prophase

Prometaphase

Metaphase



Anaphase



Telophase

Figure 12-09x Mitosis in an onion root

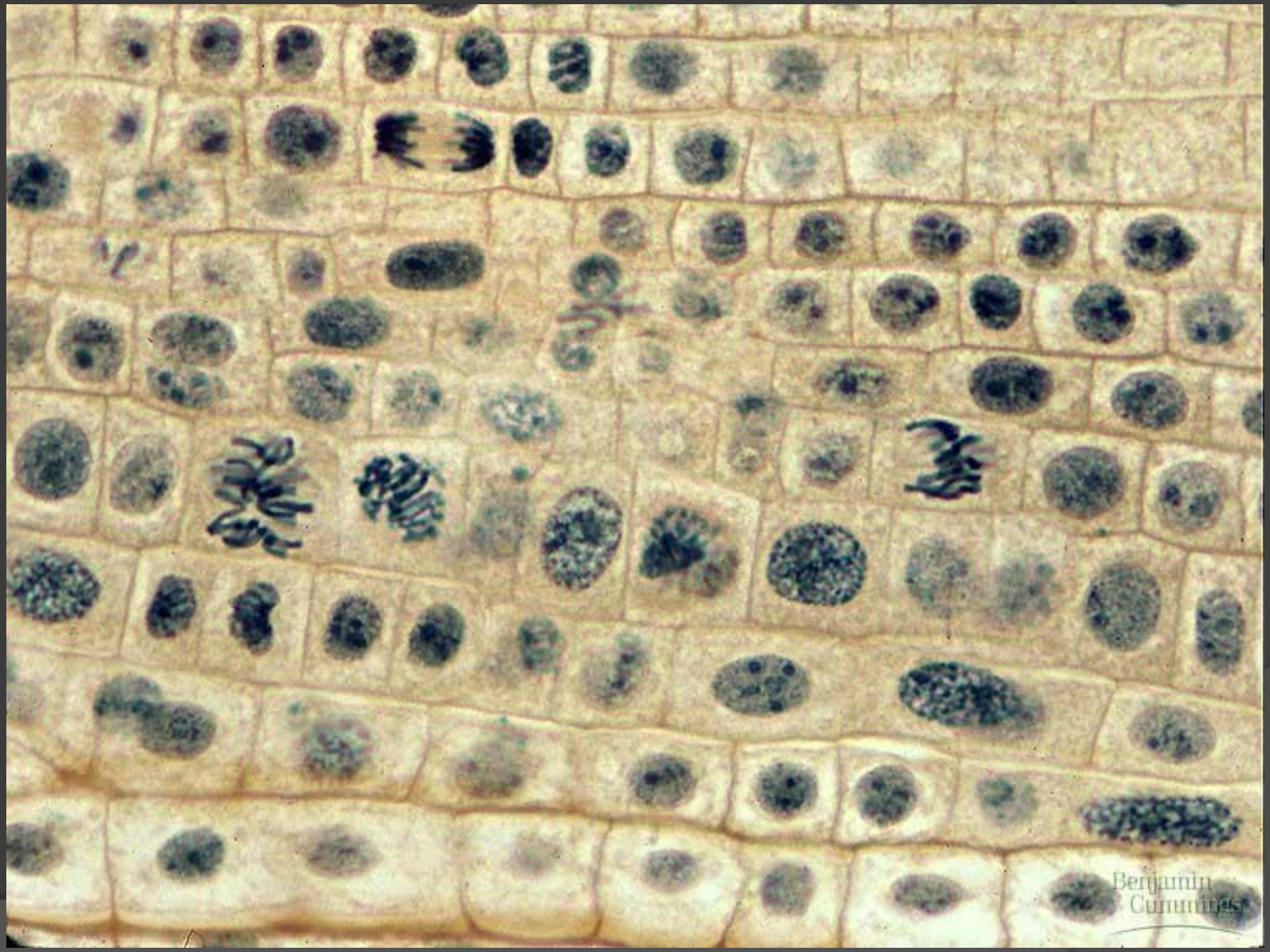


Figure 12.1b The functions of cell division: Growth and development

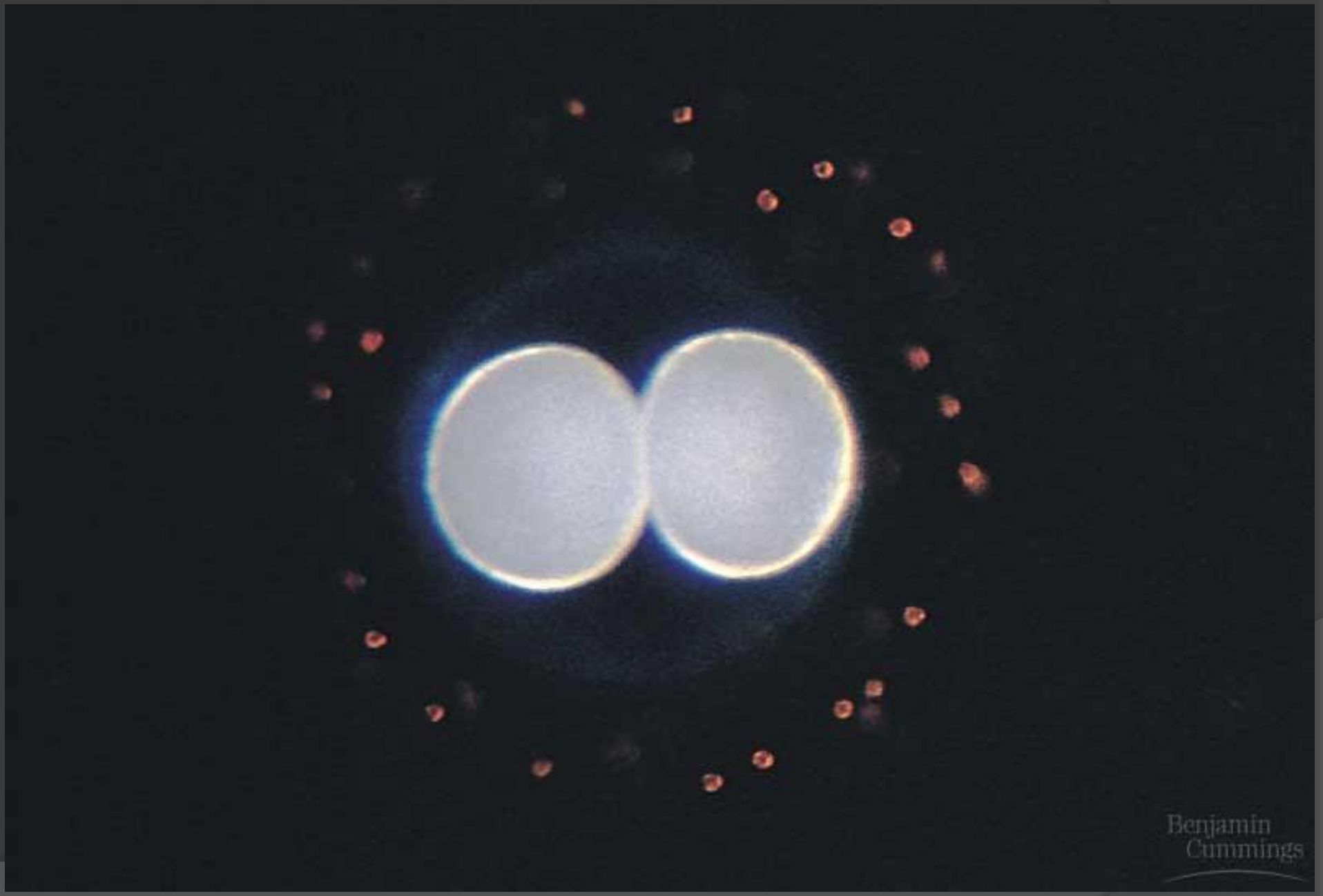
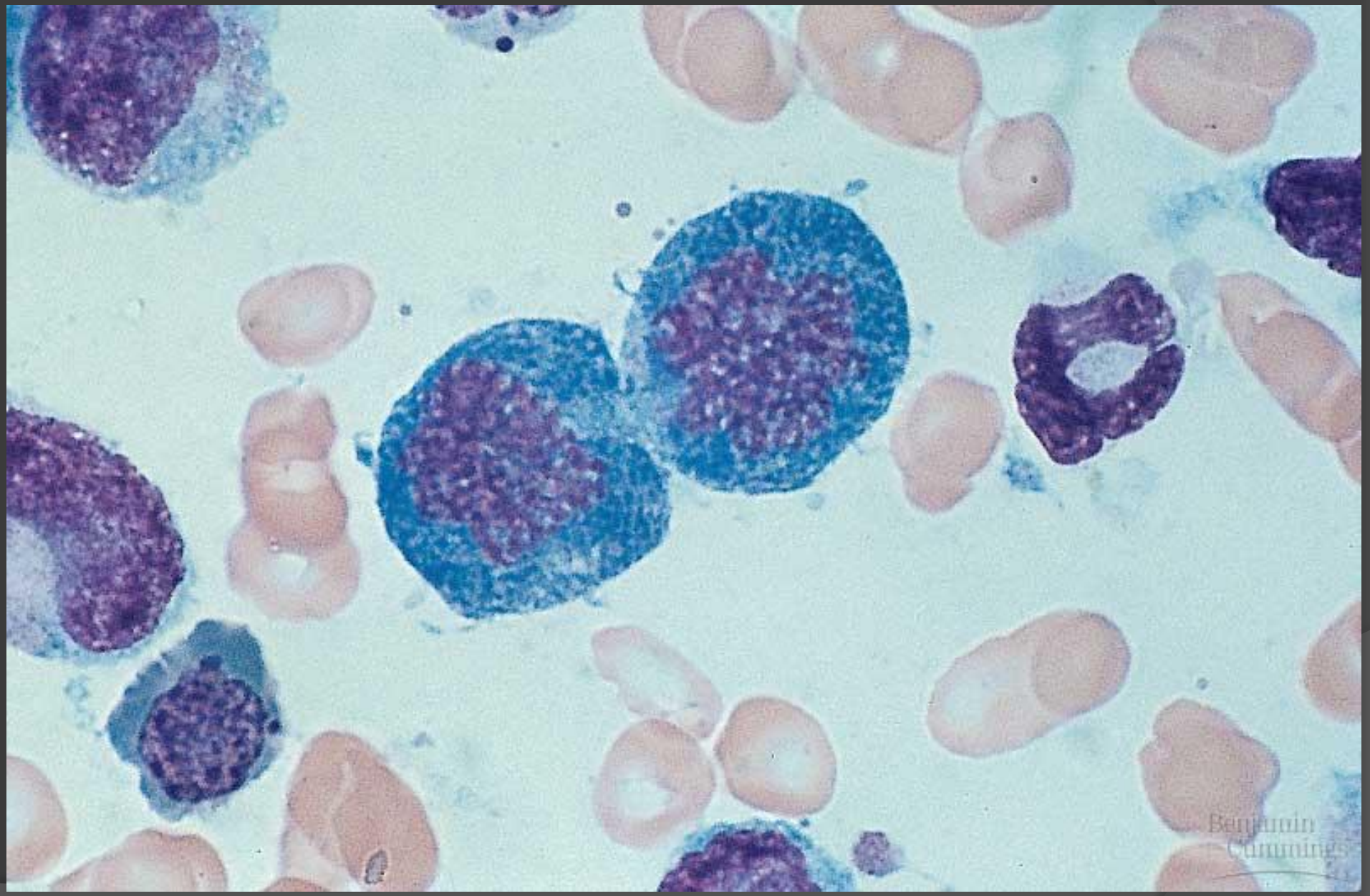


Figure 12.1c The functions of cell division: Tissue renewal



Regulating the Cell Cycle

- Cell Growth & Division are carefully controlled within the cell
- Different cells move through the cycle at different rates:
  - Muscle/nerve cells do NOT divide once they are developed
  - Blood cells/skin cells divide rapidly (every few hours)

How are cells regulated?

- What “tells” cells when to divide, duplicate chromosomes or enter another phase of the cell?

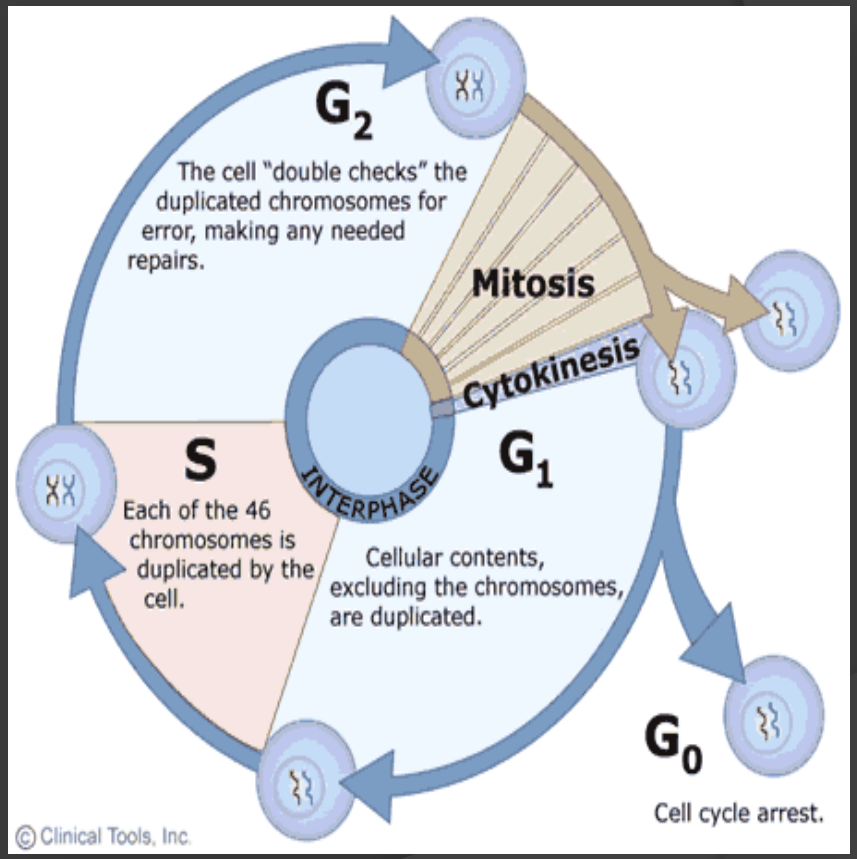
- CYCLINS: a protein family that regulates the timing of the cell cycle in eukaryotic cells

Regulator Proteins

- Internal Regulators: respond to events inside the cell
  - Check for completion of chromosome replication
  - check for formation of spindle fibers
- External Regulators: respond to outside events
  - Help speed up or slow down cell cycle
  - Growth Factors: important in embryonic development & wound healing.
  - Other proteins prevent excessive growth

Cell Cycle Checkpoints

- G1 Checkpoint:
  - Exit cell cycle and move into Go phase
    - Terminally differentiated
      - Nerve/heart cells
  - Continue cell division
    - Adult stem cells/skin cells
- G2 Checkpoint:
  - Check DNA replication
    - Repair damage
    - Apoptosis – too severe
- Metaphase Checkpoint
  - Check Spindle Fibers



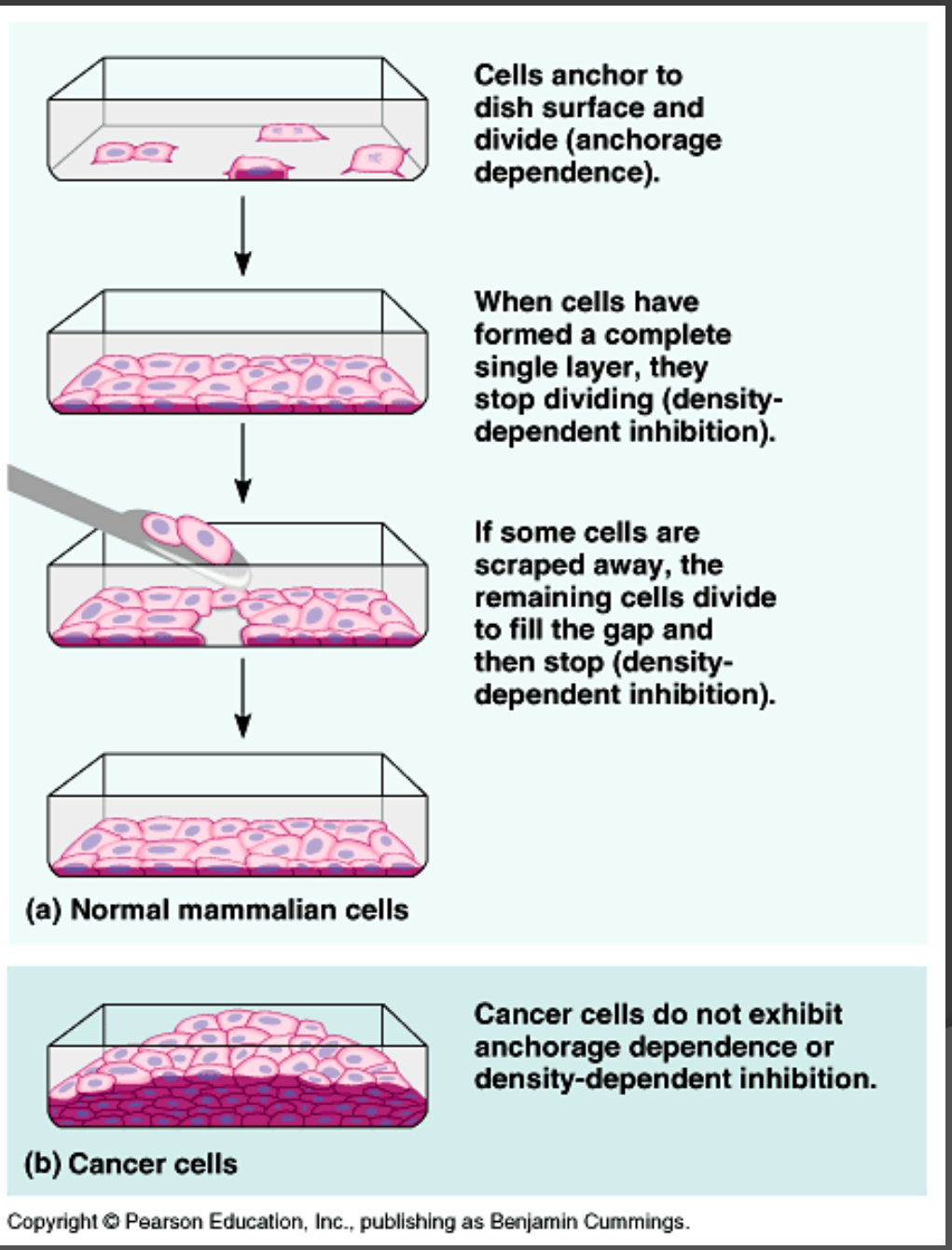
Ending Cell Life

- External/accident
- Internal/cell “suicide”
  - Apoptosis: programmed cell death
    - Cell & chromosomes shrink
    - Cell membrane breaks down
    - Neighboring cells “eat” them
  - Plays a key role in development of the shape and structure of tissues and organs.
  - Too much Apoptosis: AIDS/Parkinsons

Uncontrolled Cellular Division

CANCER

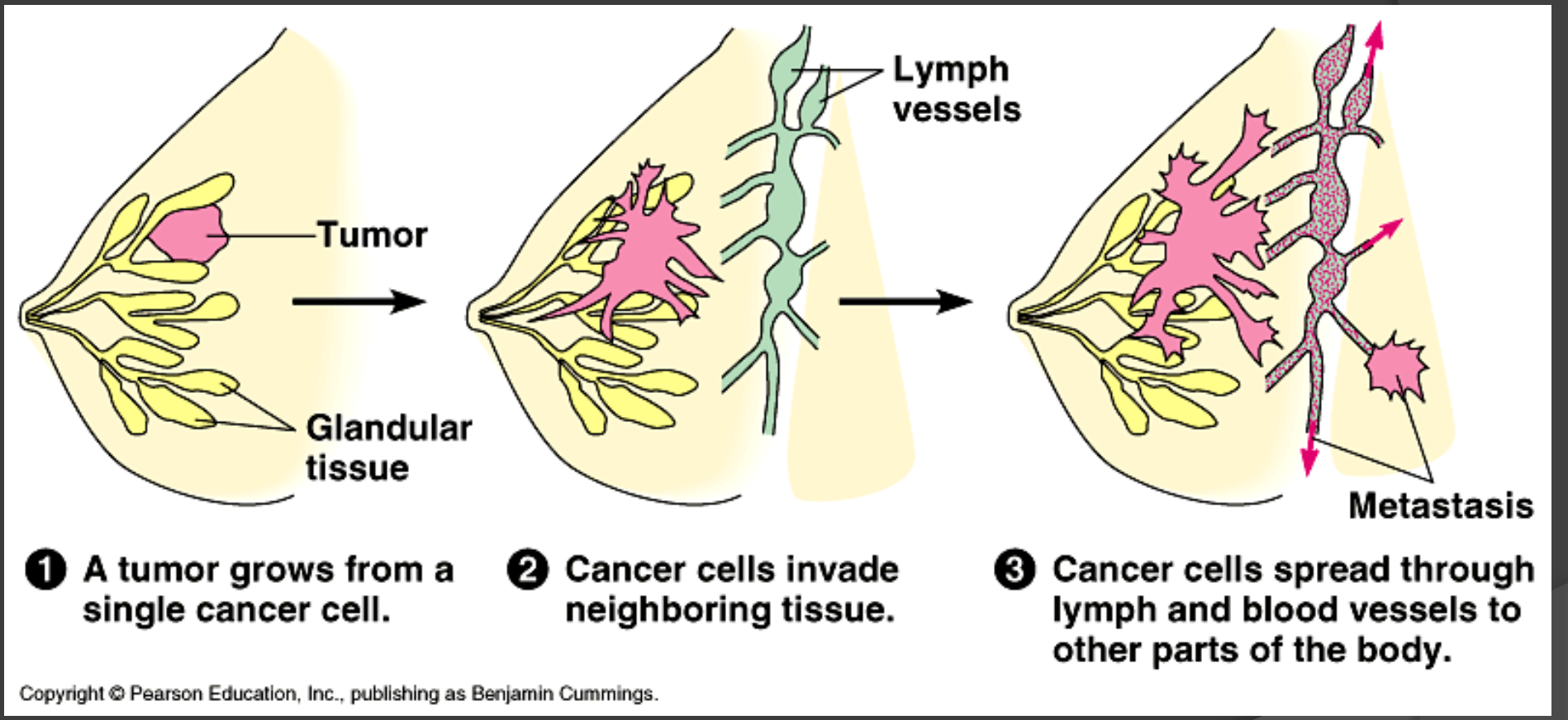
Figure 12.16 Density-dependent inhibition of cell division



Cancer

- Body cells lose the ability to control cell growth
- Cancers cells do not respond to signals to regulate cell growth
- Tumor: mass of cells
  - Bengign: Noncancerous tumor, does NOT spread to healthy tissue
  - Malignant: Cancerous, invades and destroys healthy tissue
- As cancer spreads, cancers cells absorb the nutrients other cells need, block nerve connections, keep organs from working properly.

Figure 12.17 The growth and metastasis of a malignant breast tumor



Cause

- Defects in genes that regulate cell growth
- Gene p53: halts the cell cycle until all chromosomes have been properly regulated.
- Most cancers have been found to have mutations or gene p53 “shut off”

Treatments

- Surgery
  - Localized, not spread
- Chemotherapy
  - Medical compounds (medicine) that kill or attack cancer cells.
  - Also interferes with regular cell growth/division
- Radiation