3.2

WAYS OF KNOWING – INTRO TO CHEMISTRY

0:12–0:57

SPECIALIZED IN CHEMISTRY

Hi. My name is Anne McNeil, and I'm an Assistant Professor here at the University of Michigan, where I study the chemistry of organic materials.

When I was growing up, I was interested in what everything was made of and how it worked. And before the Internet, I had to find answers to these questions in books. I even got my first job at a library so I could have access to more books. And I didn't really have a favorite subject at the time because I liked all aspects of science. And it wasn't until I got to college, when my professor was explaining how a rubber band gets its stretchy characteristics based on how the atoms are connected within that structure of rubber, that I realized that just about everything can be explained if you understand the atoms that make up that material as well as how they're connected to each other. And it was then that I decided I wanted to be a chemist.

0:57–1:25

STUDY OF MATTER

So, chemistry is broadly defined as the study of matter, and the goal is to understand the structure of matter and its composition, so understanding what elements make up that matter and how they're connected to each other. And then chemists can use that information about structure and composition to predict and understand its properties.

So, I'm showing you here a three-dimensional model of caffeine and we can use our understanding of the structure of caffeine to understand how it interacts with our body.

1:25–2:18

EVOLUTION OF CHEMISTRY

Another example you might be familiar with is ozone. As early as 1865, chemists had discovered that ozone consisted of three oxygen atoms. But it wasn't until much later that they discovered that the structure was actually this bent structure. And based on our understanding of this bent structure, we can now understand some of the properties of ozone like its ability to absorb the skin-damaging UV radiation from the sun but also some of its negative properties, like its reactivity with nitrogen oxides to generate smog.

So, just as the chemistry of the Universe has evolved from simple hydrogen and helium to now the complex molecules of DNA that are within your body, so has our study of chemistry.

So, in the old days, people were very limited on the techniques to determine both structure and composition. And instead of having some advanced techniques, they often resorted to tasting compounds and classifying them as bitter or sweet.

2:18–3:04

MODERN TECHNIQUES

Now, fortunately today, we don't taste compounds anymore. We have a number of techniques we can use to determine both structure and composition.

So, for example, if we have a crystal of caffeine, we can look at how X-rays are scattered as they pass through that crystal and use that information to identify both the atoms as well as their connectivity. We can also inject a molecule of caffeine into a mass spectrometer and get the mass of the molecule.

And we can use various forms of spectroscopy, which involves the absorption and emission of light, to identify functional groups like a carbon-oxygen double bond. And so using all of these techniques, we are no longer limited in determining both structure and composition. And as a result, you'd be amazed to see many of the innovations that are coming out of labs today.

3:04–3:40

THE CENTRAL SCIENCE

So, for example, we can completely replace glass bottles with plastic bottles that are easier to recycle and can even biodegrade.

So, chemistry is often referred to as a central science because it plays a role in so many of the other sciences.

So, for example, an astrochemist is involved in the search for life on Mars by looking for the distinct spectroscopic features of water on that surface. And geochemists are involved in telling the history of the Earth by looking at the changes in the atomic composition of rocks over time. And biochemists are involved with developing various drug molecules to help treat and cure diseases.

3:40–4:33

FUTURE INNOVATIONS

So, as chemistry is so essential to all these other sciences, chemists will play a role in the future innovations in all of these fields.

So, for example, chemical biologists are now trying to design drugs that are specific for you based on your DNA, and analytical chemists are trying to develop microchips that they can install and non-invasively monitor your health and report back to your doctor without stepping foot in an office. And materials chemists are developing materials that will capture sunlight efficiently and convert that directly into electricity so that we can reduce our reliance on fossil fuels. And synthetic chemists are developing catalysts that they can use to convert a greenhouse gas like CO2 into a useful fuel that we can burn.

And so, if you today ask a chemist what they do, you'll often hear them say, "I'm a something chemist. "I'm a materials chemist or a physical chemist, or an analytical chemist." Chemists are everywhere, and they're contributing to all of these different fields of science.