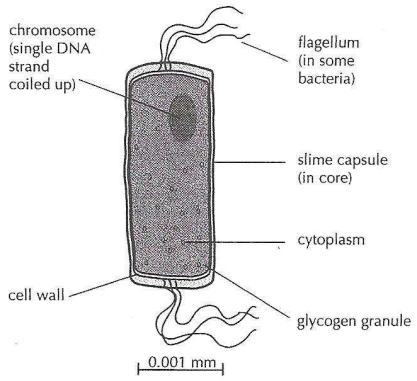
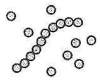
Antibacterials

INFECTIOUS ORGANISMS

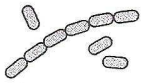
Many different types of micro-organism can cause disease, among them bacteria, viruses, fungi, yeasts, and protozoa. A typical bacterium consists of a single cell with a protective wall made up of a complex mixture of proteins, sugars, and lipids. Inside the cell wall is the cytoplasm, which may contain granules of glycogen, lipids, and other food reserves. Each bacterial cell contains a single chromosome consisting of a strand of deoxyribonucleic acid (DNA). Some bacteria are aerobic – that is they require oxygen and are more likely to infect surface areas, such as the skin or respiratory tract. Others are anaerobic and multiply in oxygen-free or low oxygen surroundings, such as the bowel. Not all bacteria cause disease and some are beneficial. Many exist on the skin or in the bowel without causing ill effects and some cannot live either in or on the body.



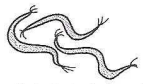
generalized diagram of a bacterium



Cocci (spherical) *Streptococcus* can cause sore throats and pneumonia.



Bacilli (rod-shaped) *Mycobacterium tuberculosis* causes tuberculosis.

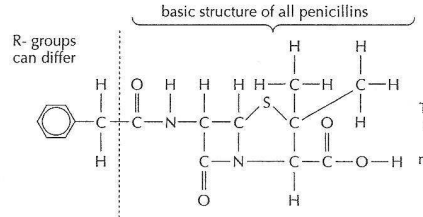


Spirochete (spiral-shaped) This group includes those bacteria that cause syphilis and infections of the gums.

DISCOVERY OF PENICILLIN

Antibacterials are chemicals, which prevent the growth and multiplication of bacteria. The first effective antibacterial, the dye trypan red, was developed by Paul Ehrlich to cure sleeping sickness. In 1910 Ehrlich also developed an arsenic containing compound, salvarsan, which was effective against syphilis. In 1935 the first 'sulfa dug' prontosil, which was effective against streptococcal bacteria, was developed.

However, the real discovery in the fight against bacteria was made by Alexander Fleming in 1928. Fleming, a bacteriologist, was working with cultures of *Staphylococcus aureus*, a bacterium that causes boils and other types of infections. He left an open petri dish containing one of the cultures in the laboratory, while he went away on holiday. Upon his return he noticed that a mould had developed and had inhibited growth of the bacterium. He deduced that the mould (*Penicillium notatum*) produced a compound (which he called penicillin), which inhibited the growth of bacteria. Although he published his results Fleming did not pursue his discovery. It was Howard Florey and Ernest Chain who overcame the problems associated with isolating and purifying penicillin. In 1941 they used penicillin on a policeman who was dying of septicaemia. They recorded a dramatic improvement in his condition, but unfortunately their meagre supply ran out before the policeman was cured and he relapsed and died. The search was on to produce penicillin in bulk. It was solved in America by growing strains of the penicillin mould in large tanks containing corn-steep liquor. In the 1950s the structure of penicillin was determined and this enabled chemists to synthesize different types of penicillin and other antibiotics (antibacterials originating from moulds) in the laboratory without recourse to moulds.



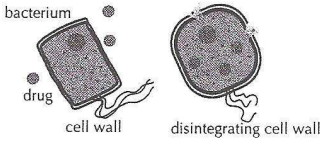
benzylpenicillin (penicillin G) The original penicillin was broken down by stomach acid so needed to be injected.

NARROW AND BROAD SPECTRUM ANTIBIOTICS

The penicillins are **narrow spectrum antibiotics**, effective against only certain types of bacteria. Other types of antibiotics, such as the tetracyclines (e.g. aureomycin and terramycin), are effective against a much broader range of bacteria (broad spectrum antibiotics). When a doctor is confronted with a patient suspected to be suffering from a bacterial infection the organism needs to be identified by taking blood, sputum, urine, pus, or stool samples. This takes time so initially a broad spectrum antibiotic may be prescribed. Once the bacterium is known the treatment may be switched to a narrow spectrum antibiotic, which is the recommended treatment for the identified organism.

MECHANISM OF ACTION OF ANTIBIOTICS

There are two main mechanisms by which antibiotics destroy bacteria. Penicillins and the cephalosporins prevent bacteria from making normal cell walls. Other antibiotics act inside the bacteria interfering with the chemical activities essential to their life function.

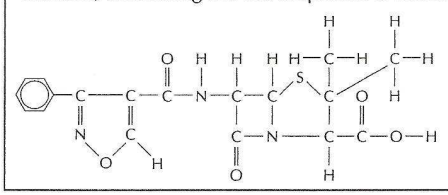


Penicillin interferes with cell-wall formation. As the cell swells, the osmotic pressure causes the wall to disintegrate and the bacterium dies.

OVERUSE AND RESISTANCE TO PENICILLINS

When penicillin became readily available to doctors it was often given to cure minor illnesses, such as a sore throat. Certain bacteria were resistant to penicillin and were able to multiply. Their resistance was due to the presence of an enzyme called penicillinase, which could deactivate the original penicillin, penicillin G. To combat this chemists developed other penicillins whereby the active part of the molecule is retained but the side chain is modified. However, as bacteria multiply and mutate so fast it is a continual battle to find new antibiotics, which are effective against an ever more resistant breed of 'super bugs'.

The use of antibiotics in animal feedstocks has also contributed to this problem. Healthy animals are given antibiotics to prevent risk of disease, but the antibiotics are passed on through the meat and dairy products to humans, increasing the development of resistant bacteria.



cloxacillin The change in the R-group makes this form resistant both to acid and penicillinase.