Alcohol and the Human Body

Alcohol's Properties[1] Alcohol is a general term denoting a family of organic chemicals with common properties. Members of this family include ethanol, methanol, isopropanol, and others. This introduction discusses the physical, chemical, and physiological aspects of the most commonly ingested of these - ethanol.

Alcohol (ethanol) is a clear, volatile liquid that burns (oxidizes) easily. It has a slight, characteristic odor and is very soluble in water. Alcohol is an organic compound composed of carbon, oxygen, and hydrogen; its chemical formula is C2H5OH. Alcohol is a central nervous system depressant and it is the central nervous system that is the bodily system that is most severely affected by alcohol (see chart below). The degree to which the central nervous system function is impaired is directly proportional to the concentration of alcohol in the blood[2].

When ingested, alcohol passes from the stomach into the small intestine, where it is rapidly absorbed into the blood and distributed throughout the body. Because it is distributed so quickly and thoroughly the alcohol can affect the central nervous system even in small concentrations. In low concentrations, alcohol reduces inhibitions. As blood alcohol concentration increases, a person's response to stimuli decreases markedly, speech becomes slurred, and he or she becomes unsteady and has trouble walking. With very high concentrations - greater than 0.35 grams/100 milliliters of blood (equivalent to 0.35 grams/210 liters of breath) - a person can become comatose and die. The American Medical Association has defined the blood alcohol concentration level of **impairment for all people** to be **0.04 grams/100 milliliters** of blood (equivalent to .04 grams/210 liters of breath). The following is a generally accepted guide to the affects of alcohol.

Stages of alcohol intoxication[33]

BAC (g/100 ml of blood or g/210 l of breath)	Stage	Clinical symptoms
0.01 - 0.05	Subclinical	Behavior nearly normal by ordinary observation
0.03 - 0.12	Euphoria	Mild euphoria, sociability, talkativeness Increased self-confidence; decreased inhibitions Diminution of attention, judgment and control Beginning of sensory-motor impairment Loss of efficiency in finer performance tests
0.09 - 0.25	Excitement	Emotional instability; loss of critical judgment Impairment of perception, memory and comprehension Decreased sensitory response; increased reaction time Reduced visual acuity; peripheral vision and glare recovery Sensory-motor incoordination; impaired balance Drowsiness
0.18 - 0.30	Confusion	Disorientation, mental confusion; dizziness Exaggerated emotional states Disturbances of vision and of perception of color, form, motion and dimensions Increased pain threshold Increased muscular incoordination; staggering gait; slurred speech Apathy, lethargy
0.25 - 0.40	Stupor	General inertia; approaching loss of motor functions Markedly decreased response to stimuli Marked muscular incoordination; inability to stand or walk Vomiting; incontinence Impaired consciousness; sleep or stupor
0.35 - 0.50	Coma	Complete unconsciousness Depressed or abolished reflexes Subnormal body temperature Incontinence Impairment of circulation and respiration Possible death
0.45 +	Death	Death from respiratory arrest

Absorption[4] Alcohol is absorbed from all parts of the gastrointestinal tract largely by simple diffusion into the blood. However the small intestine is by far the most efficient region of the gastrointestinal tract for alcohol absorption because of its very large surface area. In a fasting individual, it is generally agreed that **25%** of a dose of alcohol is absorbed from the stomach and **75%** is absorbed from the small intestine. Because of this peak blood alcohol concentrations are achieved in fasting people within 0.5 to 2.0 hours, while non-fasting people exhibit peak alcohol concentrations within 1.0 to as much as 6.0 hours.

Distribution Alcohol has a high affinity for water and is therefore found in body tissues and fluids inasmuch as they contain water. Absorbed alcohol is rapidly carried throughout the body in the blood and once absorption of alcohol is complete an equilibrium occurs such that blood at all points in the system contains approximately the same concentration of alcohol.

Elimination The liver is responsible for the elimination - through metabolism - of 95% of ingested alcohol from the body. The remainder of the alcohol is eliminated through excretion of alcohol in breath, urine, sweat, feces, milk and saliva. The body uses several different metabolic pathways in its oxidation of alcohol to acetaldehyde to acetic acid to carbon dioxide and water.

Healthy people metabolize alcohol at a fairly consistent rate. As a rule of thumb, a person will eliminate one average drink or .5 oz (15 ml) of alcohol per hour. Several factors influence this rate. The rate of elimination tends to be higher when the blood alcohol concentration in the body is very high or very low. Also chronic alcoholics may (depending on liver health) metabolize alcohol at a significantly higher rate than average. Finally, the body's ability to metabolize alcohol quickly tend to diminish with age.

Body Weight and Body Type In general, the less you weigh the more you will be affected by a given amount of alcohol. As detailed above, alcohol has a high affinity for water. Basically one's blood alcohol concentration is a function of the total amount of alcohol in one's system divided by total body water. So for two individuals with similar body compositions and different weights, the larger individual will achieve lower alcohol concentrations than the smaller one if ingesting the same amount of alcohol.

However, for people of the same weight, a well muscled individual will be less affected than someone with a higher percentage of fat since fatty tissue does not contain very much water and will not absorb very much alcohol.

Rate Of Consumption Blood alcohol concentration depends on the amount of alcohol consumed and the rate at which the user's body metabolizes alcohol. Because the body metabolizes alcohol at a fairly constant rate (somewhat more quickly at higher and lower alcohol concentrations), ingesting alcohol at a rate higher than the rate of elimination results in a cumulative effect and an increasing blood alcohol concentration.

Alcohol Content It's not how *many drinks* that you have, but *how much alcohol* that you *consume*. As you can see from the chart below some drinks are more potent than others.

Alcohol Content of Some Typical Drinks[55]

Drink	Alcohol Content
Manhattan	1.15 oz. (34 ml)
Dry Martini	1.00 oz. (30 ml)
Malt liquor -12 oz. (355 ml)	0.71 oz. (21 ml)
Airline miniature	0.70 oz. (21 ml)
Whiskey Sour/Highball	0.60 oz. (18 ml)
Table Wine - 5 oz. (148 ml)	0.55 oz. (16 ml)
Beer - 12 oz. (355 ml)	0.54 oz. (16 ml)
Reduced Alcohol Beer	0.28 oz. (8 ml)

Mixed drinks are based on typical drink recipes using **80 proof liquor**.
The amount of alcohol in actual mixed drinks may vary.

The concentration of the drinks that one ingests can have a slight effect on the peak alcohol concentration due to the differences in absorption rate of different concentrations of alcohol. Alcohol is most rapidly absorbed when the concentration of the drink is between 10% and 30%. Below 10% the concentration gradient in the gastrointestinal tract is low and slows absorption and the added volumes of liquid involved slow gastric emptying. On the other hand concentrations higher than 30% tend to irritate the mucous membranes of the gastrointestinal tract and the pyloric sphincter, causing increased secretion of mucous and delayed gastric emptying.

Alcohol Content (in Percent) of Selected Beverages[66]

Beverage	**Alcohol Content** (%)
Beers (lager)	3.2 - 4.0
Ales	4.5
Porter	6.0
Stout	6.0 - 8.0

Malt Liquor	3.2 - 7.0
Sake	14.0 - 16.0
Table wines	7.1 - 14.0
Sparkling wines	8.0 - 14.0
Fortified wines	14.0 - 24.0
Aromatized wines	15.5 - 20.0
Brandies	40.0 - 43.0
Whiskies	40.0 - 75.0
Vodkas	40.0 - 50.0
Gin	40.0 - 48.5
Rum	40.0 - 95.0
Aquavit	35.0 - 45.0
Okolehao	40.0
Tequila	45.0 - 50.5

Food Food taken along with alcohol results in a lower, delayed blood alcohol concentration peak (the point of greatest intoxication). There are two major factors involved in this phenomenon. First, because alcohol is absorbed most efficiently in the small intestine, the ingestion of food can slow down the absorption of alcohol into one's system. The pyloric valve at the bottom of the stomach will close in order to hold food in the stomach for digestion and thus keep the alcohol from reaching the small intestine. While alcohol will be absorbed from the stomach it is a slower and less efficient transition.

Second and equally important is the fact that alcohol elimination rates are inversely proportional to alcohol concentration in the blood. Therefore the suppressed levels of alcohol due to food ingestion cause the body to eliminate the alcohol that is absorbed at a faster rate.

The type of food ingested (carbohydrate, fat, protein) has not been shown to have a measurable influence on this affect but the larger the meal and closer in time between eating and drinking, the greater the diminution of peak alcohol concentration. Studies have shown reductions in peak alcohol concentration (as opposed to those of a fasting individual under otherwise similar circumstances) of 9% to 23%.

Medication If you are taking any medication, it could increase the effects of alcohol. You should always consult your physician or the medical information that accompanies the medication when drinking alcohol in conjunction with any medication.

Fatigue Fatigue causes many of the same symptoms that are caused by alcohol intoxication. These and other symptoms will be amplified if alcohol intoxication is concurrent with fatigue.

Tolerance Tolerance is the diminution of the effectiveness of a drug after a period of prolonged or heavy use of that drug or a related drug (cross-tolerance). There are two types of tolerance at work with alcohol. The first is *metabolic tolerance* in which the alcohol is metabolized at a higher rate (up to 72% more quickly) in chronic users. Because of the higher metabolic rate for alcohol lower peak blood alcohol concentrations are achieved by chronic alcohol users than the average drinker when the same amount of alcohol is ingested. The second is *functional tolerance* in which there is an actual change in the organ or system's sensitivity to the drug. Studies have shown that chronic alcohol users can have twice the tolerance for alcohol as an average person. It is important to note however that even in light of these tolerance factors, it has been shown conclusively that even in heavy alcohol users functional impairment is clearly measurable at the blood alcohol concentration levels that are currently used for traffic law enforcement and safety sensitive job performance.

Gender Differences As outlined above in the section on Body Weight and Body Type different body types coincide with different body water percentages. In general, but by no means in all cases, women tend to have a higher percentage of body fat and thus a lower percentage of body water. Therefore, in general, if a man and a woman of the same weight ingest the same amount of alcohol the woman will tend to achieve a higher alcohol concentration. This, of course, would not be true if the woman was very fit and the man was somewhat obese, but on average, this is the case. Furthermore, total body water tends to decrease with age, so an older person will also be more affected by the same amount of alcohol. According to the table below the differences in alcohol concentration due to average body composition differences based on gender would be between 16% and 10% depending on age.

Average **Total Body Water** as a function of **Sex and Age**

Age	Male	Female
18 to 40	61%	52%
over 60	51%	46%

Another gender-based difference is in the elimination of alcohol. Men's alcohol dehydrogenase enzyme digests alcohol in the stomach twice as efficiently as women's leading to lower blood alcohol for same amount ingested. Although not explained, studies appear to show that women eliminate alcohol from their bodies at a rate 10% greater than that of men.