My Chemical Romance – ***a chemistry podcast for biology students.***

Script for Episode 1: Atomic Bonds

Music in background

We are all looking for a little love and relationships make the world go round. Some relationships are casual and may degrade over time while others are strong and durable. Just like humans, chemicals form relationships with each other to reduce their stress and energy levels. We call these relationships between atoms and molecules, chemical bonds. There are a few noble atoms who are completely self-fulfilled, but most are looking for the right companion to complete them. Join us today for more about bonds between atoms on My Chemical Romance – a chemistry podcast for biology students.

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Hi I am Wendi Straub and welcome to our pilot episode of My Chemical Romance – a chemistry podcast for biology students. Today we are talking about atoms with strong chemistry and chemical couples they form.

Consider all of the different types of relationships and bonds you have with others – some are easy and have equal give and take, some are a little more uneven, and in some, one takes and other gives all of the time. Chemicals also have different types of relationships, but in both cases, the most stable bonds are those that take the least amount of energy to maintain. Similarly, the types of bonds formed depends on the personalities of the individuals – that is, how positive and negative they are; and their distance from one another. As you may know, a pair is more likely to break up as a result of attraction to another individual during a long distance relationship.

So why do atoms even form bonds? To understand this, we have to review the 2-8-8 rule of biochemistry. Living systems mostly use atoms with 18 or fewer electrons. Those electrons are placed in orbitals around the nucleus following the 2-8-8 rule - that is, up to 2 electrons will be found in the first electron orbital closest to the nucleus, then up to 8 in the second orbital and up to 8 more in the third. For example, if an atom only has 7 electrons, 2 will go in the first orbital and 5 will go in the second and the second orbital will be the outermost or valence orbital for this atom. Atoms are the most stable when their outermost orbital has a complete set of electrons (either 2, 10 or 18 are goals). Atoms form bonds with other atoms in order to have a complete outer orbital.

Sound clip, you complete me.

Atoms can complete their outer orbital three ways – they can lose electrons, they can steal electrons or they can share electrons with other atoms. Which event occurs depends on which would take the least amount of energy to manage and whether there are suitable partners around. For every negative electron an atom has, it also possesses a positive proton in the nucleus. An elemental atom is held together by the equal and opposite attractions between its protons and electrons. This means atoms have a limited capacity to attract and hold onto additional electrons – it is harder to steal three electrons than one and sometimes you just have to share.

Unlike human relationships, atomic relationships are easier to understand and predict. We can analyze exactly what each atom gets from their bonds and how likely a chemical couple is to stay together. An atom that only NEEDS one or two electrons to complete its outermost shell will be desperate to STEAL electrons from another atom. An atom that only HAS 1 or 2 electrons in an outermost shell be desperate GIVE up those electrons to another atom and drop down to a complete level. Obviously, these two types of atoms with opposing needs will have great chemistry together as one wants to give and the other wants to receive. In fact these two atoms will form our first type of atomic bond – an ionic bond. Atoms that loose or gain electrons become charged atoms called ions. If an atom gains electrons, it gains negative particles and becomes a negative ion. If an atom loses electrons, it loses negative particles and becomes a positive ion. Positive and negative ions are attracted to one another because, you know, opposites attract. Salts are compounds held together by ionic bonds. Atoms in ionic bonds are charged up and reactive, so their relationship can be disrupted by other ions and water. This makes them not suitable for most structures in living things.

Atoms that have more modest needs are more likely to share electrons with other atoms in Covalent Bonds. If an atom needs 3-5 electrons really cannot muster the energy to steal and keep that many, so it enters a social pact with other atoms to share electrons. Each atom contributes one electron to form a pair that orbits both atoms' nuclei. A single covalent bond forms between two atoms sharing one pair of electrons; a double covalent bond forms if two atoms share two pairs and a triple bond for three pairs of shared electrons. Biomolecules are usually large complexes of strong covalently bonded atoms. Most living things are made of covalent bonds because they are not easily disrupted by ions or water. Think of biomolecules as a bonded group of friends that react and respond as a whole rather than as separate individuals. Things that affect one atom, affect the entire molecule.

Finally, as in our own relationships, things are not always shared equally – just ask my husband. For atoms in covalent bonds, sometimes the bigger atom hogs the electron pairs. This occurs because the bigger atom has more positive protons in its nucleus so the electron pairs are more attracted to the larger nucleus than the smaller nucleus. As a result, the larger atom becomes partially negative as the extra electrons are usually there, and the outside of the smaller atom becomes partially positive. This covalent molecule with partially negative and positive ends is called a polar molecule because it has oppositely charged poles. Similarly, a covalent bond with unequal sharing is called a polar covalent bond and a covalent bond with equal sharing is called a non-polar covalent bond.

So to recap our episode: Atoms are most stable and at their lowest energy states when their outermost electron orbitals are complete. Atoms form bonds to complete their outermost orbital. Atoms have different needs depending on their electron arrangement according to the 2-8-8 rule. Ionic bonds form between atoms that fill their outer orbital by transferring electrons from one to the other and become oppositely charged ions. Covalent bonds form between atoms that fill their outer orbital by sharing electrons. If the electrons are shared equally, the atoms are in a non-polar covalent bond. If the electrons spend more time around the larger atom, then the atoms are in a polar covalent bond and the molecule has partial positive and negative poles.

Thank you for joining me today on My Chemical Romance as we talked about the different types of atomic bonds. I'm Wendi Straub and I hope you will join me next week as we discuss intermolecular forces and the importance of water.

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