

## CURRICULUM VITAE

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

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

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**2. HOME ADDRESS:**

**3. EDUCATION:**

B.S. 1974 Morgan State College, Baltimore, Maryland  
Major: Chemistry

Ph.D. 1981 Cornell University, Ithaca, New York  
Major: Biochemistry  
Minor: Neurobiology (Neuropharmacology)

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

**4. PROFESSIONAL APPOINTMENTS:**

5/74 - 8/74 Medicinal Chemist  
Smith, Kline and French Laboratories  
1500 Spring Garden Street  
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9/75 - 5/76 Teaching Assistant  
Cornell University  
Ithaca, New York

- 6/80 - 2/82  
NIH Postdoctoral Staff Fellow  
National Institute of Mental Health  
Biological Psychiatry Branch  
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NIH Postdoctoral Staff Fellow  
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Assistant Professor of Biology  
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Associate Professor of Biology  
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Chief, Unit on Receptor Biochemistry and Pharmacology (tenured)  
Drug Design and Synthesis Section  
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- Adjunct Professor of Molecular Biology, Cell Biology, and  
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- 9/04 – 10/07  
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|-----------------|---|
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## 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 <sup>3</sup>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<sup>2</sup>,Leu<sup>5</sup>,Cys<sup>6</sup>-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 [<sup>3</sup>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 [<sup>3</sup>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<sup>2</sup>,Leu<sup>5</sup>,Cys<sup>6</sup>]-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., Pradzick, 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 12<sup>th</sup> Camerino-Noordwijkerhout Symposium*. Pharmacology 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**

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  $^3\text{H-D-Ala}^2, \text{D-Leu}^5$ -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<sup>2</sup>, (F<sub>5</sub>)Phe<sup>4</sup>]-Dynorphin<sub>1-13</sub>-NH<sub>2</sub> (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<sup>2</sup>, Leu<sup>5</sup>, Cys<sup>6</sup>-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 ( $^3\text{H}$ 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  $^3\text{H}$ -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<sup>2</sup>,Leu<sup>5</sup>,Cys<sup>6</sup>]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 [<sup>3</sup>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<sup>2</sup>,Leu<sup>5</sup>,Cys<sup>6</sup>]enkephalin: Selective actions at the delta<sub>non-complexed</sub> site. *J. Pharmacol. Exp. Ther.* 255: 636-641, 1990.
40. de Costa, B.R. and Bowen, W.D. Synthesis and characterization of optically pure [<sup>3</sup>H](+)-azidophenazocine ([<sup>3</sup>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<sup>2</sup>,Leu<sup>5</sup>,Ser<sup>6</sup>]enkephalin (DALES): Antinociceptive actions at the delta<sub>non-complexed</sub>-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<sup>2</sup>,Leu<sup>5</sup>,Cys<sup>6</sup>]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<sup>2</sup>,Leu<sup>5</sup>,Cys<sup>6</sup>]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.
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95. Williams, W.E., Wu, R., de Costa, B.R., and Bowen, W.D. [<sup>3</sup>H](+)-Azido-phenazocine: Characterization as a selective photoaffinity probe for sigma-1 receptors. *Society for Neuroscience Abstracts 19: 1553, #638.17, 1993.*
96. Vilner, B.J. and Bowen, W.D. Sigma receptor-mediated morphological and cytotoxic effects on primary cultures of neurons. *College on Problems of Drug Dependence Abstracts, 1994.*
97. Torrence-Campbell, C. and Bowen, W.D. Differential solubilization of sigma-1 and sigma-2 receptors from rat liver membranes. *College on Problems of Drug Dependence Abstracts, 1994.*

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99. Bertha, C.M., Vilner, B.J., Bowen, W.D., and Rice, K.C. E-8-Benzylidene-2-methyl-5-phenylmorphans: Potent sigma receptor ligands with subtype selectivity. *American Chemical Society Abstracts*, 1994.
100. Zhang, Y., Bowen, W.D., Williams, W., He, X.S., de Costa, B.R., and Rice, K.C. Synthesis and receptor binding of some diamine compounds as sigma receptor ligands. *American Chemical Society Abstracts*, 1994.
101. John, C.S., Vilner, B.J., and Bowen, W.D. Development of sigma receptor-specific radiopharmaceuticals for SPECT imaging of human tumors. *American Chemical Society Abstracts*, Nucl. Chem., 1994.
102. John, C.S., Vilner, B.J., and Bowen, W.D. Synthesis and characterization of [<sup>125</sup>I]-N-(N-benzylpiperidin-4-yl)-4-iodobenzamide, a potential high affinity sigma ligand for imaging breast cancer. *American Chemical Society Abstracts*, Med. Chem., 1994.
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104. Bertha, C.M., Vilner, B.J., Williams, W., Rice, K.C., and Bowen, W.D. E-8-Benzylidene-2-methyl-5-phenylmorphans: A novel class of high affinity ligands which exhibit sigma-1 or sigma-2 subtype selectivity. *Society for Neuroscience Abstracts* 20: 746, #314.2, 1994.
105. Torrence-Campbell, C. and Bowen, W.D. Sigma-1 and sigma-2 receptors are differentially solubilized from rat liver membranes. *Society for Neuroscience Abstracts* 20: 747, #314.9, 1994.
106. Bowen, W.D. and Vilner, B.J. Sigma receptor-mediated morphological and cytotoxic effects on primary cultures of rat central and peripheral nervous system. *Society for Neuroscience Abstracts* 20: 747, #314.10, 1994.
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111. Vilner, B.J. and Bowen, W.D. Dual modulation of cellular calcium by sigma receptor ligands: Release from intracellular stores and blockade of voltage-dependent influx. *Society for Neuroscience Abstracts* 21: 1608, #631.3, 1995.
112. Joseph, D.B. and Bowen, W.D. Sigma-1 receptor-mediated inhibition of the muscarinic phosphoinositide response is associated with M1 receptor-G protein uncoupling. *Society for Neuroscience Abstracts* 21: 1608, #631.4, 1995.
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114. Zhang, Y., Williams, W., Rice, K.C., and Bowen, W.D. Characterization of novel N,N'-disubstituted piperazines as sigma receptor ligands. *Society for Neuroscience Abstracts* 21: 1610, #631.11, 1995.
115. Williams, W., Eyssalenne, A., Torrence-Campbell, C., Zhang, Y., and Bowen, W.D. Characterization of novel N,N'-disubstituted piperazines as potential irreversible agents for sigma receptors. *College on Problems of Drug Dependence Abstracts 1996, 58th Annual Scientific Meeting*: 151, 1996.
116. Cole, J.L., Berman, N., Bowen, W.D., Pasternak, G.W., and Bodnar, R.J. Genetically-obese Zucker rats display decreased sensitivity to central opioid receptor subtype antagonist weight reductions. *Society for Neuroscience Abstracts* 22: 454, #181.2, 1996.
117. Bowen, W.D., Vilner, B.J., Bandarage, U.K., and Kuehne, M.E. Ibogaine and ibogamine modulate intracellular calcium levels via interaction with sigma-2 receptors. *Society for Neuroscience Abstracts* 22: 2006, #787.5, 1996.
118. Vilner, B.J. and Bowen, W.D. Effects of sigma receptor ligands on rat superior cervical ganglion neurons in vitro. *Society for Neuroscience Abstracts* 22: 2006, #787.6, 1996.
119. Husbands, S.M., Izenwasser, S., Bowen, W.D., Vilner, B.J., Katz, J.L., and Newman, A.H. Novel analogs of rimcazole as probes for the dopamine transporter. *Society for Neuroscience Abstracts* 23: 1103, #432.17, 1997.
120. Vilner, B.J. and Bowen, W.D. Sigma-2 receptor agonists induce apoptosis in rat cerebellar granule cells and human SK-N-SH neuroblastoma cells. *Society for Neuroscience Abstracts* 23: 2319, #905.6, 1997.
121. Bowen, W.D., Vilner, B.J., Williams, W., Bandarage, U.K., and Kuehne, M.E. Novel ibogaine analogs as selective sigma-2 receptor probes: Ligand binding and functional assays. *Society for Neuroscience Abstracts* 23: 2319, #905.7, 1997.

122. Joseph, D.B. and Bowen, W.D. Investigation of sigma receptor-G-protein interaction using stimulation of [<sup>35</sup>S]GTPγ-S binding to rat cerebellar and human SK-N-SH neuroblastoma cell membranes. *Society for Neuroscience Abstracts* 23: 2319, #905.8, 1997.
123. Joseph, D.B. and Bowen, W.D. Sigma receptor ligands robustly stimulate [<sup>35</sup>S]GTPγS binding to intact SK-N-SH neuroblastoma cells but not to SK-N-SH cell membrane preparations. *Society for Neuroscience Abstracts* 24: 1594, #627.5, 1998.
124. Vilner, B.J. and Bowen, W.D. Relationship of sigma-2 receptor-mediated increases in intracellular calcium to induction of morphological changes and apoptosis in human SK-N-SH neuroblastoma cells. *Society for Neuroscience Abstracts* 24: 1594, #627.6, 1998.
125. McCracken, K.A., Miller, J., Bowen, W.D., Zhang, Y., and Matsumoto, R.R. High affinity sigma (σ) receptor ligands attenuate the effects of a cocaine overdose. *Society for Neuroscience Abstracts* 24: 494, #191.7, 1998.
126. Vilner, B.J., Coop, A., Williams, W., and Bowen, W.D. Sigma-2 receptor antagonists: Inhibition of agonist-induced calcium release and cytotoxicity in SK-N-SH neuroblastoma. *Society for Neuroscience Abstracts* 25: 1475, #598.20, 1999.
127. Bowen, W.D., Coop, A., and Vilner, B.J. Sigma-2 receptors that modulate calcium and induce cytotoxicity are localized intracellularly. *Society for Neuroscience Abstracts* 25: 1708, #680.19, 1999.
128. Bowen, W.D., Crawford, K.W., Huang, S., and Walker, J.W. Activation of sigma-2 receptors causes changes in ceramide levels in neuronal and non-neuronal cell lines. *Society for Neuroscience Abstracts* 26: 601, #226.11, 2000.
129. Williams, W., Hashimoto, A., Vilner, B.J., Rice, K.C., Bowen, W.D. Characterization of substituted 5-phenylmorphans as cell-permeant sigma-2 receptor agonists or antagonists. *Society for Neuroscience Abstracts* 26: 1161, #435.19, 2000.
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.
131. Bowen, W.D., Crawford, K.W., and Coop, A. Sigma-2 receptors may activate sphingolipid-ceramide N-deacylase (SCDase) as a mechanism to regulate cell growth. *Society for Neuroscience Abstracts* 27: 948, #364.1, 2001.
132. Crawford, K.W., Liao, Z., Hildreth, J.E., and Bowen, W.D. Sigma-2 receptor agonists inhibit HIV infection of lymphocytes by reducing membrane sphingomyelin content. *2003 Retrovirus Conference Abstracts*.

134. Wanebo, H.J., Lu, S., Cao, C., Shrayar, 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  
26<sup>th</sup> 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”

## **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, Puerto 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 - 66<sup>th</sup> 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 – 27<sup>th</sup> 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 3<sup>rd</sup>, 2006  
"Career Objectives: Junior Faculty – Staying on the Road to Tenure"
- \* Blacks in Government – 28<sup>th</sup> 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 16<sup>th</sup>, 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 14<sup>th</sup>, 2008  
“How to Set Up a Lab and Management of Resources and Personnel”

American Association of Pharmaceutical Scientists – Atlanta, Georgia, November 18<sup>th</sup>, 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 20<sup>th</sup>, 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 19<sup>th</sup>, 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 4<sup>th</sup>, 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 2<sup>nd</sup>, 2012  
“How to Set Up a Lab and Management of Resources and Personnel”

## **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.

Invention Reports and Disclosures to NIDDK Office of Technology Transfer:

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 likely comprise a novel 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 a neuroblastoma line, 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 be dependent on 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. Finally, the sigma-2 receptor, a 21.5 kDa lipid raft protein, has not yet been cloned. We have projects underway aimed at purifying sigma-2 receptor proteins, obtaining protein sequence information, and using this information to clone the sigma-2 receptor gene.

The sigma-1 receptor has been cloned and is a 25 kDa polypeptide with two putative transmembrane domains. 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. We have initiated structure-function studies of the sigma-1 receptor and its role in tumor cell proliferation and survival. Sigma-1 receptors regulate calcium signaling by amplifying release of calcium from the endoplasmic reticulum in response to the rise in IP<sub>3</sub> 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<sub>3</sub> 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<sub>3</sub> receptor in human MCF-7 breast tumor cells, which are normally devoid of sigma-1 receptors. Furthermore, studies using various receptor constructs showed that only the C-terminal segment of the receptor is required for this effect. We are further delineating the functional domains of the receptor. 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. 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) - 2004-2009

Primary research advisor to one Molecular Pharmacology and Physiology graduate student

Served or serving on Thesis Committees of 12 graduate students in MPP, Neuroscience, or Psychology graduate programs since 2005



Current advisor to 6 independent study students doing undergraduate research in the laboratory; total of 17 students since 2004.

Research advisor or mentor to 35 undergraduates at Brown University between 1983 and 1991 (Honors Thesis or summer internships), 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).

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 Proteomics Search Committee – Bioinformaticist, 2011 – present

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

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

**b. Service to Profession**

Ad Hoc Reviewer for Scientific Journals:

Biochemical Pharmacology  
Bioorganic and Medicinal Chemistry Letters  
Brain Research  
Canadian Journal of Physiology and Pharmacology  
Cancer Research  
Chemical and Engineering News  
European Journal of Cancer  
European Journal of Pharmacology  
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 Pharmacology  
Neuropeptides  
Neuropharmacology  
Neurotoxicology and Teratology  
Peptides  
Pharmacogenomics Journal (The)  
Pharmacology Letters  
Pharmacology & Therapeutics  
Proceedings of the National Academy of Sciences  
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

American Association for Cancer Research - Minorities in Cancer Research (MICR) Council – 2011 -  
2014

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 -

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 the 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

## **b. Research Grants**

### I. Past Support:

#### 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.

## II. 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.

### III. Past Support: Brown University, Private Foundations, Industry

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 phosphoinositide 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

#### IV. Current and pending support:

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 on Drug Abuse T32 Postdoctoral Training Grant

5T32DA016184-09

Substance Abuse Intervention/Outcome Research Training

(PI: Demaris Rohsenow); Role: Trainer

Brown University Division of Biology and Medicine

Start-up funds – 9/1/04 – present

Upjohn Chair support 05/08 - present

### **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

American Association for Cancer Research

International Brain Research Organization/World Federation of Neuroscientists

NIH Black Scientists Association

American Association for the Advancement of Science (past)

International Narcotics Research Conference Member (past)

New York Academy of Sciences (past)

American Chemical Society (past)

## 9. TEACHING

### Current:

BIOL 3667: Integrated Medical Sciences III – System-Based Pharmacology; course Director

BIOL 3676: Integrated Medical Sciences IV – System-Based Pharmacology; course Director

BIOL 2170: Molecular Pharmacology and Physiology (MPP Graduate Program Core Course)

BIOL 0030: Endocrinology; 4 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

### Special Lectures:

Initiative to Maximize Student Development (IMSD) Training Module

“Scientific Writing: Key Principles for Writing Manuscripts, Abstracts, and Proposals”

2009-present

### 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

## 10. DATE OF THE PREPARATION OF THE DOCUMENT:

8/28/12