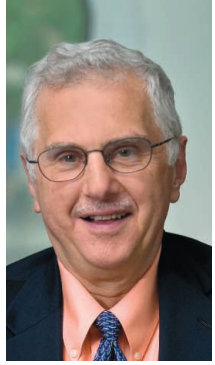

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Model Organisms and Human Health

IN THIS ISSUE OF ***SCIENCE***, WE HIGHLIGHT THE IMPRESSIVE EFFORTS TO DESCRIBE AND ANALYZE the genomes of the two organisms—the fly *Drosophila melanogaster* and the nematode worm *Caenorhabditis elegans*—that serve as the best models for understanding the biology of all animals, including humans. Hundreds of scientists have collaborated in these two major studies, which have moved us far beyond the complete descriptions of the DNA molecules that make up the fly and worm genomes published a little more than a decade ago, an accomplishment that seemed amazing then. As summarized in the Perspective on p. 1758, the new findings reveal essentially all of the tens of thousands of RNA and protein molecules that each of these organisms produces, as well as how their genetic information is packaged. Extensive Web-based databases built on these data are freely available to everyone, greatly accelerating future discoveries. Strange as it may seem, this research, aimed at reaching a deep molecular understanding of how the bodies of a fly and a worm are formed and maintained, will be critical for improving human health.

Most of the government funding for biomedical research in the United States is distributed through the National Institutes of Health. Its budget of $31 billion in 2010 reflects a widespread public appreciation that biomedical research will lead to great improvements in human health. Despite the many advances in our understanding of cells and tissues produced by this research, many diseases remain incurable. The disparity between the enormous amount now known about the chemistry and molecular biology of cells and our ability to intervene in human disease may seem incongruous to the public, but it is not at all surprising to the scientists involved: As we have learned more about how cells work, we have been surprised to discover how enormously sophisticated and complex are the processes that produce a human being.

Consider just one example. Unlike a bacterium that keeps growing and dividing as long as food is available, each cell in an animal requires a position-detection system that causes it to proliferate only when more cells of its type are needed at its particular position in a tissue. An animal cell behaves as though it contains a tiny computer, assessing the many signals that it receives from its neighborhood and then deciding whether to maintain itself unchanged (its usual fate), grow and divide, or kill itself for the good of the entire cell collective. Powerful techniques such as those used in these two landmark studies can provide us with lists of all the molecules involved. But the crucial next challenge, thus far out of reach, is to decipher exactly how the elaborate networks of signaling molecules that exist inside a cell enable it to make its crucial decisions—a process analogous to cell "thinking." Once scientists truly understand such processes, they will be able to create precise tools to correct harmful cell behaviors, as when cells multiply out of control in cancer or when they die inappropriately in degenerative conditions such as Alzheimer's disease.

The effort to use what we are learning about how cells and organisms work at the molecular level to improve human health is often called "translational medicine." The ultimate success of this important endeavor will depend on gaining much more knowledge to "translate." Because of the long evolutionary process that has given rise to the diverse array of animals that populate Earth, the molecules and mechanisms that produce humans, flies, and nematodes are nearly the same. But unlike humans, flies and worms can be experimentally manipulated, and they have short generation times that allow the complex mechanisms that form them to be deciphered with powerful genetic tools. And thus we find ourselves in a surprising position: As incredible as it seems, future research on flies and worms will quite often provide the shortest and most efficient path to curing human disease.

– Bruce Alberts

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