

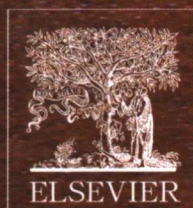
Editors  
William J. Lennarz  
M. Daniel Lane

# 生物化学 百科全书

• 第四卷(S-Z) •

ENCYCLOPEDIA OF  
Biological  
Chemistry

Volume 4 (S-Z)



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S-Z  
Volume 4

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**Biological  
Chemistry**

**生物化学百科全书**

第四卷(S-Z)

Editors

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## 编委会成员介绍

### William J. Lennarz

脂质，糖类，膜和膜蛋白

William J. Lennarz 在宾夕法尼亚州立大学获得化学学士学位，在伊利诺斯大学获得博士学位。随后，在哈佛大学做博士后，师从 Konrad Bloch 研究脂肪酸生物合成。1962 年他被任命为 Johns Hopkins 生理化学系助理教授。1967 年提为副教授和 1971 年提为正教授之后，他仍留在 Hopkins，直至 1983 年。那时，他被任命为 Robert A. Welch 教授和 Texas 大学肿瘤中心 M. D. Anderson 医院的生物化学与分子生物学系主任。1989 年，他成为 Stony Brook 的纽约州立大学 (SUNY) 的生物化学与细胞生物学系的一名重要教授和主任。1990 年他创立了 Stony Brook 细胞与发育生物学研究所，并任所长。

Lennarz 博士在许多国内和国际委员会中任职。他任生化主席组织 (Biochemistry Chairman Organization) 的会长、美国生物化学与分子生物学学会理事长和糖生物学学会理事长。他曾是国际生物化学与分子生物学联合会执行委员会成员，担任了近 10 年。

他在 Notre Dame 大学、NIH、西弗吉尼亚大学、Johns Hopkins 大学、佛罗里达州立大学、加州大学 San Diego 分校、阿肯色大学、印第安那大学和弗吉尼亚医学院都举行过专题讲座。

他是国家科学院院士。他早期工作主要是脂质和细菌细胞的表面。较近期主要致力于研究细胞表面糖蛋白的结构、生物合成和功能。生物合成研究初期关注肝脏和输卵管，现在则重点在酵母。功能研究集中在海胆 (最近是蛙) 受精和早期发育时细胞表面糖蛋白的作用。30 多年来，Lennarz 的研究得到联邦 (主要是 NIH) 的支持。最近他被任命为系终身教授和主任。

### M. Daniel Lane

代谢、维生素和激素

M. Daniel Lane 分别于 1951 年和 1953 年在衣阿华州立大学获得学士和硕士学位，1956 年在伊利诺斯大学得到博士学位。他是慕尼黑 Max-Planck 细胞化学研究所 Feodor Lynen 教授的高级博士后成员。在弗吉尼亚工艺研究所 (Polytechnic Institute) 和纽约大学医学院取得教授位置后，他于 1969 年成为 Johns Hopkins 大学医学院的一名教授，从 1978 年到 1997 年任生物化学系主任和 DeLamar 教授。他现在是 Johns Hopkins 的杰出贡献教授。2002 年他在衣阿华州立大学获得一个荣誉学位：Doctor of Humane Letters。

1987 年 Lane 博士当选为国家科学院院士，1982 年当选为美国艺术与科学院院士，1996 年当选为美国营养科学学会成员。由于对生物素依赖酶的研究，他于 1966 年在美国营养科学学会获得 Mead Johnson 奖；因对胰岛素受体的研究工作，他于 1981 年获得美国生物化学与分子生物学学会的 William C. Rose 奖。1990~1991 年，Lane 是美国生物化学与分子生物学学会的理事长。他作了很多有名的讲座 (包括 1999 年在德国的 Feodor Lynen 讲座)，并在许多编委会工作 (包括 *Journal of Biochemical Chemistry* 和 *Annual Reviews of Biochemistry*)。目前，他是 *Biochemical and Biophysical Research Communication* 的副主编。

Lane 博士已在主要期刊上发表了 280 篇研究论文。他的早期工作集中在各种不同的酶促 CO<sub>2</sub> 固定化反应，主要是酶中的 B 族维生素 (生物素) 在酶催化羧化作用中的机制。Lane 博士对于脂肪酸合成

的关键调节酶——乙酰辅酶 A 羧化酶的调节作用研究，导致他现在感兴趣的研究：即了解脂肪生成 (lipogenesis、adipogenesis) 的基本机制，以及这些过程中畸变结果 (最主要是肥胖症) 的基本机制。他的实验室目前的研究集中在：(1) 信号干细胞“定型”到脂肪细胞谱系和随之分化为脂肪细胞的基因，(2) 脑区域 (已知下丘脑) 监控和调节进食运动的机制。

## Ernesto Carafoli

生物能学

Ernesto Cararoli 于 1957 年在意大利 Modena 大学获硕士学位。随后在 Johns Hopkins 大学的 Albert L. Lehninger 实验室从事博士后研究。20 世纪 60 年代中期，他返回意大利 Modena 大学，在那里工作至 1973 年。那年，他被任命为苏黎世瑞士联邦理工学院 (Swiss Federal Institute of Technology, ETH) 生物化学教授。1998 年他作为 Podova 大学生物化学教授返回意大利。在那里，他现在也领导新建立的 Venetian 分子医学研究所 (VIMM)。

Carafoli 博士在 Johns Hopkins 作博士后时对钙是信号传递介质发生了兴趣。当他抵达那里时，他的主要兴趣是线粒体生物能学，因而他很自然地把兴趣扩展到新发现的线粒体钙转导的领域。他与该领域中的许多早期发现有关，在他返回意大利后，他继续从事线粒体和钙的工作，直至他去了 ETH。在那里，他的兴趣仍然集中在钙上，但重点转移到将钙转运通过膜和加工其信号的蛋白质。他喜爱的研究项目成了钙泵，特别是研究质膜，一个对调节钙稳态，从而对细胞的存活状态有非常重要意义的酶。特别在 1979 年他将此酶纯化后，对酶研究所做的贡献帮助确定了该酶的大部分性质，并且澄清了机制、调节和结构的重要问题。

Carafoli 博士写作或共同写作了大约 450 篇经同行评阅的文章和综述，他编辑或共同编辑了约 20 本书。他是数个期刊的编委和顾问编委，组织了大约 30 个国际专题讨论会和学术讨论会。他是从专题讨论会到国际学术讨论会，以及国际大会的为数众多场合的大会报告人或荣誉报告人。Carafoli 博士得到的荣誉和奖状包括几个国际奖和奖牌、几个学院的院士和三个荣誉学位。

## Don W. Cleveland

细胞结构和功能

Don W. Cleveland 是一个持续的贡献者。他的贡献主要是阐明了有丝分裂纺锤体组装和染色体移动的调节，以及这两者发生的错误如何产生人类肿瘤中特有的染色体的丧失。他发现了编码微管大亚基的微管蛋白基因家族，以及通过被调节的 RNA 不稳定性调控基因表达的第一个哺乳动物例子。他鉴定了纺锤体组装时对微管成核和锚定所需要的组分。他鉴定了第一个人着丝粒蛋白 (CENP-B)。后来他发现了 CENP-E，这是与着丝粒缔合的运动微管。他指出，这个运动微管对染色体附着和有丝分裂检查点的活化与沉默是必要的，这是防止有丝分裂时染色体分裂发生错误的细胞周期调控机制。

Cleveland 博士也是仔细分析主要的人类神经退行性紊乱疾病机制的领导者。他最早纯化和鉴定了着丝粒缔合蛋白质 tau，该蛋白质在人患痴呆 (包括阿尔茨海默病和皮克病) 时异常地聚集。他认为神经元发育时获得的极端不对称性是由于相互连接的神经丝、微管和肌动蛋白的可变形的排列。他指出神经丝排列的解体引起小鼠和人的运动神经元的选择性死亡。他同时也证实，神经元的死亡也可以由于与其正常活性无关的超氧化物歧化酶突变体的毒性而导致。由此他明确地揭示了主要遗传形式的脊椎侧柱硬化的机制。他表明，通过降低神经丝的含量可以大大改善此毒性。

Cleveland 博士现在是 Ludwig 肿瘤研究所细胞生物学实验室主任，加州大学 San Diego 分校医学、神经科学和细胞与分子医学的教授。他也是 *Journal of Cell Biology* 和 *Current Opinion in Cell Biology* 的编委。

## Jack E. Dixon

蛋白质/酶结构、功能和降解

Jack E. Dixon 于 1971 年获加州大学 Santa Barbara 分校化学博士学位，并在加州大学 San Diego 分校进行生物化学博士后训练。

Dixon 博士是蛋白质酪氨酸磷酸酶（PTP 酶）结构和功能研究的先驱者和领导者。他证明 PTP 酶的独一无二的催化机制是经过一个新的半胱氨酸-磷酸中间物进行的。他发现了第一个双专一性的磷酸酶，该酶使细胞周期蛋白 p80<sup>cdc25</sup> 被确定为一个磷酸酶。他也指出，对瘟疫或“黑死病”（black death）负责的细菌藏匿了曾经被描述的最活跃的 PTP 酶。他和他的同事们进一步证实这个 PTP 酶基因产物对细菌的病变是主要的。Dixon 博士和他的同事们测定了酪氨酸和双专一性磷酸酶两者的 X-衍射结构。Dixon 博士也发现，PTP 酶催化域外的序列能够起作用以指导 PTP 酶的亚细胞定位并限制它们的底物专一性。这是当今被广泛承认的 PTP 酶的调节范例。最近，他的实验室证明，与 PTP 酶具有同样序列的特定肿瘤抑制基因 PTEN 能催化脂质第二信使——磷脂酰肌醇 3, 4, 5-三磷酸（PIP3）的脱磷酸作用。这是 PTP 酶使脂质第二信使脱磷酸作用的第一个例子。PIP3 激活蛋白激酶 AKT，该酶在调控凋亡与细胞存活间的平衡起关键作用。PTEN 基因的丧失提高了 PIP3 的水平，导致 AKT 引起组合的活化和癌变。最近，Dixon 博士与 Nikola Pavletich 合作，测定了 PTEN 的 X-衍射结构。他做的结构/功能研究解释了 PTEN 的 PIP3 底物专一性，并为在人类肿瘤中观察到的许多变种提供了理论基础。Dixon 博士在工作早期就采用了分子生物学工具，因为在 20 世纪 70 年代已有可能获得这样的工具。他的实验室是首先使用合成的寡聚核苷酸来分离和广泛鉴定编码肽激素的 cDNA 的实验室之一。

Dixon 博士是药理学、细胞和分子医学，以及化学和生物化学的教授，是加州大学 San Diego 分校的科学部主任。他是国家科学院医学研究所和美国艺术和科学学院院士。Dixon 博士从美国生物化学与分子生物学学会获得 2003 年 Williams C. Rose 奖。

## John H. Exton

信号发送

John H. Exton 在新西兰出生并受教育。在那里他接受医学训练，1963 年获 Otago 大学生物化学博士学位。他在 Vanderbilt 大学的 Charles R Park 和 Earl W Sutherland 指导下进行博士后工作，1968 年成为 Howard Hughes 医学研究所的研究员，1970 年成为生理学教授。他现在是分子生理学与生物物理学教授、药理学教授和在 Vanderbilt 的 Hughes 研究员。

Exton 博士初始时主要是研究糖尿病时肝内糖代谢的变化以及用不同激素的处理，用灌注鼠肝为实验系统。他的工作集中在糖异生，并鉴定在胰岛素、肾上腺素、胰高血糖素和糖皮质激素调控下的酶促反应，并且证明在这些反应调节中环 AMP 的重要性。他也表明提供底物（特别是丙氨酸）所起的作用。

其后，Exton 博士把注意力转向肾上腺素的作用，他证实，它的许多作用不是由环 AMP，而是由钙离子介导。这些工作导致研究作为钙增加基础的磷脂酶 C 引起肌醇磷脂的降解。后来，研究结果发现了活化磷脂酶 C 的一种新的 G 蛋白：Gq。进一步研究证实，拮抗剂引起另一种磷脂（磷脂酰胆碱）被另一种磷脂酶（磷脂酶 D）降解。现在工作集中在磷脂酶 D 的生理功用。

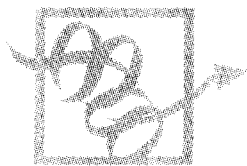
Exton 博士写了 350 多篇科学文章，现在是 *Journal of Biochemical Chemistry* 的副主编。他一直在许多科学评审小组工作，并且是许多刊物的评审人。他荣获众多奖项和荣誉，最知名的有美国糖尿病联合会的 Lilly 奖、美国科学促进会成员和选为国家科学院院士。

**Paul Modrich**

分子生物学

Paul Modrich 是 Howard Hughes 医学研究所的研究员和 Duke 大学研究中心的 James B. Duke 生物化学教授。他从 MIT 获得学士学位，从 Stanford 大学获得化学博士学位。当前他研究的是 DNA 修复机制。他一直在 *Journal of Biochemical Chemistry*、*Biochemistry*、*Proceeding of the National Academy of Sciences* 和 *DNA Repair* 的编委会工作。他的荣誉包括选入国家科学院和医学研究所、获得 Pfizer 酶化学奖和肿瘤研究的 General Motors Mott 奖，以及肿瘤研究的 Pasarow 基金奖。





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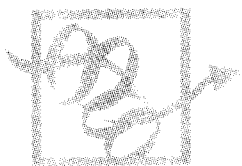
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## William J. Lennarz

*Lipids, Carbohydrates, Membranes and Membrane Proteins*

WILLIAM J. LENNARZ received his B.S. in Chemistry from Pennsylvania State University and a Ph.D. in Organic Chemistry from the University of Illinois. Subsequently he carried out postdoctoral work at Harvard with Konrad Bloch on fatty acid biosynthesis. In 1962 he was appointed Assistant Professor at Johns Hopkins in the Department of Physiological Chemistry. After promotion to Associate Professor in 1967, and full Professor in 1971, he remained at Hopkins until 1983. At that time, he was appointed Robert A. Welch Professor and Chair of the Department of Biochemistry and Molecular Biology at the University of Texas Cancer Center, M.D. Anderson Hospital. In 1989 he became a Leading Professor and Chair of the Department of Biochemistry and Cell Biology at SUNY at Stony Brook. In 1990 he founded and became Director of the Institute for Cell and Developmental Biology at Stony Brook.

Dr. Lennarz has served on many national and international committees. He has served as President of the Biochemistry Chairman's Organization, President of the American Society for Biochemistry and Molecular Biology and President of the Society for Glycobiology.

He was a member of the Executive Committee of the International Union of Biochemistry and Molecular Biology for almost a decade.

He has presented special lectures at the University of Notre Dame, the NIH, the University of West Virginia, Johns Hopkins University, Florida State University, the University of California at San Diego, the University of Arkansas, Indiana University and the Medical College of Virginia.

He is a member of the National Academy of Sciences. The focus of his early work was on lipids and bacterial cell surfaces. More recent efforts have been in the structure, biosynthesis and function of cell surface glycoproteins. The biosynthesis studies initially were carried out in liver and oviduct, but these efforts now are focused in yeast. The functional studies have concentrated on the role of cell surface glycoproteins in fertilization and early development in the sea urchin and, more recently, the frog. For over 30 years Dr. Lennarz' research has been supported by federal sources, primarily the National Institutes of Health. Recently he was appointed Distinguished Professor and Chair of his department.



## M. Daniel Lane

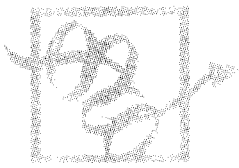
*Metabolism, Vitamins and Hormones*

M. DANIEL LANE received B.S. and M.S. degrees in 1951 and 1953 from Iowa State University and a Ph.D. in 1956 from the University of Illinois. He was a Senior Postdoctoral Fellow with Professor Feodor Lynen at the Max-Planck Institute Fur Zellchemie in Munich. Following faculty positions at Virginia Polytechnic Institute and New York University School of Medicine, he joined the faculty at the Johns Hopkins University School of Medicine in 1969 and served as DeLamar Professor and Director of the Department of Biological Chemistry from 1978 to 1997. He is presently Distinguished Service Professor at Johns Hopkins. In 2002 he received an honorary degree, Doctor of Humane Letters, from Iowa State University.

Dr. Lane was elected to membership in the National Academy of Sciences (in 1987) and was elected as a Fellow of the American Academy of Arts and Sciences (in 1982) and of the American Society of Nutritional Sciences (in 1996). He received the Mead Johnson Award from the American Society for Nutritional Sciences in 1966 for his research on biotin-dependent enzymes and in 1981, the William C. Rose Award from the American Society for Biochemistry and Molecular Biology for his work on the insulin receptor. In 1990–1991 Lane served as President of the

American Society of Biochemistry and Molecular Biology. He has presented many named lectureships (including the Feodor Lynen Lecture in Germany in 1999) and served on numerous editorial boards including the *Journal of Biological Chemistry* and the *Annual Reviews of Biochemistry*. Currently he is Associate Editor for *Biochemical and Biophysical Research Communications*.

Dr. Lane has published 280 research papers in major scientific journals. His early work focused on various enzymatic CO<sub>2</sub> fixation reactions, notably the mechanisms by which the B-vitamin, biotin, functions in enzymes to catalyze carboxylation. Dr. Lane's work on the regulation of acetyl-CoA carboxylase, the key regulatory enzyme of fatty acid synthesis, led him to his present interests which are to understand the basic mechanisms of lipogenesis, adipogenesis and the consequence of aberrations in these processes, most notably obesity. Research currently underway in his laboratory focuses on: (1) the genes that signal stem cell "commitment" to the adipocyte lineage and subsequent differentiation into adipocytes, and (2) the mechanisms by which the region of the brain, known as the hypothalamus, monitors and controls the drive to eat.



## Ernesto Carafoli

*Bioenergetics*

ERNESTO CARAFOLI earned his M.D. degree at the University of Modena in Italy in 1957. After postdoctoral studies in the Laboratory of Albert L. Lehninger at Johns Hopkins University in the mid 1960s he returned to his home institution in Italy where he worked until 1973, when he was appointed Professor of Biochemistry at the Swiss Federal Institute of Technology (ETH) in Zurich. He returned to Italy in 1998 as a Professor of Biochemistry at the University of Padova, where he now also directs the newly founded Venetian Institute of Molecular Medicine (VIMM).

Dr. Carafoli became interested in calcium as a signaling agent during his post-doctoral days at Johns Hopkins. When he arrived there his main interests were in mitochondrial bioenergetics and it was thus natural for him to expand them to the newly discovered area of mitochondrial calcium transport. He was involved in most of the early discoveries in the field, and he continued to work on mitochondria and calcium after his return to Italy and until he moved to the ETH. There his interests still remained focused on calcium, but the

emphasis shifted to the proteins that transport it across membranes and to those that process its signal. His favorite object of study became the calcium pumps, especially that of the plasma membrane, an enzyme which is essential to the regulation of calcium homeostasis and thus to the well being of cells. His contributions on the enzyme, especially after he purified it in 1979, have helped establishing most of its properties and have clarified important problems of mechanism, regulation and structure.

Dr. Carafoli has authored or co-authored about 450 peer-reviewed articles and reviews, and has edited or co-edited about 20 books. He has served on the Editorial or Advisory Boards of several periodicals and has organized about 30 International Workshops and Symposia. He has been featured as a plenary or honorary lecturer at numerous events ranging from specialized Workshops to International Symposia and Congresses. Dr. Carafoli's honors and awards include several international prizes and medals, memberships in several Academies, and three honorary degrees.



## Don W. Cleveland

*Cell Architecture and Function*

DON W. CLEVELAND has been a longstanding contributor to the elucidation of regulation of assembly of mitotic spindles and chromosome movement and how errors in these contribute to the chromosome loss characteristic of human tumors. He discovered the tubulin gene families encoding the major subunits of microtubules and the first mammalian example of control of gene expression through regulated RNA instability. He identified components required for microtubule nucleation and anchoring during spindle assembly. He identified the first human centromeric protein (CENP-B). He then discovered CENP-E, the centromere-associated, microtubule-motor that he showed to be essential for chromosome attachment and for activation and silencing of the mitotic checkpoint, the cell cycle control mechanism that prevents errors of chromosome segregation in mitosis.

Dr. Cleveland has also been a leading force in dissecting the disease mechanism for major human neurodegenerative disorders. He initially purified and characterized tau, the microtubule-associated protein

that assembles aberrantly in human dementias including Alzheimer's disease and Pick's disease. He established that the extreme asymmetry of neurons acquired during development is achieved with a deformable array of interlinked neurofilaments, microtubules and actin. He showed that disorganization of neurofilament arrays caused selective death of motor neurons in mice and humans. He also demonstrated that neuronal death could also arise by a toxicity of mutant superoxide dismutase unrelated to its normal activity, thereby uncovering the mechanism underlying the major genetic form of amyotrophic lateral sclerosis. He showed that this toxicity could be sharply ameliorated by lowering the content of neurofilaments.

Dr. Cleveland is currently Head, Laboratory for Cell Biology in the Ludwig Institute for Cancer Research and Professor of Medicine, Neurosciences and Cellular and Molecular Medicine at the University of California at San Diego. He is also the Editor of the *Journal of Cell Biology* and *Current Opinion in Cell Biology*.





## Jack E. Dixon

*Protein/Enzyme Structure, Function and Degradation*

JACK E. DIXON earned his Ph.D. in Chemistry at the University of California, Santa Barbara in 1971 and did his postdoctoral training in Biochemistry at the University of California, San Diego.

Dr. Dixon is a pioneer and leader in the structure and function of the protein tyrosine phosphatases (PTPases). He demonstrated that the unique catalytic mechanism of the PTPases proceeds *via* a novel cysteine-phosphate intermediate. He discovered the first dual-specificity phosphatase, which led to the identification of the cell cycle protein, p80<sup>cdc25</sup>, as a phosphatase. He also showed that the bacteria responsible for the plague or "black death" harbor the most active PTPase ever described. He and his colleagues went on to demonstrate that this PTPase gene product is essential for the pathogenesis of the bacteria. Dr. Dixon and his colleagues determined X-ray structures for both tyrosine and dual specificity phosphatases. Dr. Dixon also found that sequences outside of the PTPase catalytic domain could function to direct the subcellular localization of the PTPases and to restrict their substrate specificity. This is now a widely acknowledged regulatory paradigm for the PTPases. Recently, his laboratory demonstrated that the tumor suppressor gene, PTEN, which shares sequence identity with the PTPases, catalyzes the dephosphorylation of a lipid second messenger,

phosphatidylinositol 3,4,5-trisphosphate (PIP3). This represents the first example of a PTPase dephosphorylating a lipid second messenger. PIP3 activates the protein kinase, AKT, which plays a critical role in controlling the balance between apoptosis and cell survival. The loss of the PTEN gene elevates PIP3 levels leading to constitutive activation by AKT and oncogenesis. Recently, Dr. Dixon in collaboration with Nikola Pavletich determined the X-ray structure of PTEN. Their structure-function studies explain the PIP3 substrate specificity of PTEN and also provide a rationale for many of the mutations seen in human cancers. Earlier in his career, Dr. Dixon adopted the tools of molecular biology as they became available in the 1970s, and his laboratory was among the first to use synthetic oligonucleotides to isolate and extensively characterize cDNAs encoding peptide hormones.

Dr. Dixon is Professor of Pharmacology, Cellular and Molecular Medicine and Chemistry and Biochemistry and Dean of Scientific Affairs at the University of California, San Diego. He is a member of the National Academy of Sciences, the Institute of Medicine and the American Academy of Arts and Sciences. Dr. Dixon was the recipient of the 2003 William C. Rose Award from the American Society for Biochemistry and Molecular Biology.



## John H. Exton

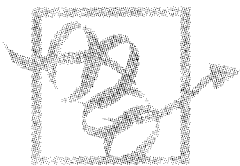
*Signaling*

JOHN H. EXTON was born and educated in New Zealand where he received his medical training and a Ph.D. in Biochemistry from the University of Otago in 1963. He did postdoctoral work at Vanderbilt University under Charles R. Park and Earl W. Sutherland, and became an Investigator of the Howard Hughes Medical Institute in 1968 and Professor of Physiology in 1970. He is presently Professor of Molecular Physiology and Biophysics, Professor of Pharmacology and a Hughes Investigator at Vanderbilt.

Dr. Exton's research initially focused on the changes in carbohydrate metabolism in liver during diabetes and treatment with various hormones using the perfused rat liver as the experimental system. His work concentrated on gluconeogenesis and identified the enzymatic reactions that were under control by insulin, epinephrine (adrenaline), glucagon and glucocorticoids, and demonstrated the importance of cyclic AMP in the regulation of these reactions. The role played by the supply of substrates, especially of alanine, was also shown.

Dr. Exton then turned his attention to the action of epinephrine (adrenaline) and demonstrated that many of its actions were not mediated by cyclic AMP but by calcium ions. This led to study of the breakdown of inositol phospholipids by phospholipase C that underlay the increase in calcium. Later this resulted in the discovery of  $G_q$ , a novel G protein that activated phospholipase C. Further studies demonstrated that agonists caused the breakdown of another phospholipid (phosphatidylcholine) by another phospholipase (phospholipase D). Current work is focused on the physiological role of phospholipase D.

Dr. Exton has authored over 350 scientific articles and is presently an Associate Editor of the *Journal of Biological Chemistry*. He has served on many scientific review groups and as a reviewer for many journals. He has won numerous awards, most notably the Lilly Award of the American Diabetes Association, Fellow of the American Association for the Advancement of Science and election to membership in the National Academy of Sciences.

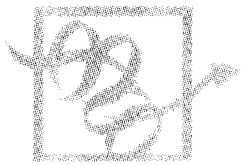


## Paul Modrich

*Molecular Biology*

PAUL MODRICH is an Investigator of the Howard Hughes Medical Institute and James B. Duke Professor of Biochemistry at Duke University Medical Center. He received his undergraduate degree from M.I.T. and his Ph.D. in Biochemistry from Stanford University. His current research addresses the mechanisms of DNA repair. He has served on the editorial boards of the

*Journal of Biological Chemistry, Biochemistry, Proceedings of the National Academy of Sciences, and DNA Repair.* His honors include election to National Academy of Sciences and the Institute of Medicine, the Pfizer Award in Enzyme Chemistry, the General Motors Mott Prize in Cancer Research, and the Pasarow Foundation Award in Cancer Research.



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