The Story of Aspirin: Chemical Structure

Acetylsalicylic acid – or, as it is more commonly known, aspirin – has a simple chemical structure. It consists of a small number of carbon, hydrogen and oxygen atoms, that form the chemical bonding patterns shown to the left and below.

In the figures shown on this poster, the colours indicate the position of the following chemical atoms:

- **Green** = carbon
- **Grey** = hydrogen
- **Red** = oxygen

These images show the atoms in aspirin adopt a “planar” configuration; the structure of the molecule is relatively flat and quite rigid.
The Story of Aspirin: Biological Function

Although aspirin has been available as a medicine since the early 1900’s, it was not until the 1970’s that we understood how it worked as a drug. Aspirin exerts its effect by permanently inactivating the enzyme cyclooxygenase. This enzyme synthesises prostaglandins and thromboxanes [1, 2].

Figure shows the molecular structure of a human cyclooxygenase protein, which is inactivated by a molecule similar to aspirin. The structure contains 2 molecules of protein (shown in green and blue), with the inhibitor shown in red. PDB file = 1PTH [2].

Aspirin produces wide-ranging effects because prostaglandins are hormones that help transmit the sensation of pain to the brain and they trigger inflammation [1, 2]. Thromboxanes promote the aggregation of platelets to form blood clots. Since heart attacks are caused primarily by blood clots, low doses of aspirin are being used to prevent clotting.

More recent studies suggest aspirin use reduces the risk of developing colorectal cancer [1]. At relatively high doses, aspirin slows down the proliferation of various cancer cells. However, the side effects of taking aspirin at these high doses limits the anti-cancer potential of the compound.

References:
There is evidence that plant extracts made from various sources, including willow bark, were used 6000 years ago to alleviate headaches, pains and fevers [1]. Indeed, Hippocrates, the father of modern medicine, who lived four centuries BC, described the use of powder made from the bark and leaves of the willow tree to treat these symptoms [1]. The modern era of aspirin began in the 18th century, when Reverend Stone described the beneficial effects of willow bark. In 1876, Thomas MacLagan, a Scottish physician, reported successfully using willow powder extract (salicin) to treat fever and rheumatism [1].

During the early 1800s many scientists analysed willow extract to find the active ingredient. This led to the purification of a substance called salicin, the Latin name for willow. These developments led to the establishment of the Heyden Chemical Company, in Germany, that produced modified salicin for medical purposes. However, since this was found to irritate the stomach, it was modified further, though controversy exists as to who modified it first [1, 2]. Identification of a successful version of the compound arrived when the Bayer Company registered the modified product, Acetylsalicyclic Acid, under the trade name Aspirin in 1899. Aspirin became known worldwide for safe and effective pain relief, being available without prescription to the public from 1915.

References: