

UNITED STATES DEPARTMENT OF JUSTICE  
DRUG ENFORCEMENT ADMINISTRATION

In the Matter of )  
 )  
MDMA SCHEDULING ) Docket No. 84-48  
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DIRECT TESTIMONY OF HAROLD F. HARDMAN, M.D., Ph.D.

I, Harold F. Hardman make the following statement:

I am a pharmacologist employed as Professor and Chairman of the Department of Pharmacology and Toxicology at the Medical College of Wisconsin. I received my doctorate in pharmacology from the University of Michigan in 1954, and my M.D. from the University of Michigan in 1958. I have served in my present capacity at the Medical College of Wisconsin since 1962. A copy of my curriculum vitae is attached as Exhibit 1.

While a medical student at the University of Michigan I conducted a study to determine the toxicity and pharmacological effects of mescaline and 7 analogs in 5 species of animals. The study was part of a contract funded by the Army Chemical Center, Edgewood Arsenal. The results of the study were declassified in 1969 and subsequently published in Toxicology and Applied Pharmacology 25, 299-309 (1973).

The compounds studied included mescaline, 3,4-methylenedioxyamphetamine (MDA), 3,4-methylenedioxymethamphetamine (MDMA) and other substituted phenethylamines. Substances were provided by the Army Chemical Center at Edgewood Arsenal. The toxicity of the compounds were determined in mice, rats and

guinea pigs after single intraperitoneal injections of the hydrochloride salts in saline and in dogs and monkeys after single intravenous injections of the hydrochloride salts. LD-50's, the amount of a substance which proves lethal in 50% of each species, were calculated on the basis of mortality within 24 hours of drug administration. A molar toxicity ratio (LD-50 in millimoles per kilogram of mescaline/ LD-50 in millimoles per kilogram of the analog) was used for comparison of toxicities. MDA was the most toxic substance in all 5 species. MDMA was the second most toxic compound in the rat, dog and monkey and the third most toxic compound in the mouse and guinea pig. MDMA was up to 6 times more toxic than mescaline and between 1.3 and 3 times less toxic than MDA. Death was preceded by the same series of physiological events after administration of lethal doses of mescaline, MDA and MDMA.

The effects of the subject compounds relating to the central nervous system, motor and autonomic functions were observed in the dog and monkey. The effects observed included ataxia, clonic and tonic convulsions, muscular rigidity, muscle tremor, mydriasis, piloerection, salivation, vascular flushing, emesis, apprehension/fright, bizarre body attitudes, apparent hallucinations, dyspnea and hypernea. These effects are part of the classical pharmacological response of the dog to intravenous mescaline.

The classical pharmacologic response to intravenous mescaline in the dog is characterized by an immediate hind limb weakness accompanied by a fluttering motion of the hind leg so

that the dog is forced to assume a sitting position. Salivation, gagging, emesis and defecation are frequent sequelae to the initial motor effects. The dog may then appear negativistic and assume bizarre body attitudes with the head and neck arched toward the floor and the front legs spread widely apart. During this period, which may last for several hours, the dog shows minimal reaction to loud noises or noxious stimuli. Subsequently, the dog appears to be weak and sleepy; however, when forcefully aroused he exhibits a pronounced hind limb ataxia. With adequate doses the initial motor effect on the hind limb consisting of overt tremors is followed by tonic and clonic convulsions. The convulsive episodes are preceded and followed by barking, yelping and apparent hallucinations. The dog usually exhibits marked mydriasis and runs wildly about the room bumping into walls and furniture. The dog also appears to be apprehensive, frightened and disoriented; barking or snarling at inanimate objects is noted frequently. With the exception of vascular flushing, all the above effects were observed after administration of both MDA and MDMA.

I have reviewed the document entitled, "Schedule I Control Recommendations Under the CSA for 3,4-methylenedioxymethamphetamine (MDMA)" and the reference literature relating to the animal pharmacology of MDMA. MDA and MDMA both produce increased motor activity in mice as well as analgesic effects in several procedures in mice. MDA and MDMA exhibit similar qualitative central nervous system effects in animals which differ in the dose at which the effects appear.

Structure-activity relationships in phenethylamine compounds

indicate that adding a N-methyl group retains central nervous system activity. Further, the toxicity studies which I conducted indicated that adding a methylenedioxy substituent on the phenyl ring results in increased toxicity. Thus from these considerations it is likely that MDMA would produce central nervous system effects similar to those of MDA.

In conclusion, although there is insufficient data available to completely characterize MDMA pharmacologically, the available information does indicate that MDMA is a centrally active stimulant compound, somewhat less toxic than MDA but more toxic than mescaline. Because of general pharmacological similarities between MDA and MDMA in animals, I would expect them both to be associated with the same types of toxic and pharmacological effects at equipotent doses in humans.

I declare under penalty of perjury that the foregoing statement is true and correct.

Executed on April 18, 1985.



Harold F. Hardman

EXHIBIT 1

CURRICULUM VITAE

1. HAROLD F. HARDMAN, M.D., Ph.D.  
Professor and Chairman  
Department of Pharmacology and Toxicology  
Medical College of Wisconsin  
8701 Watertown Plank Road  
Milwaukee, Wisconsin 53226
2. SOCIAL SECURITY NUMBER:  
143-20-2731
3. HOME ADDRESS:  
1120 Indianwood Drive  
Brookfield, Wisconsin 53005
4. HOME TELEPHONE: (414) 782-9193      OFFICE TELEPHONE: (414) 257-8267
5. BIRTH DATE, LOCATION:  
August 2, 1927  
East Orange, New Jersey
6. MARITAL STATUS:  
Married: Wife: Jean  
Children: David, Timothy, John and Susan
7. NEXT OF KIN:  
Dr. David Hardman (son)  
13 Burnwood Place  
Chapel Hill, NC 27514  
(919) 544-4817
8. CITIZENSHIP:  
U.S.A.
9. EDUCATION AND TRAINING:  
B.S., Pharmacy, 1949  
Rutgers University  
Newark, New Jersey  
  
M.S., Pharmacology, 1951  
University of Illinois  
Chicago, Illinois

9. EDUCATION (Cont'd.):

Ph.D., Pharmacology, 1954  
University of Michigan  
Ann Arbor, Michigan

M.D., 1958  
University of Michigan  
Ann Arbor, Michigan

10. MILITARY SERVICE:

Army of the United States  
Sgt., 1st Cavalry Division, 8th Regiment  
Army of Occupation, Tokyo, Japan, 1946-1947.

11. PROFESSIONAL LICENSURE:

None

12. BOARD CERTIFICATION:

None

13. FACULTY APPOINTMENTS:

Instructor (part time) of Pharmacology,  
University of Michigan, Ann Arbor, Michigan  
1954-1958

Assistant Professor of Pharmacology,  
University of Michigan, Ann Arbor, Michigan  
1958-1960

Associate Professor of Pharmacology,  
Marquette University School of Medicine  
1960-1961

Professor and Chairman of Pharmacology  
Medical College of Wisconsin, Milwaukee,  
Wisconsin 1962-

14. HOSPITAL STAFF APPOINTMENTS:

None

15. OTHER APPOINTMENTS:

Rockefeller Foundation Visiting Professor, January -  
June 1965, University del Valle, Cali, Columbia, South  
America

16. PROFESSIONAL SOCIETY MEMBERSHIPS AND AWARDS:

American Foundation for Pharmaceutical Education  
Scholarship, 1945-1953  
Rho Chi, National Honorary Pharmaceutical Society  
Galens, Honorary Medical Society, University of Michigan  
Alpha Omega Alpha, Honorary Medical Society  
John and Mary Markle Scholar, 1958-1963  
Alpha Kappa Kappa Award for excellence in preclinical  
instruction, Marquette University School of Medicine,  
1962, 1967  
Sigma Xi  
Outstanding Educator of America Award, 1973  
Who's Who in America, 38th Edition  
American Society for Pharmacology and Experimental Therapeutics  
Program Committee, 1973-1976 (Chairman)  
Member, Committee on Education and Professional Affairs, 1973-1976  
Councilor, 1976-1979  
President-Elect, 1981-1982  
President, 1982-1983  
Association for Medical School Pharmacology  
Secretary, 1970-1972  
President, 1978-1980  
American Chemical Society, Division of Medicinal Chemistry  
American Association for the Advancement of Science  
American Federation for Clinical Research  
Wisconsin Heart Association  
Research Grant Review Committee  
American Heart Association  
Medical Society of Milwaukee County  
Member Ad Hoc Committee on Alcoholism and Drug Abuse, 1971  
Milwaukee Academy of Medicine (1962-present)  
Program Committee, 1963-1969  
Council, 1971-  
Vice President, 1970-1972  
President Elect, 1973  
President, 1974  
International Society on Oxygen Transport to Tissue  
Wisconsin Heart Club  
Federation of American Societies for Experimental Biology (FASEB)  
President-Elect, 1982-1983  
President, 1983-1984

17. OTHER PROFESSIONAL ACTIVITIES AND COMMUNITY ACTIVITIES:

Journal of Medicinal and Pharmaceutical Chemistry  
Editorial Board, 1962-1967  
Wisconsin Medical Journal  
Contributing Editor "Comments on Treatment", 1962-1968  
Journal of Pharmacology and Experimental Therapeutics  
Cardiovascular Field Editor, 1964-1965  
Editorial Board, 1976-  
Research Communications in Substance Abuse  
Editorial Board, 1980-  
Joint Food and Drug Administration/National Institute of  
Mental Health Drug Abuse Advisory Committee, 1971-1974  
National Institute on Drug Abuse  
Ad Hoc Member Biomedical Review Panel, 1975-



17. OTHER PROFESSIONAL ACTIVITIES AND COMMUNITY ACTIVITIES (Cont'd.):

National Institute of General Medical Sciences  
Ad Hoc Member, Pharm Study Section, 1977-  
Pharmaceutical Manufacturers Association Foundation, Inc.  
Member, Basic Pharmacology Advisor Committee, 1975-1981  
Journal of Cardiovascular Pharmacology  
Editorial Board, 1977-

18. MEDICAL COLLEGE COMMITTEES AND ADMINISTRATIVE APPOINTMENTS:

Administrative Appointments:

1962-present Chairman, Department of Pharmacology  
1962-present Executive Committee of the Faculty  
1968-1970 Associate Dean for Basic Science Affairs

Search Committees:

1964-1965 Biochemistry Chairman  
1974-1975 Psychiatry Chairman  
1976-1977 President of Medical College of Wisconsin

Medical School Committees:

1962-1977 Curriculum Committee  
1962-1966 Marquette University Board of Graduate Studies  
1963-1967 Marquette University Committee on Growth  
and Development  
1963-1967 Committee on Relocation of Basic Sciences  
1964-1967 Marquette University Committee on Conditions of  
Faculty Service  
1967-1969 Chairman, Basic Science Building Committee  
1973-present Basic Science Chairmen Committee  
1976-1977 Ad Hoc Hearing Committee for Dismissal of a  
Tenured Faculty Member  
1977 Ad Hoc Subcommittee to Evaluate 7 Year Up or Out  
Ruling on Faculty  
1978-present Graduate Studies Council  
1978-present Ad Hoc Committee on Policies for Promotion, Tenure  
and Extended Contracts  
1979-1980 Intramural Review Committee, Department of Medicine  
1981- Intramural Review Committee of Central Academic  
Administration  
1980-1982 Member of the Board of Directors, Medical College  
of Wisconsin

19. HOSPITAL COMMITTEES:

None

20. GRANTS OR CONTRACTS:

National Institutes of Health, No. DA 00124, May 1972 - April 1975  
Principal Investigator  
Title: Hypotensive and Hypothermic Response to Marijuana  
\$140,945

20. GRANTS OR CONTRACTS (Cont'd.):

National Institutes of Health, No. DA 00124, May 1975 -  
April 1978  
Principal Investigator  
Title: Hypotensive and Hypothermic Response to Marihuana  
\$169,216.

National Institutes of Health, No. DA 00124, May 1978 -  
April 1981  
Principal Investigator  
Title: Hypotensive and Hypothermic Response to Marihuana  
\$328,114.

National Institutes of Health, No. DA 00124, July 1981 -  
June 1984  
Principal Investigator  
Title: Hypotensive and Hypothermic Response to Marihuana  
\$296,882.

National Heart, Lung and Blood Institute, No. HL 08311,  
September 1964 - August 1967  
Principal Investigator  
Title: Effects of Drugs upon Myocardial Hypoxia  
\$84,504.

National Heart, Lung and Blood Institute, No. HL 08311,  
September 1967 - August 1972  
Principal Investigator  
Title: Effects of Drugs upon Myocardial Hypoxia  
\$102,220.

National Heart, Lung and Blood Institute, No. HL 08311,  
September 1972 - August 1975  
Principal Investigator  
Title: Effects of Drugs upon Myocardial Hypoxia  
\$115,967.

National Heart, Lung and Blood Institute, No. HL 08311,  
June 1976 - May 1979  
Principal Investigator  
Title: Effects of Drugs upon Myocardial Hypoxia  
\$120,596.

National Heart, Lung and Blood Institute, No. HL 08311,  
June 1978 - May 1982  
Principal Investigator  
Title: Effects of Drugs upon Myocardial Hypoxia  
\$178,015.

Travenol, Inc., June 1975 - conclusion  
Principal Investigator  
Title: To Determine the Validity that DPG Levels are of  
Significant Value in Post Coronary Transplant Cardiac Function  
\$20,000.

20. GRANTS OR CONTRACTS (Cont'd.):

Searle Laboratories, February 1976 - conclusion  
Principal Investigator  
Title: Hemodynamic Studies  
\$18,255

Parke-Davis, May 1977 - conclusion  
Principal Investigator  
Title: Studies on Bevantolol, a New Beta Blocking Agent  
\$9,625.

Bristol-Myers Company, February 1979 - conclusion  
Principal Investigator  
Title: Studies on Sotalol  
\$20,460.

Wisconsin Heart Association, July 1974 - June 1975  
Principal Investigator  
Title: Measurement of Regional Coronary Blood Flow  
\$9,000.

Wisconsin Heart Association, July 1975 - June 1976  
Principal Investigator  
Title: Analysis of Myocardial Hypoxia  
\$9,550.

Wisconsin Heart Association, July 1976 - June 1977  
Principal Investigator  
Title: Antagonism of Myocardial Hypoxia  
\$9,550.

Training Grant, National Institutes of Health, 5T1 GM 370,  
1962 - 1972  
Principal Investigator  
\$720,521

21. PUBLICATIONS:

See Attached Publications.

22. ABSTRACTS:

See Attached Abstracts.

23. PRESENTATIONS (National, Regional, Local Meetings):

Symposia

- (1) American Society for Pharmacology and Experimental Therapeutics, August 1976  
The Effect of Antianginal Drugs upon Oxygen Supply and Oxygen Demand in the Myocardium.  
Davis, California

23. PRESENTATIONS (National, Regional, Local Meetings) (Cont'd.):

- (2) American Heart Association, November 1975  
Effect of Propranolol and Nitroglycerin  
on Hemoglobin Oxygen Affinity.  
Anaheim, California
- (3) Western Pharmacology Society, January 1979  
Chairing Symposium, "Current Concepts in the Evaluation  
and Pharmacologic Therapy of Myocardial Ischemia."  
Colorado Springs, Colorado
- (4) Oshkosh Symposium, June 1975  
"MCW Research Profile"  
Oshkosh, Wisconsin

Presentations:

- (1) Federation of American Societies for Experimental Biology  
1951, 1952, 1957, 1959, 1960, 1963, 1966
- (2) American Society for Pharmacology and Experimental  
Therapeutics  
1952, 1954, 1955, 1957, 1958, 1963, 1970, 1975
- (3) American Heart Association  
1975

24. PARTICIPATION IN WORKSHOPS, CONSULTATIONS, STUDY SECTIONS, SURVEY TEAMS:

- (1) AMSP (Association for Medical School Pharmacology Chairmen).  
Membership 1968 - present, Secretary 1970 - 1972, President  
1978 - 1980.
- (2) NIDA (National Institutes on Drug Abuse). Member of Study  
Section 1971 - 1974, Chairman 1974 - 1975, Ad Hoc Member  
1975 - 1978.
- (3) ASPET (American Society for Pharmacology and Experimental  
Therapeutics. Program Committee: Member 1971 - 1973,  
Chairman 1973 - 1976, Council (elected) 1976 - 1979.  
President elect 1981-1982, President 1982-1983
- (4) PMAF (Pharmaceutical Manufacturers Association Foundation).  
Study Section Member 1975 - 1978, Study Section Member  
1978 - 1981
- (5) Editorial Boards: Journal of Pharmacology and Experimental  
Therapeutics, Journal of Cardiovascular Pharmacology.  
Research Communications in Substance Abuse

25. TEACHING:

Advisor of the following students:

Richard C. Dage, Ph.D.  
Walter D. Meester, Ph.D.  
Sandra S. Smith, M.S.

25. TEACHING:

Advisor of the following students:

Richard C. Dage, Ph.D.  
Walter D. Meester, Ph.D.  
Sandra S. Smith, M.S.  
Richard C. Dage, Ph.D.  
Raynaldo Sandoval, M.D., M.S.  
Jose S. Serrano-Molina, M.D., Ph.D.  
David C. Warltier, Ph.D.

Committee member of the following students:

William Douglas Brooker, Ph.D.  
Pitambar Somani, M.D., Ph.D.  
Shakil Mohammed, M.D., Ph.D.  
Paulo de Miranda, Ph.D.  
Lewis H. Stocks, Ph.D.  
Donald O. Allen, Ph.D.  
John J. Lech, Ph.D.  
Nicola Zampaglione, Ph.D.  
Michael A. Commarato, Ph.D.  
Clinton N. Corder, Ph.D.  
Peter Savarie, Ph.D.  
Hector J. Gomez, M.D., Ph.D.  
Philip J. Kadowitz, Ph.D.  
Romeo T. Bachand, Jr., Ph.D.  
Richard D Heilman, Ph.D.  
Antonio Guerra, M.D., Ph.D.  
Karl F. Ober, M.D., M.S.  
Mahendr S. Kochar, M.D., M.S.  
Gary J. Jesmok, Ph.D.  
William T. Schmeling, Ph.D.  
Stanley R. Jolly, Ph.D.  
James D. Buck, M.S.  
Cecilia J. Hillard, Ph.D.

## Publications

1. Hardman, H.F.:  
Khellin as a coronary vasodilator (M. Sc. degree thesis).  
University of Illinois, Chicago Professional College, June 1951.
2. Hardman, H.F., Yard, A.C. and Chenoweth, M.B.:  
The effect of the ethylenediamine component of aminophylline on the duration of reversal of cardiac failure.  
J. Pharmacol. Exp. Therap. 109: 461-466, 1953.
3. Hardman, H.F.:  
An analysis of the cardiovascular activities of selected purine derivatives with special reference to the constituent parts of aminophylline.  
Ph.D. Thesis, University of Michigan, June, 1954.
4. Hardman, H.F., Moore, J.I. and Lum, B.K.B.:  
A method for analyzing the effect of pH and the ionization of drugs upon cardiac tissue with special reference to pentobarbital.  
J. Pharmacol. Exp. Therap. 126: 136-142, 1959.
5. Hardman, H.F., Baird, W.M., Suits, D.B. and Lum, B.K.B.:  
Analysis of the common carotid occlusion pressor reflex in the anesthetized dog.  
Amer. J. Physiol. 196: 445-448, 1959.
6. Waddell, W.J. and Hardman, H.F.:  
The intracellular pH of the isolated perfused turtle heart.  
Amer. J. Physiol. 199: 1112-1114, 1960.
7. Lucchesi, B.R. and Hardman, H.F.:  
The influence of dichloroisoproterenol (DCI) and related compounds upon ouabain and acetylstrophanthidin induced cardiac arrhythmias.  
J. Pharmacol. Exp. Therap. 132 372-381, 1961.
8. Baird, W.M. and Hardman, H.F.:  
An analysis of the effect of pH, procaine cation, nonionized procaine and procaine ethylchloride cation upon cardiac conduction time, stimulation threshold, amplitude of contraction and the relationship of these parameters to antiarrhythmic activity.  
J. Pharmacol. Exp. Therap. 132 382-391, 1961.
9. Hardman, H.F.:  
Molecular form of theophylline responsible for positive inotropic activity.  
Circulation Res. 10: 598-607, 1962.
10. Hardman, H.F.:  
Tribute to a retiring editor.  
Wis. Med. J. 61: 187-188, 1962.

11. Hardman, H.F.:  
Vasodilator drugs.  
Wis. Med. J. 61: 294-295, 1962.
12. Hardman, H.F.:  
Perspective in our chemical environment.  
Marquette Med. Rev. 28: 2-4, 1962.
13. Hardman, H.F.:  
Pharmacology "A Justification".  
Wis. Med. J. 62: 268-270, 1963.
14. Hardman, H.F.:  
Chemotherapy of herpes simplex virus and vaccinia virus.  
Wis. Med. J. 62: 417-419, 1963.
15. Hardman, H.F.:  
New concepts in the therapy of angina pectoris.  
Wis. Med. J. 63: 290-293, 1964.
16. Hoffman, N.E., Barboriak, J.J. and Hardman H.F.:  
A sensitive gas chromatographic method for determination of lactic acid.  
Analyt. Biochem. 9: 175-179, 1964.
17. Hardman, H.F. and Reynolds, R.C.:  
An effect of pH upon epinephrine inotropic receptors in the turtle heart.  
J. Pharmacol. Exp. Therap. 149: 219-224, 1965.
18. Meester, W.D., Hardman, H.F. and Barboriak, J.J.:  
Evaluation of various adrenergic blocking agents in isolated rabbit and turtle hearts.  
J. Pharmacol. Exp. Therap. 150: 34-40, 1965.
19. Hardman, H.F. and Bukhamana, P.:  
Cardiac seasonal variation: a qualitative change in pharmacological response to ethylenediamine.  
J. Pharmacol. Exp. Therap. 151: 300-306, 1966.
20. Barboriak, J.J. and Hardman, H.F.:  
The effect of pH on glycogenolysis in turtle hearts.  
Biochem. Pharmacol. 15: 1885-1888, 1966.
21. Smith, S., Barboriak, J.J. and Hardman, H.F.:  
Utilization of glucose in the anaerobically perfused turtle heart.  
J. Pharmacol. Exp. Therap. 155: 397-402, 1967.
22. Mohammed, S., Hardman, H.F. and Yard, A.C.:  
Mechanism of vasodilator response to pheniprazine.  
J. Pharmacol. Exp. Therap. 156: 221-226, 1967.

23. Meester, W.D. and Hardman, H.F.:  
Blockade of the positive inotropic actions of epinephrine and theophylline by acetylcholine.  
J. Pharmacol. Exp. Therap. 158: 241-247, 1967.
24. Dage, R.C. and Hardman, H.F.:  
Histamine responses and seasonal variation in isolated perfused turtle ventricles.  
Eur. J. Pharmacol. 4: 231-239, 1968.
25. Somani, P., Laddu, A.R. and Hardman, H.F.:  
Nutritional circulation in the heart. I. Effect of change in heart rate on myocardial oxygen consumption and nutritional circulation with constant total coronary blood flow.  
Life Sci. 8: 1151-1162, 1969.
26. Somani, P., Bachand, R.T., Hardman, H.F. and Laddu, A.R.:  
Nutritional circulation in the heart. II. A reappraisal of the effect of nitroglycerin on myocardial hemodynamics, oxygen consumption and nutritional blood flow in the isolated supported heart preparation.  
Eur. J. Pharmacol. 8: 1-13, 1969.
27. Somani, P., Laddu, A.R. and Hardman, H.F.:  
Nutritional circulation in the heart. III. Effect of isoproterenol and beta adrenergic blockade on myocardial hemodynamics and <sup>86</sup>Rubidium uptake in the isolated supported heart preparation.  
J. Pharmacol. Exp. Therap. 175: 577-592, 1970.
28. Somani, P., Hardman, H.F. and Laddu, A.R.:  
Nutritional circulation in the heart. Effect of isoproterenol and  $\beta$ -adrenergic blocking drugs.  
VIIth Int. Cong. Angiology, Liege (Belgium), 1969-1970.
29. Dage, R.C. and Hardman, H.F.:  
Histamine induced changes in tension and contractile force in the turtle ventricle.  
Eur. J. Pharmacol. 11: 13-21, 1970.
30. Hardman, H.F., Domino, E.F. and SeEVERS, M.H.:  
General pharmacological actions of some synthetic tetrahydrocannabinol derivatives.  
Pharmacol. Rev. 23: 295-315, 1971.
31. Domino, E.F., Hardman, H.F. and SeEVERS, M.H.:  
Central nervous system actions of some synthetic tetrahydrocannabinol derivatives.  
Pharmacol. Rev. 23: 317-336, 1971.
32. Hardman, H.F., Domino, E.F. and SeEVERS, M.H.:  
Structure activity relationships of  $\Delta^3$ -tetrahydrocannabinols.  
Proc. West. Pharmacol. Soc. 14: 14-20, 1971.



33. Lahiri, P.K., Barboriak, J.J. and Hardman, H.F.:  
Metabolism of free fatty acids in the perfused turtle heart.  
Comp. Biochem. Physiol. 41B: 849-855, 1972.
34. Reynolds, R.C. and Hardman, H.F.:  
The effect of pH changes and ionization on the action of epinephrine upon the isolated rabbit ileum.  
Eur. J. Pharmacol. 20: 249-255, 1972.
35. Serrano, J.S., Hardman, H.F. and Barboriak, J.J.:  
pH limits of contractility in isolated turtle heart.  
Eur. J. Pharmacol. 338: 183-185, 1973.
36. Haavik, C.O. and Hardman, H.F.:  
The effect of tetrahydrocannabinols on body temperature.  
The Pharmacology of Thermoregulation Symposium. Fifth Int. Congress on Pharmacology, San Francisco, 1972. pp. 410-416 (Karger, Basel, 1973).
37. Hardman, H.F., Haavik, C.O. and Seevers, M.H.:  
Relationship of the structure of mescaline and seven analogs to toxicity and behavior in five species of laboratory animals.  
Tox. Appl. Pharmacol. 25: 299-309, 1973.
38. Laddu, A.R., Somani, P. and Hardman, H.F.:  
Effect of beta receptor blockade upon myocardial hemodynamics and nutritional circulation in the heart.  
Myocardial Metabolism: Recent Advances in Studies on the Cardiac Structure and Metabolism. Vol. 3, pp. 409-417, 1973.
39. Laddu, A.R., Somani, P. and Hardman, H.F.:  
Nutritional circulation in the heart. IV. Effect of calcium chloride and potassium chloride on myocardial hemodynamics and clearance of <sup>86</sup>Rubidium.  
Japanese Heart J. 14: 126-134, 1973.
40. Haavik, C.O. and Hardman, H.F.:  
Evaluation of the hypothermic action of tetrahydrocannabinols in mice and squirrel monkeys.  
J. Pharmacol. Exp. Therap. 187: 568-574, 1973.
41. Haavik, C.O. and Hardman, H.F.:  
Hypothermic action of  $\Delta^9$ -tetrahydrocannabinol, 11-hydroxy- $\Delta^9$ -tetrahydrocannabinol and 11-hydroxy- $\Delta^8$ -tetrahydrocannabinol in mice.  
Life Sci. 13: 1771-1778, 1973.
42. Haavik, C.O., Collins, F.G. and Hardman, H.F.:  
Studies on the mechanism of hypothermic action of tetrahydrocannabinols.  
In Temperature Regulation and Drug Action, eds. P. Lomax, E. Schonbaum, J. Jacob, pp. 293-309, Proc. Symposium, Paris, 1974 (Karger, Basel, 1975).

43. Haavik, C.O., Crowshaw, K., Collins, F.G. and Hardman, H.F.:  
Relationship of prostaglandins and fever to the hypothermic action of  $\Delta^9$ -tetrahydrocannabinol.  
In Temperature Regulation and Drug Action, eds. P. Lomax, E. Schonbaum, J. Jacob, pp. 310-318, Proc. Symposium, Paris, 1974 (Karger, Basel, 1975).
44. Gross, G.J. and Hardman, H.F.:  
Alteration in oxyhemoglobin equilibrium (P-50) and myocardial oxygen consumption (MVO<sub>2</sub>) by nitroglycerin (GTN).  
J. Pharmacol. Exp. Therap. 193: 346-355, 1975.
45. Warltier, D.C., Hardman, H.F., Laddu, A.R., Somani, P. and Gross, G.J.:  
Myocardial distribution of coronary blood flow in the isolated, supported heart preparation.  
Cardiovascular Res. 9: 634-639, 1975.
46. Warltier, D.C., Gross, G.J. and Hardman, H.F.:  
Effect of right atrial pacing and nitroglycerin on myocardial oxygen balance.  
Eur. J. Pharmacol. 34: 229-232, 1975.
47. Hardman, H.F. and Hosko, M.J.:  
An overview of the cardiovascular-autonomic actions of cannabis.  
In Pharmacology of Marijuana, eds. M.C. Braude and S. Szara. Raven Press, New York, 1976, pp. 231-238.
48. Hosko, M.J. and Hardman, H.F.:  
Evidence for a dual mechanism of action of cannabis on central cardiovascular control.  
In Pharmacology of Marijuana, eds. M.C. Braude and S. Szara. Raven Press, New York, 1976, pp. 239-253.
49. Gross, G.J., Warltier, D.C. and Hardman, H.F.:  
Effect of adenosine on myocardial oxygen balance.  
J. Pharmacol. Exp. Therap. 196: 445-454, 1976.
50. Gross, G.J., Warltier, D.C. and Hardman, H.F.:  
Effect of propranolol and nitroglycerin on hemoglobin oxygen affinity.  
Eur. J. Pharmacol. 36: 267-271, 1976.
51. Warltier, D.C., Gross, G.J. and Hardman, H.F.:  
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