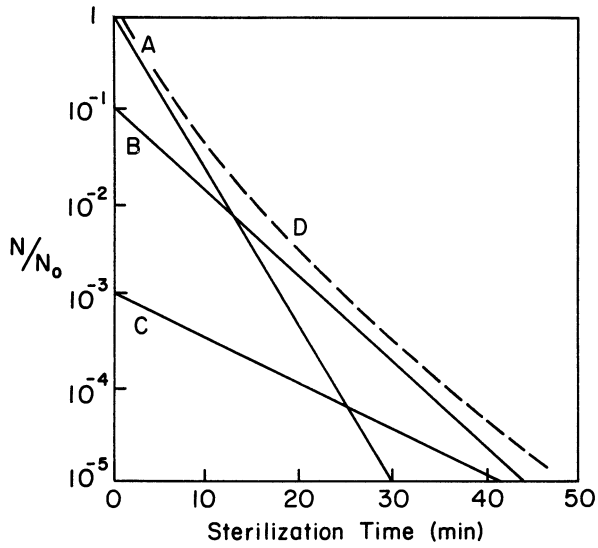

Figure 10.13. Overall survival curve (D) for a system with three distinct subpopulations (A, B, and C). Population A is normally dominant, but it is the one most sensitive to the sterilizing agent, while subpopulation C is far more resistant.

and many spores and can be used to sterilize equipment. A formaldehyde solution is often effective. Sodium hypochlorite solution (3%) has been used in sterilizing (or disinfecting) small-scale, heat-sensitive equipment. Some chemicals (e.g., ozone) cannot usually be used to sterilize fluids without adverse side reactions affecting medium quality.

For most large-scale equipment and liquids, thermal sterilization is used (filter sterilization is the only practical alternative for liquids). Usually, the dependence of the specific death rate on temperature is given by an Arrhenius equation:

$$k_d = \alpha e^{-E_{0d}/RT} \tag{10.18}$$

where R is the gas constant, T is absolute temperature, and E_{0d} is the activation energy for the death of the organism. Values for E_{0d} range from about 50 to 150 kcal/g-mol. For spores of *Bacillus stearothermophilus*, $E_{0d} \approx 70$ kcal/g-mol, and values of 127 kcal/g-mol have been determined for *E. coli*. Most thermal sterilizations take place at 121°C. The values for k_d in such situations are very high for vegetative cells (often $> 10^{10}$ min^{-1}). For spores, the values of k_d typically range from 0.5 to 5.0 min^{-1}. In most cases we are only concerned about spores when steam-sterilizing equipment and media, since the value of k_d is so much lower with spores than vegetative cells.

The E_{0d} for vitamins and growth factors in many media is about 2 to 20 kcal/g-mol. The inactivation of viability is much more sensitive to temperature changes than the degradation of important growth factors in the medium. This factor is important to the design of sterilization equipment and protocols so as to assure complete killing of foreign organisms without the destruction of necessary growth factors in the medium.

The main factors in any sterilization protocol are the temperature, time of exposure, and initial number of organisms that must be killed. The problems of sterilization increase