Section A: The Key Roles of Cell Division

1. Cell division functions in reproduction, growth, and repair
2. Cell division distributes identical sets of chromosomes to daughter cells
Introduction

• The ability of organisms to reproduce their kind is one characteristic that best distinguishes living things from nonliving matter.

• The continuity of life from one cell to another is based on the reproduction of cells via cell division.

• This division process occurs as part of the cell cycle, the life of a cell from its origin in the division of a parent cell until its own division into two.
1. Cell division functions in reproduction, growth, and repair

- The division of a unicellular organism reproduces an entire organism, increasing the population.

- Cell division on a larger scale can produce progeny for some multicellular organisms.

  - This includes organisms that can grow by cuttings or by fission.

Fig. 12.1
• Cell division is also central to the development of a multicellular organism that begins as a fertilized egg or zygote.

• Multicellular organisms also use cell division to repair and renew cells that die from normal wear and tear or accidents.
• Cell division requires the distribution of identical genetic material - DNA - to two daughter cells.
  • What is remarkable is the fidelity with which DNA is passed along, without dilution, from one generation to the next.
• A dividing cell duplicates its DNA, allocates the two copies to opposite ends of the cell, and then splits into two daughter cells.
2. Cell division distributes identical sets of chromosomes to daughter cells

- A cell’s genetic information, packaged as DNA, is called its genome.
  - In prokaryotes, the genome is often a single long DNA molecule.
  - In eukaryotes, the genome consists of several DNA molecules.
- A human cell must duplicate about 3 m of DNA and separate the two copies such that each daughter cell ends up with a complete genome.
• DNA molecules are packaged into **chromosomes**.

• Every eukaryotic species has a characteristic number of chromosomes in the nucleus.

• **Human somatic cells** (body cells) have 46 chromosomes.

• **Human gametes** (sperm or eggs) have 23 chromosomes, half the number in a somatic cell.

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Fig. 12.2
• Each eukaryotic chromosome consists of a long, linear DNA molecule.

• Each chromosome has hundreds or thousands of genes, the units that specify an organism’s inherited traits.

• Associated with DNA are proteins that maintain its structure and help control gene activity.

• This DNA-protein complex, chromatin, is organized into a long thin fiber.

• After the DNA duplication, chromatin condenses, coiling and folding to make a smaller package.
• Each duplicated chromosome consists of two **sister chromatids** which contain identical copies of the chromosome’s DNA.

• As they condense, the region where the strands connect shrinks to a narrow area, is the **centromere**.

• Later, the sister chromatids are pulled apart and repackaged into two new nuclei at opposite ends of the parent cell.
• The process of the formation of the two daughter nuclei, **mitosis**, is usually followed by division of the cytoplasm, **cytokinesis**.

• These processes take one cell and produce two cells that are the genetic equivalent of the parent.
• Each of us inherited 23 chromosomes from each parent: one set in an egg and one set in sperm.

• The fertilized egg or zygote underwent trillions of cycles of mitosis and cytokinesis to produce a fully developed multicellular human.

• These processes continue every day to replace dead and damaged cell.

• Essentially, these processes produce clones - cells with the same genetic information.
• In contrast, gametes (eggs or sperm) are produced only in gonads (ovaries or testes).

• In the gonads, cells undergo a variation of cell division, **meiosis**, which yields four daughter cells, each with half the chromosomes of the parent.
  - In humans, meiosis reduces the number of chromosomes from 46 to 23.

• Fertilization fuses two gametes together and doubles the number of chromosomes to 46 again.