**What Happened Last Night?**

Justin and a few of his friends started drinking alcohol their second year in high school. Although they didn't drink alcohol very often, when they did drink it, they drank excessively, to the point of intoxication. Actually, Justin was surprised at how much they could drink before getting really "tipsy," compared to adults he had seen drink alcohol. Sometimes he had "blackouts;" he had trouble remembering the next day what had happened the night before, but that didn't seem to affect his decision to continue drinking alcohol. He continued drinking alcohol only on some weekends into his junior year—he knew that this was a key year in high school because he needed to have decent grades for his college applications the following year.

But something strange was happening. Even if he wasn't drinking any alcohol, he was starting to have trouble remembering some of the things that he would learn in class earlier in the day, and when it came time to taking his exams, he had trouble remembering some of the things he thought he knew when he was studying. He never had these kinds of problems before. He got a little worried, and confided in his friend Katy, who remarked, "Gee, it sounds similar to my grandmother who has Alzheimer's disease". Justin responded, "Don't be ridiculous, only older people get that disease."

So Justin continued to drink alcohol to the point of intoxication through the end of high school. During his college years (he did not get into the colleges on his wish-list, but he did get into one local college), Justin drank more often and increased the amount that he drank. He still had some memory problems, but he figured that's just the way his brain worked.

However, one night after having only 2 beers, he decided to drive back to his dorm and had a car accident. Luckily, no one was killed, but he had some head trauma and was taken to the hospital to get an MRI scan. The doctor who did the scan was surprised to see that a certain part of Justin's brain called the hippocampus was smaller than normal. He showed Justin the part of his brain that was abnormal. The doctor did not think this was caused by the accident. Upon questioning him, Justin admitted that he drank alcohol every weekend, but he felt that it didn't affect his normal life in any negative way. The doctor told him that his smaller hippocampus was associated with his alcohol drinking and it puts him at increased risk of Alzheimer's disease (Katy wasn't so far off!). Justin got quite concerned and agreed to consider working with a counselor to decrease his usage of alcohol.

In the story Justin is surprised that he reacts to alcohol differently than the way in which an adult reacts to alcohol.

**1.** What are the major differences in the ways in which an adolescent and adult respond to alcohol?

**2.** Could these differences be related to the extent of brain maturation? Why or why not?

When Justin drank alcohol he stated that sometimes he had "blackouts" or inability to remember some events that happened when he was drinking. Studies in humans show that when alcohol is in the body (and the brain) it actually prevents memories from being formed so they can't be recalled later.

**3.** How does alcohol cause memory lapses or blackouts? Which brain region and neurotransmitter systems are involved? Where in the cell does alcohol act to cause memory problems?

Repeated exposure of the brain to alcohol especially levels that are present during intoxication causes damage to specific parts of the brain. In the adolescent brain the hippocampus is especially vulnerable. Damage to the hippocampus caused by alcohol may be due in part to an inhibition of neurogenesis the "birth" of new neurons from neural stem cells. Alcohol can inhibit neurogenesis by preventing cell growth and division or by promoting death of the neural stem cells by a process of apoptosis—a form of cell suicide.

**4.** What is a stem cell? How does it give rise to a neuron?

**5.** Which step(s) in the cell cycle are most likely affected by alcohol? How does this affect cell growth and division?

**6.** Explain how a cell dies by apoptosis. Why is the process described as cell suicide?

As described in the story MRI brain scans show a smaller hippocampus in people who started drinking alcohol as adolescents.

**7.** Describe how an MRI scan is obtained (be general). What kind of atom is the MRI scanner targeting to get an image? Why this atom?

**8.** Do you think that the alcohol caused a smaller hippocampus, or that people with a smaller hippocampus are more likely to abuse alcohol? Why?

**9.** Suppose you had lab rats trained to drink alcohol (they do!). What kind of experiment could you devise using the rats to determine whether the smaller hippocampus is produced by the alcohol or whether the smaller hippocampus causes them to drink alcohol? (Hint—MRI scanners have been developed for rats!)

Studies show that damage to the hippocampus (e.g. loss of hippocampal neurons) from alcohol use is similar to that found in some neurodegenerative diseases like Alzheimer's disease.

**10.** What happens to brain function when the hippocampus is damaged?

**11.** How might alcohol abuse increase the risk for Alzheimer's disease?