Understanding Science

What is science?

The word "science" probably brings to mind many different pictures: a fat textbook, white lab coats and microscopes, an astronomer peering through a telescope, a naturalist in the rainforest, Einstein's equations scribbled on a chalkboard, the launch of the space shuttle, bubbling beakers …. All of those images reflect some aspect of science, but none of them provides a full picture because science has so many facets:

These images all show an aspect of science, but a complete view of science is more than any particular instance.

- **Science is both a body of knowledge and a process.** In school, science may sometimes seem like a collection of isolated and static facts listed in a textbook, but that's only a small part of the story. Just as importantly, science is also a process of discovery that allows us to link isolated facts into coherent and comprehensive understandings of the natural world.
- **Science is exciting.** Science is a way of discovering what's in the universe and how those things work today, how they worked in the past, and how they are likely to work in the future. Scientists are motivated by the thrill of seeing or figuring out something that no one has before.
- **Science is useful.** The knowledge generated by science is powerful and reliable. It can be used to develop new technologies, treat diseases, and deal with many other sorts of problems.
- **Science is ongoing.** Science is continually refining and expanding our knowledge of the universe, and as it does, it leads to new questions for future investigation. Science will never be "finished."
- **Science is a global human endeavor.** People all over the world participate in the process of science. And you can too!

Diver photo provided by OAR/National Undersea Research Program (NURP); lab photo courtesy of Pacific Northwest National Laboratory; photo of geologists on volcano by J.D. Griggs; photo of scientist in corn field by Scott Bauer; image of Mars rover courtesy NASA/JPL-Caltech.

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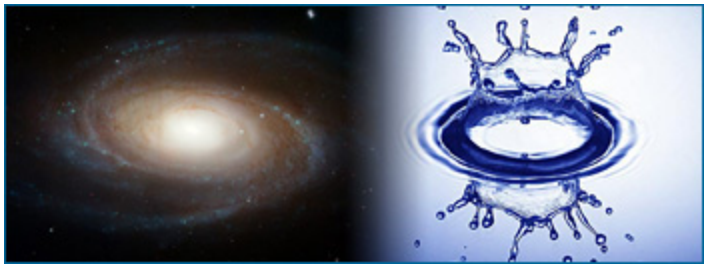
Discovery: The spark for science



"Eureka!" or "aha!" moments may not happen frequently, but they are often experiences that drive science and scientists. For a scientist, every day holds the possibility of discovery—of coming up with a brand new idea or of observing something that no one has ever seen before. Vast bodies of knowledge have yet to be built and many of the most basic questions about the universe have yet to be answered:

- What causes gravity?
- How do tectonic plates move around on Earth's surface?
- How do our brains store memories?
- How do water molecules interact with each other?

We don't know the complete answers to these and an overwhelming number of other questions, but the prospect of answering them beckons science forward.

EVERYDAY SCIENCE QUESTIONS

Scientific questions can seem complex (e.g., what chemical reactions allow cells to break the bonds in sugar molecules), but they don't have to be. You've probably posed many perfectly valid scientific questions yourself: how can airplanes fly, why do cakes rise in the oven, why do apples turn brown once they're cut? You can discover the answers to many of these "everyday" science questions in your local library, but for others, science may not have the answers yet, and answering such questions can lead to astonishing new discoveries. For example, we still don't know much about how your brain remembers to buy milk at the grocery store. Just as we're motivated to answer questions about our everyday experiences, scientists confront such questions at all scales, including questions about the very nature of the universe.

Discoveries, new questions, and new ideas are what keep scientists going and awake at night, but they are only one part of the picture; the rest involves a lot of hard (and sometimes tedious) work. In science, discoveries and ideas must be verified by multiple lines of evidence and then integrated into the rest of science, a process which can take many years. And often, discoveries are not bolts from the blue. A discovery may itself be the result of many years of work on a particular problem, as illustrated by Henrietta Leavitt's stellar discovery …

Photo of Spiral Galaxy M81 provided by NASA, ESA, and The Hubble Heritage Team (STScI/AURA); photo of water provided by Andrew Davidhazy.

Understanding Science

Henrietta Leavitt

STELLAR SURPRISES

Astronomers had long known about the existence of variable stars—stars whose brightness changes over time, slowly shifting between brilliant and dim—when, in 1912, Henrietta Leavitt announced a remarkable (and totally unanticipated) discovery about them. For these stars, the length of time between their brightest and dimmest points seemed to be related to their overall brightness: slower cycling stars are more luminous. At the time, no one knew why that was the case, but nevertheless, the discovery allowed astronomers to infer the distances to far-off stars, and hence, to figure out the size of our own galaxy. Leavitt's observation was a true surprise—a discovery in the classic sense—but one that came only after she'd spent years carefully comparing thousands of photos of these specks of light, looking for patterns in the darkness.

The process of scientific discovery is not limited to professional scientists working in labs. The everyday experience of deducing that your car won't start because of a bad fuel pump, or of figuring out that the centipedes in your backyard prefer shady rocks shares fundamental similarities with classically scientific discoveries like working out DNA's double helix. These activities all involve making observations and analyzing evidence—and they all provide the satisfaction of finding an answer that makes sense of all the facts. In fact, some psychologists argue that the way individual humans learn (especially as children) bears a lot of similarity to the progress of science: both involve making observations, considering evidence, testing ideas, and holding on to those that work.

Photo of Henrietta Leavitt provided by the American Association of Variable Star Observers (AAVSO).