Q&A: Tenacious curiosity in the lab can lead to a Nobel Prize—the unpredictable value of basic scientific research

October 3 2023, by André O. Hudson

Credit: Unsplash/CC0 Public Domain

The 2023 Nobel Prize in physiology or medicine will go to Katalin Karikó and Drew Weissman for their discovery that modifying mRNA

—a form of genetic material your body uses to produce proteins—could reduce unwanted inflammatory responses and allow it to be delivered into cells. While the impact of their findings may not have been apparent at the time of their breakthrough over a decade ago, their work paved the way for the development of the Pfizer-BioNTech and Moderna COVID-19 vaccines, as well as many other therapeutic applications currently in development.

We asked André O. Hudson, a biochemist and microbiologist at the Rochester Institute of Technology, to explain how basic research like that of this year's Nobel Prize winners provides the foundations for science—even when its far-reaching effects won't be felt until years later.

What is basic science?

Basic research, sometimes called fundamental research, is a type of investigation with the overarching goal of understanding natural phenomena like how cells work or how birds can fly. Scientists are asking the fundamental questions of how, why, when, where and if in order to bridge a gap in curiosity and understanding about the natural world.

Researchers sometimes conduct basic research with the hope of eventually developing a technology or drug based on that work. But what many scientists typically do in academia is ask fundamental questions with answers that may or may not ever lead to practical applications.

Humans, and the animal kingdom as a whole, are wired to be curious. Basic research scratches that itch.

What are some basic science discoveries that went on

to have a big influence on medicine?

The 2023 Nobel Prize in physiology or medicine acknowledges basic science work done in the early 2000s. Karikó and Weissman's discovery about modifying mRNA to reduce the body's inflammatory response to it allowed other researchers to leverage it to make improved vaccines.

Another example is the discovery of antibiotics, which was based on an unexpected observation. In the late 1920s, the microbiologist Alexander Fleming was growing a species of bacteria in his lab and found that his Petri dish was accidentally contaminated with the fungus *Penicillium notatum*. He noticed that wherever the fungus was growing, it impeded or inhibited the growth of the bacteria. He wondered why that was happening and subsequently went on to isolate penicillin, which was approved for medical use in the early 1940s.

This work fed into more questions that ushered in the age of antibiotics. The 1952 Nobel Prize in physiology or medicine was awarded to Selman Waksman for his discovery of streptomycin, the first antibiotic to treat tuberculosis.

Basic research often involves seeing something surprising, wanting to understand why and deciding to investigate further. Early discoveries start from a basic observation, asking the simple question of "How?" Only later are they parlayed into a medical technology that helps humanity.

Why does it take so long to get from curiosity-driven basic science to a new product or technology?

The mRNA modification discovery could be considered to be on a relatively fast track from basic science to application. Less than 15 years passed between Karikó and Weissman's findings and the COVID-19 vaccines. The importance of their discovery came to the forefront with the pandemic and the millions of lives they saved.

Most basic research won't reach the market until several decades after its initial publication in a science journal. One reason is because it depends on need. For example, orphan diseases that affect only a small number of people will get less attention and funding than conditions that are ubiquitous in a population, like cancer or diabetes. Companies don't want to spend billions of dollars developing a drug that will only have a small return on their investment. Likewise, because the return on investment for basic research often isn't clear, it can be a hard sell to support financially.

Another reason is cultural. Scientists are trained to chase after funding and support for their work wherever they can find it. But sometimes that's not as easy as it seems.

A good example of this was when the human genome was first sequenced in the early 2000s. A lot of people thought that having access to the full sequence would lead to treatments and cures for many different diseases. But that has not been the case, because there are many nuances to translating basic research to the clinic. What works in a cell or an animal might not translate into people. There are many steps and layers in the process to get there.

Why is basic science important?

For me, the most critical reason is that basic research is how we train and mentor future scientists.

In an academic setting, telling students "Let's go develop an mRNA vaccine" versus "How does mRNA work in the body" influences how they approach science. How do they design experiments? Do they start the study going forward or backward? Are they argumentative or cautious in how they present their findings?

Almost every scientist is trained under a basic research umbrella of how to ask questions and go through the scientific method. You need to understand how, when and where mRNAs are modified before you can even begin to develop an mRNA vaccine. I believe the best way to inspire future scientists is to encourage them to expand on their curiosity in order to make a difference.

When I was writing my dissertation, I was relying on studies that were published in the late 1800s and early 1900s. Many of these studies are still cited in scientific articles today. When researchers share their work, though it may not be today or tomorrow, or 10 to 20 years from now, it will be of use to someone else in the future. You'll make a future scientist's job a little bit easier, and I believe that's a great legacy to have.

What is a common misconception about basic science?

Because any immediate use for basic science can be very hard to see, it's easy to think this kind of research is a waste of money or time. Why are scientists breeding mosquitoes in these labs? Or why are researchers studying migratory birds? The same argument has been made with astronomy. Why are we spending billions of dollars putting things into space? Why are we looking to the edge of the universe and studying stars when they are millions and billions of light years away? How does it affect us?

There is a need for more scientific literacy because not having it can make it difficult to understand why basic research is necessary to future breakthroughs that will have a major effect on society.

In the short term, the worth of basic research can be hard to see. But in the long term, history has shown that a lot of what we take for granted now, such as common medical equipment like X-rays, lasers and MRIs, came from basic things people discovered in the lab.

And it still goes down to the fundamental questions—we're a species that seeks answers to things we don't know. As long as curiosity is a part of humanity, we're always going to be seeking answers.

Provided by The Conversation