Antibacterials

Bacteria

Bacteria are microorganisms that can cause diseases. Typical bacteria are simple organisms that consist of a single cell with a protective cell wall. Each cell contains one chromosome, made of a strand of DNA.

- Aerobic bacteria: require oxygen so are more likely to infect surface areas (e.g. skin)

- Anaerobic bacteria: multiply in oxygen-free (or low oxygen) environments such as the bowel.

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Not all bacteria cause diseases!

Different types of bacteria include:

Staphylococcus – spherical cells that may occur in clumps.

Streptococcus – chains of spherical cells.

Antibacterials – penicillin (B.6.1)

Antibacterials are chemicals that prevent growth/multiplication of bacteria. There are many available but the most famous is probably still penicillin. Since the 1940s, penicillin has saved millions of lives. It has been successful against infections including pneumonia, meningitis, syphilis and anthrax. The discovery of penicillin was one of the greatest advances in human health care. But its discovery is also one of the best examples of how luck can play an important role in science!

In 1928, bacteriologist Alexander Fleming was carrying out some experiments with *Staphylococcus aureus*, a bacterium that causes boils and other infections. He went away on holiday and left open a Petri dish that contained some of the bacteria. When he returned, he found that a mould had appeared in the dish and

that the mould had inhibited the growth of the bacteria. He concluded that the mould (*Penicillium notatum*) produced a compound that inhibited bacterial growth. Fleming called the compound penicillin.

Fleming published these results but did not investigate the compound further. Instead, Howard Florey and Ernest Chain managed to overcome problems with isolating and purifying the penicillin and in 1941 they used penicillin to treat a policeman who was dying of septicaemia. The policeman showed a dramatic improvement but unfortunately, before he was completely cured, the small supply of penicillin ran out, and the policeman died.

In the US, a method was developed to grow the penicillin mould in bulk in large tanks. Then in 1951, the structure of penicillin was determined. This allowed chemists to synthesize a range of penicillin-related compounds as well as other antibiotics (antibacterials that are obtained from moulds).

Narrow- and broad-spectrum Antibiotics (B.6.2)

Penicillin and related compounds are narrow-spectrum antibiotics. This means they are effective only against certain types of bacteria. Other antibiotics (known as broad-spectrum antibiotics) are effective against a much wider range of bacteria. Such antibiotics include aureomycin and terramycin. If a patient is thought to be suffering from a bacterial infection, the doctor may prescribe broad-spectrum antibiotics until the exact bacterium has been identified by testing blood, urine, or stool samples. When the test results reveal the exact bacterium, the doctor can then prescribe an appropriate narrow-spectrum antibiotic.

How penicillins work (B.6.3) and overuse of penicillin (B.6.4)

Penicillins work by preventing bacteria from making cell walls. It destroys a chemical called peptidoglycan which is contained in the cell walls. The cell then bursts (“lysis”). When penicillin became readily available, doctors began to

prescribe it for all kinds of minor infections such as sore throats. Some bacteria were found to contain an enzyme called penicillinase, which makes them resistant to penicillin. Chemists were forced to synthesize new compounds, which retained the active area of the molecule but modified the side chain. Unfortunately, bacteria reproduce and mutate very quickly and can become resistant to many antibacterials. So scientists must continue to search for new compounds that will prove effective against the so-called “superbugs”.

The problem of resistance has been made worse by the fact that in many countries, antibiotics are routinely added to animal foods to prevent disease. These antibiotics are then passed on to humans via the food, and the bacteria then have lots of time to develop resistance to the antibiotics.