

NIH RESEARCH MATTERS

2021 Research Highlights

With NIH support, scientists across the United States and around the world conduct wide-ranging research to discover ways to enhance health, lengthen life, and reduce illness and disability. Groundbreaking NIH-funded research often receives top scientific honors. In 2021, these honors included [Nobel Prizes to five NIH-supported scientists](#). Here's just a small sample of the NIH-supported research accomplishments in 2021. For more health and medical research findings from NIH, visit [NIH Research Matters](#).

Human Health Advances

Disease Prevention, Diagnosis, and Treatment



COVID-19 spread and vaccines

NIH researchers continued to make scientific breakthroughs to help control the COVID-19 pandemic. Studies of spread [suggested strategies for controlling infections](#). Research also revealed who was most at risk of becoming severely ill from COVID-19: nearly [two-thirds of COVID-19 hospitalizations in the U.S. were due to obesity, diabetes, hypertension, and heart failure](#). Wide-spread vaccine rollouts slowed the spread of SARS-CoV-2, the virus that causes COVID-19. The Moderna COVID-19 vaccine, developed with NIH, proved to be [94% effective against symptomatic COVID-19](#). Six months later, people who had been vaccinated [still showed signs of immunity](#). [COVID-19 vaccines saved an estimated 140,000 lives](#) through May 2021, and hundreds of thousands more have been saved since. As SARS-CoV-2 mutated and new variants became common, scientists conducted studies on booster doses of vaccine. These suggested that COVID-19 boosters [not only lengthen immunity but help broaden and strengthen the immune response](#) to protect against a wide variety of variants.



Drug delays type 1 diabetes onset

In type 1 diabetes, the immune system's T cells attack the insulin-producing beta cells in the pancreas. Those affected need insulin treatment to survive. In a clinical trial of people at risk of developing type 1 diabetes (with a median age of 13), the drug teplizumab delayed disease onset and improved insulin production. The findings support the use of the drug for delaying or preventing type 1 diabetes.

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Gene therapy effective in human trials

Advances in gene therapy are showing promise for people with life-threatening conditions. Using gene therapy, researchers were able to [introduce a healthy copy of a disease-causing gene and restore immune system function](#) in children with a rare genetic disorder called severe combined immunodeficiency, or SCID. In another study, researchers [safely delivered gene therapy to the brain to treat a debilitating neurological disease](#) for which there are no effective treatments.



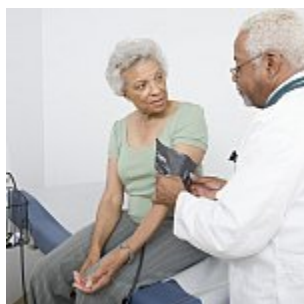
Low-fat diet compared to low-carb diet

There has been a great deal of debate over what aspects of our diets affect weight control. A carefully controlled study found that people ate fewer calories per day and lost more weight on a plant-based, low-fat diet compared to an animal-based, low-carb diet. However, the low-fat diet led to higher insulin and blood sugar levels, which can be risk factors for heart disease. The findings reveal how restricting dietary carbohydrates or fats may impact health.



Supplement targets gut microbes to boost growth in malnourished children

The effects of childhood malnutrition can cause lifelong health problems. Researchers found that a supplement designed to repair the gut microbiome—the bacteria, viruses, and fungi in the digestive system—helped malnourished children. Those given the supplement gained more weight than children on a standard nutritional supplement. The experimental supplement also raised levels of proteins in the blood associated with bone, cartilage, and brain health.



Test may help reduce racial disparities in kidney disease

A common blood test for kidney function measures a protein called creatinine. But Black Americans generally have higher amounts of creatinine. As a result, doctors take race into account when testing for kidney disease. A study showed that measuring levels of another protein called cystatin C can accurately estimate kidney function without needing to take race into account. A race-blind method for estimating kidney function could more effectively identify chronic kidney disease.

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Malaria vaccines provide strong and lasting immunity

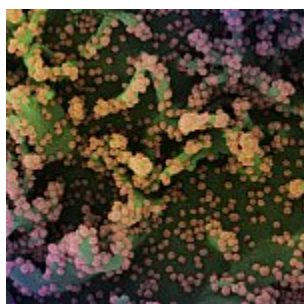
Malaria is caused by parasites transmitted by infected mosquitoes. Researchers developed a vaccine approach that uses live sporozoites, the infectious form of the malaria parasite, along with a drug that kills the parasite. In a small trial, the approach led to broad, long-lasting protection against malaria. The strategy is now being tested in real-world conditions in a Phase 2 clinical trial in Mali.



Devices in the brain help paralyzed people communicate

Technological advances are enabling people who have lost the ability to move or speak to communicate again. Scientists [developed a device to decode brain activity into words in real time](#), allowing a person with paralysis to communicate in complete sentences. Another system quickly [translates brain signals for imagined handwriting into text](#). These systems could make communication for people with severe paralysis more natural and efficient.

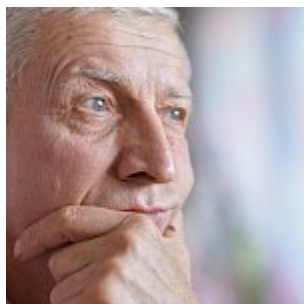
Promising Medical Findings Results with Potential for Enhancing Human Health



Advancing COVID-19 treatment and prevention

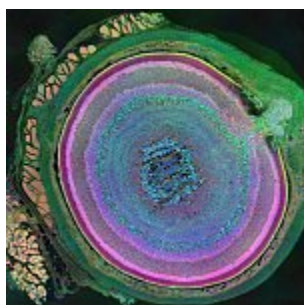
Amid the sustained pandemic, researchers continued to develop new drugs and vaccines for COVID-19. They found oral drugs that could [inhibit virus replication in hamsters](#) and [shut down a key enzyme](#) that the virus needs to replicate. Both drugs are currently in clinical trials. Another drug effectively treated both [SARS-CoV-2 and RSV, another serious respiratory virus](#), in animals. Other researchers used an [airway-on-a-chip](#) to screen approved drugs for use against COVID-19. These studies identified oral drugs that could be administered outside of clinical settings. Such drugs could become powerful tools for fighting the ongoing pandemic. Also in development are an [intranasal vaccine](#), which could help prevent virus transmission, and vaccines that can [protect against a range of coronaviruses](#).

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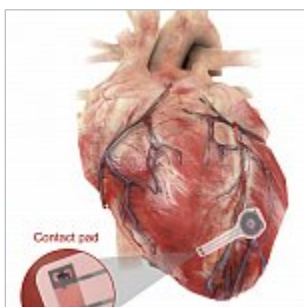
**Developments in Alzheimer's disease research**

One of the hallmarks of Alzheimer's is an abnormal buildup of amyloid-beta protein. A study in mice suggests that antibody therapies targeting amyloid-beta protein could be more effective after [enhancing the brain's waste drainage system](#). In another study, irisin, an exercise-induced hormone, was found to [improve cognitive performance in mice](#). New approaches also found two approved drugs (described below) with promise for treating AD. These findings point to potential strategies for treating Alzheimer's. Meanwhile, researchers found that people who [slept six hours or less per night in their](#)

[50s and 60s](#) were more likely to develop dementia later in life, suggesting that inadequate sleep duration could increase dementia risk.

**New uses for old drugs**

Developing new drugs can be costly, and the odds of success can be slim. So, some researchers have turned to repurposing drugs that are already approved for other conditions. Scientists found that two FDA-approved drugs were associated with lower rates of Alzheimer's disease. [One](#) is used for high blood pressure and swelling. [The other](#) is FDA-approved to treat erectile dysfunction and pulmonary hypertension. Meanwhile, the [antidepressant fluoxetine](#) was associated with reduced risk of age-related macular degeneration. Clinical trials will be needed to confirm these drugs' effects.

**[Making a wireless, biodegradable pacemaker](#)**

Pacemakers are a vital part of medical care for many people with heart rhythm disorders. Temporary pacemakers currently use wires connected to a power source outside the body. Researchers developed a temporary pacemaker that is powered wirelessly. It also breaks down harmlessly in the body after use. Studies showed that the device can generate enough power to pace a human heart without causing damage or inflammation.

**[Fungi may impair wound healing in Crohn's disease](#)**

Inflammatory bowel disease develops when immune cells in the gut overreact to a perceived threat to the body. It's thought that the microbiome plays a role in this process. Researchers found that a fungus called *Debaryomyces hansenii* impaired gut wound healing in mice and was also found in damaged gut tissue in people with Crohn's disease, a type of inflammatory bowel disease. Blocking this microbe might encourage tissue repair in Crohn's disease.

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[Nanoparticle-based flu vaccine](#)

Influenza, or flu, kills an estimated 290,000-650,000 people each year worldwide. The flu virus changes, or mutates, quickly. A single vaccine that conferred protection against a wide variety of strains would provide a major boost to global health. Researchers developed a nanoparticle-based vaccine that protected against a broad range of flu virus strains in animals. The vaccine may prevent flu more effectively than current seasonal vaccines. Researchers are planning a Phase 1 clinical trial to test the vaccine in people.



[A targeted antibiotic for treating Lyme disease](#)

Lyme disease cases are becoming more frequent and widespread. Current treatment entails the use of broad-spectrum antibiotics. But these drugs can damage the patient's gut microbiome and select for resistance in non-target bacteria. Researchers found that a neglected antibiotic called hygromycin A selectively kills the bacteria that cause Lyme disease. The antibiotic was able to treat Lyme disease in mice without disrupting the microbiome and could make an attractive therapeutic candidate.



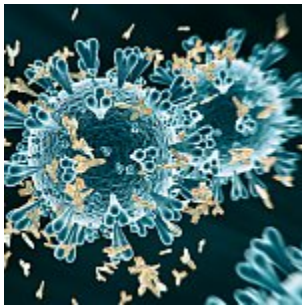
[Retraining the brain to treat chronic pain](#)

More than 25 million people in the U.S. live with chronic pain. After a treatment called pain reprocessing therapy, two-thirds of people with mild or moderate chronic back pain for which no physical cause could be found were mostly or completely pain-free. The findings suggest that people can learn to reduce the brain activity causing some types of chronic pain that occur in the absence of injury or persist after healing.

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Basic Research Insights

Noteworthy Advances in Fundamental Research



Understanding SARS-CoV-2 infection

Researchers made progress in understanding how SARS-CoV-2, the virus that causes COVID-19, interacts with the human body. They found [that cells in the mouth](#) may play an important role in infection. The virus [can infect inner ear cells](#), too, which could explain hearing and balance issues in some COVID-19 patients. Part of the damage caused by SARS-CoV-2 may relate to autoantibodies—antibodies that mistakenly attack the body’s own proteins and tissues. People who had autoantibodies before SARS-CoV-2 infection [were at higher risk of developing severe COVID-19](#). The virus also appears to [trigger the production of new autoantibodies in some people](#), which may contribute to the symptoms of “long COVID.” Other scientists found that antibodies from people who were infected and then received a single dose of the Pfizer-BioNTech vaccine [were similar to antibodies from uninfected people after their second shot](#). And researchers revealed how [certain mutations in SARS-CoV-2 variants](#) allow the virus to avoid neutralization by many antibodies.



Study reveals brain cells that sustain or suppress fearful memories

Fearful memories help people and animals respond to potential dangers. But having these memories fade when they’re no longer useful is important to avoid undue stress and anxiety. Researchers identified clusters of brain cells that compete to promote either the persistence or disappearance of fearful memories. The findings could give insight into post-traumatic stress disorder (PTSD) and anxiety disorders.



New ideas for fighting dangerous bacteria

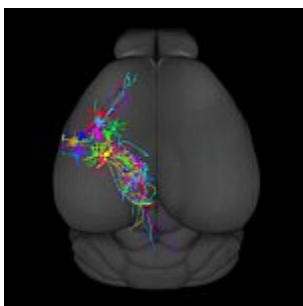
Antibiotic resistance is a significant public health problem, with bacterial infections becoming increasingly difficult to treat. Researchers are exploring new ways to fight these pathogens, including [harnessing proteins produced by normal gut bacteria](#) and [stimulating the natural abilities of the immune system](#). Scientists are also finding new antibiotic candidates [inside our own cells](#) and within [proteins produced by the human body](#).

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[How fructose may contribute to obesity and cancer](#)

Increased consumption of the sugar fructose has been linked to a rise in obesity and related cancers such as colorectal cancer. But how fructose may contribute to these conditions has been unclear. Researchers found that high levels of dietary fructose alter the gut to increase nutrient absorption in mice. The results suggest how high fructose consumption may influence obesity and certain cancers.



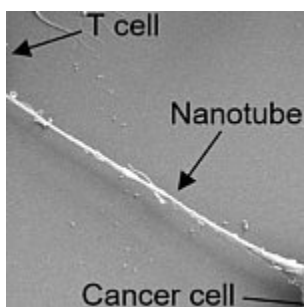
[Mapping the mammalian motor cortex](#)

There are trillions of neuronal connections in the human brain, and each brain is unique. Understanding the differences in people's brains may help scientists better understand mental health, mental illness, and neurological disease. Researchers created an atlas of the cells and connections in the mammalian primary motor cortex, the brain region responsible for directing complex body movements. Derived from studies of mice, monkeys, and humans, the atlas provides a roadmap for understanding the mammalian brain.



[Brain receptor linked to puberty and growth](#)

The timing of puberty is controlled by neurons in the brain's hypothalamus. Nutrition and body weight affect this system, but exactly how wasn't known. Scientists identified a brain receptor that links childhood nutrition to the timing of puberty and growth. People carrying mutations in the gene for the receptor started puberty later and were often shorter than average. The findings help explain how adequate nutrition affects growth and sexual development.



[Cancer cells drain energy from immune cells](#)

Cancer cells have many ways to evade the immune system to grow and spread. Researchers discovered that cancer cells use straw-like nanotubes to siphon mitochondria from immune cells. This helps energize the cancer cells and, at the same time, disable the immune cells. Inhibiting nanotube formation could potentially make certain anticancer therapies more effective.

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Hair loss studies yield insight into stem cells, stress, and aging

Stem cells play a vital role in regeneration and aging. Researchers found that a stress hormone [impairs stem cells necessary for hair growth in mice](#). The findings may lead to insights into how stress affects regeneration in other parts of the body. In another study, researchers [observed stem cells responsible for hair growth escaping](#) from hair follicles in aging mice. The results give insight into how hair and tissues age, and how some diseases associated with aging may arise.