Scottish bacteriologist who discovered penicillin, a substance produced by the mould *Penicillium notatum* and found to be effective in killing various pathogenic bacteria without harming the cells of the human body. Penicillin was the first antibiotic to be used in medicine. For this discovery, he shared the 1945 Nobel Prize for Physiology or Medicine with Howard Florey and Ernst Chain, who developed a method of producing penicillin in quantity.

Fleming was born on 6 August 1881 in Lochfield, Ayrshire, the son of a farmer. He was educated at Kilmarnock Academy and, after his father died in 1894, his poverty-stricken family sent him to London, where he first studied at the London Polytechnic Institute and then got a job as a clerk in a shipping office. While working there, and encouraged by his brother who was a doctor, he won a scholarship to study medicine at St Mary's Hospital Medical School, London, in 1902. He graduated four years later and remained at St Mary's in the bacteriology department for the rest of his career.

In his early years Fleming assisted the bacteriologist Almroth Wright, an association that continued when the two men were in the Royal Army Medical Corps and worked together in military hospitals during World War I. After the war, in 1918, Fleming returned to St Mary's as a lecturer, becoming director of the department of systematic bacteriology and assistant director of the inoculation department in 1920. He was appointed professor there and lecturer at the Royal College of Surgeons in 1928. He was knighted in 1944 and in 1946 became director of the Wright-Fleming Institute, where he continued to work until he retired in 1954. He died in London on 11 March 1955.

In 1928 Fleming made his major discovery quite by accident. He was working on the bacterium *Staphylococcus aureus* and had put aside some Petri dishes that contained the cultures. He later noticed that specks of green mould had appeared on the nutrient agar and that the bacterial colonies around the specks had disappeared. The effect on the bacteria was 'antibiosis' (against life). Fleming cultured the mould in nutrient broth and it formed a felt-like layer on the surface, which he filtered off. He tested the filtrate on a range of bacteria and found it killed some disease bacteria, but not all of them. He identified the mould as *Penicillium notatum*, a species related to that which grows on stale bread, and named the active substance it produced - the antibiotic element - 'penicillin'. Craddock, one of Fleming's assistants, grew some *Penicillium* in milk and ate the cheeselike product without any ill effects; no harm resulted, either, when mice and rabbits were injected with the material.

The purification and concentration of penicillin was, however, a chemical problem and Fleming was not a chemist. Two of his assistants made some progress but they left the matter unresolved until 1939, when Florey and Chain, in Oxford, isolated the substance and purified it. They published their results in 1940, and work began on the large-scale production of penicillin.

It was generally assumed that the original phenomenon that Fleming had observed was a common event, but Fleming was never able to produce the effect again. It has since been shown that a similar result is achieved only under very precise conditions, which are unlikely to be met during the routine
inoculation and incubation of a bacterial plate.

Fleming also developed methods, which are still in use, of staining the spores and flagella of bacteria. He identified organisms that cause wound infections and showed how cross-infection by streptococci can occur among patients in hospital wards. He also studied the effects of different antiseptics on various kinds of bacteria and on living cells. His interest in chemotherapy led him to introduce Paul Ehrlich's antibacterial agent Salvarsan into British medical practice.

In 1922 Fleming discovered the presence of the enzyme lysozyme in nasal mucus, tears, and saliva, where it catalyses the breakdown of carbohydrates surrounding bacteria and kills them. Fleming later showed it to be present in most body fluids and tissues. The enzyme thus helps to prevent infections, and has become a useful research tool for dissolving bacteria for chemical examination.

Penicillin, the first of the antibiotics, has been used with outstanding success in the treatment of many bacterial diseases, including pneumonia, scarlet fever, gonorrhea, diphtheria, and meningitis, and for infected wounds. Its discovery led to a scramble for further antibiotics in which streptomycin, chloromycetin, and the tetracyclines were discovered. Most antibiotics can now be made synthetically, and penicillin can be modified by chemical means for specific purposes.