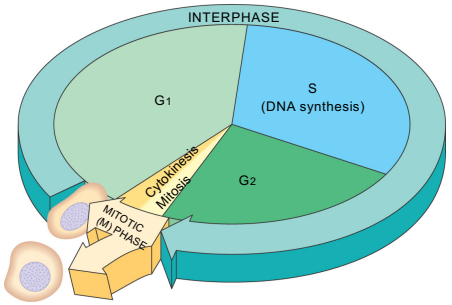
Repetition

Summary of last lecture

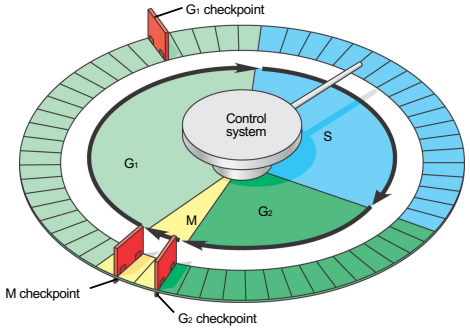
Phases of the Cell Cycle

- The cell cycle consists of
  - the Mitotic phase (M)
  - Interphase (G1, S, G2)
    - Interphase can be divided into sub-phases
      - G_1 phase
      - S phase
      - G_2 phase
    - The mitotic phase
      - is made up of mitosis and cytokinesis



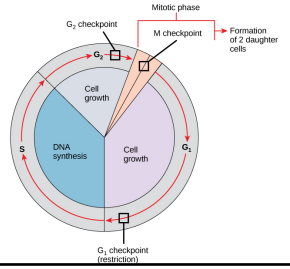
The Cell Cycle Control System

- The sequential events of the cell cycle
  - are directed by a distinct cell cycle control system, which is similar to a clock



Regulation of cell cycle

- Daughter cells have to be exact replicas of parent cells
- Mistakes in the duplication or distribution of the chromosomes lead to mutations that may be passed forward to every new cell produced from an abnormal cell.
- To prevent a compromised cell from continuing to divide, there are internal control mechanisms that operate at three main **cell cycle checkpoints**.
- A checkpoint is one of several points in the eukaryotic cell cycle at which the progression of a cell to the next stage in the cycle can be halted until conditions are favorable.
- These checkpoints occur near the end of G_1, at the G_2/M transition, and during metaphase



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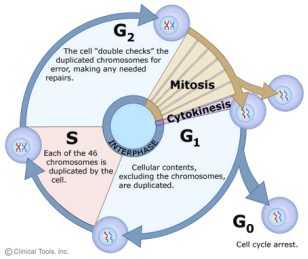
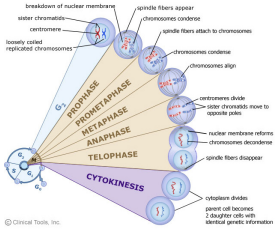
Cell cycle overview





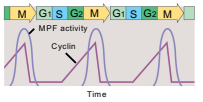
- The cell cycle is an ordered set of events, culminating in cell growth and division into two daughter cells.
- Non-dividing cells not considered to be in the cell cycle. The stages, pictured to the left, are G1-S-G2-M.
- The G1 stage stands for "GAP 1". The S stage stands for "Synthesis". This is the stage when DNA replication occurs. The G2 stage stands for "GAP 2".
- G1-S-G2 stages are together known as interphase
- The M stage stands for "mitosis", and is when nuclear (chromosomes separate) and cytoplasmic (cytokinesis) division occurs. Mitosis is further divided into 5 phases, prophase, prometaphase, metaphase, anaphase and telophase

The Cell Cycle Clock: Cyclins and Cyclin-Dependent Kinases

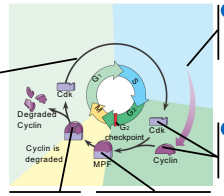
- two types of regulatory proteins are involved in cell cycle control: cyclins **and** cyclin-dependent kinases (Cdks)

the **activity of cyclins and Cdks fluctuates during the cell cycle**

(a) Fluctuation of MPF (Mitosis Promoting Factor, MPF) activity and cyclin concentration during the cell cycle



(b) Molecular mechanisms that help regulate the cell cycle



5 During G_1, conditions in the cell favor degradation of cyclin, and the Cdk component of MPF is recycled.

1 Synthesis of cyclin begins in late S phase and continues through G_2. Because cyclin is protected from degradation during this stage, it accumulates.

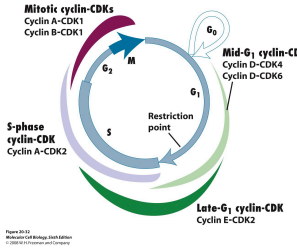
2 Accumulated cyclin molecules combine with recycled Cdk molecules, producing enough molecules of MPF to pass the G_2 checkpoint and initiate the events of mitosis.

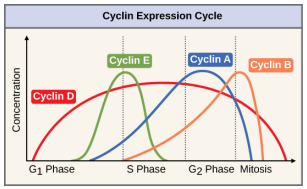
3 MPF promotes mitosis by phosphorylating various proteins. MPF 's activity peaks during metaphase.

4 During anaphase, the cyclin component of MPF is degraded, terminating the M phase. The cell enters the G_1 phase.

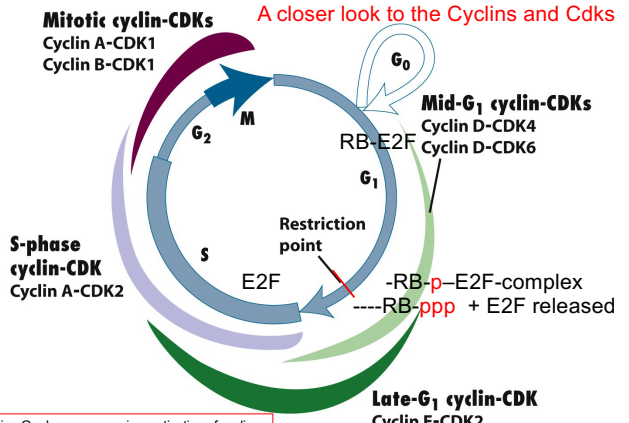
Regulation of cell cycle

- The cell cycle is a highly regulated process
- Two types of regulatory proteins are involved in cell cycle control: cyclins and cyclin-dependent kinases (CDKs)
- The levels of the four cyclin proteins fluctuate throughout the cell cycle in a predictable pattern
- After the cell moves to the next stage of the cell cycle, the cyclins that were active in the previous stage are degraded.





A closer look to the Cyclins and Cdks



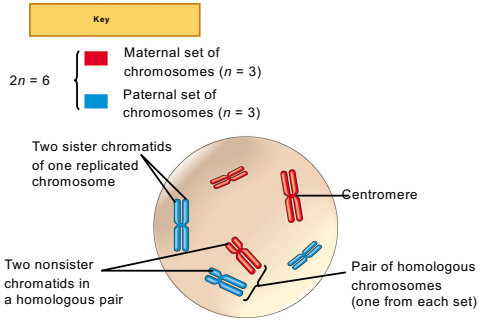
During G_1 phase progression, activation of cyclin D/cdk4 and cyclin E/cdk2 complexes by cyclin activating kinase (CAK) leads to sequential phosphorylation of the transcription factor RB.

Diploid vs. Haploid

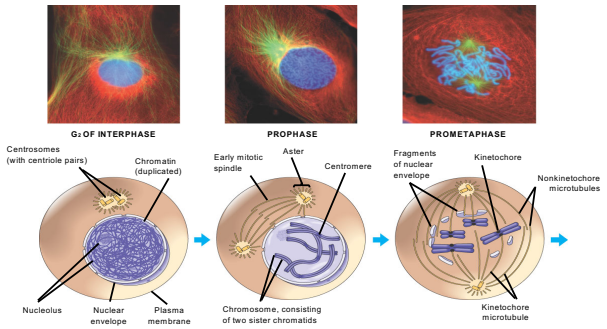
- Most human somatic (body) cells have 46 chromosomes
  - This is called the diploid condition
  - 2n = 46 (2x22 + X,Y)

- Gametes (sperms and eggs) are an exception: they only have 23 chromosomes
  - This is the haploid condition
  - n = 23

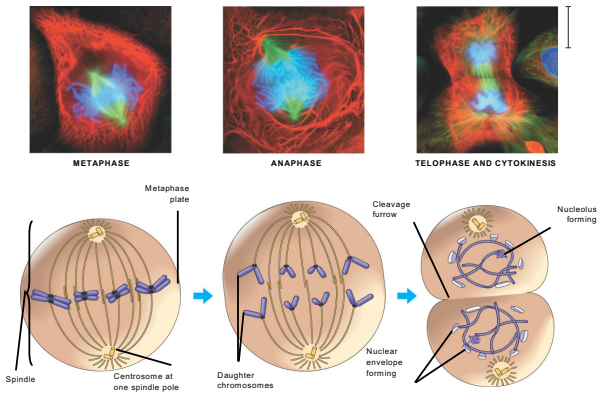
- In a cell in which DNA synthesis has occurred
  - all the chromosomes are duplicated and thus each consists of two identical sister chromatids



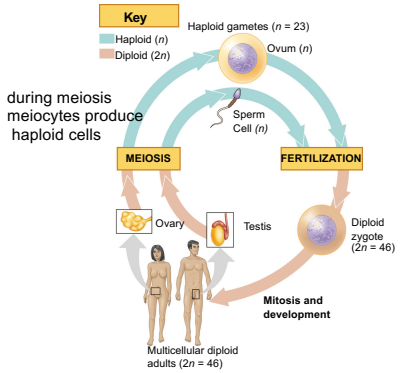
- Mitosis consists of five distinct phases
  - Prophase Prometaphase



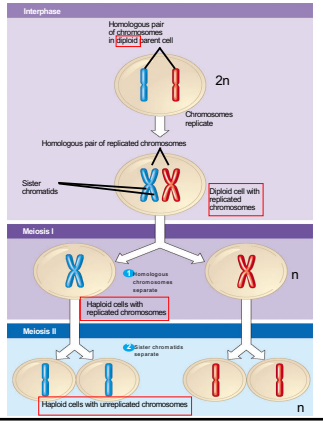
- Metaphase, - Anaphase, - Telophase



- **The human life cycle**



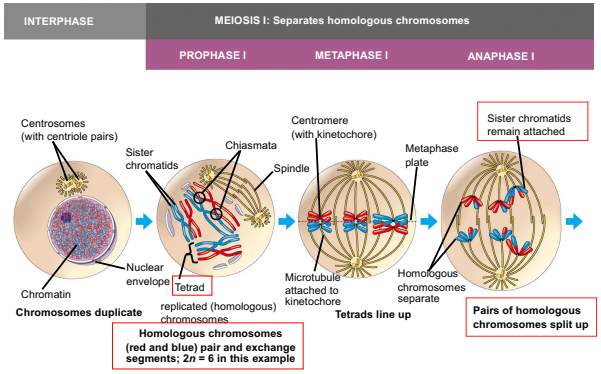
- Meiosis **reduces the number of chromosome sets from diploid to haploid**
- Meiosis takes place in **two** sets of **divisions**, meiosis I and meiosis II



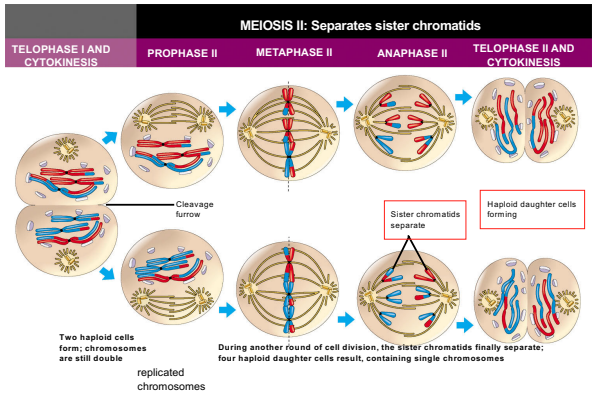
The Stages of Meiosis

- An overview of meiosis
- Meiosis I reduces the number of chromosomes from diploid to haploid
- Meiosis II produces four haploid daughter cells

- Interphase and meiosis I



- Telophase I, cytokinesis, and meiosis II



- A comparison of mitosis and meiosis