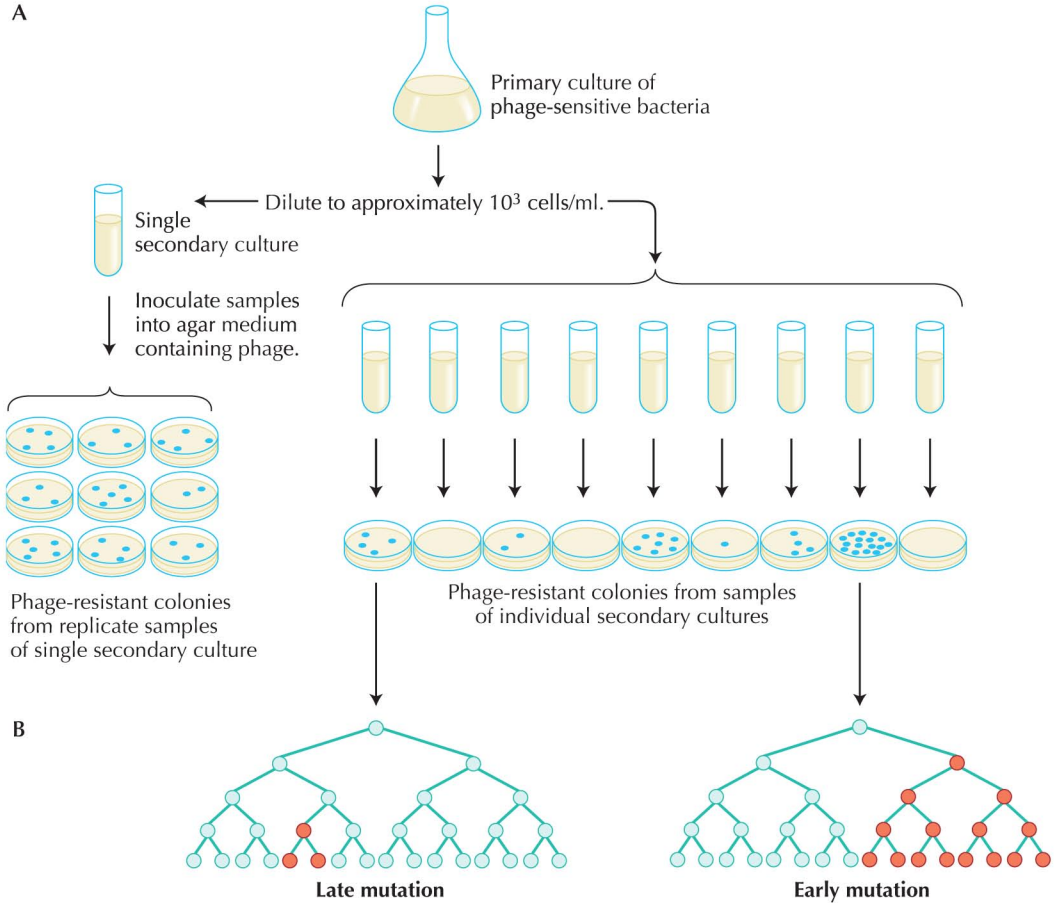

FIGURE 12.22. Fluctuation test. (*A*) The protocol as used by Luria and Delbrück to study the origin of mutations. Their test focused on mutations in bacteria that conferred resistance to killing by phage. The test was designed to determine if such mutations arose prior to exposure to the phage or specifically in response to exposure. A primary culture of bacteria was grown that had been inoculated with a phage-sensitive strain. Multiple secondary cultures were made by transferring small amounts of the primary culture to new growth media. The secondary cultures underwent many rounds of replication. Subsamples of each culture were removed, mixed with phage, and placed onto growth plates. After several days, the number of colonies on each plate was counted. This number is a measure of the number of cells in the subsample that were able to resist killing by the phage. There were two key results in this experiment. First, replicate subsamples from a single secondary culture gave similar numbers of phage-resistant colonies (shown on the *left*). Second, and more importantly, different secondary cultures of the same primary culture yielded wildly different numbers of colonies (shown on the *right*). They concluded that this "jackpot" pattern could only occur if mutations in the bacteria arose prior to their exposure to the phage. (*B*) Mutations that occurred late in the growth of the secondary culture would yield few mutant cells (shown in *red*), and thus few colonies, at the end of the growth of the culture (tree on the *left*). Mutations that occurred early would yield many mutants, and thus many colonies (tree on the *right*).