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EMIC: A Centralized Source of Chemical Mutagenesis Information

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In 1969, a group of scientists concerned with the health hazards posed by environmental mutagens formed the Environmental Mutagen Society to encourage interest in and the study of mutagens in the human environment. In order to deal effectively with this potential health problem, these scientists saw the need for a centralized source of published information on chemicals tested for mutagenicity and, therefore, set down as one of the immediate functions of the Society, the formation of a registry of chemicals tested for mutagenicity. The Environmental Mutagen Information Center (EMIC) was established at Oak Ridge National Laboratory to fill this information need by collecting, organizing, and making available the international literature on chemical mutagenesis. EMIC is now sponsored by the National Institute of Environmental Health Sciences and the National Cancer Institute.

From a simple registry of chemicals tested for mutagenicity, the scope and activities of EMIC have increased greatly. EMIC now processes all publications from the open literature dealing with the genetic effects of any environmental agent except those publications dealing exclusively with ultraviolet light or ionizing radiation.

Growing concern for the long-term effects of chemical exposure on human health and interest in the relation between mutagenicity and carcinogenicity are placing ever-increasing demands on this Center. As a result of the early realization of the need for literature control, a modern, specialized information center now serves the information needs of mutagenesis workers and other interested persons around the world.

Introduction

In environmental mutagenesis, as in other fields of science, investigators use two traditional methods to communicate the results of their work: first, formal presentations and informal discussions, and second, eventual publication of the results in scientific journals. However, the vast numbers of researchers and scientific journals tend to make these two means of communication inadequate and limit the audience to acquaintances, co-specialists, and readers of the journals in which one publishes—a fraction of those possibly interested or in need of the data. This problem is by no means new, nor are the efforts to deal with it. To chemists, biologists, and those working where these fields overlap, two outstanding information services have been available for many years and are now indispensable resources to the scientific community: Chemical Abstracts Services, begun in 1907, and Biological Abstracts/BIOSIS, begun in 1926. Recent publications (*1–3*) recount the history of these organizations and trace the development of information handling to the highly technical field which it represents today.

The basic function of the two information services mentioned above, as of many others, is to scan the world's scientific literature and to obtain citations or copies of articles falling within a defined subject area. Bibliographic and, usually, experimental details from the articles are then indexed and filed in such a way as to provide a means for rapid retrieval. The storage capacity, speed, and retrieval capabilities of computers are an indispensable part of such modern information activities.

The service provided then, is the initial screening of the literature for a group of scientists concerned with a defined area of science. This means that, instead of each scientist having to screen the total literature, the screening can be done by a few people in an information activity; these people, who are familiar with their literature collection, can then work with the scientist or other interested individual to locate the specific references required.

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The Environmental Mutagen Information Center (EMIC)

Such information activities have, like many aspects of modern life, become more and more specialized. One such specialized information center is located at Oak Ridge National Laboratory: The Environmental Mutagen Information Center (EMIC) which is supported by the National Institute of Environmental Health Sciences and the National Cancer Institute.

EMIC was initiated in 1969 by the founders of the Environmental Mutagen Society (*4, 5*), who recognized that in order to deal effectively with the health hazards of mutagens in the environment, the world's literature on this subject would have to be located, organized, and made readily available. The scope of this activity was to include all information from the open literature on the mutagenic effects of chemical, biological, and physical factors excluding publications dealing exclusively with ionizing radiation and ultraviolet light. It was apparent that individual researchers and government or industry officials concerned with environmental mutagenesis could not afford the time or resources to scan the world's literature for pertinent articles. The obvious solution was to centralize the activity and make the results available to all interested. So what began in 1969 as the part-time effort of two people has grown into an internationally recognized source of mutagenesis information. Other publications describing the Environmental Mutagen Information Center have appeared in the literature (*6, 7*).

Literature Scanning

A variety of means are used by EMIC to maintain close surveillance of the world's scientific literature. The most productive of these is the scanning of about 40 key journals which regularly publish mutagenesis studies. The journals cited most frequently in EMIC's data base are listed in Table 1, beginning with Mutation Research, from which approximately 2000 citations have been taken. References from these 40 journals make up about 50% of the data base.

References making up the other 50% of the data base come from more than 2000 other primary sources (journals, symposia, etc.) and are located mainly through the use of several secondary literature sources. Large computerized bibliographic data bases such as Chemical Abstracts, Biological Abstracts, and BioResearch Index are screened by using a series of key words associated with mutagenesis research. The resulting computer-selected and printed references are then manually screened for references within the scope of EMIC. The Institute for Scientific Information's ASCA service and the National Library of Medicine's MEDLINE system are used in the same way. Abstracts which are not searchable by computer, such as Genetics Abstracts, are scanned manually.

Further references are obtained by scanning bibliographies from books, reviews, and other publications and through information exchange with cooperating scientists working in environmental mutagenesis throughout the world.

This broad and varied approach to scanning the world's literature results in what is felt to be the most complete collection of mutagenesis literature possible.

Document File

Reprints or copies of all articles within the scope of the EMIC data base are obtained prior to entry onto computer files. Over 23,000 articles are now on file and comprise a unique and irreplaceable resource to mutagenesis workers.

Complete copies of articles are obtained for two reasons, first, to ensure that the bibliographic information going into the data base is correct and not subject to errors introduced by abstracting services or authors citing the work. The second reason is to allow EMIC to do more detailed indexing than is possible by using a more abbreviated form such as a citation or abstract.

Searching

The master data base is a computer tape of all EMIC references and indexes. It provides the most complete search capability with respect to both flexibility of search strategy and completeness of literature coverage but is only searchable through the EMIC office. Search capabilities of the EMIC data base are, however, available throughout the United States to individuals with access to either the Department of Energy supported RECON system or the National Library of Medicine's TOXLINE system. These two online, interactive, retrieval systems allow one to query a computerized EMIC file and to retrieve only those references desired. Both systems are periodically updated from the master data base.

All three computer files, the master data base, RECON and TOXLINE, provide the means for retrieving references on chemical mutagenesis based on chemicals tested, organisms studied, authors and other key data elements. Further information about the on-line systems and assistance in developing search strategies for on-line searching can be ob-

Table 1. Forty journals cited most frequently in the Environmental Mutagen Information Center data base, listed in descending order of frequency.

No.	Journal
1	Mutation Research
2	Soviet Genetics (USSR) (English translation of Genetika)
3	Cancer Research
4	Genetics
5	Nature (London)
6	Journal of Bacteriology
7	Molecular and General Genetics
8	Biochimica et Biophysica Acta
9	Proceedings of the National Academy of Sciences USA
10	Experimental Cell Research
11	Chemico-Biological Interactions
12	Cytology and Genetics (USSR)—(English translation of Tsitologiya i Genetika)
13	Experientia
14	Hereditas
15	Biochemical and Biophysical Research Communications
16	Tsitologiya (USSR)
17	Science (Washington)
18	Journal of Cell Biology
19	Human Genetics
20	Japanese Journal of Genetics
21	Journal of Molecular Biology
22	Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, Serie D: Sciences Naturelles
23	Radiation Research
24	Journal of the National Cancer Institute
25	Toxicology and Applied Pharmacology
26	Canadian Journal of Genetics and Cytology
27	Biochemical Pharmacology
28	Doklady Biological Sciences (USSR) (English translation of Doklady Akademi Nauk)
29	Cytologia
30	Bulletin of Experimental Biology and Medicine (USSR) (English translation of Byul. Eksp. Biol. Med.)
31	Virology
32	Journal of Virology
33	Lancet
34	Indian Journal of Radiation Biology
35	Biochemical Journal
36	Journal of Reproduction and Fertility
37	Chromosoma
38	Nucleus (Calcutta)
39	Biochemistry
40	Journal of General Microbiology

tained from the staff at EMIC (EMIC, Oak Ridge National Laboratory, P. O. Box Y, Building 9224, Oak Ridge, TN 37830).

Other Services

In addition to providing bibliographies for specific information requests, a variety of other products and services have resulted from the establishment of a chemical mutagenesis data base and literature file. These include bibliographic publications covering particular periods of time or specific areas of interest, support activities to workshops and conferences, and a supplemental computer file linking specific chemicals tested for mutagenicity to other sources of information on teratogenicity, carcinogenicity and toxicity as well as chemical and physical characteristics.

Supplemental Files

Requesters frequently want to know more about a chemical than just the references which report tests of its mutagenicity. Chemical and physical characteristics, structurally related chemicals, usage, production, toxicity, and evidence of carcinogenicity and teratogenicity are often important information elements which requesters need. To meet this need, a separate computer file, the EMIC Agent Registry, was established. Although not complete, many of the data elements shown in Table 2 have been or are being added to the computer file of approximately 5000 chemicals. This file has recently been made part of an ORNL information system which allows EMIC to search the file through on-line terminals. Arrangements are now being made to include a portion of the EMIC Agent Registry in the NIH/EPA

Substructure Search System which is available on-line from Tymshare (*8*). Locator fields are listed in Table 3.

This and other projects, such as a file on results of chemicals tested in the *Salmonella*/microsome assay, a computerized pattern recognition project, and a proposed file of unpublished mutagenicity studies, reflect the Center's interests in anticipating information needs and initiating programs before new information demands require crash efforts to fill immediate needs.

Table 2. EMIC Agent Registry File: information items entered or being sought for future entry for each chemical in the file.

Nomenclature
Chemical Abstracts Service (CAS) Registry Number
EMIC preferred name
CAS preferred name
Synonyms
Wiswesser Linear Notation
Usage Category
Chemical /physical characteristics
Molecular formula
Boiling point
Specific gravity
Vapor density
Solubility
Physical description
Hydrolysis rate
Storage requirements
Safety information
Toxicity
Handling precautions
Metabolism

Plant Publication

Of particular interest to those working with mutagenesis in plants is the EMIC publication, "Chemical Mutagenicity in Plants and the Mutagenicity of Plant Related Compounds." This document was published in November 1976 and initially distributed to interested researchers and administrators. It contains nearly 3000 references to articles reporting the genetic effects of chemicals on plants. In addition to the citation index, several other indexes are included to assist the user in locating references of interest. These include indexes to authors, agents tested, organisms studied, and assay systems (genetic endpoints). A separate section contains nearly 2000 references to literature reporting the genetic effects of plant-derived or related chemicals. In this section, references are not

Table 3. EMIC Agent Registry File: locator fields (each field refers to a source of information on the chemical in question).

EMIC	The Environmental Mutagen Information Center (the EMI file on RECON)
ETIC	The Environmental Teratology Information Center (the ETI file on RECON)
IARC	The International Agency for Research on Cancer Monographs
PHS-149	Public Health Service Publication No. 149, "Survey of Compounds Which Have Been Tested for Carcinogenic Activity."
TDB	The Toxicology Data Bank produced at ORNL for the National Library of Medicine
MERCK	The Merck Index, An Encyclopedia of Chemicals and Drugs (9th Edition) published by Merck and Co., Inc.
TSCALIST	Toxic Substances Control Act Candidate List
CHEMLINE	The National Library of Medicine's Chemical Dictionary File available on-line on the MEDLARS system
WATER POLLUTION	The Environmental Protection Agency's list of water pollutants
RTECS	Registry of Toxic Effects of Chemical Substances—NIOSH

Table 4. Publications of the Environmental Mutagen Information Center.

No.	Title
1	A Survey of the 1969 Literature on Chemical Mutagenesis[a]
2	A Survey of the 1970 Literature on Chemical Mutagenesis[b]
3	The Mutagenicity and Teratogenicity of a Selected Number of Food Additives (EMIC/GRAS Literature Review) (ORNL/EMIC-1)[a]
4	Chemical Mutagenesis: A Survey of the 1971 Literature (ORNL/EMIC-2)[b]
5	Chemical Mutagenesis: A Survey of the 1972 Literature (ORNL/EMIC-3)[b]
6	Chemical Mutagenesis: A Survey of the 1973 Literature (ORNL/EMIC-4)[b]
7	Chemical Mutagenesis in Laboratory Mammals: A Bibliography on the Effects of Chemicals on Germ Cells (ORNL/EMIC-5)[b]
8	Chemical Mutagenesis in Laboratory Mammals: A Bibliography on Effects of Chemicals on Germ Cells (ORNL/EMIC-6, Revision of ORNL/EMIC-5)[b]
9	Chemical Mutagenesis in Plants and Mutagenicity of Plant Related Compounds (ORNL/EMIC-7)
10	Chemical Mutagenesis: A Survey of the 1974/1975 Literature (ORNL/EMIC-8)
11	A Literature Survey of Bacterial, Fungal, and Drosophila Assay Systems used in the Evaluation of Selected Compounds for Mutagenic Activity (ORNL/EMIC-9)

[a] No longer available as a collection.
[b] Available only as photocopies from the National Technical Information Service.

limited to plant assay systems but include reports of the genetic effects of plant-derived compounds in any mutagen assay system. A complete list of EMIC publications is shown in Table 4.

Conclusion

At EMIC, all the open literature of a defined area of toxicology has been gathered into a single searchable computer file. No other area of toxicology enjoys such a unique, centralized source of information. However, a similar center for environmental teratology (*6*), established by NIEHS at ORNL, has already compiled a data base and literature file of over 10,000 references.

Both the growing concern for long-term effects of environmental contaminants on human health and the increased interest in the correlation between mutagenicity and carcinogenicity as a basis for understanding cancer causation and as providing possible short-term, low-cost tests for carcinogenicity have placed increasing importance and demands on EMIC. This has resulted in closer collaboration between the Environmental Mutagen Information Center and (1) regulatory agencies such as the Environmental Protection Agency and the Food and Drug Administration, (2) research agencies such as the National Cancer Institute, the National Institute for Occupational Safety and Health and the National Institute of Environmental Health Sciences, and (3) international groups such as the International Agency for Research on Cancer, and the International Commission for Protection Against Environmental Mutagens and Carcinogens. This close collaboration with research and regulatory communities is essential to the success of a specialized information center in the area of biomedical sciences and because of this collaboration and the dedicated work of its staff, EMIC has become an integral part of an international effort to protect human genetic welfare through studying chemical mutagenesis, determining human risk, and minimizing human exposure to environmental mutagens.

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