科爱传播
KE'AI COMMUNICATIONS
精编百科

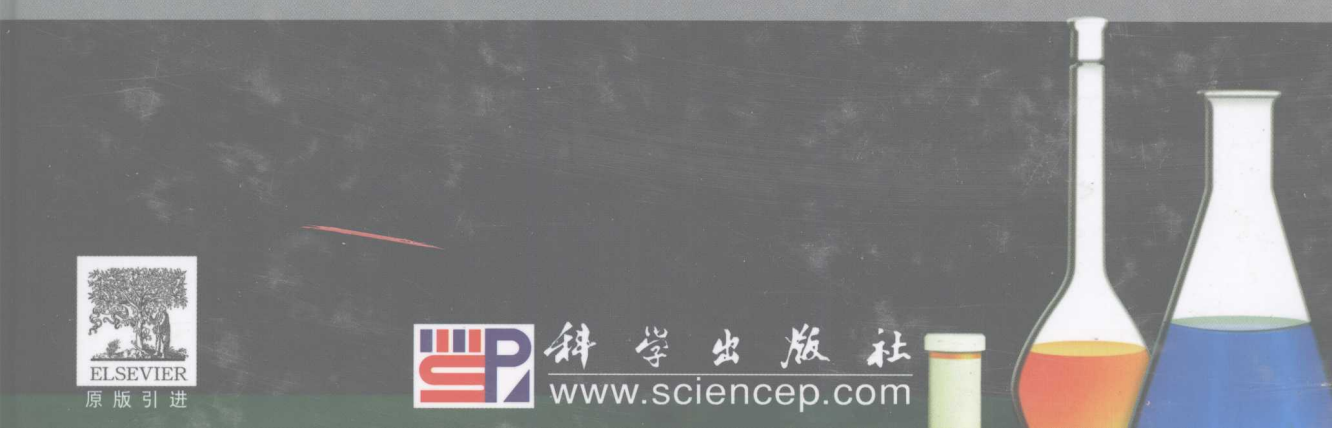
·导读版·

# Encyclopedia of Toxicology

# 毒理学百科

## 社科管理卷

Philip Wexler



ELSEVIER
原版引进

科学出版社
www.sciencep.com

# ENCYCLOPEDIA OF TOXICOLOGY

SECOND EDITION

# 毒理学百科

## 社科管理卷


Editor-in-Chief

**PHILIP WEXLER**

Associate Editors

Bruce D. Anderson

Ann De Peyster

Shayne C. Gad

Pertti J. Hakkinen

Michael A. Kamrin

Betty J. Locey

Harihara M. Mehendale

Carey N. Pope

Lee R. Shugart



科学出版社

北京

**图字:01-2007-4279 号**

This is an annotated version of
**Encyclopedia of Toxicology**, Second edition
Philip Wexler


ISBN: 0-12-745354-7



**图书在版编目 (CIP)数据**

毒理学百科=Encyclopedia of Toxicology:第 2 版. 社科管理卷:英文/(美)威克斯勒(Wexler,P.)主编. —北京:科学出版社,2007

(科爱传播. 精编百科大系)

ISBN 978-7-03-019935-5

Ⅰ. 毒… Ⅱ. 威… Ⅲ. 毒理学-英文 Ⅳ. R99

中国版本图书馆 CIP 数据核字 (2007)第 140269 号

责任编辑:田慎鹏 贾明月/责任印制:钱玉芬/封面设计:耕者设计工作室

科学出版社 出版
北京东黄城根北街16号
邮政编码:100717
http://www.sciencep.com

中国科学院印刷厂 印刷

科学出版社发行 各地新华书店经销

*

2007 年 10 月第 一 版 开本:787×1092 1/16
2007 年 10 月第一次印刷 印张:30
印数:1—1 500 字数:642 000

**定价:98.00 元**

(如有印装质量问题,我社负责调换〈科印〉)

# 导 读

随着我国公共卫生事业的发展，疾病预防与控制理念越来越受到公众的关注和社会的重视，全民防控疾病的意识明显加强。在此大背景下，一方面需要加强面向广大公众防控疾病知识的普及，另一方面对专业人士的知识更新也提出了新要求。毒理学是疾病预防控制事业的一门非常重要的支撑学科，涉及的领域非常宽广，包括医药、农业畜牧、环境、工业、军事等方面，这就要求毒理学家和从事与毒理学相关工作的人员有比较宽厚的知识面，包括深奥的专业理论知识和广博的普及知识，这样既能做好专业研究和管理工作，又能当好知识的传播人。我国毒理学学科近年来的发展非常迅速，毒理学专业人员队伍不断扩大。与此同时，我国毒理学家撰写出版的专著也不断涌现，其中不少是定位于教学或研究用的参考书。在这里，我还是非常乐意向我国毒理学同行及希望更多了解毒理学知识的广大读者，推荐这套《毒理学百科》。这套百科全书能帮助你们更深入地了解毒理学及相关领域的基础理论、专业知识和有关的背景信息。

第二版 *Encyclopedia of Toxicology* 是由美国国家医学图书馆的 Philip Wexler 博士作为主编、近四百位毒理学家参与编写的宏篇巨著。Wexler 博士曾多次来我国做学术访问，并受邀在中国毒理学会与国际毒理学联合会(IUTOX)合作组织的第五届发展中国家毒理学大会(2003 年，桂林)上作“毒理学信息资源”的学术报告。本人与 Wexler 博士也有多次直接地交流，深感他不但毒理学知识非常丰富，而且对新知识的理解应用、毒理学与其他学科的交融有独到的见解，我想他宽厚的知识面很大程度上促成了此百科全书的知识性和可读性。另外，我们的毒理学同行会从书中发现，该出版物的作者们大多是资深的毒理学专家，或是各自写作领域的著名学者，或一直从事所撰写领域的研究工作，这些因素使此百科全书更具权威性。

原版书收集了 1057 个条目，按英文字母顺序排列，内容详尽，信息量宽广。书中既有毒理学的基本理论、学科体系知识的介绍，也包含有毒理学专业知识、新的进展资料、毒理学派生出的相关社会科学问题(如历史事件、法律、条规、教育、国际和区域组织等)的信息资料。本百科全书还对近年来出现的毒理学新名词首次做了比较系统和权威性的解释，如鸟类生态毒理学、计算机毒理学、基准剂量、致癌效力因素、代谢组学等。很多在其他专著、教科书、工具书中查不到的毒理学或相关的信息资料，读者都能在此百科全书中找到，这充分体现出该著作的系统性。另外，特别令我惊叹的是，这套丛书对化学物的收集量是如此之巨大，读者几乎能从中查找到任何想要了解的毒理相关化学物。而且对每个化学物的介绍又是相当的详细，包括结构式、同类物、用途、暴露途径、毒代动力学、急毒和慢毒、毒性机理、临床应用管理(如果是药物)及解毒物等内容。这些知识不但对毒理学家有参考价值，而且对药物研发人员甚至临床医生都非常有用。本百科全书在编写风格上也完全不同于以往出版的毒理学专著、教科书或工具书，真正做到了宽细结合、深浅恰当，适合于不同专业和层次的读者参阅。

原出版物共 4 卷，每卷 750～800 页，为了方便国内读者，科学出版社委托中国毒理学会组织国内有关毒理学专家，对原著中除所有化合物以外的条目进行了梳理归类，分三卷出版。从原出版物中精选出更具毒理学专业性的条目编成《精选卷》，此卷所提供的信息

适合于毒理学科的不同专业领域的广大读者，能满足读者对毒理学基本知识的索求和专业的了解；将与毒理学研究与发展密切相关的背景知识和有关信息，如与毒理学关系非常密切的交叉或基础学科的名词术语，蛋白质组学、代谢组学、纳米技术等新的技术与概念，以及人体组织器官的生理与病理等条目，合编成《拓展卷》；将有关重大毒理学事件、毒理学信息、国际组织、毒理学相关的国际和地区法规、毒理学历史事件、军事与反恐等汇集成《社科管理卷》。当然，这种划分并没有很严格的标准，只是希望能为不同专业层次阅读做参考，有不当之处，恳请读者批评指正。

希望这套《毒理学百科》不但对我们毒理学同行有很大的借鉴作用，而且对关注毒理学事业或想了解毒理学知识与信息的广大读者也有所帮助。更希望我们的读者能从中获取丰富的知识营养，充实自己，服务于国家的卫生健康和生态环境事业。非专业人士对于毒理学概念的理解还有很多误区，甚至不了解，缺乏对其社会重要性的认识，我也希望这套百科全书对在我国普及毒理学知识发挥推动作用。

周平坤

中国毒理学会副理事长

中国毒理学会

Chinese Society of Toxicology

本书在引进、编纂的过程中得到了中国毒理学会的大力支持

# 前　言

很荣幸有机会再次向广大读者介绍这本毒理学百科全书。第二版百科全书在第一版相关内容的基础上，进行了扩展和精练，以便能够很好地服务于毒理学工作者。特别是在目前科学分类日益精细，导致个人关注面相对狭窄的情况下，此书有助于大家对毒理学学科的整体研究范畴和功能作用作一个更全面的理解。

自第一版百科全书出版以后，毒理学的发展又发生了显著的变化，而且现在这种变化有加速的趋势。经过四五十年的发展，毒理学从主要以体内毒性为基础的描述性科学，发展为包含现代生物学和化学各方面的综合性科学，从分子生物学到尖端仪器分析都有涉及。其理论基础已经从原来的主要基于病原检测和体内毒性分析的常规危害分析检测，转变为在器官、细胞和分子水平上强调毒性机制。这些变化也带来了大量毒理学著作的发行。

从那时起，分子生物学技术在毒理学的各个方面发挥了越来越重要的作用，如毒性机制的阐明、外源性化学物质代谢研究、更安全有效的药物和化学物开发、毒物暴露和效应生物标志物的研究等等，这些重要的毒理学研究都受分子生物学技术影响。此外，分析化学也继续被应用于微量外源性化学物质的检测，其检测灵敏度非常高，甚至在毒物效应短期内还未表现时就能将其检测到。目前，因为危害评价很大程度上还是依靠数学模型而不是毒理学科学，这些新的科学在危害或风险性评价的应用方面还有很多问题，但是人类的健康危害评价和环境风险评估的发展还是很显著的。

始终不变的是毒理学科技文献服务于广大专家的需求。考虑到毒理学方法基础和实践需要的双方面特征，现在更需要有综合性的著作。毒理学百科全书在其中可以起到很好的媒介作用，它比字典更详细，更便于从事危害评价、法规、教育和咨询等工作的普通工作者以及专家们获得所需要的信息，这些信息往往是他们的专长之外的知识。它还为非毒理学家了解毒理学的科学体系、原理、方法和应用这门科学提供了方便。

总之，此书是对毒理学科学的巨大贡献，是热衷于毒理学的科学家和服务于毒理学家的图书馆的必备之物。

Ernest Hodgson
William Neal Reynolds Professor
Environmental and Molecular Toxicology
North Carolina State University

（周平坤　译）

# 第二版序

时光流逝，人们对毒理学的理解和认识的追求仍在持续。我们一直希望能够结束贫穷、无知、饥饿和有害化学物暴露等问题，也一直在向这些目标努力，但困难巨大，目标依然遥不可及。化学物和由化学物而来的终产物在我们的生活中仍然扮演着重要的角色。尽管现在还不确定化学物的好处一定能超过它们带来的危害，但人们很少怀疑的是：为数众多的化学物和药物可以延长人类寿命，提高人们的生活质量。与此同时，某些化学物也会在特定的情况下对特定的人群产生危害作用。毒理学家的研究成果中就包括提供信息，告诉人们如何去更好地消除、减少和预防这些危害。

第一版毒理学百科全书发表后的 7 年中，毒理学学科的发展迈出了很大的一步。目前，分子毒理学知识在持续快速地发展。的确，通过研究取得数据结果的过程相对容易，而花时间对资料进行充分的分析和评估则要困难得多。基因组学、蛋白质组学和其他组学技术的发展，使我们能更有效地揭示环境化学物暴露和疾病易感性之间的复杂联系。美国国家毒物基因组中心(The US National Center for Toxicogenomics)建立于 2000 年，致力于信息学和计算机毒理学的研究。该机构的研究成果与其他团体的研究一道，使我们能用更有效的方法来确定化学物的安全性，研究结构-活性关系。另外，随着分析工具越来越精细和敏感，现在可以对生物系统和环境中更微量的污染物进行检测和定量。

现在越来越多的消费者(特别是在西方国家)更倾向于接受药补和替代医学疗法，人们会比以前接触更大量的草药和其他植物类药物。尽管毒理学家一直认为“天然的”不等于是“安全的”，但对草药添加物以及它们与其他化学物相互作用的危害性评价，所做的工作并不多。然而，这种状况正在发生变化。

化学战、生物战和核战争历来就是社会关注的热点，它们有时是作为现实事件，更多的是作为学术问题引起关注。在 2001 年 9.11 事件发生后，人们紧迫地意识到：需要了解非常规战争及其战剂的知识，如它们如何发挥作用、如何使人类自己免受危害等。毒理学的研究范畴也扩展到防范这种武器复活的危害。

随着现代科技的发展，制造业、加工过程以及化学物和其他产品的使用使我们获益，但也加速了有害废弃染物污染的扩散。在美国，每年有两百万吨的电子产品废弃待处理，包括 5 000 万台电脑和 13 000 万部手机。据国际电子产品回收协会统计，到 2010 年这种电子废品的数量将增加 3 倍以上。如此巨量的废物埋藏在山地或水域中，将不可避免地对我们的空气和水造成污染，其潜在的污染物包括铅、镉和铍。

动物实验的替代实验正在逐渐渗透到毒理学研究领域中。虽然整体动物实验还不会很快消失，但其他一些确定危害性和安全性的方法，现在越来越受到毒理学界的追捧，并且正在成为化学物评价的主流方法的一部分。“体外实验”方法(如细胞培养和皮肤刺激试验)和计算机分析方法提供的毒性信息正在日益增加。其中计算机分析方法基于已有的数据资料，利用计算机程序来评估类似化学物的毒性特征，有无补充的化学和物理的特征数据均可。

现在市场上纳米技术产品已经越来越多，纳米技术的研究和发展正处于上升势头。美国于 2001 年建立了国家纳米技术中心，联邦机构和大学也开始研究纳米材料对环境和人类健康的影响。

对化学物暴露（包括实际的和预计的）的深入研究，有助于我们更好地了解化学物对环境和人类健康的危害性。毒理学家与危害评估管理者间不断增加的合作非常必要，因为密切的合作可以使危害评估有确实的科学依据，为评估者和管理者们提供可信的材料，从而加强化学物危害的控制。

在全球范围内，对化学物的控制和管理已经取得了很大的发展。里约热内卢地球峰会后 10 年，世界可持续发展峰会（WSSD）于 2002 年在南非约翰内斯堡举行。会议设立的目标之一是，到 2020 年，以不对人体健康和环境产生明显副作用的方式使用和生产化学物。

2004 年 5 月 17 日，保护人类健康和环境免受持续性有机污染物（POPs）危害的斯德哥尔摩公约正式生效。POPs 是有毒性、持续存在、具有累积性、并且能在环境中长距离传播的有机污染物。此公约的目的是消除和限制这类化学物的生产和使用。而京都议定书是用来限制温室气体排放的，现在已经成为国际公认的法律，只有极少数国家对它进行抵制。

美国拥有活跃的、不断壮大的毒理学专业队伍，他们进行着开创性的毒理学研究工作，其他国家的科学家也是如此。通过因特网及其优化技术可用性的不断增强，各国科学家可以方便的进行合作和信息共享。有些重要的工作在多国共同体的赞助支持下积极开展，如经济合作与发展组织、欧盟委员会、国际化学安全署等。

全球范围的毒理学资料和信息的协调和联络工作也在积极地开展。用于化学物分类和标记的全球调和制度（GHS）已经被采纳，并且即将付诸执行。这将提供统一、连续的途径对有害化学物进行识别，并且能提供有害物的信息和针对暴露人群的防护措施。同时，在欧盟，一个叫做《化学品的注册、评估和授权》（REACH）的法规框架已建立，其提出了对于年产量或进口量超过 1 吨的化学品进行登记的制度。

最后，毒物在个人和政治谋杀或仇杀中的作用：它可能在博尔吉亚家族（Borgias）统治时代达到顶峰，但从那以后并没有终止。特别提出的一次事件发生在 2004 年乌克兰总统竞选期间。经过激烈的竞选，亲西方反对派领袖尤先科获胜，并且于 2005 年 1 月举行就职典礼。这个民主的快乐节日却被中毒事件毁坏。医生称尤先科因为大剂量二噁英中毒导致脸部毁容和其他疾病。据说二噁英是被混合于他食用的汤中而导致其中毒的。尽管整个事件还没有水落石出，但怀疑其中有政治动机。

第二版百科全书汇集了 392 作者提供的 1057 条目录，而第一版只包括 200 名作者提供的 749 条目录。实际上，第一版中所有条目的内容在第二版中都得到了充实，而某些条目则完全进行了更新。在第二版中新出现的 308 个条目中，包括鸟类生态毒理学、基准剂量、杀虫剂、计算机毒理学、致癌效力因素、代谢组学、化学事件、蒙地卡罗分析、非致死性化学武器、无脊椎动物生态毒理学、药物滥用、癌症化疗因子和消费产品等等。许多针对特殊化学物的条目都是全新的，而书中搜录的国际组织也得到了很大的扩展。某些条目罗列了许多著名的毒物中毒相关事件：如美国拉夫运河事件、泰晤士海滩事件、切尔诺贝利事件和三里岛事件等。另外许多条目涉及毒理学知识的社会应用，如文化毒理学、环境

犯罪、著名投毒者和中毒事件、古代化学生物战以及美国环境运动历史等。因此，新版的毒理学百科全书在长度、广度、以及深度上都对毒理学的许多方面进行了更为广泛和深入的概述。

Philip Wexler

（周平坤　译）

# 第一版序

现在有许多关于毒理学方面的普通或专业的单行本著作，其中大多数都针对于毒理学家和毒理专业的学生，少部分适用于非专业人员。这本毒理学百科全书的出版不是为了取代这些著作，而是希望能满足更广大读者和新的读者群对毒理学信息和知识的需求。所以在编写上采取了一种新的组织形式，减少了入门级知识和专业论文的数据资料元素，使本书定格于中级水平。

本百科全书尽管不求详尽无遗，但其内容仍然非常宽广。我们的想法是应考虑到毒理学方面基础的、关键的甚至有争议的要素，因为这些内容要素是理解毒理学学科基础及派生的社会影响所必需的。因此，这本百科全书不仅必须包括一些重要概念，如剂量效应、作用机制、试验程序、终点反应、靶位等，还应包含单个的化学物及其分类。尽管本书的重点在化学物上，我们也搜集了其他一些概念如辐射和噪音，并介绍了毒理学相关的历史、法律、条例、教育、组织和数据库。本书还需考虑到环境和生态毒理学，以便在某种程度上平衡那些侧重于实验动物和人类的知识点，因为最终需要将所有的联系深入。

在化学物选择方面，编者们根据所掌握的知识，选取了那些具有相对较高的毒性、暴露量、产量、争议性、受关注度或在其他方面引起人们兴趣的化学物。这些化学物并不代表一个化学物条规清单或数据库组合，而是我们认为毒理学必须关注的化学物质。本书没打算成为一本大规模的有毒化学物的一览表(这种一览表现在已经有好几本)。

依照许多传统的科学或其他百科全书的标准，本书完全按字母顺序排列。除了一些有用的小字典外，此编排方式在毒理学上还没采用过。这种编排，再加上详细的索引和广泛的交叉参照，应该使读者能够快速地查阅到所需要的信息。

尽管本书对毒理学家会相当有用，但更适用于其他人员，包括普通科学工作人员、医生、法律和条例专业人员和有科学基础的非专业人员。在他们工作、学习的过程中，或者有兴趣的时候，如果需要了解毒理学方面的知识，就可在此全书中获取。毒理学家在需要温习或者快速浏览一下非本专业的内容时，也可以从中查阅；但要寻求深入的处理方案时，就有必要去查阅专题论著或者专业期刊文献。

本百科全书的目的在于对那些有时很复杂的项目进行简要的概述。书中没有正式的参考文献和脚注，因为这些与百科全书的目的相关性不大。它只有简单的目录引导读者到相关的特别条目下去阅读更详细的信息。如信息资源的条目可以引导读者了解毒理学方面的电子信息。

首先，我要感谢副主编们和所有撰稿人，他们的努力成就了本百科全书。感谢原策划编辑 Yale Altman 和 Linda Marshall，他们所做的铺垫性工作对本书的编辑出版有很大的帮助；感谢来自 Academic Press 的现策划编辑 Tari Paschall 和高级制作编辑 Monique Larson，他们的学识、专长和高效率工作使本书得以顺利完成；原稿的组织和格式审定工作由 Mary Hall、Christen Bosh 和 Jennifer Brewster 完成，他们进行了非常技巧性的、耐心和细致的工作。

我以个人的名义而不是政府职员的身份参加本百科全书的工作。书中的观点仅代表我的个人观点，不代表美国国家医学图书馆或美国联邦其他机构的意见。

Philip Wexler

（周平坤　译）

*For my son Jake and my parents Yetty and Will, with love, appreciation, and respect.*

# EDITORIAL BOARD

# FOREWORD

It gives me great pleasure to once again have the opportunity to introduce the *Encyclopedia of Toxicology* to its users. The second edition is a worthy successor to the first, expanded and refined, which will serve the toxicology community well. Particularly in these days when specialization tends to narrow the individual focus, it brings a real understanding of the entire scope and function of the science of toxicology.

The changes evident at the publication of the first edition have continued at an accelerated pace. At that time it was clear that toxicology, over a period of four or five decades, had changed from a largely descriptive science based on *in vivo* toxicity to one that included all aspects of modern biology and chemistry, from molecular biology to sophisticated instrumental analysis. The philosophical basis had shifted from routine risk analysis based primarily on pathological or *in vivo* toxicological endpoints to one that emphasized mechanisms of toxic action at the organ, cellular, and molecular levels. All of this brought about an explosion in the toxicological literature.

Since then, the techniques of molecular biology have played an increasing role in the elucidation of toxic mechanisms, in the study of xenobiotic metabolism, in the development of safer and more useful drugs and other chemicals, and in the development of biomarkers of exposure and effect, to mention only a few of the more important aspects impacted by these techniques. Analytical chemistry has continued to develop to the point that vanishing small quantities of xenobiotics can be detected, quantities so small that their toxicological impact is likely to remain unknown for the immediate future. While the application of all of this new science to risk assessment remains problematical, since the latter is still largely based on mathematical models rather than toxicological science, progress in both human health risk assessment and environmental risk assessment is also evident.

What has not changed, however, is the need for the toxicological literature to serve many masters. Given the eclectic nature both of the methodological roots and the practical needs served by toxicology, general works are needed more than ever. Works such as the *Encyclopedia of Toxicology* play a critical role at an important intermediate level, more detailed than dictionaries while remaining accessible to the generalist in risk assessment, regulation, teaching, and consultation as well as specialists seeking information beyond the narrow confines of their specialty. It will also serve as an important role for nontoxicologists who need to know more of the philosophy, methods, and uses of this science.

In summary, this is an important and outstanding contribution that no serious toxicologist or library serving toxicologists can afford to be without.

**Ernest Hodgson**
William Neal Reynolds Professor
Environmental and Molecular Toxicology
North Carolina State University

# PREFACE

Time passes, but the need for toxicological understanding persists. As much as we might wish for the end of poverty, ignorance, hunger, and exposure to hazardous chemicals, and as much as we work toward these goals, the challenges are formidable, and the end is not in sight. Chemicals and finished products made from chemicals continue to play an ever-present part in our lives. Although it is not evident that the benefits of chemicals always outweigh their risks, there is little doubt that a wide spectrum of chemicals and drugs has enhanced both the duration and quality of our lives. That said, certain of them, in certain situations, are clearly harmful to certain people. Among the fruits of toxicologists' labors is information on how best to eliminate, reduce, or prevent such harm.

The discipline of toxicology has made considerable strides in the 7 years since the first edition of this encyclopedia was published. The understanding of molecular toxicology continues to advance rapidly. Indeed, it is often much easier to generate the data than to find the time to adequately evaluate it. Genomic, proteomic, and other 'omic' technologies are helping us unravel the complex connection between exposure to environmental chemicals and susceptibility to disease. The US National Center for Toxicogenomics, dedicated to research on informatics and computational toxicology, was established in 2000. As a result of this and other research, much more sophisticated approaches are now available for ascertaining chemical safety, and investigating structure–activity relationships. In addition, analytical instrumentation has become more highly refined and sensitive, making it easier to detect and quantitate even smaller amounts of contaminants in biological systems and the environment.

With greater consumer (especially Western) acceptance of complementary and alternative medicine, more people than ever before are being exposed to a vast array of herbal and other plant-based medicinal products. Although toxicologists have always recognized that 'natural' does not necessarily equate with 'safe', not much has been done to assess the hazards of herbal supplements and their interactions with other chemicals. This is beginning to change.

Chemical, biological, and nuclear warfare have always been subjects of interest, sometimes as practical matters, and more often as academic ones. In the light of the events of September 11, 2001, there has been an increased urgency in learning more about nonconventional warfare and its agents, how they operate, and how to protect ourselves from their effects. Toxicology has found itself broadening its scope to deal with this resurgent type of weaponry.

The scope of what constitutes hazards waste, an ever-present downside of the benefits we derive from the manufacture, processing, and use of chemicals and their products, continues to expand as technology moves forward. In the US two million tons of electronic products, including 50 million computers and 130 million cellphones, are disposed of every year. According to the International Association of Electronic Recylers, this number will more than triple by 2010. With such quantities in landfills and rivers, there are bound to be consequences for our air and water. Potential toxicants include lead, cadmium, and beryllium.

Alternatives to animal studies no longer represent a toxicological sideline. While whole animal testing is unlikely to disappear soon, if ever, other methods of determining hazard and safety are increasingly being embraced by the toxicology community and becoming part of mainstream chemical evaluations. *In vitro* approaches (e.g., using cell culture or skin irritation potential) and *in silico* approaches (i.e., using computer programs to estimate toxic properties based on existing data for similar chemicals with or without supplemental chemical and physical property data) are both generating increasing amounts of toxicity information.

The marketplace is seeing an increase in products utilizing nanotechnologies, and nanotechnology research and development is on the upswing. The United States has had an official National Nanotechnology Initiative since 2001. A start has also been made by federal agencies and universities in assessing the environmental and health effects of nanomaterials.

Greater insight into chemical exposures, both actual and anticipated, is helping to develop a more focused picture of the risks these exposures present to humans and the environment. Growing cooperation between toxicologists and exposure assessors is proving vital to strengthening the scientific basis of risk assessment, thus giving risk assessors and managers more credible tools to address the control of chemical hazards.

At the global level, there have been important strides in the control and management of chemicals. The 10-year followup to the Rio Earth Summit, the World Summit on Sustainable Development, was held in 2002 in Johannesburg, South Africa. Among the targets it set was to use and produce chemicals by 2020 in ways that do not lead to significant adverse effects on human health and the environment.

The Stockholm Convention to protect human health and the environment from persistent organic pollutants (POPs) became binding on May 17, 2004. POPs tend to be toxic, persistent, accumulative, and capable of traveling long distances in the environment. This Convention seeks to eliminate or restrict the production and use of such chemicals. The Kyoto Protocol, designed to decrease greenhouse gas emissions, has now become an international law, despite the resistance of several countries.

The United States hosts a vibrant and growing community of toxicology professionals who perform innovative toxicological research, and scientists in other countries are making their presence felt equally. Global information sharing and collaborations among these investigators are growing, facilitated by the increased accessibility of the Internet and its enhanced technologies. Significant work is proceeding under the auspices of multinational bodies such as Organisation for Economic Co-operation and Development, the European Commission, and the International Program on Chemical Safety.

Efforts to harmonize and link data and information on toxic chemicals throughout the world have been multiplying. The Globally Harmonized System (GHS) of classification and labeling of chemicals has been adopted and is ready for implementation. This will provide a consistent and coherent approach to identifying hazardous chemicals, as well as provide information on such hazards and protective measures to exposed populations. Meanwhile in the European Union, a regulatory framework known as REACH (Registration, Evaluation and Authorization of Chemicals) has been proposed for the registration of chemical substances manufactured or imported in quantities greater than one ton per year.

Last, but not least, the role that poisons played in personal and political intrigues and vendettas, although it may have peaked with Borgias, by no means ended there. A case in point was the 2004 presidential elections in Ukraine. After a bitterly contested battle for the presidency of Ukraine, Viktor Yushchenko emerged victorious and was inaugurated in January 2005, a happy day for democracy, but with a toxic twist. Yushchenko, according to physicians, suffered severe facial disfigurement (chloracne) and other ailments by being poisoned with large dose of dioxins, allegedly mixed in some soup he consumed. Fortunately he is recovering gradually. Although the full story has not yet emerged, political motivations are suspected.

This second edition has grown from 749 entries submitted by 200 authors to 1057 entries contributed by 392 authors. Virtually all the entries from the first edition have been updated and in some cases entirely new versions of these entries have been written. Among the 308 topics appearing for the first time in this edition are avian ecotoxicology, benchmark dose, biocides, computational toxicology, cancer potency factors, metabonomics, chemical accidents, Monte Carlo analysis, nonlethal chemical weapons, invertebrate ecotoxicology, drugs of abuse, cancer chemotherapeutic agents, and consumer products. Many entries devoted to specific chemicals are also brand new to this edition and the international scope of organizations included has been broadened. Entries describing a number of well-known toxin-related incidents, e.g., Love Canal, Times Beach, Chernobyl, and Three-Mile Island, have been added. In addition to the scientific-based entries, others focus on the societal implications of toxicological knowledge. Among them are Toxicology in Culture, Environmental Crimes, Notorious Poisoners and Poisoning Cases Chemical and Biological Warfare in Ancient Times, and a History of the US Environmental Movement. Thus, this new edition has been expanded in length, breadth, and depth and provides an extensive overview of the many facets of toxicology.

Philip Wexler

# PREFACE TO THE FIRST EDITION

There are many fine general and specialized monographs on toxicology, most of which are addressed to toxicologists and students in the field and a few to laypeople. This encyclopedia of toxicology does not presume to replace any of them but rather is intended to fulfill the toxicology information needs of new audiences by taking a different organizational approach and assuming a middle ground in the level of presentation by borrowing elements of both primer and treatise.

The encyclopedia is broad-ranging in scope, although it does not aspire to be exhaustive. The idea was to look at basic, critical, and controversial elements in toxicology, which are those elements that are essential to an understanding of the subject's scientific underpinnings and societal ramifications. As such, the encyclopedia had to cover not only key concepts, such as dose response, mechanism of action, testing procedures, endpoint responses, and target sites, but also individual chemicals and classes of chemicals. Despite the strong chemical emphasis of the book, we had to look at concepts such as radiation and noise, and beyond the emphasis on the science of toxicology, we had to look at history, laws, regulation, education, organizations, and databases. The encyclopedia also needed to consider environmental and ecological toxicology to somewhat counterbalance the acknowledged emphasis on laboratory animals and humans because, in the end, all our connections run deep.

In terms of the chemicals, we the editors of this book made a personal selection based on our own knowledge of those with relatively high toxicity, exposure, production, controversy, newsworthiness, or other interest. The chemicals do not represent a merger of regulatory lists or databases of chemicals; they are what we consider to be, for one reason or another, chemicals of concern to toxicology. The book was not intended as a large-scale compendium of toxic chemicals, several of which already exist.

In the tradition of many standard encyclopedias, scientific and otherwise, the encyclopedia is organized entirely alphabetically. Other than in a few useful but smaller scale dictionaries, this style of arrangement has not been done before for toxicology. This organization, along with a detailed index and extensive cross-references, should help the reader quickly arrive at the needed information.

Next, although this book should be of use to the practicing toxicologist, it is geared more to others who, in the course of their work, study, or for general interest, need to know about toxicology. This would include the scientific community in general, physicians, legal and regulatory professionals, and laypeople with some scientific background. Toxicologists needing to brush up on or get a quick review of a subject other than their own specialty would also benefit from it, but toxicologists seeking an in-depth treatment should instead consult a specialized monograph or journal literature.

The encyclopedia is meant to give relatively succinct overviews of sometimes very complex subjects. Formal references and footnotes were dispensed with because these seemed less relevant to the encyclopedia's goals than a simple list of recommended readings designed to lead the reader to more detailed information on a particular subject entry. The entry on Information Resources leads readers to print and electronic sources of information in toxicology.

First and foremost, thanks go to the Associate Editors and contributors, whose efforts are here in print. Yale Altman and Linda Marshall, earlier Acquisitions Editors for the books, were of great assistance in getting the project off the ground. Tari Paschall, the current Acquisitions Editor, and Monique Larson, Senior Production Editor, both of Academic Press, have with great expertise and efficiency brought it to fruition. Organization and formatting of the original entry manuscripts were handled with skill, patience, and poise by Mary Hall with the help of Christen Bosh and Jennifer Brewster.

My work on the *Encyclopedia of Toxicology* was undertaken as a private citizen, not as a government employee. The views expressed are strictly my own. No official support or endorsement by the US National Library of Medicine or any other agency of the US Federal Government was provided or should be inferred.

Philip Wexler