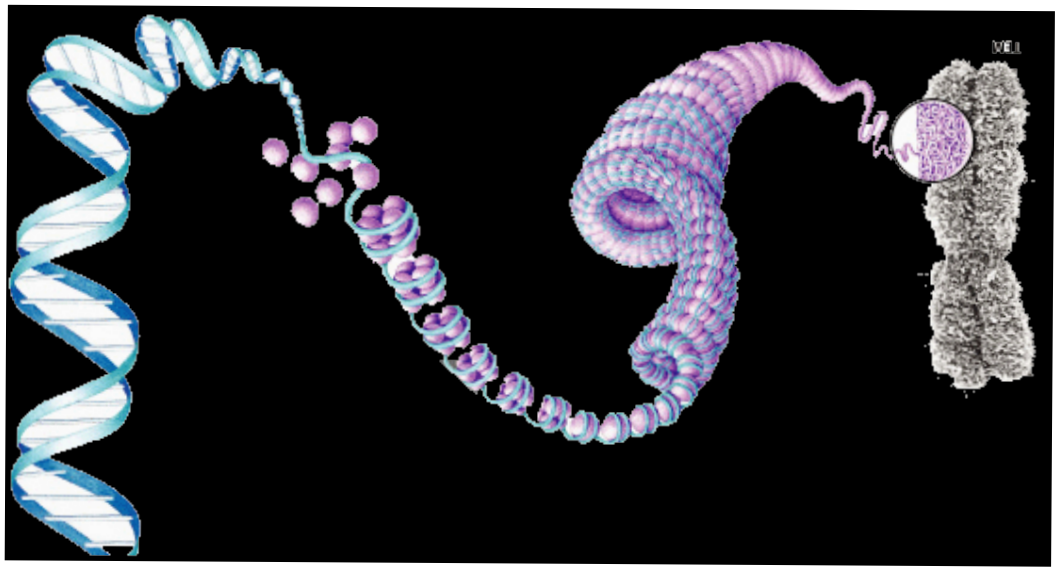
Cell Division

- Chromosome structure
  - Made of chromatin (mix of DNA and protein)
  - Only visible during cell division

Cell Division

- Chromosome structure
  - The DNA in a cell is packed into an elaborate, multilevel system of coiling and folding.



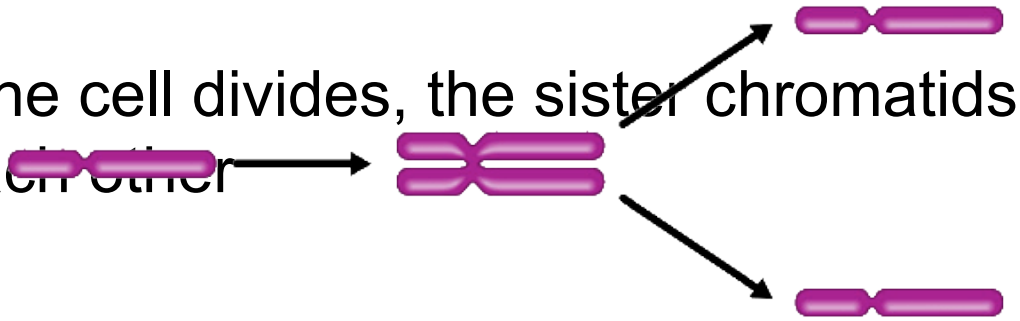
Double helix Nucleosome Helical fiber Chromosome

Cell Division

- Chromosome structure

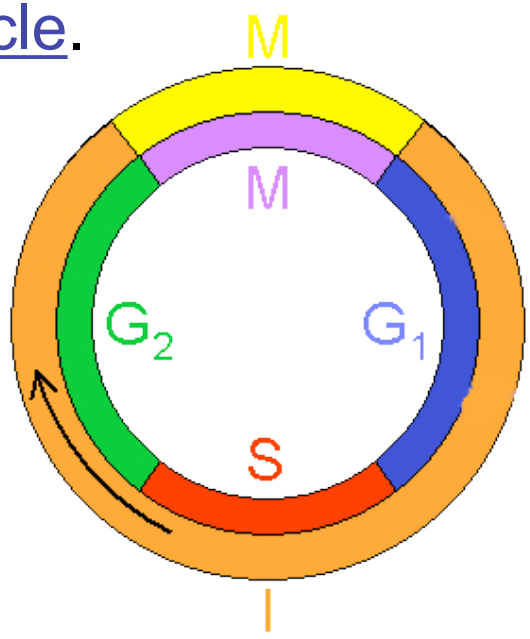
- Before a cell divides, it duplicates all of its chromosomes, resulting in two copies called sister chromatids

- When the cell divides, the sister chromatids separate from each other



Cell Division

- The Cell Cycle
  - Eukaryotic cells that divide undergo an orderly series of events called the cell cycle.
    - Consists of two distinct phases:
      - Interphase (I) - cell grows & copies its chromosomes in preparation for cell division
      - Mitotic phase (M) - cell division occurs



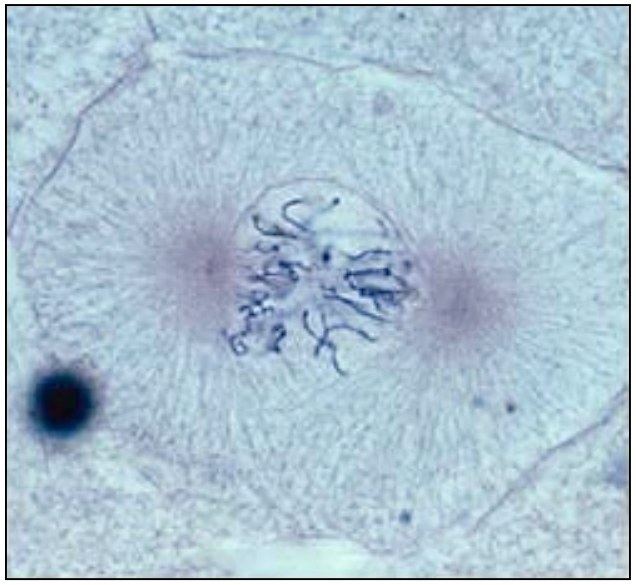
Cell Division

- Mitosis
  - Division of a nucleus into 2 daughter nuclei
  - Consists of four distinct phases:

    - Prophase
    - Metaphase
    - Anaphase
    - Telophase

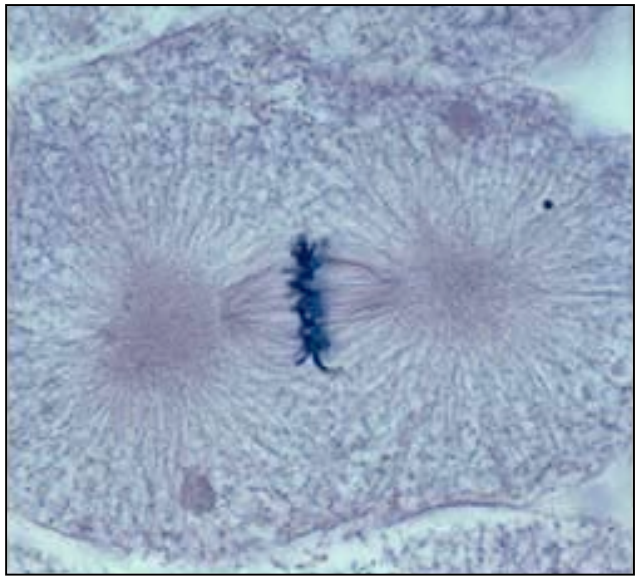
Cell Division

- Prophase
  - chromosomes condense & form visible chromatids
  - centromere starts to form (region of sister chromatid & microtubule attachment)
  - nuclear membrane breaks down



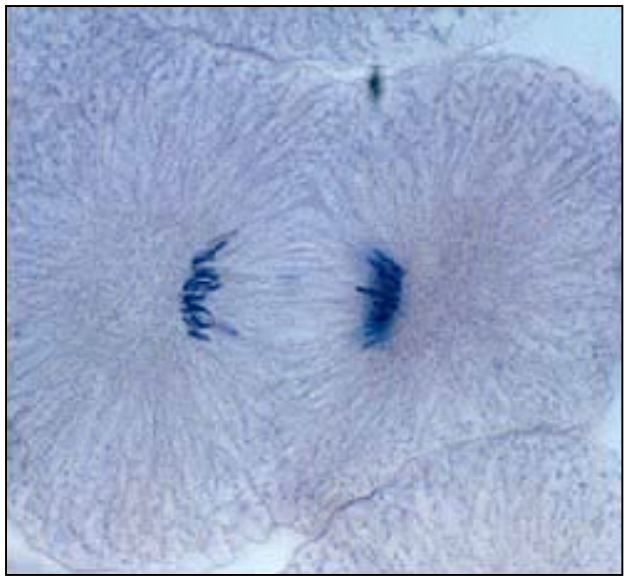
Cell Division

- Metaphase
  - chromosomes align on the metaphase plate along the center of the cell
  - nuclear membrane gone
  - microtubules attach to an area of the centromere called the kinetochore



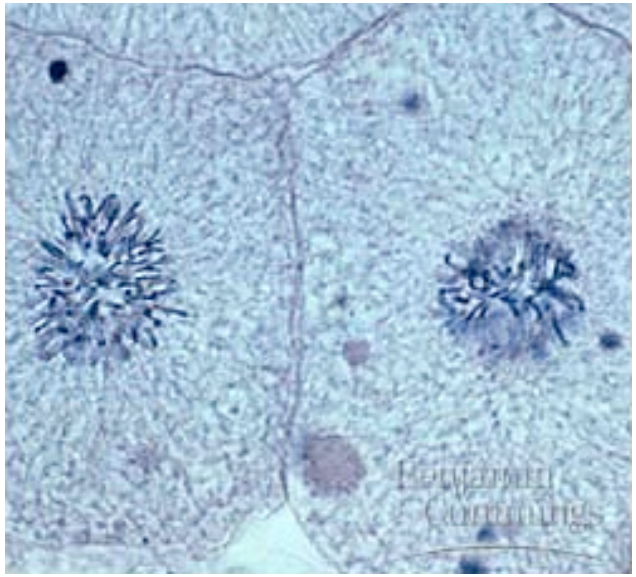
Cell Division

- Anaphase
  - individual chromatids separate to opposite ends of the cell



Cell Division

- Telophase
  - chromosomes reassemble at each “pole”
    - nuclear membrane reforms
    - cytoplasm divides (cytokinesis)
  - chromosomes uncoil, become extended & again cannot be identified



Cell Division

- Comparison of animal and plant cell division
  - Cytokinesis
    - Animals
      - Furrowing (contracting ring) of cell membrane
    - Plants
      - Cell plate formation
      - Cell membrane formation
      - Cell wall formation

Cell Division

- Regulation of cell division
  - Normal plant and animal cells have a cell cycle control system
  - Mechanisms of cell division regulation include:
    - contact inhibition
    - anchorage dependence
    - growth factors

Cell Division

- Out of control cells
  - Cancer is caused by a breakdown in control of the cell cycle
  - Cancer cells
    - cells become deregulated and immortal (transformation)
    - loss of contact inhibition and anchorage dependence
    - grow in unorganized lumps called tumors

Cell Division

- Cancer tumors
  - Tumors that are surrounded by a basement membrane are called benign.
    - can often be removed by surgery
  - Tumors that invade surrounding tissues are called malignant.
    - surgical removal often incomplete
  - Metastasis - spread of transformed cells to locations distant from the original site

Cell Division

- Types of cancer treatments
  - Radiation and chemotherapy disrupt cell division.
  - Target rapidly dividing cancer cells as well as normal cells.
    - those of scalp (causing hair loss)
    - intestinal lining (nausea / loss of appetite)
    - bone marrow (causing suppression of immune system)

Cell Division

- NEW Types of cancer treatments
  - Boosting immune system as a whole.
  - Targeting the immune system against tumor-associated antigens.
  - Using antibodies to target anti-cancer drugs to attack cancer cells more exclusively.

Cell Division

- The Genetics of Cancer
  - Proto-oncogenes
    - Normal genes that can become oncogenes ("cancer causing genes")
    - Found in many animals
    - Code for growth factors that stimulate cell division
  - For a proto-oncogene to become an oncogene, a mutation must occur in the cell's DNA

Cell Division

- The Genetics of Cancer
  - Tumor suppressor genes
    - Normal genes that control DNA repair
    - Mutation of these genes often result in failure of DNA repair which may result in cancer.

Cell Division

- Cancer has complex causes and risk factors
  - Increasing age
    - perhaps due to accumulated mutations or exposure to carcinogens
  - Cancers associated with viruses.
    - viruses may cause cancer by inserting oncogenes into host DNA
    - Human T-cell Leukemia Virus (HTLV)
    - Human Papilloma Virus (associated with cervical cancer)
  - Physical and chemical carginogens.
  - Dietary factors (high-fat, low-fiber diet = “bad”)

Cell Division

Meiosis

- Definition
  - Reduction division
  - Gamete formation by means of 2 cell divisions resulting in haploid cells

- Significance
  - Variation
  - Sexual reproduction allows for new genetic combinations.

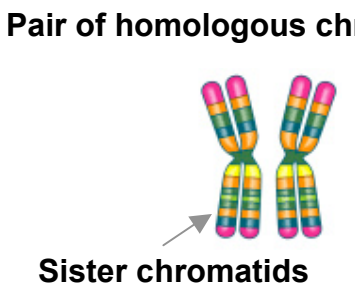
Cell Division

Meiosis

- Homologous chromosomes
  - Chromosomes come **in** matched pairs
  - Their number is characteristic of species

  (human - 46; chimpanzee - 48; fruit fly - 8)

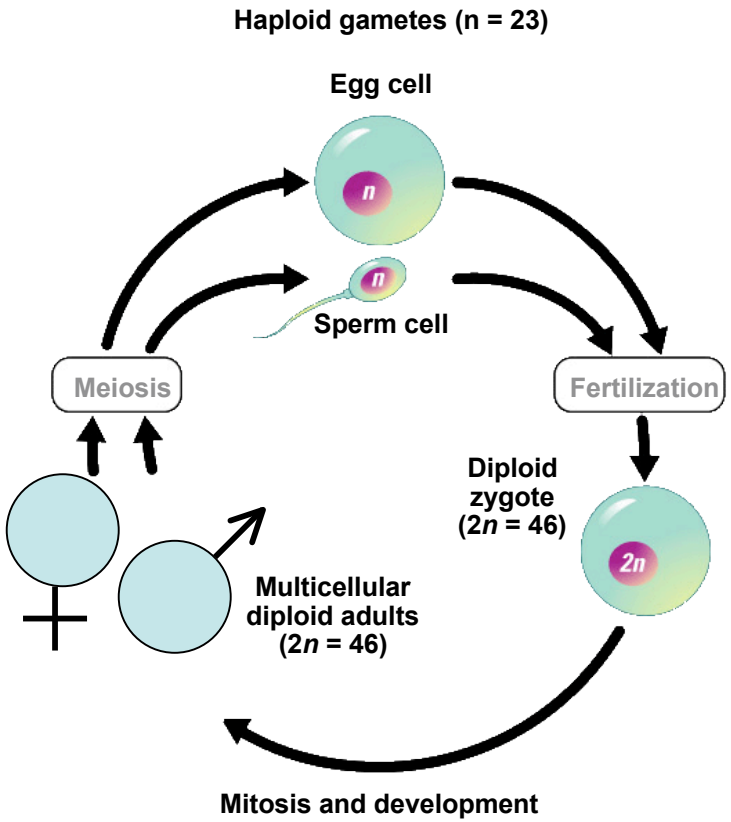
- **Somatic cells** (typical body cells)
  - Humans have 46 chromosomes
  - Two different sex chromosomes, X and Y
  - 22 pairs of matching chromosomes, called autosomes



Cell Division

Life cycle of a sexual organism

- Sequence of stages leading from the adults of one generation to the adults of the next
- Humans are diploid organisms
  - cells contain two sets of chromosomes
  - gametes are haploid, having only one set of chromosomes

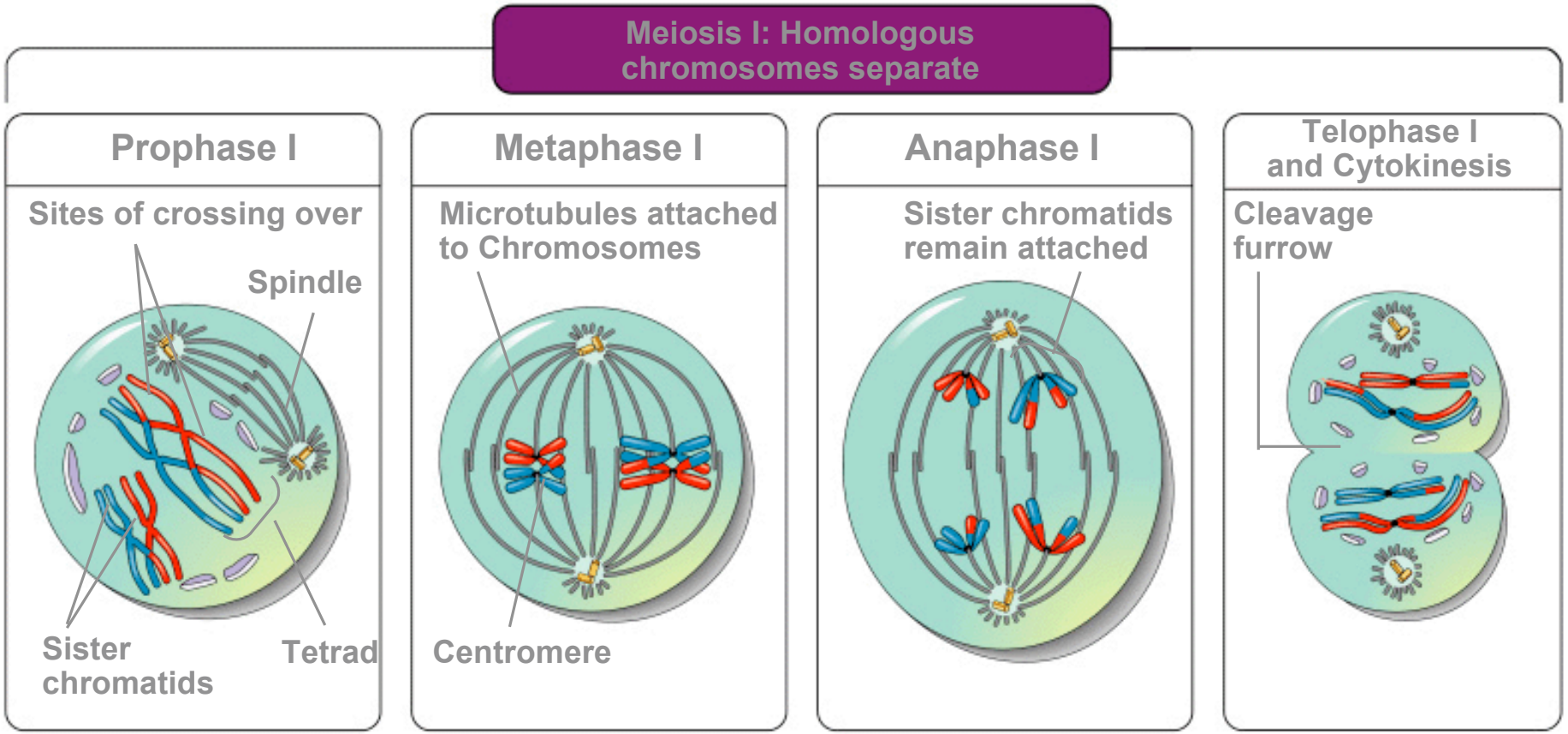


Cell Division

Meiosis (My what-is?)

- Meiosis produces gametes for sexual reproduction
- Two consecutive divisions occur, meiosis I & meiosis II, preceded by interphase.
- Crossing over occurs (leads to variation)

Cell Division



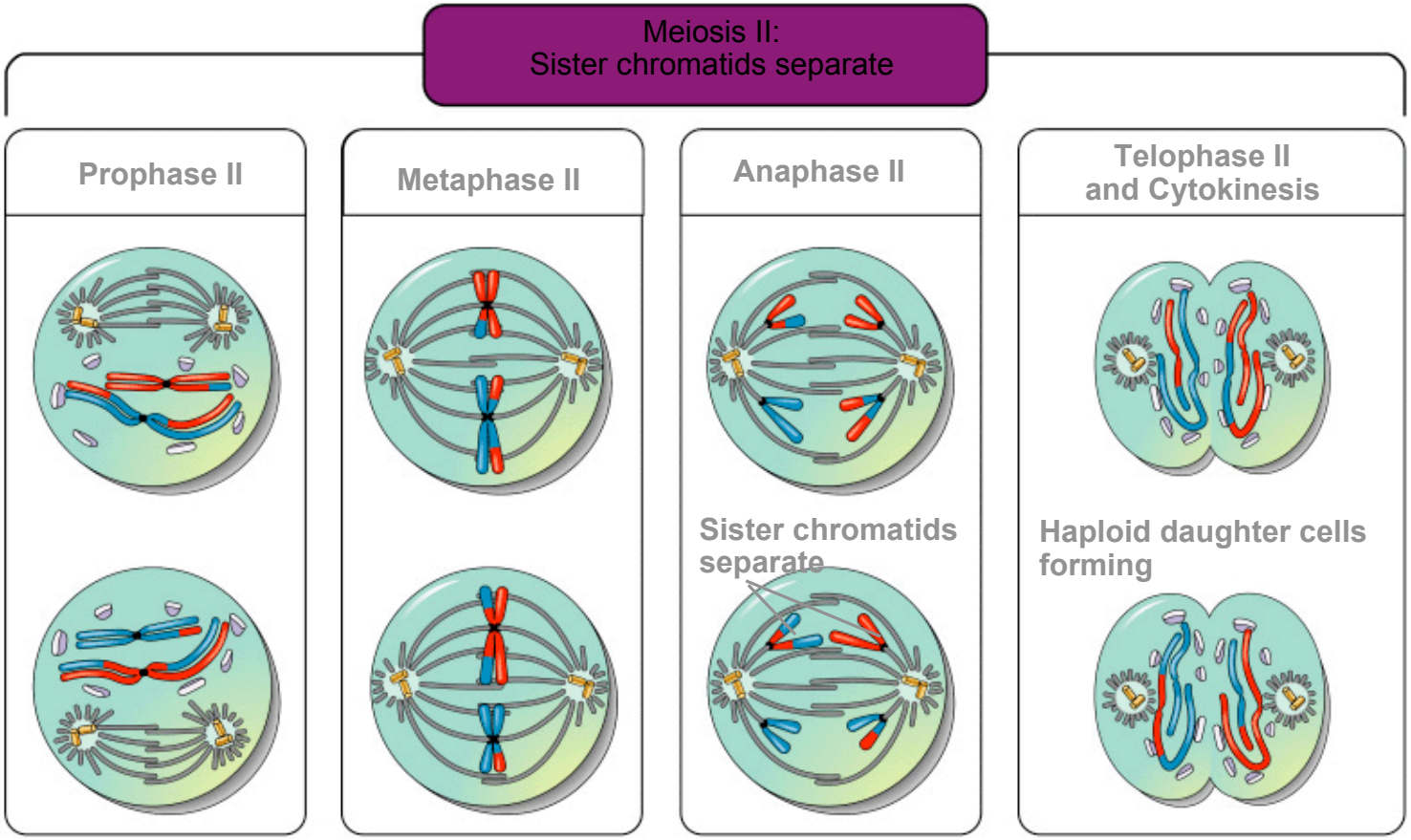
Homologous chromosomes pair and exchange segments

Tetrads line up

Pairs of homologous chromosomes split up

Two haploid cells form: chromosomes are still double

Cell Division



During another round of cell division, the sister chromatids finally separate;
four haploid daughter cells result, containing single chromosomes

Cell Division

Genetic Variation

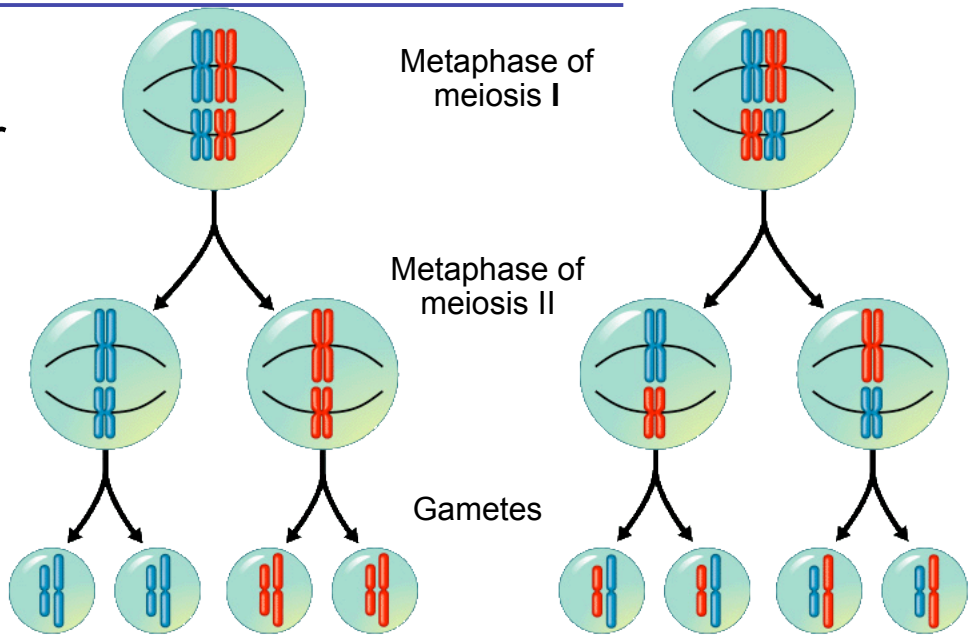
- Offspring of sexual reproduction are genetically different from their parents & from one another
  - Independent assortment of chromosomes
  - Random fertilization
  - Crossing over

Cell Division

Genetic Variation

- Independent assortment of chromosomes

- Every chromosome pair orients independently of the others during meiosis



Cell Division

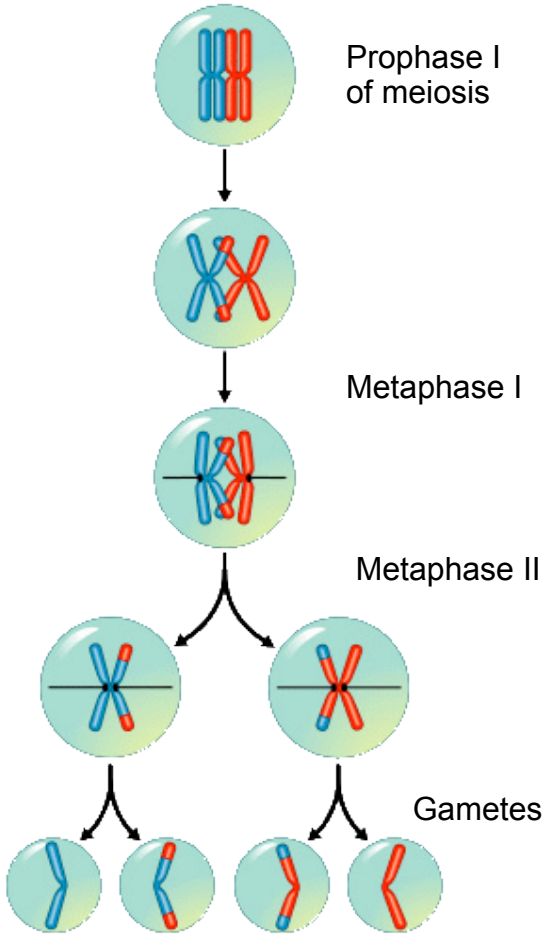
Genetic Variation

- Random fertilization
  - Egg cell is fertilized randomly by one sperm, leading to genetic variety in the zygote.

Cell Division

Genetic Variation

- Crossing over
  - Homologous chromosomes exchange genetic information
  - Genetic recombination occurs



Cell Division

Comparing Mitosis and Mitosis