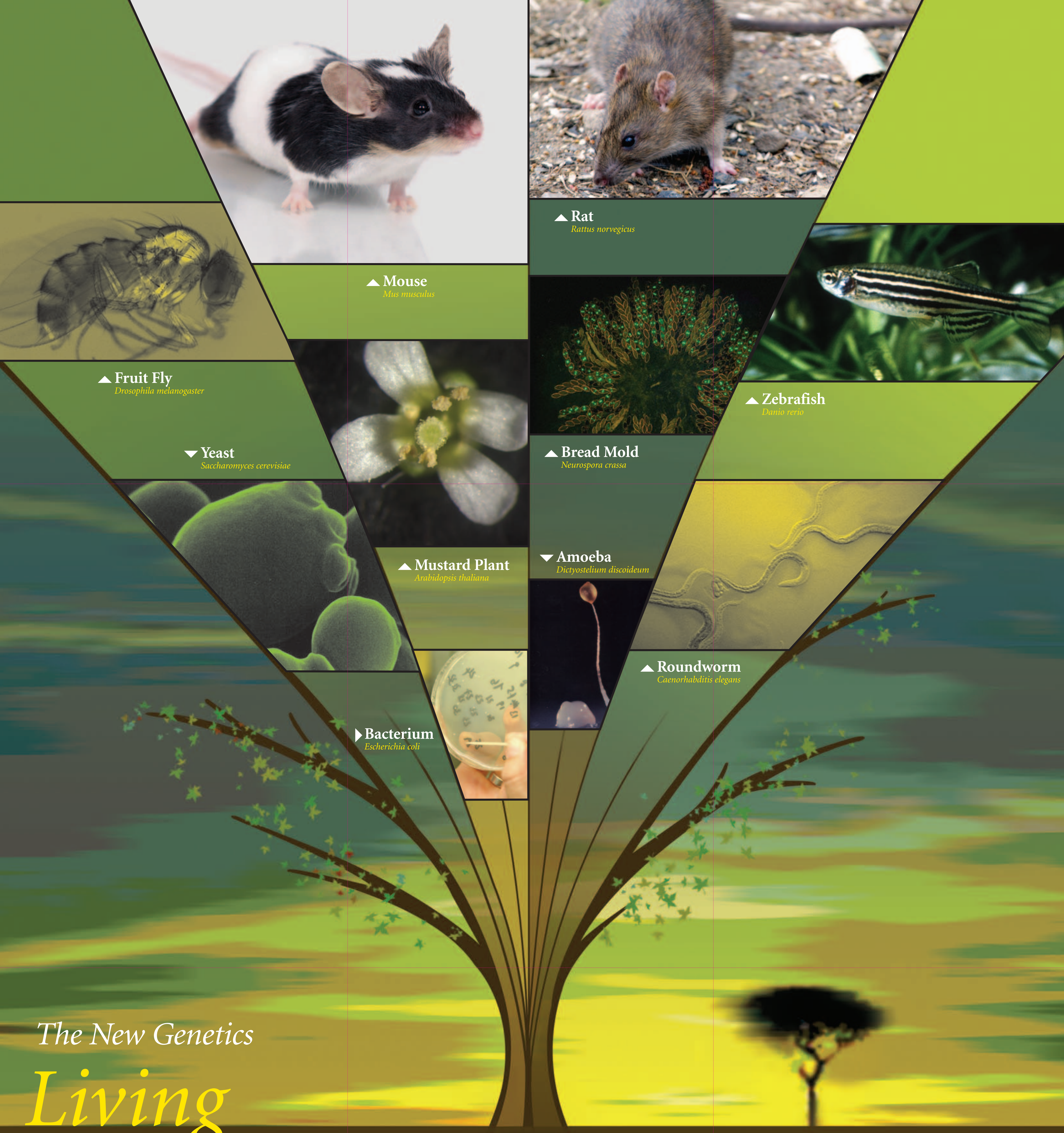

The New Genetics

Living Laboratories

Like most people, you probably think of fruit flies as kitchen nuisances. But did you know that scientists use these organisms for medical research?

Fruit flies and other model organisms—as different as mice, plants, and zebrafish—permit scientists to investigate questions that would not be possible to study in any other way. These living systems are, relatively speaking, simple, inexpensive, and easy to work with.

Model organisms are indispensable to science because creatures that appear very different from us and from each other actually have a lot in common when it comes to body chemistry. Even organisms that don't have a body—mold and yeast, for example—can give scientists clues to the workings of the tissues and organs of people.

This is because all living things process the nutrients they consume into the same chemicals, more or less. The genes for the enzymes involved in metabolism are similar in all organisms.

The back of this poster shows a sampling of the wide variety of living laboratories that scientists are using to advance human health.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
National Institutes of Health
National Institute of General Medical Sciences

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1 *Escherichia coli:* Bacterium

"Once we understand the biology of Escherichia coli, we will understand the biology of an elephant." So said Jacques Monod, a French scientist who won the 1965 Nobel Prize in physiology or medicine for his work on gene regulation. Monod was an early proponent of the value of experimenting with simple organisms like bacteria.

Are all bacteria bad? If all you've ever heard about *E. coli* is its notorious link to tainted hamburger meat, you may not realize that non-disease-causing strains of the bacterium live in the intestinal tracts of humans and other animals, helping them in a variety of ways.

E. coli are also an important tool for genetic researchers who study genes from many different organisms.

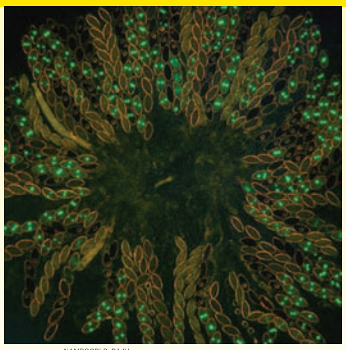
2 *Dictyostelium discoideum:* Amoeba

REX L. CHISHOLM

This microscopic amoeba—100,000 of them form a mound as big as a grain of sand—is an important tool for health studies. Scientists have determined that *Dictyostelium discoideum (Dicty)* normally grows as separate, independent cells. However, when food is limited, neighboring cells pile on top of each other to create a large, multicelled structure containing up to 100,000 cells. This blob ambles along like a slug, leaving a trail of slime behind. After migrating to a more suitable environment, the blob firms up into a towerlike structure that disperses spores, each capable of generating a new amoeba.

Because of its unusual properties and ability to live alone or in a group, *Dicty* intrigues researchers who study cell division, movement, and various aspects of organ and tissue development.

3 *Neurospora crassa:* Bread Mold

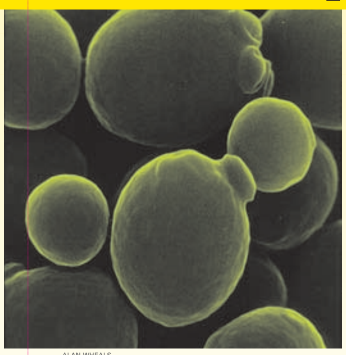


NAMBOORI B. RAJU

Chances are you don't think of a moldy bread crust as a potential science experiment, but thousands of researchers around the world do! *Neurospora crassa (Neurospora)*, which is a species of mold that thrives on bread, is a widely used model organism for genetic research.

Biologists like to use *Neurospora* because it is simple to grow and has features that make it very suitable for answering questions about how species arise and adapt, as well as how cells and tissues change their shape in different environments. Since *Neurospora* produces spores on a 24-hour cycle, the organism is also useful for studying the biological clocks that govern sleep, wakefulness, and other rhythms of life.

4 *Saccharomyces cerevisiae:* Yeast

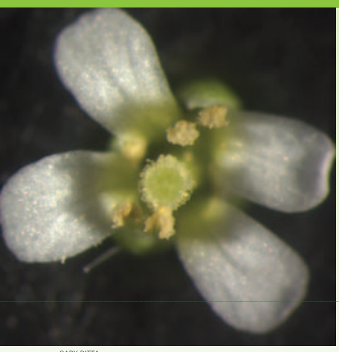


ALAN WHEALS

There are hundreds of different kinds of yeast, but *Saccharomyces cerevisiae*, the one scientists study most often, is an important part of human life outside the lab, too. It is the yeast that bakers use to make bread and brewers use for beer.

Like *Neurospora*, yeast is actually a fungus—not a plant, not an animal, but related to both. It is also a eukaryote (as is *Neurospora*)—a "higher" organism with an organized, protective nucleus that holds its chromosomes. Researchers like yeast because it grows fast, is cheap to feed and safe to handle, and its genes are easy to work with. We know a lot about mammalian genes because scientists can easily insert them into yeast and then study how they work and what happens when they don't work.

5 *Arabidopsis thaliana:* Mustard Plant



GARY DITTA

Researchers who study plant growth often use *Arabidopsis thaliana (Arabidopsis)*, a small, flowering plant related to cabbage and mustard. This organism is appealing to biologists because *Arabidopsis* has almost all of the same genes as other flowering plants and has relatively little DNA that does not encode proteins, simplifying the study of its genes. Like people and yeast, plants are also eukaryotes. *Arabidopsis* grows quickly, going from seed to mature plant in only 6 weeks—another plus for researchers who study how genes affect biology.

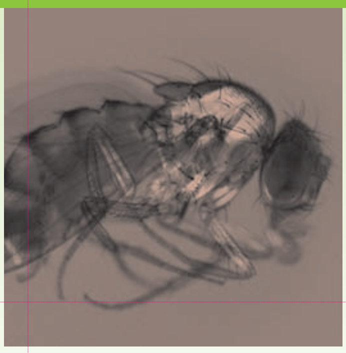
What do you have in common with a mustard plant? Plant cells, and parts of plant cells, communicate with each other in much the same way that human cells do. For that reason, plants are good models for genetic diseases that affect cell communication.

6 *Caenorhabditis elegans:* Roundworm

Caenorhabditis elegans (C. elegans) is a creature that is a lot smaller than its name! Several of these harmless roundworms would fit on the head of a pin, although their usual habitat is dirt. In the lab, they live in petri dishes and eat bacteria. *C. elegans* contains just 959 cells, almost a third of them forming its nervous system. Researchers know the fate of every one of these cells!

This worm is particularly prized by biologists because it is transparent, so what goes on in its tiny body is in plain view under a microscope. But for such a small, simple animal, *C. elegans* has a lot of genes—more than 19,000 (humans have about 25,000). Decoding the *C. elegans* genome was a huge milestone for biology, since it was the first animal genome to be sequenced completely. Scientists quickly learned that a vast number of genes in *C. elegans* are very similar to genes in other organisms, including people.

7 *Drosophila melanogaster:* Fruit Fly



The fruit fly species most commonly used for research is named *Drosophila melanogaster (Drosophila)*. A geneticist's fruit fly is pretty much the same as the ones that fly around your overripe bananas. In the lab, though, some of the flies are exposed to damaging chemicals or radiation, which changes the sequence of their DNA. Researchers allow the flies to mate, then search among the offspring for flies with abnormalities. Abnormal flies are then mated to produce more offspring with the abnormality, enabling researchers to close in on the defective genes involved.

Hundreds of fruit flies can live in a pint-sized milk bottle or even a small vial, and they reproduce so quickly that keeping track of a particular gene as it passes through a couple of *Drosophila* generations takes only about a month.

8 *Danio rerio:* Zebrafish

MONTE WESTERFIELD

Zebrafish were originally found in slow streams, rice paddies, and the Ganges River in East India and Burma. They can also be found in most pet stores and are a home aquarium favorite. Although the fish have been used by some geneticists for research since the early 1970s, in recent years they have become an especially popular model organism.

Many researchers are drawn to zebrafish because their eggs and embryos are transparent, making it possible to watch development unfold. In a span of 2 to 4 days, zebrafish cells split and form different parts of the baby fish's body: eyes, heart, liver, stomach, and so on. Zebrafish research has taught scientists about a range of health-related matters in people, including birth defects and the proper development of blood, the heart, and the inner ear.

9 *Mus musculus:* Mouse

The branches of life's genetic tree that led eventually to mice and to human beings split off from each other 75 million years ago, back in the dinosaur age. But we are both mammals, and we share 85 percent of our genes. Because some mouse diseases are very similar—sometimes identical—to human diseases, mice are exceptionally valuable for research.

Since the late 1980s, researchers have been able to engineer mice with missing genes. Scientists make these "knockout" mice to learn what goes wrong when a particular gene is removed. This gives them valuable clues about the gene's normal function. Identifying these genes in humans has helped define the molecular basis for many illnesses.

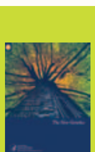
10 *Rattus norvegicus:* Rat

The Norway rat, or lab rat, was the first animal domesticated for use in scientific research. Currently, they make up about one-fourth of all research animals in the United States. Lab rats have been used for many decades for testing drugs, and much of what we know about cancer-causing molecules was learned in basic research with rats.

Although rats are mammals just like mice, they differ in important ways. Rats are much bigger than mice, making it easier for scientists to do experiments that involve the brain. For example, rats have taught scientists a lot about substance abuse and addiction, learning, memory, and certain neurological diseases. Rats are also much better models than mice for studying asthma and lung injury.

What Is NIGMS?

The National Institute of General Medical Sciences (NIGMS) supports basic biomedical research on genes, proteins, and cells. It also funds studies on fundamental processes such as how cells communicate, how our bodies use energy, and how we respond to medicines. The results of this research increase our understanding of life and lay the foundation for advances in the diagnosis, treatment, and prevention of disease. The Institute's research training programs produce the next generation of biomedical scientists, and NIGMS has programs to encourage minorities underrepresented in biomedical and behavioral science to pursue research careers.



This poster is derived from the NIGMS publication *The New Genetics*. To order a free copy, visit http://www.nigms.nih.gov/publications/classroom.htm

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