**BORON AND TIN IN NUCLEAR MEDICINE: THE DEVELOPMENT OF
REACTIVE
SOLID-STATE REAGENTS FOR USE IN PET AND SPECT**

Final Report

May 1, 1996 - April 30, 2002

George W. Kabalka, Ph.D.

Department of Chemistry
The University of Tennessee
Knoxville, Tennessee 37996-1600

January 13, 2006

PREPARED FOR:
THE U.S. DEPARTMENT OF ENERGY
UNDER GRANT NUMBER DE-FG02-96ER662199

1. Isotope Incorporation Reactions and Radiolabeled Imaging Agents

The major thrust of the DOE program at The University of Tennessee was the development of new synthetic methodology for use in the rapid incorporation of short-lived isotopes. In the initial stages of the program, efforts were directed at the use of functionalized organometallic reagents that would rapidly react with radiolabeled agents generated by the medical cyclotron or reactor. These included $^{18}\text{F}_2$, $^{15}\text{O}_2$, $^{13}\text{NH}_3$, ^{11}CO and Na^{123}I . The early studies led to the development of extensive new isotope incorporation chemistry. These studies validated the feasibility of using reactive intermediates, such as the organoboranes, and acted as a catalyst for others to investigate organometallic agents based on mercury, tin, and silicon.¹

In addition, the early studies led to the first syntheses of new agents, which have since proven to be clinically important either in their own right or as lead compounds for related agents; these include (*E*)-17 α -[^{123}I]iodovinylestradiol, **8**,² [^{15}O]-butanol, **9**,³ *N*-(3-iodopropen-2-yl)-2-carbomethoxy-3-(4-chlorophenyl)tropane, **10**,⁴ and 4-(*E*)-18-iodo-17-octadecenoic acid, **11**.⁵

Other agents prepared in our laboratories included [^{13}N]-putrescine, **12**,⁶ as well as iodine-123 labeled 4-O-(*E*)-3-iodopropen-2-yl-allose, **13**,⁷ and 3-*N*-methyl-5-iodo-2-thienylbutyrophenone, **14**.⁸

During the period of the current grant, I am pleased to report that we made significant strides in the development chemistry designed to generate new nuclear medicine imaging agents, as described in the following sections. Significantly, we began the development of new solid-state and polymeric reagents that provide the basis for the proposed radiopharmaceutical chemistry studies. The results of our studies are summarized below.

(a) Radioiodinated Alzheimer's Imaging Agents

We completed the synthesis of a regiospecifically radioiodinated Congo Red, **15** analogue.⁹

Because Congo Red (CR) has a high affinity for the β -pleated structure of all forms of amyloid, we explored the use of this molecular probe as a carrier of iodine-123, which can be visualized *in vivo* using SPECT. *In vitro* experiments indicated that the iodinated derivatives interacted with the β -pleated structure of amyloid in a manner comparable to the native dye. Further, we demonstrated that the affinity of iodinated Congo Red (ICR) for amyloid fibrils was retained as evidenced by congophilia and a green birefringence binding constant (Kds) and in their capability to inhibit the binding of native CR in competitive assays.

We used golden hamsters (*mesocricetus auratus*, Charles River Lab.) in which amyloid production was induced with repeated intraperitoneal and subcutaneous injections of amyloid enhancing factor and lipopolysaccharide, until a significant amount of amyloid deposition was histochemically confirmed in sacrificed animals. Amyloid deposits in spleen, liver, and kidney were detected in tissue section by immunohistochemical means. Quantitation of amyloid deposits was performed using tissue-homogenates of the same organs by a standard enzyme-linked immunosorbent assay (ELISA). Amyloid deposition was enhanced with aging (a spontaneous, senile type of amyloid deposit is typical for aged male hamsters). Following anesthesia, animals (amyloid and healthy young controls) were injected with **15**. Initial planar imaging results were satisfactory despite the fact that the intraperitoneal injection route gave a long “background” as remaining material in the peritoneal cavity. The study validated the use of polyunsaturated systems as markers for amyloid plaques but the inability of these molecules to penetrate the blood brain barrier lead us to look for more effective agents. Recent reports concerning the remarkable specificity of diarylethene derivatives⁷⁴ for amyloid plaques have led us to focus on the synthesis and evaluation of these agents in the next phase of the study.

(b) ¹²³I-Tacrine

In patients with Alzheimer’s disease (AD), the levels of acetylcholine, a neurotransmitter implicated in memory and learning, are significantly low. An enzyme responsible for the breakdown of acetylcholine is acetylcholinesterase. Tacrine, commercially known as Cognex®, is one of the two approved cognitive enhancers for use by AD patients. This

drug is a very potent ($IC_{50} = 0.319 \mu M$) and selective AChE inhibitor. Our efforts focused on synthesizing an analogue of tacrine for use as a SPECT tracer to map acetylcholinesterase. ^{10,11} Iodine-123 labeled tacrine, **17**, was synthesized from the corresponding boronic acid precursor. The material is currently being evaluated by colleague, Dr. Duane Miller, at the University of Tennessee Medical Center in Memphis, Tennessee regarding evaluation of the radioiodinated imaging agent.

(c) 1-(3-[¹⁸F]Fluorobenzyl)4-[2-(N-Phthalimid-yl)ethyl]piperidine

As noted earlier, a selective loss of choline acetyltransferase has been observed in the cerebral cortex of Alzheimer's patients. Another agent which has the ability to potentiate the actions of acetylcholine by inhibiting the degrading enzyme acetylcholinesterase is 1-benzyl-4-[2-(N-phthalimid-1-yl)ethyl]piperidine, which has an IC_{50} value of $30 \mu M$. We recently completed the synthesis of the iodine-123 analogue **18** using electrophilic radioiodination and are in discussions with Dr. Miller at University of Tennessee in Memphis concerning evaluation of the agent.

(d) Breast Tumor Imaging

We first reported the use of the iodovinyl group for stabilizing radioiodine *in vivo* in an estradiol reagent, **8** (page 16), in 1981.⁷⁸ Since that time a wide variety of iodovinyl radiopharmaceuticals have been developed, including a number of iodovinylestradiols. Interestingly both the nature of the estrogen derivative and the synthesis of the iodovinyl group have proven to be fruitful areas of research.

The stereochemistry of the 17 α substituent in 17 α -iodovinylestradiol agents has proven to be important in the receptor binding affinity of the agent. It has been demonstrated that the *Z* isomer of the parent iodovinylestradiol, **8**, binds to receptors to a significantly greater extent than the corresponding *E* isomer.¹²

In an effort to probe the mechanism of the binding, we prepared a series of 17 α substituted estradiols in which the stereochemical characteristics of carbons 20 and 21 were modified systematically. The *Z* and *E* isomers (**19** and **20**) were prepared.¹³

The ligands were incubated with rat uterine cytosol prepared from immature female rats to determine relative binding affinities (RBA) compared to estradiol as the standard ligand. Incubations were performed at 0 degrees for 1-2h. (These studies were carried out in collaboration with Dr. John Katzenellenbogen). The results of the competitive binding assays revealed that the *Z* alkene bound more avidly than the *E* isomer, which is consistent with earlier studies focused on the parent iodovinylestradiol reagents.^{88, 14}

(e) Lung Tumor Studies

As a test of our hypothesis that benzylideneanabaseines will be selective for α_7 -nAChR and thus useful for imaging small cell lung carcinoma, we synthesized the stable iodine labeled derivative **21** (A1 in Figure 2) and carried out a competitive radio-receptor

assay in which nicotine and **21** competed with [125 I]- α_7 -bungarotoxin (50 pM) for α_7 binding sites. Compound **21** proved to be more effective than nicotine in competing for [125 I]- α_7 -bungarotoxin, Figure 2.

Figure 2. Radioreceptor assay in which nicotine and anabaseine analogue **21** competed with the site-selective ligand for the α_7 nAChR, α_7 -bungarotoxin (50 pM), in the human SCLC cells NCI-H69. Similar to anabaseine itself, the analogue had a higher affinity than nicotine for the α_7 binding sites (EC_{50} nicotine: 1.05×10^{-8} ; EC_{50} anabaseine analogue: 1.15×10^{-10}).

Analogue **21** was prepared utilizing procedures developed in our laboratory as well as literature procedures.¹⁵ Aldol condensation of anabaseine with the 2,4-dimethoxybenzaldehyde (prepared from commercially available 4-iodo-1,3-dimethoxybenzene by the Vilsmeier reaction¹⁶) afforded iodobenzylideneanabaseine **21**.

2. Solid-State Organometallic Reagents

(a) Boronated Esters

As outlined earlier, we began a study of the use of solid-state boronate derivatives as radiopharmaceutical precursors. These studies are based on our previously developed radiohalogenation studies involving the electrophilic halogenation of boronic acids. The advantages of the boronic acids are low toxicity and the fact that functional groups are well tolerated.

(Where X = ¹²³I, ¹²⁵I, ¹³¹I, ⁷⁶Br)

Until recently, the prerequisite boronic acids (most notably the aryl and vinyl derivatives) were not readily available. The situation has changed markedly in recent years, due to the development of the chemistry in which organic halides are converted to the boronic acids via the simple addition of commercially available boron diesters.^{17,18}

Since our proposed research is centered on the use of solid boronic ester substrates, we investigated the use of boronate esters in radiohalogenation reactions.¹⁹

(Where R = aryl or vinyl and can contain both electron attracting and withdrawing groups such as carbomethoxy-, chloro-, methoxy-, acetyl-, etc.)

The reactions generate the desired radioiodinated products in excellent yield and with radiopurities in excess of 98%.

(b) Solid State Chemistry

We prepared samples of boronated surfaces (as illustrated below) by allowing the appropriate boronic acid to react with alumina reagents of varying compositions (α , γ , δ , and η). The transition aluminas are formed via dehydration during calcination, with the ultimate product of dehydration being γ -alumina. The transition aluminas (γ , δ , θ etc)

are distinct crystalline phases that are formed with γ -alumina being the most important for catalytic applications. γ -Alumina is characterized by a high surface area which is thermally stable and highly irregular. Most importantly, it is amphoteric because it contains both acid and base sites. These sites can be of varying base or acid strengths

depending upon their dehydration state and the method of functionalization. (The organic chemist is most familiar with the varying states of γ -alumina, which are used in chromatography; they are graded according to the Brockman Scale.)

Our initial investigation utilized simple vinylboronic acids because the reactions of vinylboronate esters have been well characterized in halogenation reactions. We prepared boronic ester derivatives of alumina by dehydrating mixtures of boronic acids and aluminas. The studies are based on our observations involving boronic acid behavior on solid surfaces.^{20,21}

The new materials were halogenated to produce vinyl halogen derivatives. Interestingly, we have found that the regiochemistry of the vinyl halides appears to be dependent on the surface. This could be significant in light of recent studies which indicate that the *Z* vinyl iodides often demonstrate enhanced physiological activity.^{88,89,90} As anticipated, the boronic acid by-product is retained on the alumina, which simplifies isolation and purification of the desired products.²²

The coating of alumina with boron derivatives has led us to exciting discoveries. In addition to the change in regiochemistry of the vinyl iodide noted earlier, we found that a number of the boronated aluminas have significant synthetic capabilities which we have been exploring as a means to construct molecular frameworks to be used in

pharmaceutical preparation.^{23,24} For example, boronated alumina reagents were cross-coupled with aryl and vinyl halides using a palladium catalyzed cross-coupling reaction.

(c) *Polymeric Tin Derivatives*

Our investigation of new iodination reactions also included the preparation of polystyrene derivatives of tin, such as **22**.

Polymer **22** was coupled to protected benzedine **23** to form **24** (as shown on the next page). Intermediate **24** was then used to prepare radioiodinated Congo Red, **15**, via polymer **25**.⁸⁵

Although the chemistry led to the desired product, generating the tin polymer proved tedious and tin was found to elute from the reaction media under some conditions. In addition, Congo Red studies demonstrated that this reagent did not cross the blood brain barrier.

In summary, a number of the goals outlined in the original proposal were accomplished including the preparation of a series of new radiopharmaceuticals. New isotope incorporation routes were developed that can be used to efficiently prepare clinically useful radiopharmaceuticals. An investigation into new, solid-state and polymeric radiohalogen incorporation routes was initiated but further studies will be required before they are applicable to the clinical environment. Thirty-nine graduate students, thirteen

postdoctoral fellows, and twenty five undergraduate students received training in the UT-DOE Nuclear Medicine Program. In addition, 101 journal articles have appeared or are in press and 87 refereed research abstracts were also published which describe the results of our studies and I was invited to present lectures at 41 universities and scientific gatherings.

References:

1. Kabalka, G. W.; Varma, R. S. "The Synthesis of Radiolabeled Compounds Via Organometallic Intermediates," *Tetrahedron* **1989**, *45*, 6601.
2. Kabalka, G. W.; Gooch, E. E. "Rapid and Mild Syntheses of Radioiodine Labeled Radiopharmaceuticals," *J. Nucl. Med.* **1981**, *22*, 908.
3. Kabalka, G. W.; Lambrecht, R. M.; Sajjad, M.; Fowler, J. S.; Kunda, S. A.; McCollum, G. W.; MacGregor, R. "Synthesis of ^{15}O -Labeled Butanol Via Organoborane Chemistry," *Int. J. Appl. Rad. Isot.* **1985**, *35*, 853.
4. Goodman, M. M.; Kung, M. P.; Kabalka, G. W.; Kung, H. F.; Switzer, R. "Synthesis and Characterization of Radioiodinated *N*-(3-Iodopropen-2-yl)-2 β -Carbomethoxy-3 β -(4-chlorophenyl)tropanes: Potential Dopamine Re-uptake Site Imaging Agents." *J. Med. Chem.* **1994**, *37*, 1535.
5. Goodman, M. M.; Kabalka, G. W.; Meng, C. "Synthesis of Iodine-123 Labeled 4-O-(*E*)-3-Iodopropen-2-yl Branched Carbohydrates." Unpublished research results.
6. Kabalka, G. W.; Goodman, M. M.; Green, J. F.; Marks, R.; Longford, D. "Synthesis of Nitrogen-13 Labeled Amines Using Organoborane Polymers." *J. Labelled Compd. Radiopharm.* **1993**, *32*, 165.
7. Goodman, M. M.; Kabalka, G. W.; Meng, C. "Synthesis of Iodine-123 Labeled 4-O-(*E*)-3-Iodopropen-2-yl Branched Carbohydrates." Unpublished research results.
8. Waterhouse, R. N.; Gotsick, T.; Kabalka, G. W.; Goodman, M. M.; O'Brien, J. C. "Synthesis and Evaluation of [^{123}I]-3-N-Methyl-2-iodothienylspiroperidol: A Novel Dopamine D_2 Receptor Imaging Agent for SPECT." *J. Labelled Compd. Radiopharm.* **1995**, *37*, 18.
9. Kabalka, G. W.; Namboodiri, V.; Akula, M. "Synthesis of Iodine-123 Congo Red via a Solid Phase Organic Synthesis." *J. Labelled Compds. and Radiopharm.* **2001**, *42*, 5793.
10. Kabalka, G. W.; Murthy, A. R. "Synthesis of 7-[(^{123}I)]iodotacrine: a Potential SPECT Agent to Map Acetylcholine Esterase." *J. Labelled Compd. Radiopharm.* **1999**, *42*, 959.
11. Kabalka, G. W.; Murthy, A.; Zhang, J. H. "[^{123}I]Iodocognex, a Potent SPECT Agent to Map Acetylcholinesterase via a Boronic and Acid Precursor." *J. Radiolabelled Compds. and Radiopharm.* **2001**, *44*, S260.

-
12. Ali, H.; Rousseau, J.; Ghaffari, M. A.; van Lier, J. "Synthesis, Receptor Binding and Tissue Distribution of (17 α ,20E)- and (17 α ,20Z)-21-[¹²⁵I]Iodo-19-norpregna-1,3,5(10),20-tetraene-3,17-diol." *J. Med. Chem.* **1988**, 31, 1946.
 13. Kabalka, G. W.; Shoup, T. M.; Goodman, M. M. "Synthesis and Evaluation of a New Series of 17 α -[¹²³I]Iodovinyl Estradiols." *Nucl. Med. Biol.* **2000**, 27, 279.
 14. Rijks, L.; Busemann, S. E.; Stabin, M. G.; de Bruin, K.; Janssen, A. G.; Van Royen, E. A. "Biodistribution and Dosimetry of Iodine-123 Labelled Z-MIVE: An Estrogen Receptor Ligand for Breast Cancer Imaging." *Eur. J. Nucl. Med.* **1998**, 25, 40.
 15. Spath, E.; Mamoli, L. "Eine Neue Synthes Des D,1-Anabesine." *Ber.* **1936**, 69, 1082.
 16. Govindachari, T. T.; Nagarajan, K.; Partyhasaradhi, P. C. "Synthesis of Tri-O-Methyl Wedololactone." *J. Chem. Soc.* **1957**, 458.
 17. Ishiyama, T.; Murata, M.; Miyaura, N. "Palladium(0)-Catalyzed Cross-Coupling Reaction of Alkoxydiboron with Halorenes: A Direct Procedure for Arylboronic Esters." *J. Org. Chem.* **1995**, 60, 7508.
 18. Miyaura, N.; Suzuki, A. "Palladium-Catalyzed Cross-Coupling Reactions of Organoboron Compounds." *Chem. Rev.* **1995**, 95, 2457.
 19. Kabalka, G.W.; Akula, M. R.; Zhang, J. H. "Synthesis Of Radioiodinated Aryl Iodides Via Boronate Precursors." *J. Nucl. Med. Biol.*, submitted.
 20. Kabalka, G.W.; Hair, M.; Pagni, R. M. "Solventless Suzuki-coupling Reactions on Palladium Doped KF/Al₂O₃." *Organic Lett.* **1999**, 1423.
 21. Kabalka, G. W.; Pagni, R. M.; Hair, C. M.; Wang, L.; Namboodiri, V.; "Suzuki Coupling Using Pd(0) and KF/Al₂O₃." In Supported Catalysts Sherrington, D. C. and Kybett, A. P. (ed.), Royal Society of Chemistry, Cambridge, U. K. **2001**, 219.
 22. Kabalka, G. W.; Akula, R. R.; Zhang, J. H. "Preparation of Radiodinated (Z)-Vinyl Iodides Via Vinylboronates: Organoboron Chemistry Revisited." *J. Radiolabelled Compds. Radiopharm.* **2001**, 44, S942.
 23. Kabalka, G.W.; Hair, M.; Pagni, R. M. "Solventless Suzuki-coupling Reactions on Palladium Doped KF/Al₂O₃." *Organic Lett.* **1999**, 1423.
 24. Kabalka, G. W.; Pagni, R. M.; Hair, C. M.; Norris, J. L.; Wang, L.; Namboodiri, V. "Organoboron Chemistry on Alumina: The Suzuki Reaction." In Organoboranes for Synthesis, Eds. P. V. Ramachandran and H. C. Brown, American Chemical Society Symposium Series #783, Oxford University Press, **2001**, 148.

4. ***Bibliography of DOE Publications During Grant Period***

(a) *Journal Articles (Radiohalogenation/Halogenation)*

1. Kabalka, G. W.; Das, B. C.; Das, S. "Rhodium Catalyzed 1,4-Addition Reactions of Diboron Reagents to Electron Deficient Olefins." *Tetrahedron Lett.* **2002**, 43, 2323.
2. Kabalka, G. W.; Wang, L. "Ligandless Palladium Chloride Catalyzed Homo-Coupling of Arylboronic Acids in Aqueous Media" *Tetrahedron Lett.* **2002**, 43, 3067.
3. Kabalka, G. W.; Wu, Z.; Ju, Y. "A New Method for Alkylation of Aromatic Aldehydes Via Alkylboron Chloride Derivatives in the Presence of Oxygen." *Tetrahedron* **2002**, 58, 3248.
4. Kabalka, G. W.; Malladi, R. R. "One-Pot Synthesis of ω -Chloroesters Via the Reaction of Acid Chlorides With Tetrahydrofuran in the Presence of Trichloroborane." *Syn. Comm.* **2002**, 32, 1997.
5. Kabalka, G. W.; Wu, Z.; Ju, Y. "A New Reaction of Aryl Aldehydes with Aryl Acetylenes in the Presence of Boron Trihalides" *Org. Lett.* **2002**, 4, 1491.
6. Akula, M. R.; Zhang, J. H.; Kabalka, G. W. "Synthesis Of 2,4-Dimethyl-5-Iodobenzaldehyde", *Org Prep. Proced. Int.* **2002**, 34, 430.
7. Kabalka, G. W.; Bollu, V. "Preparation of (Z) and (E)-Vinyl Selenides Utilizing Vinylboronic Acids and Vinylboronic Esters in Ionic Liquids" *Tetrahedron Lett.* **2002**, 43, 3793.
8. Malladi, R. R.; Kabalka, G. W. "A New Synthesis of Alkenes Via a Boron Trifluoride Mediated Reaction of Aliphatic Ketones with Aromatic Ketones." *J. Chem. Research* **2002**, 224.
9. Kabalka, G. W.; Bollu, V.; Das, B. C. "Allylboration of Carbonyl Compounds in Ionic Liquid" *Green Chem.* **2002**, 4, 472.
10. Pagni, R. M.; Kabalka, G. W.; Lee, C.; Malladi, R. R.; Collins, B.; Conley, N. "Organic Reaction in Ionic Liquids on Supported Reagents" in *Green Industrial Applications of Ionic Liquids with Supported Reagents*, Rogers, R. and Seddon, K. American Chemical Society Symposium Series, **2002**, 818, 42.
11. Kabalka, G. W.; Akula, M. R.; Zhang, J. "Synthesis Of Radioiodinated Aryl Iodides Via Boronate Precursors." *J. Nucl. Med. Biol.* **2002**, 29, 841.
12. Kabalka, G. W.; Wu, Z.; Ju, Y. "A Novel Titanium Tetrahalide-Mediated Carbon-Carbon Bond Forming Reaction: Regioselective Synthesis of Substituted (E,Z)-1,5-Dihalo-1,4-dienes." *Org. Lett.* **2002**, 4, 3415.
13. Kabalka, G. W.; Pacer, G. A.; Akula, M. R.; Zhang, J.H.; Longford, C. P. D. "Synthesis of 1-3-[¹⁸F]fluorobenzyl)-4-[2-(N-phthalimid-1-yl)ethyl]piperidine." in *Synthesis and Applications of Isotopically Labelled Compounds, Proceedings of the International Symposium, 7th*. Editor(s) Pleiss, U.; Voges, R., John Wiley and Sons, Chichester, UK, **2001**, 354-357.
14. Akula, M. R.; Singhaus, R. R.; Zhang, J. H.; Kabalka, G. W. "Synthesis of 3-[2-(1-(3-[¹²³I]iodobenzyl-4-piperidinyl)ethyl)]1,2-benzisoxazole: A Potent SPECT Agent to Map Acetylcholinesterase." in *Synthesis and Applications of Isotopically Labelled Compounds, Proceedings of the International Symposium, 7th*. Editor(s) Pleiss, U.; Voges, R., John Wiley and Sons, Chichester, UK, **2001**, 388-391.

15. Kabalka, G. W.; Namboodiri, V.; Akula, M. "Synthesis of Iodine-123 Congo Red via a Solid Phase Organic Synthesis." *J. Labelled Compds. and Radiopharm.*, **2001**, 44, 1.
16. Kabalka, G. W.; Wu, Z.; Ju, Y. "Chloroalkylation of Aryl Aldehydes Using Alkylboron Dichlorides in the Presence of Oxygen." *Tetrahedron Lett.* **2001**, 42, 6239.
17. Kabalka, G. W.; Smith, G. T.; Nichols, T.L.; Dyke, J.P.; Longford, P.D.; Hubner, K.F. "The Role of Dynamic Positron Emission Tomography for Quantifying Boron-10 *In Vivo* Using the Fructose Complex F-18 Labeled Boronophenylalanine PET," *Frontiers in Neutron Capture Therapy*, Hawthorne, M.F. and Wiersma, R.M. (Eds), Plenum Press, New York, **2001**, 853.
18. Nichols, T.L.; Kabalka, G.W.; Smith, G. T.; Dyke, Longford, P.D.; Hubner, K.F. "Treatment Planning Based on Dynamic Positron Emission Tomography for Boron Neutron Capture Therapy for Glioblastoma Multiforme," *Frontiers in Neutron Capture Therapy*, Hawthorne, M.F. and Wiersma, R.M. (Eds), Plenum Press, New York, **2001**, 185.
19. Kabalka, G. W.; Wu, Z.; Ju, Y. "Boron trihalide-promoted addition of aryl aldehydes to styrenes: A new convenient and highly efficient synthesis of 1,3-dihalo-1,3-diarylpropanes" *Tetrahedron Lett.*, **2001**, 42, 5793.
20. Kabalka, G. W.; Akula, R. R.; Zhang, J. H. "3-(2,4-Dimethyl-5-[¹²³I]Iodo)Benzylidene) Anabaseine: A Potent SPECT Agent for Imaging Lung Cancer." *J. Radiolabelled Compds. and Radiopharm.*, **2001**, 44, S359.
21. Kabalka, G. W.; Akula, R. R.; Zhang, J. H. "3-(2,4-Dimethyl-5-[¹²³I]Iodo)Benzylidene) Anabaseine: A Potent SPECT Agent for Imaging Lung Cancer." *J. Radiolabelled Compds. and Radiopharm.*, **2001**, 44, S359.
22. Kabalka, G. W.; Akula, R. R.; Zhang, J. H. "Preparation of Radiodinated (Z)-Vinyl iodides Via Vinylboronates: Organoboron Chemistry Revisited." *J. Radiolabelled Compds. and Radiopharm.*, **2001**, 44, S942.
23. Kabalka, G. W.; Nichols, T. L.; Akula, M.; Longford, C.P.D.; Miller, L. "Synthesis of Carbon-11 Labeled *para*-boronophenylalanine for Boron Neutron Capture Therapy and Their use in PET Based Treatment Planning." in *Synthesis and Applications of Isotopically Labelled Compounds, Proceedings of the International Symposium*, 7th. Editor(s) Pleiss, U.; Voges, R. , John Wiley and Sons, Chichester, UK, **2001**, 329-332.
24. Kabalka, G. W.; Murthy, A.; Zhang, J. H. "[¹²³I]Iodocognex, a Potent SPECT Agent to Map Acetylcholinesterase via a Boronic and Acid Precursor." *J. Radiolabelled Compds. and Radiopharm.*, **2001**, 44, S260.
25. Pacer, G. A.; Akula, M. R.; Longford, C. P. D.; Kabalka, G. W. "Synthesis of 1-(3-[¹⁸F]Fluorobenzyl)-4-[2(N-phthalimid-1-yl)ethyl]piperidine." *J. Radiolabelled Compds. and Radiopharm.*, **2001**, 44, S920.
26. Kabalka, G. W.; Wu, Z.; Ju, Y. "Reductive Bromination of Aromatic Aldehydes Using Alkylboron Dibromides." *Tetrahedron Lett.* **2000**, 41, 5161.
27. Kabalka, G. W.; Srivastava, R. R.; Das, B.C.; Nichols, T. L.; Smith, G. T. "The Development of Boron Neutron Capture Agents Utilizing Positron Emission Tomography," in *Contemporary Boron Chemistry*, Hughes, A.K.; Davidson, M. (Eds.) Royal Society of Chemistry, Cambridge,

United Kingdom, **2000**, 120.

28. Kabalka, G. W., Shoup, T. M., Goodman, M.M. "Synthesis and Evaluation of a New Series of 1 α_7 -[¹²³I]Iodovinyl Estradiols," *Nucl. Med. Biol.*, **2000**, 27, 279.
29. Kabalka, G.W.; Wu, J. "Conversion of Aromatic Aldehydes to gem-Dichlorides Using Boron Trichloride. A New Highly Efficient Method for Preparing Dichloroarylmethanes," *Tetrahedron Lett.*, **2000**, 41, 579.
30. Kabalka, G.W.; Murthy, A. R. "Synthesis of 7-[¹²³I]Iodotacrine: a Potential SPECT Agent to Map Acetylcholin Esterase," *J. Labeled Compd. Radiopharm.*, **1999**, 42, 959.
31. Kabalka, G. W.; Narayana, C.; Yang, K. "Bromination of Alkenes With Sodium Perborate And Sodium Bromide," *Synth. Commun.*, 28, **1998**, 925-929.
32. Bendel, P.; Frantz, A.; Kabalka, G. W.; Salomon, Y. "Boron-11 NMR of Borocaptate: Relaxation and *In Vivo* Detection in Melanoma-Bearing Mice," *Magnetic Resonance in Medicine*, 39, **1998**, 439-447.
34. Kabalka, G. W.; Murthy, A. R. "A Convenient Synthesis of Hindered *N*-Aryl Substituted Cyclic Amines," *Synth. Comm.* **1998**, 28, 2063
35. Kabalka, G. W., "Recent Developments in Boron Neutron Capture Therapy," *Ex. Opin. Ther. Patents* **1998**, 8, 545.
36. Nichols, T.L.; Kabalka, G. W.; Smith, G. T.; Longford, D.; Buonocore, E.; Hubner, K.F. "The Use of Positron Emission Tomography in Treatment Planning For Boron Neutron Capture Therapy: A Clinical Perspective," *Clinical Physiology* **1998**, 18:3, 255.
37. Waterhouse, R.N.; Gotsick, J.T.; Kabalka, G.W.; Goodman, M.M.; O'Brien, J.C. "In Vivo Evaluation of [¹²³I]-8-[4-[2-(5-Iodothienyl)]-4-Oxobutyl]-3-Methyl-1-Phenyl-1,3,8-Triazaspiro[4.5]Decan-4-One as a Potential Dopamine D₂ Receptor Radioligand for SPECT," *Nucl. Med. Biol.* **1998**, 25, 77.
38. Waterhouse, R. N.; Gotsick, J.T.; Kabalka, G. W.; Goodman, M. M.; O'Brien, J.C. "Synthesis of [¹²³I]-8-[42-(5-iodothieryl)]-4-oxobutyl]-3-methyl-1,3,8-triazaspiro[4.5]decan-4-one: A Potential Dopamine D₂ Receptor Radioligand for SPECT," *J. Labeled Compds. Radiopharm.* **1998**, 41, 363.
39. Kabalka, G. W.; Yu, S. and Li, N.-S. "Selective Hydroboration of Alkenes and Alkynes In the Presence of Aldehydes and Ketones," *Canadian Journal of Chemistry* **1998**, 76, 800.
40. Kabalka, G. W.; Yang, K.; Reddy, N. K; Narayana. C. "Bromination of Alkynes Using a Mixture Of Sodium Bromide and Sodium Perborate," *Synth. Comm.* **1998**, 28, 3807.
41. Kabalka, G. W.; Li, N.-S.; Yu, S. "Synthesis of 2-Acyl-1,4-Diketones Via the Deacylation of α,β -Unsaturated Ketones," *Organometallics*. **1998**, 17, 3815.
42. Kabalka, G. W.; Tejedor, D.; Li, N.-S. Malladi, R.R.; Trotman, S. "An Unprecedented Tandem Aldol—Grob Reaction Sequence," *J. Org. Chem.* **1998**, 63, 6438.
43. Kabalka, G. W.; Tejedor, D.; Li, N.-S.; Reddy, M. R.; Trotman, S. "Boron Trifluoride Induced Fragmentation of α -Aryl α -Hydroxy Ketones." *Tett. Lett.* **1998**, 39, 8071.

44. Kabalka, G.W.; Tejedor, D.; Li, N.-S.; Malladi, R.R.; Trotman, S. "A Tandem Aldol-Grob Reaction of Ketones with Aromatic Aldehydes," *Tetrahedron* **1998**, *54*, 15525.
45. Meng, X.; La, B.; Fortunak, J. M.; Wang, Z.; Kabalka, G.W. "Enantioselective reduction of α -Hydroxy Carboxylic Acid: Direct Enriched α -Oxocarboxylic Acids to Enantiomerically Enriched α -Hydroxy Carboxylic Acids Via Neighboring Group Control", *Tett. Lett.* **1998**, *39*, 5501.
46. Kabalka, G. W. and Yang, K. "Bromination of Alkenes With Sodium Perborate And Sodium Bromide" *Synth. Commun.*, **1998**, *28*, 925.
47. Kabalka, G. W.; Akula, M.R. "A Convenient Synthesis of Hindered *N*-Aryl Substituted Cyclic Amines," *Synth. Comm.* **1998**, *28*, 2063.
48. Waterhouse, R. N.; Gotsick, T.; Kabalka, G. W.; Goodman, M. M.; O'Brien, J. C. "In Vivo Evaluation of [^{123}I]-8-[4-[2-(5-Iodothieryl)]-4-Oxobutyl]-3-Methyl-1-Phenyl-1,3,8-Triazaspiro[4.5]Decan-4-One as a Potential Dopamine D₂ Receptor Radiogland SPECT", *Nuclear Medicine & Biology*, **1997**, *24*, 837.
49. Kabalka, G. W., Pagni, R. M. "Organic Reactions on Alumina, *Tetrahedron* **1997**, *53*, 7999.
50. Li, N.-S.; Yu, S.; Kabalka, G. W. "Synthesis of Alkylarylcarbinols via the Reaction of Organoboranes with Arylmethyl Chlorides." *Organometallics*, **1997**, *16*, 709.
51. Kabalka, G. W.; Li, N.-S.; Yu, S. "Carbonylation of Dialkylcyanocuprates with Carbon Monoxide: Synthesis of α -Hydroxyketones." *Tetrahedron Lett.* **1997**, *38*, 2203.
52. Yang, D.T.C.; Zhang, C.J.; Kabalka, G. W. "Oxidation of α -Substituted Carbonyl Compounds to Carboxylic Acids in Aqueous Media Using Ultrasound." *Synth. Comm.* **1997**, *27*, 1601.
53. Kabalka, G. W., Maddox, J. T., Bogas, E., Kelley, S. W., "Alkylation of Aldehyde (Arenesulfonyl)hydrazones with Trialkylboranes", *J. Org. Chem.* **1997**, *62*, 11.
54. Li, N.-S. Yu, S.; Kabalka, G. W. "A Facile One Pot Synthesis of Alkylarylcarbinols from α,α -dichloroarylmethanes and Trialkylboranes in the Presence of Magnesium or Lithium." *J. Organomet. Chem.* **1997**, *531*, 101.
55. Kabalka, G. W.; Hondrogiannis, G. "Directive Effects in the Hydroboration of 1-Alkenyl Derivatives of *o*-Carborane with Representative Hydroborating Agents." *J. Organomet. Chem.*, **1997**, *536*, 327.
56. Kabalka, G. W.; Li, G "Synthesis of Aromatic Amines Using Allyl Azide," *Tetrahedron Lett.*, **1997**, *33*, 5777.
57. Kabalka, G. W.; Yu, S.; Li, N.-S. "Selective Hydroboration of Terminal Alkenes in the Presence of Aldehydes and Ketones", *Tetrahedron Lett.* **1997**, *38*, 5455.
58. Kabalka, G. W.; Yu, S.; Li, N.-S. "Selective Hydroboration of Unconjugated Alkynyl Ketones and Aldehydes," *Tetrahedron Lett.*, **1997**, *38*, 7681.
59. Kabalka, G. W., Reddy, M. R., Hair, M. "Diastereoselective Reduction of α -hydroxyketones with Amineboranes in the Presence of Lithium Perchlorate" *Tetrahedron Lett.* **1997**, *38*, 7705.

60. Lee, S. K.; Kabalka, G. W.; "Fluorine-18-Labeled Carboranes for Use in PET Imaging of BNCT Agents Containing Carboranes." "Advances in Neutron Capture Therapy, Vol. II, Chemistry and Biology" B. Larson, J. Crawford and R. Weinreich (eds), Elsevier Science, Amsterdam, **1997**, 299.
61. Kabalka, G. W.; Akula, M.R.; Zhang, Z.Y. "Regiospecific Synthesis of 3,3'-[2-[¹²³I]Iodo-1,1'-biphenyl]-4,4'-diylbis(azo)]bis[4-amino-1-naphthalenesulfonic acid] Disodium Salt." *J. Labelled Compd. Radiopharm.* **1997**, 40, 81.
62. Akula, M. R.; Kabalka, G. W. "Synthesis of 9-Amino-7-[¹²³I]Iodo-1.2.3.4-Tetrahydroacridine: A Radiotracer for Mapping Acetylcholinesterase." *J. Labelled Compd. Radiopharm.* **1997**, 40, 83.
63. Zhang, Z. Y.; Zigler, S. S.; Kabalka, G. W. "Separation of [¹⁸F]Fluoride from [¹⁸O]Water and Single-Vessel Synthesis of 2-[¹⁸F]Fluoro-2-deoxy-D-glucose Using Kryptofix® 222." *J. Labelled Compd. Radiopharm.* **1997**, 40, 286.
64. Kabalka, G. W.; Akula, M. R.; Zhang, Z. Y.; Dalton, J. T.; Kirkovsky, L.; Miller, D. D. "Synthesis of (R)-(-)-4' [¹²³I]Iodophenyl)sulfonyl]-2-hydroxy-2-methyl-3'-(trifluoromethyl)propionanilide: A Potential SPECT Agent for Evaluating Prostate Cancer." *J. Labelled Compd. Radiopharm.* **1997**, 40, 351.
65. Srivastava, R. R.; Kabalka, G.W.; Longford, C.P.D. "Synthesis of Carbon-11 Labeled 1-Amino-3-[2-(7-(2-Hydroxyethyl)-1,7-Dicarba-Nido-Dodecaborane (12)-1-YL)ethyl]cyclobutanecarboxylic Acid: A PET Agent for Use in BNCT Treatment Planning." *J. Labelled Compd. Radiopharm.* **1997**, 40, 395.
66. Kabalka, G. W.; Li, N.-S, Yu, S "Asymmetric Syntheses of Alkylarylcarbinols via Reaction of a Chiral Alkylboronic Ester and Arylmethyl Chloride," *Tetrahedron Asym.* **1997**, 8, 3843.
67. McGinnis, M.; Green, J. F.; Tan, L. C.; Palmer, R.; Siler, J.; Vagle, K.; Pagni, R. M.; Kabalka, G. W. "Selectivities of Diels-Alder Reactions Catalyzed by Highly Acidic Boronated Aluminas", *J. Org. Chem.* **1996**, 61, 3496.
68. Zippi, E. M.; Grover, J.; Valiulis, M. B.; Tibbets, C.; Kabalka, G. W. "Functionalization of Cross-Linked Poly(Styrene) in the Preparation of a PET Target Material." *App. Radia. Iso.* **1996**, 47, 513.
69. Zippi, E. M.; Kabalka, G. W. "Synthesis, Characterization and Pyrolysis of Poly(Styrene/Divinylbenzene) Derivatives." *Carbon* **1996**, 34, 1539.
70. Kabalka, G. W.; Maddox, J. T.; Bogas, E. "A Facile Alkylation of Arylaldehyde Tosylhydrazones with Trialkylboranes", *Synth. Commun.* **1996**, 26, 999.
71. Kabalka, G. W.; Narayana, C.; Reddy, N. K., "Stereoselective Synthesis of *anti*-1,3-diols", *Tetrahedron Lett.* **1996**, 37, 2181.
72. Yang, D. T. C.; Cao, Y. H.; Evans, T. T.; Kabalka, G. W. "The Ultrasound Assisted Oxidation of α -Substituted Carbonyl Compounds. *Synth. Commun.* **1996**, 26, 4275.
73. Akula, M. R.; Kabalka, G. W. "Reduction of Azobenzenes to Diphenylhydrazines." *Synth. Commun.* **1996**, 26, 3821.

(b) *Journal Articles (Solid Surfaces and Boronic Acid)*

1. Kabalka, G. W.; Wu, Z.; Ju, Y. "A New Convenient Method for Alkylation of Aromatic Aldehydes Via Alkylboron Chloride Derivatives in the Presence of Oxygen." *Tetrahedron*, **2002** 58, 3243.
2. Kabalka, G. W.; Wang, L. "Ligandless Palladium Chloride Catalyzed Homo-Coupling of Arylboronic Acids in Aqueous Media" *Tetrahedron Lett.*, **2002**, 43, 3067.
6. Kabalka, G. W.; Das, B. C.; Das, S. "Rhodium Catalyzed 1,4-Addition Reactions of Diboron Reagents to Electron Deficient Olefins." *Tetrahedron Lett.*, **2002**, 43, 2323.
7. Kabalka, G. W.; Wang, L.; Pagni, R. M. "Potassium Fluoride Doped Alumina: An Effective Saponification Under Solvent Free Conditions." *Green Chem.* **2001**, 3, 261.
8. Kabalka, G. W.; Wang, L.; Pagni, R. M. "Rapid Microwave-Enhanced, Solventless, Desilylation Procedure on Potassium Fluoride Doped Alumina." *ARKIVOC* **2001**, iv, 5.
9. Kabalka, G. W.; Wang, L.; Pagni, R. M. "Rapid Microwave-Enhanced, Solventless Songashira Coupling and Coupling Cyclization Reaction on Alumina: A Route to Aryl Alkynes, 2-Substituted-benzo[b]furans and 2-Substituted-indoles." *Tetrahedron* **2001**, 57, 8017.
10. Kabalka, G. W.; Wang, L.; Pagni, R. M. "A Novel Route to 2-(dialkylaminomethyl)-benzo[b]furans Via a Microwave-Enhanced, Solventless Mannich Condensation—Cyclization on Cuprous Iodide Doped Alumina." *Tetrahedron Lett.* **2001**, 42, 6049.
11. Kabalka, G. W.; Pagni, R. M.; Hair, C. M.; Wang, L.; Namboodiri, V.; "Suzuki Coupling Using Pd(0) and KF/Al₂O₃ " in Supported Catalysts" Sherrington, D. C. and Kybett, A. P. (ed.), Royal Society of Chemistry, Cambridge, U. K., **2001**, 266.
12. Kabalka, G. W.; Wang, L.; Pagni, R. M. "A Microwave-Enhanced Solventless Mannich Condensation on CuI-Doped Alumina" *Synlett* **2001**, 676.
13. Kabalka, G. W.; Namboodiri, V.; Wang, L. "Suzuki Coupling with Ligandless Palladium and Potassium Fluoride." *Chem. Comm.* **2001**, 775.
14. Kabalka, G. W.; Wang, L.; Pagni, R. M. "A Microwave-Enhanced, Glaser Coupling Under Solvent Free Conditions" *Synlett* **2001**, 108.
15. Kabalka, G.W.; Yang, K.; Wang, Z. "The Reaction of α .-Ketoacids with Allylboronates" *Syn.Comm.*, **2001**, 31, 511.
16. Kabalka, G. W.; Wang, L.; Pagni, R. M. "Microwave Enhanced Glaser Coupling Under Solvent Free Conditions." *Synlett*, **2001**, 108.
17. Kabalka, G. W.; Pagni, R. M.; Hair, C. M.; Norris, J. L.; Wang, L.; Namboodiri, V. "Organoboron Chemistry on Alumina: The Suzuki Reaction" in Organoboranes for Synthesis, Eds. P. V. Ramachandran and H. C. Brown, American Chemical Society Symposium Series #783, Oxford University Press, **2001**, 148-158.

18. Kabalka, G. W.; Pagni, R. M.; Wang, L.; Namboodiri, V. Hair, M.C. "Microwave-assisted, Solventless Suzuki Coupling Reactions on Palladium-doped Alumina" *Green Chem.*, **2000**, 2, 120.
19. Kabalka, G. W.; Malladi, R. R. "Reduction of Aldehydes Using Trialkylboranes in Ionic Liquids" *Chemical Communications*, **2000**, 2191.
20. Kabalka, G. W.; Wang, L.; Namboodiri, V.; Pagni, R. M. "Rapid Microwave-Enhanced, Solventless Sonogashira Coupling Reaction on Alumina" *Tetrahedron Lett.* **2000**, 41, 5151.
21. Kabalka, G. W.; Malladi, R. R.; Kelley, S. "Preparation of Ketones via the Palladium-Catalyzed Cross Coupling of Acid Chlorides with Organoborane Reagents," *Tetrahedron Lett.*, **2000**, 42, 999.
22. Kabalka, G.W.; Wu, Z.; Trotman, S. E.; Xiao, G. "The Alkylation of Aromatic Aldehydes with Boron Halide Derivatives," *Org. Lett.*, **2000**, 2, 255.
23. Kabalka, G.W.; Hair, M.; Pagni, R. M. "Solventless Suzuki-coupling Reactions on Palladium Doped KF/Al₂O₃," *Organic Lett.* **1999**, 1423.
24. Yu, S.; Li, N.-S.; Kabalka, G.W. "Stereoselective Synthesis of Highly Functionalized Trisubstituted Olefins via the Aldol Reaction of Allenoxyborinates with Carbonyl Compounds," *J. Org. Chem.* **1999**, 64, 5822.
25. Li, G.; Kabalka, G.W. "Application of 1,2:5,6-di-O-Cyclohexylidene-D-mannitol As the Chiral Director in Matteson's Asymmetric Homologation," *J. Organomet. Chem.* **1999**, 581, 66.
26. Kabalka, G.W.; Li, N.-S.; Tejedor, D.; Malladi, R.R.; Trotman, S. "Synthesis of (E)-1-aryl-1-alkenes Via A Novel BF₃•OEt₂ Catalyzed Aldol-Grob Reaction Sequence," *J. Org. Chem.*, **1999**, 64, 3157.
27. Kabalka, G.W.; Li, N.-S.; Tejedor, D.; Malladi, R.R.; Gao, X; Trotman, S. "The Synthesis of Carboxylic Acid via An Aldol-Grob Reaction Sequence," *Synth. Commun.*, **1999**, 29, 2783.
28. Kabalka, G. W.; Yu, S.; Li, N.-S.; Lipprandt, U. "The Reaction of α , ω -Acetylenic Ketones with Dicyclohexylborane: Stereoselective Synthesis of Functionalized Trisubstituted Olefins," *Tetrahedron Lett.* **1999**, 40, 37.

(c) *Published Research Abstracts (Radiohalogenation/Halogenation)*

1. "Preparation of Radioiodinated Anabaseine Derivatives Via Borane Intermediates." G. W. Kabalka, N. Natarajan, M. Akula, J. Zhang. 8th Americans Conference, Death Valley, CA (Jan, 2002).
2. "Radioiodination of Vinyl and Arylboronates: Synthesis of Novel Radiopharmaceuticals" G. W. Kabalka, M. R. Akula, J. Zhang, 212th ACS National Meeting, Chicago, IL (August, 2001).
3. "3-(2,4-Dimethyl-5-[123I]Iodo) Benzylidene) Anabaseine: A Potent SPECT Agent for Imaging

- Lung Cancer." J. H. Zhang, M.R. Akula, G. W. Kabalka, 14th International Symposium on Radiopharmaceutical Chemistry, Interlaken, Switzerland (June, 2001).
4. "Use of Positron Emission Tomography for Determination of Cellular-Level Kinetics." L. F. Miller, T. L. Nichols, M. Khan, G. W. Kabalka, A. Rahim, G. T. Smith, A. I. Apostoaei, C. A. Large. 13th Symposium on Microdosimetry, Stresa, Italy (June, 2001).
 5. "Preparation of Radioiodinated (Z)-Vinyl Iodides Via Vinylboronates: Organoboron Chemistry Revisited." G. W. Kabalka, M. R. Akula, J. H. Zhang, 14th International Symposium on Radiopharmaceutical Chemistry, Interlaken, Switzerland (June, 2001).
 6. "[¹²³I]Iodocognex, a Potent SPECT Agent to Map Acetylcholinesterase via a Boronic and Acid Precursor." M. R. Akula, J. H. Zhang, G. W. Kabalka, 14th International Symposium on Radiopharmaceutical Chemistry, Interlaken, Switzerland (June, 2001).
 7. "Synthesis of 1-(3-[¹⁸F]Fluorobenzyl)-4-[2(N-phthalimid-1-yl)ethyl]piperidine." G. A. Pacer, M. R. Akula, C. P. D. Longford and G. W. Kabalka, 14th International Symposium on Radiopharmaceutical Chemistry, Interlaken, Switzerland (June, 2001).
 8. "The Development of PET Labelled Agents in Cancer Treatment Planning." G. W. Kabalka, Pacifichem 2000, Honolulu HI (December, 2000).
 9. "Use of Positron Emission Tomography for Determination of Tissue Specific Kinetics." L. F. Miller, G. Kabalka, M. Khan, A. Rahim, T. Nichols, M. Wyatt, J. Thie, G. Smith, and I. Apostoaei. The Ninth International Symposium on Neutron Capture Therapy for Cancer. Osaka, Japan (October, 2000).
 10. "Incorporation of Radiohalogens Via Organoborane, Organotin, and Related Reagents." G. W. Kabalka. Fourth International Symposium on Radiohalogens. Whistler, BC Canada, (September, 2000).
 11. "The Use of Positron Emission Tomography in the Design and *In Vivo* Detection of New Drugs" G. W. Kabalka. Gordon Conference on Drug Metabolism, Plymouth, New Hampshire (July, 2000).
 12. "Synthesis of Benzyl Bromides Via Reductive Bromination of Aryl Aldehydes by Isopinochampheylboron Dibromide." G. W. Kabalka, Z. Wu, Ju. Yuhong. BUSA VII Pittsburgh, PA, (June, 2000).
 13. "Synthesis of Dichlorarylmethanes and Arylalkanols via the Reactions of Chloroboranes with Aromatic Aldehydes." G. W. Kabalka, Ju Yuhong, and Z. Wu. BUSA VII Pittsburgh, PA, (June, 2000)
 14. "Synthesis of Carbon-11 and Fluorine-18 Labeled *para*-Boronophenylalanine and Their Use in PET-Based Treatment Planning for Boron Neutron Capture Therapy." G. W. Kabalka, T. L. Nichols, C.P.D. Longford, G. T. Smith. International Isotope Meeting, Dresden Germany (June, 2000).
 15. "Synthesis of 1-(3-[¹⁸F]Fluorobenzyl)-4-[2-*N*-Phthalimid-1-ylethyl]piperidine." G. W. Kabalka, M. Akula, G. Pacer, J. Zhang, C. P. D. Longford. International Isotope Meeting, Dresden Germany (June, 2000).
 16. "Synthesis of 1-(3-[¹⁸F]Fluorobenzyl)-4-[2-*N*-Phthalimid-1-ylethyl]piperidine" M. Akula, R.

- Singhaus, J. Zhang, G. W. Kabalka. International Isotope Meeting, Dresden Germany (June, 2000).
17. "Synthesis of Carbon-11 and Fluorine-18 Labeled *para*-Boronophenylalanine and Their Use in PET-based Treatment Planning for Boron Neutron Capture Therapy." G. W. Kabalka, T. L. Nichols, C.P.D. Longford, G. T. Smith. Third Annual Medical Center Research Day, Knoxville, TN (May, 2000).
 18. "Polymer-Based Radioiodinated Congo Red Agents" G. W. Kabalka, V. Namboodiri, M. Akula. Third Annual Medical Center Research Day, Knoxville, TN (May, 2000).
 19. "Radioiodinated Agents for Lung Cancer." G. W. Kabalka, M. Akula, J. Zheng. Third Annual Medical Center Research Day, Knoxville, TN (May, 2000).
 20. "The Synthesis of Dichloroarylmethanes and 1-Phenylalkanols Via the Reaction of Chloroboranes with Aldehydes." G. W. Kabalka and Z. Wu. 219th ACS National Meeting, ORGN 488, San Francisco, CA (March, 2000).
 21. "N-[2-[3-[¹⁸F]Fluorobenzyl)-4-piperidinyl]ethyl]phthalimide: A Potential PET Agent for Mapping Acetylcholinesterase." G. W. Kabalka, G. A. Pacer, M.R. Akula and J. Zhang. 219th ACS National Meeting, MED 100, San Francisco, CA (March, 2000).
 22. "Synthesis of 1-[¹²³I]iodobenzyl-4-[2-(*N*-phthalimid-1-yl)ethyl]piperidine" G. W. Kabalka, G. A. Pacer, M. R. Akula. ACS Southeastern Regional Meeting. Knoxville, TN (October 1999).
 23. "Synthesis of 1-[¹²³I]iodobenzyl-4-[2-(*N*-phthalimid-1-yl)ethyl]piperidine" Authors: G. A. Pacer, M. R. Akula and G. W. Kabalka, 13th International Symposium of Radiopharmaceutical Chemistry; St. Louis, MO (July 1999).
 24. "1-(3-[¹²³I]iodobenzyl)-4-[(5,6-dimethoxy-1-oxoindan-2-yl)methyl]piperidine: A Potent SPECT Agent to Map Acetylcholinesterase" Authors: M. R. Akula and G. W. Kabalka, 13th International Symposium of Radiopharmaceutical Chemistry; St. Louis, MO (July 1999).
 25. "Synthesis of 2-[¹⁸F]fluorobenzidine: A Precursor to Bisdiazodyes: Potential Radioligands to Image Amyloid Deposits in the Brain of Alzheimer's Patients" Authors: M. R. Akula, C.D. P. Longford and G.W. Kabalka, 13th International Symposium of Radiopharmaceutical Chemistry; St. Louis, MO (July 1999).
 26. "Synthesis of 9-Amino-7-[¹⁸F]fluoro-1,2,3,4-tetrahydroacridine: A Potential PET Agent for Evaluating Acetylcholinesterase" Authors: M. R. Akula, C. P. D. Longford and G. W. Kabalka, 13th International Symposium of Radiopharmaceutical Chemistry; St. Louis, MO (July 1999).
 27. "Synthesis of Fluorine-18 Labeled 1-amino-3-(4-dihydroxyborylphenyl) cyclobutanecarboxylic Acid: a Pet Agent for Use in BNCT Treatment Planning." R. R. Srivastava, C.P.D. Longford, and G. W. Kabalka, 13th International Symposium of Radiopharmaceutical Chemistry; St. Louis, MO (July 1999).
 28. "The First Use of ¹⁸F-*para*-Boronophenylalanine for Imaging Metastatic Malignant Melanoma Using Positron Emission Tomography" G. W. Kabalka, T.L. Nichols, G.T. Smith, K.F. Hubner, C.P.D. Longford, Second Tennessee Conference on Biomedical Engineering. Nashville, TN (June 1999).
 29. "1-(3-[¹²³I]iodobenzyl)-4-[5,6-Dimethoxy-1-oxoindan-2-yl)methyl]piperidine: A Potent

- SPECT Agent to Map Acetylcholinesterase.” Murthy Akula and George W. Kabalka. Joint Institute for Biological Sciences (JIBS) and Graduate Program for Genome Science and Technology Colloquium, Knoxville, TN (May, 1999).
30. “Synthesis of 9-Amino-7-[¹⁸F]fluoro-1,2,3,4-tetrahydroacridine: A Potential PET Agent for Evaluating Acetylcholinesterase.” Murthy Akula and George W. Kabalka. Joint Institute for Biological Sciences (JIBS) and Graduate Program for Genome Science and Technology Colloquium, Knoxville, TN (May, 1999).
 31. "Preparation of Ketones via the Palladium-catalyzed Cross Coupling of Acid Chlorides with Organoborane Reagents". G. W. Kabalka, M. R. Reddy, D. Tejedor and S. Kelley. National American Chemical Society Meeting in Dallas, TX (March, 1998).
 32. "Synthesis of 2-Acyl-1,4-diketones Via The Diacylation of α , β -unsaturated Ketones". N.-S. Li, S. Yu, George W. Kabalka. National American Chemical Society Meeting in Dallas, TX (March, 1998).
 33. “The Reactivity of Carbohydrate Boronates”. Zheng Han, George W. Kabalka, and Guisheng Li. Second Annual Research Day University of Tennessee Medical Center in Knoxville, TN (May, 1998).
 34. “Synthesis of 9-Amino-7-[¹⁸F]fluoro-1,2,3,4-tetrahydroacridine: A Potential PET Agent to Map Acetyl Cholinesterase in Alzheimer Patients”. Murthy Akula, Desmond P. Longford and George W. Kabalka. Second Annual Research Day University of Tennessee Medical Center in Knoxville, TN (May, 1998).
 35. “Molecular Diagnosis of Amyloidosis: Therapeutic and Diagnostic Implications”. R. Hercic, C. Murphy, J. Wall, D. Weiss, S. Macy, A. Solomon and G. W. Kabalka. Second Annual Research Day University of Tennessee Medical Center in Knoxville, TN (May, 1998).
 36. "Application of 1,2:5,6-di-o-cyclohexylidene-d-mannitol as the Chiral Director in Matteson's Asymmetric Homologation" George W. Kabalka and Guisheng Li. BUSA-VI: Boron USA Workshop in Athens, GA (May, 1998).
 37. "Alkylation of Carbonyl Compounds via the Reaction of Trialkylboranes with Arenesulfonyl Hydrazones". G.W. Kabalka, J.T. Maddox, E. Bogas, S.W. Kelley, U. Lipprandt. BUSA-VI: Boron USA Workshop in Athens, GA (May, 1998).
 38. "Bromination of Alkynes with Sodium Perborate and Sodium Bromide". G.W. Kabalka and K. Yang. BUSA-VI: Boron USA Workshop in Athens, GA (May, 1998).
 39. "The Reactivity of Carbohydrate Boronates". G. W. Kabalka, Z-X. Han and G. Li. BUSA-VI: Boron USA Workshop in Athens, GA (May, 1998).
 40. "Synthesis of 3-oxoalkylphosphonates Via The Conjugate Addition of Acylcuprates to Diethyl Vinylphosphonate". N.-S. Li, S. Yu, G. W. Kabalka. National American Chemical Society Meeting, Boston, MA (August, 1998).
 41. The Reaction of α , β -Acetylenic Ketones with Dicyclohexylborane. A Stereo-selective Synthesis Of Functionalized Trisubstituted Olefins". G. W. Kabalka, S. Yu and N.-S. Li. National American Chemical Society Meeting, Boston, MA (August, 1998).
 42. "Synthesis of α -alkylstyrenes via the Reaction of Ketones with Aromatic Aldehydes in the

- Presence of Boron Trifluoride". G. W. Kabalka, D. Tejedor, M. R. Reddy and S. Trotman. National American Chemical Society Meeting, Boston, MA (August, 1998).
43. "Structure of the BPA-Fructose Complex: A C-13 NMR Investigation". P. Bendel, C. Anderson, G.W. Kabalka. Eighth International Meeting on Neutron Capture Therapy, LaJoya, CA (September, 1998).
 44. "Magnetic Resonance Imaging of Tall Fescue", C. L. Anderson, J. P. Dyke, J. F. Green, K. D. Gwinn, G. W. Kabalka. 3rd International Symposium on Grass/*Acremonium* Interactions, Athens, GA (May, 1997)."
 45. Solid State NMR Spectra of Tall Fescue Seed", J. F. Green, K. D. Gwinn, C. L. Anderson, G. W. Kabalka. 3rd International Symposium on Grass/*Acremonium* Interactions, Athens, GA (May, 1997).
 46. "Synthesis of Carbon-11 Labeled 1-Amino-3-[2-(7-(2-hydroxyethyl)-1,7-dicarba-*nido*-dodecaboran(12)-1-yl)ethyl]cyclobutanecarboxylic Acid: A PET Agent for Use in BNCT Treatment Planning." R. R. Srivastava, G. W. Kabalka, C.P. D. Longford, The XIIth International Symposium on Radiopharmaceutical Chemistry" Uppsala Sweden (June, 1997).
 47. "Separation of [¹⁸F]Fluoride from [¹⁸O]Water and Single-vessel Synthesis of 2-[¹⁸F]fluoro-2-deoxy-D-glucose Using Kryptofix® 222." Z. Y. Zhang, S. S. Zigler, and G. W. Kabalka, The XIIth International Symposium on Radiopharmaceutical Chemistry" Uppsala Sweden (June, 1997).
 48. "Synthesis of 9-Amino-7[¹²³I]iodo-1,2,3,4-Tetrahydroacridine. A Radiotracer for Mapping Acetylcholinesterase". M. R. Akula and G. W. Kabalka, The XIIth International Symposium on Radiopharmaceutical Chemistry" Uppsala Sweden (June, 1997).
 49. "Asymmetric Synthesis of Alkylarylcarbinols From Pinanediol Alkylboronic Ester and Arylmethyl Chlorides" G. W. Kabalka, N.-S. Li and S. Yu. 214th National American Chemical Society Meeting in Las Vegas, NV (September, 1997).
 50. "Selective Hydroboration of Alkenes in the Presence of Aldehydes and Ketones." G. W. Kabalka, S. Yu, and N.-S. Li, 214th National American Chemical Society Meeting in Las Vegas, NV (September, 1997).
 51. "Synthesis of 7-[¹²³i]iodotacrine" M. Akula and G. Kabalka, Sixth International Symposium on The Synthesis and Applications of Isotopes and Isotopically Labeled Compounds (September, 1997).
 52. "Regiospecific Synthesis of Iodine-123 Labeled Congo Red". G. W. Kabalka, M. R. Akula, and Z. Y. Zhang, Sixth International Symposium on The Synthesis and Applications of Isotopes and Isotopically Labeled Compounds (September, 1997).
 53. "Synthesis of Iodine-123 Labeled Casodex". G. W. Kabalka, M. Akula, Z. Zhang, J. Dalton, L. Kirkovsky and D. D. Miller. Sixth International Symposium on The Synthesis and Applications of Isotopes an Isotopically Labeled Compounds (September, 1997).
 54. "Alkyl Esters of 3-(3'-Nitrophenyl)carbamoyl Ecgonine: The Effect of Increasing Steric Bulk at C-2 and Lipophilicity Upon Biological Activity", J. T. Gotsick, G. W. Kabalka, M. M. Goodman, and D. Xing, 211th National Meeting, American Chemical Society, New Orleans, LA

(March, 1996).

55. "The Mechanism of the Alkylation of Aldehyde Arenesulfonyl-Hydrazones with Trialkylboranes", G. W. Kabalka, E. Bogas, and J. T. Maddox, 211 National Meeting, American Chemical Society, New Orleans, LA (March, 1996).
56. "The *s-cis* and *s-trans* π Complexes of B-bromocatecholborane and (*E*)-2-butenal", M. B. McGinnis, C. L. Anderson, K. Vagle, R. M. Pagni, and G. W. Kabalka, 211th National Meeting, American Chemical Society, New Orleans, LA (March, 1996).
57. "Synthesis of Carboranyl Alkynyl Uridine and 2-Deoxyuridine Derivatives", N. K. Reddy, C. Narayana, and G. W. Kabalka, Boron-USA Meeting, Guanajuato, Mexico (May, 1996).
58. "Boronated Aluminas as Catalysts for Ketal Formation", C. L. Elam, N. K. Reddy, R. M. Pagni, and G. W. Kabalka, Boron-USA Meeting, Guanajuato, Mexico (May, 1996).
59. "Coupling of Alkyl or Aryl Groups via Trialkylboranes and Arylsulfonylhydrazones", G. W. Kabalka, E. Bogas, and J. T. Maddox, Boron-USA Meeting, Guanajuato, Mexico (May, 1996).
60. "Regiospecific Synthesis of Iodine-123 Labeled Congo Red. A Potential SPECT Agent for Evaluating Alzheimer's Disease". M. R. Akula, Z. Y. Zhang, C. P. D. Langford, and G. W. Kabalka. The Society of Nuclear Medicine 43rd Annual Meeting, Denver, CO (June, 1996).
61. "Kinetics of 4-Borono-2-[F-18]fluoro-L-phenylalanine-fructose [F-18]-BPA-F) in Glioblastoma Multiforme (GBM). K. F. Hübner, G. W. Kabalka, G. T. Smith, W. S. Reid, N. K. Reddy, C.P.D. Longford, T. G. Roberts, E. Buonocore. The Society of Nuclear Medicine 43rd Annual Meeting, Denver, CO (June, 1996).
62. "Mechanistic Studies of the Alkylation of Arenesulfonyl-Hydrazones with Trialkyl- Boranes". G. W. Kabalka, E. Bogas, J. Maddox, The International Meeting on Boron Chemistry, Heidelberg, Germany (July, 1996).
63. "Diastereoselective Reduction of α -Hydroxyketones with Amineboranes in the Presence of Lithium Perchlorate". C. Narayana, M. Hair, G. W. Kabalka. The International Meeting on Boron Chemistry, Heidelberg, Germany (July, 1996).
64. "Alkylarylcarbinols from Benzyl Chloride and Alkylboronic Esters in the Presence of Lithium Dicyclohexylamide". G. W. Kabalka, N.-S. Li, S. Yu. The International Meeting on Boron Chemistry, Heidelberg, Germany (July, 1996).
65. "Selectivity of Diels-Alder Reactions Catalyzed by Highly Acidic Boronated Aluminas". M. B. McGinnis, J. F. Green, K. Vagle, L. C. Tan, R. Palmer, J. Siler, R. M. Pagni, G. W. Kabalka. The International Meeting on Boron Chemistry, Heidelberg, Germany (July, 1996).
66. "The Synthesis of Alkylarylcarbinols via the Reaction of Organoboranes with Benzyl Chloride". G. W. Kabalka, N.-S. Li, S. Yu. The 212th National Meeting, American Chemical Society, Orlando, FL (August, 1996).
67. "Diastereoselective Reduction of α -Hydroxyketones with Amineboranes in the Presence of Lithium Perchlorate". G. W. Kabalka, C. Narayana, M. Hair. The 212 National Meeting, American Chemical Society, Orlando, FL (August, 1996).
68. "Synthesis of Fluoride-18 Labeled Carboranes for Potential Use in Imaging BNCT Agents". S. K.

Lee, G. W. Kabalka. Seventh International Symposium on Neutron Capture Therapy, Zurich, Switzerland, (September, 1996).

69. "Use of a Commercially Available Anion Exchange Cartridge for Recovery of [^{18}F]Fluoride Ion", Z. Y. Zhang, D. Patton, S. Zigler, G. W. Kabalka. RDS Users Meeting, Knoxville, TN (October, 1996).

(d) *Published Abstracts (Solid Surfaces and Boronic Acids)*

1. "Preparation of Radioiodinated Anabaseine Derivatives Via Borane Intermediates." G. W. Kabalka, N. Natarajan, M. Akula, J. Zhang. 8th Americans Conference, Death Valley, CA (Jan, 2002).
2. "Dynamic Reactions on Solid Surfaces" G. W. Kabalka, L. Wang, R. M. Pagni, ACS Southeast Regional Meeting, Savannah, GA (September, 2001).
3. "Synthesis of Stilbenes Via Homocoupling of Aryl Aldehyde Tosylhydrazones" G. W. Kabalka, Y. Ju, Z. Wu. 212th ACS National Meeting, Chicago, IL (August, 2001).
4. "Boron Trihalide-Promoted Addition of Aryl Aldehydes to Styrenes: A New Convenient and Highly Efficient Synthesis of 1,3-Dihalo-1,3-diarylpropanes." G. W. Kabalka, Z. Wu, and Y. Ju. 212th ACS National Meeting, Chicago, IL (August, 2001).
5. "Comparison of the Behavior of Ionic Liquids with Supported Reagents." R. M. Pagni, and G. W. Kabalka, 211st ACS National Meeting, San Diego, CA (April, 2001).
6. "Suzuki Coupling Using Pd(0) and KF/A₂O₃." G. W. Kabalka, R. M. Pagni and C. M. Hair. 4th International Symposium on Supported Reagents and Catalysis in Chemistry. University of St. Andrews Scotland (July, 2000).
7. Microwave Assisted, Solventless Suzuki Coupling Reaction on Palladium-Doped Alumina." G. W. Kabalka, R. M. Pagni, L. Wang, V. Namboodiri, T. Kase. BUSA VII Pittsburgh, PA, (June, 2000).
8. "Microwave Assisted Solventless Suzuki—Coupling Reactions on Palladium Doped KF/Al₂O₃." G. W. Kabalka, R. M. Pagni, M. Hair, J. Norris, V. Namboodiri and L. Wang. 219th ACS National Meeting, ORGN 588, San Francisco, CA (March, 2000).
9. "Organoboron Chemistry on Alumina: The Suzuki Reaction" G. W. Kabalka, C. M. Hair, J. L. Norris, R. M. Pagni. ACS Southeastern Regional Meeting. Knoxville, TN (October 1999).
10. "The Reaction of α -ketoacids with Allylboronates" G. W. Kabalka, K. Yang, Z. Wang. ACS Southeastern Regional Meeting. Knoxville, TN (October 1999).
11. "Synthesis of 4-dihydroxyborylphenyl analogues of 1-aminocyclobutanecarboxyl acid: Potential BNCT agents" G. W. Kabalka, R. R. Srivastava, R. R. Singhaus. ACS Southeastern Regional Meeting. Knoxville, TN (October 1999).
12. "Boron Trifluoride Mediated Synthesis of 3-Methyl-1,1-Dihydronaphthalenes" G.W. Kabalka, R.R. Malladi, N.-S. Li, D. Tejedor. ACS National Meeting. New Orleans, LA (August 1999).
13. "Solventless Suzuki Coupling Reactions on Alumina" G.W. Kabalka, C. M. Hair, J.L. Norris,

- R. M. Pagni. ACS National Meeting. New Orleans, LA (August 1999).
14. "The Use of Boron Trifluoride in Synthesis: Preparation of 3-methyl-1,2-dihydronaphthalenes" R. R. Malladi, N.-S. Li, D. Tejedor, and G. W. Kabalka. The Xth International Conference on the Chemistry of Boron. Durham, UK (July, 1999).
 15. "The Reaction of α -ketoacids Allylboronates" G. W. Kabalka, K. Yang, and Z. Wang. The Xth International Conference on the Chemistry of Boron. Durham, UK (July, 1999).
 16. "Solventless Suzuki-coupling Reactions on Palladium Doped $\text{KF/Al}_2\text{O}_3$ " M. Hair, R. M. Pagni, G. W. Kabalka. The Xth International Conference on the Chemistry of Boron. Durham, UK (July, 1999).
 17. "Alkylation of Carbonyl Compounds via the Reaction of Boranes with Arenesulfonyl Hydrazones." G. W. Kabalka*, S. W. Kelley, J.T. Maddox, Ekaterini Bogas, U. Lipprandt. National American Chemical Society Meeting, Anaheim, CA (March, 1999).
 18. "A Tandem Aldol-grob Reaction of Ketones with Aromatic Aldehydes." G. W. Kabalka*, D. Tejedor, N.-S. Li, R. R. Malladi, S. Trotman. National American Chemical Society Meeting, Anaheim, CA (March, 1999).

(e) *Invited Lectures*

1. "Boron Halides in Synthesis", International Meeting on Boron Chemistry, Moscow, Russia (July, 2002).
2. "The Use of Boron Halides in Synthesis." Purdue University, West Layette, IN (March, 2002).
3. "The Development of New Lung Imaging Agents." Northeastern University, Boston, MA (February, 2002).
4. "The Use of Positron Tomography for Treatment Planning in BNCT." Atomic Energy Commission, Buenos Aries, Argentina (November, 2001).
5. "The Development of Boronated Amino acids for Potential Use in BNCT." Atomic Energy Commission, Buenos Aries, Argentina (November, 2001).
6. The Use of Metal Salts and Oxides in Organic Synthesis." Purdue University, West Lafayette, IN (November, 2001).
7. "The Development of Pharmaceuticals for Use in the Detection of Cancer." University of North Carolina, Asheville, NC (October, 2001).
8. "Microwave Enhanced Solventless Carbon-Carbon Bond Forming Reactions on Alumina." ACS SE Regional Meeting, Savannah, GA (September 2001).
9. "Use of PET for Developing Cancer Treatment Plans." Uppsala University, Uppsala Sweden (September, 2001).
10. "Design of Radiolabeled Agents for PET." University of Helsinki, Helsinki Finland, (September, 2001).

11. "Reactions on Solid Surfaces." Crompton Corp. Pittsburgh, PA (March, 2001).
12. "The Use of PET in Drug Design." Galaxo-Smith Kline Pharmaceuticals, Philadelphia, PA (February, 2001).
13. "New Synthetic Methods." Georgia College and State University, Macon, GA (February, 2001).
14. "Development of PET Labeled Agents for Cancer Treatment." PacifiChem, Honolulu, HI (December, 2000).
15. "The Development of PET Labelled Agents in Cancer Treatment Planning." Pacificchem 2000, Honolulu, HI (December, 2000).
16. "Green Chemistry." The 52nd Southeast and 56th Southwest American Chemical Society Regional Meeting, New Orleans, LA (December, 2000).
17. "The Use of Boron and Tin in Nuclear Medicine." DOE Symposium, Williamsburg, VA (October, 2000)
18. "Incorporation of Radiohalogens Via Organoborane, Organotin, and Related Reagents." Fourth International Symposium on Radiohalogens. Whistler, BC Canada, (September, 2000).
19. "Positron Emission Tomography as a Tool for the Development and Evaluation of New Drugs." Gordon Conference on Drug Metabolism, Plymouth, New Hampshire (July, 2000).
20. "The Use of Positron Tomography in the Development of New Chemotherapeutic Agents", The Seventh International Isotope Meeting, Dresden, Germany (June, 2000)
21. "Design and Synthesis of Diagnostic Pharmaceuticals." East Tennessee State University, Murfreesboro, TN (December 1999).
22. "Solventless Suzuki Coupling Reactions on Alumina." ACS National Meeting. New Orleans, LA (August 1999).
23. "Synthesis of Radiolabeled Agents", University of North Carolina at Pembroke, Pembroke, NC (January, 1998).
24. "Positron Emission Tomography", Pfeiffer College, Misenheimer, NC (January, 1998).
25. "New Synthetic Methods" North Carolina A & T, Greensboro, NC (January, 1998).
26. "Synthesis of Radiolabeled Pharmaceuticals", East Carolina University, Greenville, NC (February, 1998).
27. "Advances in MRI and PET", Occupational Health Nursing Association, Knoxville, TN, (March, 1998).
28. "*In Vivo*" Detection of Neutron Capture Agents Using Tomography". 1998 American Nuclear Society Annual Meeting, Nashville, TN (June, 1998).
29. "Application of MRI and PET to Solving Biological Problems", Biochemistry Department, University of Tennessee, Knoxville, TN (February, 1997).

30. "Development of New MRI Imaging Agents for Use in Nuclear Medicine", Department of Chemistry, Towson State University, Baltimore, MD (February, 1997).
31. "Organoboranes in Medicine", Purdue University, West Lafayette, IN (May, 1997)
32. "The Development of New Tumor Imaging Agents for Use in Neutron Therapy", 1997 U.T. Research Symposium, Knoxville, TN (October, 1997).
33. "New Approaches to Cancer Treatment", Knoxville Science Club, Knoxville, TN (October, 1997).
34. "Alzheimer Disease: A Biochemical Approach" Cole Neuroscience Meeting Knoxville, TN (November, 1997).
35. "The Role of Chemistry in Medicine." Mexico City, Mexico (April 1999)
36. "Synthesis of Agents for Use in Nuclear Medicine", University of Louisville, Louisville, KY (February, 1996).
37. "Modern Medical Imaging", Junior Science Symposium, Knoxville, TN (March, 1996).
38. "The Design and Synthesis of New Medical Imaging Agents", West Virginia University, Morgantown, WV (April, 1996).
39. "Reaction of Organoboranes with Carbonyl Compounds", International Meeting on Boron Chemistry, Heidelberg Germany (July, 1996).
40. "New Organoborane Reactions", Louisiana State University, Shreveport, LA (October, 1996).
41. "Boranes in Nuclear Medicine", University of California, Santa Cruz, CA (November, 1996).

3. Graduate And Postdoctoral Students

Thirteen postdoctoral students, fourteen graduate students and twenty five undergraduate students received research support during this period by the Department of Energy Nuclear Medicine Program.

(a) Postdoctoral Students

Dr. Weiling Bao
Dr. Bhaskar Das
Dr. Sasmita Das
Dr. Rama Malladi
Dr. Nan-Sheng Li
Dr. Suk Lee
Dr. Akula Murthy

Dr. Vasu Namboodiri
Dr. Huiping Shi
Dr. Lei Wang
Dr. Zhongzhi Wu
Dr. Jianhua Zhang
Dr. Zhang Han

(b) Graduate Students

Gang Dong (Ph.D. candidate)
Bogus, Ekatrina (Ph.D., 1997)
Chandra Elam (M.S. 1998)
Timothy Gotsick (Ph.D. 1997)
Max Hair (Ph.D. 1999)
Yuhong Ju (Ph.D. 2001)
Shane Kelley (Ph.D. 2000)
Nisha Natarajan (Ph.D. 2002)
George Pacer (M.S. 1999)
Robert Singhaus (M.S. 1999)
David Tejegor (Ph.D. 1998)
Gao Xiao (Ph.D. candidate)
Kathy Yang (Ph.D. 2000)
Su Yu (Ph.D. 1999)

(c) *Undergraduate Students*

Sarah Trotman (1996)
Claire Arnauld (1997)
Martin Chandler (1997)
Sabrina Hutchens (1997)
Mark Jenkins (1997)
Erin Kish (1998)
Stephanie Hicks (1998)
Ute Lipprandt (1998)
Jeremy Norris (1998)
Smita Patil (1998)
Surya Singh (1998)
Keven West (1998)
Catherine Chidester (1999)
Jordan Haney (1999)
Sarah Trotman (1999)
Nicie Conley (2000)
Brad Collins (2000)
Jason Susong (2000)
Michael Finger (2001)
MacShelle Steward (2001)
John Holbrook (2001)
David Spence (2001)
Ha Tran (2001)
Annette Stephens (2002)
Kate Wilson (2002)