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No single organism has a monopoly in science. This issue of Science focuses on the reasons why scientists choose to do their investigations in particular biological systems. See page 1427. [Cover design by Sharon Wolfgang, Washington, DC]

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Information for contributors appears on page XI of the 25 March 1988 issue. Editorial correspondence, including re-
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EDITORIAL

Biological Systems

The proper study of mankind may well be the fly, the frog, the bacterium, and the
nematode, as well as the rat, the ape, and mankind itself, because studies of specific
biological systems have taken a central role in modern biology. This has not always
been true; originally biology emphasized taxonomy and the diversity of species. As
the number of identified species increased, the similarities among differing species were noted,
and more in-depth studies of individual species were appropriate. Gradually certain systems
became preferred models for biological systems in general, a tendency which has now been
accelerated as molecular approaches have become the lingua franca of modern biology.

The concept of selecting a common system for in-depth study emerged slowly. In some
disciplines it was once considered poor etiquette to work on a colleague's system: if he or she
used the toad, you used the frog. That practice led to great inefficiency, because of the details of
manipulating any system—how to grow the organism, the chemistry of the cell wall, mating
habits—had to be worked out over and over again. Therefore, workers focused on a few
systems such as Escherichia coli, Drosophila melanogaster, or inbred mice, in which many of the
important housekeeping procedures had been elucidated. In this issue of Science some of the
major experimental systems are described in terms of the state of the art, potential
advantages, and possible disadvantages.

Of the systems outlined here, retroviruses, bacteria, and yeast are the simplest, most
manipulable, and most intensively delineated. Retroviruses (Varmous) are revealing per se
as well as being useful tools for gene delivery into other systems. Magasanik, while pointing
out the past triumphs of using bacteria to understand regulation, metabolism, and genetics,
indicates there is much gold still to be mined and gives examples. Yeasts are essentially on
a par with bacteria in case of recombinant DNA manipulation, but—as indicated by Botstein
and Fink—it is their complexity, as in cell compartments, cell cycle regulation, and protein
sorting, that makes them valuable as eukaryotic models.

Higher on the evolutionary ladder, the nematode, the fly, and the frog have the advantage of complexity beyond the single cell, but represent far simpler species than
mammals. Every cell can be identified in the nematode (Kenyon), which makes it ideal for
cell lineage studies. Studies in Drosophila (Rubin) can now use recombinant DNA, genetic
selection, and a history of neurologic and developmental information. The frog (Dawid and
Sargent) is a historical system for studying development; the frog oocyte has become a
major system for expression of foreign RNA and DNA. Plants have a special role (Goldberg)
because of the importance of botanical species and because of their novel developmental
processes, among them the capacity for mature cells to regenerate.

Eventually, one must have mammalian studies, and those of the rat, the ape, and the
human are three of the most important. Transgenic animals (Jaenisch), particularly
transgenic mice, have become major tools for studying the effects of individual genes on
the whole animal and permit the generation of precise animal models for human genetic
diseases. For understanding of many human responses, primates (King et al.) are clearly the
best source, but dealing with these large and sophisticated animals makes them a court of last
resort; it is always necessary to consider whether alternative systems are available.

Then, of course, there is mankind. Human beings are capable of describing emotional
states as well as physical conditions such as pain, they can often provide generations of family
history, and they can reveal multitudinous clinical data (White and Caskey). Defensive
medicine may thus be an unexpected boon to research. In their Perspective, Sladek and
Shoulson present views on the need for caution in attempting to realize the great potential
of transplantation of fetal material for human therapy.

The assembly of a Science special issue involves the efforts of many, but one editor
traditionally takes the lead. In this case, Barbara Jasny came close to editorial heroism in
surmounting difficulties that arose in production; she played vital roles in the selection of
topics, special assistance to authors, and the editing of final manuscripts.

It is our intention to add some of the systems that have been missed because of the
limitations of space in this issue to a final volume on biological systems. We hope, however,
that this initial set of articles will be useful to all our readers, from graduate students to
research directors to general readers who seek a more thorough understanding of specialty
systems.—Daniel E. Koshysh, Jr.