

A Brief Guide to Model Organisms

Escherichia coli • *Saccharomyces cerevisiae* • *Neurospora crassa* • *Arabidopsis thaliana*
Caenorhabditis elegans • *Drosophila melanogaster* • *Mus musculus*

This brief guide collects in one place the main features of model organisms as they relate to genetics. Each of seven model organisms is given its own two-page spread; the format is consistent, allowing readers to compare and contrast the features of model organisms. Each treatment focuses on the special features of the organism that have made it useful as a model; the special techniques that have been developed for studying the organism; and the main contributions that studies of the organism have made to our understanding of genetics. Although many differences will be apparent, the general approaches of genetic analysis are similar but have to be tailored to take account of the individual life cycle, ploidy level, size and shape, and genomic properties, such as the presence of natural plasmids and transposons.

Model organisms have always been at the forefront of genetics. Initially, in the historical development of a model organism, a researcher selects the organism because of some feature that lends itself particularly well to the study of a genetic process in which the researcher is interested. The advice of the past hundred years has been, "Choose your organism well." For example, the ascomycete fungi, such as *Saccharomyces cerevisiae* and *Neurospora crassa*, are well suited to the study of meiotic processes, such as crossing over, because their unique feature, the ascus, holds together the products of a single meiosis.

Different species tend to show remarkably similar processes, even across the members of large groups, such as the eukaryotes. Hence, we can reasonably expect that what is learned in one species can be at least partly applied to others. In particular, geneticists have kept an eye open for new research findings that may apply to our own species. Compared with other species, humans are relatively difficult to study at the genetic level, and so advances in human genetics

owe a great deal to more than a century of work on model organisms.

All model organisms have far more than one useful feature for genetic or other biological study. Hence, after a model organism has been developed by a few people with specific interests, it then acts as a nucleus for the development of a research community—a group of researchers with an interest in various features of one particular model organism. There are organized research communities for all the model organisms mentioned in this summary. The people in these communities are in touch with one another regularly, share their mutant strains, and often meet at least annually at conferences that may attract thousands of people. Such a community makes possible the provision of important services, such as databases of research information, techniques, genetic stocks, clones, DNA libraries, and genomic sequences.

Another advantage to an individual researcher in belonging to such a community is that he or she may develop "a feeling for the organism" (a phrase of maize geneticist and Nobel laureate Barbara McClintock). This idea is difficult to convey, but it implies an understanding of the general ways of an organism. No living process takes place in isolation, and so knowing the general ways of an organism is often beneficial in trying to understand one process and to interpret it in its proper context.

As the database for each model organism expands (which it currently is doing at a great pace thanks to genomics), geneticists are more and more able to take a holistic view, encompassing the integrated workings of all parts of the organism's makeup. In this way, model organisms become not only models for isolated processes but also models of integrated life processes. The term *systems biology* is used to describe this holistic approach.