**Susan gets Sued!**

One night Renita, Susan, Carlos, and Jerome left a party where they had been drinking alcohol and they had a car accident in which Renita was killed. Susan, the driver, survived, and she is being sued by Renita's parents.

Susan claims that she had 3 beers while at the party, but her friends each had 4, so she was elected the designated driver. Soon after the accident, they were rushed to the hospital and blood samples were obtained from the 4 teens. The lab tests showed that Susan had a blood alcohol concentration (BAC) of 0.13%, which was actually higher than the BAC obtained from the guys.

You have just been hired as an expert (a pharmacologist) by the plaintiffs (Renita's parents) to prove that Susan was not telling the truth. However, reviewing the case, you informed Renita's parents that Susan could be telling the truth. You indicate that there are **3 reasons** why Susan's BAC could have been as high as (or higher than) the guys' (with just as much intoxication), even if she drank less. What are the reasons?

In order to discuss the 3 reasons why females can have similar BACs (and degree of intoxication) to males when they drink less alcohol, there are several things to consider about the chemistry of alcohol and the biological factors that govern its movement around the body. Alcohol, or ethanol, is a very interesting molecule. It is polar, so it mixes with water, including blood plasma (the aqueous portion of the blood). But it also has a non-polar character to it, which is important in terms of its ability to get into the brain, where it produces intoxication. Consider the chemical nature of alcohol first.

1. What is an alcohol? What is the chemical structure of ethanol? How does the molecular formula differ from the structural formula of ethanol? What is it about the ethanol molecule that gives it both polar and non-polar characteristics?

Alcohols can consist of increasing chains of carbon atoms (either straight chained or branched). These different alcohols have different solubilities in water.

1. What are the chemical characteristics of increasing straight carbon chains of alcohols that determine their degree of solubility in aqueous solutions?

When Susan drank the alcohol, it entered her stomach and then moved across cell membranes of the gut to get into the capillaries of the bloodstream. This happens quite readily because ethanol is a very small molecule and because of its polar character.

1. What type of cells will ethanol have to cross to move from the gut into the capillaries? What method of transport will ethanol use—passive or active? Explain how the transport would work.

Once in the capillaries, ethanol moves into the veins, circulates throughout the body, and travels to the brain where it produces intoxication. But when the ethanol reaches the liver, it is oxidized by enzymes to inert products, which have no intoxicating effects. The process of enzymatic alteration of compounds is called metabolism.

1. Draw a schematic to show how ethanol is metabolized completely to produce inert metabolites (Hint: there are 2 steps and 2 enzymes involved). Where in the cells are these enzymes found? Where in the body are these enzymes found?

Humans vary in their ability to metabolize ethanol. This variation is because different people have different forms of the same enzyme that metabolizes the ethanol. Some forms of the enzyme metabolize ethanol more quickly than do other forms. The faster the ethanol is metabolized, the lower the BAC.

**5.** What can explain the presence of different forms of the ethanol-metabolizing enzyme? How would a difference in the form of these enzymes in females versus males explain different BACs?

**6.** Are these enzymes found in the same places in males and females?

**7.** What would be the consequence of reduced enzyme activity in females in terms of the degree of intoxication?

**8.** What other factors besides gender can affect the amount of ethanol in the blood and the BAC?

Body composition is also an important determinant of the concentration of drugs like alcohol in the blood and in other parts of the body. There are two primary compartments within the human body into which drugs typically distribute: water and fat. Water is found in the bloodstream, all the extracellular spaces and within cells as well. Fat is found in fat cells (adipocytes) and in the brain white matter (myelin).

**9.** Once ethanol gets into the bloodstream, which compartments will it enter? Why?

**10.** Does the size of these compartments differ between females and males? If so, how would that affect the BAC (and the degree of intoxication)?

So, now you can give Renita's parents the 3 reasons why she showed the same BAC compared to the guys, even though she drank less beer.