

NIH News in Health

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Discoveries in Basic Science A Perfectly Imperfect Process

Have you ever wondered why science takes so long? Maybe you haven't thought about it much. But waiting around to hear more about COVID-19 may have you frustrated with the process.

Science can be slow and unpredictable. Each research advance builds on past discoveries, often in unexpected ways. It can take many years to build up enough basic knowledge to apply what scientists learn to improve human health.

"You really can't understand how a disease occurs if you don't understand how the basic biological processes work in the first place," says Dr. Jon Lorsch, director of NIH's National Institute of General Medical Sciences. "And of course, if you don't understand how the underlying processes work, you don't have any hope of actually fixing them and curing those diseases."

Basic research asks fundamental questions about how life works. Scientists study cells, genes, proteins, and other building blocks of life. What they find can lead to better ways to predict, prevent, diagnose, and treat disease.

How Basic Research Works •

When scientists are interested in a topic, they first read previous studies to find out what's known. This lets them figure out what questions still need to be asked.

Using what they learn, scientists design new experiments to answer



important unresolved questions. They collect and analyze data, and evaluate what the findings might mean.

The type of experiment depends on the question and the field of science. A lot of what we know about basic biology so far has come from studying organisms other than people.

"If one wants to delve into the intricate details of how cells work or how the molecules inside the cells work together to make processes happen, it can be very difficult to study them in humans," Lorsch explains. "But you can study them in a less complicated life form."

These are called research organisms. The basic biology of these organisms can be similar to ours, and much is already known about their genetic makeup. They can include yeast, fruit flies, worms, zebrafish, and mice.

Computers can also help answer basic science questions. "You can use computers to look for patterns and to try to understand how the different data you've collected can fit together," Lorsch says.

But computer models have limits. They often rely on what's already known about a process or disease. So it's important that the models include the most up-to-date information. Scientists usually have more confidence in predictions when different computer models come up with similar answers.

This is true for other types of studies, too. One study usually only uncovers a piece of a much larger puzzle. It takes a lot of data from many different scientists to start piecing the puzzle together.

Building Together • Science is a collective effort. Researchers often work together and communicate with each other regularly. They chat with other scientists about their work, both in their lab and beyond. They present their findings at

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national and international conferences. Networking with their peers lets them get feedback from other experts while doing their research.

Once they've collected enough evidence to support their idea, researchers go through a more formal peer-review process. They write a paper summarizing their study and try to get it published in a scientific journal. After they submit their study to a journal, editors review it and decide whether to send it to other scientists for peer review.

"Peer review keeps us all informed of each other's work, makes sure we're staying on the cutting-edge with our techniques, and maintains a level of integrity and honesty in science," says Dr. Windy Boyd, a senior science editor who oversees the peer-review process at NIH's scientific journal of environmental health research and news.

Different experts evaluate the quality of the research. They look at the methods and how the results were gathered.

"Peer reviewers can all be looking at slightly different parts of the work," Boyd explains. "One reviewer might be an expert in one specific

method, where another reviewer might be more of an expert in the type of study design, and someone else might be more focused on the disease itself."

Peer reviewers may see problems with the experiments or think different experiments are needed. They might offer new ways to interpret the data. They can also reject the paper because of poor quality, a lack of new information, or other reasons. But if the research passes this peer review process, the study is published.

Just because a study is published doesn't mean its interpretation of the data is "right." Other studies may support a different hypothesis.

Scientists work to develop different explanations, or models, for the various findings. They usually favor the model that can explain the most data that's available.

"At some point, the weight of the evidence from different research groups points strongly to an answer being the most likely," Lorsch explains. "You should be able to use that model to make predictions that are testable, which further strengthens the likelihood that that answer is the correct one."

An Ever-Changing Process •

Science is always a work in progress. It takes many studies to figure out the "most accurate" model—which doesn't mean the "right" model.

It's a self-correcting process. Sometimes experiments can give different results when they're repeated. Other times, when the results are combined with later studies, the current model no longer can explain all the data and needs to be updated.

"Science is constantly evolving; new tools are being discovered," Boyd says. "So our understanding can also change over time as we use these different tools."

**Wise Choices**
Research in the News

When you read or hear about a new study, ask:

- What question is the study trying to answer?
- How do the findings fit in with previous studies on the topic?
- Has the study been peer reviewed?
- Are there other studies that have confirmed the idea, or is it new and untested?
- Was the study done in people or a research organism?
- Who do the findings apply to? Was the study done in certain groups of people?
- What questions still need to be answered?

Science looks at a question from many different angles with many different techniques. Stories you may see or read about a new study may not explain how it fits into the bigger picture.

"It can seem like, at times, studies contradict each other," Boyd explains. "But the studies could have different designs and often ask different questions."

The details of how studies are different aren't always explained in stories in the media. Only over time does enough evidence accumulate to point toward an explanation of all the different findings on a topic.

"The storybook version of science is that the scientist is doing something, and there's this eureka moment where everything is revealed," Lorsch says. "But that's really not how it happens. Everything is done one increment at a time." ■

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Editor Harrison Wein, Ph.D.

Managing Editor Tianna Hicklin, Ph.D.

Graphics Alan Defibaugh (illustrations),
Bryan Ewsichek (design)

Contributors Erin Bryant, Tianna Hicklin, and
Sharon Reynolds

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Office of Communications & Public Liaison
Building 31, Room 5B52
Bethesda, MD 20892-2094
email: niHnewsinhealth@od.nih.gov
phone: 301-451-8224

**Web Links**

For more about how research works, see "Links" in the online article: newsinhealth.nih.gov/2020/10/discoveries-basic-science

Tired or Wired?

Caffeine and Your Brain

A hot cup of coffee or tea is a highlight of the morning for some people. It can make you feel awake and alert. Caffeine is the chemical that causes these sensations. But does caffeine have other effects on the brain?

Caffeine is found naturally in tea and coffee. But it is added to energy drinks and many types of soda. It's even put in some snack foods and medications. More than eight out of 10 adults in the U.S. consume caffeine in some form.

So how does caffeine wake you up? Your body naturally produces a chemical called adenosine. It builds up in your body during the day.

"The sleepiness you feel at the end of the day—that's adenosine," explains Dr. Sergi Ferre, a brain scientist at NIH. Its buildup tells your brain when it's time to rest.

Caffeine blocks adenosine from working on brain cells. This prevents you from feeling sleepy.

"But the body adapts," Ferre says. If you regularly consume caffeine, your body produces more adenosine. So people need more caffeine over time to get the same wakeful feeling.

Adenosine also makes it unpleasant to quit caffeine suddenly, says

Ferre. If you take away the caffeine, extra adenosine in the body can cause feelings of withdrawal for a while. These include headaches and increased sleepiness.

Caffeine also interacts with other chemicals in the brain. If you consume more than normal, some of these interactions are what make you feel "overcaffeinated." Your heart may race, or you can feel anxious or sick to your stomach.

But caffeine doesn't affect everyone the same way. That's because people's bodies can break it down at different speeds. How fast your body does this depends largely on your **genes**, explains Dr. Marilyn Cornelis, a nutrition researcher at Northwestern University.

Experts recommend that some people avoid caffeine. These include people with gut troubles like acid reflux, people who have trouble sleeping, and people who have high blood pressure or heart problems. Children, teens, and women who are pregnant or breastfeeding are often advised to stay away from caffeine, too. Talk with your health care provider if you're concerned about caffeine and your health.

"Even healthy people should avoid mixing caffeine with alcohol," explains Ferre. "This is because caffeine can block the brain from feeling the depressant effects of alcohol. This might lead someone to drink more than they normally would, increasing their impairment."

But research suggests that caffeine on its own is likely harmless for most healthy adults in low to



moderate amounts, says Cornelis. She and others are studying whether it might even have positive effects on thinking, learning, and memory.

"When you drink caffeine, your attention is greater," she says. "That contributes to our brain's ability to retain information. That might lead to improvements in long-term cognitive function." Her team is exploring new ways to measure the effects of caffeine on the brain and the role genes play in your body's response.

While a few cups of unsweetened coffee or tea a day are likely fine for most people, Cornelis adds, some sources of caffeine can contain a lot of sugar. Excess sugar isn't good for the body or brain, she says. If you're looking for a pickup without sugar or caffeine, see the Wise Choices box for tips. ■

Definitions

Genes

Stretches of DNA, a substance you inherit from your parents, that define characteristics such as how likely you are to get certain diseases.



Wise Choices

Stay Alert Without Caffeine

- **Get enough sleep.** Most adults need between seven and eight hours of sleep every night to feel rested.
- **Eat regularly.** When you don't eat, your blood sugar levels drop, making you feel tired.
- **Drink enough water.** Staying hydrated can help you stay alert.
- **Take a break for exercise.** If you're feeling drained in the middle of the day, it helps to move around.



Web Links

For more about caffeine, see "Links" in the online article: newsinhealth.nih.gov/2020/10/tired-wired



Health Capsules

For links to more information, please visit our website and see these stories online.

Contact Lenses Slow Children's Nearsightedness

Myopia, or nearsightedness, usually starts during childhood and worsens over time. A new study found that a type of contact lens can slow its progression.

People with myopia can see close objects clearly, but things farther away are blurry. Those with severe myopia have a greater risk of developing other eye problems later in life.

Myopia is caused by the eye growing too long from front to back. Light then focuses in front of the retina (the light-sensitive tissue at the back of the eye) instead of directly

on it. Single-vision contact lenses can focus light mainly back on the retina. But they also focus some light behind the retina. That can cause the eye to grow longer.

Researchers tested whether multifocal contact lenses could slow progression of myopia. The lenses have more than one prescription set in a bullseye pattern. The center focuses light on the retina. The outer part focuses light in front of the retina.

The study tracked disease progression in 287 nearsighted children, ages seven to 11. Some children wore

single-vision contact lenses. Others wore one of two prescription strengths of multifocal contacts.

Researchers measured vision changes over three years. The stronger multifocal lenses slowed progression of nearsightedness the most. These lenses also slowed the eye growth that causes myopia.

"Compared with single-vision contact lenses, multifocal lenses slow myopia progression by about 43% over three years," says Dr. David A. Berntsen of the University of Houston, one of the study's leads. ■

Manage Stress and Build Resilience

It's hard to avoid stress. Work, money, current events, and the hassles of everyday life are just a few of the things that can cause stress. Long-term, or chronic, stress is linked to several health conditions like heart disease, high blood pressure, diabetes, depression, and anxiety.

It's important to learn how to manage stress so it doesn't overwhelm you. The first step is to recognize your body's signals. These could include headaches, poor concentration, or feeling on edge. Once you identify these signs, work to counter their ef-

fects. Some people benefit from deep breathing, going for a walk, or writing down their thoughts.

Whatever works for you, make taking care of yourself part of your daily routine. Work in time to exercise, eat healthy foods, and get good quality sleep. This will help make you more resilient to life's stresses.

Experts also recommend staying socially connected. Being in touch with family and friends can combat stress and depression. Video chats and other technology make staying in touch easier than ever.

If you can, also try to see problems a different way. Experts call this "reframing." Stuck in traffic? It may be an opportunity to enjoy some music or catch up on a podcast. Practice reframing the situation and you'll likely get better at it over time.

Finally, if stress is affecting your well-being, talk to a health professional. They can help guide you through times of severe stress. For more tips, visit <https://go.usa.gov/xG5XS>. ■



Featured Website

Healthy Pregnancy for Every Body

<https://go.usa.gov/xGBjV>

Plus-size women are at higher risk for certain health problems during pregnancy. It's important for all women to work with their

health care provider to plan for a healthy pregnancy. Learn how to set pregnancy goals and plan steps to reach them.



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