**CURRICULUM VITAE**

**Wayne D. Bowen, Ph.D.**

**1. Wayne D. Bowen, Ph.D**

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**2. HOME ADDRESS:**

**3. EDUCATION:**

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| B.S. | 1974 | Morgan State College, Baltimore, Maryland<br>Major: Chemistry |
| Ph.D. | 1981 | Cornell University, Ithaca, New York<br>Major: Biochemistry<br>Minor: Neurobiology (Neuropharmacology) |

**Dissertation Title:** Oxidative Sterol Demethylation: Removal of the 14α-Methyl Group of Lanosterol During Microsomal Cholesterol Biosynthesis

**4. PROFESSIONAL APPOINTMENTS:**

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| 5/74 - 8/74 | Medicinal Chemist<br>Smith, Kline and French Laboratories<br>1500 Spring Garden Street<br>P.O. Box 7929<br>Philadelphia, Pennsylvania |
| 9/75 - 5/76 | Teaching Assistant<br>Cornell University<br>Ithaca, New York |

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|---|---|
| 6/80 - 2/82 | NIH Postdoctoral Staff Fellow<br>National Institute of Mental Health<br>Biological Psychiatry Branch<br>Section of Biochemistry and Pharmacology<br>Bethesda, Maryland |
| 2/82 - 7/83 | NIH Postdoctoral Staff Fellow<br>National Institute of Mental Health<br>Clinical Neuroscience Branch<br>Section on Brain Biochemistry<br>Bethesda, Maryland |
| 7/83 - 7/89 | Assistant Professor of Biology<br>Section of Biochemistry<br>Division of Biology and Medicine<br>Brown University<br>Providence, Rhode Island |
| 7/89 - 9/91 | Associate Professor of Biology<br>Section of Biochemistry<br>Division of Biology and Medicine<br>Brown University<br>Providence, Rhode Island |
| 9/91 – 9/04 | Chief, Unit on Receptor Biochemistry and Pharmacology (tenured)<br>Drug Design and Synthesis Section<br>Laboratory of Medicinal Chemistry<br>National Institute of Diabetes and Digestive and Kidney Diseases<br>National Institutes of Health<br>Bethesda, Maryland<br><br>and<br><br>Adjunct Professor of Molecular Biology, Cell Biology, and Biochemistry and Adjunct Professor of Neuroscience<br>Division of Biology and Medicine<br>Brown University<br>Providence, Rhode Island |
| [ 9/95 - | Promoted to GS Grade 15 - Academic Full Professor Equivalent ] |
| 9/04 – 10/07 | Professor of Biology<br>Department of Molecular Pharmacology, Physiology, & Biotechnology<br>Division of Biology and Medicine<br>Brown University<br>Providence, Rhode Island |

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| 10/07 – 7/21 | Professor of Biology and Chair,<br>Department of Molecular Pharmacology, Physiology,<br>& Biotechnology<br>Division of Biology and Medicine<br>Brown University<br>Providence, Rhode Island |
| 5/08 – present | Upjohn Professor of Pharmacology |
| 7/21 – 6/22 | Upjohn Professor of Pharmacology and Professor of Neuroscience<br>Department of Neuroscience<br>Division of Biology and Medicine<br>Brown University<br>Providence, Rhode Island |
| 6/22 – present | Upjohn Professor of Pharmacology Emeritus<br>Professor of Neuroscience Emeritus<br>Department of Neuroscience<br>Division of Biology and Medicine<br>Brown University<br>Providence, Rhode Island |

## 5. COMPLETED RESEARCH, SCHOLARSHIP, AND/OR CREATIVE WORK

### a. Chapters in Books

1. Quirion, R., Bowen, W.D., and Pert, C.B. Mu, delta, and kappa opiate receptors: Interconvertible forms of the same receptor. In: *Advances in Endogenous and Exogenous Opioids*. Proceedings of the International Narcotic Research Conference, Kyoto, Japan. Kodansha Ltd., Tokyo, Japan, pp. 63-65, 1981.

2. Bowen, W.D. and Kooper, G. Photoaffinity labeling of opiate receptors with $^{3}$H-etorphine: Possible species differences in glycosylation. *Progress in Opioid Research, National Institute on Drug Abuse Research Monograph Series* 75: 17-20, 1986.

3. Bowen, W.D., Kelemen, M., Huey, R., and Stewart, D. Characterization of D-Ala$^{2}$,Leu$^{5}$,Cys$^{6}$-enkephalin: A novel synthetic opioid peptide with slowed dissociation from delta receptors. *Progress in Opioid Research, National Institute on Drug Abuse Research Monograph Series* 75: 193-196, 1986.

4. Bowen, W.D., Tolentino, P., and Varghese, P. Investigation of the mechanism by which sigma ligands inhibit stimulation of phosphoinositide metabolism by muscarinic cholinergic agonists. in: *Progress in Clinical and Biological Research, Volume 328: The International Narcotics Research*

*Conference (INRC) '89*. (R. Quirion, K. Jhamandas, and C. Gianoulakis, eds.) Alan R. Liss, Inc., New York, NY, 1990. pp. 21-24.

5. Walker, J.M., Patrick, S.L., Thurkauf, A., Rice, K.C., and Bowen, W.D. Inhibition of cholinergic analgesia by (+)-opiates. in: *Progress in Clinical and Biological Research, Volume 328: The International Narcotics Research Conference (INRC) '89*. (R. Quirion, K. Jhamandas, and C. Gianoulakis, eds.) Alan R. Liss, Inc., New York, NY, 1990. pp. 81-84.

6. Bowen, W.D., de Costa, B., Hellewell, S., Thurkauf, A., Walker, J.M., and Rice, K.C. Characterization of [$^3$H](+)-pentazocine, a highly selective sigma ligand. in: *Progress in Clinical and Biological Research, Volume 328: The International Narcotics Research Conference (INRC) '89*. (R. Quirion, K. Jhamandas, and C. Gianoulakis, eds.) Alan R. Liss, Inc., New York, NY, 1990. pp. 117-120.

7. Matsumoto, R.R., Bowen, W.D., and Walker, J.M. Down-regulation of sigma receptors by chronic haloperidol. in: *Progress in Clinical and Biological Research, Volume 328: The International Narcotics Research Conference (INRC) '89*. (R. Quirion, K. Jhamandas, and C. Gianoulakis, eds.) Alan R. Liss, Inc., New York, NY, 1990. pp. 125-128.

8. Walker, J.M., Bowen, W.D., Roberts, A.H., de Costa, B., and Rice, K.C. Autoradiographic distribution of [$^3$H](+)-pentazocine binding sites in guinea pig brain. in: *New Leads in Opioid Research: Proceedings of the International Narcotics Research Conference, International Congress Series No. 914*. (J.M. van Ree, A.H. Mulder, V.M. Wiegant, and T.B. van Wimersma Greidanus, eds.) Excerpta Medica - Elsevier, Amsterdam, The Netherlands, 1990, pp. 263-265.

9. Hemstreet, M.K., Matsumoto, R.R., Bowen, W.D., and Walker, J.M. A Correlation between sigma receptor binding and behavioral potency of sigma ligands in rats of various ages. in: *New Leads in Opioid Research: Proceedings of the International Narcotics Research Conference, International Congress Series No. 914*. (J.M. van Ree, A.H. Mulder, V.M. Wiegant, and T.B. van Wimersma Greidanus, eds.) Excerpta Medica - Elsevier, Amsterdam, The Netherlands, 1990, pp. 265-267.

10. Matsumoto, R.R., Hemstreet, M.K., Bowen, W.D., and Walker, J.M. Physiological effects of sigma ligands in the rat red nucleus. in: *New Leads in Opioid Research: Proceedings of the International Narcotics Research Conference, International Congress Series No. 914*. (J.M. van Ree, A.H. Mulder, V.M. Wiegant, and T.B. van Wimersma Greidanus, eds.) Excerpta Medica - Elsevier, Amsterdam, The Netherlands, 1990, pp. 267-270.

11. Hellewell, S.B., Bruce, A.E., and Bowen, W.D. Characterization of "sigma-like" binding sites in rat liver membranes: Further evidence for sigma-1 and sigma-2 sites. in: *New Leads in Opioid Research: Proceedings of the International Narcotics Research Conference, International Congress Series No. 914*. (J.M. van Ree, A.H. Mulder, V.M. Wiegant, and T.B. van Wimersma Greidanus, eds.) Excerpta Medica - Elsevier, Amsterdam, The Netherlands, 1990, pp. 270-271.

12. Bowen, W.D. and Tolentino, P.J. Activation of sigma receptors results in down-regulation of muscarinic cholinergic receptors. in: *New Leads in Opioid Research: Proceedings of the International Narcotics Research Conference, International Congress Series No. 914*. (J.M. van

Ree, A.H. Mulder, V.M. Wiegant, and T.B. van Wimersma Greidanus, eds.) Excerpta Medica - Elsevier, Amsterdam, The Netherlands, 1990, pp. 272-273.

13. Reid, A.A., Bowen, W.D., Setterlund, C., and Rothman, R.B. The competitive NMDA receptor antagonist, CPP, allosterically modulates NMDA receptor associated PCP binding sites in the absence of steric hindrance. in: *Problems of Drug Dependence 1990: Proceeding of the 52nd Annual Scientific Meeting, National Institute on Drug Abuse Research Monograph 105*. (L.S. Harris, ed.), U.S. Government Printing Office, Washington, DC, 1991, pp. 339-340.

14. Wild, K., Jiang, Q., Iannone, M., Bowen, W., Porreca, F. Lack of irreversible antagonism of opioid delta receptors by [D-Ala$^2$,Leu$^5$,Cys$^6$]-enkephalin in the mouse isolated vas deferens preparation. in: *Problems of Drug Dependence 1990: Proceeding of the 52nd Annual Scientific Meeting, National Institute on Drug Abuse Research Monograph 105*. (L.S. Harris, ed.), U.S. Government Printing Office, Washington, DC, 1991, pp. 402-403.

15. Radesca, L.A., de Costa, B.R., Bowen, W.D., DiPaolo, L.J., and Rice, K.C. Identification of a novel class of highly potent sigma ligands related to the kappa-selective agonist, U50,488. in: *Problems of Drug Dependence 1990: Problems of Drug Dependence 1990: Proceeding of the 52nd Annual Scientific Meeting, National Institute on Drug Abuse Research Monograph 105*. (L.S. Harris, ed.), U.S. Government Printing Office, Washington, DC, 1991, pp. 518-519.

16. de Costa, B.R., Rothman, R.B., Bowen, W.D., Radesca, L., Band, L., Reid, A., Di Paolo, L., Walker, J.M., Jacobson, A.E., and Rice, K.C. Novel kappa opioid receptor and sigma ligands. in: *Problems of Drug Dependence 1991: Proceeding of the 53rd Annual Scientific Meeting, National Institute on Drug Abuse Research Monograph 119*. (L.S. Harris, ed.), U.S. Government Printing Office, Washington, DC, 1992, pp. 76-80.

17. Carroll, F.I., Abraham, P., Parham, K., Bai, X., Zhang, X., Brine, G.A., Mascarella, S.W., Martin, B.R., May, E.L., Todd, S.L., Sauss, C., Di Paolo, L., Wallace, P., Walker, J.M., and Bowen, W.D. Synthesis, binding affinity (sigma, PCP, mu opioid), and molecular modeling study of (+)- and (-)-N-substituted N-normetazocine analogs. In: *Multiple Sigma and PCP Receptor Ligands: Mechanisms for Neuromodulation and Neuroprotection?* J.-M. Kamenka and E.F. Domino, eds. NPP Books, Ann Arbor, MI, 1992, pp. 33-44.

18. Bowen, W.D., Tolentino, P.J., Hsu, K.K., Cutts, J.M., and Naidu, S.S. Inhibition of the cholinergic phosphoinositide response by sigma ligands: Distinguishing a sigma receptor-mediated mechanism from a mechanism involving direct cholinergic antagonism. In: *Multiple Sigma and PCP Receptor Ligands: Mechanisms for Neuromodulation and Neuroprotection?* J.-M. Kamenka and E.F. Domino, eds. NPP Books, Ann Arbor, MI, 1992, pp. 155-167.

19. Rothman, R.B., Reid, A.A., Kim, A., Ni, Q., Xu, H., de Costa, B.R., Rice, K.C., and Bowen, W.D. The competitive NMDA receptor antagonist, CPP, allosterically modulates the NMDA receptor associated phencyclidine binding site in the apparent absence of steric hindrance. In: *Multiple Sigma and PCP Receptor Ligands: Mechanisms for Neuromodulation and Neuroprotection?* J.-M. Kamenka and E.F. Domino, eds. NPP Books, Ann Arbor, MI, 1992, pp. 307-330.

20. Vilner, B.J. and Bowen, W.D. Characterization of sigma-like binding sites of NB41A3, S-20Y, and N1E-115 neuroblastomas, C6 glioma, and NG108-15 neuroblastoma-glioma hybrid cells: Further evidence for sigma-2 receptors. In: *Multiple Sigma and PCP Receptor Ligands: Mechanisms for Neuromodulation and Neuroprotection?* J.-M. Kamenka and E.F. Domino, eds. NPP Books, Ann Arbor, MI, 1992, pp. 341-353.

21. Matsumoto, R.R., Bowen, W.D., and Houk, J.C. Modulation of a brainstem motor circuit by sigma ligands. In: *Multiple Sigma and PCP Receptor Ligands: Mechanisms for Neuromodulation and Neuroprotection?* J.-M. Kamenka and E.F. Domino, eds. NPP Books, Ann Arbor, MI, 1992, pp. 465-476.

22. Walker, J.M., Patrick, S.L., Hemstreet, M.K., Hohmann, A.G., Martin, W.J., Matsumoto, R.R., Goldstein, S.R., Prawdzik, G.A., Walker, F.O., Hammer, R.P., Jr., de Costa, B., Bowen, W.D., and Patrick, R.L. Role of sigma receptors in nigrostriatal dopamine neurotransmission. In: *Multiple Sigma and PCP Receptor Ligands: Mechanisms for Neuromodulation and Neuroprotection?* J.-M. Kamenka and E.F. Domino, eds. NPP Books, Ann Arbor, MI, 1992, pp. 577-597.

23. Quirion, R., Bowen, W.D., Itzhak, Y., Junien, J.-L., Musacchio, J.M., Rothman, R.B., Su, T.-P., Tam,. S.W., and Taylor, D.P. Classification of sigma binding sites: A proposal. In: *Multiple Sigma and PCP Receptor Ligands: Mechanisms for Neuromodulation and Neuroprotection?* J.-M. Kamenka and E.F. Domino, eds. NPP Books, Ann Arbor, MI, 1992, pp. 959-965.

24. Bowen, W.D. Sigma receptors: recent advances and clinical potentials. in: Receptor Chemistry Towards the Third Millennium, Proceedings of the 12th Camerino-Noordwijkerhout Symposium. Pharmacochemistry Library, Vol. 31. H. Timmerman, general ed.; U. Gulini, M. Gianella, W. Quaglia, and G. Marucci, eds. Elsevier, Amsterdam, 2000, pp. 211-218.

25. Edited Book: *Sigma Receptors: Chemistry, Cell Biology and Clinical Implications*. (R. Mastumoto, T.-P. Su, and W.D. Bowen, eds.), Springer, 2007.

**b. Refereed Journal Articles (2022 h-index = 64)**

1. Kaiser, C., Jen, T., Garvey, E., Bowen, W.D., Colella, D.F., and Wardell, J.R., Jr. Adrenergic agents. 4. Substituted phenoxypropanolamine derivatives as potential beta-adrenergic agonists. *J. Med. Chem.* 20: 687-692, 1977.

2. Bowen, W.D. Oxidative sterol demethylation: Removal of the 14 alpha-methyl group of lanosterol during microsomal cholesterol biosynthesis, Ph.D. Thesis, Cornell University, 1981.

3. Bowen, W.D., Gentleman, S., Herkenham, M., and Pert, C.B. Interconverting mu and delta forms of the opiate receptor in rat striatal patches. *Proc. Natl. Acad. Sci. USA* 78: 4818-4822, 1981.

4. Trzaskos, J.M., Bowen, W.D., Fisher, G.J., Billheimer, J.T., and Gaylor, J.L. Microsomal enzymes of cholesterol biosynthesis from lanosterol: A progress report. *Lipids* 17: 250-256, 1982.

5. Olgiati, V., Quirion, R., Bowen, W.D., and Pert, C.B. Characterization of Type 2 opiate receptors. *Life Sciences* 31: 1675-1678, 1982.

6. Bowen, W.D., Pert, C.B., and Pert, A. Nigral-6-hydroxydopamine lesions equally decrease mu and delta opiate binding to striatal patches: Further evidence for a conformationally malleable Type 1 opiate receptor. *Life Sciences* 31, 1679-1682, 1982.

7. Bowen, W.D. and Pert, C.B. Conformational malleability of opiate receptors: Sulfhydryl modification alters ion-induced mu/delta ligand selectivity shifts in rat striatal sections. *Cellular and Molecular Neurobiology* 2: 115-128, 1982.

8. Quirion, R., Bowen, W.D., Herkenham, M., and Pert, C.B. Visualization and solubilization of rat brain opiate receptors with a kappa ligand selectivity pattern. *Cellular and Molecular Neurobiology* 2: 333-346, 1982.

9. Rothman, R.B., Bowen, W.D., Schumacher, U.K., and Pert, C.B. Effect of beta-FNA on opiate receptor binding: Preliminary evidence for two types of mu receptor. *Eur. J. Pharmacol.* 95: 147-148, 1983.

10. Trzaskos, J.M., Bowen, W.D., Shafiee, A., Fischer, R.T., and Gaylor, J.L. Cytochrome P-450-dependent oxidation of lanosterol in cholesterol biosynthesis: Microsomal electron transport and C-32 demethylation. *J. Biol. Chem.* 259: 13402-13412, 1984.

11. Rothman, R.B., Bowen, W.D., Bykov, V., Schumacher, U.K., Pert, C.B., Jacobson, A.E., Burke, T.R., Jr., and Rice, K.C. Preparation of rat brain membranes greatly enriched with either type-I-delta or type-II-delta opiate binding sites using site-directed alkylating agents: Evidence for a two-site allosteric model. *Neuropeptides* 4: 201-215, 1984.

12. Rothman, R.B., Bowen, W.D., Herkenham, M., Jacobson, A.E., Burke, T.R., Jr., Rice, K.C., and Pert, C.B. A quantitative study of $^{3}$H-D-Ala$^{2}$,D-Leu$^{5}$-enkephalin binding to rat brain membranes: Evidence that oxymorphone is a noncompetitive inhibitor at the lower affinity delta binding site. *Mol. Pharmacol.* 27: 399-408, 1985.

13. Walker, J.M., Coy, D.H., Young, E.A., Baldrighi, G., Siegel, S.F., Bowen, W.D., and Akil, H. [D-Ala$^{2}$,($F_5$)Phe$^{4}$]-Dynorphin$_{1-13}$-$NH_2$ (DAFPHEDYN): A potent analog of dynorphin 1-13. *Peptides* 8: 811-817, 1987.

14. Walker, J.M., Bowen, W.D., Atkins, S.T., Hemstreet, M.K., and Coy, D.H. Mu-opiate binding and morphine antagonism by octapeptide analogs of somatostatin. *Peptides* 8: 869-876, 1987.

15. Bowen, W.D., Hellewell, S.B., Kelemen, M., Huey, R., and Stewart, D. Affinity labeling of delta opiate receptors using D-Ala$^{2}$,Leu$^{5}$, Cys$^{6}$-enkephalin: Covalent attachment via thiol-disulfide exchange. *J. Biol. Chem.* 262: 13434-13439, 1987.

16. Bowen, W.D., Rodrigues, P.A., Wanzor, T.E., Jacobson, A.E., and Rice, K.C. Differential coupling of mu-competitive and mu-noncompetitive delta opiate receptors to guanine nucleotide binding proteins in rat brain membranes. *Biochem. Pharmacol.* 37: 467-472, 1988.

17. Rothman, R.B., Bykov, V., Rice, K.C., Jacobson, A.E., Kooper, G.N., and Bowen, W.D. Tritiated-6-beta-fluoro-6-desoxy-oxymorphone ([$^3$H]FOXY): A new ligand and photoaffinity probe for the mu opioid receptors. *Neuropeptides* 11: 1-6, 1988.

18. Walker, J.M., Matsumoto, R.R., Bowen, W.D., Gans, D.L., Jones, K.D., and Walker, F.O. Evidence for a role of haloperidol-sensitive sigma 'opiate' receptors in the motor effects of antipsychotic drugs. *Neurology*, 38: 961-965, 1988.

19. Kooper, G.K., Levinson, N., Copeland, C., and Bowen, W.D. Photoaffinity labeling of opiate receptors using intrinsically photoactive $^3$H-opiates. *Mol. Pharmacol.* 33: 316-326, 1988.

20. Bowen, W.D., Walker, J.M., Yashar, A.G., Matsumoto, R.R., Walker, F.O., and Lorden, J.F. Altered haloperidol-sensitive sigma receptors in the genetically dystonic (dt) rat. *Eur. J. Pharmacol.* 147: 153-154, 1988.

21. Roy, B.F., Bowen, W.D., Rose, J.W., McFarland, H.F., McFarlin, D.E., Frazier, J., Murphy, D.L., and Morihisa, J.M. Human anti-idiotypic antibody to the opiate receptor. *Annals of Neurology* 24: 57-63, 1988.

22. Walker, J.M., Bowen, W.D., Thompson, L.A., Frascella, J., Lehmkuhle, S., and Hughes, H.C. Distribution of opiate receptors within visual structures of the cat brain. *Exp. Brain Res.* 73: 523-532, 1988.

23. Bowen, W.D., Kirschner, B.N., Newman, A.H., and Rice, K.C. Sigma receptors negatively modulate agonist-stimulated phosphoinositide metabolism in rat brain. *Eur. J. Pharmacol.* 149: 399-400, 1988.

24. Bluth, L.S., Rice, K.C., Jacobson, A.E., and Bowen, W.D. Acylation of sigma receptors by Metaphit, an isothiocyanate derivative of phencyclidine. *Eur. J. Pharmacol.* 161: 273-277, 1989.

25. Calcagnetti, D.J., Helmstetter, F.J., Fanselow, M.S., and Bowen, W.D. [D-Ala$^2$,Leu$^5$,Cys$^6$]Enkephalin: Short term agonist effects and long term antagonism at delta opioid receptors. *Peptides* 10: 319-326, 1989.

26. Bowen, W.D., Hellewell, S.B., and McGarry, K.A. Evidence for a multi-site model of the rat brain sigma receptor. *Eur. J. Pharmacol.* 163: 309-318, 1989.

27. Dudek, S., Bowen, W.D., and Bear, M. Glutamate-stimulated phosphoinositide metabolism in developing rat brain. *Devel. Brain Res.* 47: 123-128, 1989.

28. Forster, J., Morris, A.S., Shearer, J.D., Mastrofrancesco, B., Inman, K.C., Lawler, R.G., Bowen, W.D., and Caldwell, M.D. Glucose uptake and flux through phosphofructokinase in wounded rat skeletal muscle. *Am. J. Physiol.* 256: E788-E797, 1989.

29. de Costa, B.R., Bowen, W.D., Hellewell, S.B., George, C., Rothman, R.B., Reid, A.A., Walker, J.M., Jacobson, A.E., and Rice, K.C. Alterations in the stereochemistry of the kappa-selective opioid agonist U50,488 result in high affinity sigma ligands. *J. Med. Chem.* 32: 1996-2002, 1989.

30. de Costa, B.R., Bowen, W.D., Hellewell, S.B., Walker, J.M., Thurkauf, A., Jacobson, A.E., and Rice, K.C. Synthesis and evaluation of optically pure [$^3$H](+)-pentazocine, a highly potent and selective radioligand for sigma receptors. *FEBS Letters* 251: 53-58, 1989.

31. Goldstein, S.R., Matsumoto, R.R., Thompson, T.L., Patrick, R.L., Bowen, W.D., and Walker, J.M. Motor effects of two sigma ligands mediated by nigrostriatal dopamine neurons. *Synapse* 4: 254-258, 1989.

32. Matsumoto, R.R., Bowen, W.D., and Walker, J.M. Age-related differences in the sensitivity of rats to a selective sigma ligand. *Brain Res.* 504: 145-148, 1989.

33. Calcagnetti, D.J., Bowen, W.D., and Holtzman, S.G. Stress-induced tolerance to delta receptor agonist DPDPE and selectivity of the irreversible delta ligand, DALCE. *Brain Res.* 509: 205-212, 1990.

34. Bowen, W.D., Moses, E.L., Tolentino, P.J., and Walker, J.M. Metabolites of haloperidol display preferential activity at sigma receptors compared to dopamine D-2 receptors. *Eur. J. Pharmacol.* 177: 111-118, 1990.

35. Matsumoto, R.R., Hemstreet, M.K., Lai, N.L., Thurkauf, A., de Costa, B.R., Rice, K.C., Hellewell, S.B., Bowen, W.D., and Walker, J.M. Drug specificity of pharmacological dystonia. *Pharmacol. Biochem. and Behav.* 36: 151-155, 1990.

36. Hellewell, S.B. and Bowen, W.D. A sigma-like binding site in rat pheochromocytoma (PC12) cells: Decreased affinity for (+)-benzomorphans and lower molecular weight suggest a different sigma receptor form from that in guinea pig brain. *Brain Res.* 527: 244-253, 1990.

37. de Costa, B.R., Rice, K.C., Bowen, W.D., Thurkauf, A., Rothman, R.B., Band, L., Jacobson, A.E., Radesca, L., Contreras, P.C., Gray, N.M., Daly, I., Iyengar, S., Finn, D.T., Vazirani, S., and Walker, J.M. Synthesis and evaluation of N-substituted *cis*-N-methyl-2-(1-pyrrolidinyl)cyclohexylamines as high affinity sigma receptor ligands. Identification of a new class of highly potent and selective sigma receptor probes. *J. Med. Chem.* 33: 3100-3110, 1990.

38. Reid, A.A., Kim, C.-H., Thurkauf, A., Monn, J.A., de Costa, B.R., Jacobson, A.E., Rice, K.C., Bowen, W.D., and Rothman, R.B. Wash-resistant inhibition of guinea pig brain phencyclidine and haloperidol-sensitive sigma receptor sites by affinity ligands: Determination of selectivity. *Neuropharmacology* 29: 1047-1053, 1990.

39. Jiang, Q., Bowen, W.D., Mosberg, H.I., Rothman, R.B., and Porreca, F. Opioid agonist and antagonist antinociceptive properties of [D-Ala$^2$,Leu$^5$,Cys$^6$]enkephalin: Selective actions at the delta$_{\text{non-complexed}}$ site. *J. Pharmacol. Exp. Ther.* 255: 636-641, 1990.

40. de Costa, B.R. and Bowen, W.D. Synthesis and characterization of optically pure [$^{3}$H](+)-azidophenazocine ([$^{3}$H](+)-AZPH), a photoaffinity label for sigma receptors. *J. Labelled Compd. Radiopharm.* 29: 443-453, 1991.

41. Mattia, A., Vanderah, T., Mosberg, H.I., Omnaas, J.R., Bowen, W.D., and Porreca, F. Pharmacological characterization of [D-Ala$^{2}$,Leu$^{5}$,Ser$^{6}$]-enkephalin (DALES): Antinociceptive actions at the delta$_{\text{non-complexed}}$-opioid receptor. *Eur. J. Pharmacol.* 192: 371-375, 1991.

42. Jiang, Q., Takemori, A.E., Sultana, M., Portoghese, P.S., Bowen, W.D., Mosberg, H.I., and Porreca, F. Differential antagonism of opioid delta antinociception by [D-Ala$^{2}$,Leu$^{5}$,Cys$^{6}$]enkephalin (DALCE) and naltrindole 5'-isothiocyanate: Evidence for delta receptor subtypes. *J. Pharmacol. Exp. Ther.* 257: 1069-1075, 1991.

43. Arjune, D., Bowen, W.D., and Bodnar, R.J. Ingestive behavior following central [D-Ala$^{2}$,Leu$^{5}$,Cys$^{6}$]enkephalin (DALCE), a short-acting agonist and long-acting antagonist at the delta opioid receptor. *Pharmacol. Biochem. Behav.* 39: 429-436, 1991.

44. Berson, D.M., Graybiel, A.M., Bowen, W.D., and Thompson, L.A. Evidence for intrinsic expression of enkephalin-like immunoreactivity and opioid binding sites in cat superior colliculus. *Neurosci.* 43: 513-529, 1991.

45. Wiest, P.M., Olds, G.R., and Bowen, W.D. *Schistosoma mansoni*: Protein phosphorylation during transformation from cercariae to schistosomula. *Exp. Parasitol.* 73: 214-222, 1991.

46. Radesca, L., Bowen, W.D., Di Paolo, L., and de Costa, B.R. Synthesis and receptor binding of enantiomeric N-substituted cis-N-[2-(3,4-dichlorophenyl)ethyl]-2-(1-pyrrolidinyl)cyclohexylamines as high affinity sigma receptor ligands. *J. Med. Chem.* 34: 3058-3065, 1991.

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130. Williams, W., Shu, J.E., and Bowen, W.D. Effect of sigma-2 receptor ligands on calcium mobilization in isolated microsomes. *Society for Neuroscience Abstracts* 27: 97, #39.14, 2001.

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134. Wanebo, H.J., Lu, S., Cao, C., Shrayer, D., Wan, Y., and Bowen, W. Chemoresistance of pancreatic cancer may be reversed by blocking the prosurvival Akt/PI3K/mTOR and mutant KRAS signaling pathways. *Proceedings AACR Special Conference: Targeting PI3K/mTOR Signaling in Cancer*. February 24-27, 2011, San Francisco, CA. Abstract #B49, p. 140-141, 2011.

**e. Invited Lectures**

**1) Seminars**

Howard University
Department of Psychology
Washington, D.C. - 1981

Howard University School of Medicine
Department of Neurophysiology
Washington, D.C. - 1982

National Heart, Lung, and Blood Institute
Laboratory of Cellular Metabolism
Bethesda, Maryland - 1982

Board of Scientific Counselors
National Institute of Mental Health
Bethesda, Maryland - 1982

City University of New York, Hunter College
Department of Biological Sciences
New York, New York - 1982

Meharry Medical College
Departments of Biology and Biochemistry
Nashville, Tennessee - 1983

Massachusetts Institute of Technology
Department of Biology
Cambridge, Massachusetts - 1983

Tulane University School of Medicine
Department of Psychiatry and Neurology
Department of Biochemistry
New Orleans, Louisiana - 1983

Brown University Colloquium
Molecular and Cell Biology Program
Providence, Rhode Island - 1983

Tougaloo College
Departments of Biology and Chemistry
Tougaloo, Mississippi - 1984

Division of Endocrinology
Rhode Island Hospital
Providence, Rhode Island - 1985

University of Tennessee Center for the Health Sciences
Department of Biochemistry
Memphis, Tennessee - 1985

Rhode Island/Brown Science Collaborative
Brown University
Providence, Rhode Island - 1986

City University of New York, Hunter College
Department of Biological Sciences
New York, New York - 1986

Tougaloo Natural Science Colloquia
Natural Science Division
Tougaloo College
Tougaloo, Mississippi - 1986

Third Annual Nabrit Symposium
Departments of Biology and Chemistry
Atlanta University
Atlanta, Georgia - 1986

Brown Biology Summer Institute
Brown University
Providence, Rhode Island - 1986

Brown University
Graduate Program in Molecular Biology,
Cell Biology and Biochemistry
Providence, Rhode Island - 1986

Harvard University
Department of Biochemistry and Molecular Biology
Cambridge, Massachusetts - 1986

University of California at Berkeley
Department of Biochemistry
Berkeley, California - 1987

Southeastern Massachusetts University
Department of Biology
North Dartmouth, Massachusetts - 1988

Brown Biology Institute
Brown University
Providence, Rhode Island - 1988

Monsanto-Searle Pharmaceuticals
Division of Drug Development
St. Louis, Missouri - 1988

University of Rhode Island
Department of Biochemistry
Kingston, Rhode Island - 1988

Peptide Designs
Germantown, Maryland - 1989

Southeastern Massachusetts University
Department of Biology
North Dartmouth, Massachusetts - 1989

Opioids and Behavior Meeting
Dartmouth-Squam Lake
Squam Lake, New Hampshire - 1989

Clinical Biochemistry Series
University of Rhode Island, Annex
Providence, Rhode Island - 1989

National Institute on Drug Abuse Technical Review Meeting:
*Sigma, PCP, and NMDA Receptor Systems*
National Research Center on Drug Abuse
Addiction Research Center
Baltimore, Maryland - 1989

Neuroscience Colloquium
Neuroscience Graduate Program
Brown University
Providence, Rhode Island - 1989

Rensselaer Polytechnic Institute
Department of Psychology
Troy, New York - 1990

FASEB 1990 Satellite Symposium
"*Properties of the Neuroleptic Sensitive Sigma-DM System: Implications for Schizophrenia Research*"
Washington, DC - 1990

Department of Anatomy and Reproductive Biology
Department of Pharmacology
University of Hawaii
Honolulu, Hawaii - 1990

Department of Biochemistry
National Center for Toxicological Research
Jefferson, Arkansas - 1990

Neuroscience Branch
Addiction Research Center
Baltimore, Maryland - 1990

Department of Pharmacology and Toxicology
University of Maryland School of Pharmacy
Baltimore, Maryland - 1990

Department of Pharmacology
University of Miami School of Medicine
Miami, Florida - 1990

Laboratory of Medicinal Chemistry
National Institute of Diabetes and Digestive and Kidney Diseases
National Institutes of Health
Bethesda, Maryland - 1990

Department of Psychiatry
Dartmouth Medical School
Hanover, New Hampshire - 1990

Department of Pediatrics
Women and Infants Hospital of Rhode Island
Providence, Rhode Island - 1990

Department of Biochemistry
University of Tennessee Center for the Health Sciences
College of Medicine
Memphis, Tennessee - 1990

Department of Chemistry
New York University
New York, New York - 1991

Department of Neuroendocrinology
Rockefeller University
New York, New York - 1991

Department of Pharmacology
Smith-Kline Beecham Pharmaceuticals
King of Prussia, Pennsylvania - 1991

Meeting of NIDDK Laboratory and Branch Chiefs
National Institute of Diabetes and Digestive and Kidney Diseases
NIH
Bethesda, Maryland - 1992

Institute of Animal Behavior
Rutgers University
Newark, New Jersey - 1992

Department of Pharmacology
George Washington University School of Medicine
Washington, DC - 1992

Department of Biochemistry
School of Medicine
Meharry Medical College
Nashville, Tennessee - 1992

Psychiatric Disorders Section
Neuroscience Division
Parke-Davis Pharmaceuticals, Ann Arbor, Michigan - 1992

FISONS Pharmaceuticals
Rochester, New York - 1993

Division of Chemistry and Life Sciences
Research Triangle Institute,
Research Triangle, North Carolina - 1993

Department of Pharmacology
Howard University School of Medicine
Washington, D.C. - 1993

Minority Biomedical Research Support Program
Departments of Chemistry and Psychology
University of Southern Colorado
Pueblo, Colorado - 1993

Summer Research Early Identification Program
Brown University
Providence, Rhode Island - 1993

NIDDK Board of Scientific Counselors
National Institutes of Health
Bethesda, Maryland - 1993

Philander Smith College
Division of Natural and Physical Sciences
Little Rock, Arkansas - 1994

Meeting of NIDDK Laboratory and Branch Chiefs
National Institute of Diabetes and Digestive and Kidney Diseases, NIH
Bethesda, Maryland - 1995

Morgan State University
Department of Biology
Baltimore, Maryland - 1995

Black Scientists and the Biomedical Research Enterprise - Distinguished Panel Member National Institutes of Health, Bethesda, Maryland - 1996

The Howard Hughes Medical Institute for High School Biology Teachers
Princeton University,
Princeton, New Jersey - 1996

NIH Black Scientists Association
"Science Working for Us" Seminar Series
National Institutes of Health
Bethesda, Maryland - 1997
“Sigma Receptors: Can a Novel Receptor System Provide New Insights into the Actions of Antipsychotic Drugs and Other Psychoactive Agents?”

Hunter College Science Symposium
Hunter College
New York, New York - 1997
“Life at the Chemistry-Biology Interface: Development of Novel Agonists and Antagonists for the Study of Sigma Receptors”

NIH Summer Seminar Series for Students 1997
National Institutes of Health
Bethesda, Maryland - 1997
“Old Drugs - New Receptors: Exploring the Pharmacology of Sigma Receptors”

NIAID Introduction to Research Symposium
National Institutes of Health
Bethesda, Maryland - 1998
"The Pharmacology of Sigma Receptors: Teaching Old Drugs New Tricks"

National Institute on Drug Abuse
Baltimore, Maryland - 1998
"Sigma-2 Receptors Modulate Intracellular Calcium and Induce Apoptosis"

National Eye Institute
National Institutes of Health
Bethesda, Maryland - 1999
“Sigma Receptors: Role in Modulation of Intracellular Calcium and Induction of Apoptosis”

Morgan State University
Department of Biology
Baltimore, Maryland - 1999
“The Biochemistry and Pharmacology of Sigma Receptors”

Cocaine Treatment Discovery Program
NIDA Medications Development Division
National Institutes of Health
Bethesda, Maryland - 1999
“Sigma Receptors: An Update and Relevance to Problems of Drug Abuse”

Department of Pharmaceutical Sciences
University of Maryland School of Pharmacy
Baltimore, Maryland - 2000
“Sigma-2 Receptor-Mediated Induction of Apoptosis and Modulation of Intracellular Calcium”

Division of Chemistry
National Center for Toxicological Research
Jefferson, Arkansas - 2000
“Activation of Sigma-2 Receptors: A Novel Pathway to Apoptosis”

NIH Undergraduate Scholarship Program
National Institutes of Health
Bethesda, Maryland - 2000
“The Biochemistry and Pharmacology of Sigma Receptors”

Brain and Behavior Mentoring Program -
Summer Colloquium Series
Department of Psychology
Brown University
Providence, Rhode Island - 2000
“How I Got There” seminar series

Department of Pharmacology
College of Pharmacy
Florida A&M University
Tallahassee, Florida - 2000
“Activation of Sigma-2 Receptors: A Novel Pathway to Apoptosis”

Department of Chemistry
College of Pharmacy and Pharmaceutical Sciences
Hampton University
Hampton, Virginia - 2001
“Activation of Sigma-2 Receptors: A Novel Pathway to Apoptosis”

Grantsmanship Symposium
Morgan State University
Baltimore, Maryland - 2001
“Writing Successful Manuscripts”

Brain and Behavior Mentoring Program Summer Colloquium Series
“How They Got There” seminar series
Department of Psychology
Brown University
Providence, Rhode Island - 2001
“The Biochemistry and Pharmacology of Sigma Receptors”

Gerontology Research Center
National Institute on Aging
National Institutes of Health
Baltimore, Maryland - February 8, 2002
"Sigma-2 Receptors Activate a Novel Pathway to Apoptosis"

Department of Pharmacology and Toxicology
Virginia Commonwealth University
Richmond, Virginia - February 21, 2002
"Sigma-2 Receptors Activate a Novel Pathway to Apoptosis"

Department of Molecular Pharmacology, Physiology, and Biotechnology
Division of Biology and Medicine
Brown University
Providence, Rhode Island - March 13, 2002
"Sigma-2 Receptors, Apoptosis, and a Novel Sphingolipid Signaling Pathway"

School of Computer, Mathematical, and Natural Sciences
9th Undergraduate and Graduate Research Symposium
Morgan State University
Baltimore, Maryland - April 18, 2002
Keynote seminar: "Sigma-2 Receptors, Apoptosis, and a Novel Sphingolipid Signaling Pathway"

Laboratory of Molecular Biology, Center for Cancer Research
National Cancer Institute
National Institutes of Health
Bethesda, Maryland – November 1, 2002
“Sigma-2 Receptors, Apoptosis, and a Novel Sphingolipid Signaling Pathway”

National Alliance for the Mentally Ill
Providence, Rhode Island - July 21, 2005
"The Cutting Edge in Psychiatric Medications"

Department of Pharmacology and Therapeutics
University of South Florida College of Medicine
Tampa, Florida – July 22, 2005
"Sigma-2 Receptor-Mediated Apoptosis in Tumor Cell Lines"

Department of Psychological and Brain Sciences
Gill Lecture
Indiana University
Bloomington, Indiana – February 19, 2007
"Sigma-2 Receptor-Mediated Apoptosis in Human SK-N-SH Neuroblastoma Cells"

Department of Biology
Biology Seminar Series
Morehouse College
Atlanta, Georgia – March 13, 2007
"Sigma-2 Receptor-Mediated Apoptosis in Human SK-N-SH Neuroblastoma Cells"

Cardiovascular Research Center
Department of Medicine, Rhode Island Hospital and Warren Alpert Medical School at Brown University
Providence, Rhode Island – February 11, 2009
"Sigma Receptors: Novel Modulators of Calcium Signaling and Cell Survival"

McLean Hospital
Harvard Medical School
Belmont, Massachusetts – January 25, 2010
"Sigma-2 Receptor-Mediated Apoptosis in Neuronal and Non-Neuronal Cells"

Department of Biomedical and Pharmaceutical Sciences
College of Pharmacy
University of Rhode Island, Kingston Rhode Island – March 4, 2010
"Sigma-2 Receptor-Mediated Apoptosis in Cancer Cells"

Department of Chemistry Frontiers Seminar Series
Wayne State University, Detroit Michigan – April 12, 2010
"Sigma-2 Receptor-Mediated Apoptosis in Cancer Cells"

Columbus Science Institute (COSI)
Columbus, Ohio – February 26, 2010
History Makers: Science Makers Seminar Series -
Biology: From Molecules to Man *(videotaped for PBS broadcast)*
"Sigma Receptors and Cancer"

Brown University
Providence, Rhode Island – June 3, 2010
Brown University Staff Day
"Spicing Up Your Health: Anti-Cancer Effects of the Indian Curry Powder, Turmeric"

National Center for Minority Health and Health Disparities (NCMHD)
National Institutes of Health, Bethesda, Maryland – June 29, 2010
"Sigma Receptors: Novel Targets for Anti-Tumor Agents"

The F. Ivy Carroll Symposium: 50 Years of Research at RTI International
Durham, North Carolina - November 1, 2010
"Sigma Receptor Regulation of Cell Proliferation and Survival: The Cancer Connection"

Department of Neuroscience & Pharmacology, School of Medicine
Meharry Medical College
Nashville, Tennessee – March 30, 2011
26th Annual Ralph J. Cazort Heritage Lecture
"Sigma-2 Receptor-Mediated Apoptosis: Implications for Cancer Chemotherapy and Antipsychotic Drug Treatment"

National Institute on Drug Abuse (NIDA)
National Institutes of Health
Baltimore, Maryland – March 20, 2012
"Role of Sigma-2 Receptors in Cell Survival: Sigma-2 Receptor-Mediated Apoptosis"

The History Makers: 4th Annual Back to School with the History Makers (National Event)
Classical High School
Providence, Rhode Island – September 27, 2013
"Journey Through a Life in Science"

School of Pharmacy
University of Hawaii at Hilo
Hilo, Hawaii – January 15, 2014
"Sigma-2 Receptor-Mediated Apoptosis in Cancer Cells"

UNC Lineberger Comprehensive Cancer Center
School of Medicine, Univeristy of North Carolina at Chapel Hill
Chapel Hill, North Carolina – March 26, 2014
"Sigma-2 Receptor-Mediated Apoptosis in Cancer Cells"

Symposium and Reminiscence: In Memory of Dr. William G. Coleman, Jr.
Lister Hill Auditorium, National Library of Medicine
Bethesda, Maryland - December 9th, 2014
"Intersection Between Chemistry and Biology: Toward Targeting a Novel Receptor for Triple Negative Breast Cancer Therapy"

22nd Annual Undergraduate and Graduate Science Research Symposium
Keynote Speaker
Morgan State University
Baltimore, Maryland - April 14, 2015
"Targeting Sigma-2 Receptors for the Treatment of Cancer"

7th Annual Back to School with the History Makers
Classical High School
Providence, Rhode Island – October 13, 2016
"Journey Through a Life in Science"

STEMJazz Meeting
Brown University
Providence, Rhode Island – March 19, 2019
"Sigma-2 Receptors and Cancer Cell Survival: Different Sides of the Same Coin?"

Pfizer Pharmaceuticals
Molecular Targets of Drug Discovery
Pfizer Campus, Groton, Connecticut – October 1, 2019
"Sigma Receptors and Cancer Cell Survival: A Novel Target for Anti-Cancer Therapy"

Cancer Biology Group Meetings
Joint Program in Cancer Biology/Pathology and Laboratory Medicine
Brown University
Providence, Rhode Island – December 6, 2019
"Sigma-2 Receptors and Cancer: Modulators of Metabolism, Mediators of Cell Death"

Department of Pharmacology and Neuroscience
University of North Texas Health Science Center
Fort Worth, Texas – March 24, 2020 (Cancelled due to COVID-19 pandemic)
"Divergent Effects of Sigma-2 Receptors on Cancer Cell Survival"

Breast Cancer Translational Research Disease Group Meeting
Brown University
Providence, Rhode Island – November 19, 2020 (virtual by Zoom)
"Sigma-2 Receptor Ligand-Induced Programmed Cell Death in Triple Negative Breast Cancer"

Pfizer Course – NEUR 1500
Virtual to students at Pfizer - February 9, 2021
"Chemical Synaptic Transmission"

Inaugural Dr. Curtis Harper Distinguished Lectureship
Keynote speaker
Department of Pharmacology, School of Medicine
University of North Carolina-Chapel Hill
Chapel Hill, North Carolina – (Given virtually April 6, 2021)

**2) Invited talks at national and international meetings**

*Gordon Research Conference on Molecular Pharmacology - Plymouth, New Hampshire, 1981

Gordon Research Conference on Mode of Action of Opiates and Multiple Opiate Receptors - Ventura, California, 1983

Collegium Internationale Neuro-Psychopharmacologicum (C.I.N.P.) - Puerto Rico, 1986

*Opioids and Behavior - Squam Lake, New Hampshire, 1989

*National Institute on Drug Abuse Technical Review Meeting: *Sigma, PCP, and NMDA Receptor Systems* - Baltimore, Maryland, 1989

*FASEB 1990 Satellite Symposium - "*Properties of the Neuroleptic Sensitive Sigma-DM System: Implications for Schizophrenia Research*", Washington, DC, 1990

*Third French-U.S. Seminar - "*Multiple Sigma and PCP Receptor Ligands: Mechanisms for Neuromodulation and Neuroprotection?*", Montpellier, France, 1991

*American College of Neuropsychopharmacology (A.C.N.P.) - San Juan, Peurto Rico, 1991; Study Group Participant; "*The Sigma Receptor: Biochemistry, Physiology, and Clinical Potential*"

*Second Kelvin Conference on Synaptic Transmission - Glasgow, Scotland, 1992

*Collegium Internationale Neuro-Psychopharmacologicum (C.I.N.P.) XIXth Congress - "*Sigma Receptors: Recent Advances and Clinical Potential*", Washington, D.C., June, 1994

*12th Camerino - Noordwijkerhout Symposium: Receptor Chemistry Towards the Third Millennium - "Sigma Receptors: Recent Advances and New Clinical Potentials", Camerino, Italy, September, 1999

*Conference on Ibogaine - "Sigma Receptors and Iboga Alkaloids: Sigma-2 Receptors Mediate Ibogaine-Induced Changes in Intracellular Calcium and Apoptotic Cell Death", New York, NY, November, 1999

*Gordon Research Conference on Glycolipid and Sphingolipid Biology - "Sigma-2 Receptors, Sphingolipid Signalling, and a Novel Pathway to Apoptosis", Ventura, California, January, 27 - February 1, 2002

*First International Meeting on Neurobiology of the Skin –
Munster, Germany – February 13-15, 2004
"Sigma Receptors as Novel Target Structures for Cancer Chemotherapeutics"

*College on Problems of Drug Dependence - 66th Annual Scientific Meeting,
San Juan, Puerto Rico – June 12-17, 2004
Symposium XI – Sigma Receptors: Evolution of an Enigma to a Therapeutic Target for Drugs of Abuse
"Overview: History, Pharmacology, and Molecular Biology of Sigma Receptors"

*Blacks in Government – 27th Annual National Training Conference, Orlando, Florida, August 1-5, 2005;
BIG National Health Initiatives Health Symposium
"Neurodegenerative Diseases and Cancer"

American Association for Cancer Research 2006 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research
Washington, D.C. – April 3rd, 2006
"Career Objectives: Junior Faculty – Staying on the Road to Tenure"

*Blacks in Government – 28th Annual National Training Conference,
New York, New York - August 23, 2006;
BIG National Health Initiatives Health Symposium
"Depression and Other Mood Disorders: Medications and How They Work"

American Association for Cancer Research 2007 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research
Los Angeles, California – April 16th, 2007
"How to Set Up a Lab and Management of Resources"

American Association for Cancer Research 2008 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research
San Diego, California – April 14th, 2008
"How to Set Up a Lab and Management of Resources and Personnel"

American Association of Pharmaceutical Scientists – Atlanta, Georgia, November 18th, 2008
Symposium Title: Sigma Receptors: Viable Therapeutic Targets for Medication Development
Talk title: "Sigma Receptors and Cancer"

American Association for Cancer Research 2009 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research
Denver, Colorado – April 20th, 2009
"How to Set Up a Lab and Management of Resources and Personnel"

American Association for Cancer Research 2010 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research
Washington, D.C. – April 19th, 2010
"How to Set Up a Lab and Management of Resources and Personnel"

American Association for Cancer Research 2011 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research

Orlando, Florida – April 4th, 2011
"How to Set Up a Lab and Management of Resources and Personnel"

American Association for Cancer Research 2012 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research
Chicago, Illinois – April 2nd, 2012
"How to Set Up a Lab and Management of Resources and Personnel"

American Association for Cancer Research 2013 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research
Washington, DC – April 2013
"Tenure Track/Research Track"

American Association for Cancer Research 2014 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research
San Diego, California – April 7th, 2014
"How to Set Up a Lab and Management of Resources and Personnel"

Society for Neuroscience Professional Development Committee
Career Development Topics: A Networking Event
Washington, D.C. - November 15, 2014
"Managing Laboratory Resources"

American Association for Cancer Research 2015 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research,
Philadelphia, PA – April 2015
"How to Set Up a Lab and Management of Resources and Personnel"

Society for Neuroscience Professional Development Committee
Career Development Topics: A Networking Event
Chicago, IL - October 2015
"Managing Laboratory Resources"

American Association for Cancer Research 2016 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research
New Orleans, LA – April 2016
"How to Set Up a Lab and Management of Resources and Personnel"

Society for Neuroscience Professional Development Committee
Career Development Topics: A Networking Event
San Diego, CA – November 2016
"Managing Laboratory Resources"

American Association for Cancer Research 2017 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research
Washington, DC – April 2017
"How to Set Up a Lab and Management of Resources and Personnel"

American Association for Cancer Research 2018 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research
Chicago, IL – April 2018
"How to Set Up a Lab and Management of Resources and Personnel"

Society for Neuroscience – 2018 Annual Meeting
The Third International Symposium on Sigma-2 Receptors: Role in Health and Disease
November 3, 2018 - San Diego, CA
"Differential Sigma-2 Receptor/TMEM97-Mediated Cytotoxic and Metabolic Stimulative Properties of Monovalent and Bivalent SN79 Analogs"

Society for Neuroscience – 2019 Annual Meeting
The Fourth International Symposium on Sigma-2 Receptors: Role in Health and Disease
October 18, 2019 – Loyola University, Maywood, IL
"Characterization of Sigma-2 Receptor Ligand-induced Metabolic Stimulation in Human SK-N-SH Neuroblastoma Cells"

American Association for Cancer Research 2020 Annual Meeting – MICR Professional Advancement Roundtable: Navigating the Road to a Successful Career in Cancer Research
Held virtually due to COVID-19 pandemic - June 2020
"How to Set Up a Lab and Management of Resources and Personnel"

Society for Neuroscience – 2020 Annual Meeting (held virtually as a "Neuroscience Connectome Event" January 2021)
The Fifth International Symposium on Sigma-2 Receptors: Role in Health and Disease
January 13-15, 2021
Panel II: Sigma-2 Receptors in Oncology and Diseases of the Periphery – January 14, 2021
*"Sigma-2 Receptor Ligand-Induced Programmed Cell Death Mechanisms in Triple Negative Breast Cancer"*
Panel III: Moderator, Sigma-2 Receptors Nomenclature Committee – January 15, 2021
*"Discussions on Nomenclature: The Necessary Evil"*

American Association for Cancer Research 2022 Annual Meeting – MICR Professional Advancement Reception and Roundtable: Navigating the Road to a Successful Career in Cancer Research
New Orleans, LA – April 11, 2022
"How to Set Up a Lab and Management of Resources and Personnel"

American Association for Cancer Research 2022 Annual Meeting – Professional Advancement Session Panel Discussion; *"Building an Effective Mentorship Team: Essential Strategies at Every Stage in Your Career"*
New Orleans, LA – April 12, 2022

**f. Patents**

Patents and Pending Patent Applications:

de Costa, B. R., Rice, K. C., Gray, N. M., Contreras, P. C., Jacobson, A. E., Thurkauf, A. E., Radesca, L. A., and Bowen, W. D.: Nitrogen-Containing Cyclohetero Cycloalkylaminoaryl Derivatives for CNS Disorders. U. S. Patent Number: 5,130,330; Date of patent issue: July 14, 1992, Filed January 31, 1990.

Bowen, W., de Costa, B. R., Dominguez, C., He, X.-S., Rice, K. C.: Nitrogen-Containing Cyclohetero Cycloalkylaminoaryl Derivatives for CNS Disorders. U. S. Patent Number: 5,346,908; Date of patent issue: September 13, 1994, Filed June 25, 1992, 13 pages (Application Case No. 2697, Searle-Monsanto).

de Costa, B. R., Bowen, W. D., He, X.-S., Radesca, L., Rice, K. C: Nitrogen-Containing Cyclohetero Alkylamino Aryl Derivatives for CNS Disorders. U. S. Patent Number: 5,571,832; Date of patent issue: November 5, 1996, Filed June 20, 1994, 16 pages.

Bowen, W., de Costa, B.R., Dominguez, C., He, X.-S., Rice, K.C.: Nitrogen-Containing Cyclohetero Cycloheteroaminoaryl Derivatives for CNS Disorders. U.S. Patent Number: 5,656,625; Date of patent issue: August 12, 1997, Filed May 17, 1995, 16 pages.

Bowen, W. D., de Costa, B. R., Dominguez, C., He, X.-S., and Rice, K. C: Aralkyl Bridged Diazabicycloalkane Derivatives for CNS Disorders. U. S. Patent Number 5,679,673; Date of patent issue: October 21, 1997, Filed Nov. 21, 1994, 13 pages.

Bowen, W. D., de Costa, B. R., Dominguez, C., He, X.-S., and Rice, K. C: Aralkyl Diazabicycloalkane Derivatives for CNS Disorders. U. S. Patent Number 5,679,679; Date of patent issue: October 21, 1997, Filed December 2, 1994, 15 pages.

de Costa, B. R., Rice, K. C., Gray, N. M., Contreras, P. C., Jacobson, A. E., Thurkauf, A., Radesca, L. A., Bowen, W. D., Walker, J. M.: Nitrogen-Containing Cyclohetero Cycloalkylaminoaryl Derivatives for CNS Disorders. U. S. Patent Number 5,739,158; Date of patent issue: April 14, 1998, Filed as continuation-in-part to U. S. Patent Number 5,130,330.

Bowen, W.D., de Costa, B. R., Dominguez, C., He, X.-S., Rice, K. C.: Nitrogen-Containing Cyclohetero Cyclo-Heteroaminoaryl Derivatives for CNS Disorders. U. S. Patent Number 5,856,318; Divisional application to U. S. Patent Number: 5,656,625, Date of patent issue: January 5, 1999, Filed August 11, 1997.

John, C. S., Baumgold, J., McAfee, J. G., Moody, T., Bowen, W.: Methods for Cancer Imaging and Therapy Using Benzamine Compounds. U. S. Patent Number 5,911,970, (continuation-in-part of application serial number 08/058,628); Date of patent issue: June 15, 1999, Filed April 21, 1995.

Bowen, W., de Costa, B.R., Dominguez, C., He, X.-S., Rice, K.C.: Aralkyl Diazabicycloalkane Derivatives for CNS Disorders. U. S. Patent Number 5,958,920; Divisional application to U. S. Patent Number 5,679,679, Date of patent issue: September 28, 1999, Filed October 20, 1997.

John, C. S., Baumgold, J., McAfee, J. G., Moody, T., Bowen, W.: Benzamide Compounds for Cancer Imaging and Therapy. U. S. Patent Number 5,993,777, Date of patent issue: November 30, 1999, Filed June 6, 1995, (continuation-in-part of application No. 08/426,366, April 21, 1995, which is a continuation-in-part of application No. 08/058,628, May 6, 1993, abandoned).

John, C.S., Baumgold, J., McAfee, J.G., Moody, T., and Bowen, W.: Benzamide Compounds Containing a Heterocyclic Ring for Tumor Imaging and Therapy. U. S. Patent Number 6,015,543, Date of patent issue: January 18, 2000, Filed June 6, 1995, (continuation-in-part of application No. 08/426,366, April 21, 1995, Pat. No. 5,911,970, which is a continuation-in-part of application No. 08/058,628, May 6, 1993, abandoned)

de Costa, B. R., Bowen, W. D., He, X.-S., Radesca, L., Rice, K. C.: Nitrogen-Containing Cyclohetero Alkylamino Aryl Derivatives for CNS Disorders. Divisional application to U. S. Patent Number: 5,571,832, Filed August 11, 1997.

de Costa, B. R., Bowen, W. D., Dominguez, C., He, X.-S., and Rice, K. C.: Nitrogen-Containing Cyclohetero Alkyl Fused Cycloaminoaryl Derivatives for CNS Disorders. U. S. Patent Application Case No. 2744, 1992 [Searle-Monsanto]. Pending.

Bowen, W., de Costa, B.R., Dominguez, C., He, X.-S., and Rice, K.C.: Aralkyl Diazabicycloalkane Derivatives for CNS Disorders. U.S. Patent Number 6,310,064, Date of patent issue: October 30, 2001, Filed July 6, 1999, application No. 09/347,659.

John, C.S., Baumgold, J., McAfee, J.G., Moody, T., and Bowen, W.: Benzamide Compounds for Cancer Imaging and Therapy. U.S. Patent Number 6,447,748; Date of patent issue: September 9, 2002; Application number 3857115; Filed August 30, 1999.

John, C.S., Baumgold, J., McAfee, J.G., Moody, T., and Bowen, W.: Compounds for Cancer Imaging and Therapy. U.S. Patent Number 6,517,811; Date of patent issue: February 11, 2003; Application number 09/755,366; Filed January 5, 2001.

Crawford, K.W. and Bowen, W.D.: Potentiation of Antineoplastic Agents Using Sigma-2 Ligands. Filed May 8, 2001. Pending.

Crawford, K.W., Bowen, W.D., and Hildreth, J.E.: Sigma-2 Receptor Agonists and Their Use in the Treatment of HIV Infection. Filed January 2003. Pending.

<u>Invention Reports and Disclosures to NIDDK Office of Technology Transfer:</u>

Bowen, W.D., John, C.S., and Vilner, B.J. Sigma Receptor-Specific Ligands for Tumor Diagnostic and Therapeutic Applications. NIH Employee Invention Report, February, 1994.

Carroll, F.I., Mascarella, W.S., Bowen, W.D. Sigma Ligand for Use as Radiopharmaceuticals for Tumor Diagnosis. Invention Disclosure, Research Triangle Institute, 1995.

Bowen, W.D. and Vilner, B.J. Sigma Receptor Ligands as Anti-Tumor Agents. NIH Employee Invention Report.

Crawford, K.W. and Bowen, W.D. Sigma Receptor Ligands as Chemosensitizing Agents for Cancer Therapy. NIH Employee Invention Report, April, 1999.

Crawford, K.W., Bowen, W.D., and Hildreth, J.E. Sigma-2 Receptor Agonists in Treatment of HIV Infection. NIH Employee Invention Report.

## 6. RESEARCH IN PROGRESS

Research in this laboratory is directed at elucidation of the structure and function of sigma receptors. Sigma receptors (formerly classified as opioid receptors) are membrane-bound proteins that recognize several important classes of psychotropic drugs, including antipsychotic agents such as haloperidol, the psychotomimetic agent phencyclidine (PCP), some synthetic opiates such as pentazocine, and some psychostimulants like cocaine. Sigma-1 and sigma-2 receptor subtypes are currently known, and comprise a novel, pharmacologically defined receptor family distinct from any known neurotransmitter or hormone receptor system. Both subtypes are present in the CNS as well as in peripheral tissues, and are expressed in high density in a number of neuronal and non-neuronal tumor cell lines. No endogenous ligands for these receptors have yet been clearly identified, although there is existing evidence for such substances and progesterone and other neurosteroids have been shown to interact with sigma-1 receptors.

Most work in our laboratory currently focuses on the possible role of sigma-2 receptors in regulation of cell proliferation and survival. We have found that chronic activation of sigma-2 receptors induces apoptosis in a wide variety of cell types. We are investigating the signaling mechanisms leading to the induction of cell death, and have found that these mechanisms are cell type-specific. For example, in breast tumor cells, apoptosis occurs via a novel mechanism that is both caspase- and p53-independent, whereas in neuroblastoma, cell death is dependent on caspase 8/10 activation. Signaling involves both transient and sustained changes in cytosolic calcium levels. We are interested in determining the mechanisms of calcium flux and the downstream effects of these calcium signals. Signaling also involves changes in cellular sphingolipids (ceramides and lysosphingolipids). Sphingolipids are involved in myriad cellular processes including cell survival, regulation of ion channels, and cell-cell recognition. Lysosphingolipids act via specific G-protein coupled receptors on the cell surface, as well as through certain intracellular targets, and ceramides are known to modulate the activity of various protein kinases and phosphatases involved in cell growth. We are investigating the role of sphingolipid signaling in neuronal and non-neuronal cells and how this system interfaces with sigma-2 receptors. Also under investigation are effects of sigma-2 receptor activation on mitochondria. Apoptosis in both neuronal and non-neuronal cell types appears to involve loss of mitochondrial membrane potential and release of mitochondrial apoptogenic factors. The roles of mitochondrial pro- and anti-apoptotic Bcl-2 family proteins are under study.

The study of a series of SN79 analogs has revealed a previously unknown function of the sigma-2 receptor. Some ligands in this series induce programmed cell death by mechanisms described above. However, other ligands induce no apparent change in cell viability, but rather appear to stimulate hallmarks of glycolytic cellular metabolism. This is initially evidenced by an increase in reduction of MTT dye, an effect blocked by sigma-2 antagonists. We have shown that ligands in this class induce an increase in ATP levels, a decrease in basal ROS level, and stabilization of HIF1α with subsequent induction of VEGF expression. These results suggest that sigma-2 receptors may play some role in regulating the Warburg effect (aerobic glycolysis) and enhancing the ability of cancer cells to survive in hypoxic environment. This effect would be consistent with the upregulation of sigma-2 receptors in cancer cells. We are investigating additional sigma-2 receptor-mediated changes in metabolic endpoints and attempting to elucidate upstream signaling mechanisms leading to this metabolic effect.

The sigma-2 receptor, a 21.5 kDa lipid raft protein, has recently been identified as the known protein, TMEM97. While little is known about the function of TMEM97, this discovery has made available molecular tools with which to study sigma-2R/TMEM97 and will greatly facilitate further studies of this receptor and its role in normal and cancer cell biology.

The sigma-1 receptor has been cloned and is a 25 kDa polypeptide. It's x-ray crystal structure reveals one transmembrane domain and a homotrimeric structure. In contrast to sigma-2 receptors, activation of sigma-1 receptors appears to exert protective and perhaps trophic effects on neurons and other cell types. Others have shown that activation of sigma-1 receptors potentiates neurite outgrowth in culture, whereas we have shown that activation of sigma-2 receptors causes neurite retraction. Blockade of sigma-1 receptors by selective antagonists or antisense deoxyoligonucleotides has been shown to block the toxic effects of cocaine, a psychotropic agent that binds to sigma-1 receptors. Furthermore, sigma-1 receptor activation in the hippocampus has a cognitive enhancing effect. Sigma-1 receptors regulate calcium signaling by amplifying release of calcium from the endoplasmic reticulum in response to the rise in $IP_3$ via GPCR activation. The sigma-1 receptor appears to signal solely by protein-protein interactions. The liganded receptor binds to ankyrin in the ER membrane and relieves a tonic inhibition of the $IP_3$ receptor that is imparted by its interaction with ankyrin. We have shown that stable overexpression of sigma-1 receptors induces a constitutive activation of the $IP_3$ receptor in human MCF-7 breast tumor cells, which are normally devoid of sigma-1 receptors. Our studies using various receptor constructs showed that only the C-terminal segment of the receptor is required for this effect. Furthermore, cells overexpressing active sigma-1 constructs proliferate more rapidly than untransfected cells and have a survival advantage. We are investigating the signaling mechanisms that are involved in inducing what appears to be a more highly aggressive phenotype. The studies suggest that the sigma-1 receptor could be a biomarker for assessing proliferative status of tumor cells.

We are involved in the design and synthesis of novel small molecule ligands for sigma-1 and sigma-2 receptors. Since the natural ligand(s) is unknown and many existing sigma ligands interact with other receptors, selective synthetic probes for sigma receptors are necessary. Through close collaboration with medicinal chemists, we have developed and are continuing to develop highly selective receptor agonists and antagonists for use as tools to study receptor function. We are interested in elucidating the structural features of ligands that determine binding affinity, impart subtype selectivity, and that specify agonist/antagonist properties. Some of these compounds may have clinical potential as therapeutic agents.

Studies of sigma receptors will shed light on novel modes for regulation of cell proliferation and survival. It may be possible to target sigma-2 receptors with agonists or sigma-1 receptors with antagonists to induce apoptosis in tumors rendered drug-resistant due to acquisition of mutations in key components of the classical apoptotic pathway, such as p53 and caspases. Also, the potential role of sigma-2 receptors in cancer cell metabolism may lead to other targets to induce cell death. Sigma receptors in the CNS could conceivably play a role in neurodegenerative disorders. Furthermore, since typical neuroleptics such as haloperidol activate sigma-2 receptors, these studies may have important implications for treatment of psychiatric disorders with respect to the debilitating motor side effects induced by these agents.

## 7. SERVICE

### a. Service to University

Co-Director of Molecular Pharmacology and Physiology Graduate Program,
Division of Biology and Medicine – 2005-2009

Academic advising:

Human Biology Concentration Advisor (Health and Disease/Brain and Behavior) – 2004-present

Primary research advisor to three Molecular Pharmacology and Physiology Ph.D. students

Primary research advisor to one Biomedical Engineering and two Biotechnology Masters students

Served or serving on Thesis Committees of graduate students in Molecular Pharmacology and Physiology, Neuroscience, Molecular and Cell Biology, Pathobiology, Chemistry, or Psychology graduate programs since 2005

Research advisor or mentor (Independent Study or Honors Thesis) to 31 undergraduates at Brown University between 1983-1991 and 33 undergraduate students 2004-present, 24 of whom have publications in refereed journals and 4 having book chapter publications.

Mentored 13 undergraduates at NIH (Summer Internship or MARC Program)

Advisor to 12 postdoctoral fellows over past 10 years (6 at Brown since 9/1/04).

Hilary Nicolson (MPP Graduate Program) – who completed her degree in May 2016 was recipient of the Joukowsky Outstanding Dissertation Prize for her thesis entitled ***"A Matter of Life and Death: Novel Ligands Mediating Cytotoxic Function and Revealing Metabolically Stimulative Function of the Sigma-2 Receptor in Human Cancer"***

Committees:

Dean's Advisory Council on Faculty Diversity, 2/05 – 2008

Howard Hughes Medical Institute, Undergraduate Science Education Proposal Action Committee, 5/05

Dean's Action Committee on Associate Dean for Graduate Student and Postdoctoral Training Position, 6/05

Dean's Search Committee for Associate Dean for Graduate Student and Postdoctoral Training Position, 9/05

Provost's Search Committee for Vice President of Research, 2006

Institutional Animal Care and Use Committee, 7/1/05 – 11/30/08

Medical Curriculum Committee, 7/1/06 – 2008

MPPB Physiologist Search Committee, 10/1/06 – 3/1/07

Proteomics and Protein Biophysics Search Committee, 10/10/06 – 4/1/07

Dean's Working Group on the Graduate School, 2007-2008

Provost's Department Chairs Agenda Committee, 2008 – 2009

Center for Genomics and Proteomics Search Committee Chair – Structural Biologist, 2008 – 2009

Center for Cardiovascular Research Search Committee – Electrophysiologist, 2010- present

Center for Genomics and Proteiomics Search Committee – Bioinformaticist, 2011 – present

President's Search Committee for Brown University Provost – 2010-2011

MPPB Structural Biology Search Committee (NMR spectroscopist) – 2011-2012

Provost's Search Committee for Dean of Medicine and Biology – 2012-2013

President's Deficit Reduction Committee – 2014-2015

NEASC Steering Committee – 2016 – 2018

Search committee for Chairman of Department of Pathology and Laboratory Medicine – 2016-2017

Search committee for Associate Dean of Minority Affairs, Alpert Medical School – 2016

Provost's Visiting Professor Program Committee – 2016 - present

Molecular Pharmacology and Physiology Graduate Program Steering Committee

Brown University Core Facilities Advisory Committee – 2017 – present

Tenure Committee for Chairman of Department of Pathology and Laboratory Medicine – 2017-2018

Alpert Medical School Committee on Diversity and Inclusive Teaching & Learning (formerly known as Race in Medicine Task Force) – 2016 – present

Chemistry Department Full Professor Promotion Committee – Prof. Jason Sello - 2018

Chemistry Department Search Committee – senior hire – 2018 – 2019

MPPB Education Committee - 2020

Research Achievement Awards Committee – 2021

**b. Service to Profession**

Ad Hoc Reviewer for Scientific Journals:

ACS Medicinal Chemistry
Biochemical Pharmacology
Bioorganic and Medicinal Chemistry Letters
Brain Research
Canadian Journal of Physiology and Pharmacology
Cancer Research
Chemical and Engineering News
eLife
European Journal of Cancer
European Journal of Pharmacology
Expert Opinion on Therapeutic Targets
Journal of the American Chemical Society
Journal of Biological Chemistry
Journal of Experimental Zoology
Journal of Medicinal Chemistry
Journal of Neurochemistry
Journal of Neuroimmunology
Journal of Neuroscience
Journal of Pharmacology and Experimental Therapeutics
Life Sciences
Molecular Imaging and Biology
Molecular Pharmacology

Neuropeptides
Neuropharmacology
Neurotoxicology and Teratology
Peptides
Pharmacogenomics Journal (The)
Pharmacology Letters
Pharmacology & Therapeutics
Proceedings of the National Academy of Sciences
Scientific Reports
Trends in Pharmacological Sciences

Consulting and Advisory Committees:

Ad hoc conference review for the New York Academy of Sciences

Ad hoc reviewer, Advisory Board for the Alzheimer's Disease and Related Disorders Program, state of Missouri

SK Corporation, Bio-Pharmaceutical R & D Center, Scientific Advisory Board (1999 – 2002)

Mitsubishi Chemical America, Pharmaceutical Development Center, Scientific Advisory Committee (2001 - 2003)

External Advisory Committee – Research Centers in Minority Institutions Grant; Morgan State University (2001 – present); Chair 8/1/06 - present

External Advisory Committee – SCORE Program; Hunter College, City University of New York (2003 – 2007)

External Advisory Committee – MBRS/SCORE Program; Florida A&M University (2005 - present)

Gerson Lehrman Group Council of Consultants (2006 – present)

Scientific Advisory Board, Affichem Pharmaceuticals (2006 – present)

American Association for Cancer Research - Minorities in Cancer Research (MICR) Travel Fellowship Selection Committee – 2010

NIGMS Strategic Plan Stakeholders Meeting – Strategic Plan for Biomedical and Behavioral Research Training (July 25, 2011)

American Association for Cancer Research - Minorities in Cancer Research (MICR) Council – 2011 - 2016
Co-Chair, AACR-MICR Minority Serving Institutions Faculty Scholar in Cancer Research Award Committee
Co-Chair, AACR-MICR Distinguished Lectureship Series Committee

Society for Neuroscience – Professional Development Committee – 2012 - 2015

AACR-MICR Minority Serving Istitutions Faculty Scholar in Cancer Research Award Committee – 2016 – present

HistoryMakers *ScienceMakers* Advisory Committee – 2016- present

Department of Biological Chemistry and Molecular Pharmacology, Harvard Medical School – Confidential Advisor in a promotion case – 2019-2020

Dean of Faculty of Medicine, Harvard Medical School – Ad hoc committee for a faculty promotion, 2020

Scientific Advisory Board, DeoBioSciences, Inc. - 2022 - present

Harvard Medical School – External Review Committee for Therapeutics Graduate Program – for May 2022

National Institutes of Health Study Sections**:**

1) Biochemistry Study Section, National Institute on Drug Abuse (Ad Hoc Member), June 1985

2) Cellular Neurobiology and Psychopharmacology Study Section, National Institute of Mental Health (Regular Member), 1989 - 1991

3) Neuropharmacology and Neurochemistry Review Committee, National Institute of Mental Health (Regular Member), 1992

National Institutes of Health Committees (Intramural):

1) Tenure Track Search Committee - Metabolic Diseases Branch, NIDDK (1994 - 1995)

2) Pharmacology Research Associate (PRAT) Program Advisory Committee, NIGMS (1995 - 2001)

3) Tenure Track Search Committee - Laboratory of Biochemistry, NCI (1996 - 1997)

4) Minority Affairs Advisory Committee, NIDDK (1996 - 2004)

5) NIDDK Renal Physiologist Search Committee (1997)

6) Continuing Medical Education (CME) Advisory Committee (1998 - 2001)

7) Tenure Track Search Committee - Laboratory of Bio-organic Chemistry, NIDDK (1999)

8) Chair, Department of Pharmacology and Toxicology, NIH-Foundation for Advanced Education in the Sciences (FAES) Graduate School (1999 – 2004)

9) NIH Black Scientists Association -
Co-chair, Membership and Communications Committee (1997 – 2004)
Speakers Bureau (1998 – 2001)

**8. Academic honors, research grants, fellowships, honorary societies**

**a. Honors and Awards:**

Dean's List Morgan State College (1970-74)
Promethean Kappa Tau Freshman Honor Society (1971)
Most Outstanding Sophomore Chemistry Major Award (1972)
Analytical Chemistry Award (1973)
Beta Kappa Chi National Scientific Honor Society (1973)
Alpha Kappa Mu National Honor Society (1973)
Graduated Morgan State College Summa Cum Laude (1974)
Outstanding Young Men of America (1986)
Men of Achievement (1989)
Delivered Biology Concentration Commencement Address, Brown University (1990)
*Ad Eundem* Honorary Degree, Brown University (1990)
Recognition Award, Daniel Hale Williams Medical Society and Office of Minority Medical Affairs, Brown University Division of Biology and Medicine (May 1991)
Sterling's Who's Who (1996)
Award of Appreciation, Keynote Address, Science-Mathematics-Engineering Fair, Morgan State University (March 23, 1996)
Certificate of Appreciation, Student and Teacher Internship Program, Howard Hughes Medical Institute, Montgomery County Public Schools, and National Institutes of Health (1996-1997)
Certificate of Recognition, NIH Speakers Bureau, National Institutes of Health (June 12, 2000)
Special Recognition Award, Discussion with a Scientist Series, Undergraduate Scholarship Program, National Institutes of Health (2000)
Award of Recognition for Research in Receptor Biochemistry and Pharmacology, Keynote Address, Undergraduate and Graduate Science Research Symposium, Morgan State University (April 18, 2002)
President, NIH Black Scientists Association (2001)
Nominated for AACR-Minorities in Cancer Research – Jane C. Wright Lectureship Award
Named among the 700 most cited scientists by Institute for Scientific Information (2006 – present)
Jack and Linda Gill Lecturer - Indiana University, February 19, 2007
Named Upjohn Professor of Pharmacology by Brown University Corporation (May 28, 2008)
Ralph J. Cazort Lecturer – Meharry Medical College, March 30, 2011
The History Makers: "Science Makers" - archived biographical interview, October 9, 2012
http://www.thehistorymakers.com/biography/wayne-bowen

Charles H. Wright Museum of African American History - Detroit, Michigan: biography featured in ongoing exhibition entitled "Inspiring Minds: African Americans in Science and Technology"
Listed by Thomson Reuters-Research Analytics among the 17 most highly cited researchers at Brown University: http://researchanalytics.thomsonreuters.com/institution/brown-university.html
Featured on Brown University home page highlighting sigma-2 discovery – https://news.brown.edu/articles/2015/11/sigma2

**b. Research Grants**

**I. Past Support (1983 – 2004):**

a. Completed Intramural Research Support

NIH/NIDDK Intramural Research Program 09/1991 – 08/2004
PI: W.D. Bowen
*Structure and Function of Sigma Receptors*

b. NIH Grants (while at Brown before move to NIH intramural program in 1991)

National Institute on Drug Abuse
"Identification and Analysis of Opiate Receptor Proteins"
R01 DA03776
Principal Investigator: Wayne D. Bowen (33.3% effort)
6/1/85 - 3/31/92
To purify and structurally analyze kappa opiate receptors.

Division of Research Resources
BRS Shared Instrumentation Grant
S10 RR03381-01
"Peptide Synthesizer and Peptide Sequencer"
Principal Investigator: Wayne D. Bowen
4/1/87 - 3/31/88: $101,000
Used to establish a macromolecular biochemistry core facility at Brown University.

National Institute of Neurological Disorders and Stroke
"Role of Sigma Receptors in Movement Disorders"
R01 NS26746
Principal Investigator: Wayne D. Bowen (33.3% effort)
12/1/88 - 11/30/91
To study biochemical systems modulated by sigma receptors *in vitro* and physiological systems modulated by these receptors *in vivo*, with particular emphasis on the role of sigma receptors in dystonia

National Institute on Drug Abuse
"Sigma Opiate Receptor Pharmacology"
R01 DA04988

Principal Investigator: J. Michael Walker
Co-Principal Investigator: Wayne D. Bowen (10% effort)
10/1/88 - 8/31/91
Studies of the basic pharmacology of the sigma receptor, including studies of its regulation by chronic neuroleptic treatment and verification of *in vitro* and *in vivo* models of sigma activity.

National Institute on Drug Abuse
"Development of Selective Sigma Receptor Ligands"
R01 DA05721
Principal Investigator: Frank I. Carroll, Research Triangle Institute
Co-Principal Investigator: Wayne D. Bowen (5% effort with Brown University Subcontract)
9/1/89 - 8/31/92
To conduct computer modelling studies for prediction of structural requirements for drugs specific to the sigma receptor.

Division of Research Resources
BRS Shared Instrumentation Grant
"Molecular Graphics Workstation"
Principal Investigator: J.W. Suggs, Department of Chemistry, Brown University
7/89 - 6/90
$83,000 (no salary, no supplies)
To establish workstations for molecular modelling studies.

c. Collaborations on NIH grants (named as "Collaborator" under personnel after move to NIH intramural program in 1991):

National Institute on Drug Abuse
"Development of Selective Sigma Receptor Ligands"
R01 DA05721
Principal Investigator: Frank I. Carroll, Research Triangle Institute,
Department of Chemistry and Life Sciences
Collaborator: Wayne D. Bowen
9/1/92 - 3/31/99
Design of potent and selective sigma ligands based on the benzomorphan structure, with particular emphasis on design of sigma-2-selective compounds.

National Institute of Mental Health
"Sigma Receptor Subtypes and Motor Side Effects"
R29 FIRST Award, MH50564
Principal Investigator: Rae Matsumoto, University of Oklahoma Health Sciences Center,
Department of Pharmacology and Toxicology, College of Pharmacy
Collaborators: Wayne D. Bowen and Brian R. de Costa
To study the role of sigma receptor subtypes in the cerebellorubro-spinal motor system and to characterize the action of putative sigma agonists and antagonists in this system.

National Cancer Institute
"Novel Diagnostic Agents for Imaging Malignant Melanoma"
R29 FIRST Award (R29 CA58496)
Principal Investigator: Christy John, George Washington University Medical Center,
Division of Nuclear Medicine
Collaborator: Wayne D. Bowen
5/94 - 4/99
To develop new radiodiagnostic agents for imaging human malignant melanoma micro-metastasis using SPECT and PET. To investigate the utility of sigma receptors as tumor markers for radioimaging.

National Cancer Institute
"Sigma Receptor-Specific Radiopharmaceuticals for Imaging Human Tumors"
R01 CA70784
Principal Investigator: Christy John, George Washington University Medical Center,
Division of Nuclear Medicine
Collaborator: Wayne D. Bowen
7/1/97 - 6/30/00
To develop non-invasive SPECT imaging agents for human breast cancer.

National Institute on Drug Abuse
"Sigma Ligands for the Treatment of Cocaine Overdose"
Principal Investigator: Rae Matsumoto, University of Oklahoma Health Sciences Center,
Department of Pharmacology and Toxicology, College of Pharmacy
Collaborator: Wayne D. Bowen
To investigate the ability of sigma antagonists to attenuate the toxic effects of cocaine and to develop potential compounds for treatment.

d. Past Support: Brown University, Private Foundations, Industry (1983-1991)

Biomedical Research Support Grant (Brown University)
"The Opiate Receptor: Identification and Purification of Ligand Binding Subunits"
Principal Investigator: Wayne D. Bowen
7/1/83 - 3/31/84 $2,000

Rhode Island Foundation
"Multiple Opiate Receptor Types: Purification of Ligand Binding Sites and Analysis of Subunit Structure"
Principal Investigator: Wayne D. Bowen
7/10/84 - 7/10-85 $3,180

Rhode Island Foundation
"Multiple Opiate Receptor Types: Purification of Ligand Binding Sites and Analysis of Subunit Structure"
Principal Investigator: Wayne D. Bowen
7/10/85 - 7/10-86 $3,500

Biomedical Research Support Grant (Brown University)
"The Biochemical Role of Opiates and Opioid Peptides in the Central Nervous System"
Principal Investigator: Wayne D. Bowen
4/1/85 - 3/31/86 $5,500

Biomedical Research Support Grant (Brown University)
"Effect of Opiates on Phosphoinositide Metabolism and Protein Kinase C Activity in Rat Brain"
Principal Investigator: Wayne D. Bowen
4/1/86 - 3/31/87 $3,500

Dystonia Medical Research Foundation
"Sigma Receptors and Dystonia"
Principal Investigators: Wayne D. Bowen and J.M. Walker (J.M.W.; Department of Psychology, Brown University)
3/1/87 - 2/28/89: $26,617 first year, $27,109 second year, direct costs only; no salary.
To study sigma ligand-induced alterations in motor function and alterations in binding properties of sigma receptors in mutant dystonic rats.

Biomedical Research Support Grant (Brown University)
"Modulation of Agonist-Stimulated Phosphoinositide Turnover by Sigma Receptors in Brain and PC12 Cells"
Principal Investigator: Wayne D. Bowen
6/1/88 - 8/31/88 $6,837
To investigate the possibility of functional sigma receptor heterogeneity by comparison of phophoinositide modulation in brain and PC12 cells.

Monsanto-Searle Pharmaceuticals
Joint Research Collaborative Agreement Between Brown, NIH, and Monsanto-Searle
$5,000
To characterize novel ligands for sigma and PCP receptors in biochemical assay systems.

2007 Salomon Award, Office of Vice President for Research, Brown University 2007 - 2008
PI: W.D. Bowen
*"Correlation of Sigma-1 Receptor Expression and Function with Indicators of Tumor Aggressiveness and Metastatic Potential"* - $15,000

**II. Past Support (2004 – ):**

National Institute on Drug Abuse
R21DA022326-01A2 04/01/08 - 03/31/11
PI: W. Peti; Co-PI: W.D. Bowen
*"Structure of the Sigma-1 Receptor"*
The major goals of this project are to determine the solution structure of the sigma-1 receptor using NMR spectroscopy and to delineate the functional domains.

RI-STAC 01/01/10 – 6/30/11
PI: J.N. Jacobs, Organomed Corporation
PI: W.D. Bowen, subaward
"Development of Novel Agents for Cancer Prevention and Therapy from the Natural Spice Turmeric"
Total Project Award: $200,000
Subaward: $80,000
The goals of this project are to isolate, purify, and characterize curcumin-unrelated compounds from extracts of turmeric spice with the purpose of developing novel anticancer agents.

National Institute of General Medical Sciences
1-T32 GM077995-01A2 7/1/10 – 6/30/15
Predoctoral Training Program in Transdisciplinary Pharmacological Sciences
(PI: Edward Hawrot); Role: Trainer

National Institute of General Medical Sciences
1-T32 GM077995-01A2
Predoctoral Training Program in Transdisciplinary Pharmacological Sciences
(PI: Oancea, E.); Role: Trainer

National Institute on Drug Abuse T32 Postdoctoral Training Grant
5T32DA016184-09
Substance Abuse Intervention/Outcome Research Training
(PI: Demaris Rohsenow); Role: Trainer

**III. Current Support:**

Research support:

Brown University Division of Biology and Medicine
Start-up funds – 9/1/04 – present

Upjohn Professor of Pharmacology endowment support 05/08 - present

Training grants:

**1)** 1-T32 GM139793-01 07/01/2021 – 06/30/2026
Interdisciplinary Training in Pharmacological Sciences (Predoctoral)
(MPI: Wayne Bowen, Elena Oancea, Anita Zimmerman); Role: Trainer

Funds from this grant are used to train graduate students in the basic principles of pharmacology and in the application of pharmacological principles and methodologies in the study of sigma-2 receptors.

**2)** T32GM136566-02 07/01/10 – 6/30/2025
Interdisciplinary and Inclusive Predoctoral Training in Molecular, Cellular, and Biochemical Sciences
(PI: Kimberly Mowry, Mark Johnson, Erica Larschan); Role: Trainer

Funds from this grant are used to train graduate students in the application of cell and molecular biology approaches to the study of sigma-2 receptors.

**3)** T32MH020068-21 07/01/1999 – 08/31/2026
Interdisciplinary Predoctoral Neuroscience Training Program in the Neuroscience Graduate Program (PI: David Sheinberg, Diane Lipscombe); Role: Trainer

Funds from this grant are used to train graduate students in the role of sigma receptors in the brain, with an eye towards potential targeting for treatment of neurological disorders.

**c. Scholarships and Fellowships:**

Undergraduate:

Morgan State College Scholarships (1971-73)
Chemistry Department Scholarship (1971)
Chemistry Honors Scholarship (1974)

Graduate:

Smith, Kline and French Graduate Scholarship (1974)
National Research Service Award (1975)
Nabrit Fellowship (Ford Foundation) (1976-79)

**d. Membership in Professional Organizations:**

Society for Neuroscience (S*f*N)
American Association for Cancer Research (AACR)
Minorities in Cancer Research (MICR)
International Brain Research Organization/World Federation of Neuroscientists
NIH Black Scientists Association (BSA)
American Association for the Advancement of Science (AAAS)
International Narcotics Research Conference Member (INRC) (past)
New York Academy of Sciences (past)
American Chemical Society (past)

**9. TEACHING**

Current:
BIOL 2170: Molecular Pharmacology and Physiology (MPP Graduate Program Core Course)
BIOL 0030: Endocrinology; 5 lectures on Peptide Hormone Biosynthesis, Mechanisms of Hormone Action, and Neuroendocrinology
NEUR 0010: The Brain: An Introduction to Neuroscience; 2 lectures on Chemical Synaptic Transmission
BIOL 1950: Directed Research/Independent Studies (undergraduate)

BIOL 1960: Directed Research/Independent Studies (undergraduate)
NEUR 1970: Independent Study (undergraduate)
BIOL 2980: Graduate Independent Study
BIOL 3667: Integrated Medical Sciences III – System-Based Pharmacology; course Director
BIOL 3676: Integrated Medical Sciences IV – System-Based Pharmacology; course Director

Special Lectures:
Initiative to Maximize Student Development (IMSD) Training Module
"Scientific Writing: Key Principles for Writing Manuscripts, Abstracts, and Proposals"
2009-2013

Past:
BI 217 – Topics in Molecular Pharmacology and Physiology; course Director

Participation in other courses:
BI 110 – Cell Physiology and Biophysics
BI 217 (old name) – Receptors, Channels and Signaling
BN 204 – Advanced Molecular and Cellular Neurobiology
BIOL 1810 – 21st Century Applications of Cell and Molecular Biology

**10. DATE OF THE PREPARATION OF THE DOCUMENT:** 12/5/2022