Acceptance speech

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John F. Hartwig, awardee in the Basic Sciences category (17th edition)

When you wake up or go to bed, I doubt you think of catalysts, but I do. The fabric in your pajamas and sheets, the food of your breakfast and midnight snack, the medicine you took to lower your cholesterol or blood pressure, the soles of your shoes, the bag you used to pack your lunch sandwich, and the screen on your phone that told you it was time to get up, all came from catalysts my group and I seek to invent and think about day and night. Catalysts are a reaction component that makes the reaction go faster, but themselves are unchanged. My research group invents a particular type of catalyst: synthetic, molecular catalysts containing a single metal atom surrounded by organic molecules that control the reactivity of the metal atom. These catalysts are used to make organic molecules that change people's lives. They have been used to make the molecules in drugs that treat cancer, HIV, hepatitis C, depression, and psoriasis.

Catalysts have been around since life existed, but in biological systems we call them enzymes. It is probably not a coincidence that the discovery of enzymes – that is, substances that cause the chemical reactions in your body to occur, like digesting your food – occurred slightly before, and then in parallel with, the growth of the field of synthetic, chemical catalysis. Now, people estimate that more than 30 trillion dollars of the annual worldwide economy or 1/3 of the sum of all gross domestic products in the world requires catalysts.

My research group is known for creating four different reactions and types of catalysts. One includes reactions with palladium catalysts, which our group and Steve Buchwald's at MIT discovered, that form bonds between carbon atoms and nitrogen atoms. Before our discoveries, molecular catalysts like those we study typically made bonds between two carbon atoms. Now, people know these catalysts can form bonds between carbon and the other elements of living systems – nitrogen, oxygen, sulfur, and phosphorus.

The second class of reaction breaks carbon-hydrogen bonds, some of the strongest bonds in synthetic or natural molecules, in mild and useful ways. We discovered catalysts that enable installation of a valuable boron atom that made it possible to create drugs that also treat HIV and many cancers. At a fundamental level, this work showed that carbon-hydrogen bonds can be reactive positions of molecules, rather than just inert structural elements.

The third area combines enzymes, or biological catalysts, with synthetic catalysts. We showed a way that molecular catalysts can be embedded into proteins to make artificial enzymes – we call them bionic enzymes – that catalyze reactions in a way that is more typical of a laboratory than a living system. This strategy allows the protein surrounding the homogeneous catalyst to control the molecules and the positions of these molecules that react. Most recently, we have shown how these bionic enzymes can be integrated into a biosynthetic pathway within bacteria to make products not found in nature. We envision that we and others can create entirely new approaches to chemical synthesis by combining synthetic biology with synthetic chemistry.

Finally, we have used catalysts to change the structures of the most common plastics, giving them new properties or deconstructing them to the small units they were made from. This work has exciting promise for making recycling more energy efficient and cost-effective. Most recently, we showed that the carbon-carbon bonds of polyethylene and polypropylene (numbers 2, 4 and 5 in the triangle recycling symbols, which make up more than half of all plastics) can be broken in a controlled way to regenerate the molecules from which the plastics were made. This type of recycling is called chemical recycling, and such mild chemical recycling of polyethylene and polypropylene was thought to be impossible.

This is an occasion to celebrate scientific achievements, but I want to make clear that all our breakthroughs were made with major support from US federal government agencies that are facing severe cuts or even dismantling. These agencies also support the training of our students who then embark on their own independent careers, inventing their own highly impactful molecules. Two former members of my own lab led teams at Merck and Pfizer, who so rapidly produced Remdesivir and Paxlovid, medications to treat COVID. Without such support and scientific advances, we would never have developed a vaccine against COVID or these medications that mitigate the effects of COVID.

Thus, I want to make clear that I am deeply grateful to the agencies that have supported the work of my lab continuously for three decades. I am also grateful to Pedro Perez, who nominated me for this award, to the committee for recognizing our contributions, and for the support of my family. I also want to express how strongly I appreciate the support of the BBVA Foundation for their recognition of accomplishments in the sciences, from social sciences to basic sciences.

While I am the one speaking, I am accepting this award on behalf of my entire lab, especially the PhD students and postdocs who have been the driving force of the research recognized by this award. This award is as much or more for them as for me.

Thank you.