



**Figure 1.1.** Photograph of Alexander Fleming's original plate showing the growth of the mold *Penicillium notatum* and its inhibitory action on bacterial growth. (With permission, from Corbis Corporation.)

World War II provided the impetus to resurrect the discovery. Sulfa drugs have a rather restricted range of activity, and an antibiotic with minimal side effects and broader applicability was desperately needed. Howard Florey and Ernst Chain of Oxford decided to build on Fleming's observations. Norman Heatley played the key role in producing sufficient material for Chain and Florey to test the effectiveness of penicillin. Heatley, trained as a biochemist, performed as a bioprocess engineer. He developed an assay to monitor the amount of penicillin made so as to determine the kinetics of the fermentation, developed a culture technique that could be implemented easily, and devised a novel back-extraction process to recover the very delicate product. After months of immense effort, they produced enough penicillin to treat some laboratory animals.

Eighteen months after starting on the project, they began to treat a London bobby for a blood infection. The penicillin worked wonders initially and brought the patient to the point of recovery. Most unfortunately, the supply of penicillin was exhausted and the man relapsed and died. Nonetheless, Florey and Chain had demonstrated the great potential for penicillin, if it could be made in sufficient amount. To make large amounts of penicillin would require a process, and for such a process development, engineers would be needed, in addition to microbial physiologists and other life scientists.

The war further complicated the situation. Great Britain's industrial facilities were already totally devoted to the war. Florey and his associates approached pharmaceutical firms in the United States to persuade them to develop the capacity to produce penicillin, since the United States was not at war at that time.