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Perspective

Concepts of Catalysis in Medicinal Inorganic Chemistry

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DESCRIPTION

In the field of medicinal inorganic chemistry, catalysis has emerged as a promising method for delivering new drug candidates and overcoming the disadvantages of metallodrugs. Catalysis has been used in conjunction with metal complexes to provide novel therapeutic treatments. We describe major breakthroughs in the creation of metal catalysis schemes for the activation of exogenous organic prodrugs and the construction of catalytic metallodrugs that harm bio molecular targets. Furthermore, there are some recent findings of flavin-mediated bio orthogonal catalytic activation of metal-based prodrugs, a novel catalysis technique that uses metal complexes as substrates rather than catalysts.

Catalysis refers to a species ability to accelerate the rate at which a chemical reaction occurs. For historical reasons, the discipline is usually divided into two sub-categories: homogeneous (homo=same, geneous=phase) and heterogeneous (hetero=different). Catalysts that are in the same phase as the chemical reactions they are speeding up are referred to as homogeneous catalysis. All of biology's enzymes are involved in these reactions, which usually take place in the liquid phase. While liquid phase homogeneous catalysis is the most common, gas phase and solid phase homogeneous catalytic processes also exist. The catalyst in a heterogeneous catalyst is in a distinct phase. This form of catalysis is responsible for the great majority of bulk chemicals generated each year, which are used to make all of the things we take for granted around us, such as plastics, and is also widely used for oil refinement in gasoline.

Inorganic catalysts are also known as heterogeneous catalysts, are metal-supported that mimic the exquisite function of nature's catalysts: enzymes. The metal connects to a solid through absorption. It's critical to make sure there are enough active sites for the reactants to interact with during this process. Because of their enormous surface areas, porous materials such as carbon, silica, and alumina are used as supporting materials. The number of active sites grows as the surface area grows.

In business and academia, heterogeneous catalysts play an important role in hydrogenation and cross-coupling reactions. These catalysts are easier to remove and recycle since they are in a different phase than the other starting ingredients and the desired molecule once the reaction is complete. Inorganic catalysts have become particularly valuable in industrial and bulk processes as a result of this. Heterogeneous catalysts, unlike organ catalysts and ligands, are difficult to optimize.

The tension between the thermodynamics of a specific reaction, which tells you whether something should happen, and the kinetics, which tells you how fast something will happen, is an important idea in catalysis, and indeed all of chemistry. Imagine the energy of a molecule being represented by a *z*-coordinate while the reaction "proceeds" on the x-y plane, which is how people think of chemical reactions. If this sounds complicated, think of energy as the height of land features such as mountains in relation to their location. A molecule in this scene would be a crater lake, a site where you can't move downhill without first going uphill. Even if a crater lake should flow down to the sea on a global scale, the local conditions around it require it to first flow uphill, which we can assume does not happen on a regular basis.

This analogy helps to visualize what happens in a chemical reaction: the atoms involved are stuck in an energy "lake" and can't change, but given the right conditions, such as temperature or photons, they can break through the energy barrier and flow down to another energy "lake" where the atoms are joined in a different way. The activation energy is the name of this energy barrier. Consider drilling a hole from one lake to another because the water does not have to "up and over" it can readily flow to another location. This is exactly what a catalyst does; it doesn't change the overall energy of the system or where it will eventually end up (thermodynamics determines this), but it does make it easier for the system to get there and hence speeds up the process (it increases the rate).

This comparison helps you remember the textbook definition of a catalyst: A material that lowers the activation energy of a reaction pathway, increasing the rate at which a thermodynamic

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equilibrium is reached. A catalyst accomplishes this, but it does not explain how. It's just useful for determining whether you're looking at catalysis in operation; the process behind heterogeneous catalysts is far more complex.