Organic Chemistry in Human Contexts

Transcript

Instructor: Brett McCollum

00:00:00:20 - 00:00:30:00
Instructor: Ethanol and Methanol are both alcohols, and they look really similar in terms of their chemical structure. They only differ in the length of the carbon bonds. However, within the human body, they have particularly different chemistry, in terms of how it interacts with the body and the consequences of consumption. Let's first consider ethanol. Ethanol is consumed by many human cultures.

00:00:30:00 - 00:01:39:04
Instructor: Within the body, it is digested by an enzyme alcohol dehydrogenase, ADH. When that happens, it is converted from an alcohol into an aldehyde. This is further digested within the liver and converted by another enzyme into the conjugate base of the carboxylic acid. Now, this eventually gets further broken down into carbon dioxide and water. So, while ethanol is consumed by humans across multiple cultures, improper preparation of ethanol can sometimes result in contamination by methanol.

00:01:39:04 - 00:02:12:68
Instructor: Methanol when it's consumed in the body can lead to blindness or even death. To understand that, we need to consider the chemistry that occurs. As an alcohol, it interacts with the same enzyme, ADH, which converts it from an alcohol into an aldehyde. That aldehyde, you probably know. If we want, we can add in the implicit hydrogens.

00:02:15:28 - 00:02:53:11
Instructor: Now this is used to store, specimens, biological specimens. Do you recognize that molecule? It's formaldehyde. Now, it gets further broken down in the liver to form formate. Formate is understood to be primarily responsible for the toxicity to the human brain and the optic nerves, which is why it can lead to blindness and to death.

00:02:53:11 - 00:03:38:79
Instructor: If you accidentally consume methanol, we need a process by which to remove it from the human body or to reduce its reactivity with the body in order to keep you safe. There's three main strategies. The first strategy is to introduce a drug that would react with ADH, thus inhibiting the reaction pathway leading to formate. The other strategy is to remove the methanol from the body. The third strategy is to introduce something that would compete with the methanol for any available ADH.

00:03:38:79 - 00:04:39:51
Instructor: That first strategy, it involves a particular drug called 4-methylpyrazole. This drug will bind with the ADH, reducing the availability of it, thus inhibiting the reaction pathway that produces formate. The second strategy is to remove the methanol from the blood through dialysis. In some cases, where there are concerns that the volume of methanol consumed is dangerously high, they may actually add a third strategy to try and reduce the reactivity of the methanol within the body. As I mentioned, that's about introducing yet another molecule that will compete with methanol for the available enzyme.

00:04:39:51 - 00:05:16:09
Instructor: Because this enzyme specifically reacts with alcohols, that competitor would need to be an alcohol. What alcohol do humans consume? Ethanol. And that's what the third strategy is. They might hook you up inside the hospital with a drip that contains ethanol, thus encouraging that reaction pathway, reducing the amount of available ADH enzyme that could have led to the formate.

00:05:16:09 - 00:05:36:79
Instructor: This strategy is recommended under certain circumstances, and with certain guidance parameters by the US National Institute for Health. It's important to understand those before ever using this strategy in which to minimize the impacts of methanol consumption.