

**OCRN: News at the Speed of Chemistry**  
Skit Production by the Barany Thespians of Prof. Barany's Fall 2004 Chemistry 2301 Class

**Cast:**

Clint Hanson – musical arranger; leaving group (saxophone)  
Gretchen Beebe – nucleophile (flute)  
Ricky Hartono – substituent  
Eddie Martono – substituent  
Priya Muthu – extra atom for rearrangement  
Xochill Martinez – nucleophile in E1 reaction  
Professor Barany – technical advisor; chiral carbon  
Shane Richardson – camera man  
Tim Marass – script; narrator

Music for S<sub>N</sub>2 reaction: “Louie Louie”

Music for E2 reaction: “Uncle John”

This is OCRN, the Organic Chemistry Reaction Network, broadcasting live. My name is Tim Marass, and I'll be calling the play by play on the reactions today. Let's take a look at the starting lineups for today's reactions:

First up, the Chiral Carbon. A Chiral Carbon has 4 DIFFERENT substituents! As we don't have any wires to hang someone in the air to show the proper geometry, the carbon's hat will represent a hydrogen.

Substituents: a methyl group and a deuterium

The leaving group, a halogen, with saxophone

Strong nucleophile, with flute

**S<sub>N</sub>2 Rxns**

We'll start off by broadcasting from the Two World of strong nucleophiles and bases. It looks like the first reaction, the S<sub>N</sub>2, is ready to happen, let's watch... (WATCHING WITH NO COMMENTS) ...What an amazing S<sub>N</sub>2 reaction!

That happened fairly quickly. However, let's take a look at the instant replay in slow-motion and break it down. And here comes the nucleophile... It looks like she's coming toward the carbon on a back-side attack... the substituents are being pushed into a transition state as a result of the nucleophile coming closer... and the leaving group is going, going, gone! He's outta here! the nucleophile has bonded to the carbon and we have inversion of the substituents!

**E2 Rxns**

Next up, we'll have an S<sub>N</sub>2 reaction where the nucleophile acts as a base. We just saw an S<sub>N</sub>2 reaction on that last play, but it looks like the substituents have bulked up with more atoms, we'll have to see how this affects the nucleophile's strategy.

We're back and the game is underway! Here she comes...

Alright, let's take a look at that in slow motion. Here comes the nucleophile. Oh, and she is denied by steric hindrance, one of the secrets of O-Chem! Oh, denied again, that's gotta hurt! But she doesn't look like the kind of molecule to be going away empty-handed... She's circling the tetrahedral structure... And she just stole a proton from one of the substituents and has become positively charged! A double bond has formed and

the leaving group is taking off again in a concerted fashion. But this time it looks like the leaving group, which is negative, is going to hook up with the base. What a great way to show that, in E2 reactions, nucleophiles act as strong bases. That, ladies and gentlemen, is a textbook E2 reaction!

But the double bond didn't have to form on only one substituent, it could have happened on the other side instead... Let's take a look at a not-so-instant replay to demonstrate the regiochemistry of the reaction... the base is coming in... she is again denied access to the carbon by the big boys of steric hindrance on the back side... but this time she's grabbing a proton from the other substituent! A double bond is forming, and the negatively-charged leaving group is again taking off with the base. That's what we in the biz like to call regiochemistry, which refers to the different orientations in which double bonds can form.

### **S<sub>N</sub>1 Rxns**

And we're back for yet another reaction, but this time we're entering the One-World of weak nucleophiles, where the nucleophile does almost nothing! Just a reminder that these reactions are brought to you by the University of Minnesota, an outstanding research university in the Midwest leading the way to the future. The University of Minnesota: enriching minds, enriching lives. Here comes the nucleophile, she's circling around... but before she does anything, the leaving group takes off! Astonishing! And now the substituents are planar with the carbon... but not for long, the nucleophile is forming a bond with the carbon off a back side attack,, and now the substituents are resuming their tetrahedral position! What a great S<sub>N</sub>1 reaction!

But that reaction doesn't always have to happen that way. When the substituents are planar, the nucleophile can attach on either side of the molecule. Let's take another look at this reaction. Here comes the nucleophile, and the leaving group just suddenly takes off, leaving the substituents in a planar configuration... but this time the nucleophile is coming around the front side... and it's a front-door attack!

Thus, we can see that no matter how things line up in an S<sub>N</sub>1 reaction, we'll always get a 50:50 racemic mixture of the two possible products, because each product is equally likely!

But this reaction could have gone yet another way. Yes, it could have been an E1 reaction.

### **E1 Rxns**

In this reaction, the nucleophile is really slow. Here the leaving group takes off again before the nucleophile is even close! And this time the leaving group is taking a proton from one of the substituents and getting out of there! But the nucleophile just isn't in the game at this point, so the substituent who lost the proton forms a double bond with the carbon, leaving the nucleophile out in the cold! And it looks like that leaving group that left with the proton has become an acid! Boy howdy, that's an E1 reaction if I ever saw one!

### **Rearrangement**

Now it's time for my favorite reaction: rearrangement, which you will not find in the Two World because rearrangement only happens in the One World. In this reaction, the nucleophile forms a bond with a molecule other than the expected carbon that had the leaving group. Let's watch the fun begin! The leaving group takes off from the carbon leaving it with a positive charge making it a lousy carbonium ion; In response, the carbon grabs a hydrogen from one of its neighboring substituents! Now the nucleophile can't form a bond with the carbon, so she comes over to the substituent that just lost its proton and forms a bond! Yes, that's right, the nucleophile formed a bond with a molecule other than the carbon from which the leaving group was attached! That was a hydride shift rearrangement, ladies and gentlemen.

Well ladies and gentlemen, all of the atoms took part in some pretty amazing reactions today. Boy, reactions like those really make organic chemistry look good! Well, that's all for this broadcast. Until next time, I'm Tim Marass for OCRN signing off.