2.4: The Cell Cycle and Changes in DNA Content

Four stages of a typical cell cycle

The life cycle of eukaryotic cells can generally be divided into four stages and a typical cell cycle is shown in Figure \(\PageIndex{13}\). When a cell is produced through fertilization or cell division, there is usually a lag before it undergoes DNA synthesis (replication). This lag period is called Gap 1 (\(G_1\)), and ends with the onset of the DNA synthesis (\(S\) phase, during which each chromosome is replicated. Following replication, there may be another lag, called Gap 2 (\(G_2\)), before mitosis (\(M\)). Cells undergoing meiosis do not usually have a \(G_2\) phase. **Interphase** is as term used to include those phases of the cell cycle excluding mitosis and meiosis. Many variants of this generalized cell cycle also exist. Some cells never leave \(G_1\) phase, and are said to enter a permanent, non-dividing stage called \(G_0\). On the other hand, some cells undergo many rounds of DNA synthesis (\(S\)) without any mitosis or cell division, leading to endoreduplication. Understanding the control of the cell cycle is an active area of research, particularly because of the relationship between cell division and cancer.

![Cell Cycle Diagram](https://bio.libretexts.org/Bookshelves/Genetics/Book%3A_Online_Open_Genetics_(Nickle_and_Barrette-Ng)/02%3A_Chromo…)

Figure \(\PageIndex{13}\): A typical eukaryotic cell cycle.(Original-Deyholos-CC:AN)
Measures of DNA content and chromosome content

The amount of DNA within a cell changes following each of the following events: fertilization, DNA synthesis, mitosis, and meiosis (Fig 2.14). We use “c” to represent the DNA content in a cell, and “n” to represent the number of complete sets of chromosomes. In a gamete (i.e. sperm or egg), the amount of DNA is 1c, and the number of chromosomes is 1n. Upon fertilization, both the DNA content and the number of chromosomes doubles to 2c and 2n, respectively. Following DNA replication, the DNA content doubles again to 4c, but each pair of sister chromatids is still counted as a single chromosome (a replicated chromosome), so the number of chromosomes remains unchanged at 2n. If the cell undergoes mitosis, each daughter cell will return to 2c and 2n, because it will receive half of the DNA, and one of each pair of sister chromatids. In contrast, the 4 cells that come from meiosis of a 2n, 4c cell are each 1c and 1n, since each pair of sister chromatids, and each pair of homologous chromosomes, divides during meiosis.

Figure \(\PageIndex{14}\): Changes in DNA and chromosome content during the cell cycle. For simplicity, nuclear membranes are not shown, and all chromosomes are represented in a similar stage of condensation.(Original-Deyholos-CC:AN)

Contributors and Attributions

- Dr. Todd Nickle and Isabelle Barrette-Ng (Mount Royal University) The content on this page is licensed under CC SA 3.0 licensing guidelines.