Susan, a new intern at the local hospital, was working the admissions desk one Monday morning. A man and a woman rushed through the doors, carrying a second woman. “Help! Can you help us?” one called. Susan and a nurse rushed them into an exam room.

“What happened?” Susan asked while examining the patient. “We don’t know!” the female student sobbed. “Brittany started feeling sick at a party last night. She came home and went to sleep, but then couldn’t wake up this morning. She was acting so weird we decided to bring her here.”

Susan carefully observed the woman lying on the table. She was rolling her head and clearly seemed confused. However, there were no obvious signs of trauma. “Has Brittany taken any drugs recently?” Susan asked. The two students hesitated and looked at each other. Finally one of them nodded. “I think she took some Ecstasy last night.”

Susan thought for a moment. Ecstasy had been fairly popular on the party scene for several years now. She had seen people on the drug become somewhat confused, but not delirious. Maybe Brittany was having an adverse reaction to the drug. It was a start. To be safe, Susan ordered a series of blood tests. In the meantime, she checked her medical references to find out as much as she could about how Ecstasy affected the body.

Ecstasy (MDMA) Animation
http://learn.genetics.utah.edu/content/addiction/drugs/mouse.html

Animation describing the neurological/molecular mechanisms by which ecstasy works

Ecstasy (MDMA) Fact Sheet

• MDMA (3,4 methylenedioxymethamphetamine) is a synthetic, psychoactive drug chemically similar to the stimulant methamphetamine and the hallucinogen mescaline. MDMA acts as both a stimulant and psychedelic. It produces an energizing effect, distorts both physical and cognitive sensations, and may impair memory.

• MDMA affects a neuron’s ability to use the chemical serotonin. Serotonin plays an important role in regulating mood, aggression, sexual activity, sleep, and sensitivity to pain. Research in animals indicates that MDMA is a neurotoxin. MDMA is potentially harmful to health and, on rare occasions, may be lethal.

Ideas why Brittany is ill?

MDMA may affect:
• Blood pressure
• Pulse rate
• Body temperature
  • Hyperthermia
  • Hypothermia
• Water Balance
  • Dehydration
  • Excess water
• Blood sugar level
• Vision
Brittany's Test Results

<table>
<thead>
<tr>
<th>Item and measure</th>
<th>Normal</th>
<th>Brittany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate (beats/min)</td>
<td>60-100</td>
<td>90</td>
</tr>
<tr>
<td>Blood Pressure (mmHg)</td>
<td>90/50 - 140/90</td>
<td>135/87</td>
</tr>
<tr>
<td>Temperature (°F)</td>
<td>98.6</td>
<td>100.2</td>
</tr>
<tr>
<td>Glucose (mg/dl)</td>
<td>60-109</td>
<td>72</td>
</tr>
<tr>
<td>Sodium-Na⁺ (mM/L)</td>
<td>135-146</td>
<td>115</td>
</tr>
<tr>
<td>Potassium-K⁺ (mM/L)</td>
<td>3.5-5.5</td>
<td>2.9</td>
</tr>
<tr>
<td>Chloride-Cl⁻ (mM/L)</td>
<td>95-109</td>
<td>88</td>
</tr>
<tr>
<td>O₂ (mmHg)</td>
<td>80-100</td>
<td>93</td>
</tr>
<tr>
<td>CO₂ (mM/L)</td>
<td>22-32</td>
<td>24</td>
</tr>
</tbody>
</table>

CQ#1: What do the test results suggest is causing Brittany's illness?

A. High blood pressure or rapid heart rate
B. Hypoglycemia (too little blood sugar water)
C. Hyperthermia (too hot)
D. Hypothermia (too cold)
E. Excess water (too much water)
F. Dehydration (too little water)

Ecstasy Case Continued

Susan spoke to the students in the waiting area. "Did Brittany have much to drink last evening?" "Just one beer," replied one. "She had a test today and wanted to study. She did drink a lot of water. You're supposed to do that to prevent a hangover aren't you? She seemed really thirsty."

Susan thought for a minute. Normally, Brittany's kidneys would respond to drinking a lot of water by producing large amounts of dilute urine. However, Ecstasy acts as an antidiuretic and forces the kidneys to make concentrated urine instead. This would prevent Brittany's body from getting rid of excess water and could cause her electrolytes to fall. Could this be causing her symptoms?

CQ#2: Assume movement of a molecule is limited. It can move to the opposite side of a container or stay where it is. If movement is random, what is the probability (0-100%) that the molecule will move to the opposite side?

Diffusion / Osmosis Animations

http://physioweb.med.uvm.edu/diffusion/
CQ#3: Assume there are 10 molecules on one side of a container. How many would you expect to move to the opposite side?

A. 10  C. 0  
B. 5  D. It is impossible to predict

Diffusion with Many Particles

http://physioweb.med.uvm.edu/diffusion/tocpage.htm

(Animation)

CQ#4: Which statement best describes how these molecules will behave over time due to random movement?

A. Red molecules will move from side A to B.  
B. Blue molecules will move from side B to A.  
C. All of the molecules will move so that red and blue will become equal on both sides.  
D. More molecules will move from side A to B than from side B to A.

Brittany’s cells

Inside Cells

300 mM Salt

Outside Cells

250 mM Salt

CQ#5: Which of the following molecules could move through a phospholipid membrane with the least difficulty?

A. H₂O  
B. Glucose  
C. Na⁺  
D. O₂  
E. An amino acid
Aquaporins

Brittany's Tissues

CQ#6: What do you expect to happen over time in Brittany’s cells?

A. Water will move from inside to outside ONLY.
B. Water will move from outside to inside ONLY.
C. Water will move in both directions, but more water will move inside.
D. Water will move in both directions, but more water will move outside.
E. Water will not move.

Inside Cells
Outside Cells
300 mM Salt  250 mM Salt

Brittany was treated for hyponatremia. The treatment included giving her an IV of fluids with normal or slightly higher sodium concentrations to correct the salt imbalance in her tissues.

A problem associated with acute (sudden) hyponatremia, or water intoxication, is swelling of tissues due to osmotic uptake of water by cells. Fortunately, because she received treatment, they were able to reverse the swelling effects before her brain stem was damaged.

Hyponatremia can be very serious because of the possibility of brain damage.

Problems with Hyponatremia

- Fraternity hazing killed Matthew Carrington, a student at California State Chico February 2005.
- In Sacramento, Jennifer Strange died after a water-drinking contest "Hold your wee for a Wii" sponsored by a local radio station, January 2007.
- Artist Andy Warhol died after hospital staff accidentally administered excess water after gall bladder surgery (1987).
- Infants fed diluted formula for extended periods of time can suffer from hyponatremia.

So what happened to Brittany?

Passive diffusion
Facilitated diffusion
Active Transport

Endo & Exocytosis

Golgi Apparatus

Vesicle

Cell Membrane