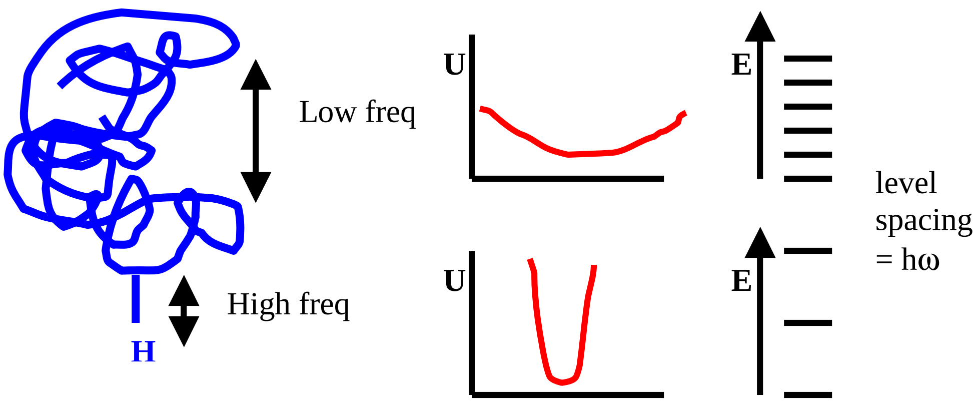
In class we glossed over where those energy levels come from, saying that it's all quantum mechanics and it depends on the system. This is true, but the case of the harmonic oscillator is relevant to many things you have studied and it turns out that it's not very complicated: the energy levels are all equally spaced, and their spacing is **hω** where h is Plank's constant (remember learning something in chemistry class about energy being quantized?) and ω is the frequency of the oscillation. It turns out that the harmonic oscillator is an excellent approximation for the fluctuations of proteins and their bonds. This picture is supposed to be a protein which has a characteristic global fluctuation (to let substrates in and out of its active site, for example) and one of the hydrogens covalently attached to this protein. The big fluctuation of the protein is a low-frequency (low ω) motion and the fluctuation of the hydrogen covalently attached is a high-frequency motion.



We can think about energy levels and temperature like a ladder and a pogostick…
The frequency tells you how far apart the rungs on the ladder are. The temperature tells you how springy your pogostick is and therefore how high in energy you can reach on the ladder. So if your temperature is around 298K, then your pogostick spring is made of some pretty good rubber and you can bounce around but not too high. At 1000K you're bouncing on a really fantastic spring and can go all over the place. And at 0K, your spring is just a stick of wood. See how this affects your probability distribution of where you are in E:
We can draw probability distributions like on page 178 of your textbook… Using the energy levels we drew above, we can plot distribution functions at different temperatures…

And despite my lame drawings, you can probably see that as we discussed in class, when we are at a low temperature and a high frequency motion, the E-bars are so far apart that we are unlikely to see anything except the lowest possible energy level (the rungs of the ladder are so far apart your low-quality pogostick just can't get you up there). But for a lower frequency motion, more energy states are populated because the bars are closer together. However at higher temperature, we can reach higher energy levels, even in the high-frequency case, because our pogostick is very bouncy when the temperature is high. So physically, this means that at room temperature (about 298K, which is pretty low), proteins undergo large-scale low frequency motions, which is often necessary for their function. However, the covalent bonds that hold the protein together are not vibrating wildly because 298K is way too low for them to reach the energy levels required to do this.