Epimers and anomers pdf

Anomers and epimers are both diastereomers, but an epimer is a stereoisomer that differs in configuration at any stereogenic center, while an anomal is actually an epimer that differs in configuration from acetal/hemiacetal carbon. Before we talk about the differences between epimers and anomals in detail, it helps if we first understand what stereoisomers are all about. What is a stereoisomer? To understand what a stereoisomer is, it is crucial to know a thing or two about isomerism in general. An isomer is a molecule that has the same molecular formula as another molecule, but has different chemical properties. Another way of saying this is that isomers contain the same number of atoms in each element, but the arrangement of these atoms is different. Different types of isomers, including 2-fluoropropane and 1-fluoropropane position isomers on the left (Photo credit : Vladsinger / Wikimedia Commons) There are two types of isomerism; structural isomerism (in which functional groups are attached in different ways) and stereoisomerism. Stereoisomeris stereoisomers are isomeric molecules whose molecular formula is the same, but the 3-D orientations of their constituent atoms in space are different. Stereoisomers are divided into two types: enantiomers and diastereomers. Enantiomers are stereoisomers that are mirror images non-overlapping of each other. Also known as optical isomers, they have similar physical properties. (S)-(+)-lactic acid (left) and (R)-(–)-lactic acid (right) are mirror images that are unsuperimable of each other (Photo credit : NEUROtiker / Wikimedia Commons) Diastereoisomers are those stereoisomers who have different configurations to one or more (but not all) stereoisomers without being mirrored images of each other. The term epimer is used to refer to diastereomers that differ in configuration to a single chiral center. An anomer is actually a kind of epimer that differs in configuration, especially at acetal/hemiacetal carbon. Epimer vs. Anomer While an epimer is one of a pair of stereoisomers that differ in configuration to a single chiral center (stereogenic), an anomer is actually an epimer (also a cyclic saccharide) that differs in configuration, especially to acetal or hemiacetal carbon (refers to the image below to differentiate between acetal carbon and hemiacetal). An epimer is one of a pair of stereoisomers that differ in configuration only at the chiral center. As such, all other stereocentres (if any) are the same in both molecules. If the pair of molecules has only 1 stereocenter, then the epimers are enantiomers, while when the molecules have 2 or more stereocenters, the epimers are called diastereomers. (Source) Refers to the next figure with two chlorobutane stereoisomers. (R)-2-Clorobtan and (S)-2-clorobtan differ in absolute configuration at C2. Note that 2-clorobtan has only one stereocenter; that is why these are enantiomers. On the other hand, in the stereoisomer structures of tartaric acid, you can see that the two epimers (i.e. (2R,3R)-tartaric acid and (2R,3S)-tartaric acid) differ in the absolute configuration at the stereocenter C3. Note that tartaric acid has two stereocentres, which is why these epimers are diastereomers. An anomer is a kind of stereoisomer; anomers are saccharides or glycosides that are epimers, which are distinct from each other in the configuration of C-2, if they are cetoses, or in the configuration of C-1, if they are aldozes. In many cases, carbohydrates happen to exist in cyclic/acyclic forms. During cycling, carbon in the carbonyl group turns into a new stereocenter. Such cycling leads to the formation of two diastereomers, which differ in the position of the attachment of a particular functional group (Source). The new stereocenter is called anomalic carbon. The following figure should help visualize this: Two anomals are designated alpha and beta, depending on the configurational relationship between the anomalic center and the anomalic reference atom. If the hydroxyl group on C-1 and the -CH2OH group on C5 are on opposite sides of the six-member ring, C1 is said to be anomer α. If they are on the same side, C1 is said to be β anomer. Example: α-D-Glucopyranosis and β-D-glucopyranosis. Note that the two stereoisomers (in the figure above) differ from each other in the C-1 configuration. To conclude, both epimers and anomers are stereoisomers; In fact, anomalies are a special case of epimers. The main difference between them is that the epimers differ in configuration at a single chiral center (stereogenic), but the anomalies differ in configuration, especially in acetal or hemiacetal carbon. References Izomerism explain scars between closely related molecules. Isomerism is divided into two major groups like structural isomerism and stereoisomerism. Structural isomeris has different structures for the same chemical formula. Stereoisomerism shows different spatial arrangements of molecules that have the same molecular formula. Anomers and epimers are found under stereoisomers. The terms anomer and epimer are used to describe carbohydrate structures. They are used to identify differences between organic compounds. The main difference between anomers and epimers is that anomals differ from each other in their structure to their anomalous carbon, while epimers differ from each other to any of the chiral carbons present in their structure. Key areas covered 1. What are Anomers - Definition, Explanation of structure with examples 2. What are Epimers - Definition, Explanation of structure with examples 3. What are the similarities between Anomers and Epimers - Outline of Common Features 4. What is the difference between anomers and Epimers - Comparing Key Differences Key Terms: Anomers, Carbohydrates, Chiral Epimers, Isomerism, Stereoisomer, Structural Isomers are Anomers Anomers are stereoisomers that occur because of the difference in the configuration to their anomalous carbon. Anomalous carbon is the carbon atom that has an aldehyde or a group of ketones in the acyclic form of a sugar molecule. Sugar molecules are composed of a group of aldehyde or ketone at one end and a group of alcohol at the other end of the acyclic form of the sugar molecule. To become more stable, these groups of two heads can react with each other by forming a cyclic sugar molecule. In this cyclic form, the anomalic carbon has attached a group –OH. The position of this group –OH in an anomeric molecule is in the opposite direction to that of the other molecule. Figure 1: Two glucose anomers The conversion of an anomeric form to the other anomeric form is called anomerization. This is a reversible process. However, both anomers are stable molecules with a cyclic structure. The two anomers are called anomer alpha (α) or anomer beta (β). After showing in the image above, the group –OH attached to the anomalous carbon of the alpha anomer is in the opposite direction to that of the glucose beta anomer. The anomalous carbon is given in a green color. Epimers are a type of stereoisomers that are different from each other only at a single chiral carbon. Epimers are a type of diastereomers. Although there is more than one chiral carbon, epimers differ from each other only at a single carbon center. Epimers are not mirrored images of each other. Figure 2: Epimers After shown in the image above, D-glucose and D-manose are epimers of each other. The blue part indicates where the isomeris took place. Here, the group –OH is pointing to the left side in D-manosis where it is on the right side for D-glucose. Other carbon atoms are also chiral carbons in these molecules, but are identical to each other. Therefore, the carbon atom where isomerism occurred is called epimeric carbon. Similarities between anomers and Epimers Anomers and epimers types are stereoisomers. Both types are formed by difference in a carbon atom. Both types are commonly found in sugar molecules. Isomerism occurs due to differences in the position of a group –OH attached to a carbon. Definition Anomers: Anomers are stereoisomers that occur because of the difference in the configuration to their anomalous carbon. Epimers: Epimers are a type of stereoisomers that are different from each other only at a single chiral carbon. Carbon where isomerism occurs Anomers: Isomerism occurs to the anomeric carbon of anomeri. Epimers: Isomerism occurs in the epimeric carbon of the epimers. Sugar structure Molecule Anomers: Anomers are cyclic molecules. Epimers: Epimers can be acyclic or cyclic molecules. Conclusion Anomers and epimers are stereoisomers. A form of anomer can be converted to the opposite form of anomer. That's called anomerization. The process of forming an epimer is epimerization. Although both anomers and epimers are which differ from each other at a carbon center, they are distinct terms. The main difference between anomers and epimers is that anomals differ from each other in their structure to their anomalous carbon, while epimers differ from each other to any of the chiral carbons present in their structure. References: 1. Epimers. OChemPal, Available here. Accessed Aug 21, 2017.2. Anomer. Wikipedia, Wikimedia Foundation, July 19, 2017, Available here. Accessed August 21, 2017. Image Courtesy: 1. Glucose anomer miguelferig By miguelferig - Own Work (Public Domain) via Commons Wikimedia2. Epimers-Glucose Mannose De Munmannea – Own Work (Public Domain) via Commons Wikimedia