How Alcohol Induces Intoxication

When alcohol (ethanol) is consumed, a process takes place in the human body that causes one to become intoxicated. Alcohol is a term used to refer to ethanol, a colorless, volatile, flammable liquid (chemical make-up: C₂H₅OH) that is the intoxicating agent in liquors. Intoxication refers to a state where one’s capacity for reason and action is inhibited (usually by alcohol or drugs). The process consists of the ethanol compound entering the bloodstream to inhibit one’s brain function. This process begins when alcohol is ingested and absorbed through the digestive system.

Absorption

Alcohol is most commonly ingested orally, where it begins to travel through the digestive system. Unlike the way solid or liquid would be digested, alcohol does not travel through the digestive system to be excreted as waste. Alcohol begins the digestive process after oral ingestion where it is absorbed into the bloodstream before being processed into waste. As can be seen in figure 1, the alcohol enters the body through the mouth and travels through the esophagus until reaching the stomach. In the stomach about 20% of the alcohol is absorbed into the bloodstream. This figure will vary depending on the concentration of the alcohol as well as the contents already in the stomach at the time of ingestion. For example, if there is more food in the stomach (especially food high in protein or fat), the rate at which alcohol is emptied from the stomach and its subsequent absorption will decrease. After being processed by the stomach, the remaining alcohol passes on to the small and large intestines and is absorbed into the bloodstream. However, not all of the alcohol is absorbed; a small amount (approximately 10%) is excreted through urine, sweat, saliva and breath.

Figure 1. Digestive system


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The amount absorbed and rate of absorption will determine the blood alcohol concentration (BAC). Blood alcohol content is a measurement of the concentration of ethanol in one’s blood. This figure is measured by milligrams of ethanol per 100 milliliters of blood. For example, if there is 0.08 milligram of alcohol per 100 milliliters of one’s blood, then this person has a BAC of 0.08. The higher the blood alcohol concentration, the more intoxicated one is considered.

**Depression of Central Nervous System**

When one wants to move his/her arm, the brain must send a message to the arm telling it to move. To do this, the brain sends neurotransmitter molecules (molecules that transmit signals from one neuron to a “target” neuron) from the end of a nerve. These molecules act as messengers, reaching a target nerve (neuron) cell telling the arm to move. When alcohol becomes part of the equation, it attaches to these target nerve cells where it attempts to block the message making it more difficult for one to perform such an action.

To understand this, reference the image below. The purple axon, sitting above the blue receptor, sends these neurotransmitter molecules to the blue receptor. This blue receptor could be considered the target nerve that causes the arm to move. So, when alcohol is involved, the ethanol molecules attach to the blue receptor cell, and inhibit its ability to receive these neurotransmitter molecules.

![Figure 2. Neurotransmission](<www.kickoff.net.au>)

The intoxicated feeling one will obtain depends on the part of the brain targeted by the alcohol.

**Cerebral Cortex**

The cerebral cortex is the part of the brain that is usually affected first. The cerebral cortex is the part of the brain responsible for cognitive thinking, behavior and voluntary muscle movements. So, when alcohol diminishes the rate of information exchange in this part of the brain, one can feel less sensitive to touch or
pain. This is an illusion; the body still receives the damage, but the brain simply does not process the information as quickly, causing one to not acknowledge this pain. Since the cerebral cortex also controls behavior, alcohol involvement here will induce a change in usual behavior. This means that, upon intoxication, one will lose some of the ability to control his/her behavior. He/she will begin to lose the ability to understand what is appropriate and his/her inhibitions.

**Limbic System**
The limbic system controls and regulates emotion. When alcohol slows down this part of the brain, one emotions can become significantly exaggerated. This is why people tend to cry, fight and laugh more when intoxicated.

**Cerebellum**
The Cerebellum is the area of the brain controlling the coordination of muscle movement. Information telling the muscles to move together in a sort of harmony is received here. Therefore, the more alcohol involved in this area, the more one will lose coordination. This is what causes difficulty in simple tasks such as walking, or sometimes even standing.

**Hypothalamus and Pituitary Gland**
This is the part of the brain that causes the production of anti-diuretic hormone (ADH). ADH is the hormone that causes one's kidney to retain or conserve water. When alcohol stops the production of this hormone, the body stops conserving as much water. So, alcohol does not "go right through you", it causes one to release water rapidly demanding increased urination.

**Medulla**
This is the last part of the brain that alcohol reaches. The Medulla is responsible for one to continue performing actions without cognitive thinking. When this is inhibited by alcohol, one will begin to lose consciousness and fall asleep.

The figure below depicts the effects of alcohol depending on blood alcohol concentration (BAC). These effects can be described by the part of the brain reached at each level. For example, at a BAC of 0.12, one becomes emotionally irrational. So, the alcohol has reached the limbic system.

<table>
<thead>
<tr>
<th>BAC</th>
<th># Drinks Consumed</th>
<th>Effects</th>
<th>Hours needed to metabolize alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>1 - 2</td>
<td>Relaxation; decreased inhibition and judgment; decreased reaction time and alertness</td>
<td>2 - 3</td>
</tr>
<tr>
<td>0.05 - 0.10</td>
<td>3 - 4</td>
<td>Marked decrease in fine motor skills, reaction time, and judgment; may be clumsy; exaggerated behaviors</td>
<td>4 - 6</td>
</tr>
<tr>
<td>0.10 - 0.15</td>
<td>5 - 7</td>
<td>Vision and perception affected; can be verbally argumentative, emotionally irrational; further impairments in reaction time and judgment</td>
<td>6 - 10</td>
</tr>
<tr>
<td>0.15 - 0.30</td>
<td>8 - 10</td>
<td>Staggering; slurred speech; blurred vision; sensory and motor skills greatly affected; nausea/vomiting</td>
<td>10 - 24</td>
</tr>
<tr>
<td>more than 0.30</td>
<td>more than 10</td>
<td>Stuporous; may be conscious but unaware of surroundings; decreased respiration; anesthesia at levels above 0.35; approximately 50% will die at levels above 0.40</td>
<td>more than 24</td>
</tr>
</tbody>
</table>

**Figure 3. BAC Based Effects**
Image adapted from <http://publichealth.hsc.wvu.edu/alcohol/Effects-on-the-Body/Short-Term-Effects>

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Elimination

Alcohol is eliminated from the body when it is metabolized. Metabolism is a term referring to the chemical process where food is converted to obtain nutrients. Alcohol is metabolized in the liver. First, an enzyme called dehydrogenase converts the alcohol (ethanol) into acetaldehyde. The acetaldehyde is then broken down further into acetic acid (acetate). Acetic acid can be harvested by the body and used as energy. The acid that is not burnt off as energy is broken down into carbon dioxide, water and fatty acids. At this point, alcohol no longer remains and, therefore, is eliminated. The liver metabolizes 90% of the alcohol; 5% leaves the body by evaporation through breathing; 5% is excreted through urine.

The process occurs over a certain period of time, depending on several factors, including tolerance, age and gender. The average rate of elimination is one standard drink (10 grams) per hour. In figure 4 below, a typical BAC curve can be seen.

Summary

Alcohol intoxication is induced when the alcohol is absorbed in the stomach and intestines to enter the bloodstream. The alcohol reaches the brain, attaches to the receptor cells inhibiting the cells ability to receive information. The inability to receive information at a normal rate causes one to become intoxicated. After a period of time, the alcohol is metabolized and eliminated from the body, ending the feeling of intoxication.