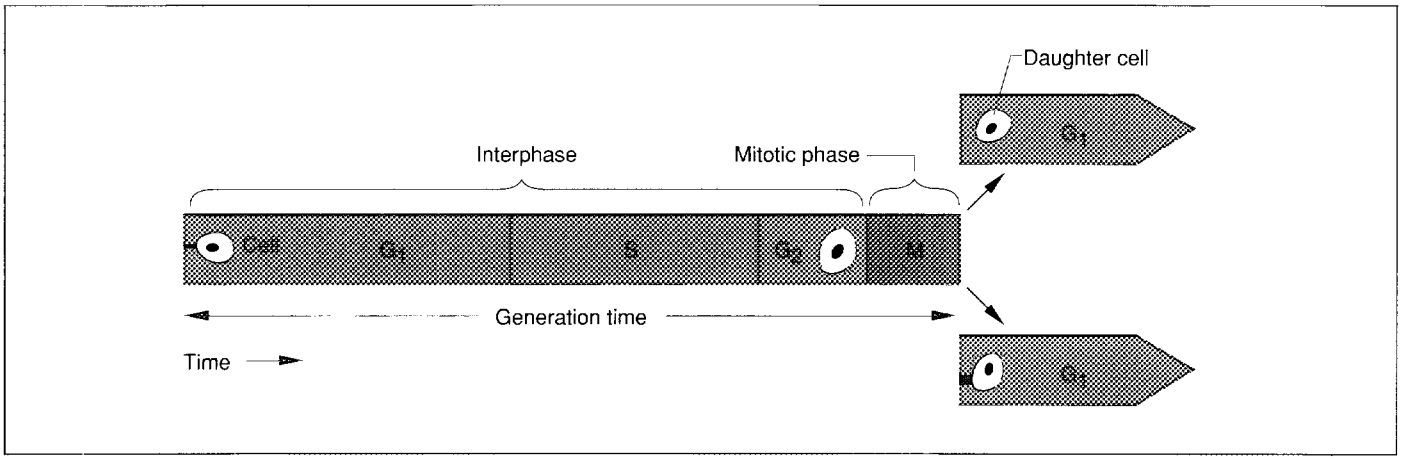
THE EUKARYOTIC CELL CYCLE



The term "cell cycle" refers collectively to the events that occur within a eukaryotic cell between its birth by mitosis and its division, again by mitosis, into two daughter cells. The cell may be either a one-celled organism such as baker's yeast (*Saccharomyces cerevisiae*) or a somatic cell of a multicellular organism. Early studies of the eukaryotic cell cycle concentrated on the microscopically visible and dramatic physical events of the cell-division, or mitotic, phase (M). Onset of the mitotic phase is signaled by the appearance of microscopically visible worm-like bodies within the nucleus, that is, by the condensation of duplicated chromosomes into a much less diffuse configuration. The mitotic phase ends when the cell separates into two daughter cellls, each of which then embarks on its own cycle. (Details of the mitotic phase are presented in "Mitosis.")

Because the early microscopic studies revealed little physical activity during the portion of the cell cycle that precedes the mitotic phase (other than a relatively small increase in cell size), that portion was inappropriately named the resting phase, or interphase. We now know that most of the biosynthetic activity required of a cell—both for its own maintenance and reproduction and for its function or functions as a constituent of a multicellular organism—occurs during interphase.

Most of the biochemicals produced by a cell are synthesized throughout interphase. DNA is a notable and easily detected exception, and for that reason interphase is subdivided into the period between cell birth and the onset of DNA synthesis (G_1), the period of DNA synthesis (S), which ends when all the nuclear DNA has been replicated and hence the number of chromosomes has doubled, and the period between the end of DNA synthesis and the beginning of the mitotic phase (G_2). After a cell has entered S, it is committed to completing the cell cycle, even when environmental conditions are extremely adverse.

The length of the cell cycle, the generation time, varies with environmental conditions and among species and cell types. For example, epithelial cells, the cells that line the interior and exterior surfaces of the human body, have relatively short generation times (about eight hours); fibroblasts, cells that assist in healing wounds, complete their cell cycle only on demand; mature red blood cells never undergo mitosis; and embryonic cells divide very rapidly. Observed generation times for those cells that do have a regular cycle range from about a few minutes to a few months. The variation in generation time is due mainly to a variation in the length of G_1 and of G_2. The mitotic phase of most species and most cell types occupies only about 10 percent of the generation time.

The cell cycle of bacteria, in addition to being shorter (typically less than an hour), is also less complex. In particular, DNA is synthesized continuously, the two copies of the single bacterial chromosome do not undergo extensive condensation before cell division, and a mechanism simpler than the one illustrated in "Mitosis" assures parceling out of one chromosome copy to each daughter cell.