Alcohol

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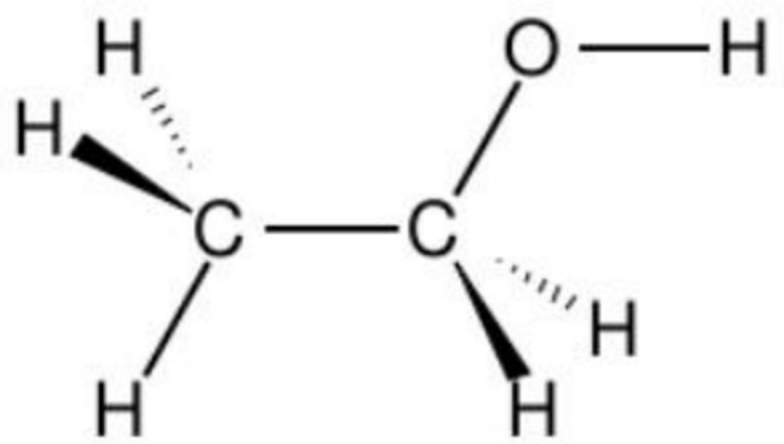
What is it?

Exposure Name: Alcohol

Alcohol has countless alternative names due to the various uses of it. Alcohol typically used for consumption is called ethyl alcohol or ethanol[1]. Alcohol used in the industry and various products is known as methyl alcohol, methanol, or wood alcohol[2] .

Chemical Structure ethyl alcohol (image only):



Uses of Alcohol

Uses of alcohol can vary. Ethyl alcohol usage is mainly used for consumption[3]:
In alcoholic beverages

- Beer: approximately 5% alcohol
- Wine: Between 12-15% alcohol
- Distilled liquor: Ranges from 30-50% alcohol, but can be higher

Methyl alcohol is used mainly in the industry. Some example include[4]:

- As a biofuel additive
- For surgical suture packaging
- In inks
- In synthetic rubber, paint, and lacquer
- In various medications
- For the manufacturing of acetaldehyde, acetic acid, ethylacetate, ethylchloride, ethylether, butadiene, ethylene dibromide, soaps, cleaning preparations, dyes and explosives.
- As a solvent for labs, resins, fats and oils

- As a pharmaceutical, such as rubbing compounds
- In perfumes

Methyl alcohol is also known to naturally occurs in blood, urine, fruits and vegetables[5].

There is no recommended daily intake of either ethyl alcohol or methyl alcohol, as alcohol is non-essential[6].

What are the health impacts?

Toxicity symptoms from consumption of ethyl alcohol in adults can include[7]:

- Memory loss
- Inebriation
- Liver disease
- Cancer

Children's toxicity from consumption of ethyl alcohol symptoms include[8]:

- Lowered IQ
- Learning and behavioral problems

Health effects of ethyl alcohol vary on the dosage. Ethyl alcohol is said to be therapeutic if used in moderate doses. If used moderately is also said to decrease the risk of heart disease and can also flush out kidneys. Moderate ethyl alcohol usage is defined as 1-3 glasses of wine weekly.[9]

Acute health effects from ethyl alcohol include dehydration and depression of the central nervous system, but they also vary with each blood alcohol concentration, including[10]:

- .05 blood alcohol concentration: reduced inhibitions
- .10 blood alcohol concentration: Slurred speech
- .20 blood alcohol concentration: Euphoria and motor impairment
- .30 blood alcohol concentration: Confusion
- .40 blood alcohol concentration: Stupor
- .50 blood alcohol concentration: Coma
- Above .50 blood alcohol concentration: Respiratory paralysis and death

Chronic health effects of ethyl alcohol usage can include risk of cirrhosis in the liver and many forms of cancer due to the accumulation of acetaldehyde in the liver[11].
Other poor health outcomes due excessive drinking can include[12]:

- Unintentional injuries such as motor vehicle accidents, drowning, falls and burns
- Violence, including child maltreatment, homicide and suicide
- Alcohol abuse and dependency

Toxicity symptoms from methyl alcohol can include[13]:

- Irritation in eyes, skin and upper respiratory system
- Headache
- Drowsiness

- Nausea
- Vomiting
- Visual disturbance
- Optic nerve damage (blindness)
- Dermatitis

Symptoms of methyl alcohol poisoning can include[14]:

- Death
- Central nervous system depression
- Vomiting
- Metabolic acidosis
- Severe vision impairment within 8-24 hours of exposure
- Blindness
- Alcoholic ketoacidosis
- Diabetic ketoacidosis
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<u>Disease endpoints for ethyl alcohol</u>

Information below comes from following source unless otherwise indicated: Heindel, Jerrold J., Newbold, Retha, et al. Endocrine disruptors and obesity. *Nature Reviews*. November 2015; 11(11): 653-661[15]. The "strong", "good", and "limited" categories are taken from the CHE Toxic and Disease Database structure.

Strong evidence has been shown linking ethyl alcohol to the following health endpoints:

- Acute hepatocellular injury (hepatitis)
- ADD/ADHD, hyperactivity
- Behavioral problems*
- Breast cancer
- Cardiac congenital malformations*
- Cirrhosis
- Cognitive impairment (includes impaired learning, impaired memory, and decreased attention span) / mental retardation / developmental delay
- Congenital malformations - general
- Cranio-facial malformations*
- Delayed growth
- Esophageal cancer
- Fetal alcohol syndrome / fetal solvent syndrome
- Fetotoxicity (miscarriage / spontaneous abortion, stillbirth)
- Hearing loss
- Hepatocellular cancer (liver cancer)
- Hormonal changes (levels of circulating sex hormones - FSH/LH, Inhibin, and/or estrogens, progesterones, androgens, prolactin)
- Laryngeal cancer
- Low birth weight / small for gestational age / intra-uterine growth retardation

- Pancreatitis
- Porphyria (toxic)
- Psychiatric disturbances (disorientation, hallucinations, psychosis, delirium, paranoias, anxiety/depression, emotional lability, mood changes, euphoria)
- Reduced fertility - male (infertility and subfertility)
- Skeletal malformations*
- Steatosis (fatty liver)
- Testicular toxicity

Good evidence has been shown linking ethyl alcohol to the following:

- Menstrual disorders (abnormal bleeding, short cycles, long cycles, irregular cycles, painful periods)
- Myelodysplastic syndrome (pre-leukemia)
- Oral cancer
- Oral clefts (cleft lip and palate)

Strong evidence has been shown linking methyl alcohol to the following:

- Acute tubular necrosis
- Decreased vision (includes blindness, retinopathy, optic neuropathy)

Good evidence has been shown linking methyl alcohol to the following:

- Pancreatitis
- Parkinson's disease / movement disorders

Highly sensitive populations to ethyl alcohol include pregnant women and fetuses. Pregnant women who consume alcohol expose their unborn fetus to it as well. Fetal exposure to alcohol can lead to various complications, which fall on the fetal alcohol spectrum disorder (TOXIPEDIA)[16].

Various groups may metabolize alcohol differently due to many factors including age, gender, physical condition, how quickly alcohol was consumed and race or ethnicity. Certain groups have challenges metabolizing acetaldehyde, which is what alcohol is metabolized into, due to the amounts and types of metabolizing enzymes they have. For example, about 50% of the Asian heritage has an inactive form of aldehyde dehydrogenase (ALDH) due to a single base change in the gene which encodes for ALDH. Without this necessary gene, acetaldehyde blood levels rise, which leads to various toxic side effects[17]. (TOXIPEDIA)

Additionally, women metabolize alcohol differently than men. This is for many reasons. First, women tend to be smaller, so they intake a higher dose of alcohol per body weight. Next, women metabolize less of their alcohol in the intestine, which leads to higher absorption, leading to higher blood alcohol concentration. Lastly, women tend to have a higher body fat percentage per body weight. This leads to women have a lower volume of fluid by weight. All in

all, drink for drink, women will have a higher blood alcohol concentration than a man would due to differences in the body's metabolism[18].

Read more on metabolizing alcohol here[19].

How are we exposed?

Sources of exposure can vary depending on the type of alcohol. Sources of exposure to ethyl alcohol mostly include alcohol which is consumed, such as alcoholic beverages. Sources of exposure to methyl alcohol include various home, manufacturing and industrial products. Various sources are listed above in the "uses of alcohol" section[20]. A list of products in which methanol are used in can be found here[21]. Typical routes of exposure include inhalation, ingestion and skin or eye contact[22].

How do we prevent or reduce exposures?

Regulation of ethyl alcohol varies by country. In the United States, the government set an age restriction on purchasing alcohol to be 21 years of age. The OSHA permissible exposure limit for general industry is 1,000 ppm[23]. There is also regulation to reduce drinking and driving, as there is a legal limit of blood alcohol concentration for driving which is between .08 and .1[24]. Additional recommendations are extended by the government to pregnant women to avoid alcohol during pregnancy to not expose the fetus[25]. The recommendations from the 2015-2020 Dietary Guidelines for Americans explain that the following groups should not drink alcohol at all[26]:

- Anyone under age 21
- Women who are or may be pregnant
- Anyone who is driving, planning to drive or participating in activities which require coordination, certain skills and alertness
- Anyone taking certain prescription or over the counter medications, which interact with alcohol
- Individuals with certain medical conditions
- Those recovering from alcoholism, and those who are not able to control how much they drink

The various regulations put into place along with education on ethyl alcohol usage within school are preventative methods taken. By regulating the age of who can purchase alcohol, this helps prevent and reduce the prevalence of teen drinking. In addition, all schools provide education on alcohol usage and its effects within various points of schooling[27].

OSHA has set regulations to ensure safe usage of methyl alcohol. Currently, the general permissible exposure limit in the general industry is 200ppm. This limit is the same for the construction industry and shipyard employment, two common occupations with high exposure[28]. Prevention of methyl alcohol exposure focuses on avoiding skin and eye contact. If contact does occur, it is critical to wash skin immediately when contacted. First aid if exposure occurs includes, irrigation of eyes immediately, flushing skin with water, providing respiratory

support if it is inhaled and providing immediate medical attention if it is swallowed [29]. OSHA provides specific respirator regulations, which can be found here[30].

Other regulations on methanol include limiting the percent of methanol in windshield washing fluids to be 3%. As calculated by the eMSCA, swallowing windshield wiper fluid can be lethal, if it contains high doses of methanol[31]. Limiting methanol is critical as a lethal dose in humans is between 2 to 8 ounces, if taken orally. Methanol poisoning can also occur after inhalation or dermal absorption, and this has been seen before in the workplace[32]. Because methanol is used in countless products which families use daily, limiting the amount of methanol present can help reduce the chance of methanol poisoning.

History & Ethics

Ethyl alcohol has been used for centuries for countless reasons. It was used as a relaxant and for its euphoric effects, as a standard part of peoples diets, for medicinal and recreational purposes[33]. Although, in recent years, excessive drinking has been draining our economy. In 2010, excessive drinking cost the US $249 billion dollars which is a huge increase from 2006, where it cost $223.5 billion. These huge costs include reduced workplace productivity, crime and treating people for health problems which are related to excessive drinking. Not only is excessive drinking draining our economy, but it is also taking 88,000 lives each year in America. Excessive alcohol usage is responsible for 1 in 10 deaths among working aged Americans. This is said to be an underestimate as well, as it is challenging to correctly understand the damage alcohol does, as it is often not reported[34].

Methyl alcohol also causes significant health problems if consumed. It can often be found in various home-distilled spirits, such as moonshine. It has been reported that bootleg liquor is sometimes added or substituted in drinks due to commercial alcohols costs. Bootleg alcohol is very cheap, in comparison. Homemade liquor is unsafe, due to the inability to separate out methyl alcohol and ethyl alcohol, leading to consumption of unsafe amounts of methyl alcohol[35]. Not only is the amount of methyl alcohol present unsafe, but also this liquor is often brewed in car radiators or old fuel drums. In addition to brewing the liquor in unsafe materials, often, harmful ingredients such as rubbing alcohol, lye and paint thinner along with other products are added. This illegal moonshine can still be found today in American Moonshine and is as cheap as $5 a gallon, which can be 1/5 to 1/10 of the cost of commercial liquor[36]. This price makes it much more appealing and accessible to groups with low income, even though it holds a life threatening risk.

Helpful Infographics

http://www.cdc.gov/media/images/releases/2015/p1015-excessive-alcohol.pdf

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