CLIP 1: BETSY INTERVIEW

[00:21:25.28] Interviewer: So what if I asked a different question about these two graphs. So before, you were talking about ATP going to ADP, right? Is that right?

Betsy: Mm hmm.

[00:21:38.26] Interviewer: So between these two graphs, if one of these represented ATP and one of them represented ADP which one would you say was which?

[00:21:52.26] Betsy: (immediately writes ATP on the right and "ADP+P in water" on the left)

[00:22:07.12] Interviewer: Okay, why?

[00:22:10.03] Betsy: Because in biology they always assume that it's in water 'cause the whole system is mostly made up of water. So if I put these two graphs together (draws new graph with two valleys)

[00:22:33.06] so this is ATP (labels shallower well) and it takes a little bit of energy to put in to get ADP (motions up and back down, and labels deeper well),

[00:22:42.03] but ADP is much more stable than this (points to ATP), and this is because the phosphate reacts with the water and forms a really stable.

[00:22:55.13] So it's **in a well** but it **falls into a deeper well** once the bond breaks. I'm pretty sure.

[00:23:06.17] Interviewer: Okay, um. And is this consistent with what you were saying before, like about comparing the-- ways to compare those two graphs?

[00:23:15.05] Betsy: Yeah, what-- I said before that-- Yeah. Because this intermediate that's made (pointing to ADP) -- well, not intermediate, because that would be here (points to local maximum in between wells) -- but this product that is made, this stabilized phosphate group, is more stable than ATP so it has to have a lower potential energy.

[00:23:34.01] Interviewer: Ok.

Betsy: Right? That makes sense. Yeah. That makes sense. (convincing self)

[00:23:39.27] Interviewer: So you were talking about before that this one on the left, you can get more energy out of that system?

Betsy: mmm, But usually you get energy out of the ATP, is that what you're saying? So there's confusion there?

[00:23:51.09]

Betsy: Uhm, well you get-- the reason why ATP is used to drive other reactions is because the breaking down of it forms something stable. Right? And then-- Yeah, that's-- they call ATP a high-energy bond because--

[00:24:18.07]

Interviewer: Yeah, why do they-- what does that mean when they call it a high energy bond?

[00:24:23.18] Betsy: Yeah, it doesn't actually have-- Professor Redish was talking about that, it doesn't actually hold energy, like it's not-- like, the bond itself doesn't have a lot of energy, but it's the fact of breaking it and forming this (points to ADP) is even more-- is **even lower energy**. [00:24:44.23] So you can get-- the difference between **here** and **here** (labels vertical difference between two wells), this is the energy that's given off to drive the rest of the system. Or drive the rest of the reaction. (pause) I think.

[00:24:59.25]

Interviewer: Have you heard that term, "high-energy bond", before, or was that just in this class?

[00:25:06.21]

Betsy: No, I've heard it before but we talked about it in this class recently.

Interviewer: Ok. So what di you-- if you were using that term before, what did you usually mean by that?

[00:25:20.03] Betsy: I thought it meant that, I don't know, when I think of high energy (moving hands in "vibration") I think of fast moving molecules within-- or fast moving atoms in (inaudible) molecules. [00:25:33.27] So I was thinking, ATP is really unstable and it really wants to break apart. And that's why I was so confused with why you have to put energy in (gestures to this) to break ATP, because if it had all this energy then wouldn't it just want to break apart (gestures) itself?[00:25:53.03] But the truth is that you have to put in a little bit of energy (tracing curve upward) to **drop down into that well** and that's why it doesn't just break (gestures) into-- I mean, it does spontaneously break, but it takes some other stuff to get it there.

[00:26:10.05]

CLIP 2: SAM INTERVIEW

[00:19:30.14] I: Imagine that two pieces of candle wax were melted in two identical pans on two equally hot stoves, and that they were still being heated even after they completely melted. If one of the pools of liquid wax were heated for an additional 1 minute after it had melted, and the other pool were heated for additional 5 minutes after it had melted, then which of the following statements best describes the way the two pools of wax cool and resolidify?

[00:19:54.29] A. The wax that was heated for 5 minutes after melting would take longer to solidify than the wax that was heated for only 1 minute after melting.

[00:20:03.08] B. The wax that was heated for 5 minutes after melting would take the same amount of time to solidify as the wax that was heated for only 1 minute after melting.

[00:20:13.13] C. The wax that was heated for 5 minutes after melting would solidify slightly faster than the wax that was heated for only 1 minute after melting.

[00:20:22.15] D. Other.

[00:20:24.07] S3: Now I think, ok, so, this one intuitively it seems like if you heat it longer. Okay. If you heat it longer after it's melted, as I said in the previous problem, the temperature is going to increase. To resolidify, the temperature has to get down to the phase transition temperature, and then start solidifying. So, it would solidify at the same rate, it just would take longer getting to the point where it would be allowed to solidify. However, heat transfer is a funny thing and it's faster when there's a bigger difference in temperature. So if they're both sitting in the same room (holds two imaginary objects in two hands at the same level), and one is five times hotter than the other, then I think, the one that's five times hotter cools five times faster, I think it's a proportional relationship. So they might actually resolidify at the same time, or you know, in the same amount of time, unless, of course, I'm completely off on heat transfer. So, I guess I'll say they take the same amount of time.

[00:21:39.14]

I: And how would you explain that in terms of …..

[00:21:44.07]

S3: I guess I'd have to use the ramp thing again. That if you have .. So they're both.. The cold side.. So heat flows from hot to cold (hand movement indicates something moving from high position to low position) which is like thinking of hot as **higher up on a ramp** and cold as **lower down**. [00:22:01.17] But if they both have the same, ah, if they both have the same **starting point**, then they both end at the **same place** (looking at her own gestures) but the one that's at 1-min heating is **here** (uses arm as a ramp), so it's flowing **down** like this and the speed **down this ramp** would be your heat transfer (uses a finger to show motion down the ramp). [00:22:22.15] And one's **all the way up here** (increases the slope of the ramp), five times **higher** (indicates the height), so the slope is five times more (indicates the slope; no longer looking at her own gestures), which I think means that it would cool five times faster 'cause the heat would be transferred into the air and radiate away faster.

[00:22:38.22]

I: Do you know why that is? Do you have any ideas why that is?

[00:22:43.08] S3: I think it's just if you think of temperature as a form of energy, you know, if you rescale temperature, it's energy. And um, if energy's flowing, really energetic stuff is gonna make itself heard (rallies with her hands) and it's gonna flow faster, because it's more energetic, than less energetic stuff, cooler stuff.

[00:23:15.20]