National Institute of General Medical Sciences

Research Organisms

A research organism is any creature that scientists use to study life.

What is a research organism?

A research organism is any creature that scientists use to study life. Examples range from those with just one cell, such as bacteria, to more complex ones, such as mice. NIGMS funds studies of research organisms to understand fundamental aspects of biology, which are common to all organisms, including humans. Research organisms may also reveal novel biological processes that can become important technologies for use in research or medicine. An example of such a discovery is the CRISPR gene-editing system, which led to the 2020 Nobel Prize in Chemistry.

To know what causes a disease, it's first necessary to understand the biological processes affected by it. This knowledge can then tell scientists how a malfunction in those processes produces the disease, thereby allowing them to develop and test possible treatments.

Scientists can study research organisms in ways they can't study people. For example, they can change the genes in a research organism to see what effect it has on various processes. By making such changes, researchers can answer biological questions that they can't answer by studying humans.

Any NIH-funded research that includes animals or people must follow certain laws and rules to protect their welfare and minimize risks.

Zebrafish. Credit: iStock

Why are research organisms useful for studying diseases?

Research organisms have many of the same genes as human beings. When scientists discover a link between a particular gene and a human disease, they typically find out what that gene does in a research organism. These findings can provide important clues about what causes a disease and help to develop potential diagnostic tools and treatments that are later tested in clinical trials.

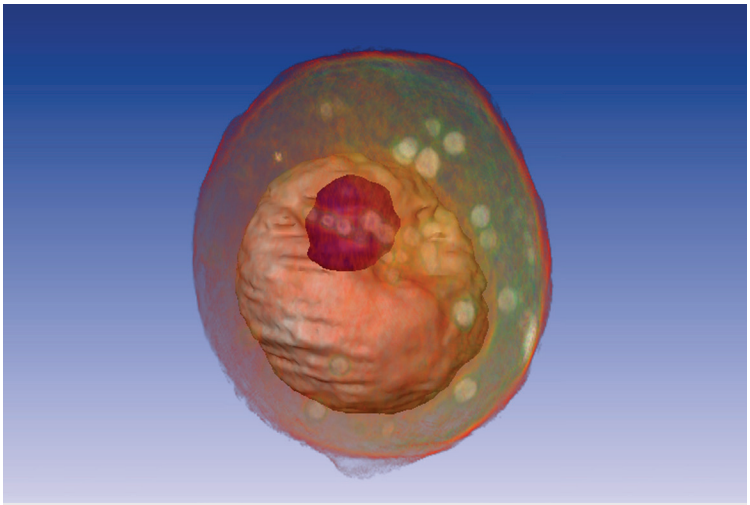
Research organisms are also useful because a disease's natural course in humans can take dozens of years, whereas a research organism can quickly develop a version of that disease or some of its symptoms. This helps scientists learn new details in much less time. Furthermore, research organisms can be less expensive and easier to study than people.

Like the similarities, the contrasts between other organisms and human beings can also be informative. For instance, figuring out why the naked mole rat doesn't develop cancer could help researchers determine how to prevent cancer in people.

How has work with research organisms influenced our understanding of human health?

Much of what we know about human biology comes from studies of research organisms, and they've led to the development of new tools to diagnose and treat disease. When research organisms are used to examine elements of human diseases, they're often referred to as model organisms. Here are a few examples of NIGMS-funded research in this area:

- Zebrafish shed light on the development of the heart and of brain regions that drive behavior. They have see-through eggs and embryos, making it easy to watch the earliest stages of their development.
- Yeast showed a process called the cell cycle that cells use to copy their contents and multiply. Millions of people with cancer benefit from this information because many cancer drugs hinder the cell cycle. Yeast studies also allowed researchers to discover how genes turn on or off and understand how changes in gene activity cause disease.



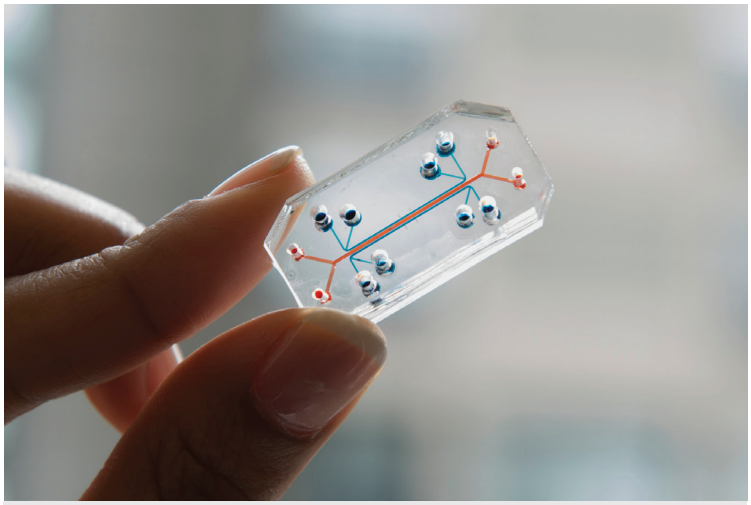
Yeast cell. Credit: Carolyn Larabell, University of California, San Francisco, and the Lawrence Berkeley National Laboratory

Fruit fly. Credit: iStock

- Fruit flies, bread mold, bacteria, and mice all played roles in scientists' identification of the basic components of circadian clocks, which drive daily biological rhythms. The research revealed connections between these clocks and sleep deprivation, obesity, diabetes, depression, and other human health conditions.
- Rats and mice helped researchers understand what happens to biological systems as people age. They've also provided more insight into medication safety, molecules that cause cancer, and the genetics of Down syndrome, cystic fibrosis, heart disease, and cancer.
- Studies of a variety of model organisms helped scientists develop tools, including DNA chips for studying a cell's gene activity, and CRISPR for editing DNA in living organisms. Research has also shown how model organisms fix damaged pieces of DNA, pass changes in genes to their offspring, and regenerate missing or injured body parts.

Are there alternatives to using research organisms for these studies?

Scientists alternatively use computer models and lab-on-a-chip systems for health research. Computers can serve as virtual laboratories and enable scientists to perform experiments that are difficult, time consuming, or expensive to do in actual labs. Computer simulations track biological processes in research organisms, allowing researchers to computationally test, for example, the possible effects of various drugs on those processes. Then, they can study just the most promising drugs in living organisms.



Sample tissue chip featuring a "lung-on-a-chip." Credit: Wyss Institute for Biologically Inspired Engineering, Harvard University

Like more traditional animal models, no single computer model can accurately predict an outcome. Therefore, researchers often ask the same questions using different models. When multiple models yield similar results, scientists have more confidence in the predictions.

Another option over using research organisms is putting living human tissues and cells onto small see-through chips. These "tissue chips" or "organs on chips" copy the structure and activity of organs in the human body. Scientists, including researchers at the National Center for Advancing Translational Sciences, have made tissue chips for the lungs, heart, kidneys, skin, and liver, among others. They can also connect these chips together to test a treatment's effects on several organs at the same time. They hope that using organs on chips will help speed up testing of potential new drugs for a variety of diseases.

What are the limits of research organisms and other model systems?

Although research organisms have many similarities to people, they also have major differences. For example, drugs that are safe in animals aren't always safe in people. That's why researchers try to test their findings in a variety of research organisms and must ultimately confirm the results by looking at humans.

Similarly, while computer models are helpful, research organisms are still needed to confirm their predictions.

Learn More

NIGMS Resources

- **Research Organisms** (*Biomedical Beat* blog posts)
- **Studying Genes** (Fact sheet)
- **Glossary** (Pronunciations and easy-to-understand definitions)

Other Resources

- **Why Are Animals Used in NIH Research?** (NIH)
- **How Does the NIH Ensure Animal Welfare?** (NIH)
- **Computational Modeling** (NIBIB)
- **Meet Chip** (NCATS)

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